Soft Path for Water Strategy for the Abbotsford / Mission Water and Sewer Commission

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Executive Summary

Many Canadians believe that our fresh water resources are boundless. The truth is that only a small proportion of our water is renewable and located close to where most Canadians live. Continuing to take more and more water from nature while ignoring wasteful use at farms, factories and households will likely lead us to an arid future of our own making. The best way to secure the future for fresh water is to develop a plan that draws all "new" water from better use of existing supplies and to change habits and attitudes.

The "soft path" is a planning approach for fresh water that differs fundamentally from conventional, supply-focused water planning. The soft path approach allows us to unleash the full potential of demand management by changing water-use habits, technologies and practices. As a matter of principle, the soft path works within ecological limits and promotes local public participation to ensure sustainability of our water resources.

The City of Abbotsford and District of Mission are part of the Fraser Valley Regional District (FVRD) in the Lower Mainland of British Columbia. As in the rest of the Lower Mainland, the FVRD has experienced considerable growth over the past twenty years, sixty percent of which has occurred in the City of Abbotsford. Population is predicted to continue to grow, with the FVRD projected to reach 389,000 by 2021, and 462,600 by 2031. With a population of more than 131,000, Abbotsford is the fifth largest city in British Columbia. Due in part to its proximity to the fast-growing Greater Vancouver, the City will see continued growth with the population expected to exceed 195,000 by the early 2020's.

This heavy growth and growing demand for water has increasingly strained the region's water supplies. The Abbotsford Mission Water and Sewer Commission (the joint water system that serves the residents of Abbotsford and Mission) currently provides up to 156 mega litres per day (MLD), but can only comfortably handle 140 MLD, meaning that the system is close to capacity on hot summer days. While the AMWSC anticipates that the system will have enough water until 2018, the City and District's growing population will dictate that a new water source is needed after that. AMWSC is faced with a choice to either build costly infrastructure (current options include tapping into Stave Lake or installing a twin pipeline to run alongside the current water supply from Norrish Creek) or to defer this need for new infrastructure by engaging in long-term water conservation planning. This strategy seeks to provide direction to this second option.

A Sustainable Future for Abbotsford/Mission

A commitment to "preserving water supplies for the next generation" – meaning that all new demands for water will be met through conservation and efficiency rather than expanding supply, would be a significant step toward water sustainability and water management leadership in Abbotsford/Mission. Aiming for water neutrality in Abbotsford/Mission would mean mandating the highest level of water efficient fixtures and appliances in all new construction, use of alternative sources of water (e.g. rainwater capture and recycled water) for toilet flushing and landscape management, the use of off-site recycled water where available, conservation-based pricing for the residential and ICI sectors, and a progressive programme that targets reductions in residential and municipal outdoor water use and use in greenhouses and food processing plants in the agricultural sector.

Using the POLIS WaterSmart Scenario Builder, a desired future condition was created as the simplified goal of preserving water supplies for future generations by meeting all new water needs until 2031 through conservation and efficiency measures. This target is based on the understanding that expanding current water takings and constructing the associated infrastructure will damage local aquatic ecosystem health — both of which can be avoided through conservation and increased water productivity.

Based on population projections, three scenarios for water use in 2031 were calculated:

1) **Business as Usual**
2) **Enhanced Efficiency**
3) **Conservation Commitment**

The **Enhanced Efficiency** scenario targets average day reductions from **Business As Usual** of approximately 20% by 2031, in line with targets established by similarly sized municipalities. The **Enhanced Efficiency** scenario is a relatively straightforward goal and should be considered readily achievable provided funds and personnel are directed to the program.

The **Conservation Commitment** scenario explores a commitment to securing the water necessary for a thriving community through conservation efforts. A 45% reduction in annual average daily water use by 2031 would be required to meet this target while providing services for the increasing population. Peak day demand reduction of approximately 150 MLD would be targeted. This is the preferred scenario.

Both of these scenarios involve short-term strategies such as enforcing prohibited uses of water, expanding the prohibited uses of water, extending outreach efforts, and encouraging regional conservation measures. Long-term strategies include increasing water conservation through reduction of outdoor water use and new technology, maximizing water recycling, and enhancing stormwater capture.

Choosing a New Path Forward

This analysis demonstrates that it is not difficult to envision a better water future for Abbotsford/Mission- one that is sustainable yet permits vigorous development and agreeable lifestyles for residents and local business. However, conservation does not just happen. It will take concerted action and political leadership for Abbotsford/Mission to move to a sustainable use of fresh water. As this strategy illustrates, this action does not require immediate radical change, but it does require new thinking on getting an early start on implementing a step-by-step process that will, over the next 20 to 30 years, change the way water is managed in Abbotsford/Mission.

Section 1 - Introduction

Fresh water is vital to Canada's long-term prosperity. Yet despite its critical importance, water in this country is undervalued and often perceived (and managed) as if it were a virtually limitless resource. In water-stressed areas such as British Columbia's populated Lower Mainland, this "myth of abundance" remains firmly entrenched even though the region's drinking water supplies are under stress, conflicts among water users and uses are increasingly common, aquatic ecosystem health and fisheries are in decline, and economic opportunities are threatened (Brandes and Kriwoken, 2006: 90).

The traditional, supply-oriented, approach to water management in the Lower Mainland is strained by rapid population growth, pollution, increasing demands by residents for sustainable approaches, and the uncertainty of a changing climate. Changes in the region's economic priorities are another significant factor: emerging regional economic reliance on agriculture focuses attention on water security and emphasizes the need for a new approach to water management. During this period of rapid change many water supply systems in the Lower Mainland may be challenged to meet future projected demands based on their current supply capacity. Traditional water management approaches, based on bigger dams, deeper wells, and complex treatment plants, may simply not be ecologically sustainable in the long term. Fortunately, a new paradigm of water management is emerging—an approach focused primarily on water conservation and efficiency, with the potential to ensure long-term sustainability and social and economic prosperity. It is called the "soft path" for water.

As demand management programmes become more comprehensive and longer term, they approach a holistic way of thinking about water – the soft path. As with demand management, the soft path strives for efficiency in water use, but goes beyond efficiency by fundamentally challenging today's patterns of freshwater consumption (see Box 1.1). Demand management focuses on "how" – how to do the same with less water. The soft path, in contrast, focuses on "why" – why use water to do this in the first place? For example, why do we use half the potable water that is piped to a house in the summer for watering lawns and gardens and washing sidewalks? Demand management would urge more efficient sprinklers with automatic shut-offs, maybe even watering restrictions. The soft path goes further: recycling water from bathtubs and washing machines or, better yet,

Box 1.1 A Continuum of Water Management

Supply Management

Asks: How can we meet projected water needs given current trends in water use and population growth?

Solution: Construction of dams, pipelines, canals, wells, desalination systems and interbasin transfers.

Demand Management

Asks: How can we reduce needs for water to conserve the resource, save money, and reduce environmental impacts?

Solution: Gain efficiency through technical fixes and consumer education.

Soft Path

Asks: How can we deliver services currently provided by water (sanitation and irrigation, for example) in ways that recognize the need for economic, social and ecological sustainability?

Solution: Reduce water use through innovation, conservation, water reallocation and changing patterns of use and re-use so that more water is left *in situ*.

Adapted from Brandes & Brooks (2007). *The Soft Path in a Nutshell (Revised)*. Available at www.poliswaterproject.org drought-resistant greenery that requires little or no watering once it is established.

1.1 Strategy Purpose

This soft path for water strategy is a "real world" application of the soft path concept for the City of Abbotsford and the District of Mission. This work is part of a national soft path pilot project programme led by the University of Victoria's POLIS Project on Ecological Governance that seeks to test and refine tools for water soft path planning and implementation in Canadian communities. Through a number of sites in British Columbia and Ontario, this initiative applies the soft path approach to water planning at multiple scales and contexts to explore its potential for applying a widespread and more sustainable approach to water management in Canada.

This project was initiated by the POLIS Project on Ecological Governance and the Abbotsford/ Mission Water and Sewer Commission (AMWSC) to assess the potential to improve water sustainability planning and implementation. The City of Abbotsford and District of Mission, located southeast of Vancouver, both face growing demands for water and energy related to the significant economic development and population growth in the region and the corresponding costly expansion of infrastructure. AMWSC has recognized that improving the overall water efficiency of its system will have at least three significant impacts:

- Reduce or defer the need for capital expenditures related to infrastructure expansion
- Help establish the region's position as one of Canada's most proactive and progressive municipalities regarding water efficiency
- Help reduce the region's environmental footprint

1.2 Strategy Overview

This report is divided into four sections. Following this introduction, Section II provides an overview of the respective planning contexts of the City of Abbotsford and District of Mission and points to some of the emerging issues and challenges in the region. This includes a discussion of the region's geography and hydrology, water and the local economy, climate change impacts and some aspects of the institutional framework for water management. Specific details about water use, infrastructure and water management in the City of Abbotsford and District of Mission are also provided in this section.

Section III begins a more detailed soft path discussion, and outlines the potential of water conservation. Three different soft path scenarios are developed for the City of Abbotsford and District of Mission. Each of the scenarios—**Business as Usual**, **Enhanced Efficiency** and **Conservation Commitment**—is summarized in terms of water use and savings potential. The Business as Usual scenario describes future water use for the AMWSC under current management practices. The Enhanced Efficiency scenario applies some common demand management techniques to the Business as Usual model to demonstrate potential water savings. The Conservation Commitment scenario goes even further to integrate efficiency and conservation measures. This is the preferred scenario, which illustrates what a commitment to "Preserving Water supplies for the Next Generation" would entail for the AMWSC.

Section IV provides a comprehensive listing of recommendations and next steps for the AMWSC to begin developing a sustainable approach to water management. Each Action Item is accompanied by a "Who Else is Doing It?" section that highlights valuable experiences from communities from Canada and beyond that have started down this path and are already capitalizing on innovative thinking, technologies and institutions. Potential water conservation and efficiency measures for each scenario were subjected a qualitative screening process before being included in the strategy. Only those measures that are technically feasible, regionally appropriate and socially acceptable have been included as recommendations. Further details on the screening process are in provided in Section 4.1.

Section 2 - The City of Abbotsford and District of Mission

2.1 Population and Growth

The City of Abbotsford and District of Mission are part of the Fraser Valley Regional District (FVRD) in the Lower Mainland of British Columbia. As in the rest of the Lower Mainland, the FVRD has experienced considerable growth over the past twenty years with the population growing from approximately 135,598 in 1981 to 247,900 in 2001. Sixty percent of this growth has occurred in the City of Abbotsford. Population is predicted to continue to grow, with the FVRD projected to reach 389,000 by 2021, and 462,600 by 2031.[3] With a population of more than 131,000, Abbotsford is the fifth largest city in British Columbia. Due in part to its proximity to the fast-growing Greater Vancouver, the City will see continued growth with the population expected to exceed 195,000 by the early 2020's.[4] The District of Mission has adapted a medium population growth scenario (2% per year) with expected growth to around 42,000 by the 2020's.

To accommodate this growth Mission's OCP recommends subdivision infill development and new development in the eastern section of the District. Much of ICI-zoned land is underutilized and while there is small growth projected in this sector, no significant change in agricultural use is projected.[5] In contrast, only a comparatively small portion of the City of Abbotsford is designated for urban development. Urban growth is limited by several factors, the most significant being the Agricultural Land Reserve (ALR) that encompasses over 74% of the city's total land area. Environmental constraints imposed by steep mountainous terrain and riparian areas around streams reduce developable land areas to an even higher degree. These constraints mean that the City must prepare for increased densities of all types of land use in order to accommodate anticipated residential and employment growth. Economic activity and policies within the neighbouring Greater Vancouver Regional District (the third largest metropolitan area in Canada) will continue to impact growth and development in Abbotsford.[6]

Table 2.1 City of Abbotsford and District of Mission Population Growth

	Abbotsford	Mission	Total AMWSC
2006 Residential Serviced Population	104,931	27,460	132,391
2006 Equivalent Serviced Population	174,500	35,049	**205,549**
Future Serviced Population 2031	211,031	43,148	254,179
2031 Equivalent Serviced Population	372,656	57,603	**430,266**

Source: Water Master Plan Part I Technical Memo (AMWSC, 2009)

[3] City of Abbotsford OCP (2005), Part 2

[4] City of Abbotsford OCP (2005), Part 2

[5] WSMP (2006) Dayton&Knight, 2006

[6] City of Abbotsford OCP (2005), Part 2

2.2 Water Management

The City of Abbotsford and the District of Mission work cooperatively to operate and manage a joint water system that serves the residents of Abbotsford and Mission under the name Abbotsford/Mission Water and Sewer Commission (AMWSC).

The system is made up of surface water from local mountain streams and lakes as well as the transnational Abbotsford-Sumas aquifer. The primary source of water is Norrish Creek, with back up provided by Cannell Lake and 18 local ground water wells. The back-up sources are typically used to augment peak water demands, and in spring and fall when storms cause high turbidity in Norrish Creek.

The AMWSC supplies water through approximately 80 kilometers of transmission mains between the Norrish supply to various distribution points (reservoirs and booster pump stations). The City of Abbotsford maintains and operates approximately 900 kilometers of water mains, 21 individual pressure zones, 12 reservoirs, 10 booster pump stations, and eight pressure reducing stations.[7] Currently there are 18 wells with a capacity of 56 million litres per day. There is a small portion of the urban core in Clearbrook (approximately 210 hectares) that is serviced by Clearbrook Waterworks, an FVRD improvement district.[8] Current water licenses for the AMWSC are outlined in Table 2.2.

The District of Mission operates two water systems under permit from the Ministry of Health: the District of Mission Water System and the Ruskin Townsite Water System. It also operates a collection and trunk main sewerage system serving the urbanized areas of Mission. Most of the properties without municipal sewer service use ground disposal systems, however there are a small number of properties which employ holding tank system. Mission also operates a drainage system throughout the District, comprised of enclosed pipes and open channels. Most of the urban area has an enclosed system typically referred to as the “storm sewer system” with most rural areas having open channels typically referred as the “drainage system” and collectively referred to as the storm drainage system.[9]

Table 2.2 Licensed Supply in 2007

Source	Licensed Annual Withdrawal	Licensed Maximum Day Withdrawal
Norrish Creek (Primary Use)	92 MLD	141.5 MLD
Cannell Lake (Primary Use in Mission)	9.1 MLD	9.1 MLD
Abbotsford-Sumas Aquifer (Backup)	N/A	N/A
Total Supply	**101 MLD**	**151 MLD**

Wastewater generated by both the City of Abbotsford and the District of Mission is treated at the J.A.M.E.S. wastewater treatment facility. The facility is currently required to treat BOD, TSS, and ammonia to a level between 14-20 mg/L, and uses energy-efficient trickling filters for biological treatment. The wastewater treatment plant reuses a portion of the wastewater for in-plant requirements.

[7] City of Abbotsford OCP (2005), Part 2

[8] City of Abbotsford OCP (2005), Part 2

[9] District of Mission website. Last accessed July 27, 2009.

2.3 Water Demands in the City of Abbotsford and District of Mission

2.3.1 Peak Water Demands

Peak water demands are of particular interest because they dictate water supply capacity. Water demands approximately double during the summer months and are heavily impacted by outdoor water use and the agricultural sector. Peak day demands are much more variable from year to year than base water demands[10] as a result of temperature, rainfall patterns, and the duration of drought periods and hot weather.[11]

AECOM identified the peak (maximum) day demands (MDD) for Abbotsford at 110.98 MLD measured on July 26, 2006. This increased demand is attributed primarily to outdoor water use in the residential sector and food processing and livestock watering and washing in the agricultural sector. The overall peaking factor is 1.8, which is significantly higher than peaking factors noted in jurisdictions with conservation programming in place.[12] For example, the Capital Regional District on Vancouver Island reduced its peak day factor from between 1.8-2.0 to below 1.5 in 2001 by adopting Stage 3 water restrictions.

