Chapter 5

Water Conservation

Contents

We spend a lot of money, energy and GHGs treating water.

Why waste so much of it?

Abstract

Because of the huge energy footprint of treated potable water, and the high cost of water/wastewater infrastructure, municipalities save both money and energy when its water customers and its own facilities use water more efficiently. Water conservation (including water reuse) can also minimize the harmful effects of excess water-taking on aquatic ecosystems, while keeping water available for other water uses, including population growth and agriculture. While per capita water use in Ontario has dropped in the past twenty years, it is still wastefully high.

The provincial government should:

1. set higher efficiency standards for water fixtures in new buildings and at point-of-sale;
2. ensure that individual water metering can be installed in multi-unit buildings;
3. facilitate greywater and rainwater reuse;
4. require municipalities to consider conservation, especially of outdoor water use, as an alternative to new water infrastructure;
5. require water reporting for the broader public sector; and
6. look for opportunities to integrate water and energy conservation programs.

5.1 Why is Water Conservation Important?

Water conservation is essentially energy conservation in another form. Every litre of water that does not need to be treated, pumped, and collected and treated in the wastewater system, reduces energy use, roughly in proportion to the percentage drop in water use.[1] Water conservation can also avoid expensive water/ wastewater plant expansions or upgrades, and deliver environmental benefits by reducing the impact of water-takings on aquatic and wetland ecosystems (see text box 5.1.1).

Water conservation is essentially energy conservation in another form.

For these reasons, water conservation should be a key part of the water infrastructure planning of all municipalities, particularly those with an increasing population. Implementing water conservation requires stepping outside the boundaries of the municipal water system to reach end users in the community, and thus requires a different set of policy tools.

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In this chapter, we look at:

- Trends in water use in Ontario municipal water systems;
- The roles of the province and municipalities in delivering water conservation;
- How water pricing and metering can reduce water waste;
- Opportunities for codes and standards to reduce indoor water use in buildings; and
- How and why to reduce the summer peak in water consumption by addressing outdoor water use.

We conclude with recommendations on initiatives the province can take to facilitate water conservation in Ontario.

5.1.1 The Environmental Benefits of Water Conservation

By reducing the amount of water extracted from the natural environment, water conservation can deliver significant environmental benefits, in addition to reducing energy and infrastructure costs.

Municipal water systems obtain their water either from surface waterbodies or watercourses (roughly 90%) or from groundwater, through wells (roughly 10%).[2] Although most of the water is returned to surface waters after wastewater treatment, the quality and temperature of the water is usually altered. In addition, the water is usually returned to the environment in a different location, sometimes in a different watershed. All three types of changes - quantity, quality and location - affect the local water cycle.

The environmental impact of municipal water-takings is particularly important for those communities that do not draw their water from the Great Lakes, simply because water-takings have more impact on groundwater, smaller waterbodies, and streams. In these areas, water taking and wastewater discharge can cause conflict with other water users (e.g., lowering the water level in wells) as well as:

- Reduced local water quality;
- Lower water levels in lakes (impacting aquatic and shoreline habitats);
- Water flow reductions in streams (in extreme cases, changing permanent streams to intermittent streams), affecting aquatic biota;[3]
- Loss of wetlands and springs; and
- Increases in summer stream temperatures, eliminating cold or cool water habitat that many fish species require.

Like most other major water users, municipal drinking water systems require permits to take water under the *Ontario Water Resources Act*, specifying the maximum volume of water that can be withdrawn. When reviewing applications for new permits (or for increases to permitted volume of water withdrawn), the Ministry of the Environment and Climate Change (MOECC) is required to consider the potential impact on natural ecosystem functions. In practice, this system has many gaps, and does not adequately monitor and protect ecosystem functions.[4]

In areas where water taking could negatively impact natural ecosystems, municipalities may have difficulty obtaining permits for new or increased water-takings. As part of source water protection planning under the *Clean Water Act, 2006*, source protection committees developed water budgets between 2006 and 2010 for many watersheds to assess whether water quantity threats, including municipal water takings, could compromise municipal water supplies. Significant water quantity threats were identified in parts of 7 of the 22 Source Protection Areas and Regions covered by source protection plans. This includes areas slated for significant population growth. Some such areas, such as Guelph and Orangeville, have made water conservation a high priority.

Low Summer Flows and Climate Change

Water-takings have their greatest impact on ecosystems during drought conditions, often in late summer, when water levels and stream flows are at their lowest. This is usually when municipalities take the most water, and when competing water demands, e.g., for agriculture, also peak.

In 2016, much of southern Ontario experienced serious drought, with eastern Ontario reaching Level III (the most severe level of water stress) under the Ontario

Water conservation can help reduce the environmental damage caused by water taking.

Low Water Response program (Figure 5.1). This meant that water supply was officially inadequate to meet demand, and resulted in conservation authorities requesting users to reduce their water use.[5]

Climate change will likely increase the frequency and severity of droughts. Together, lower snowpacks, longer, hotter and drier summers, and more of the rain being concentrated in extreme events, are expected to reduce summer baseflow to rivers and streams.[6] While not a panacea, water conservation can help reduce the environmental damage caused by water taking, especially during droughts.

