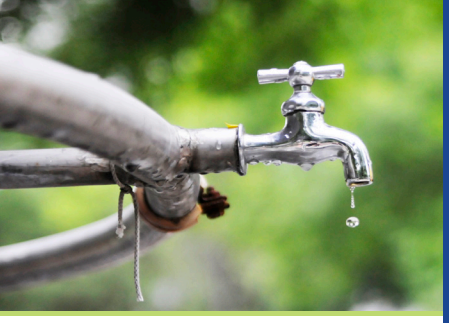
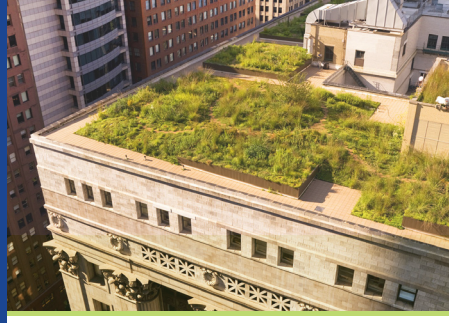


GREATER LAKES

Reconnecting the Great Lakes Water Cycle



High Returns on Better Water Management for the City of Guelph

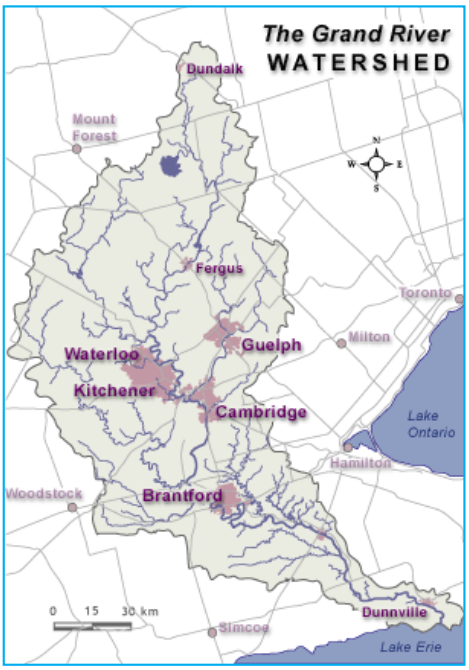
Greater Lakes Project | March 2015

The Great Lakes Commission's Greater Lakes project explores municipal water conservation/efficiency programs and green infrastructure projects that address human water needs in ways that are more strongly linked to the natural water cycle. This fact sheet presents our analysis of Guelph's water resources and suggests additional programs and projects that will result in a resilient water system more in sync with nature, making it more economically and environmentally sustainable.

Guelph has made major strides in water conservation and efficiency, making it a leader in this field. Nevertheless, our analysis shows that more work can show measurable and significant results, particularly with the use of green infrastructure programs.

The Fractured Water Cycle

Guelph, just like other municipalities, has been built in a way that disrupted the natural water cycle. Water supply has been withdrawn from the ground or a stream, but is rarely returned to the same place. Once used, water was treated as waste – whether as wastewater or stormwater – to be gotten rid of as quickly as possible through pipes discharging to streams, rivers or the Great Lakes. By moving rainwater away from their homes and businesses as rapidly as possible, the water is prevented from percolating into the ground, where it can restore local water supplies and be available for the ecosystem. The resulting stormwater runoff discharges at excessive rates leading to erosion, pollutant transport and downstream flooding. We have now come to realize that restoring the natural hydrology is a cost-effective and sustainable approach to addressing these problems.



