On Tap

Urban Water Issues in Canada
Discussion Paper

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WESTERN CITIES PROJECT

This discussion paper is part of the Canada West Foundation's ***Western Cities Project,*** a multi-year research and public consultation initiative focused on identifying the policy challenges faced by western Canada's largest cities, and best practices in resolving such policy challenges. Through the Canada West Foundation's emphasis on citizen engagement, the Western Cities Project promotes public awareness of the growing importance of cities to the economic, social and cultural lives of western Canadians.

The project, which began in 2000, includes the following research components:

- Urban Water Management
- Urban Infrastructure
- Urban Finance
- Urban Regions
- Urban Aboriginal People
- Urban Growth and Affordable Housing
- Marketing Western Cities on the Global Stage
- Municipalities in Federalism
- Urban Arts and Culture

To learn more about the Western Cities Project, please visit the Canada West Foundation website (www.cwf.ca).

Executive Summary

Background

Canada holds 20% of the world's freshwater resources and on a per capita basis has more water than any other large country. It is not surprising that lakes and rivers hold a prominent place in Canadian history, economic development and self-image. Canadians rely on a lot of water, not only for drinking purposes, but also for recreation, irrigation, manufacturing, industry, agriculture, urban development, transportation, oil and gas processing, thermal power generation, and mining. Despite the fact that water is basic for health, central to our economy and enjoyed for recreation and aesthetics, it is often taken for granted, undervalued and overused.

Water Issues

Inattention to water management can create a vast array of water issues including growing concerns over national and international water availability and conservation; the demand for and allocation of water for human activity; and the protection, quality, and contamination of water resources. Even Canada, with an abundant supply of freshwater, is not without water availability concerns. Factors influencing water availability and increases in demand for water in and around urban areas will affect western Canadian cities. Greater public awareness of water management as an important urban issue and the role municipal governments have in water policy is needed.

On Tap: Urban Water Issues in Canada is the first of three Canada West Foundation studies that look at urban water management issues facing western Canada's large cities. This discussion paper provides an overview of Canadian water policy issues generally and urban water policy issues in particular. Three areas were explored:

- Why Canadians need to be concerned about water policy issues;
- How urban centres affect water availability in Canada; and
- The role of municipal governments in water policy, including water pricing, water quality, and water protection.

Methodology

The study is based primarily on recent academic research, as well as government websites and policy documents.

Summary of Findings

Why should Canadians be concerned about water issues?

There are two main reasons that Canadians need to pay greater attention to water issues:

- Pressures are being placed on Canada's water resources, creating water availability concerns.

- Water is fundamental to public health, and threats to water quality should not be taken lightly. Although from a comparative global perspective Canada has good access to safe water, water quality does vary across the country. Some areas for improvement for safer water provision include protecting drinking water sources, implementing changes to regulatory standards and technology, and removing jurisdictional ambiguities.

How do urban centres affect water availability?

Five key factors affect urban water availability in Canada:

- Urbanization and suburbanization;
- Infrastructure and infrastructure financing;
- Water contamination;
- Consumption habits; and
- Environment and climate.

Strains are placed on existing water supplies due to growth in suburban and metro-adjacent communities, high consumption habits, and deteriorating infrastructure. Municipal, industrial and agricultural activities can contaminate water resources and affect water quality, thereby reducing water availability. For instance, untreated urban stormwater discharges may be one of the largest sources of uncontrolled pollution. Finally, long-term trends in global climate change will affect water resources in some regions. Municipal governments can play a role in influencing both availability and demand for water.

What is the role of municipal governments in water policy?

Water policy has numerous dimensions, including demand management, water quality, and watershed and source protection. Municipal governments are significant actors in water policy. Municipalities can use a variety of public policy tools to manage water demand and promote water conservation activities. For instance, although pricing can be used as an effective instrument to manage water demand, existing rate structures often do not reflect the full cost of water. Municipal governments play a critical role in ensuring water safety, including water and wastewater treatment and distribution. Finally, municipalities have control and influence over land uses in their jurisdictions, and as a result have some ability to protect drinking water sources and manage watersheds.

Urban areas have significant need for safe, reliable water systems, as well as growing demands for water usage. Urban Canadians should pay greater attention to water issues, and improve their understanding of how policy tools can be employed to better ensure water quality, water availability and water protection.

INTRODUCTION

Water is essential to Canada. Basic for health, central to our economy and enjoyed for recreation and aesthetics, water plays an important role in maintaining and enhancing quality of life for all Canadians. Yet despite its centrality to our immediate and long-term wellbeing, Canadians often take water for granted. Canada is frequently perceived to be a country with an abundance of good quality water, and there is little recognition that a number of critical water challenges face Canada both in the short-term and for generations to come. There is even less awareness of the role that urban centres and their related municipal governments play in water policy.

To frame discussion and debate on Canadian water policy issues generally, and on urban water policy issues in particular, *On Tap: Urban Water Issues in Canada* explores three questions:

- *Why should Canadians be concerned about water policy issues?*
- *How do urban centres affect water availability in Canada?*
- *What is the role of municipal governments in water policy?*

In order to answer these questions, the study assessed the most current research, as well as government websites and policy documents. While *On Tap* does not presume to provide a comprehensive overview of all Canadian water issues, or even of all urban water issues, it does provide an introduction to a number of key water concerns facing Canada's cities.

WHY SHOULD CANADIANS BE CONCERNED?

Canadians are reliant on water. From a purely economic perspective, it is estimated that water contributes $7 to $23 billion to the Canadian economy per year (Natural Resources Canada 2002). And, of course, water is inextricably linked to human health. Recent assessments indicate that each individual requires approximately 50 litres of clean water per day to ensure that basic health and vitality needs are met (this includes water for drinking, sanitation, hygiene, and food preparation) (Gleick, et al. 2001; Gleick 1996; United Nations Educational, Scientific, and Cultural Organization 2001).

Given the centrality of water to our economy and our health, and given that water is a vulnerable resource, Canadians must increase their attention to water policy. There are at least two reasons for doing so. The first is water availability: pressures are increasingly being placed on Canada's water resources, and we must ensure that water resources are managed in a sustainable way. The second is public health: as the water contamination tragedies in Walkerton, Ontario and North Battleford, Saskatchewan demonstrate, water quality must not be taken for granted in Canada. The discussion below highlights some key issues in water availability and water quality.

Water Availability

Canada is nationally wealthy in terms of total water supply. Canada has 7% of the world's renewable supply of freshwater resources and 20% of the world's total freshwater resources (including water in glaciers and the polar ice cap). However, there is tremendous variability locally and regionally in the availability of water (Environment Canada 2003). Indeed, 60% of the nation's water supply is not readily accessible to over 80% of the population, as the population is geographically concentrated and situated away from the majority of water supplies (Environment Canada 2001). As well, activities that contaminate water supplies limit the availability of good quality water. Many of the challenges facing Canadian water systems are related to non-availability.

