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Municipal Water Rates in Canada: Current Practices and Prices, 1991

D.M. Tate and D.M. Lacelle

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Water and Habitat Conservation Branch
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prices varied geographically, reaching highs in the Prairies and the territories and lows on both coasts and in Quebec. Water availability, climate, and tradition may account for these geographic variations.

- Water infrastructure financing has recently been an issue of some importance for public policy. While water rate revenues comprise the major source of funds, total costs are almost certainly greater than the estimated $3.3 billion raised. Any remaining deficit has to be picked up though transfers from other levels of government. In the future, several major capital needs will arise if water systems are to remain effective components of national infrastructure, including renovation and expansion of existing systems, improved wastewater treatment to the secondary level, and complete water metering. Estimated net additional capital plus associated O&M costs lie in the $4.5 billion range annually between 1993 and 2003 and fall to $1.8 billion thereafter.

- Modest revisions to water pricing practices, including an overall doubling of average prices, an across-the-board 60% sewer charge and full metering would raise an estimated additional revenue between $4.3 billion and $4.5 billion annually. These additional revenues would be sufficient to meet the estimated required costs. The need for additional general cross-subsidies from other levels of government are not required in our opinion in most areas. However, the analysis reported here is a macro-level one, and individual circumstances may vary. A few municipalities may require additional help, but this requirement should not cloud the overall "message," indeed public policy, of moving as quickly as possible to full cost recovery.

- In terms of sustainability, current municipal water pricing practices give cause for concern. A brief consideration of financial, economic and physical viability, as well as environmental and public health, leads to the conclusion that municipal water systems are unsustainable under current pricing practices.

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1.0 INTRODUCTION

1.1 Background

Considerable debate has occurred over the last 15 years regarding the levels of funding necessary to provide Canadians with a safe, environmentally sustainable municipal water and wastewater infrastructure. There is evidence that existing levels of funding may be inadequate for infrastructure maintenance, replacement, and expansion to meet future needs. For example, in 1985, the Federation of Canadian Municipalities (FCM, 1985) conducted a survey of municipal infrastructure needs[1], which showed a considerable funding shortfall of at least $6 billion, modified 2 years later to $7.5 billion. Although the FCM study is somewhat out of date, there is no proof that the situation has improved. In fact, one piece of evidence to the contrary is the current tripartite infrastructure funding program, shared by the federal, provincial, and municipal levels of government, 35% of which has been devoted to water infrastructure projects. In addition to the shortfall in maintenance and expansionary funding for municipal water infrastructure, a concern also exists that available funding mechanisms may be insufficient to upgrade existing systems to meet new, more stringent environmental standards (Beaulieu et al., 1993).

Current funding mechanisms involve significant "user-pay" revenues, through water rates, as well as often substantial subsidies to local water systems from senior levels of government, and cross subsidies among user groups. The extent to which user-pay financing should be relied upon is an important question for public water management.

At the heart of the user-pay debate for municipal water and wastewater services lies the issue of municipal water rates[2]. The design and levels of the rates have a direct impact on the use of water, the costs of system design and maintenance, and the amount of revenue raised. Canadian water and sewer rates vary widely, primarily because each municipality is free to establish its own set of practices and criteria. In some cases, municipalities may be subject to general pricing guidelines imposed by other municipalities that provide water (or sewage treatment), by regional water management agencies, or by their respective provincial governments. Many municipalities follow the guidelines set out in the Water Rate Manual published by the American Water Works Association (AWWA, 1983) and some are beginning to use a new rate manual published by the Canadian Water and Wastewater Association (CWWA, 1993). The absence of standard practice has resulted in a wide variety of rate structures, many of which have been inherited from the quite distant past.

1.2 Purpose and Scope of the Paper

This paper provides data and analysis on rate structures and levels in use in 1991 and is the fifth such paper prepared since 1983[3]. The paper presents data on the structure of water rates and the resultant retail prices for water servicing across the country. These data provide municipal officials, rate makers, and other policy makers with much of the data needed to assess the effectiveness of current pricing arrangements and the burden that water bills impose on the average water user. For example, the data and analysis contained in this paper permit the examination of user-pay policies. Indirectly, they can also provide important information as to the degree to which cross-subsidy arrangements exist among user groups, and also allow observations as to the economic efficiency and equity of current water pricing arrangements. All of these considerations played a part in the collection and analysis of the data contained in this paper.

The paper comprises a basic analysis of the types of water rate schedules used by Canadian municipalities in 1991 and links these to the levels of municipal water use in these municipalities. Current prices are presented for typical consumers,

[1] The FCM survey covered all aspects of municipal infrastructure, not just water supply and wasterwater treatment. Where the phrases "water system" and "water servicing" are used, they refer to both water supply and treatment.

[2] The term "water rate" is used throughout this paper to refer to the schedules by which municipalities charge for water supply and waste water services. All prices resulting from the use of rates, accordingly, include both types of service, unless otherwise specified.

[3] For previous reports, see Tate, Reynolds and Dossett (1983), Fortin and Tate (1985), Tate (1988) and Tate and Lacelle (1992).

in terms of unit, marginal, and total prices[4] paid for water services. The report also analyzes current water pricing practices within the context of estimated revenue requirements to provide self-financed water and wastewater systems in the future.

The remainder of Section 1 outlines the methodology used and the principal limitations of the analysis. Section 2 describes the major characteristics of the water pricing rate schedules and includes several price calculations. This section emphasizes the types of rate schedules in use, monthly total price for typical consumers, and price per cubic metre for residential and commercial water users. The data are presented on a provincial and population size basis. These compilations permit basic observations as to the spatial variability of prices across Canada. They also allow comparisons among various community sizes to determine whether economies of scale actually occur in the provision of water service, as is often claimed. Section 3 estimates future requirements for capital plus operating and maintenance (O&M) to assure adequate levels of water servicing. These are then placed into the context of revenue simulation, based on water prices set to assure full cost recovery and economic efficiency. The last section contains the principal conclusions of the report and their implications for public policy.

1.3 Methodology

The methodology used here employed a survey of 1991 water rates, mailed to all Canadian municipalities containing at least 1000 persons. The survey questionnaire requested copies of 1991 water and sewage rate schedules, as well as related information on water use. Water utility rate schedules are readily available in municipalities, thereby minimizing response burdens; water usage information was collected to fulfil the requirements of a concurrent project. Questionnaire distribution differed from previous surveys in two ways. Firstly, the survey period was shortened to only two years after the previous (1989) survey in order to correspond with information collected in the 1991 National Census. The earlier resurvey period used was three years. Secondly, the survey was sent to all municipalities with populations over 1000 persons. Previous surveys covered only samples of those municipalities with populations between 1000 and 5000. It was felt that a "universal" survey would produce more accurate results than the sample survey.

Analysis focused on two main tasks: to establish some common descriptive benchmarks to compare the rates across municipalities and to calculate retail prices to consumers so as to draw inter- municipal and inter-provincial comparisons. This part of the analysis used simple averaging, medians and percentiles to summarize the findings, and reports population-weighted averages for the respective provincial and population size groupings. Population-weighted averages represent water servicing charges to average residential users in a slightly better way than simple averages. The difference in methods produced small changes in results, but these are insignificant, and do not affect inter-year comparisons.

The pricing portions of the analysis convert the diverse range of rate types into prices that are comparable across municipalities. All prices presented here are monthly ones (even if billed quarterly, bi-annually etc.), and the price calulations include all normal minimum charges (e.g., meter or service charges) by the respective municipalities. Most Canadian municipalities recover some or all of the costs for sewage collection and treatment through extra charges, or "surcharges" on water bills, primarily because return flows are not metered. Where such surcharges form part of the water rates, they are included in the price calculations contained here. Residential and commercial prices were considered separately throughout the report. Industrial water prices were not calculated because the wider range of variability in industrial water use made it unlikey that representative volumes could be selected.

Retail price analysis included three standard volumes of residential and commercial monthly water use. To facilitate inter-year comparisons, these correspond to the volumes used in the earlier analysis of municipal water prices in 1986 and 1989. For residential use, these volumes were 10, 25, and 35 m^3 per month; they represent a "lifeline"

[4] In this paper, unit prices refer to the prices of water per cubic metre (m^3) used in the respective rate schedules to determine the total monthly amount of a customer's water bill. Marginal price refers to the price for one further unit of water over a given volume unit. A further discussion of these pricing criteria is included in Section 2.2.

amount of usage, an average family usage and a high family usage respectively. For commercial use, volumes were 10, 35, and 100 m^3 per month. The latter volume represents intensive uses such as light manufacturing or larger stores and offices. Survey returns were compiled into a database describing the types of rates in use, the characteristics of the rates (e.g., number and size of blocks, unit prices within respective blocks), information on sewer surcharges, domestic metering, and total water prices for selected monthly volumes of use by both residential and commercial water users[5]. Finally, the rates were assessed in the context of revenue generation to assure sufficient funding for economically and environmentally sustainable municipal water systems.

1.4 Limitations of the Data and Analysis

This report has a number of analytical limitations:

- The survey did not collect data on system costs, such as capital or operating and maintenance costs. Thus, the extent to which these costs influence the setting of water rates has not been examined on a municipality-by-municipality basis. The rates and prices presented in this report are limited to the retail conditions faced by consumers. No conclusions can be drawn about the degree to which these prices reflect the full cost of providing water services in the surveyed municipalities. The issue of macro-level capital needs is addressed, however, in section 3. Further, in some municipalities, water rates may be regarded as a method of general revenue generation, and as such may also include cost elements not related to water servicing. For these reasons, the comparative analysis provided herein is insufficient by itself to describe fully the role of water pricing in financing water services in individual municipalities.

- Some municipalities fund a portion of their water-related expenditures from general revenue; this portion may vary from year to year. As implied in the foregoing paragraph, no data on this issue were collected in the study's survey.

- The analysis deals only with domestic and commercial water rates and prices. Industrial, irrigation, and wholesale rates (i.e. the rates paid by municipal utilities to other municipalities, or regional, or provincial water suppliers) are not included.

- The questionnaires were completed by water servicing and administrative personnel in the respective municipalities, and the accuracy of the data reflect the knowledge of these persons. In cases where discrepancies appeared, either within the 1991 responses themselves (e.g., contradictory data) or between years (e.g., an abnormal and unexplained change in prices), respondents were contacted to clarify their responses. (Some 500 telephone calls were made for this purpose.)

- In addition to these conceptual limitations, one arithmetical limitation pertains to the study. The rate and price calculations contained in the paper are mostly from non-weighted data[6]. Thus, a rate from a small town is treated the same as one from a major city. Biases introduced using this method could be offset by using weighted average calculations, but this was not done in order to maintain reasonable uniformity with previous reports, and also because the biases were found to be minor for the most part.

