Thinking Beyond Pipes and Pumps

Top 10 Ways Communities Can Save Water and Money

POLIS Project on Ecological Governance
University of Victoria

By Oliver M Brandes, Tony Maas and Ellen Reynolds
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Beyond Pipes and Pumps—A new water infrastructure

Thinking Beyond Pipes and Pumps presents an expanded definition of urban water infrastructure—one that goes beyond the existing physical infrastructure of pipes, pumps and reservoirs. This new infrastructure includes innovative physical components, water sensitive urban design and conservation programs designed to complement existing water supply networks. It emphasizes decentralized technologies and lasting local programs that inspire behavioural change. Most importantly, this new infrastructure relies heavily on building and maintaining "social infrastructure"—the planning processes, education programs, and financial and human resources needed to liberate the full potential of water efficiency and conservation, and to foster sustainable water use at the community level.

By developing such an infrastructure, water management shifts its focus beyond expensive, expansive and ecologically damaging physical infrastructure, toward dramatically increased water productivity. In this context, increasing water efficiency and conservation is more than just the right thing to do. It is the only way to address the dual goals of meeting human water demands and sustaining aquatic ecosystem health—foundations of lasting water security.

From research to action

Thinking Beyond Pipes and Pumps is intended to inspire and facilitate action. Based on three years of research by the Water Sustainability team at the University of Victoria's POLIS Project on Ecological Governance, this handbook integrates leading thinking on water conservation and sustainable water management. It is a practical resource designed for community leaders, water managers and policy makers seeking to make the case for, and promote, a comprehensive and long-term approach to water demand-side management. By illustrating the potential of this approach, it urges communities to take water security to the next step—to look "beyond the pipes and pumps" and develop new ways of managing water that offer opportunities for big savings, of both water *and* money.

WATER SECURITY

Water security means access to adequate quantities of water, of acceptable quality for human and environmental uses … Water security for the protection of wetlands, aquatic ecosystems, and biodiversity is fundamental—not only for the well-being of these natural systems but also for human systems.

Source: Kreutzwiser, R. and R. de Loë. *Water Security: From Exports to Contamination of Local Water Supplies.* In B. Mitchell (Ed.), (2004). *Resource and Environmental Management in Canada: Addressing Uncertainty* (3rd Ed.). Toronto: Oxford University Press. pp. 166-7.

DEMAND-SIDE MANAGEMENT

Demand-side Management (DSM), or demand management, is an approach that uses policies and measures to control or influence demand for a good, service or resource. Water demand management, as a comprehensive and long-term approach, seeks to improve overall water productivity and deliver water services matched to the needs of end users.

From the exclusively supply-side infrastructure of the Roman aqueduct and the modern dam...
Photo of Ruskin Dam: BC Hydro.

The handbook begins with The ***POLIS Top 10***—a list of immediate opportunities for communities to take action. The list includes standard water saving measures such as metering, volume-based pricing, education and fixture rebates, along with more cutting-edge strategies such as rainwater harvesting, reuse and recycling, community-based social marketing and urban (re)design for water conservation. The *POLIS Top 10* includes valuable experiences from communities that have started down this path and are already capitalizing on innovative thinking, technologies and institutions.

Each of the *Top 10* represents an opportunity for individuals, utilities and, most importantly, communities to save water *and* money. Together, they represent a suite of actions that can be tailored to create made-at-home water management approaches on a community-by-community basis.

The second portion of the handbook establishes the context and rationale for why a new approach to urban water management is not only possible, but desperately needed. It

...to the "new infrastructure" of decentralized technologies, water conservation and healthy ecosystems.
Photo (far left): UBC Design Centre for Sustainability.

Makes the Case—from both business and ecological perspectives—for integrating water efficiency and conservation into daily activities in Canadian communities. It points ***Toward Solutions*** by emphasizing the power of managing water demand as a core element of sustainable water management. And finally, it ***Looks to the Future*** of water management and presents a living example of a community-level project at the vanguard of 21st century urban planning.

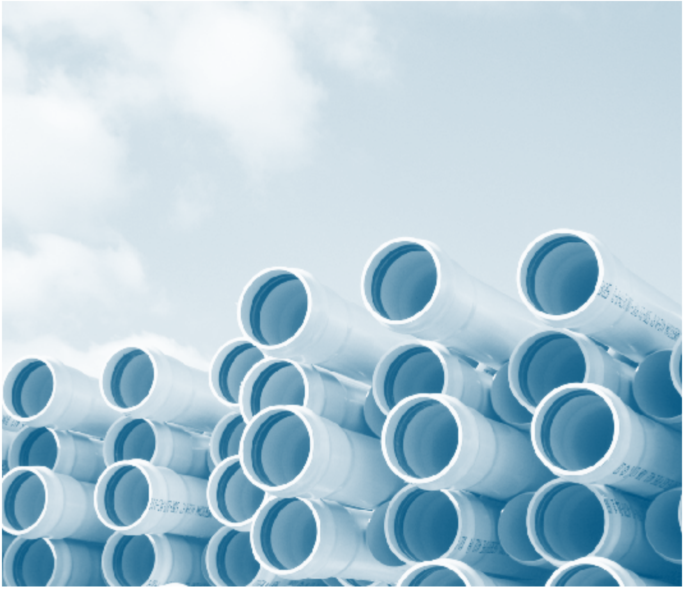
Efficiency vs. Conservation

Efficiency is a *means*, and conservation an *end*. In most cases, efficiency will allow for some conservation, but it may also serve as permission to consume. Take, for example, lawn watering: significant efficiency gains are possible with the use of low-flow sprinklers, but with more and more lawns to water, such measures simply amount to a "better way" of doing something we should not be doing in the first place. A water conservation approach questions the underlying assumption that turf-grass is the only good and desirable form of landscaping, and by doing so, opens the door to creating landscapes that require only minimal irrigation or none at all. A comprehensive approach then combines efficiency and conservation to initiate a shift in both practice and behaviour.

Efficiency is about doing things a better way. Conservation is about doing different things—such as Xeriscaping. Photo: Abkhazi Garden, Victoria, BC.

Source: Brandes, O.M. and D.B. Brooks. (2006). The Soft Path for Water: A Social Approach to the Physical Problem of Achieving Sustainable Water Management. *HORIZONS*, 9(1), p. 73.

The POLIS Top 10 — Ways communities can save water and money



Recognizing the local nature of water management challenges—that context is (almost) everything—the *Top 10* identifies critical components of any truly comprehensive water conservation program. The list is non-hierarchical—it is not in order of priority, but rather a top 10 where all the "hits" are winners.

The full potential of the *Top 10* lies in strategic integration of the many complementary and synergistic options. For example, as water prices increase and volume-based pricing encourages conservation, efficient fixtures, reuse technologies and rainwater harvesting become significantly more cost-effective and desirable. So, while specifics may vary from place to place, the general concepts of each strategy can be integrated to create an effective water conservation program for just about any community.

Each of the *Top 10* meets the following basic criteria:

- technically feasible;
- broadly applicable;
- socially acceptable; and,
- cost-effective compared to infrastructure expansion.

Presented in a quick-reference format, each *Top 10* "hit" includes a summary, key considerations and opportunities for implementation, at least one example where the practice has been put into action, and suggested first steps for utilities and local governments. Additional resources are also listed for each of the *Top 10* to assist communities as they adapt the approaches to suit local needs.

10. Fix the leaks! Reduce waste

Waste is the bane of any water utility. Leaks—or "real water losses"—are the most troubling element of what water efficiency experts call non-revenue water. Other elements of non-revenue water include "unbilled authorized consumption" for services like fire fighting, main flushing and street cleaning, and "apparent water losses" such as unauthorized consumption (i.e. theft) and metering and billing inaccuracies.[1]

According to Environment Canada, an average of 13% of municipal water is unaccounted for.[2] However, as a performance indicator, percentages are misleading because they are totally dependent on user consumption levels; percentages represent the portion of total water demand that is "non-revenue" but say nothing of the *actual volume*. The International Water Association (IWA) has developed a new approach based on their Standard Water Balance model and Infrastructure Leakage Index (ILI). The former categorizes water uses into standardized categories; the latter provides new, more representative, performance indicators. The ILI is a ratio of a community's current actual level of real water losses to the unavoidable level of real losses. In other words, it compares current real water losses to a technically achievable minimum (i.e. best practice).[3]

Wasted water also amounts to lost revenue, undermining a utility's financial viability. Leaks may also lead to infiltration of water into sewers, hampering performance and adding to operational costs for waste- and stormwater systems.

End-use leakage is also an issue—one that costs both customers and water purveyors. While many utilities use pamphlets and bill "stuffers" urging customers to check for and fix leaks, this does not mean they are actually dealt with. Indeed, leaking toilets and faucets are not uncommon occurrences in homes, office buildings and businesses.[4] All of this waste is literally money down the drain.

Leak detection & repair

In industry, leak detection and repair is common practice. Even considering the costs of repairs, it just makes sense; wasting inputs and losing output is simply bad for business. The same can be said for municipal water systems. Why pay for treatment and distribution only to let high quality water seep into the ground or trickle away?

PROBLEM:

Leaks result in significant water loss, often due to ageing infrastructure.

SOLUTION:

Detect and repair leaks by integrating regular water audits and maintenance programs.

CHALLENGES:

The financial strain on utilities of up-front costs for integrated metering programs, detection, maintenance and monitoring.

SAVINGS:

Fixing leaks can easily result in 5% to 10% water savings—upwards of 30% is possible in systems with older infrastructure.

Water audits are used to detect leaks in distribution systems and at the end of the pipe. In municipalities without water meters, system leaks are often only discovered and dealt with when water reaches the surface or property is damaged. This passive detection and reactive repair can amount to huge water losses and significant financial costs.

Environment Canada estimates that Canadian communities are losing an average of 13% of municipal water to leaks and various unmetered uses.

Metering, monitoring & maintenance

An integrated metering program that combines metering at water treatment plants with zone (i.e. neighbourhood, building complex, subdivision or campus) and end-use metering can greatly improve leak detection. More sophisticated sonic leak detection, which makes use of sound equipment to pinpoint the location of leaks, is increasingly common.

Home or end user water audits, along with preventative maintenance programs, save customers money and free-up municipal infrastructure capacity. Utilities can ensure that routine inspection and maintenance of water fixtures become everyday practices. For households, initial water savings of around 5% have been regularly reported as a result of audits.[5] For institutional, commercial and industrial (ICI) customers, audits may be more complex, but the pay-offs in both water and financial savings are also larger. To reap the long-term benefits of such pay-offs, either in home or industry, communities need to make an initial investment in implementation.

Long-term programs = long-term savings

At the system level, leak detection and repair programs may be designed and conducted by in-house staff or outsourced to a private partner. Implementation is relatively simple, requiring little or no involvement of end users. End-use leak detection is more challenging because it requires customer participation. The key to success is to make a strong public case and to provide leak detection and repair packages with information on financial savings, detection kits and repair tips. Social marketing can take this a step further, sending utility staff members door-to-door to help customers understand and fix problems. In either case, capitalizing on long-term savings requires utilities to commit staff and financial resources for ongoing programs that are built into annual budgets.

