Virtually Untapped:
Water Demand Management in Ontario

Dan Shrubsole, PhD.
Department of Geography
Faculty of Social Science
The University of Western Ontario
London, Ontario, N6A 5C2
dashrubs@uwo.ca

Prepared for:
Environment Canada, Ontario Region

June 2001

Executive Summary

Environment Canada, Ontario Region is considering how it can best contribute to effective water management. This report contributes to that undertaking by describing and assessing the current practice of demand management in Ontario and the roles that Environment Canada, Ontario Region can support. The overriding recommendation is that:

> *Environment Canada, Ontario Region should assume a leadership role for promoting the effective implementation of water demand management within the Province of Ontario. This will require it to work in various forms of partnership with all levels of government, public and private water providers, First Nations communities, non-government organizations, and the public. Such leadership should build on the strengths associated with initiatives developed over the past 10 years. These strengths are grounded in the principles of the ecosystem approach, partnerships, and informed decision making.*

Subsequent chapters and recommendations support this conclusion.

The report is organized around six chapters. Chapter 1 provides an overview of integrated water management. Demand management is one of five substantive strategies that collectively reflect integrated water management. The rational for demand management is outlined.

Chapter 2 describes the data collection system that supports all water management strategies. Two water use types are noted – instream and withdrawal. Instream uses are usually measured through the traditional hydrometric network. The following recommendations would enhance the practice of water demand management by improving the current data collection efforts:

> *Environment Canada, Ontario Region should assess the capacity of the present hydrometric, weather, surface and groundwater monitoring network to effectively support informed decision making about instream and withdrawal water uses. New stations should be sited at appropriate locations in the province in order to adequately support informed water supply, water quality and demand management decision making.*
>
> *Environment Canada, Ontario Region, should direct research efforts towards estimating the amounts of water required for instream uses, which includes, in addition to the water used for hydroelectric power generation, water that sustains the natural environment, that supports river transport, and that is needed for recreational activities in Ontario.*
>
> *Given federal responsibilities for navigation and fisheries, it is appropriate for the federal government to participate in initiatives that concern these instream water uses. In this context, Environment Canada, Ontario Region, should seek appropriate collaborative efforts with the Ministry of Natural Resources and other provincial and local agencies, including First Nations Communities, in furthering the development and implementation of the Ontario Water Response – 2000 document.*

Concerning data collection for withdrawal uses, the report suggests the following action:

Environment Canada, Ontario Region should ensure that water withdrawal data continues to be collected and that future efforts pursue the criteria of an ideal database noted by Vandierendonck and Mitchell (1997) (Table 2.2). This involves reviewing and improving the INUDAT and MUD initiatives, and extending it to the agricultural and mining water sectors.

Two recommendations are made in Chapter 2 that support an integrated approach to instream and withdrawal uses:

Environment Canada, Ontario Region should undertake studies that assess the total value of water – instream and withdrawal.

Environment Canada, Ontario Region should work with Ontario Ministry of the Environment, Agriculture Canada, the Ontario Ministry of Agriculture and Rural Affairs, the Ontario Farm Environmental Coalition, the Rural Association of Municipalities of Ontario, Ontario Ministry of Natural Resources, conservation authorities, First Nations communities, and relevant non-governmental organizations to improve the nature and level of water conservation initiatives that are required as a condition of the Permit to Take Water Program.

Municipal water use is the focus of Chapter 3. It provides the following recommendations:

Environment Canada, Ontario Division should work with First Nation Communities, the Assembly of First Nations, the Department of Indian and Northern Affairs and other relevant participants to ensure the implementation of the water-related recommendations of the Royal Commission on Aboriginal Affairs (1996).

In order to better inform the public, water managers and politicians about the status of the current infrastructure, Environment Canada, Ontario Region should publish information concerning the efficiency ratio trends for municipalities which have reliable and accessible data. Appropriate remedial actions should be encouraged and undertaken in those municipalities that are judged to be inefficient.

As the metering of municipalities improves, Environment Canada, Ontario Region should move to better quantify infrastructure efficiency by applying a mix of indicators including the efficiency ratio, linear leakage index, net efficiency ratio, linear flow index and full network assessment.
Environment Canada, Ontario Region, should work with Ontario Ministry of Housing, the building industry, and the Ontario Water Works Association to ensure that the most effective water efficient fixtures are incorporated into the Ontario Plumbing Code. At the same time, changes can be made to the 'ecological labelling' of dishwashers and washing machines and other household appliances.

In cooperation with the Federal Department of Finance, consideration should be given to the reform tax provisions in order to promote water conservation investments. A similair

initiative could be targeted to the Ministry of Finance and Ministry of the Environment in the Province of Ontario.

Environment Canada, Ontario Region should support the retrofitting of meters in those circumstances that provide for socially beneficial outcomes.

Environment Canada, Ontario Region should support changes to the Ontario Building Code that would ensure all new buildings are required to install water meters.

Environment Canada, Ontario Region, should lead by example by promoting greater water-use efficiency in federal government facilities and operations. It should also work with provincial and municipal governments on a similair initiative. The water savings obtained from these demonstrations should be effectively publicized.

Environment Canada, Ontario Region should seek additional funding for the development and use of new water efficient technologies. This could be accomplished in cooperation with Industry Canada. The National Centre for Excellence for Clean Water located at the University of Waterloo could also contribute to and participate in this process.

Environment Canada, Ontario Region, should support research that describes and assesses how municipalities finance water services. This would include examining the water rate and property tax structure and debt levels.

Environment Canada, Ontario Region should review and revise the current grant system available to municipalities from provincial and federal sources that support water and wastewater services. While the elimination of grants would better promote water conservation, a second best alternative could be to provide these funds in the form of loans rather than grants.

Past efforts to promote water conservation by tying grants to specific performance measures have proven difficult to put into practice. Since many municipalities lack metering, which is a basic requirement to promote informed decision making and full cost pricing, consideration should be given to targeting those municipalities that lack metering (or the relevant portions of those municipalities) to install meters as a condition for future funding. Funding of the metering program would be over and above what a municipality would require for needed infrastructure works. A reasonable goal should be to increase metering penetration to 95% by 2010. At present, a specific full-cost pricing approach should not be a requirement of any federal support program.

Present federal funding arrangements appear to bias supply management options. If this is the case, Environment Canada, Ontario Region should promote the inclusion of water demand management techniques, such as metering and toilet replacement, in future water support programs.

Environment Canada, Ontario Region should undertake or support research that addresses the relationship between socioeconomic status and the ability of people to meet their basic water requirements. Part of this research initiative could also assess the desirability and feasibility of implementing a range of socially responsible rate structures.

Environment Canada, Ontario should extend its current economic research efforts and gather reliable data on elasticity of demand. These data, combined with computer models improve the ability to predict the impacts of conservation rate structures on revenues.

Environment Canada, Ontario Region should work with the Ontario Water Works Association in identifying the need to better familiarize municipal water managers with the financial and economic aspects of water management. This forum could better familiarize water managers with the research findings and practical implications of demand management. Environment Canada, Ontario Region should support the implementation of any desirable and feasible initiative that is targeted at informing and educating water utility managers about the financial, economic and social aspects of demand management.

Environment Canada, Ontario Region should develop and improve the distribution and presentation of educational and research material for the web. This includes its own web site, links to the Environment Canada web site, and other organizations such as the Ontario and Canadian Water and Wastewater Associations.

Environment Canada, Ontario Region should adopt a social marketing approach to water (and other) conservation efforts in specific municipalities in order to determine if a higher rate of appropriate behaviours is achieved. Kassier and McKenzie-Mohr (1998) provide some initial thoughts on community-based social marketing on which to build from.

Environment Canada, Ontario Region encourage the demonstration of xeriscaping at federal, provincial and local parks.

Environment Canada, Ontario Region complete or support a research study that follows the advice provided by Molz and Hafsi (1997).

Environment Canada, Ontario Region support any initiatives that better delineates the functions of ownership, operation, financing and enforcement.

Chapter 4 considers the agriculture water sector. The following recommendations are made:

Environment Canada, Ontario Region should determine the effectiveness of the Environmental Farm Plan (EFP) program. It should consider the desirability of formalizing its role in the EFP program, and if appropriate, discuss the feasibility of this initiative with relevant parties. There appears to be a need for additional technical and

financial resources that could be provided through Environment Canada, Ontario Region.

Environment Canada, Ontario Region should consider targeting those areas of intense water competition identified by Kreutzwiser and de Loë (1999) for a concerted effort to reduce the demand for water.

Environment Canada, Ontario Region should monitor the relative strengths and weaknesses of a variety of institutional arrangements responsible for the allocation of water.

Existing standards and guidelines for the use of treated wastewater should be validated, and if required, new ones should be developed, to safeguard public health and the environment.

Environment Canada, Ontario Region should support research that supports the reuse of water. Initially, this could be focused on those areas that are presently under water stress. Based on these results, Environment Canada, Ontario Region should support the use of treated wastewater whenever appropriate. In determining 'appropriate', it will be necessary to collaborate with other provincial and local agencies that deal with water and public health, as well as the NGO community and general public. In this manner, definitions, standards and guidelines can be established.

The status of industrial water use is outlined in Chapter 5. Since there is an abundance of information on water quality and relatively little on demand management, the following recommendation is made:

In order to enhance the competitiveness of Ontario's industries, Environment Canada. Ontario Region should cooperate with Industry Canada, relevant provincial agencies, the Ontario Chamber of Commerce, other relevant industry NGOs and individual companies to promote water audits of individual plants. Given its importance to the Ontario economy, priority may be given to the automobile manufacturing sector.

Environment Canada, Ontario Region should work with the Ontario Chamber of Commerce to promote and develop in both image and practice that Ontario is not only an economically competitive, but also a water efficient jurisdiction. The latter translates into lower production costs. Case studies that document the actual savings to companies should be completed and well publicized.

In practice, the federal government can influence water quality and quantity management through provisions of the *Fisheries Act* and the *Canadian Environmental Assessment Act*.

Environment Canada, Ontario Region should undertake research that provides a rigorous and systematic analysis of industrial water use in Ontario. In undertaking this effort, it may consider the suggestions provided above. At the federal level, Industry

Canada may provide useful comments on research opportunities. Comparisons with other jurisdictions would provide insight into Ontario's industrial and water-use competitiveness.

The final chapter outlines potential priority directions that Environment Canada, Ontario Region might consider. Rather than identify a sector-based priority list, the report suggests one based on approaches to demand management. Specifically, the following priorities are identified:

Environment Canada, Ontario Division should work with First Nation Communities, the Assembly of First Nations, the Department of Indian and Northern Affairs and other relevant participants to ensure the implementation of the water-related recommendations of the Royal Commission on Aboriginal Affairs (1996).

Environment Canada, Ontario Region should establish the following priorities: supporting effective water supply and water use databases; promoting and supporting universal metering; advocating the elimination of subsidies that are means biased (or have grants replaced by loans); researching and advocating socially responsible pricing systems; researching the reuse and recycling of water in all water sectors; and supporting educational efforts, including research into social marketing.

Environment Canada, Ontario Region should promote and support efforts that lead to the development of an effective Ontario Water Policy.

Table of Contents

List of Tables

Chapter 1
Water Demand Management: The Quest for Balance

1.0 Introduction

Reliable water supply and the protection of aquatic resources through effective water management are essential to support all aspects of human life and ecosystems. The use of water in Ontario is varied because of differences in precipitation patterns, geologic conditions, settlement patterns and economic development. Despite these differences, the need to meet the needs of all users – municipal, industrial, agricultural, hydroelectric, ecological – is a top priority for all levels of government. Five interconnected strategies support the contemporary concept of integrated water management that seeks to achieve an effective, efficient and equitable approach that meets all user needs (including ecological requirements). These five elements are:

- *Watershed planning and land use strategies* that affect the availability of and quality of water;
- *Water supply management strategies* that are concerned with the withdrawal, pre-treatment and distribution of water from surface or groundwater sources;
- *Water demand management strategies* that are concerned with the efficient distribution and use of water;
- *Water quality management strategies* that are concerned with returning water to the environment after it has been used; and
- *Remedial Strategies* that are concerned with emergency response and long-term clean-up or ecosystem restoration.

This report considers the role of water demand management in meeting the needs of diverse water users.

Water resources can be limited in terms of quantity and quality. "Expanding the supply" or "managing the demand" are the two general ways to meet the increasing requirements for water and other resources (*e.g.* energy, land for waste disposal). The first approach seeks to increase the supply of water – water supply management. This strategy has been the dominant strategy applied by water managers and it remains an important element of contemporary water management. Water demand management seeks to broaden the range of choice available to water managers confronting water quantity and/or quality problems by focusing attention on reducing or rescheduling the demand for water. In this manner, demand management seeks to achieve a balance between quality and quantity, and supply and demand-side options.

1.1 Water and its Management in Ontario: Myths and Realities

With a water supply that is the envy of many other places, Ontarians might be easily convinced that there is no need to limit the demand for water. Approximately 17% of the province is covered by water and 20% of the world's freshwater supply is found in the Great Lakes – a resource that is shared with several states in the United States (Ontario Ministry of Natural

Resources, 1984). Until recently, expanding existing supplies or developing new water sources were the preferred approaches to meeting increasing water needs. Known as "supply management", this strategy focuses attention on water development – pumping water from existing or new surface and groundwater supplies, or building dams, reservoirs and diversions – in order to supply water wherever it was needed and in whatever amounts desired. In the past, supply management was favoured because water resources were perceived as abundant and were obtained at relatively low cost, and was often supported by senior government grants.

Tate (1984) stated that water management in Canada had become a "one-armed giant" because it almost exclusively dealt with the problem of meeting demands by increasing the supply of water through project-oriented, structural solutions. Believing that "two arms are better than one", he advocated that it would be more appropriate to consider both the supply and demand of water. This can be achieved through water conservation, which is defined as

> *any socially beneficial measure that reduces or reschedules the average or peak withdrawal from ground and surface water sources, reduces water consumption, or reduces flows from the water and wastewater distribution system, while maintaining or mitigating the extent to which return flows are degraded* (modified from Brooks and Peters, 1988; Tate 1989; Baumann *et al.*, 1998).

This definition suggests that water conservation is a general concept related to initiatives that provide for the efficient use of water resources as well as protect surface and groundwater resources. Achieving a balance – between surface and groundwater sources, between quality and quantity, and among different user groups which includes ecological needs – is a fundamental principle in water conservation. It balances "the water that is available at any particular point in time and space with the demand for water for various 'uses', and the need for enough water to safeguard human health and the aquatic ecosystem" (European Environmental Agency, 2001, 10). Water demand management refers to initiatives that decrease the demand for water.

1.2 Water Demand Management

The goal of water demand management is to use water more efficiently. Options to promote this goal include: (1) installing water meters; (2) modifying rate structures; (3) reducing landscape and agricultural water use; (4) modifying plumbing, irrigation and industrial water systems; and (4) conducting educational programs. On a short-term basis, water demand management can relieve stresses during a drought. In the longer term, it can offset or postpone the development or expansion of water supply and/or wastewater treatment facilities. Demand management can also be beneficial because projects often have short payback periods, and lead to reduced capital and operating costs for water and wastewater treatment facilities.

On this basis, it would be nice to believe that the important question would revolve around not whether demand management should be pursued, but how it will be achieved. However, the reality is likely different. Although water demand management is becoming more popular, there is significant resistance to its effective and full implementation. For instance, some people have

narrowly consider demand management as "short-term efforts to minimize the effects of a drought or other temporary water shortage" (Fleming and Grisham,1989, 34). Others have marginalized the role of demand management believing that it was not "valuable as a stand-alone solution to the water supply problem." (Carrell *et al*., 1992, 7 as cited by Heath, 2001). Given these types of comments, Environment Canada, Ontario Region should be prepared to respond to them.

A list of general obstacles to water conservation is provided below. Expanded and modified from Postel (1994) and Heath (2001), it can serve as a basis for Environment Canada, Ontario Region to better understand some of the general perceived shortcomings with water conservation and respond to its critics. The general obstacles are:

- *A preference of equity over efficiency:* "From the perspective of interests in the project area, it does not matter if national economic benefits are less than the costs. Interests in the project area focus on the benefits that are heaped on their locality and ignore the costs which are distributed to a diffuse national (or provincial) public" (Anderson and Robinson, 1985, 65).
- *Political visibility and viability:* Supply management in the form of dams, pipelines and well fields are very visible on the landscape. Demand management in the form of regulations, prices and low-flow water devices is relatively less visible, and can be seen as constraining human behaviour. While it may be desirable, politicians who support increasing water prices may not be popular among an electorate that favours equity over efficiency (see above).
- *Current low prices:* At present, there is little financial incentive in many communities to save water because it is priced below the actual cost of supplying it. Debt, taxes and grants from senior governments often hide the true cost. This situation means that arguments in support of water conservation must be based on fostering long-term behavioural change through the adoption of a conservation and stewardship ethic, rather than catering to an individual's desire to save money.
- *Fragmented institutional arrangements for water management:* Although we recognize that water must be managed on a systems or ecosystem basis because it moves through the hydrologic cycle and supports a wide range of human activities, the management of its use is divided among different levels of government and different government agencies. This horizontal and vertical fragmentation of responsibility is potentially inefficient and requires people to spend the time to coordinate and cooperate with people from other agencies. Conservation efforts can be perceived as requiring generally more effort to achieve collaboration because they are continually responding to changing public needs and wants, and require the ongoing support of relatively more participants than supply management approaches.
- *A view that a little more water leads to a little more wealth:* This is particularly true for gardeners and agricultural water users where a little more water is perceived to provide better lawns, gardens and more agricultural production. The myth of an abundant water supply perpetuates this view among some users in Ontario.
- *A reluctance by some water managers to adopt new and unfamiliar approaches:* Water demand management focuses attention on the human aspect of the resource – economics, financing, perceptions and attitudes. Since a water manager's training is usually focused on supply management principles (*e.g.* Darcy's Law, water balances, delivery rates, water

pressures), they may be uncomfortable and therefore unwilling or reluctant to implement pricing or other demand management strategies.

These obstacles are real and significant. Failure to overcome them will continue the tradition of the "one armed giant" that overly relies on the water supply management approach.

Several present and future challenges support the shift from water supply management to a mix of techniques that better embraces water demand management in Ontario. Although the total quantity of water in the province is very significant, much of it is located in the 'wrong place' or is available at the 'wrong time'. About 68% of the runoff flows northwards through the Hudson/James Bay and the Nelson Rivers and is not available to the populated areas of Ontario (Environment Canada, 1998). From a supply management perspective, the solution to this problem means that water should be moved to where people are located. Though water sources are numerous in Ontario, relatively few of these remain easily accessible and available for water usage. As local water resources reach their withdrawal limits, this alternative becomes more expensive in financial, ecological and social terms. Water conservation encourages people to use less water in a socially beneficial way.

The temporal distribution or the reliability of water flow relative to user demand is another factor supporting water demand management. Water flows in Ontario are generally highest during spring and lowest over the summer. This cyclic pattern of availability contrasts Ontario's demand for water which is generally highest during the summer. This situation has lead to some problems. Between 1985 and 1995, 35% of rural water users in Ontario had experienced at least one water shortage; and between 1989 and 1999, 79% of municipal water systems experienced at least one water supply problem (Dolan *et al*., 2000). This point is confirmed by the Government of Canada (2000) which concluded that the withdrawal of water for municipal, industrial and agricultural uses was sufficient to constitute a stress on water resources. Despite Ontario's apparent abundance of water resources, it is drought prone. In the absence of effective action, current short-term problems could become longer-term ones. Since several groundwater aquifers, such as in Oxford County, are nearing their capacity, municipal and individual users will be considering supply management alternatives to develop nearby or distant surface waters (Kruetzwiser and de Loë, 2000). Most of these projects will involve substantial sums of money and must recognize the biophysical limits of the resource. Achieving a balance between the need to pay for these facilities and our ability to do so might be difficult. Larger municipalities and most rural communities that rely exclusively or extensively on groundwater are especially susceptible to this type of water availability problem.

Climate change poses uncertainty about the future availability of the resource. Research completed by Environment Canada and the U.S. National Oceanographic and Atmospheric Administration indicated that water levels in the Great Lakes could be lowered by up to 1 metre. Tate (2001) suggested that this scenario should prompt municipal water managers to consider the following effects:

- The costs required to obtain water will increase. These increases could be very significant because existing facilities would need to be extended/improved. This affects municipal, agricultural and industrial water users.
- Since water flows would be lower, better waste treatment facilities would have to be built in order to meet current standards.
- Localized areas that rely on groundwater sources for all or part of their supply could face water shortages.

There are growing demands and increased competition for limited surface and groundwater resources. Canada has the second highest per capita withdrawal or use rate of water in the world reflecting our inefficient use of the resource (OECD, 1999). Population growth in the range of 15% to 20% can be expected over the next 25 years, and will place increased pressures on surface and groundwater resources. Continued urbanization, characterized by the persistent growth of larger urban centers as well as smaller regional centers, will place a high level of stress on a relatively small geographic area that supplies water and/or on receiving waters. As living standards rise, an increase in the use of water for residential purposes may increase. Per capita water demand can also increase and reflect lifestyle changes such as hot tubs, jacuzzis and swimming pools. Water efficiency can be improved by using water-saving appliances. Water for agriculture in Ontario is expected to increase significantly by 2020 (IJC, 2000). In the absence of any problems raised by climate change and increasing per capita demands, estimates suggest that Ontario's municipal infrastructure requires major investments in the order of $32 billion over the next 20 years (Ontario Water and Wastewater Association, 1999). Water conservation is one effective means of reducing these costs as well as the level of conflicts among users.

