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Foreword

On behalf of the Intergovernmental Committee on Urban and Regional Research (ICURR), we are pleased to present this study documenting municipal practices in water conservation.We hope that the report will help Canadian communities wishing to take action on this issue.

ICURR's research on the many facets of urban sustainability has been developed through the years under the leadership of its sponsors, the provincial and territorial ministries of Municipal Affairs and the Canada Mortgage and Housing Corporation. This report complements four previous reports dedicated to urban environmental planning and development of urban sustainability indicators. In particular it focuses on best practices in the field of water conservation. In doing so it brings light to a subset of municipal initiatives in a manner akin to that of Virginia Maclaren's comprehensive guide of municipal environmental practices entitled *Sustainable Development in Canada: From Concept to Practice* (1992)

ICURR would like to express its gratitude to the Ecosystems and Environmental Resources Directorate of Environment Canada for the support in making translation of the report into French possible. Our thanks are also extended to Dr. Waller and his team for their commitment to seeing this report fully completed.

André Lanteigne
Executive Director, ICURR

Dr. Claude Marchand
Research Director, ICURR

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Christopher Gates is a Senior consultant with REIC Consulting Ltd, He is a Registered Professional Planner who has been responsible for numerous water efficiency and energy efficiency initiatives, for federal, provincial and municipal government agencies, and for the private sector. He provided valuable advice and information throughout the ICURR project.

David Moore served as a CWRS Research Assistant. He was responsible for most of the effort required to prepare for and conduct the survey that formed the initial stage of the ICURR project.

Executive Summary

The project that is reported here was intended to provide information about Canadian municipal initiatives to reduce residential water consumption.

A survey of 102 municipalities produced 64 responses, which represent approximately half of Canadians served by piped water.

Assessment of survey results, and subsequent follow-up, resulted in preparation of case studies of 12 municipalities that were considered to have undertaken water conservation programs that could provide useful examples to other Canadian water utilities.

The following conclusions are based on the survey, the case studies, and other relevant experience reported in recent literature.

Many Canadian municipalities have adopted water conservation programs.

Water conservation programs implemented by many Canadian municipalities have been successful in reducing water demands, and capital and operating costs, and can be highly cost-effective, measured in return on investment to municipalities or individual customers.

Water conservation programs should be integrated into long range water supply planning.

Any municipality embarking on a water conservation program should carefully identify the objectives and the potential benefits of such a program.

Program development should recognize differences between water conservation and water efficiency, and between water conservation measures andwater conservation incentives.

There is no universal water conservation program that will be appropriate for every Canadian municipality; water conservation programs should be tailored to address problems and situations that are unique to each community.

Water conservation can reduce hydraulic loads on wastewater treatment plants and on-site sewage systems, and reduce pollutant discharges to the environment.

Metering is a primary element in an effective water conservation program.

A consumption-based price structure—which cannot exist without metering—if based on realistic prices and appropriately selected to address local circumstances, can result in significant reductions in water consumption.

Inclusion of wastewater charges in water bills can be a significant water conservation incentive.

Municipal infrastructure initiatives—such as leak detection and repairs, meter calibration, and retrofit of municipal buildings—can be cost-effective water conservation measures, and do not result in revenue reductions.

Residential retrofit programs can accomplish significant reductions in water demand, depending upon the degree of consumer participation and whether toilet retrofits are permanent replacements or kits.

Public information is an essential component of any water conservation program; important elements of a public information program are definition of purpose, definition of audience, and use of appropriate measures to deliver the intended message.

School programs and demonstration projects can be important elements of public information programs.

Municipal regulations can provide important incentives for the adoption of conservation measures related to exterior water use, and for installation of meters and water-conserving fixtures in new development.

Collaboration with other agencies, businesses, service clubs, community organizations, and the media can enhance municipal programs by making available human, financial, and other resources, including the experience and contacts that the collaborators provide.

Chapter 1

Introduction

Municipalities or utilities responsible for municipal water supplies could have a variety of reasons to reduce residential water consumption. These might include opportunities to:

- avoid or defer costs of capital works,
- avoid or defer development of a new source,
- comply with conditions for receipt of transfer payments from another level of government, or
- address environmental concerns, including awareness of water as a resource.

Results of municipal water conservation may be reflected not only in costs and benefits related directly to municipal water supply; they may also be related to impacts on capital and operating costs for collection and treatment of wastewater.

Municipalities or utilities can influence water consumption attributed to residential areas by

(1) Installation of infrastructure, at the residential and utility level, that is intended to reduce water use, e.g.:
    - installation of residential water meters, which increases consumer awareness of the value of water, and may influence water use if the cost is considered significant; and
    - infrastructure improvements, such as leak detection and repair, in supply and distribution systems.
(2) Adoption of policies and practices that regulate or influence consumer behaviour, which might include:
    - regulations, such as building code requirements for low-flow fixtures in new construction, or limitations on exterior water use;
    - education, about the environmental or monetary advantages of conservation, and what the user can do;
    - collaboration, with community groups or other government agencies with related interests and mandates; and
    - fiscal measures, such as
        - application of a water and wastewater billing system—where water is metered—that is based on water use; or
        - financial incentives, such as free or reduced price low-flow retrofit products.

The project on which this report is based was designed to provide information that would inform municipalities about Canadian municipal initiatives to reduce water consumption. It would also document, in case study format, examples of successful initiatives, including their costs and results. The terms of reference for this project are included in Appendix D.

The first step in the project was to develop a working list of municipalities that were understood to have undertaken water conservation initiatives. Individuals known to the project team who were considered to be likely sources of information were contacted, and were able to supply lists of municipalities and

contacts, as well as other potential sources of information. All suggested sources of information were contacted.

Upon completion of the working list of municipalities and respective contacts, each was telephoned to introduce the project, and to request their collaboration.

A survey questionnaire was developed and sent to each of these municipalities, designed to address key questions posed in the terms of reference and related questions that were identified by the study team. Follow-up telephone calls were made where necessary to interpret or elaborate information in the questionnaire.

Results of the survey were examined to identify municipalities that might provide useful case studies examples of residential water conservation. Twelve municipalities were selected as case studies, based on:

- availability of information about the costs and results of their water conservation initiatives.
- willingness to provide further information and review the completed case study; and
- representation of a range of
  - geographical regions
  - community sizes
  - motivations for conservation, and
  - conservation initiatives.

Representatives of these municipalities responded in a timely manner to requests for additional information, and reviewed, and corrected or elaborated, the draft case studies.

The municipal survey and its results are reviewed in Chapter 2. The case studies are presented in Chapter 3. Chapter 4 is a discussion based on the survey and case study results, which leads to conclusions that are presented in Chapter 5.

Chapter 2

Municipal survey

2.1 Introduction

The survey questionnaire that was developed and used for this study is included as Appendix A. the questionnaire was sent to 102 Canadian municipalities.

Questionnaires were returned by 65 municipalities, a return rate of approximately 64 percent. A list of respondents, including contact names, mailing addresses, and telephone and Fax numbers, is presented in Appendix B.

Results of the survey, which are presented in detail in Appendix C, are reviewed in this chapter.

2.2 Survey Responses

Table 1 presents a breakdown, by province or territory, of the responses. That table also compares the serviced population of responding utilities with national statistics. The latter data is based on a national survey, updated every two to three years, that involves 1493 communities with populations exceeding 1000 persons (Environment Canada, 1994).

No responses were received from Newfoundland or PEI. For the other provinces and territories responses were 40 to 100 percent of enquires.

The total population served by the responding utilities was about 10,245,000 persons, or approximately half of all Canadians served by piped water. For individual provinces or territories the percentage of serviced population represented by responses ranged from 0 to 95%.

Table 2 shows that survey responses represented the complete range of system sizes. Populations serviced by the responding utilities ranged from 600 to 1,650,000 persons.

Table 1. Comparison of survey response data with national statistics.

NATIONAL STATISTICS (1)					SURVEY RESPONSES		
Province/ Territory	Total Population (2)	Population Served with water	% of Total	Avg. Daily Flow (m^3/d)	Surveys: Distributed/ Returned	Population Served	% of Total Surveyed
Nfld.	408565	375245	91.8	301392	1/0	0	0
P.E.I.	70736	38807	54.9	19281	1/0	0	0
N.S.	642641	477408	74.3	296524	5/4	265819	56
N.B.	499431	345956	69.3	391605	10/4	171000	49
Que.	5973005	5560834	93.1	4575067	14/7	2029266	36
Ont.	9282118	8536658	92.0	4545540	28/20	3026946	35
Man.	849981	796903	93.8	397026	5/3	634397	80
Sask.	665450	638449	95.9	304475	10/8	56950	9
Alta.	2235860	2117022	94.7	1051128	6/4	1385034	65
B.C.	3217758	2789535	86.7	1912845	20/13	2636529	95
Terr.	68329	61584	90.1	33032	2/2	39000	63
Canada	23913874	21738401	90.9	13827915	102/65	10244941	47

(1) Environment Canada, 1994.
(2) Population of communities greater than 1,000.

Table 2. Number of responding municipalities by range of populations served.

Population Range	Number of Utilities
<10,000	21
10,000-50,000	20
50,000	8
100,000-5000,000	9
>500,000	7

2.3 Water Source

Where information about source capacity was provided, it was used to estimate the relative total capacity of each source:

- Surface water sources 11090 ML/day
- Groundwater sources 410 ML/day
- Both, but proportion not known 785 ML/day

The majority of responding municipalities (68%) use surface water as a water source. Much smaller fractions use groundwater (18%) or a combination of both surface and ground water supplies (14%).

2.4 Water Demand

The survey attempted to identify average per-capita demand (total water production divided by population served) and average residential consumption (based on residential use only).

Some of the summarized responses are based on interpretations of the information provided. The ability of individual municipalities to separately identify residential demand depends on the extent to which individual services are metered. In a few cases information was given in terms of consumption per service; a factor of 2.7 (Statistics Canada, 1991 Census, average number of occupants per household) was applied to obtain an estimate of per-capita demand.

Estimated average per-capita demand for the responding municipalities ranges from 160-4000 litres per capita per day (L/c/d), with a mean of 653 L/c/d. It is interesting to note that the Environment Canada Statistics (Table 1) provide a similar value: 634 L/c/d. Average residential use ranged from 160 to 1060, with a mean of 402 L/c/d.

2.5 Reasons for Water Conservation

Sixty-three of the 64 municipalities indicated that they have undertaken water conservation initiatives.

Respondents were asked to identify and rank reasons why water conservation was undertaken. The answers were ranked, assigning 10 points for first choice, 9 points for second choice, etc. Results, grouped in order of decreasing importance, are (values in brackets are total points for each answer):

- To raise awareness of water as a resource (396)
- To defer water treatment capital costs (362)
- Environmental concerns (289)

- To avoid the need of a new water supply (288)
- To defer wastewater treatment capital costs (244)
- To avoid the need of extended reservoirs (159)
- As a condition of receiving transfer payments from a higher level of government (100).

2.6 Water Conservation Initiatives

2.6.1 Residential Water Metering

Sixty percent of the 64 municipalities that provided this information are fully metered. This represents 51% of the total population of these municipalities.

Nineteen percent of these municipalities have no metering. As indicated in Table 3, the remaining 21 percent are fairly uniformly distributed between the two extremes.

Examination of the survey responses revealed no evident relationship between the extent of residential metering and per-capta residential water use.

A possible relationship between metering and the percentage of total water use attributable to residences was also explored, considering the possibility that where a significant portion of water use was non-residential there might be less interest in residential water conservation. No relationship was apparent.

Table 3 Percent of Residences that are Metered

Percentage of 64 Municipalities	Percent of Residences that are Metered
19	0
4	1-5
2	5-25
4	25-75
2	75-99
60	100
100	

2.6.2 Infrastructure Projects

Infrastructure work was carried out by 55 (85%) of the responding utilities as part of their residential water consumption reduction initiatives. One or more of the following infrastructure projects was undertaken by each of the 55 communities:

- leak detection and or repair of water line (43)
- installation of pressure reducing valves PRV's (10)
- installation of new or updated water meters (36)
- installation of new or updated computerized water use monitoring equipment such as SCADA (Service Control and DATA Acquisition) (21).

2.6.3 Retrofit Programs

A retrofit is considered to include both a fixture replacement, such as a ULF toilet, or a modification such as a toilet dam.

Thirty-nine of the 65 communities (60%) responding to the survey indicated they had a retrofit program in place. Of these 39 communities, 37 (95%) had one or more of the following components in their program: toilet dams, low-flow (LF) showerheads, faucet aerators and washers. LF toilet replacement constituted part of the retrofit program for 13 communities. Implementation of the various retrofit programs was accomplished in a number of ways. The following list summarizes the individual techniques used and indicates (in brackets) how many of the 39 municipalities employed each of the techniques.

- Subsidization (30)
- Advertising (18)
- Resident pick-up (11)
- Delivery door to door (13)
- Mail-out (8)
- Free installation (17)
- Subsidized installation (3)
- Rebate incentive (4)
- Follow-up study (5)

2.6.4 Exterior Water Usage

Conservation focusing on exterior water use was promoted in various ways by approximately 80% of the respondent communities. The programs and number of participating municipalities (in brackets) were:

- water restrictions (lawn watering, car washing, irrigation) (37)
- xeriscaping demonstrations (14)
- public education (35) and advertising (30)
- efficient sprinkler promotions (10)
- rain barrel promotions (2)

2.6.5 Water Rates and Cost Recovery

The survey questionnaire recognized four methods of pricing water:

- flat rate, a single charge regardless of water use
- constant rate, based on water used
- declining block, where the unit charge is less for successive blocks of water used
- increasing block, where the unit charge is greater for successive blocks of water used.

The survey questionnaire did not recognise that some municipalities have other rate structures:

- a minimum charge based on meter size, and a consumption charge, based on a constant, declining block or increasing block structure, for additional use; or
- a minimum charge that includes water use in the billing period up to a fixed amount, and a consumption charge for water in excess of that amount based on a constant, declining block, or increasing block structure.

Attempts were made to clarify responses from these communities by follow-up telephone calls, but the following summary may still reflect some difficulties in interpretation of these answers.

Information on rate structure was provided by 61 of the 65 respondent municipalities. The most common residential rate structure reported is flat rate (23 of 61 respondents (42%)). In order of decreasing popularity, the remaining rate structures and the percentage of municipalities using them are: declining block (21%), increasing block (18%), constant (11%), and a base rate plus consumption cost (8%).

Considering the rate schedules in terms of population served, 58 percent are charged a flat rate, 19 percent a declining block rate, 14 percent an increasing block rate, 5 percent a constant rate and 3 percent a base rate plus a volume-based consumption charge.

Representatives from many of the responding communities stated that an appropriate rate structure for residential use, along with universal metering, was an important, if not essential, part of a water conservation program. The flat rate was not considered to be an incentive leading to water conservation. All municipalities using the increasing block rate felt this form of pricing resulted in a reduction of water use. Opinions about whether constant tate and declining block rate promote water conservation were mixed. for those communities using a constant rate structure, 63 percent felt water conservation was being promoted. For communities with a declining block rate structure, 28 percent expressed the same feeling. A number of communities that used a flat rate or declining block rate structure were examing a change to an increasing block structure as a water conservation initiative. One respondent pointed out that if the initial block in an increasing or declining block rate structure is too large relative to household water use the water conservation advantage of the former or disadvantage of the latter, compared with a constant rate, will not be realized.