The peak day demands for each sector estimated by AECOM were combined to provide peak daily demands for each sector in the AMWSC.

2.3.2 Average Annual Demand

An analysis of average annual water demands is useful for understanding annual trends in operating cost and for benchmarking average per capita daily water use in each sector against other communities. However, average summer demands and peak daily demands provide a more accurate illustration of the potential for water shortages and system design needs.

Total average annual daily water production in Abbotsford and Mission was 78.19 MLD in 2007. Table 2.4 further disaggregates water use in Abbotsford and Mission into residential, industrial, commercial and institutional (ICI), agricultural and non-revenue water demand for 2007. Abbotsford is universally metered and the water use from each sector is based on actual measured volumes reported by AECOM (2009). However, Mission is not metered and therefore water use for each sector represents a "best guess" estimate and is considered much less accurate than the Abbotsford analysis.

2.3.3 Residential Demand

Residential water use constitutes approximately 50% of the total water demand in Abbotsford and an estimated 60% in Mission. An average daily residential water consumption of 281 litres per capita per day (Lcd) in 2007 and 293 Lcd in 2006 was calculated for Abbotsford by dividing the total metered residential water use by the serviced population.[13] A residential water use of 260-300 Lcd is within the range of other urban municipalities in Ontario.[14]

[10] Base water demands are the demands that remain approximately constant year round, and can be estimated by examining winter water use patterns.

[11] OWWA (2008)

[12] See for example OWWA (2008) and Maddaus (2002).

[13] The population and water use projections differ by one year. However this error is anticipated to provide lower than actual per capita consumption values, which will result in a conservative estimate of the potential savings associated with water conservation.

[14] See for example Environment Canada (2007); City of Guelph, (2009); Region of Peel, (2004).

Environment Canada's Municipal Water and Wastewater Survey suggests that British Columbia's average per capita water demand is 420 Lcd, and AECOM notes that the National Water and Wastewater Benchmarking Initiative (NWWBI) indicated average residential water use in BC is 440 Lcd.[15] Mission is not currently metered, and AECOM therefore utilized the NWWBI as an estimate, assuming a per capita water use of 440 Lcd.

Indoor water use was estimated by Kerr Wood Leidl at 77% of total annual average daily use by examining bulk meter readings.[16] This ratio of indoor to outdoor use is considered low in comparison to similarly sized urban communities in Ontario, where indoor use represents between 90 and 95% of ADD. This suggests that AMWSC may have higher outdoor residential water use, or that summer agricultural use impacts the ratio of base to summer demands.

2.3.4 Agricultural Demand

Potable water supplied by the AMWSC is not permitted for irrigation, however the production and processing of food is important to the region.[17] Municipally supplied agricultural water is allocated approximately 36% to livestock, poultry and dairy operations, 10% to greenhouse operations and 54% to other agricultural uses. The food processing industries, including fruit and cheese processing, consume considerable volumes of water and are anticipated to contribute significantly to the peak water demands.

Table 2.3 Water Use for Agricultural Purposes

Sector	2007Demand	# of Accounts	% of Total
Poultry	1.64 MLD	189	17%
Dairy	1.66 MLD	243	17%
Livestock	0.21 MLD	128	2%
Greenhouses	1.01 MLD	43	10%
Food Processing, Mixed Farming, Grain and Forage	5.29 MLD	1275	54%
Total Agricultural Demand	**9.8 MLD**	1878	100%

Although individual agricultural water users are metered, data are currently only reported once a year. Available information does indicate that food processing, mixed farming and grain and forage comprise the largest agricultural use of water in the region, however a detailed summary of high volume accounts within this sub-sector was not readily available. The number of accounts that comprise this agricultural sub-sector make a detailed analysis of water efficiency options difficult. Livestock operations, poultry and dairy farms and greenhouses together constitute the remaining agricultural demand for water. Many of the agricultural demands for water, particularly fruit and vegetable processing, are anticipated to contribute to the peak day demands for water. Agricultural peak demands for water have been accounted for in the peak day analysis and projections prepared by AECOM by assigning a peaking factor of 2 to the entire agricultural sector. This peaking factor was also included in the Scenario Builder analysis.

[15] Environment Canada (2007); AMWSC (2009).

[16] Kerr Wood Leidl (2006).

[17] AMWSC (2006)

2.3.5 ICI Demand

The ICI sector accounts for 17% of average daily demand. A detailed analysis of ICI demands was unavailable, however this sector is typically comprised of a mixture of manufacturing, golf courses, indoor use by employees, and outdoor landscape use.

City planning information indicates the 2006 ICI employment population of 57,313 will increase to 115,534 by 2031. AECOM assumed that ICI water demand will increase linearly with the increase in jobs and the 2007 ICI metered water usage of 13 MLD will increase to an average day demand of 25.9 MLD.

2.3.6 Non-Revenue

The non-revenue water demand in the City of Abbotsford was 17.5% of ADD in 2007. Non-revenue water was calculated by subtracting the total water accounted for by municipal billings (meter readings) from the total volume measured by the AMWSC bulk water meters. Non-revenue water includes both system leakage and leakage at the end-use, fire hydrant use, water system flushing, water meter inaccuracies, and other non-metered water uses. Typical non-revenue values in Canada range between 5 and 20%, however a percentage does not necessarily accurately represent the degree of water loss in a system, as this is heavily dependent on the volume of water used by individual facilities.[18] The Infrastructure Leakage Index (ILI) is considered the appropriate benchmark for the degree of water loss in a municipality. The ILI requires a detailed IWA Water Balance and is recommended as a "best practice" to accurately assess the opportunity for leakage reduction.[19]

2.3.7 Future Projections

Future average day and peak day water use projections are used as the **Business as Usual** scenario. Residential water use projections assumed the historical per capita demands of 281[20] and 440 Lcd for Abbotsford and Mission respectively; no water conservation and demand management measures have been incorporated into the business as usual projections. However, revisions to the BC Building Code that mandate ultra low flow toilets (6 litres per flush) in all new construction are anticipated to significantly reduce the per capita demands in Abbotsford and Mission by 2031 given that the population, and presumably the number of homes, is projected to double.

Annual average daily water demands for the combined system are projected to reach 162 MLD in 2031 as reported in Table 2.4. Peak day demands of 291 MLD in 2031 were estimated by assuming that the peaking factors for each community will remain constant. Non-revenue water was assumed to increase linearly under a BAU scenario and projected to constitute 17% of total future demands in both Abbotsford and Mission.

Table 2.4 AMWSC Summary Table of Current and Projected Demands

Sector	2007 Water Demand (MLD)	2031 Water Demand (MLD)
Peak/Max Daily Demand (MDD)	**141.6**	**291.8**

[18] Environment Canada (2007).

[19] AWWA (2006).

[20] AECOM assumed the 2006 residential per capita demand of 293 Lcd as a conservative approach. We have used the 2007 value of 281 Lcd for consistency with the 2007 current demands, however we do not anticipate this discrepancy to significantly affect interpretation of the final results.

Average Daily Demand (ADD)	78.2	162.2
Residential	41.6	79.82[21]
ICI	13.07	25.9
Agricultural	9.83	27.8
Non-Revenue	13.72	28.7

2.4 Water Infrastructure Improvements and Expansion

The AMSWC system is already approaching the current peak day capacity of Cannell Lake and Norrish Creek (150 MLD combined) with water use soaring to over 140 MLD on peak days. With population expected to double over the next 20 years, the AMWSC is planning to expand peak daily supply capacity by an estimated 150 MLD in addition to sourcing an estimated 50 MLD for emergency supply. The proposed expansion would involve a combination of treatment using membranes and conventional sand filtration.

The J.A.M.E.S wastewater treatment plant currently treats approximately 64 MLD and has a planned expansion to accommodate an estimated 130 MLD (equivalent population of approximately 450,000) by 2031.[22] Increasing levels of nutrients or a pH increase in the Fraser River could result in more stringent effluent ammonia requirements, which would necessitate a further expansion to accommodate advanced nitrification. Regulatory agencies are also encouraging a shift from chlorination of wastewater effluents to ultraviolet (UV) disinfection.[23] Requirements for advanced nitrification and/or UV disinfection could substantially increase both expansion and operating costs.

2.5 Water Demand Management in Abbotsford/Mission

The AMWSC commissioned a Drought Management and Water Conservation Study in 2006 that outlined a series of recommended water conservation and water management best practices.[24] The study identified a potential for water savings between 6 and 48 percent of total average day water demands through a series of best management practices such as volume-based conservation pricing, metering, and leak detection and conservation programming measures including toilet rebates, efficient fixture bylaws for new homes, and outdoor water audits. To date, despite having these comprehensive water conservation recommendations, the AMWSC has implemented a handful of best management practices and has initiated basic water conservation programming as outlined in Table 2.5.

[21] AECOM projected 80.89 MLD as a result of using the 2006 residential per capita demand of 293 LCD for projections. The 2007 per capita of 281 Lcd was retained for this analysis for consistency. This difference will result in predicted water savings erring on the conservative side.

[22] AMWSC (2006b).

[23] AMWSC (2006b).

[24] See Kerr Wood Leidl (2006)

Table 2.5 Existing AMWSC Water Conservation and Efficiency Measures and Impact

	Measure	Impact / Effectiveness
Best Practices of Water Management	**Leak Detection and Reduction** Mission's 2007 Water Capital budget provided $100,000 for the development of a Leak Detection Program. In addition, the District received a Provincial Local Government Infrastructure Planning Grant of $10,000 for the program	In 2008 four leaky water mains or services were detected, and repaired or replaced. The estimated annual water savings from the 4 repaired leaks is 7,300 cubic meters.
	Metering • Abbotsford plans to retrofit existing Automatic Meter Reading (AMR) meters using Advanced Smart Meter technology • Effective October 2008, all new developments in Abbotsford must supply and install water meters	Costs are estimated around $12,000,000. Mission's application for funding for metering program has not yet been successful. The District won't be going forward with the program without a grant. Advanced Metering Infrastructure (AMI) technology would significantly improve the ability to detect leaks, to disaggregate water use for each sector, to understand indoor vs. outdoor demands, and to monitor the effectiveness of water conservation programs. This measure is also recommended for the District of Mission.
Water Conservation and Demand Management	**Watering Restrictions** • AMWSC has established a watering restriction bylaw limiting outdoor watering to one day a week and also includes time of day watering restrictions to 6-8 am	This program is similar to that used in the Capital Regional District. Mission uses staff to monitor restrictions. Approximately 200 notices were given out in Abbotsford last year
	Public Education • During the summer of 2008 Abbotsford issued advertisements in the local paper and on local buses, placed banners across main roads, and implemented an extensive radio ad campaign.	Approximately $120,000 was spent on the public education program in 2008 in total for both Abbotsford and Mission.

	Measure	Impact / Effectiveness
	Rebates • Abbotsford and Mission currently offer a $50 rebate for replacing a 13 L toilet with an ultra low flush toilet (6 Lpf). Toilets are required to have a rating of 250 g/flush and be CSA or Warnock Hersey Certified. • Abbotsford and Mission both offer 200 litre rain barrels made from recycled industrial food containers for $57 each. Diverters that attach to the downspout and direct rainwater into the rain barrel are included	Unknown
	Other District of Mission's Community Plan Bylaw Policy 1.2.3 states that it will "require new developments to incorporate low impact development elements to manage rainfall at the source" and that it will "promote water conservation and develop programs to reduce water consumption."	Not yet implemented

2.6 A Sustainable Water Future for the Watershed

A commitment to "preserving water for the next generation" – meaning that all new demands for water will be met through conservation and efficiency rather than expanding supply, would be a significant step toward water sustainability and sustainable water leadership in Abbotsford/Mission. Aiming for water neutrality in Abbotsford/Mission would mean mandating the highest level of water efficient fixtures and appliances in all new construction, use of alternative sources of water (e.g. rainwater capture and recycled water) for toilet flushing and landscape management, the use of off-site recycled water where available, conservation-based pricing for residential and ICI sectors, and a progressive programme that targets reductions in residential and municipal outdoor water use and use in greenhouses and food processing plants in the agricultural sector.

Who's Already Doing it?

- *Calgary, AB* – Calgary's "30-in-30 by 2030" target is aimed at accommodating Calgary's future population growth with the same amount of water removed from the Bow River in 2003. The City's Water Efficiency Plan takes into account residential, commercial, municipal and industrial water use.
- *Los Angeles, CA* – Released an aggressive water conservation plan in July 2008 that targets 100% of new demand for water to be met through water conservation and water recycling by 2030, with 50% of all new demand being filled by recycled water by 2019 and the other 50% being met through additional conservation.
- *Guelph, ON* – Guelph is aiming for a 20% (10,600 m3/day) water reduction by 2025 with an explicit goal "to use less water per capita than any comparable Canadian City"
- *Okotoks, AB* – Okotoks is one of the first municipalities in the world to establish population growth limits linked to infrastructure development and the environmental carrying capacity of water source (Sheep River).
- *Dawson Creek, BC* has committed to a 50% reduction in water use by 2020
- *Great Lakes St. Lawrence Cities Initiative (GLSLCI)* has 62 member municipalities from the river's mouth to the innermost reaches of Lake Superior, and 33 local governments – not all of them GLSLCI members –working towards water consumption levels that would, by 2015, be 15 per cent below the volume used in 2000
- *Region of Peel, City of Waterloo, and Region of Durham, ON* have all pledged to increase water efficiency by approximately 10% over 10 years.

Section 3 – Water Conservation and the Soft Path in Abbotsford/Mission

3.1 Uncertainty and Adaptive Management

A precautionary approach suggests that we prevent unnecessary damage to ecological health by first tapping the significant source of new water available through conservation. Adapting to climate change and reducing human impact on the environment is fundamental to a long-term comprehensive approach to water management. It will also be a condition of BC Provincial infrastructure funding.[25] While it is difficult to predict exactly how communities will be affected by climate change, it is important to recognize that water conservation planning is an iterative process of testing and improving methods of analysis and management policies and practices, meaning that strategies should be robust and perform well under a range of potential but initially uncertain future developments.

A 'scenario analysis' approach can help resource managers and interested stakeholders better understand the inherent uncertainties about future management and, in turn, help uncover more innovative and successful management strategies for adapting to possible futures. Ultimately, the point—and power—of scenarios is not to develop a precise view or prediction of the future. It is to enable us to look at the present in a new and different way, and to find new possibilities and choices we might have previously overlooked or ignored.[26]

3.2 Applying the Soft Path Approach: Future Water Use Scenarios for AMWSC

For this strategy, the desired future condition is one that preserves water supplies for future generations by meeting all new water needs until 2031 through conservation and efficiency measures. This target is based on the understanding that expanding current water takings and constructing the associated infrastructure will damage local aquatic ecosystem health — both of which can be avoided through conservation and increased water productivity.

Box 3.1 How Much Does Water Really Cost?
Unlike other extractive activities that have an obvious direct impact on ecological health (toxics, forestry, dams), our demand for increasing volumes of water has a cumulative "death by a thousand cuts" impact on our freshwater ecosystems. The ecological impacts of removing too much water from the source include the following:

- Energy demands for pumping, treating and heating water contribute to new hydropower dams and/or greenhouse gas emissions.
- Production of large quantities of concrete, steel and PVC used to expand hard infrastructure has known ecological impacts.
- Diversion of water across local watershed boundaries can cause significant alterations to the natural hydrology.
- Wastewater generates point source pollution to local streams and rivers.
- Chemicals added into the water for treatment - chlorine, alum, ferrous and polymers - are ultimately released to local water bodies.