Guelph's Watershed and Water Sources

Guelph is situated in Ontario's central Grand River sub-basin, which is heavily urbanized. This urbanization has caused excessive stormwater runoff from hardened surfaces, such as roads, parking lots, roofs and compacted soils on many lawns. This is resulting in localized flooding during severe rain events. Urbanization has also led to rainfall bypassing the natural infiltration that recharges the groundwater. At the same time, the city relies solely on groundwater for its public water supply. The groundwater supply is sustained by rain and snow that seep into the ground so, when rainfall is shunted directly to the rivers and streams, the groundwater supply decreases. Groundwater is further depleted when groundwater is withdrawn, delivered to households, and then transported to the wastewater treatment plant. The treated effluent is returned directly to the Speed River with little opportunity to re-

charge the groundwater. The Speed River then discharges into the Grand River. The potential stress on its groundwater supply was determined by a Lake Erie Source Protection Committee study to be moderate.[1] This same study determined that the Eramosa River above Guelph, which is a source for the city's water supply, was also moderately stressed.

For its water supply, the city relies on 21 operational groundwater wells. This is augmented by the Arkell Spring Grounds Glen collector system, which collects shallow groundwater through a series of underground perforated pipes. To enhance the supply of water into the collector system, the city operates the Eramosa River intake and an artificial recharge system at the Arkell Spring Grounds. From April 15 to November 15, water is pumped from the river into an infiltration pond where it replenishes groundwater supplies.

With an estimated 2011 population of 121,688, the city's peak water use rate is 48,308 cubic metres per day and off-peak is 43,608 cubic metres per day. The population is expected to grow by 50 percent to 186,299 by 2038.[2] The residential sector accounts for over half of the total demand.

Putting Water Conservation and Efficiency into Practice

The city of Guelph is a sustainable water use success story, but the city still recognizes the need to keep improving. Because the city recognizes groundwater as a finite resource, it has been pursuing water efficiency programs to manage demand since 1998. If no conservation and efficiency programs were implemented, the city would exceed its capacity by 2040. The city's primary goal is to reduce the amount of drinking water produced every day while continuing to grow. Since 2001, Guelph has added more than 15,000 new citizens, but decreased water use by nearly 10,000 cubic metres per day!

The chart below (figure 1) plots future water demand scenarios out to 2035. The blue line plots the baseline demand scenario (meaning that no conservation programs are used). In this scenario, population is the sole driver of demand. The red line shows demand as a result of replacing inefficient plumbing fixtures and appliances—such as toilets, showerheads, washing machines and dishwashers—with modern efficient appliances, as is increasingly required in government standards. The green line plots future demand after addition of savings from more aggressive programs such as home audits and greywater reuse systems to appliance upgrades.

Service Area Demands (in Million Litres)