Fixing leaks in Halifax, Nova Scotia

The Halifax Regional Water Commission (HRWC) took a new approach to reducing leaks in its water distribution systems. The Commission adopted the International Water Association (IWA) methodology—the first North American utility to do so—that uses an integrated approach to water loss control. Using noise-mapping surveys and a computerized monitoring system to detect leaks allows the HRWC to pinpoint problems and immediately dispatch crews to the area. Between 1998 and 2004, the HRWC reduced water leakages in the Dartmouth and Halifax systems by 27 million litres of water a day, a cost saving of $500,000 annually.[6]

…and in Las Vegas, Nevada

The Las Vegas Valley Water District (LVVWD) monitors leaks with an underground sounding system that includes over 8000 detection units. Between January 2004 and December 2005, the system identified 540 leaks including a number of sub-surface leaks that may not have otherwise been found. The approach is estimated to save 353,224 cubic metres (93,312,000 gallons) of water per month. The total cost for replacing, treating and distributing the lost water was estimated at over US$2.2 million. The up-front cost of the equipment was US$2.15 million, with an annual operating cost of US$626,000. Comparing these figures to the cost of replacing, treating and distributing the same amount of water, the program paid for itself in less than three years.[7]

First Steps…

Utilities:

- Develop a comprehensive leak detection and system maintenance program.
- Develop a plan to implement integrated metering.

Local government:

- Require periodic water system efficiency reviews or audits.
- Revise budgets to earmark sufficient financial resources for ongoing leak detection and maintenance programs.

Resources:

AWWA Waterwiser Web site – Water Loss Control. Available at: www.awwa.org/WaterWiser/waterloss/.

AWWA Water Loss Control Committee. (2003). Applying worldwide BMPs in water loss control. AWWA Journal, 95(8) pp. 65-79.

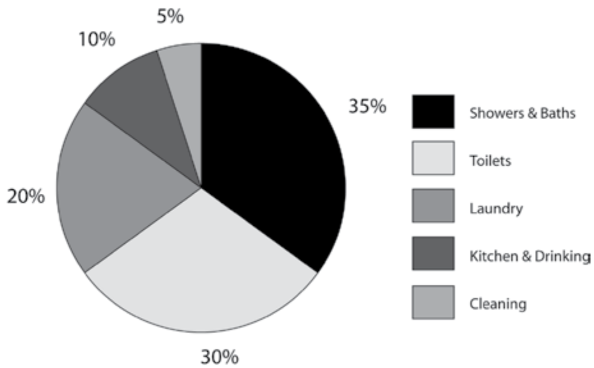
International Water Association (IWA). (2005). Leakage 2005: Water Loss Task Force Conference. Proceedings available at: www.leakage2005.com.

InfraGuide: National Guide to Sustainable Municipal Infrastructure. Available at: www.infraguide.ca.

9. Stop flushing the future

Canadian urbanites are among the most profligate water users in the world. According to recent data, Canadians use 335 litres per capita per day[8] in and around the home, and trends suggest that because of increasing population and urbanization, total residential water use has been rising in Canada for many years.[9]

Residential indoor water use



Source: Environment Canada Freshwater Web site (Accessed August 2006). Available at: www.ec.gc.ca/water/images/manage/effic/a6f7e.htm.

Residential (or domestic) water use includes all water used within and around our homes—for everything from drinking and cooking to flushing toilets and hosing down driveways. One of the main reasons for high indoor water use is that most homes are equipped with inefficient fixtures and appliances.

Household appliances such as high-efficiency laundry machines also have the potential for big water and energy savings.
Photo: R. Ruzzier

PROBLEM:

Inefficient fixtures and appliances are common in most homes.

SOLUTION:

Install efficient toilets, faucets and showerheads and water-saving dishwashers and washing machines that provide the same services using less water (and energy).

CHALLENGES:

Permissive building and plumbing codes, and a lack of incentives and resources to promote efficient technologies.

SAVINGS:

Efficient fixtures and appliances can result in indoor water savings of 33% to 50% with payback periods under two years in many cases.

Installing efficiency

Technological improvements over the past 20 years mean that we can now enjoy the same quality and reliability of service we are accustomed to, but using far less water. Table 1 outlines some of the water and energy savings associated with the "magic five" of indoor water savings—toilets, showers, faucets, laundry machines and dishwashers.

Table 1 - The 'magic five' of indoor water savings

End use	Model	Water use	Water & Energy Savings[i]
Toilet	Ultra-low-flow	6 litres per flush	Water: 30-80 lcd
	High Efficiency Toilets (HETs) use 20% less than ULFs and are usually dual flush or pressure assist models	Less than 4.8 litres per flush	Water: 24-64 lcd
	Composting	Negligible	Water: 60-110 lcd
Showerhead	Low-flow	9.5 litres per minute	Water: 10-40 lcd Energy: 0.4-1.8 kWh/cd
Faucet	Low-flow	9.5 litres per minute	Water 6-40 lcd Energy: 0.4-0.8 kWh/cd
Laundry Machine	High-efficiency	60-102 litres per load	Water: 17-40 lcd Energy: 0.5-1.0 kWh/cd
Dishwasher	High-efficiency	26.5 litres per load	Water: 1-3 lcd Energy: 0.4-1.4 kWh/cd

Source: Vickers, A. (2001). *Handbook of Water Use and Conservation: Homes, Landscapes, Businesses, Industries, Farms*. Amherst, Massachusetts: WaterPlow Press. pp. 115-126.

Toilets offer the greatest potential for indoor water savings. Conventional models use 13 litres per flush (lpf), with older models using 20 or more. By contrast, Ultra Low Flush (ULF) models use only 6 lpf, and newer High Efficiency Toilets (HETs) have average flush volumes of less than 4.8 litres and provide similar (and in some cases better) performance at comparable prices.[10]

Older showers and faucets are also big water wasters. Efficient models of both have proven performance records and are readily available at costs comparable to conventional models. Efficient showerheads also save energy and reduce heating costs. So, a new $10 showerhead can save a household around $10 to $15 in water and $20 to $50 in energy costs per year.[11]

Combined impacts are where the real savings become apparent. Installing a 6 lpf toilet, an efficient showerhead and a faucet aerator is estimated to reduce indoor water use by about 35%, representing a potential 30% total reduction of in- and outdoor water use in a typical household.[12]

Household appliances such as laundry machines and dishwashers also have the potential for big efficiency gains. Replacing conventional laundry machines with high efficiency models, such as front loaders, can reduce water demand per load from a range of 148 to 212 litres down to 60 to 102 litres (i.e. using less than half the amount of water). Front loaders work more efficiently by tumbling clothes on a horizontal axis through a smaller pool of water than more common top loading machines. Similar efficiency gains are

[i] Lcd = litres per capita per day; kWh/cd = kilowatt-hours per capita per day.

Dual flush models are considered High Efficiency Toilets (HETs) and typically use 6 litres per flush for the full flush and 4.2 litres or less for the reduced flush (on average less than 4.8 litres per flush). Photo: E. Reynolds.

possible with water-saving dishwashers, which are competitively priced compared to less efficient models, but use only a fraction of the water.

Incentives for end users

Getting these water-, energy- and money-saving technologies off the shelf and into use is often the greatest challenge. In some cases, this happens naturally as older, inefficient models break down or fall out of fashion. However, for most of the technologies discussed above, brand new inefficient models are still readily available, so the trick is to get the most efficient ones—not just any new ones—into action.

Fixture give-aways can be economically feasible. Low-flow showerheads are the best example of a relatively inexpensive fixture that results in significant water savings. Showerheads and faucet aerators are often included in free water efficiency kits offered by municipalities.

For more expensive technologies such as toilets and washing machines, financial incentives may be required to encourage replacement of water wasting models. Rebates, which typically range from $40 to $150 per unit, shorten the payback period and increase the penetration of water-efficient models. In the same way, pricing changes—discussed in depth later—are also powerful financial incentives to get water-efficient technologies off the shelf and into use.

Making it law

Other more direct options help ensure that only water-saving technologies are used, including legal tools such as by-laws and building and plumbing codes to restrict the use of inefficient models. Ontario's building code, for example, stipulates that toilets in all new housing must use 6 litres or less per flush to pass inspection.

Innovative legal tools have been introduced in some areas requiring homes to undergo water fixture inspections and replacement on resale. Before a real estate deal can be finalized in parts of the United States, sellers must have their properties inspected to ensure that fixtures—toilets, showerheads and faucets—meet water efficiency standards.

Installing efficiency in Alberta & British Columbia

Many successful examples of fixture replacements exist, some encompassing entire communities. For example, Cochrane, Alberta, reduced water consumption by 15% and deferred a multi-million dollar pipeline by giving away toilet dams, low-flow showerheads and faucet aerators.[13] Others like the Sylvia Hotel, in Vancouver, BC, target high-use sectors or customers. This 90-year-old, 120-room hotel replaced toilets, showers, urinals and installed aerators. The result was a 47% reduction in water use, not to mention the added benefit of increased customer satisfaction.[14]

Recently, the Sunshine Coast Regional District (SCRD) in BC began an aggressive Bathroom Fixture Replacement Program in partnership with the fixture manufacturer Caroma. Residents of Sechelt, Gibsons and other SCRD communities can swap up to two of their 13+ litre toilets for dual flush toilets and receive low-flow showerheads and faucet aerators all professionally installed free of charge (a $500 value). By the end of 2006, 1400 households in the district will have fixture replacements in up to two bathrooms per household.[15]

First steps…

Utilities:

- Develop and implement cost-effective fixture replacement programs, such as shower and faucet giveaways, and toilet and appliance rebates.

Local government:

- Enact by-laws that require tested and approved high performance water-saving technologies in new buildings or renovations requiring a permit.
- Enact by-laws requiring home water audits and retrofits with every house resale.

Resources:

Canada Mortgage and Housing Corporation (CMHC). (2000). *Household Guide to Water Efficiency: Homes, Landscapes, Businesses, Industries, Farms.*

Canadian Mortgage and Housing Corporation (CMHC). *Dual flush Toilet Testing. Technical Series 02-124*. Available at: www.cmhc.ca.

Vickers, A. (2001). *Handbook of Water Use and Conservation.* Amherst, MA: WaterPlow Press.

Water Wiser – The Water Efficiency Clearinghouse Web site: www.waterwiser.org.

Veritec Consulting Inc. & Koeller and Company. (2006). *Maximum Performance (MaP) Testing of Popular Toilet Models. (7th Ed.)*. Available at: www.cwwa.ca.

8. Make managing demand part of daily business

When planning water supply projects such as raising dams, expanding distribution systems and upgrading treatment facilities, municipalities turn to engineering and construction professionals—the right people for the job. In the same way, effective demand-side management (DSM) programs require staff with the right skills. What often happens, however, is that program design and administration gets tacked onto the responsibilities of municipal water engineers—not necessarily the right people for the job. As noted by Rob de Loë, Canadian Research Chair in Water Governance, "Venturing into the institutional and educational realm is often difficult for managers who have been trained exclusively in engineering aspects of municipal water supply."[16]

To realize the full potential of water efficiency and conservation, managing demand must become part of daily business. Yet despite growing popularity, in most municipalities demand management programs are still viewed and treated as stop-gap measures designed to buy the time needed to increase supply. This often results in ad hoc programs that are understaffed and under-funded, and that eventually under perform.

Advantages of dedicated DSM staff

Conservation staff can:

- reduce water use more effectively through improved planning and implementation of long-term DSM programs;
- design, implement and enforce water rationing programs in periods of drought, or when water demands threaten to exceed available supply;
- build relationships with the community and help guide the planning and implementation of DSM programs that require citizen participation;
- monitor and adapt DSM programs over the long term;
- gather and analyze information about local patterns of water use.

Source: Brandes, O.M. and K. Ferguson (2004). *The Future in Every Drop: The benefits, barriers, and practice of urban water demand management in Canada.* Victoria, BC: The POLIS Project on Ecological Governance at the University of Victoria. p. 25. Available at: www.waterdsm.org

PROBLEM:

Current approaches to demand management are often not comprehensive enough, and are rarely part of daily business in most communities.

SOLUTION:

Implement permanent water conservation programs and hire permanent staff with technical skills and understanding in fields such as economics, psychology and education.

CHALLENGES:

For utilities to commit the financial and institutional resources to hire demand management professionals and create long-term (10 years or more) water conservation programs.

