Developing Water Sustainability Through Urban Water Demand Management

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> "As we peer into the twenty-first century, water conservation is looking far more like an imperative than an option."
>
> (Vickers 2001: xv)

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Urban Water Demand Management

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Executive Summary

The sustainability of freshwater supplies is a growing concern worldwide. Even in Canada, a nation rich in fresh water resources, many communities are experiencing problems with local water supplies.

Currently, supply-side management characterizes urban water provision in Canada. This approach responds to rising demands by seeking out new sources of water and expanding infrastructure capacity. To achieve water sustainability in Canada's cities, a fundamental shift in urban water planning and management is necessary. Continuing to expand infrastructure and develop new water sources is increasingly expensive and ultimately unsustainable, economically and ecologically.

The potential of urban water demand management

Demand-side management (DSM), or demand management as it is generally called, is a complementary approach that aims to avoid many of the problems of excessive water use by reducing, or at least capping, water demand. Demand management, as a comprehensive, integrated and long-term approach seeks to improve overall productivity of water use and deliver water services matched to the needs of end users. Given the current situation of unsustainably high and inefficient urban water use in Canada, DSM has significant potential to reorient urban water management on to a sustainable path.

Many municipalities in Canada are already undertaking some demand management measures such as education to promote water conservation, rebate programs, and watering restrictions during times of drought. However, these measures are usually implemented in a limited and *ad hoc* manner, and often only as temporary measures until additional new supply is secured. Such an approach will not achieve the substantial and reliable long-term water savings and environmental benefits that DSM offers.

Demand management is central to the concept of a 'soft path' for water. The soft path approach strives for sustainability and equity by initially allocating water to meet both, basic human needs, and those of aquatic ecosystems. The remaining resource is then allocated among various competing needs to maximize economic productivity and other social requirements. Coupled with an effective strategy to assess ecological water requirements, the soft path strives to strike a balance between all the anthropocentric uses of water and the integrity of aquatic ecosystems.

Overcoming the gridlock

Although benefits of DSM are significant, barriers such as overcapitalization, low prices and a supply-side engineering bias, fuelled by ***root causes,*** restrict the widespread adoption of urban water demand management in Canada. The interconnected and interrelated nature of these barriers creates a ***gridlock*** that resists the adoption of a comprehensive approach to demand management in Canada.

Governance and opportunities for government action

Overcoming the inertia of the status quo in urban water management is difficult but necessary. Progressing to a comprehensive, integrated and long-term approach requires action by many different actors including all levels of government, professional associations, civil society and end

users. "Good" governance in the urban water context ensures stakeholder involvement, integrated planning, institutional accountability and protection of the watershed environment.

Although governance is more than just government, a critical role for government exists. Municipal, provincial, territorial and federal governments must emphasize a comprehensive, long-term and integrated approach. Important themes for the various levels of government are integration of demand management into all aspects of water policy and the critical need for co-ordination to ensure effective planning and implementation of DSM.

Federal action towards a sustainable society

A strong federal presence is needed in the water sector in Canada. Urban water demand management is a key element of the ongoing transition toward a sustainable society. To promote a reorientation toward water efficiency and conservation, the federal government's resources should be used enable communities to undertake local demand management initiatives. Key areas for federal action include, creating guidelines and standards, ensuring information is standardized and data are collected and distributed, and linking funding for urban water infrastructure to demand management requirements.

- ***Ensure sufficient capacity exists within the federal government to administer and implement federal water policies***

Implementation requires resources. If the federal government wishes to maintain even a modest presence in the water sector Environment Canada must focus some of its energies on re-building capacity and institutional know how. They can begin by assessing and implementing relevant portions of past federal water initiatives, in particular the 1987 Federal Water Policy.

- ***Create a National Water Commission for the 21st Century***

Such an entity will provide guidance, direction and coordination on the appropriate role of government in addressing national and international water resource protection and emerging water management issues. An interim option is to create a water use efficiency task force to consider options and coordinate efforts. This would include representation from all levels of government and from multiple departments (such as environment, energy, municipal affairs, public works, and education), professional and industry associations, citizen groups and NGOs.

- ***Improve data standardization, collection and analysis***

Such data should include: water end use, water source health, ecological flow requirements, and water savings associated with conservation measures. This will further the understanding of Canadian water use and the potential for conservation. This can include improving the MUD database or further development of Canadian models and computer simulation packages for disaggregated demand and revenue forecasting under conservation measures.

- ***Develop and update guidelines, such as model plumbing codes and model re-use/reclamation regulations, to assist lower levels of government.***

Although these guidelines are not binding, they can provide valuable guidance to local and provincial authorities when attempting to implement regional initiatives.

- ***Improve certification of water efficient technology and develop and promote mandatory labelling regulations.***

Such regulations and certifications allow citizens and consumers to make informed decisions, and will promote the adoption of innovative conservation focused alternatives.

- ***Improve the enforcement of federal legislation related to urban water use.***

By simply enforcing existing laws, many municipalities and other primary users will have incentives to conserve by finding appropriate local solutions.

- ***Review all federal subsidies to the water industry***.

Changing granting processes to local governments, such as adding DSM encouragements or requirements to grants and/or shifting grant monies away from infrastructure expansions and towards DSM programs is a powerful lever for change. By limiting subsidies, the federal government can promote full cost accounting for water utilities.

- ***Continue to lead by example, implementing DSM measures in all government facilities, and use government procurement programs to improve the market for efficient technology.***

By demonstrating the importance of water conservation and the potential for innovative solutions governments can help create a lasting "water ethic" in its citizens.

Water Facts Sheet

The World's Water

- There is an estimated 1,386,000 cubic kilometres of water on the planet, but only 2.5 % of it is fresh water.
- About one-third of the total world's freshwater supply is found underground; most of the rest is locked in glaciers, ice caps and permanent snow cover.
- Overall, only 0.77 % of all water on Earth is estimated as held in forms accessible to humans.
- One-third of the world population currently experiences severe water scarcity, another third moderate scarcity.
- More than one billion people worldwide lack access to safe drinking water; 2.4 billion lack access to adequate sanitation.
- The failure to satisfy basic water needs leads to hundreds of millions of cases of water-related diseases and two million to five million deaths annually.

Fresh Water in Canada

- Comprising less than 1 % of global population, Canadians possess 20 % of the world's total freshwater resources and 7 % of its renewable supply of fresh water.
- Almost 9%, or 891 163 square kilometres, of Canada's total area is covered by fresh water.
- 60 % of the freshwater in Canada drains north; however, 90 % of the national population lives within a few hundred kilometres of the southern border.
- Annually, Canada's rivers discharge 7% of the world's renewable water supply – 105 000 cubic metres per second.
- It take 250 000 L of water to produce one car; 33 000 L for a single computer.
- The majority of Canadians receive their domestic water from lakes and rivers – 26 % rely on groundwater resources.
- In a recent assessment of global 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.
- Between 1972 and 1996, Canadian freshwater withdrawals increased by almost 90%, yet the population grew by just over 30%.
- Despite comparable levels of wealth and standards of living, Canadians use more than four times the amount of water used by the average European.
- Canada ranks 28 of 29 OECD countries in terms of per capita water consumption.
- 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%.

Urban Water

- More than 80 % of Canadians live in urban areas, and 91% of this population is served by municipal water supply.
- Population growth in the range of 15 to 20 percent is expected over the next 25 years in Canada, with the majority occurring in large urban areas and regional centres.
- After a steady decline from 1991 to 1996, per capita residential water consumption in Canada rose five percent to 343 litres per day in 1999.
- In 1999, total municipal water flows in Canada were the equivalent of 638 litres per person per day, an increase of approximately two percent from 1996.

- The average Canadian uses a total of 4 400 litres water per day, taking into account all uses of water: agriculture, manufacturing, mining, some power production, and municipal, which includes residential and commercial uses.
- Residential use is the most significant component of Canadian municipal water use, representing over half of the total volume used in the municipal sector.
- About 26 % of municipalities with water systems reported water shortages in the 1994 to 1999 period, citing seasonal shortages due to drought, infrastructure problems and increased consumption as the most common reasons for these shortages.
- Recent drought conditions resulted in the lowest water supplies in the Great Lakes Basin in over thirty years.
- It is estimated that climatic warming of one degree Celsius increases municipal water consumption in the Great Lakes region by 1.3%.
- Between 1989 and 1999, 79 % of municipal water systems in Ontario experienced at least one water supply problem.
- 14% of water wells in BC have exhibited declining water levels, primarily due to human activities.

The Demand-Side Approach

- Less than 3% of the water produced at a large municipal water treatment plant is used for drinking.
- More than half of all water supply lines in Canada are estimated to be in need of repair.
- On average, 14% of municipal piped water is lost in pipeline leaks – in some communities this proportion reaches 30%.
- Some communities lose up to 40 % of treated water from leaking distribution systems.
- Municipal wastewater represents the largest source of effluent discharged to Canadian waters, totaling nearly 4.3 billion cubic metres in 1991.
- Seven of Canada's worst polluters (by volume of toxic chemicals dumped into water) are municipal sewage treatment plants.
- It is estimated that health-care costs related to water contamination in Canada total $300 million per year.
- Estimates for 1994 put the operational costs of water and wastewater services in Canada at $5.9 billion and capital expenditures at $4.7 billion.
- The cost of unmet infrastructure requirements just to maintain existing capital stock and service is between $38 and $49 billion. Demands for new capital are expected to exceed $41 billion by 2015.
- The amount of water required by toilets in the US has declined by up to 75% in the last two decades as new efficiency standards have been adopted.
- Canadian municipal water prices rank second lowest among OECD nations while per capita water use is among the highest.
- In 1996, 56 % of over 1400 Canadian municipalities surveyed were using flat rate structures for water billing.
- Canadian households billed on flat rate schedules use 70 % more water than those under volume-based schedules.
- Only 55 % of single-family homes in Canada are metered for water services – by contrast, countries such as the United States, Finland and France, report levels of water metering at 90 to 100 %.
- With the application of a water conservation strategy, a typical household can reduce water consumption by 40% or more, with little or no impact on lifestyle.

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1 Introduction

The sustainability of freshwater supplies is a growing concern worldwide. Even in Canada, a nation rich in fresh water resources, many communities are experiencing problems with local water supplies.

Fresh water plays a critical role in the development and well-being of Canada's urban centres. As cities continue to evolve, managing the freshwater demands of urban populations is becoming increasingly complex. Myriad factors combine to challenge the sustainability of Canada's urban water systems, including increasing levels of water use, seasonal water shortages, pollution, failing infrastructure and the associated costs, concern for the integrity of aquatic ecosystems, and the uncertain impacts of global climate change.

Achieving urban water sustainability in Canada's cities requires a fundamental shift in urban water planning and management. Traditional supply-side water management has brought tremendous benefits to Canadians. However, continuing to expand infrastructure and develop new water sources is increasingly expensive and ultimately unsustainable, economically and ecologically.

Europe, Australia, parts of the United States and some regions in Canada are moving toward more holistic and integrated management of freshwater resources. Emphasis is shifting from exploitation of water resources through further development of large-scale infrastructure to the maintenance of safe, reliable water systems by ***curbing water demand*** and ***managing human activities*** within watersheds to protect or enhance aquatic ecosystem health. This holistic, integrated approach, however, remains underutilized in Canada.

Developing sustainability in industrialized societies such as Canada requires situating human activity, including economic activity, within the ecological context. Fundamentally, this means that excessive demand for energy and resources must be reduced; dematerialization and substitution[1] are two broad strategies for doing so. The emerging concept of water "soft paths[2]" and urban water demand management embody these strategies, which are both key elements in the transition toward an ecologically sustainable society.

1.1 Purpose and overview

This paper provides background on issues related to urban water demand management and the obstacles impeding a transition to a demand management approach. It also identifies opportunities for the federal government to chart a new course toward sustainable water use in Canada's urban centres. By providing viable action plans, the intent is to foster collective action and a comprehensive, long-term and integrated approach to developing a sustainable water management regime in Canada.

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[1] **Dematerialization** involves reducing the flow of materials and energy through society by improving the efficiency and productivity of resource use (e.g. low-flow toilets and fixtures). **Substitution** refers to the replacement of scarce resources with alternatives or shifting the emphasis of our economy from commodities toward services (e.g. use of rain water or reclaimed wastewater for irrigation).

[2] The soft path for water is similar to, and takes its name from, the energy soft path that emerged in response to the energy crisis of the 1970s (Lovins 1977, Hawken et al 1999, Brooks 2003, Wolff and Gleick 2002).

The background paper is organized into 8 sections. This Introduction provides the context for urban water issues and management in Canada. Section 2 discusses the social and ecological needs for fresh water in order to assess appropriate conservation levels to meet social, economic and ecological objectives. Section 3 outlines paradigms of water management and develops the potential for a "soft path" approach to fresh water management in Canada. Using a conceptual model, section 4 seeks to help decision-makers better understand the barriers impeding the transition to demand management and urban water sustainability. The final sections focus on immediate opportunities for action, primarily from a federal perspective, and provide a road map for implementation.

Sections 2 through 5 follow a similar format. Each includes a background discussion on a particular component of urban water management followed by ***opportunities for action*** intended to move toward the transition to sustainable urban water management. Sections 6 and 7 synthesize these opportunities into specific courses of action for each level of government, and section 8 concludes with a detailed action plan for the federal government and an implementation matrix.

2 Social and ecological needs for fresh water

The challenge of achieving sustainability in freshwater management is to strike a balance between the competing needs and desires of human social and economic systems and the integrity of aquatic ecosystems[3]. To date, Canadian water managers have been extremely successful at manipulating and exploiting freshwater resources to increase economic growth and standards of living. Indeed, Canada's expertise in the "science of water development" – which has spawned at least 54 large inter-basin diversions and 793 large dams – has been a critical factor in developing and maintaining the country's prosperity (Shrubsole and Tate, 1994: 2; Tharme 2003: 399).

This prosperity is costly. Much of the nation's natural hydrologic infrastructure is now highly regulated for flood control and hydropower generation, and large amounts of water are withdrawn for agricultural, industrial and municipal use. This level of development continues to undermine the integrity of aquatic ecosystems and disrupt watershed processes.

As in many parts of the world, exploitation of freshwater resources in Canada progressed with little understanding of the related disruption of aquatic ecosystem integrity. As the negative impacts of human development on freshwater systems become increasingly apparent, the water management paradigm that views every drop of freshwater flowing into the sea as a wasted resource is slowly giving way to more integrated, ecosystem-based approaches. At their core, these approaches seek to maintain or enhance the integrity of aquatic ecosystems and sustain the socially valuable goods and services they provide.