The traditional perceptions of water scarcity are often associated with visions of drought and an impression that nature has failed to deliver what it was supposed to. However, this view is in large part a myth. In reviewing water management activities worldwide, Postel (1994) maintained that the much more disturbing signs of water scarcity suggest that water shortages are more often a product of human activities rather than nature. In this light, climate change is but one potential challenge confronting Ontarians. The more significant challenge may pertain to the human element – our ability to pay for more and improved water and wastewater treatment facilities, and to achieve effective, efficient and equitable allocations of a limited water resource – irregardless of any impacts related to climate change. These new realities challenge the myth of an abundant and inexpensive water resource base. In promoting the general benefits that water conservation provides, Environment Canada, Ontario Region may wish to consider the following ideas that were provided by Postel (1994) and Heath (2001). In their view, water demand management contributed to:

- *increased availability of water:* Reduced water demands provide security of supply through increased water availability. Reduced water demands also increase the amount of water that remains in the natural environment, supplementing stream flows and otherwise maintaining the ecological integrity of environmental systems.

- *improved environmental efficiency:* Reduced water demands lead to the more efficient use of water resources. The prospect of conserving water for industrial, agricultural and municipal water users should reduce operational costs.
- *reduced environmental impacts:* Demand reductions mean less water is taken from the natural environment and less water has to be treated and discharged, resulting in reduced environmental impacts of water supply and wastewater treatment operations. Reduced demands can help or avoid the use of inferior water sources, and protects the quality of groundwater sources by reducing over-pumping (Vickers, 1991). Through simulation modeling, one study indicated that a 40% reduction in water use might reduce effluent concentrations at sewage treatment plants between 30% and 47% (Patry, 1990).
- *improved economic efficiency or the deferral of costly water supply projects:* Increasing water efficiency can "buy time" by delaying the need for large capital investments needed to expand water and wastewater treatment facilities (Tate, 1990). The future costs to maintain, replace, expand and upgrade Ontario's aging infrastructure are just now being realized. In many cases, the savings achieved by delaying this type of investment can provide the financial resources to more than cover the costs of implementing a comprehensive demand management program. Water reduction initiatives at 10 federal facilities indicated that investments to reduce water use had payback periods of between 2 and 34 months, with annual savings ranging from $16,000 to $53,000 (Foerstal, 1994).
- *operational cost savings to deliver water and treat wastewater:* There are relatively few easily accessible and available sources of water, particularly for those users who are not located adjacent to large lakes. Water efficiency means that less energy is required to pump water. Reduced demands means less water has to be treated and less chemicals added for its treatment - an obvious economic and environmental benefit. For domestic users, less energy is used to heat water.
- *increased industrial competitiveness:* Industry present many opportunities for water conservation, in large part, due to more stringent pollution laws. Japan has showed tremendous gains in water use efficiency. Between 1965 and 1989, Japan's industrial output for each cubic metre of water used increased from $21.00 to $77.00. Although a number of factors such as structural change within the economy influenced this 3.5 fold increase in productivity, it largely reflected gains in water use efficiency (Postel, 1994). In many industrial sectors – pulp and paper, steel, chemicals and automotive manufacturing – the most competitive technologies tend to be the most efficient technologies. These are also the most environmentally-friendly technologies. Lower costs to business lead to increased competitiveness. As the world's economy becomes more globalized, Ontario's industries and the towns and cities that support them must compete with the best practices and products from all parts of the world.
- *increased revenues:* As noted earlier, the Ontario Water and Wastewater Association estimates that $32 billion will be required over the next 20 years to expand and develop Ontario's water infrastructure. Effective water pricing can ensure appropriate funds are available in a timely manner.
- *increased economic activity:* Econometrics Research Limited (1995) compared the economic impacts of pursuing a water demand versus a water supply management strategy in Halton Region. They concluded that the demand management option would translate into $193 million in employment income provincially, and $82 million locally. This compared

with $142 and $54 respectively for the water supply option. Thus, water demand management has significant opportunities for economic growth.

Contemporary water management encompasses all aspects of planning, water quality, water supply, water demand management and remedial actions. Water demand management allows another source of water that is already at our disposal to be tapped in a socially beneficially manner. Water demand management is no longer a strategy narrowly applied to drought situations, but an ongoing supply augmentation tool that all water users in Ontario should utilize.

1.3 Environment Canada's Past Involvement in Water Demand Management

Within Canada, Environment Canada has played an influential and leadership role in water conservation. In 1972, Environment Canada in cooperation with Statistics Canada began collecting information on industrial water use through the Industrial Water Use Surveys Database (INUDAT). These two agencies also initiated the Municipal Water Use Database (MUD) in 1983. These early efforts to obtain basic data were very significant and these databases are fundamental to improve existing and develop new initiatives.

Another form of federal leadership occurred in 1987 with the development of the *Federal Water Policy.* That document outlined the federal government's commitment to: (1) the efficient and equitable use of freshwater, and (2) the protection and enhancement of water quality. Water conservation was central to achieving these goals through the "polluter pays" principle, the realistic pricing of water and technological development that would increase water use efficiency. During the 1980s, the federal government conducted a series of studies about municipal and industrial water use patterns, and pricing schemes throughout the country. It also took a lead role in organizing Canada's First National Conference and Trade Show on Water Conservation in 1993 (Shrubsole and Tate, 1994), as well as in working with the provinces through the Canada Council of Ministers of the Environment to create a National Action Plan to Encourage Municipal Water Use Efficiency (1994). The Action Plan acknowledged the shortcomings of the traditional supply management approach to providing people with water and advocated the use of water conservation in order to save money and energy, and delay or reduce the expansion of existing water and wastewater systems. It promoted mandatory water metering, auditing, retrofitting and applying the user pay principle. Research has been completed and is available on Environment Canada's web site. Environment Canada, Ontario Region has also made its research studies available through its web page. The Ontario Region also played a role in the development of the Canadian Water and Waterworks Association website which contains a number of case studies that describe water conservation in action.

The Province of Ontario also took a leadership role. In 1992, it initiated a Water Efficiency Strategy that promoted full cost recovery and information and education. It was not effectively implemented and to date, the province lacks an effective program to promote water conservation.

Primarily based on these activities, Bruce and Mitchell (1995) concluded that the systematic use of demand management in Canada was in its "infancy stage". More recent actions by the federal

government suggest that we have not matured since that time and some questions regarding senior governments' commitment to water conservation have been raised. For instance, the Great Lakes Charter is being revised with the intent of raising the trigger points that prompt the notification of provincial and state governments around the Great Lakes about water withdrawals. In the absence of effective water conservation efforts, this supply-oriented approach could lead to a predicament – the creation of additional supply can lead to an increased demand which prompts the need for additional supply projects. The Canada/Ontario Agreement on the Great Lakes Ecosystem focuses on three issues: Remedial Action Plans (RAPs) and Lakewide Management Plans (LAMPs), Environmental Pollution (and particularly critical pollutants), and municipal sustainability. With the exception of the focus on pollution prevention, water conservation is not referred to. In general, grants made available to local governments for infrastructure development seem to favour water supply over water demand management strategies. While there is clear need for Environment Canada and others to take a lead role in water conservation and demand management, no one appears to be answering the call.

Although demand management has been recognized as one of five fundamental components in integrated water management, it is a virtually untapped approach by federal and Ontario governments. Unfortunately for Ontarians, an abundance of time, as with an abundance of water, may very well prove to be a myth. Ontario must immediately takes steps to develop its water demand management strategies to a state of maturity. This need prompts this report's key recommendation:

> *Environment Canada, Ontario Region should assume a leadership role for promoting the effective implementation of water demand management within the Province of Ontario. This will require it to work in various forms of partnership with all levels of government, public and private water providers, First Nations communities, non-government organizations and the public. Such leadership should build on the strengths associated with initiatives developed over the past 10 years. These strengths are grounded in the principles of the ecosystem approach, partnerships, and informed decision making.*

This report seeks to identify the important aspects and key factors in water demand management as they relate to specific withdrawal water uses. The information was largely gained from a review of the literature that is found in the Bibliography.

1.4 Report Organization

Chapter 2 describes the two types of water uses (instream and withdrawal), the current sources of information on these two water sources, and recommends actions for Environment Canada, Ontario Region and other water managers. The major withdrawal water uses in Ontario are reviewed in order to provide context for the following three chapters. Chapters 3, 4 and 5 review the current practice in Ontario of water demand management in the municipal, agricultural and industrial sectors. Comparisons with activities in other jurisdictions are provided. Chapter 6

provides a commentary on significant findings, the way ahead, and thoughts on how Environment Canada, Ontario Region may wish to establish its priorities.

In Chapters 2-5, recommendations are made. For each recommendation, the type of activity Environment Canada should pursue is identified and a sense of priority (*i.e.* high, medium and low) provided. Although this report was researched and written with Environment Canada, Ontario Region's needs in mind, this priority ranking is based on the author's sense of the need for action irrespective of jurisdictional issues. Chapter 6 discusses how Environment Canada, Ontario Region may wish to prioritize action items.

Chapter 2
Water Use Data and An Overview of Withdrawal Water Use in Canada

2.0 Introduction

Ontario's average annual water supplies are generally adequate to support present and future average annual water demands (Tate, 2001). However, these annual and province-wide perspectives mask the water shortages that many Ontario water users are already facing. In 1988 and 1999, southwestern and eastern Ontario experienced an extended period of low rainfall and high temperatures (OMNR *et al.*, 2000). During drought or periods of high demand, present supplies are insufficient to meet present demands at the community or individual rural household level (Dolan *et al.*, 2000). Many Ontario communities and rural households have faced mandatory water restrictions, agricultural land practices have shifted, and there have been reduced stream flows as a result of droughts (Gabriel and Kruetzwiser, 1993). Recent drought conditions "resulted in some of the lowest water levels and driest soils recorded for several decades" (OMNR *et al.*, 2000, i). Currently, a high level of competition for water in some regions of the province is causing water shortages and decreased water quality. Many water managers are finding it more difficult to achieve an acceptable balance among all water users as climatic, social, political, economic, financial and technological factors shift and change our thinking about desirable and feasible water futures. Water demand management is one means to make this task easier to achieve.

This chapter is divided into three main sections. The first describes the basic types of water uses in order that their interaction and interdependence can be better appreciated. Of relevance to water demand management is its role in attaining an appropriate balance between instream and withdrawal uses. Since acquiring adequate data is essential to determining when this balance is achieved, this section describes current water quantity data collection efforts. Pursuing any one of the five contemporary water management strategies (Chapter 1) relies on, among other things, an adequate data base. The second section reviews water uses, particularly withdrawal water uses in Canada and Ontario. This information establishes a context for subsequent chapters that describe uses and activities within the major withdrawal sectors of Ontario. A summary is provided in the third section.

2.1 Types of Water Uses

The two basic types of water use are **instream uses** and **withdrawal uses.** Instream uses, such as hydroelectric power generation, transportation, waste disposal, fisheries, wildlife, heritage conservation and recreation, occur "in the stream" (water remains in its natural setting). Withdrawal uses, such as municipal use, manufacturing, irrigation, mineral extraction and thermal power generation, remove water from its natural setting by pipes or channels for a period of time and for a particular use. All, part or none of the water withdrawn may be returned to its source.

Basic information about the quantity and quality of water as well as the patterns of use is a cornerstone in achieving effective water management. Without this information, it is difficult to determine the nature and extent of current and future shortages. These data allow us to construct water balance diagrams that can be used to assess how human activities influence the distribution of water throughout the year. In considering water conservation, it is appropriate to consider the data that support our understanding of withdrawal and instream uses.

2.1.1 Instream Water Use Data Sources

Since water is not removed from the lake or stream, instream uses are best measured by flow rates and water levels. These data have been collected in some parts of Ontario for over 100 years through the hydrometric network. Unfortunately, the capacity of the existing hydrometric network to support informed decision making at the local level for instream and withdrawal uses is unclear.

From a federal perspective, this situation reflects the impacts of the 1995 Program Review. As noted by Morrison (2001), the federal government initiated an aggressive program of downsizing in nine of its departments due to concerns over the federal deficit. It required all of its agencies to identify their core functions and maintain only those programs that served those functions in a cost-effective manner. By the time Program Review was completed in 1997, freshwater research in Canada had suffered a 55% reduction in budget (Morrison, 2001). The outcome of Environment Canada's downsizing strategy was to maintain the capacity for policy and science, and reduce its capacity for services. Hydrometric monitoring activities were considered as a 'service'.

On a global scale, Canada operates an efficient hydrometric monitoring network. Scott *et al.* (1998) noted that in 1995, the cost of operating one hydrometric station in Canada was $7,700 while it was over $17,000 (Cdn) in the United States. Like Canada, the 1990s saw other countries reduce their support to the hydrometric network. However, Scott *et* al. (1998) concluded that reductions to Canada's network were the largest among four nations (New Zealand, Finland, United States and Canada) that publish this information (Table 2.1).

Between 1990 and 1998, the number of stations across Canada had dropped 21%, from 3,374 to 2650. "Although stations with limited informational value or redundant should be considered for network reduction, clearly 21% of the former national network did not fall into these categories. This loss of hydrometric information is viewed as highly problematic…" (Scott *et al*., 1998, 51). It has been suggested that the reduced capacity of Environment Canada to monitor water, as a result of this downsizing strategy, has impeded its ability to formulate defensible policy (Bruce and Mitchell, 1995).

At the time of Program Review, it was believed that other water management agencies and researchers would be willing and able to pay for services in order that cost recovery could be achieved. The user-pay philosophy applied to accessing these data has frustrated other

Table 2.1:
National Hydrometric Network Reductions in Selected Countries

Country	Land Area (km^2)	% of Global Renewable Fresh Water	Hydrometric Stations in 1990	Recent # of Hydrometric Stations	% reduction
Canada	9,922,290	7	3,374	2,650 (1998)	21
United States	9,528,351	6	7,363	6,950 (1997)	6
New Zealand	268,538	1	288	230 (1996)	20
Finland	336,959	0.3	721	671 (1996)	7

(Scott *et al.*, 1999)

water management agencies, such as conservation authorities, that have faced their own cost-cutting initiatives. They, other water management agencies, the research community and others, have been hard-pressed to obtain funds required to purchase basic hydrometric data.

Although these comments are made in the context of the entire country, there are clear implications for Environment Canada, Ontario Region's water management activities. One recent positive step made in data collection was provided by the Ontario Government which announced a $6 million package to support conservation authorities and municipalities in the development of a groundwater-monitoring network. The intent is to provide a provincial database of hydrogeological maps to show groundwater availability, and undertake chemical analysis of groundwater supplies (OMOE, 2000). There is no commitment to ensuring the long-term funding of this initiative. Despite this progress, it is appropriate to recommend the following:

> *Environment Canada, Ontario Region should assess the capacity of the present hydrometric, weather, surface and groundwater monitoring network to effectively support informed decision making about instream and withdrawal water uses. New stations should be sited at appropriate locations in the province in order to adequately support informed water supply, water quality and demand management decision making. Steps should be taken to ensure adequate and stable baseline funding is secured.*
> ***Priority: High***

Acting on this recommendation will require additional funding. At least two alternative funding sources should be considered. First, increased transfers from federal, provincial or local governments would extend past practice. The cost-sharing arrangements between federal and provincial governments that have supported the hydrometric network might be a blueprint for a joint Environment Canada, Ontario Region and Province of Ontario groundwater monitoring network (Scott *et al*., 1998). Second, municipal water providers as well as self-providers could support appropriate costs to support the hydrometric network. In the case of municipal water providers, new or increased levels of user charges could support this funding need. In the case of self-providers for the industrial or mining sector, additional and ongoing fees for a license would

provide some of the required funds. Once it is collected, there should be no fee to acquire the data for research or other purposes.

In the spirit of integrated management, it would also be appropriate for Environment Canada, Ontario Region to seek opportunities to link the hydrometric network with the water quality monitoring network in order that total loads of substances rather than relative concentrations can be measured.

2.1.2 Identifying Minimum Instream Flows

Another important aspect of instream water uses is to identify minimum flow requirements throughout the year that are required to meet specific water uses such as navigation through waterways or to maintain wildlife. These serve as benchmarks against which water withdrawals can be considered.

Two general approaches have been used to identify minimum flows. The first approach establishes minimum flows on the basis of computer simulations that quantify, for each particular species, the amount of habitat available in a given stretch of the stream at each stage of its life cycle and under varying streamflow conditions (Postel, 1985). It can also be used to simulate hydroelectric and recreational water needs. Though more accurate, such methods are time-consuming and costly, requiring much field data and scientific expertise to interpret them. This approach identifies desirable minimum flow levels. The Inquiry on Federal Water Policy concluded that we were only beginning to appreciate the magnitude of water needs for the support of the ecosystem and had yet to obtain reliable estimates of instream requirements (Pearse *et al*., 1985).

The second approach identifies minimum flows believed to be feasible and are based on a fixed percentage of the average annual flow. While easily identified for rivers with long stream flow records, it makes neither any allowance for variations in annual flow that are characteristic of many rivers nor for the long-term, cumulative effects that low flows may have on fish and other aquatic populations. However, based on the past record, these minimum flows are believed to be achievable and measurable targets. This approach was advocated in *Ontario Water Response – 2000 (Draft)*, a document that outlined Ontario's approach to low water conditions (OMNR *et al*., 2000). Three drought thresholds have been established based on precipitation and streamflow. Streamflow thresholds are to be calculated for each gauging station through the following equation:

% of average = monthly flow/lowest average summer flow

Seasonal variation in flow patterns is addressed by specifying different thresholds for the spring and other times of the year. Based on the drought index, a range of water restrictions can be applied. Success of this approach relies on an adequate hydrometric network. Unfortunately, no reference is made within the *Ontario Water Response – 2000 (Draft)* document that this requirement is being met on a province-wide basis.

A significant challenge facing Ontarians is the increased vulnerability of society to prolonged droughts. Water demand management can assist us in minimizing the damages of long and severe drought. According to the Environmental Commissioner of Ontario (2000), *Ontario Water Response – 2000 (Draft)* is not likely to be treated as a high priority in the immediate future. This situation prompts the following recommendation:

> *Environment Canada, Ontario Region, should direct research efforts towards estimating the amounts of water required for instream uses, which includes, in addition to the water used for hydroelectric power generation, water that sustains the natural environment, that supports river transport, and that is needed for recreational activities in Ontario.* ***Priority: High***

These flows will serve as a benchmark mark against which the appropriateness of new or increased withdrawal or instream water uses can be assessed.

The capacity of local municipalities and conservation authorities to successfully undertake their responsibilities under the *Ontario Water Response – 2000* is unclear. In order that Ontario can be better prepared for drought conditions, the following recommendation is made:

> *Given federal responsibilities for navigation and fisheries, it is appropriate for the federal government to participate in initiatives that concern these instream water uses. In this context, Environment Canada, Ontario Region, should seek appropriate collaborative efforts with the Ministry of Natural Resources and other provincial and local agencies, including First Nations Communities, in furthering the development and implementation of the Ontario Water Response – 2000 document.* ***Priority: High*****.**

2.2 Withdrawal Water Use Data Sources

Withdrawal uses are measurable as quantities of intake, discharge and consumption. The quantity of water withdrawn or used is referred to as intake. Discharge refers to the amount returned to the source. The difference between intake and discharge is called consumption; that is the amount of water removed or 'lost' from the system making it unavailable to downstream users (Demayo and Watt, 1993). Two other measures of withdrawal use are recirculation and gross water use**.** Recirculation refers to water that is reused in a particular distribution system. It may be used more than once in a specific process or used once and then recycled to another process. Recirculation most commonly occurs in industrial users such as pulp and paper, petroleum refining and steel making. Gross water used is the total amount of water used (intake + recirculation).

In contrast to the hydrometric network, the systematic collection of data on water withdrawals is relatively recent with the Industrial Water Use Surveys Database being the first sector to be monitored on a nationwide basis in 1972. Other important withdrawal water uses include municipal, agricultural and rural domestic. Environment Canada has played an important role in

supporting the collection of information on withdrawal uses. As noted earlier, it worked in cooperation with Statistics Canada to develop and administer INUDAT. These two agencies played a fundamental role in establishing the Municipal Water Use Database (MUD) in 1983.

Vandierendonck and Mitchell (1997) assessed how adequately these and other databases supported informed decision making in Ontario. They established a set of criteria that should serve as a benchmark against which the performance of a database could be assessed (Table 2.2).

A summary of their findings is provided in Table 2.3. In short, they concluded that there was no uniform, readily accessible database of water use in Ontario. Data about agricultural and rural domestic water use were not being collected or maintained on a systematic basis. There were some serious inaccuracies and inconsistencies in some water use databases. They identified the need to enhance the consistency of data collection in order that it be collected for the same year, at the same frequency, and in the same units for all water sectors. They also identified the need to provide information on the variability of water use over the year. Present water use data tends to promote the myth of superabundance because they often cover annual averages that mask peak demands. In order to avoid this problem and to better reflect extreme events such as droughts that should be considered in water management decisions, maximum use of water for all sectors should be recorded. This can be achieved by noting the average daily withdrawals for each month.

