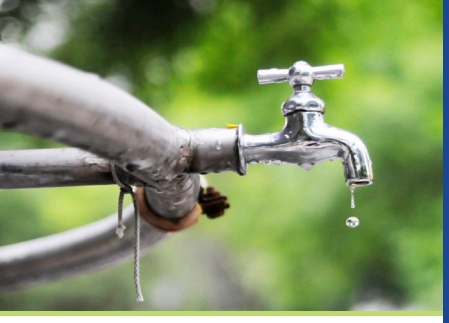
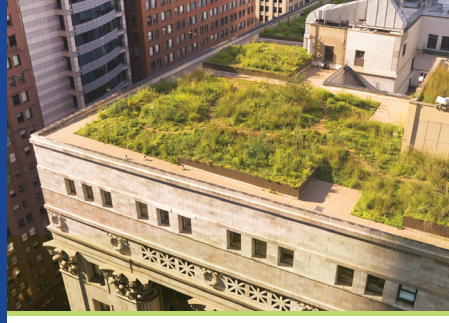


GREATER LAKES

Reconnecting the Great Lakes Water Cycle



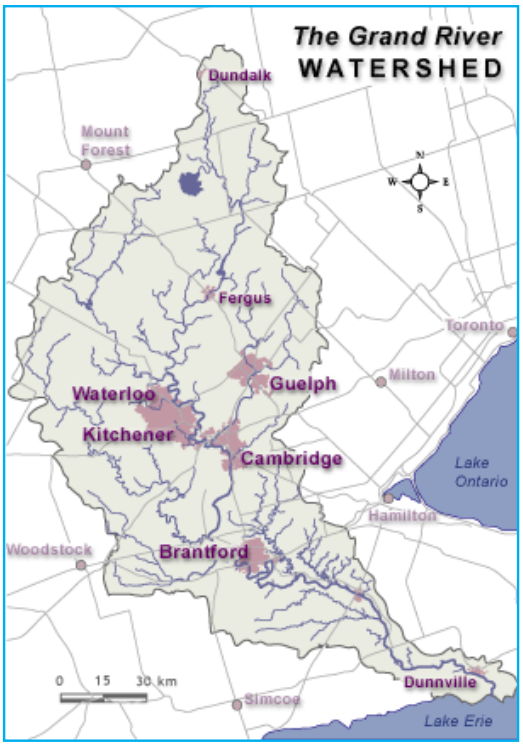
Managing Water in Waterloo Region: Thirty Years of Success, but Still More to Do

Greater Lakes Project | August 2015

The 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 Waterloo Region's water resources, highlights its successes 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.

The Fractured Water Cycle

Waterloo Region, just like other municipalities, was built in a way that disrupted the natural water cycle. Water supply, withdrawn from the ground or a stream, is rarely returned to the same place. Once used, water is treated as waste – whether as wastewater or stormwater – to be gotten rid of as quickly as possible through pipes discharging to streams or rivers. Likewise, moving stormwater away from 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. An example of this is a rain event on the region's more than 700 kilometers (about 400 miles) of roads. A one-inch rain fall leads to close to 15 million litres (4 million gallons) of water hitting the streets directly (not including parking lots, lawns and other hard surfaces) and over two billion litres (600 million gallons) per year going to the storm sewer system. The resulting stormwater runoff discharges at excessive rates leading to erosion, pollutant transport and downstream flooding.



A more highly variable climate is predicted as a result of climate change. This is likely to exacerbate an already fractured water cycle. With concerns of climate change, larger rainfall intensities may lead to more dramatic surface runoff at times and cause greater flooding and erosion. Also, alterations in rainfall patterns may affect drought patterns. Longer droughts and increasing temperatures are expected to cause earlier and faster spring melt, larger demand for water from agriculture, and increasing water temperatures, which can degrade stream habitat.

Restoring the natural hydrology is the most cost-effective and sustainable approach to addressing these problems.