Canadians are reliant on freshwater – water not contained in oceans, seas or glacial ice. There are two types of freshwater: surface freshwater and groundwater. Surface freshwater is found in lakes and rivers, and is unevenly distributed across the country (Figure 1). Groundwater is withdrawn from underground water sources called aquifers. It is not known precisely how much groundwater exists in Canada, but it is known that groundwater, like surface freshwater, is limited in its availability. In Alberta, for example, groundwater is thought to be more abundant than surface freshwater, yet it is estimated that only 0.01% of it is recoverable for use as certain geological conditions are required in order for the water to be accessed (Alberta Environment 2002).

Given water's importance and differences in availability, Canadians should be concerned about the increasing pressures being placed upon existing water supplies. For instance, between 1972 and 1996, Canadian water withdrawals increased by almost 90%, yet the population grew by just over 30% (Environment Canada 2002a). This trend towards heightened demand is a cause for concern.

FIGURE 1: Surface Freshwater Area in Canada

	Total Freshwater Area (km^2)	Freshwater as a % of Provincial or Territorial Area	Freshwater as a % of Total Canadian Freshwater Area
British Columbia	19,549	2%	2%
Alberta	19,531	3%	2%
Saskatchewan	59,366	9%	7%
Manitoba	94,241	15%	11%
Ontario	158,654	15%	18%
Quebec	176,928	12%	20%
New Brunswick	1,458	2%	0.2%
Nova Scotia	1,946	4%	1%
Prince Edward Isld	0	0%	0%
Nfld and Labrador	31,340	8%	4%
Northwest Territories	163,021	12%	18%
Nunavut	157,077	8%	18%
Yukon	8,052	2%	1%

SOURCE: Statistics Canada 2003.

Water is withdrawn and used for a number of reasons:

- Agriculture: Water is used for irrigation in crop production, and as drinking water in livestock production.
- Manufacturing: Water is used in the manufacturing of paper and paper products, primary metals, and chemicals and chemical products, among other purposes (Scharf et al. 2002).
- Mining: Water is commonly used as a coolant and as a wash during production. It is also used to separate ore from rock, and to carry away unwanted materials.
- Municipal: Fifty-two percent of water in the municipal sector is used for residential or domestic purposes, 19% for commercial purposes and 16% for industrial. Water leakage from inadequate infrastructure accounts for 13% of municipal use (Environment Canada 2002a). Municipalities are not large consumptive users of water.
- Electric power and other utilities: Water is used as a condenser coolant in thermal power generation, and it is also converted into steam that drives generators producing electricity.

Overall, water use in Canada is increasing. In Manitoba, for example, water use is growing at a rate of approximately 5% per year (Government of Manitoba 1994). As water use increases, stresses are placed on water supplies, affecting their long-term sustainability. In a recent provincial water study in British Columbia, for example, 14% of water wells exhibited declining water levels, due primarily to human activities (Government of British Columbia 2002). Water availability can also decline because of other factors such as contamination or environmental degradation. The end result is worrisome: increasing water use demands and decreasing water availability.

The trend is equally worrisome if one looks at water consumption rather than gross water use. Most uses consume some water; in other words, less water is returned to the source than was taken out. As Figure 2 demonstrates, some water uses consume more water than others. For instance, the electric power and other utilities sector has the highest gross use of all water users, but it re-circulates a substantial portion of the water it withdraws, and therefore consumes very little. The agricultural sector, on the other hand, has a comparatively low gross use, yet it consumes almost seven times the amount of water as the electric power and other utilities sector. Total water consumption for all of Canada had an overall growth rate of 19% between 1991 and 1996 (Statistics Canada 2002). This stresses the larger water system, as the demands of competing water users may, and frequently do, exceed available water resources or a water source's natural recovery rate.

Given these pressures – increasing demands for water use, increasing water consumption rates, and decreasing water availability – it is not surprising that governments are paying greater attention to water demand management to ensure the sustainability of existing water supplies. Water demand management aims at striking a balance between water demand and availability, so that water resources are not exhausted, and competing users have adequate access to those resources.

Water Quality and Public Health

In addition to water availability, Canadians should be concerned about water policy as it relates to public health. Water needs to be treated or disinfected to kill pathogens, which are disease-causing organisms transmitted by water. Some examples are cholera, typhoid, E.Coli, Giardia and Cryptosporidium. The link between safe water and health is illustrated by the following international data (Hinrichsen, et al. 1997):

FIGURE 2: Major Withdrawal Uses of Water in Canada, 1996

	GROSS WATER USE		TOTAL INTAKE	RE-CIRCULATION	TOTAL DISCHARGE	WATER CONSUMPTION	
	Million m^3	Percent	Million m^3	Million m^3	Million m^3	Million m^3	Percent
Agriculture	4,636	7.0%	4,636	0	1,197	3,439	66.9%
Mining	1,878	2.8%	681	1,196	672	9	0.2%
Other Primary Resources	1,244	1.9%	231	1,013	138	93	1.8%
Electric Power and Utilities	40,281	60.8%	28,664	11,617	28,183	481	9.4%
Manufacturing and Industrial*	14,259	21.5%	7,277	6,981	6,595	682	13.3%
Personal and Government Sectors	3,922	5.9%	3,922	0	3,482	440	8.6%
Total, Whole Economy	66,220	100.0%	45,411	20,809	40,268	5,145	100.0%

SOURCE: Statistics Canada 2002. See Glossary for Definitions. *Includes paper and paper products, primary metal, chemical and chemical products, other manufacturing industries, and other industries.

- Approximately 2.3 billion people worldwide suffer from water-related diseases.
- The lack of sanitary waste disposal and access to clean water is responsible for over 12 million deaths a year.
- A 1991 review of over 100 studies of the effects of clean water and sanitation on human health found that the median reduction in deaths from water-related diseases was 69% among people with access to safe drinking water and proper sanitation.
- It is estimated that 60% of all infant mortality is linked to infectious and parasitic diseases, most of which are water-related.
- 80% of diseases in developing countries are water-related (Environment Canada, 1992).

From a comparative global perspective, Canadians have relatively good access to safe water supplies (although this access is not as secure for some Aboriginal or rural communities). Waste and wastewater treatment, drinking water guidelines and regulations, and public health practices have eradicated most water-related illnesses in Canada (Environment Canada 1992).

Yet despite Canada's relatively good standing on safe water provision, the recent outbreaks of waterborne disease in Walkerton, Ontario and North Battleford, Saskatchewan have demonstrated the profound impact that threats to water quality can have on public health, and have also shed light on the broader socio-economic implications of poor water quality. It is estimated that health-care costs related to water contamination in Canada total $300 million per year (Health Canada 1997). These costs could be much higher. In 1993, Cryptosporidium in the water supply made one half of Milwaukee, Wisconsin's 800,000 city residents sick, and resulted in 100 deaths. The US National Research Council estimated the cost of this tragedy at $25 billion US (Peterson 2001).