While the work of Environment Canada and others has been valuable, there is room for improvement. One of the three fundamental principles adopted by Environment Canada in its *Freshwater Strategy* was a role for science. In order to support an effective role for science in decision making, the following recommendation is made:

> *Environment Canada, Ontario Region should ensure that water withdrawal data continues to be collected and that future efforts pursue the criteria of an ideal database noted by Vandierendonck and Mitchell (1997) (Table 2.2). This involves reviewing and improving the INUDAT and MUD initiatives, and extending it to the agricultural water sector and mining sectors.* ***Priority: High.***

There is a role for Environment Canada and its regional offices to support effective data collection of withdrawal uses. At this time, developing an effective protocol for water use data collection is a high priority. The possibility of coordinating water use data collection in Ontario among agencies and establishing one central database requires further consideration. This approach would extend the Great Lakes Regional Water Use Database to the entire province and would have the following two advantages. First, it would serve as an aggregated database of all provincial water uses. Second, it would also be a site-specific database that could be accessed on a regional or watershed basis (Vandierendonck and Mitchell, 1997). In this manner, it could be linked to the *Ontario Water Response – 2000* initiative in order that supplies of and demands for water can be assessed during times of drought. In terms of research, water uses are currently estimated using a variety of techniques when data are unavailable. It would be appropriate to determine the accuracy of the water use data that are being collected in Ontario and to develop

Table 2.2:
Criteria to Assess Withdrawal Water Use Databases

Who is withdrawing water and how much?

- Water use sectors include municipal, industrial, agricultural, rural domestic
- How much relates to: (a) water withdrawal, (b) discharge, (c) consumption, (d) for the industrial sector recirculation, gross water use and use rate

What is the source of the water supply?

- Ground or surface, self supplied or municipal supplier
- Is it drawn directly by the user (self supplied) or by a public (municipal) or private water utility?

In which watershed is the withdrawal located?

What is the variability of the water use?

- What is the maximum amount of water withdrawn within a year for each of the water use sectors?
- What is the temporal or seasonal variability of water use within the year?

What is the price of water?

- What is the relationship between water use and its price?
- Does the price of water accurately reflect the full cost of providing it?

What is the volume of water required for instream users of water?

- Instream use includes the natural environment in which wildlife and fish exist, sea and river transport, recreational activities, hydroelectric power generation and dilution and assimilation of discharges water (polluted)

What is the accuracy of the data?

- The methods used and standards followed for data collection will determine the accuracy and reliability of the data

How accessible are the water use data?

- Accessibility encompasses both being readily available and easily understood
- Readily available means the data are easily located and retrieved
- The data must also be easily understood in that the data are complete, comparable, compatible and useful

(after Vandierendonck and Mitchell, 1997)

Table 2.3:
Major Characteristics of Withdrawal Use Databases in Ontario

Water Sector	Database Name and Sponsors	Survey Frequency	Data Collected	Some Major Concerns
Industrial Sector	Industrial Water Use Surveys Database (INUDAT) Environment Canada & Statistics Canada	Every 5 years to coincide with census	- how much is withdrawn - water source - watershed - variability of water use during the year	- no way to standardize individual responses - smaller industries may be missed
Municipal Sector	Municipal Water Use Database (MUD) Environment Canada & Statistics Canada	Every 3 years starting in 1986	- population served - average daily water and sewage water flow - water source - watershed	- municipalities of <1000 not surveyed - some municipalities do not meter use - consumption of water cannot be obtained - omits data on peak use - omits First Nations people
	Utility Monitoring Information Ontario Ministry of the Environment (MOE)	Monthly	- how much is withdrawn - watershed - average daily use by month	- water source not recorded - cost of water not recorded - data charges now applied
	Survey of Municipal Water Rates in Ontario Ontario Section of the American Water Works Association	Every 2 years starting in 1987	- metering/billing practices - conservation strategies - revenues - consumption - sales	- data charges applied - effective coverage a problem
Agricultural Sector	A Review of Water Use and Water Use Efficiency in Ontario Agriculture	For 1991 census only	- estimates of water withdrawn on monthly basis	- water source not recorded - consumption not addressed
Rural Domestic Sector	Water Well Information System MOE	ongoing	- potential yield	- actual use not provided - water source not recorded - watershed not recorded

(compiled from Vandierendonck and Mitchell, 1997)

new and more accurate methods for data collection (Vandierendonck and Mitchell, 1997).

In terms of extending the databases, it is clear that financial considerations are and will be an important challenge. Consideration should be given to systematically obtaining this information through INUDAT and MUD, or alternative mechanisms such as making the submission of the revenues, costs and reserves to the Ontario Ministry of the Environment as a requirement of the Permit to Take Water Program. Environment Canada, Ontario Region has a role to play in improving the collection of hydrometric data in the province.

2.2.1 An Overview of Withdrawal Uses in Canada and Ontario

The volume of water withdrawn from lakes, rivers, and groundwater sources to meet our needs reflects one aspect of human impact on water resources. Withdrawals of water vary widely across Canada. Table 2.4 shows the regional water intake in Canada for each major activity. Not surprisingly, Ontario has the largest withdrawals per year. The different withdrawals reflect different economic and social demands. Statistics Canada (2000) data show that thermal power production is the largest withdrawal use in Canada, followed by manufacturing, municipal, agriculture, and mining withdrawals. The thermal power sector is included for information only and will not be dealt with in this report. The thermal power industry, which includes both fossil fuel and nuclear electrical generating stations, was responsible for 63% of total water intake in 1991 – 4 times more than the next biggest user, manufacturing. Since 1972, Canada's use of thermal power has increased constantly. Ontario dominates the used of water for thermal electric power generation with almost 24,000 million m^3 of the nation's 28,357 million m^3 total. While water used to cool thermal power plants is almost all returned to its source, there are concerns that heavy metals dissolved from pipes used to carry the water through the plant can enter waterways. The relatively warmer water that is returned to the source can also have environmental impacts (Linton, 1997).

Since 1972, municipal water use in Canada has been rising. Fortunately, most of the water used by municipalities is returned to the source. However, depending on the level of treatment provided, that water could be harmful to the environment and human health. Urban water use rates vary across the country from a high of over 560 litres per day in Newfoundland to about 185 litres per day in Prince Edward Island. A high intake of water will produce a correspondingly high volume of wastewater which means higher costs are needed to support our municipal water infrastructure (*i.e.* water treatment plants, wastewater treatment plants and pipes).

Manufacturing accounted for 16% of water withdrawals in 1991. The manufacturing sector primarily uses water as a coolant, solvent, transport agent and source of self-generated energy. These processes can contaminate discharge water with a wide variety of substances that individually or collectively can impact human and ecological health (Linton, 1997). Paper and

Table 2.4:
Water Intake in Canada, 1991 (million m^3)

Region	Thermal Power	Manufacturing	Municipal [a b]	Agriculture	Mining	Total Intake
Atlantic	2,126	601	356	15	77	**3,175**
Quebec	1,005	1,616	1,703	100	74	**4,498**
Ontario	23,095	3,457	1,660	186	87	**28,485**
Prairies	2,025	447	685	3,014	50	**6,221**
British Columbia [c]	106	1,161	698	676	75	**2,716**
National total	**28,357**	**7,282**	**5,102**	**3,991**	**364**	**45,096**
% of total	**63**	**16**	**11**	**9**	**1**	**100**
% total without thermal power	**-**	**44**	**30**	**24**	**2**	**100**

(after Statistics Canada, 2000)

[a] Municipal data exclude water supplied to industry.
[b] Municipal data include estimates for rural residential water use.
[c] Sectorial data for the Yukon and Northwest Territories are included with British Columbia.

allied products, chemicals, and primary metals were the three main industrial users. Ontario uses almost 50% of the nation's total water use for manufacturing which reflects the concentration of industry there. The manufacturing sector has reduced their withdrawals through improved water technology efficiency. Increased recirculation of water reflects some of the declines in water use for this sector.

The mining category includes metal mining, non-metal mining, and the extraction of coal. Water is used by the mining industry to separate ore from the rock, to cool drills, to wash the ore during production, and to carry away unwanted material. Although the mining industry had a gross use almost as great as agriculture, mining accounted for only about 1% of all water withdrawals in 1991. This was the smallest withdrawal use, but mines in Canada recirculate water to a greater extent than any other withdrawal user. However, they can cause significant impact on the environment. Leakage from tailings ponds is sometimes problematic (Linton, 1997). Other stages of mining operations can also have negative effects. On a positive note, since 1972 the mining sector has reduced their withdrawals through improved water technology efficiency.

In the context of Ontario, thermal power generation dominates water users with 81% of total withdrawals. This reflects the presence of many coal and nuclear-powered electrical stations located on the shores of the Great Lakes. Industrial manufacturing is the second largest users of water with about 12% of total withdrawals in the province. Municipal uses are about half this rate. While agriculture accounts for only about 0.6% of the water withdrawals, about 79% of this is consumed. Most of these withdrawals would occur during the summer months of June, July and August. This water was used mainly for irrigation and livestock watering (Dolan *et al.*, 2000). Approximately 2.8 million people rely on groundwater for their domestic uses, and 90% of farms use groundwater supplies in their homes.

There is no question that water serves a wide variety of needs through withdrawal and instream uses. In order that the total value of water be better appreciated and support subsequent recommendations on the pricing of water, the following recommendation is made:

> *Environment Canada, Ontario Region should undertake studies that assess the total value of water – instream and withdrawal.* ***Priority: High.***

2.3 The Institutional Arrangements for Water Supply Management

The withdrawal of surface and groundwater is regulated under the Permit to Take Water Program (PTTWP) which is established under the *Ontario Water Resources Act* and administered by the Ministry of the Environment. Initiated in 1961, it requires that all major water users, including municipalities, obtain a permit from the Ontario Ministry of the Environment (MOE) for the withdrawal of water in excess of 50,000 litres per day (Mitchell and Shrubsole, 1992). Exemptions are provided for withdrawals for household consumption, livestock or poultry watering, fire fighting and those withdrawals established prior to 1961. "Any withdrawal can be brought under the permit system, even if it consumes less than 50,000 litres per day, if it interferes with any public or private interests in water, subject to the previously noted exempted purposes" (Muldoon and Saint-Laurent, 1990, 21). Permits are to be issued on an equitable basis of precedence and priority among competing users (Muldoon and Saint-Laurent, 1990). If the proposed use of water is considered to wasteful, malicious or would have adverse environmental impacts, an application can be denied. While not required, water conservation measures (*e.g.* metering of use, specific fixtures) can be identified as a condition of approval.

The Environmental Commissioner on Ontario (2001) reviewed aspects of the PTTWP in 1999 and found a number of inconsistencies and deficiencies. He also identified the following three major areas of concern:

> *First, public accountability and transparency are threatened because of inaccuracies and omissions in the Registry notices for PTTWs, and because the actual PTTWs often omit or misrepresent crucial information. Second, ecosystem protection may be threatened because MOE staff are issuing permits for new water takings without access to fully complete or accurate information on existing water takings. Third, the problems with PTTW administration may be promoting conflict about PTTWs and are contributing to the growing number of leave to appeal applications related to PTTWs under the EBR* (Environmental Commissioner of Ontario, 2001, ii).

As part of his review, Ontario's Environmental Commissioner (2001) completed a detailed audit of the PTTWP for the period June 1999. During this time, MOE had announced a moratorium on permits because of significant concerns over the mining of the province's water resources. Although the moratorium was not implemented, water conservation issues should have received a higher level of scrutiny during this time. Of the 14 permits approved in June 1999, only 5 specifically required the measurement and reporting of water withdrawals. This low level of

measurement detracts from informed decision making. Without these measures, the province will continue to be unable to effectively allocate water resources, and conflicts among and between withdrawal and instream water users can be expected to increase.

The reality is that water taking permits under the PTTWP are routinely issued without serious consideration of their individual or cumulative effect on other water uses. Moreover, there is little effort to monitor the number and location of all permits. It is unlikely that instream uses, such as ecosystem functions, are effectively considered under this process. Water demand management techniques are virtually ignored. There are no reasons to believe that the present management system ensures that water is used for its best use. Therefore, the following recommendation is made:

> *Environment Canada, Ontario Region should work with OMOE, Agriculture Canada, the Ontario Ministry of Agriculture and Rural Affairs, the Ontario Farm Environmental Coalition, the Rural Association of Municipalities of Ontario, Ontario Ministry of Natural Resources, conservation authorities, First Nations communities, and relevant non-governmental organizations to improve the nature and level of water conservation initiatives that are required as a condition of the Permit to Take Water Program.* ***Priority: High.***

2.4 Summary

This chapter has highlighted the need to improve existing instream and withdraw water use databases. To achieve more integrated water uses, new hydrologic baselines for individual watersheds that include the full range of instream and withdrawal uses must be defined. Federal, provincial, regional and local governments, aboriginal communities, other agencies (*e.g.* conservation authorities, public utilities, AMO, OWWA), NGOs and the public should effectively participate in this process. The comments in this chapter outline some of the information requirements that would better inform this process.

There will be no single correct approach or outcome because of the diversity of Ontario's human and physical geography. However, successful solutions will be characterized by the integration of air, surface and groundwater flows, and the quality and quantity of water; and by a balance between withdrawal and instream uses, and between procedural and substantial fairness. Demand management has a crucial role to play in this regard. Given Environment Canada, Ontario Region's responsibilities for fisheries and its past leadership in data collection, it has a strong legislative base to involve itself and lead this process.

This discussion also provides a context for subsequent chapters that examine the major withdrawal use sectors in Ontario – municipal, agricultural, industrial and mining – that are considered in the next three chapters.

Chapter 3
The Municipal Sector

3.0 Introduction

Municipal water supply is confronted by at least three major problems: water quality (including public health), water quantity, and financing. Municipal wastewater effluent represents the single largest source of effluent in Ontario (Environment Canada, 2000). These discharges, combined with storm sewer and combined storm sewer runoff can impact human uses and the environment. As the Walkerton Tragedy so effectively demonstrated, water quality problems can also be seen in the context of inadequate water treatment. In terms of quantity, it was noted earlier that with an apparent abundance of water resources, Ontarians might not perceive the need to adopt water demand management strategies. This belief can also be supported when examining Ontario's water use relative to other provinces and the national average (Table 3.1). In 1996, Ontarians used on average 272 l/capita/day, well below the national average of 326 l/capita/day. On this basis, one might conclude that Ontario's level of water use is reasonable. However, this standard is inappropriate. On the one hand, these data cover four water users that are often connected to municipal water supply systems – household or residential, industrial, commercial and institutional. In provinces such as Newfoundland and British Columbia, a relatively high portion of the non-residential users is connected to municipal water supply and treatment systems. The influence of climate can be seen in the relatively lower rates of use among the Prairie Provinces. If national rankings were applied and the Province of Ontario committed itself to being the nation's leading jurisdiction, its water use would be reduced by almost 32%. However, as the following text will demonstrate, the adequacy of using national averages to judge the merits of Ontario's efforts is questionable.

The following discussion suggests that it is desirable and feasible to further reduce Ontario's performance through effective water demand management. This statement is supported on the basis of the practice of water demand management in other jurisdictions. In a globalized economy, it is the activities of other nations rather than national averages that might be seen as establishing more appropriate use levels. No matter which target is selected, Ontario should be significantly reducing its water use in the municipal sector.

Water supply has traditionally been a local public service in Ontario (Sancton and Janik, 2001). However, its funding has been shared among all three major levels of government. Generally, past management activities have been and continue to be biased towards supply management strategies. In particular, funding arrangements from senior governments have subsidized water and wastewater treatment facilities. These cost-sharing arrangements provide a considerable obstacle to implementing effective demand management strategies.

There are several techniques that can achieve reductions in water use in a "socially beneficial" manner. Tate (1990) classified water demand management measures in the municipal sector into three categories: social-political, structural-operations, and economic (Table 3.2). Structural-

Table 3.1:
Per Capita Municipal Water Use in Canada by Province (1996)

Province	Use (litres/person/day)
Newfoundland	561
British Columbia	440
New Brunswick	414
Quebec	366
Canadian Average	***326***
Ontario	***272***
Nova Scotia	269
Territories (including Nunavut)	268
Alberta	256
Manitoba	249
Saskatchewan	228
Prince Edward Island	186

(Environment Canada, no date)

operational techniques focus on the physical nature of the water and wastewater systems in order to reduce usage and/or save money. Economic strategies, which are believed to be the most effective means of reducing water demand, focus attention on market forces. Socio-political strategies direct efforts at changing consumer's attitudes and behaviours through the use of techniques such as education campaigns, and the development of water policies. Prior to reviewing each general approach, brief but important comments are made concerning the status of water demand management in Aboriginal communities.

3.1 Water Management in Aboriginal Communities

In its final report, the Royal Commission on Aboriginal Peoples (1996) recommended that the Government of Canada increase funding for constructing and operating water and sewer systems to ensure that all First Nations communities were adequately served within five years. Since that time, no effective action has been taken to implement its water-related recommendations. Environment Canada (2000, 12-13) expressed a desire to promote the involvement and benefits for Aboriginal peoples in water use and development decision making. There is a clear need to address the needs of aboriginal communities for clean and adequate water supplies. While Aboriginal communities dominate the population in many northern watersheds, they also form part of the human landscape in southern Ontario. This suggests that, in the spirit of partnership, Aboriginal communities must be better incorporated into the existing and new management processes that have included federal, provincial and local governments in southern Ontario. Since demand management is part of the solution to water management problems, it is recommended that:

Environment Canada, Ontario Division should work with First Nation Communities, the Assembly of First Nations, the Department of Indian and Northern Affairs and other relevant participants to ensure the implementation of the water-related recommendations of the Royal Commission on Aboriginal Affairs (1996). ***Priority: High.***

Table 3.2:
Water Demand Management Measures in the Municipal Sector

General Approach	Examples
Structural-Operational	Household appliances - taps with air devices - taps with thermostats - taps with infared sensors - electronic taps - washers, dishwashers - low flow showerheads - low flow toilets Metering Water accounting Leak detection Reduce evaporation Water audits Pressure management Dual supply lines Reuse and recycling
Socio-political	Information and education Landscape efficiency Water policies Water restrictions Regulations and standards Privatization
Economic	Pricing and costing Adjust water rights
Restrict future growth	No growth policies

3.2 Structural-operational Policies

Structural-operational strategies focus attention on the water and wastewater treatment and distribution systems. Reducing usage and/or saving money through leak detection programs, the installation of water efficient fixtures, water reclamation efforts, and metering typify this approach. Grey water use is another possible strategy to increase water supplies. Grey water can be captured from sinks, tubs and laundry facilities and reused for landscape irrigation. Rainwater can be collected from roof runoff and used for landscape irrigation. Gray water use could help reduce local demand for potable fresh water over the long term. Where drains currently discharge into the storm sewer networks, additional benefits of disconnecting them could be realized (Russell *et al*., 1994).

Canada's and Ontario's high standard of living is reflected in its high and changing water demand patterns. Indoor toilets and daily showers/baths are enjoyed by most of Ontario's residents. Some households expend considerable effort on, and perhaps water their gardens. Some people own swimming pools. More recently, hot tubs and Jacuzzis are becoming a more popular item in some households. These place increased demands on both the water and electrical delivery systems. While it is difficult to predict how future social tastes might result in significantly higher per capita water use rates, it would be prudent to consider water demand management as a means of providing these wants. Leak detection, water-efficient household appliances and metering are specific structural-operational measures that are discussed below.

3.2.1 Leak Detection

Losses of water in the distribution system can be very high. These problems detract not only from the efficiency of the network, but also contribute to degraded water quality (low water pressure in the system increases the risk of contamination). The term 'leakage' covers a range of problems including:

- losses in the network because pipes are not properly sealed; leakage usually occurs at joint pipes, and is particularly relevant in old and extended networks;
- losses in users' installations before water is metered;
- under measurement by meters when the flow is low (*e.g.* mechanical problems); and
- when all uses are not metered (*e.g.* public gardens, street cleaning) and 'use' is estimated, under or over reporting of 'losses' can occur (European Environment Agency, 2001).

According to Postel (1985), investing in leak detection and repair is one of the most universally cost-effective conservation measures that can be undertaken. She also maintained that energy savings would be realized through this approach since less water would be pumped through the municipal water infrastructure. "Direct energy costs account for about 20% of the total operating budgets of most water and wastewater utilities so cutting the volume of flow can significantly lower utility costs" (Postel, 1985, 43). Despite these potential savings, there is not universal

support for leak detection and repair because it can be very expensive. "In some instances, increasing water production to feed leaks may prove cheaper… The consequences is that local authorities may decide not to trace leakage despite low efficiency ratios but continue their wasteful use of water" (European Environment Agency, 2001, 25).

In general, Ontario's municipalities have actively engaged in activities to improve the efficiency of the water distribution system. Environment Canada played a leadership role in informing water utilities about the benefits of leak detection and water audits (Foerstel, 1994). According to Kreutzwiser *et al.* (1998), the repair of water distribution lines has been completed by 128 (87.7%), leak detection projects implemented by 92 (63.4%) and the installation of meters on new accounts by 74 (52.5%) of responding municipalities. Of note in these data is that since 52.5% of responding municipalities installed meters on new development, only these municipalities will have the option of pricing water. A substantially higher proportion of regional municipalities and cities, compared to towns, villages and townships had implemented leak detection. This suggests that for smaller municipalities, improving network efficiency is not a high priority. This perception coincides with a price of water that is generally lower than the provincial average and also with a lack of household metering. Municipal officials responding to the Kreutzwiser *et al.* (1998) survey perceived that these operational strategies contributed an average of 19.3% to total water savings. The most important factor in facilitating the effective implementation of operation and maintenance strategies was access to additional funding.