Waterloo Region's Watershed & Water Sources

Located in Ontario's Grand River watershed, Waterloo Region is comprised of three urban municipalities (Cambridge, Kitchener and Waterloo), and four rural townships (North Dumfries, Wellesley, Wilmot and Woolwich). With a combined population of more than 553,000, Waterloo Region is one of the fastest-growing areas in Ontario and is expected to reach a total population of 729,000 by 2031.

The Waterloo Region supplies drinking water to its three municipalities and four townships, which in return sell it to retail customers. The source for 80 percent of the public water supply is groundwater; 20 percent is from surface water. It is the second largest municipality in Canada that is so dependent on ground water for its public water supply. A total of 122 wells and surface water intakes supply a volume of approximately 292 million cubic litres of water per day. Over 60 percent of the total use is for residential purposes. Wastewater flows to region-owned wastewater treatment plants, which discharge to the Grand River.

Thirty Years of Water Conservation and Efficiency

Working on water conservation for over thirty years, Waterloo Region is a leader in water conservation in the Great Lakes-St. Lawrence River basin. The true test of Waterloo's leadership started during a string of dry summers from 1997 to 2002. During this time period, annual precipitation levels across the watershed were below the average by 11 percent, or about 60 centimeters (two feet) of rain. The shortfall was equivalent to eight months worth of rain. Especially during the summer of 2002, the maximum weekly water demand peaked at approximately 189 million litres per day. This was close to the system capacity. The failure of even one well could have resulted in demand exceeding supply. The region also reported relatively high water demands in smaller rural systems during that same summer, requiring the trucking of water to maintain adequate water supply during peak periods. This water crisis catalyzed a more aggressive approach to water conservation.

The primary goal was to reduce outdoor water use by developing and enforcing lawn watering restrictions, employing rain barrels and educating water users. The most effective tool was the out-door water use by-law. This by-law permits lawn watering only once a week within certain time restrictions. Enforcement has been a critical component of this by-law's success. This by-law is now embraced by the community and seen as the "new normal." In addition, Waterloo Region has subsidized tens of thousands of rain barrels since 2001 to promote outdoor water conservation; many households have hooked several barrels up in series to build capacity. Savings attributed to the outdoor water use program, primarily the by-law, have been conservatively estimated at 22 million litres per day on average from June through September.

As a result, Waterloo Region achieved an estimated combined indoor and outdoor water savings of 8.5 million litres per day from 2007 and 2010. While population for the region continued to grow from 2003 to 2010, the average and peak water demands dropped (see figure 1). Because of these water savings, the region was able to defer an estimated one billion dollar infrastructure project to pipe water from Lake Erie almost 100 kilometres to Waterloo Region as an alternative to their current ground water supply . Because of on-going and increased water conservation and efficiency programs, the Region now suspects that it will never need the pipeline to Lake Erie.

Region of Waterloo Average and Maximum Week Water Consumption vs. Population 2000-2010