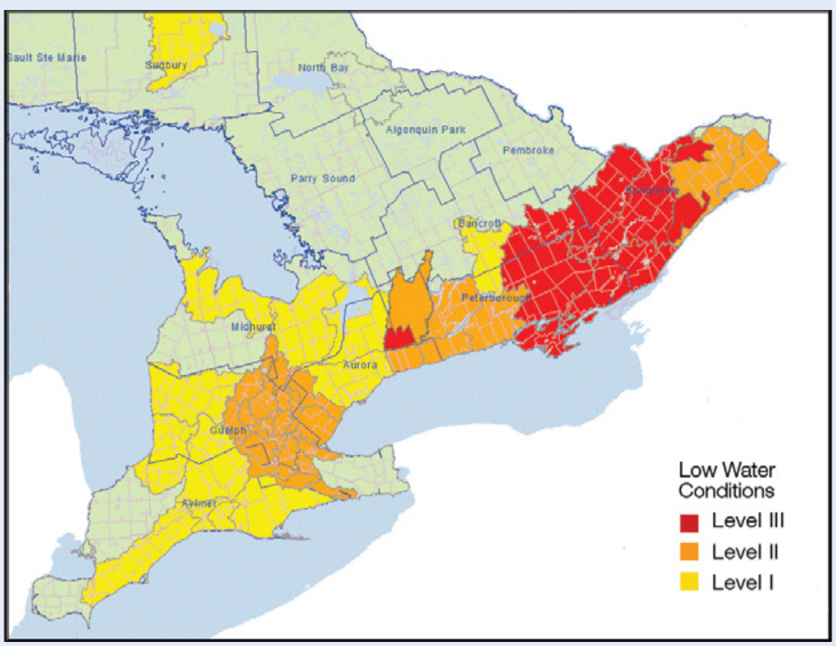

Figure 5.1. Low water conditions, southern Ontario, August 31, 2016

Source: Ontario Ministry of Natural Resources and Forestry

5.2 How Much Water do we Use?

According to the Organization for Economic Development and Co-operation, Canadians use the fourth most water per capita of 28 nations profiled, withdrawing approximately 1000 m^3 of water per person per year.[7] Ontarians use even more water, roughly 1745 m^3 per capita in 2011.[8] These statistics include water takings for all uses except hydroelectric power production, and are heavily dependent on a jurisdiction's energy, agricultural, and industrial mix. As shown in Chapter 1, 86% of Ontario's overall water takings are used for thermal power production, primarily cooling water used at nuclear power plants on Lake Ontario.

In terms of municipal water systems, the most recent comprehensive Ontario data is from Statistics Canada's *Survey of Drinking Water Plants, 2013*. In 2013, Ontarians took, on average, 386 litres of water per person per day from municipal systems, including 200 litres per person per day for residential use. This is slightly less than the Canadian averages of 466 litres per person per day for all municipal use, and 223 litres per person per day for residential use.[9] We found no comprehensive international benchmarks, but a 2008 United Kingdom study showed that many European nations use only 110-150 litres per person per day for residential use.[10] This illustrates the great potential for water conservation in Ontario. Some municipalities have targets close to these levels of efficiency; Guelph's residential water use was 180 litres per person per day in 2013, and the target is to reach 157 litres per person per day by 2038.[11]

Water use from Ontario municipal systems has been declining, both as an absolute quantity and on a per capita basis. Though Ontario municipal drinking water systems served one million more residents in 2013 than in 2005 (11.6 million vs. 10.6 million), total potable water consumption fell 13%, from 1.88 billion m^3 to 1.63 billion m^3.[12] Per capita consumption fell even further between 2004 and 2013, by 20% for total water use and 23% for residential use, as shown in Figure 5.2.

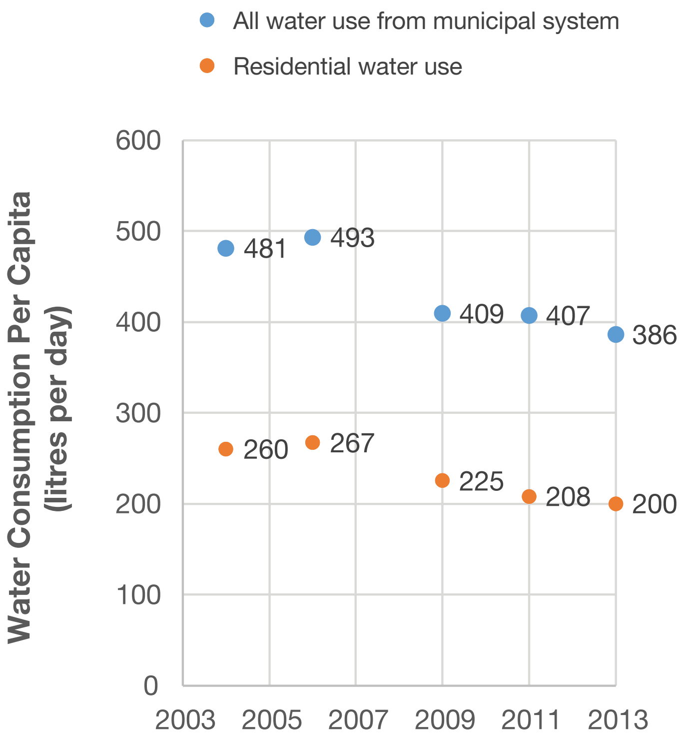

Figure 5.2. Water consumption per capita, Ontario municipal drinking water systems

Source: Statistics Canada, *Municipal Water Use Report* (multiple years);[13] Table 153-0127 from *Survey of Drinking Water Plants, 2013* (2015)[14]

Water use is decreasing across North America, driven primarily by more efficient water fixtures and appliances. The *Residential End Uses of Water Study, 2016* studied water use in 23 water utilities across North America and found that indoor water use in single-family homes had fallen by 15% per person between 1999 and 2016. Ontario-specific factors discussed in this chapter, such as municipal water conservation programs, near-universal water metering, and water efficiency standards in the Ontario Building Code, may account for the sharper decrease in Ontario residential water use.