SAVINGS:

The sky is the limit, based on the aggressiveness and creativity of the programs.

DSM programs & professionals

Making demand management part of everyday business means developing the capacity to design and implement long-term, comprehensive programs. In the modern information and knowledge economy, good water infrastructure is as much about the tangible as the intangible. Pipes, pumps, concrete and steel are critical parts of our urban water system, but so are the programs and initiatives that manage water demand.

Managing water demand involves a complexity that differs from supply-side management and projects, and requires professionals with specific training, skills and resources. Traditional disciplines of water management—primarily engineering and the natural sciences—are important to maintain safe, reliable urban water infrastructure. However, to effectively manage the demand on infrastructure requires an expanded disciplinary perspective. Demand management professionals draw heavily on the social sciences, integrating expertise from economics, psychology, sociology and education.

Investing in such professionals is critical to effective urban water management in the 21st century. Programs that promote water conservation and begin to instil a lasting water ethic require dedicated human and financial resources to develop.

Money, resources & commitment

Finding the financial resources to hire staff and maintain such programs is often the biggest challenge, particularly for smaller communities. Many innovative financing opportunities exist—from taxes on water use to changes in water fee structures and special levies on developers or industrial users. For smaller communities, creating regional DSM staff positions supported by the provincial or federal government may also be an option.

Despite the initial cost, it is important to remember that creating dedicated demand management positions will translate into significant financial benefits. Hiring people to cut demand now reduces future operating costs and the expense of infrastructure expansion. Over the longer term, municipalities could finance such positions through the cost savings they achieve. For example, the campus sustainability office at the University of British Columbia (UBC) is operated on money saved through energy and water savings—an approach that could be adapted to municipalities to support water conservation positions.

The Capital Regional District in Victoria, BC, is emerging as a regional water conservation leader with its efforts to make demand management part of everyday business.

Dedicated DSM professionals in Calgary, Alberta

Responding to a booming population and a limited water supply, water managers in the city of Calgary have developed one of Canada's most elaborate water efficiency programs that includes six staff members supported by communication and customer service personnel. Initiatives target residential, commercial and civic water use and range from educational campaigns to technology rebate programs to repairing leaks in city water mains. The program takes a broad-based approach, with elements designed to foster change both in the water system and in social behaviour. Programs fall under seven theme areas: leading by example; aligning policy with conservation objectives; source substitution; technology retrofit and incentives; providing technical assistance; developing a water ethic; and community outreach.[17]

First steps…

Utilities:

- Create permanent DSM staff positions that are integrated with utility operations, finance and planning departments, and strategic decision making.

Local government:

- Promote the benefits of managing demand as a core part of day-to-day water management.
- Provide financial and staff support to utilities to encourage a long-term commitment to water conservation programs at the community level.

Resources

W.O. Maddaus and L.A. Maddaus. (2006). *Water Conservation Programs – A Planning Manual.* AWWA Manual of Water Supply Practice – M52. Denver, CO: American Water Works Association.

Brandes, O.M. and K. Ferguson (2004). *The Future in Every Drop: The benefits, barriers, and practice of urban water demand management in Canada.* Victoria, BC: The POLIS Project on Ecological Governance at the University of Victoria.

The POLIS Project on Ecological Governance – Water Sustainability Project Web site: www.waterdsm.org.

InfraGuide: National Guide to Sustainable Municipal Infrastructure. Available at: www.infraguide.ca.

7. Link conservation to development

"What we do on the land shows up in the water" is a common adage in watershed planning. Threats to water quality come immediately to mind, such as agricultural chemicals running off the land or urban pollutants finding their way into the water system. Equally concerning are the impacts of development on the water cycle—on how much water is used, and on the size and capacity of urban water infrastructure. Yet the connection between urban design and water use receives little attention in development and infrastructure planning. As a result, few financial incentives exist to ensure that water conservation is considered as *part of* urban development or infrastructure upgrade and repair.

Linking conservation to funding & permits

Linking funding for development to demand management is a sure-fire way to encourage conservation. Communities can apply innovative "water offset" by-laws to building permits, requiring proof that any additional water demand resulting from new development is off-set by reducing water use in existing homes (or businesses) with water efficiency measures. This helps to ensure that all "new" water is tapped from conservation and that growing communities stabilize their "water footprint" and acknowledge that limits to growth do exist.

Infrastructure funding provides another opportunity to promote conservation. Availability of capital, in the form of funding transfers from senior governments to municipalities, is a driving force in all infrastructure investment decisions. The process for assessing grants, along with contingencies placed on their approval, can provide strong incentives for conservation—and can simultaneously eliminate current disincentives or perverse supply-side subsidies. Federal and provincial grants for upgrading water and sewage treatment infrastructure represent substantial sums of money. The motivation for communities to conserve water would increase significantly if these funds were allocated only when applicants show proof of an acceptable level of action on demand management. This is currently the practice in British Columbia.

Implementing & enforcing incentives

The main challenge in levering infrastructure funding to promote water conservation is to ensure that senior governments consistently implement and enforce conditions. Agencies that provide and administer funding for major infrastructure projects could

PROBLEM:

The current process for funding urban water infrastructure does not promote conservation and innovation.

SOLUTION:

Link conservation to development by making water infrastructure funding and development permits contingent on demand management planning and action.

CHALLENGES:

Local resistance to conditional funds or permits; enforcement and follow-up on conditional funding agreements to ensure implementation.

SAVINGS:

Water savings of 20% to 30% can be readily achieved in many communities using off-the-shelf technologies and modest water pricing reforms.

Dockside Green development in Victoria, BC, is becoming a global showcase for large-scale sustainable development. Illustration: Dockside Green Ltd.

enforce conditional water conservation plans by withholding future funds until conservation efforts are demonstrated. In response, municipalities can offer regulatory support and incentives such as tax benefits or administrative streamlining for cutting-edge developments that result in conservation activities in other parts of the community.

Taking this approach a step further, rather than making infrastructure funding *contingent on* demand management, senior governments could earmark funding or offer low-interest loans *specifically for* demand management programs. A revenue-neutral approach for provincial and territorial governments is to simultaneously reduce grants for infrastructure expansion while increasing grants for demand management programs.

Conservation incentives in California

In Morro Bay, California, builders are required either to pay a standard hook-up fee for new developments, or to retrofit existing houses to the point that the reduction in water use matches the water requirements of the new development.[18]

First Steps...

Local government:

- Require that all new developments and retrofits of existing buildings and homes make use of the best available water conservation technologies.

Senior government:

- Change the eligibility requirements for infrastructure funding to make it contingent on achieving specific water conservation goals.
- Establish funding specifically for comprehensive and integrated demand management programs.

Resources:

POLIS Project and Friends of the Earth Canada. (2004). *Federal Fiscal Policies to Link Infrastructure Funds to Water Demand Management Programs.* Briefing note to the Prime Minister of Canada, March 2004. Available at: www.waterdsm.org

Environmental Protection Agency (EPA) – Water Conservation Plan Guidelines. Available at: www.epa.gov

6. Price it right

Canadians rank among the world's highest per capita water users, which is not surprising given that municipal water rates rank among the lowest of all developed countries.[19] Low water prices encourage wasteful use, artificially increase demand and provide little incentive for efficiency improvements. This pricing problem also leads to overcapitalization of water systems—an inefficient use of scarce public funds.

In almost all cases, Canadian water rates fail to reflect environmental costs, and in many cases, rates do not even reflect the full financial costs of providing the service. Although "full costs" are ultimately paid one way or another—most commonly through property and business taxes—shifting the full costs into water prices encourages conservation by revealing the cost to customers. An easy way to better reflect the full costs in water pricing—and to promote conservation—is to include sewage fees in water bills.

Better water pricing

The problem is not only with the price of water, but also with pricing structures. Recent research suggests that water demand is equally sensitive to changes in pricing structures and changes to water prices.[20] A set price or flat rate—common in approximately 40% of Canadian communities[21] —is considered to be the least effective pricing structure for reducing demand. Think of an all-you-can-eat buffet; once you pay your fee, you tend to over indulge. Flat-rate water pricing has a similar effect.

Under flat-rate structures—where the fee is independent of water use—end users consume significantly more than if they pay by the volume they use. This relationship is supported by compelling evidence: on average, those Canadians paying flat rates use 74% more water than those under volume-based structures.[22] Volume-based pricing can be made even more effective by increasing the price as the volume used increases.

Many experts believe that without correct price signals little chance exists to change behaviour.[23] Together, *the carrot* (water pricing that better reflects the full cost to the utility and society of providing the service) and *the stick* (price structures that penalize consumptive behaviour) are a foundation

PROBLEM:

Canada's current water prices and predominant pricing structures promote wasteful use and reduce cost effectiveness of water-efficient technologies.

SOLUTION:

Implement "full cost" prices with volume-based pricing structures that reflect the importance and value of water to promote conservation, and that ensure equitable access.

CHALLENGES:

To implement metering and gain political support to increase water prices and change pricing structures while ensuring full access to basic water needs.

SAVINGS:

Effective water pricing can result in upwards of 20% water savings over the long term and can create incentives for development of innovative conservation technologies and practices.

Table 2 - Conservation-oriented pricing

Approach	Description	Impact
Uniform rates	Price per unit is constant	Reduces average demand
Increasing block rates	Price per block increases as consumption increases	Reduces both average and peak demand by providing increasing incentive to reduce waste
Seasonal rates (for drought periods)	Prices during peak periods (e.g. summer) are higher	Sends stronger signal during period of peak demand or low water availability
Excess-use rates	Prices significantly higher for above-average use	Can target excessive users thus reducing peak demand
Indoor/outdoor rates	Prices for indoor uses are lower than are prices for outdoor uses	Reduces seasonal peak demand which is mainly from outdoor use and is considered more responsive to price changes
Feebates	High water users pay a premium that is distributed to those who use less	Promotes revenue neutrality and provides incentives by penalizing heavy users and rewarding low users

of any conservation program. Table 2 outlines a range of conservation-oriented pricing approaches and their impacts on managing water demand.

Installing meters, implementing change

Metering is essential for the adoption of any volume-based pricing structure. Some analysts report that metering alone, without any changes to pricing, can result in water use reductions of 10% to 40%.[24] However, without a corresponding shift to volume-based pricing, metering may not sustain this initial level of savings as water use often rebounds to varying degrees after the installation of meters.

The primary driver for creating a conservation-based rate system is to encourage efficiency and reduce water use. The goal need not be limited to recovering costs. Conservation-based pricing implies that prices should be high enough to promote behaviour change and the uptake of new technology. However, the importance of equitable access to water and revenue neutrality to secure political support for changes cannot be overstated. Equity can be addressed through *lifelines*—a structure that provides the first block of water at low or no cost to all consumers to ensure basic human water needs are met. Dealing with revenue neutrality requires a strategic plan, and the support of community leaders to put it into action.

Politics - The BIG challenge

Although managing a volume-based pricing system requires more administration, the biggest challenge is generating political support. Making the move to conservation-based pricing takes strong political leadership—a challenge because the benefits of cheap water are generally taken for granted, and the consequences of not changing pricing are easily ignored. The key is to achieve broad community support through education and available water conservation opportunities. For example, if water prices doubled, with volume-based pricing, implementing new technologies could cut demand in half and the customer's water bill would remain the same.

Volume- or conservation-based pricing may also result in less stable revenue streams for municipalities. While this is understandably unpopular, a variety of strategies can be used to compensate for the increased revenue uncertainty. Examples include regular rate reviews (i.e. fine tuning), contingency funds, and legal instruments requiring that excess revenue be invested in customer conservation technologies, or to offset future revenue shortfalls and reduce future rates.