2.1 Water and the economy

Fresh water is central to Canadian economic development. Environment Canada (1992) estimates that water contributes $7.5 to $23 billion annually to the economy. Although this estimate is over 10 year old, it clearly demonstrates the significance of fresh water to economic security and progress in Canada.

A common assumption among water planners is that economic and population growth inevitably leads to increasing water withdrawals and infrastructure expansion (Gleick, 2003: 291). However, substantial evidence indicates that the link between economic growth and increasing water demand can be broken. For example in the U.S., total water withdrawals increased in lock step with the rising GDP for much of the 20th century. During the 1980s, these trends began to diverge. Since that time, total water withdrawals have been decreasing while the GDP continues to increase (Gleick, 2002: 373; Wolff and Gleick, 2002: 23). See Appendix 2 for a graph illustrating this relationship.

This "decoupling" of water demand and economic output has also been observed in other industrialized countries such as Japan, China and Finland (Wolff and Gleick, 2002: 23; Gleick, 2003: 302). Although there is no conclusive evidence of this trend in Canada, regional information suggest that it is occurring (Brooks, 2003: 17).

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[3] See Appendix 1 for a discussion of the concept of ecological integrity.

The phenomenon is attributable to two factors. The first is a shift in economies away from water-intensive industrial activities such as steel or chemical production and irrigated agriculture toward service-based industries such as telecommunications, recreation, tourism and financial services. The second factor is a general increase in water productivity[4] related to economic activities that require large amounts of fresh water for production. For example, since the 1930s, the amount of water consumed per tonne of steel produced has decreased from 200 or 300 to as little as 3 or 4 tonnes in the most efficient operations (Gleick, 2002: 373).

2.2 Ecological services provided by freshwater ecosystems

Freshwater (or aquatic) ecosystems encompass a range of habitats including streams, rivers, ponds, wetlands and lakes, as well as their linked groundwater systems and riparian zones that connect them to adjacent land. Aquatic systems provide a wide variety of goods and services to the human economy. Collectively, these benefits are referred to as ecological services, defined by Daily (1997: 6) as "the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life."

The most fundamental of these services is providing fresh water for human survival. The generally accepted absolute minimum amount of fresh water required for human survival is approximately 5 litres per capita per day (lcd). To meet additional basic needs such as sanitation, food preparation and bathing, Health Canada recommends an allotment of 60 to 80 lcd; Gleick (1996: 83) recommends a minimum of 50 lcd.

Given Canada's endowment of freshwater resources, securing the quantities of water required to meet minimum human needs has not been a significant challenge. Indeed, average residential water use is currently 343 lcd – almost six times greater than Health Canada's recommended minimum (Brandes, 2003). Despite recent water quality concerns in a number of communities, most Canadians have access to abundant supplies of clean water. One major exception is concern over water quality in many First Nations communities.

In addition to maintaining water supplies for agriculture, industry and municipal use, freshwater ecosystems provide numerous other extractive benefits including fish and waterfowl, instream services such as flood control and purification of human and industrial waste (Carpenter and Postel, 1997; Baron et al, 2003). Over the long term, healthy freshwater systems are critical for sustaining these services for future generations and to maintain the ecological capacity to adapt to environmental changes such as global climate change (Baron et al, 2002: 1248). Appendix 3 provides a more comprehensive list of the benefits provided by freshwater ecosystems.

Various attempts have been made to capture the economic value of aquatic ecosystem services. For example, based on functions such as flood control, recreational fishing and water filtration, Schuyt and Brander (2004: 4 estimate the global value of wetlands alone at US$70 billion annually. Similarly, Postel and Richter (2003: 10) estimate the value of goods and services provided by the world's lakes, rivers and wetlands at US$6.6 trillion.

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[4] Water productivity is the amount of measurable output per unit of water is used. Units of output may be physical (e.g. tonnes of grain) or economic (e.g. the dollar value of the good or service produced). Productivity is commonly reported as the ratio of GDP to the volume of water withdrawn (Wolff & Gleick, 2002: 17).

It is difficult to accurately determine the economic worth of ecosystem services since many are public goods that are not quantitatively valued by the market economy (Postel and Carpenter, 1997: 199). As a result, the value of these services and the water required to produce and maintain them, are largely ignored in water management.

2.3 Threats to freshwater ecosystem services

The scale and intensity of human activity in and around freshwater bodies poses major threats to the sustainability of the aquatic environment. Discharges of municipal and industrial wastewater and pollution from non-point sources – such as agricultural and urban run-off – introduce dangerous amounts of toxic chemicals, nutrients and silt to aquatic ecosystems that negatively impact the water quality for fish, wildlife and human populations (Brandes, 2003: 19).

High levels of water use increase the volume of water withdrawn and the quality and quantity of return flows. In many cases, only a portion of the withdrawn water is returned to original sources, often in a degraded state. For example, summer flows in the Grand River system in southern Ontario contain up to 40% effluent from wastewater treatment facilities (Sproule-Jones, 2003: PC).

Modification of natural flow regimes is also a serious threat to the sustainability of freshwater ecosystems (Bunn and Arthington, 2002: 1). In Pearse's Inquiry on Federal Water Policy, he noted, "Canada's most serious water use problems are not related to inadequate supply at all, but to degraded water quality and to disrupted flow regimes. No one knows this better than our Native peoples who have watched their traditional pursuits on water deteriorate from pollution of all kinds and from storage and diversion projects that manipulate lake levels and river flows." (Pearse et al. 1985)

Although these human disturbances are often considered separate from planning and management, their cumulative impacts have significant consequences. The era of large dam construction is nearing an end in Canada. However, the presence of existing structures, continued alteration of watercourses with smaller-scale projects, poor land-use practices, insufficient waste treatment and rising water demands continue to undermine the health of aquatic ecosystems and threaten their ability to provide the many services Canadians depend upon.

2.4 Allocating water for ecosystems

Traditional approaches to water resource management treat fresh water primarily as an input to economic production. Water is first allocated to "productive" human uses, such as agricultural and industrial activities, municipal water supplies, transportation and hydropower generation. Without explicitly allocating water to support ecosystem function, only residual amounts remain for this purpose (Postel and Richter, 2003: 39).

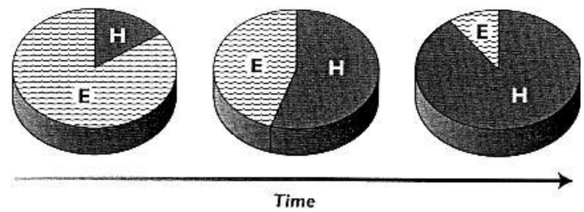
To fuel production and accommodate the growing human population throughout the 20^{th} Century, policies encouraged rapid economic growth and resulted in more freshwater withdrawals and large-scale modifications of aquatic systems. The impact of these polices, as illustrated in Box 1, is a constant decline in the residual amount of water available to sustain ecosystem health and productivity.

Box 1 also presents an alternative to these traditional policies. This new approach to freshwater allocation acknowledges the human water economy as nested within the finite "natural water economy." With such an approach, ecosystem health becomes an explicit goal of water management and development (Postel and Richter, 2003: 37) Placing a "sustainability boundary" on human water use acknowledges the hydrologic limits of watersheds and aquifers and the need to allocate water specifically to sustain healthy aquatic ecosystems.

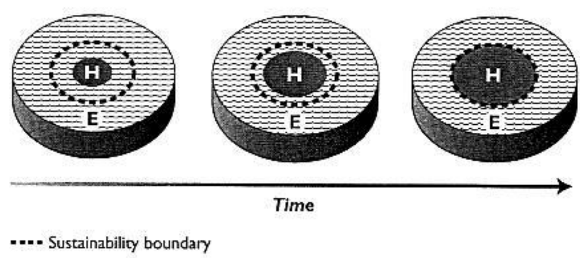
Maintaining or enhancing the health and productivity of freshwater ecosystems requires more than merely allocating a minimum volume of water to an "ecological sector." Many complex and interrelated physical, biological and chemical processes sustain the integrity of aquatic ecosystems. Each type of system (i.e. river, lake or wetland) has unique water requirements within a certain range of quality, quantity and variability (Baron et al, 2002: 1249). Determining the water requirements of aquatic ecosystems requires a sound understanding of the dynamic relationship between hydrology and ecology.

Significant research and practical experience in South Africa, Australia and some areas in the U.S. have led to the development of holistic methods for assessing the water needs of aquatic ecosystems. In light of growing pressure on Canadian freshwater resources, this is an important area for further research and capacity must be built within the federal and provincial/territorial governments. Appendix 4 provides further detail on ecosystem requirements for fresh water.

Box 1: Water allocation models



Twentieth-Century Approach to Water Allocation. The conventional approach to allocating water is to permit human uses (H) for agriculture, cities, and industries to keep expanding, leaving for natural ecosystems (E) whatever slice of the "water pie" happens to remain. Over time, this residual slice becomes too small to support ecosystem functions adequately, causing the disappearance of species and the loss of valuable ecosystem services.



Proposed Twenty-First-Century Approach to Water Allocation. In this new approach to allocating water, scientists and policymakers define the quantity and timing of flows needed to support freshwater ecosystem health, and then establish a "sustainability boundary" that protects these flows from human use and modification. Human uses of water (H) can increase over time, but only up to the sustainability boundary. At that point, new water demands must be met through conservation, improvements in water productivity, and reallocation of water among users. By limiting human impacts on natural river flows and allocating enough water for ecosystem support (E), society derives optimal benefits from river systems in a sustainable manner.

Postel and Richter, 2003: 39

2.5 Policies for ecological water allocation

Sustainable human societies ultimately depend on sustainable ecological systems. Because the integrity of aquatic ecosystems is fundamental to most, if not all, human water uses, ecosystem requirements for water must be central to water management. The environment is a "voiceless" stakeholder in water management and planning. Consequently, society must depend on legal and policy instruments to ensure that sufficient flows are allocated and properly managed to sustain healthy aquatic ecosystems for this and future generations.

2.5.1 The Canadian context

Canada does not have a clear, overarching policy that supports ecosystem water requirements. The current water allocation system used by provinces and territories rarely considers environmental needs when issuing licenses and permits. For example, when provinces and territories license surface withdrawals, they do not ensure adequate base flows are maintained (Thomson 1994: 171; Water Conservation Strategy for B.C. 1998: 28, 29). According to Sproule-Jones (2003: PC), some streams in the Great Lakes basin would run dry for part of the year if all permit holders withdrew their allotted volumes.

Some wildlife legislation requires sufficient in-stream flows in times of drought. However, effectively incorporating such considerations into decision-making and long-term planning is rare. Furthermore, the legislation does not reflect the volume, timing and quality of water needed to maintain overall ecosystem integrity. As Thompson (1991: 160) concludes, "there is but limited recognition of conservation or environmental uses as legitimate subjects of licensing pursuant to water licensing statues in Canada."

Canada has made some progress curtailing inter-basin transfers and the related disruption of freshwater ecosystems. However, in Canada, more water is diverted from one river basin to another than any other country on Earth. This happens despite legislation in most provinces that prohibits large-scale diversions of water between major watersheds – albeit with certain loopholes (Boyd 2003: 14, 59). Prohibiting such transfers by strictly enforcing legislation not only protects watersheds, but also forces regions to live in balance with their local hydrologic systems (Arlosoroff 1994: 25; Postel 1994: 20; Mitchell and Shrubsole 1997: 14).

2.5.2 International benchmarks

- Canada is not alone in its limited recognition of ecosystem needs for water. Indeed, most nations have yet to establish clear policies legitimizing environmental flow requirements (Dyson et al, 2003: 79). South Africa and Australia are recognized as world leaders in the development of legal and policy frameworks that support ecosystem requirements for fresh water; some U.S. jurisdictions have also made progress in this area (see

Box 2).

2.6 Summary

Protecting and restoring the integrity and productivity of freshwater ecosystems is critical to the development of sustainable Canadian communities. Doing so will require development and implementation of policies that establish ecosystems as legitimate users of fresh water resources and recognize the limits of watersheds and aquifers. The policies must also serve as practical tools to assess the needs of aquatic ecosystems and deliver water to meet these needs.

Opportunities for action:

- Develop a national policy on ecological requirements for fresh water that establishes protection and restoration of ecosystem integrity and productivity as an explicit goal of water management. The policy must include guidelines for establishing sustainability boundaries for local aquatic ecosystems.

- Develop expertise to foster the development and implementation of strategies to assess and manage environmental flows. Capacity and expertise within federal and provincial governments should be built in this emerging field to demonstrate leadership and ensure scientifically sound and sustainable outcomes.

Box 2: International benchmarks for environmental flow requirements

South Africa's *National Water Act*, passed in 1998 as part of post-apartheid constitutional reform, is by far the most advanced national policy with respect to environmental flows. The policy is based on the public trust doctrine, which obliges governments to hold certain rights in trust for citizens and protect these rights for the common good. The Act establishes a two-part water "reserve" that is not subject to competition from other water users. The first part of this water reserve is used to meet basic human needs; the second part is specifically used to support ecosystem functions (Postel and Richter, 2003: 84; Dyson et al, 2003: 82).

The Act states: "the quantity, quality and reliability of water required to maintain the ecological function on which humans depend shall be reserved so that the human use of water does not individually or cumulatively compromise the long term sustainability of aquatic and associated ecosystems" (SADWAF, 1996). The Act is supported by government guidelines that help scientists and communities determine the ecological limits of withdrawals from local bodies of water. This legislation is still in its infancy and therefore the impacts of implementation are unknown.

United States - No explicit policy to support ecosystem flows exists in the U.S.; however, the public trust doctrine has been used to protect aquatic ecosystems in a number of jurisdictions. For example, in August 2000 the Hawaii Supreme Court ruled that public interests, which include ecosystem protection, take priority over commercial water uses in decisions concerning water allocation (Postel and Vickers, 2004: 48). In another decision based on the public trust doctrine, the California Supreme Court mandated that the city of Los Angeles reduce withdrawals from tributaries feeding Mono Lake, which has lost much of its water stock due to diversions by the city (Postel, 2000: 944).

Australia – Primary authority over water resources in Australia lies with state and territorial governments – a situation similar to Canada's federal-provincial division of power over fresh water management. In response to deteriorating ecological conditions in many of the nation's aquatic ecosystems, the Australian Commonwealth (federal) government took the initiative to establish the Council of Australian Governments (COAG) Water Reform Framework. With all state premiers as signatories, the Framework seeks to reform water policy to promote sustainable water use and protect aquatic ecosystems (Postel and Richter, 2003: 86).