There are several ways of measuring the efficiency of the water distribution network. These types of measures can be used to determine the feasibility of implementing repairs as well as a criterion to determine the eligibility for municipalities to obtain capital grants for infrastructure improvement. One approach to calculate system efficiency is through the "efficiency ratio" which is:

Efficiency ratio (%) = metered volume / distributed volume * 100

While simple to calculate, it must be interpreted carefully. Since it does not consider the total volumes of water that might be used (*e.g.* metered, unmetered, network maintenance), it cannot be used to compare different networks. Therefore, it would be difficult to utilize this measure to rank the relative need of a municipality to receive grants for supply-oriented projects. However, the efficiency ratio can be used to identify trends in relative efficiency over time of the same system (European Environmental Agency, 2001). Efficiency can also be measured through a "linear leakage index" which compares lost volumes of water to the length of the network through the following equation:

Linear Leakage Index (m^3/day/km) = losses(m^3/day) / length of network (km)

This measure can be compared to benchmarks that could be established by governments. For instance, in a privatized water system, water pricing regulators may wish to establish a benchmark for leakage before price increases were granted. Other efficiency measures include the "net efficiency ratio", "linear flow indexes" and "full network assessment". Since many

municipalities in Ontario lack extensive metering (Section 3.3), applying any effective province-wide efficiency target is difficult. As outlined in subsequent sections, a priority item for Environment Canada, Ontario Region should be to support the establishment of metering in all municipalities.

With respect to leak detection, the following recommendations are made:

> *In order to better inform the public, water managers and politicians about the status of the current infrastructure, Environment Canada, Ontario Region should publish information concerning the efficiency ratio trends for municipalities which have reliable and accessible data. Appropriate remedial actions should be encouraged and undertaken in those municipalities that are judged to be inefficient.* ***Priority: Low.***
>
> *As the metering of municipalities improves, Environment Canada, Ontario Region should move to better quantify infrastructure efficiency by applying a mix of indicators including the efficiency ratio, linear leakage index, net efficiency ratio, linear flow index and full network assessment.* ***Priority: Medium.***

3.2.2 Household Appliances

Although there is a paucity of research that has examined the changing water use patterns of Ontario households, it is certain that most of the municipal water is for use within households. Most of this water is for toilet flushing, bathing, showering, clothes washing machines and dishwashers. Relatively little is used for cooking and drinking (Table 3.3). Table 3.3 also provides the patterns of water use by households in Canada, England and Wales, Finland and Switzerland. The Canadian data were incorporated into the table for illustrative purposes only and caution should be applied in making direct comparisons to other countries. In particular, the Canadian data excluded direct measurement of external and miscellaneous uses (*e.g.* gardens, car washes). However, some general conclusions can be made. First, Canadians relatively high rate of use is explained largely in one room – the bathroom. Approximately 65% of household use occurs there.

Part of this difference reflects different social tastes among these countries. However, it also reflects, it large part, different levels of 'technology' that are currently utilized in most homes. Unfortunately, many more Canadians use water fixtures that are not water efficient. Significant water savings, in the order of 43% to 89%, can be realized through the use of water saving fixtures (Table 3.4). Clearly, significant savings can be realized in using the 'state-of-the-art' technology in both households and public buildings. Switzerland, which uses a comparable relative (5) amount of water in the bathroom, utilizes much less water than Canada. The washing of clothes in Canada also uses much more water than those countries identified in Table 3.3.

Table 3.3:
Pattern of Household Use in Selected Countries (litres/person/day and (% use))

Household Use	Canada[a]	England and Wales[b]	Finland[b]	Switzerland[b]
Toilet Flushes	97.8 (30)	46.5-50.5 (33)	20.3 (14)	52.1 (33)
Baths/Showers	114.1 (35)	28.2-30.6 (20)	42.0 (29)	50.6 (32)
Clothes and dish washing	65.2 (20)	19.7-21.4 (14)	43.5 (30)	25.3 (16)
Kitchen and Drinking	32.6 (10)	4.2 – 4.6 (3)	5.8 (4)	4.7 (3)
Misc.	-	38.1-41.3 (27)	30.4 (21)	22.1 (14)
External use	-	4.2 – 4.6 (3)	2.9 (2)	3.1 (2)
Av. Daily use (l/person/day)	326	141-153	145	158

[a] Environment Canada (1995)
[b] European Environment Agency (2001); OECD (1999)

Table 3.4:
Potential Water Savings with Available Water-conservation Fixtures in the United States (1997) (litres/household/day)

Type of Use	Without Conservation		With Conservation		Saving (%)
	Amount	% Total	Amount	% Total	
Toilets	69.2	28.4	39.3	23.2	44
Clothes Washers	56.3	23.1	39.7	23.4	30
Showers	46.1	18.8	37.8	22.4	18
Faucets	38.9	16.0	37.8	22.5	2
Leak Repair	24.9	10.2	5.7	3.4	77
Baths	4.5	1.9	4.5	2.7	0
Dish washers	4.2	1.6	4.2	2.4	0
Total Use	244.1	100	169.0	100	31

(modified from AWWA, 1997)

In 1996, some progress was made to ensuring water efficient toilets were installed in Ontario. Amendments to the Ontario Plumbing Code required toilets to use 5.9 litres per flush or less. Faucets are to use 8.4 litres per minute or less, and showerheads 9.8 litres per minute or less (Sharrett *et al*., 1994). In other jurisdictions such as Australia and Germany, 3.8 litre per flush toilets work very well (Chaplin, 1998). Showerheads are available in the United States with maximum flows of less than 5.7 litres per minute. Faucets with flows of less than 2 litres per minute are common fixtures in new homes. In many cases, fixtures not only save water, but cater to a range of consumer wants (*e.g.* style, colour). This increases the level of public acceptance.

Kreutzwiser *et al.* (1998) provided some insight into current practice. In their survey of municipal water use and conservation in Ontario, they found that low-flow showerheads were the most common device included in voluntary retrofit programs. They were used by 55 (37.9%) of municipalities responding to their questionnaire. Faucet aerators (with 42 municipalities (29%)), toilet dams or bags (35 (24.1%)) and low-flush toilets (31 (21.7%) were less frequently used. These voluntary plumbing fixture programs were frequently targeted at the residential rather than other sectors in regional municipalities and cities.

Municipal officials responding to the Kreutzwiser *et al.* (1998) survey perceived that voluntary plumbing fixture retrofit programs contributed an average of 11.6%, and working with large industrial water users who used the municipal infrastructure contributed an average of 9.6% to total water savings. Voluntary programs were easiest to implement when there was low (or no) cost to homeowners and there were tangible monetary savings to water users in the form of lower water bills. Senior government subsidies play a role in supporting low or no cost programs. However, the adequacy of present efforts is unclear.

Despite the advantages of adopting water efficient appliances, the Kruetzwiser *et al.* (1998) survey suggests that home and building owners are often slow to implement them. Information and education campaigns are often required to explain the reasons and the advantages of adopting new appliances.

Since there have been recent improvements to water conserving devices, it is recommended that:

> *Environment Canada, Ontario Region, should work with Ontario Ministry of Housing, the building industry, and the Ontario Water Works Association to ensure that the most effective water efficient fixtures are incorporated into the Ontario Plumbing Code. At the same time, changes can be made to the 'ecological labelling' of dishwashers and washing machines and other household appliances.* ***Priority: High.***
>
> *In cooperation with the Federal Department of Finance, consideration should be given to the reform tax provisions in order to promote water conservation investments. A similair initiative could be targeted to the Ministry of Finance and Ministry of the Environment in the Province of Ontario.* ***Priority: Medium.***

3.2.3 Metering

Pricing strategies are perceived to be the most effective means of promoting efficient water use. However, in order to apply any pricing system, households, businesses, institutions and industries that are connected to the municipal water supply system must be metered in order that their individual water use be measured. Table 3.5 indicates the nature of metering in selected countries.

Table 3.5:
Percentage of Single Family Homes and Apartments that are Metered in Selected Countries and in Ontario

Country	Year	Single Family	Apartments	All households
Ireland	1998	0	0	0
England and Wales	1998	12+	"a few"	11
Canada	**1998**	55	**"few"**	**n.a.**
Denmark	1996	64	"all in Copenhagen"	n.a.
Ontario[a]	**1994**	**79**	**-**	**-**
Belgium	1997	90	"many cases"	n.a.
United States	1997	90+	n.a.	n.a.
Italy	1998	90-100	"many examples"	<30
Australia	1998	95-100	"insignificant"	n.a
Austria	1998	100	"very few"	n.a.
Finland	1998	100	"very low"	n.a.
France	1995	100	>50	88
Germany	1997	100	10-20	55-60
Japan	1997	100	94	100

[a] Schaefer and Hurst (1999) (after OECD, 1999)

Table 3.5 suggests there are many experiences relevant to metering. Although metering has been considered in Ireland, it has been deemed to be uneconomical and "there appears to be no serious consideration underway of the domestic metering option" (OECD, 1999, 46). Canada and Ontario are at the lower ends of metering water use (Table 3.5). Raising this level of penetration may meet with significant resistance. Following privitization of the water industry, metering was aggressively undertaken in parts of England and Wales. For instance the Anglian Water Company increased household metering from 2.7% of customers in 1992 to 38% by 1999 (OECD, 1999). In England and Wales, metering was a very controversial policy issue, in part, because of its possible implications for low-income households. In the face of determined opposition, two water companies (Anglian and Yorkshire) withdrew from their mandatory metering programs. Although OFWAT, the economic regulator of the privatized water companies in England and Wales, "is formally opposed to universal domestic metering (on cost-benefit grounds), it supports compulsory selective metering in the following circumstances: (1) where new resources are scarce (and hence expensive); (2) where households are consuming significant amounts of "discretionary" water (*e.g.* for luxury use, especially garden watering); and (3) for new homes where initial installation costs are relatively low" (OECD, 1999, 47). All water companies in England and Wales provide homeowners the option of having meters installed. They hope that households, which use relatively little water, will elect to be metered and therefore have an opportunity of paying a smaller bill (OECD, 1999). This type of pragmatic approach may be one which Environment Canada, Ontario Region, wishes to promote.

Table 3.5 suggests that the metering penetration for apartment blocks is, relative to single family homes, much more varied. While most countries meter the water supplies to apartment buildings, very few offer separate metering for each apartment. In these circumstances, the water bill is incorporated as part of the monthly rent. Some areas are moving to the metering of apartments. In Hamburg (Germany), a program to install meters in all apartments was initiated in 1985, and all new and renovated apartments are to be metered.

Relative to other developed countries, Canada has a low rate of metering use (Table 3.5). Although Ontario municipalities are more frequently using metering, it remains relatively low (Table 3.4). Schaefer and Hurst (1997) reported that 79% of Ontario municipalities (containing 67% of its population) had metering in 1994, compared with 65% of municipalities (containing 56% of Ontario's population) in 1989. Kruetzwiser *et al.* (1998) provide more recent data (Table 3.6). They surveyed municipalities in Ontario about the percentage of municipalities that metered major sectors that connected to its water supply: residential, commercial, institutional and industrial. They found that metering was more widespread in the industrial (80.1%) and institutional sectors (78.6%) (Table 3.5). These sectors typically have a fewer number but larger users of water than the residential (64.1%) and commercial sectors (72.6%). A similar pattern exists across Canada (Waller *et al*., 1997). Kreutzwiser *et al*. (1998) also found that regional municipalities and cities relative to towns, villages and townships more frequently applied residential metering. According to Kreutzwiser *et al.* (1998), metering was perceived by municipal water managers to be the most effective water saving strategy. This view is shared by Tate (2001) because it is linked to pricing strategies.

Table 3.6
Metered water users in each sector (%)

Sector	N	Mean %
Residential	132	64.1
Commercial	128	72.6
Institutional	115	78.6
Industrial	109	80.1

(Kruetzwiser *et al*. 1998)

The impact of the introduction of metering on water consumption is difficult to separate from other initiatives (*e.g.* increased water charges, information campaigns, leak detection) because they are often applied simultaneously. Despite this problem, Brooks and Peters (1988) indicated that metering, in the absence of any rate increases, had resulted in water use reductions of 10% to 40%. This estimate is reasonably consistent the 10% to 25% reductions identified by the European Environmental Agency (2001).

Although there are examples, such as Ireland, of jurisdictions that do not meter water use, it is a very common approach that can provide the basic information about water losses within the system and the basis for volumetric pricing. In the absence of metering and pricing, successful

water conservation "cannot be easily achieved unless the accompanying institutional arrangements are well-rooted and accepted by all participants" (OECD, 1999, 51). As evidenced by a very high water use rate, this latter requirement does not exist in Ontario. Therefore, it is recommended that:

> *Environment Canada, Ontario Region should support the retrofitting of meters in those circumstances that provide for socially beneficial outcomes.* ***Priority: High.***
>
> *Environment Canada, Ontario Region should support changes to the Ontario Building Code that would ensure all new buildings are required to install water meters.* ***Priority: High.***

In the early 1990s, Environment Canada was a leader in promoting water audits and retrofit programs, and promoting water conservation in federally operated facilities. This momentum appears to have been lost. It is therefore recommended that:

> *Environment Canada, Ontario Region should lead by example by promoting greater water-use efficiency in federal government facilities and operations. It should also work with provincial and municipal governments on a similair initiative. The water savings obtained from these demonstrations should be effectively publicized.* ***Priority: High.***
>
> *Environment Canada, Ontario Region should seek additional funding for the development and use of new water efficient technologies. This could be accomplished in cooperation with Industry Canada. The National Centre for Excellence for Clean Water located at the University of Waterloo could also contribute to and participate in this process.* ***Priority: High.***

3.3 Economic Strategies

There is growing support for an accurate valuation of water resources as part of any water policy. Despite the conclusion by the Government of Canada (2000) and others that water is a scarce or "stressed" resource in some parts of Ontario and should therefore have a high opportunity cost, it is often undervalued. In particular, past valuations have generally excluded instream uses. When water is undervalued, either because the price is subsidized or because opportunity costs have not been accounted for, effective water use is discouraged. Integrated and sustainable water management strategies support the total economic valuation of water across all its uses. Theses comments support the earlier recommendation that called for research on the valuation of water uses.

While Ontario and other jurisdictions in Canada and elsewhere have long been aware of the effectiveness of economic strategies, water continues to be generally under priced. This situation is somewhat puzzling, particularly in today's political climate. "On the right, user charges are in vogue and, on the left, preserving water is in vogue" (Sancton and Janik, 2001, 10). In this

political environment, it is hard to believe that governments have not effectively applied full-cost recovery. In considering this apparent contradiction, at least three aspects are relevant – the rate structure, the actual price charged, and the role of grants from senior governments. Each issue is discussed below.

3.3.1 Rate Structures

Four general types of rate structures can be applied to water:

- A *flat rate system* that applies a fixed charge regardless of the amount of water used. This provides no incentive to conserve water because any investments in water conservation will not be recouped through lower water bills. No metering is required to apply this rate structure.
- A *declining block rate system* that charge successively lower prices for set volumes of water as consumption increases through a series of blocks. In other words, the amount of money paid for higher volumes of water is relatively less than that charges for lower volumes. This provides little incentive to conserve water. Metering is required to apply this rate structure.
- A *constant block rate* charges the same price for all volumes of water used. This provides a moderate incentive for conservation. Metering is required to apply this rate structure.
- An *increasing block rate* prices water in a such a manner that the cost of water increases as the volume of water used increases. This provides a strong incentive for water conservation. Metering is required to apply this rate structure.

In the last three systems, the number of blocks is a key issue. If they are too large (particularly for the first block), a flat rate structure will essentially exist. The OECD (1999) provided information on municipal water rate structures (Table 3.7).

The use of the flat rate system appears to be declining recently in most countries and prices increased significantly in the 1990s (OECD, 1999). Increasing block rate structures are generally found in Italy, Portugal and Spain. In contrast to many other countries, the flat rate system became more popular in Canada between 1984 and 1996 (Table 3.7). Although this finding may reflect response bias from the relatively large number of smaller utilities in Canada that volunteered answers to the most recent surveys, it suggests that Canada is out of step with other developed nations.

In Ontario, municipalities establish water rate structure and prices, and these can vary widely (Table 3.9). Residential, commercial, industrial and institutions can be serviced by the municipal water system. The survey completed by Kreutzwiser *et al*. (1998) found that a flat rate was the most commonly used rate structure applied to Ontario homes (52.3%) (Table 3.9). Constant rate (37.3%) and declining block rate (12.4%) were also frequently applied to Ontario residents. Constant rate structures were the most popular method applied to commercial (41.8%) and

institutional (39.2%) water users. Flat rates and declining rates were frequently applied to these two water use types. The increasing block rate was applied to less than 10% of residential, commercial and institutional water users. The 9.2% reported for the residential category reflects an increase from the 4% of municipalities that reported using an increasing block rate structure in 1994 (Schaefer and Hurst, 1997). More detailed analysis of the data suggested that regional municipalities, cities and villages used conservation rate structures (*i.e.* constant and increasing) more frequently than towns and townships (Kreutzwiser *et al.*, 1998). As expected, this finding is consistent with the pattern of metering water use that was described earlier. However, these patterns are interesting since it is the latter groups that can be generally expected to have more difficulties achieving adequate capacity to deliver water services. This could have implications for the manner in which senior governments subsidize the capital costs of water projects in these municipalities.

Table 3.7
Municipal Water Rate Structure in Selected Countries
(% of utilities within a given structure)

Country	Year	Number of Utilities Sampled	Flat Rate	Constant Block	Increasing Block	Decreasing Block	Usual # of Blocks
Australia	1997	15	-	69	27	4	2
Canada	**1996**	**1,452**	**56**	**27**	**4**	**13**	**2**
England & Wales	1998		89	11	-	-	-
Finland	1998		-	100	-	-	-
France	1990	500	2	98	-	-	-
Germany	1998		-	100	-	-	-
Ireland	1998	In general tax	-	-	-	-	-
Italy	1998		-	-	100	-	-
Japan	1998	1,900		42	57	1	2-7
Netherlands	1996	28	7	90	3	-	-
U.S.	1997	151	2	33	30	34	3

(after OECD, 1999)

Table 3.8:
Municipal Water Rate Structure in Canada (1986-1996)
(% of responding utilities)

	1986	1989	1991	1994	1996
Flat Rate	47	53	61	58	56
Declining Block	28	23	14	14	13
Constant Rate	23	22	22	24	27
Increasing Block	2	2	3	4	4
Total	100	100	100	100	100
No. of responding utilities	591	732	1,416	1,508	1,452

(Source: Environment Canada, various)

Table 3.9:
Rate Structure used for the Municipal Sector in Ontario (1998)

Rate Structure	Type of User							
	Residential		Commercial		Industrial		Institutional	
	N	%(a)	N	%(a)	N	%(a)	N	%(a)
Unmetered Flat	80	52.3	45	29.4	20	13.1	25	16.3
Declining Block	19	12.4	37	24.2	35	22.9	32	20.9
Constant Block	57	37.3	64	41.8	60	39.2	60	39.2
Increasing Block	14	9.2	14	9.2	10	6.5	10	6.5
Other	8	5.2	6	3.9	5	3.3	5	3.3

(Kruetzwiser *et al.*, 1998)

In this table, N is the number of responding municipalities reporting a rate structure. Responding municipalities could indicate more than one rate structure.
a: % denominator is total number of responses 153. Percentages do not total to 10 for rows or columns.

Metering is a prerequisite to establish pricing structures based on the volume of water used. With 79% of households on meters (Table 3.5), it is not surprising that the use of volumetric pricing structures is relatively low in Ontario. Many communities apply the flat rate system which provides no economic incentive to conserve water. The increasing block rate system, which should send the strongest message to conserve water, is the least popular form of pricing. Although the flat rate system is not widely applied, some countries do use it. For

instance, in the general absence of metering, England and Wales apply charges based on the property value. Ireland applies a flat rate through local charges although this has been the subject of considerable debate (European Environment Agency, 2001).

3.3.2 The Price of Water

The pricing of water reflects the availability and quality of water, as well policy considerations. This combination of factors makes it difficult to assess the direct influence of price on reducing water demand. It also hampers the comparison of water prices among countries. However, the OECD (1999) provided the best available assessment on the role of water pricing in influencing water use (Table 3.10).

On a global scale, water use rates vary significantly among OECD countries from just over 100 litres/capita/day (lcd) to more than 300 lcd (Table 3.10). Countries can be categorized into four groups. First, a high use group using more than 250 lcd is comprised of Canada, the United States, Australia and Japan. Although the OECD (1999) suggested that Canadian withdrawal rates are declining, we are still the highest municipal water users in the world. Although the Province of Ontario uses less than the national average, it would qualify as a member of this high water use group (Table 3.10). A second group of countries uses about 200 lcd. Three of the countries - Italy, Spain and Turkey – have relatively warm and dry climates that might influence their use. Sweden has a high rate of personal washing and dishwasher use (OECD, 1999). A large number of countries are in the "mid-range" withdrawal group of between 130-190 lcd. Many European and emerging economic countries are in this water use group. Finally, low water use countries include Hungary, the Czech Republic, Hungary, Portugal, Belgium and Germany. According to the OECD (1997, 18),

> *the presence of Belgium and Germany in this group is…interesting [because] these are relatively "mature" economies, long believed to have "strong" water economy policies for households, yet they still seem to be able to reduce their [withdrawal] rates in recent years.*

To put this data into another perspective, Gleick (1996) recommended a basic water requirement for human domestic needs of 50 lcd – 5 for drinking, 20 for sanitation, 15 for bathing and 10 for food preparation. On global and absolute scales, there are clear opportunities for Ontarians to reduce their withdrawals of water without significantly sacrificing their economic or social quality of life.