Price drives innovation

Conservation-based pricing strategies also foster innovation and market transformation. Increasing the market for water-efficient technologies promotes further research and development and stimulates new industries to provide technological solutions. Indeed, it has been suggested that much of the technology required to achieve an "optimum state of conservation" may not be discovered unless the correct signals are provided through social institutions such as appropriate pricing.[25]

Metering is essential for the adoption of any volume-based pricing structure. Some analysts report that metering alone can result in water use reductions of 10% to 40%.

Changing water pricing is not a silver bullet solution. In fact, changing pricing without providing customers with guidance on how they can decrease their water use, and education about why such changes are needed, will likely be met by stiff opposition. That said, pricing measures are critical to comprehensive and integrated demand management programs.

Finding a better price

…**around the world:** The OECD found that metering combined with volume-based pricing was one of the most effective measures for water conservation, with water use reductions ranging from 20% in Copenhagen, Denmark and 33% in Gottenberg, Sweden, to 41% in Toowoomba, Australia, and 45% in Philadelphia, USA.[26]

…**in the United States:** Irvine Ranch Water District (IRWD) in California replaced its flat rate-per-unit charge with an increasing block-rate structure in 1991. IRWD's rate structure represents an aggressive approach to promoting conservation and has formed the foundation of a larger water conservation program linked with an existing water recycling and reuse program. In the six years following implementation of the rate structure, a 12% reduction in water use was observed for the residential water use customer group.[27]

…**and in Canada:** The SEKID (South East Kelowna Irrigation District) project near Kelowna in the Okanagan Basin, British Columbia, reduced agricultural water allotments by 27% per year over a five-year period through an increasing-block pricing system.[28]

First steps…

Utilities and local government:

- Work together to secure the political and financial support for universal metering and appropriate volume-based and equitable pricing structures suited to local conditions.

Senior government:

- Provide funding for universal metering.
- Provide research data and support to communities seeking to customize pricing structures to local conditions.

Resources:

InfraGuide: National Guide to Sustainable Municipal Infrastructure (2006). *Water and Sewer Rates: Full Cost Recovery*. Available at www.infraguide.ca/lib/db2file.asp?fileid=4903

Canadian Water and Wastewater Association. (1994). *Municipal Water and Wastewater Rate Manual.* Ottawa: CWWA. Available at: www.cwwa.ca.

Canadian Water and Wastewater Association. (1997). *Municipal Water and Wastewater Rates Primer.* Ottawa: CWWA. Available at: www.cwwa.ca.

Want, Y.D., W.J. Smith Jr. and J. Byrne. (2005). *Water Conservation-Oriented Rates: Strategies to Extend Supply, Promote Equity, and Meet Minimum Flow Levels.* American Water Works Association (AWWA).

The California Urban Water Conservation Council. (1997). *Designing, Evaluating and Implementing Conservation Rate Structures.*

5. Plan for sustainability

In most communities, demand management programs are developed on an incremental basis with little regard for long-term planning. The tendency is to start with low-cost and politically acceptable measures such as public information and watering restrictions. This short-term and ad hoc approach is the result of narrow planning time frames—usually 2 to 3 years—aligned with electoral cycles and established to develop political capital by demonstrating concrete results in a short period.

Reaching the full potential of water conservation requires comprehensive and long-term strategic planning. Indeed, in many cases, supply-side infrastructure expansion can be avoided through long-term demand management planning and strategic implementation.

Planning for sustainability

Planning for sustainability ensures that ecosystem health and water conservation are foundations of planning processes and outputs. Taking a comprehensive approach to planning can help water providers catalogue existing efforts, refine them to ensure maximum benefits, and identify new opportunities to reduce water use. Ultimately, planning can help utilities and local jurisdictions manage competing water-related goals, including implementing stringent water quality standards; meeting infrastructure needs; and mitigating the impacts of climate change, population growth, and the increasing demand for water.

Conventional water planning processes tend to isolate water managers—those who carry out the planning—from others such as industry representatives, homeowners and facility operators. But the tools of demand management—education, legal instruments, pricing and small-scale, decentralized technologies—require more interaction with end users than supply-side approaches. This makes demand management a prime candidate for collaboration. Stakeholder participation in both planning and implementation is critical to a successful demand management program. As Wallace et al. suggest, "The hope for achieving sustainability in water management lies in the establishment of interdependent, community-based partnerships and increased stakeholder involvement."[29]

PROBLEM:

Most water conservation programs are viewed as short-term efforts to buy time until the next water source can be found and developed.

SOLUTION:

Initiate strategic water planning that looks 10 to 50 years into a community's future, involves all stakeholders, and places ecological health at its core.

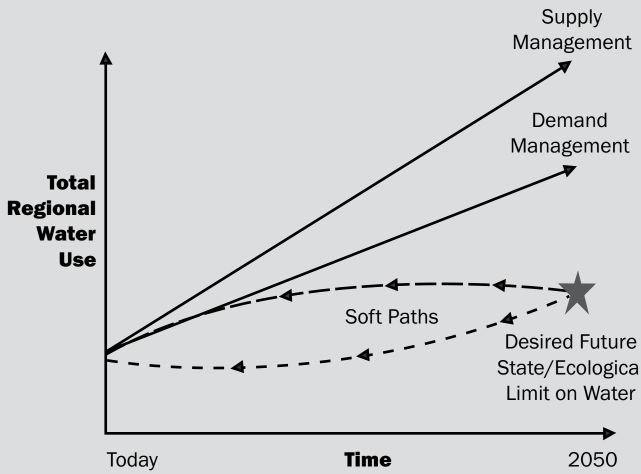
CHALLENGES:

To look beyond the electoral cycle and invest in programs that may take years before significant returns are achieved; to engage the community in planning and implementation.

SAVINGS:

Planning for sustainability may avoid many unnecessary costs; an effective water conservation program can result in water savings of 20% to 50%.

Planning for the Future with a Soft Path Approach



'Backcasting' to a sustainable future

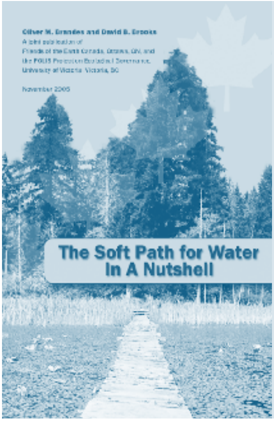
Rather than forecasting into an uncertain future by extrapolating from the past, the soft path relies on backcasting. This approach to planning starts by envisioning a desired future that reflects human needs and ecological limits. After determining what water might be available—considering the ecologically and socially acceptable limit on withdrawals—planners work backward to find feasible paths to meet long-term social and economic needs.

Source: Brandes, O.M. and D.B. Brooks. (2005). *The Soft Path for Water in a Nutshell*. Victoria, BC: The POLIS Project on Ecological Governance and Friends of the Earth Canada. Available at: www.waterdsm.org.

The 'soft path' for water

The "soft path" for water is a holistic approach to water management that takes demand management to the next level by planning *for* sustainability. The soft path differs fundamentally from conventional, supply-focused water planning beginning with its conception of water. Conventional planning treats water as an end product; by contrast, the soft path views water as a means to accomplish certain tasks. This liberates water planners to explore innovative solutions to *manage* demand rather than simply delivering more water to *satisfy* demand.

Developing scenarios that demonstrate the water saving potential of different management approaches—or packages of demand management measures—is central to soft path planning. Scenario planning can also promote wider community engagement and dialogue around water sustainability.



Core principles of the soft path approach

- Nest human water demands within local eco-hydrological limits
- Focus on providing services rather than water per se
- Maximize productivity of water withdrawals
- Match the quality of water supplied to quality required by end use
- Strive for open, democratic, participatory planning
- Backcast—planning backward to connect a desired future state to present conditions

For most communities, a straightforward starting point may be "no new water until 2050." This allows the utility, with community involvement, to envision what programs can be initiated today to defer additional infrastructure needs for at least a generation.

As with any strategic planning, this type is not a one-off event; plans must be regularly revisited through an iterative cycle of implementation, monitoring and assessment.

First steps…
Utilities and local government:

- Make an official commitment to long-term (10 to 50 years into the future) strategic planning that focuses on water conservation, community participation, and living within the local water budget.

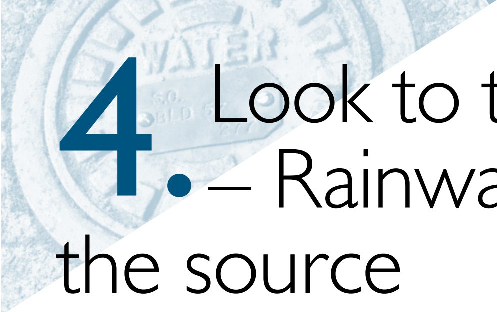
Resources:

Brandes, O.M. and D.B. Brooks. (2005). *The Soft Path for Water in a Nutshell.* Victoria, BC: The POLIS Project on Ecological Governance and Friends of the Earth Canada. Available at: www.waterdsm.org.

Brooks, D.B. (2005). Beyond Greater Efficiency: The Concept of Water Soft Paths. *Canadian Water Resources Journal*, 30(1), pp. 83-92.

Gleick, P.H. (2003). Global Freshwater Resources: Soft-Path Solutions for the 21st Century. *Science*, 302, pp. 524-528.

Gleick, P. et al. (2003). *Waste Not, Want Not: The Potential for Urban Water Conservation in California.* Oakland, California: Pacific Institute for Studies in Development, Environment, and Security. Available at: www.pacinst.org.



4. Look to the sky – Rainwater as the source

The prevailing landscape aesthetic in North America, and perhaps the most influential factor affecting outdoor residential water use, is the lush green lawn.

A typical suburban lawn requires up to 100,000 litres of water—over and above rainfall—during the summer season. Depending on season, location and climate, this represents anywhere from 30% to 75% of total residential water demand—about 20% of the total for the average household.[30] Also, overuse of fertilizers and pesticides (often associated with standard lawn care) can lead to surface- and groundwater contamination, threatening drinking water supplies and ecosystem health.

In most communities, outdoor water use is the primary factor contributing to peak demand, and consequently putting pressure on infrastructure capacity. In some regions, total municipal water use may double or more during the summer months because of outdoor watering.[31] For this reason, outdoor water demand during the summer should be one of the main targets of water conservation programs.

Looking to the sky

In some countries, rainwater collected from roofs or other impermeable surfaces is a viable source of water for outdoor irrigation, and for many indoor uses such as laundry washing or toilet flushing.[32] Yet in Canadian cities, with average precipitation rates ranging from about 260 to 1500 millimetres per year,[33] rainwater harvesting is vastly underused, resulting in missed opportunities to save 40% to 50% of the water currently used around the home.

Rainwater harvesting systems for residential use are gaining acceptance in North America, and are already well-established in Australia, Europe and throughout the Middle East. In Hong Kong, skyscrapers collect and store rainwater to supply the buildings' water requirements, and the island of Bermuda has relied on rainwater cistern systems as the primary source of residential water supply for some 300 years.[34]

PROBLEM:

Communities are missing out on using rainwater as a valuable water source.

SOLUTION:

Promote decentralized infrastructure to harvest rainfall and create outdoor (Xeriscaped) spaces that rely primarily on precipitation for irrigation.

CHALLENGES:

Building and plumbing code restrictions; the financial burden of rainwater harvesting infrastructure for homeowners and builders; the enduring legacy of sprawling lawns that exists in most Canadian communities.

SAVINGS:

Rainwater harvesting and Xeriscaping can result in 50% savings in outdoor water, and rainwater harvesting can save up to 40% of water indoors (for toilet flushing and washing clothes).

A modern and integrated design for rainwater harvesting at the University of Victoria. Photo: E. Reynolds.