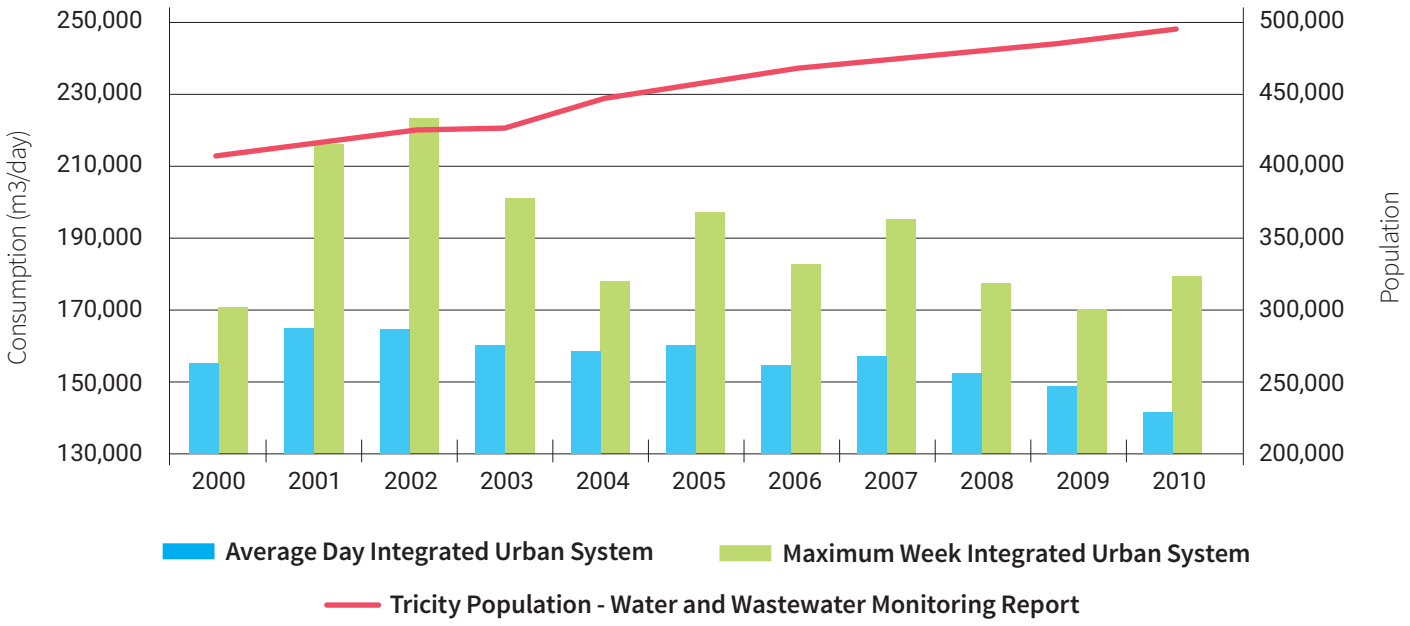


Figure 1.

Forecasting Financial, Water and Energy Savings

Will continued investments in water conservation and efficiency in Waterloo make an impact into the future? To answer this question, the Greater Lakes project analyzed the water, energy and emission savings of the Region's 17 water conservation and efficiency programs as well as their cost-effectiveness over the next twenty years using the Alliance for Water Efficiency's Water Conservation Tracking Tool. These 17 programs include:

- **CII tank and valve high efficiency (HE) toilet:** Targeted at the commercial, industrial and institutional (CII) sectors, these programs offer incentives to: 1) replace 13-litre or more per flush tank-type toilets with models that have a flush volume of 4.8 litres or less; and 2) replace valve-type (flushometer) 13-litre per flush or more toilets with models that have a volume of 4.8 litres or less.
- **CII laundromat:** Offers an incentive to CII customers to replace inefficient clothes washers in laundromats with high-efficiency machines.
- **CII pre-rinse spray valve:** Pre-rinse spray valves are used in commercial and institutional settings to rinse food waste from pots, pans, utensils and dishware before they enter the dishwasher. Water conserving valves consume less water and have an equal or better rinsing effectiveness because of improved spray pattern design. This program offers an incentive to CII customers to replace pre-rinse spray valves.
- **Community education:** This program is comprised of the following components: 1) landscape topsoil depth education and advocacy, 2) residential hot water recirculation system research, 3) plumber training, 4) commercial sub-metering education and advocacy and 5) website and CII e-newsletter.
- **School curriculum:** Provides school-aged children with education about water efficiency.
- **CII audit/recommendations:** Provides commercial, industrial and institutional customers with strategies and financial incentives to reduce water use.

Based on the analysis from the tool, Waterloo Region is considering implementing six new programs:

- **CII cooling tower:** Cooling towers are often used to cool buildings, provide refrigeration or cool industrial equipment. This program offers a $2,000 rebate for cooling tower retrofits aimed at conductivity controllers and efficient management practices,
- **Developer incentives – 1) hot water recirculation system program** offers $150 incentives to install hot water recirculation systems that literally recirculate hot water in pipes and reduce, or eliminate the wait time for hot water; **2) rainwater harvesting system** program incents developers to install in new residential construction plumbed rainwater harvesting systems at $2,500 per system. These systems capture rainwater for in-house, non-potable uses such as toilet flushing; and **3) greywater system program** offers a $1,000 per system incentive to install greywater systems that collect greywater from such uses as showers and baths, filters the water and treats it with chlorine. Once it is filtered and chlorinated it can be used to flush toilets.
- **Restaurant certification program:** Provides recognition to restaurants for using water efficiently. Rebates are offered to restaurants for lowering water use through the replacement of inefficient toilets, urinals pre-rinse spray valves and ice machines.
- **Residential rainwater harvesting rebate (outdoor only):** Offers rebates for the purchase of rainwater harvesting barrels and tanks. The harvested rainwater is used to water plants and other outdoor, non-potable applications.
- **Targeted user program – education, audit and rebate:** Targets residential customers that have high water consumption patterns and provides either/or a combination of education, water audits or rebates for water efficient fixtures.
- **Toilet flapper replacement:** Toilet flappers wear out with age and are often the cause for a leaking toilet. This program provides replacement toilet flappers to residential customers.

The Water Savings

If Waterloo Region continues to implement the 17 water conservation and efficiency programs at the rate currently planned, its water demand will be reduced by 8 billion litres over 20 years, from 2015 to 2035. Figure 2 plots future water demand scenarios out to 2035. The blue line plots the baseline demand scenario (meaning that no additional conservation programs are used). In this scenario, population is the sole driver of demand. The redline 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 toilet replacement, commercial audits and community education.

Waterloo Region's planned water conservation and efficiency programs are modest with, for example, only 35 toilet replacements and 10 laundromat replacements each year. More aggressive programs could result in a greater difference between the baseline code savings and the baseline program savings now shown in figure 2.

The Financial Savings

Even with the relatively modest programs planned, their net present value is over $4 million (table 1). The net present value (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). Two programs – the Targeted User Rebate Program and the CII Audit Program – are the largest contributors to the overall NPV at over $2 million each.

Even though individually some programs (e.g., education, greywater systems and rainwater harvesting) may be in the red as shown in Table 1, implementing the entire portfolio of programs would increase the overall water savings and financial benefits. Given the return on these modest investments, imagine the potential benefits from pursuing more aggressive programs.

Service Area Demands (in Million Litres)