The data contained in Table 3.10 provides mixed news for Canada. The good news is that based on the limited evidence available, its rate of water use appears to be declining, albeit at a very moderate rate. The bad news suggests that relative to other OECD countries, only the Czech Republic pays less for water than Canada and that Canada is the highest residential (not total) water user in the world. The data also reinforces a long-held finding – the higher the price for water, the lower the domestic use. This implies that pricing is likely an important and under-

Table 3.10:
Estimated per Capita Residential Water Use and Rates for OECD Countries in the 1990s

Country	Average Municipal Water Price (US$/m^3)	Average Daily Domestic Water Use (litres/capita/day)	Water Use Trend
Canada	***0.70***	***326***	***Decreasing***
United States	*1.25*	*305*	*Stable*
Japan	*2.10*	*278*	*Stable*
Australia	1.64	268	Stable
Ontario	***-***	***272***	***Decreasing***
Italy	*0.84*	*213*	*Stable*
Spain	1.07	210	Increasing
Greece	1.14	200	Increasing
Turkey	1.51	195	Increasing
Sweden	2.60	191	Stable
Korea	0.34	183	Increasing
Luxemborg	1.01	170	Decreasing
New Zealand	-	165[a]	-
Switzerland	1.29	158[b]	Decreasing
England and Wales	*3.11*	*141[c]-153[d]*	*Increasing*
Finland	2.76	145	Decreasing
Ireland	-	142	-
Norway	-	140	Decreasing
Poland	-	140	Decreasing
Denmark	3.18	139	Decreasing
France	*3.11*	*137[b]*	*Stable*
Austria	1.05	135	Decreasing
Netherlands	3.16	130	Stable
Belgium	2.06 - 2.36	122	Stable
Portugal	-	119	-
Germany	*1.69*	*116[b]*	*Declining*
Czech Republic	0.68	113	Declining
Hungary	0.82	102	Declining

(after OECD, 1999)

[a] for year 1987, [b]household use only, small business excluded; [c] metered homes; [d] unmetered homes

*G-7 countries and **Ontario** shown in italics*

utilized tool in Ontario's water conservation efforts. A central question then becomes; "What is preventing Ontario from raising rates?".

3.3.3 Subsidies, Financing and Full-Cost Recovery

Water development has been essential to the prosperity of urban and rural Ontario. In order to assist municipal development, senior governments have subsidized the capital cost of the municipal water infrastructure. In the 1950s and 1960s, the Province of Ontario, through the Ontario Water Resources Commission (OWRC), provided municipalities with attractive loan interest rates and an ability to defer principal payments for five years. It also provided support to municipalities for infrastructure planning and operation. In 1969, the Government of Ontario began to directly subsidize the capital costs of OWRC-constructed water supply and sewerage works. By the 1970s, municipalities could directly apply for funding to the Ontario Ministry of the Environment, which had assumed the duties of the former OWRC, to build their own facilities. During the 1970s, the federal government, through the Canada Mortgage and Housing Corporation (CMHC), also provided capital grants for water infrastructure (Morrison, 2001). These programs were so "successful" that between provincial and CMHC grants, 100% of the capital cost could be achieved. Thus, local water users, who would obtain the benefit, would not pay for the capital costs. This caused water management and public administration problems. Local accountability and responsibility were often eroded because the MOE was also involved in planning, building, financing, operating these facilities as well as establishing and enforcing regulations (Sancton and Janik, 2001).

By the late 1970s, there were calls for more realistic water pricing. The federal government responded in 1980 by canceling the CMHC program (Pearce *et al*., 1985). In this way, water service providers would be forced to cover their costs and encourage water use efficiency. The user pay principle was confirmed in the *Federal Water Policy (1987)*. In the 1980s, water conservation was supported through the CCME's National Action Plan to Encourage Water Use Efficiency (CCME, 1994). "In this action plan, the federal government agreed to integrate water efficiency criteria into infrastructure assistance programs, fund research and development into water-use efficiency activities, share information on municipal water conservation projects via the internet, and promote private-public sector technologies that enabled more efficient use of water" (Morrison, 2001, 13).

At this time, the Province of Ontario was also promoting water conservation. The rules for capital grants were changed in order to promote the proper maintenance of plants, water conservation, the effective use of existing systems, and good environmental and land use planning (Sancton and Janik, 2001). Traditionally, the rules for grants had favoured the construction of traditional facilities by smaller municipalities and did not require effective management of the water system. One major problem at this time related to the establishment of indicators, such as full-cost pricing, that would allow effective water operations to be rewarded. As one provincial water manager stated in 1993:

> *We are currently trying to get information on what municipalities have as their total rates and how they're billing them. It has been very difficult…Simply looking at their billings for water and sewage [does not necessarily provide] a really clear idea of what those total rates are* (as cited by Sancton and Janik, 2001, 14).

The problems of defining full-cost pricing were also reflected in a recent survey of water practices among Ontario municipalities. Kruetzwiser *et al.* (1998) reported that of the 145 responding municipalities, 99 (68.3%) reported full-cost pricing while 46 (31.7%) indicated that they recovered an average of 69.1% of the cost. Shortfalls in the water bill were supplemented through property taxes and development lot levies. However, Kruetzwiser *et al.* (1998, 11) suggested that caution should be applied in interpreting these results because

> *some respondents may have been optimistic in their assessment of cost recovery, particularly with regards to adequately providing for infrastructure maintenance and replacement, administration and environmental upgrades.*

There appears to be inconsistent interpretations among municipal water managers regarding the scope of full-cost pricing.

This finding is not surprising. In Ontario, municipalities have, with the support of provincial and federal grants and advice, developed and administered their own water systems and a range of different structures has evolved. Complicating the full-cost pricing issue are several factors including: (1) the perception that water should be and frequently is inexpensive in those municipalities; (2) past capital grants, and free operational advice and/or subsidized operational costs; (3) historic cost accounting that failed to capture the full value of water; and (4) an expectation that senior government grants would continue to be available regardless of any a water utilities' level of performance. These factors combine to serve as obstacles to the general application of full-cost recovery. They have also support the over-development of some municipal systems – that is their capacity was built beyond reasonable growth needs. These systems would require additional subsidies for maintenance. In the end, a cycle of dependency has been established whereby some municipalities rely on senior government assistance for capital and operational works.

Motivated, in part, by these concerns, the Provincial Government announced in 1997 that municipalities would assume full responsibility for the local delivery of all water and sewage services and that measures were being developed to assist smaller communities facing financial hardship (Sancton and Janik, 2001, 15). Since 1997, the government has announced at least $640 million in spending on water and sewage treatment grants. Working through the Ontario SuperBuild Corporation, the intent is to move "toward full cost recovery for water and sewer treatment services which will be a fundamental principle of the government's long-term strategy to ensure that future investment needs are met on a timely basis" (Ontario 2000 as cited by Sancton and Janik, 2001, 16). Funds must be spent on capital supply-oriented projects. However, water conservation initiatives, such as the installation of meters or leak detection, do

not appear to be eligible for funding (Morrison, 2001). This decision works at cross-purposes to integrated water management.

Recent activities at the federal level also seem to detract from water demand management. Morrison (2001) noted that between 1994 and 1998, the federal government reintroduced subsidies for water and wastewater projects but failed to require full-cost pricing and conservation measures as a condition. More recently, the federal government renewed its commitment to municipal water and wastewater development through the Infrastructure Canada, Green Municipal Enabling Fund and Municipal Investment Fund. "While implementation of full-cost pricing is one of the criteria used to evaluate proposals under these federal programs, municipalities are not required to institute full-cost pricing in order to be eligible for federal subsidies" (Morrison, 2001, 14).

It has long been recognized that subsidizing the true cost of water undermines the adoption of water conservation strategies. Grants have distorted from the true value of water and have biased management efforts in favour of withdrawal over instream water uses. The failure of water prices to reflect the true cost of water has also encouraged the over-development of the water infrastructure and discouraged conservation. Ideally, subsidies should be eliminated. However, since the political and other benefits are perceived to outweigh these costs, some form of grant system will likely continue. Senior governments must differentiate between grants that redress inequities among municipalities, and those that bias the means of achieving desired ends. The latter has become the common practice in Ontario. This situation prompts the following recommendations:

> *Environment Canada, Ontario Region, should support research that describes and assesses how municipalities finance water services. This would include examining the water rate and property tax structure and debt levels.* ***Priority: Low.***
>
> *Environment Canada, Ontario Region should review and revise the current grant system available to municipalities from provincial and federal sources that support water and wastewater services. While the elimination of grants would better promote water conservation, a second best alternative could be to provide these funds in the form of loans rather than grants.* ***Priority: High.***
>
> *Past efforts to promote water conservation by tying grants to specific performance measures have proven difficult to put into practice. Since many municipalities lack metering, which is a basic requirement to promote informed decision making and full-cost pricing, consideration should be given to targeting those municipalities that lack metering (or the relevant portions of those municipalities) to install meters as a condition for future funding. Funding of the metering program would be over and above what a municipality would require for needed infrastructure works. A reasonable goal should be to increase metering penetration to 95% by 2010. At present, a specific full-cost pricing approach should not be a requirement of any federal support program.* ***Priority: High.***

Present federal efforts appear to bias supply management options. If this is the case, Environment Canada, Ontario Region should promote the inclusion of water demand management techniques, such as metering and toilet replacement, in future water support programs. ***Priority: High.***

3.3.4 Socially Acceptable Price Levels

When considering water pricing, it is important to have regard for those vulnerable people and groups who may have difficulties in paying for water used to meet essential needs. Disconnection is the most severe form of penalty for people who fail to pay their bills. No Canadian or Ontario-based research has effectively addressed this general issue. Thus, it is unclear how less fortunate people in those Ontario communities that have increased water rates, have coped. In other jurisdictions, rate structures have been developed to provide socially responsible rate setting. For instance, one rate structure for qualifying low-income customers would see a portion of the monthly water supply which is considered non-discretionary (the basic amount needed for sanitation, cooking, cleaning). Beyond this basic amount (*e.g.*, 30,240 litres per month), a higher rate will take effect (Stallworth, 2000). Utilities can also offer budget billing programs, elderly discounts and conservation assistance to assist low-income families. In Sydney, Australia, a Pensioners Rebate plan, and a Payments Assistance plan have been developed to help people who are experiencing financial difficulty (OECD, 1999).

Environment Canada, Ontario Region should undertake or support research that addresses the relationship between socioeconomic status and the ability people to meet their basic water requirements. Part of this research initiative could also assess the desirability and feasibility of implementing a range of socially responsible rate structures. ***Priority: High****.*

3.3.5 Revenue Stability

Perceived or actual revenue stability is a second problem that confronts the implementation of full-cost pricing. Many utilities worry that water users may reduce their use of water in an unpredictable manner and reduce needed revenues that support capital and operational expenditures (Beecher *et al.*, 1994). “If consumers respond with a higher-than-expected reduction in water use, conservation can cause utilities to experience reduced revenues and an unstable cash flow” (Stallworth, 2000, 18). Given the predominant use of flat rate structures in Ontario, this fear is likely widespread. Better familiarizing water utility managers, many of whom are relatively unfamiliar with the economic and financial aspects of water management, might better respond to economic strategies. Environment Canada, Ontario Region could play a role in addressing this need.

Environment Canada, Ontario Region should extend its current economic research efforts and gather reliable data on elasticity of demand. These data, combined with computer models can improve the ability to predict the impacts of conservation rate structures on revenues. ***Priority: Medium.***

Environment Canada, Ontario Region should work with the Ontario Water Works Association in identifying the need to better familiarize municipal water managers with the financial and economic aspects of water management. This forum could better familiarize water managers with the research findings and practical implications of demand management. Environment Canada, Ontario Region should support the implementation of any desirable and feasible initiative that is targeted at informing and educating water utility managers about the financial, economic and social aspects of demand management. ***Priority: High.***

3.4 Socio-Political Strategies

Socio-political strategies direct efforts to changing consumer's attitudes and behaviours towards the use of water through education, public awareness campaigns, privatization of utilities, and the development of water policies. It is apparent that Ontario's relatively high water use reflects some of the problems in engaging it to accept water conservation. One challenge for Environment Canada, Ontario Region as well as other water managers, is to effectively educate and activate citizens to change their attitudes and behaviours, largely through adopting water efficient fixtures and changing household water uses (*e.g.* gardening). Designing and delivering an effective message to encourage individual involvement in this process of change can be very costly.

Environment Canada, Ontario Region has developed a web site that contains a number of research papers on residential and agricultural water use, and economic valuation studies. It also played a role in developing the "success stories in water conservation" that are available through the Canadian Water and Wastewater Works Association website. Environment Canada's web site also provides water conservation information, and numerous reports, publications, brochures and information sheets are available. The 1993 National Conference and Trade Show on Water Conservation illustrates another of Environment Canada's efforts to inform and educate the public and private sector. There is no doubt that these efforts have been important and valuable. A lack of information on what upgrades are needed is often the second highest perceived barrier for homeowners to make energy (and perhaps water) improvements to a home. Only the perception that the initial costs were too expensive ranked higher. There is a clear need and benefit for water management agencies to seek the public's involvement through information and education programs, and marketing initiatives. Each is considered below.

3.4.1 Public Education Initiatives

A variety of methods exist to inform the public about water conservation. Two general approaches can be identified. The first is formal initiatives provided through school programs. These can be targeted at the general public or can be focused on specific user groups. Public education programs embrace many forms including brochures, booklets, bill inserts, demonstration projects, media advertisements, web sites and conservation awards. Kreutzwiser *at al*. (1998) reported that over half of municipalities indicated the implementation of some kind of public awareness campaign. Print media (23% of all approaches used), information packages (19.2% of approaches used, and working with local schools (15.7% of approaches used) were the most popular methods. Rain barrel promotions, xeriscaping demonstrations, public lectures and meetings, water days at treatment plants and education programs directed at industrial/commercial/institutional sectors were used much less frequently

The second approach is social marketing, which is defined as the "process for planning and implementing strategies for change. And,…is a set of concepts and techniques for carrying out various aspects of the social marketing process" (Andreasen, 1995, 7). Kennedy (2001, 12) suggests that social marketing "aims to change and mitigate those barriers that limit the broad adoption of a belief or behaviour."

Both traditional and social marketing approaches have a role to play in changing people's behaviour. However, what water managers must be more attuned to is the type of behavioural change desired. Applying the ideas of Kempton *et al.* (1984) to the field of residential water conservation, three types of water-use behaviour can be identified:

- *Investment behaviour*, which refers to the purchase of new fixtures, such as low flow toilets and faucets, for the home.
- *Management behaviour*, which refers to being more efficient with water resources through changed behaviour. Taking shorter or less frequent showers, and not leaving the tap running when cleaning teeth would illustrate this type of behaviour.
- *Curtailment behaviour*, which refers to significantly reducing or eliminating specific behaviours. No longer watering or washing the car with tap water typify this behaviour.

These three behaviours are significantly different. Curtailment involves an ongoing reduction in comfort or ease. Management is also an ongoing behavioural change. In contrast, investment behaviour only requires people to make one decision. "Investment can be marketed using traditional marketing techniques, however, management and curtailment involve ongoing behaviour changes, and therefore can benefit from the use of social marketing" (Kennedy, 2001, 13).

An educational approach to water conservation assumes that once an individual is informed about the high cost of their inefficient water use pattern, they will adopt new practices. This outcome is not always achieved. Understanding this limitation establishes a context for the

development of a social marketing approach. The essence of the approach is to understand the barriers to behaviour, and then develop strategies to overcome them.

This discussion prompts two recommendations:

> *Environment Canada, Ontario Region should develop and improve the distribution and presentation of educational and research material for the web. This includes its own web site, links to the Environment Canada web site, and other organizations such as the Ontario and Canadian Water and Wastewater Associations.* ***Priority: Medium.***
>
> *Environment Canada, Ontario Region should adopt a social marketing approach to water (and other) conservation efforts in specific municipalities in order to determine if a higher rate of appropriate behaviours is achieved. Kassier and McKenzie-Mohr (1998) provide some initial thoughts on community-based social marketing on which to build from.* ***Priority: High.***
>
> *Environment Canada, Ontario Region encourage the demonstration of xeriscaping at federal, provincial and local parks.* ***Priority: High.***

3.4.2 Privatization

Water management in Canada has been dominated by senior government decisions concerning agriculture, water rights, transportation, hydro and thermal electric generating, manufacturing, mining, and municipal drinking needs. Financing water treatment and sewage treatment plants and the distribution system is an ongoing legacy of the past supply management era, and will continue to be an important aspect to provide water in the future. However, a new element in the debate pertains to the role of government in owning and operating water and wastewater treatment facilities. Popularized by Margaret Thatcher's privatization of British Telecom in 1984 which spread to the water sector in 1989, at least 93 countries had partially privatized water and/or wastewater services or were in the process of doing so by the end of 2000 (Brubaker, 2001). Rees (1998, 95) commented that privatization had become more popular recently because public water utilities are often viewed as "lacking innovative capacity and being unable to compete in world markets", were hopelessly overstaffed, inefficient and incapable of providing basic services to growing populations. Privatization of water and wastewater utilities is motivated by several factors including:

- providing desperately needed investment in infrastructure renewal and expansion that governments are believed to be unable to make without unreasonably increasing debt and/or taxes. As old systems age and new regulations demand higher and more expensive treatment systems, the public sector's ability to adequately finance facilities is being extended (Thompson Gow and Associates, 1995; Brubaker, 2001).
- increasing the effectiveness of the water and wastewater system. Multinational water companies have devoted significant effort towards research and development that

enables them to tap expertise that is not accessible by the public sector. Private sector personnel are likely more adequately trained than public officials (Thompson Gow and Associates, 1995; Neto, 1998; Brubaker, 2001).

- improving the economic performance of the water utility by ensuring that over-development of the water infrastructure does not occur (Thompson Gow and Associates, 1995; Neto, 1998; Brubaker, 2001).
- providing for the full costing of water. The private sector is not prone to the 'politics' of water that could encourage the implementation of low prices. Grants and subsidies which have long distorted water utility's practices would be discontinued (Brubaker, 2001).
- removing of the potential conflict of interest which has seen governments responsible for implementing and enforcing water quality standards. Allowing the public sector to focus efforts on regulation and enforcement increases the level of accountability (Brubaker, 2001).

In the privatized water environment of the millennium, governments are setting policy and regulating activities – both economic and water-related. The private sector is often owning, operating and financing water and wastewater works.

According to the president of the Association of Municipalities of Ontario, "the single most important impediment to the successful maintenance and rehabilitation of Ontario's municipal infrastruture is a shortage of funds" (as cited by Brubaker, 2001, 37). The National Round Table on the Environment and the Economy estimated that nation-wide, between $38 and 49 billion over the next 20 year was required to maintain and revitalize existing infrastructure. In Ontario, the OWWA (2000) estimates that $32 billion is required over this same period. If senior governments introduced higher water and wastewater quality standards, these estimates would increase substantially. The strain of inadequate financing may already be surfacing. Between 1996 and 1998, 121 municipal sewage treatment facilities failed to comply with their Certificates of Approval (Shrubsole and Green, 2001). The public seems generally unaware of these transgressions. However, it is very aware of incidents such as the Walkerton tragedy and North Battleford (Saskatchewan) crisis. After the Walkerton crisis, MOE inspectors found that 357 of 645 municipal water treatment plants failed to comply with standards. These violations did not occur overnight. Instead, they reflect a "long-standing problem: Governments, paralysed by conflicting objectives and loyalties, have rarely forced publicly owned, publicly operated, or publicly financed water treatment plants to comply with provincial laws and standards" (Brubaker, 2001, 51). The conflicting roles of government detract from accountable government.

Recently, there have been very significant developments concerning the ownership and funding for treatment plants in Ontario. At present, 29 private companies are operating what were once publicly owned and operated municipal water systems. These are operating in villages, such as Campden, small communities such as Forest, Listowell, Petrolia, Goderich and Plimpton, and large municipalities such as the Regional Municipalities of Haldimand-Norfolk and Hamilton-Wentworth. The largest and most controversial privatization occurred in Hamilton (Brubaker,

2001). The experience in this community is supported in the literature – that caution must be exercised in awarding contracts. In this way, the previously identified benefits that can be achieved through privatization can be realized.

The Hamilton case is instructive because it illustrates the problems associated with some contracts. Brubaker (2001) noted the following issues:

- In 1995, Philip Utilities Management Corporation (PUMC) was awarded the contract in order to reward a local company and reap some $15 million in promised investments to develop an environmental enterprise centre and an international training centre. Typically, issues such as poor utility management, over-staffing and poor utility performance are addressed through privatization.
- In 1999, PUMC was sold to Azurix, which inherited the unfulfilled promises.
- The operational savings provided by the contract were less than 4% of the previous costs. This is modest compared to experiences elsewhere.
- In terms of utility performance, BOD levels have improved, while suspended solids, phosphorous, nitrogen and ammonia have worsened.
- In 1996, a problem at a sewage plant sent about 1 million litres of wastewater into Hamilton Harbour and under the contract, the city, not Philip was liable for the damage. This situation clouds issues of accountability. It was not until 1999, when Azurix bought PUMC did a final outcome arise; Azurix agreed to pay claims at its expense.

In terms of performance, it is unclear if a municipally-operated system in Hamilton would or could have achieved better results. Many of the problems were perceived to be beyond any operator's control. However, the initial motivations for the signing the contract are lessons for other municipalities considering the privatization of their utilities. Governments must ensure that appropriate regulations and enforcement provisions are provided in the contract. These include matters such as high water quality, conservation, equity and efficiency, and the private service provider's goals of profit. Water providers must be accountable for the achievement of these public goals and for the protection of public health (IJC, 2000).

In 1997, the Province of Ontario transferred ownership of the water infrastructure to municipalities. As noted earlier, 29 have privatized aspects of these operations. The Ontario Clean Water Agency (OCWA), a provincial crown corporation, operates 161 water treatment plants and 233 sewage treatment plants. Since the province is involved in these operations, it may remain reluctant to prosecute the non-compliance of requirements specified in Certificates of Approval. This supports the need to better delineate ownership, operation, financing and enforcement. The Office of Privatization is currently reviewing OCWA's future.