Some respondents believed that increased billing frequency reduced water consumption, by making customers more conscious of water use.

Respondents were asked to indicate those costs that were recovered by way of water or wastewater charges. Answers are summarized below:

- Operating Costs of Water Supply (57)
- Capital Costs of Water Supply (45)
- Depreciation of Water Supply (23)
- Operating Costs of Waste Water Management (25)
- Capital costs of Waste Water Management (20)
- Depreciation of Waste Water Treatment Systems (12)

These answers may have been influenced by the form of the questions, which in retrospect might have been clearer. They nevertheless suggest that water rates generally do not reflect the complete costs of water supply and wastewater disposal.

2.6.6 Laws and Regulations

Thirty-six of the 65 (55%) responding communities indicated that they have in place or have introduced new laws/bylaws/regulations/ ordinances as part of their water conservation initiatives. Examples include:

- exterior use restrictions (lawn watering on odd/even days during the week; manual lawn watering only; timer requirements for underground sprinkler systems; limited use for car washing;
- all new connections require meter installation;
- restrictions on interior water use equipment (prohibit single-pass water cooling systems);

- water conservation plan requirement for new construction to obtain building permit; or
- mandatory installation of low-flow toilets.

2.6.7 Public Awareness Programs

Public awareness promoting water conservation was employed by 87 percent of respondent communities, in a number of ways. The most popular form was the distribution of brochures/pamphlets/information packages through the print media. Other techniques involved public lectures, posters and signs and radio and television commercials.

For those communities using printed material in their campaigns most of the information was produced in-house. This information was supplemented mainly by material obtained through the American Water works Association, federal, provincial, municipal and private agencies, and provincial hydro utilities.

2.6.7.1 School Programs

Forty-two of the 65 responding communities indicated that water conservation has been promoted in schools in their districts, primarily through school visits (29), field trips to water and/or wastewater treatment plants (24), distribution of water awareness kits (18), water conservation poster contests (9), and water conservation videos.

The largest target group in school-aged children were those enrolled in grades 4 to 6 (Table 4). Comments from municipal respondents indicated that this age group was the most receptive, attentive, and most eager to learn about water conservation techniques. It was hoped that knowledge gained by these students would be transmitted to family members.

Table 4. School water conservation programs, by grade

Grades Visited	# of Municipalities	% of 42 respondents
Grades 1-3	22	55
Grades 4-6	36	90
Junior High	17	43
Senior High	11	28

2.6.8 Collaborating Groups

A number of municipalities identified groups that collaborated with them in promoting water conservation. These included:

- Local Economic Development groups
- Local Chamber of Commerce
- Community Environmental groups "Green" Programs
- Service Clubs
- Local School Boards
- Science Centres
- Nursery/Garden Centres
- Naturalists Clubs/Sanctuaries
- Fruit Growers Associations
- Local Plumbing Contractors.

2.7 Costs and Benefits of Water Conservation Programs

The survey results did not provide significant information about costs of water conservation initiatives. Reported benefits of water conservation programs are summarized below, together with respondent's comments about factors affecting the success of their water conservation initiatives. Case studies in Chapter 3 document results from 12 municipalities for which detailed information was available.

2.7.1 Water Use Reduction

Reported reductions in water use resulting from water conservation initiatives are summarized in Table 5. This information was not available from most of the responding municipalities.

Table 5. Projected and actual water savings.

	# of Communities	% Respondents
Projected Savings		
0%	1	2
1% - 10%	9	14
11% - 20%	10	15
21% - 30%	6	9
31% - 40%	0	0
Actual Savings		
1% - 10%	2	3
11% - 20%	1	2
21% - 30%	5	8
31% - 40%	2	3
Not Reported	13	20
Savings not known	15	23

It is not possible to assign specific reductions in water use to specific conservation initiatives; commonly more than one initiative was responsible for reported water savings. Many of those who responded indicated that it was too early in their programs to determine actual results.

Fifty-seven percent of the reporting communities indicated water savings, projected or actual, as a result of water conservation initiatives. Thirty-seven percent reported savings greater than 10 percent, and 17 percent reported savings greater than 20 percent.

2.7.2 Cost Recovery

Depending on the form of water conservation initiative, the time frame for the recovery of implementation costs ranged from 2 weeks to 10 years. Most survey results do not provide information that can associate specific water conservation initiatives with related cost recovery periods, but the following example was reported.

The water supply serving roughly 6400 persons in the Town of Winkler, Manitoba experienced demands that exceeded the capacity of the water supply system. After only two weeks from the date of

publicising their concerns through print and radio media a sufficient reduction in demand was realized, eliminating the immediate need for other initiatives to reduce demand or increase the supply.

2.7.3 Wastewater Reduction Benefits

Forty-four of the 65 responding utilities (68%) indicated that water conservation initiatives were beneficial to their wastewater treatment systems. The results are summarized in Table 6; some utilities cited more than one benefit.

Table 6. Waste water system benefits due to water conservation.

Benefits to Wastewater System	Number of Positive Responses (from 44 utilities)
Delay Expansion or Construction of Further Wastewater Treatment Facilities	33
Delay Repair/Replacement of Pipeline Infrastructure	10
Other Benefits (reduced operational costs, chemicals, electricity, increased plant treatment efficiency resulting from reduced hydraulic loading)	14

Eighteen communties estimated or stated actual reductions in wastewater flows as a result of the water conservation initiatives undertaken by their community (Table 7). In most cases reported flow reductions were less than 10 percent.

Table 7. Reduction of Wastewater flows associated with water conservation initiatives.

% Flow Reduction	# of Municipalities
0 - 5	8
6 - 10	6
11 - 15	1
16 - 20	1
21 - 25	1
26 - 30	1

2.7.4 Success of Water Conservation Initiatives

The majority of respondents felt that their water conservation initiatives were successful.

Specific comments about factors influencing the success of water conservation programs were:

- Metering is considered "a must" for communities that want to decrease consumption. Without a user-pay system, water will continue to be wasted. In communities where metering was introduced as part of a water conservation initiative, reduction started as soon as the metering was implemented.
- Consumers must start paying more for the true value of a precious commodity. Many respondents felt water prices did not reflect true costs.

- It is difficult to measure the success of a plumbing component retrofit program without performing a follow-up study. Many representatives from communities who have established retrofit programs realize this, but due to a lack of funds or manpower cannot perform a follow-up.
- Water conservation promotion is considered crucial in a successful program. Public awareness about a potentially fragile resource has increased in communities who advertised and promoted water conservation. Many representatives felt that without public awareness and assistance, water conservation cannot be accomplished.
- The addition of a sewer charge to metered water rates has proven to be an effective way to reduce water consumption.

2.7.5 Initiatives with Limited Success

Only three communities indicated that their initiatives were not successful. One respondent felt that the public education program in the community was not successful, and for that a water conservation program to be effective, metering must be implemented. In the second community, the price of water was not considered to be high enough, thus making it difficult to promote water conservation when the cost incentive for conservation was not there. In the third, the success of the program was difficult to monitor because no metering was in place.

No specific problem was identified by more than one or two respondents, except the limitations that lack of metering or low water costs placed on program implementation or success.

Specific difficulties identified by individual municipalities were:

- Retrofits
  - no way to tell whether retrofit kit items will stay in place and water savings will be long term.
  - toilet bags leaked
  - fixture rebate considered not successful: very poor response.
- Exterior water use
  - voluntary limits not considered successful.
- Public Information
  - difficult to convince hotel sector to conserve
  - restaurant cards not considered successful
  - high school program not considered successful.

Chapter 3

Case Studies

This chapter presents case studies that describe water conservation programs and projects undertaken in twelve Canadian municipalities. In each case information is provided about the objectives of the program, water conservation initiatives, and program costs and results. Results include, where applicable, unsuccessful initiatives.

Selection of the case study municipalities was based on information obtained in the survey reported in Chapter 2. Municipalities chosen were those that have undertaken significant water conservation programs, had documented costs and benefits, and were willing to share their experience with other Canadian municipalities through the results of this project.

The twelve communities represent all regions of Canada, from Nova Scotia to the North West Territories, and system sizes that range from those serving from 10,000 persons to those that serve up to 650,000.

Objectives of the programs described here include reductions of average demands, peak seasonal demands, and/or peak day demands, in order to

- defer capital costs of water treatment, distribution or storage, and/or wastewater collection and treatment, or
- reduce operating costs of these facilities.

Solutions include those that address unaccounted for water and water use for municipal purposes, and those intended to reduce demands by residential and other customers.

Some programs are broadly based, and employ a variety of initiatives. Others—like Barrie that has undertaken universal building retrofit, or Kelowna that has undertaken universal metering—are more focused.

Although the emphasis of the project reported here is residential water conservation, the case studies also describe other initiatives, such as public information programs, that address more than one sector, or those, like leak detection and repair, that may also contribute to reduced demand and cost savings. In many cases it not possible to attribute cost savings to a specific water conservation activity.

3.1 BARRIE, ONTARIO

Residential Population	71,413
Residential Demand	417 L/cap/day
Current metering	100 percent of residences

The following case study includes information from Gates et al, 1996, and Smith, 1996, in addition to that received from the City of Barrie.

3.1.1 Program Objectives

The objective of Barrie's Water Conservation program is to reduce
average water demands in order to defer an increase in the capacity of its wastewater treatment plant, and to defer construction of a new water treatment plant.

3.1.2 Water Efficiency Initiatives

The Barrie Water Conservation program focuses on fixture replacement. It is the first of its magnitude to be delivered anywhere in Canada.

Other water conservation measures that have been implemented are also summarized below. A parallel measure, which applies to all Ontario communities, is a provincial plumbing code requirement, effective January 1, 1993, that established maximum fixture flows in new construction: showers- 9.5 L/minute, aerators- 8.35 L/minute, toilets- 13 L/flush (reduced to 6L/flush effective January 1, 1996).

3.1.2.1 Fixture replacement program

The following information is derived from Gates et al, 1996, who report the results of the first year of a monitoring and evaluation project that will document and assess Barrie's fixture replacement program. It will record, in addition to program costs and demand changes, sanitary sewage effects, including flow, sludge volumes, sewage concentrations, and solids deposition problem; results at this point are preliminary only.

Specific objectives of the conservation program, which started in January of 1995, are to accomplish the following within a three-year period:

- Contact 100% of households
- Contact 100% of industrial, commercial and institutional(IC&I) users.
- Complete fixture replacement in 15,000 of the city's 26,000 households.
- Reduce water use in participating households by 50 litres per person per day.
- Reduce water use in the IC&I sector by 30 percent (this phase scheduled to begin in late 1996).

The program provides fixtures and fittings free of charge to the householder, and offers the services of pre-qualified plumbing contractors who install toilets for a set fee ($53 for one, $85 for two, $112 for three).

The Water Conservation program is the responsibility of Barrie's Municipal Works Department. The program was initiated, and conducted during the first year, under the Ontario Ministry of Energy and Environment's Green Communities program. Under that program, the City contracted with a community-based organization called Be Green Barrie to deliver the residential program by way of that group's Green Home Tune-up project, in which advisors addressed waste, water use, and energy efficiency in every household and contacted owners or managers of multi-residential buildings. Due to cancellation of the Green Communities program, the City decided in January of 1966 to rely on recruitment of households via media ads and the marketing efforts of the pre-qualified plumbing contractors.

In about 50% of Home Tune-up visits no fixtures were ordered. A survey indicated that reasons included wanting to see the fixtures in a showroom, wanting to discuss with spouse, problems such as

colour matching or floor repair, not interested, low consumption or already had low flow fixtures, couldn't afford installation, or didn't recognize financial savings. The success of marketing in multi-unit buildings, where decisions by management resulted in numbers of orders, was greater.

As of February, 1996, 6900 toilets had been replaced in 4470 households, together with about 4000 showerheads and 7500 kitchen sink and faucet aerators.

3.1.2.2 Rate Increase

Barrie's water rates increased by 7 percent on April 1, 1996.

3.1.2.3 Altered rate structure

Barrie changed its declining-block rate structure from three blocks to two blocks, effective January, 1996.

3.1.2.4 Exterior Water Use

A Public Utilities Commission regulation regarding odd/even lawn watering in summer results in an annual notice sent with each water bill in April. A $50 fine can be added to a water bill.

3.1.2.5 Public Awareness Program

3.1.2.5.1 Program Objectives

Objectives of the public awareness program included advertisement and encouragement of

- the retrofit program
- outdoor water use regulations
- water conserving practices

3.1.2.5.2 Program Components

For the 21,000 households in single family housing, the Water Conservation program was marketed as part of the Green Home Tune-up service. Marketing and promotion initiatives were designed to create name recognition for the service, and to recruit householders to have a tune-up.

Promotional activities included:

- Newspaper articles, advertisements, and special inserts
- Radio news items and advertisements
- Cable TV
- Local neighbourhood Green Tent displays
- School materials
- Water bill inserts
- School programs
- Xeriscaping demonstration garden
- City staff e-mail notice
- Street banner, bus shelter signs, on-bus advertisements
- Electronic signs
- Car magnets

Newspapers, word of mouth, and displays were most often cited as reasons for Tune-up requests.

A separate strategy was developed for the multi-unit sector. It included both general advertising and promotion, and direct marketing by letter to property owners and managers. Marketing materials were tailored to situation where either owners of tenants were responsible for utility bills. Standard materials were prepared for follow-up contacts with building managers and tenants.

3.1.3 Collaborations

The first year's program was delivered with the assistance of the Be Green Barrie program. The Ontario Clean Water Agency (OCWA), Barrie Public Utilities Commission (PUC), and the City of Barrie were partners in that program; the City provided financial support, and the PUC provided training and billing histories for the program.

The City developed contractual relationships with equipment suppliers and plumbers. Available ULF toilets were reviewed, in consultation with OCWA. Three units were selected based on previous use in the field and use of Canadian components, and local suppliers were asked to bid a basic price for units in white, bone, and grey, and an upgrade price for other colours. Five standard models and three upgrade models were selected for the program. Householders were expected to pay the incremental cost of the up-grade.

Plumbing contractors were recruited via a tendering process that specified that the City could award all or part of the work to the winning bidder, and that other bidders would be allowed to match the winner's price. In negotiations with the winner, that firm was guaranteed all of the multi-unit work; other bidders were offered, and several selected, the opportunity to work in the single-family market at the same price.

3.1.4 Program Costs

Costs to implement the water efficiency program in year one were (Gates at al, 1996):

- Fixtures and fittings - $ 860,800
- Program delivery - 477,515
- Installation (estimated - 293,250
- Evaluation by Ontario Clean Water Agency - 65,000

$1,696,565

These costs do not include disposal of old fixtures. The City is stockpiling toilets at a local landfill site, anticipating their use, after crushing, as an aggregate for municipal construction projects. Crushing of the toilets will cost $4 per tonne, compared with a cost of $5 to $6 per tonne for new aggregate.

The forgoing costs represent an average of about $380 per re-fitted household. Costs per unit were somewhat less for multiple unit buildings, in which the number of toilets averaged 1.16 compared with 1.9 in single family houses.

Because the program delivery costs in the first year included significant start-up costs, it is anticipated that the unit cost for this item, over the three years of the program, will be lower that those indicated above.

These costs were offset by a 30 percent grant from the Ontario Clean Water Agency.

3.1.5 Program Results

Based on a sample of 310 accounts for which reliable billing data was available, it was determined that average consumption decreased, from 900 to 630 L/household/day, as a result of conservation. Analysis of the data indicated that the hypothesis that savings of 20% or greater are achievable would be accepted at the 90% confidence level.