5.3 Provincial and Municipal Roles in Water Conservation

The province and municipalities both have roles in encouraging water conservation.

5.3.1 Provincial Role

The Ontario government's water conservation tools include its power to:

1. Set codes and standards for appliances and other products;
2. Mandate water reporting;
3. Require municipal water sustainability plans, and
4. Make voluntary water conservation programs, supported by dedicated funding, available to customers across Ontario, as it has done for electricity and natural gas.

So far, it has made limited use of these tools.

Codes and Standards

The province can set requirements for water conservation in new buildings through the Ontario Building Code, and is supported in this role by the Building Code Conservation Advisory Council. It can also establish water efficiency standards for appliances and other products sold in Ontario, under either the *Green Energy Act, 2009* (for products that also use energy, such as clothes washers and dishwashers), or the *Ontario Water Resources Act* (for all other products that use water, such as water fixtures).

The Ministry of Municipal Affairs (MMA) consulted on changes to the Building Code most recently in fall 2016. No significant amendments related to water efficiency were proposed, but a second phase of consultation is forthcoming, with the intent of bringing in changes for the 2019 Building Code. MMA has indicated that some proposals related to water efficiency are likely to be part of this consultation.[15]

Specific opportunities for codes and standards are discussed in Section 5.5.

Water Reporting

As described in Chapter 3, Ontario mandates energy reporting, but not water reporting, by the broader public sector (i.e., municipalities, universities, hospitals, etc.).[16] Ironically, wastewater treatment plants are often large consumers of potable water. In contrast, large private sector buildings will soon be required to report their energy **and water** consumption, via the online tracking and benchmarking tool Portfolio Manager.[17] The goal is to promote water conservation efforts in these buildings.

Knowing how much water a facility consumes, particularly in relation to other similarly-placed buildings, makes it easier to identify opportunities for savings, exactly as it does for energy use. Figure 5.3 provides a clear example of how water use reporting can help building owners compare their water use against other similar buildings and determine if they need to improve efficiency and reduce water use.

Water reporting by the broader public sector facilities (i.e., municipalities, universities, hospitals, etc.), preferably through Portfolio Manager, would enable these customers

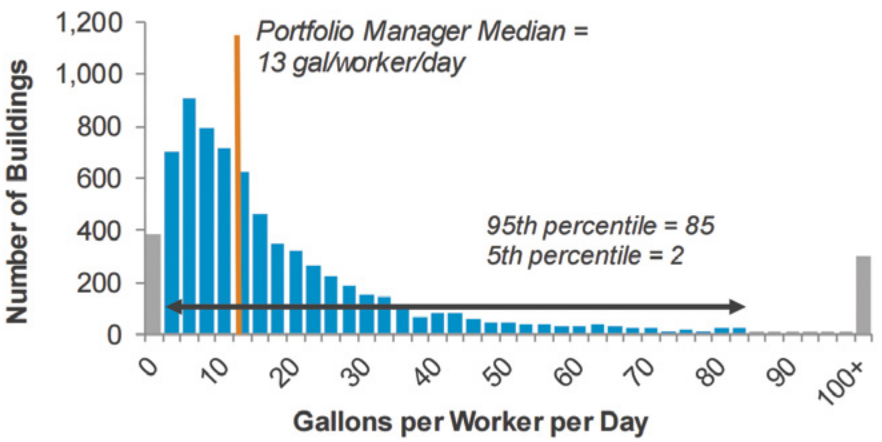

Figure 5.3. An example of water use benchmarking for office buildings

Source: ENERGY STAR Portfolio Manager, Water Use Tracking (Factsheet)

Ontario mandates energy reporting, but not water reporting, by the broader public sector.

to better assess and reduce water use (and bills) in their own buildings. Municipalities would also benefit from water conservation in broader public sector buildings, by reducing the amount of potable water they would need to treat and pump.

Water Sustainability Plans

As discussed in Chapter 4, the *Water Opportunities Act, 2010* enables MOECC to develop a regulation that would require municipal water systems to develop a Municipal Water Sustainability Plan, including a water conservation plan, and strategies for maintaining and improving the municipal service relating to water use and impacts on Ontario's water resources. Such plans would assess the value of water conservation to the particular water system, and determine whether municipal resources and funds should be dedicated to water conservation. This authority has not been used.

The MOECC has required York Region and municipalities within the Lake Simcoe watershed to prepare and implement water conservation and efficiency plans, but under different legal authority (the Environmental Approval for York Region's Southeast Collector Trunk Sewer twinning, and the Lake Simcoe Protection Plan). In these circumstances, strong site-specific drivers for water conservation existed - concerns about minimizing the amount of wastewater from York Region to be treated in Durham Region and discharged into Lake Ontario, and preserving adequate in-stream flows in the Lake Simcoe watershed, respectively.

The Ministry of Energy also provides some funding for local energy planning through its Municipal Energy Plan grant program. Four of the first six plans (for Wawa, Temiskaming Shores, Woodstock, and Vaughan) completed under this program do reference water conservation measures.