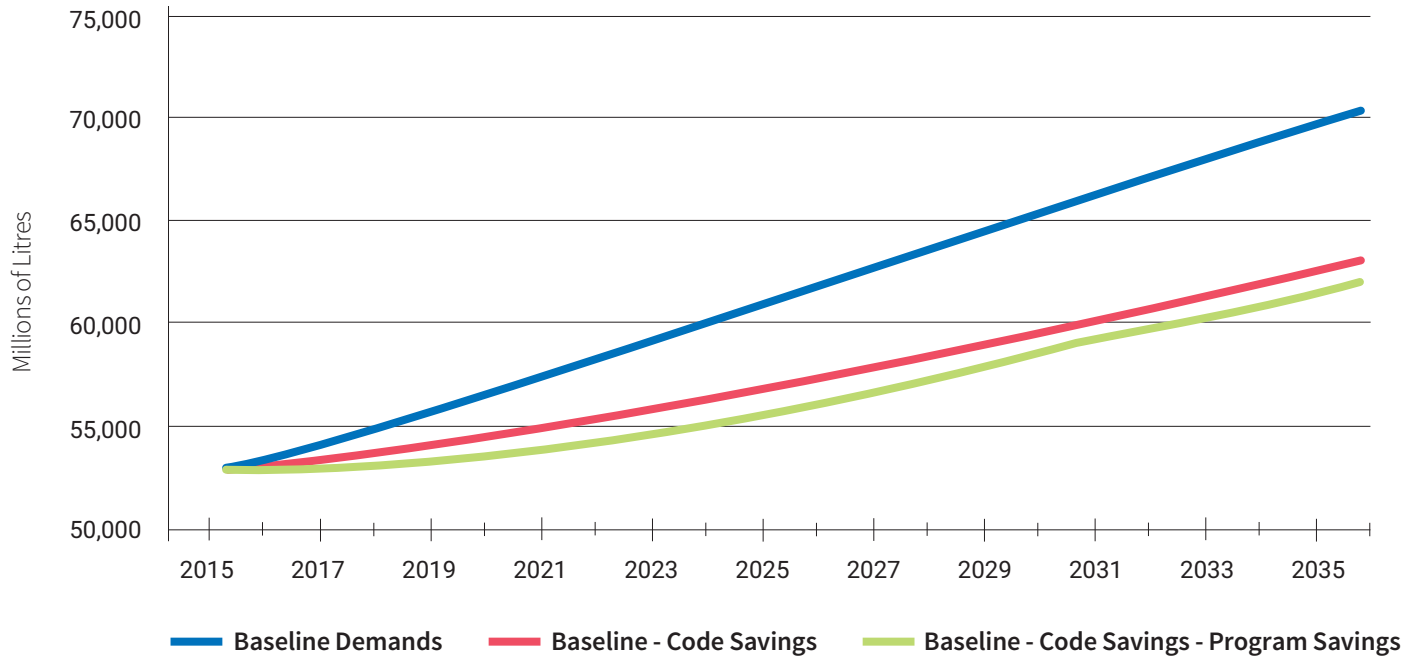


Figure 2. Prepared by the Alliance for Water Efficiency

Waterloo Region Costs and Benefits of Water Conservation Programs

Activity Name	PV Cost ($)	PV ($) Benefit	NPV ($)	B/C Ratio
CII Tank-Type HE Toilet	$ 8,791	$ 124,655	$ 115,864	14.18
CII Valve-Type HE Toilet	$ 50,168	$ 94,846	$ 44,678	1.89
CII Laundromat	$ 12,900	$ 27,250	$ 14,350	2.11
CII Pre-Rinse Spray Valve	$ 22,170	$ 334,930	$ 312,761	15.11
Community Education	$ 1,290,042	$ 370,051	$ (919,991)	0.29
School Curriculum	$ 143,338	$ 32,530	$ (110,808)	0.23
Developer Incent: Hot W. Recirc System	$ 57,335	$ 61,771	$ 4,436	1.08
Developer Incent: RainW Harv. System Plumbed	$ 334,455	$ 38,147	$ (296,309)	0.11
Targeted User Prog: Education	$ 1,146,704	$ 1,390,991	$ 244,287	1.21
Targeted User Prog: Audit	$ 365,512	$ 495,456	$ 129,944	1.36
Targeted User Prog: Rebate	$ 401,346	$ 2,644,591	$ 2,243,245	6.59
CII Cooling Tower	$ 267,564	$ 168,968	$ (98,596)	0.63
Restaurant Certification Program	$ 121,837	$ 636,457	$ 514,619	5.22
CII Audit/Recommendations	$ 1,469,215	$ 3,498,394	$ 2,029,179	2.38
Developer Incent: GreyW. Recyc. System	$ 86,003	$ 4,496	$ (81,507)	0.05
Residential Rainwater Harvesting Rebate Outdoor Only	$ 157,672	$ 19,958	$ (137,714)	0.13
Toilet Flapper Replacement	$ 86,003	$ 158,866	$ 72,864	1.85
Total	**$ 6,021,057**	**$ 10,102,358**	**$ 4,081,302**	**1.68**

Table 1. Prepared by the Alliance for Water Efficiency

The Energy Savings and Emission Reductions

Water conservation and efficiency programs reduce the energy needed to pump, treat and deliver water to customers and decreases the amount of water being treated in wastewater treatment plants. Also, decreased water use in homes reduces the energy needed to heat water. These in turn reduce energy costs and the greenhouse gas emissions associated with these processes. Figure 3 illustrates the energy savings from reduced water demands. The green bars display the value of energy savings incurred by the utility. 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 than municipalities are for pumping purposes, their main reason for energy consumption. 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 4 displays the associated reductions in metric tons for the greenhouse gas carbon dioxide. These savings are significant.