The proposed reforms call for states to recognize ecosystems as legitimate water users. Two of the Framework's 20 principles hold particular promise for water distribution that supports ecosystem health. One of the principles calls for legal recognition of the ecosystem's water requirements; the other recommends placing a cap on withdrawals where existing environmental flows do not adequately protect ecological integrity. Under the commonwealth system, the principles must be incorporated into state law and policy in order to realize the Framework's full potential (Postel and Richter, 2003: 86).

In the country's largest river basin, the Murray-Darling, severly low water conditions and the related ecological impacts prompted authorities to place a cap on withdrawals from the basin. To prevent further deterioration, the four states that share the basin have agreed to allocate 25% of river's natural flow to support ecosystem functions (Postel, 2000: 944). This innovative policy allows for trading of water allotments among permit holders, which frees up unused water for redistribution, and is expected to provide incentives to significantly increase water efficiency in all sectors (Postel and Richter, 2003: 92).

3 Paradigms of urban water management

Water development projects during the 20th Century have benefited Canadians tremendously. However, increasing incidences of local water shortages and recent water quality disasters have led many to question the technical reliability and institutional capacity of urban water management. People are beginning to recognize that continuing to expand infrastructure and develop new water sources has become increasingly expensive and ultimately unsustainable, botheconomically and environmentally.

3.1 The supply-side approach

Supply-side management treats fresh water as a virtually limitless resource, resulting in a regime of water policy and practice concerned primarily with securing sufficient quantities of water to meet forecast demand. Underlying this approach is the assumption that current levels of water demand are insensitive to policy and behavioural changes (Renzetti, 2003: 1; Shrubsole and Tate, 1994: 1). This supply-side orientation rarely takes full account of environmental or economic impacts of municipal water services.

Large, centralized engineering projects – dams, diversions, treatment and distribution systems – are products of the supply-side approach. Continuing to depend on expansion of these high throughput water systems puts an increasing, and often unnecessary, strain on the economic stability of municipal water utilities and the integrity of the local aquatic ecosystems (Shrubsole and Tate, 1994: 2; Gleick, 2000: 128). As Duncan Ellison (2003: PC), Executive Director of the Canadian Water and Wastewater Association suggests, "simply expanding supply to meet an unrestrained demand just doesn't make sense in most cities."

3.2 Demand management

Demand-side management (DSM)[5] is gaining recognition in a number of resource fields including transportation, energy and, more recently, water. In a recent report, the NRTEE[6] (2003) explicitly recommends demand management as a key strategy for mitigating the downward trend in environmental quality in Canadian cities. It is relevant to note, however, that the NRTEE report does not adequately address demand management in the urban water context.

In the context of urban water systems, DSM[7] involves any measure or group of measures that improves the efficiency and timing of water use. Pricing, education, water efficient technologies, and regulatory regimes that promote re-use and recycling are examples of demand-side approaches. At its core, urban water demand management recognizes that developing new water sources may be too costly whereas influencing consumer demand is more cost-effective. This is particularly true when environmental and economic costs of urban water services are taken into account. For a thorough discussion of urban water demand management and the relationships among demand tools, see Maas 2003.

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[5] Curran (2000:18) defines DSM generally as "reducing the demand for a service or resource rather than automatically supplying more of the service or resource being sought." DSM is commonly referred to simply as demand management.

[6] NRTEE. 2003. Environmental Quality in Canadian Cities: The Federal Role. Available at: www.nrtee-trnee.ca.

[7] Brooks and Peters (1988: 3) define water demand management as "any measure that reduces average or peak withdrawals from surface or groundwater sources without increasing the extent to which wastewater is degraded."

Contrary to the widespread misconception that Canada possesses an abundance of available water, there are pressing reasons to improve water management. These include high levels of urban water use, a growing number of municipalities facing limitations of supply and/or infrastructure, increasing capital costs of infrastructure expansions, the environmental impacts of water withdrawals and wastewater discharges, and the consequent impacts on downstream drinking water quality (see Box 4).

Box 4: The case for urban water demand management in Canada

High urban water use	*Supply limitations*	*Capital costs*	*Environmental impacts*	*Drinking water quality*
• Canadians are the 2nd highest urban water users in the world, using 2½ times more water than the average European. • Total municipal water use increased 6% during the 1990s. • The average Canadian uses 343 litres per capita per day (lcd) in the home. • Total residential water use increased 21% during the 1990s.	• A number of surface waters have reached, or are close to, their limit for withdrawals. • Groundwater extraction will be, or is already, depleting a number of aquifers. • Large numbers of water sources are contaminated or at risk of contamination. • Increasing uncertainty about stream flows and lake levels due to global climate change.	• Water/ wastewater infrastructure upgrades represent significant unmet capital costs – estimated at $23 to $49 billion Canada wide. Stringent drinking water standards will further increase costs. • Increasing peak water and/or wastewater treatment demands creates additional capital costs.	• Water withdrawals and wastewater returns are geographically concentrated, which amplifies their impact. • Development projects (dams and diversions) destroy aquatic and land habitat, introduce non-native species and block fish migration. • Ground and surface water withdrawals can reduce surface water flows, altering marine habitat and damaging fish populations.	• Reduced water flow through the treatment process is less costly, allowing money to be used to meet higher drinking water standards and reducing the amount of water treated to this level. • Less volume of wastewater increases the effectiveness of sewage treatment and decreases pollution in receiving waters that provide communities downstream with drinking water. • Decreased demand reduces the need for additional water sources and protects groundwater sources from over-pumping.

Many of the water management concerns outlined in Box 4 are becoming more common and will increase as municipal water use continues to rise. Although demand management is not a panacea for all that ails urban water management, it can help mitigate many of these problems.

Adopting DSM into urban water management can help reduce, or at least cap, current urban water use and wastewater production. In the context of population growth and urbanization, this means increasing per capita water use efficiency in order to stabilize or reduce total water use. Ultimately, by increasing water use efficiency, DSM programs mitigate the pressures of excessive urban water use on municipal finances, infrastructure and the aquatic ecosystems that these systems rely upon.

3.3 The "soft path" for water

DSM is central to the concept of "soft paths" for water – an overarching, long-term approach to water planning that fundamentally re-evaluates the way freshwater resources are developed, managed and used (Gleick, 2002: 373). The soft path strives for sustainability and equity in water management by increasing water productivity rather than seeking out additional supplies. It also ensures that stakeholders are engaged in decision-making and explicitly recognizes ecosystems as legitimate users of fresh water (Wolff and Gleick, 2002; Brooks, 2003).

Box 5: Soft paths for water

The soft path differs fundamentally from conventional (or "hard path") water planning in its conception of water demand. A soft path approach rarely views water as the end product, but more often as the means to accomplish certain tasks such as household sanitation or agricultural production. Brooks (2003: 10) notes, "With some important exceptions, the demand used in common projections is not for water itself, but for services provided by water." Under a soft path approach, the role of water planning and management becomes one of a service provider – the objective is to satisfy demands for water-based services rather than supplying water *per se* (Gleick, 2002: 373).

The soft path complements and works within existing water infrastructure to limit or eliminate the need for further supply-side developments. It relies largely on demand-side measures such as efficient technologies, education, regulation, and the rational use of economic instruments to increase the productivity of current withdrawals while ensuring equitable access to the resource.

A key feature of soft path planning is the recognition that many existing water needs can be met with far less water, and often with water of a *lower* quality, than is currently used. High efficiency toilets, for example, reduce the amount of water used for sanitation; however, there is significant potential to further increase water productivity by using reclaimed wastewater to flush toilets or by moving to dry sanitation systems that completely eliminate water use.

Traditional methods for determining future water needs rely primarily on long-range projections that assume an ever-increasing demand. These projections rarely consider changes in technology, costs, prices, customer preferences and market forces, and therefore commonly overestimate future demand (Wolff and Gleick, 2002: 29). Rather than forecasting future demand based on past trends, the soft path uses an approach to planning known as "backcasting" in which planners define a preferred future then work backwards to find feasible paths to reach that future situation (Brooks, 2003: 35).

Critically important is an effective strategy that assesses ecological water requirements, and integrates these requirements into the backcasting process. For example, the sustainability boundary, or volume of water required to meet basic human needs and those of aquatic ecosystems, should be established for the system (i.e. watershed or aquifer). Soft path principles and a comprehensive demand-management approach can then be applied to ensure that the remaining resource is efficiently distributed and productivity is maximized for economic development and other social needs.

Opportunities for action:

- Facilitate the paradigm shift in water management away from the entrenched supply-side focus toward a comprehensive demand-side management based on the soft path planning approach. For example, the recent NRTEE report, "Environmental Quality in Canadian Cities: The Federal Role", could easily be extended to explicitly include urban water management. In particular, *Recommendation 6* should be adapted to include a more comprehensive treatment of demand management for urban water.

4 Major barriers to DSM

In Canada, much of the current urban water distribution system may be financially and/or environmentally unsustainable. Demand management can stretch existing capacity by delaying the development of further infrastructure and new sources of supply. It may also liberate water supplies to benefit the environment, meet the needs of future growth in population and industry or mitigate risks associated with an uncertain future.

Demand management is relatively advanced among regulated electricity utilities in North America, but rigorous application of DSM techniques in the water sector, especially in Canada, is still in its infancy (CRM 1996: 1,3; Tate 1990:49). This slow development cannot be explained by the lack of water-efficient technology or know-how. DSM methods and tools have been around for many years, and modern efficient fixtures and appliances have been on the market for decades (Brooks 2003a: 33). Yet, there are still many reasons for Canada's sluggish adoption of DSM (see Box 6). A full description of each barrier is provided in Appendix 6.

Box 6: Barriers that Impede the Adoption of DSM in Canada

Attitudinal barriers	*Financial barriers*	*Data and informational barriers*	*Administrative barriers*
• Myth of superabundance • Human economy and human-built infrastructure considered separate from the environment • Ideal of free market society without government intrusion • Belief that reduced water use imposes a reduced standard of living • Concern that DSM savings are unreliable and/or insubstantial • Political preference for high visibility projects	• Subsidies and low pricing • Need for predictable and stable revenues • Need to maintain sufficient revenues in the face of overcapitalization • Lack of funding for DSM • Gap in payback period	• Wariness about DSM by decision-makers • Lack of comprehensive cost/benefit models • Ineffective DSM programs	• Fragmented administration • Centralized engineering bias • Formulaic thinking • Inflexible policies

4.1 Understanding the barriers to demand management

Many demand management solutions are available to both water providers and end users, yet implementation in Canada has been limited due to the barriers noted above. These barriers can be seen to produce a form of gridlock illustrated in a conceptual model that categorizes them as *root causes*, *current practices*, and *entrenching factors* (see Box 5).

Historical conditions, the evolution of water management in Canada, and the influence of the more fundamental root causes are the central factors that maintain the supply-side focus of current water management. However, with an understanding of the individual barriers and their inter-relationships, policies and action plans will be better positioned to overcome the existing inertia and promote widespread adoption of a comprehensive, integrated and long-term approach to DSM.

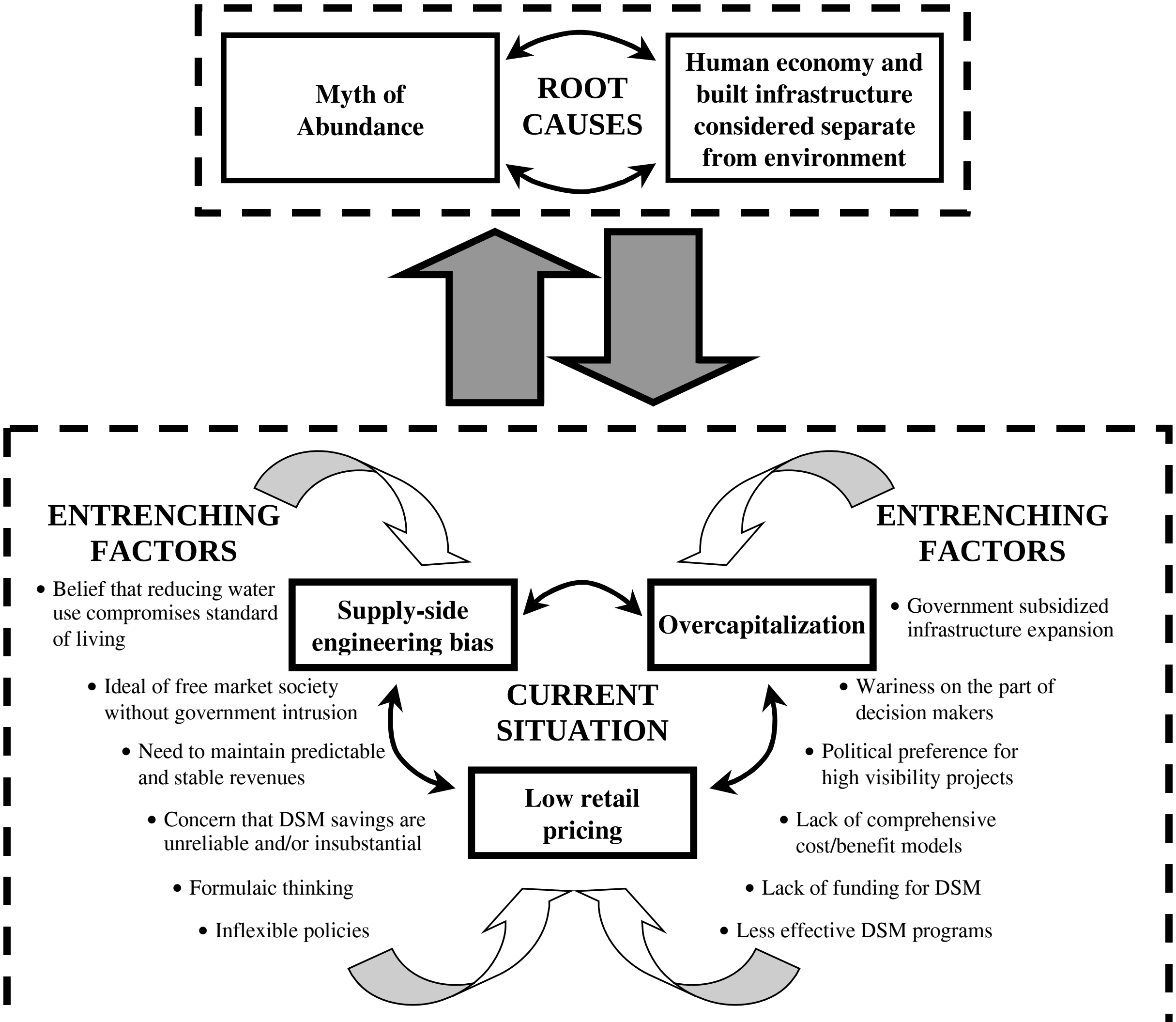
This conceptualization illustrates how many of the barriers work together to entrench the current situation, and how this influences, and is influenced by, root causes. It attempts to capture the complexity and limitations of the current urban water regime and emphasizes the importance of simultaneously tackling a number of barriers to effectively address this gridlock.