Of course, there is no approach to water provision that can completely guarantee safe water. To this end, the goal of any drinking water system should be to deliver water with a level of risk that is so negligible the reasonably informed citizen would feel safe drinking it (O'Connor 2002). Reports from the Walkerton and North Battleford inquiries and other experts have identified areas for improvement:

- ***Source protection:*** It is generally accepted that enforceable multi-barrier approaches are the most effective way to minimize risk (Federal-Provincial-Territorial Committee on Drinking Water et al. 2002; O'Connor 2002; Christensen 2001; Auditor General of British Columbia 1999). Multi-barrier approaches are comprehensive approaches to safe water provision: they seek to reduce or prevent

Water Quality on First Nation Reserves

Some of the poorest water quality in Canada is found on First Nation reserves. The incidence of water-borne diseases in First Nation communities, for example, is several times higher than the incidence in the general Canadian population (Health Canada 1997). In 1995, Health Canada and the Department of Indian Affairs and Northern Development conducted an extensive survey of drinking water on reserves. The survey concluded that water quality on 25% of the country's reserves did not meet basic safety standards (Government of Canada 1995). In response to those findings, the federal government doubled its capital funding allocation for reserve water and sewage systems (O'Connor 2002). In 2001, Health Canada undertook a follow-up survey to measure progress. It found that 12% of Aboriginal communities had water systems that posed a potential threat to human health (Canadian Press 2001).

Recent funding commitments give one indication of exactly how critical the water quality situation currently is on reserves. Since 1995, Indian and Northern Affairs Canada has invested over $560 million to address urgent water and wastewater system upgrades, and $215 million was allocated for capital improvements in 2002-2003 (Indian and Northern Affairs Canada 2003). In May 2003, Indian and Northern Affairs Canada, Health Canada and Environment Canada announced $600 million in new funding for improving the quality of water and wastewater treatment in First Nation communities. As well, a new First Nation Water Management Strategy will help to improve water quality on reserves and address infrastructure upgrades, operations and maintenance, certification of operators, stronger inspection, monitoring and reporting regimes, and the establishment of clearly defined standards, protocols and policies.

contamination of drinking water from source to tap through source water protection, water treatment, water distribution, and monitoring and testing. Source protection is the first step in a multi-barrier approach that would prevent waterborne contaminants from flowing through the system to consumers and is the most effective way to guarantee the quality of drinking water (O'Connor 2002; Laing 2002). Drinking water source protection is but one component of implementing comprehensive watershed management plans. For instance, the management of wetlands and their adjacent areas is critical for water resource sustainability and the protection of drinking water (Gabor et al. 2001).

- ***Regulatory standards and technology:*** There are an array of standards that should be examined including those for treatment, monitoring, enforcement, laboratory testing, and those necessary to attain high quality in management and operations. Regulatory standards and practices regarding the quality of drinking water should be made more stringent and brought into line with the most current technology and best practices. For example, better tests for E. coli are available that allow for easier identification. It would be appropriate that regulatory standards should follow. As well, there should be better training for plant operators, more water treatment plant inspections, and overall improvements to the way that some municipal water providers manage and operate water systems.

- ***Responsibility:*** The fragmentation of jurisdictional responsibilities is of particular concern, as it can lead to oversights in the provision of safe drinking water. Such was the case articulated by O'Connor (2002) in the Report of the Walkerton Inquiry. He concluded that the Walkerton water tragedy was partly the result of institutional and jurisdictional ambiguities, which blurred the lines of responsibility in the provision of water, leading to monitoring oversights. The responsibility issue is not unique to Ontario. In British Columbia, for instance, the provincial Auditor-General pointed to similar health and public policy issues related to jurisdictional fragmentation (Auditor General of British Columbia 1999). The main issue is that all levels of government in Canada have some stake in water, and existing legislative and policy frameworks are not presently structured to accommodate effective multi-barrier approaches.

Public opinion research on Canadian confidence in water quality demonstrates that there are some public concerns in this area. The Canada West Foundation's Looking West 2003 survey of 3,202 western Canadians found that 21.5% of respondents

disagreed with the statement "I am confident that the drinking water in my area is safe" (Berdahl 2003). In rural areas, over one in four respondents expressed a lack of confidence in the safety of their drinking water; this dropped down to less than one in five for respondents living in the large census metropolitan areas (CMAs).

Summary

Canadians have at least two reasons to be concerned about water policy: water availability and water quality. At first glance, Canada possesses an abundance of good quality water; however, this is not necessarily the case. Water supplies are limited and, if expert predictions hold true, diminishing. As the next section will show, pressures are being placed upon the country's water resources in the form of increasing consumption and contamination. Water is not as readily available as many would believe. At the same time, water quality is a public health issue. Quality varies across the country, and many Canadians are not afforded access to the same level of water quality.

If there is one issue that constitutes a Canadian water crisis, it is that of misinformed public perception. Canadians have generally overstated the availability of water and the extent to which it is being safely provided across the country. If the key challenges in water are to be addressed and overcome, it is imperative that Canadians start to understand that there are pressing water issues even in a country as rich in water as Canada.

Having explored why Canadians should be concerned generally about water policy, the remainder of the report will consider the urban dimensions of water policy.

Rural Water Quality

The majority of rural populations are serviced by groundwater, commonly from wells or dugouts, either through private household systems or through small to mid-scale local water treatment and distribution facilities. According to the Safe Drinking Water Foundation, rural water quality is a pressing matter. Unfortunately, knowledge of rural water issues is limited because there are presently no comprehensive, national research overviews of the state of groundwater resources (Van der Camp and Grove 2001). Still, there are many other indications that Canadian rural communities and households are particularly vulnerable to poor water quality. Three key factors affect the safety of rural water quality:

1) *Technical differences:* Differences in technical and socio-economic resources create disparities in water treatment, supply and accessibility in rural areas (Watson and Lawrence 2003). For example, a typical rural water treatment plant or rural household processes poor quality water for only a couple of minutes, whereas the typical urban municipality treats its water for up to two hours or more, in some cases, using a variety of treatment procedures (Peterson 2000).

2) *Individual responsibilities:* Rural communities or households are rarely provided with the technical expertise needed to ensure safe water. In Ontario, owners of private water systems are themselves responsible for ensuring its quality (O'Connor 2002). Compare this, for example, to the 17 specialists one particular Calgary treatment facility employs for its water quality research laboratory alone (Peterson 2000).

3) *Lack of testing:* Studies report a general lack of water testing among rural populations (Fitzgerald et al. 2001). A 1994 pilot study in Alberta concluded that 42% of farmers do not treat their drinking water in any way, and 27% had never tested the quality of their water (Cessna 2001).

Clearly, rural residents are not typically afforded the same level of water quality provision as their urban counter-parts. Given the issues in water treatment and delivery, source water contamination in rural areas is also of concern. The quality of rural water may be negatively affected by naturally occurring contaminants, such as arsenic and iron that leach into source waters (Health Canada 1996). Perhaps more importantly, source waters may also be affected by a variety of human activities, which, in the rural setting, include contamination from agricultural practices. The trend towards intensive farming and livestock operations poses a threat to rural water systems, as these practices can add harmful levels of chemicals and nutrients to source waters (Agriculture and Agri-Food Canada 2003). Research indicates that farm families reliant on groundwater have a higher risk of contamination than do those families receiving treated water from municipal systems (Health and Welfare Canada 1993). For this reason, regional water systems – in which metro-adjacent communities access municipal water – are growing.