Value of Energy Savings

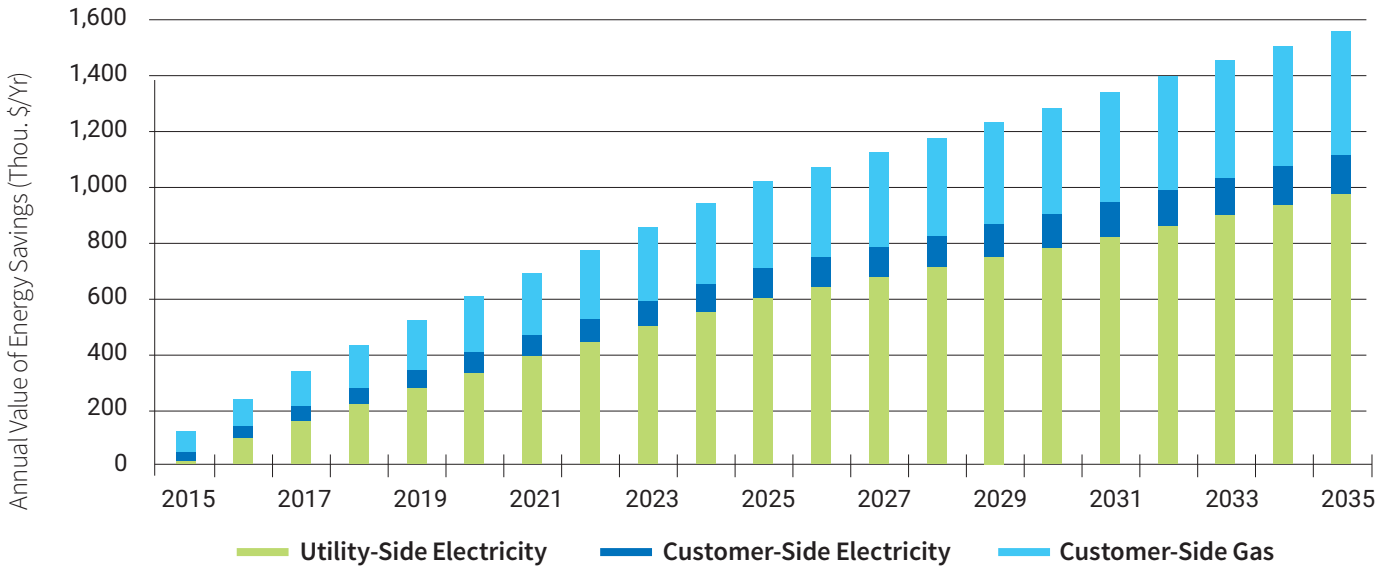


Figure 3. Prepared by the Alliance for Water Efficiency

Cumulative CO_2 Emission Reductions

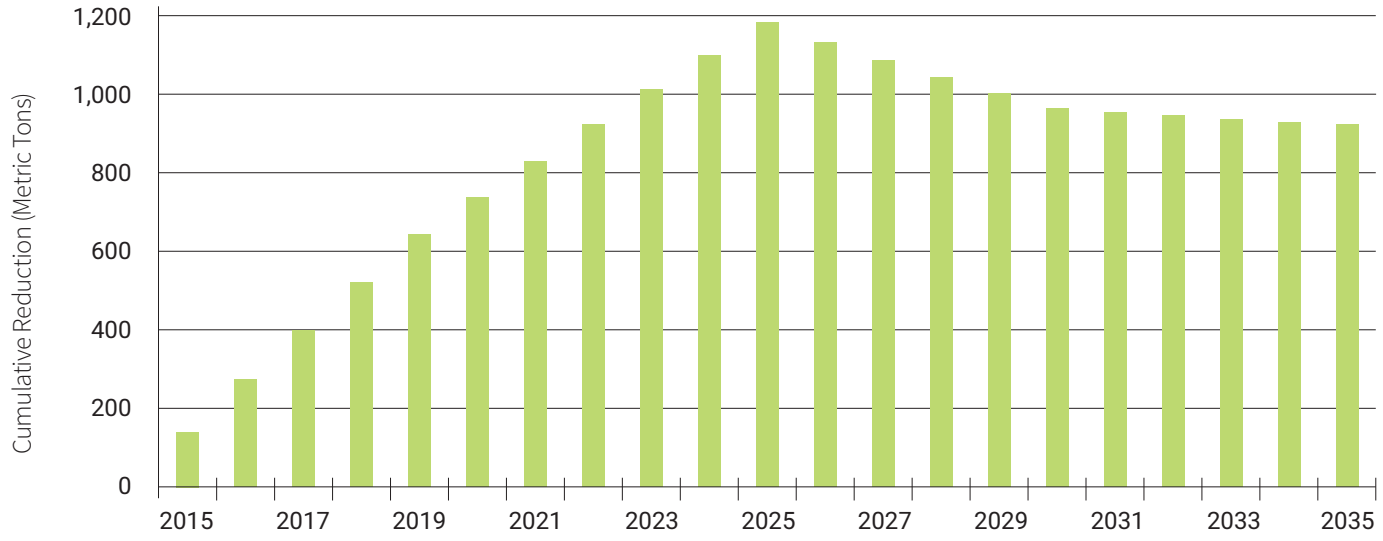


Figure 4. Prepared by the Alliance for Water Efficiency

Improving the Fractured Water Cycle

Urbanization has severely altered the natural water cycle. The result is increased peak flows and lower low flows – both of which stress natural drainage courses. It also exacerbates flooding and leads to pollution associated with runoff.

Going back to nature and adopting strategies that mimic the natural water cycle makes financial and environmental sense in the world of water resources management. 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. Observations from our analysis are listed below.

- **Reduce costs, energy and emissions:** While Waterloo Region has a successful history of water conservation, our analysis shows that it still can reduce water consumption and save money, energy and emissions by continuing old programs and starting new ones. Other communities should consider these programs for their water systems.
- **Treat rainwater where it falls:** Among these 17 programs, two of them keep rainwater at the site where its falls: a) Developer incentives for rainwater harvesting and greywater recycling systems and b) Residential rainwater harvesting rebate outdoor program. While the financial costs may still outweigh the benefits for these specific programs, they may in the long run provide both environmental and financial benefits by reducing stormwater and recharging groundwater.

  One approach could be to build a series of larger cisterns to collect rainwater from a 2-inch rainfall. More water could be stored if a larger number of cisterns were installed, or if cisterns of larger volumes were constructed. Further, a cistern system connecting cistern storage across many buildings would likely have greater benefits and cost savings for an urban community dealing with stormwater problems. The cities of Waterloo and Kitchener (within Waterloo Region) are in the second year of an innovative program to promote stormwater runoff reduction through a credit on stormwater fees for people who use rain barrels, cisterns, water gardens or infiltration beds.