This conception suggests what Capra (1982: 25) calls a "systemic problem" where the individual drivers are closely interconnected and interdependent. This cannot be fully understood or rectified with the *fragmented* methodology characteristic of historical approaches. To address this "gridlock," it is necessary to change the structure of the web itself. To do so requires moving beyond isolated strategies and tackling a number of barriers simultaneously, strategically and comprehensively.

Opportunities for action:

This model presents a comprehensive look at the barriers impeding the adoption of demand management approaches. Using a more holistic and conceptual perspective of the root causes and the many factors entrenching these barriers will help identify strategies and opportunities for action toward a comprehensive, integrated and long-term approach to demand management. This theoretical grounding is the foundation for the action plans presented in the following sections.

Box 7: Conceptual model of the relationships among the barriers to DSM in Canada



In the case of urban water management, two barriers reinforce and drive many others, namely: the view of human society and our economy as separate from the environment, and the myth of superabundance. The view of separation encourages human society to manipulate natural water sources in ways that do not fully consider ecological integrity; and the myth of superabundance contributes to the focus on supply-side management.

The barriers in this illustration evolved over time, with many reinforcing effects. Consider the current situation of low retail pricing. Low prices are an important driver of over-inflated demand, since users have little financial incentive to practice efficient water use. The typical response to such demand focuses on engineered solutions that result in overcapitalization. In this way, low retail pricing reinforces both "overcapitalization" and a "supply-side engineering bias" – collectively maintaining the status quo of inflated demand in Canada.

Currently, low prices are possible due to subsidies from higher levels of government and the environment[1]. The current mode of government-subsidized infrastructure expansion results in overcapitalization. With overcapitalization a utility must maintain revenue to service the debts incurred. This provides an incentive to keep prices low to maintain the high demand, which also justifies the capital expenditure.

5 Facilitating demand management through good water governance

Overcoming the inertia of the status quo in urban water management is difficult yet necessary. Moving from a traditional supply-side focus to a demand-oriented water management regime requires action by many different actors, including all levels of government, professional associations, civil society and end users. To fully realize the potential of water demand management we must move beyond isolated and reactive conservation programs toward a comprehensive, integrated and long-term approach.

This section discusses a number of ***processes*** (strategic planning and coordination, integrated planning and watershed management stakeholder participation and capacity building) that are key elements of good water governance. Each of these processes represents an opportunity to facilitate the transition of urban water management toward a comprehensive demand management approach and, ultimately, to foster water sustainability in Canada's cities. These processes are applicable to water management efforts undertaken at all levels of government, and can also strengthen cooperative efforts undertaken by multiple levels. They broadly represent ***opportunities for action*** and are integral to any water management strategy.

Governance

Bakker (2003a: 5) defines water governance as "the range of political, organizational and administrative processes through which communities articulate their interests, their input is absorbed, decisions are made and implemented, and decision makers are held accountable in the development and management of water resources and delivery of water services."

Governance is more than just government. It includes broader institutions and social decision-making processes, such as those involving business and "civil society." Encompassing the political system, laws, regulations, institutions, financial mechanisms, civil society development, and consumer rights "governance both sets the rules, including roles and responsibilities that influence behaviour, and the process of making those rules" (GWP 2003: 1).

Freshwater jurisdiction

Primary responsibility for freshwater resources lies with provincial and territorial governments; and urban water management is typically delegated to local governments and water utilities. The federal government is less directly involved with urban water services, but still plays an important role in promoting national standards and guidelines, infrastructure funding, and in implementing research and data collection. It also has constitutional authority over navigation, pollution prevention, shared waters, fisheries and fish habitat.

5.1 Strategic planning and coordination

Ensuring that utilities and governments conduct strategic and coordinated planning prior to taking action is an important aspect of water management. In Canada, this coordination is often difficult because of the shared responsibilities of water management among different levels of government. Nonetheless, a coordinated approach is particularly important in reference to demand management since different levels of government – and various departments or agencies within each level – may all be involved in the development of DSM programs.

Relationships among DSM measures further complicate the development of demand management programs. Some measures are mutually reinforcing and others can be mutually diminishing or even mutually exclusive. Synergies and detractions may occur between measures undertaken by one level of government or between measures undertaken by various levels. This degree of complexity requires strategic planning and careful coordination of activities by all stakeholders to ensure effective and efficient implementation of demand management programs.

5.2 Integrated planning and watershed management

To consider DSM as isolated water management strategy would risk missing important synergies within water management and within other resource sectors. "Integrated planning" aims to mitigate this risk by broadening the scope of planning and management to include supply-side options and other resource and land-use considerations (CRM 1996: 13; Beecher 1998).

Choosing the overall least-cost solution to meet society's needs for water services requires consideration of various combinations of demand and supply-side options. Indeed, Wolff and Gleick (2002: 29) suggest that, "unless demand management is fully integrated with water-supply planning, it will remain an underused and misunderstood part of our water future."

Integrated planning also examines the implications of different demand and supply-side combinations on other sectors such as wastewater treatment, energy use, and impacts on the natural environment. In fact, some water DSM measures may only be economically attractive when their secondary benefits[8] are taken into account (Shrubsole and Mitchell 1997: 310; Wolff and Gleick 2002: 14, 15).

Water resource management is, however, often detached from other sectors, and various aspects of water management are often artificially separated (Fitzgibbon 1994: 167). For example, the responsibilities for groundwater and surface water management are often divorced, even though withdrawals from one can significantly influence the other. Similarly, water provision and wastewater management are often handled separately. These examples clearly illustrate opportunities for improving integrated planning.

Another important example of integrated planning is watershed management, also known as integrated water resources management (IWRM)[9]. This involves consideration of the cumulative impacts of all activities within a watershed in an effort to maintain overall watershed health. The licensing of municipal water withdrawals and wastewater discharges should be considered alongside other activities in the watershed, such as intakes and outflows of other municipalities' water systems as well as land and resource uses such as agriculture and forestry (Shrubsole and Mitchell 1997: 309).

Moving toward watershed-based management was a key recommendation put forth by Justice O'Connor in his report following the public inquiry into the Walkerton tragedy. A watershed approach begins with a "water budget," which calculates the balance between intakes and outflows

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[8] Water-efficient washing machines and dishwashers, for example, are highly cost-effective; this would be true even if water were free, when you consider the avoided energy expenses for heating water. Such energy use reductions will likely also have additional environmental benefits (Wolff and Gleick 2002: 13, 14). It is therefore often necessary to consider water efficiency, energy efficiency and household waste reduction collectively, such as in Ontario's "Green Community" strategy (Sharratt et. al. 1994: 78).

[9] The Global Water Partnership (2003: 1) defines IWRM as "a process that promotes the co-ordination, development and management of water, land and related resources."

from all sources for a watershed and documents all major sources of contamination (Cooper 2003: 24). A watershed plan analyzes all flows in and out of a watershed in an attempt to balance competing needs for water and equitably allocate the limited resources (FCM 2001: 42)[10]. Allocating sufficient water to the environment and managing this water to sustain ecosystem functions and productivity is an important, but often neglected, component of watershed planning (see section 2.4).

Watershed management and integrated planning are critical if the cumulative effects of human activities are to be managed within the context of ecological sustainability. Jurisdictional boundaries for urban planning are typically limited to municipal borders and therefore exclude substantial portions of the city's watershed. However, long-term urban planning requires reliable predictions of water availability and quality – issues that can only be considered in the context of the watershed (FCM 2001: 42). Demand management in urban centres is only one aspect of a broader watershed perspective. Conservation in cities is a critical first step and can result in positive impacts both up- and downstream. Without an effective watershed plan (and of course, its implementation), a city or region is unable to optimize investments and address wasteful practices across all water-using sectors.

5.3 Stakeholder participation

Decision-making processes, such as those used in planning and implementing DSM programs, are also fundamental governance issues. Included in these processes are considerations of what role residents and local conservation groups should have - for example, to influence plans for reservoir expansion or other supply-oriented options. This appears to be a relatively straightforward issue, however, in a broader context it relates to the fundamental nature of participatory democracy and how the environment is considered and influenced by society at large. Such issues are especially important with demand management because it requires the broad participation of users, which can be seriously undermined if their views are not included during decision-making processes.

Increasing participation is possible by forming permanent and empowered citizens advisory committees, with broad representation including plumbers, homebuilders, environmentalists, and citizens-at-large (RMI 1991: 20; Marsalek et. al. 2002: 28; Mee 1998: 198).

Greater public participation has many benefits: it can help to educate, engage and inspire the public; determine public support and concern over particular measures; gather public input to guide, run, and/or provide additional imagination to planning processes; alleviate public concerns and scepticism; change the perception that programs are created and run by distant experts; lessen the need to later mediate conflict; create ambassadors for the program; enrich community solidarity and public involvement in community affairs; produce a stronger consensus for action; generate media interest; legitimize programs; and, later, monitor implementation of the program (Wallace et. al. 1997: 120-123).

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[10] Groundwater replenishment rates can similarly be calculated from which maximum extraction rates could be determined to prevent "groundwater mining" and depletion of aquifers. This ensures that streams, wetlands and other ecologically significant features that receive groundwater discharge are not negatively affected

5.4 Building capacity for water demand management

As noted above, demand management often involves some degree of complexity. This complexity stems from the need to engage in comprehensive, long-term and integrated planning, which includes participation by end users and analysis of their responses to various programs. Effective planning and implementation of DSM programs requires specific expertise, which is often quite different from that of typical water managers and planners. To fully integrate DSM into the long-term operations of a utility or government agency, this expertise needs to be permanent. Utilities and governments might therefore choose to create a separate water conservation division, or dedicate staff in existing departments, specifically to conservation efforts (Vickers 1994: 95)[11]. Box 8 outlines some of the many potential advantages to having dedicated conservation departments and/or staff.

Although most of the advantages suggested below are associated with local capacity building, it is equally important to develop expertise in demand management at ***all levels*** of government. More comprehensive and coordinated efforts are possible as long as the capacity for demand management exists in federal and provincial governments. Furthermore, if senior governments posses the capacity for DSM, they will be better positioned to provide advice and support to and identify opportunities for action for local governments.

Box 8: Potential advantages with the creation of dedicated conservation departments

- Conservation staff can reduce water use more effectively through improved planning and implementation of long-term DSM programs.
- Conservation staff can design, implement and enforce water-rationing programs in critical periods of drought or when water demands threaten to exceed available supply.
- Conservation staff can get to know and involve community members.
- Conservation staff can develop local area knowledge. This can help guide planning through an understanding of local public concerns and the potential for participation. It can also help improve the effectiveness of certain DSM measures, such as education and marketing campaigns, by incorporating local concerns in message content.
- Conservation staff can monitor DSM programs over the long term, allowing programs to be adapted and improved over time.
- Conservation staff can gather and analyze information about local water-use habits, patterns of use, and how households value water in the broader context. For example, general water researchers have a good understanding of the average person's valuation of a small amount of water for drinking each day (through studies tracking the recent rapid increase in bottle water sales). However, much less is known about how households value less vital uses of water such as showering, lawn watering and clothes washing (Renzetti 2003: 4). By gathering such information, DSM measures can be improved through more effective targeting or more appropriate rate setting.

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[11] The Region of Ottawa-Carleton hired a Water Efficiency Coordinator and Edmonton has a full-time Water Conservation Engineer who administers the city's conservation programs (Sharratt et. al. 1994: 77; Mackenzie and Parsons 1994: 108). Other cities and regions such as Waterloo, Victoria, Calgary, Toronto, Winnipeg and Vancouver have dedicated staff and resources to ensure some level of DSM is provided.

6 Federal action to promote urban water demand management

Federal jurisdiction over water is limited to water on federal lands, matters related to fisheries and navigation, and the management of international boundary waters. Federal lands include national parks and wildlife areas, migratory bird sanctuaries, military bases, federally owned land, First Nations reserves and, in some cases, the land in the territories. In general, the federal government is not directly involved with urban water services except through infrastructure funding. However, there are more than 20 federal Acts and regulations in Canada that pertain to water.

A strong federal presence is needed in the water sector in Canada. To promote efficiency and conservation of urban water resources the federal government can:

- invigorate federal activity in water policy;
- develop capacity for demand management;
- create guidelines and standards;
- ensure information is standardized, and data are collected and distributed;
- improve enforcement of existing legislation;
- link grants and funding for infrastructure to demand management requirements; and
- demonstrate leadership by improving water use efficiency in federal facilities.

Federal resources and capacity can also be used to enable communities to undertake local demand management initiatives. This assistance extends from simply providing information and guidance to creating new federal programs and agencies to promote demand management. In partnership with universities and relevant associations, these agencies could develop primary ecological and social research to examine international best practices. They could also promote local solutions, within a national approach.

A compelling analogy exists between the energy and water sectors with respect to opportunities for federal action. The federal government does not have significantly more responsibility for energy than it does for water; however, the government did create an Office of Energy Efficiency (formerly Office of Energy Conservation). Also, the *Energy Conservation Act* covers such issues as labelling and standards within the energy sector. These opportunities for federal government involvement in the energy sector suggest that similar opportunities should exist for efficiency and demand management within the water sector.

6.1 Invigorating the federal water policy

The *Federal Water Policy,* tabled in Parliament in 1987, represented the high point of the federal government's interest in water management. The overall objective of the policy is to encourage the use of fresh water in an efficient and equitable manner, consistent with the social, economic, and environmental needs of present and future generations. It was developed to protect and enhance the quality of the water resource by promoting the wise, efficient management and use of water. It also established a policy to eliminate funding for new water or sewer infrastructure, which encourages realistic pricing for both services (Environment Canada 2003: 48; Dangerfield 1994: 55; Hillard 1994: 118; Shrubsole and Tate 1994: 8). In many ways the *Federal Water Policy* is as relevant today as it was in 1987.

Following the establishment of this policy, the federal government introduced the *Green Plan*, which emphasizes the need for water demand management. Other water policy instruments implemented after 1987 include: the federal *Guidelines for Canadian Drinking Water Quality*, the *Water Conservation Plan for Federal Government Facilities* in 1993, and the *National Action Plan to Encourage Water Use Efficiency* in 1994 (Foerstel 1994: 63-66; Mitchell and Shrubsole 1997: 19; Boyd 2003: 50). More recently, however, federal involvement in water management has declined significantly. Some experts have gone so far as to state that, in the water context, the federal government is "for the most part irrelevant at this point" (Maas 2003: 27).