HOW DO URBAN AREAS AFFECT WATER AVAILABILITY?

There are five key factors affecting water availability in Canada: urbanization and suburbanization; infrastructure and infrastructure financing; water contamination; consumption habits; and environment and climate. As the discussion below demonstrates, urban areas have an important affect on each of these factors, as urban areas are the sites of most human activity and considerable industrial activity.

Urbanization and Suburbanization

Canada is becoming more urban. Consequently, demands for water resources are coming from a larger and more geographically concentrated assemblage of competing users. From the period 1971-2001, Canada's urban population grew by 45.7% (Statistics Canada 2003a). In 2001, almost 80% of Canadians resided in urban areas of at least 10,000 people (Statistics Canada 2003b). Most urban development has been restricted to an area running adjacent to the United States border, where 90% of Canada's population is currently situated, and where water resources have already been stressed by human activities.

While Canada has experienced considerable urban growth, much of this growth has occurred in areas surrounding metropolitan cores, through suburbanization and the development of metro-adjacent communities. This development pattern has been termed the "donut effect," where growth rates around metropolitan centres exceed those of the metropolitan centres themselves. In the 2001 census, the populations of 27 urban municipalities increased 4.3% from 1996-2001, whereas their surrounding municipalities experienced a growth rate of twice that, at 8.5% (Statistics Canada 2003b). These figures suggest that the key Canadian settlement trend is not so much urbanization as it is suburbanization (Foot 2002). This has important implications for water supply.

There are three general types of water servicing systems. First, there are large water and wastewater treatment and distribution systems serving large urban populations. Second, there are small to mid-scale central systems that service small to mid-size communities or connect several rural households. Finally, there are private well and septic disposal water systems that are typically designed for low-density, rural areas. In many parts of the country, however, private wells are installed in suburban subdivisions of moderate to high densities.

Some metro-adjacent developments are not supplied through large municipal systems, and therefore numerous wells are required to meet water demands. This poses a problem for groundwater supplies. Simply stated, too many wells may pump too much water for aquifers to sustain themselves. Even when aquifers are not exhausted, supply problems occur when multiple users draw water from the same aquifer. Excessive use of an aquifer can lower water tables, which in turn can lower the stream and lake levels those aquifers discharge water into, making the resource less readily available (Environment Canada 2002a). These strains on water systems are further heightened when one takes into account that suburban migrants are bringing city-bred water uses, habits, and attitudes to their new areas of residence (Environment Canada 2002b).

Infrastructure & Infrastructure Financing

Local water systems (drinking water, wastewater and stormwater) in Canada are primarily operated by local public utilities commissions, departments of municipal governments, or, in some cases, through partnerships with private firms. Depending on the size of the municipality, water systems can range from utilizing a single groundwater source to systems that are reliant on large networks of reservoirs, treatment plants, and distribution systems. The available water supply and quantity of water used can be affected by inefficiencies in the distribution system.

It is estimated that more than 50% of water supply lines are currently in need of repair (Environment Canada 2001). This deteriorating infrastructure is having a significant influence on water supplies throughout Canada. For instance, existing municipal infrastructure systems have used over 79% of their service life (Canadian Society for Civil Engineering 2003).

Water mains in Canada are currently being replaced at a rate of 0.6% a year. If this trend continues, it will take 150 years to replace the existing water infrastructure system (Canadian Society for Civil Engineering 2003). It can be expected that significant water losses will continue if required infrastructure improvements are not addressed.

The projected costs for infrastructure upgrades are substantial. The National Roundtable on Environment and Economy (1996) estimated that unmet water and wastewater infrastructure needs ranged from $38 to $49 billion. This water infrastructure deficit is a pressing matter, particularly in urban centres, where many Canadian municipalities are experiencing difficulty in addressing fiscal demands (Vander Ploeg 2001, 2002a, 2002b; Semmens 2003; Chase and Abbate 2003).

Contamination

Contamination, the addition of undesirable substances to water caused primarily by human activity, poses a serious threat to water availability (Environment Canada 2002a). On a daily basis, municipal, industrial, and agricultural activities can contaminate Canadian freshwater resources and affect water quality. Since water quality is intimately linked to availability, contamination is a pressing matter. Five select sources of contamination include:

- **Agriculture:** Sediment nutrients and pesticides applied in farming can enter water systems. As well, the livestock industry produces large manure volumes, and can contribute concentrated volumes of nutrients and bacteria to water systems.

- **Acid Rain:** Two common air pollutants – sulphur dioxide and nitrogen oxide – are released as emissions into the Earth's atmosphere and returned as acid rain. Acid rain impairs the ability of water bodies to support aquatic life.

- **Chemical Hazards:** A variety of different chemicals, including metals (e.g., lead, chromium), organics (e.g., benzene, herbicides, some pharmaceuticals), and radiological contaminants (e.g., radon, uranium) may be present in water. Possible sources include industry, landfills, urban runoff, sewage disposal, agriculture and nature itself. There are concerns with several industrial chemicals (e.g., tetrachloroethylene for drycleaning), endocrine-disrupting substances and pharmaceuticals (e.g., estrogen) because little is known about their affect on water.

- **Urban Runoff:** Rainfall and snowmelt carry pollutants, oils and other street materials, and thermal energies from the urban environment and transport them into water systems. This runoff creates water contamination issues in areas of high urban development. Trends indicate that increases in population and urbanization will directly result in increases in urban runoff. Untreated urban stormwater discharges may be one of the largest sources of uncontrolled pollution impacting the quality of receiving waters.