Technologically, rainwater harvesting systems are relatively simple and can often be assembled by homeowners or builders with readily available materials and a basic understanding of plumbing and construction.[35] A typical system consists of a collection system (i.e. roof, gutters and downspouts), a cistern or storage tank, a delivery mechanism (i.e. gravity or pump) and filters to treat the water. They can range in size from rain barrels to larger systems with cisterns or storage containers constructed of polyethylene, galvanized steel or concrete. A typical 45,400-litre system, installed and winterized on Canada's West Coast, would cost approximately $13,000 in polyethylene, $17,000 in galvanized steel and up to $25,000 in concrete.[36]

This relatively simple technology can result in significant water savings. For example, with as little as 20 to 30 millimetres of monthly rainfall (a dry climate), a typical roof could still collect enough water to irrigate 25 to 40 square metres of lawn or garden area or flush an efficient toilet for a month—saving approximately 121 litres per capita per day.[37]

Benefits of rainwater harvesting

Rainwater harvesting is more reliable and cost-effective than many centralized options. Beyond enhancing local water security and potentially reducing costs, benefits include:

- reduced environmental impacts associated with reduced demands on centralized water systems and water sources;
- improved urban stormwater quality;
- reduced erosion and flooding associated with high rainfall; and,
- deferred or reduced requirements for centralized infrastructure and operations for water, wastewater and stormwater.[38]

The economic argument for rainwater harvesting is particularly compelling. Researchers in Australia found that using rainwater tanks in dryer regions such as the Lower Hunter and Central Coast deferred infrastructure needs by 28 to 100 years—with savings of $78 million in Lower Hunter and $47 million in the Central Coast. Wetter areas like Sydney or Brisbane yield even greater water savings.[39] The key to success in these examples is not just to provide water for outdoor uses such as garden watering, but also to make rainwater available for toilet flushing, laundry and hot water—thus constantly drawing down the rainwater tanks.

Xeriscaping: The new urban landscape

Xeriscaping, a trademark term used to describe a form of *dry landscaping*, is another water conservation option that looks to the sky for its water source. While most outdoor demand management measures seek to improve irrigation efficiency, Xeriscaping actually conserves water by landscaping with drought-resistant plants to reduce water use and loss to evaporation and run-off (see Table 3).

Plants are grouped by *hydrozones* (i.e. plants with similar water requirements), allowing for more efficient watering according to plant needs. The most drought-tolerant plants are used as wind breaks to shelter less hardy plants. *Natural landscaping* is a similar approach which relies only on drought-resistant *native* plants to virtually eliminate supplemental watering (i.e. beyond precipitation) except in extreme drought. Experience indicates that Xeriscaping can reduce outdoor residential water use by over 50% while maintaining the visual appeal and seasonal change of standard landscaping.

Table 3 - Typical outdoor irrigation water use savings

Method	Savings in outdoor irrigation water use
Improved irrigation technology: Automatic shutoff nozzle on hose Rainfall shutoff device on automatic irrigation systems Drip irrigation system	 5-10% 5-10% 25-75% (of non-lawn irrigation)
Water-wise landscape planning and design (e.g. Xeriscaping)	20-50% (potentially to 100%)
Reduced lawn area	15-50%
Use of native and low-water-use plants	20-30%
Comprehensive audit	10-15%

Source: Vickers, A. (2001). *Handbook of Water Use and Conservation: Homes, Landscapes, Businesses, Industries, Farms*. Amherst, Massachusetts: WaterPlow Press. pp. 152-200.

Code restrictions & up-front costs

The primary barriers associated with rainwater harvesting are building and plumbing code restrictions, high initial costs, and misperceptions about water quality. Currently, most provincial plumbing codes do not allow non-potable, non-municipal water supplies into dwellings. Additional meters would also be required for appropriate sewage billing where wastewater charges are based on metered municipal water supply.

Overcoming the barriers and promoting this "off the grid" water supply option requires municipalities to take an active role. Using financial incentives to overcome the short-term financial barriers is critical for success.

Demonstration projects can begin to change community perspectives on what constitutes beauty in our urban landscape. Photo: Xeriscaping in the Region of Durham, Ontario.

The City of Austin, Texas, offers a 30% rebate of up to US$500 to promote rainwater harvesting, and in Germany, widespread subsidies and technical support helped homeowners with the costs and technical challenges of implementation.[40]

Rainwater harvesting and Xeriscaping demonstration projects in highly visible locations such as city halls, government buildings, parks and recreation areas, effectively promote conservation. Coupled with aggressive education programs, demonstration projects can begin to change community perspectives on what constitutes beauty in our urban landscapes. Municipalities can create incentives to ensure developers of new buildings, subdivisions and residential units include water-efficient landscaping from the start. Not only does this avoid future water challenges, it is more cost effective than attempting to "retrofit" the landscape after the fact.

Xeriscaping and natural landscaping may require additional time and money for planning and replanting in the short term to reap the benefits of reduced maintenance time and costs over the medium and long term. Helping people overcome this short-term barrier may require fairly aggressive financial incentives such as "cash for grass," where residents are rewarded with rebates for not growing water-guzzling lawns.

Xeriscaping in Practice

Between 1990 and 2003, a study by the US National Xeriscape Demonstration Program compared the financial costs and water demand of Xeriscaping to standard landscaping with the following results:

- Phoenix realized water saving of 53% on properties with Xeriscaping;
- southern Nevada maintained a 39% summer water savings compared to properties not converted to Xeriscape;
- homes in Austin used 31% less water than those with conventional landscapes;
- cities along Colorado's Front Range used 18% to 63% less water than popular Kentucky bluegrass landscapes;

- in Colorado, surveys revealed that Xeriscape participants were generally satisfied with their new landscapes and would recommend them to others; and,
- Denver Water found an 11% increase in the number of Xeriscaped yards in Denver over the three-year study period.[41]

A study by the North Marin Water District in California found that water-conserving landscapes featuring about half as much turf as traditional yards required 54% less water, 25% less labour, 61% less fertilizer, 22% less herbicide, and 44% less fuel (for mowing) to maintain.[42]

Rainwater harvesting in Australia

Figtree Place, near Newcastle, New South Wales, Australia, is a water sensitive urban re-development consisting of 27 residential units. The site uses rainwater stored in tanks to supply hot water and toilet flushing demand. Water use was reduced by around 45% with noticeable cost savings. A two-year program to monitor roof water, tanks and hot water systems revealed that water quality improved in the roof to tank to hot water system treatment chain—and the quality complied with the Australian Drinking Water Guidelines.[43]

First steps…

Utilities:

- Provide funding and technical support to the public to set up rainwater harvesting systems.
- Create incentives to promote Xeriscaping, including pilot projects and highly visible demonstration sights.

Local government:

- Require all existing government buildings and lands to rely on rainwater as a primary water source—then advertise it to the public.
- Work with senior government to reduce legal and regulatory impediments to rainwater harvesting.

Resources:

Canadian Mortgage and Housing Corporation (CMHC). (2005). *Rainwater Harvesting Workshop Proceedings*. Toronto, Ontario: CMHC. May 24, 2005.

Konig, K. (2001). *The Rainwater Technology Handbook – Rain harvesting in building.* Dortmund, Germany: Wilo-Brain.

Bennett, J. (1998). *Dry-Land Gardening: A Xeriscape guide for dry-summer, cold-winter climates.* Toronto, Ontario: Firefly Books Ltd.

Weinstein, G. (1999). *Xeriscape Handbook: A How-to Guide to Natural Resource-Wise Gardening.* 2nd Ed. American Water Works Association (AWWA).

Xeriscaping-Colorado Water Wise Council. Available at: www.xeriscape.org/index.html.

Making rainwater harvesting common practice in Germany

A brief chronology of legal and institutional development illustrates how Germany addressed the barriers and created opportunities to become a leader in rainwater harvesting.

Small-scale rainwater harvesting. Photo: UBC Design Centre for Sustainability.

1980 – Previous legislation for "general mandatory connection to and utilization of the public water supply" was changed, providing the legal basis for domestic rainwater harvesting systems, including private water supplies from cisterns.

1988 – Hamburg was the first German federal state (similar to Canadian provinces) to introduce a grant program for installing rainwater systems in buildings. Approximately 1500 systems for private homeowners were financed over the course of seven years; 94% of users reported that they were generally happy and had no reservation about recommending rainwater use to others.

1992 – The Hessen state government introduced a tax on groundwater intended to maintain both the quality and quantity of available supply. Revenue collected from this tax was put toward financial incentives for implementing water-saving measures. Specifically, the funds assisted in the construction of rainwater and process water systems and associated education and training programs.

1993 – In Hessen, the government amended its building regulations, giving municipalities and local communities the power to make rainwater use mandatory. The states of Baden-Württemberg, Saarland, Bremen, Thuringen, and Hamburg followed. These code changes catalyzed a new era in municipal planning, and ushered in a process of technical innovation to improve performance and reduce costs associated with rainwater harvesting systems.

1996 – Industrial and professional associations published a water quality evaluation study showing no health risk for domestic use of rainwater for toilets and laundry, thus increasing acceptability of rainwater as a viable source.

2002 – Senior government published technical codes for construction to make rainwater harvesting part of standard building construction.

Sources: Konig, K.W. (2001). *The Rainwater Technology Handbook: Rainharvesting in Building.* Dortmund, Germany: Wilo-Brain. pp. 100-101; and, Konig, K.W. (May 24, 2005). Presentation at *The Rainwater Harvesting Workshop*. Toronto, Ontario: CMHC.

3. Close the urban water loop

Water withdrawn for municipal use typically follows a cycle from the source to the drinking water plant, off to the user, onward to the sewage treatment plant and back to the environment to then become someone else's source. Each year, municipalities and utilities pay more and more for this system, with much of the cost spent on bringing source water to a standard of quality suitable for drinking.

Yet, within our households we flush up to 30% of that drinking water right down the toilet. In summer months, we use high quality water to irrigate lawns, golf courses and other landscaping. Very little of the water treated to drinking water standards is actually used for purposes that require such high quality. According to Environment Canada, drinking and cooking consumes only about 5% of indoor residential water use.

Filtered reclaimed water can be reused without health risks for laundry washing cycles, toilet flushing and irrigation.

PROBLEM:

All municipal water is treated to drinking water standards, yet, more than two-thirds of that water is for end uses that do not require drinking water quality.

SOLUTION:

Use reclamation, reuse and recycling to better match water quality to end uses.

CHALLENGES:

Low water prices that reduce the cost effectiveness of reuse and recycling; negative perceptions about dual plumbing and the risks associated with reused and recycled water.

SAVINGS:

Reusing or recycling water for toilets and outdoor irrigation alone results in "double use" of existing water supplies—equating to a 50% water savings.

In this era of frequent water shortages, strained infrastructure capacity and growing environmental concern, the questions are obvious: Why treat all water to drinking water standards? Why use it only once? Why not match water quality to the requirements of end use? Why not turn wastewater into a resource?

Reclamation, Reuse & Recycling – The 3 R's

Reclamation, reuse and recycling are increasingly common practices in the world of water management. Reclamation refers to treatment of previously-used water (i.e. wastewater, greywater or stormwater) to a desired water quality. Reuse typically refers to the use of reclaimed water for a purpose different from that of the initial use. Recycling refers to use for the same purpose, and is commonly found in industrial applications such as cooling.[44] All of these processes reduce both the amount of water withdrawn from sources and the discharge of wastewater to the environment.

Together with rainwater harvesting, reuse and recycling are the next big trends in the realm of water efficiency. Indeed, any application for which water of potable quality is *not* required represents an opportunity to use reclaimed water.

It's only "waste" water if it's wasted.

The 3 R's on many scales

Reclaimed water has the potential to be used across sectors and on many different scales. It can be used in the residential sector to flush toilets and water lawns; on public lands to irrigate parks and playing fields; in agriculture to support non-food crop irrigation; and in the institutional, commercial and industrial (ICI) sector to cool water and irrigate golf courses.

