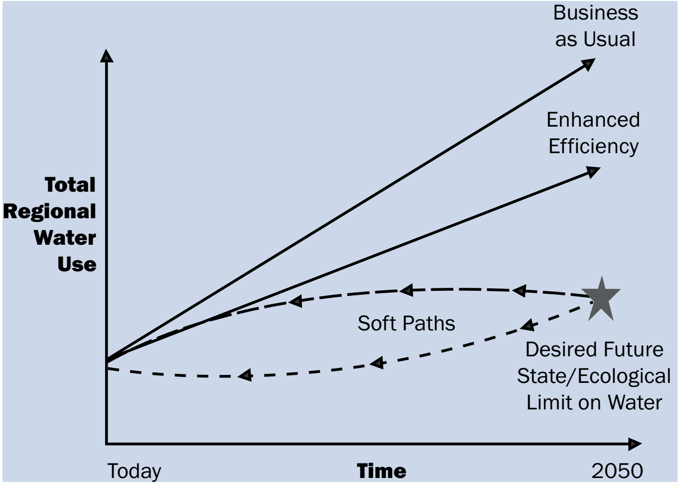
Urban Water *Soft Path*

'Back of the Envelope' Backcasting Framework



The Water Sustainability Project

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Soft Path for Water Research in Canada

The Canadian water soft path study is the first test anywhere in the world of the application of water soft path concepts to specific political jurisdictions in specific ecological and geographic settings. The study was undertaken as collaborative effort led by Friends of the Earth Canada and included the Arthur Irving Institute at Acadia University, the Environment and Resource Studies Department at the University of Waterloo, and the POLIS Project on Ecological Governance at the University of Victoria. Water soft paths were investigated on three scales: 1) the municipal and community scale; 2) the watershed scale in Nova Scotia; and 3) the provincial scale in Ontario.

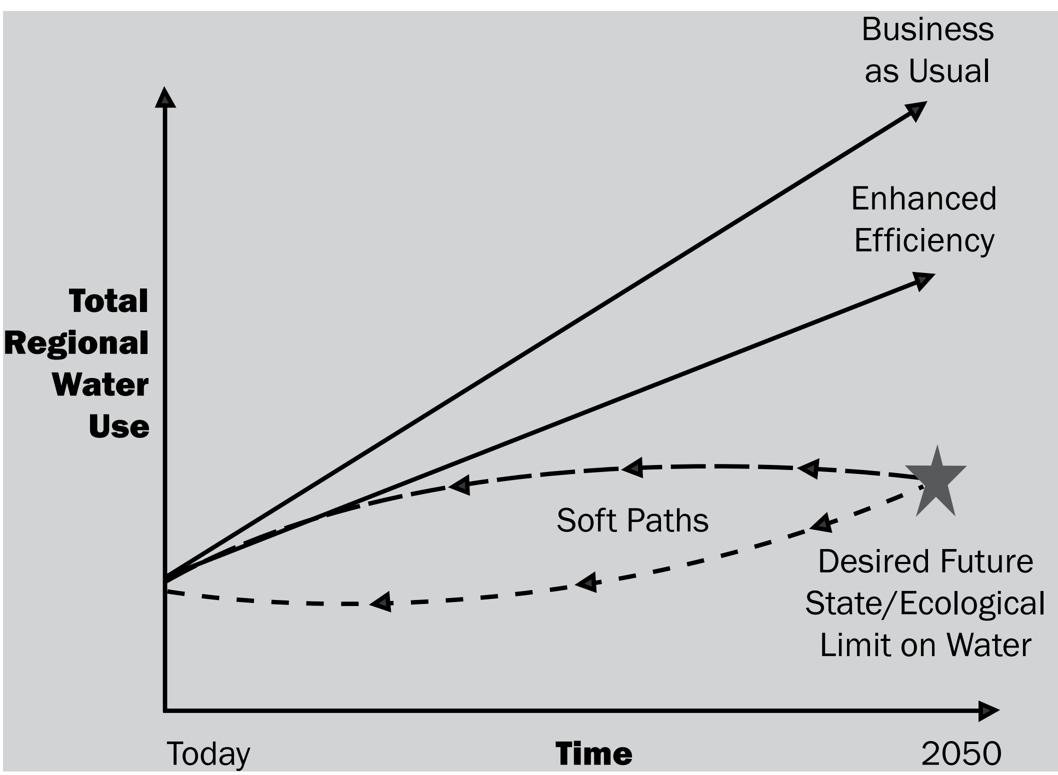
For more information, see the web sites: Friends of the Earth (www.foecanada.org) and POLIS's water project (www.waterdsm.org).

Urban Water Soft Path 'Back of the Envelope' Backcasting Framework

Summary

What does it do? The Urban Water Soft Path "Back of the Envelope" Backcasting Framework (BEBF) compares various possible scenarios of future water use at the community scale (i.e. municipality or region) in the context of soft path water planning. Soft path planning employs backcasting, a planning approach that begins by envisioning possible future states, then works backwards to connect a desired future to the present by integrating policies, programs and technological innovation. We refer to this as a "back of the envelope" approach to acknowledge the approximate and generalized nature of our assumptions, estimates and calculations. The scenarios are not accurate depictions of the future, but rather illustrative narratives of possible paths for local level water management. Our main goal in developing and exploring these scenarios is to illustrate the potential of a comprehensive approach to water conservation and efficiency, with the initial results pointing to recommendations for specific actions to foster a more sustainable approach to urban water management.

How does it work? The framework involves the application of an analytical tool—the Water Soft Path Scenario Builder—to determine the macro impact of different "packages" of micro measures (i.e. policies, programs and technologies) on total water use. The tool provides the quantitative (water savings) dimension of each of the three scenarios established in this framework. Two of the scenarios, *Business as Usual* and *Enhanced Efficiency*, are projections; the third, the *Soft Path*, backcasts from a pre-determined desired water future that reflects local environmental, social and economic conditions. The diagram below graphically illustrates the approach to planning and water reductions associated with these scenarios of future water use.



Urban Water Soft Path 'Back of the Envelope' Backcasting Framework

Introduction

The Urban Water Soft Path "back of the envelope" Backcasting Framework (BEBF) is an element of the National Soft Path Research Initiative led by Friends of the Earth Canada and involving the Faculty of Environmental Studies at the University of Waterloo; the Arthur Irving Academy for the Environment at Acadia University; and, the POLIS Project on Ecological Governance at the University of Victoria. Members of the soft path research team set out to develop, test and refine the methodological approach and tools for water soft path planning.[1] This urban component supports the broader initiative by illustrating the potential of a long-term and integrated approach to water conservation and managing demand (i.e. a soft path approach) at the *community scale* (municipal or regional scale).