The majority of recommendations in the *Federal Water Policy* were never implemented (Boyd 2003: 15; Pearse 2002: 15-2). A simple first step for the federal government is to re-assess these past initiatives, re-evaluate priorities, and move ahead with implementation. Such implementation requires sufficient capacity - skills, staffing and funding - within the relevant federal departments.

To ensure that the capacity exists, the federal government must initiate a reversal of the staff and budget reductions in federal water departments over the last twenty years. These reductions have included: dissolution of the Inland Waters Directorate, dormancy of the Interdepartmental Committee on Water, lack of follow up reports on the *Federal Water Policy*, funding reductions from $9 million in 1990 to $0.5 million in 1997 for administering the *Canada Water Act*, a 55% cut to the Department of Fisheries and Oceans Freshwater Science program, and the termination of the Water Advisory Committee (Pearse and Quinn 1996: 335).

In light of these changes, some question the federal government's ability to administer even a modest water policy. In any event, "even in a reduced role, it is important that policy be coherent and consistent, and that the administrative structure have the scientific capacity, support and organization to implement it properly" (Pearse and Quinn 1996: 339).

6.1.1 National Water Commission for the 21st century[12]

By creating a national entity, such as a water commission, the federal government can ensure a leadership role in water resource issues. A National Water Commission could direct an aggressive effort to protect Canada's water resources and to advise the country on how to address global water crises[13]. Such a commission could start by refreshing the federal water policy, to include: a workable strategy to deal with pressing infrastructure needs; improvements to water resource and aquatic ecosystem protection; and an evaluation of the potential for other modes of water services delivery, such as through cooperatives or private partners.

While recognizing that effective water management entails strategic provincial and local action, national policies and actions are also critical to ensure efforts are coordinated and productive. A non-partisan water commission would draw from many disciplines-- including the natural and engineering sciences, economics, and public policy -- and would represent all levels of government, public interest groups, and the private sector (Gleick 2003c).

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[12] A similar idea has been proposed before the Legislative Hearing of the Subcommittee on Water and Power of the Committee on Resources in the US Congress by Peter Gleick and the Pacific Institute (Gleick 2003c).

[13] Globally, the realization is growing that the failure to meet basic human and environmental needs for water is the greatest development disaster of the 20th century (Gleick 2003c: 1). Despite a range of threats to water resources across the world, Canada has not offered adequate leadership in providing resources, education, and technological and financial assistance to address these problems. Instead, world leadership on these issues is being provided by the Netherlands, Japan, France, UK and Germany.

6.2 Guidelines and standards

Creating guidelines and standards is an important role for the federal government. Guidelines, though not legally binding, can serve to create national standards and a certain economy of scale in policies and implementation. Because of Canada's poor track record for following national guidelines and the excessive flexibility associated with them, the federal government should act to foster comprehensive and workable program goals. Creating complementary standards, which are legally binding and enforceable, are critical to ensure successful incorporation of guidelines (which are not enforceable) (Boyd 2003: 21)

The U.S. has achieved some success with the 1992 federal *Energy Policy Act* that established national maximum allowable flow rates for toilets, showerheads, and faucets in new and renovated residential and non-residential facilities (Platt and Morrill 1997: 289; Vickers 2001: 17,18,20,40). Other countries, such as Australia, Denmark and Singapore, have set even stricter requirements, allowing toilets that use no more than 3.0 to 4.5 lpf (Vickers 2001: 24). The division of power in Canada gives primary responsibility for such legislation to the provinces; however, the federal government can assist by updating the *Canadian Plumbing Code* to reflect best available technology.

Box 8: The Energy Policy Act and water efficiency in the U.S.

"Over the next 20 to 25 years, U.S. water utilities are expected to see reductions in water demand as a result of national water-efficiency requirements established by the U.S. *Energy Policy Act* of 1992 (EPAct). This landmark legislation set maximum water-use levels for toilets (1.6 gallons per flush), urinals (1.0 gallons per flush), and showerheads (2.5 gallons per minute). Efficiency standards apply to plumbing fixtures in new and renovated residential and non-residential facilities. The EPAct standards will have a cumulative, long-term impact on indoor water use, as existing high-volume fixtures are gradually replaced, particularly in the residential sector. The water savings that the EPAct is expected to produce among U.S. residential and non-residential customers have been projected from 6 to 9 billion gallons per day by 2020, by which time most exiting fixtures will have been replaced with ones that comply with EPAct. Studies of 16 U.S. localities showed that the EPAct standards will reduce water demand enough to save local water utilities $166 million to $231 million as a result of deferred or avoided investments to expand drinking water treatment or storage capacity."

Source: (Vickers 2001: 20)

Guidelines aid planning. The EPA's conservation planning guidelines for water utilities have proven effective in promoting demand management programs (EPA 1998), and they could easily be adapted to Canada. The Canadian federal government can also develop model re-use and reclamation regulations. Currently, no national guidelines for wastewater re-use exist, and the *Canadian Plumbing Code* makes no allowances for reclaimed water (Marsalek et. al. 2002: 7,13,26). In contrast, the U.S. federal government has developed a set of *Guidelines for Water Reuse* to aid those regions without criteria or standards of their own.

Lack of information is often a barrier to environmentally responsible behaviour (Boyd 2003: 331). By improving standardization, performance testing and labelling of water-efficient fixtures and appliances, the federal government can increase confidence and promote action by lower levels of government and end-users.

Currently, deficient CSA certification procedures create uncertainty for consumers and reluctance by provincial governments to mandate their use. For example, despite obtaining CSA certification, independent testing has demonstrated that four of the 10 most popular ULF toilet models currently sold in Canada fail to meet maximum flush volume and/or waste removal performance standards (Maas 2003: 12). Efforts to improve certification processes are primarily driven by associations like the CWWA. Government leadership and guidance can facilitate credible and reliable water-efficiency eco-labelling programs, similar to the program for household appliances under the federal *Energy Efficiency Act* (Boyd 2003: 331).

Other national standards relating to urban water also require updating. For example, mandating efficient fixtures could lead to smaller piping requirements, which would require additional changes to provincial plumbing codes. Standards committees, such as the Standing Committee on Plumbing Services of the Associate Committee on the National Building Code should assess this on a national level to avoid provincial duplication (Gates 1994: 337).

6.3 Data collection and analysis

The 1987 *Federal Water Policy* states, "scientific and socio-economic research, technological development, and data collection are essential tools for dealing with the increasing scope and complexity of the emerging water problem." Despite explicit statements about federal responsibilities, the lack of detailed and standardized data on Canadian water-use and the effects of conservation programs hinder water planners and researchers (Thompson 1994b: 210; Kassem and Tate 1994: 196; Brandes 2003: 28, 33, 34). Without sufficient data, for example, it is difficult to understand the local price elasticity of demand for water. Without the information on how consumers respond to price changes, it is difficult to predict revenues when considering DSM pricing programs. Water flows, ecological needs, and climate impacts are other areas that require more detailed and standardized data.

A nationally agreed-upon set of water use categories and definitions is necessary to achieve a common understanding of the data on water use in Canada. Data must be detailed enough to allow analysis for end use and conservation measures, and should enhance water demand forecasting. This data must also be accessible and readily available to all stakeholders through a central source. Standardized information collection and analysis is described as "fundamental to achieving the development and implementation" of water conservation strategies (Doyle 1994: 413). This is an important area where the federal government can take a clear leadership role.

6.4 Improved enforcement of federal legislation

The federal government has powerful legal tools at its disposal, including the *Fisheries Act* and the *Canadian Environmental Protection Act,* to protect aquatic ecosystems from infrastructure expansions, excessive withdrawals and polluting discharges. The enforcement of such legislation, however, is severely lacking. During the 1990s, Canadian communities spent significant funds to upgrade sewage treatment facilities, but many communities still discharge raw or inadequately treated sewage into receiving waters with little consequence (Boyd 2003: 237-240). "Charges are rarely laid against municipalities, which like foreign diplomats, seem to be immune from prosecution" (Boyd 2003: 35).

Two recent prosecutions, *R. v. Dawson City* and *R. v. Iqaluit* affirm that increasing enforcement of existing laws can motivate improved sewage treatment. In these cases, convictions under the *Fisheries Act* are changing current practices.

These recent cases demonstrate that courts are indeed willing to protect the environment. Even the federal government admits, "legislation and regulation are only as good as their enforcement," yet most governments in Canada fail to properly enforce the environmental legislation that already exists (Boyd 2003: 237). This general lack of enforcement is well documented (Boyd (2003), Friends of the Earth (2001), Sierra Legal Defence Fund (2001), Christie (2000), Benidickson (2002)). Even Parliament's Standing Committee on Environment and Sustainable Development concluded in 1998, "Environment Canada and indeed some provinces are not enforcing environmental laws when they could and should. This failure to act is of deep concern."

Enforcing legislation like the *Fisheries Act* or *CEPA* more stringently would create strong incentives for municipalities to raise funds for improved sewage treatment. When faced with the option of more expensive treatment, municipalities could be motivated to decrease wastewater production and, consequently, decrease water use. In Whitehorse, Yukon, for example, the city was required to upgrade its sewage treatment to a secondary level, but initial cost estimates were well in excess of what the city could afford and/or what higher levels of government were willing to fund (Raines 1994: 408). In response, the city initiated a water conservation program designed to reduce per capita water use by almost 50%.

6.5 Linking or reducing infrastructure expansion grants

Linking infrastructure funding to demand management is a powerful tool that the federal government can use to engage and assist municipalities in water demand management. Federal grants[14] to upgrade and expand water and wastewater treatment facilities total billions of dollars annually. The government could create a significant incentive for provincial and municipal governments to integrate DSM into long-term water planning by making these grants contingent on DSM integration.

In certain regions, this mechanism is already being used to some degree. To be considered for infrastructure funding in B.C., for example, municipalities are required to submit water conservation plans with grant applications for water and wastewater infrastructure. In most areas of the country, however, funding is granted with little or no consideration of the potential for water conservation to eliminate or defer infrastructure expansion.

To effectively reorient funding programs toward demand management requires changes to the administration of infrastructure funding programs. This entails developing guidelines for both federal agencies and funding partners (the provinces and the FCM) to ensure that publicly funded infrastructure is subject to demand management planning.

Urban demand management plans must be comprehensive, exploring all opportunities to reduce demand in order to identify least-cost options. Detailed implementation schedules and performance-based criteria are critical to ensure that existing infrastructure is wisely used. Preparing DSM plans is an important first step; however, enforcement mechanisms will also be needed to provide incentives and ensure guidelines are followed and program objectives are met.

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[14] Including the Infrastructure Canada Program, the Canada Strategic Infrastructure Fund, the Green Municipal Investment Fund and Green Municipal Enabling Funds.

6.6 Future proofing

The federal government has the capacity to develop a longer-term perspective than most local governments. The potential for long-term forecasting allows the government to promote options and measures that may not have short-term paybacks. Research and development is an obvious example since technological innovation may create future solutions.

The federal government might also ensure that this type of "future proofing"[15] is undertaken. Water re-use and recycling are effective ways to reduce local water use, although in any particular location it may not be applicable in the short term. To make it economically feasible in the future, however, simple and relatively cheap pre-emptive actions could be undertaken now, such as promoting demonstration projects or providing incentives to install dual plumbing that will facilitate grey water re-use in future developments.

A simple way for the federal government to plan for the future is by looking to jurisdictions that are already water stressed, such as Israel, California and Australia. Understanding how such jurisdictions are overcoming current water issues will assist local activities in the future.

[15] Future proofing entails, not only designing buildings to be more efficient today, proofing against rising utility costs (such as energy or water), but also readying for tomorrow by investing in infrastructure to be used in the future. For example, water reuse and recycling may not yet be financially feasible; however, installing dual piping will facilitate future re-use and recycling efforts.

7 Provincial / territorial and municipal opportunities for action

The subsidiary principle states that water should be managed at the lowest appropriate level. Therefore, provincial and local governments have a responsibility to ensure that local organizations, civil society and the private sector are encouraged and empowered to implement locally viable, sustainable solutions.

7.1 Provincial / territorial

Regulating and administering fresh water use is primarily a provincial[16] responsibility under the Canadian Constitution. The ensuing regulatory and policy regime sets the context within which industry, municipalities, farmers, businesses, utilities, and consumers are able and motivated to initiate and adopt conservation options. Provinces and territories can influence water use in many ways. Specifically, they can encourage demand management by:

- Coordinating and promoting regional approaches
- Regulating and pricing withdrawals and discharges
- Empowering communities to undertake local demand management initiatives by providing resources, guidance and/or legislative authority
- Mandating efficiency requirements by amending plumbing codes
- Using financial incentives such as limiting supply infrastructure grants or attaching conservation conditions to any such grants

Other examples of ways provinces and territories can influence water use include:

- Actively enforcing existing laws and regulation
- Promoting full-cost accounting for municipalities and water utilities
- Enacting regulations and guidelines for reclamation and reuse
- Setting province- or territory-wide targets (such as a "zero-growth" infrastructure policy)
- Allocating grants specifically for DSM programs

Provinces and territories can also directly implement DSM measures themselves. Provincial education programs – targeting the general public, specific users or municipal councillors – could be established, for example. Also, provincial and territorial authorities could develop pilot projects and specific demonstration sites, and perform water audits and retrofit programs in government buildings and public housing.

The following is a selection of critical, immediate opportunities for action by provincial authorities to reduce water use and ensure water management is more sustainable.

[16] Although the federal government, specifically Indian and Northern Affairs Canada, has the overall responsibility for the management of water resources in the North, the *Northwest Territories Water Act*, the *Yukon Waters Act* and the *Nunavut Water Act* provide a unique framework for managing water resources, such as establishing a water board in each territory that is responsible for conservation, development, and use of water resources (Environment Canada 2003: 46).

7.1.1 Regulating and pricing withdrawals and discharges

Provinces generally require major water users, such as municipal water utilities, to obtain a licence or permit before withdrawing water (Fitzgibbon 1994: 164). This process allows users to withdraw (or "abstract") water from surface sources such as rivers and lakes or from underground. Included in this process is the eventual discharge of treated wastewater into receiving waters, which also serve as water sources. This current system of water allocation does little to either promote DSM directly or ensure that water resources are efficiently used.

Conservation pricing for withdrawals and discharges

In general, provincial licence fees for water are not set according to conservation pricing principles (Environment Canada 2003: 16). Often no fee is charged for water permits, as in Ontario, or fees are nominal and merely cover administration costs, as in British Columbia, Manitoba, Saskatchewan and Nova Scotia (Renzetti 2002; Dangerfield 1994: 50).