5.3.2 Wawa: Integrating Water and Energy Conservation

Wawa is a small municipality in Northern Ontario that has integrated community water conservation initiatives into its energy conservation planning. Wawa's *Municipal Energy Plan* (completed in early 2016 with funding assistance from Ontario's Municipal Energy Plan grant program) notes that per capita water use in Wawa is three times the provincial average, and needs to be reduced, in part because water use is still increasing and straining the capacity of the new water filtration plant.[18] One reason for the high usage is that water use was unmetered until 2014. Another reason is the need for bleeder valves to keep water flowing in the winter to prevent freeze-up.

Wawa's *Energy Conservation Plan* (required under O. Reg. 397/11) builds on the Municipal Energy Plan and spells out near-term measures to reduce water use.[19] The most important is to start billing citizens based on volume of water use, now that metering is in place. Wawa has hired a community energy planner who will also have responsibility for water conservation. Other near-term actions Wawa is taking include developing a bylaw to restrict lawn watering in the summer and introducing a rain barrel program.

Water Conservation Programs

The province could also make new voluntary water conservation programs, supported by dedicated funding, available to customers across Ontario, as it has done for electricity and natural gas. Why are there no provincial water conservation programs? One reason is that, while the MOECC licences all municipal water systems, there is no provincial *economic* regulator for water providers. In the energy sector, the province has used the Ontario Energy Board to require electric and gas utilities to deliver energy conservation programs.

A second reason is that the economic and environmental value of water conservation varies greatly across communities, more so than it does for energy conservation.[20] Only about 10-15% of a municipality's costs of providing water/wastewater operations are directly proportional to the amount of water consumed.[21] These variable costs include energy and chemical inputs. Water conservation immediately reduces these costs. The remaining 85-90% of costs (mostly from the capital cost of infrastructure) are fixed in the short-term, though not in the long-term. Only a few communities quickly reap large savings in avoided infrastructure costs through water conservation; others do not.

> The economic and environmental value of water conservation varies greatly across communities.

Water conservation will be most attractive in:

- Growing communities where population is increasing and water or wastewater plants are nearing capacity;
- Regions at risk of exceeding their sustainable level of water withdrawal from the environment; and
- Greenfield developments where opportunities exist to downsize planned infrastructure.

Where municipal water infrastructure is close to capacity, conservation benefits can be great. In the City of Guelph, water efficiency programs delivered between 2006 and 2014 cost about $1.31 for each litre per day of water savings. By comparison, expansion of water and wastewater treatment infrastructure capacity was estimated to cost $4.68 per litre per day, more than three times as much.[22]

In municipalities where conservation does not avoid infrastructure costs, conservation can be politically unattractive. If the fixed costs of operating the water system must be recovered from a declining volume of water use, water **rates** for customers may rise, at least in the near term, although water **bills** (on average) will fall.[23]

5.3.3 Municipal Role

The municipal role in water conservation begins with its own systems. At least 10% of treated water does not reach end users, but is lost from the distribution system, primarily through leaks. The importance of this leakage, and methods for reducing it, are discussed in Chapter 2.

In terms of customers' water use, municipalities' major influence comes from whether, and how, they use water metering and water pricing to encourage conservation. Aside from that, only a minority of municipalities offer water conservation programs to the public. In the ECO's water-energy efficiency survey, only 27% of responding municipalities offered even one water conservation program to customers, with discounts on rain barrels and water-efficient toilets being the most popular initiatives. Only a handful of these municipalities, such as York Region, Guelph and Waterloo, have detailed plans that spell out the savings expected from water conservation and the programs and actions needed to achieve them.

> Municipalities' major influence comes from whether, and how, they use water metering and water pricing.

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5.3.4 Charging for Water: Meters and Pricing

Ontario municipalities make better use of water pricing now than they did a generation ago, but there is still lots of room for improvement.

Flat Rates to Meters

Twenty-five years ago, almost one-fifth of Ontario municipal water customers paid a flat fee for their water service, where their bill did not vary with the amount of water consumed. Today, at least 98% of municipal water customers have water meters, and pay by how much water they use (volumetric rates).[24]

Unsurprisingly, water use in Ontario was much higher (35% or more) among users on flat rates (Figure 5.4) than among those who paid volumetric rates.[25] Recently, the Town of Moosonee, ON saw a 20% drop in water use after installing meters and moving to volumetric pricing.[26] Thus, the most important step to conserve water – moving from flat pricing to volumetric pricing – has been largely completed in Ontario.

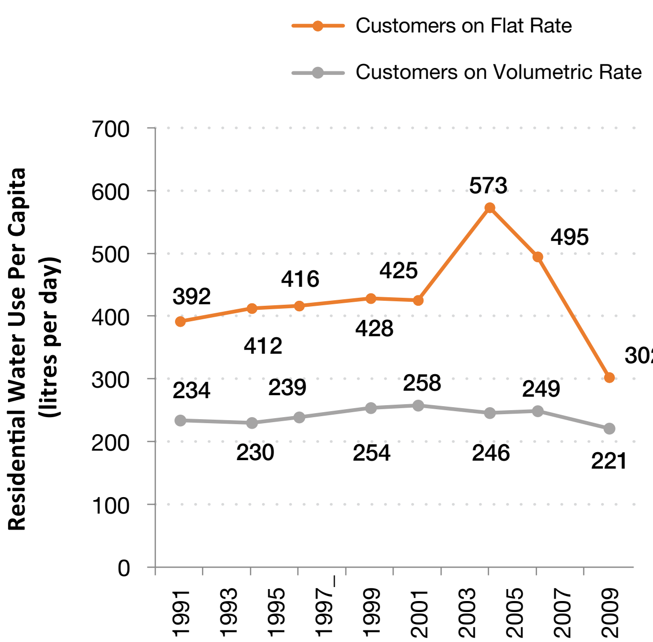

Figure 5.4. Water consumption per capita, Ontario municipal drinking water systems