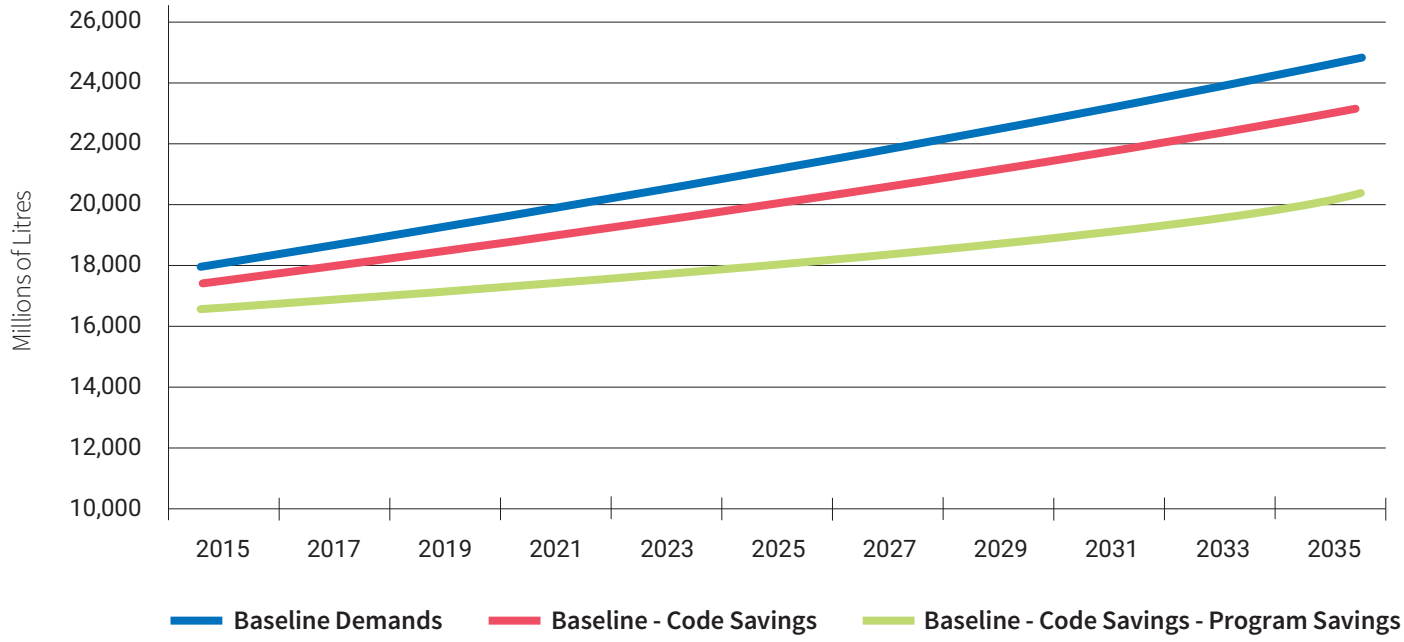


Figure 1. Prepared by the Alliance for Water Efficiency

1 Lake Erie Source Protection Committee. 2012. Grand River Source Protection Area Approved Assessment Report. Cambridge, ON: Lake Erie Source Protection Committee. http://www.sourcewater.ca/swp_watersheds_grand/2012_GR_ApprovedAR_Ch8.pdf

2 The city of Guelph persuaded the province to reduce their growth projection numbers, since the city determined that its water supply or assimilation capacity will limit future growth.

This data is based on Guelph's ongoing commitment to implement the following water conservation and efficiency programs:

- **Royal flush toilet rebate for single family, multi-family, and Institutional-Commercial-Industrial (ICI) sectors:** Offers incentives to replace 13-litre or more per flush toilets with new WaterSense-certified models with a flush volume of 4.8 litres or less.
- **Smart Wash washing machine rebate:** Offers a $100 incentive to customers who replace an old top-loading washing machine with a new high-efficiency EnergyStar clothes washer with a water factor of 6.0 or less.
- **Blue Built Home program:** Certifies new homes based on the inclusion of high-efficiency fixtures and appliances. There are three levels of certification for Blue Built Homes: bronze, silver and gold. The requirements are related to toilets, clothes washers, hot water delivery systems, greywater systems, and rainwater harvesting systems.
- **Greywater reuse systems:** Offers a rebate program for home residential greywater systems that collect greywater from such uses as showers and baths. The greywater is then filtered and treated with chlorine and used to flush toilets.
- **ICI audit and capacity buyback program:** Provides ICI water consumers with financial assistance for water use facility audits and potential one-time financial incentives for the implementation of capital retrofits to permanently reduce water use at their respective places of business. This program, ultimately, pays ICI customers to reduce water consumption at a specified rate.
- **Rainwater harvesting system:** Offers incentives to its customers for two types of rainwater harvesting systems: seasonal outdoor systems and all-season indoor/outdoor systems.
- **Healthy landscape visit:** Offers its water customers free consultations to help improve gardens and landscapes.
- **Efficient home visit audits:** The city of Guelph collaborates with eMERGE Guelph and other organizations/agencies to provide efficient home visits. Part of the home visit includes a focus on water efficiency.

Making ¢ents of Water Conservation and Efficiency Programs

Not only have water conservation and efficiency programs led to a decline in water use; they also have led to reduced costs for supplying water and handling wastewater. The Greater Lakes project evaluated Guelph's many water conservation and efficiency programs using the Alliance for Water Efficiency's Conservation Tracking Tool, and came up with some significant findings.