The framework illustrates the impact of combining various micro measures (e.g. low-flow toilets, education, conservation pricing, Xeriscaping, etc.) on macro conditions (i.e. total water use). Calculations of water savings reflect leading research and experience on available and emerging efficiency technologies and practices for conservation and sustainable water use. However, we caution that the approach developed here is largely illustrative, serving primarily as a strategic planning tool, and is not necessarily an accurate portrayal of the future. Included in this framework is an analytical tool designed to calculate water saving associated with various technologies or practices. Our calculations are purposely coarse and are based on a number of assumptions, which is why we emphasize the "back of the envelope" nature of the results associated with the BEBF and the decision support tool.

The framework relies on the techniques of scenario-based planning and backcasting to explore various possible options for urban water management. It includes **three scenarios**: *Business as Usual*, *Enhanced Efficiency* (or Demand-side Management), and the *Soft Path*.

Scenario-Based Planning

Scenario-based planning entails developing narrative descriptions of possible futures or situations. The water use (or water reduction) calculations associated with our scenarios were developed with the decision support tool, a Microsoft Excel spreadsheet that disaggregates total water demand into component parts, subjects the disaggregated components to water conservation and efficiency measures, and then re-aggregates the data to determine the full impact on total water use (see Annex A for more details).

Water savings resulting from each measure are the combined product of *water efficiency factors* and *penetration values*. Water efficiency factors indicate water savings resulting from use of a particular technology or practice (see Annex B for estimates of water savings that provide the foundation for the water efficiency factors applied in the tool). Penetration values, expressed as percentages, are estimates of the uptake (or application) of a given measure or practice. Penetration rates are strongly influenced by institutional and policy arrangements, including programs that promote (or fail to promote) water conservation and efficiency. For example, an aggressive toilet rebate program that includes installation will result in a higher number of households using low-flow toilets (i.e. greater penetration of the technology).

[1] For more details on the Soft Path approach generally see Brandes, O.M. and D.B. Brooks. 2005. *The Soft Path for Water in a Nutshell*. The POLIS Project on Ecological Governance and Friends of the Earth Canada. University of Victoria. Victoria, BC. For more details about the National Study see www.waterdsm.org or The Friends of the Earth Canada web site www.foecanada.org.

Backcasting

Humans have sought insights into the future since the beginning of our history. Yet the future has always been, and will continue to be, uncertain. Many futures are possible and the future depends, at least in part, on the decisions we make today.

Approaches to studying the future rarely claim the ability to predict in detail. Rather, future studies usually focus on assessing various possible futures and the conditions that make them probable. The goal is to better understand trajectories of development and the implications of decisions taken in the present on realizing a desired future.

Backcasting is an established concept in the literature related to future studies.[2] It is only one of many methods for studying the future; others include trend analysis, cost-benefit analysis, visioning and modeling. Each is well established with extensive literature and each serves a slightly different function.

Backcasting focuses on how a desirable future might be created, not on what futures are likely to occur. The process starts by establishing a desired future state—in our case, based on sustainable water use—and then works backwards to determine what policy, technology and behavioural changes are required today (and over the longer term) to realize this future.

In developing our scenarios we consider population growth and economic development as exogenous factors. The scenarios do not consider possible controls on population or direct interventions in economic development. For the *Soft Path* scenario, our desired future state (i.e., the star in Figure 1) is based on fundamental principles of ecology concerning sustainable water use and ecosystem health, and ideally would reflect community values and priorities. However, in any specific real world case, many options could lead to the desired future (multiple possible paths exist); for our study we simply identify one of the more obvious and achievable routes.

Our scenarios

Figure 1 graphically illustrates the implications on future water use of three scenarios developed in this framework: *Business as Usual (BAU), Enhanced Efficiency (EE) and Soft Path (SP).* BAU and EE scenarios are projections—extrapolations based on certain assumptions (i.e. measures employed and penetration values). The SP scenario is a product of the backcasting approach.

The Business as Usual scenario simply extrapolates current water use patterns forward based on population and economic growth projections. This scenario is the status quo or baseline to which all other scenarios are compared to indicate the level of water savings possible through conservation and efficiency. In the BAU scenario only existing water conservation and efficiency measures and initiatives are included.

Enhanced Efficiency is a minimal water savings scenario. Projected demand is reduced below the BAU scenario by employing basic water reducing measures and techniques. This scenario focuses primarily on enhancing efficiency and is achieved with commonly available technologies and accepted

[2] Backcasting originated (and is more commonly used) in the energy field. For example, see Robinson, J. 1982. "Energy back-casting: A proposed method of policy analysis." *Energy Policy* 10, 377-344 and McDowell, W. and M. Eames. 2006. "Forecasts, scenarios, visions, backcasts and roadmaps to the hydrogen economy: A review of the hydrogen futures literature." *Energy Policy* 34, 1236-1250. For more general discussions of backcasting see Robinson, J. 2003. "Future subjunctive: Backcasting as social learning" *Futures* 35, 839-856; and, Swart, R.J., P. Raskin, and J. Robinson. 2004. "The problem of the future: Sustainability science and scenario analysis." *Global Environmental Change* 14, 137-146.

practices that do not require significant behavioural, structural or institutional change. Examples include technologies such as 6-litre toilets, low-flow showerheads and water efficient clothes washing machines and dishwashers, and policies such as building code changes, lawn watering by-laws, some education and basic economic incentives (i.e. minor water pricing structure changes and rebate programs for water efficient fixtures).

The Soft Path scenario is far more comprehensive. It incorporates the various measures included in the EE scenario, as well as adoption of more advanced technologies and practices (e.g. dual flush and some composting toilets; waterless sanitation in certain commercial and institutional settings; Xeriscaping; and, widespread reuse, recycling and rainwater harvesting) that require changes to individual behaviour and perceptions, laws and regulations, and, in some cases, water management institutions. This scenario employs a backcasting approach and is context-dependent—seeking to realize an envisioned future that reflects local ecological and economic conditions, and social values and priorities. A "desired future" of "no new water" (i.e. where all future growth in water demand is offset through conservation and efficiency) is a reasonable "desired future" for community-scale soft path planning. The specific SP scenario outlined in Table 1 is only an initial guideline (or starting point) and represents one possible "soft path" to water sustainability for a given community.