Source: Ontario Sewer & Watermain Construction Association, *Bringing Sustainability to Ontario's Water Systems*, 2016, p. 38

However, residents in many multi-unit buildings, particularly multi-unit residential buildings (MURBs), still do not pay for their own water use. This is because many MURBs (particularly high-rise buildings) have only one bulk meter connection, offering no ability to bill individual units based on actual consumption. These occupants are, effectively, still on flat rates, and have little incentive to conserve water. This is especially important to address as roughly half of new housing starts in Ontario in recent years have been in multi-unit buildings.[27]

Several municipalities (e.g., Waterloo and Guelph) offer or plan to offer programs to encourage multi-unit buildings to install individual unit water metering where the building plumbing layout permits (individual metering may be impossible or cost-prohibitive in some existing buildings, as it requires a building plumbing layout with a unique point of connection for each unit).[28] In a recent southwestern Ontario project, a 60-unit townhouse complex without sub-metering had per capita water use 26% higher than the municipal average. Once individual units acquired their own meters and paid their own bills, per capita water use fell 20%.[29]

Individual meters are easy to install if the plumbing design plans for them. In low-rise buildings (e.g., row-houses), each unit can usually be connected directly to the municipal system and metered; in a multi-storey building, the more likely option is a bulk connection to the utility system, with individual sub-metering of supply connections from the bulk meter. Hamilton has passed a bylaw requiring individual metering in horizontal MURBs (i.e. row houses) and industrial, commercial, and institutional (ICI) buildings.[30] Hamilton also encourages individual metering in vertical MURBs.

Smart Water Meters

The first generation of meters only measured total water use and had to be read manually, on-site. Today, many Ontario utilities are moving to "smart" water meters that send customer water use data to the utility electronically. This eliminates manual door-to-door meter reading, and can generate much more detailed water use data that can facilitate conservation. For example, metered data at regular intervals (e.g., every hour) makes leak detection easier and faster.

Some municipalities (for example, Toronto's mywaterToronto initiative, see Figure 5.5) offer customers access to their metered data via the Internet, along with instructions on how to use the data to identify leaks.[31] Leaks within the house are estimated to account for 13% of water use in single-family households. The Ministry of Energy is assessing whether to require municipalities to make metered water data (along with electricity and gas data) available to customers in the standardized Green Button data format.[32] This would facilitate multiple options for residential and business customers, and (if desired) third-party conservation services, to analyse water consumption data.

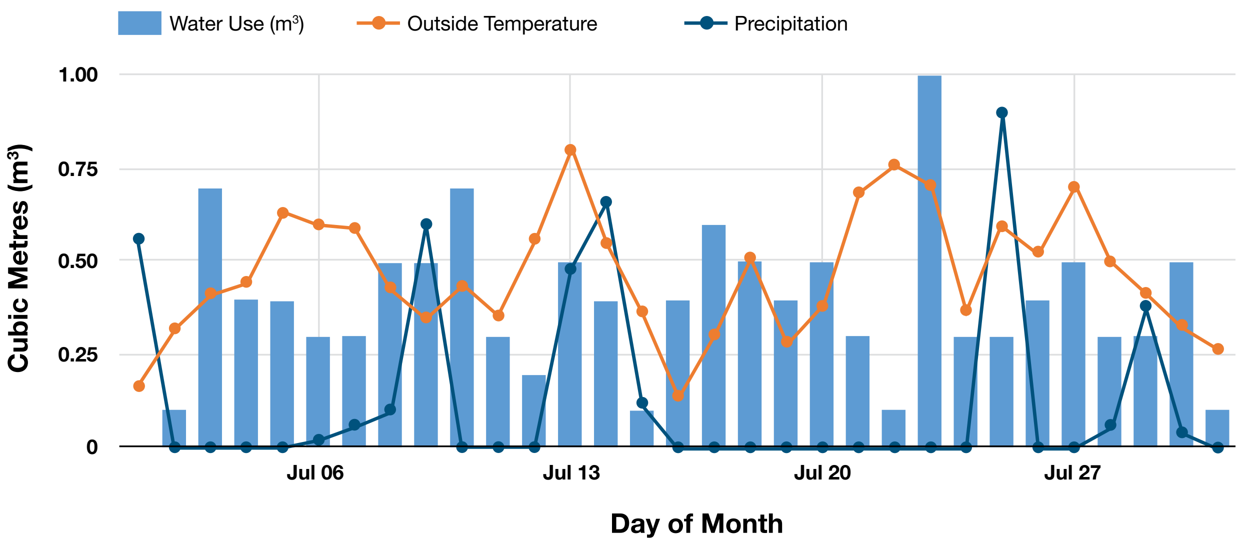

Figure 5.5 Sample customer water meter data from mywaterToronto web portal

Setting Water Rates

The price for water charged by many municipalities is too low to sustainably fund capital, operations and maintenance expenses of their water/wastewater systems, as discussed in Chapter 4. While many Ontario jurisdictions have raised rates significantly in recent years, a large number (at least 41% as of 2013, based on a previous ECO survey) are still not at full-cost recovery. These unreasonably low prices lead to both infrastructure deficits and increased water use. One estimate is that a 1% price increase leads to a 0.16% decline in Canadian residential water use.[33] The ECO has, for years, recommended that the province require full-cost recovery for drinking water systems, as recommended by the Walkerton Inquiry.[34]

Similarly, simple volumetric pricing does not provide appropriate incentives to focus water conservation on the summer peak when it provides the greatest environmental and financial benefits. Better alternatives include higher summer rates, rates that rise with the amount of water use (i.e., increasing block rates), and different rates for indoor and outdoor water consumption. For maximum impact, conservation programs and rate designs should be developed hand in hand.