The lack of appropriate withdrawal charges is one of the primary causes of artificially low retail prices for water. These low prices create a chain of over-consumption, starting with primary users, such as industry, farmers and municipalities. Low withdrawal prices eventually result in water utilities overcapitalizing. The increased capacity to supply water associated with overcapitalization is an incentive for utilities to maintain low prices, which results in further over-consumption by individual consumers and end users. This form of subsidy distorts a host of water-use decisions down the water-use chain. Ultimately, "the inefficient price of the resource becomes embedded in the stock of industrial capital and in the design of municipal water utility systems" (Renzetti 2002: 495).

A more appropriate pricing system would ensure abstraction charges are reflective of local conditions. One option is for abstraction charges to consist of a flat rate *licensing fee* to cover administrative costs, an *availability charge* reflecting the capital and environmental cost of providing the supply, and an *actual charge* based on the volume of water withdrawn (Watson 1997: 230). A similar pricing approach could also apply to the discharge of treated wastewater into receiving waters, whereby users would be charged fees based on both the quantity and quality of the discharge (i.e. concentration of pollutants). Integrating wastewater charges into pricing creates more incentives for conservation.

Another benefit of this type of pricing system is the generation of additional provincial or territorial revenue. This revenue could be used to pay for conservation efforts on a province- or territory-wide basis, to restore damaged aquatic ecosystems and to help fund local DSM programs. Ensuring a revenue-neutral approach could be useful for increasing political acceptability of the program.

7.1.2 Mandatory efficiency requirements

Requiring the installation of efficient indoor fixtures in all new construction and major renovations is an important way to reduce residential indoor water use. Such mandatory requirements are common in the U.S. In 1989, Massachusetts was the first state to require ultra-low-volume toilets. This type of requirement now applies across the U.S. due to federal regulation and is proving to be a valuable component in a comprehensive demand management strategy (Vickers 2001: 17; Doyle 1994: 413).

Canada, Ontario and B.C. have included some efficiency requirements in their plumbing codes (Dangerfield 1994: 47; Sharratt et. al. 1994: 82, 83; Mitchell and Shrubsole 1997: 19). The *Ontario Plumbing Code,* which applies to all renovations (with permits) and new construction, creates increasingly strict conservation requirements over time. Efficient faucets (max 8.4 lpm) and showerheads (max 9.8 lpm) were required after January 1993; low-volume toilets (max 13.2 lpf) were required after August 1993; and ultra-low-volume toilets (max 5.9 lpf) were required after January 1996. The City of Toronto estimates that total water demand for the period of 1996 to 2011 will be reduced by 62 million litres per day based on these building code changes alone (City of Toronto 2002: 37).

Mandatory measures from other sectors can also be adapted and applied to the water sector. In some jurisdictions, for example, legislated thresholds require automobile manufacturers to guarantee that a minimum percentage of vehicle sales meet designated standards for low or no emissions (Boyd 3002: 316). Similar requirements could be applied to manufacturers of fixtures and other water use technologies such as irrigation systems. Another example is the Danish requirement that industry implement any energy-efficiency measures that pay for themselves within four years through reduced energy costs (Boyd 2003: 332). Again, such requirements could be adapted for application to water use efficiencies in Canada.

7.2 Municipal & egional

Local governments, operating under provincial legislation, deliver water services to most Canadians. Despite regional variations, water utilities operating at the municipal level generally play the key role in water provision, wastewater treatment, stormwater management and price setting. In addition, they are often the primary implementers of water demand management programs.

Regional water authorities, where they exist, also have an important role to play in those urban centres. In such cases, regional authorities act as wholesalers, treating and delivering water to member municipalities who in turn act as retailers, delivering water to end-users such as homes, businesses and local industries. Coordination is required to determine whether the regional authority, the individual municipalities, or both should plan and implement conservation measures. A regional authority might develop and distribute educational materials and provide technical and financial assistance to member municipalities undertaking leak detection and repair programs; and a member municipality might determine its own retail conservation pricing structure.

Planning involves anticipating the future and organizing activities in response. Planning for conservation can help water systems catalogue their existing efforts, refine their efforts to ensure maximum benefits, and identify new opportunities to reduce water use. Ultimately, planning can help utilities and local jurisdictions manage rising costs and competing goals, such as increasing water quality requirements, infrastructure needs, the effects of climate change, and future population and demand growth.

7.2.1 Conservation Planning

Conservation planning can be beneficial to all water providers, not just those with impending infrastructure expansion projects. Even areas that consider supplies plentiful and have adequate infrastructure capacity may find that conservation planning helps use existing resources more efficiently and may save money over the long term, potentially deferring future capital projects indefinitely.

Many communities in Canada have already implemented some DSM measures. The majority of communities, however, apply them only incrementally and not usually as part of a long-term planning process. They usually begin with low-cost and politically acceptable measures such as public education and watering restrictions (Water Conservation Strategy for B.C. 1998: 26, 30). This approach is unlikely to result in long-lasting or substantial water savings. Instead, a comprehensive, long-term and integrated planning process is required to fully reap the benefits of DSM.

Box 9: Key principles and steps in developing a successful water supply and conservation plan

Planning principles	• Integrated management i.e. include consideration of all related resources and services, including water, wastewater, and energy. • Stakeholder participation i.e. include all stakeholders during DSM planning. • Focus on underlying services i.e. focus on providing services such as bathing and sanitation rather than water provision *per se*. By keeping the true objective in focus, creative alternatives may appear.
Planning steps	• Demand management study Predicts future water and wastewater demands and infrastructure requirements, and so determines where to focus conservation efforts. • Identify goals Specific conservation goals can help focus a planning process, provide guidance and a benchmark for evaluation. • Inventory of options From a comprehensive study of available DSM measures and supply-side options, create an initial list of feasible combinations. • Cost-benefit analysis Compare and assess the various combinations. • Water conservation and supply plan Develop a blueprint for action. • Implementation and evaluation Evaluation is critical to determine the impacts of the program and necessary changes on a continuous basis.
Sources: (Vickers 1994: 94,95; CRM 1996: 8-16; Water Conservation Strategy for B.C. 1998: 31; Opitz and Dziegielewski 1998; Vickers 2001: 2-4,405-407)	

8 Summary and Action Plan

Federal leadership is needed to ensure that Canada's water resources are protected and managed in a sustainable manner. Although the direct jurisdiction of the federal government is limited, it still has an important role promoting urban water sustainability by enabling provinces and local governments to implement DSM.

Box 10 is a detailed action plan that summarizes many of the opportunities outlined in this discussion. Similar action plans exist for provincial and municipal governments.[17]

Box 10: Federal DSM Action Plan

- ***Ensure sufficient capacity exists within the federal government to administer and implement federal water policies***

Implementation requires resources. If the federal government wishes to maintain even a modest presence in the water sector, Environment Canada must focus some of its energies on re-building capacity and institutional know how. They can begin by assessing and implementing relevant portions of past federal water initiatives, in particular the 1987 Federal Water Policy.

- ***Create a National Water Commission for the 21st Century***

Such an entity will provide guidance, direction and coordination on the appropriate role of government in addressing national and international water resource protection and emerging water management issues. An interim option is to create a water use efficiency task force to consider options and coordinate efforts. This would include representation from all levels of government and from multiple departments (such as environment, energy, municipal affairs, public works, and education), professional and industry associations, citizen groups and NGOs.

- ***Improve data standardization, collection and analysis***

Such data should include: water end use, water source health, ecological flow requirements, and water savings associated with conservation measures. This will further the understanding of Canadian water use and the potential for conservation. This can include improving the MUD database or further development of Canadian models and computer simulation packages for disaggregated demand and revenue forecasting under conservation measures.

- ***Develop and update guidelines, such as model plumbing codes and model re-use/reclamation regulations, to assist lower levels of government.***

Although these guidelines are not binding, they can provide valuable guidance to local and provincial authorities when attempting to implement regional initiatives.

- ***Improve certification of water-efficient technology and develop and promote mandatory labelling regulations.***

Such regulations and certifications allow citizens and consumers to make informed decisions, and will promote the adoption of innovative conservation-focused alternatives.

- ***Improve the enforcement of federal legislation related to urban water use.***

By simply enforcing existing laws, many municipalities and other primary users will have incentives to conserve by finding appropriate local solutions.

- ***Review all federal subsidies to the water industry***.

Changing granting processes to local governments, such as adding DSM encouragements or requirements to grants and/or shifting grant monies away from infrastructure expansions and towards DSM programs, is a powerful lever for change. By limiting subsidies, the federal government can promote full cost accounting for water utilities.

- ***Continue to lead by example, implementing DSM measures in all government facilities, and use government procurement programs to improve the market for efficient technology.***

By demonstrating the importance of water conservation and the potential for innovative solutions, governments can help create a lasting "water ethic" in its citizens.

[17] See "The Future in Every Drop", a forthcoming report to be released by The POLIS Project on Ecological Governance at the University of Victoria.

Box 10 and Box 13 propose a blueprint for comprehensive action and implementation in Canada. It emphasizes some of the key opportunities for all levels of government, and provides policy direction. It is intended to promote dialogue for ***developing water sustainability through urban water demand management***

Box 10: Matrix of federal action to implement demand management in Canada

Action	Primary Benefit	Specific Example	Expense	Priority	Primary Impediment	Key Department(s)
Implement Federal Water Policy	Creates a comprehensive national approach to water management in Canada	1987 Federal Water Policy	**Low** – update Pearse Inquiry and Existing Policy	**High**	Competing priorities	Environment Canada
Develop water management capacity	Provides expertise and leadership in government	National Water Commission	**Varies –** depending on level of commitment	**Med**	Competing priorities	Environment Canada, Natural Resources Canada, and Infrastructure Canada
Guidelines and standards	Provides guidance and information for lower levels of government	National plumbing code	**Low**	**Med**	Lack of priority	CMHC and National Research Council
Gather and provide information and data	Provides indicators of long-term trends on the state of water resources	StatsCan general water withdrawal statistical series	**Low**	**High**	Lack of capacity	Environment Canada, StatsCan, Provincial Ministries
Enforcement of existing legislation	Provides direct incentives for environmental protection and synergistic incentives for water conservation	*Fisheries Act, CEPA*	**Revenue neutral** – additional expenses would potentially be offset by increased penalties	**Med**	Lack of political will	DFO and Environment Canada
Linking grants for funding infrastructure to demand management	Increases efficiency and ensures least-cost options are used	Proposed NRTEE Transportation and Energy DSM	**Revenue neutral**	**Very High**	None	Infrastructure Canada
Future proofing	Creates innovation for solutions of future problems	Demonstration projects	**Varies**	**Low**	Funding	CMHC

Box 13: Matrix of provincial and municipal action to implement demand management in Canada

Action	Primary Benefit	Specific Example	Expense	Priority	Primary Impediment	Key Department(s)
Provincial Action:						
Regulate and price freshwater withdrawals	Promotes full cost accounting	Australia, U.S. and Europe	**Revenue neutral** – may even provide revenue similar to stumpage fees in forestry	**High**	Lack of political will	Provincial Ministry of Environment (or equivalent)
Mandating efficiency requirements	Ensures future developments will incorporate efficient fixtures	Amending provincial plumbing codes	**Low**	**High**	Distrust of existing water efficient technology	Relevant provincial authorities
Municipal Action:						
Conservation planning	Promotes least-cost options for meeting water needs	U.S. Environmental Protection Act	**Revenue neutral** – cost will be offset by savings from deferred infrastructure expansion	**High**	Lack of comprehensive, integrated and long-term DSM capacity	Water utilities and municipal government
Build demand management capacity	Provides indicators of long-term trends on the state of water resources	Hire permanent DSM staff	**Revenue neutral** – cost will be offset by savings from deferred infrastructure expansion and operating costs	**High**	Supply-side management bias	Water utilities and municipal government
Full cost, volume-based retail pricing (with lifeline minimums)	Provides incentives for all urban water users efficiency	Some examples exist, however, better models are needed	**Revenue neutral** – once issues such as over-capitalization have been addressed	**High**	Historically low prices and a current belief in an over abundance of water	Water utilities and municipal government

9 Appendices

Appendix 1: Ecological Integrity

As an emerging concept, a universally accepted definition of ecological integrity is elusive. However, as the concept is becoming increasingly common in the field of ecology and in broader discussions of sustainability, both scientists and policy-makers are working toward a workable definition.

The notion of wholeness is central to the concept of ecological integrity. As Angermeier and Karr (1994) note, "Integrity implies an unimpaired condition or the quality or state of being complete or undivided; it implies correspondence with some original condition." In this context, ecological integrity is generally used to describe the overall condition of an ecosystem relative to that of a natural or undisturbed system. This includes both biotic components, such as plant and animal life, and abiotic components, such as geological structure and hydrological processes. Rather than focusing on individual species or processes, ecological integrity reflects the broader structures (e.g. assemblages of plants, landforms) and functions (e.g. sediment transport, energy flow, hydrologic variation) in an ecosystem.

Ecological integrity is seen as an overarching term that encompasses ecosystem features such as resilience, elasticity and stress response that allow ecosystems to maintain function and structure under changing environmental conditions (Higgs, 2003: 122). Kay and Schneider (1994: 7) note that for an ecosystem to have integrity it must have the ability to operate under normal environmental conditions, cope with changes in environmental conditions (stress), and continue to evolve and develop (persist) in light of these stresses.