Figure 1: Water Use Scenarios

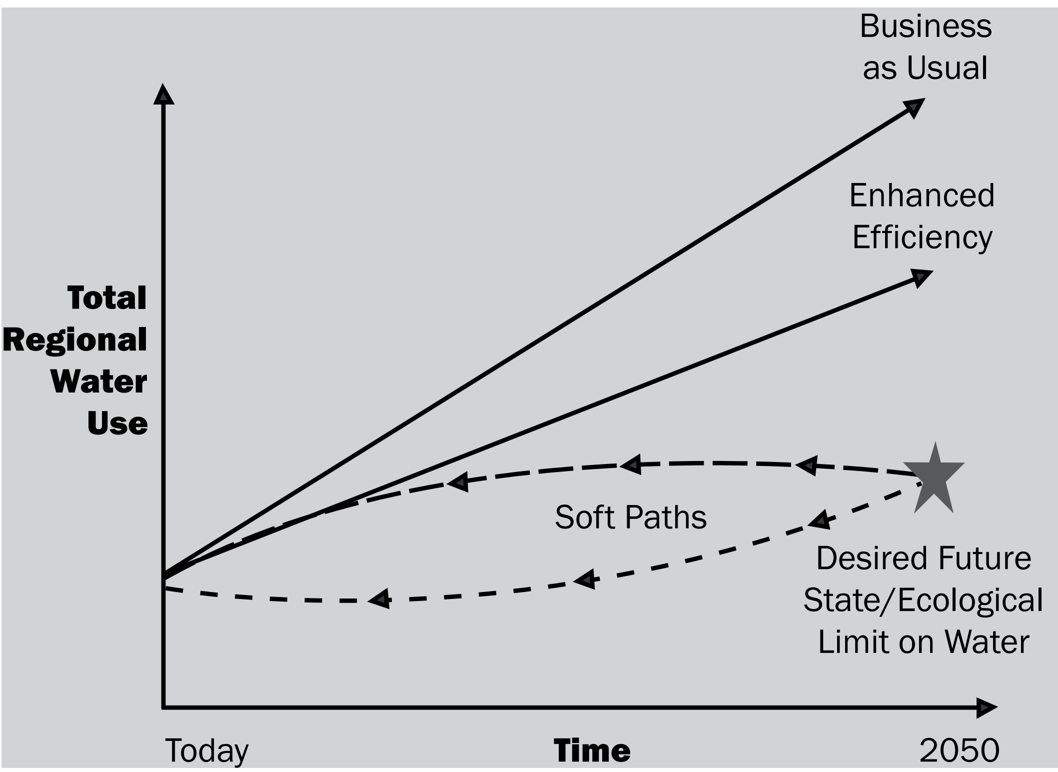


Table 1 on the next page summarizes the water efficiency factors and penetration values, broken down by subsector and end use, for the *Enhanced Efficiency* and *Soft Path* scenarios.[3] Since the Soft Path is developed through backcasting, the elements we include are only an initial rough guide because they are defined for each community; developing a mix tailored to a given community requires context specific information and citizen participation. Nonetheless, this scenario (with the characteristics as outlined in Table 1) is a good indication of what a realistic, yet aggressive, commitment to conservation might entail.

3. Since the BAU scenario is a projection of status quo conditions, it is not subject to efficiency factors or penetration values.

Table 1: Water reduction scenario assumptions							
Water Use Sector	**Water End Use**	**Scenarios**					
		Enhanced Efficiency			**Soft Path**		
		Measure	**Factor**	**Penetration**	**Measure**	**Factor**	**Penetration**
Residential Indoor	Toilets	6-L Dual-flush	0.36 0.20	90%* 10%*	Dual-flush Composting or alternative source	0.20 0	80%* 20%*
	Laundry	High-eff washing machine	0.55	100%*	High-eff WM Alternative source	0.55 0	50%* 50%*
	Showers	Low-flow ULF**	0.58 0.48	50%* 50%*	ULF Changed behaviour	0.48 0.30*	50%* 50%*
	Bath	No change			Changed behaviour	0.75*	100%
	Faucets	Low-flow	0.71	50%*	Low-flow	0.71	100%*
	Dishwashers	High-eff	0.71	100%*	High-eff Super high-eff	0.71 0.51	50%* 50%*
	Leaks	25% leak reduction	0.75	100%	50% Aggressive leak reduction	0.50	100%
Residential Outdoor	Lawn	Appropriate time of day, technology Modest Xeriscaping	0.70 0.50	50% 10%*	Appropriate time of day, technology Modest Xeriscaping	0.70* 0.50	30% 70%*
	Garden	No change			No change		
	Other (car washing, outdoor cleaning etc.)	By-law limitations	0.90	100%	Aggressive by-law limitations and enforcement	0.50	100%
Institutional-Commercial	Restrooms and kitchens	Mid-eff package: 6L toilets,spray-nozzles, LF faucets, high-eff DWs	0.60	100%	High-eff package: dual-flush toilets, spray nozzles, ULF faucets, super hight-eff washers, alternative sources	0.40	100%
	Outdoor	Appropriate time of day, technology Modest Xeriscaping	0.70 0.50	50%* 10%*	Modest Xeriscaping Aggressive Xeriscaping and alternative source	0.70 0	25%* 75%*
	Cooling/ heating	Single pass cooling ban	0.50	100%*	Looping and reuse/ recycling	0	100%*
Industrial	Details location specific	Technological innovation	0.90	100%*	Technological innovation	0.75	100%*
Unaccounted	Including: fire prev. parks & rec leakage	System audits	0.90	100%	Aggressive system audits and alternative sources for public lands	0.75	100%

* denotes increased water penetration reduction impacts associated with pricing and/or targeted education programs

**ULF = Ultra Low-Flow

Calculating Water Savings

Water efficiency factors (WEFs) are the building blocks of our scenarios. Each measure has an associated *water efficiency factor* representing the water savings potential resulting from its use. They are expressed as values between 0 and 1, where 0 indicates a 100% reduction in water use (no water use) and 1.00 indicates no change in water use. WEFs were developed from leading conservation research and studies where water savings have been verified, estimated or demonstrated in practice. Annex B includes estimates of water savings used to generate our WEFs for various technologies or practices. Though based on the best available information drawn from the technical and policy literature, these factors are for the most part approximations of possible impacts on water use.