Water pricing is not covered in detail in this report because it has been reviewed extensively elsewhere. An excellent recent Ontario-specific analysis is *Bringing Sustainability to Ontario's Water Systems*.

The price for water charged by many municipalities is too low.

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5.4 Promising Conservation Targets

We now turn to opportunities to reduce water consumption in specific end uses. The users of municipal water after it has been extracted from the environment and treated are shown in Figure 5.6. The residential sector is the largest consumer of municipal water, accounting for about half of total water use, followed by the ICI sector.

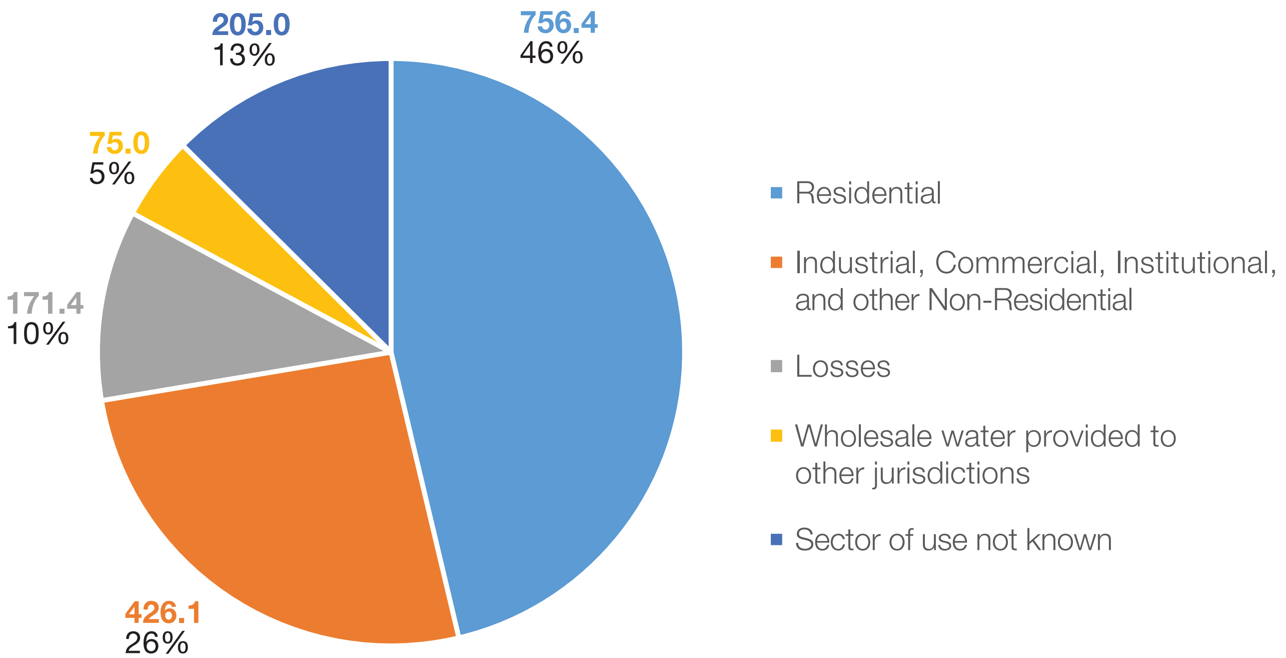

Figure 5.6 Annual water consumption by sector (million m^3), Ontario municipal drinking water systems, 2013

Source: Statistics Canada, Table 153-0127 from *Survey of Drinking Water Plants, 2013* (2015).

Note: Water reported as "losses" is predominantly from leaks, but also includes other non-revenue water use such as maintenance and flushing of the distribution system. "Wholesale water provided to other jurisdictions" would include, for example, the volumes of water collected and treated by Toronto that is provided to York Region.

In both the residential and ICI sectors, water use can typically be divided between:

- Indoor water use from fixtures and appliances (Sections 5.5 and 5.6);
- Outdoor water use, primarily for landscaping (Section 5.7).

Actions to reduce water use in these categories are generally similar for residential or ICI buildings.

In addition, some ICI customers use water in custom water-intensive processes such as food and beverage production. These processes are often specific to the individual business or industry, and are not amenable to one size fits all solutions. Some Ontario municipalities have a "Capacity Buyback Program", which provides a financial incentive for such businesses to reduce their water use.[35] These programs may also provide assistance for an initial water audit to help identify water savings opportunities. Policies to reduce custom ICI use are not discussed further in this report.

5.5 Indoor Use – Efficient Water Fixtures and Appliances

Indoor water use, particularly in residential buildings, is concentrated in a handful of products, as shown in Figure 5.7. This makes it an ideal candidate for codes and standards that set high minimum efficiency levels for these products.

Indoor water use, particularly in residential buildings, is concentrated in a handful of products.