2.0 AN OVERVIEW OF 1991 MUNICIPAL WATER RATES AND PRICES

2.1 Survey Response Rates and Coverage

The response to this survey was 87%, relatively high for mailed surveys. Of the 1523

[5] For further information regarding this database, please contact Mr. D. Lacelle, Municipal Water Use Analyst, at (819) 953-1519.

[6] Except as noted earlier. See p. 3.

municipalities, 1173 supplied water rate schedules (Table 1), 112 reported that they did not have municipal water systems, and 41 had rate schedules that could not be analyzed systematically because of their unique water pricing practices. For example, many of the latter municipalities (mostly in Quebec) traditionally based their water charges on assessed property value or frontage. There were only 197 non-respondents. Approximately 20.4 million persons, or 87% of Canada's total urban population, resided in the municipalities included in this report. The remainder of the urban population resided in either the non-respondent municipalities or in municipalities with water rates based on property assessments.

Many municipalities contain areas that are rural in nature, due in part to differing provincial definitions of "municipality" or to the presence of large estate-type lots. Frequently, these areas are not serviced by the municipal water system. When this factor is allowed for, 18.9 million persons in the surveyed municipalities (Table 2), or 93% of the surveyed population, were served by municipal water supplies, and thereby subject to municipal water pricing. Table 2 also indicates that 89% and 79% respectively of the surveyed population are served by sewers and/or sewage treatment, and thus could be subject to some form of sewer charges.

The municipalities included in the analysis pumped an average of 11.7 million cubic metres (MCM) of water per day through distribution systems in 1991 (Table 3). This volume comprised 83% of the total pumpage by all Canadian municipalities. About 54% of the water supplied by respondent municipalities was used by residential customers. The ratio of residential total volume to total volume was lower in the urban centres, reflecting a wider variety of other users in larger urban areas, as opposed to any decline in the intensity of residential usage. No significant changes occured in total daily water usage over the period since the last survey, with total usage increasing by only 1% and residential total usage by 8%. Some of the provincial totals, particularly with respect to water usage with the various urban size groups, changed more substantially, due largely to reporting differences in a few major centres, as well as the addition of many small municipalities. In some cases, a municipality outgrew its 1989 size group, thereby increasing the totals in the next largest group.

2.2 Rate Schedule Types and Characteristics

2.2.1 Water rates and economic incentives

In a market-oriented economy such as Canada's, the prices of most goods and services are major determinants of usage. Even in the case of basic services such as water supply and wastewater treatment, this has been found to be true. Evidence of the inverse relationship between price and water demand has been well documented by many researchers, such as Grima (1972), Howe and Linaweaver (1967), and Hanke (1978). Even using total water usage data like the ones contained in this paper, Shaw (1984) found a statistically significant inverse relationship between water price and the quantity demanded. The analysis of the water pricing data contained in this paper employs an economic framework focusing on a determination of the incentives for rational usage inherent in this basic economic reationship.

A water utility's rate schedule governs the price that is ultimately charged to individual customers for water services. By so doing, it is an implicit determinant of the level of water usage. Throughout Canada, the wide variety of rate schedules in use can be categorized into two basic types – flat and volume-based[7]. The distinction between the two types is important in determining the degree of incentive or disincentive influencing the water (and sewage service) demands of customers. Kellow (1970), for example, found that water use in the unmetered, flat rate areas of Calgary was approximately double that in Edmonton, a fully metered municipality of similar size and geographic characteristics in which prices were based on volume of water usage.

In general, flat rates are associated with higher water use than volume-based rates because customers pay a fixed price per billing period for an unlimited water supply and wastewater services, and accordingly have no incentive to monitor or control their use (Kindler and Russell, 1984, p.

[7] These terms are defined in sections 2.2.2 and 2.2.3 of the paper.

Table 1

Number of Municipalities by Province, Population (in brackets), and Population Size Group, 1991

Province	Population Size Group (000 persons)											
	1-5		5-10		10-50		50-100		100+		Total	
Newfoundland	63	(134)	6	(39)	6	(101)	0	(0)	1	(100)	76	(374)
P.E.I.	8	(15)	2	(14)	1	(15)	0	(0)	0	(0)	11	(44)
Nova Scotia	21	(54)	7	(52)	13	(265)	1	(68)	1	(120)	43	(559)
New Brunswick	31	(61)	8	(49)	6	(108)	2	(132)	0	(0)	47	(350)
Quebec	192	(507)	65	(441)	87	(1 734)	13	(896)	1	(305)	358	(3 883)
Ontario	113	(280)	63	(434)	79	(1 673)	16	(1 142)	22	(5 319)	293	(8 848)
Manitoba	23	(45)	7	(53)	3	(62)	0	(0)	1	(610)	34	(770)
Saskatchewan	52	(97)	5	(29)	6	(119)	0	(0)	2	(359)	65	(604)
Alberta	64	(138)	32	(195)	15	(280)	3	(177)	2	(1 326)	116	(2 116)
British Columbia	50	(135)	19	(136)	37	(670)	13	(889)	4	(976)	123	(2 806)
Territories	5	(14)	0	(0)	2	(35)	0	(0)	0	(0)	7	(49)
Canada Total	622	(1 480)	214	(1 442)	255	(5 062)	48	(3 304)	34	(9 115)	1 173	(20 403)

Table 2

Levels of Water Servicing, by Water System Component and Province, 1991

Province	Total Surveyed Population (000)	Water Supply		Sewage Collection		Sewage Treatment	
		Pop. Served (000)	% of Total	Pop. Served (000)	% of Total	Pop. Served (000)	% of Total
Newfoundland	374	350	94	324	87	50	13
P.E.I.	44	37	84	44	100	44	100
Nova Scotia	559	437	78	404	72	114	20
New Brunswick	350	325	93	316	90	289	83
Quebec	3 883	3 617	93	3 311	85	1 857	48
Ontario	8 848	8 154	92	7 966	90	7 964	90
Manitoba	770	755	98	755	98	757	98
Saskatchewan	604	603	100	602	100	602	100
Alberta	2 116	2 029	96	2 006	95	2 005	95
British Columbia	2 806	2 554	91	2 425	86	2 356	84
Territories	49	45	92	45	92	43	88
Canada Total	20 403	18 906	93	18 198	89	16 081	79

156). Volume-based charges offer varying incentives for limiting water use, depending upon their particular structural characteristics. They provide signals to consumers about the amount of water they are demanding. The linkage between resource usage on the one hand, and economic and environmental impacts on the other, becomes visible at the individual consumer level.

2.2.2 Flat rates

Flat rates comprise the simplest type of rate schedule from both a customer and an administrative viewpoint. Flat rates are fixed payments imposed in each billing period, unrelated to the volume of water used. In return for this payment, customers obtain unlimited access to water servicing. Municipalities determine flat rate charges in a variety of ways, taking into account the cost of providing service and, in some cases, expected consumption. Charges may vary among

Table 3

Daily Water Pumpage (10^6m^3 per day) in Canadian Municipalities[1], by Province and Population Size Group, 1991

Province	Population Size Group (000 persons)											
	1-5		5-10		10-50		50-100		100+		Total	
Newfoundland	71	(53)	30	(20)	82	(46)	0	(0)	77	(39)	260	(158)
P.E.I.	5	(4)	3	(2)	11	(3)	0	(0)	0	(0)	19	(9)
Nova Scotia	33	(17)	35	(16)	89	(55)	41	(19)	79	(32)	277	(139)
New Brunswick	41	(25)	41	(27)	52	(35)	236	(76)	0	(0)	370	(163)
Quebec	327	(206)	270	(179)	1 157	(718)	622	(389)	237	(142)	2 613	(1 634)
Ontario	148	(100)	165	(103)	734	(405)	606	(309)	2 932	(1 204)	4 485	(2 121)
Manitoba	27	(18)	17	(10)	34	(19)	0	(0)	300	(126)	378	(173)
Saskatchewan	41	(29)	13	(7)	68	(36)	0	(0)	219	(88)	341	(160)
Alberta	71	(53)	108	(62)	123	(79)	94	(41)	709	(298)	1 105	(533)
British Columbia	128	(96)	135	(93)	407	(284)	499	(351)	682	(370)	1 851	(1 194)
Territories	7	(4)	0	(0)	25	(20)	0	(0)	0	(0)	32	(24)
Survey Total	899	(605)	817	(519)	2 782	(1 700)	2 098	(1 185)	5 135	(2 299)	11 731	(6 308)
Canada Total[1]	1 048		886		3 050		2 282		6 711		13 977	

1 Numbers in brackets refer to residential usage; unbracketed numbers refer to total usage.

2 The "Canada total" is based on the contents of CWS' Municipal Water Use database (MUD), which contains all Canadian municipalities over 1000 persons. The comparison between the survey results and the contents of the MUD database provides an approximate indicator of the comprehensiveness of the survey.

user classes (e.g., residential and commercial, or among different types of commercial establishments) within the same municipality. There are also a number of indirect methods of water charging, which are equivalent to a flat rate system. For example, additions to the property tax bill, frontage charges, or special assessments for water servicing are unrelated to water usage. As noted earlier, these indirect methods were not analyzed because they required the use of data available only locally.

The principal disadvantage of flat rate pricing is that it results in higher water use than volume-based pricing, because the price of an additional volume of water (i.e., the marginal cost of water[8]) is zero. Customers may take as much water as they choose at no additional cost; this leads to wasteful water use practices such as lawn watering during rain storms, failure to replace dripping faucets, or using treated, potable water to clean a driveway. In other words, customers have neither the incentive nor the information required for awareness of the desirability of conserving water. Also, the municipality has minimal control over water demands, except through administrative measures such as lawn watering restrictions.

2.2.3 *Volume-based rates*

Water Meters: Volume-based pricing requires meters for measuring the water usage for an individual customer. Almost 10 million Canadians (Table 4) draw from municipal water supplies that are unmetered. At an average household size of three persons, Canada requires the installation of an estimated 3.3 million water meters to achieve complete volume-based water pricing. Some municipalities estimate water bills by metering a sample (usually less than 10%) of their consumers and using that sample to estimate water prices. Unmetered customers have no incentive to conserve water.