Water efficiency factors are combined with *penetration values* to determine the applied impact of a particular technology or practice on future water use. Penetration values are "best guesses" or assumptions on the part of the analyst about the percentage of users employing a technology or engaging in a certain practice. This "best guess" approach, coupled with gaps in the water conservation literature, is why our work here can only be described as illustrative (i.e. "back of the envelope").

Special measures

A few *special measures*—pricing reform (and metering), education and alternative water sources—stand out as generally applicable and important components of any comprehensive approach, but are difficult to quantify in terms of water savings and overall impact. Metering, price reform and education can have a definite impact on water use (e,g. shortening shower times or reducing lawn watering), but are most effective when used in conjunction with various other measures. In a comprehensive water conservation and efficiency program these measures act as catalysts to promote development and uptake of new practices (i.e. Xeriscaping instead of standard lawn irrigation) or new technologies (i.e. replacing 6 L toilets with dual-flush may because such transformation may require education and a price incentive to promote cost-effective decisions). Our framework incorporates the effects of these special measures directly by influencing WEFs and indirectly by increasing penetration of given technologies or practices. We recognize this is an over-simplification, but for the purposes of this approach, it provides sufficient indication of the impact of these measures might have on overall water use.

Pricing reform (and metering)

In Canada, water pricing is often a flat rate—users pay a set administrative fee (that often does not cover administration or infrastructure operation and maintenance) and then all the water used is essentially free. This approach requires no signals and creates no incentive to reduce water use. More effective water pricing systems decrease per capita water demand by creating incentives to replace technologies (i.e. replacing high water use fixtures with more efficient models) or by changing certain practices by providing cost signals associated with volume of water used. Many different types of pricing structures exist—with implementation limited only by required changes to billing administration. For this study we simply assume pricing reform entails a shift in pricing structure from a flat rate to a conservation-oriented volume-based rate structure in which costs increase with the amount of water used. However, it is also important to note that to employ such a volume-based pricing systems requires universal metering of individual users (i.e. homes and businesses). so we assume full metering of these water users.

Our study does not deal with the impacts of pricing in a detailed manner; rather our focus is simply to indicate that in some cases, such as fixture replacement or outdoor residential use, pricing can have a significant effect by promoting substitution of more efficient options or changes in behaviour. Although we recognize that over the longer term, changes to pricing result in other indirect effects such as technological innovation and institutional change, our framework does not.

In our study, pricing reform (and implied universal metering) affects water use by increasing penetration values (i.e. increasing uptake of efficient technologies) or more directly by catalyzing behavioural changes that reduce water use (which is captured by increasing the WEFs). In essence, we use pricing as a catalyzing component affecting either the water efficiency factor (e.g. in the case of duration of showers or volume of baths) and/or the penetration values.

Education

Outreach and education to inform water users about water conservation initiatives is essential to any successful program. However, a truly effective education program will also increase public knowledge about the rationale for water conservation, the potential benefits, and how to engage in local action.

Similar to pricing, education can have direct effects on behaviour, but its primary benefit is as a catalyst for other initiatives. Education provides the "why" of incorporating new technologies and changing practices and behaviour. For our purposes, we use education primarily as a catalyst to increase higher penetration values. However, more aggressive education programs that employ social marketing can have a more direct effect. For example, the Region of Durham in Ontario has adopted a social marketing approach into 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.[4]

Social marketing differs from conventional approaches because more time and effort are invested up-front to understand barriers prior to program design and implementation.[5] Using focus groups of stakeholders to identify barriers and suggest possible incentives creates the direct and interactive contact with end users that helps achieve the level of "buy in" needed to inspire action.

Alternative sources

Rainwater harvesting and reusing reclaimed water are also important elements of our study. We assume these alternative sources (rainwater and reclaimed wastewater) are sufficiently available and can be used. Alternative sources replace current demand on centralized water supply systems, effectively reducing the water efficiency factor to 0 (alternative water sources replace current water sources, thereby reducing total "new" water use). Significant research about these alternatives is available, and reliance on both rainwater and reuse is increasingly common in places such as California, Florida, Israel, Germany, Australia, and even here in Canada in Vernon, British Columbia.[6]

4. Maas, T. 2003. *What the Experts Think: Understanding Urban Water Demand Management in Canada*. POLIS Project on Ecological Governance. University of Victoria, BC. Available at www.waterdsm.org

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

6. See, for example, Brandes, O.M., T. Maas, and E. Reynolds. 2006. *Thinking Beyond Pumps and Pipes: The Top 10 Ways Communities Can Save Water and Money*. The POLIS Project at the University of Victoria. Victoria, BC. Available at www.waterdsm.org.

Generic Urban Example

To illustrate the application of this framework, we developed the 3 scenarios—*Business as Usual, Enhanced Efficiency* and *Soft Path*—for a general urban centre with a base population of 200,000 in 2005 growing to a population of 300,000 in 2050.

To develop this generic case, and to identify the technologies and practices that are required to achieve our desired soft path outcome of off-setting all growth through efficiency and conservation (i.e. no "new" water), we look to a variety of real world examples. The calculations presented here draw on soft path analyses for a number of communities including the Town of Oliver in the Okanangan Basin, Victoria and The Capital Regional District in British Columbia as well as some smaller communities in Ontario. In this way, we use real world examples to illustrate our approach and to create a generalized urban soft path case that may be replicated across urban regions in Canada.[7] Table 2 summarizes the water use and water savings associated with each of the scenarios; the more detailed **Water Reduction Scenario Breakdowns** are found in **Annex C**.

Table 2: Summary of Water Use in Various Soft Path Scenarios for a Generic Urban Region in 2050

Water Use Sectors	Business as Usual		Enhanced Efficiency		Soft Path	
	Total water use	Daily water use (LCD)	Total water use	Daily water use (LCD)	Total water use	Daily water use (LCD)
Total	68,109	622	51,891	474	38,379	350
Residential	35,416	323	24,740	226	17,631	161
Res. Indoor	17,708	162	9,688	88	6,263	57
Res. Outdoor	17,708	162	15,052	137	11,368	104
Institutional & Commercial	12,940	118	8,489	78	3,720	34
Industrial	10,897	100	9,807	90	8,173	75
Non-Revenue	8,854	81	8,854	81	8,854	81

Notes:

- Table 2 assumes a base population of 200,000 in 2005 and 300,000 in 2050.
- Total water use = 1000's of cubic metres per year.
- LCD = Litres per Capita per Day.
- Formula to convert "Total water use" to LCD: Total water use ÷ population in 2050 ÷ 365 days per year x 1000 litres per m^3

7. For additional details on the various case studies and the water conservation calculations that drive the urban soft path analysis see the POLIS Water Sustainability Project's web site at www.waterdsm.org.