Toilet	Faucet	Shower	Clothes washer	Leak	Bath	Other*	Dishwasher
24%	**20%**	**20%**	**16%**	**13%**	**3%**	**3%**	**2%**
123 L/day	**102 L/day**	**102 L/day**	**83 L/day**	**67 L/day**	**17 L/day**	**15 L/day**	**8 L/day**
TIP: Install water-efficient toilet (4.8 litres per flush or lower)	**TIP:** Install water-efficient faucets; Turn tap off while washing dishes, brushing teeth or shaving	**TIP:** Install water-efficient showerheads; Shorten showers; Reduce water temperature for energy savings	**TIP:** Choose water-efficient front-loading washer; Run with full loads; Use cold water setting for energy savings	**TIP:** Check whether water meter is running when no water is being used; test toilets for leaks using coloured dye	**TIP:** Reduce volume of bathwater; Reduce water temperature for energy savings	**TIP:** Use water-consuming appliances (e.g., humidifiers) only when needed	**TIP:** Run with full loads

*The "Other" category includes evaporative cooling, humidification, water softening, and other uncategorized indoor uses.

Figure 5.7: Indoor household water uses

Source: Water Research Foundation, *Residential End Uses of Water, Version 2*, 2016.

Note: Water use statistics based on a sample of approximately 1,000 single-family homes in 23 locations across the United States and Canada. Outdoor water use is not included.

The share of efficient water fixtures and appliances in buildings began to increase in the 1990s, driven primarily by U.S. federal water efficiency standards introduced in 1992. Initially, there was a large efficiency gap between new and existing products (e.g., toilets using 6 litres per flush (lpf), replacing older models that used 13 or even 20 lpf), creating an opportunity for significant water savings. Many municipalities introduced programs at that time to incent customers to upgrade to more efficient equipment in existing homes, primarily clothes washers and toilets. At the same time, gas utilities put significant resources into delivering more efficient showerheads and faucets, to conserve hot water (and natural gas).

Most of these original conservation programs have been cancelled or modified. To deliver further water savings today, water conservation programs or codes and standards must incent or mandate product efficiency levels materially better than the 1992 standards. There are still opportunities for significant water savings, although not as large as the initial round of efficiency improvements (see text box 5.6.1).

For example, the voluntary WaterSense certification is given to products that are more efficient (generally 20% more) than the 1992 standards. WaterSense certification also guarantees that labelled products perform adequately, through third-party performance testing. Almost all showerheads and faucets sold now already meet the WaterSense standard, but only 30% of toilet sales do, at least in the U.S. (data on the Ontario market is not available, but Ontario stores still carry a large number of 6 lpf models).[36] The current WaterSense requirement for toilets is 4.8 lpf.

Under the *Water Opportunities Act, 2010*, Ontario has authority to set point-of-sale standards for toilets and other fixtures sold in Ontario, for example to mandate WaterSense efficiency levels. It has not done so, despite previous ECO recommendations.[37] However, under the *Green Energy Act, 2009*, it has recently passed water efficiency standards for products that also use energy, in particular, clothes washers and dishwashers.[38] For these products, Ontario was able to harmonize with water efficiency standards established by the U.S. Department of Energy. However, for water fixtures that do not use energy, neither the U.S. nor the Canadian government has been active in recent years in setting mandatory efficiency standards. Ontario would need to act alone if it wished to establish such standards.

For new buildings, Ontario has used its authority to improve standards for water fixtures as part of regular Building Code updates. For example, the 2017 Code requires 4.8 lpf toilets in new residential buildings, although not commercial buildings. Water efficiency requirements for toilets have traditionally been weaker in commercial buildings than residential, in part due to concerns about whether low-flow toilets can adequately transport waste through long drainlines. However, recent research by the Plumbing Efficiency Research Coalition has found that transport of waste through drainline systems is not a technical problem for 4.8 lpf toilets in new commercial buildings.[39]

5.6 Greywater Systems – Another Way to Reduce Indoor Water Use

Not all household water use requires water treated to potable standards. Some purposes, such as flushing toilets, could be adequately met with greywater - the relatively clean effluent from bathroom sinks, bath tubs/ showers and washing machines.[40] This makes a lot of sense because the average amounts of water used for showering/bathing and toilet flushing are almost equal. This form of water reuse can deliver large water savings, as shown in text box 5.6.1.

Greywater systems are a form of decentralized water reuse, since the system is maintained by the property owner or manager and the collected water is reused within the house or commercial/industrial facility. Greywater systems offer essentially the same benefits as water conservation - cost benefits for the property owner in the form of lower water bills, system benefits as less water is being transported through the water infrastructure, and environmental benefits in the form of lower source water withdrawal and lower energy use and greenhouse gas emissions. Centralized water reuse, typically reusing water collected and treated at a municipal wastewater plant, is discussed in more detail in Chapter 6.