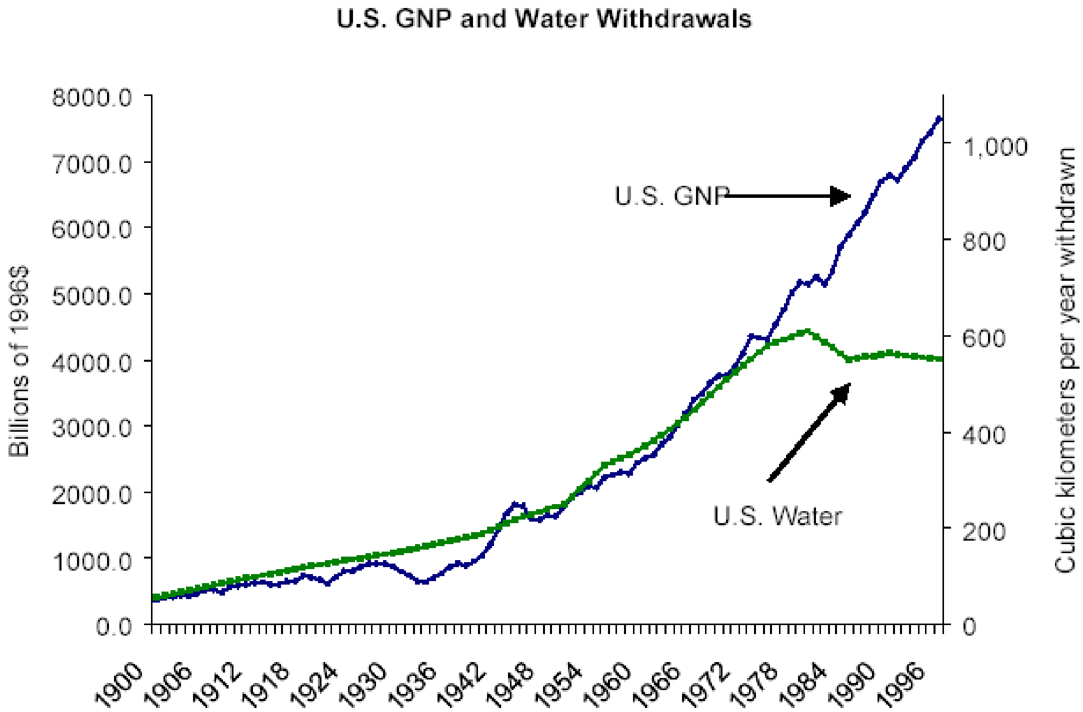
Examples of more technical definitions include:

> "the condition of an ecosystem where the structure and function of the ecosystem are unimpaired by stresses induced by human activity, and the ecosystem's biological diversity and supporting processes are likely to persist" - *Parks Canada*
>
> "An ecosystem has integrity when it is deemed characteristic for its natural region, including the composition and abundance of native species and biological communities, rates of change and supporting processes. Ecosystems have integrity when they have their native components (plants, animals and other organisms) and processes (such as growth and reproduction) intact." - *Panel on the Ecological Integrity of Canada's National Parks*

For further reading on ecological integrity see:

- Ecological Integrity and the Management of Ecosystems. 1993. S. Woodley, J. Kay, and G. Francis (Eds). St.Lucie Press.
- Ecological integrity: integrating environment, conservation, and health. 2000. D. Pimentel, L. Westra and R.F. Noss (Eds.) Island Press.

Appendix 2: Decoupling water withdrawals from the economy



Source: Testimony of Dr. Peter H. Gleick Before the Subcommittee on Water Resources and Environment Of the Committee on Transportation and Infrastructure United States Congress Hearing: Water: Is it the 'Oil' of the 21st Century? June 4, 2003.
Available at: http://www.pacinst.org/testimony/water_efficiency_testimony.pdf

Appendix 3: Services provided by freshwater ecosystems

Service	***Benefits***
Provision of water supplies	Greater than 99 percent of industrial, irrigation and residential water supplies worldwide come from natural freshwater systems
Provision of food	Fish, shellfish and waterfowl are important food sources for people and wildlife
Water purification	Wetlands filter and break down pollutants, enhancing water quality
Flood mitigation	Functionally intact fresh water systems buffer stormwater flows, reducing flood damage
Drought mitigation	Functionally intact freshwater systems absorb rainwater, slow runoff and help recharge groundwater
Provision of habitat	Rivers, streams, floodplains and wetlands provide habitat and breeding sites for numerous aquatic, avian and terrestrial species
Soil fertility maintenance	Functional river-floodplain systems constantly renew the fertility of surrounding soils
Nutrient delivery	Freshwater systems store and transport nutrients within the watershed
Maintenance of coastal zones	Freshwater flows maintain the salinity gradients that are critical to the biological diversity and productivity of deltas and coastal marine environments
Aesthetic/cultural values	Natural freshwater systems are sources of inspiration and deep cultural and spiritual values
Recreational opportunities	Swimming, fishing, hunting, boating, wildlife viewing, etc.
Hydropower generation	Flowing freshwater ecosystems provide opportunities for both conventional hydro power generation and more ecologically sound micro-hydro options
Biodiversity conservation	Freshwater and riparian ecosystems harbour diverse assemblages of species that support many of the services in this table and also conserve genetic diversity for future generations

Adapted from: Postel and Richter, 2003; Moss et al, 2003

Appendix 4: Ecosystem requirements for freshwater

Environmental flows[18]

The concept of environmental flows emerged in response to the proliferation of large-scale water developments throughout North America during the mid-20th century. At the most basic level, environmental flows entails leaving some portion of a stream or river's flow *in situ* to manage the condition of an ecosystem (Brown and King, 2003: 11).

Environmental flow assessment (EFA) is the process of determining how much of the original flow of a river or stream is left to flow onto its floodplain and into connected lake or marine ecosystems, and how this flow is to be a managed to support economic activities and environmental objectives. A recent review identifies some 207 methodologies, recorded in 44 countries, for assessing environmental flow requirements (Tharme, 2003: 397). In addition to a growing body of literature in academic journals, a number of books and edited volumes on the topic have been published over the past decade. See below for further reading on environmental flows and EFA methodologies.

Early approaches for assessing and setting environmental flows focused on establishing minimum flow requirements for a select group of economically and recreationally important aquatic species such as salmon or trout (Tharme, 2003: 401; Poff et al, 1997: 779; Dyson et al, 2003: 20). As a result, the prescription of single, flat-line minimum flows quickly became the norm in water resource development projects. Even as more sophisticated methods incorporating the interactions between flow and habitat maintenance have emerged, the application of EFA remains narrowly focused on sport and commercial fish species and the prescription of minimum flows (Annear et al, 2002: 4; Poff et al, 1997: 779).

Practically all EFA methods and models in use today are overly simplistic and fail to recognize the complex, dynamic nature of aquatic ecosystems (Richter, 1997: 232). However, over the past decade, pioneering efforts by South African and Australian scientists and water managers have led to the development of holistic methodologies for assessing environmental flows – so called because consideration is given to the entire ecosystem rather than selected species or particular ecosystem services. Holistic approaches seek to maintain or enhance the structure and function of aquatic ecosystems, relying on an understanding of the natural flow regime to guide infrastructure (i.e. dam) operation and place limits on water abstractions (Postel and Richter: 55; Dyson et al, 2003: 20).

Freshwater and ecosystem integrity

Five interconnected environmental drivers together regulate much of the structure and function of aquatic ecosystems. Each varies over a given range according to changes in climate and length of day. Focusing on any one single driver will not provide a true representation of ecosystem structure and function. Effectively assessing and managing human impacts on aquatic ecosystem integrity– from land use changes, to flow modifications, to pollution inputs – requires consideration of all of these factors in an integrated manner and on an ongoing basis (Baron et al, 2003: 4).

[18] Several terms are used to describe ecological flow requirements. These include instream flows, maintenance flows, conservation flows and minimum flows. "Environmental flows" is often viewed as the most comprehensive term, encompassing all components of aquatic ecosystem, their dynamic nature, the importance of natural flow variability, and social and economic considerations (Thompson, 1991: 158; Brown and King, 2003: 11).

Environmental drivers in freshwater ecosystems

1. The ***flow regime*** defines the rates and pathways by which rainfall and snowmelt enter and circulate within river channels, lakes, wetlands, and connecting groundwater, and also determines how long water is stored in these ecosystems.
2. ***Sediment and organic matter inputs*** provide raw materials that create physical habitat structure, refugia, substrates, and spawning grounds and supply and store nutrients that sustain aquatic plants and animals.
3. ***Temperature and light characteristics*** regulate the metabolic processes, activity levels, and productivity of aquatic organisms.
4. ***Chemical and nutrient conditions*** regulate pH, plant and animal productivity, and water quality.
5. The ***biotic assemblage*** (plants and animals) influences ecosystem process rates and community structure.

The natural flow regime

A growing body of scientific knowledge indicates that the natural variability of freshwater flows, including both flood and drought events, is critical to maintaining the ecological functions and biological diversity of freshwater ecosystems (Poff *et al*, 1997; Baron *et al*, 2003; Richter *et al*, 2003). Indeed, flow regime is now regarded as a 'master variable' that drives many other ecosystem processes (Richter *et al*, 2003: 207; Poff *et al*, 1997: 769).

Under natural conditions, flow regime varies over space and time according to local climatic conditions and surrounding landscape structure. Temporally, flow may vary on an hourly, daily, inter-annual and intra-annual and basis. Spatially, this fluctuation in flow influences the degree of river and stream channel inundation, lake levels and groundwater and wetland recharge. The ecological structure and function of streams and rivers is regulated by five critical components of the flow regime (Poff et al, 1997: 770):

- **Magnitude** - the amount of water moving past a fixed location at any given time
- **Frequency** - how often a flow of a given magnitude is observed over a given time interval
- **Duration** - the period of time associated with specific flow conditions
- **Timing** - the regularity with which a given flow condition occurs (e.g. annual peak flows)
- **Rate of change** - how quickly a flow changes from one condition to the next

Together, these components describe the variable flow conditions for aquatic ecosystems. Each of these flow conditions has a unique influence on the integrity of river and stream ecosystems and related lake, wetland and groundwater systems.

Aquatic ecosystems and species have evolved according to the rhythms of natural flow variability (Baron et al, 2003: 3). This natural variability, however, is precisely what traditional water resource management sets out to avert. Indeed, the focus of water management over the past century has been on dampening natural flow dynamics to ensure reliable water supplies and control of downstream flooding (Richter *et al*, 2003: 207).

The cumulative impacts of flow modification and the myriad other human disturbances on freshwater systems result in marked changes in ecosystem processes. If flow regimes are altered beyond critical limits, the ecological integrity and self-sustaining productivity of aquatic ecosystems become severely compromised (Poff *et al*, 1997: 770; Richter *et al*, 2003: 207). This in turn compromises the ability of ecosystems to provide goods and services vital to human health and economies such as storage and purification of water for drinking water supply, as well as fisheries production and flood mitigation.

Natural flow conditions

Flow level	**Ecological Roles**
Low (base) flows	• Define whether the river flows year-round or only in the wet season <u>Normal low flows:</u> • Provide habitat for aquatic species • Maintain suitable water temperature, dissolved oxygen concentrations and water chemistry • Maintain water table levels in floodplain providing soil moisture of riparian vegetation • Provide drinking water for terrestrial animals • Keep fish and amphibian eggs suspended • Enable fish to migrate to spawning and feeding areas Drought level flow flows: • Enable recruitment of certain floodplain plants • Purge invasive/introduced species from aquatic and riparian communities • Concentrate prey to the benefit of predators
Higher flows (Small floods)	• Shape physical character of river/stream channel • Determine size of stream/riverbed substrate • Control encroachment of riparian vegetation into channel • Restore water quality conditions following prolonged low flow conditions, flushing away wastes and pollutants • Aerate eggs in spawning gravels • Maintain suitable salinity in estuaries
Large floods	• Provide migration and spawning cues for fish • Trigger new life cycle phases (e.g. for insects) • Provide habitat for spawning and juvenile fish • Provide feeding opportunities for fish, waterfowl • Recharge wetlands, groundwater • Control distribution and abundance of plants on floodplain • Deposit nutrients in floodplain • Shape physical habitat of floodplain • Purge invasive/introduced species from aquatic and riparian communities

Further reading on ecosystem needs for water

Rivers for Life: Managing Water for People and Nature

Sandra Postel and Brian Richter. 2003. Island Press.

Rivers for Life explains why restoring and preserving natural river flows are key to sustaining freshwater biodiversity and healthy river systems, and describes innovative policies, scientific approaches, and management reforms for achieving these goals.

Instream Flows for Riverine Resources Stewardship

Tom Annear *et al*. 2002. The Instream Flow Council.

Instream Flows stresses the importance of addressing instream flow issues within the legal and institutional constraints of states and provinces. It includes descriptions and critical opinions of 29 instream flow methods.

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Various authors. 2003. Canadian Water Resources Association.

This Special Issue of the CWRJ contains 11 articles concerning "State-of-the-Art in Habitat Modelling and Conservation of Flows."

Water Resources and Environment, Technical Note C. 1: Environmental Flows: Concepts and Methods

Catherine Brown and Jacqueline King (Authors). 2003. The World Bank.

First in a series of four edited by Richard Davis and Rafik Hirji, this publication introduces concepts and methods for determining environmental flow requirements for rivers. The full technical series focuses on the direct effects of flow on the ecological functioning of rivers and the management of water quantity.

Flow: The Essentials of Environmental Flows

Megan Dyson, Ger Bergkamp & John Scanlon, eds. 2003. IUCN.

This 'hands on' guidebook explains what needs to be done to restore environmental flows to river and groundwater systems, including technical, scientific, financial and policy considerations.

"Instream flow methods: A comparison of approaches."

I.G. Jowett. 1997. In *Regulated Rivers: Research & Management*, Vol. 13, pp. 115-127.

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Appendix 5 – Barriers impeding widespread adoption of DSM in Canada

Attitudinal Barriers

A number of commonly held beliefs or attitudes in Canada impede the move to demand management:

Myth of superabundance: Many Canadians perceive that Canada has so much freshwater that no significant water problem does or could exist (Mitchell and Shrubsole 1997: 1). Clearly, this is not the case. This faulty perception likely arises from a confusion between 'renewable water supply' (net amount), which is the precipitation that falls and then flows towards the sea, and the 'total water' (gross amount), which is the renewable water plus the stock of fresh water contained in lakes and 'fossil' aquifers (Sprague 2003: 28). Beyond this initial confusion, a second concern is that only a small portion of the potentially available 'renewable water supply' is actually accessible without significantly impacting on hydrological process and the health of the natural system. This is an important myth to overcome, but it will likely take considerable educational efforts to do so.

The Myth of Superabundance

"… [I]f we waste our resources, we could soon find ourselves facing the same problems as nations which lack our quantity or quality of water. This vision of inefficient water use is something quite frankly which can be a pretty difficult 'sell'. A major challenge exists to convince Canadians that their water use is a problem. I remember when I was in primary school being taught that Canada had the largest proportion of freshwater in the world. We should not underestimate the effort required to counteract this myth of water abundance."

Jean Charest, then federal Minister of the Environment, at the 'Every Drop Counts' conference in 1994

Human economy and human-built infrastructure considered separate from the environment: The construction of new large scale water developments, such as dams and diversions, has slowed in recent years in North America, but there remains a persistent view that the human economy and human-built infrastructure is separate from the environment and can continue to grow independently from it (Wolff and Gleick 2002: 5,6). In North America, growth and the associated increases in water demand tends to be "equated with goodness" (Sims 1978: 253). This view has led to major disruptions in ecological services such as the natural availability of clean water.