Volume-based Rates: Volume-based rates relate the amount paid for water servicing to the amount of water demanded by customers. Several different methods can be used for establishing this linkage, the simplest being a constant charge per unit (e.g., cubic metre) of water used. This type of pricing schedule is referred to here as a "constant unit charge" (CUC). CUCs may have a fixed charge

8 The price of an additional unit of water above current use is referred to as the marginal cost of that unit. In theory, the price of each unit of water supplied should be set at the marginal cost of supplying it (see Hirschleifer et al., 1960, chapter 5). See section 2.2.7 for further discussion.

Table 4

Population Served (000s) with Water and Without Meters, by Province and Population Size Group, 1991

	Degree of Metering				
Province	0	0.1 - 10%	10.1 - 90%	90.1 - 99.9%	Total
Newfoundland	346	23	0	0	368
P.E.I.	38	0	0	0	38
Nova Scotia	41	44	3	1	89
New Brunswick	153	87	2	1	244
Quebec	4 370	266	65	2	4 703
Ontario	634	244	862	21	1 761
Manitoba	26	10	2	0	38
Saskatchewan	7	0	0	1	9
Alberta	49	18	572	2	641
British Columbia	1 353	631	39	2	2 025
Territories	17	3	3	0	23
Population Size Group (000s)					
0 - 5	1 015	55	35	2	1 107
5 - 10	665	94	44	2	805
10 - 50	2 117	354	170	6	2 648
50 - 100	1 277	245	0	8	1 530
100 +	1 962	578	1 298	11	3 849
Canada Total	7 036	1 326	1 547	29	9 939

component that is unrelated to the actual volumes of water used. This type of rate is referred to as a "two-part tariff."

Other types of volume-based schedules vary their charges with the level of water use, or among user groups, and may also be combined with certain fixed charges. These are referred to as "block rate" schedules, with the most common being the declining block rate (DBR). Under this type of schedule, water use in each billing period is divided into successive volumes or blocks, with use in each ascending block charged at a lower price per unit than in the previous block. Typically, one or two initial blocks cover residential and light commercial water use, with subsequent blocks containing heavy commercial and industrial uses. The lower unit prices in the upper blocks are usually justified by the savings claimed for serving large industries. The low costs per unit associated with successively higher blocks mean that declining block rates reduce the incentive for water conservation, as this type of rate has declining marginal costs.

Some municipalities employ conservation-oriented increasing block rate (IBR) schedules, in which the prices increase in successive blocks of the rate schedule. In other words, the unit price of water increases progressively through the blocks of the rate schedule. In these cases, consumers have an incentive to conserve water to avoid the higher rates in the upper blocks. Users of large amounts of water, or users with high peak flows, have the largest impact upon water system planning and sizing, since systems must be built to meet the largest demands. When employed for these types of users, increasing block rates can lower water demands and system costs significantly.

The final type of schedule considered in this paper can best be called complex. This type of schedule attempts to combine two different declining block rates (or as in one case in the survey, an increasing block rate) into the same schedule. Prices thus appear to fall until a certain level of usage is reached, then rise, and later fall again. These rates are usually an attempt to combine components of residential and commercial pricing systems into one schedule. Complex rates may also occur if sewer charges are calculated on the basis of block limits that differ from those used for the water schedule.

The most common situation is for municipalities to have parallel block rate schedules for residential, commercial, or industrial users. In addition, rates for the highest volume users in many communities are often the result of direct individual negotiations (possibly a form of monopoly distortion) by the companies and the respective municipalities, as the latter engage in "competition" with each other for employment opportunities. Customers may also be differentiated geographically or by jurisdictions such as larger regional municipalities or water boards. Higher rates may also be charged to more distant customers, but this generally occurs only if jurisdictional boundaries are crossed, since equity concerns[9] within a municipality usually dictate against this practice.

[9] The equity issue is addressed briefly in the last section of the paper.

2.2.4 Sewer Charges

Charges related to sewage collection and treatment (referred to in this report as sewer charges) are frequently integrated with water charges in calculating customer billing. Sewer charges take several forms across Canada. In the case of flat rate billing, the sewer charges are also flat charges. However some municipalities with metered rates also have flat sewer charges. The flat sewer charge is thus the most frequently used type, with 963 examples nationally (Table 7). The second type of sewer charge (632 cases) comprises a fixed percentage of the customer's bill for water supply; thus, if the water pricing system is volume-based, then the sewage charges will also be volume-based. In most of these cases, the sewer charge percentage is quite high – often over 40% of the total water bill and sometimes in excess of 100%. Other types of sewer charges are based upon the chemical composition of the sewage (26 cases), municipal property assessment, and various combinations of the preceding types. As noted already, the total water prices in this paper (with the exception of those in Table 14) include relevant sewer charges.

2.2.5 Frequency of rate schedule usage

The 1991 water rate survey resulted in receipt of 2762 residential or commercial rate schedules (Table 5), an increase of over 1300 from the 1989 survey. As mentioned already, many municipalities employ parallel residential and commercial schedules, and many others maintain metered and unmetered schedules. For these reasons, there are more than twice as many rates as there are municipalities. The rate schedules are categorized by flat or volume-based groups (Table 5) and by customer user group (Table 6), the latter to allow observations of any differential practices between user groups.

Flat rate charges made up over half (824) of the 1419 residential rate schedules and were concentrated in the smaller urban size groups. Flat rate residential charges were employed most frequently (when compared with other types of rates) in Newfoundland and Quebec. The remaining 595 schedules comprised various forms of volume-based schemes, with the constant unit, and the declining block rates predominating. Only 39 residential schedules were increasing block, and three were complex rates. These latter two types were concentrated in Ontario and the prairie provinces, and in the less than 50 000 population group.

Much the same pattern emerged for commercial water users: that there were 483 commercial flat rates is particularly noteworthy in terms of water conservation, since some users in this category may use large volumes of water. Through the use of flat rates, these users benefit from relatively large cross-subsidies from smaller users. Conversely, the increase in the number of increasing block rates (45) and complex rates (15) undoubtedly reflect an effort by some municipalities to exercise greater control over their larger water users.

In some instances, a volume-based rate structure can have the same characteristics as a flat rate. This occurs if the volume-based structure contains a minimum charge that includes a volume of water greater than the normal range of residential usage. In particular, 687 municipalities (of 1291 municipalities with minimum charges; see Table 7) had minimum charges that included a volume component. Thus municipalities with volume-based rate structures may, in fact, have many of their residential customers facing flat rate pricing conditions, with the resultant loss of economic incentives to conserve. More will be said about this issue in section 3 of the paper.

Differences did emerge among basic rate practices between the two user groups. Specifically, flat rate pricing was more likely to be used for residential customers than for commercial ones. This tendancy is noticeable particularly in coastal provinces and in Quebec. This suggests that municipalities are somewhat more conscious of pricing issues for commercial establishments than for residential users.

Rate structures establish the parameters used in setting water prices to consumers. The following two tables summarize these parameters by describing the frequency distribution of charge levels for flat rates, minimum charges, and sewer charges (Table 7) and unit prices (i.e., prices per cubic metre) for the three forms of volumetric pricing (Table 8). Most flat rate charges fell between $13.00 and $20.00 (and over) per month (Table 7).

Table 5

Frequency Distribution of Municipal Water Rates, by Rate Type[1], Province, and Population Size Group, 1991

	Flat Rate Types		Volume-Based Rate Types				
Province	Flat	Assessment	CUC	DBR	IBR	Complex	Total
Newfoundland	135	2	10	6	0	0	153
P.E.I.	14	0	8	0	0	0	22
Nova Scotia	31	0	3	78	0	0	112
New Brunswick	67	0	10	19	2	0	98
Quebec	532	60	204	29	11	2	838
Ontario	261	10	242	184	26	4	727
Manitoba	12	2	12	47	0	0	73
Saskatchewan	17	0	75	33	16	2	143
Alberta	53	1	123	65	18	4	264
British Columbia	178	2	54	63	11	6	314
Territories	7	0	11	0	0	0	18
Population Size Groups (000s)							
1 - 5	793	35	310	202	32	5	1377
5 - 10	224	7	171	91	17	2	512
10 - 50	239	20	190	177	31	3	660
50 - 100	34	7	41	31	3	6	122
100 +	17	8	40	23	1	2	91
Canada Total	1307	77	752	524	84	18	2762

[1] Assessment = Assessment-based flat rate; CUC = Constant unit charge; DBR = Declining block rate; IBR = Increasing block rate. See section 2.2 for more detail on the specific characteristics of each rate structure.

Table 6

Frequency Distribution of Residential (and Commercial) Water Rates, by Rate Type[1], Province and Population Size Group, 1991

	Flat Rate Types				Volume-Based Rate Types									
Province	Flat		Assessment		CUC		DBR		IBR		Complex		Total	
Newfoundland	75	(60)	1	(1)	2	(8)	1	(5)	0	(0)	0	(0)	79	(74)
P.E.I.	11	(3)	0	(0)	0	(8)	0	(0)	0	(0)	0	(0)	11	(11)
Nova Scotia	25	(6)	0	(0)	1	(2)	37	(41)	0	(0)	0	(0)	63	(49)
New Brunswick	42	(25)	0	(0)	3	(7)	8	(11)	1	(1)	0	(0)	54	(44)
Quebec	314	(218)	29	(31)	56	(148)	1	(28)	4	(7)	0	(2)	404	(434)
Ontario	182	(79)	8	(2)	116	(126)	72	(112)	14	(12)	1	(3)	393	(334)
Manitoba	10	(2)	1	(1)	6	(6)	23	(24)	0	(0)	0	(0)	40	(33)
Saskatchewan	16	(1)	0	(0)	39	(36)	14	(19)	8	(8)	1	(1)	78	(65)
Alberta	37	(16)	1	(0)	63	(60)	30	(35)	8	(10)	0	(4)	139	(125)
British Columbia	107	(71)	1	(1)	19	(35)	16	(47)	4	(7)	1	(5)	148	(166)
Territories	5	(2)	0	(0)	5	(6)	0	(0)	0	(0)	0	(0)	10	(8)
Population Size Groups (000s)														
1 - 5	470	(323)	16	(19)	124	(186)	78	(124)	15	(17)	1	(4)	704	(673)
5 - 10	141	(83)	4	(3)	76	(95)	34	(57)	9	(8)	0	(2)	264	(248)
10 - 50	173	(66)	12	(8)	73	(117)	68	(109)	13	(18)	0	(3)	339	(321)
50 - 100	26	(8)	4	(3)	17	(24)	12	(19)	1	(2)	2	(4)	62	(60)
100 +	14	(3)	5	(3)	20	(20)	10	(13)	1	(0)	0	(2)	50	(41)
Canada Total	824	(483)	41	(36)	310	(442)	202	(322)	39	(45)	3	(15)	1 419	(1 343)

[1] Assessment = Assessment-based flat rate; CUC = Constant unit charge; DBR = Declining block rate; IBR = Increasing block rate. See section 2.2 for more detail on the specific charactistics of each rate structure.