  When these programs are considered as part of the entire suite of 17 programs, the financial and environmental benefits are numerous.
- **Investigate means of encouraging/requiring Green Infrastructure:** To increase storage and groundwater recharge, green infrastructure can provide the least cost, most effective means for a municipality to manage stormwater runoff on a site-by-site basis.
- **Marrying the Green and Grey :** Recent studies suggest that a combination of green and grey infrastructure provides the lowest cost – 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 or required to fund a city-wide green infrastructure program on both public and private property. Private investors are not constrained to work on public property and can work with other private partners to pool small-scale green infrastructure projects to provide the maximum benefit at the lowest cost. City leaders should consider the benefits of green infrastructure as they craft the policies impacting the urban drainage system.
- **Consider innovative technologies that support a reconfigured drainage system:** Green infrastructure best management practices provide complementary, integrated approaches to traditional stormwater management. Once a series of storage ponds/vessels are 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 to capture the rainfall. The technology is available to develop sophisticated systems that provide this benefit. Early results suggest that for a fairly small investment, the operational benefit of green infrastructure 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, Melissa Soline, Great Lakes and St. Lawrence Cities Initiative, and Jim Ridgeway, Environmental, Consulting & Technology, Inc. Special thanks to Steve Gombos, Region of Waterloo, for providing guidance.