A 20% reduction, for the sample households, corresponds to 62 L/capita/day, which exceeds the Conservation program target of 50 L/capita/day. If these results are borne out by the results of the Water Conservation program, it could therefore exceed its target by about 25%.

The financial impact of these results is that the Water Conservation Program is expected to postpone for three to five years a $23 million investment in expansion of Barrie's wastewater treatment plant: water conservation plus a $20 million plant upgrade was adopted as an alternative to a $43 million upgrade required to accommodate flows based on traditional water use.

In addition, the City's groundwater supply was expected to reach its capacity within 5 to eight years, requiring an estimated investment of $23.5 million for a new surface water source. The water conservation program is expected to postpone this investment by at least 5 years.

3.1.6 References

Gates, C., Ramsay, D., and Brown K., 1996, "An Evaluation of the Effectiveness of a Municipal toilet Replacement Program", presented at AWWA Conference, Toronto.

Jenkins, L., 1993, "Canadian Water Conservation Survey", report, City of Edmonton Public Works Department, Water Branch.

3.1.7 Respondent

The above information was provided by, and this case study was reviewed by:

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3.2 EDMONTON, ALBERTA

Residential Population	616,700
Residential Demand	210 L/cap/day
Current metering	100 percent of residences

3.2.1 Program Objectives

The objectives of Edmonton's water efficiency program are to reduce water demands in order to offset effects of population growth in order to defer capital expenditures for facilities expansion.

In 1990 Edmonton City Council approved a Water Conservation Policy and strategy, and set a goal of a 10 percent per-capita reduction by the end of 1997.

A projected population growth rate of 1.4 percent, coupled with decommissioning of Rossdale Plant #3 in 1997, will require a 180,000,OOO litre per day increase in the capacity of the E.L. Smith plant. The estimated cost of this expansion, and associated piping, was $ 150,000,000.

In January of 1993 it was estimated that delay of the plant expansion by 5 years would involve a 15 to 20 percent reduction in per-capita demand.

3.2.2 Water Efficiency Initiatives

A Water Conservation Advisory Committee, representing water user and public interest groups, was established in 1993 to advise City Council about its water conservation program.

A survey of active water conservation programs in other Canadian cities was undertaken, and is reported in Jenkins, 1993.

3.2.2.1 Infrastructure

Edmonton has an ongoing Network Maintenance Program, which has resulted in revenue recovery on 95 percent of water plant production, i.e., unaccounted for water is less than 5 percent of total production.

Elements of this program include:

- meter maintenance program,
- leak detection using an electronic leak detector
- routine maintenance of main valves and curb service valves
- cast iron pipe replacement programs, preceding roadway and sewer improvements
- main replacement program, focused on sections with a water break density of 5 breaks per kilometer
- corrosion control anode inspection and replacement program.

3.2.2.2 Retrofit

A pilot home retrofit program, which involved 4,000 homes and used 4 separate delivery methods, was conducted in the fall of 1991.

3.2.2.3 Industrial Water Audit

Water audits were conducted in 1993 of large commercial and industrial and commercial users. Newspapers advertisements invited customer participation, which assumed that participating firms would pay 50 percent of audit costs and commit to implementation of initiatives with short payback periods. Twenty-five responses were received from large customers. City staff assisted consultants in on-site duties related to the audits, providing experience that would allow staff to conduct future audits.

3.2.2.5 Altered rate structure

Consideration was given to revising the rate structure to introduce a fixed charge that would cover costs of metering and billing, and a singe residential rate.

3.2.2.6 Public Awareness Program

3.2.2.6.1 Program Objectives

Objectives of Edmonton's public awareness program have been consumer awareness and encouragement of indoor and outdoor water conservation.

3.2.2.6.2 Program Components

Each year since 1990 the City has sent to all water customers a brochure that outlines inside and outside water conservation measures. A logo and theme, "Saving Water Makes Cents", appears on all water conservation materials.

A restaurant program aimed at increasing water awareness, called "Just Ask", was introduced in 1993: table cards distributed to all restaurants indicate water used to wash a single glass in the restaurant industry.

A brochure dealing with bathroom water use and bathroom water leakage was distributed in 1993, together with leak detection tablets to allow a customer to check for toilet leaks.

3.2.3 Program Costs

The City's portion of costs of industrial water audits in 1993 was $ 80,000.

3.2.4 Program Results

Per-capita water consumption in Edmonton was reduced, between 1988 and 1992, from 450 to 422 L/cap/day, a reduction of 5 percent.

The 1991 home retrofit pilot program yielded lower than expected savings: a 4.6 percent reduction in water use in installed homes. Recommendations from the program included:

- Deliver enhanced public education with retrofit instruction.
- Ensure that retrofitted homes achieve 100 percent retrofit of targeted fixtures.
- Select retrofit equipment to assure 100 percent customer satisfaction.

3.2.5 Respondent

The above information was provided by, and this case study was reviewed by:

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3.3 KELOWNA, BRITISH COLUMBIA

Residential Population	94,000
Residential Demand	1762 L/account/day
Current metering	ICI sectors only

3.3.1 Program Objectives

The objective of Kelowna's water efficiency initiative is to reduce average water demand in order to reduce capital and operating costs of its water and wastewater systems.

Kelowna is not faced with an immediate water shortage, but at some time water may be a limiting factor on growth. However, the cost of supplying water, and of and treating water and wastewater, is expected to escalate: the City will be faced with an expansion of its wastewater treatment plant, and upgrade of its water treatment plant that currently provides only disinfection.

3.3.2 Water Efficiency Initiatives

Kelowna's primary water conservation program is based on universal metering of water service connections, and billing based on water consumption. The roles of other water conservation initiatives that are recognized by the City are also summarized below.

3.3.2.1 Meter Installation Program

The meter installation program will result in metering 100 percent of the community's services in the period between April and November of 1996.

3.3.2.2 Fixture Replacement

The City does not have a fixture replacement program. This activity is currently voluntary, in collaboration with local retailers.

3.3.2.3 Rate Increase

Increased rates are under consideration, and will be announced in January, 1997. Mock metered billing will begin in the Spring of 1997, and actual billing will start in of early 1998.

3.3.2.4 Altered Rate Structure

Kelowna's residential water rate structure will be changed from the current flat rate to billing based on metered consumption.

3.3.2.5 Public Awareness Programs

3.3.2.5.1 Program Objectives

Objectives of public awareness initiatives include:

To enlist public support

- for the metering program, and
- for increased water rates.

To advertise the meter installation program.

To encourage household water conservation, including outdoor use and xeriscaping.

To encourage conservation in the industrial, commercial, institutional (ICI) sector.

3.3.2.5.2 Program Components

Promotional activities have included:

- Newspaper articles, columns, and advertisements
- Radio
- Water bill inserts
- School programs
- ICI brochures
- Direct mailing of educational materials
- High visibility public displays.

3.3.3 Collaborations

The City of Kelowna decided to explore the possibility of entering into a public/private partnership whereby a private partner would invest the money up front and regain it over time. The City invited the best and most creative proposals from the private sector for an agreement spanning 15 years (renewable in 5 year increments).

This approach encouraged proponents to submit plans with the most innovative and least expensive way to achieve the objectives of the project, unlike the traditional design-tender-build process where ingenuity is limited because contractors must adhere to predetermined specifications.

After reviewing the relevant project management experience, expertise, and financial position of the various bidders, the City of Kelowna decided to embark on a $3.9 million public/private partnership with Schlumberger Industries; this called for the company to handle all facets of meter operations. Schlumberger also will also provide a 2 and 1/2 year public awareness campaign.

In addition to the supply and installation of 11,200 residential meters and refurbishing/replacement of 1,200 commercial meters, Schlumberger would perform ongoing maintenance to the metering system, meter reading services for water and electricity meters, a comprehensive public education program, and 15-year financing. As part of the contract, the City has the option of buying out the contract at the end of each five year period.

By engaging the company, the City felt that it would benefit from its knowledge and abilities for future improvements in the meter program.

The all inclusive costs offered in the winning proposal were lower than the other bidders and lower than the projected costs of the works done by City employees. The City also wanted to benefit from the use of Schlumberger's state-of-the-art technology throughout the term of the contract and the transfer of risk from the City to the private company. As the company would be responsible for the delivery of all elements of the proposal, responsibility was more clearly defined and direct than with the other proposals, allowing for greater flexibility in service provision.

3.3.4 Program Costs

Costs of Kelowna's metering and public awareness programs will be:

• Metering	$ 3,900,000
• Public Awareness	300,000
	$ 4,200,000

3.3.5 Program Results

The projected result of universal metering, increased rates, and the public awareness campaign is a 20 to 30 percent decrease in water use in Kelowna.

The expected financial impacts of this decrease in consumption are deferral of a $10,000,000 investment for wastewater treatment, and a saving of a total of at least $600,000 over a 20 year period in reduced water pumping costs.

3.3.6 Respondent

The above information was provided by, and this case study was reviewed by:

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3.4 LONDON, ONTARIO

Residential Population	316,000
Residential Demand	265 L/cap/day
Current metering	100 percent of residences

3.4.1 Program Objectives

Objectives of London's water efficiency program have been to reduce average and peak water demands in order to meet long-term demand objectives and avoid or defer capital costs.

3.4.2 Water Efficiency Initiatives

Water conservation measures that have been implemented in London are summarized below. A parallel measure, which applies to all Ontario communities, is a provincial plumbing code requirement, effective January 1, 1993, that established maximum fixture flows in new construction: showers- 9.5 L/minute, aerators- 8.35 L/minute, toilets- 13 L/flush (reduced to 6L/flush effective January 1, 1996).

3.4.2.1 Infrastructure

London undertook a program of leak detection, and repair of transmission and distribution mains.

A meter management program was also undertaken, in which meters are changed on a regular basis, calibrated, and replaced, with the objective of reducing and unaccounted-for water use and lost revenue.

3.4.2.2 Retrofit

A retrofit program encourages residents to purchase toilet dams, low flow showerheads and faucet aerators at cost.

3.4.2.3 Rate Increase

A full user pay sewer charge was implemented in 1996. This eliminated previous municipal tax charges for storm and sanitary sewer and established user pay rates for both: a rate based on water consumption for sanitary sewer and a flat rate charge for storm sewer.

3.4.2.4 Altered rate structure

In 1991 the residential rate structure for residential customers was changed to an increasing block rate structure, i.e., the conservation rate structure.

3.4.2.5 Exterior Water Uses

London's outdoor water use by-law—which applies between June 1 and August 31—is based on an even/odd water use schedule.

Residents with even numbered municipal addresses may use water out of doors on even numbered calendar days. Residents with odd numbered municipal addresses may use water out of doors on odd numbered calendar days.

3.4.2.6 Public Awareness Program

3.4.2.6.1 Program Objectives

The objectives of London's public awareness initiatives are to

- advertise water efficiency programs
- encourage public support for infrastructure programs
- encourage participation in retrofit programs, and recognition of outdoor use regulations
- encourage water conserving practices within and outside the home.

3.4.2.6.2 Program Components

Advertising initiatives have used radio, school programs, water bill inserts, and special promotions. Materials prepared and or used for these initiatives have included brochures, pamphlets, and information packages.

3.4.2.7 Collaborations

The City of London has been one of the supporting partners of a community initiative initiated under the Province of Ontario's Green communities Program. London Green Horizons, now a private, non-profit organization conducts a program of carrying out environmental home check-ups. The Green Home Check-up included a component of reviewing household water use. As part of this program, 1,500 low-flow showerheads were distributed.

3.4.3 Program Costs

Estimated costs of elements of London's water efficiency initiatives are approximately:

- Meter management program $800,000
- Public Awareness $109,000

None of these costs were subsidized from other sources.

3.4.4 Program Results

Information is not available about the relative effectiveness of individual water efficiency initiatives, but records of actual billed residential water consumption between 1988 and 1995 indicate the following reductions in residential water use:

- a 75 percent reduction in Summer (May-September) use, and
- a 20 percent reduction in the non-Summer period.

3.4.5 Respondent

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3.5 NEW GLASGOW, NOVA SCOTIA

Residential Population	10,000
Residential Demand	231 L/cap/day
Current metering	100 percent of residences

3.5.1 Program Objectives

The objective of New Glasgow's water efficiency program is to defer capital costs of additional water treatment, and to avoid the need to develop a new water supply.

3.5.2 Water Efficiency Initiatives

3.5.2.1 Metering

In the period 1989 to 1994 New Glasgow implemented a meter installation program that resulted in metering of all services in the community.

3.5.2.2 Infrastructure

New Glasgow undertook an infrastructure improvement program that included leak detection and repair, and installation of pressure reducing valves.

3.5.2.3 Retrofit

New Glasgow is currently collaborating with the Clean Nova Scotia Foundation in a pilot/demonstration residential retrofit program.

On Earth Day, April 22, 1996, the Clean Nova Scotia Foundation launched a year-long water conservation program called "Be Water-Wise...It Makes Cents".

The goal of the program is to demonstrate the economic and environmental benefits of residential water conservation, and to determine the most effective approach to reducing residential water consumption.

The program targeted 300 households in each of three communities, including New Glasgow. The households were divided into three groups:

- Group 1 is a Control group that receives information only via public information programs.
- Group 2 receives an information package on why and how to conserve water, delivered and explained by volunteers; and
- Group 3 receives the information package plus the opportunity to participate in a retrofit program.

The retrofit program offers a installation of a water-saving kit—which includes an ultra low flow (ULF) toilet, and a low-flow shower head and faucet aerator—for $75 plus taxes. Upgrade options for non-standard toilets or showerheads are also offered.

A list of plumbers who have agreed to install the toilets and devices for a fixed price of $30 (paid by the program) is provided to the homeowner. Plumbers have agreed to complete a form that includes the water meter reading on the day of installation, signature of the homeowner that the installation was complete, and signature of the contractor to whom the old toilet was delivered for recycling.

Contractors were identified in each community who could crush old toilets for use as road aggregate or other construction applications.

Information\education packages presented to Groups 2 and 3 include an explanation of the program, a fact sheet with general and local information on water conservation, and brochures on why and how to conserve water in the home. Participating households agreed to provide survey information during and after the one-year test period, and to conduct a leak detection test prior to the program. A special newspaper ad will acknowledge the contribution of each household to the program.

Communication/education is an important component of the program, which includes:

- launching of the program with a news conference at a local water treatment plant;
- a media strategy aimed at radio, television and print media in each community; and
- program information provided on local Internet pages.

Results of the program will be communicated and promoted via provincial and community media, provincial and municipal politicians, news conferences, and meetings and workshops with water managers and other interested municipal and provincial representatives.

The results of the program will be assessed based on:

- water usage in all of the targeted homes, compared with baseline usage before the program, using municipal records of metered consumption; and
- surveys of households in each group to determine effects of the program of their attitudes and actions.

The program received financial support from the three communities, the Atlantic Canada Water Works Association, the Environmental Partners fund, and the Canada- Nova Scotia Water-Economy Agreement, and in-kind support from Crane Supply Inc. in discounted cost of ULF toilets.

Volunteers who participated in the program in New Glasgow included the graduating class of the New Glasgow High School, who made the Water-wise program their project for the year, and the Nova Scotia Youth Conservation Corps. Training for volunteers was provided by the program.

The program was guided by an Advisory Committee that included representatives from three levels of government, voluntary organizations, and other interested parties.