The scenario analysis begins with population projections. Using data supplied from AECOM, population was assumed to grow from 132,000 to 254,000 in 2031. Based on this projection, three scenarios for water use in 2031 were calculated:

[25] POLIS (2009).

[26] Gleick (2005)

1) **Business as Usual**
2) **Enhanced Efficiency**
3) **Conservation Commitment**

For the *Business As Usual* scenario, current water use patterns were extrapolated to 2031 using the AECOM analysis described in Section 2.3.7. To develop alternative scenarios, different packages of water efficiency measures and practices were applied to the **Business As Usual** baseline scenario baseline. Combined with the targeted shift in population uptake for each measure (called the penetration rate), we arrived at the community's total water use under these new hypothetical conditions.

Reducing discretionary (non-essential) water use such as lawn watering, car washing, and pools, can significantly reduce peak day demands and delay infrastructure expansion. The **Enhanced Efficiency** scenario was therefore developed with the intention to target peak day demands, while simultaneously offering programming that will reduce average day demand and thereby save operating costs and reduce pressures on local water resources. The **Conservation Commitment** scenario examined the goal of "Preserving Water for the Next Generation", essentially a commitment to finding the water needed for the community to grow through conservation.

3.3 Scenario Development

Abbotsford and Mission have been examined as a complete system because the water is extracted from the same source and wastewater is a combined collection system. Two alternative scenarios were constructed using the **POLIS WaterSmart Scenario Builder**. This Microsoft Excel spreadsheet-based tool follows a number of steps to arrive at total water demand under a given scenario. At a minimum, the Scenario Builder requires quantitative information about current and projected population and per capita water demand. Based on these values, it calculates current and projected average annual demand.

Both current and projected demands are then disaggregated into sectors (i.e. residential, institution & commercial, industrial, agricultural) then into sub-sectors (i.e. residential is subdivided into indoor and outdoor uses). Suites of water conserving technologies and practices are then applied to the disaggregated elements of the projected demand. For example, the penetration rate of water conservation measures is adjusted by shifting a portion of the future population from current per capita water demands of an average home to "efficient" homes with reduced water demands.

The reduced demand values are then re-aggregated into sub-sectors, sectors and total demand for the community. These re-aggregated values can then be compared to **Business as Usual** conditions to determine potential water savings for each of the two water saving scenarios. Further details on the WaterSmart Scenario Builder are included in Appendix E.

Both water-saving scenarios integrate a number of measures into "packages". The **Enhanced Efficiency** scenario uses a basic suite of demand management measures primarily focused on reducing peak day demands through outdoor water use by-laws and audits and by increasing efficiency (for example by increasing the penetration rate of ULF 6 L toilets and High Efficiency 4.8 Litres Toilets and high efficiency clothes washers through rebate and educational programmes) and water loss reduction.

The **Conservation Commitment** scenario was developed using a backcasting approach. It starts with the goal of "preserving water supplies for future generations" which is achieved by offsetting increases in water demand from growth through water efficiency and conservation. In order to meet this goal, re-aggregated total demand in the future must be less than or equal to current total water demand. This scenario applies many of the measures more aggressively than the **Enhanced Efficiency** scenario and includes a number of more innovative technologies, including alternative sources of non-potable water (e.g. rainwater and/or reclaimed water).

Appendix B outlines the packages of water conservation measures used to develop the two water saving scenarios. Appendix F details typical values for many of the parameters used in Scenario Building. Tables 3.1 and Figures 3.1 and 3.2 illustrate the outputs of the WaterSmart Scenario Builder for all three scenarios.

3.4 Scenario Results

The **Enhanced Efficiency** scenario targets average day reductions from **Business As Usual** of approximately 20% by 2031, in line with targets established by similarly sized municipalities. This value represents a targeted reduction in peak day demand of approximately 100 MLD from BAU. The AMWSC Drought Management report estimated conservation could reduce demands by 6 to 35 percent in Abbotsford and 15 to 48 percent in Mission, which is within the range targeted by other communities and confirms the results of the Scenario Builder. Municipal Water Efficiency Plans tend to target a 10 to 20 percent reduction in average daily water use over 10 years through cost-effective rebates, auditing, and capacity buyback programs alone.[27]

The **Enhanced Efficiency** scenario is therefore a relatively straightforward goal and should be considered readily achievable provided funds and personnel are directed to the program. All estimates have been based on assumptions for indoor and outdoor residential water use, which may contain inaccuracies as a result of insufficiently detailed data. As monthly (or daily) meter readings are obtained through the AMI system and universal metering is adopted, the data and estimated savings can be refined.

The second scenario **Conservation Commitment**, explores a commitment to securing the water necessary for a thriving community through conservation efforts. A 45% reduction in annual average daily water use over 24 years would be required to meet this target while providing services for the increasing population. Peak day demand reduction of approximately 150 MLD would be targeted. The results of both scenarios are summarized in Table 3.1.

To illustrate the cumulative savings achieved through conservation in comparison to growth rates, the increase in efficiency from gross per capita use of 591 LCD down to 519 LCD and 374 LCD, for Enhanced Efficiency and Conservation Commitment scenarios respectively, was assumed to be secured in approximately equal increments over 24 years. In other words, the AMWSC launches a 24-year water conservation strategy with approximately equal increases in efficiency each year. The decrease in gross per capita water use was then interpolated between 2007 and 2031, and multiplied by population (also assumed to increase at a constant rate of approximately 5,000 people per year) to result in an estimate of annual water demands for each scenario. The results are presented in Figures 3.1 and 3.2.

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[27] City of Guelph (2009); Region of Peel (2004); Region of Waterloo (2006); CMHC (2004).

Table 3.1 Scenario Summary Table for the Combined AMWSC System

Parameter	Current 2007	BAU[28] 2031	Scen. 1: Enhanced Efficiency	Scen. 2: Conservation Commitment
Serviced Population	132,391	254,179	254,179	254,179
Peak Day Water Use (MLD)	**141.58**	**291.8**	**193 (34%)**	**147 (50%)**
Annual Average Daily Water Use (MLD)	**78.2**	**162.2**	**132.2 (18%)**	**97.8 (41%)**
Residential Water Use (MLD)	41.57	79.82[29]	56.8	32.8
Residential Per Capita Demands (LCD)	*314*	*314*	*224*	*129*
Residential Indoor Demand Per Capita Demand (LCD)	*242*	*242*	*189*	*107*
ICI (MLD)	13.07	25.9	24.0	21.1
Agriculture (MLD)	9.83	27.8	25.0	22.3
Non-Revenue (MLD)	13.72	28.7	26.3	21.6

[28] All BAU projections will be slightly different than AECOM's reported values as a result of extrapolation of growth factors for each sector. The differential is far less than the inherent error in predicting long term per capita demands for both a supply side and demand side approach – in particular given the absence of daily metering data for sector demands.

[29] AECOM projected 80.89 MLD as a result of using the 2006 residential per capita demand of 293 LCD for projections. The 2007 per capita of 281 Lcd was retained for this analysis for consistency. This difference will result in predicted water savings erring on the conservative side.

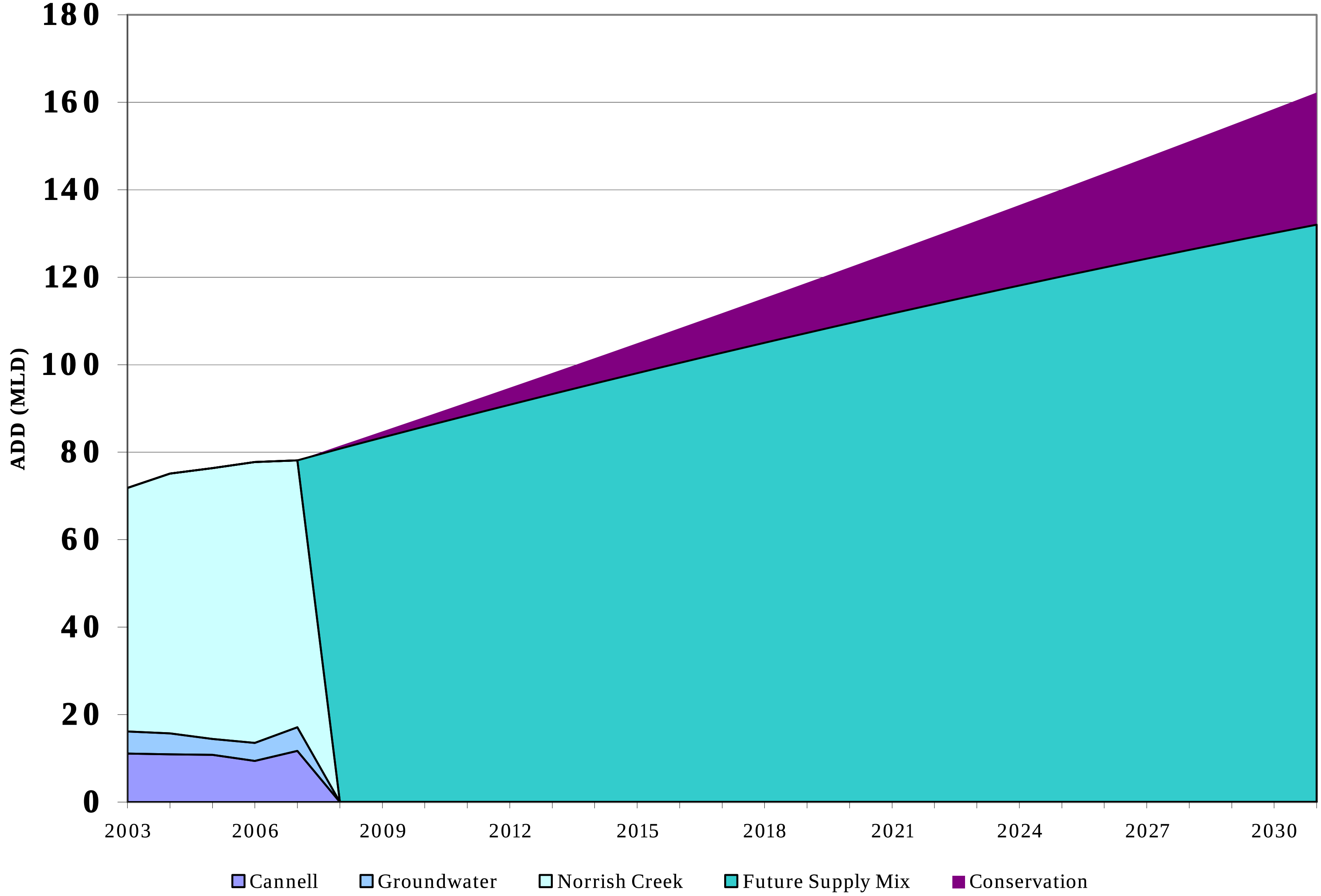

Figure 3.1 Enhanced Efficiency Sources of "New Supply"

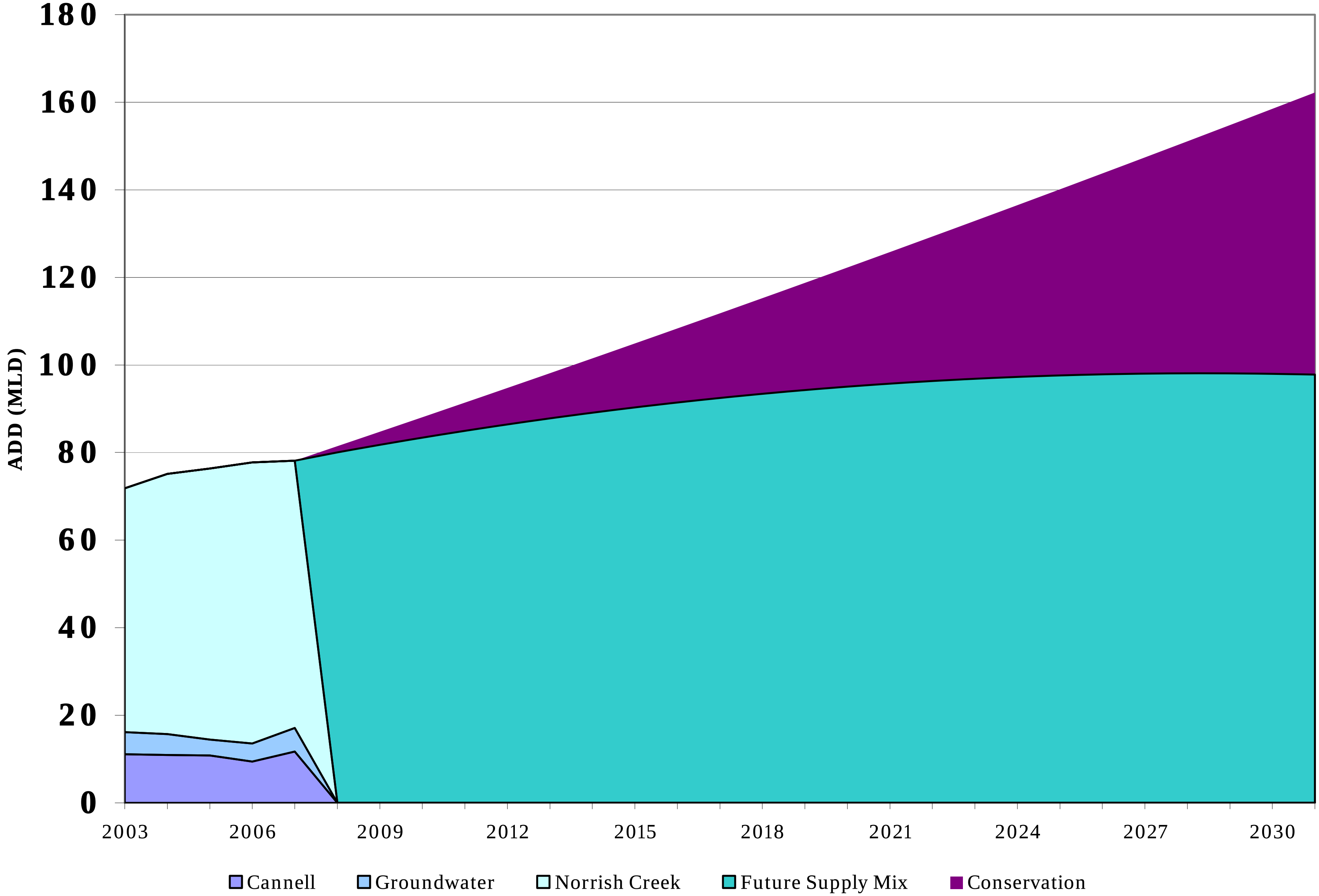

Figure 3.2 Conservation Commitment Sources of "New Supply"

3.5 Peak Day Analysis

Table 3.2 summarizes target peak day savings for each scenario. Targeted peak day savings are also identified for each sector in Table 3.2, along with a description of the shift in practices required to realize savings, relevant policies, measures and actions to enable change, and examples of communities that have implemented similar measures. Reduction of peak day demands offers significant system efficiencies – meaning 50% of the system is not constructed to serve a single day (or in some cases a single hour) of the year.

The participation rates presented in Table 3.2 should be considered as one example of how the suggested targets might be realized. For example, the savings generated by 50% of homes shifting to partially (50%) xeriscaped landscapes could also be achieved by 25% of homes shifting to 100% xeriscaped landscapes. Composting toilets are gaining in popularity, and adoption of this technology would reduce the demands of an efficient home from 130-150 LCD to below 110 LCD – and the overall participation rate could accordingly be much lower. The participation rates noted are intended to serve as examples of what the future *could* look like, but should not be considered prescriptive.

The targeted water savings presented may differ from conservation targets in other municipalities where targets are addressed primarily through rebates issued by the municipality. A comprehensive soft path strategy also accounts for savings achieved by the homeowner as a result of the many influences that may effect behavioural change including education, market trends, bylaws, and pricing.