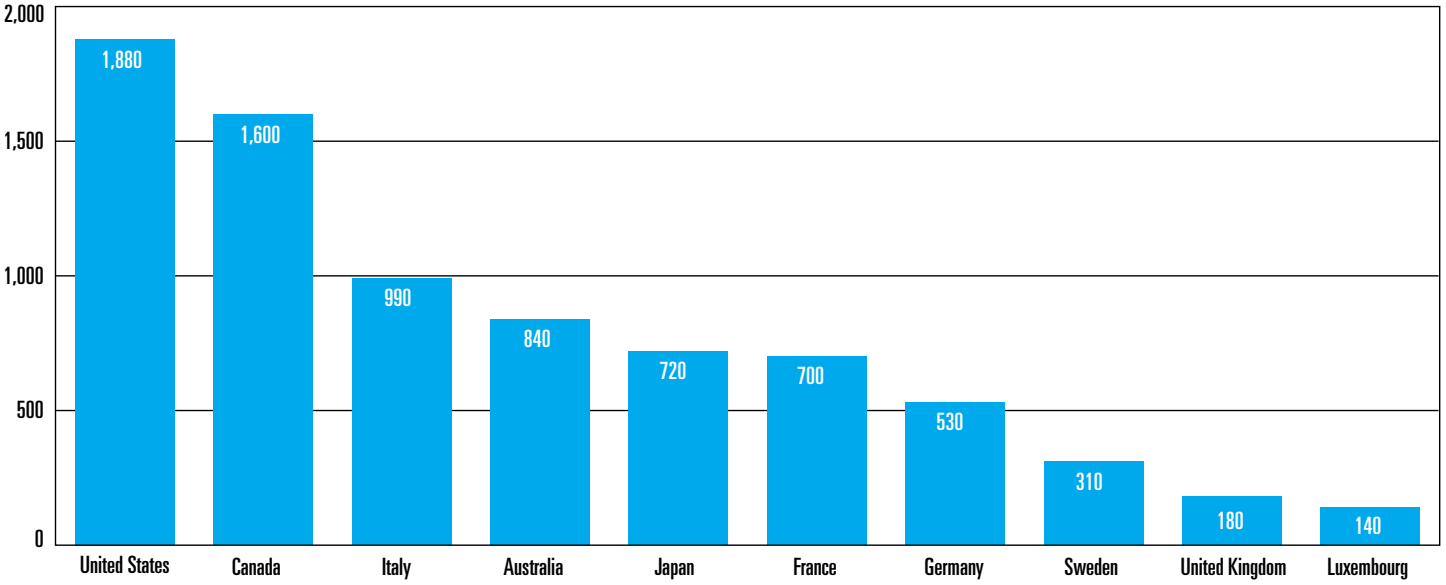
- **Municipal Wastewater:** Municipal effluents are the liquid wastes that come from municipal sewer systems and water treatment plants. These effluents can contain debris, chemicals, pathogens, wastes, and nutrients that can render water unsuitable. The level of water treatment used by a municipality influences the number and affect of contaminants.

Consumption Habits

Much of Canada's economy is driven by water and as a result, Canadians use a great deal of water. Unfortunately, Canadians do not tend to use water efficiently. In a recent assessment of global water wealth, Canada ranked 129 of 143 countries in a water use index measuring how efficiently a country uses water for domestic/residential, agricultural, and industrial purposes (World Water Council 2002; Centre for Ecology and Hydrology 2002). A different measure, used by the Organisation for Economic Cooperation and Development (OECD), ranks Canada 28 among its 29 member nations in terms of per capita water consumption (OECD 1999). Only one other nation – the United States - has a higher (worse) consumption rate (Figure 3). Furthermore, since 1980, overall water use in Canada has increased by 25.7%, a rate five-times higher than the overall OECD increase of 4.5% (Boyd 2001).

High water use in Canada can also be illustrated by looking at daily per capita uses in the municipal sector, which includes residential, commercial, and some industrial uses. Canada's high per capita water use showed little decline throughout the 1980s and 1990s, as per capita municipal water use increased by 2% between 1996 and 1999 (Environment Canada 2001). Excessive water use is particularly characteristic of the municipal residential sector, which includes domestic and household water uses, and accounts for 50% of all municipal uses in Canada (Environment Canada 2002a).

FIGURE 3: Water Consumption in Selected OECD Countries, 1999
(Per Capita Consumption in Cubic Meters per year)



SOURCE: OECD, 1999.

The poor consumption habits of Canadians can be attributed to the lack of a strong water conservation ethic. The development of such an ethic has been hindered, in part, by current water pricing policies: 55% of Canadians served by municipal water systems are subject to water use payment structures that do not promote conservation (Environment Canada 2002b). As a result, a significant proportion of Canadians have little economic incentive to be efficient in domestic water use.

Environment Canada (2002b) indicates that, with the application of a water conservation strategy, a typical household can reduce water consumption by 40% or more, with little or no effect on lifestyle. Unfortunately, there are few regulatory measures in place to ensure such conservation strategies are employed. For example, there is currently no consistent requirement in plumbing codes across the nation for the use of water efficient fixtures (Environment Canada 2002c). In fact, Canada is behind other countries in providing consistent codes, guidelines, regulations, and policies affecting water use efficiency (Environment Canada 2002c).

Environment and Climate

A growing body of literature suggests that Canada's water resources may be threatened by long-term trends in global climate change. There is consensus among scientific communities that global temperatures are indeed increasing. The 1980s and 1990s were the warmest decades on record, and 10 of the last 15 years have been the warmest in global meteorological history (Government of Canada 2002). These trends have significant implications for water resources because changes in temperatures affect precipitation levels, wind patterns, and humidity, which in turn affect the water cycle (Government of Canada 2002).

Although experts have not articulated explicit projections on climate change, there is some consensus as to how Canadian water resources will be impacted. Due to forecasted increases in extreme weather conditions, in some regions both groundwater and surface water resources stand to be negatively affected. Groundwater resources are particularly vulnerable to climatic factors. For instance, in some cases climate change is expected to lower groundwater levels and slow water recharge rates, meaning aquifers will be more stressed to sustain themselves. Also, climate change is anticipated to reduce surface freshwater supplies (Kling et al. 2003). Finally, global warming is expected to increase the frequency of droughts in the prairie region, where drought and soil moisture deficits already cause serious water availability issues.

From a demand-side perspective, it is expected that the warmer temperatures and drier conditions caused by climate change will contribute to heightened water demand. For example, it is estimated that warming of one degree Celsius increases

municipal water consumption in the Great Lakes region by 1.3% (United States Environmental Protection Agency 2002). When increases in demand are coupled with decreases in supply, water availability issues are further amplified. It should be noted that some experts stress that vulnerabilities to climate change are ultimately dependent on the responses of users, and how efficiently they manage water use.

Although predictions regarding climate change are often controversial, all levels of government should not ignore possible implications; steps should be taken to mitigate any risk.

Summary

There are a number of factors affecting water availability in Canada: urbanization, infrastructure, climate change, contamination, and consumption habits. Clearly, urban centres contribute to each of these factors. Given that it is impossible to increase water supply, Canada has only two options: limit the impacts of factors that reduce availability, and reduce demands for water. And, it must be noted, municipal governments can play a role in influencing both availability and demand.

For instance, in terms of the environmental and climatic affects on water availability, municipal governments can play a role in strategies to reduce greenhouse gas emissions. In terms of contamination, municipal governments can work to reduce the pollutants in urban runoff, and can ensure appropriate municipal wastewater treatment levels. Municipal governments can work together to create regional water systems to reduce the affects of suburbanization on groundwater. As noted earlier, the longer infrastructure upgrades are postponed the greater are the strains on water supplies; thus, municipal governments and other governments can work to reduce water loss by ensuring timely infrastructure investments.

And finally, municipal governments can encourage lower water consumption rates through water pricing policies. The general point to stress is that municipal governments are important actors in managing water availability. The next section of this paper will examine a number of ways municipal governments are engaged in water policy.

WHAT IS THE ROLE OF MUNICIPAL GOVERNMENTS IN WATER POLICY?