3.5.2.4 Rate Increase

Industrial water use rates were increased by 35 percent over a four year period, as a result of the altered rate structure.

3.5.2.5 Altered rate structure

New Glasgow's declining block rate structure was reduced from three blocks to two blocks.

3.5.2.6 Public Awareness Program

3.5.2.6.1 Program Objectives

The utility believes that public awareness programs must be a continuing effort.

3.5.2.6.2 Program Components

Public awareness programs have included distribution of information materials, which have included those developed by Ottawa-Carleton.

3.5.2.7 Collaborations

The utility has collaborated with organizations responsible for events such as Earth Day and mall demonstrations. Collaboration with Clean Nova Scotia is described above.

3.5.3 Program Costs

Costs of New Glasgow's water efficiency initiatives were not available when this report was prepared.

3.5.4 Program Results

Water demand in New Glasgow decreased from 2.2 ML/day in 1984 to 1.5 ML/day in 1995. The decrease is attributed to

- introduction of universal metering
- revised water rates and rate structure
- leak detection and repair program.

The pilot residential retrofit program is expected to provide guidance about possible program effectiveness and to recommend implementation approaches.

3.5.5 Respondent

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3.6 OTTAWA-CARLETON, ONTARIO

Residential Population	650,000
Residential Demand	267 L/cap/day
Current metering	100 percent of residences

The following case study includes information from Jenkins, 1993, in addition from that received from the Regional Municipality of Ottawa-Carleton.

3.6.1 Program Objectives

The objective of the Region's water efficiency initiatives is to reduce maximum daily demands.

A Water Efficiency Strategy, approved in 1992, recognized that

- if current growth in maximum daily demand was maintained, consumption would exceed current production capacity by the year 2006; and
- a total of nearly $300 million in capital projects was proposed for construction over the period 1998 to 2011.

A 1994 Water Demand study provided a detailed analysis of water production and use in the Region, based on a detailed examination of billing and pumpage records, land use planning, and other factors related to water use. The report recommendations included emphasis on peak outdoor water use, commercial demands, and non-revenue water use (which is currently 27 percent of water production).

3.6.2 Water Efficiency Initiatives

Water efficiency measures that have been implemented are summarized below. A parallel measure, which applies to all Ontario communities, is a provincial plumbing code requirement, effective January 1, 1993, that established maximum fixture flows in new construction: showers- 9.5 L/minute, aerators- 8.35 L/minute, toilets- 13 L/flush (reduced to 6L/flush effective January 1, 1996).

3.6.2.1 Infrastructure

Infrastructure programs related to water efficiency include leak detection and repair, and water meter update programs.

The leak detection program, initiated in 1984, uses an outside contractor to investigate 500 km of pipe each year.

A meter change out program, initiated in 1986, has replaced nearly 60,000 meters. The ongoing program anticipates 8,000 change outs each year.

3.6.2.2 Retrofit for Multi-unit Residential Facilities

A short term residential pilot project concluded in 1996. Water conserving devices included toilet dams and faucet washers; low-flush toilet replacement, low flow showerheads, and irrigation devices were provided if specifically requested by an applicant. The pilot was run on a cost-recovery basis with capital investments paid back to the utility based on savings in the participant's water bill. The usual pay-back period was 1 to 3 years.

3.6.2.3 Pilot Audit of Large Volume Water Users

A pilot audit of large volume water users has been based on high- volume users representing a variety of uses, their willingness and financial ability to implement recommendations from the audits, and their willingness to share results with others.

3.6.2.4 Pilot Water Treatment

A pilot plant evaluation has been conducted of a filter backwash process that uses 1/3 of the water required for conventional backwash in a water treatment plant.

3.6.2.5 Increased Meter Reading Frequency

The region has taken steps to increase the frequency of meter reading and billing. Remote reading devices are expected to be installed in all buildings by the year 2000. Anticipated results include better data for pilot studies, pricing decisions, and identification of non-revenue water, and opportunities to reinforce water-efficient behavior through application of benefits or penalties.

3.6.2.6 Public Awareness Program

3.6.2.6.1 Program Objectives

The objectives of Ottawa-Carleton's public awareness initiatives are to encourage water conservation, indoors and outdoor, and to encourage retrofit and advertise its retrofit program.

3.6.2.6.2 Program Components

The program has included

- Media advertising- primarily print
- Radio and TV coverage
- A WISE WATER USE education program
- School programs
- Inserts with Spring residential water bills
- Brochures and pamphlets
- Public lectures and workshops
- Posters and signs.

3.6.2.7 Collaborations

The Region has implemented a Community Environmental Projects Grant program, in which $75,000 is set aside for community partnerships, and has collaborated with Envirosense (a green community initiative) in a rainbarrel promotion.

3.6.3 Program Costs

Costs of implementing the Region's Water Efficiency Strategy have totaled about $250,000 per year, plus 2 staff members. In 1997 the anticipated cost is $150,000 plus 1 staff member.

3.6.4 Program Results

Anticipated savings resulting from reduction of peak water demands are deferral of $22,000,000 in infrastructure requirements.

3.6.5 References

Regional Municipality of Ottawa-Carleton, 1992, Water Efficiency Strategy Report.
R.V. Anderson Associates Limited, 1994, Water Demand Study, Regional Municipality of Ottawa-Carleton.
Jenkins, L., 1993, Canadian Water Conservation Survey, Edmonton Department of Public Works.

3.6.5 Respondent

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3.7 ROSEMERE, QUEBEC

Residential Population	12,000*
Total Demand	475 L/cap/day
Current metering	100% percent of residences*

* Rosemere Service de l'Hygiene du Milieu distributes water to Ville Rosemere, Ville Lorraine, and Ville Bois Des Filion, (total population 30,000). The first two are fully metered; Ville Bois Des Filion is not.

3.7.1 Program Objectives

Objectives of Rosemere's water efficiency program are to reduce average and peak demands in order to reduce capital and operating costs for both water and wastewater.

3.7.2 Water Efficiency Initiatives

3.7.2.1 Infrastructure

Rosemere introduced system metering and controls for flow regulation, variable pumps, and pressure controls. It also implemented a leak control program.

3.7.2.2 Retrofit

Toilet dams were made available to households by the utility.

3.7.2.4 Altered Rate Structure

The cost of annual water consumption up to 227 m^3 has remained at $90 since 1987. Cost of water consumed in excess of 227 m^3 has increased in this period from $0.16/$m^3$ to $ 0.51/m^3.

3.7.2.5 Regulations

A town by-law includes regulations to control outdoor water use.

3.7.2.6 Public Awareness Program

3.7.2.6.1 Program Objectives

The objective of the public relations program was to encourage residential water conservation practices, indoor and outdoor.

3.7.2.6.2 Program Components

Print and radio advertising and brochures and other information packages have been used. Radio advertising was discontinued in 1993 because print media were found to be more specific, more effective, and less costly.

3.7.3 Program Costs

Costs of the Rosemere's water efficiency initiatives were not completely available when this report was prepared. Approximately $ 100,000 per year is spent on leak repair.

3.7.4 Program Results

Savings have occurred in water and wastewater capital and operating costs, but the amount of these savings has not been documented.

An indication of the success of water efficiency initiatives is that water demands have not increased in proportion to estimated increases in population.

3.7.5 Respondent

The above information was provided by, and this case study was reviewed by:

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3.8 CITY OF TORONTO, ONTARIO

Residential Population	635,400
Residential Demand approximately	300 L/cap/day
Current metering approximately)	30 percent of residences

The following case study includes information from Jenkins, 1993, in addition to that received from the City of Toronto.

3.8.1 Program Objectives

The objectives of Toronto's water efficiency program are to reduce or defer capital and operating costs, and reduce operating costs, of both water and wastewater management.

These programs are also intended to reduce energy consumption in the treatment and delivery of water, collection and treatment of wastewater, and in wasteful consumption of delivered water.

3.8.2 Water Efficiency Initiatives

Water conservation measures that have been implemented are summarized below. A parallel measure, which applies to all Ontario communities, is a provincial plumbing code requirement, effective January 1, 1993, that established maximum fixture flows in new construction: showers- 9.5 L/minute, aerators- 8.35 L/minute, toilets- 13 L/flush (reduced to 6L/flush effective January 1, 1996).

3.8.2.1 Metering

Toronto has implemented a Universal Metering Programme, which targets an installation rate of 5,000 meters per year and complete metering of all residential accounts within 20 years.

Metering is mandatory for new customers or those requiring replacement or repair of interior piping. Installation of residential meters in the period 1991 to 1996 increased the proportion of the residential population served by meters from 20 percent to 30 percent.

3.8.2.2 Infrastructure

Toronto has an on-going leak detection and repair program. A three-person crew is assigned to a program that will systematically check all mains in the city over a 20 year period.

3.8.2.3 Retrofit

The City distributes a water saving kit — which includes a toilet tank dam, low-flow showerhead, faucet aerators, and leak detection tablets — to customers participating in the Universal Metering Programme and to schools participating in educational programs.
In City-owned properties where the pay-back period for retrofit is less than 3 years, retrofits are being undertaken that include ultra low-flush toilets, low flow fixtures, and mechanical retrofits.

3.8.2.4 Water Conservation Plan For New Development

A developer or owner of a new development is required to submit, as part of a development permit application, a water conservation plan that addresses the following elements:

- an inventory of all water and sewage related piping, equipment, fixtures, and appliances;
- a description of the policies, programs, processes and equipment that will be put in place to conserve water and/or reduce the discharge of wastewater; and
- a water audit, including consumption rates and expected volume of water consumption and wastewater generated by all equipment, fixtures, and appliances.

The water conservation report must be submitted for approval prior to issuance of a building permit. Appropriate on site checks will be carried out by City personnel.

3.8.2.5 Rate Increase

Toronto has a single constant rate for residential, commercial, and industrial users — currently $\$1.05/M^3$ — which has increased by approximately 20 percent in the past five years.

3.8.2.6 Exterior Water Use

The are currently no legal limitations on outdoor water use, but homeowners are requested to water no more than 3 times per week; it is also requested that those with odd address numbers water only on odd days, while those with even address numbers water only on even days.

3.8.2.7 Water Audits

Home water audits are offered to residential customers who experience high water bills. Water audits and staff training are available to all businesses on request.

3.8.2.8 Public Awareness Program

3.8.2.8.1 Program Objectives

The objectives of Toronto's public awareness and information programs are:

- to encourage public support for the Universal Metering Program,
- to advertise the retrofit program, and
- to encourage indoor and outdoor water conservation.

3.8.2.8.2 Program Components

The program has been delivered through

- advertising in print, radio and TV,
- inserts in water bills
- school programs
- public displays, including bus shelters, libraries, and schools, and
- forums and workshops with ratepayers associations.

An average of 5000 students, in Grades 4 to 6, participate each year in the School Educational Programme.

Information materials have been acquired or prepared to address each of these audiences.

3.8.2.9 Collaborations

The City has collaborated with other agencies

- with Metro Toronto in a Water Efficiency Committee
- with the Ontario Clean Water Agency
- with the AWWA/CWWA Water Efficiency Committee.

Private groups with whom the City has collaborated include:

- RAP
- Ratepayers associations
- Green Community groups.

3.8.3 Program Costs

Annual costs of Toronto's water efficiency initiatives are estimated to be:

- Metering program- $1,000,000
- Leak detection (emergency repair)- $ 45,000
- Retrofit of City buildings- $ 500,000
- Public awareness/education- $ 100,000
- Water saving kits- $ 100,000

None of these costs have been subsidized by other agencies.

3.8.4 Program Results

Results of Toronto's water conservation initiatives have been an overall decrease in consumption of 8 percent since 1991.

Estimated savings from retrofit of City buildings are more than $ 700,000 per year.

One of the initiatives that is considered to be particularly successful is the "Every Drop Counts, Water Conservation Curriculum", which is widely used in the School Educational Program.

Door-to-door drop off of Water Saving Kits is not considered to be completely successful, unless there is direct contact with householders to explain why it is important to save water, the importance of installing the kits, and how they are installed.

3.8.5 References

Jenkins, L., 1993, "Canadian Water Conservation Survey", report, City of Edmonton Public Works Department, Water Branch.

3.8.6 Respondent

Unless indicated otherwise, the above information was provided by, and this case study was reviewed by:

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3.9 VANCOUVER, BRITISH COLUMBIA

Residential Population	471,800
Average Demand	650 L/cap/day
Current metering	58 % of population (multi-family, 3 units or more)

3.9.1 Program Objectives

The objective of Vancouver's water efficiency program is to reduce average and peak demands, in order to avoid or defer capital costs for water supply, and costs for purchase of water and disposal of wastewater.

The City's population is increasing, and its per-capita demand has also increased — from 630 to 775 L/cap/day between 1965 and 1990.

The City obtains its water from the Greater Vancouver Regional District (GVRD), and pays for water based on the amount it uses. Commencing in 1996 municipal wastewater treatment costs will also be based on flow rates.

The capacity of Vancouver's supply system is limited by the capacity of its reservoir and delivery facilities. Increasing the capacity of the supply system will involve new reservoirs and/or raising of existing dams.

3.9.2 Water Efficiency Initiatives

In 1993 the City hired a water conservation analyst to initiate a water demand management program. The analyst's responsibilities include administration of a GVRD Water Shortage Response Plan (WSRP) to limit summer lawn sprinkling, retrofit programs, water audits, public information and education, liaison with other City departments, development of new initiatives, and solicitation of funding from provincial and federal programs. The program is funded from water rates through the waterworks operating budget.

This report is based on this program in the period 1993 to 1995. It does not include information about the utility's infrastructure program of leak detection and repair.

3.9.2.1 Retrofit

Two pilot studies undertaken by the City involved 150 housing units. A further 2000 homes were retrofitted under a BC21 Powersmart program that included the GRVD and several regional municipalities and power utilities. These programs provided low-flush toilets, low-flow shower heads and faucet aerators.

Data from these projects is being collected and analyzed, to provide a basis for decisions about proceeding with a larger city program. Consideration is being given to introduction of a rebate or incentive program to encourage retrofit.

3.9.2.2 New Buildings

In 1994 the City mandated the installation of ultra low-flow fittings for new construction.

3.9.2.3 Rate Increase

Single family and duplex dwellings. which are unmetered, pay an annual flat rate charge for water. All other customers pay for water based on consumption.

The flat rate charge has increased each year: from $ 177 to $ 199 per unit between1995 and 1996.

3.9.2.4 Altered Rate Structure

The industrial, commercial, and multi-family metered rate was changed, from a declining block rate to a constant rate, phased in over the period 1991-1995.

3.9.2.5 Exterior Water Use

In 1993 Vancouver City Council enacted a Water Rationing By-law that, in response to conditions in Summer months that are defined by the GVWD's Water Shortage Response Plan, will

- limit or prohibit lawn watering;.
- prohibit use of a garden hose to wash exterior surfaces,
- limit water use for other exterior purposes, including vehicle washing and gardening, and
- provide exemptions for commercial and other uses.

The enforcement strategy involves sending warning letters in response to complaints, and registered letters to repeat offenders.

Beginning in 1995 the City

- implemented a Green Barrel pilot program, in which 1000 rain barrels were distributed to citizens for about $ 60 each (50 percent of cost).
- coordinated design and installation (with Environment Canada funding) of a demonstration xeriscaping garden.

3.9.2.6 Public Awareness Program

3.9.2.6.1 Program Objectives

Objectives of Vancouver's public awareness program are to:

- provide public education about reasons for and methods of water efficiency,
- advertise and support outdoor water restrictions,
- encourage retrofit and advertise the program, and
- encourage water conserving practices, indoors and out.