Our *Enhanced Efficiency* scenario demonstrates the significant potential of committing to a demand management approach that incorporates readily available technologies and practices. In our generic urban case, this scenario results in a water savings of approximately 24%, which in this case, amounts to an actual water savings of over 16 million cubic metres per year by 2050 compared to the business as usual scenario. Much of the real water savings were realized primarily through increased indoor efficiency: low-flow and dual-flush toilets, efficient showers and faucets, and water saving clothes washers.

Under this *Soft Path* scenario, by employing more comprehensive measures in a more aggressive package, water savings of almost 44% are possible—resulting in an overall savings for the generic case of just under 30 million cubic metres of water per year compared to the business as usual case. This is a significant amount of water savings—7 million cubic metres less water being used in 2050 than today.[8] This means that a population growth of almost 75% can be readily offset through conservation and efficiency.[9]

The *Soft Path* scenario builds on the initial water savings developed in the *Enhanced Efficiency* scenario, but is far more comprehensive. It starts by incorporating commonly available efficiency-based measures such as low-flow toilets and showerheads, water efficient clothes washing machines and dishwashers, and policies such as building code changes, lawn watering by-laws, some education, and basic economic incentives such as volume-based pricing systems. But to achieve the desired future of "no new water" the *Soft Path* scenario must go further. It involves adoption of more advanced technologies and practices: composting toilets and waterless urinals; Xeriscaping; and, widespread reuse, recycling and rainwater harvesting. These more aggressive measures require changes to individual behaviour and perceptions, laws and regulations, and, in some cases, to water management institutions themselves.

It is important to note that even more substantial water savings—beyond the 44% noted above—are possible with a soft path approach. In fact, we estimate that water savings of over 60% may be achievable in Canadian communities. Given the nature of our example—a goal of "no new water" until 2050 and beyond and a projected 50% growth in population—we applied the options most likely to achieve the targeted outcome.

A future different from the past

Our work demonstrates that potential to reduce urban water use is significant. Not only is more efficiency possible in the future; a much more significant goal of "no new water" until at least 2050 is also achievable, even under conditions of significant population growth. This soft path analysis is concrete proof that we do not need to elevate "trend into destiny." Our past urban water use patterns and habits need not dictate our future. A future different from the past is certainly possible; action, however, must begin today.

8. Based on a current water use of approximately 45 million cubic metres per year or 622 litres per capita daily (the Canadian average according to Environment Canada).

9. This is not unfettered "permission to grow" as other ecological constraints (e.g. land availability) and social values must also be considered.

Annex A: The WSP Scenario Builder[10]

By Tony Maas, Carol Maas and Katherine Zaletnik

What does it do? The WSP Scenario Builder facilitates a systematic approach to determining the potential for water savings through the application of efficiency and conservation measures. Several water conservation models already exist; however, this tool was designed specifically to develop and test the scenarios described in the "Back of the Envelope" Backcasting Framework (BEBF). The tool is not intended to replace a detailed conservation audit, but to provide for the preliminary evaluation of various scenarios under a soft path approach. Costs of implementing measures and the financial savings associated with the reduced water use are not addressed with thise tool.

How does it work? Analysts first select a *design year* approximately 40 to 50 years in the future. Current and projected population estimates (or economic growth) for the design year, combined with the current per capita water demand for each sector (residential, industrial and commercial, institutional and non-revenue water), are minimum required inputs to the Scenario Builder. Water use is then further disaggregated into end uses (e.g. toilets, laundry, lawn watering, etc.) if possible with real data, but more likely based on averaged data. Current water use is displayed for each end use as both *daily per capita demand* (LCD) and annual *current demand* (i.e. daily per capita demand multiplied by the current population, multiplied by 365). The tool then projects the future water demand (*BAU*) using population growth statistics. This BAU demand is the Business As Usual (BAU) scenario as it does not incorporate any water conservation strategies beyond those in use today.

Each measure (i.e. water conserving technology or practice) has an associated water efficiency factor that represents water savings associated with its use. Up to three measures can be combined and applied to each end use in our model.

The Scenario Builder then computes a *scenario projected demand* for each measure by multiplying the water efficiency factor, penetration and BAU projected demand. Table A (below) provides an example of this calculation for a single measure. The scenario projected demands for each measure within a specific end use are then totaled and can be compared to the original BAU water demand to determine the total potential water saved. Scenario projected demands for all end uses are then re-aggregated into sub-sectors, sectors and the *scenario total projected water demand*.

The scenario's *total projected water demand* represents the final aggregated water use and reflects the potential water savings from implementation of the specified water conservation measures. This value, expressed in cubic metres per year, allows a direct comparison between projected BAU water demands and the demands of alternate scenarios such as *Enhanced Efficiency* and *Soft Path* scenarios developed for this study.

Table A. Excerpt from the WSP Scenario Builder for a single measure

End use	Projected Population	Current Per Capita Demand (LCD)	Current Demand (m3/yr)	BAU Projected Demand (m3/yr)	Measure	Water Efficiency Factor	Penetration	Scenario Projected Demand (m3/yr)
Toilet	8,573	164	262,613	513,201	4.5/3 dual	0.20	80%	82,112

[10]. The development of this Scenario Builder was complemented by a similar effort at the British Columbia's Ministry of Community Service (MCS), led by Liam Edwards. The BC MCS calculator incorporated a large amount of demand and supply data on water use, as well as costs associated with supplying, storing and treating the resource. The development of each tool was influenced by the other; however, since they serve slightly different purposes, different models were created. Nonetheless, we would like to thank Liam Edwards for sharing his insight and working with us to create our Scenario Builder.