Peaking factors are also highly variable from year to year as these are heavily dependent on weather patterns and watering bans. The estimates in Table 3.2 assume a reduction in the peaking factor from 1.8 to 1.6 as a result of education, conservation-based pricing and watering bans.[30] AMWSC has a much higher peak day demand for municipally- supplied agricultural water than other communities in Ontario for example. However, agricultural demands account for only approximately 14% of total peak day demand, meaning the overwhelming opportunity for reducing peak day demands lies within the residential sector. The Scenario Builder enables application of sector-specific peaking factors, and a peaking factor of 2 was retained for all scenarios to ensure a conservative approach to the agricultural sector (which requires more detailed audits of the large water users). The reduced peaking factor for the residential sector, along with the existing peaking factor for ICI and agricultural sectors, was then held constant and applied to outdoor water demands to project future peak day demands.

These projections should be considered a first estimate. Despite the uncertainty in future estimates of peaking factors as well as in the conventional water demand and population projections, the results illustrate the potential reduction in water demand based on the success of programs elsewhere.

3.6 Where Are the Savings?

Indoor residential water use has an enormous potential for water savings, largely because of the large volume of water typically used for toilet flushing clothes washing and in some cases leaks. Ensuring all new development incorporates the most efficient fixtures and technology possible would significantly reduce future water use. While many Canadian references and websites identify indoor per capita demand of 250 Lcd or greater, Veritec (2008) has shown that demands of as low as 147 Lcd can readily be achieved in new homes – representing residential demands that approach that of many European countries. Incorporating further efficiencies into new homes under the Conservation Commitment scenario such as hot water

[30] OWWA (2008)

recirculation systems, rainwater harvesting systems, grey water harvesting systems etc. could further reduce this demand. Use composting toilets would not only ensure reduced water and energy use, but would also reduce nutrient loadings to the Fraser River. An inefficient fixture installed today may persist for 10 to 20 years. “Future proofing” new homes with efficient technology is critical to ensuring the long-term sustainability of the water system.

Reducing outdoor water use in the residential sector is the second largest potential for water savings in Abbotsford and Mission, and the scenarios have considered the benefits of widely acknowledged best practices including tuning automatic irrigation systems and shifting landscape design to xeriscaped (a minimum 50% of landscape) and drip irrigation. Future proofing outdoor water use is also well suited to new development. Outdoor water audits and education for existing homes, and working with landscape and irrigation professionals can assist in minimizing outdoor water use in new homes.

Table 3.1 Targeted Peak Day Water Savings by Sector

Measures	Targeted Peak Day Water Saved		Examples in Practice
	Scenario 1	**Scenario 2**	
Total Peak Day Demand Reduction	**Target Reduction** **= 97 MLD** 30% less than BAU *Peaking Factor reduced from 1.8 to 1.5*[31]	**Target Reduction** **= 148 MLD** Preserve Water Supplies for Future Generations beginning 2010 *Peaking Factor Reduced from 1.8 to 1.5*	Seattle – in 15 years, population grew 20%, it reduced peak day demands by 30% overall. (Maddaus, 2002) Peaking factors in Ontario range between 1.2-1.6 (OWWA, 2008)
Reduced Use or Shifted Demand *Assume a reduction from a peaking factor of 1.8-1.6*	**28.4 MLD** *10% less than BAU*	**28.4 MLD** *10% less than BAU*	Kelowna – metering and education = 20% reduction despite 25% increase in population (Klassen, 2007). Abbotsford’s residential sector uses 40% less water than Mission – presumably from metering alone.
Residential Indoor: efficient toilets, clothes washers, faucets, showerheads.	**13 MLD** *100% New Homes High Efficiency* OR *50% New Homes / 50%*	**34 MLD** *100% New Homes High Efficiency* *100% Existing Homes Retrofit to High Efficiency*	Edmonton’s bylaw for water efficient fixtures (Edmonton, 2008) Ontario Building Code ensured all new homes since 1996 were

[31] The peaking factor is also a function of base demands, and the agricultural peaking factor was assumed to stay constant at 2.0

[32] Required 6 Lpf toilets and 9.5 LPM showerheads in all new homes since 1996 and has an average residential per capita use of 260 LCD – compare to BC’s per capita of > 400 LCD.

Measures	Targeted Peak Day Water Saved		Examples in Practice
	Retrofits	*Efficiency* *100% Homes using non-potable water for toilets*	Efficient[32]
Outdoor water conservation Efficient homes are: • 50% of landscape xeriscaped • drip/micro irrigation • tuned-auto irrigation	**44[33] MLD Residential** *80% Homes Efficient:* *25% of all homes use non-potable sources for outdoor use.* **2.8 MLD Commercial Institutional** *80% Landscapes Efficient* *25% of all homes use non-potable sources for outdoor use.*	**60 MLD Residential** *80% of Homes Efficient* *60% of all homes use non-potable sources for outdoor use.* **3.5 MLD Commercial Institutional** *80% of Landscapes Efficient* *50% of all outdoor use is non-potable sources.*	Cochrane, Kelowna, Vernon have outdoor landscape bylaws that ensure all new homes are efficient or better. City of Tucson (2008) mandates all commercial development plans have a rainwater harvesting plan. Southeast Queensland (2008) mandates rainwater harvesting for non-potable use in all new homes.
Industrial Water Use Audits and/or Capacity Buyback, Once through Cooling	**1.3 MLD** *10% increase in efficiency*	**2.6 MLD** *20% increase in efficiency*	15-50% potential reduction (Vickers, 2001; Cohen, 2004)
Commercial Rebates: Toilets, Urinals and Pre-Rinse Spray Valves	**0.2 MLD** *500 Toilets, 200 Pre-Rinse Spray Valves*	**1.8 MLD** *5000 Toilets, 2000 Pre-Rinse Spray Valves*	15-50% potential reduction (Vickers, 2001; Cohen, 2004) Region of Peel (2004) toilet replacement targeted 11,600 commercial toilets. City of Calgary had replaced 1300 pre-rinse spray valves by 2008.
Agriculture	**5.3 MLD** *10% reduction in demand*	**10 MLD** *20% reduction in demand*	10 – 40% reduction potential (Cooley, 2009, Georgia's Water Conservation Implementation Plan, 2009)
Non-Revenue	**2.4 MLD**	**7.2 MLD**	10-35% reduction

[33] Assumes 10% of future population has automatic irrigation systems

Measures	Targeted Peak Day Water Saved		Examples in Practice
	10% reduction	*20% reduction*	potential (Environment Canada)

Section 4 – Getting from Here to There: Action Items for Implementing a Soft Path Strategy

Contemporary urban water efficiency efforts are typically viewed as *ad hoc* measures aimed at buying time until new supplies can be secured and developed. The soft path differs fundamentally from these efforts by directing planners to look beyond programs aimed at simply using water in more efficient ways. Instead the soft path tackles broad questions—asking not only how to use water more efficiently, but in some cases, why use water at all? This approach shifts the objective of water management from expanding and maintaining water supply infrastructure to providing water-related services, such as new forms of sanitation, drought-resistant landscapes, rain-fed ways to grow certain crops, or even influencing what crops are grown in the first place.

This strategy is not a detailed analysis, nor does it provide a complete plan of action. Instead this is a coarse survey that illustrates what is possible by integrating various technological and policy measures. This should not be considered an endpoint. On the contrary, it is only the beginning of a dialogue about what kind of future makes sense for Abbotsford and Mission. A number of potential barriers slow or impede the implementation of water conservation measures. Perhaps most important among these is the general lack of public awareness in Abbotsford and Mission about the region's water resource limits and the associated impacts on economic development and ecosystem health. This lack of awareness limits community and political commitment to a long-term and comprehensive approach to demand management. With little sense of urgency, inertia maintains the status quo.

The following action items and associated recommendations represent the immediate (and likely most effective) opportunities to begin creating a more sustainable approach to water management for the AMWSC, regardless of which scenario is adopted.

4.1 Screening Measures for Action Items

Although there are many ways to reduce water use, not all of them are applicable to AMWSC. Potential water conservation and efficiency measures were subjected a screening process before being included in Abbotsford/Mission's Soft Path Plan. Each recommendation was qualitatively evaluated based on the following criteria and only those measures meeting these criteria have been included as recommendations below:

Technical Feasibility
Measures must be based on proven technology and expertise and must reduce water demands as intended

Applicability
Measures must address inefficient water demand occurring in the region and be within AMWSC's jurisdiction

Social Acceptability
Measures must satisfy the values and priorities of the Abbotsford/Mission community (participation rates may be greater for measures that are more socially acceptable)

Where possible, *cost-effectiveness* was also taken into consideration when reviewing potential measures. While some water efficiency planning works to gauge cost-effectiveness according to the degree to which a given measure costs less to implement than to meet the same water demand through infrastructure expansion, a soft path approach takes a more holistic look at costs, including the cost of removing water from the ecosystem (generally difficult to measure using conventional approaches to costing).

4.2 Action Items - All Sectors

4.2.1 Set an Overall Water Use Goal of "Preserving Water Supplies for the Next Generation"

Adopting a vision of "Preserving Water Supplies for the Next Generation" for Abbotsford/Mission inspires a paradigm shift towards water conservation without using an absolute or percentage reduction target that may be difficult to quantify. It means focusing on the abundant supply of "new water" that is being flushed down the drain in the interest of ensuring the long term sustainability of water supplies, minimizing damage to sensitive aquatic ecosystems from new infrastructure, and increasing overall community resilience by doing more with less. The financial benefits of committing to conservation now will reduce all future expenditures on water and wastewater. Water conservation planning is flexible and can be adapted over time with improvements in technology, changing social values and norms and the needs of the community stemming from increasing pressures on limited resources.

An overarching water conservation target sends a clear signal to the public that water conservation and efficiency are essential to continued economic and ecological health. Naturally, there are challenges associated with setting overarching targets, particularly in the absence of solid baseline information on existing water use and the potential for water savings in each sector (residential, institutional, commercial and industrial). Yet in spite of these challenges, a target provides incentive for change and a benchmark with which to gauge progress.

4.2.2 Create a Water Demand Management Team

Hiring permanent staff with technical skills and understanding in diverse fields such as ecology, social marketing, economics, and education is a critical first step in developing and implementing any long-term water conservation strategy. A project team that is shared between the City of Abbotsford and District of Mission, working toward the same goal and objectives and sharing information, resources and expertise will be able to exercise greater control over the implementation process, thereby increasing the likelihood of success. Responsibilities of the team can include measuring, tracking and reporting on the performance of the water soft path strategy and establishing and implementing water conservation and efficiency measures.

Specific Actions

- Create a Water Demand Management Team to be shared by the City Abbotsford and District of Mission that includes three full-time staff positions, including residential, agricultural and ICI and outreach positions and 4 seasonal (summer) positions

Who's Already Doing It?

- *CRD* has a comprehensive DSM team with 5.5 FTE as of 2009 and 4 summer students plus 1 winter co-op student every year with an annual total operating budget in 2008 of $1.5 million
- The *City of Guelph, ON* has 3 FTE and 4 PTE (seasonal) staff with an annual budget for its Water DSM programme of $825,000. Beginning in 2010 the staffing will increase to 6

FTE and 4 PTE (seasonal) with 1 PTE (ongoing co-op student) and an annual budget of $2-million

4.2.3 Implement Full-Cost and Volume-Based Pricing

In the majority of Canadian communities water rates fail to reflect environmental costs, and in many cases do not even reflect the full financial cost of providing water services. Canadians paying flat rates use 74% more water than those under volume-based structures. [34] Full cost water rates should extend to protecting the source, replacing aging infrastructure at a reasonable rate, water conservation planning and programming, education, research, and treatment of wastewater as opposed to a narrow focus on water treatment infrastructure.

Specific Actions

- Implement universal metering in District of Mission
- Implement separate volume-based pricing schemes for residences, businesses and agriculture to encourage water conservation
- Provide homeowners and businesses with water bills that clearly indicate their daily water use, which can then be compared to water use per person on the City of Abbotsford and District of Mission websites
- Implement volumetric wastewater charges for non-residential customers to encourage water conservation

Who's Already Doing It?

- The *Capital Regional District* has implemented full-cost pricing so that customers pay the entire cost of the water they use, including the capital costs and maintenance costs
- *South East Kelowna Irrigation District* reduced agricultural water use by 27% over a five-year period through an increasing-block pricing system
- *City of Calgary* provides a good model in terms of content and format for displaying water consumption and payment information on residential water bills
- *Great Melbourne, Australia* began incorporating the costs of water conservation programmes into water pricing in 2008

4.2.4 Plan for Sustainability Through "Wet Growth"

Land use decisions determine water use and watershed health now and in the future, and many 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 water use considerations – has negative impacts that may not be evident until years later. AMWSC should explore implementing water and land use policies that require all new developments to either offset new water demands with conserved water or purchase water rights.

Specific Actions

- Require that all land use decisions be assessed for watershed impacts

[34] Environment Canada (2005).

- Approve all new construction in a manner that ensures avoiding negative impact on the supply and quality of potable water by requiring a permit and a development plan for all construction that states how potential problems related to water supply and quality will be handled
- Have developers include water efficiency packages for homeowners as part of their development permits
- Set reasonable irrigation limits on residential construction by establishing minimum lot sizes
- Offer incentives to developers to develop "closed loop" communities that supply their own "off the grid" wastewater systems and use rainwater harvesting for outdoor and toilet use

Who's Already Doing It?

- Dockside Green in Victoria, BC is a 1.3 million square foot development comprised of mixed residential, office, retail and industrial space in downtown Victoria. The development uses a "triple bottom line" approach to integrate 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, including 100 percent onsite sewage treatment.

4.3 Residential Sector

4.3.1 Efficient Indoor Residential Water Use

Municipalities spend millions of dollars per year on rebate programs that would no longer be necessary if water-wasting fixtures (such as 13L toilets, top-loading clothes washers, inefficient pre-rinse spray valves) were no longer available for purchase. Mandating best available efficient fixtures in all new construction that meet or exceed existing international standards through bylaws and by updating specifications regularly is much more cost effective than conducting retrofits later, and ensures all new demands for water are the most efficient possible.

Residential water consumption is influenced by both lifestyle (personal habits, showering frequency/duration, laundry frequency, irrigation practices etc.) and the technology used in the home (type of toilet, showerhead, clothes washer etc.). Typically about 75% of indoor water use is related to just three elements: toilet flushing (31%) laundry (25%) and showers (19%). [35] A recent study shows that up to half of the water savings achieved by retrofitting homes with efficient clothes washers, dish washers, toilets, showerheads, fridges and landscape packages appears to be from changes in participant lifestyle and habits vs. improvements in technology.[36] This is significant in terms of recommendations because it means that the potential for water savings is far greater than can be explained simply by the installation of efficient appliances. In other words, municipal efficiency improvement programmes should promote both physical changes to fixtures, appliances, gardens etc. through rebate and give-away promotions, as well as habitual changes regarding how these fixtures, appliances, and gardens are achieved through education and outreach programmes.[37]

[35] Aquacraft. Residential End Use Study.

[36] Veritec (2008)

[37] The study also calculated that the payback period associated with upgrading the study homes is approximately 3.4 years - which is reasonable considering that the retrofitted fixtures and appliances installed will last much longer than 3.4 years. It

Specific Actions

- Mandate WaterSense fixtures in all new construction
- Investigate options to require the installation of water efficient fittings and fixtures in all existing homes upon resale, or mandating disclosure of water efficiency at point of sale
- Work with local businesses and retailers to extend standards beyond new construction to point of sale transactions (i.e. discourage the sale water inefficient fixtures such as 13 L toilets)
- Require plumbing rough-ins that enable future water collection and use of alternative sources for toilet flushing and lawn watering (purple pipes) as will be mandated in BC according to Living WaterSmart by 2010
- Create an extensive high-efficiency fixture and appliance retrofit and installation programme for all residences that focuses on toilets, showerheads and clothes washer replacement

Who's Already Doing It?