4.9.2.6.2 Program Components

The public awareness program has included

- print media, radio, and TV
- water bill inserts
- a school theatre program

- public service announcements for use in theatres
- a calendar/workbook for elementary schools
- participation in conferences, workshops, and science programs
- development of the demonstration xeriscape garden and rain barrel program.

A major component of the education program was development and presentation of a school theatre program entitled " The A2Z of H2O". Based on favorable reception in its first year, the play is being updated to add new information that will include stormwater management.

Recognizing that many people were ignorant of the details of the outdoor water use regulation, newspaper advertisements, press releases and radio and TV interviews were used to publicize the program.

3.9.2.7 Collaborations

The projects identified above have involved collaboration with other public agencies, including this School Board, Nurseries, and Parks, and other groups in development of the xeriscape display and other presentations.

3.9.3 Program Costs

A report to Vancouver City Council in May of 1995 documented the costs and results of the first two years of the City's water conservation program.

Development and presentation of the school theatre program to 20,000 students, including booklets for each student, cost $ 25,000, or $ 1.25 per student, and will cost about $ 1 per student to present in the future. Offering of the program in other jurisdictions is recognized as a method of cost recovery.

The water conservation program was successful in attracting about $ 74,000 from senior government sources to support demonstration programs and workshops.

3.9.4 Program Results

The first two years of the water conservation program were considered to be very successful. In 1993 and 1994 consumption dropped to the lowest level in 25 years, to 650 L/cap/day from a high of 800 L/cap/day in 1985. Per-capita consumption in Vancouver, which was 10 percent greater than that in the GVRD in 1991, was reduced to 4.5 percent greater than the regional average in 1994.

A comparison of projected costs, and cost savings, based on 1993-94 results, is summarized here:

Annual program costs	$ 111,000
Annual savings	
- water purchase from GVWD	$ 320,000
- GVRD sewer charge	$ 250,000
	$ 570,000
Annual net saving	$ 459,000

The comparison above does not consider cost savings associated with deferral of capital improvements required if or when water demands exceed the capacity of the existing supply system.

Because sprinkling restrictions proved to be very successful in reducing Summer demands, and in educating people about the importance of water conservation, they will be continued.

The school theatre program, offered to 20,000 students in 1994, was enthusiastically received by students and teachers, and will continue.

The BC21 Powersmart retrofit program that was directed at 2000 homes achieved participation of only 20 percent. Possible reasons for the low response were:

- There was little incentive for conservation in the absence of metering.
- The area included new homes, which may already have included water-efficient fixtures.
- The area included a large proportion of persons whose first language was not English, and the first information provided was in English; although subsequent materials and contacts were in other languages they may not have fully recognized cultural differences.

3.9.5 Respondent

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3.10 VERNON, BRITISH COLUMBIA

Residential Population served	29,000[*]
Residential Demand approximately	500 L/cap/day
Current metering	100 percent of residences

3.10.1 Program Objectives

Objectives of Vernon's water efficiency initiatives are to reduce peak demands in order to avoid capital and operating expenditures on water supply.

3.10.2 Water Efficiency Initiatives

3.10.2.1 Metering

In the period between June and December of 1992 the percentage of metered residential custometers increased from zero to 80 percent.

[*] 3,500 of Vernon's population is served by another, unmetered, water supply.

3.10.2.2 Infrastructure

New pressure reducing valves were installed to reduce mainline water pressures.

3.10.2.3 Retrofit

In conjunction with meter installations, water conserving devices were installed: early flapper closure devices (pop-flush) for toilets; low flow showerheads, and tap aerators in bathrooms and kitchens.

School urinals were retrofitted with solenoid valves to limit water supply to flush tanks to periods when the bathroom light is on.

3.10.2.4 New Buildings

New residential units must install low flow showerheads. Vernon is awaiting changes in CSA standards before requiring 6 litre toilets.

3.10.2.5 Altered Rates and Rate structure

In 1994 a flat rate price structure was replaced with an increasing block structure, with a maximum quarterly charge of $175. A base charge of $33/quarter applies to usage up to 45 m^3; usage between 45 and 300 m^3/quarter is charged at $ 0.34/m^3; and usage greater than 300m^3 is charged at $ 0.56/m^3.

As of January 1, 1996, residential sewer charges are based on water consumption. Charges in each quarter are based on water use in the previous year; in the first quarter of 1996 the rate was $ 1.39/m^3, with a minimum charge based on 20m^3.

3.10.2.6 Exterior Water Use

The City has a regulation requiring alternate day lawn watering.

3.10.2.6 Public Awareness Program

3.10.2.6.1 Program Objectives

The objectives of Vernon's public awareness initiatives are to advertise exterior water use regulations, and to encourage water conservation, indoor and outdoor.

3.10.2.6.2 Program Components

The program has included

- Media advertising- print, radio, and TV
- Extensive school programs, focused on primary grades; a booklet on area water systems is now part of the Grade 4 curriculum
- Utility bill inserts
- Mall displays during Environment Week
- Talks to service clubs
- Electronic signs outside of businesses
- Bumper stickers

- A xeriscape demonstration plantation with an interpretative sign outside of City Hall, and another completed in 1996 at a recreation facility
- A drought-tolerant planting guide produced for local nurseries
- Tee shirts with new logo "Think Water- Every drop counts"
- Development of a shower head display unit, with flow gauges, that compares regular and low flow units.

3.10.2.7 Collaborations

Vernon's water efficiency program has included collaboration with

- BC Ministry of Environment, Lands, and Parks
- BC Ministry of Education
- Environment Canada
- Water Efficiency Committee of BC Water and Wastewater Association
- University Womens Club and Naturalists Club, which are represented on committees
- Local Strata Organization
- 14 local businesses that include water efficiency messages on their notice boards

The city is collaborating with B.C. Gas and B.C. Hydro in a demonstration project, involving an 80 lot subdivision, that will assess the costs and benefits of equipment and software that provides automatic remote metering and allows customers to monitor and manage their energy and water use.

3.10.3 Program Costs

The meter installation program cost about $ 900,000; average cost to supply and install a meter was $ 155.

Residential retrofits cost about $ 100,000; other costs, including school bathroom retrofits, were an additional $ 200,000. Costs to supply and install solenoid valves for school urinals were $ 200 per bathroom.

The province of British Columbia subsidized 25 percent of the cost of the metering and retrofit program.

An ongoing public awareness program costs approximately $ 15,000 per year.

3.10.4 Program Results

Reductions in water use and cost savings associated with specific initiatives are difficult to quantify.

The retrofit of school bathrooms is estimated to save 19,000 m^3 per year.
Overall results have been

- a 28% reduction in residential water use, by 100 L/cap/day
- reduction in treatment and pumping costs:
  - $ 2,000,000 in deferred capital costs
  - $ 56,000 per year in operating costs.

Initiatives that were less successful than expected were

- Use of toilet bags in retrofits: they leaked.
- Use of restaurant table cards indicating that water would only be served on request: not accepted by the public.

3.10.5 Respondent

The above information was provided by, and this case study was reviewed by:

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3.11 WINNIPEG, MANITOBA

Residential Population	621,000
Residential Demand	250-300 L/cap/day
Current metering	100 percent of residences

3.11.1 Program Objectives

Objectives of Winnipeg's water efficiency initiatives are to reduce average demand in order to defer or avoid capital expenditures for water supply.

Winnipeg's water demand is approaching the capacity of its Shoal Lake Supply aqueduct. The goal of the City's program is a 5 percent reduction in per-capita consumption by the year 1997, and 10 percent by 2010. This will defer construction of a second 160 km aqueduct — at a cost of $300-$400 million — or development of additional surface or groundwater sources.

3.11.2 Water Efficiency Initiatives

3.11.2.1 Water Conservation Database

Development of a computer-based database was initiated in 1993, initially to record information for the pilot retrofit program, and later to include all customers in the billing system.

The database is being used to

- report historic consumption by an individual account or a group of accounts;
- identify indoor and outdoor water use in correlation with weather data;
- assess results of water conservation initiatives; and

plan new programs.

3.11.2.2 Infrastructure

Infrastructure projects related to water conservation include leak detection and repair, and calibration of pumping station water meters.

An analysis of water consumption in 1992 compared with 1989 indicated a reduction in unaccounted for water from 107 to 42 L/cap/day, or from 22 to 16 percent of total demand. The difference was attributed to calibration of pumping station meters, a 60 percent reduction in watermain breaks due to system improvements and renewals, and possibly weather effects.

A pilot study to review the cost effectiveness of a leak detection program was conducted in 1993. The study indicated the occurrence of significant undetected leakage. A formal leak detection program has been initiated.

3.11.2.3 Retrofit

The estimated saving in Winnipeg from use of a low flush toilets would be 70 L/household/day; use of a ultra-low flush units would save 137 L/household/day.

A pilot residential retrofit project was conducted in 1993. The single family component involved 3600 homes (of a total of about 155,000 in Winnipeg), for which 4 methods of distribution of retrofit kits, and free kits vs a nominal charge, were evaluated. Fifteen apartment buildings, which included about 300 units, and 10 City office buildings were also retrofitted.

Retrofits kits included, for customer installation: early flapper closure devices for toilets, low flow showerheads, shower aerators, and toilet leak detection dye tablets.

Based on results of the pilot program, and ease of implementation, a multi-family program was initiated in 1994 as a first priority, resulting in retrofit of 3275 units following contacts with 80 owners/managers of buildings; there represented over 80 percent of water consumption in this class. The 1995 program involved contacts with a further 50 owners/managers.

Phase 1 of a single family mail program, also initiated in 1994, targeted 800 homes and resulted in sale of 54 kits. A further 650 kits were sold from City offices. The 1995 mail program targeted 80,000 homes.

3.11.2.4 New Buildings

The City currently does not require installation of water conserving fixtures in new construction.

A 1992 report indicated that most new residential housing in Winnipeg included low-flow toilets.

The City was a partner in the Manitoba Advanced House, which was landscaped with low water use plants and shrubs, included low water use fixtures and technology, and provided for metering and analysis of water use.

3.11.2.5 Altered Rates and Rate structure

A water rate study conducted in 1993 proposed that the current declining block rate system be changed to a uniform rate. This change is currently undergoing public review.

In 1995 the Block 1 water rate was increased by 9.7 percent.

A change to monthly billing, and inclusion of a comparison with previous consumption, will be initiated in 1997.

3.11.2.6 Exterior Water Use

It is estimated that about 7 percent of Winnipeg's annual water demand is for outdoor water use. The City does not have regulations, or summer pricing, that are directed at outdoor use.

A review of green space irrigation on City property is proposed. The City's Parks Department currently draws irrigation water from rivers lakes and streams where possible, and is reviewing landscape, irrigation, and golf course maintenance practices with the intent of water conservation.

3.11.2.7 Industrial Programs

Industrial consumption represents about 10 percent of Winnipeg's water demand. In 1994 a survey was undertaken of 44 companies that represented 79 percent of this demand; responses were received from 28 firms, which represented 62 percent of the industrial demand. Results of the survey indicated that many companies are practicing water conservation, and that opportunities exist for the City to work with companies to increase industrial water conservation. These opportunities are currently being explored.

3.11.2.8 Public Awareness Program

Winnipeg has made a major commitment to public awareness and information programs, which represent the largest single element in its water conservation budget.

3.11.2.8.1 Program Objectives

Objectives of Winnipeg's public awareness programs have been to raise public awareness of the issue, and to provide easy to follow actions for public participation in the program.

3.11.2.8.2 Program Components

Elements of the public awareness and information programs have been

- Public education, through media and billboards;
- Community education;
- Formal school programs;
- A toilet leak campaign; and
- Employee education.

Based on testing of results of early efforts, most advertising will be on television, followed by newspapers. Public focus groups have been used for program evaluation and development.

Community education, which involves displays and presentations, has included: development of a water conservation display that includes story boards and a water- efficient shower display; presence of the water conservation team at home shows; and presentations to groups that have included apartment owners, education groups, and children's groups.

The objective of the formal education component is to develop and maintain a curriculum supplement to educate the City's youth in order to achieve long term understanding, support, and participation related to water conservation. The program began in 1993 with a public education workshop that included education, advertising, and water conservation specialists. Subsequent consultation with education consultants and educators led to development of a supplement — aimed at the Grade 6 level — which was pilot tested in early 1995. The pilot supplement was evaluated and re-designed based on student and teacher feedback, and distributed in the Fall of 1995.

A water conservation home page has been established on the Internet, to enhance the existing education program and specifically the school program. It offers an interactive account of the history of Winnipeg's water supply, from its beginning to the current water conservation program.

Efforts made to encourage water efficiency in City departments have included, or will include: pilot retrofit of City buildings; program promotion in a City employee newsletter; and provision of City departments with the knowledge and information required to make the City a leader and example in water conservation.

3.11.2.9 Collaborations

In its water conservation programs the City has collaborated with many groups and organizations. Examples are educators involved in the school program, and sponsorship of the Fort Whyte Centre's "green spaces" demonstration. An education partnership has been established with the Centre to handle distribution of water conservation education materials.

3.11.3 Program Costs

The expected cost of the water conservation program in years 1993-1995 was about $680,000 per year, which can be compared with deferral of capital costs of $300 to $400 million.

The estimated breakdown of costs of program initiatives over this period was:

Public education (media, etc.)	$755,000
Community education	$ 25,000
Formal school program	$ 60,000
Pilot retrofit program	$ 30,000
Single family retrofit	$103,000
Multi-family retrofit	$ 86,000
Toilet leak campaign	$ 700
Industrial programs	$ 22,000
Unaccounted-for water study	$ 36,500
Customer accounts data base	$ 95,000
Program evaluation surveys	$ 15,000

3.11.4 Program results

Results of the single family pilot study were reductions in indoor water use of

- 11 L/household/day in the control group, attributed to increased awareness through public education programs;
- an additional 9 L/household/day in the homes that received only flyers soliciting their participation in the program;
- a further 17 L/household/day in those who were offered and accepted a free kit, and 51 L/household/day in those who purchased a kit for $15.

Estimated annual savings for each group were $4.55, $8.27, $15.31, and $29.39 respectively; the pay-back period for those that purchased the kit was therefore 6 months.

The study also concluded, based on results of homeowners' use of dye tablets in the retrofit kits, that an estimated 14 percent of Winnipeg homes and 9 percent of toilets have leaks. Results of leak repairs were average savings of 66 L/household/day.

Savings for apartment units averaged 59 L/unit/year, corresponding to an annual cost saving of about $35/unit/year.

The single family retrofit program, which was estimated to cost a total of $250,000, is expected and to result in city-wide water savings of 2.3 ML/day. The multi-unit program, estimated to cost $90,000, is expected to save 1.7 ML/day.

Water sales in the period 1990-1994 decreased from about 88 to 76 billion litres/year. Part of this decrease is attributed to water conservation; other possible reasons include weather variations that affect outdoor use, reductions in industrial and commercial demands, improved meter accuracy, and natural demand variations.

Winnipeg has learned a many lessons about the relative merits of alternative methods of retrofit program delivery. Examples are

- Free kits, dropped off or provided on request, resulted in much lower installation rates and lower water savings compared with homes that paid for a kit.
- Customers preferred, about two to one, deluxe kits that included an adjustable shower head and an early closure flapper valve.
- The percentage of those contacted who bought or accepted a kit increased when obtaining a kit was easier, i.e., home delivery vs mail out vs depot pickup.
- Based on comparison of city-wide program costs and water use reduction, it was determined that a mail-out program, based on time-time payment for retrofit kits, was the most cost-effective program delivery option for single family units.