Water policy includes numerous dimensions – demand management, quality, and watershed and source protection – and it is therefore not surprising that all three orders of government have a role to play in Canadian water policy. In this section, we will outline the role played by municipal governments in three key areas: water pricing (demand management), water quality, and source protection.

Municipal Governments and Water Pricing

There is a growing recognition that water management must focus on managing water demand, as little can be done to increase supply. In this respect, it is important not to overlook the role of individual human consumption in managing water demand. Although the municipal sector is not a large consumptive user of water, there are costs related to its treatment and distribution. The various public policy tools that promote water conservation activities can offset some of these costs, and many of these fall within the jurisdiction of municipal governments or public utilities. They include structural changes (e.g., water metering, wastewater re-use, drought resistant landscaping), operational tools (e.g., leak repair, water use restrictions), economic efficiencies (e.g., changing rates structures, pricing policies), and socio-political tools (e.g., public education, legislation, and by-laws).

Many academics and water policy experts argue that Canada's water resources are being unnecessarily depleted as a result of existing pricing structures (Renzetti and Kushner 2002; Pearse and Brocking 2002; Lee 2001). There is evidence suggesting that pricing can be used as an effective instrument to manage water demand. Yet, many users are not charged the full cost of water, and they therefore have little or no economic incentive to use water efficiently. It follows that as long as water is provided at less than its full cost, users do not – and cannot be expected to – recognize the value of the resource, the cost of supplying it, the cost of disposing it, and the environmental costs of using it (Pearse and Brocking 2002). It is from this basis that academics

and experts argue that governments should develop pricing structures with a view to full cost recovery in water provision.

Canadian municipal water pricing structures are typically set by municipal water agencies, to which provincial governments often delegate supply and retail pricing authority. In some cases, municipal prices may be established through guidelines set by regional water agencies, or by provincial governments themselves (Burke et al. 2001).

Water pricing structures and retail rates vary considerably in Canada. Municipalities each have unique circumstances and these influence the criteria they use to inform local pricing practices. Two basic pricing systems are employed: flat-rate and volume-rate. In flat-rate systems, fixed payments are imposed in particular payment periods, and users obtain unlimited access to water servicing upon payment. Occasionally, municipalities use indirect forms of the flat-rate system, such as additions to property taxes or special assessments. In volume-based systems, water meters determine the amount of water used and water services are priced accordingly. There are several ways in which volume-based rates can be applied (see Figure 4).

The type of water pricing system employed by municipalities is important because rate structures are key determinants of water demand. Pricing structures ultimately determine whether or not users are inclined to use water efficiently (Burke et al. 2001). Flat rate systems tend to result in higher water use than volume-based systems, because users are not required to pay additional costs for volumes consumed (Tate and Lacelle 1995). Nationally, households paying flat rates use 50% more water than those paying volume-based rates (Environment Canada 2001). It is evident that volume-based pricing and more specifically, metering, results in more efficient water use. However, only 57% of the municipal population was metered in 1999. Further, metering has only gradually increased since 1991, despite increasing documentation of water use efficiency in volume-based pricing (Environment Canada 2001).

It is interesting to note that the public may be open to a different approach to water pricing. Canada West Foundation's Looking West 2003 survey asked 3,202 western Canadians to agree or disagree with two statements on water pricing: "To conserve water resources, governments should charge industries the full cost of the water they use" and "To conserve water resources, governments should charge citizens the full cost of the water they use." As Figure 5 demonstrates, western Canadians are supportive of increased water pricing, although increasing water fees to industries receives more support than does increasing water fees to citizens (Berdahl 2003).

FIGURE 4: Types of Volume-Based Rate Charges

TYPE OF WATER CHARGE	HOW TYPICAL WATER CHARGES ARE APPLIED
Constant Unit Charge	A constant fee is charged per unit of water used.
Declining Block Rate	Water use in billing periods is divided into successive volumes or blocks, with each block charged at a lower price unit than the previous block.
Increasing Block Rates	The unit price of water increases progressively through the blocks of a rate schedule.
Complex Pricing	Price is based on a combination of Constant Unit Charge, Declining Block Rate, and/or Increasing Block Rate structures.

SOURCE: Derived by Canada West Foundation.

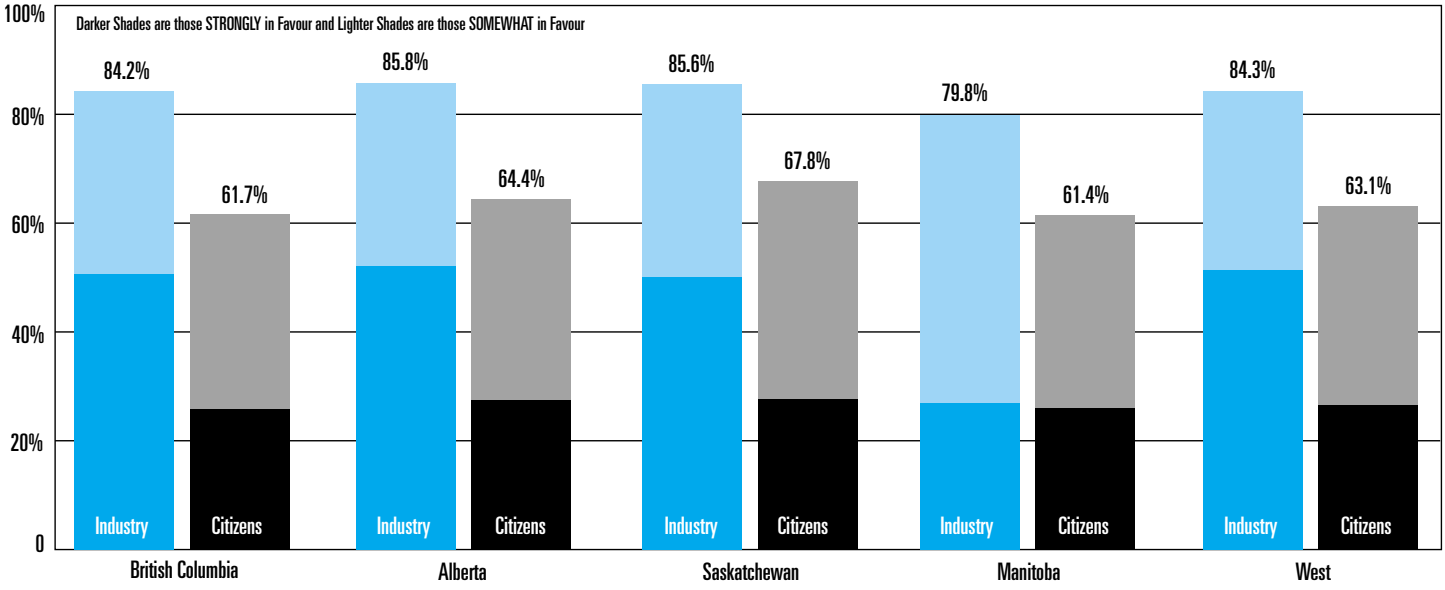
Water pricing is only one example of the various public policy tools available for managing water demands in urban areas. What are the best means by which municipal governments can influence residential water demand? How can municipal governments best use different policy tools to achieve water demand management with both high success rates and at a manageable cost? These are among the questions that will be addressed in a forthcoming Canada West study of urban water demand management, to be released in January 2004.