As Table 1 shows, taking the whole portfolio of programs into consideration, **the city is saving nearly *six times* that of the program costs**. The avoided costs associated with water supply and wastewater systems are factored into the benefits. Table 1 summarizes the net present value (NPV) for all programs. The NPV is the present value benefits (which is the economic value of future cost savings today and includes avoided capacity, avoided supply and avoided wastewater costs) minus the present value costs (which are what the utility spends to fully fund the conservation program). For example, the single family (SF) Royal Flush Toilet Rebate program has a total present value in avoided costs of $16,336,900. It costs only $2,276,300 to implement the water efficiency program, and therefore the NPV (the present value minus present cost) is a dramatic savings of $14,922,257.

City of Guelph Costs and Benefits of Water Conservation Programs

Activity Name	PV Cost ($)	PV Benefit ($)	NPV ($)
Royal Flush Toilet Rebate, SF	$1,676,300	$12,068,155	$10,391,855
Royal Flush Toilet Rebate, MF	$525,400	$2,534,944	$2,009,544
Royal Flush Toilet Rebate, ICI	$55,800	$441,405	$385,605
Smart Wash Washing Machine Rebate	$1,333,250	$4,806,374	$3,473,124
Blue Built Home - Bronze	$329,280	$545,126	$215,846
Blue Built Home - Silver	$15,900	$21,487	$5,587
Greywater Reuse Systems	$21,000	$3,157	$(17,843)
ICI Audit and Capacity Buyback Program	$967,395	$12,323,719	$11,356,324
Rainwater Harvesting System	$50,000	$7,264	$(42,736)
Healthy Landscape Visit	$368,970	$36,022	$(332,948)
Efficient Home Visit Surveys (GEL/NetZero City)	$229,505	$24,127	$(205,378)
Total	**$5,572,800**	**$32,811,780**	**$27,238,980**

Table 1. Prepared by the Alliance for Water Efficiency

The city of Guelph estimates that the per litre cost of supplying water from new water supply and wastewater treatment infrastructure is approximately twice as costly as saving a litre of water through conservation and efficiency.

Energy Savings and Emission Reductions

Water conservation and efficiency programs reduce the need to pump, treat and deliver water to customers and decrease the amount of water being treated in wastewater treatment plants. Also, decreased water use in homes reduces the energy costs to heat the water. These in turn reduce the energy consumption and greenhouse gas emissions associated with these processes. Figure 2 illustrates the energy savings from reduced water demands. The green bars display the value of energy savings incurred by the utility or municipality. The blue bars display the value of energy saving that the customers receive from participating in the conservation programs. The gas savings are only associated with the customers because they are more likely to use gas for heating water purposes. For example, the customer will receive savings on gas for replacing hot water heaters or other appliances that use gas with more efficient ones. Figure 3 displays the associated reductions in metric tons for the greenhouse gas carbon dioxide. These savings are significant.