3.11.5 References

Jenkins, L., 1993, "Canadian Water Conservation Survey", Edmonton Department of Public Works.

Tetres Consultants Inc., 1994, "Water Conservation, 1993 Annual Report", report to City of Winnipeg Waterworks, Waste and Disposal Department.

Wardrop Engineering, Inc. and Tetres Consultants, Inc., 1994, "Summary report, Water Conservation Pilot Retrofit Program", City of Winnipeg Waterworks, Waste and Disposal Department.

City of Winnipeg, 1995, Water Conservation Program Briefing Notes.

3.11.6 Respondent

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3.12 YELLOWKNIFE, NWT

Residential Population	16,000
Residential Demand	275-300 L/cap/day
Current metering	100 percent of residences

3.12.1 Program Objectives

Objectives of Yellowknife's water efficiency initiatives are to avoid or defer capital costs for wastewater (spring overflow from the City's lagoon has occurred), and to reduce operating costs for water supply.

An associated objective of the leak detection and repair program is reduction of water, from leaks, under roads, which causes frost heaving, voids under pavement, melting permafrost, and ice that leads to settlement and deterioration of pavement.

3.12.2 Water Efficiency Initiatives

3.12.2.2 Infrastructure

The primary elements of Yellowknife's water efficiency program have been:

- leak detection, and repair of distribution and service lines, and
- elimination of bleeders for freeze protection in public and private systems.

The City initiated a leak detection program in 1992, using consultants, but in 1993 purchased a leak noise correlator for use by City staff.

Old 1/4" single-line copper services were protected from freezing by heat tape. When the tape failed the accepted practice was to leave water running the year round. In 1990 about 280 bleeders on private services were eliminated, by installing either a second service pipe and a recirculating pump, or an Aquaflow unit; costs were shared between the City and residents. In addition, about 120 residential bleeders were replaced with a second pipe and pump in areas where the City was upgrading water mains.

A Water and Sewer By-law was introduced to prohibit private service bleeders, except as a temporary measure if problems occurred during the winter.

Bleeders also existed on some dead-end City mains. During existing infrastructure replacement programs nineteen 1/2" bleeders were removed from City mains, and replaced with recirculating systems.

3.12.2.3 Retrofit

The City has not introduced a residential retrofit program, but homeowners retrofit on their own initiative because of high water rates.

3.12.2.4 Rate Increase

Yellowknife's water rates are already high because of high production and delivery costs: $2.62 per m^3 consumption charge, in addition to "access" and "demand" charges.

3.12.2.5 Altered rate structure

Consideration is currently being given to recommendations offered in the rate manual of the Canadian Water and Wastewater Association, 1994.

3.12.2.6 Exterior use

The high cost of water, and metering, discourage unnecessary outdoor water use.
In the Old Town of Yellowknife a reduced flat rate is actually applied in the summer to encourage lawn watering and property improvements, in order to enhance the tourist appeal of the area. This area is served in the Summer via an above ground polyethylene piping system, and the balance of the year by trucked water and sewer.

3.12.2.6 Public Awareness Program

3.12.2.6.1 Program Objectives

The objective of Yellowknife's public awareness program is to encourage water conserving practices inside and outside of the home.

3.12.2.6.2 Program Components

The program has involved water bill inserts, and occasional distribution of information materials at trade shows.

3.12.2.7 Collaborations

The City has collaborated with the power company (Northland Utilities) in public education.

It has also shared a booth with plumbing contractors at trade shows, promoting water conservation.

3.12.3 Program Costs

Capital costs of water main improvements between 1990 and 1995 are estimated at approximately $ 650,000.

Existing City staff were used to follow up with homeowners on the removal of bleeders and leak detection.

Costs of removal of bleeders on water mains as part of infrastructure improvements is difficult to estimate; some would be removed at no additional costs, while the greatest cost to remove a single bleeder might be in the order of $ 20,000.

Costs of adding an additional shallow bury water line and recirculating pump to upgrade a single private service are about $ 4,000 if installed in Summer.

3.12.4 Program Results

Water demand has reduced steadily over the past 4 years: reductions in each year were 9.2, 5.5, 5.7, and 13.6 percent. The overall reduction in this period was 30 percent.

Metered residential water usage did not change markedly during this period; demand reductions were primarily the result of eliminating leaks and bleeders.

Turning off a single 1/4" private service bleeder, which put out an estimated 4.5 l/min, resulted in an annual cost saving of about $1,500. Turning off a 1/2" City main bleeder, which put out about 40.l/min, saved approximately $14,000 per year.

Associated cost savings in operating costs by elimination of bleeders have been approximately $600,000 per year, based on reduced water demand and savings of $0.66 per cubic meter in costs of pumping water and sewage, heating water and recirculating water, and chemicals.

Detection and repair of 10 to 15 leaks per year since 1990 has resulted in a further saving of about $150,000 per year. In addition, use of the leak noise correlator has saved staff time in leak detection and repair.

A further result of the water efficiency program has been deferral of capital costs for additional wastewater treatment.

3.12.5 Reference

CWWA, 1994, "Water Rates Manual", Ottawa.

3.12.6 Respondent

The above information was provided by, and this case study was reviewed by:

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Chapter 4

Discussion

4.1 Introduction

This chapter attempts to distill, from the information in Chapters 2 and 3 and other sources, lessons that may be useful for Canadian municipalities that are considering, or should consider, adoption of new or enhanced water conservation measures.

4.2 Water Conservation Programs are Widely Used

Many Canadian municipalities have adopted water conservation or water efficiency programs. Municipalities that responded to the survey that is reported in Chapter 2 represent about one-half of Canadians who are supplied with piped water. All but one of these municipalities reported that they have undertaken some form of water conservation initiatives.

4.3 Water Conservation Programs are Successful

The examples in Chapters 2 and 3 indicate that water conservation programs implemented by many Canadian municipalities have been successful in

- reducing water demands, and
- saving capital and operating costs, and

can be highly cost-effective, measured in return on investment to municipalities or individual customers.

The survey results describe success in terms of reductions in water demand or water flows, but contain limited information about costs or cost savings associated with these initiatives. The case studies illustrate clearly that investment in water efficiency programs, in the context of long range water management planning, can be highly cost-effective.

4.4 Water Conservation and Water Efficiency

Benefits of water conservation may be monetary, in that capital and operating costs of water supply and wastewater disposal are reduced, or that the cost to a water user is less, or they may be environmental or social.

McNeill and Tate, 1991, review social arguments for water conservation, which may include non-monetary reasons such as uncertainties about future needs, preserving options for future development, ecosystem benefits, and sustainable development of water resources. Environmental and social benefits of water conservation cited by Maddaus et al, 1996, include reduced pollution and fewer aesthetic effects associated with new capital facilities, and increase water for other in-stream uses such as fish and wildlife.

For municipalities and users in the ICI (Industrial, Commercial, Institutional) sectors, decisions related to water conservation are primarily based on monetary considerations. In the residential sector, the success of public information programs that emphasize environmental and social benefits attests to the importance that individual consumers attach to these benefits.

Loudon, 1994, explains with examples the difference between *water conservation* and *water efficiency*. The latter term—which is also used by survey and case study respondents in Chapters 2 and 3—implies a reduction in water demand that is sought in order to achieve an economic benefit. Municipal water conservation will not necessarily result in water efficiency: it is possible to employ water conservation measures that reduce water demand but result in reduced revenue or in increased costs that are not offset by financial savings. Examples, related in particular to setting of water rates, are cited below. Tate, 1990, uses the term *water demand management*, and cites its benefits as making effective use of funds available for water supply development, reduced peak loading, significant energy savings, and industrial benefits.

4.5 Integration of Water Conservation into Long Range Planning

Maddaus et al, 1996, present case studies from the U.S. and New Zealand that illustrate procedures for integration of demand management into long range water supply planning. They indicate the importance of identifying, in planning and presentation, of a conservation objective, customer target groups, conservation measures, implementation techniques, forecasted savings in water use, implementation costs, and savings in operation and maintenance costs.

Several of the case studies in Chapter 3 provide examples:

- Beginning in 1990, the City of Winnipeg began a process that led in 1992 to a Water Conservation report that proposed a long-term strategy for water conservation in Winnipeg (Tetres Consultants Inc., 1994).
- A report by the Regional Municipality of Ottawa-Carleton, 1992, described a Water Efficiency Strategy for that municipality, which was followed by a detailed water demand study (R.V. Anderson and Associates Limited, 1994).
- Gates, et al, 1996, describe The Barrie Water Conservation Program, which focuses on universal fixture replacement.

The need for and role of a municipal water efficiency program will depend on the contribution that such a program can make to achieving the objectives of a long term water strategy, and the investment in the program will reflect the perceived economic return. Some of the case studies in Chapter 3 describe substantial commitments to studies and implementation programs where the potential returns are great. In other communities programs of water efficiency planning and implementation have been more modest, reflecting the scale of both benefits and cost of water efficiency programs.

The case studies and references cited here suggest that any municipality embarking on a water efficiency program should carefully identify the objectives and the potential benefits.

Objectives are commonly defined in terms of reduction of water demands, defined in terms of annual, seasonal, or maximum daily water use. Associated reductions in wastewater flows or energy consumption may also be a concern.

Benefits are expressed in terms of avoidance or deferral of capital or operating costs. Although the survey results indicate that environmental concerns are a major reason for water conservation, the case studies and the professional literature indicate that water supply planning by municipal utilities is based on monetary criteria.

Projections of population growth, and of water demand under alternative water use scenarios, can be compared with source, delivery, treatment and system capacity as a basis for estimates of future capital and operating costs, and definition of water conservation goals.

Development of a water efficiency program involves identification and assessment of alternative initiatives that can achieve the goals, and recognition of relative demands for unaccounted-for water and the residential and ICI sectors, and their impacts on annual, seasonal, or maximum day demands.

Vickers, 1996, argues that it is necessary to distinguish between *water conservation incentives* and *water conservation measures*. Measures are actions that result in water conservation through hardware installation (e.g., fixture retrofit), behavior modification (e.g. wise water use), or management decisions (e.g., meter maintenance and repair, xeriscape gardening, leak detection and repair). Incentives include educational, financial, and regulatory initiatives that encourage or require water conservation measures.

4.6 Tailoring Programs to Community Circumstances

There is no universal water efficiency program that is will be appropriate for every Canadian municipality. Maddaus et al, 1996, emphasize the importance of tailoring water conservation programs to the characteristics of a specific service area.

Chapters 2 and 3, and other Canadian examples, indicate that municipalities have used a variety of program objectives and program approaches that are intended to address local circumstances.

A residential retrofit program is not considered necessary in Yellowknife, where the high cost of water motivates owners to undertake this work on their own. Cameron et al, 1994, describe a water conservation strategy designed for local conditions in the Northwest Territories, where a significant number of consumers are supplied with trucked water.

Vernon's program of universal metering, and Barrie's universal retrofit program, focus on specific initiatives that are appropriate to these communities. Other communities have adopted a mix of initiatives to address their individual situations.
Variables that determine selection of water conservation initiatives could include:

- the extent of current metering
- current unaccounted for water
- relative demands of residential vs other sectors that offer opportunities for water conservation
- the magnitude of seasonal demands.

4.7 Water Conservation and Wastewater Management

Survey results in Chapter 2 indicate that many municipalities have reduced wastewater flows, and capital and operating costs of wastewater management, as a result of water conservation.

Hydromantis, 1993, reviewed the effect of hydraulic load reductions on wastewater treatment plant performance, which could be achieved by water conservation and/or or sewer infiltration reduction, and concluded that these programs could result in significant reduction in pollution loads to Hamilton Harbour and in capital and operating costs.

Another effect of residential water conservation—which was not identified in this project—is reduced hydraulic load on on-site systems in parts of municipalities where municipal wastewater collection and treatment is not provided. Results can be reduced possibility of failure and/or longer life.

The role of integrated billing for water and wastewater services is discussed below.

4.8 Water Conservation Initiatives

Initiatives employed by a municipality to achieve water conservation objectives might include economic, structural, operational, and socio-political techniques (Tate, 1990).

4.8.1 Metering

It is evident from survey and case study responses that metering is considered to be a primary element in an effective water conservation program.

Metering serves a variety of roles in municipal water management;

- introduction of metering may produce a substantial reduction in residential consumption;
- metering is an essential basis for consumption-based water rate structures;
- metering provides information about water use by sector, which is necessary for effective planning, and for monitoring of the performance of water efficiency initiatives.

The Kelowna case study indicates a predicted 20 to 30 percent decrease in water use as a result of universal meter installation and a revised rate structure.

Potential costs and benefits of metering are indicated by the Kelowna case study: a cost of $4.2 million will result in deferral of $10 million in capital investment, and ongoing savings in pumping costs.

New Glasgow has completed a metering program, and Vernon's program is 80 percent complete; both have recorded significant results. Toronto is undertaking 20 year program aimed at complete metering.

McNeill and Tate, 1991, discuss two results of the introduction of metering:

- an initial reduction in use based on a psychological response, as consumers recognize that they can control the size of their water bills through their own actions; and
- an economic response that depends on the impact of consumption-based water rates.

The initial response to introduction of metering, which may be substantial, can be followed by a rebound to equal or higher water use if economic benefits of conservation are not apparent.

Loudon, 1994, points out that an effective rate structure depends on metering, and cites surveys that show that many Canadian communities do not have universal metering, particularly for residential units. Loudon and others have pointed out that the existence of metering is not, of itself, a water conservation measure. It is an instrument that provides information; that information must be used effectively—as a basis for realistic rate structure, and for planning and management—if the potential benefits of metering are to be realized.

Water pricing policies in Canadian communities vary widely. This may explain why the survey results reported in Chapter 2 did not indicate a relationship between metering and residential water use.

McNeill and Tate, 1991, cite studies that showed reductions in demand after metering of 10 to 55 percent. Reduced outdoor use was considered to be an important influence on demand, which could have significant implications for pricing policies and other incentives.

McNeill and Tate also cite studies from individual communities that show demands in unmetered areas and residences that are 46 to 100 percent greater than in metered areas. Loudon, 1994, compared demands in twelve Canadian communities, half metered and half unmetered. Per-capita demand in the unmetered communities was greater by 60, 68, and 203 percent for average day, maximum day, and maximum hourly demands.

4.8.2 Pricing and Price structures

A consumption-based price structure—which cannot exist without metering—if based on realistic prices and appropriately selected, can result in significant reductions in water consumption.

Eight of the 12 case study municipalities have implemented or have under consideration rate increases and/or the following modifications to their rate structures:

- reduction in the number of blocks in the rate structure;
- introduction of a fixed residential meter charge with a variable consumption rate;
- change from flat rate to consumption based billing;
- change to an increasing block rate structure;
- change from declining block to constant rate structure.

Loudon, 1994, cites Lacelle, 1991, who estimated approximate annual residential per capita use in Ontario for several rate types: flat rate- 125 m^3, constant rate- 87 m^3, decreasing block- 79 m^3, and increasing block- 60 m^3.

Loudon emphasizes the importance of rate structures that address situations that are unique to each system. These include the defined objectives of water conservation—reduction in annual, seasonal, or daily peak demand, and the relative size and nature of residential and ICI demands.

Rate setting manuals have been produced by AWWA, 1983, 1992, and CWWA, 1994.