Table 7

Frequency Distibution of Flat Rates, Minimum Charges and Sewer Charges, by Price Level, Province and Population Size Group, 1991

	Number of Flat Rates, by Price Level ($)				Number of Minimum Charges for Water + Sewer[1]		Number of Sewer Charges, by % of Total Water Bill or as Flat Charges — % of Water Bill —				
Province	<6.5	6.5-13	13-20	>20	A[2]	B	<20	20-40	>40	Flat	Total
Newfoundland	0	24	80	31	5	8	0	2	1	102	105
P.E.I.	0	3	7	4	4	4	0	0	8	12	20
Nova Scotia	0	7	15	9	7	74	0	12	6	18	36
New Brunswick	4	9	19	35	11	20	0	7	16	55	78
Quebec	44	223	167	98	100	111	3	15	6	236	260
Ontario	2	41	77	141	184	234	15	75	222	198	510
Manitoba	0	4	3	5	55	4	16	26	13	7	62
Saskatchewan	0	3	7	7	108	16	7	26	16	84	133
Alberta	0	6	10	37	144	62	11	58	37	139	245
British Columbia	17	75	45	41	63	66	3	10	16	111	140
Territories	0	1	2	4	6	5	0	3	2	1	6
Population Size Groups (000s)											
1 - 5	43	228	259	263	327	192	28	102	91	618	839
5 - 10	6	57	78	83	137	117	8	59	62	156	285
10 - 50	15	91	77	56	182	203	12	60	119	148	339
50 - 100	2	11	12	9	22	54	1	6	39	30	76
100+	1	9	6	1	19	38	6	7	32	11	56
Canada Total	67	396	432	412	687	604	55	234	343	963	1 595

[1] Includes both residential and commercial rates.

[2] A = Minimum charges that include a volume of water;
B = Minimum charges that do not include a volume of water. Note that this section of the table refers only to metered rates.

Nevertheless, over 460 municipalities charged less than $13.00 per month. This is indeed a cheap price for water, and probably does not reflect the total cost of water servicing. The exceptionally low flat rates were found mainly in Quebec and British Columbia and tended to occur in the first and third population size groups. There appears, however, to be no systematic explanation of the size group data.

Minimum charges were concentrated in Ontario and the western provinces. Most of the pricing schedules in the latter included specified water volumes within their minimum charges. On a Canada-wide basis, the ratio between rates that include a minimum water volume (687) in a minimum charge and those that do not (604) was roughly equal.

Most proportional sewer charges (often referred to as sewer surcharges) were found in Ontario and the western provinces. Ontario had the highest number (222) in the over 40% range, with some exceeding 100% of the basic water bill. Flat sewer charges were more evenly distributed. Some of the change in this sewer charge data since 1989 is due to an improved question on the survey form, since flat sewer charges were poorly enumerated in 1989. A trend is emerging toward the increased use of sewer charges, as they are an easily visible and understandable environmental charge.

2.2.6 Average and marginal residential water prices

The periodic water bills paid by customers are based on the unit charges (e.g., cents/cubic metre) built into the water rates. These unit prices, for both constant unit and block rate schedules[10]

[10] All block rates, including increasing and complex types, were included in this analysis. A slight problem occurred in the analysis of marginal costs, caused by the coincidence of the 25 m^3 and 35 m^3 levels of usage with the break points in some rate structures. This causes the marginal price at those levels of usage to appear disproportionately large. However, this occurred on only four occasions in 1991.

Table 8

Unit Prices (cents/m^3) for Volume-based Rate Schedules, by Province and Population Size Group, 1991

	Constant Unit Charges				First Block Prices				Last Block Prices			
Province	Mean	Median	10th Percentile	90th Percentile	Mean	Median	10th Percentile	90th Percentile	Mean	Median	10th Percentile	90th Percentile
Newfoundland	18	19	9	24	20	19	***	***	10	8	***	***
P.E.I.	30	30	***	***	***	***	***	***	***	***	***	***
Nova Scotia	***	***	***	***	36	33	23	60	20	17	8	38
New Brunswick	59	56	26	96	70	68	39	101	31	40	18	68
Quebec	33	29	16	56	32	30	22	45	27	21	10	66
Ontario	74	71	33	126	84	78	41	136	58	56	24	105
Manitoba	117	98	57	246	110	102	62	174	76	71	36	144
Saskatchewan	76	77	35	111	85	79	44	121	70	66	38	110
Alberta	86	85	25	142	101	96	36	167	82	74	26	141
British Columbia	28	22	11	64	35	26	12	75	26	9	17	66
Territories	197	200	60	469	–	–	–	–	–	–	–	–
Population Size Group (000s)												
1 - 5	69	58	22	128	75	66	25	128	54	44	9	110
5 - 10	59	48	19	102	73	67	26	118	53	47	13	98
10 - 50	54	48	17	99	70	57	20	159	51	45	11	136
50 - 100	52	43	22	119	58	57	20	92	41	39	16	66
100+	78	80	33	126	72	67	26	146	47	33	15	96
Canada Total	62	53	20	121	72	62	24	133	51	44	12	107

*** Not applicable because of too few data points.; – not applicable because of no relevant rates.

(Table 8) vary among provinces and population size groups. The constant unit prices in Table 8 refer to those schedules where the price of water per unit of usage is held constant or to schedules having two blocks in which the first block corresponds to a minimum bill. For both of these arrangements, there is only one non-zero price for water. The data in Table 8 cannot be used to estimate actualcustomer billing, as the effects of minimum charges, minimum values, and intermediate blocks are not represented. Retail water prices for the constant unit charge mode of pricing averaged \$0.62/m^3 (\$0.52 in 1989) on a national basis. For the block rate structures, the average ranged between \$0.72 for the first block and \$0.51 cents for the last (\$0.62 and \$0.39 respectively in 1989). In most cases, as in previous surveys, median unit prices fell below their respective means, showing that in statistical terms the data were skewed to the left, indicating the prevalence of lower-than-average rates. The decreasing average prices from the first to the last block indicate the bias towards declining block rate structures.

On a national basis, a systematic spatial variation in the unit rates emerged, as it did in the previous surveys. The prairie provinces had the highest rates among the provinces, with the lowest rates occurring in the coastal areas. There were no significant price patterns among the population size groups. One might expect lower rates for larger urban areas, because of economies of scale. Table 8 shows no such pattern, leading to the conclusion that, if scale economies exist, they are not being passed to consumers in the form of lower prices.

The overall observation from Table 8 is that unit water rates across Canada remain very low. The differences between provinces partially reflect variations in the average cost of providing municipal water services. For instance, a number of cost advantages prevail in Newfoundland and British Columbia, the provinces with the lowest average rates. These advantages include abundant supplies, frequent availability of gravity-fed systems, and generally good ambient quality. On the other hand, parts of the prairie provinces incur frequent water shortages and have significant water problems in some areas, which tend to increase the costs of supply. Similarly, in the territories, climatic conditions (especially permafrost) contribute to high supply costs. Finally, one significant "downside" of low unit prices is the impact on

revenue generation, an issue addressed in more detail in Section 3.

Table 9 shows the marginal cost of an extra cubic metre of water at the 25 and 35 m^3 levels of monthly usage. Economic theory suggests that consumption of an extra (or marginal) unit of a good or service depends on the price of that unit. Basically, a consumer will demand a product up to the point where satisfaction (economists call this "utility") from the last (i.e., the marginal) unit is equal to its price. If prices are lower than the satisfaction derived from consuming larger quantities, demand will be increased. Conversely, if price exceeds the marginal utility, demand will fall. Only at the point where price equals marginal utility is the level of demand economically justified. Low marginal prices will tend to create high demand. On the supply side, "the best use of resources is to produce just up to the point where marginal costs begin to exceed the price that consumers are willing to pay for the additional unit produced..." (Hirschleifer et al., 1960). The theory of "marginal cost pricing" for water services (see, for example McNeill, 1989; McNeill and Tate, 1991) says that the price for water per unit of usage should be set equal to the marginal cost of production. For present purposes, it is unnecessary to enter a complete explanation of marginal cost pricing principles, but it is important to note that the marginal price of water is an important indicator of the conditions underlying demand. A working application of these principles may be found in the recently published water rate-setting manual by the Canadian Water and Wastewater Association (1993).

A wide range of marginal prices generally occurred, as exemplified by the range between the national 10th and 90th percentiles for both volumes of usage in Table 9. Within provinces, the same wide range was often evident; for example, the prairie provinces, which have the highest prices, also had some of the widest ranges. The high marginal price in the territories, while based on only a small number of municipalities (five metered rate schedules), reflects the high cost of all services in this climate. Lowest marginal prices were found in Quebec, Nova Scotia, and British Columbia. At the 35 m^3 level of consumption, the ranges of marginal prices were often reduced due to a larger number of municipalities reaching the second block of declining block rate structures. Marginal prices, for the most part, fall under \$0.72 /m^3, very low in comparison with the prices of other liquids in common use. For example the cost of a similar quantity of soft drink, the next-cheapest liquid examined, is about \$850.00 for the same quantity (Table 10)!

Despite a full 10 m^3 of water difference, provincial marginal prices from 25 to 35 m^3 usually changed by only one cent! This indicates that the split between the first and second blocks of residential rate schedules is usually above the 35 m^3 level of monthly usage, and is another example of low and poorly priced municipal water throughout Canada.

2.2.7 Unit price comparisons, 1986–1991.

A time series of municipal water pricing shows that a high degree of variability is apparent in prices from 1986 to 1991 (Table 11). (Flat rates are not included in this table.) This variability occurs for three reasons. The municipalities in the smallest size group represent samples (not necessarily the same municipalities) in the first two survey years. As mentioned earlier, the 1991 survey covered all Canadian municipalities over 1000 persons. Second, sewer charges are attracting increasing attention as a means of revenue generation, and the national water industry is in a state of transition, with some municipalities having such charges, and others not. Finally, some municipalities have modified their rate structures in such a way as to move themselves from one category to another.

In spite of the inter-provincial variability visible in Table 11, the data for the population size groups, as well as the Canadian totals, show a significant upward trend in unit water prices. For instance, the national averages for all block categories increased by at least 50%. The marginal prices (at 35 m^3) also rose from \$0.38 to \$0.72, a near-doubling in five years. Because rates are still very low, there appears to be a significant revenue raising capacity in the industry[11]. The increase in unit rates was especially notable in Ontario and the prairie provinces. New Brunswick showed a decrease (possibly a sampling variation in the first

[11] This subject is addressed in detail in Section 3.