- The "Target 140" programme in Australia saw residents of Southeast Queensland reduce their per capita water use from 295 lpd to 140 lpd through a series of restrictions, education programmes and water conservation-based rates. The programme attributes the largest reduction in residential water use to its "Home WaterWise Rebate Scheme", an extensive home visit programme that had project staff going to each home and replacing all fixtures with high efficiency fixtures as well as rainwater tanks plumbed into internal fixtures at a significantly subsidized cost to homeowners
- The *US Energy Policy Act* sets minimum water efficiency standards for both new construction and all point of sale transactions
- *District of Campbell River Engineering Services* has produced a good paper on conducting both residential and commercial indoor water audits for the purposes of identifying high water use devices that can then be replaced or retrofitted to save water
- *Sunshine Coast Regional District* saved approximately 3.2% of total annual municipal water use in 2007 alone through its rebate and installation programme

4.3.2 "Go Golden" Campaign to Reduce Outdoor Water Use

Outdoor water use is the primary factor contributing to peak demands in Abbotsford/Mission. For this reason, outdoor summer demands should be one of the primary targets of the water conservation programme. Although odd/even day watering restrictions are common in Canada, from a practical and mathematical perspective they tend to offer little in the way of savings. Instead, limiting water use to one day per week is becoming more common in the US and Ontario and the AWMSC should ensure that the time of day restrictions corresponds with efforts to reduce peak hourly demands.

Specific Actions

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was also projected that after the 3.4 year period the homeowner will start to save more than $200 per year in water and energy costs (Veritec 2008, p.22)

- Implement a bylaw limiting outdoor residential watering to one day per week and use a tiered system of communication/outreach program and enforcement to enforce compliance
- Mandate water efficient landscapes in all new homes
- Set a target of reducing municipal irrigation by 15% through a number of measures including a centralized irrigation system (the largest in North America) as well as irrigating “only when necessary” and banning irrigation on boulevards, medians, traffic; using drought-tolerant plants and xeriscaping; having developers submit irrigation master plans early
- Offer residential landscape water audits and home visits as a component of existing public education and outreach campaigns
- Continued incentives and rebates programme for homeowners for rain barrels and rain gauges, hose timers and automatic irrigation systems
- Offer automatic irrigation system tuning and education local landscape irrigation professionals
- The Irrigation Industry Association of British Columbia’s head office is in Abbotsford. This is an excellent opportunity to require certified installers and/or drip (micro) irrigation systems in new homes by working with the certification body. Consider developing something similar to WaterSense certified irrigation specialist based on the WaterSense specifications and begin by committing to only using these types of installers for City parks and other municipal properties

Who’s Already Doing It?

- *York, Guelph, Waterloo, ON* each implement bans during drought conditions and use a tiered system of communication/outreach program and enforcement to enforce compliance.
- *City of Kelowna* found that seasonal residential landscape water audits and home visits (mid-April to August 31st), where City staff visited homeowners and conducted irrigation system, landscape and soil assessments was key to reducing outdoor water use by 15% in the first year of the programme. WaterSmart staff is certified by the Irrigation Association of BC. Similar pilot programmes completed in Durham and Halton, Ontario have shown an average peak day savings of about 200 litres per single-family household. The pilot programmes involved distributing water efficiency items such as rain gauges and hose washers and information pamphlets to households.
- *Vernon, BC* limits lawn coverage to 30% of property
- *Cochrane, AB* requires that all landscaped areas have a naturescaping component, where **“naturescaping ”** refers to the modification and enhancement of a lot or development area through the use of natural indigenous vegetation, in conjunction with permeable or pervious surfacing material, such as brick, stones, wood, and similar indigenous landscaping materials. **100%** on all non-residential developments are required to be naturescaped, **50%** of all multi-unit residential developments, and **25%** of all other residential developments
- *City of Calgary* found that its Parks Department accounted for 15 -17% of all irrigation in Calgary. The fact that these are highly visible places meant that improving Parks’ irrigation

practices was partially about addressing a public perception issue. The City set a target of reducing municipal irrigation by 15% through a number of measures including a centralized irrigation system (the largest in North America) as well as irrigating "only when necessary" and banning irrigation on boulevards, medians, traffic; using drought-tolerant plants and xeriscaping; having developers submit irrigation master plans early on and having only IA certified designers submit plans and install irrigation systems that will be turned over to the City

- *District of Campbell River Engineering Services* has produced a good paper on conducting a landscape and irrigation water audit

4.4 ICI Sector

Increase efficiency and conservation across the ICI sector.

Specific Actions

- Designate one staff from DSM team as ICI specialist with responsibilities that include conducting comprehensive process-based audits of ICI
- Educate businesses about their water use and encourage them to implement water conservation programmes through an "Every Drop Counts" programme
- All businesses using more than a certain amount (for example, 10ML/year) must prepare, submit and comply with a Water Efficiency Management Plan (WEMP). Under the WEMP the business must achieve a 10-20% reduction in total water consumption or comply with best practice in an agreed upon timeframe
- Develop water efficiency guidelines to assist businesses in implementing WEMP as an ongoing priority
- Implement incentive-based capacity "buy back" programme
- Implement restaurant rebate & pre-rinse spray valve and accommodation industry bathroom audit and retrofit programmes

Who's Already Doing It?

- The *Capital Regional District* has an ICI efficiency staff member to conduct ICI audits as does the City of Toronto
- *Sydney, Australia Water's* "Every Drop Counts" programme is an interactive arrangement with businesses to diagnose, develop, implement and review improvement plans. An online plan selector programme allows nurseries, landscapers and gardeners to select water efficient plants for their area and soil type. Low cost and crisis accommodation are provided with audits and retrofits to facilitate their participation to help meet water use efficiency targets
- All businesses in *South East Queensland, Australia* using more than 10ML/year must prepare and comply with a WEMP
- *City of Calgary* launched a Pre-rinse Spray Valve programme in 2007 that targeted restaurants, institutional kitchens and other food prep facilities. A total of 1,200 high-flow prerinse spray valves were replaced with low-flow models. On average, participants saved

358 litres per day per spray valve installed, with estimated water and energy savings between $1,40o and $1,800 over the five-year life of a valve. Some participants even reported canceling the installation of second hot water tanks for their facility.

- *City of Toronto* and the *City of Guelph* both have capacity buyback programmes to "buy back" water savings from ICI users in order to help defer proposed expansions to water supply networks. A one time capacity buy back incentive is offered to each facility, paid once the water savings have been confirmed by onsite metering data.

4.5 Agricultural Sector

4.5.1 Data Collection

Abbotsford already collects annual data from flow meters in order to measure water used for agricultural purposes. In order to make informed decisions about water use, the AMWSC should make a concerted effort in close cooperation with farmers to gather more data about agricultural water use. This information would not only enhance understanding of the timing of water demands, it can also help farmers plan for farm water use and measure the success of their conservation efforts.

Specific Actions

- Farmers and growers should be provided with reports from annual meter readings for comparison of their water use with others farmers and growers
- Audits of largest users to enable municipal staff to conduct research into efficient technologies and practices for specific agricultural and food processing subsectors

4.5.2 Improve Water Efficiency in Greenhouses and Food Processing

Greenhouse growing uses just one-third the amount of water of field grown crops. Irrigation represents the biggest opportunity for improving efficiency in a greenhouse operation. Three areas should be considered when looking to reduce water use in greenhouses: reducing wasted water and runoff, improving efficiency of the irrigation system, and reusing irrigation water (the largest opportunity for water savings in greenhouses).

For food processing operations, emphasis is increasingly placed on shifting away from reusing water toward using less water for the same process.

Specific Actions

- Implement rebate programmes to install more water efficient devices for use in greenhouses and food processing plants
    - By 2012, all new, and by 2020, all existing devices for use in greenhouses (drip or trickle and sub-irrigation systems such as ebb and flow, flood floors, troughs or capillary mats) as well as water recycling/recirculation systems and in food processing plants (high-pressure, low-volume nozzles on spray washers, fogging nozzles, in-line strainers for all spray headers) should have application efficiencies of 80% or greater.
- Produce education materials that remind greenhouse growers of water efficient growing techniques such as grouping plants with similar water needs together to improve efficiency and watering plants intermittently to increase absorption. Materials should also

point to the potential of water recycling and rainwater harvesting through storage ponds, retention basins, and storage tanks as a means for reducing water use

- Conduct onsite water audits to help food processors use less water (for example, using a broom rather than a hose to push waste food scraps into grates; upgrading to efficient spray nozzle systems, etc.).

4.5.3 Water Quality

Water quality is a significant issue in the Lower Fraser Valley. Despite efforts by researchers and the farming community to reduce inputs of nitrates by reducing fertilizer and manure applications, the number of chickens produced on the aquifer has steadily increased, resulting in elevated levels of chicken manure. Policies should be put in place that do not contribute to the widespread eutrophication of receiving waters

Specific Actions

- Design and implement policies that regulate stocking densities and manure management procedures

4.6 Looking to the Future

4.6.1 Rainwater and Waste(d) Water as the Source

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. Yet in Canadian cities, with average precipitation ranging from about 260 to 250 millimeters per year, rainwater harvesting is vastly underused, resulting in missed opportunities to save 40% to 50% of the water currently used around the home. Rainfall in summer months can be sporadic in Abbotsford/Mission suggesting that larger cisterns would be more appropriate than rainbarrels. Rainwater would likely best be utilized for indoor toilet flushing during winter months when rainfall is abundant.

Specific Actions

- Municipal staff should investigate local rainfall patterns and identify the best opportunities for rainwater capture in each sector
- Designers, builders and the FVRD building inspector should work to make clients aware of the potential of designing for some degree of rainwater catchment
- Develop practical guidelines and specifications to assist homeowners in the proper installation of rainwater, greywater and black water collection systems and the installation of composting toilets
- Implement rebate and installation programmes to enable uptake of onsite rainwater catchment and greywater reuse for homeowners

Who's Already Doing It?

- *Guelph, ON* is piloting rainwater harvesting cisterns and reuse
- *Pimpama Coomera* housing development in Southeast Queensland (2500 homes, growing by 120 homes/month) has a Class A+ Recycled Water Treatment Plant that supplies toilets & outdoor water use. Each home also has mandatory rainwater tanks used for laundry cold water & outdoor use.

4.7 Implement for Success

The observed rate of water savings will depend on the aggressiveness, available funding and effectiveness of the program; the residential, industrial, commercial and agricultural growth rates; and natural replacement frequencies of water use fixtures. For example, a toilet has a typical replacement period of 25 years, whereas a clothes washer will tend to be replaced on average every 7-10 years making the rate of substitution with an efficient model much more rapid. Figure 4.1 illustrates two possible rates of implementation for the Enhanced Efficiency Scenario.

Methodologies for estimating these replacement rates and savings are available in a number of readily available references including water efficiency plans developed for other communities[38] and water efficiency planning manuals.[39] Specific programming calculations are, however, beyond the scope of a long-term soft path planning exercise and should be executed by in-house staff during the first year of program planning.

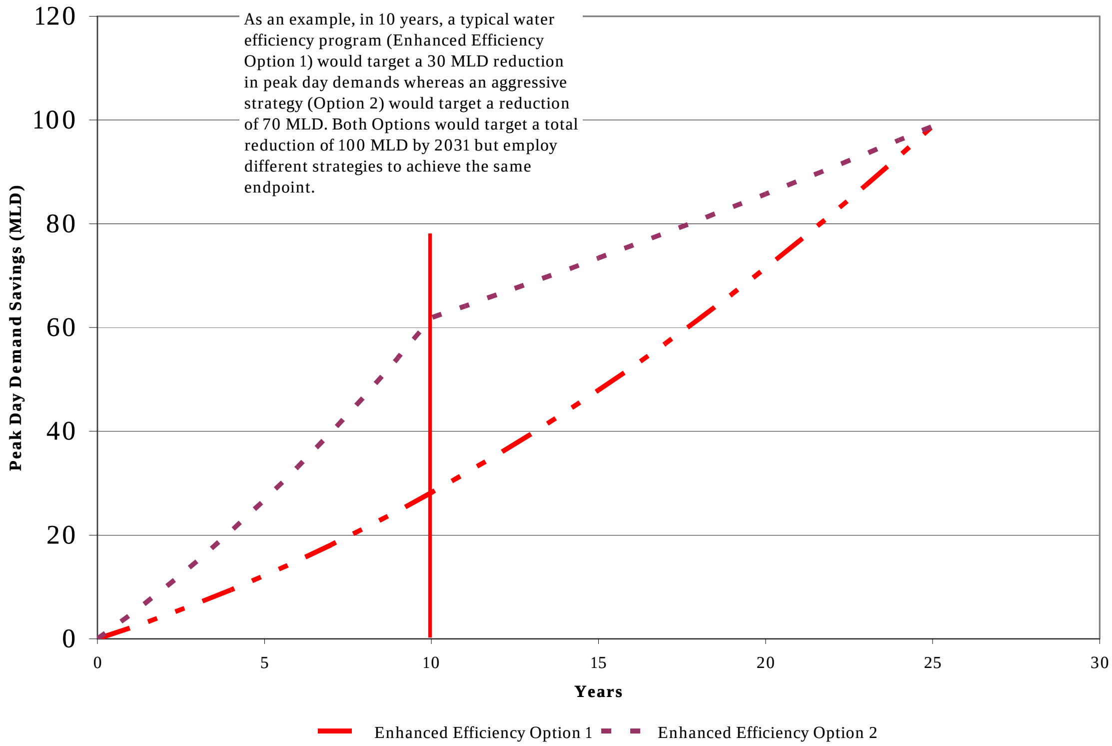

Figure 4.1. Alternatives for Implementing the Enhanced Efficiency Scenario

The Soft Path strategy can be delivered through a combination of in-house staff and external consultants and contractors depending on needs and capacity. The following sample implementation plan can be applied to both the Enhanced Efficiency and the Conservation Commitment scenarios.