Cuthbert and Lemoine, 1996, examined rate setting processes directed at water conservation in three U.S. municipalities, and concluded that significant reductions are possible with the use of water conserving rates, particularly if they are applied in conjunction with an active conservation program. Key elements of a successful program were considered to be

- strong public education and involvement in the rate setting process;
- basing rates on actual cost of providing water service to each customer class
- avoiding punitive rates that exceed actual cost just to achieve conservation
- gradual implementation of increased rates over time.

Loudon, 1994, explains and assesses the relative merits of alternative rate structures, using examples from the experiences of Canadian municipalities. Structures he considers include increasing block rates and seasonal rates. He provides examples of situations where an inappropriate rate structure can be ineffective and/or lead to reduced revenue.

Eaton, 1996, reviews current methods of financing water and wastewater systems in Ontario, examines problems associated with these methods, and provides recommendations about system improvement and implementation. Problems with current systems include: failure to recover full servicing costs from water and wastewater charges; inefficient rate structures; no metering; rate structures that do not promote conservation; consumer unawareness of the true costs of water and wastewater services; and municipal accounting practices in many communities that add all revenues into general funds and cannot relate water-related revenues to associated costs.

Loudon, 1994, discusses the importance of a wastewater surcharge as a powerful incentive for water conservation. He points out that typically a wastewater surcharge will double the water bill, an increase that is highly unlikely to occur, for any class of customer, as a result of an increase in water rates.

4.8.3 Municipal Infrastructure Initiatives

Municipal infrastructure initiatives — such as leak detection and repair, meter calibration, and retrofit of municipal buildings — can be important water conservation measures.

These measures, in addition to being cost-effective, do not result in revenue reductions.

Eighty-five percent of the utilities that responded to the survey reported some form of infrastructure work related to water conservation. Most of this work involved leak detection and repair, and/or installation of new or updated meters. Other initiatives were installation of pressure reducing valves or new or updated computerized monitoring systems.

Six of the 12 case study utilities report that they have undertaken leak detection and repair programs. Edmonton's ongoing network maintenance program has reduced unaccounted-for water to less than 5 percent of total production. Keating, 1996, describes state-of-the-art technology and procedures for identifying unaccounted-for water in municipal systems.

In Winnipeg, calibration of pumping station meters, and a 60 percent reduction in watermain breaks due to system improvements and renewals, reduced unaccounted-for water from 22 to 16 percent of total demand.

London and Ottawa-Carleton reported systematic meter management programs. Ottawa-Carleton has replaced 60,000 meters since 1984, and plans to replace 8,000 more each year.

New Glasgow and Vernon have installed pressure reducing valves to reduce system pressures.

Yellowknife has significantly reduced water use through its program to eliminate bleeders used for freeze protection in both public and private systems.

4.8.4 Residential Retrofit Programs

Replacement of existing fixtures in residential buildings with water conserving fixtures can accomplish significant reductions in water demand. Sixty percent of the municipalities surveyed indicated some form of retrofit program.

Retrofit normally applies to toilets, shower heads, and sink faucets. Toilet retrofit may consist of fixture replacement, or of modification by installation of dams or displacement devices that reduce the volume per flush or devices that allow selection of the flush volume.

Reported retrofit programs range from Barrie's universal retrofit program, to municipalities where public information programs were designed to encourage residents to retrofit. Other municipalities have provided additional incentives in the form of subsidized fixtures or fixture modifications, and subsidized installation.

Some municipalities have included leak detection tablets in home retrofit kits.

Barrie provides the most complete example of a fixture retrofit program. Anticipated results a reduction in residential water use of at least 20 percent. A large proportion of residential retrofits are also expected in Yellowknife, because of the high cost of water.

Results in other communities have depended on:

- degree of participation as a result of advertising, subsidies, or other incentives,
- long term commitment of consumers to use of removable fixture modifications, which may require long term public information campaigns, and
- performance of fixture modifications, e.g., toilet displacement bags have leaked, and conventional toilets designed for higher flush rates may not flush effectively.

4.8.5 Public Information Programs

It is clear from the survey and case study responses that public information is an essential component of any water conservation program. Some respondents attribute the limited success of their water conservation programs to inadequate public information.
Consideration of the survey and case study results suggests that important elements of a public information program as a water conservation incentive are:

(1) Definition of purpose:

- understanding of the benefits — monetary, environmental or social—of water conservation;
- understanding that a specific measure or measures — public, corporate, or personal — can achieve those benefits; and
- understanding how to implement water conservation measures.

(2) Definition of audience: politicians, public at large, school children, or municipal staff; and
(3) Selection of appropriate measures to deliver the intended message to the defined audience.

Purposes of a program might be to produce:

- understanding and support of municipal initiatives such as metering, retrofit, or infrastructure programs;
- understanding of the reason for and value of specific water conservation measures in residential and other water use sectors; or
- understanding, by residents or ICI water consumers, of how they can implement water conservation measures.

Many responding municipalities have used materials produced by organizations and agencies such as AWWA and Environment Canada, and by community organizations, and some have produced impressive in-house materials, that describe reasons for and benefits of water conservation.

Media advertising has been used to promote water conservation in general, to describe and seek support for proposed initiatives, and to inform consumers how they can save water. Print media was considered more effective by some respondents.

School programs were an important element in many programs. Most efforts were targeted at grades 4 to 6.

Demonstration and pilot projects were included in a number of programs. Examples of projects to pilot and/or demonstrate residential retrofit are in New Glasgow and Edmonton. Municipalities that have provided xeriscaping demonstrations include Vancouver and Vernon.

4.8.6 Regulations

Regulation that have been cited by survey and case study respondents have been employed as incentives for the adoption of three water conservation measures:

(1) Where Summer peak demands are high, typical regulations require that lawn watering be limited to odd or even days of the week, depending on the street address number, and may place other limitations on exterior water use.
(2) Provincial regulations (in Ontario) and some municipal regulations elsewhere require installation of water conserving fixtures in new construction.
(3) Regulations in municipalities that are not completely metered may require installation of water meters in new construction.

Dramatic reduction in London's Summer water demand illustrates the effectiveness of watering regulations. The Barrie and Kelowna case studies, although they record effects of municipal installation rather than regulations, nevertheless indicate the potential impact of regulations that require installation of water conserving fixtures or meters in new construction.

4.8.7 Collaborations are Important

It is evident from the survey responses in Chapter 2, and many of the case studies in Chapter 3, that the respondents have taken advantage of opportunities to collaborate with other agencies, businesses, service clubs, community organizations, and the media.

Collaborations have enhanced municipal programs by making available human, financial, and other resources, including the experience and contacts that the collaborators provide. Examples have included

- collaboration with power utilities in shared programs of household water and energy conservation;
- collaboration with plumbers in trade show booths;
- providing speakers to service clubs; and
- collaboration with community organization in retrofit and public information programs, and xeriscaping demonstrations.
- media collaboration has involved articles, interviews, and press releases.

Chapter 5

Conclusions

1. Many Canadian municipalities have adopted water conservation programs.

2. Water conservation programs implemented by many Canadian municipalities have been successful in reducing water demands and capital and operating costs, and can be highly cost-effective, measured in return on investment to municipalities or individual customers.

3. Water conservation programs should be integrated into long range water supply planning.

4. Any municipality embarking on a water conservation program should carefully identify the objectives and the potential benefits of such a program.

5. Program development should recognize differences between water conservation and water efficiency, and between water conservation measures and incentives.

6. There is no universal water conservation program that will be appropriate for every Canadian municipality; water conservation programs should be tailored to address problems and situations that are unique to each community.

7. Water conservation can reduce hydraulic loads on wastewater treatment plants and on-site sewage systems, and reduce pollutant discharges to the environment.

8. Metering is a primary element in an effective water conservation program.

9. A consumption-based price structure—which cannot exist without metering—if based on realistic prices and appropriately selected to address local circumstances, can result in significant reductions in water consumption.

10. Inclusion of wastewater charges in water bills can be a significant water conservation incentive.

11. Municipal infrastructure initiatives—such as leak detection and repairs and meter calibration, and retrofit of municipal buildings—can be cost-effective water conservation measures, and do not result in revenue reductions.

12. Residential retrofit programs can accomplish significant reductions in water demand, depending upon the degree of participation and whether toilet retrofits are permanent replacements or kits.

13. Public information is an essential component of any water conservation program; important elements of a public information program are definition of purpose, definition of audience, and use of appropriate measures to deliver the intended message.

14. School programs and demonstration projects can be important elements of public information programs.

15. Municipal regulations can provide important incentives for the adoption of conservation measures related to exterior water use, and installation of meters and water-conserving fixtures in new development.

16. Collaboration with other agencies, businesses, service clubs, community organizations, and the media can enhanced municipal programs by making available human, financial, and other resources, including the experience and contacts that the collaborators provide.

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Appendix A

Survey Questionnaire

CWRS / ICURR SURVEY: MUNICIPAL INITIATIVES TO REDUCE RESIDENTIAL WATER CONSUMPTION

Fax your completed survey to David Moore/CWRS
Fax No: (902)-420-7551

Centre for Water Resources Studies
Technical University of Nova Scotia
P.O. Box 1000
Halifax, Nova Scotia
B3J 2X4

1. What is the name of your utility or municipality?
   _____
   _____

2. Please complete the following:

   Your name and title_____
   _____

   Address_____
   _____
   _____

   Phone number_____
   Fax number _____
   E-Mail_____

3. What is the population that is served by your water supply?
   _____

4. What is the source of your water supply?
   - ❑ Groundwater
   - ❑ Surface water

5. What is the production capacity? _____ ML/d

6. What is the average per capita water usage in your system?
   _____ l/c/d

7. What is the average residential water usage in your system?
_____ l/c/d

8. What percentage of residential customers in your municipality are metered?
_____%

9. Why did your utility/municipality undertake a water conservation program (rate "1" most important, "2" second most important, etc.)?

___ Raise awareness of water as a resource
___ Environmental concerns
___ Defer water treatment capital costs
___ Defer wastewater treatment capital costs
___ Avoid the need of a new water supply
___ Avoid the need of extended reservoirs
___ As a condition of receiving transfer payments from a higher level of government
___ Other _____

10. To what extent does your utility/municipality recover the cost of water production and treatment through water rates? (check the following that apply):

❑ Operating costs of water supply
❑ Capital costs of water supply
❑ Depreciation of water supply
❑ Operating costs of wastewater management
❑ Capital costs of wastewater management
❑ Depreciation of wastewater treatment systems
❑ Other_____
_____

11. Has your utility/municipality introduced a plumbing component (retrofit or replacement) program as part of a water conservation initiative?

❑ Yes ❑ No

If you answered yes, please answer the following 4 questions.

11a. What type of products were involved in the retrofit/replacement?

❑ Toilet dams
❑ Faucet washers
❑ Low flush toilet replacement
❑ Low flow showerheads
❑ Faucet aerators
❑ Other _____

11b. What type of buildings were targeted?

- ❑ Residential
- ❑ Municipal buildings
- ❑ Industrial

11c. Was the cost of the retrofit/replacement fittings subsidised?

- ❑ Yes
- ❑ No

If yes, how?_____

11d. How was the distribution of the retrofit/replacement program carried out? (check one or more boxes)

- ❑ Advertising
- ❑ Resident Pick-up
- ❑ Delivery door-to-door
- ❑ Follow-up study
- ❑ Mail-out
- ❑ Free installation
- ❑ Subsidised installation
- ❑ Rebate incentive

If possible, explain in more detail:_____
_____

12. Has your utility/municipality introduced new laws/bylaws/regulations/ordinances for water usage as part of your water conservation initiatives? ❑ Yes ❑ No

If yes, give details_____
_____
_____

13. Has your utility/municipality actively undertaken infrastructure work as a part of your water conservation initiatives? ❑ Yes ❑ No

If yes, what type of work has been done?

- ❑ Leak detection and repair of transmission or distribution lines
- ❑ Installation of water pressure reduction valves (prv's)
- ❑ Installation of new or updated water meters
- ❑ New or updated computerized monitoring of water usage
- ❑ Other - Explain_____
  _____

14. Have conservation programs focusing on exterior water use been promoted?

❑ Yes ❑ No (If yes, check the following which apply:)

- ❑ Watering restrictions (e.g. lawn irrigation)
- ❑ Xeriscaping demonstrations
- ❑ Public education
- ❑ Advertising
- ❑ Efficient sprinkler promotions
- ❑ Other - Explain_____

15. Have you carried out public awareness campaigns for water conservation in your utility/municipality? ❑ Yes ❑ No

    15a. If you answered yes, please rank the following in order of importance (rate "1" most used or important, "2" second most used or important, etc.)
    ___ Brochures/pamphlets/information packages
    ___ Public lectures
    ___ Posters/signs
    ___ Print media
    ___ Radio
    ___ Television
    ___ Other _____

    15b. If your utility uses print material in your public awareness program,
    ❑ Do you produce it in-house?
    ❑ Do you use material from other sources? List the sources
    _____
    _____
    ❑ Print material not used.

16. Has your utility/municipality collaborated with non government organizations or community groups in promoting water conservation?
    ❑ Yes ❑ No
    If yes, which groups and how?
    _____
    _____

17. Has your utility/municipality promoted water conservation to young people in schools?
    ❑ Yes ❑ No

    17a. If yes, how has water conservation been promoted in the schools?
    ❑ Through school visits and talks
    ❑ Field trips to the water treatment plant
    ❑ Education through water awareness kits
    ❑ Water conservation poster contests
    ❑ Water conservation videos
    ❑ Other _____

    17b. What age groups have been targeted?
    ❑ Grades 1-3
    ❑ Grades 4-6
    ❑ Junior High
    ❑ Senior High

18. Have there been any other water conservation initiatives undertaken by your utility/ municipality? ❑ Yes ❑ No

If yes, please describe these initiatives:

_____

_____

19. What is the rate structure of the water billing in your utility/municipality?

- ❑ Flat rate
- ❑ Constant rate
- ❑ Declining block rate
- ❑ Increasing block rate
- ❑ Seasonal rates

Other _____

19a. Does your utility/municipality feel that your billing structure has promoted water conservation? ❑ Yes ❑ No

Comments _____

_____

19b. Has your utility/municipality introduced increased billing frequency as a water conservation initiative? ❑ Yes ❑ No

20. What are the ___ actual or ____ projected (check one) savings in water consumption as a result of the water conservation initiatives?

_____% reduction and/or $_____ cost savings

21. When do you expect your utility/municipality to recover the costs of your water conservation initiatives?

- ❑ 1 month
- ❑ 6 months
- ❑ 1 year
- ❑ 2 years
- ❑ 5 years
- ❑ 10 years
- ❑ Other (explain)_____

22. If your municipality is serviced by a wastewater treatment system, please answer the following 5 questions:

22a. Is jurisdiction over wastewater collection and treatment
vested within your agency? ❑ Yes
or is it vested elsewhere? ❑ Elsewhere

If elsewhere, please specify_____

_____

22b. Do you expect your water conservation initiatives will be beneficial to your waste water treatment system? ❑ Yes ❑ No ❑ Unknown

If you answered yes, how will the benefits be realized?