WSP Scenario Builder assumptions, inputs and limitations

The WSP Scenario Builder is intended to illustrate the macro impact of strategic, comprehensive integration of various water-efficiency and conservation technologies and practices. The tool includes the following inputs, assumptions and limitations:

1. Verifiable estimates from available literature and existing examples were used to determine average water savings of efficient water end-use fixtures or technologies to calculate water efficiency factors.
2. Impacts of different housing types on water use (i.e. detached, semi-detached, row-housing or apartments) are not directly considered, but are addressed indirectly through reductions in outdoor water use associated with smaller lawns. Only the water-use behaviour associated with single family households are used in the calculations.
3. The penetration values are based on "common sense" assumptions and "best guesses" on the part of the analyst. For example, consideration of the availability of the end-use fixtures or technology (e.g. showerheads, dishwashers etc.) and simplicity of installation (i.e. easier to install; cheaper and more accessible technologies have higher base penetration) influenced our "best guess." Such best guesses are typical of future research studies.
4. Alternative sources (i.e. rainwater or reclaimed water) are used only for toilets, clothes washing machines or outdoor use. Irrigated public areas such as golf courses, parks and sports fields for schools would be maintained using rainwater or reclaimed water.
5. Many of the water conservation measures used in the tool require changes to existing by-laws and building codes; we assume that these changes will occur (or are possible) to facilitate the water conservation efforts.

The WSP Scenario Builder is only the first step toward more detailed site-specific plans. Ccommunities can use this tool for an initial assessment and to initiate a discussion about what is possible and the opportunities available.

Annex B: Literature Review of Water Conservation Measures

The table on the following three pages summarizes information on many water conservation and efficiency measures, and includes estimates of the water savings achievable with each. The measures are organized into the following three types: structural and operational; socio-political; and economic. The technologies, practices and measures range from simple and common technologies (6-litre toilets) to forward-thinking, sophisticated measures such as greywater systems and Xeriscaping. Most of the measures are available in Canada, with the few exceptions noted in Table B.

For more details about possible water saving opportunities, see the recent POLIS publication *Thinking Beyond Pipes and Pumps: Top 10 Ways Communities Can Save Water and Money* at the Water Sustainability Project web site (www.waterdsm.org).

Table B. Literature review of water conservation measures

Technology/ Practice	Water Saving (%)	Water Saving[11]	Context	Source
Structural and Operational Strategies				
Toilets				
6-L toilet	64%	52.5 L/day	6-L replacing 16.5 L	Mayer et al., 1999, pg 232. City of Calgary, 2005, pg 13 AWWA, 2006, pg 53
6-L toilet (commercial)	54%	21 L/day	6 L replacing 13 L	AWWA, 2006, pg 53
3.78 L/flush urinal	50%	11.36 L/day	Replacing 7.57 L/flush urinals with 3.785 L/flush urinals	AWWA, 2006, pg 53
1.89 L/flush urinal	50%	1.89 L/flush	Require low flush urinals in new ICI	AWWA, 2006, pg 63
Dual-flush toilet	78%	12.8	4.4/3 L replacing 16.5L	Mayer et al., 1999, pg 23
Dry use/ composting toilet	100%	82.5 L/day	Replacing 16.5 L average water use for toilet	Commonwealth of Australia, 2005, pg 1
Waterless urinal	100%	11.36 L/day	Replacing 3.785 litre/flush urinal with no water urinal	AWWA, 2006, pg 53
Alternative water source toilet (grey-water/ rainwater)	100%	82.5 L/day	Replacing 16.5 L toilet	CEVE, 2000, pg. 1
Early closure device	Up to 35%	11.35 L	Installing an early closure device on toilet	Province of Manitoba, Undated, pg 2; AWWA, 2006, pg 53
Water displacement device	57%	9.46 L/day	Installing a device that reduces the amount of water used by older toilet types	AWWA, 2006, pg 53
Showerheads and Faucets				
Low-flow showerheads	53%	120 L/day	7 L/min replacing 15L/min	City of Davis, Undated, pg 12 City of Calgary, 2005, pg 3 Gleick, Peter et al, 2003, pg 75
Shorter showers	47%	64 L/day	Reduce time for shower from 15 min to 8 min	City of Calgary, 2005, pg 2
Low-flow faucets	21%	20 L/day	9.5 L/min replacing 12 L/min	City of Calgary, 2005, pg 12 U.S. Department of Energy, 2004, pg 13. AWWA, 2006, 53
Ultra low-flow faucets	53%	50.4 L/day	5.7 L/min replacing 12 L/min	Efficiency Partnership, 2005 Mayer et al, 1999, pg. 563. Region of Waterloo, 2005, pg. 2
Aerators	15.8%	15.16 L/day	Adding an aerator to a faucet to reduce water use	AWWA, 2006, pg. 125
Restaurant low-flow spray nozzles	50% of kitchen spray use	3900 L/day	Installing a low-flow spray nozzle in restaurant	AWWA, 2006, pg 63 (based on average daily demand per connection in GVRD: Vickers, 2002, pg 233)
Pre-rinse spray valve (commercial)		757 L/day	Installing a low-flow valve for pre-rinse sprays in restaurants	AWWA, 2006, pg 125
Insulate hot water pipes		7.57 L/day	Protect hot water pipes from losing energy and water	AWWA, 2006, pg 53
Pressure reducer		17 L/day	Installing a device on a faucet or general supply to reduce water pressure	AWWA, 2006, pg 53
Self-closing spray taps	50%	48 L/day	6 L/min replacing 12 L/min	Louw, DB and WE Kassier, 2002, pg. 34
	25% of faucet end use		Install self-closing spray taps in new ICI buildings	AWWA, 2006, pg 63