[38] See for example Region of Peel (2004) and City of Guelph (2009)

[39] See for example OWWA (2006)

Table 4.1 Sample Implementation Plan

	SHORT TERM			MEDIUM TERM	LONG TERM
	Year 1	**Year 2**	**Year 3**	**Year 10**	**Year 20**
Measures *Technologies and practices – indoor*	Plan and launch residential audit & retrofit programme	Continue residential audits & retrofits	Continue residential audits/retrofits	All existing devices for use in greenhouses and water recycling/recirculation systems and in food processing plants should have application efficiencies of 80% or greater	All residences and ICI use waterless toilets
Technologies and practices – outdoor	Plan and launch outdoor water use audits on residential properties Establish retail discounts for moisture gauges, hose timers and automatic irrigation systems for residential sector	Begin audits for ICI and agricultural customers (large volume users)	Continue audits for ICI and agricultural customers Implement rebate programmes to install more water efficient devices for use in greenhouses and food processing	Complete ban on lawns and water inefficient landscapes except those designated for recreational use (parks, schools etc.)	All residences and ICI properties have onsite state-of-the-art rainwater harvesting and stormwater management systems
Water capture, reuse and recycling	Establish retail discounts for residential rain tanks and grey water systems	Explore industrial and large-scale irrigation applications of greywater reuse Requirements for new developments	Pilot large-scale irrigation application of greywater on City landscapes (e.g. parks and grounds)	Implement supply-side technologies for Integrated Resource Management in municipal system	Municipal system is fully plumbed with purple pipes
Instruments *Information, education and promotion*	Create DSM team Public launch of strategy Develop	Informative water bills Add residential water-use calculator to	Continue promotion of audit and retrofit services Develop a demonstration		

	SHORT TERM			MEDIUM TERM	LONG TERM
	Year 1	Year 2	Year 3	Year 10	Year 20
	"Water Wise" info section on website, and include explanation of workings and cost of the water system Promote audit and retrofit programme (including free installs) Educate on indoor water use reductions (residential and ICI); Link to Go Golden and Every Drop Counts campaigns	website Continue promotion of audit and retrofit services Educate about outdoor water use (residential and ICI), including promoting use of rainwater harvesting tanks and xeriscaping Produce outreach materials on reducing water use in greenhouses Conduct onsite water audits to help food processors use less water (for example, using a broom rather than a hose to push waste food scraps into grates).	(water-wise) garden Educate about the safety of treated recycled water		
Regulations	Mandate low-flow fixtures in all new construction Study options available for	Ban the sale of water inefficient devices by working with local businesses	Institute permanent regulations re: housing driveways/paths and moisture gauges on auto	Ensure all land use decisions are assessed for watershed impacts	All planning begins with assessing the expected impact on the watershed

	SHORT TERM			MEDIUM TERM	LONG TERM
	Year 1	**Year 2**	**Year 3**	**Year 10**	**Year 20**
	rainwater harvesting and large-scale greywater re-use in residential and ICI sectors Strengthen regulations for temporary restrictions on outdoor water use (ex. Introduce 50% xeriscaping requirement in all new developments)	and retailers to extend standards to point-of-sale transactions Mandate plumbing rough-ins that enable future water collection and use of alternative sources for non-potable use (toilets, outdoor) Develop water efficiency guidelines to assist ICI in implementing WEMP as an ongoing priority Require all ICI using more than a certain amount to prepare, submit and comply with a water efficiency management plan	sprinkler systems Continue giveaways and subsidies with audit Design and implement agricultural policies that regulate stocking densities and manure management procedures		(watercentric planning)
Economic incentives	Cost analysis and options for full-cost accounting Launch low-flow fixture (toilet and showerhead)	Implement new full-cost accounting pricing scheme for residential customers Continue low-	Launch conservation-based pricing schemes for ICI and agricultural customers Implement volumetric	Water prices reflect full ecological costs of removing water from source and treating all recycled water to drinking water quality	

	SHORT TERM			MEDIUM TERM	LONG TERM
	Year 1	Year 2	Year 3	Year 10	Year 20
	installation programme (residential)	flow fixture (toilet and showerhead) installation programme (residential) Launch low-flow fixture (pre-rinse spray valves and toilets) rebate programme (ICI) Offer incentives to developers to develop "closed loop" communities	wastewater charges for ICI customers Offer incentives to developers to develop "closed loop" communities Implement incentive-based capacity "buy back" programme		

4.8 Cost Comparison

We have not calculated costs here. The case for the cost-effectiveness of water conservation programs has been made in many communities across Canada. For example, if the City of Barrie, Ontario had not proceeded with a programme to conserve water and reduce wastewater flows beginning in 1998, construction on its wastewater treatment plant would have cost approximately $41 million, compared to approximately $3.1 million for the conservation programme.[40] The Region of Peel's Water Efficiency Plan (2004) resulted in a cost-benefit ratio of 0.29, or about one-third the cost of expanding Peel's water and wastewater infrastructure.

Many of the cost-benefit analyses that have suggested water conservation can provide "new water" at a fraction of the cost of supply-side hard infrastructure rely heavily on rebates to achieve savings. Although this approach is both reliable and measurable, rebates are by no means the least cost approach. Policies, regulation and education can achieve similar impacts at a fraction of the cost of rebate programs.

A budgetary cost estimate was constructed using historical unit costs (per L/d) for water conservation programs developed in other communities (refer to Appendix C for details). The budgetary cost of securing "new water" through conservation was estimated at $26.8 million for the Enhanced Efficiency scenario in comparison to an estimated $83 million[41] for the equivalent potable water supply infrastructure – a cost savings of 70% for potable water supply

[40] Ontario MOE (August 2008).

[41] Equivalent potable water supply infrastructure was estimated at $2.8/(L/d) based on average daily demand. This value is well within reported values for other communities, and was estimated based on a proposed capital cost of $240 million for an estimate 85 MLD increase in ADD capacity (Abbotsford News, 2009).

alone (excludes potential wastewater savings). A more aggressive Conservation Commitment to preserving water supplies for future generations was estimated to have a higher overall unit cost, but at an estimated cost of $105 million would still be approximately 40% lower cost than the equivalent supply side approach.

And the savings don't stop there. In addition to direct onetime capital cost savings for upgrading supply, the following additional savings and environmental benefits could potentially be realized by 2031 (ranges represent the difference between the Enhanced Efficiency and Conservation Commitment scenarios):

- Operating and maintenance cost savings for potable water treatment estimated at $1.4 – 3.1 million dollars per year[42]
- Operating and maintenance costs for wastewater treatment and collection, and potable water distribution
- Significant cost savings for future water treatment systems,
    - For example, the future population post-2031 would be multiplied by 390-520 LCD as opposed to 640 LCD resulting in a 20-40% savings on capital expenditures beyond 2031
- Capital costs for wastewater pumping expansion, estimated at $8 million dollars[43]
- Reduced storm water overflows and run-off by capturing rainwater and reducing base sewage flows, protecting the Fraser River and Abbotsford-Sumas aquifer
- An estimated 32-71 tonnes of chlorine will be prevented from entering the ecosystem each year
- An estimated 19,000-38,000 tonnes[44] of CO2e reduced every year from reduced hot water use in the residential sector alone.

A literature review of economic and environmental benefits of water conservation is provided in Appendix D.

4.9 Conclusions

For both the Enhanced Efficiency and Conservation Commitment scenarios, short-term strategies include enforcing prohibited uses of water, expanding the prohibited uses of water, extending outreach efforts, and encouraging regional conservation measures. Long-term strategies include increasing water conservation through reduction of outdoor water use and new technology, maximizing water recycling, and enhancing stormwater capture.

The **Enhanced Efficiency** scenario targets average day reductions from **Business As Usual** of approximately 20% by 2031, in line with targets established by similarly sized municipalities. The **Enhanced Efficiency** scenario is relatively straightforward goal and should be considered readily achievable provided funds and personnel are directed to the program.

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[42] Assumes average O&M cost of $0.134/m^3$ for conventional potable water treatment from NWWBI (2007). Excludes O&M costs for the distribution system.

[43] Based on a review of components of the AMWSC Wastewater Master Plan (2006) that could be avoided, primarily additional pumping capacity and outfall expansion.

[44] Assumes 60% of homes use natural gas in BC (Ryan, 2005)

The **Conservation Commitment** scenario explores a commitment to securing the water necessary for a thriving community through conservation efforts. A 45% reduction in annual average daily water use over 24 years would be required to meet this target while providing services for the increasing population. Peak day demand reduction of approximately 150 MLD would be targeted. This is the preferred scenario.

Regardless of which scenario is adopted, it is clear that a comprehensive and long-term water conservation programs represent the best option for meeting growing water demands in Abbotsford/Mission. Creating sustainable communities requires the right programmes and techniques to conserve water resources. A conservation-based approach to land use decisions, development and design will ensure that Abbotsford/Mission begins to develop a secure and prosperous future.

Appendices

Appendix A - Summary of Recommendations and Actions

	Recommendation	Actions
All Sectors	Future Water Use targets	• Set an overall water use goal of "No New Water for a Generation" for Abbotsford/Mission
	Implement Full-Cost and Volume-Based Pricing	• Implement universal metering in District of Mission • Implement separate volume-based pricing schemes for residences, businesses and agriculture • Provide homeowners and businesses with water bills that clearly indicate their daily water use, which can then be compared to diagrams of water use per person on the City of Abbotsford and District of Mission websites • Implement volumetric wastewater charges for non-residential customers to encourage water conservation
	Create a Water Demand Management Team	• Create a Water Demand Management Team to be shared by the City Abbotsford and District of Mission that includes three full-time staff positions, including residential, agricultural and ICI and outreach positions and 4 seasonal (summer) positions

	Recommendation	Actions
	Plan for Sustainability Through "Wet Growth"	• Require that all land use decisions be assessed for watershed impacts • Approve all new construction in a manner that ensures avoiding negative impact on the supply and quality of potable water by requiring a permit and a development plan for all construction that states how potential problems related to water supply and quality will be handled • Have developers include water efficiency packages for homeowners as part of their development permits • Set reasonable irrigation limits on residential construction by establishing minimum lot sizes • Offer incentives to developers to develop "closed loop" communities that supply their own "off the grid" wastewater systems and use rainwater harvesting for outdoor and toilet use

	Recommendation	Actions
	Require Minimum Water Efficiency Standards	• Mandate WaterSense fixtures and water efficient landscapes in all new construction • Investigate options to require the installation of water efficient fittings and fixtures to all existing homes upon resale, or mandating disclosure of water efficiency at point of sale • Work with local businesses and retailers to extend standards beyond new construction to point of sale transactions (i.e. ban the sale water inefficient fixtures such as 13 L toilets) • The Irrigation Industry Association of British Columbia's head office is in Abbotsford. This is an excellent opportunity to require certified installers and/or drip (micro) irrigation systems in new homes by working with the certification body. Consider developing something similar to WaterSense certified irrigation specialist based on the WaterSense specifications and begin by committing to only using these types of installers for City parks, etc. • Mandate plumbing rough-ins that enable future water collection and use of alternative sources for toilet flushing and lawn watering (purple pipes) as will be mandated in according to Living WaterSmart by 2010 • Create an extensive high-efficiency fixture and appliance retrofit and installation programme for all residences that focuses on toilets, showerheads and clothes washer replacement

	Recommendation	Actions
	"Go Golden" Campaign to Reduce Outdoor Water Use	• Implement a bylaw limiting outdoor residential watering to one day per week and use a tiered system of communication/outreach program and enforcement to enforce compliance • Set a target of reducing municipal irrigation by 15% through a number of measures including a centralized irrigation system (the largest in North America) as well as irrigating "only when necessary" and banning irrigation on boulevards, medians, traffic; using drought-tolerant plants and xeriscaping; having developers submit irrigation master plans early • Implement a full suite of bylaws, including restricting lawn size or banning lawns altogether in new construction, drought-tolerant landscaping requirements, permanent one-day-per-week watering restrictions, cutting off extreme customers after due warning, and conservation-based water rates that penalize heavy users (including municipal users) • Build residential landscape water audits and home visits into existing public education and outreach campaigns • Continued incentives and rebates programme for homeowners for rain barrels and rain gauges, hose timers and automatic irrigation systems
ICI Sector	Increase efficiency and conservation across the ICI sector	• Designate one staff from DSM team as ICI specialist with responsibilities that include conducting comprehensive process-based audits of ICI • Educate businesses about their water use and encourage them to implement water conservation programmes through a "Every Drop Counts" programme • All businesses using more than a certain amount (for example, 10ML/a) must prepare, submit and comply with a Water Efficiency Management Plan (WEMP). Under the WEMP the

	Recommendation	**Actions**
		business must achieve a 25% reduction in total water consumption or best practice in an agreed timeframe • All businesses using 1 ML/a or more must ensure that all internal water fixtures on the premises are efficient • Develop water efficiency guidelines to assist businesses in implementing WEMP as an ongoing priority • Implement incentive-based capacity "buy back" programme • Implement restaurant rebate & pre-rinse spray valve and accommodation industry bathroom audit and retrofit programmes
Agricultural Sector	Data Collection	• Farmers and growers should be provided with reports from annual meter readings for comparison of their water use with others'

	Recommendation	Actions
	Improve Water Efficiency	• Implement rebate programmes to install more water efficient devices for use in greenhouses and food processing plants o By 2012, all new, and by 2020, all existing devices for use in greenhouses (drip or trickle and sub-irrigation systems such as ebb and flow, flood floors, troughs or capillary mats) as well as water recycling/recirculation systems and in food processing plants (high-pressure, low-volume nozzles on spray washers, fogging nozzles, in-line strainers for all spray headers) should have application efficiencies of 80% or greater. • Produce education materials that remind greenhouse growers of water efficient growing techniques such as grouping plants with similar water needs together to improve efficiency and watering plants intermittently to increase absorption. Materials should also point to the potential of water recycling and rainwater harvesting through storage ponds, retention basins, and storage tanks as a means for reducing water use • Conduct onsite water audits to help food processors use less water (for example, using a broom rather than a hose to push waste food scraps into grates).
	Improve Water Quality	• Design and implement policies that regulate stocking densities and manure management procedures
Looking to the Future	Rainwater and Waste(d) Water as the Source	• Designers, builders and the FVRD building inspector should work to make clients aware of the cost-effectiveness of designing for some degree of rainwater catchment • Develop practical guidelines and specifications to assist homeowners in the proper installation of rainwater, greywater and black water collection systems and the installation of composting toilets • Implement extensive rebate and installation programmes to enable uptake of onsite rainwater catchment and greywater reuse for homeowners • Require rainwater tanks on all new residential buildings

	Recommendation	Actions
		• Require rainwater tanks for toilet flushing to be installed in new commercial and institutional buildings

Appendix B - WaterSmart Scenario Builder Analysis

Figure B1 Current Water Demand Disaggregation Following Peaking Factor Reduction from 1.8 to 1.6

Growth	Share	Sector	Ave PerCap LCD	Annual Ave Day (m³/d)	Summer (m3/d)	Historical Peak Day (m³/d)	Peak Day/Ave
		TOTAL AVERAGE DAILY DEMAND	591	78,200	102,831	125,120	1.60
1.94	53%	RESIDENTIAL	314	41,570	60,633	76,438	1.84
1.94	100%	SINGLE-FAMILY	314	41,570	60,633	76,438	1.84
	77%	INDOOR SINGLE FAMILY	242	32,039	32,039	32,039	1.00
	23%	OUTDOOR SINGLE FAMILY	72	9,531	28,594	44,399	4.66
	90%	LAWN & GARDEN	65	8,578	25,735	41,540	4.84
	10%	OUTDOOR OTHER	7	953	2,859	2,859	3.00
0	0%	MULTI-FAMILY	0	-	-	-	-
	0%	INDOOR MULTIFAMILY	0	-	-	-	-
	0%	OUTDOOR MULTIFAMILY	0	0	-	-	-
1.98	8%	COMMERCIAL & INSTITUTIONAL	49	6,535	7,189	8,757	1.34
	95%	INDOOR CI	46.9	6,208	6,208	6,208	1.00
	5%	OUTDOOR CI	2	327	980	2,549	7.80
1.98	8%	INDUSTRIAL	49	6,535	6,535	6,535	1.00
	0%	INDUST 1	0.0	-			-
	0%	INDUST 2	0.0	-			-
	0%	INDUST 3	0.0	-			-
	100%	OTHER	49.4	6,535			-
2.83	13%	AGRICULTURAL	74	9,830	14,745	19,660	2.00
2.09	18%	NON-REVENUE	104	13,730	13,730	13,730	1.00
	7%	UNBILLED AUTHORIZED	7.38	978			
	10%	APPARENT LOSSES	10.37	1,373			
	83%	REAL LOSSES	85.95	11,380			