Table 9

Marginal Water Prices[1] (cents/m³) for Residential Customers, by Province and Population Size Group, 1991[2]

	25 m³/month				35 m³/month			
Province	Mean	Median	10th Percentile	90th Percentile	Mean	Median	10th Percentile	90th Percentile
Newfoundland	***	***	***	***	***	***	***	***
P.E.I.	–	–	–	–	–	–	–	–
Nova Scotia	36	33	23	57	36	33	23	56
New Brunswick	66	66	44	86	67	68	44	86
Quebec	36	33	20	64	37	33	20	64
Ontario	77	73	37	126	77	74	38	126
Manitoba	113	100	63	178	106	100	57	161
Saskatchewan	80	76	38	116	81	77	41	116
Alberta	89	91	25	143	90	91	26	144
British Columbia	33	24	17	61	32	24	17	56
Territories	181	200	***	***	181	200	***	***
Population Size Group (000)								
1 - 5	76	66	25	129	75	66	25	129
5 - 10	69	62	22	116	69	62	22	116
10 - 50	70	57	26	128	70	58	27	133
50 - 100	64	55	24	104	59	54	22	94
100 +	77	76	35	122	75	76	33	121
Canada Total	72	66	24	126	72	65	24	127

1 Marginal price refers to the extra amount of money that residential consumers must pay for one additional cubic metre of water at the 25 m³ and 35 m³ levels of monthly water usage.

2 Thirty-six municipalities were removed from the analysis at the 25 m³ level as their marginal costs were equal to zero. This occurs when minimum volume or minimum charges were not reached, and the rates were effectively flat rates. At 35 m³, 19 municipalities were removed for this reason.

*** No data due to small sample size.

– No applicable rates.

Table 10

Typical Prices for Popular Liquids ($/m³)

Beverage	Cost*
Tap Water**	0.82
Cola	850.00
Milk	985.00
Bottled/Mineral Water	1 500.00
Beer	2 500.00
Wine	9 000.00
Whiskey, Gin ...	26 700.00

* All costs are in 1992 Canadian dollars.

** Only tap water includes automatic delivery to the user. This figure includes the cost of waste treatment.

two years), while British Columbia, with the lowest prices in the country, changed from $0.23 to $0.32, a 39% increase. The largest change in unit prices occurred in New Brunswick, where one municipality actually lowered its unit rates. Some of the apparent decreases in price are due to sampling differences in the earlier surveys, as well as some rather large changes among small numbers of respondents.

2.2.8 Summary

Water rate schedules across Canada are extremely diverse, with each municipality setting its own rates. The result is a set of practices that has to be reduced to a set of statistics, like those in this section, to be understood. Of the 1173 municipalities included in this study, 2762 domestic or small commercial rate schedules were analyzed. There were five main types of rate schedules: flat rate, constant unit rate, declining block rate, increasing block rate, and complex. The most common rate schedule type was the flat rate, followed by the constant unit charge. Some block rate schedules have portions that are effectively flat, for example, a minimum bill portion including

Table 11

Unit Water Price Comparisons (cents/m^3), by Province and Population Size Group, 1986-1991

	Constant Unit Charges			First Block Rates			Last Block Rates			Marginal Prices (35 m^3/month)		
Province	1986	1989	1991	1986	1989	1991	1986	1989	1991	1986	1989	1991
Newfoundland	64	17	18	34	***	20	17	***	10	14	***	***
P.E.I.	***	26	30	30	31	***	32	23	***	15	***	–
Nova Scotia	***	32	***	88	29	36	43	15	20	21	28	36
New Brunswick	127	52	59	110	60	70	53	31	41	79	56	67
Quebec	24	26	33	22	26	32	21	16	27	23	27	37
Ontario	40	65	74	43	70	84	24	41	58	37	63	77
Manitoba	77	125	117	89	89	110	58	53	76	81	96	106
Saskatchewan	56	83	76	54	97	85	39	72	70	54	91	81
Alberta	56	72	86	72	100	101	46	74	82	59	78	90
British Columbia	19	26	28	24	28	35	13	19	26	23	23	32
Territories	115	124	197	***	***	–	***	***	–	57	***	181
Population Size Groups (000s)												
1 - 5	39	52	69	55	68	75	36	39	54	42	57	75
5 - 10	40	54	59	52	60	73	28	37	53	39	59	69
10 - 50	38	49	54	42	63	70	27	42	51	37	61	70
50 - 100	29	53	52	39	44	58	23	31	41	28	52	59
100 +	47	61	78	55	66	72	24	37	47	40	58	75
Canada Total	38	52	62	48	62	72	29	39	51	38	59	72

Note: These data cannot be used to estimate actual customer billing as the effects of minimum charges, minimum values, and intermediate blocks are not represented.

*** No data due to small sample size.

– No relevant rates.

a minimum volume of water. Most municipalities have some form of sewer charge associated with their water rates.

Few of the rate schedules provide financial incentives to conserve water, avoid wastage, or minimize the costs of providing water servicing. As a result, over 70% of the rate schedules in current use tend to be associated with high urban water demands. Marginal prices at normal residential usage levels changed substantially from a 1986 mean of $0.38 to a 1991 mean of $0.72 for 35 m^3 per month. There was a wide range of variation in unit prices between provinces, which probably reflected natural advantages and/or provincial cross subsidies.

2.3 Monthly Total Retail Water Prices

To demonstrate the impact of water prices on residential and commercial users, the water rates described in the previous section were used to simulate total monthly prices for selected standard volumes of monthly usage. This permits interprovincial and intermunicipal comparisons of water prices at the retail level. The data in the following sections include any relevant minimum and/or sewer charges.

2.3.1 Residential water prices

Water prices to residential customers vary widely across the country (Table 12), reflecting the variation in unit water prices and the use of various ancillary charges. As in previous papers on municipal water rates[12], price calculations are based on volumes of 10, 25, and 35 m^3 per month as the standard volumes of monthly water supply. The first volume represents a minimal monthly water use (i.e. a "lifeline" rate), while the second and third represent average and high family usage. The national mean monthly residential water price at the 25 m^3 level was $20.57 ($23.36 at 35 m^3), reaching lows in Quebec and the coastal areas, and highs in the prairie provinces and the territories. Median prices in most provinces fell below the

[12] See above, footnote 3.

Table 12

Total Residential Water Prices ($/month) for Selected Volumes of Service, by Province and Population Size Group, 1991

	10 m^3/month				25 m^3/ month				35 m^3/month			
Province	Mean	Median	10th Percentile	90th Percentile	Mean	Median	10th Percentile	90th Percentile	Mean	Median	10th Percentile	90th Percentile
Newfoundland	14.76	15.00	8.80	19.17	14.86	15.00	9.70	19.17	14.94	15.00	9.70	19.17
P.E.I.	19.50	18.51	9.64	34.50	19.50	18.51	9.64	34.50	19.50	18.51	9.64	34.50
Nova Scotia	17.59	16.45	9.87	27.27	20.57	19.65	12.30	31.36	22.57	21.32	13.85	34.26
New Brunswick	19.47	17.87	10.33	26.60	21.32	20.63	11.00	32.89	22.66	20.63	11.00	37.49
Quebec	12.75	11.67	5.83	20.50	13.43	12.50	6.73	20.88	14.00	12.92	7.08	22.88
Ontario	18.63	16.66	8.53	28.86	23.98	22.75	13.34	37.54	27.90	26.60	14.03	44.44
Manitoba	15.60	13.65	8.79	25.84	28.34	26.89	13.42	42.02	36.61	35.27	13.42	56.08
Saskatchewan	18.35	17.76	12.22	24.99	26.71	27.15	15.71	37.18	33.08	33.35	16.00	45.70
Alberta	24.50	23.67	10.40	34.13	32.66	33.19	13.50	47.17	38.97	39.14	13.97	57.88
British Columbia	13.45	11.67	5.86	23.47	14.31	12.04	6.69	24.65	15.70	13.21	6.75	25.70
Territories	35.88	33.42	19.80	50.00	45.99	50.00	19.80	66.69	55.06	56.50	19.80	89.39
Population Size Group (000s)												
1 - 5	17.32	15.83	7.87	28.49	20.39	17.96	8.33	35.80	22.75	18.71	8.33	42.62
5 - 10	17.17	15.63	8.00	27.05	21.13	19.17	8.63	35.20	24.13	20.38	9.17	41.64
10 - 50	16.36	14.46	7.43	28.58	20.63	17.79	8.76	38.26	23.79	19.68	8.85	47.05
50 - 100	15.98	14.52	6.12	27.09	20.40	18.52	7.64	33.63	23.52	19.38	8.73	41.76
100+	12.76	13.25	6.91	18.01	19.85	19.00	8.92	31.65	24.77	23.68	8.92	42.52
Canada Total	16.86	15.36	7.50	28.35	20.57	18.16	8.33	36.00	23.36	19.58	8.75	43.55

mean at both the 25 m^3 and 35 m^3 level of usage, indicating that more rates fell below the provincial averages than above them. The average prices generally fell as urban populations grew, although this trend is not as apparent at the 35 m^3 per month level as it is for the two lower volumes. Thus, the data showed slight economies of scale as urban size grew.

A substantial increase in residential water prices occurred in most areas between 1986 and 1991 (Table 13). For example, at the 35 m^3 per month level, the national mean grew from $16.08 in 1986 to $23.36 in 1991, with the largest overall changes occurring in Alberta, Nova Scotia, and Prince Edward Island. These changes have been neither regular or consistent; in the 1986 to 1989 period, Ontario and Saskatchewan had the largest changes. The slight declines in prices in some years for Prince Edward Island, New Brunswick, and Saskatchewan, are believed to have resulted from sampling variations.

The data in Table 12 contain sewer charges where applicable. To examine the effect of these sewer charges on water prices, the 25 m^3 per month portion of the table was calculated without the sewer charges (Table 14). This is a somewhat abstract procedure, since the sewer charges rarely stand alone as a separate billing item. Other portions of this paper (see Section 2.2.4) have indicated that the sewer charge portion of water charges is often quite large. For example, at the national level, the average monthly price to residential customers fell to $ 14.42 without the sewer charges (cf. $20.57 with the charge included). In the aggregate, therefore, the sewer charges account for about 30% of the average residential monthly water bill. (In 1989, this was only 26%.) The effects of sewer charges were most noticeable in Prince Edward Island, New Brunswick, and Ontario. There was little change in Nova Scotia, Quebec, and the territories. Larger urban centres had more reliance upon sewer charges than smaller ones.