Value of Energy Savings

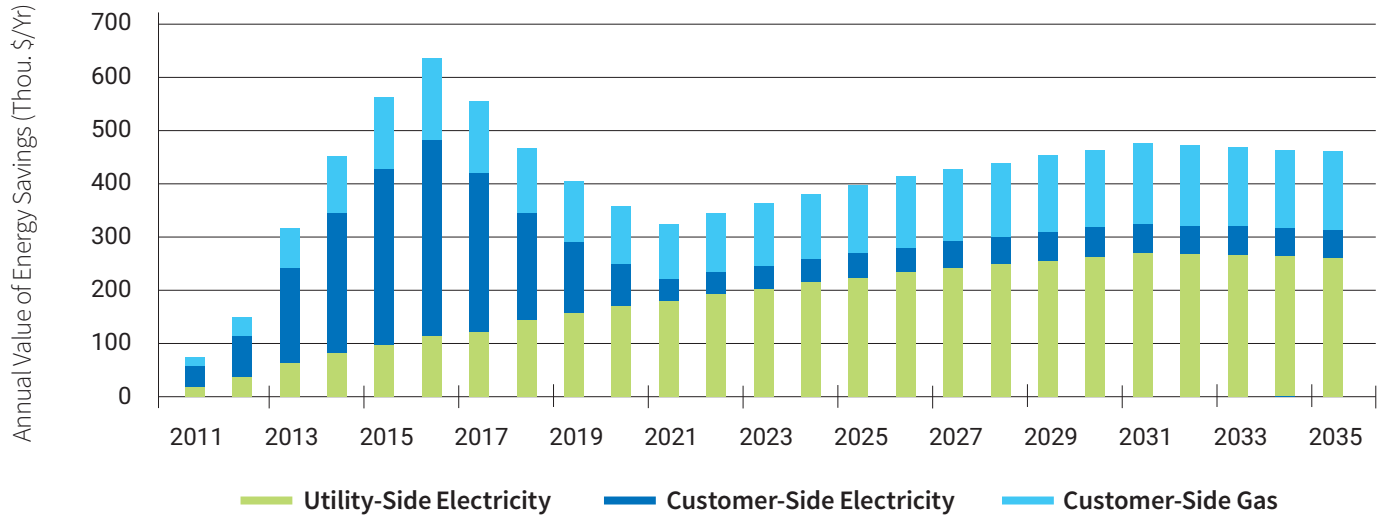


Figure 2. Prepared by the Alliance for Water Efficiency

Cumulative CO_2 Emission Reductions

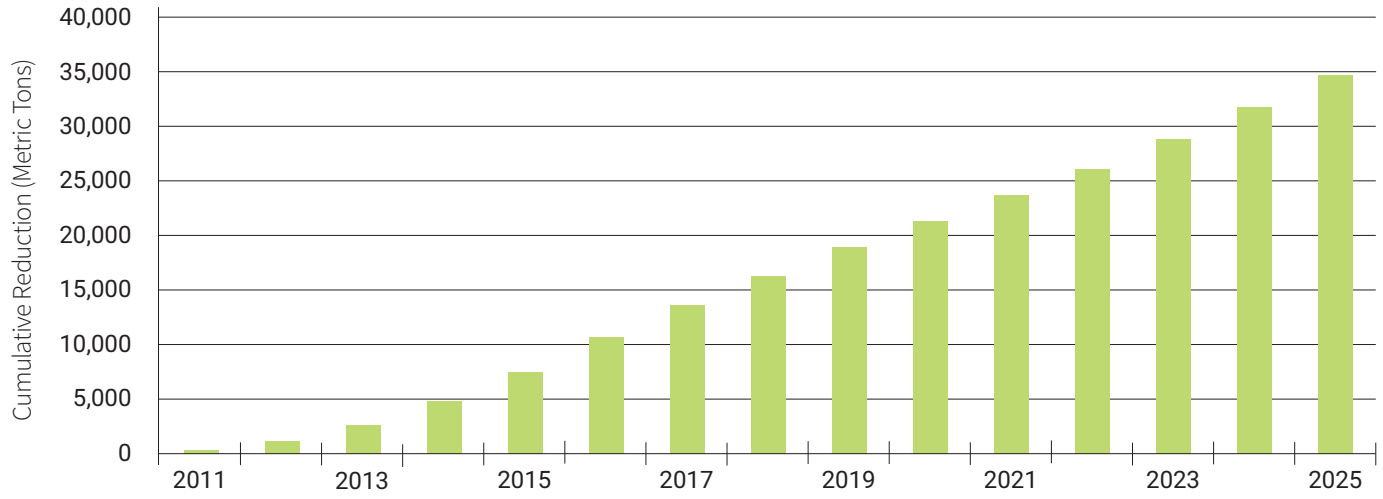


Figure 3. Prepared by the Alliance for the Water Efficiency

Improving the Fractured Water Cycle

The water conservation programs implemented by the city of Guelph have been successful both financially and ecologically – but more can be done. The stresses on the groundwater source, while decreased, are still substantial. Rather than relying solely on withdrawing and storing river water to augment groundwater sources, Guelph could look to better/smarter means of managing the water that falls on the urbanized area. A transition is needed to programs that capture the surface runoff, utilize natural processes to clean that water, and then use that water to further reduce the need for treated drinking water, as well as deliver runoff in a controlled and sustainable way.

Urbanization has severely altered the natural water cycle. The result is increased peak flows and lower low flows – both of which stress the natural drainage courses. It also exacerbates flooding and leads to pollution associated with runoff. By capturing rainfall close to where it falls, allowing portions to infiltrate, storing some of the excess flows and releasing those flows at a controlled rate, the receiving waters are allowed to recover.

Guelph, like all urban areas, could benefit from a more active onsite stormwater management program. These programs have been successfully implemented through both regulatory and incentive programs. The goal of these programs is to capture a given amount of rain water—say 300 mm over the site—and either reuse that water (for irrigation, landscaping or toilet flushing) or release that water at a more natural rate. This storage can take the form of ponds, tanks, cisterns or a variety of commercially available underground storage/infiltration devices. All of these will lead to increased infiltration, decreased peak flows, reduced erosion, improved in-stream water quality, and increases in biodiversity.

Here are a few recommendations toward restoring the natural hydrologic processes.

- **Continue and expand water conservation and efficiency –** The existing water conservation programs are successful and should remain in place and be expanded with exploration of additional water efficiency and conservation programs. Overall, the entire portfolio of water conservation and efficiency programs provide a very positive benefit for the city.