Figure B2 Indoor Residential Demand

		Today's Average	Efficient Homes	High Efficiency Homes	Totals	Per Capita Demand (LCD)
SINGLE FAMILY						
PER CAPITA WATER (LCD)		242	195	132		
INDIRECT ENERGY (KWH/C/D)		0.26	0.21	0.14		
CURRENT POPULATION DISTRIBUTION		132,391	-	-	132,391	
2006 CURRENT MUNICIPAL WATER USE (M3/D)		32,039	-	-	32,039	242
BAU POPULATION DISTRIBUTION		254,179	-	-	254,179	
2036 BAU MUNICIPAL WATER USE (M3/D)		61,511	-	-	61,511	242
SCEN 1 POPULATION DISTRIBUTION		132,391	-	121,788	254,179	
2036 SCEN 1 MUNICIPAL WATER USE (M3/D)		32,039	-	16,030	48,069	189
Sources	MUNICIPAL	100%	100%	100%		
	ALTERNATIVE SOURCES	0%	0%	0%	-	0
SCEN 2 POPULATION DISTRIBUTION		-	-	254,179	254,179	
2036 SCEN 2 MUNICIPAL WATER USE (M3/D)		-	-	27,295	27,295	107
Sources	MUNICIPAL	100%	100%	0%	-	
	ALTERNATIVE SOURCES	0%	0%	100%	6,161	24

Figure B3 Outdoor Residential Demand

		Un-tuned Auto-Irrig	Tuned Auto-Irig	Conven-tional	Best Practices	Totals	Per Capita (LCD)
RELATIVE WATER USE FACTOR		1.00	0.30	0.15	0.07		
SINGLE FAMILY							
CURRENT POPULATION DISTRIBUTION		10%	0%	90%	0%	100%	
2006 MUNICIPAL WATER (M3/D)		3,650	-	4,928	-	8,578	65
Sources	MUNICIPAL	100%	100%	100%	100%		
	ALTERNATIVE SOURCES	0%	0%	0%	0%	-	0
BAU POPULATION DISTRIBUTION		10%	0%	90%	0%	100%	
2036 BAU MUNICIPAL WATER (M3/D)		7,008	-	9,461	-	16,469	65
Sources	MUNICIPAL	100%	100%	100%	100%		
	ALTERNATIVE SOURCES	0%	0%	0%	0%	-	0
SCEN 1 POPULATION DISTRIBUTION		2%	8%	28%	62%	100%	
2036 SCEN 1 MUNICIPAL WATER (M3/D)		1,051	1,261	2,208	2,395	6,916	27
Sources	MUNICIPAL	75%	75%	75%	75%		
	ALTERNATIVE SOURCES	25%	25%	25%	25%	2,305	9
SCEN 2 POPULATION DISTRIBUTION		2%	8%	28%	62%	100%	
2036 SCEN 2 MUNICIPAL WATER (M3/D)		561	673	1,177	1,277	3,688	15
Sources	MUNICIPAL	40%	40%	40%	40%		
	ALTERNATIVE SOURCES	60%	60%	60%	60%	5,532	22

Figure B4 Peak Day Results for Peaking Factor Reduction from 1.8 to 1.6

SUMMARY TYPE	PER CAPITA DAILY PRODUCTION (LCD)				TOTAL DAILY PRODUCTION (m³/D)			
Peak Day	CURRENT	BAU	SCEN 1	SCEN 2	CURRENT	BAU PROJECTED	SCEN 1	SCEN 2
YEAR	2006	2036	2036	2036	2006	2036	2036	2036
TOTAL AVERAGE DAILY DEMAND	945	1,036	782	611	125,120	263,339	193,141	144,130
RESIDENTIAL	577	586	358	217	76,438	148,880	90,934	55,126
SINGLE-FAMILY	577	586	358	217	76,438	148,880	90,934	55,126
INDOOR SINGLE FAMILY	242	242	189	107	32,039	61,511	48,069	27,295
OUTDOOR SINGLE FAMILY	335	344	169	109	44,399	87,369	42,865	27,831
LAWN & GARDEN	314	302	127	68	41,540	76,719	32,215	17,181
OUTDOOR OTHER	22	42	42	42	2,859	10,650	10,650	10,650
MULTI-FAMILY	0	0	0	0	0	0	0	0
INDOOR MULTIFAMILY	0	0	0	0	0	0	0	0
OUTDOOR MULTIFAMILY	0	0	0	0	0	0	0	0
COMMERCIAL & INSTITUTIONAL	66	68	56	49	8,757	17,186	14,170	12,581
INDOOR CI	47	48	48	41	6,208	12,292	12,116	10,526
OUTDOOR CI	19	19	8	8	2,549	4,893	2,055	2,055
INDUSTRIAL	49	51	46	41	6,535	12,939	11,645	10,351
AGRICULTURAL	148	420	420	420	19,660	55,638	50,074	44,510
NON-REVENUE	104	113	104	85	13,730	28,696	26,317	21,561

Appendix C - Capital Cost Evaluation

The following evaluation of capital costs has been constructed using empirical data from water efficiency plans in other locales, and is included for illustrative purposes only. The appropriate mix of policy, rebate, water audit and education instruments should be determined by the community and the AMWSC. The estimated cost per L/d for each scenario differs as a result of including rebates for higher cost technologies such as rainwater harvesting. The final cost per L/d can be adjusted by relying more heavily on policy instruments which are virtually free, or adjusting the value of rebates.

The reported unit capital costs, though within the range of costs reported in other communities, also exclude economic benefits such as reduced operating and maintenance costs, significantly reduced replacement costs, reduced future expansion costs and many environmental benefits that have associated costs. These values should therefore not be utilized as the sole performance measure to weigh a water conservation program against an infrastructure expansion.

Table C1 Budgetary Capital Cost Summary for Enhanced Efficiency

Sector	Target Reduction	Rebate	Audit	Policy	Estimated Unit Costs[45]/ (L/d)	Total Estimated Cost[46] ($)
Total Average Day Demand Reduction	**29.6**				**$0.91**	**$26,839,300**
Reduced Peaking Factor (PDD)	28.4			70%	$0.10	$2,811,600
Indoor Residential	13	33%		67%	$0.60	$7,800,000
Outdoor Residential	9.5	19%	19%	63%	$0.96	$9,128,900
Outdoor Commercial	0.4	38%	38%	23%	$1.97	$788,500
Industrial	1.3	N/A	N/A	N/A	$1.35	$1,755,000
Commercial	0.2	100%			$1.57	$313,300

[45] Cost indices have been developed based on historical unit costs for rebate, audit and education programs in the Region of Peel, York Region, City of Guelph and Region of Waterloo.

[46] Total costs were estimated multiplying unit costs for each type of measure (rebate, policy, audit, education) by the estimated percentage of the savings achieved through each measure.

Agriculture	2.8				$1.35	$3,780,000
Non-Revenue	2.4				$0.19	$462,000

Table C2 Budgetary Cost Summary for Conservation Commitment

Sector	Target Reduction	Rebate	Audit	Policy	Estimated Cost[47]/ (L/d)	Total Estimated Cost[48] ($)
Total Average Day Demand Reduction	**64.4**				**$1.63**	**$105,030,500**
Reduced Peak Demands (PDD)	28.4			70%	$0.10[49]	$2,811,600
Indoor Residential	34	50%		50%	$1.95	$66,300,000
Outdoor Residential	12.8	25%	25%	50%	$1.53	$19,600,000
Outdoor Commercial	0.5	38%	38%	23%	$2.36	$1,177,900
Industrial	2.6	N/A	N/A	N/A	$1.35	$3,510,000
Commercial	1.8	100%			$1.57	$2,820,000
Agriculture	5.5				$1.35	$7,425,000
Non-Revenue	7.2				$0.19	$1,386,000

[47] Cost indices have been developed based on historical unit costs for rebate, audit and education programs in the Region of Peel, York Region, City of Guelph and Region of Waterloo.

[48] Total costs were estimated multiplying unit costs for each type of measure (rebate, policy, audit, education) by the estimated percentage of the savings achieved through each measure.

[49] Education cost

Appendix D - Literature Review of Water Conservation Benefits

	New Infrastructure	Conservation
Capital Costs (one time costs) for Water and Wastewater	**Range $2-10 / (L/d)**[50]	**$0.6 – 2.8 / (L/d) cost of overall 10-20 year program**[51] • <<$0.3 / (L/d) bylaw for new construction, pricing & education[52] • $0.19 / (L/d) for leak reduction • $0.2-6 / (L/d) for rebates[53] • $1.35 / (L/d) for ICI capacity buyback
Potable Water Supply	$0.4 - 4 [54] / (L/d)	See Above
Future Supplies	Status Quo	Save 20-50% of future expansion costs as a result of much lower per capita demands
Wastewater	$0.6 – 5.7[55] / (L/d)	Save on pump and transmission main size, and treatment processes that are flow dependent. Composting toilets and wastewater reuse also directly reduce future treatment plant size (load).
Operating & Maintenance	**$0.15-1.4/$m^3$**	**$0-0.02/$m^3$**
Potable Water Treatment **Distribution**	$0.05-0.9 [56] /$m^3$	$0-0.02 [58] /yr

[50] City of Guelph (2009); Region of Peel (2004); NWWBI (2007)

[51] Average Annual Day basis

[52] Region of Waterloo (2006) budget for water conservation education; bylaws and pricing instruments have costs approaching $0.

[53] Value of rebate dependent on technology offered

[54] CMHC (2005); City of Guelph (2006)

[55] CMHC (2005); City of Guelph (2009)

[56] NWWBI (2007); OMBI (2007); $0.075 in Montreal (Ferguson, 2009)

[57] OMBI (2007)

[58] City of Guelph (2009) included $0.02/yr for monitoring water efficiency programming

	$ 4 – 10 [57]/ 1000 km	
Wastewater Treatment (Secondary & BNR) **Wastewater Collection**	$0.1-0.45 [59]/ m^3 $1-10 [60]/ 1000 km $0.09[61]/$m^3$	$0 Save pumping energy costs and pump expansion capital and O&M costs. Save chemical costs. UV and ozone treatment in particular may benefit from cost savings resulting from reduced flows.
Other costs		
Stormwater Costs / I&I	$31.45/$m^3$ of storage capacity[62] Sewer & Urban Ditches $0.5-3.5[63] / 1000 km	Rainwater harvesting has potential to reduce storm-water management costs, particularly if rainwater is used for toilet flushing.
Carbon Costs	$20-75[64]/tonneCO2e	$0 Carbon savings could be significant if pumps are powered by natural gas.
Intrinsic Water Value	$0.05[65] / m^3	
Replacement Costs	Pumps have a typical life of 10-20 years; membranes are much less. These replacement costs are often excluded from cost-benefit comparisons of conservation vs. hard infrastructure.	A 40 year lifecycle highlights significant conservation savings. Efficient fixtures and technology will be replaced by the end-user at no cost to the municipality. Replacing leaky pipes can reduce damage caused to roads saving additional costs.
Cost over-runs	Capital cost over-runs are frequent.	Cost over-runs are unlikely as rebate programs are fixed price, salaries are straightforward to budget, and a firm budget can be allocated for marketing.
Source Protection	New sources have to be protected which typically incurs	Source protection is embedded in the cost of conservation measures.

[59] $0.11/m3 AMWSC (2006); $0.075/m3 CMHC (2004); NWWBI (2007)

[60] NWWBI (2007); OMBI (2007)

[61] Montreal (Ferguson, 2009)

[62] Montreal (Ferguson, 2009)

[63] NWWBI (2007)

[64] Estimated based on purchasing offset credits (CarbonZero, 2009) and recommendations from Tomorrow Today: How Canada Can Make a World of Difference.

[65] Kerr Wood Leidl (2006)

	additional expenditures.	Conservation serves to reduce the impact on local water resources.
Risk Management	Increasing pressure on upstream sources, climate change, pollution all present risks to water supply.	Conservation mitigates risk by reducing demands for limited supply.

Appendix E – Understanding the WaterSmart Scenario Builder

This appendix explains the POLIS WaterSmart Scenario Builder, a Microsoft Excel spreadsheet developed to facilitate the development of the various scenarios presented here. It elaborates on the brief discussion of the tool presented in Section III and where possible provides the rationale for assumptions and judgments by analysts.

The POLIS WaterSmart Scenario Builder: A Soft Path Analysis Tool, is a tool designed for a specific purpose, from a particular perspective. Other tools exist to support activities such as water supply planning, water footprinting, and water efficiency planning. Each is intended to answer a particular question. How much water do we need (water supply planning)? How much water are we using (water footprinting)? Or how can we affordably use less water (water efficiency planning)?

Each of these tools is also set within a particular view of the world. Most neglect ecological limits to human water use. Most are based on the assumption that past political, economic and social trends will determine future conditions. And most rely on a cost-benefit framework to determine what is feasible in terms of developing new supply, or what water efficiency measures are economically efficient under existing conditions.

The WaterSmart Scenario Builder fits with and complements (rather than replaces) many, if not all, of these tools. It helps take an important first step toward developing detailed conservation audits or water efficiency plans by engaging communities in 'what if?' discussions about possible futures for water use – before asking what is economical. As such, it sets aside analysis of the economic costs and benefits associated with implementing the measures, or the capital cost savings associated with the reduced water use.

Input data

The Scenario Builder is designed to work with minimal inputs. While data collection for urban water use is improving in Canada, data remain incomplete for the detailed requirements of this analysis (i.e. breakdown of water use to the level of sub-sectors and indoor/outdoor use).
At a minimum, the required data inputs include current population and current water demands—either on a per capita basis (i.e. litres per capita-day – L/c-d) or on a community-wide basis (i.e. cubic metres per year – m3/yr). In some cases, local data on the sectoral breakdown of water demands are available and lead to a more robust or contextualized analysis. In the absence of such data, general values for the region, province or the country as a whole must be used as a first estimate.

Process

The WaterSmart Scenario Builder facilitates a systematic approach to determining the potential for water savings through application of efficiency and conservation measures. The tool works on the basis of integration – on determining the macro impact of integrating different packages of micro measures (i.e., policies, programs and technologies) on total water use. It accomplishes this by:

- Disaggregating total water demand of an urban or watershed community into its component elements (uses)
- Treating each of those elements with water efficiency and conservation measures using four water Sectors: Residential, ICI (Industrial, Commercial and Institutional), Agricultural and

Non-Revenue; and

- Re-aggregating to determine the macro impact of the various micro measures on total water use

By iterating through this process, the analyst (or planning team) can refine the micro measures to arrive at a package showing total water use that reflects desired future conditions. Sounds simple, but as with most complex socio-ecological problems, the devil is in the details – these details, and the devils within, are described below.

Desired Future State

The first step in the backcasting process – and in developing the resulting scenarios – is to define a desired future state for water use. This begins by deciding how far into the future to look; or in the parlance of the WaterSmart Scenario Builder, selecting a design year. Variables such as current and future population, changes in living patterns, and estimated growth in the various water sectors, are used to define the context of the design year.

The selected design year must be 20 to 50 years in the future. This long view is critical for a number of reasons. First, philosophically, any effort aimed at developing a sustainable society requires thinking in terms of intergenerational equity – to meet the needs and aspirations of present generations without compromising the opportunities for future generations to do the same. Second, and more pragmatically, the design year should be set far enough into the future to allow sufficient time to observe the full impact of proposed technological, social and policy shifts associated with scenarios. Transformational change of the type envisioned by the soft path approach can take decades to be fully realized. Third, no magic wand exists to change instantly all inefficient toilets into low-flow ones; even with incentives, rates of replacement of existing stock can be slow. Finally, taking a short view – looking only 5 to 10 years into the future – is also likely to direct attention away from non-technological measures, such as education, social marketing and policy changes, that often take significant time to stimulate behavioral change and to result in water use reduction. Indeed, taking a short view may prematurely write-off the soft path approach or a particular scenario before the full impact can be realized.