The data in Table 12 are also unweighted; that is, each municipality is treated equally in the calculation of provincial, national, and size group averages. In other words, a rate in a city of 100 000 has the same "weight" in the calcuations as a town of 1000. Previous versions of this report had

Table 13

Comparison of Mean Monthly Residential Water Prices ($/month) for Selected Volumes of Water, by Province and Population Size Group, 1986-1991

	Monthly prices, 1986			Monthly prices, 1989			Monthly prices, 1991		
Province	10 m^3	25 m^3	35 m^3	10 m^3	25 m^3	35 m^3	10 m^3	25 m^3	35 m^3
Newfoundland	7.97	7.97	7.97	11.18	11.96	12.43	14.76	14.86	14.94
P.E.I.	11.26	13.46	14.93	13.90	13.90	13.90	19.50	19.50	19.50
Nova Scotia	10.06	11.98	13.26	13.05	15.69	17.46	17.59	20.57	22.57
New Brunswick	14.87	16.57	17.75	18.60	21.08	22.81	19.47	21.32	22.66
Quebec	8.12	8.87	9.54	9.97	10.69	11.25	12.75	13.43	14.00
Ontario	11.49	14.84	17.39	15.96	21.00	24.57	18.63	23.98	27.90
Manitoba	11.76	24.11	31.91	13.47	26.30	34.85	15.60	28.34	36.61
Saskatchewan	12.59	20.47	26.26	17.15	28.87	34.84	18.35	26.71	33.08
Alberta	18.04	24.25	29.86	21.32	28.54	34.16	24.50	32.66	38.97
British Columbia	8.62	9.21	10.09	10.58	11.24	11.87	13.45	14.31	15.70
Territories	19.80	27.50	33.19	27.82	35.77	41.07	35.88	45.99	55.06
Population Size Groups (000s)									
1 - 5	12.96	15.56	17.62	14.75	17.73	19.81	17.32	20.39	22.75
5 - 10	11.03	14.03	16.40	14.42	17.83	20.40	17.17	21.13	24.13
10 - 50	10.54	13.46	15.82	14.83	18.94	21.92	16.36	20.63	23.79
50 - 100	9.41	11.71	13.57	12.98	17.07	19.98	15.98	20.40	23.52
100 +	8.34	12.69	15.91	11.67	17.56	21.81	12.76	19.85	24.77
Canada Total	10.90	13.68	16.08	14.40	18.15	20.88	16.86	20.57	23.36

Table 14

Average Residential Water Price ($/month) Excluding Sewer Charges, by Province and Population Size Group, 1991

Province	Monthly Price without Sewer Charge (25 m^3 level)	% Change[1]
Newfoundland	11.18	-25
P.E.I.	10.36	-47
Nova Scotia	17.68	-14
New Brunswick	12.60	-41
Quebec	11.32	-16
Ontario	14.91	-38
Manitoba	20.18	-29
Saskatchewan	18.25	-32
Alberta	21.57	-34
British Columbia	10.33	-28
Territories	40.33	-12
Population Size Groups (000s)		
1 - 5	14.57	-29
5 - 10	15.06	-29
10 - 50	14.27	-31
50 - 100	11.91	-42
100 +	12.92	-35
Canada Total	14.42	-30

[1] From the respective averages of Table 12.

encountered some minor criticisms for failing to use weighted averages. These criticisms focused in two areas. First, simple averages contain bias because prices from (many) small centres have equal weight to those of the (relatively few) larger centres. If there were a systematic trend in the rates as urban size changed (e.g., economies of scale), it could affect the provincial and national averages. Second, a few municipalities provide no water services to a portion of their population. Weighting the price data using the population served data would eliminate this source of bias. Since the 1991 survey included all municipalities, it was possible to examine the effect of population-based weighting on the average price data contained in Table 12 (again using the 25 m^3 per month level of usage).

The effect of weighting on the basis of population served proved insignificant at the national level (Table 15), with the weighted national average price being only one percent under its unweighted counterpart at the 25 m^3 per month level. The average price in the smallest population size group remained unchanged, while in the largest urban grouping prices rose by five percent. This was expected, since the weighting method was

Table 15

Average Residential Water Price ($/month) Weighted by Population Served, by Province and Population Size Group, 1991

Province	Weighted Average Price (25 m^3 level)	% Change[1]
Newfoundland	14.02	-6
P.E.I.	18.22	-7
Nova Scotia	19.69	-4
New Brunswick	27.55	29
Quebec	12.90	-4
Ontario	21.20	-12
Manitoba	28.25	0
Saskatchewan	28.96	8
Alberta	34.40	5
British Columbia	13.53	-5
Territories	51.26	11
Population Size Groups (000s)		
1 - 5	20.29	0
5 - 10	20.44	-3
10 - 50	19.51	-5
50 - 100	20.09	-2
100 +	20.90	5
Canada Total	20.39	-1

[1] From the respective averages of Table 12.

designed to remove the possible small group bias of simple averaging. Provincially, New Brunswick, Ontario, and the territories showed relatively large changes in average prices. The 29% increase in New Brunswick was expected because previous surveys had shown a wide range in prices between municipalities in the province's smaller size groups, which in fact, had biased the average prices in the manner outlined above.

2.3.2 Commercial water prices

Commercial water prices (Table 16) showed many of the same patterns as those described above, except that commercial rates tended to be somewhat higher. Commercial rates also seemed to be increasing at a faster rate than residential rates. A higher monthly volume (100 m^3 per month) was used in compiling prices, as some individual commercial establishments use greater amounts of water than domestic users. Direct comparisons between the two user groups can be made at both the 10 m^3 and 35 m^3 levels.

2.3.3 Summary

Mean (unweighted) prices to domestic consumers for 25 m^3 and 35 m^3 of water monthly (average family water usage) vary from $13.43 and $14.00 in Quebec to $32.66 and $38.97 in Alberta, being substantially higher in western than in eastern Canada. (Rates are higher in the territories, but this can be attributed to small sample size and unique environmental conditions.) Most rates increased considerably from 1986 to 1991, with the major changes among the provinces occurring in Alberta, Nova Scotia, and Prince Edward Island. Nationally, about 30% of the average billing at 25 m^3 consists of sewer charges. Commercial water prices tend to be higher than residential prices across the country.

3.0 WATER PRICING AND THE INFRASTRUCTURE FINANCING ISSUE

As noted in the Introduction, there exists a chronic funding shortfall problem in many areas of Canada with regard to municipal water infrastructure. The solution to this problem rests with setting realistic water servicing prices, designed to recover the full costs of system construction, upgrading, and expansion. This approach stands in marked contrast to current approaches, which rely often on combinations of (low) water prices, cross-subsidies among users, and subsidies from senior levels of government. This section examines an application of the data summarized in this paper to the issue of generating increased revenue. This analysis will show that funds required could be raised in most areas through realistic pricing, without causing undue financial hardship to water system customers[13].

The section begins by presenting the results of a fairly simple and straightforward calculation of

[13] There may exist special "hardship" cases that require individual attention. However, these appear to be exceptions, which should not dominate the debate, as they may have done in the past. It is more advantageous to start from a general position, such as the one taken here, and to deal with legitimate exceptions as they arise. within the overall framework of realistic pricing.

Table 16

Total Commercial Water Prices ($/month) for Selected Volumes of Service, by Province and Population Size Group, 1991

	10 m^3/month				35 m^3/month				100 m^3/month			
Province	Mean	Median	10th Percentile	90th Percentile	Mean	Median	10th Percentile	90th Percentile	Mean	Median	10th Percentile	90th Percentile
Newfoundland	18.16	16.00	10.00	28.87	18.89	16.80	10.09	28.87	20.94	18.00	11.20	31.92
P.E.I.	25.32	30.71	12.50	34.50	28.53	34.50	12.50	40.01	38.91	34.50	20.00	63.40
Nova Scotia	26.93	26.13	14.50	40.42	34.20	32.50	21.00	49.95	51.77	52.40	31.77	72.11
New Brunswick	26.50	23.29	8.38	46.68	31.29	25.44	12.57	61.03	43.69	28.77	11.45	94.13
Quebec	14.93	13.00	6.00	26.25	17.55	15.33	8.10	30.38	26.43	22.17	9.17	50.13
Ontario	23.09	20.00	8.65	40.50	35.62	32.05	16.50	55.84	71.35	67.91	20.00	28.36
Manitoba	24.37	20.02	14.41	39.64	41.39	37.77	20.55	70.89	102.10	96.08	49.53	158.59
Saskatchewan	20.95	19.92	10.01	32.55	38.38	37.92	26.29	51.48	88.93	89.00	53.56	120.60
Alberta	28.57	25.15	14.03	45.29	46.74	45.82	23.32	71.21	99.34	100.39	34.00	160.57
British Columbia	17.92	14.66	8.13	33.57	21.39	17.70	9.90	38.69	33.46	28.20	11.44	64.30
Territories	41.21	45.45	***	***	70.36	60.00	***	***	178.49	141.64	***	***
Population Size Group (000s)												
1 - 5	20.61	18.03	6.28	40.69	27.48	23.90	7.88	55.95	48.51	32.29	8.33	130.32
5 - 10	21.59	19.16	8.12	38.28	29.79	25.49	10.27	52.37	55.07	39.65	12.73	114.05
10 - 50	19.92	16.72	7.58	37.25	29.55	26.19	9.80	55.62	57.15	48.32	11.83	117.21
50 - 100	19.47	14.66	6.39	40.00	29.90	25.95	10.10	58.76	58.07	52.41	18.75	122.00
100+	17.31	14.57	7.94	33.20	32.06	29.75	14.10	52.13	73.15	75.38	30.36	130.67
Canada Total	20.48	17.66	8.00	36.89	28.65	24.97	10.15	51.27	52.92	39.10	11.67	114.86

*** Percentiles not calculated becaues of small sample size.

revenue generation for Canada and its regions[14] based on the water rates summarized in this paper. Then it presents an estimate of additional financial requirements to assure water system adequacy in the future. This estimate is somewhat speculative, but is based on the best information currently available. We then proceed to consider options for raising the required additional revenue and examine the impact on current water rates should full cost pricing be implemented throughout Canada. The section concludes with a discussion of the economic, social, and financial advantages of full cost pricing.