Opportunities range from small-scale integrated household fixtures and on-site systems to large municipality-wide projects. Table 4 provides some examples.

Table 4 - Opportunities for reclamation, reuse and recycling

Scale	Application	Examples
	Fixtures with built-in reuse	Japanese toilets with built-in hand basins drain water directly to tanks for flushing.[45]
	On-site reuse or recycling within single family home, multi-family complex, or ICI building	Toronto's Healthy House relies on precipitation as source water, and uses reclaimed and reused wastewater (up to five times). This reduces water demand by 90% while maintaining the same quality and reliability of service as a conventional home.[46] Greywater from the University of British Columbia's C.K. Choi building is treated onsite in a Phragmite (tall grass) system and reused for irrigation.[47] In Vancouver's Quayside Village, a 19-unit residential complex, water from sinks and showers is reused in toilet flushing, reducing water demand and wastewater flows by 40%.[48]
	Neighbourhood or campus reuse of domestic wastewater for local reuse	Since 1926, Grand Canyon Village in Arizona has employed a dual distribution system to distribute reclaimed water for irrigating playing fields, toilet flushing, vehicle washing and construction uses.[49] A system under development for Iqaluit, Nunavut, will reclaim wastewater from a cluster of homes for use in flushing toilets and washing clothes. It is expected to reduce water demand by almost half.[50]
	Municipality-wide direct reuse	Vernon, British Columbia, has been reusing municipal wastewater since 1977 and now reclaims 100% of it to irrigate agricultural, forestry and recreational lands.[51] In River Hebert, Nova Scotia, a Ducks Unlimited Canada project reuses effluent from a wastewater treatment lagoon for wetland creation and replenishment.[52] In Phoenix, Arizona, secondary effluent is supplied to a reclamation plant at the Palo Verde Nuclear Power Plant to provide cooling tower water.[53]
	Municipality-wide planned indirect recycling	San Diego, California, is planning to augment the city's source water reservoir with advanced treated wastewater, which will supplement other stored water. This blended water then undergoes the usual water treatment before distribution.[54]

Hurdles: Real & perceived

While the potential for use of reclaimed water in Canada's urban areas is significant, the practice of water reuse and recycling is limited. In the past, technological hurdles were seen as the key challenge; Canadian experts now agree that technological issues related to water reuse have for the most part been resolved.[55]

In most regions of the country, regulatory frameworks do not support recycling and reuse. British Columbia is one exception. The province's Municipal Sewage Regulation (1999) and Code of Practice for the Use of Reclaimed Water (2001) have been described as "far ahead of the rest of Canada," permitting large-scale water reclamation projects and providing guidelines for water reuse.[56] As for provinces that are lagging behind, things may be about to change. The Canadian Mortgage and Housing Corporation (CMHC) in collaboration with Health Canada and Environment Canada is currently developing a guideline for using household water from showers and baths for toilet flushing. The Canadian Standards Association has developed a dual plumbing standard to be used in conjunction with this guideline.

Stormwater reuse for public art at the Olympic Park in Sydney, Australia. Photo: www.wsud.org

The widespread lack of financial incentives is a bigger issue. In particular, Canada's subsidized, rock-bottom water prices make it difficult for reclaimed water to compete economically. For recycled water to become mainstream, pricing regimes must take fuller account of the economic and environmental costs of water services. Environmental taxes, such as volume-based withdrawal fees and effluent discharge pricing based on contaminant loading would also significantly increase the economic appeal of the three R's.

Social barriers also exist. Top among these are public health concerns. Yet sources suggest that, from a health perspective, filtered reclaimed water can be reused without health risks for laundry washing cycles (but not rinse cycles), toilet flushing, and irrigation.[57] According to Eric Jackson, former Director of Water Reclamation for the City of Vernon, "no documented public health issues have arisen in Vernon's water reuse program since its inception over 25 years ago."[58]

The real problem is public perception. Education—of citizens, public servants and elected officials—must go beyond brochures and testimonials. Demonstrations and pilot studies that let the public and decision makers observe and participate are the best ways to win over doubters.

Closing the loop in Florida

St. Petersburg, Florida, completely closed its urban water cycle by reusing all wastewater, resulting in zero discharge to the surrounding environment. The city has two water distribution systems: one that delivers fresh water for drinking and most household uses, and another that distributes treated wastewater for irrigating parks, road medians, residential lawns, and other end uses that do not require drinking water quality. The reclaimed water costs about 70% less than the drinkable supply. And given the nutrients in reclaimed water, using it can reduce or eliminate use of synthetic lawn fertilizers.[59]

First steps…

Utilities:

- Identify local partners (e.g. NGOs, community groups and businesses) and develop high profile pilot projects and demonstration sites that highlight the potential of the 3Rs and build community support.

Local government:

- Work with senior governments to change legislation and regulations to permit water reuse and recycling.
- Enact by-laws that require dual plumbing in all new developments to reduce future retrofit costs and create demand for water reuse and recycling.

Resources:

Canadian Council of Ministers of the Environment. (2002). *Linking Water Science to Policy: Water Reuse and Recycling. Proceedings of the Water Science and Policy Workshop - May 30-31, 2002*. Calgary, Alberta: CCME. Available at: www.ccme.ca.

Hellebust, A. (2006). *Wastewater Reuse in Residential, Institutional and Commercial Buildings in Canada: Current Motivations, Future Scenarios and Initiatives.* EcoWerks Technologies Corporation. Prepared for Friends of the Earth Canada.

Purple Pipes – California Reuse and Recycling Web site: www.srcsd.com/purplepipes/index.htm.

Waller, D.H. et al. (1998). *Innovative Residential Water and Wastewater Management.* Canadian Mortgage and Housing Corporation (CMHC). Available at: www.cmhc-schl.gc.ca.

Canadian Mortgage and Housing Corporation. (1998). *Regulatory Barriers to On-Site Water Reuse.* Technical Series 98-101. CMHC. Available at: www.cmhc-schl.gc.ca.

2. Design communities for conservation

Land use decisions determine water use and watershed health now and in the future, and many current patterns of development are problematic. Standard subdivision design is a classic example of how "urban sprawl" inevitably leads to more and bigger water pipes. This type of land use decision—often divorced from local water use considerations—has negative impacts that may not be evident until years later. Examples include:

- startlingly high water demands associated with excessive outdoor water use;
- reduced groundwater recharge resulting from widespread impermeable surfaces; and,
- erosion and flooding associated with inadequate stormwater management.

Such land use decisions have cumulative effects that complicate policy making. To appease increasing water demands, water managers and municipal councils are forced to find new water sources or increase demand on existing sources. This in turn contributes to the cycle of over-built infrastructure for water delivery, wastewater treatment and stormwater management.

Australia is a leader in Water Sensitive Urban Design (WSUD) as demonstrated here with a green roof in Sydney. Photo: www.wsud.org.

PROBLEM:

Current municipal development decisions often negatively impact local watersheds.

SOLUTION:

Promote water sensitive urban design by limiting sprawling lawns, promoting "green" infrastructure, and requiring that all land use decisions be assessed for watershed impacts.

CHALLENGES:

The misconception that water sensitive urban design must be more expensive than standard approaches.

SAVINGS:

Compact water sensitive urban design can save 50% of outdoor water use.

A sprawl of a problem

Over the last decade, studies have linked suburban sprawl to increased traffic and air pollution and to the rapid loss of farmland and open space. Sprawl also threatens water quality. Rain that runs off roads and parking lots carries pollutants that poison rivers, lakes, streams and oceans. But sprawl not only pollutes our water, it also reduces water supplies. As impervious surfaces—roads, parking lots, driveways, and roofs—replace meadows and forests, rain can no longer seep into the ground to replenish aquifers. Instead, water is swept away by gutters and sewer systems.

Source: Otto, B., K. Ransel, J. Todd, D. Lovaas, H. Stutzman and J. Bailey. (2002). *Paving our Way to Water Shortages: How Sprawl Aggravates the Effects of Drought.* American Rivers, Natural Resources Defense Council.

Water sensitive urban design (WSUD)

Water sensitive urban design (or re-design) is closely related to *Smart Growth*—a concept in land use and development that promotes livable communities, environmental protection, and efficient use of tax dollars.[60] WSUD specifically aims to improve urban stormwater quality and encourage water conservation by optimizing planning and water cycle management. This approach to urban planning and design focuses on water management at the level of individual lots and considers how water, wastewater and stormwater services can be provided in ways that secure and enhance watershed health. Growth can be managed in a variety of ways, including comprehensive provincial growth management legislation, smart growth incentives, and urban growth boundaries. The key to facilitating WSUD is governments coordinating with water resource agencies during planning processes. In California, for example, state legal amendments link land use planning to water sustainability by requiring proof of the reliability of water supply for new municipal developments (e.g. 20-year supply demands for the equivalent of at least 500 residential homes).[61]

The real cost of WSUD

A primary stumbling block is the misconception that WSUD is more expensive than conventional urban development approaches. In some cases additional up-front costs are required (although not always—as the examples below demonstrate), but certainly from a community or even a homeowner's perspective, the long-term benefits of ecologically friendly design will outweigh the costs.

Smart Growth reducing costs and conserving water

Applying smart growth principles can significantly reduce the cost of water provided by communities and the quantity of water demanded by their residents. More compact development allows for shorter transmission systems, making them more efficient to operate and less susceptible to water loss through leakage. Encouraging compact neighbourhood design on smaller lots reduces water demand for landscaping. Directing development to areas served by existing infrastructure and maintaining that infrastructure can make systems more efficient.

Source: EPA. (2006). *Growing Toward More Efficient Water Use: Linking Development, Infrastructure, and Drinking Water Policies.* Washington, DC: US Environmental Protection Agency. p. 7. Available at www.epa.gov/smartgrowth.

Design for conservation in Australia and Canada

Research from Australia demonstrates the potential for significant savings. Figtree Place, an inner suburb of Newcastle, New South Wales, was constructed using a WSUD approach, resulting in savings of $25,900 in construction costs—almost $1000 per dwelling. Greenfield Subdivisions, also in Newcastle, produced a 53% savings in stormwater drainage construction costs using a WSUD approach, and is expected to considerably reduce environmental impacts.[62] Dockside Green, discussed in the final section of this handbook, is an excellent Canadian example of the economic, environmental and social benefits of holistic and integrated design.

First steps…

Local government:

- Make an official commitment to integrate land use decisions with water planning, with specific attention to integrating stormwater management and subdivision design that complements and enhances the existing "green" infrastructure.
- Set performance standards in by-laws for permeability, infiltration, tree cover, ecological function, buffering and zoning.

Senior governments:

- Help establish urban containment boundaries and require regional growth strategies and official community plans that are consistent with local water budgets.

Resources:

Smart By-laws Guide. Available at West Coast Environmental Law Web site: www.wcel.org. And for smart growth and sustainability legal support and strategies see Curran and Co. Web site: www.dcurranandco.ca.

Environmental Law Clinic, University of Victoria, Faculty of Law. (2006). *Green Infrastructure Model By-law Package.* Environmental Law Clinic Web site: www.elc.uvic.ca (forthcoming fall 2006).

Stephens, K., P. Graham and D. Reid. (2002). *Stormwater Planning – A Guidebook for British Columbia.* Victoria, BC: BC Ministry of Water, Land and Air Protection. This publication is complemented by the Water Balance Model Web site, an interactive and scenario-based tool available at: www.waterbalance.ca.

Argue, J. (2004). *Water Sensitive Urban Design: Basic Procedures for 'Source Control' of Stormwater – A Handbook of Australian Practice.* University of South Australia. See also, Water Sensitive Urban Design in Australia Web site: www.urbanwater.info/engineering/wsud.cfm.