It would be inappropriate to provide a detailed review the approaches to, and the strengths and weaknesses of privatization in this report. These tasks have been competed by previous studies (Thompson Gow and Associates, 1995; IJC, 2000; Brubaker, 2001). However, in terms of future research, there is a need to provide for a more consistent use of methods in order that firmer

generalizations can be made. In reviewing the outcomes of privatization in France, the United Kingdom, Australia and New Zealand, Molz and Hafsi (1997) concluded that it was difficult to make comprehensive evaluations of the outcomes of privatization. Over 120 studies were reviewed of which 30% were based on anecdotal qualitative outcomes, and 50% applied quantitative measures. They suggested that future studies assess privatization outcomes applying a longitudinal research design, and apply quantitative and qualitative techniques. Given the controversy and importance of privatization, and the need for research on Ontario practice, the following recommendations are made.

> *Environment Canada, Ontario Region complete or support a research study that follows the advice provided by Molz and Hafsi (1997).* ***Priority: Low.***

> *Environment Canada, Ontario Region support any initiatives that better delineates the functions of ownership, operation, financing and enforcement.* ***Priority: High.***

3.5 Summary

Several Ontario municipalities do not have metering and cannot apply water pricing. These two mechanisms are central to water conservation initiatives. Many municipalities that do meter have yet to achieve full-cost recovery, and adopt conservation pricing structures. Towns, townships and villages, those communities that have a relatively greater difficulty in having adequate capacity to deal with water management, have generally done the least on the water conservation front. Relative to practice elsewhere in the world, Ontario is in the "down at the bottom of the pack". This situation is, in large part explained by the long-standing and ongoing access that municipalities have had to grants from senior governments. Rather than provide a level playing field, these grants have been biased towards supply management strategies. Senior governments must carefully consider funding approaches that provide for opportunity and effectiveness. Combined with the prevailing myth of a superabundant water resource, financial arrangements have made it very difficult to bring the long list of alternative demand management techniques (Table 3.2) into action.

In considering future action, it is appropriate to identify guiding principles that would demonstrate senior and local government's commitment to effective demand management. This can be done within the context of a water conservation policy. However, since that initiative should transcend all water uses, it will be considered in Chapter 6.

Chapter 4
The Agricultural Water Sector

4.0 Introduction

Nearly 3.7 million people in Ontario depend on groundwater as their main source for water supply. The clear majority of these live in rural communities and on farms. In contrast to many urban communities that rely on the Great Lakes for their supply, the majority of rural residents and agriculture depend on a variety of smaller sources – lakes, rivers, dugout ponds and groundwater. In these situations, rural people are relatively more vulnerable to changes in the supply of water than their urban counterparts. For instance, Dolan (2000) reported that in 1988, precipitation in southwestern Ontario was less than 40% of the average during the period May to July and streamflows were as much as 20% of the normal in June. This dry period contributed a reduction in field crops yields by14% to 30% compared to the average of the previous five years. It also resulted in crop insurance payments of $55 million and $12 million being paid to livestock producers (Kruetzwiser and de Loë, 1999). Schellenberg and Piggott (1998 as cited by Dolan, 2000) estimated that rates of groundwater withdrawal in a study of 13 southern Ontario counties were significantly higher than recharge rates. In some instances, the rates of withdrawal were as much as three times greater than the annual groundwater recharge. Water conservation can minimize or avoid the conflicts, and economic and environmental damages associated with water shortages.

This discussion is divided into four parts. First, the nature of the agricultural water database is reviewed. These comments support many statements provided in Chapter 2. General approaches to water demand management in agriculture are outlined in the second section. This discussion highlights the linkage between water quality and quantity management in agricultural areas. Selected practices of agricultural water demand management are provided in the third section. Section four provides a summary.

4.1 The Agricultural Water Use Database

Vandierendonck and Mitchell (1997, 404) concluded that "water use data pertaining to the agricultural sector are not collected or maintained on a systematic basis." Instead, provincial water use in the agricultural sector is estimated based on some regional studies, the most significant one being *A Review of Water Use and Water Use Efficiency in Ontario Agriculture* (Ecologistics Limited, 1993). Agricultural water use volumes are based on estimates using data for livestock numbers and area of land under cultivation, together with coefficients. "There is a weakness in the use of coefficients based on assumptions concerning farm practices. The amounts recorded for agricultural water use give the amount of water that might have been used but not the actual use. It must be appreciated that water use can be highly variable among farms and within water use applications" (Vandierendonck and Mitchell, 1997, 404). They also maintained that research efforts to date had focused attention on the amount of water withdrawn and relatively little had been done to document the source and location of water for agricultural

use in Ontario. These comments reinforce the need for research concerning the use of coefficients in water use studies.

de Loë *et al.* (2001) updated the estimates of water use for the agricultural sector (Table 4.1). In 1996, all agricultural sectors were estimated to use 186 million m^3/year up from 168 million m^3/year in 1991. The experience throughout most of the world is that the main water use within agriculture is for irrigation, with demands for livestock watering making minor contributions. Ontario does not reflect this trend. While irrigation is substantial, livestock watering uses over 50% of all agricultural water (Table 4.1).

Table 4.1:
Estimates of Agricultural Water Use in Ontario (million m^3/year)

Agricultural Sector	Ecologistics Ltd. (1991)	Rural Water Management Group (1996)
Livestock (All)	61.5	53.7
Field Crops	20.3	23.6
Fruit Crops	11.6	21.8
Vegetable Crops	22.7	22.2
Specialty Crops	52.2	51.8
Total Agriculture	**168.0**	**186.0**

(Source: de Loë *et al.*, 2001)

Livestock production depends on reliable access to water of suitable quality in order to provide drinking water, to clean facilities, to sanitise equipment and to dilute manure. These needs would have to be met throughout the year. In contrast, irrigating crops would place demands on water sources primarily in the months of June, July and August. In Ontario, irrigation is primarily applied to high-value specialty crops that include tobacco, sod and nursery stock. Irrigation water is also used for frost control. Not provided in Table 4.1 are the estimated water needs for aquaculture that were 96.1 million m^3 (1991) and 84 million m^3 (1996) (de Loë *et al.*, 2001).

4.2 General Approaches to Water Conservation in the Agricultural Sector

Kromm and White (1990) identified three general approaches to agricultural water conservation: field practices, management strategies and system modifications. Two other approaches may be added – economic and socio-political (Table 4.2). Field practices aim to keep water in the field, more efficiently distribute it across fields, and encourage retention of soil moisture. These practices do not require large capital investment. Management strategies monitor soils and water

conditions, and collect information to aid in better decision making regarding the scheduling application or improving efficiency of the irrigation system. System modifications refer to the addition or alteration of an existing water system. Economic strategies can be employed by government to support water conservation through pricing or reallocation mechanisms. Socio-political factors aim to change attitudes and behaviour.

Table 4.2:
Water Conservation Measures in the Agricultural Sector

	Specific Type of Agricultural Use	
General Approach	**Livestock**	**Irrigation**
Economic	price water subsidize adjustments insurance	price water subsidize adjustments insurance
Socio-Political	regulate withdrawals temporary restrictions provide information require code	regulate withdrawals temporary restrictions provide information require code
Livestock Operations & Field Practices	shade for stock adequate ventilation	level land use stubble mulch conservation tillage chisel compacted soil pond rain/snowmelt pond irrigated water capture rainwater
Management Strategies	meter use reduce livestock	meter use measure precipitation monitor soil moisture schedule irrigation reduce irrigation area change crops
System Modifications	reduce pressure reuse/recycle repair leaks watering equipment water-saving devices	add drop tubes to centre pivots retrofit wells with smaller pumps drip/trickle techniques efficient irrigation

Relative to irrigation, opportunities for livestock water conservation are generally fewer since about 89% of water used in the livestock sector is required to meet the daily nutritional water needs of the animals (Ecologistics Limited, 1993). Significant water-savings can be achieved through reducing spillage losses and reducing volumes of water used for sanitation purposes.

Many measures, however, require significant financial investment (Ecologistics Limited, 1993), and managerial expertise, as they must be integrated into often highly specialized livestock operations (Dolan, 2000). Implementing measures can be impeded by the high costs of farming combined with low crop prices (Kromm and White, 1990). Kromm (1994) examined differences in the adoption of water conserving practices between American and Canadian farmers. In general, Canadian farmers were slower to adopt new measures. Kromm (1994) attributed this to the type of irrigation system utilized, crop grown, relative expense, and suitability of practice for local conditions. He also noticed that newer innovations were not widely available in Canada nor was there an immediate water scarcity as in the High Plains of the United States. This finding can also reflect the higher levels of subsidies provided to U.S. farmers to adopt new technologies. Managing water quantity and quality is but one of many pressures that farmers face in a very competitive global agricultural trade market. The potential benefits of adopting water demand management on farms include: reduced operating costs, on-farm costs, drought impacts, soil erosion, drainage problems, groundwater overdraft, and improved crop yields, and quality and water supply reliability, as well as improved water quality and aquatic habitat.

4.3 Practice of Water Conservation on Farms in Ontario

As a single approach, water demand management has not been a high-profile response to improving farming practices in Ontario. Instead, it has been incorporated into a more general program, the Environmental Farm Plan (EEP) program. Initiated in 1992, the EEP program assists farmers better manage their operations. Under the program, farmers develop a plan that addresses a wide range of environmental issues that can occur both on and off the farm. It has many participants including the Ontario Farm Environmental Coalition, Agriculture Canada, OMAFRA, MOE and MNR. Farmers who attend workshops sponsored by the Ontario Soil and Crop Improvement Association can develop their own plans, or professional consultants can be hired. In either case, a committee of local farmers review plans anonymously. Grants of up to $1500 can be provided for plans that have been peer reviewed. Water conservation is one of many items that can be addressed in plans. Van Osch (1997) surveyed farmers and government officials who participated in the program. There was general support for the program from both groups. Of the 19 farmers who returned the survey, almost half indicated technical and financial barriers impeded more effective implementation.

Dolan *et al.* (2000) surveyed agricultural water users in eight southwestern Ontario townships that had a high level of water demand. She found that agricultural water users were more likely to reduce water use in the home by maintaining household appliances, pipes and taps. Livestock water uses were also more frequently reduced by maintaining watering equipment floats and seals (81 of 96 respondents (84%)). Rescheduling irrigation (32 of 34 respondents (94%)), monitoring soil moisture (19 of 31 respondents (61%)), using stubble mulch (15 of 28 respondents (54%), ponding rainfall (17 of 33 respondents (52%)) and conservation tillage (14 of 28 respondents (50%) were the most popular means or reducing irrigation usage (Kreutzwiser *et al.*, 1999). Water conservation in livestock was associated with higher levels of sales (gross) and agricultural activities as the primary source of household income. Some of the constraints

impeding water conservation in the agricultural sector were the low cost of water, and the high cost of conservation technologies. Unfortunately, it was unclear how many of these respondents participated in the EFP program and what specifically motivated participants to take action. It is also unclear how effectively the EFP program is addressing water supply and demand issues. This prompts the following recommendation:

> *Environment Canada, Ontario Region should determine the effectiveness of the Environmental Farm Plan (EFP) program. It should consider the desirability of formalizing its role in the EFP program, and if appropriate, discuss the feasibility of this initiative with relevant parties. There appears to be a need for additional technical and financial resources that could be provided through Environment Canada, Ontario Region.* ***Priority: Medium.***

4.4 Research for Future Agricultural and Rural Water Conservation

Since agricultural water users generally rely on a limited supply, there is often significantly heavier competition for these limited supplies with other rural users, municipalities, rural commercial and industrial users, golf courses, and rural residents (de Loë *et al*., 2001). At the same time, the balance between these withdrawal users and instream users should be maintained. In their study of water use, Kreutzwiser and de Loë (1999) mapped the spatial pattern of agricultural water use at the township level. Their analysis indicated a concentration of agricultural water use in southern Essex County, Hamilton-Wentworth Region, Niagara Region, southern Simcoe County, northern York Region and a portion of Durham Region. Specialty, fruit and vegetable food crops place heavy demands on water resources in these areas. These areas are located adjacent to urban areas where competition for water supplies is significant. It would appear that some areas of the province presently relying on groundwater resources are mining that resource (Dolan, 2000). The associated economic losses of water shortages and drought are significant. This situation prompts the following recommendation:

> *Environment Canada, Ontario Region should consider targeting those areas of intense water competition identified by Kreutzwiser and de Loë (1999) for a concerted effort to reduce the demand for water.* ***Priority: High.***

There are several approaches to address this problem. First, metering could provide more reliable information than the present use of estimates. Second, improvements to irrigation equipment could be considered. At present, most irrigation is done through sprinklers in order to prevent frost and provide water. Although it is more water efficient, drip irrigation is rarely used. Third, the pricing of water is an option. However, this is not likely a feasible approach from a societal perspective. In addition, previous research indicates that agricultural water pricing is effective only in regions where water is scarce, and as a consequence is treated as a tradable good (OECD, 1999). Two other approaches are discussed below as potentially innovative solutions: institutional reform and water reuse.

4.4.1 Institutional Reform

In some instances, the water-saving alternatives identified in Table 4.2 have been viewed as inadequate in the absence of institutional reform. In response to the serious problems associated with groundwater overdraft, the State of Arizona (USA) passed a *Groundwater Management Act* (1980). It established four Active Management Areas (AMA) in which intensive groundwater management was prescribed due to large and ongoing overdrafts (Peacock, 1994). Each area was to develop strategies that would achieve a "safe yield" (*i.e.* zero groundwater overdraft) of groundwater supplies in specific areas of the State, including Phoenix and Tucson, by 2025. Over that time period, five successive management plans will be developed and implemented, each one imposing more stringent conservation measures on all water users. Starting in 2006, during the third management period, water rights are to be retired in order to permanently reduce water demands and achieve "zero overdraft". This most restrictive approach complements two other policy tools – water conservation programs and its enforcement. According to Peacock (1994), the *Groundwater Management Act* had the following shortcomings:

> (1) Since strict controls were placed only within the four AMAs, incentives were established to import water from outside the areas. This contributed to an unanticipated outcome - the development of "water farms" that were created by municipalities, developers, investors and utilities. These entities purchased irrigated land outside the AMA in order to access its water rights.
>
> (2) No limits were placed on the quantity of groundwater that could be legally pumped from existing irrigation wells within the Critical Zone Areas.
>
> (3) Irrigation groundwater users were provided with the flexibility to bank unused water credits (unlimited credits) and withdrawal excess water allotments (up to half their annual allotment). However, if the groundwater right is transferred to a non-irrigation use, the credits cease to exist. Thus, there is an incentive for only short-term rather than long-term conservation.
>
> (4) Relative to other water users, irrigation users are the target of more stringent restrictions. By 2000, municipal providers must make "reasonable reductions in per capita use"; industrial water users must implement "conservation requirements based on the use of the latest commercially available conservation technology consistent with economic return". In contrast, irrigation users are required to undertake "maximum conservation consistent with prudent long-term farm management" (Peacock, 1994, 23). Prudent long-term farm management has been interpreted to refer to economic feasibility rather than reasonable economic return.

Peacock (1994) concluded that this policy could be improved if transferable and enforceable property rights in the stock and flow of groundwater and other sources of water were established. He also suggested that since the costs of enforcing water conservation measures on irrigators was

most expensive, that a more balanced approach be used to achieve reductions from all water users.

The institutional reform of agricultural water use in Ontario might present itself in three forms. First, the Permit to Take Water Program might be reformed and a higher degree of consideration be given to water demand management options as part of the decision-making process. Second, as part of the Provincial Governments privatization of municipal water works, responsibility for agricultural water use could be transferred to a private authority. Third, if and when water supplies are under higher levels of stress, regulatory standards, such as those implemented in Arizona may be initiated.

> *Environment Canada, Ontario Region should monitor the relative strengths and weaknesses of a variety of institutional arrangements responsible for the allocation of water.* ***Priority: Low.***

4.4.2 Water Reuse

Reusing municipal and industrial wastewater is also a strategy for increasing freshwater supplies. Two types of reuse can be identified: indirect and direct. Treated water can be indirectly reused when it is discharged into a watercourse, diluted and used again downstream. For instance, in England, most water withdrawals are from streams and surface waters that receive significant quantities of treated wastewater (indirect reuse). Direct reuse means the direct supply of water of treated effluent from the treatment plant to the user (*e.g.* industry, agriculture, recreational facility, domestic user). It can also apply to the artificial recharge of an aquifer. Countries such as Cyprus, France, Greece, Italy, Malta, Portugal and Spain, have implemented direct use schemes irrigation. However, in recent years an increasing number of initiatives and research projects have been undertaken into direct reuse of water, particularly in the domestic and commercial sectors (European Environment Agency, 2001). Generally, the direct reuse of treated water has been in response to water shortages rather than as planned activity.

The benefits of recycled water are:

- an increase in available water resources;
- better water management – it allows the substitution of freshwater for other uses while reserving the latter for direct human use;
- a potential reduction in pollutants to be discharged into freshwater;
- a better use of nutrient content in the treated water; and
- a guarantee of regular water supply, especially where water is scarce (European Environment Agency, 2001).

In general, the reuse of treated water in Canada is not widely viewed as socially acceptable. This reluctance reflects, in part, public concerns over health risk. It is also "linked to the lack of standards and guidelines to regulate reused water quality, and to the lack of validation of existing ones" (European Environment Agency, 2001, 52). California's reclaimed water quality

standards could be a model for Ontario to follow. Briefly, the level of stringency varies with the end use. Virtually all disease-causing organisms must be removed before reclaimed water can be used on agricultural food crops and parks, but the standards are progressively less stringent for pasture, golf courses, fibre, forage, and orchard and vineyard crops (Postel, 1997). The NRC (1994) endorsed greater use of reclaimed wastewater.

> *Existing standards and guidelines for the use of treated wastewater should be validated, and if required, new ones should be developed, to safeguard public health and the environment.* ***Priority: High.***

Another factor concerns the high cost of implementing reuse projects. Using sand filtration systems can cost $37.00-$65.00 (Cdn) (capital cost) and $0.008-0.016 (operational cost). Reverse osmosis can cost $117.00-$149.00 (capital cost) and $0.15-0.20 (operational) to treat 1 m^3 of water (European Environment Agency, 2001). This high level of investment could discourage potential users.

> *Environment Canada, Ontario Region should undertake and sponsor support research that supports the reuse of water. Initially, this could be focused on those areas that are presently under water stress. Based on these results, Environment Canada, Ontario Region should support the use of treated wastewater whenever appropriate. In determining 'appropriate', it will be necessary to collaborate with other provincial and local agencies that deal with water and public health, as well as the NGO community and general public. In this manner, definitions, standards and guidelines can be established.* ***Priority: High.***

4.5 Summary

Rural water supplies are being stressed in portions of the province. Relatively little is known about current the effectiveness of current initiatives that promote demand management. Environment Canada, Ontario Region has a role in promoting future research and supporting current and future initiatives.

Chapter 5:
The Industrial Water Sector

5.0 Introduction

Unlike the municipal and agricultural sectors, there has not been a recent review of the industrial water sector in Ontario. Therefore, it is not possible to provide the same level of detail. However, some general observations can be made. The OECD (1999) suggested that industrial water use from the public water supply has tended to decline in the majority of OECD countries. In Canada, manufacturing water use increased between 1972 and 1981, but fell substantially from 1981 to 1991 (Tate and Rivers, 1991). These decreases in industrial water use can be explained by at least three factors. First, industrial water users appear to be responsive to price increases. However, in Ontario, industrial water rate structures are not always based on economic principles and some flat rates are used (Table 5.1). In particular, industrial firms can negotiate contracts with municipalities for water services, and these contracts are normally negotiated at bulk rates, unrelated to the precise quantities of water used (Tate and Scharf, 1991). Those industries that supply themselves with water would likely not pay a price for its use.

Table 5.1:
Ontario Water Pricing Structures for Industries Using Municipal Water Infrastructure

Rate Structure	Industrial Users (N (%))
Flat Rate	20 (13.1%)
Declining Block Rate	35 (22.9%)
Constant Rate	60 (39.2%)
Increasing Block Rate	10 (6.5%)
Summer Surcharge	2 (1.3%)
Other Rate Structures	3 (2.0%)

(after Kreutzwiser *et al.*, 1998)

Second, industrial water users have more options available for reducing consumption through the adoption of water saving technologies. Third, more stringent pollution controls have often been achieved by increasing or introducing water recycling into processes. This has been a prime motive for water use reductions in Canada. The impact of all three factors is seen in the increase in water recycling.

The next section reviews water conservation and reuse in the industrial sector in order to direct future research efforts.

5.1 Research Directions for Water Conservation in the Industrial Sector

If industrial water use is to decrease, we must better understand how water is actually used by industries. Ideally, this could be achieved by comparing different types of industries with a standardized water use classification system. Industry types can be classified according to the SIC code. Although a substantial literature on individual water uses exists, we lack a water use classification system across a wide range of industries. An initial water use classification was provided by Chao-Hsien (1991) and included the following:

> *Process water*: is used as an integral part of the production process. It is placed in concert with or made part of the product being manufactured. Primary uses would include cleaning, transporting, and direct cooling.
>
> *Indirect cooling water*: does not contact the object cooled.
>
> *Boiling water*: passes from a liquid to a vapour phase and then condenses as pure water.
>
> *Support water*: is used to meet personal needs of the employees, maintain an aesthetic and comfortable work environment, provide fire protection, or maintain buildings or equipment.
>
> *Construction water*: is used in making concrete or when building a new structure.