3.1 Calculation of Annual Water Rate Revenue

By using average monthly water prices for residential and commercial customers (Tables 12 and 16), it is a straightforward task to estimate total annual rate-based revenue. Essentially, this is a matter of multiplying the average residential and commercial water prices by the number of connections to the system in each municipality, pro-rating the monthly figures to annual, and then aggregating the results. Before doing this on a national level, this method was used to simulate annual revenue in Ontario, where there were data available to corroborate the results of this procedure. This verification was done using 1989 results from an earlier piece of internal research, the water rate data of which corresponds in form to the data used in this paper.

A number of assumptions were necessary. Ontario had a population of 9.6 million persons in 1989. It was assumed that, for residential water use, there were three persons per connection, giving a total 3.2 million individual residential services and, further, that each volume-based connection used an average of about 30 m^3 of water services per month. For flat rate users, an average monthly price of $19.50 was assumed to apply to the 33% of connections falling under flat rate pricing. For commercial water use (313 900 connections), an average monthly volume of about 70 m^3 was used to calculate monthly revenue. To

[14] For the purposes of this section, all data and tables are presented at the regional, as opposed to the provincial, level of detail. This streamlines the presentation while retaining the detail required for our purposes.

allow for industrial water use, for which no data were available, it was assumed that industrial revenues were equal to the commercial revenues. This was considered to be a conservative estimate since (1) industrial water use is normally larger than commercial, but (2) there are fewer industrial users, and (3) many of the larger industries have individual water servicing contracts, to which we had no access. The total annual revenue simulated in this manner was $1.18 billion (Table 17).

Detailed public account data from the Ontario Ministry of Municipal Affairs showed that total revenue from water rates in Ontario municipalities in 1989 was $1.1 billion. This finding confirms the accuracy of the revenue estimation procedure used here. Table 18 shows the results of using the same procedure for 1991, on a national scale. This analysis shows that appoximately $3.3 billion annually is raised through municipal water rates. By any standard, therefore, the municipal water "industry" is a major one, as well as being one vital to public well-being. It is also the only one in Canada of this magnitude that fails to account for (i.e., meter) over 50% of its primary product, water supply and waste treatment.

3.2 Estimated Capital Plus O&M Requirements for Adequate Water Systems[15]

The underlying purpose of Section 3 is to examine briefly the implications for water rates to move to full cost pricing for water services. To do so requires an attempt to estimate Canada-wide capital and O&M costs to install and maintain adequate water systems. Such estimates have been very difficult to make, as they are frequently municipality- and analyst-specific. The FCM report of 1985 is the only document in the past 25 years that has attempted such an estimation, and that report contained partial coverage only. This fact, plus the out-of-date nature of the FCM study, means that it cannot be relied on exclusively. New estimates therefore need to be made. It is assumed that the current revenue raised through water rates ($3.3 billion) is being used to meet current O&M plus "regular" capital needs, and that the estimates below refer to additional expenditures required for upgrading, renovation, and expansion.

Table 17

Estimation of Annual Water Rate Generation by Ontario Municipalities, by User Class, 1989

Class of User	(A) Number of connections (000)	(B) Charge/ Connection ($)	Estimated Annual Revenue ($Million) (A × B × 12)/1000
Residential Flat Rate	1056	19.50	247.1
Residential Volume-based			
(a) 25 m^3/month	2144	21.00	540.3
(b) 35 m^3/month	2144	24.57	632.1
(c) Average			586.2
Commercial			
(a) 35 m^3/month	312.9	30.85	115.8
(b) 100 m^3/month	312.9	61.04	229.2
(c) Average			172.5
Industrial[1]			172.5
Total			1178.3

1 Industrial revenues = commercial revenues by assumption.

Table 18

Estimated Annual Municipal Revenues ($ million) from Water Rates, by User Class and Region, 1991

Region	Residential	Commercial	Industrial	Total
Atlantic	94.6	49.1	49.1	192.7
Quebec	293.0	78.3	78.3	449.6
Ontario	851.7	320.7	320.7	1493.1
Prairies	485.8	196.2	196.1	878.2
British Columbia	138.4	64.8	64.8	268.0
Canada Total	1863.5	708.8	708.8	3281.6

Note: Assumptions are the same as those used in Table 17.

For the purposes of the following analysis, the data were adapted from a recent internal report analyzing infrastructure financing options (Beaulieu et al., 1993) plus a number of assumptions. The internal report focused on the capital costs of installing universal metering throughout Canada, as well as secondary waste treatment in all municipalities over 1000 persons. The former is the prerequisite of realistic pricing; the latter is necessary to meet a minimum safe level of environmental quality. Table 4 showed that almost 10 million Canadians reside in urban areas

15 The analysis in this section has been done in terms of constant 1993 dollars.

that have unmetered water services. Assuming 3 persons per connection, there is a requirement for 3.3 million residential water meters. Each service would cost about $200 per meter for installation, resulting in a total cost for universal metering of $660 million.

The internal report referred to above contains the results of a sample survey of municipalities with regard to their current investment plans for waste treatment (Table 19). Planned expenditures for the 1993-98 period total nearly $5 billion. The assumption made here is that these are committed projects and built into current rates. In addition, it is assumed that this is an approximation of a regular municipal water system capital program (as noted above). The FCM (1985) report referred to earlier showed that waste-treatment-related expenditures account for 55% of total water system expenditures. Allowing for the water supply side of the water servicing system, the total estimated expenditures are about $9 billion, broken down as in Table 19, or about $1.8 billion per year. These capital expenditures form just over half of the $3.3 billion current revenue base (Table 18). Because they are regular expenditures, they form part of the current rate revenue base and are therefore net reductions from total additional investment requirements.

MacLaren (1985) estimated the total replacement value of Canadian municipal water and wastewater utilities at $110 billion. There appears to be no more up-to-date country-wide estimate of water system capital costs, and we assume that this is "in the ballpark" for total required new capital expenditure. The average life of water system components, allowing for regular O&M, is taken to be 40 years, implying that $2.75 billion should be spent annually on system upgrading. Considering a possible backlog in upgrading and renovation projects, it was assumed that 5% of the total replacement value would comprise the required expenditure for the next 10 years (Table 20). To this must be added an allowance to install universal metering (estimated above at $660 million). We assumed that full metering would be done over the next 10 years. When all capital expenses are taken into account, annual total capital expenditures are estimated at $5.66 billion for the period 1993-2003; $2.75 billion thereafter. From this estimate, the "regularly scheduled" expenditures of Table 19 (i.e., $1.8 billion) must be deducted. Thus,

Table 19

Planned Expenditures on Municipal Waste Treatment Plants, by Region, 1993-1998 ($ million)

	Waste Treatment System			Total Water System
Region	Low Estimate	High Estimate	Average	Average
Atlantic	677	736	705	1282
Quebec	951	1414	1215	2209
Ontario	1759	1826	1788	3251
Prairie	468	485	478	869
British Columbia	785	821	781	1420
Canada Total	4640	5282	4966	9030

over the long run, net new capital outlays total $3.76 billion for the 1993-2003 period; $0.95 billion thereafter (Table 20).

To this must be added an allowance for increased O&M costs. Many O&M expenses are (1) already being incurred (for those systems requiring upgrading), or (2) likely to decrease after system renovation. However, the estimated capital outlays includes allowances for system expansion, thereby requiring an increase in O&M expenditures. We have assumed that increased O&M will cost an additional 15% of capital outlays, or $0.83 billion over the accelerated expenditure period, and will remain at that level thereafter. When all of the data and assumptions are taken into account, a total of $4.6 billion is the estimated additional monetary requirement for the period 1993-2003 (Table 20); this reduces to $1.8 billion after 2003.

3.3 Additional Revenue Sources Using Water Pricing

These financial requirements can be placed into the context of water rates as the primary vehicle for raising the needed revenue. If the rate structures remained as they were in 1991 and price levels doubled on average nationally (roughly an additional $20/month per connection – Table 12), an additional $2.2 billion could be raised[16]. This would clearly meet the monetary requirements beyond 2003, but would be inadequate for the

[16] This amount takes into account the effect of decreased water demand due to a doubling of prices. See the discussion of price elasticity presented later in this sub-section.

Table 20

Summary of Estimated Water System Revenues and Costs (billions of constant 1993 $) to Achieve Municipal Water System Adequacy, by Costing Element

Costing Element	Total Cost	Annualized Revenue/Cost 1993–2003	Annualized Revenue/Cost 2003→	Source
Annual Revenue	n.a.	3.3	3.3	Table 18
Capital Costing	n.a.	n.a.	n.a.	
Total Replacement Value	110	n.a.	n.a.	MacLaren (1985)
Capital Outlays for Meters	0.56	0.06	n.a.	3.3 million meters @ $200 each; done over 10 years
Annual Capital Costs for Systems	n.a.	5.50	2.75	2.5% of System Replacement value per year; doubled for "catch-up" 1993–2003. (Assumed)
Total Annual Capital Requirement	n.a.	5.56	2.75	
Current Capital Outlays	n.a.	1.80	1.80	Table 19
Net Annual Capital Requirement	n.a.	3.76	0.95	Calculated
Net New Annual O&M	n.a.	0.83	0.83	15% of new capital for 1993–2002 period (Assumed)
Total Annual Net New Money Requirements	n.a.	4.59	1.78	Calculated

Table 21

Revenue Impacts (10^6) of Rate Level Changes and Related Modifications, by Region, 1991

Region	Doubling Current Rate Levels[1]	Placing a 80% Sewer Charge on Services[2]	Adoption of Full Metering for Residential Services		Total Additional Revenue	
			a	b	a	b
Atlantic	131.6	98.3	3.2	10.2	233.1	240.1
Quebec	305.7	388.7	6.8	161.7	701.2	856.1
Ontario	1015.5	852.1	44.9	44.9	1912.5	1912.5
Prairies	597.2	502.7	24.0	24.0	1123.9	1123.9
British Columbia	180.9	147.6	21.3	77.3	349.8	405.8
Territories	1.4	1.8	0.0	0.0	3.2	3.2
Canada Total	2232.3	1991.2	100.2	318.1	4323.7	4541.6

1 Source: Table 18.

2 For municipalities with no sewer charges. Residential monthly flows = 30 m^3; commercial monthly flows = 70 m^3.

a. Adoption of the regional monthly average water price.

b. Adoption of at least the national average monthly water price.

1993–2003 period. There are a number of options (Table 21) for raising the revenue stream to the required level. Two have been examined that seem to make sense from a "good management practice" viewpoint:

- An 80% sewer charge in municipalities that currently have no sewer charges;
- The adoption of full metering of residential customers. Two pricing options were tested following full metering: adoption of the regional average monthly water price for newly metered customers (calculated from Table 12 between the 25-m^3 and 35-m^3 levels of usage); and, where the latter were less than the average national monthly price, adoption of the latter price.