US Environmental Protection Agency. (2004). *Protecting Water Resources with Smart Growth* (2004). Washington, DC: EPA. Available at: www.epa.gov/smartgrowth/publications.htm#water.

1. Educate, educate, educate

Canadians are among the highest water users in the world, using twice as much per capita as the average European. Despite emerging threats to water security such as climate change, pollution and increasing urbanization, most Canadians do not consider water quantity an issue. Because of our relative abundance of water, conservation is seen as a well-intentioned activity, but not a necessity.

Outreach and education

Outreach and education that inform water users about water conservation initiatives are a must for any successful demand management program. Even mandatory programs such as watering restrictions are rarely successful without promotion and publicity. The most effective education programs will also increase public knowledge about the need for water conservation, the potential benefits of demand management, and how to participate in local action.

A varied and multi-faceted approach is needed—one that engages individuals in community-based solutions to water security problems. To achieve this, education programs must be developed for different groups of end users, such as homeowners, renters, businesses and industry. Programs must also be developed to address water professionals, community and political leaders, and children.

The main benefits of a good education program include:

- instilling conservation habits in water users;
- heightened public awareness of the need to conserve to the point where other measures, such as volume-based pricing and regulation, become acceptable and can be implemented;
- enhanced public demand for elected officials to address water issues as a policy priority before a crisis is reached;
- continued awareness through regular public reminders of the need for conservation;
- changed values toward a lasting "water ethic."

PROBLEM:

Lack of understanding about the need for, and potential benefits of, water conservation, and how to effectively put it into action.

SOLUTION:

Implement outreach and education programs that go beyond information dissemination to engage and inspire citizens to permanently change behaviours.

CHALLENGES:

To engage community members in meaningful education programs that will help replace perceptions of Canada's "water wealth" with an enduring "water ethic."

SAVINGS:

The sky is the limit—most experts believe that, even in developed countries, only 50 to 80 litres per capita per day of high quality water is needed to maintain a good standard of living.

Education about water conservation exists in many forms and makes use of every imaginable teaching aid—from preschool programs to university seminars, from fridge magnets to interactive on-line games. Whether through information campaigns, media advertising, school curricula or other methods, the purpose of education on water conservation is not only to inform, but to influence behaviour. Motivation follows engagement—and motivation is what is needed to create lasting changes in behaviour.

Victoria Compost Education Centre demonstration project of a green roof and "bathtub ponds" fed by rainwater. Photo: E. Reynolds.

Social marketing

According to Doug McKenzie-Mohr, environmental psychologist and promoter of *community based social marketing*, information campaigns alone will not foster sustainable behaviours. Conventional education programs focused on disseminating information often reflect an inadequate understanding of the barriers to behavioural change.

Social marketing differs from conventional approaches because more time and effort is invested up-front to understand barriers prior to program design and implementation.[63] Using focus groups of stakeholders to identify barriers and recommend incentives creates the direct, interactive contact with end users that encourages a high level of "buy in" needed to inspire action.

For end users, saving money is an effective motivator for changing behaviour. Others are also motivated by saving energy and being good environmental citizens. But, even with sufficient motivation, programs must also make it easy for end users to participate, especially early on.

Steps to community-based social marketing

Community-based social marketing involves four steps:

1. Identify the barriers and benefits to an activity by reviewing existing research, and conducting focus groups and randomized surveys;
2. Develop a strategy that uses "tools" such as communications and marketing techniques and incentives that have been proven effective in changing behaviour;
3. Pilot the strategy using community test groups; and,
4. Evaluate the strategy once it has been implemented across a community.

Source: McKenzie-Mohr, D. (2006). *Quick Reference: Community-Based Social Marketing*. Available at: www.cbsm.com.

Education materials are only the start. The purpose of education on water conservation is not only to inform, but to influence behaviours. Photo: E. Reynolds.

Tailoring programs

To be effective, education programs must be tailored to local needs, and must involve key constituent groups, such as homeowner associations, landscapers or plumbers. The Massachusetts Water Resources Authority, for example, sponsored workshops and provided information at professional trade shows, such as performance details on ultra-low-flow toilets. Tours of demonstration projects can be offered to professional and industry groups, allowing for more detailed technical discussions.

Programs can also be targeted at the customers who use more water than average. In Palo Alto, California, for example, the City hired college students to make personal visits, distribute information and give advice on conservation to residents with the highest water use.[64]

Children: Targeting education campaigns at children is highly effective. In addition to the potential of promoting life-long water conservation habits, a study in Vernon, BC concluded that children in primary school can teach parents more about water conservation than a utility representative ever could.[65] Before embarking on a school campaign, educating teachers first will improve the campaign's effectiveness. In British Columbia, "teach the teacher" guides have been developed for this purpose.[66]

Decision makers and government employees: Elected decision makers and government employees also need attention to build support for conservation. A recent survey in British Columbia found that only 10% of respondent municipalities were actively educating elected officials on water issues such as conservation. The result is that decision makers may be largely unaware of the potential benefits of demand management.[67] Municipal employees can also be targeted, since they not only represent a large group of water users, but are also involved in water supply and management, and are potential conservation ambassadors.[68]

Instilling a 'water ethic'

Although education and marketing campaigns are generally politically and publicly acceptable, NGOs have an important role in raising public awareness and engaging the public to the point where governments and water utilities will themselves undertake such campaigns. Government funding and training for NGOs will help ensure that a diverse community is involved in the process. The shared goal of balancing the water budget for a region encourages many disparate organizations and individuals to work together to develop more sustainable behaviours and practices—the first step toward a lasting water ethic.

Social marketing in Ontario

The Region of Durham in Ontario adopted this approach for its outdoor water efficiency program with notable success. The program started in 1997 with the Region employing summer students in a community-based social marketing program to work with homeowners to reduce residential lawn watering. The result was a 32% reduction in peak water demand over a three-year period.[69]

First steps…

Utilities:

- Identify high water use groups and target them in social marketing and education campaigns to reduce water consumption patterns.
- Expand education programs beyond brochures to include opportunities for community engagement to instill behavioural change.

Local Government:

- Make an official political commitment and provide financial and human resources to support ongoing education programs.

Resources

McKenzie-Mohr, D. (2006). *Quick Reference: Community Based Social Marketing.* Available at: www.cbsm.com.

Environment Canada. PowerPoint presentation (graphics and notes). Available at: www.ec.gc.ca/water/en/info/pubs/speak/e_slides.htm. Also from Environment Canada, a series of printer-ready utility bill "stuffers" that can be personalized by municipalities. Available at: www.ec.gc.ca/water/en/info/pubs/brochure/e_broch.htm.

Grant, T. (2003). Educating for the Environment. *Electronic Green Journal*, Issue 19. See also *Green Teacher Magazine*, Toronto, Ontario, and the Web site: www.greenteacher.com.

Australian Sustainable Schools Initiative Web site: www.deh.gov.au/education/sustainable-schools/index.html.

Making the Case – Conservation as the best source of 'new' water

Over the past decade, large municipalities across Canada have begun to integrate water efficiency into daily business, especially short-term initiatives such as fixture replacements, basic education programs and watering restrictions. Smaller and mid-sized municipalities are now following this lead. Driving the progress are threats such as drought and pollution, profligate water use and large-scale water diversions, which draw increasing attention to water's vital role in the health of communities. While these initiatives are a good start, as our *Top 10* demonstrates, much more is possible.

Benefits of demand management

Shifting the focus of urban water management from the standard supply-side approach toward a demand management paradigm has many benefits. Perhaps the most obvious over the long term is that the overall benefits to society—financial and environmental—far outweigh the costs. Maintaining healthy aquatic ecosystems cannot be underestimated as a long-term benefit. And avoiding or deferring infrastructure costs such as harmful and costly diversion projects is a huge benefit. Also, saving water saves energy and other resources that go into operating urban water infrastructure—another compelling argument for change. All of these benefits free up public funds that could then be applied to upgrade or replace ageing infrastructure, improve drinking water quality, wastewater and stormwater treatment, or to support other community programs such as policing, social services or recreation.

BIG MONEY SAVINGS

In the Regional Municipality of Durham, Ontario, estimates indicate that it would cost approximately $125 million for new infrastructure to provide the equivalent supply of water as will be made available by implementing a 10-year water efficiency plan, costing only about $17.2 million.

Source: Veritec Consulting. (2004). *Regional Municipality of Durham Water Efficiency Plan – Final Report.*

The business case

Urban water and wastewater systems are capital intensive. By maximizing the efficiency of existing built infrastructure and minimizing the need for future expansions, Canadian municipalities can reduce the strain on tight budgets. Because reductions in energy and chemical costs go hand-in-hand with reduced water use, reducing demand can also influence the costs of treating and distributing water, and of collecting and treating wastewater.

In the water conservation field, much of the "low-hanging fruit," such as water-efficient toilets, showers and appliances, often have payback periods of less than five years. Lower water and sewage bills for homeowners also create incentives to conserve.

Consider replacing toilets in single-family homes. In an average community, with approximately 40,000 participating homes, that single measure would reduce water use by about 6.6 million litres per day. At a value of $4.37 per litre of water saved, this equates to $29 million in avoided infrastructure costs. The total cost of the toilet replacement program is approximately $5 million, including administrative support and a toilet rebate—much less than the cost of providing that water through infrastructure expansion. And the savings could be even greater if existing toilets are replaced with HETs rather than standard 6-litre toilets.[70]

Low prices + high use = major infrastructure deficits

Most Canadian municipalities face pressing problems related to water and wastewater services. Yet Canadian municipal water prices rank second lowest among OECD nations. Not surprisingly, per capita water use is among the highest, with the OECD going so far as calling Canadian water "cheaper than dirt."[71]

The influence of these low prices is reflected in our profligate water use, and the over-capitalization of infrastructure that has in part led to the infrastructure deficit observed in many communities across the country. Excessively low water prices challenge community efforts to promote conservation, as many conservation options are easily dismissed as simply not cost-effective.

Conservation makes good fiscal sense. In Ontario's Regional Municipality of Durham, for example, the Region has determined that a long-term commitment to conservation could save the municipality approximately $125 million over the next 10 years.

Making the water & energy link

Energy and water resources are interrelated—conserving water conserves energy, which in turn conserves more water and vice versa. Yet, while energy conservation has been gaining momentum since the 1970s, the need for water conservation is only beginning to enter Canadians' collective consciousness.

California provides an example of the potential benefits of linking water and energy conservation. Regulated utilities in California are on track to meet their energy efficiency goals at a greatly reduced cost over the next two years simply by focusing on water conservation. "Water-related energy use consumes 19% of the state's electricity." This includes storage, delivery and treatment of water, as well as energy used by customers to heat water and to supply water for landscape irrigation. Consequently, regulators in California recently agreed to divert some of the ample funding earmarked for energy conservation to water conservation in recognition that saving water means saving energy, and it all means saving money.[72]

To create long-term water security, a community must live within its ecological water budget.

The ecological case

Urban development and high water use alter the hydrological cycle and place increasing demands on Nature's infrastructure and services. Municipal water withdrawals and the associated wastewater discharges result in geographically concentrated impacts on the local environment. The most obvious impacts are associated with dams, diversions and surface- and groundwater taking. Such hydraulic infrastructure places pressure on the structure and function of aquatic ecosystems—with impacts reverberating up- and downstream of the actual infrastructure.

Groundwater management also impacts environmental health. Aquifer overdraft can affect the health of surface water systems—particularly in dry seasons when base stream flows are fed largely by groundwater sources such as springs and aquifers. Over pumping of groundwater reduces the volume available for these fragile ecosystems, which in turn impacts other ecological variables, such as temperature and nutrient balance, that sustain aquatic ecosystems and the fish populations within them.