Municipal Governments and Water Quality

There is no single level of government or agency solely responsible for water quality in Canada. Since provinces and territories maintain constitutional authority over water resources, the provision of water quality falls under their legal jurisdiction. However, federal and municipal governments also have significant roles and mandates, meaning the lines of responsibility for water quality are not always clearly drawn.

FIGURE 5: Support for Charging the Full Cost of Water to Industry and Citizens

(Percent Strongly or Somewhat in Favour of Charging Full Costs to Industry and to Citizens)



SOURCE: Berdahl 2003.

As demonstrated in Figure 6, the jurisdictional responsibility for water quality monitoring is fragmented among various government levels and agencies. Although it may appear that jurisdictional responsibilities for water quality are neatly compartmentalized among the three levels of government, the reality is that responsibility for water management is very complex. There are many stakeholders, such as non-government organizations, that do not have direct or even indirect jurisdictional responsibility, but who are involved in research, public education, and lobbying activities with regards to water quality concerns.

Municipal governments play a major role in ensuring water safety, including water treatment, water distribution, wastewater treatment, stormwater treatment, and providing consumer information regarding conservation and quality. For large cities, water management constitutes a significant municipal role with large budgets and staff sizes. For example, for the City of Calgary in 2001, water functions (supply and distribution, wastewater treatment and disposal, solid waste management) amounted to almost $250,000,000. Just within their city limits alone, municipal governments face considerable stress in ensuring water quality. And as urbanization trends continue, there will be both ever-growing demands for urban water and increased pollution stress.

There is also increased recognition of the need for municipal governments to work together to manage water quality. Urban water quality is affected by activities in metro-adjacent communities, such as residential construction projects, leaching from septic tanks, and farm and feedlot operations. At the same time, rural and metro-adjacent communities are increasingly seeking to access the water of large cities, due to the cost involved to meet higher treatment standards and/or unavailability of their own supply. A number of cities have regional water boards to co-manage water resources. For example, the Greater Vancouver Regional Authority is responsible to acquire, treat and deliver water to its member municipalities, serving two million people through a network of storage lakes, reservoirs and 500 kilometers of supply mains. Edmonton's regional supply system provides drinking water for many rural and First Nation communities – some over 100 kilometers away. Calgary's drinking and wastewater system is currently connected to the adjacent communities of Airdrie and Chestermere, and the city's wastewater system also serves Cochrane. The Mayor of Calgary aims to connect other adjacent communities to the system, with the short-term goal of a new water treatment plant. These examples demonstrate that "water sharing" does occur. However, demand is increasing and there are growing calls to share water with communities at ever-greater distances. Such trends will continue to increase the complexity of urban water quality management in the years ahead.

FIGURE 6: Jurisdictional Responsibilities in Water Quality Monitoring

JURISDICTION	WATER QUALITY MONITORING RESPONSIBILITY
FEDERAL Little legislative authority for drinking water resources, except for water located on federal lands (e.g., national parks and Indian reserves).	There are more than 20 federal acts regarding water. Many of the federal responsibilities and activities related to water are shared with the provinces/territories. Despite the absence of constitutional responsibility for water quality, the federal government maintains an active role through research support, rural programs and the engagement of intergovernmental mechanisms. For instance, the federal government supports local and regional monitoring of specific problem contaminants, frequently in partnership with provincial or municipal governments. Other examples of intergovernmental bodies include: the Federal-Provincial Subcommittee on Drinking Water that develops national guidelines for drinking water quality (not legally binding, but used by provinces/territories); Canadian Council of Ministers of the Environment, which discusses National environmental priorities; and the Water Quality Task Group that develops water quality guidelines for protection of aquatic life.
PROVINCIAL/TERRITORIAL Constitutional authority for natural resources within provincial boundaries, including water.	The provinces/territories set standards for drinking water quality and develop regulatory frameworks for ensuring water quality standards are met. Regulatory frameworks include laws, regulations, permit standards, and protocols for water testing, treatment, construction and operation of delivery systems, reporting requirements, and regulatory supervision. Testing requirements vary by province.
MUNICIPAL/LOCAL Delegated the day-to-day responsibility of water and wastewater services.	Local management and delivery of drinking water, including water treatment, distribution, sampling, testing, and analysis (to meet provincial standards). Municipalities are also responsible for many aspects of land use planning and development that can affect water quality. Local health boards, health units, or health regions have a role in addressing water quality issues, such as surveillance and health risk assessments.

SOURCE: Derived by Canada West Foundation.

Municipal Governments and Source Protection

As noted earlier, water contamination has a significant affect on water availability. Municipal governments, along with other stakeholders, must ensure that their watershed is protected from contamination. A watershed or drainage basin consists of all the lands that drain into one body of water, which can be large (e.g., North Saskatchewan River) or small (e.g., a creek). Watersheds are important components of ecosystems. They are the most practical unit for managing water resources because effects are felt at the watershed level and not at the level of political boundaries, such as municipalities.

Watershed management planning is not a new concept, and various forms of source protection exist in many jurisdictions across Canada. However, the events in Walkerton resulted in wide spread public acknowledgement of source protection as an important step in maintaining water quality. Watershed management takes a broad-based ecosystem approach to water and deals with all water-related natural features, fisheries, land-uses, water linkages and green space planning.

One component of watershed management is watershed-based source protection, which considers that the quality and quantity of ground and surface water are influenced by the overall health of a watershed. Water resources can be protected and enhanced if the diversity, function, and health of key natural features in a watershed are maintained (e.g., riparian corridors, forested lands, wetlands). The benefits of source protection include cost effectiveness, because keeping contaminants out of drinking water sources decreases the need for costly water treatment. As well, protecting water is the only type of defence for some consumers who may rely on untreated groundwater from wells. Ensuring healthy watersheds is also the simplest way to protect the safety of drinking water (Advisory Committee on Watershed-based Source Protection Planning 2003).

Threats to the quality of water occur in virtually all watersheds, and can be managed according to the level of risk they present to the water source. All water contains naturally occurring substances – mainly bicarbonates, sulphates, sodium, chlorides, calcium, magnesium, and potassium. These substances can enter both groundwater and surface water from: the surrounding vegetation and wildlife; precipitation and runoff from adjacent land; soil and geologic formations in the river basin (catchment area); biological, physical and chemical processes in the water; and human activities in the region (Environment Canada 2002a). All bodies of water are intimately connected to the land and the air so that whatever occurs to one also affects the other. Water can purify itself biologically – similar to kidneys in humans – but only to a certain degree. The water can only absorb so much and then the natural cleaning processes are no longer able to function adequately.