In analyzing the revenue effects of water price increases, account has to be taken of the price elasticity of demand. Price elasticity refers to the measurement of how resource usage (in this case water usage) changes in response to a change in price. Earlier in the paper, we pointed out studies that showed the decreased water demand resulting from increases in the price of water. These have found, in general, that water is quite price inelastic, in that a given percentage increase in price will lead to a less-than-proportional decrease in water usage. For the purposes of this paper, we have assumed an average price elasticity of -0.2, which implies, for example, that a 10% increase in price will lead to a 2% fall in water demand. Thus, for the a doubling of basic water prices will result in a 20% decrease in usage. Similarly, the 80% sewer surcharge will cause a 12% decrease in demand. Accordingly, the pricing modifications proposed in the simulation analyzed here will lead to an estimated demand decrease of 32%. This effect has been incorporated into Table 21.

In addition to the $2.2 billion that could be raised through a general doubling of water prices, a country-wide total of $2.0 billion would be raised through a 80% sewer charge. (Sewer charges of this magnitude are already in use in some municipalities.) Universal metering and pricing reform in flat-rate communities would raise between $0.1 billion and $0.3. As shown in Table 21, additional annual revenues for the complete simulation would total between $4.3 billion and $4.5 billion. These fairly inexpensive water rate and pricing reforms would meet the financial requirements for both the "catch-up" period (1993-2003) and the period beyond 2003. Thus, at the macro-economic level all of the forecast financial requirements in Table 20 could be met through the pricing reforms simulated here.

In considering these reforms, it should be recalled that the calculations outlined here are macro-level ones; in other words, they apply to fairly broad areas, and circumstances in individual municipalities may vary. Certainly, some areas may require additional assistance if there are serious problems. But many others will require no reform, simply because they are in good physical and financial shape. The lesson from the macro-level analysis is that reasonable rate and pricing reforms can raise sufficient revenues to meet foreseeable additional capital requirements. Such reforms are also one major key to sustainable municipal water systems for the future, a subject which will now be examined.

3.4 Water Prices and Sustainable Municipal Water Systems

As pointed out earlier, price theory suggests that consumption of an extra (or marginal) unit of a good or service depends upon the price of that unit, and further, that the price of the marginal unit is the price that should be set for the commodity. Our study compiled the marginal price of water at the 35-m^3 level of usage, and found that it is generally below $1, and nationally below 50 ¢. These low prices imply that consumers would have very little incentive to curtail their use of water, and that water wastage may be occurring.

The pricing and infrastructure issues can be usefully addressed within a context of environmental sustainability, or in more popular terms, sustainable development[17]. This concept suggests a number of conditions that have to be met in order that municipal water systems achieve sustainability. These form a useful frame of reference for the substantive portion of this paper. The conditions referred to are (1) economic and financial viability, (2) physical viability, and (3) environmental and human health.

Economic and financial viability relates to the ability of a municipal water service to be self-sustaining financially, and at the same time carry out its functions with a reasonable degree of economic efficiency. The latter, in simple terms, conveys the idea of achieving overall ends at least cost. The former refers to a recurring theme in this paper that municipal water (and wastewater) utilities should cover the full costs of system operations by means at their own disposal and without undue subsidization, either between customers or from higher levels of government. It seems quite clear that full cost recovery does not occur in many areas, as demonstrated by frequent demands for federal and provincial co-financing of municipal water infrastructure.

[17] A discussion of the sustainable development concept, taken here to mean "socioeconomic development today, without harming the ability of future generations to grow and develop," is beyond the scope of this paper.

The issue of efficient expenditures is closely bound to the financial issue. A primary finding of this study is that Canadian retail water prices are very low in both absolute and relative terms, and that consumers receive the wrong signals about the value of water used. To most, municipal water services are cheap commodities that need not be conserved. Thus, water is viewed in most instances as a requirement to be met, not as a demand that can be changed through pricing practices. Artificially high demands inflate operating and maintenance costs, including significant energy costs. Prices fail to reflect the total costs of system construction, maintenance, and renovation. The deteriorating condition of water-related infrastructure is proof of this. Declining block rates or, even worse, flat rates, for which marginal costs are zero, fail to recognize that large water users are primarily responsible for overall system capacity, design, and costs. Thus, in reality, there are implicit subsidies to large water users from the general public.

The actual situation is even more unfavourable than simple price-demand comparisons indicate. Because they are low, prices are rarely taken into account in projecting water demands. Many consultants and analysts assume a constant, or even increasing water use per capita, and then multiply these "coefficients" by projected population figures to generate projected water "requirements" for the future. These requirements then become design parameters and lead to systems being expanded or built that would be too large if water price were more reflective of actual resource values. Once these systems are built, they have to be used, which forms an incentive for keeping prices low, forcing another expansion of the system before it would be required if prices reflected actual economic conditions. Thus the cycle of low prices - high demands - overbuilding is self-reinforcing. This is a waste of scarce public resources, and by all indicators, not sustainable economically. Thus, on both financial and economic grounds, many Canadian municipal water systems are currently neither financially nor economically sustainable.

Physical viability relates to the continuing integrity of physical infrastructure. Both in Canada (FCM, 1985) and the U.S., evidence suggests that municipal infrastructure has deteriorated over the past decade. The FCM documented a significant shift in funding out of the infrastructure area into more visible and locally more attractive projects, such as arts centers, recreational complexes and the like. The federation's study documented the decreasing proportional share of municipal budgets formed by public works expenditures. These factors suggest that municipal water systems are physically unsustainable over the long run if current trends continue.

The way out of this economic and physical problem of unsustainability appears quite simple: a rise in water prices to consumers to levels that recover the full costs of water supply and waste treatment. This paper has shown, in macro-level terms, that a few alterations in pricing practices and moderate increases in prices would be sufficient to raise the required revenue to assure long term viability in financial terms and increase efficiency as well. Such a policy would raise prices by about $30 per month for an average consumer, a little more than the cost of a case of beer or monthly cable television service. With proper education and information programs, such a move would be "saleable," especially given the priority placed currently on environmental issues by the public.

Environmental and human health, the real foci of sustainable development, are invariably affected by deteriorating water system infrastructure. The relationship between advances in water supply and waste treatment on the one hand and the eradication of water-borne disease on the other is well established. While we are not experts in the public health field, logic suggests that infrastructure deterioration has potentially damaging effects on public health. Since this deterioration is, at root, the result of revenue insufficiency, current practices in municipal water pricing are simply not sustainable from the viewpoint of environmental and human health.

4.0 CONCLUSIONS

- Water rates and prices constitute the largest source of revenue for municipal water and wastewater utilities. This paper has examined the characteristics of this important source of revenue, based on a survey of almost 1200 Canadian

municipalities. The paper is framed in terms of determining the nature of the incentives implicit in the rates and prices for efficicient, non-wasteful water use; which we refer to also as water conservation.

- The survey resulted in the receipt of just under 2700 residential and commercial rate schedules. Half were of the flat rate type, which offers no incentive at all for efficient water use. Interestingly, substantial portions of major metropolitan areas billed their customers on a flat rate basis. An additional 19% of rate schedules were of the declining block rate type, which, while a form of volume-based pricing, offers only declining and weak incentives for efficient water use. Only about 30% of rates, accordingly, had any significant efficiency incentives.

- In terms of customer classes, flat rates applied significantly more to residential than to commercial customers. Also, many of the so-called volume-based schedules had quite large volumes of water (i.e., above average daily usage) attached to their minimum charges, thereby effectively placing their customers into the flat rate category.

- For the volume-based rates, unit prices were very low, usually under $1.00 per cubic meter. The unit prices increased by an average of 67% over the 1986 to 1991 period. There was no evidence of economies of large scale in the unit price statistics.

- Sewer surcharges are becoming an increasingly popular means of recovering waste treatment costs. These most commonly take the form of a percentage added to the basic water supply bill, for sewage return flows are rarely measured for individual services. In 1991, 23% of the water rates contained such sewer charges, with the average effect of the charges being to raise basic water bills by 30%. Some municipalities, however, had sewer charges over 100% of the basic water bill.

- Marginal prices are, at least theoretically, key benchmarks in the decision to use one unit more or less of a commodity, in this case municipal water services. Marginal water prices in Canada were very low, and, subsequently, economic factors seldom enter the decision-making "calculus" related to water use. In the case of flat rates, marginal prices are zero, and this factor alone, often acting implicitly, leads to very high demands on municipal water services.

- Meters are key instruments in implementing an effective water pricing regime, and yet some 10 million customers received unmetered water services in 1991, including large portions of those in some of Canada's largest cities. The municipal water industry, as noted already, has revenues in the $3 billion range and is the only industry in Canada of that magnitude that fails to measure such a large proportion of its primary product. Full metering is the most important step that could be taken to improve the financial condition of municipal water utilities.

- Retail prices of water (and wastewater) services averaged just under $23.50 per month (at the 35-m^3 level of usage). This represented a 45% overall price increase in the 1986 to 1991 period. While this appears significant in proportional terms, it represents a very small amount in absolute terms, especially when the very great benefits to society of public water services are considered. Commercial water prices were somewhat higher than residential ones, but were still minimal on average. Retail water prices varied geographically, reaching highs in the Prairies and the territories and lows on both coasts and in Quebec. Water availability, climate, and tradition may account for these geographic variations.

- Water infrastructure financing has recently been an issue of some importance for public policy. While water rate revenues are the major source of funds, total costs are almost certainly greater than the $3.3 billion raised. The remainder has to be picked up though transfers from other levels of government. In the future, several major capital needs will arise if water systems are to remain effective

components of national infrastructure, including renovation and expansion of existing systems, improved wastewater treatment to the secondary level, and complete water metering. Estimated net additional capital plus associated O&M costs lie in the $4.5 billion range annually between 1993 and 2003 and fall to $1.8 billion thereafter.

- Modest revisions to water pricing practices, including an overall doubling of average prices, an across-the-board 60% sewer charge, and full metering would raise an estimated additional revenue between $4.3 billion and $4.5 billion annually. These additional revenues would be sufficient to meet the estimated required costs. The need for additional general cross-subsidies from other levels of government are not required in our opinion in most areas. However, the analysis reported here is a macro-level one, and individual circumstances may vary. A few municipalities may require additional help, but this requirement should not cloud the overall "message," indeed public policy, of moving as quickly as possible to full cost recovery.

- In terms of sustainability, current municipal water pricing practices give some cause for concern. A brief consideration of financial, economic, and physical viabilty, as well as environmental and public health leads to the conclusion that municipal water systems are unsustainable under current pricing practices.

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