To create long-term water security, a community must live within its ecological water budget—one that includes a precautionary buffer to safeguard ecosystem water needs. This will ensure future generations have access to the same benefits and quality of life we currently enjoy.

"Hydraulic infrastructure is literally killing the aquatic world."

Source: Postel, S. (2000). Entering an Era of Water Scarcity: The Challenges Ahead. *Ecological Applications*, 10(4), pp. 941-948.

Cumulative impacts

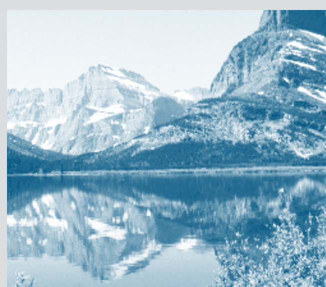
More than 20% of all freshwater fish species are now threatened or endangered because dams and water withdrawals have destroyed the free-flowing river ecosystems that sustain them. The American Fisheries Society estimate that 354 species of fish in North America are at risk, primarily due to habitat destruction through the excessive use and mismanagement of water.

Swedish scientists Mats Dynesius and Christer Nilsson report that 77% of the large river systems in the United States, Canada, Europe and the former Soviet Union are altered by dams, reservoirs, diversions, and irrigation projects. They warn that, because of the extent of river modification, key habitats such as waterfalls, rapids, and floodplain wetlands could disappear entirely from some regions, extinguishing many plant and animal species that depend on running water habitats. Perhaps the most startling finding is that the weight of impounded waters at high latitudes in the northern hemisphere has slightly altered the tilt of the earth's axis and increased the speed of the earth's rotation.

Sources: Gleick, P. (2002). *Water Facts, Trends, Threats, Solutions*. Oakland, California: Pacific Institute for Studies in Development, Environment, and Security. Available at www.pacinst.org; Postel, S. (1994). *A Global Perspective on Water Conservation*. In Shrubsole, D. and D. Tate (Eds.). *Every Drop Counts* (p. 13). Canadian Water Resources Association; Postel, S. and B. Richter. (2003). *Rivers for Life: Managing Water for People and Nature* (p. 14). Washington DC: Island Press.

A word about climate change

Climate and the water cycle are intimately linked. As temperatures increase and the weather changes, so too does the amount and timing of precipitation. For Canada, the general prognosis is for more precipitation falling as rain rather than snow, and the snow that does fall will melt and run off the land faster and sooner. In non-winter months, predictions are for more frequent severe storms and droughts—not necessarily less precipitation overall, but fewer rain days with larger volumes of rainfall per day. Such changes will significantly impact groundwater recharge and influence surface water flows. Add to this the water loss from land through evaporation from the soil and increased plant transpiration that result from rising temperatures, and we can see a very different context for water management emerging every day.



Time for a name change? "In 1850, there were 150 glaciers in Glacier National Park; now, there are only 35 left...There is a prediction that by 2030 there will not be any glaciers left (in Glacier National Park)."

Source: Dr. Hester Jiskoot, Assistant Professor, University of Lethbridge, Proceedings of the Standing Committee on Energy, the Environment and Natural Resources, March 8, 2005. Photo: Glacier National Park Web site.

Toward Solutions – The power of managing demand

Demand-side management has been used extensively in Canada over the years to alleviate transportation congestion and reduce energy consumption. Measures include conservation-based pricing, smart technologies, public education, and regulations that force innovation by promoting efficiency, conservation and alternative sources. In the water context, these same measures can be used to conserve water and dramatically increase water productivity to meet human needs and desires for services such as sanitation, landscaping and personal hygiene.

Comprehensive water demand management programs are multi-faceted efforts aimed at simultaneously changing water provision, waste disposal, energy demand and land use, to redirect social development onto a new path. Relying less on pipes and pumps, this new path focuses instead on changing behaviour, attitudes and values. It requires water planners to satisfy demands for water-based *services* such as sanitation and irrigation rather than simply delivering more and more water to meet ever increasing demand.

The California potential

A recent state-wide study in California profiles a compelling example of the potential savings of a demand management approach. The Pacific Institute reports that the total of commercial, industrial, residential and institutional water use could be cost-effectively cut by at least 30% using off-the-shelf technologies. Further, this dramatic efficiency improvement can be achieved more quickly and cleanly than any new supply project under consideration. They emphasize that "the potential for conservation and efficiency improvement in California is so large that even when the expected growth in the state's population and economy is taken into account, no new water-supply dams or reservoirs are needed in the coming decades."

Source: Gleick, P., D. Haasz, C. Henges-Jeck, V. Srinivassan, G. Wolff, K. Cushing, and A. Mann. (2003). *Waste Not, Want Not: The Potential for Urban Water Conservation in California.* Oakland, California: Pacific Institute for Studies in Development, Environment, and Security. Available at: www.pacinst.org.

Reasons to conserve water in Canada

- **High and rising urban water use** – Canadians are among the highest municipal water users in the world. The average total municipal water consumption (including residential, ICI and unaccounted for water) is 622 litres per capita per day.[73] This tradition of overuse is deeply entrenched in our culture, water use habits and urban designs. Despite water conservation efforts, and a decrease in per capita water use, urbanization and population growth are driving up total water use.
- **Supply limits** – Scarcity of freshwater resources—both ground and surface water—is common in most urban areas where the geographic concentration of human activity imposes a significant strain on limited water supplies.
- **Costs** – Efficient use of existing capital-intensive infrastructure can be cost effective, especially if municipalities consider the savings in energy and chemical costs from reduced pumping, treatment and distribution.
- **Environmental impacts** – Urban development and high water use alter the hydrological cycle and place increasing demands on natural infrastructure. Urban water impacts add to other cumulative factors, such as point and non-point source pollutants, that damage the aquatic and riparian environment.
- **Quality and quantity concerns** – High urban water use places increasing stress on water treatment systems. The increased wastewater volumes can result in less effective treatment, potentially threatening the quality of receiving waters and undermining the integrity of the entire system.

The great Canadian water myth

Looking at Canada as a whole, renewable water supplies exceed water demands, leading many to conclude that water scarcity cannot possibly be a problem. However, at a community level, other factors such as water quality and local availability must also be considered to get an accurate picture of our water "wealth." Population distribution is another important consideration. While 60% of our renewable water resources flows north, the majority of Canadians (85%) live along the southern border. After factoring in the water needs of aquatic ecosystems, the reality is that in most places—especially where most Canadians live—communities usually have just enough water, not extra.

A commitment to 'no new water'

As this handbook demonstrates, opportunities to improve water productivity abound. These gains are, however, just the beginning of the water saving story. Some communities are exploring the potential of meeting all new water demands through efficient use of existing supplies and conservation. In Calgary, Alberta, this "no new water" approach is a driving force behind one of Canada's most comprehensive water demand management strategies. In Victoria, British Columbia, and the surrounding capital region, local leaders and water managers are also exploring the potential of a regional commitment to "no new water."

Looking to the Future – Water management in the 21st century

In Canada, long-term water security in the face of growing populations and a changing climate is a social dilemma that will not be resolved with technical solutions alone. Lasting solutions require a focus on the broader social and cultural contexts that shape attitudes and behaviours—a focus not just on managing watersheds, but managing the people within watersheds. Instead of assuming an endless water supply or dreaming up large-scale technologies to harness water, this paradigm seeks to manage demand, increase water productivity and instil a conservation ethic.

The future of water management

Comprehensive and long-term water conservation programs are the new water infrastructure. In many places, they also represent the best option for meeting growing water demands. These programs, built around innovative efficiency-based technologies, pricing that promotes conservation, interactive education and engaged citizens, are the foundations of 21st century urban water management.

Comprehensive and long-term water conservation programs are the new water infrastructure.

Creating sustainable communities requires the right programs and techniques to conserve water resources. A conservation-based approach to land use decisions, development and design will ensure that society begins to develop a secure and prosperous future. Witness the potential at Dockside Green in British Columbia's capital city (see box). Today this example is considered to be on the cutting edge of sustainable development. If sustainability is truly the goal, this type of project must become tomorrow's standard practice.

The potential for water conservation stems from a fundamentally different concept of water in our human environment. This does not mean doing without. Instead it is about taking a long-term approach with a focus on holistic water resource management and a water ethic that permeates much of what we do. Not only is this approach better for the environment, it is cheaper in the long run—and in this way becomes the only sustainable option.

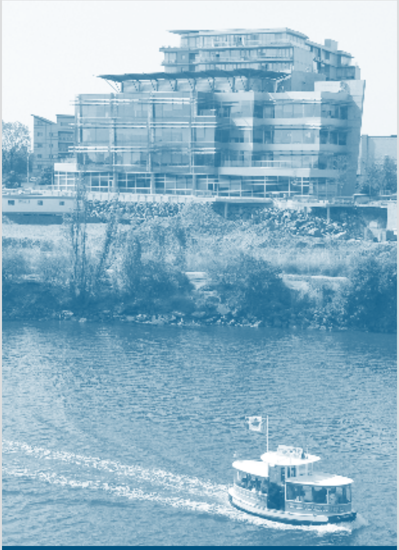
Solutions exist. The urgency increases daily. Changing the world one watershed at a time is the goal. Your community is the place to start.

Dockside Green — At the vanguard of 21st century urban planning

Dockside Green in Victoria, British Columbia, is being developed on 15 acres of former industrial land near the downtown core. Dockside Green will house approximately 700 residential units in the planned total of 1.3 million square feet of mixed residential, office, retail and industrial space. This model of modern urbanization brings together many of the Top 10 water savings options outlined in this handbook.

The developer is aiming for the Leadership in Energy and Environmental Design (LEED) Platinum rating for each building on the site, establishing the project as a global showcase for large-scale sustainable development. It is a model for holistic, closed-loop design, functioning as a total environmental system in which form, structure, materials, mechanical and electrical systems will be interdependent—a largely self-sufficient, sustainable community where waste from one area will provide fuel for another.

One hundred percent of Dockside Green's sewage will be treated on site and reused primarily to flush toilets and for irrigation, reducing the demand for potable water. Excess treated water will be exported for sale to off-site customers, such as industrial users.



Dockside Green integrates many of the Top 10 into its design. If sustainability is truly the goal, this type of project must become tomorrow's standard practice. Photo: E. Reynolds.

Using a "triple bottom line" approach, this development integrates a closed-loop water system featuring cutting-edge conservation technologies, alternative sources, drought-resistant landscaping, and water reuse and recycling to minimize municipal water demands and water impacts. Dockside Green's innovative approach to conserving and reusing water will save approximately 70 million gallons of water per year—the same amount used in all of the Greater Victoria area on the year's driest day. Potable water use in residential and commercial/office buildings will be approximately 60% to 65% lower than standard developments.

For more information see the Dockside Green Web site: www.docksidegreen.com/index.

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POLIS PROJECT ON ECOLOGICAL GOVERNANCE

Created in 2000, the POLIS Project on Ecological Governance is a research-based organization housed at the University of Victoria in British Columbia. Researchers who are also community activists work together at POLIS to dismantle the notion of the environment as merely another sector, and to make ecological thinking and practice a core value in all aspects of society. Among the many research centres investigating and promoting sustainability worldwide, POLIS represents a unique blend of multidisciplinary academic research and community action.

www.polisproject.org

WATER SUSTAINABILITY PROJECT

Created in January of 2003 at the POLIS Project, the Water Sustainability Project seeks to understand the structure and dynamics of urban water use, and to provide mechanisms to help reorient water management in Canada from supply to demand-side approaches. The WSP team has developed a comprehensive legal and policy framework for urban water management and detailed action plans for federal, provincial and municipal governments. The Project is also investigating the emerging field of watershed governance to test its practical implementation and explore its potential for “developing sustainability” in Canada.

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