Watersheds are affected by pressures that stem from historical and new land uses, both inside and outside of a watershed. There are a variety of activities that can affect the health of watersheds including water transfers and diversions, temperature changes that affect water supply, and incompatible actions that can damage watersheds, such as the increased clearing of land, sources of contamination (e.g., agriculture, septic system leakage, stormwater runoff), overfishing, the destruction of stream bank vegetation, and draining wetlands. Watershed-based source protection planning identifies areas where threats to drinking water sources exist and then creates strategies to address them.

What role do municipalities play in source water protection? The extent that municipalities are involved in source water protection varies across Canada, but in general they have control and influence over land uses and land use planning within their jurisdictions (Figure 7). Municipal governments therefore have some ability to protect drinking water sources from contamination but this can be constrained for a number of reasons. Political boundaries do not align with watershed boundaries, and because land and water users may have different and/or competing interests, it can require substantial

FIGURE 7: Jurisdictional Responsibilities in Source Water Protection

JURISDICTION	SOURCE WATER PROTECTION RESPONSIBILITY
FEDERAL Generally holds little legislative authority for water resources, except for water located on federal lands (e.g., national parks, Indian reserves).	Federal jurisdiction applies to fisheries, navigation, and the management of international boundary waters and therefore plays a role in protecting water quality. Canadian Environmental Protection Act – regulations regarding release of toxic substances into source waters. Federal government does not typically enforce provisions and leaves this to the discretion of the provinces/territories.
PROVINCIAL/TERRITORIAL Jurisdictional authority over natural resources, including water.	Responsible for environmental management and protection. Responsibility for source water and watershed protection typically fragmented among numerous authorities and government departments. No standard approach to source water protection in Canada, as environmental legislation varies by province or territory.
MUNICIPAL/LOCAL	Land-use planning decisions consider protection of source waters. Role in planning, financing and management of infrastructure related to water treatment and delivery. Direct responsibility for wastewater via statutory mandate to provide sewage treatment and control discharges into sewage systems.

SOURCE: Derived by Canada West Foundation.

coordination of the various stakeholders to protect drinking water sources. In some cases, municipalities provide drinking water source protection that is better than what is required by their respective provincial governments. Currently no provincial or territorial government has a stand-alone designated agency responsible for protecting all aspects of drinking water and drinking water sources.

Despite the fact that protecting drinking water sources makes logical sense, most regulations do little to protect the catchments that supply drinking water. However, many provincial governments are taking positive steps in this direction and have in place some components of source water protection legislation. Unfortunately none (yet) require that source water protection take precedence over other considerations, such as development. The events at Walkerton and North Battleford were the driving forces behind proposed provincial changes related to the legislated protection of water sources. Provincial changes to watershed protection may result in municipalities playing a greater role. For example, in April 2003, the Advisory Committee on Watershed-based Source Protection Planning in Ontario released its final report that, among its many recommendations, states that new powers should be given to municipalities to develop and implement source protection plans, and to have more control and influence over land uses and land use planning.

Many non-governmental organizations and/or non-profit organizations are also involved in conducting activities for the protection, conservation, and improvement of watersheds and the improvement of water management. These stakeholders range from wilderness and recreation groups to specific watershed and water basin councils and authorities. Most groups are involved in public education, citizen engagement, research and information exchange regarding water use management and awareness of water issues. They also lend their expertise to all levels of government and water users.

Summary

While municipal governments are only one of many actors in water policy, they are still significant actors. Indeed, municipal governments face growing demands in terms of water management, and these demands will only increase as cities grow larger and water needs grow greater. For this reason, it is important that municipal governments have the policy tools in place to deal with increasing water policy challenges.

A FOCUS ON URBAN WATER

In recent years, growing attention has been paid to Canada's cities. This is not surprising, given that over 80% of Canadians live in urban centres, with one in two living in large cities. There has also been emerging attention to water issues, both in Canada and internationally. However, there has been scant attention to water management issues in urban centres. The vast scope of water issues – growing concerns over national and international water supply and conservation, the demand for water for industrial and agricultural purposes, and water quality in rural areas – has overwhelmed urban water issues.

Despite the lack of public attention, there can be no doubt that water issues are of importance to Canada's urban areas. Urban areas have significant need for safe, reliable water systems, as well as growing demands for water usage. As a result, cities have an important role to play in water quality, water protection and water demand management.

In addition, urban areas value their water resources for aesthetic and quality of life reasons. Cities have historically developed around major water bodies and river systems. While this practice originally served practical purposes, urban water sources have evolved into part of urban identities. Not only do water bodies have an important aesthetic role to play in cities, they also serve as recreational sites. Indeed, water bodies are among a city's most important forms of natural capital. However, a city's ability to develop and utilize this natural capital depends on the quality of the water. Recreational sites do not develop successfully around unattractive, polluted, poor smelling water bodies, and the urban business community is unable to capitalize on waterfront businesses and economic opportunities (such as boardwalk cafes, river-edge theatre productions, boating shops, and so forth) if the water quality is inadequate. In short, a city's water bodies are an asset and an opportunity for cities – and this opportunity is wasted if water quality is substandard.

Urban Canadians need to pay greater attention to water issues, and improve their understanding of how policy tools can be employed to better ensure water quality, water availability and water protection. Doing so is essential if we are to ensure urban prosperity and quality of life in the years to come. ■

GLOSSARY

Gross water use: Gross water use is an efficiency measure of the total amount of water used in a process, such as irrigation or for domestic purposes. Since many users often reuse the same water, the gross water use could be equal to several times the water intake.

Re-circulation: Re-circulation is also referred to as the recycling rate and represents the difference between the gross water use and water intake. This is the number of times that the water is reused and indicates the level of efficiency of a particular water use.

Sustainability: Sustainability is a term that has been defined in many different ways. In 1987, the Brundtland Commission defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987). The values inherent in the concept of sustainability include environmental health, economic development and social equity. According to the Government of Canada (2003) sustainable water management is concerned with reconciling the diverse needs of water users and promoting the use of water in a way that recognizes its social, economic and environmental benefits. In other words, sustainability is assuring a sufficient supply of water across a broad cross-section of simultaneous users now and in the future.

Water consumption: Water consumption refers to water that has been removed from its source and is no longer available for use because it has evaporated, transpired, been incorporated into products and crops, consumed by humans or livestock, ejected directly into the ocean, or otherwise removed from freshwater resources, thereby making it unavailable for subsequent human use. Consumption is the difference between water intake and water discharge.

Water discharge: Water discharge refers to the quantity of water returned at or near the source after use.

Water intake: Water intake is the quantity of water withdrawn from the source for a particular activity over a specified period of time. This is a measure of the demand imposed by a particular use on the water source at a given location.

Withdrawal: Withdrawal refers to freshwater that is removed from any natural source such as a river, lake or aquifer and then used for various purposes. If the water is not consumed then it may be returned to the environment and used again. Withdrawal use is measurable as quantities of intake, discharge, and consumption.

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