It is also important that indicators of water use efficiencies be comparable. The two most common measures are: (1) water use per employee; and (2) water use per unit of output produced or value added in manufacturing. Since the level of technology, regulatory standards, economic conditions and amount of water use and reuse can vary among industries, these measures only provide general guides. It is also important to provide consistent definitions of the reuse rate. For instance, Jermar (1987) defined water reuse as the reused water divided by the gross water applied. Kollar and McAuley (1980) defined it as gross water divided by the water intake.

It was noted previously that one benefit of water demand management pertained to increasing industrial competitiveness. This advantage has not been well developed. Environment Canada, Ontario Region should consider the following:

1) *in order to enhance the competitiveness of Ontario's industries, Environment Canada. Ontario Region should cooperate with Industry Canada, relevant provincial agencies, the Ontario Chamber of Commerce, other relevant industry NGOs and individual companies to promote water audits of individual plants. Given its importance to the Ontario economy, priority may be given to the automobile manufacturing sector.* ***Priority: High.***

2) *That Environment Canada, Ontario Region work with the Ontario Chamber of Commerce to promote and develop in both image and practice that Ontario is not only an*

economically competitive, but also a water efficient jurisdiction. The latter translates into lower production costs. Case studies that document the actual savings to companies should be completed and well publicized. ***Priority: High.***

In practice, the federal government can influence water quality and quantity management through provisions of the *Fisheries Act* and the *Canadian Environmental Assessment Act*.

Environment Canada, Ontario Region should undertake research that provides a rigorous and systematic analysis of industrial water use in Ontario. In undertaking this effort, it may consider the suggestions provided above. At the federal level, Industry Canada may provide useful comments on research opportunities. Comparisons with other jurisdictions would provide insight into Ontario's industrial and water-use competitiveness. ***Priority: Medium.***

On the basis of this research, the desirability and feasibility of any activities by Environment Canada, Ontario Region can be assessed.

Chapter 6:
The Way Ahead

6.0 Summary

Water demand management is one of five major strategies that combine to form integrated water management. Therefore, it should be linked to watershed and land use planning, water supply management, water quality management and remedial measures. Water demand management must be viewed as a means to an end, and should only be implemented when there is a clearly defined purpose.

This chapter is divided into two sections. The first examines how Environment Canada may wish to consider developing its internal priorities. The second briefly considers future directions for the water management activities of Environment Canada, Ontario Region.

6.1 The Way Ahead: Setting Priorities within Environment Canada

There are at least two ways to establish priorities. The first is to examine the relative merits of each of the three sectors reviewed in the preceding chapters and select the 'most important' sector. The merits of selecting each sector are summarized below:

> *Municipal sector:* the water demands are very concentrated geographically, and they place enormous strains on inland water bodies both in terms of water withdrawn to meet these concentrated demands, as well as pollution that results from the wastewater discharges. In addition, expanding and developing water and wastewater systems are very capital intensive. Since the majority of Ontarians live in urban centers, Environment Canada, Ontario Region may wish to consider these pragmatic reasons for selecting this as the priority sector.
>
> *Agricultural Sector:* rural residents and agricultural water users are the most vulnerable groups affected by current and future water shortages. Agricultural water uses are the largest consumer of water. Demand management would assist in solving some of the regional problems that are present in Ontario.
>
> *Industrial Sector:* the least is known about the nature of water uses in the industrial sector. Environment Canada, Ontario Region could fill this gap. Manufacturing is the second largest withdrawal user (next to thermal electric power generation). Since manufacturing is the economic engine of the province, water demand management could be linked with province-wide economic development initiatives. Federal jurisdiction over fisheries provides a potential opportunity for Environment Canada, Ontario Region to influence water uses for new industry.

An alternative perspective on priority setting would be to focus attention on the means of implementing water demand management rather a focus on individual sectors. In this regard, guidelines for water conservation developed by the EPA (1998) might be helpful (Table 6.1). It identifies three levels of water conservation.

Table 6.1:
Levels of Water Conservation

Basic Measures

- Universal metering
- Water accounting and loss control
- Cost accounting and pricing
- Information and education

Intermediate Guidelines

- Water use audits
- Retrofits
- Pressure management
- Landscape efficiency

Progressive Measures

- Replacements and promotions
- Reuse and recycling
- Water use regulations
- Integrated resource management

(modified from EPA 1998)

Many Aboriginal communities in Ontario continue to be inadequately served by their water systems, and have not yet reached the basic measures of water concervation noted in Table 6.1. Clearly, this is not acceptable. Therefore, a priority item reiterates an earlier recommendation:

> *Environment Canada, Ontario Division should work with First Nation Communities, the Assembly of First Nations, the Department of Indian and Northern Affairs and other relevant participants to ensure the implementation of the water-related recommendations of the Royal Commission on Aboriginal Affairs (1996).*

On a province-wide basis, the preceding discussion suggests that Ontario lacks many of the basic measures for water conservation in all sectors. Metering, an essential element of water demand management, is implemented on an inconsistent basis among and within the three water sectors reviewed in this report. At the municipal level, savings from the introduction of metering are estimated to be 10% to 40% of supply. Metering provides a basis to consider the feasibility of applying water charging systems and leak reduction programs. On this basis, Environment Canada, Ontario Region should promote the metering of all water users in the province. Once

metering is in place, the Province of Ontario and municipalities can determine the desirability and feasibility of achieving other levels of water conservation (Table 6.1). In order to provide for a more balanced approach to water management, Environment Canada, Ontario Region should advocate that the current system of cost-sharing grant arrangements available through senior governments be reconsidered in order that full-cost pricing be encouraged. Since full-cost pricing should be done in a socially responsible manner, Environment Canada, Ontario Region should undertake or sponsor research that considers how vulnerable groups can be protected from unreasonable price levels. Guaranteeing a basic level of domestic water at an affordable price is an important principle what should be promoted. In terms of thinking about water management over the next 10-20 years, Environment Canada, Ontario Region should consider undertaking research that considers reuse and recycling of water. In this manner, it will be in an informed position when changing circumstances prompt more intense public scrutiny of this alternative.

> *Environment Canada, Ontario Region should establish the following priorities: supporting effective water supply and water use databases; promoting and supporting universal metering; advocating the elimination of subsidies that are means biased (or have grants replaced by loans); researching and advocating socially responsible pricing systems; researching the reuse and recycling of water in all water sectors; and supporting educational efforts, including research into social marketing.* ***Priority: High.***

6.2 The Way Ahead: Working with Others

Changing societal expectations, financial circumstances and political realities have influenced the role the federal government and its relationship with provincial and local governments, aboriginal communities, the private sector, the NGO community and the public. Federal and provincial agencies generally have less money, although this could change in the aftermath of the public inquiries associated with Walkerton and North Battleford. During the 1980s and 1990s, the federal government has been experimenting with a number of partnerships and it was one of three key principles of its *Freshwater Strategy*. However, the desired outcomes from these activities has been less clear.

Perhaps Environment Canada, Ontario Region would consider establishing new baselines for integrated water management as a fundamental first step re-establishing water management principles. Effective integrated water management in the new millennium requires that new hydrologic baselines that reflect the full range of valued water uses be developed for watersheds across the province. In identifying these baselines, a new partner to the 'traditional set' of government and non-government participants must be incorporated into the process of defining that baseline - aboriginal communities. Environment Canada, Ontario Region has clear jurisdictional responsibilities to undertake these discussions. The federal *Fisheries Act* establishes some standards but these must be supplemented by provincial, local, aboriginal and private initiatives to bring about ecosystem restoration. Interested groups in Ontario's watersheds must be effectively empowered to chart a sustainable future by defining resource

goals and developing programs to achieve these goals. Some of the Professional Associations and Trade Organizations that Environment Canada, Ontario Region may wish to engage in this and other initiatives are included in Appendix 1.

Over the last 10 years, problems of water allocation have become increasingly difficult in Ontario. This is particularly the case in and near urban areas as well as in those instances associated with interbasin diversions. Responses of the past have relied on water supply approaches. Present and future approaches will rely on a mix of water demand and water supply approaches. However, a central question remains to how to allocate water among various uses – instream and withdrawal. Issues of equity and fairness in water allocation will become an increasingly important in Ontario water management. This highlights the need for effective partnerships in managing water.

There can be no uniform definition of success of water conservation or sustainability because of the mix of withdrawal and non-withdrawal uses and the condition of the water environment differs across the province. Effective water management will inevitably be watershed specific and will require a different mix of watershed and land use planning, water supply management, water demand management, water quality management and remedial measures. There is no doubt that future strategies will place more emphasis on non-structural watershed and land use management, water demand management and integrating ground and surface water resources than previous efforts. To these ends, Environment Canada, Ontario Region should encourage the Province of Ontario to review its *Water Efficiency Strategy*, revitalize it, and commit to its implementation. That document could have made considerable progress in water conservation when it called for zero growth in demand over 20 years. However, there was no apparent effective commitment to its implementation by the Province of Ontario. This revitalized strategy could form one of five pillars to support the development of an Ontario Water Policy that would improve the management of Ontario's most diverse natural resource. At every level of government, leadership is required to make water conservation and demand management an integral part of long-term planning. The policy statement would include at a minimum a statement of principles, approaches, and clarification concerning the institutional arrangements for all aspects of water management. To date, this has not occurred, and water conservation remains virtually untapped as a means of effectively stretching available supplies of water in Ontario. Thus, the final recommendation is:

> *That Environment Canada, Ontario Region should promote and support efforts that lead to the development of an effective Ontario Water Policy.* ***Priority: High.***

Bibliography

Allan, R.J. (1995). "Impact of Mining Activities on the Terrestrial and Aquatic Environment with emphasis on Mitigation and Remedial Measures." *Heavy Metals*. W.Salomons and others (eds.). Berlin: Springer.

American Water Works Foundation (1998). *Water Affordability Programs*. Denver, Colorado: AWWARF.

Anderson, M. and J. Robinson. (1985). *Role of Demand Management in a Federal Water Policy.* Ottawa: Inquiry on Federal Water Policy, Research Paper No. 20.

Anrdeasen, A.R. (1995). *Marketing Social Change – Changing Behaviour to promote Health.* Ottawa: University of Ottawa Working Paper 84-53.

Author Unknown. (1999). "Best Practice Environmental Management in Mining: Water Management." Available at: www.ameef.com.au/publicat/bpem/watermn.htm

AWWA. (1997). "Household End Use of Water Without and With Conservation." *1997 Residential Water Use Summary – Typical Single Family Home.* Available at: www.waterwiser.org/wateruse/tables.html.

Beecher, J.A. *et al*. (1994). *Revenue Effects of Water Conservation and Conservation Pricing: Issues and Practices*. Columbus, Ohio: National Regulatory Research Institute.

Booth, L. and F. Quinn. (1995). "Twenty-five years of the Canada Water Act." *Canadian Water Resources Journal*. 20: 65-90.

Brooks, D. and R. Peters. (1988). *Water: The Potential for Demand Management in Canada*. Ottawa: Science Council of Canada.

Brubaker, E. (2001). *The Promise of Privatization*. Toronto: Energy Probe Research Foundation.

Bruce, J. and B. Mitchell. (1995). *Broadening Perspectives on Water Issues*. Ottawa: Royal Society of Canada Incidental Report No. IR95-1.

CCME. (1994). *National Action Plan to Encourage Municipal Water Use Efficiency.* Winnipeg: Canadian Council of Ministers of the Environment.

Chao-Hsien, L. (1991). *A Scientific Basis for Industrial Water Conservation.* Logan, Utah: Unpublished PhD. Thesis, Utah State University, Department of Civil and Environmental Engineering.

Chaplin, S. (1998). “Water Efficiency: The Next Generation.” Mimeo: The Rocky Mountain Instititute.

Chambers, C. and M. Winfield. (2000). *Mining’s Many Faces*. Toronto: The Canadian Institute for Environmental Policy and Law.

de Loë, R., R. Kreutzwiser and J. Ivey. (2001). “Agricultural Water Use in Ontario.” *Canadian Water Resources Journal*. 26(1): 17-42.

Demayo, A. and E. Watt. (1993). *Glossary of Water Terms: English-French*. Cambridge: Canadian Water Resources Association.

Dolan, H. (2000). *Rural Water Use Decision Making: Adoption of Water Conservation Practices in Southwestern Ontario*. Guelph: Unpublished Ph.D. Thesis, University of Guelph, Department of Geography.

Dolan, A.H., R. Kreutzwiser and R. de Loë. (2000). “Rural Water Use and Conservation in Southwestern Ontario.” *Journal of Soil and Water Conservation.* 55(2): 161-171.

Ecologistics Ltd. (1993). *A Review of Water Use and Water Efficiency in Ontario Agriculture*. Waterloo: Agricultural Working Group, Ontario Ministry of Agriculture and Food.

Environment Canada (1995). *Water: No time to waste: A Consumer’s Guide to Water Conservation.* Ottawa: Supply and Services Canada.

Environment Canada. (2000). *Fresh Water – A Federal Discussion Paper (Draft).* Ottawa: National Water Issues Branch, Environment Canada.

Environmental Commissioner of Ontario. (2000). *Changing Perspectives: Annual Report 1999-2000*. Toronto: Queen’s Printer.

Environmental Commissioner of Ontario. (2001). *Ontario’s Permit to Take Water Program and the Protection of Ontario’s Water Resources: A Brief to the Walkerton Inquiry*. Toronto: Environmental Commissioner of Ontario.

European, Environmental Agency. (2001). *Sustainable Water Use in Europe*. Copenhagen: European Environmental Agency.

Farid, C., J. Jackson and K. Clark. (1997). *The Fate of the Great Lakes: Sustaining or Draining the Sweetwater Seas?*. Toronto: Canadian Environmental Law Association and Great Lakes United.

Fleming, W.M. and A. Grisham. (1989). “Long-term Options for Municipal Water Conservation.” *Journal of the American Water Works Association.* 81(3): 34-42.

Foerstel, H. (1994). "Water Conservation Plan for Federal Government Facilities." *Every Drop Counts*. D. Shrubsole and D. Tate (eds.). Cambridge: Canadian Water Resources Association. 63-72.

Gabriel, A.O. and R. Kruetzwiser. (1993). "Drought Hazard in Ontario: A Review of Impacts, 1960-1989 and Management Implications." *Canadian Water Resources Journal*. 18(2): 117-132.

Gleick, P. (1996). "Basic Water Requirements for Human Activities: Meeting Basic Needs." *Water International*. 21:83-92.

Heath, L.K. (2001). *Education for Water Efficiency Initiatives in the Regional Municipality of Waterloo: Measuring Current Effectiveness to improve Future Success.* Waterloo: unpublished MES thesis, Department of Geography, University of Waterloo.

Hofmann, N. and B. Mitchell. (1995). "Evolving toward participatory Water Management: The Permit to Take Water Program and Commercial Bottling in Ontario." *Canadian Water Resources Association*. 20(2): 91-100.

International Joint Commission. (2000). *Protection of the Waters of the Great Lakes: Final Report to the Governments of Canada and the United States*. Windsor: International Joint Commission. Available at: www.ijc.org.

Jemar, M.K. (1987). *Water Resources and Water Management*. New York: Elsevier Publishers Ltd.

Kaisser, J. and D. McKenzie-Mohr. (1998). *Tools of Change – Proven Methods for promoting Environmental Citizenship*. Ottawa: National Round Table on the Environment and Economy.

Kelley, M. (1988). *Mining and the Freshwater Environment*. London: Elsevier Science Publishers Ltd.

Kennedy, R.D. (2001). *The Effectiveness of Local versus National Marketing Initiatves for Home Energy Efficiency Evaluations: The Use of Social Marketing for the Residential Energy Efficiency Project in Waterloo Region*. Waterloo: University of Waterloo, unplublished M.A.E.S. thesis in Local Economic Development.

Kollar, K.L. and P. McAuley. (1980). "Water Requirements for Industrial Development." *Journal of the American Water Works Association*. 72(1): 2-9.

Kromm, D.E. (1994). "Water Conservation in the Irrigated Prairies of Canada and the United States." *Canadian Water Resources Journal*. 18(4): 451-459.

Kromm, D.E. and S.E. White. (1990). “Adoption of Water Saving Practices by Irrigators in the High Plains.” *Water Resources Bulletin.* 26(6): 999-1012.

Kreutzwiser, R. and R. de Loë. (1998). *Managing Water Supply Conflicts: A Survey of Ontario Municipalities*. Guelph: Rural Water Management Group, Department of Geography, University of Guelph.

Kreutzwiser, R., L. Moraru and R. de Loë. (1998). *Municipal Water Conservation in Ontario: Report on a Comprehensive Survey*. Burlington: Environment Canada.

Kruetzwiser, R. and R. de Loë. (1999). *Agricultural and Rural Water Use in Ontario*. A Report to the Agricultural Adaptation Council under the National Soil and Water Conservation Program. Guelph: Rural Water Management Group, Department of Geography, University of Guelph.

Kreutzwiser, R. and R. de Loë. (2000). “Municipal Water Supply: Can Ontario Municipalities cope with their Water Woes?”. *Municipal World*. March: 19-21.

Leadlay, H. and R. Kruetzwiser. (1999). “Rural Water Supply Allocation in Ontario: An Evaluation of Current Policy and Practice.” *Canadian Water Resources Jounral.* 24: 3-16.

Linton, J. (1997). *Beneath the Surface: The State of Water in Canada*. Ottawa: Canadian Wildlife Federation.

MacFarlane, R. (1984). “Water Use Index.” *Canadian Water Resources Journal.*

Meybeck, M., D.Chapman and R. Helmer. (1990). *Global Freshwater Quality*. Cambridge: Basil Blackwell Ltd.

Mining Association of Canada. (1996). *Mining in Canada: Facts and Figures 1995*. Ottawa: Mining Association of Canada.

Mitchell, B. and D. Shrubsole. (1992). *Ontario Conservation Authorities: Myth and Reality*. Waterloo: Department of Geography, University of Waterloo Publication Series Number 35.

Molz, R. and T. Hafsi. (1997). “Evaluation and Assessment of Privatization Outcomes: A Conceptual Model and Empirical Evidence.” *Environment and Planning – Government and Policy*. 15: 481-495.

Morrison, H.A. (2001). *Draft: Diagnostique: Federal Water Policy and Ontario Region*. Manuscript prepared for Environment Canada, Ontario Region.

Muldoon, P. and C. Saint-Laurent. (1990). *Turning Off the Tap: Water Conservation Law in Ontario with emphasis on the Municipal Level*. Toronto: Canadian Institute for Environmental Law and Policy.

Natural Resources Canada. (1995). *Sustainable Development and Minerals and Metals: An Issues Paper*. Ottawa: Natural Resources Canada.

Neto, F. (1998). "Water Privatization and Regulation in England and France: A Tale of Two Models." *Natural Resources Forum*. 22(2): 107-117.

OECD. (1999). *The Price of Water: Trends in OECD Countries*. Paris: OECD.

Ontario Ministry of Natural Resources, Ontario Ministry of the Environment, Ontario Ministry of Agriculture, Food and Rural Affairs, Ontario Ministry of Municipal Affairs and Housing, Ontario Ministry of Economic Development and Trade, Association of Municipalities of Ontario and Conservation Ontario (2000). *Ontario Water Response – 2000 Draft.* Mimeo.

Ontario Ministry of the Environment. (2000). *2000-2001 Business Plan.* Toronto: Ontario Ministry of the Environment.

Patry, G.G. (1990). *Assessing the Effects of Hydraulic Load Reductions on Wastewater Treatment Plant Peformance.*" Hamilton: McMaster University, Department of Civil Engineering.

Peacock, B.E. (1994). *Complying with the Arizona Groundwater Management Act: Policy Implications.* Unpublished PhD thesis, The University of Arizona, Department of Economics.

Pearse, P.H. and F. Quinn. (1996). "Recent Developments in Federal Water Policy: One Step Forward, Two Steps Back. *Canadian Water Resources Journal*. 21:329-340.

Pearse, P.H., F. Bertrand and J.W. MacLaren. (1985). *Currents of Change*. Ottawa: Inquiry on Federal Water Policy.

Pigram, J.J. (1999(. "Economic Instruments in the Management of Australia's Water Resources: A Critical Review." *Water Resources Development*. 15(4): 493-509.

Postel, S. (1984). *Water: Rethinking Management in an Age of Scarcity*. Worldwatch Paper 62. Washington: Worldwatch Institute.

Postel, S. (1985). *Conserving Water: An Untapped Alternative*. Worldwatch Paper 67. Washington: Worldwatch Institute.

Postel, S. (1989). *Water for Agriculture: Facing the Limits.* Worldwatch Paer 93. Washington: Worldwatch Institute.

Postel, S. (1994). "A Global Perspective on Water Conservation." *Every Drop Counts.* D. Shrubsole and D. Tate (eds.). Cambridge: Canadian Water Resources Association. 11-22.

Robb, G. and J. Roninson. (1995). “Acid Drainage from Mines.” *The Geographical Journal*. 161(1):

Root, A.L. (1995). “Challenges to instream flow protection in Oregon.”SO: *Rivers*. 5(3): 184-194.

Royal Commission on Aboriginal Peoples. (1996). *Report*. Ottawa: Royal Commission on Aboriginal People.

Russell, P., R. Tobin, W. Robertson, B. Thomas and A. Townsend. (1994). “Domestic Water Conservation: The Light Grey Option.” *Every Drop Counts*. D. Shrubsole and D. Tate (eds.). Cambridge: Canadian Water Resources Association. 303-316.

Sanchez, L.E. (1998). “Industry Response to the Challenge of Sustainability: The Case of the Canadian Nonferrous Mining Sector.” *Environmental Management*. 22(4): 521-531.