- ❑ Delay the expansion or construction of further waste water treatment facilities

❑ Delay the repair/replacement of pipeline infrastructure
❑ Other _____

22c. Has your municipality experienced sewer transport problems from reduced flow as a result of your water efficiency programs?
❑ Yes ❑ No

22d. Are sewer costs recovered
❑ In the water bill (e.g. through a sewer surcharge)
❑ Through property tax
❑ Other_____

22e. What are the ___ actual or ___ projected (check one) savings in wastewater treatment as a result of the water conservation initiatives?
_____% reduction and/or $_____ cost savings

23. Have the water conservation initiatives in your utility/municipality been successful?
❑ Yes ❑ No
Comments _____
_____
_____
_____

24. Were there any components of your water conservation program that your utility/municipality felt were not successful or beneficial?
❑ Yes ❑ No
Please explain_____
_____
_____

25. Does your utility/municipality plan to add or extend the water conservation initiatives presently already in place?
❑ Yes ❑ No
Please explain_____
_____
_____
_____

26. Does your utility/municipality plan to drop or cut-back on one or more aspects of your present water conservation initiatives?
❑ Yes ❑ No
Please explain_____
_____
_____

Please list any reference material or information sources that may be relevant.

Other comments:

Appendix B

Questionnaire Respondent List

Municipality	Contact and Mailing Address	Phone/Fax
Dartmouth	Debbie Leonard, Manager, Customer Service Halifax Regional Municipality - Dartmouth Halifax Regional Water Commission, PO Box 9335 Station A, Halifax, N.S. B3K 6A4	902-490-4998/ 902-490-4808
Halifax	Debbie Leonard, Manager, Customer Service Halifax Regional Municipality - Halifax Halifax Regional Water Commission, PO Box 9335 Station A, Halifax, N.S. B3K 6A4	902-490-4998/ 902-490-4808
Middleton	Steven Hawboldt ACAP Clean Annapolis River PO Box 395, Annapolis Royal, N.S. B0S 1A0	902-532-7533/ 902-678-1253
New Glasgow	Bob Funke, Town Engineer Town of New Glasgow PO Box 7, New Glasgow, N.S. B2H 5E9	902-755-7788/ 902-755-5051
Moncton	Ron LeBlanc, Director of Special Projects City of Moncton 774 Main St., Moncton, N.B. E1C 1E8	506-853-3333/ 506-853-3543
Riverview	Jim Steeves, Superintendent of Public Works Town of Riverview 30 Honour House Court, Riverview, N.B. E1B 3Y9	506-387-2027/ 506-387-2130
Sackville	Pierre A. Breau, Town Engineer Town of Sackville PO Box 660, Sackville, N.B. E0A 3C0	506-364-0400/ 506-364-0414
Saint John	Murray Jamer, Director of Water and Sewerage City of Saint John PO Box 1971, Saint John, N.B. E2L 4L1	506-658-2928/ 506-658-4740
Cap-de-la-Madeleine	Roger Nadeau, Surintendant Ville du Cap-de-la-Madeleine 10 Hôtel de Ville, C.P. 220, Cap-de-la-Madeleine, Québec G8T 7W4	819-373-1337/ 819-373-1332
Laval	André Perrault, Service de l'environment, directeur Ville de Laval 3, place Laval, bureau 430, Ville de Laval, Québec H7N 1A2	514-662-4545/ 514-662-4362
Montréal	Sylvio Perreault, ingénieur, Chef de division - Gestion des reseaux Ville de Montréal Bureau 2.100, 700, rue Saint-Antoine Est, Montréal, Québec H2Y 1A6	514-872-3142/ 514-872-5655
Rosemère	Daniel Babineau, Directeur de Service Ville de Rosemère 100, rue Charbonneau, Rosemère, Québec J7A 3W1	514-621-6630/ 514-621-2606
Saint-Eustache	Rodrigue Chiasson, Surintendant Ville de Saint-Eustache 45, Rue Chenier, Saint-Eustache, Québec J7R 4Y8	514-472-4440/ 514-623-7318
St. Romauld/St. Jean	Marcel Deslandes, Directeur Ville de St. Romauld/St. Jean 55 Rue de L'Eglise, C.P. 43100, St-Romuald, Québec G6W 7N2	418-839-0744/
Ville de Charlesbourg	Pierre Hotte, Chef de division Hygiène Ville de Charlesbourg 7505, 1ère Avenue, Charlesbourg, Québec G1H 2X7	418-624-7705/ 418-624-7707
Barrie	Barry Thompson, Energy Officer City of Barrie P.O. Box 400, 70 Collier St., City of Barrie L4M 4T5	705-726-4242/ 705-739-4235

Municipality	Contact and Mailing Address	Phone/Fax
Brockville	Nigel White, Treasurer Brockville 25 Front Avenue, PO Box 157, Brockville, Ontario K6V 5V2	613-342-6661/ 613-342-6610
Collingwood	Terry Hockley, Water Superintendent Collingwood PUC PO Box 189, 39 Hurontario St., Collingwood, Ontario L9Y 3Z5	705-445-1581/ 705-445-0791
Deseronto	Richard Beare, Clerk-Admininstrator Town of Deseronto Box 310, 331 Main Street, Deseronto, Ontario K0K 1X0	613-396-2440/ 613-396-3141
Ernstown (Amherstview)	David C. Thompson, Township Engineer Township of Ernestown PO Box 70, 263 Main St., Odessa, Ontario K0H 2H0	613-386-7351/ 613-386-3833
London	Patricia Lupton, Base Coordinator of Water Quality and Efficiency City of London P.O. Box 5035, London, Ontario N6A 4L9	519-661-5613/ 519-661-2355
North Bay	Peter Bullock, Manager of Environmental Services City of North Bay PO Box 360, North Bay, Ontario P1B 8H8	705-474-0400/ 705-495-0936
Owen Sound	Dave Wilkinson, P.Eng., Engineering Supervisor PUC of the City of Owen Sound PO Box 935, 1355 17th St East, Owen Sound, Ontario N4K 6H6	519-376-4530/ 519-376-6823
Parry Sound	Tony Agnello, Water Works Superintendent Town of Parry Sound PUC 125 Williams St., Parry Sound, Ontario P2A 1V9	705-746-5866/ 705-746-7789
Peterborough	Jean Greig, Water Resources Coordinator Peterborough Green Up 209 Simcoe St., Peterborough, Ontario K9H 2H6	705-745-3238/ 705-745-4413
Port Colborne	Robert Cotterill P.Eng., Director City of Port Colborne 239 King Street, Port Colborne, Ontario L3K 4G8	905-835-2900/ 905-834-5746
Regional Municipality of Durham	Chang S. Lee, P.Eng., Special Assistant Regional Municipality of Durham 105 Consumers Drive, Whitby, Ontario L1N 6A3	905-668-7721/ 905-668-2051
Regional Municipality of Haldimand-Norfolk	Terrence H. Hall, Technical Assistant Regional Municipality of Haldimand-Norfolk Environmental Services Department, 70 Town Centre Drive, Townsend, Ontario N0A 1S0	519-587-4911/ 519-587-5554
Regional Municipality of Ottawa-Carleton	Trish Johnson Cover, Manager, Water Efficiency Branch Regional Municipality of Ottawa-Carleton 111 Lisgar St., Ottawa, Ontario K2P 2L7	613-560-2050/ 613-560-1274
Regional Municipality of Waterloo	Deborah Walker, Manager, Water Efficiency Regional Municipality of Waterloo 150 Frederick St, 7th Floor, Kitchener, Ontario N2G 4J3	519-575-4503/ 519-575-4452
Sidney	Anne E. Rector, Special Projects Officer Township of Sidney RR #5, Bellville, Ontario K8N 4Z5	613-966-3344/ 613-966-4973
Thunder Bay	Darryl Matson, Manager, Environment Division City of Thunder Bay Transportation and Works Department, 155 Front Street, Thunder Bay, Ontario P7C 5K4	807-684-2836/ 807-345-1909
Toronto	Pamela Georgopoulos, Water Conservation Coordinator Toronto 14th Floor, East Tower City Hall, Dept. Public Works & Environ., 100 Queen Street, West, Toronto, Ontario M5H 2N2	416-392-7660/ 416-392-7874
Township of Kingston	Cynthia Beach, Deputy Works Administrator Township of Kingston 1425 Midland Ave., Postal Bag 3400, Kingston, Ontario K7L 5L6	613-384-1770/ 613-384-7106
Windsor	Bill Prestanski, Marketing Manager Windsor Utilities Commission 787 Ouellette Ave., Windsor, Ontario N9A 5T7	519-255-2847/ 519-255-7752
Town of The Pas	Nelson W. Fulford, Municipal Superintendent Town of The Pas PO Box 870, The Bas, Manitoba R9A 1K8	204-623-9454/ 204-623-5506

Municipality	Contact and Mailing Address	Phone/Fax
Winkler	Vince Anderson, Chief Administrative Officer Town of Winkler 185 Main St., Winkler, Manitoba R6W 1B4	204-325-9524/ 204-325-5915
Winnipeg	Duane Griffen, P.Eng., Water Conservation Program Coordinator City of Winnipeg 1500 Plessis Road, Winnipeg, Manitoba R2C 5G6	204-986-4483/ 204-224-0032
Assiniboia	Peter Kordus, Town Superintendent Town of Assiniboia PO Box 670, 131 Third Avenue West, Assiniboia, Saskatchewan S0H 0B0	306-642-3382/ 306-642-5622
Avonlea	Tim Forer, Administrator Village of Avonlea Box 209, Avonlea, Saskatchewan S0H 0C0	306-868-2221/ 306-868-2221
Gravelbourg	Marc Gauthier, A.Sc.T., Town Superintendent Town of Gravelbourg Box 359, Gravelbourg, Saskatchewan S0H 1X0	306-648-3400/ 306-648-3400
Kindersley	Dan Gunnlaugson, Engineering Superintendent Delmer Rienhart, WTP Manager Town of Kindersley PO Box 1269, Kindersley, Saskatchewan S0L 1S0	306-463-2675/ 306-463-4577
Melfort	Jim McAlister City of Melfort PO Box 2230, Melfort, Saskatchewan S0E 1A0	306-752-5911/ 306-752-5556
Prince Albert	Arnie McKay, Utilities Engineer City of Prince Albert 1084 Central Ave., Prince Albert, Saskatchewan S6V 7P3	306-953-4905/ 306-953-4915
Rosetown	Gary Crowder, Administrator Town of Rosetown PO Box 398, Rosetown, Saskatchewan S0L 2V0	306-882-2214/ 306-882-3166
Wynyard	Sheila Hitchings, Town Administrator Town of Wynyard PO Box 220, Wynyard, Saskatchewan S0A 4T0	306-554-2123/ 306-554-3224
Banff	Les Hunter, Utilities Supervisor Town of Banff PO Box 1260, Banff, Alberta T0L 0C0	403-762-1240/ 403-762-1263
Calgary	Doug Jamieson, Production Engineer City of Calgary, Water Works Div, Location 35 PO Box 2100 Station M, Calgary, Alberta T2P 2M5	403-287-5111/ 403-243-9485
Cochrane	Martin Schmitke, Chief Administrative Officer Town of Cochrane PO Box 10, Cochrane, Alberta T0L 0W0	403-932-2075/ 403-932-6032
Edmonton	Lee Jenkins, Team Leader, Water Conservation City of Edmonton 3rd Floor Century Place, 9803 - 102A Avenue, Edmonton, Alberta T5J 3A3	403-944-7603/ 403-944-7619
Cranbrook	Gary Mott, City Engineer, Manager of Utilities City of Cranbrook 40 - 10th Avenue S., Cranbrook, B.C. V1C 2M8	604-426-4211/ 604-426-4026
Greater Vancouver Regional District	Nancy Bonham, P.Eng., Water Conservation Engineer Greater Vancouver Regional District Water and Construction Department, 4330 Kingsway, Burnaby, B.C. V5H 4G8	604-451-6181/ 604-432-6297
Merritt	Yvonne Porada, City Clerk City of Merritt PO Box 189, 2185 Voght Street, Merritt, B.C. V0K 2B0	604-378-4224/ 604-378-2600
Nelson	Bob Adams, Director of Works and Services City of Nelson 502 Vernon St., Nelson, B.C. V1L 4E8	604-352-8217/ 604-352-2131
Port Alberni	Ken Watson, P.Eng., City Engineer City of Port Alberni 4850 Argyle St., Port Alberni, B.C. V9Y 1V8	604-720-2838/ 604-723-3402

Municipality	Contact and Mailing Address	Phone/Fax
Comox-Strathcona Regional District	Wes Whyte, Supervisor of Field Services Comox-Strathcona Regional District PO Box 3370, Courtenay, B.C. V9N 5N5	604-334-6000/ 604-334-4358
Nanaimo Regional District	Natalie Cielanga, A.Sc.T., Engineering Technologist Nanaimo Regional District PO Box 40, Lantzville, B.C. V0R 2H0	604-390-6560/ 604-390-1542
Resort Municipality of Whistler	Rob Miller, P.Eng. Resort Municipality of Whistler 4325 Blackcomb Way, Whistler, B.C. V0N 1B4	604-932-5535/ 604-932-6734
Rutland Waterworks District	Bruce Wilson, General Manager Rutland Waterworks District 160 Highway 33 West, Kelowna, B.C. V1X 1X7	604-765-5218/ 604-765-7765
Vancouver	Jeff Smyth, Water Conservation Analyst City of Vancouver City Hall, 453 West 12th Ave., Vancouver, B.C. V5Y 1V4	604-871-6144/ 604-871-6190
Vernon	Eric Jackson, A.Sc. T., Director of Water Reclamation City of Vernon 3400 - 30th Street, Vernon, B.C. V1T 5E6	604-545-8682/ 604-545-8682
Victoria	Shelley Parkhouse, Water Conservation Coordinator Greater Victoria Water District 479 Old Island Highway, Victoria, B.C. V9B 1H7	604-474-9638/ 604-474-4012
White Rock	Chester Merchant, General Manager White Rock Utilities 1235 Johnston Rd., White Rock, B.C. V4B 3Y8	604-536-6112/ 604-536-3412
Yellowknife	Neill Jamieson, Manager of Public Works and Engineering City of Yellowknife PO Box 580, 4807-52nd Street, Yellowknife, NWT X1A 2N4	403-920-5639/ 403-920-5668
Whitehorse	Sabine Schweiger, Environmental Coordinator City of Whitehorse 2121 Second Avenue, Whitehorse, Yukon Y1A 1C2	403-668-8312/ 403-668-8386

Appendix C

Glossary of Terms

A.Q.T.E.	Association Québécoise techniques de l'environnement
AWWA	American Water Works Association
CCME	Canadian Council of Ministers of the Environment
constant rate	charges a fixed price of each unit (i.e. cubic metre) of water consumed
CWWA	Canadian Water and Wastewater Association
declining block rate	schedules charge a successively lower price for set volumes of water as consumption increases through a series of blocks
ICURR	Intergovernmental Committee on Urban and Regional Research
increasing block rate	works in essentially the same way as declining block rate, except hat the price of water increases in successive blocks
flat rate	is a fixed charge that is levied regardless of the volume used
LF	low-flow, as in "low-flow faucet"
L/c/d	litres/capita/day
ML/d	millions of litres/day
PRV	pressure reducing value
retrofit	adaptation or replacement of a water use fixture to reduce water consumption
SCADA	Service Control and Data Acquisition
xeriscaping	a term invented by the Denver Water Department in 1981. It refers to water conservation through creative landscaping. The main principles include good planning, proper soil preparation, efficient irrigation and use of water-stingy plants. (also see Fuller et al, 1995)
consumption rate	sometimes called 'run-off rate', is a charge levied to that volume of water over and above an initial set volume