11. The water savings is based on three flushes per person per day.

Dishwashers and Clothes washers				
Water efficient dishwashers	24%	10 L/week	30L/load replacing 40L/load	City of Davis, Undated, pg 2
Water efficient dishwashers	36%	14.4 L/week	25.6L/load replacing 40L/load	EPCOR Canada, Undated, pg 1
Water efficient dishwashers	44%	17.5 L/week	22.5L/load replacing 40L/load	City of Calgary, 2005, pg 1
Water efficient dishwashers	55%	22 L/week	18L/load replacing 40L/load	Government of Australia, 2005, pg 1
Water efficient clothes washer (commercial)		170 L/day	Replacing a regular clothes washer with water efficient model	AWWA, 2006, pg 125
Water efficient clothes washer	45%	77.3 L/load	Average 92.7L (average) replacing 170L	Gleick, Peter et al, 2003, pg 125 (source for frequency of use): Louw, DB and WE Kassier. 2002, pg 118
Horizontal axis washing machine	33%	20.8 L/day	Average 113.5 L replacing 170L	AWWA, 2006, pg. 53
Outdoor Water Uses				
Water saving equipment in a swimming pool	30%	6411 L/day	Reducing/ eliminating leaks; ensuring pools are water efficient	European Environment Agency. 2001, pg. 69
Xeriscaping	30%	995.5 L/day	Xeric landscape replacing turfgrass	Sovocool et al., 2006, pg 92
Xeriscape mix	50%	51.5 L/day	Reducing green turf by half	Gleick, Peter et al, 2003, pg 64
Water saving "equipment" for irrigation	Approx 62%	117.8 L/day	Increase water efficiency of municipal irrigation	European Environment Agency. 2001, pg 69
Rain shutoffs		75.7 L/day	Installing a rain gauge to shut sprinkler off when raining	AWWA, 2006, pg 125
Hose timers		11.5 L/day	Putting a timer on a garden hose to reduce excess watering	AWWA, 2006, pg 125
Smart controllers	24%	24.72 L/day	Add smart controller to automatic irrigation systems	CUWC Council, 2005, pg 37
Rainbarrel program		900,000 L/ year	Using rainwater for residential lawn irrigation	BCMOE, 2001, pg 5
Agriculture				
Surface systems (flood)	55%efficient		Efficient agriculture	Louw, DB and WE Kassier 2002, pg 9
Conventional sprinkler	75% efficient		Efficient agriculture	Louw, DB and WE Kassier 2002, pg 9
Mechanical (centre pivot)	80% efficient		Efficient agriculture	Louw, DB and WE Kassier 2002, pg 9
Micro jet	85% efficient		Efficient agriculture	Louw, DB and WE Kassier 2002, pg 9
Leaks etc.				
Fixing leaks	75.6%	18.9 L/day	Repairing household leaks	AWWA, 2006, pg 53
		21801 L/day	Fixing one belowground leak averaging 15L/min	Jones, Marcellus Jr., 2006, pg 33
	12-15%		Repairing leaks in water supply system	Louw, DB and WE Kassier. 2002, pg 44
Household leaks	77%	19.3/L/day	"with conservation"	Louw, DB and WE Kassier, 2002, pg 118
Remove garbage grinder (commercial)		1514 L/day	Removing apparatus that grinds garbage in restaurant	AWWA, 2006, pg 125
Water saving equipment and leakage detection in individual schools	51-79%	15058 L/day	Improving efficiency of schools	European Environmental Agency, 2001, pg 69.
Cooling tower meters (commercial)	20% of cooling use		Sub-meter installation for cooling towers	AWWA, 2006, pg 63

Socio-political strategies				
By-laws	30%	32.96 L/day	Mandatory restriction limiting watering to twice per week	Vickers, Amy, 2006, pg 60
By-laws	53%	57.68 L/day	Mandatory restriction limiting lawn watering to once per week	Vickers, Amy, 2006, pg 60
Public Education and Behaviour changes	2-5% (of all end uses)	22.78 L/day	Information and education of water conservation	Louw, DB and WE Kassier. 2002, pg 120; BCMOE, 2001, pg 6; AWWA, 2006, pg 63
Public Education and Behaviour changes	15%	99.65 L/day	Reduce peak water usage	Derdall, 2002, pg 1
Irrigation Audit		113.55 L/day	Using an audit to identify residential water inefficiencies	AWWA, 2006, pg 125
Water use regulation		94.6 L/pers/day	Greywater reuse, residential	Louw, DB and WE Kassier. 2002; pg 120
A reuse program for hotel and motel owners(in Florida: encouraging room occupants to reuse towels rather than get fresh ones every day)		189.25 L/room/day	The estimated average was 50 gallons of water saved per occupied room per day. Participating hotels and motels also saved an average of 20 to 30% on laundry costs, and the amount of detergent used also decreased.	WaterBucket, 2006, pg 1 (Estimated results show that program participants saved a combined 100 million gallons of water in only one year. The audits covered properties ranging in size from one to 1000 rooms.)
Indoor audit (commercial)	15% of all end uses	378.5 L/day	Using an audit to identify water inefficiencies	AWWA, 2006, pgs 63, 125
Irrigation audits (commercial)		946.25 L/day	Using an audit to identify irrigation inefficiencies	AWWA, 2006, pg 125
Indoor water audits (residential)		75.7 L/day	Using an audit to identify water inefficiencies	AWWA, 2006, pg 125
Economic Strategies				
Increasing residential water rates and Universal metering	2-4%	19.53 L/day	10% increase in price	Louw, DB and WE Kassier. 2002, pg 120
	25-30%		Replacing flat rate with meter; pay according to use	Louw, DB and WE Kassier. 2002, pg 43
	34%		Installing meter on residential water accounts	BCMOE, 2001, pg 5
Home retrofit program		106.85 L/day	Providing households with rebates to install low-flow fixtures: showerhead $7, bathroom aerator $1; up to $14 per household	BCMOE, 2001, pg 6
Rainbarrel rebates		22.7 L/day	Providing money back on purchase of rainbarrel	AWWA; 2006, pg 125
Irrigation rebate		113.55 L/day	Rebates on high-efficiency product purchases	AWWA; 2006, pg 125
Clothes washer rebates(residential)		56.8 L/day	Rebate on high-efficiency clothes washer purchase	AWWA; 2006, pg 125
Coin-op clothes washer rebates (multifamily and commercial)	35% of laundry		Rebate on high-efficiency clothes washer purchase	AWWA, 2006, pg 63
Toilet rebates (residential)		94.6 L/day	Rebate on high-efficiency toilet purchase	AWWA; 2006, pg 125
Toilet rebates (commercial)		128.69 L/day	Providing commercial users with rebates to install low-flow toilets	AWWA, 2006, pg 125
Water rate/ sewer rate; rebates; stormwater utility approach; integration of water issues (rain, grey, potable)	5-13.8% reduction using an increasing block rate		Utility pricing to include full cost; increase water rate; rebates on efficient water fixtures; a 10% increase in water rates provided about 3% more revenue while triggering a 7% reduction in use	USEPA, 1995, pg 122 Louw, DB and WE Kassier, 2002, pg 43
Submetering	20-40%		Install meters in subunits, such as apartments and condominiums	USEPA, 1995, pg 10