- **Investigate means of encouraging/requiring onsite storage of stormwater –** Onsite storage will not only increase groundwater levels over time, but it will reduce flooding potential and polluted runoff. It can also provide incentives for an enhanced green infrastructure program.
- **Investigate means of encouraging/requiring green infrastructure –** Building upon a storage requirement supporting an increased infiltration program, green infrastructure can provide the least cost, most effective means of managing runoff on a site-by-site basis. It can also provide for the least cost municipality-wide stormwater management program.
- **Marrying the green and grey –** Recent studies suggest that a combination of green and grey infrastructure provide the lowest cost and most effective means of achieving the financial, technical and ecological goals of returning to a more natural urban drainage system.
- **Align municipal policies to encourage the use of green infrastructure as well as encourage private investment in green infrastructure –** With appropriate incentives (and appropriate controls) private investors can be encouraged to provide the funding necessary to rapidly implement a citywide green infrastructure program on both public and private property. The benefits should be weighed as city leaders craft the policies needed to reconfigure the urban drainage system. Because they are not constrained to work on public property, private investors, working through a local aggregator, can often provide the maximum benefit at the lowest cost.
- **Consider innovative technologies that support a reconfigured drainage system –** Green infrastructure best management practices provide complementary, alternative approaches to traditional stormwater management. Once a series of storage ponds/vessels have been constructed, they can be operated in an efficient manner if the filling and emptying of the volume is done in conjunction with weather prediction. Stated simply, when it starts to rain, ideally the entire storage volume is available. Technology providers have developed sophisticated systems to provide this benefit. Early results suggest that for fairly small investment, the operational benefit can be substantially improved. The final stormwater management program should be crafted to take advantage of these new technologies, when appropriate.

This publication was authored by Rebecca Pearson, Great Lakes Commission and edited by John Jackson, Greater Lakes project manager, Christine Manninen, Great Lakes Commission, and Melissa Soline, Great Lakes and St. Lawrence Cities Initiative. Special thanks to Wayne Galliher, City of Guelph, for providing guidance.