Slowly replacing this view is the recognition that human-built infrastructure is embedded within a natural ecological 'infrastructure'. This natural infrastructure includes wetlands, streams, vegetation and animal life that cleans, stores and utilizes water in productive ways, and provides other human uses such as fishing, swimming, and tourism. As Bocking explains, "we cannot pretend that natural systems are plumbing networks that can be endlessly manipulated by humans" (Maas 2003: 7). Recognition of all the benefits associated with this natural infrastructure provides the foundation for a shift to demand management. These benefits should be specifically incorporated into modern watershed management and integrated planning processes.

Ideal of free market society without government intrusion: Demand management can be considered an unacceptable government intrusion. This intrusion is viewed as a form of social engineering, which offends the notion of a free market society (Sims 1978: 253,254). This concern is misplaced. Supply side developments are themselves usually the result of vast government subsidies and artificially low water prices (Wolff and Gleick 2002: 28). In contrast, a number of DSM pricing measures actually remove these types of government intrusion by promoting full cost recovery rather than public subsidies.

Additionally, many DSM measures are not mandatory but voluntary, relying on educational or financial incentives. Although some DSM programs may include a degree of government intrusion, they are generally mild and proactive in nature, especially compared to the more severe impositions that would otherwise be required in the future, such as outright watering bans or expensive remediation projects.

Belief that reduced water use imposes a reduced standard of living: A belief exists that reducing water use somehow means a loss of prosperity, whether it is a loss of economic growth in the industrial sector or a reduction in the standard of living in the residential sector (Wolff and Gleick 2002: 23,28). As discussed in section 2.1, evidence suggests otherwise – economic growth is not dependent on increasing water use.

Demand management may actually promote economic growth. Evidence from the energy sector demonstrates demand management approaches provide more jobs than capital-intensive supply-side approaches by, for example, stimulating small businesses that retrofit residences or re-landscape gardens and lawns (Brooks, 1978). Many aspects of the water sector are analogous to the energy sector, and one would expect demand-side options to increase small-scale economic activity in the water sector.

Similarly, current domestic standards of living need not require current high levels of water use. In the residential sector, comparisons between Canadian cities show a fourfold variance in water use between communities with similar standards of living (Brandes 2003: 12,27). Comparable European cities generally use less than half the water used in Canadian cities.

Many water efficient fixtures and appliances, such as showerheads, washing machines and low flow toilets use significantly less water but work just as well or better than older less efficient models. As summarized by Environment Canada, "water conservation doesn't mean cramping lifestyles by doing without: it simply means reducing the amount of water we waste" (Environment Canada 1990: 4).

Concern that demand management savings are unreliable and/or insubstantial: A common belief is that DSM measures are only effective at producing temporary water savings. However, where appropriate planning processes are undertaken, demand management can produce long term, reliable water savings of 20-30% per capita in most North American cities without any sacrifice in economic output or quality of life (Foerstel 1994: 70; Gates 1994: 325; Postel 1994: 14; Vickers 2001: xvi).

Overcapitalization refers to overly large infrastructure projects, such as reservoirs and a diversion project, compared to what is needed, or at least would be needed if demand were reasonably estimated (Wolff and Gleick 2002: 9, 30; Platt and Morrill 1997: 283). Overcapitalization results from overestimated future water demands because of the belief that water demand is relatively independent of other factors, such as technology, prices, and public awareness (Gleick et al. 2003: 18).

Political preference for high visibility projects: Supply-side projects such as dams, reservoirs and pipelines are highly visible. Such developments often create positive media exposure for the politicians and decision makers responsible, despite the long-term negative cost-benefit ratio. In contrast, demand management is often less visible. From a politician's perspective, there are simply no votes in higher water prices or low volume toilets, but cutting ribbons on large infrastructure makes for good media optics. Only by better informing the public of the consequences of such decisions and creating an ethic of sustainability will politicians opt for the less visible path. A substantial effort is required to cast demand management in a progressive light that engages politicians on its merits.

Financial Barriers

A number of financial barriers impede the adoption of DSM.

Subsidies and low pricing: Current municipal water rates in Canada – the retail price to end users – are among the lowest in the world. One of the primary drivers of these low prices is subsidies (FCM 2001: 37). Additionally, the most common pricing structure in Canada is the 'flat rate' where users pay a fixed amount regardless of how much water they actually use. In contrast, 'volume-based' pricing charges customers according to individual volume used. Low prices and flat rate structures encourage high demand, which results in overcapitalization to meet that demand, and fosters an attitude of water as a free and abundant with little need for conservation. This situation also hinders the adoption of efficient technologies since cheap water makes these technologies less cost effective. In addition, a cavalier attitude toward water use reduces the incentive to adopt cutting edge conservation oriented alternatives.

Similarly, water utilities generally do not pay on a volume basis for the water they withdraw or for the discharges they return. The result is another type of subsidy that also contributes to low retail prices.

Need for predictable and stable revenues: Water utilities need to maintain predictable and stable revenues. The belief is that efficiency improvements are relatively risky compared to more reliable and proven supply side approaches (Wolff and Gleick 2002: 11).

Some DSM programs have failed to achieve their target savings and savings have sometimes been unreliable. For example, price increases sometimes lead to initial reductions in demand, but demand gradually increases over time (Loudon 1994b: 252). Such problems, however, are not inherent to the demand management approach; the real issue is a proper planning and implementing of DSM programs.

Of course, demand management measures do have an element of risk, such as predicting the results of voluntary incentive measures, but these risks are likely no more, and in some cases less than, uncertainties associated with supply side measures (Wolff and Gleick 2002: 11, 12).

In fact, many DSM programs allow future demand to be more accurately predicted by reducing the variability of water use for each end use. Predicting total water use for toilet flushing is more difficult when toilets of widely differing volumes are used. Where DSM programs lead to widespread use low-volume alternatives, more accurate predictions are possible (RMI 1991: 8). DSM measures that lessen peak demands, such as outdoor efficiency programs, can also improve the stability of revenues throughout the year (Vickers 2001: 151).

Need to maintain sufficient revenues in the face of overcapitalization: For utilities that are overcapitalized and operate under debt burdens from previous infrastructure expansions, a 'conservation conundrum' exists (Tate 1990: 20). The utility must service its debt and cover operating costs with the revenues it receives from billing customers. However, undertaking a DSM program that reduces water demand will (assuming volume-based pricing is in effect) decrease the utility's revenues. Furthermore, operating costs for water utilities are relatively inelastic relative to demand, meaning that such costs decrease little even if demand decreases substantially. In this case, the utility's revenue will be reduced, but it will still have the same debt servicing and about the same operating costs as before. In this light, water conservation may not seem an attractive proposition.

The best option, of course, is to avoid such burdensome overcapitalization in the first place. Alternatively, DSM measures can be used to reduce per capita water use by an amount that merely offsets increasing demand associated with rising populations. In this case, total water demand and therefore total revenue can remain steady[19], allowing future infrastructure expansions to be avoided. To promote this type of situation, future federal and provincial infrastructure grant programs should be firmly tied to DSM, and rigorous design assessments should be conducted to avoid overcapitalization.

Another option to address this revenue stability issue is ensuring that some of the benefits from conservation flow to the utility. In Ontario, the energy sector has experimented with this option by adjusting the rate of return allowed for the utility to the proportion of energy that is saved. This cost adjustment places the utility in a cost-neutral position between DSM and supply-side options, removing the disincentive of reduced revenue associated with conservation. Similar models could easily be adapted to the water sector.

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[19] This situation is termed a 'steady state' or 'zero growth' policy.

Lack of funding for DSM: Lack of funds and appropriate staff are constraining DSM (de Loë 2001: 70). DSM programs require sufficient budgets for staff and planning, and generally have substantial up-front implementation costs. Research by Tate (1997: 53) and Jackson (1994: 116) demonstrates that water conservation programs can have high cost-benefit ratios, in some cases exceeding 1:15. In some areas, for every dollar spent on DSM, three dollars are saved in capital expansion costs. Utilities and all levels of government therefore require increased upfront funding for DSM.

Gap in payback period: An important consideration when comparing demand and supply side options is the 'payback gap'. The payback gap is the difference between the payback periods required by utilities and by end-users (RMI 1991: 72). Utilities often make supply investments which may not be paid back for 20 years or more. In contrast, a homeowner or renter investing their own money in an efficiency improvement will typically want their cost repaid within a year or so, or they may not undertake it due to poor information, 'hassle factor', limited capital, or perceived risk. Similarly, industrial, commercial and institutional users often look for payback periods of less than two years, even though this time frame represents a return on investment of 45% or more.

As a result of such payback gaps, society as a whole misallocates large amounts of capital (i.e. we buy too little efficiency and too much supply). This 'payback gap' can be corrected if a utility uses the same investment criteria for demand management as they do for supply side projects. Whenever such efficiency costs less than supply expansions, investing in improved efficiency for their customers through giveaways and rebate or loan programs will then correct the 'payback gap'.

Data and Informational Barriers

A lack of coordinated data collection, analysis, and dissemination limits the shift to demand management in Canada. This information gap leads to a variety of concerns.

Wariness about DSM by decision-makers: Better information on the implications of demand management is needed to convince political decision-makers that risks are manageable. Better information can also alleviate concerns about municipal liability for promoting particular DSM retrofit technologies (Gates 1994: 340).

Lack of information about water savings associated with particular measures and how these savings will affect the revenues and effectiveness of particular technologies has meant that conservation specialists in Canada rely on assumptions or conventional wisdom derived largely from US case studies (Gates 1994: 334). These case studies may only have limited application in Canada. Canadian governments, water utilities, industries, and professional organizations should be undertaking such studies in this country to resolve this information gap.

Lack of Comprehensive Cost/Benefit Models: Saving water typically also saves energy and reduces wastewater, but decision-makers rarely consider these 'indirect' or secondary dollar savings. Current cost-benefit models used to assess infrastructure options lack sufficient sophistication, and do not account for the potential benefits of more integrated systems (FCM 2001: 37). For example, the costs of wastewater collection, treatment and disposal are often the same as, or greater than, costs related to potable water supply.

Reduction in the needed supply (unless used for outdoor purposes) saves on operational and eventually capital costs at the wastewater end. Most cost comparisons of demand side and supply side measures neglect this additional benefit (Brooks 2004). While some models begin to address some of these concerns, improved modeling tools that better reflect conditions in Canada are needed to help predict the full impact of DSM.

Ineffective DSM programs: Accurate data on water use and the impact of DSM measures, such as cost savings for households, are essential to encourage the participation of water users. This data can improve the design of conservation efforts and assist in assessing existing DSM programs. Collectively, this information will improve future DSM program design (Foerstel 1994: 66). Additionally, more information on local ecological impacts of municipal water use, both current and long term, and under various climate change scenarios, will improve the effectiveness of local education campaigns. In particular, information on the merits of DSM needs to be prepared for a range of clients including businesses, industry, politicians, community groups and homeowners. Equally important is stakeholder access to this common data and information.

Administrative Barriers

Administrative barriers are often structural in nature, and significantly impede progress on DSM.

Fragmented administration: Water resource management in Canada has been characterized as "a bewilderingly complex administrative galaxy", (Dangerfield 1994: 43; Fitzgibbon 1994: 167). Although it is recognized that water should be managed on an integrated ecosystem basis, in reality management is divided among different levels of government and between different agencies within any given level government (Shrubsole 2001: 3). Given this vertical and horizontal fragmentation of responsibility for water management, coordinating activities among the various agencies requires energy and time.

Some fragmentation is inevitable as surface and groundwater often cross political boundaries. Particular difficulties are encountered in areas where two-tiered municipalities exist, such as where a regional authority supplies wholesale water to member municipalities. The varying internal structures, information systems, and policies of such authorities can impede communication and information sharing (Maas 2003: 26). This disconnect poses a significant barrier to integrated and comprehensive conservation efforts.

Municipal and provincial levels of government are also often unable to coordinate their efforts effectively. For example, some municipalities and regional water agencies have requested building code changes to mandate the use of water efficient fixtures. These requests, however, are generally not given priority by the provincial authorities who posses the relevant jurisdiction (Maas 2003: 26). Furthermore, the vertical organization typical of most provincial bureaucracies limits communication among the various ministries responsible for infrastructure funding programs, environmental quality and public health, impeding the effectiveness of many comprehensive demand management efforts.

Often demand management requires action at multiple levels of government. Many DSM measures that promote water reuse or that affect wastewater flows have implications for multiple departments. Thus to overcome fragmented water resource management regimes, it is necessary to integrate the activities of different departments in the planning of DSM programs, and for coordination between different levels of government.

Centralized engineering bias: The historical focus of water management has been on works and physical infrastructure; and engineers often dominate water utilities. An engineering approach is most accustomed to meeting undifferentiated demands through large, centralized supply side options (Wolff and Gleick 2002: 5, 9, 15, 16; Platt and Morrill 1997: 284). In contrast, demand management shifts the primary burden from engineering logistics to less familiar social strategies, which may be resisted by traditional water managers (RMI 1991: 7).

Demand management relies on the direct participation of individual water users, and requires investments on individual premises. The water provider must consider this type of investment just as valid as centralized supply investments. Typically, large engineering firms "continue to do most of the thinking and planning with respect to urban water systems" and it is "uncommon for major engineering firms to consider even physical DSM solutions…let alone educational and economic tools…" "Venturing into the institutional and education realm is often difficult for managers who have been trained exclusively in engineering aspects of municipal water supply" (Maas 2003: 25). To address many of these concerns requires different professional skills and training, as outlined in the next section.

Formulaic thinking: Engineering and other water management disciplines are usually focussed on design methods that optimize components in isolation, and focus on single rather than multiple benefits (FCM 2001: 36). For example, calculating optimal construction and flow requirements relative to a set projected demand is relatively uncomplicated.

This formulaic approach is often preferred because it provides straightforward and clear solutions. However, it resists more integrated options like demand management because the benefits are more difficult to isolate and calculate. For example, demand management benefits are achieved in various aspects of water provision, such as energy savings, wastewater reductions, reduced chemicals for treatment, and lower capital costs associated with less infrastructure. Naturally, ecological impacts are also an important consideration and, collectively, these benefits can be difficult to determine.

Inflexible Policies: Many policies and regulations prevent holistic approaches and on-site applications. Prescriptive policies that entrench the status quo and frustrate innovation, such as wastewater regulations that limit water reuse, do not embody the potential offered by new environmental technologies or the value of protecting ecological processes (FCM 2001: 36). Federal and provincial infrastructure programs require more flexibility to encourage the adoption of environmentally sustainable technologies and innovative 'closed-loop' processes.

Similarly, local land use policies (such as regional growth strategies that ignore local water source conditions) can facilitate unsustainable water use patterns when they promote initiatives like "big-lawn" suburban developments.

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