Sancton, A. and T. Janik. (2001). *Provincial-Local Relations and Drinking Water in Ontario*. Paper submitted for the Walkerton Inquiry.

Sanderson, M. (1998). *The Grand Climate: Weather and Water in the Grand River Basin.* Cambridge: The Grand River Foundation.

Econometric Research Limited. (1995). *Residential Water Demand in Halton*. Burlington: Environment Canada.

Schaefer, K.A. and J.M Hurst. (1997). “Municipal Water Use and Pricing in Ontario, 1983-1994.” *Canadian Water Resources Journal*. 22(4): 417-431.

Schellenberg, S. and A Piggott. (1998). “An Assessment of Groundwater Use on Thirteen Counties in Southern Ontario.” *Groundwater in a Watershed Context*. Cambridge: Canadian Water Resources Association.

Scott, D., T.R. Yuzyk and C. Whitney. (1998). “The Evolution of Canada’s Hydrometric Network: A Century of Development.” *Partnerships in Water Resource Management: Proceedings of the CWRA 52nd Annual Conference.* Nova Scotia. 42-54.

Sharratt, K., B. Wardle and G. Fiotakis. (1994). “Ontario’s Water Efficiency Strategy.” *Every Drop Counts*. D. Shrubsole and D. Tate. (eds.). Cambridge: Canadian Water Resources Association.#.

Shrubsole, D. and D. Tate. (eds.) (1994). *Every Drop Counts*. Cambridge: Canadian Water Resources Association.

Shrubsole, D. and M. Green. (2001). *Managing Toxic Chemicals: Research Opportunities for Vulnerability Studies*. Ottawa: Emergency Preparedness Canada.

Solomon, F. and PDAP Advisory Group. (1999). *Counting What Counts: External Verification of the Australian Minerals Industry Code for Environmental Management*. Canberra: CSIRO.

Stallworth, H. (2000). "Conservation Pricing of Water and Wastewater." Unpublished manuscript, US Environmental Protection Agency. Page 20

Tate, D.M. (1990). *Water Demand Management in Canada: A State of the Art Review*. Ottawa: Environment Canada, Inland Waters Directorate, Social Science Research Series No. 23.

Thompson Gow and Associates. (1995). *Canada's Untapped Resource: Public-Private Partnerships in Water Supply and Wastewater Treatment*. Ottawa: Technology Transfer Office, Environmental Technology Advancement Directorate, Environment Canada.

US EPA. (1998). "Guidelines for Water Conservation Plans." Available at: www.epa.gov/owm/webguid.html.

Vandierendonck, M. and B. Mitchell. (1997). "Water Use Information for Sustainable Water Management: Building Blocks and the Ontario Situation." *Canadian Water Resources Journal*. 22(4): 395-415.

Van Osch, K. (1997). "An Assessment of Farm Plans and Countryside Planning in Ontario." *Environments*. 25(1): 15-28.

Vickers, A. (1993). "Municipal Water Conservation: Designing a Program to meet your System's Needs." *Every Drop Counts.* D. Shrubsole and D. Tate (eds.). Cambridge: Canadian Water Resources Association. 93-96.

Waller, D.H., R.S. Scott, C. Gates and D.B. Moore. (1997). *Canadian Municipal Water Conservation Initiatives.* Toronto: Intergovernmental Committee on Urban and Regional Research.

Weatherston, L. with T. Downey and B. Mitchell. (1997). *Integrated Resources Management: Opportunities for the Ontario Mining Industry*. Waterloo: Resources Policy Study Group, University of Waterloo, Paper #1.

World Commission for Water in the 21st Century. (2000). *A Water Secure World: A Vision for Water, Life and the Environment: Report*. The Hague: World Commission for Water in the 21st Century.

Appendix 1
Professional Associations and Trade Organizations
With an Interest in Water Conservation

Professional Associations

Canadian Association on Water Quality
Environmental Technology Centre
3439 River Road South
Gloucester, Ontario, K1A 0H3
Activities: Publishes "Water Quality Research Journal of Canada". Promotes research on scientific, technological, legal and administrative aspects of water pollution research and control.

Canadian Institute for Environmental Law and Policy
#400, 517 College Street
Toronto, Ontario, M6G 4A2
URL: www.web.net/cielap
Activities: membership is open: affiliations include Canadian Environmental Network and Great Lakes United. At analyses current environmental issues in Canada and provides leadership in the development of environmental law and policy.

Canadian Institute of Mining, Metallurgy and Petroleum
#1210, 3400, boul de Maisonneuve ouest
Montreal, Quebec, H3Z 3B8
URL: www.cim.org
Activities: comprised of individuals and organizations, it provides a forum to discuss the Environmental aspects of the mining, metals and petroleum industries. Publishes the CIM Journal.

Canadian Institute of Planners
#801, 116 Albert Street
Ottawa, Ontario, K1P 5G3
URL: www.cip-icu.ca
Activities: comprised of professional community and regional planners in the public and private sectors it promotes discussion on sustainable human settlements. Publishes Plan Canada journal.

Canadian Institute of Resources Law
PF-B 3330, University of Calgary
2500 University Drive NW
Calgary, Alberta, T2N 1N4
URL: www.ucalgaryy.ca/~cirl
Activities: has completed studies related to mining, forestry and the environment.

Canadian Society of Agricultural Engineering
PO Box 381
RPO University
Saskatoon, SK, S7N 4J8
URL: www.engr.usask.ca/societies/csae/
Activities: provide expertise in the areas of farm power and machinery, structures and the environment, soil and water

Canadian Society of Soil Science
General Delivery
Pinawa, MN, R03 1L0
URL: www.umanitoba.ca/csss
Activities: open to those who are concerned with farming practices as they affect soil quality and the development of soil conserving cropping practices. Publishes Canadian Journal of Soil Science. It is engaged in land use, soils research and classification.

Trade Organizations

Aggregate Producers Association of Ontario
#2, 365 Brunel RoaD
Mississauga, Ontario, L4Z 1Z5

Agricultural Groups concerned about Resources and the Environment
40 Eglinton Ave. West, 5th Floor
Toronto, Ontario, M4P 3B1
URL: www.agcare.org
Activities: Our Farm Environmental Agenda (drafted with other groups) which outlines the strong commitment of farmers, through Environmental Farm Plans, to document present environmental conditions on their farms, develop a strategy for making appropriate changes, document actual farm practices and use that data for the development of new farm environmental initiatives; jointly administers Ontario Pesticide Education Program with OMAFRA.

Agricultural Institute of Canada
#1121, 141 Laurier Ave. West
Ottawa, Ontario, K1P 5J3
URL: www.aic.ca
Activities: serves 9 professional associations including the Canadian Society of Agronomy. It has an Environmental Task Force and news service.

American Public Works Association (Ontario Chapter)
URL: www.apwa.net

American Water Resources Association
#300, 950 Herndon Pkwy
Herndon VI 20170-5531 USA
URL: www.uwin.siu.edu/~awra/
Activities: Advance research, planning and management of water. Provide forum for communication of ideas.

American Water Works Association
6666 West Quincy Ave.
Denver, CO 80235 USA
URL: www.awwa.org
Activities: Promotes public health and welfare in the provision of drinking water of unquestionable quality and sufficient quantity. Affiliated with Canadian Waste Water Association and other groups.

Assembly of First Nations
One Nichol St., 10th Floor
Ottawa, Ontario, K1N 7B7
URL: www.afn.ca
Activities: Committee on the Environment, Conservation and Sustainable Development and Great Lakes environmental health impacts. Focus of AFN is to gain constitutional recognition of Natives as distinct peoples both legally and politically.

Association of Municipalities of Ontario
#1701, 393 University Ave.
Toronto, Ontario, M5G 1E6
URL: www.amo.on.ca
Activities: Has an Environmental Committee. Purpose of AMO is to unite Ontario's municipalities; to promote and enhance effective municipal government, to provide strategic leadership by developing quality policy to educate governments, the media and the public.

Automotive Parts Manufactures' Association
#516, 195 The West Mall
Toronto, Ontario, M9C 5K1
URL: www.capma.com
Activities: Has a waste water analysis and reduction project. General goal is to promote the manufacture in Canada of automotive parts, systems, components, materials, toolds, equipment and supplies.

Business Council on National Issues
Royal Bank Centre
#806, 90 Sparks Street
Ottawa, Ontario, K1P 5B4
Activities: National economy and competitiveness, economy and trade; environment; social policy; political reform; corporate governance

Canadian Association of Energy Service Companies
9 Village Squire Lane
Thornhill, Ontario, L3T 1Z8
Activities: represents companies involved in providing energy efficiency and conservation goods and services; representatives of Canadian utilities and government agencies. Wishes to attain national and provincial energy efficiency, conservation and alternative energy objectives in an environmentally responsible manner.
Canadian Association of Petroleum Producers
URL: www.capp.ca

Canadian Bottled Water Association
#203-1. 70 East Beaver Creek Road
Richmond Hill, Ontario, L4B 3B2
Activities: comprised of companies with an interest in the Canadian bottled water market. Promotes the interests of the industry.

Canadian Centre for Pollution Prevention (C2P2)
100 Charlotte Street
Sarnia, Ontario, N7T 4R2
URL: www.c2p2.sarnia.com
Activities: comprised of pollution prevention stakeholders. Has a Great Lakes Regional Roundtable. Promotes pollution prevention across Canada and internationally through information transfer services.

Canadian Chamber of Commerce
#501, 350 Sparks Street
Ottawa, Ontario, K1R 7S8
URL: www.chamber.ca
Activities: has a chamber in most municipalities. Purpose is to create a climate of competitiveness, profitability and job creation enterprises of all sizes in all sectors across Canada. Has an Environment Committee.

Canadian Council of Ministers of the Environment (CCME)
#360, 123 Main Street
Winnipeg, Manitoba, R3C 1A3
URL: www.ccme.ca/ccme
Activities: establishes and maintains an intergovernmental forum for discussion and joint action on environmental issues; to harmonize environmental legislation, policies, procedures and programs; to develop nationally consistent environmental objectives, standards and databases, complimentary strategies, accords and agreements.

Canadian Environment Industry Association (has Ontario Branch)
Branch Address:
#102, 23 Lesmill Road
Toronto, Ontario, M3B 3P6
URL: www.ceia.on.ca
Activities: comprised of Ontario-based companies that provide environmental technologies and services that protect the environment and help achieve sustainable development.

Canadian Environmental Auditing Association
6519B Mississauga Road
Mississauga, Ontario, L5N 1A6
URL: www.mgmt14k.com/ceaa
Activities: compromised of practitioners if environmental auditing. Publishes "The Auditorial". It encourages the development and the discipline of environmental auditing.

Canadian Environmental Network
#300, 945 Wellington St.
Ottawa, Ontario, K1Y 2X5
URL: www.isn.net~network/cen.html
Activities: comprised of NGOs with a focus on environmental concerns and which share the objectives of CEN. Not open to individuals and government, political parties and for-profit organizations. Has "Water" and "Environment" Committees as well as an Ontario Branch.

Canadian Federation of Agriculture
#1101, 75 Albert Street
Ottawa, Ontario, K1P 5E7
URL: www.cfa-fca.ca
Activities: comprised of farm organizations and farm co-ops. Ontario Federation of Agriculture is a member. Has an Agriculture and Environment section on web page though it does not directly address water supply or demand issues.

Canadian Groundwater Association
PO Box 60
Lousana, Alberta, T0M 1K0
Activities: comprised of members who belong to a provincial Ground Water or Water Well Association, it encourages the management and protection of ground water by creating partnerships for public awareness and utilization; to continually serve as recognized stewards of the groundwater resource in Canada; to promote the development of ground water guidelines and strategies.

Canadian Homebuilders Association
#200, 150 Laurier Ave. West
Ottawa, Ontario, K1P 6M7
URL: www.chba.ca

Activities: Comprised of members involved in the residential construction industry, it is involved in the development of an Energy Building Code and an Environmental Code of Practice".

Canadian Pulp & Paper Association
Sun Life Building
1155 rue Metcalfe, 19e etage
Montreal, QC, H3B 4T6
URL: www.open.doors.cppa.ca
Activities: comprised of 59 corporations and is affiliated with the Pulp and Paper Research Institute of Canada, it supports national educational projects. It represents the interests of the industry.

Canadian Pulp & Paper Machinery Manufacturers' Association
#601, 116 Albert Street
Ottawa, Ontario, K1P 5G3
URL: memac.org
Activities: not specified

Canadian Sanitation Supply Association
#G10, 300 Mill Road
Toronto, Ontario, M9C 4W7
URL: www.cssa.com
Activities: comprised of manufactures or distributors of sanitation products and services, it promotes discussion and public awareness about the sanitation industry.

Canadian Society of Agronomy
#907, 151 Slater Street
Ottawa, Ontario, K1P 5H4
Activities: to be involved in all aspects of field crop production across Canada.

Canadian Standards Association
178 Rexdale Blvd.
Toronto, Ontario, M9W 1R3
URL: www.csa.ca
Activities: it is comprised of 7000 volunteers who contribute to standards writing committees. It contributes to international environmental initiatives through the ISOs; administers ISOs technical committee on Environmental Management on behalf of the Standards Council of Canada, and provides a neutral forum for developing consensus solutions and building environmental considerations into organizational management and decision making.

Canadian Urban Institute
10 St. Patrick Street
6th floor
Toronto, Ontario, M3T 3A3

URL: www.interlog.com/~cui
Activities: brings together private, public and not-for profit sectors to address the challenges facing large cities in Canada and abroad.

Canadian Water Quality Association
#330, 295 The West Mall
Toronto, Ontario, M9C 4Z4
Activities: promotes the individual right to quality water, to educate water professionals, to promote the growth of the water quality improvement industry; to serve as a unified voice in government and public relations; to provide a role in consumer education.

Canadian Water Resources Association
c/o Membership Office
PO Box 1329
Cambridge, Ontario, N1R 7G6
URL: www.cwra.org
Activities: to stimulate public awareness and understanding of Canada's water resources; to encourage recognition by all governments of the high priority of water as a resource and towards that end, to encourage the formulation of appropriate water policies; to provide a forum for the exchange of information related to management of Canada's water resources; to participate with appropriate agencies in international water resource activities.

Canadian Water and Wastewater Association
#402, 45 Rideau Street
Ottawa, Ontario, K1N 5W8
URL: www.cwwa.ca
Activities: comprised of 131 corporate, 18 institutional members and others, it represents the common national interests of Canadian water and wastewater systems, particularly related to the

management, legislative and regulatory issues, particularly in respect to the actions of the federal government.

Canadian Well Logging Society
#1600, 734-7th Street
Calgary, Alberta, T2P 3P8
URL: www.canpic.ca/cwls
Activities: publishes a CWLS journal.

Christian Farmers Federation of Ontario
115 Woolwich Street
Guelph, Ontario, N1H 3V1
URL: www.christianfarmers.org
Activities: comprised of farmers, it is interested in a broad range of agricultural issues that impact of the quality of life. Among other things, it promotes the family farm and stewardship.

C.D. Howe Institute
125 Adelaide St. East
Toronto, Ontario, M5C 1L7
URL: www.cdhowe.org
Activities: research and educational institute identifying current and emerging economic and social policy issues facing Canadians; to recommend particular policy options; to communicate conclusions of research to domestic and international audiences.

Clean Water Action
URL: www.essential.org/cwa

Conservation Council of Ontario
#600, 3 Church Street
Toronto, Ontario, M3E 1M2
Activities: is committed to the conservation of the environment and natural resources for the common good and sustainable future of Ontario.

Conservation Ontario
Box 11, 120 Bayview Parkway
Newmarket, Ontario, L3R 4W3
URL:-www.conservationontario.org
Activities: coordinates the activities of the province's conservation authorities.

Environment Probe
225 Brunswick Avenue
Toronto, Ontario, M5S 2M6
URL: www.nextcity.com/environmentprobe/
Activities: to restore strong property rights in order to empower Canadians with the means to protect the environment; to promote full-cost water pricing to protect the quality of Canadian waters.

Federation of Canadian Municipalities
24 Clarence Street
2nd Floor
Ottawa, Ontario, K1n 5P3
URL: www.fcm.ca
Activities: has a standing committee on Environmental Issues. It advocates and promotes a strong, effective and accountable municipal government.

Federation of Northern Ontario Municipalities
81 St. Brendon Street
Sudbury Ontario, P3E 1K4
Activities: to liaison with the Provincial Government in support of Northern Ontario municipalities.

The Great Lakes Research Consortium
www.esf.edu.glrc

Great Lakes United
#307, 2360 rue Notre Dame Ouest
Montreal, QC, H3J 1N4
Activities: a US-Canada organization that promotes the conservation and protection of the Great Lakes-St. Lawrence ecosystem.

Green Canada
#7, 477 Pelissier Street
Windsor, Ontario, N9A 4L2
URL: www.greencanada.agora.ca
Activities: not specified

Greenpeace Canda
605, 250 Dundas Street West
Toronto, Ontario, M5T 2Z5
URL: www.greenpeacecanada.org
Activities: non-violent public protest. Conduct scientific, economic and policy research.

IRC International Water and Sanitation Centre
URL: www.irc.nl

Lifewater Canada
URL: www.lifewater.ca

Mining Association of Canada
#1105, 350 Sparks Street
Ottawa, Ontario K1R 7S8
URL: www.mining.ca
Activities: to represent the interests of member companies engaged in the mining industry. Work with governments on public policy related to minerals.

Municipal Engineers Association
#2, 530 Otto Road
Mississauga, Ontario, L5T 2L5
Activities: provide unity and focus for professional engineers employed by Ontario's municipalities through the sharing of knowledge and information and by addressing issues of common concern.

Ontario Association of Landscape Architects
#101, 2842 Bloor Street West
Toronto, Ontario, M8X 1B1
URL: www.oala.on.ca
Activities: promote and improve the profession and to support improvement and/or conservation of the natural, cultural, social and built environment

Ontario Cattlemen's Association
130 Malcolm Road
Guelph, Ontario, N1K 1B1
URL: www.tdg.ca/ontag/oca
Activities: among other things it addresses water quality issues related to the industry.

Ontario Environmental Network
25 Douglas Street
Guelph, Ontario, N1H 2S7
URL: www.web.net/~oen
Activities: increase public's awareness of environmental organizations in Ontario and facilitate cooperation among these organizations.

Ontario Federation of Agriculture
40 Eglington Avenue, 5th Floor
Toronto, Ontario, M4P 3A2
URL: www.ofa.on.ca
Activities: has developed "Our Farm Environmental Agenda" (in cooperation with AgCare, Christian Farmers' Federation, and Ontario Farm Animal Council) that outlines a commitment to environmental management on farms.

Ontario Ground Water Association
2995 Delia Cres.
Brights Grove, Ontario, N0N 1C0
Activities: annual conventions and workshops. Wants to protect and promote use of groundwater, to place the water well and contracting business on a scientific and business basis; to encourage and support the interest and welfare of the water well industry in Ontario.

Ontario Mining Association
#1501, 110 Yonge Street
Toronto, Ontario, M5C 1T4
Activities: improve the competitiveness of the Ontario mining industry. Has an Environmental Steering Committee.

Ontario Municipal Administrators' Association
101-49 Emma Street
Guelph, Ontario, N1E 6X1

Ontario Municipal Management Institute
PO Box 58009
Oshawa, Ontario, L1J 8L6
Activities: to promote the education, training and research on local government.

Ontario Municipal Water Association
#69, 225 Benjamin Road
Waterloo, Ontario, N2J 3Z4
Activities: an affiliate of the AWWA, it acts as a spokesperson for the municipal water supply authorities in Ontario; works and improves municipal water supply.

Ontario Petroleum Institute Inc.
#104, 555 Southdale Road East
London, Ontario, N6E 1A2
URL: www.ontpet.com
Activities: encourage the responsible exploration and development of oil, gas and hydrocarbon resources of Ontario.

Ontario Sewer & Watermain Construction Association
#300, 5045 Orbitor Drive, Unit 12
Mississauga, Ontario, L4W 4Y4
Activities: has Clean Water Action Committee. Represents the construction industry.

Ontario Soil & Crop Improvement Association
1 Stone Road West
Guelph, Ontario, N1G 4Y2
URL: www.ontariosoilcrop.org
Activities: to communicate responsible economic management of soil, water and crops to Ontario farmers.

Ontario Water Works Association
45-23rd Street
Toronto, Ontario, M8V 3M6
URL:www.owworg

Organization of Small Urban Municipalities (Ontario)
55 King Street West
Cobourg, Ontario, K9A 2M2

Pollution Probe Foundation
12 Madison Avenue
Toronto, Ontario, M5R 2S1
URL: www.pollutionprobe.org
Activities: to define environmental problems through research; to promote understanding through education, and to press for practical solutions through advocacy.

Professional Engineers Ontario
#1000, 25 Sheppard Avenue West
Toronto, Ontario, M2N 6S9
URL: www.peo.on.ca
Activities: regulate professional engineering while enhancing engineering culture and practice.

Pulp & Paper Research Institute of Canada
570, boul St-Jean
Pointe Claire QC, H9R 3J9
Activities: comprised of members who produce pulp and paper products, it conducts research on environmental issues in the pulp and paper industry

Soil & Water Conservation Society
URL: www.swcs.org/

Stockholm Environment Institute
URL: www.sei.se

Water Environment Association of Ontario
63 Hollyberry Trail
Toronto, Ontario, M2H 2N9
URL: www.weao.org
Activities: to inform members and others of ever-increasing developments in the environmental field through conferences, newsletters and seminars.

WaterCan
323 Chapel Street
Ottawa, Ontario, K1N 7Z2
URL: www.watercan.com
Activities: organize World Water Day and clean water projects. Raise awareness of need to manage water resources responsibly and effectively.