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Annex C: Water Reduction Scenario Breakdowns

Average city – Business as Usual (21 Feb 07 Base year: 2005 – Projected to 2050)

Demographics	
Year	Population
2005	200000
2050	300000

input cells

DISAGGREGATION						PROJECTION
Total	Sector	Sub-sector	End-use	Demand (LCD)	Demand (m3/yr)	Demand (m3/yr)
Generic 100%				622	45,406,000	68,109,000
	Residential 52.0%			323	23,611,120	35,416,680
		Indoor 50%		162	11,805,560	17,708,340
			Toilet 30.0%	49	3,541,668	5,312,502
			Laundry 20.0%	32	2,361,112	3,541,668
			Shower 18.4%	30	2,172,223	3,258,335
			Bath 1.8%	3	212,500	318,750
			Faucet 12.8%	21	1,511,112	2,266,668
			Dishwasher 1.4%	2	165,278	247,917
			Leaks 13.2%	21	1,558,334	2,337,501
			Misc 2.4%	4	283,333	425,000
		Outdoor 50%		162	11,805,560	17,708,340
			Lawncare 70.0%	113	8,263,892	12,395,838
			Garden 20.0%	32	2,361,112	3,541,668
			Other 10.0%	16	1,180,556	1,770,834
	I & C 19.0%			118	**8,627,140**	12,940,710
			Restrooms 40.0%	47	3,450,856	5,176,284
			Outdoor 22.0%	26	1,897,971	2,846,956
			Cooling/Heating 28.0%	33	2,415,599	3,623,399
			Other 10.0%	12	862,714	1,294,071
	Industrial 16.0%			100	**7,264,960**	10,897,440
	Unaccounted 13.0%			81	**5,902,780**	8,854,170

Average city – Enhanced Efficiency (21 Feb 07 Base year: 2005 – Projected to 2050)

Demographics		
Year	**Population**	
2005	200000	
2050	300000	

input cells

DISAGGREGATION						PROJECTION	REAGGREGATION				
Total	Sector	Sub-sector	End-use	Demand (LCD)	Demand (m3/yr)	Demand (m3/yr)	End-use	Sub-sector	Sector	Total	
Generic 100%				622	45,406,000	68,109,000				**51,891,294**	1.14
	Residential 52.0%			323	23,611,120	35,416,680			**24,740,322**	1.05	
		Indoor 50%		162	11,805,560	17,708,340		**9,688,233**	0.82		
			Toilet 30.0%	49	3,541,668	5,312,502	**1,827,501**				
			Laundry 20.0%	32	2,361,112	3,541,668	**1,947,917**				
			Shower 18.4%	30	2,172,223	3,258,335	**1,726,917**				
			Bath 1.8%	3	212,500	318,750	**318,750**				
			Faucet 12.8%	21	1,511,112	2,266,668	**1,938,001**				
			Dishwasher 1.4%	2	165,278	247,917	**176,021**				
			Leaks 13.2%	21	1,558,334	2,337,501	**1,753,126**				
			Misc 2.4%	4	283,333	425,000	**0**				
		Outdoor 50%		162	11,805,560	17,708,340		**15,052,089**			
			Lawncare 70.0%	113	8,263,892	12,395,838	**9,916,670**				
			Garden 20.0%	32	2,361,112	3,541,668	**3,541,668**				
			Other 10.0%	16	1,180,556	1,770,834	**1,593,751**				
	I & C 19.0%			118	**8,627,140**	12,940,710			**8,489,106**		
			Restrooms 40.0%	47	3,450,856	5,176,284	**3,105,770**				
			Outdoor 22.0%	26	1,897,971	2,846,956	**2,277,565**				
			Cooling/Heating 28.0%	33	2,415,599	3,623,399	**1,811,699**				
			Other 10.0%	12	862,714	1,294,071	**1,294,071**				
	Industrial 16.0%			100	**7,264,960**	10,897,440	**9,807,696**		**9,807,696**		
	Unaccounted 13.0%			81	**5,902,780**	8,854,170			**8,854,170**		

Average city – Soft Path (21 Feb 07 Base year: 2005 – Projected to 2050)

Demographics	
Year	Population
2005	200000
2050	300000

input cells

DISAGGREGATION						PROJECTION	REAGGREGATION				
Total	Sector	Sub-sector	End-use	Demand (LCD)	Demand (m3/yr)	Demand (m3/yr)	End-use	Sub-sector	Sector	Total	
Generic 100%				622	45,406,000	68,109,000				**38,379,544**	**0.85**
	Residential 52.0%			323	23,611,120	35,416,680			**17,631,840**	**0.75**	
		Indoor 50%		162	11,805,560	17,708,340		**6,263,086**	**0.53**		
			Toilet 30.0%	49	3,541,668	5,312,502	**850,000**				
			Laundry 20.0%	32	2,361,112	3,541,668	**973,959**				
			Shower 18.4%	30	2,172,223	3,258,335	**1,270,750**				
			Bath 1.8%	3	212,500	318,750	**239,063**				
			Faucet 12.8%	21	1,511,112	2,266,668	**1,609,334**				
			Dishwasher 1.4%	2	165,278	247,917	**151,229**				
			Leaks 13.2%	21	1,558,334	2,337,501	**1,168,750**				
			Misc 2.4%	4	283,333	425,000	**0**				
		Outdoor 50%		162	11,805,560	17,708,340		**11,368,754**			
			Lawncare 70.0%	113	8,263,892	12,395,838	**6,941,669**				
			Garden 20.0%	32	2,361,112	3,541,668	**3,541,668**				
			Other 10.0%	16	1,180,556	1,770,834	**885,417**				
	I & C 19.0%			118	**8,627,140**	12,940,710			**3,720,454**		
			Restrooms 40.0%	47	3,450,856	5,176,284	**2,070,514**				
			Outdoor 22.0%	26	1,897,971	2,846,956	**355,870**				
			Cooling/Heating 28.0%	33	2,415,599	3,623,399	**0**				
			Other 10.0%	12	862,714	1,294,071	**1,294,071**				
									8,173,080		
	Industrial 16.0%			100	**7,264,960**	10,897,440	**8,173,080**				
									8,854,170		
	Unaccounted 13.0%			81	**5,902,780**	8,854,170	**8,854,170**				

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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