The future that is put forward should be one that is desired broadly by the urban or watershed community that will influence, and be influenced by, actions taken to realize it. Ideally, it will have been developed in consultation with the community. A future vision is more likely to have influence if it is a shared vision. Therefore, visioning processes strive for participation by a broad range of community interests and actors. That said, the process of establishing this future state should not be viewed as a bargaining process to arrive at consensus around a lowest common denominator. It must be imaginative rather than simply a projection of the status quo. And it must incorporate the best available science on local hydrological carrying capacity, with allowance for unpredicted changes in that carrying capacity (as with those stemming from climate change).

For some communities or individuals, this visioning step may prove to be the most difficult part of the soft path approach. In some cases, dense or jargon-laden scientific and engineering studies may challenge non-technical participants to engage effectively in decision-making. More often, an absence of studies and other information will challenge all participants. This difficulty in defining a reasonable target future for water use should not prevent or dissuade practitioners from pursuing a soft path for water. Rather, an adaptive approach should be adopted – working from an initial desired future that can be refined over time (using the

Scenario Builder) as new information on water demand, local hydrological conditions, and climate change impacts becomes available.

To get started, a goal of maintaining, at a minimum, current watershed health is likely a reasonable desired future state. This goal – often referred to as no new water – has been used in several soft path studies to date. Essentially, no new water means capping water takings at existing volumes and rates so as to exert no additional pressure on the watershed ecosystem from higher rates of water use.

Disaggregating demand

By disaggregating water demand into its component elements, the WSP Scenario Builder digs deep into the details of a community's water use. It exposes the intricacies of who uses water, how much, and for what purposes. Reviewing these intricacies exposes a wealth of opportunities to apply water efficiency and conservation measures.

The Scenario Builder takes a step-wise approach to disaggregating water demand – first into sectors, onward into sub-sectors, and finally, where possible, to end-uses. Using an urban centre as an example, sectors would include residential, ICI, agricultural and non-revenue water. Sub-sectors under the residential sector would include single and multi-family and indoor and outdoor water use.

Whenever possible this disaggregation should be based on current information. However, given the paucity of empirical data on water use, particularly at the scale of end use, it is often necessary to adopt benchmarks from other sources. Sources may include case studies or water management plans, conversations with water management practitioners, or nationally or regionally averaged compilations, such as that provided by Environment Canada (2008) or the American Water Works Association (Mayer et al., 1999). For simplicity, the scenario builder has adopted two standard benchmarks for indoor water use. "Efficient Homes" are assumed to have a typical demand of 200 Lcd and are characteristic of new homes with requirements for ultra low flow toilets (6L), energy efficient top loading washing machines, 9.5 Lpm showerheads and 8.35 Lpm faucets. "High Efficiency Homes" have top-loading washers, and high efficiency 4.8 Lpf toilets and a typical water demand of 145 Lcd. These technologies are all available "off-the-shelf" and benchmarks have been validated by water efficiency experts.

Model Calibration to Business As Usual

The goal of any water conservation plan or soft path strategy is to increase the uptake (penetration rate) of water conserving practices (measures) and decrease the prevalence of water-intensive practices. To understand the behavioural, technological and policy changes required to realize a desired future state, a reasonable depiction of existing water use patterns must first be established. This depiction – often referred to in scenario-based planning as the 'business as usual' (BAU) case –is, quite simply, a forward extrapolation of current water use patterns based on population and economic growth projections.

The BAU scenario provides a benchmark against which to compare all additional scenarios, but it is more than that. For modelers it represents an opportunity to 'calibrate' – a critical though often overlooked step in developing an understanding of current community water use. Calibration provides an opportunity to question, challenge and better understand assumptions of penetration rates for the BAU scenario, and to refine those assumptions to arrive at values that represent, as closely as possible, the actual prevalence or absence of water conserving practices in today's society.

For example, a community's current residential per capita water use is compared against the standards for efficient homes described above, and against the range of typical per capita residential demands. This is a simple but effective gauge of the accuracy of water use estimates and assumptions. Benchmarks and typical values are also provided for many other parameters including residential vs. ICI, non-revenue water, and percentage of outdoor water use.

Through a process of calibration and recalibration, assumptions of water use are replaced with empirical data, which essentially means that the BAU becomes less speculation and more reality. In this way, the BAU resolves uncertainties related to input assumptions and the WaterSmart Scenario Builder evolves toward a working model that more accurately represents a society's water use.

Soft path scenarios

With a desired future state established and BAU conditions determined, the work of building alternative scenarios begins. At this point the disaggregated water demand – the intricate details of water use – is subjected to 'treatments.' These treatments come in the form of a combination of water efficiency and conservation measures and penetration rates. The Scenario Builder lays out the required community uptake of various measures necessary to realize its desired future. The Scenario Builder enables the user to specify the population that will uptake a change in technology or behaviour, in essence the penetration rate of new practices. Water savings are then calculated as the difference between the current water use and the potential for efficient water use, based on the population assigned to shift to efficient water use practices.

The many measures available have the potential to reduce or even eliminate water use across the full range of end uses. Penetration rates, in this case population, are quantitative measures of the uptake of a given measure into use by society over some period of time. They are strongly influenced by policies and programs such as water pricing, rebates, education and social marketing, and bylaws and regulations. The policy context must be considered as alternative scenarios are developed because it directly affects the penetration of behavioural change and technology into use.

For example, an aggressive toilet rebate program or an increase in water price will result in a high degree of efficient technology penetration, such as low flow toilets and front loading clothes washers. Figure E1 illustrates two alternative scenarios in addition to business as usual. Looking closely at the population, one can see in numbers the shift toward water saving fixtures and alternative sources of water (i.e. in scenarios 1 and 2, a shift toward higher population residing in efficient homes, and lower populations residing in homes with the current per capita usage).

	Today's Average	Efficient Homes	High Efficiency Homes
SINGLE FAMILY			
PER CAPITA WATER (LCD)	242	195	142
INDIRECT ENERGY (KWH/C/D)	0.18	0.14	0.10
CURRENT POPULATION DISTRIBUTION	132,391	-	-
2007 CURRENT MUNICIPAL WATER USE (M3/D)	32,009	-	-
BAU POPULATION DISTRIBUTION	254,186	-	-
2031 BAU MUNICIPAL WATER USE (M3/D)	61,456	-	-
SCEN 1 POPULATION DISTRIBUTION	132,391	-	121,795
2031 SCEN 1 MUNICIPAL WATER USE (M3/D)	32,009	-	17,350
SCEN 2 POPULATION DISTRIBUTION	-	-	254,186
2031 SCEN 2 MUNICIPAL WATER USE (M3/D)	-	-	25,942

Figure E1 Scenario Building in the Residential Indoor Sector

The WaterSmart Scenario Builder's strength lies in its capacity to explore a multitude of 'what if?' scenarios by experimenting with various combinations of measures and penetration rates to determine the impact of particular packages of technologies or practices on future water use. For example, one community may choose to focus on residential and ICI rebate programs as its primary mechanism for water conservation. Another community might choose to implement policies that encourage rainwater harvesting, grey-water reuse and xeriscaping to reduce future water use. Both scenarios could ultimately lead to the same end but through different means.

If, after selecting a suite of measures and penetration rates, the resulting future water use exceeds the threshold identified in the community visioning process, efficiency and conservation measures must be re-visited, increasing the application and penetration of waters saving measures in an iterative manner until the desired future state is reached. As the community begins to understand in more explicit terms the extent to which water efficiency and conservation must be employed, it may decide that the desired future water state itself should be adjusted. This is the essence of the iterative visioning and backcasting process using the WaterSmart Scenario Builder as a tool to support decision-making.

Re-aggregating for comparison

The resulting calculations are re-aggregated to the level of sub-sectors and sectors. Comparing these re-aggregated values of projected demands to the business as usual case illustrates the water saving potential for the scenario. The results for a number of parameters including annual average municipal water demands, peak day demands, and energy and GHG savings are reported on a summary sheet.

While the calculations performed by the WaterSmart Scenario Builder are fairly straightforward, it is important to note that the scenarios are based largely on assumptions and judgments of the analysts. This is in large part due to the nature of studying the future: we must rely on informed judgment to speculate about behavioural changes, technology uptake and technological innovation. This informed judgment approach was used to determine the shift in population distribution from inefficient to efficient practices in this analysis, the potential for savings in the industrial and agricultural sector and the reduction in peaking factor achievable through education and pricing.

Such contextual refinement can only be achieved by opening the planning process to community scrutiny and detailed community engagement. That said, we believe our analysis can provide sufficient specifics about the potential of a comprehensive approach to water conservation to inform a wider community dialogue. We acknowledge that our analysis is only the start and not the final prescription.

The conservation and efficiency measures considered in the scenario analysis have been validated by water efficiency experts as measurable best practices and should be considered conservative estimates. The targets are really a function of the uptake of each measure. Rebates will result in different participation rates than bylaws or market shifts, for example. At this time, the scenarios explored focused on measures that have been validated extensively in other communities. However, there is a significant potential for future savings by adopting more progressive technologies and practices such as composting toilets, 100% xeriscaped lawns or no lawns, rainwater for showers, etc. These practices, initiated over the course of 20 years, could offer significant *additional* water savings as values and provincial policies change.

Appendix F- Typical Values for Parameters

PARAMETER	TYPICAL/ DEFAULT	RANGE	NOTES	REFERENCE
INTRO				
Natural Gas Used for Hot Water Heating	30% in Ontario	10-70%	Different for each province, consult reference	Ryan (2005) Figure 5
COMMUNITY WATER USE				
Number of Summer Months	4 (mid-May to mid-Sept)	2-8	Dependent on climate and type of irrigators	
CURRENT WATER USE				
Disaggregation of Water Use - % of Municipal Total Annual Daily Demand				
%Residential	52%[66] in Canada	52% (290 LCD) for pop. > 500,000 & 72% (450 LCD) for pop. < 1,000	**Community specific** Small or bedroom communities will have a higher percentage of residential water use.	Environment Canada (2009)
Indoor Per Capita Water Use	230 LCD in Ontario	150-300 LCD	New homes should have an indoor water use < 200 LCD Homes with significant leakage could have water use as high as 350 LCD	Environment Canada (2007); Veritec (2008)
%Indoor Single Family Residential Water Use	93% of annual average typical in Ontario	80-98% of annual average in Canada		Calculations from Ontario Municipalities
Outdoor Per Capita Water Use	30 LCD typical in Ontario	20-40 LCD	Dependent on rainfall and irrigated area	Calculation based on 10% outdoor use & MUD Database
%Outdoor Single Family Lawn & Garden	> 90% of total outdoor water use			Estimate
%Commercial Institutional (CI)	19% in Canada		Highly variable depending on the community	Environment Canada (2009)
% Indoor CI	75%	60-95% for all ICI	Highly variable depending on the types of institution	Estimate
% Outdoor CI	25%			Estimate
% Industrial	16% in Canada	N/A	**Community specific**	Environment Canada (2009)
%Agricultural	0%	Urban 0%	Community specific. Dependent on proximity	

[66] All sector percentages are percentages of **municipally** supplied water

			of agriculture to municipal supply	
%Non-Revenue	13% in Canada[67]	5-20% across Canada	Community specific. Dependent on age and size of distribution mains, leak reduction programs, etc.	Environment Canada (2009)
%Unbilled Authorized	1.25% of System Input Volume		Main flushing, fire fighting, etc.	Estimate
%Apparent Losses	10%	5-15%	Meter Inaccuracies; 5% on end-use meter + 5% on water supply meters	Estimate
%Real Losses	70%		Note that 50% of these losses may be background losses	Estimate
Peak Day Factors				
Peak Day/Total ADD	1.4	1.2-1.6	Historical (actual, not design) peaking factor with respect to average day demand. Note that smaller municipalities (with lower industrial use) may experience higher peaking factors	OWWA (2008) for medium – large Ontario municipalities
Peak Day/Non-Revenue	1.0	N/A	Non-revenue is not assumed to be impacted by peak day demands.	Assumption
Growth Factors				
Commercial Institutional	Equivalent to the population growth	N/A	Typically identical to the population growth	
Industrial	1.0	1.0 – Population Growth Factor	Difficult to predict, and the water use is sometimes not predicted to change from the current status in urban communities	
Residential	Equivalent to the population growth	N/A	Specific to single family and multi-family population growth	
Agricultural	1.0	N/A		
Non-Revenue	Equivalent to	N/A	Equivalent to the	

[67] Note: The percentage of Non-Revenue water is strongly influenced by the total volume of water used in a community, and can be skewed by high volume water users, for example. Non-Revenue and Real Losses cannot effectively be compared to best practices using a percentage. An IWA Water Balance should be conducted and an ILI value calculated. Percentages are used within the WaterSmart Scenario Builder for simplicity - but a high or low percentage must be evaluated on an individual basis.

	the population growth		population growth	
INDOOR RESIDENTIAL WATER USE				
Efficient Homes	Approx. 200 LCD	Ontario, and British Columbia, each require 6 L toilets in all new construction since 1996 and 2008 respectively.		Based on Veritec (2008); Mayer & deOreo (1999)
High Efficiency Homes	130-150 LCD	Clothes Washers are replaced approximately every 10-14 years and sales are moving toward horizontal axis, water efficient, models. It is estimated that 40% of sales in 2005 were front loading clothes washers (NRCAN, 2007; Figure 2-4). High efficiency toilets are becoming more widely available and will be mandated in California by 2014.		Based on Veritec (2008); Mayer & deOreo (1999)
OUTDOOR WATER USE				
Un-tuned Automatic Irrigation Systems	Water Use Factor of 1.0	An estimated 10% of homes, in urban communities, are equipped with automatic irrigation systems, using an estimated 60% total residential water for irrigation. New homes are increasingly being equipped with automatic irrigations systems. Assumes 3 - 3.75" of water delivered.		OWWA (2008)
Tuned Automatic Irrigation Systems	Water Use Factor of 0.3	It is assumed that very few homes are today optimally tuned for water savings. Assumes 1" of water delivered. 70% less water use than un-tuned		OWWA (2008)
Manual, overhead sprinklers	Water Use Factor of 0.15	Used in 90% of homes & businesses Assumes delivery of ¼ to 1/5" per week. 80% less water use than Un-tuned Automatic Irrigation Systems		OWWA (2008)
Drip Irrigation & Efficient Landscaping	Water Use Factor of 0.07	Efficient Landscaping 20-80% less Drip irrigation 25-75% less than manual	It is assumed that very few homes today adopt best practices for outdoor use.	Gleick et al. (2003); pg 73 AWE (2009)
Alternative Sources	Reduce 100% of potable water irrigation demands		Rainwater and greywater could potentially supply 100% of outdoor water use needs, assuming water was ½" per week	OWWA (2008) page 31
COMMERCIAL INSTITUTIONAL				
Targeted CI Water Savings	5% reduction of total future demand typical of programs	5-10% readily achievable	Greatest opportunity exists for toilets, urinals, showerheads and faucets. If individual users	Vickers (2001); pg 239 Cohen (2004)

	today	15-35% typical potential	known, 50% of potential could be achieved.	
INDUSTRIAL				
Targeted Industrial Water Savings	10% reduction of total future demand	5-10% readily achievable 33-50% typical potential	VERY municipality specific. Greatest opportunity exists for adjusting blow-down cycles in cooling equipment and recycling process water. If individual users known, 50% of potential could be achieved.	Vickers (2001); pg 239 Cohen (2004)
NON-REVENUE				
Water Loss Reduction	20% of Real Losses Typical of Municipal Savings Today	10-40%		Estimate
IMPLEMENTATION				
Overall Targeted Reduction in Water Use	10% of BAU in 10 Years targeted through Ontario municipal programs today	10-40% of BAU in 10 years (dependent on baseline water use)	Reduction in water use is a percentage of BAU projected water use achieved by Municipally supplied rebates	Review of Water Efficiency Plans from the Region of Peel, Durham Region, York Region, Region of Waterloo, City of Guelph, City of Calgary and Southeast Queensland, Australia

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