A typical greywater reuse system is similar to Figure 5.8 below. The used water from the showers and sinks flows through a greywater treatment process into a small holding tank that then feeds the reused water to the toilet tanks.[41] More sophisticated systems can include larger water storage tanks, including concrete tanks cast as part of the building foundation, and can also make use of rainwater as well as greywater.[42]

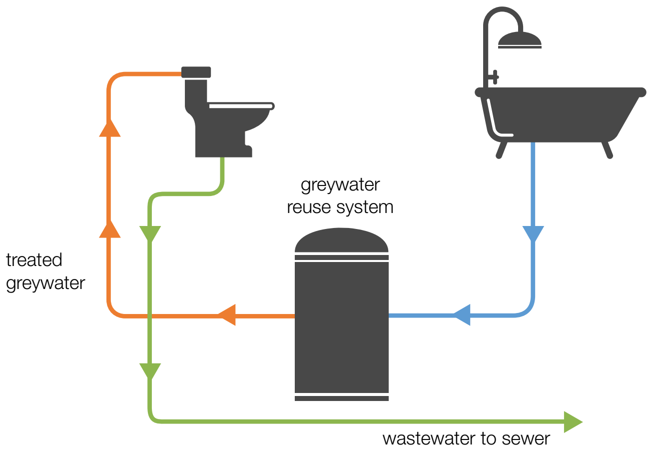

Figure 5.8: Household greywater reuse system

Source: Adapted from City of Guelph, http://guelph.ca/living/environment/water/water-conservation/greywater-reuse-system/

A greywater system in a home requires a dual plumbing system to separate the greywater collected from shower and bathroom sink drains from the city's water lines. A rough-in for a greywater system costs around $500 if it is included during the construction stages of a new home.[43] With the plumbing system in place, a greywater system can be added at any time; until then, potable water continues to be fed to the toilet tanks for flushing.

Greywater tank for domestic water reuse (on left).
Source: Region of Durham.

If the plumbing system is not built to be greywater-compatible, the cost to put in a greywater system later can be much more substantial, often thousands of dollars just for the plumbing changes.

Greywater and Rainwater in the Building Code

Amendments to the Ontario Building Code in 2012 clearly define the plumbing standards a greywater or rainwater system must conform to before it is used in homes and businesses, and the allowable uses of greywater and rainwater. Greywater can be used for:

- water closets (toilets);
- urinals;
- sub-surface irrigation; and
- the priming of traps.

Rainwater can be used for these purposes, and also for:

- clothes washers;
- laundry trays;
- mop sinks;
- bedpan washers;
- hose bibbs.

These standards only apply to the plumbing requirements, not the quality or level of treatment required for the reclaimed water. MMA has indicated that the quality of reclaimed water is an area it may include proposals for in the next Code consultation.[44] Some guidance can be found in Health Canada's *Canadian Guidelines for Domestic Reclaimed Water for Use in Toilet and Urinal Flushing*. The first version of the guideline, released in 2010, focused on the end use of toilet and urinal flushing, with the goal of ensuring that the operation of water reuse systems is protective of public health. The intent is for this guideline to eventually become a comprehensive document that will provide recommendations on a variety of water reuse activities.

The document recognizes that reusing water for flushing of toilets and urinals (in commercial properties) reduces water bills and has an overall beneficial impact on the environment. However, because certain microorganisms and pathogens in the reused water can pose a health risk, it proposes guidelines for water quality parameters for domestic reclaimed water used in toilets and urinals.[45] The guideline recommends that at a minimum, all domestic reclaimed water should be disinfected and further chlorinated if required.

5

5.6.1 Priority Green Clarington Demonstrates Savings In New Homes from Water-Efficient Technologies and Greywater Recovery[46]

Are there still cost-effective opportunities to reduce indoor water use in a typical new house, given that the current Ontario Building Code (OBC) already mandates relatively high water efficiency standards? A recent study in Clarington holds some of the answers. The Priority Green Clarington demonstration project worked with three builders to outfit six new houses with water-saving technologies that go beyond Code requirements:

- Ultra low-flow toilets (3.0-3.8 litres per flush, OBC maximum is 4.8);
- Low-flow showerheads (6.6 litres per minute, OBC maximum is 7.6);
- Low-flow kitchen faucets (5.7 litres per minute, OBC maximum is 8.35); and
- Greywater reuse (in three of the six houses) – using water drained from showers, recovered, and treated, as a (partial) source of water for toilet flushing, replacing potable water.

Water usage at individual water fixtures in the houses was sub-metered over a full year after the homes were sold and occupied, making it possible to determine how much these technologies affected household water use, and what level of water savings could be achieved in comparison to a house built with OBC levels of water efficiency.

The greywater recovery system delivered the largest water savings (13 litres/person/day), providing more than half (59%) of the water needed for toilet flushing. However, it was the only water efficiency measure tested that was not cost-effective, due to its high upfront cost, including installation. These costs may come down as this technology becomes more mainstream.

The other three water-efficient technologies all paid back their upfront costs through savings on the water bill in less than five years. Using the Region of Durham's water and wastewater rates, Priority Green homes without greywater recovery would save $57 on their annual water/wastewater bill, while homes with greywater recovery would save $128 annually.

The project recognized the linkage between water and energy, and estimated the reduction in energy use at the Region of Durham's water/wastewater operations due to the lower volume of water pumped and treated. Water use was responsible for 178 ekWh/year (equivalent kilowatt-hours) of embedded energy use in homes built to Code and 152 ekWh/year in Priority Green homes.

Most notable, perhaps, is the whole-house water savings (Figure 5.9). Homes built to the Priority Green standard used an average of 140 litres per person per day.[47] A billing analysis of 113 similar new homes in the same neighbourhoods built to Code found that these homes averaged 26% higher water use (176 litres per person per day). Even more striking, the average residential per capita water consumption in all existing homes in the Region of Durham was 230 litres per person per day, 64% higher than in Priority Green houses. This strongly suggests that opportunities remain to improve water efficiency in older houses through more efficient water fixtures, management of outdoor water use, and through the installation of greywater systems.

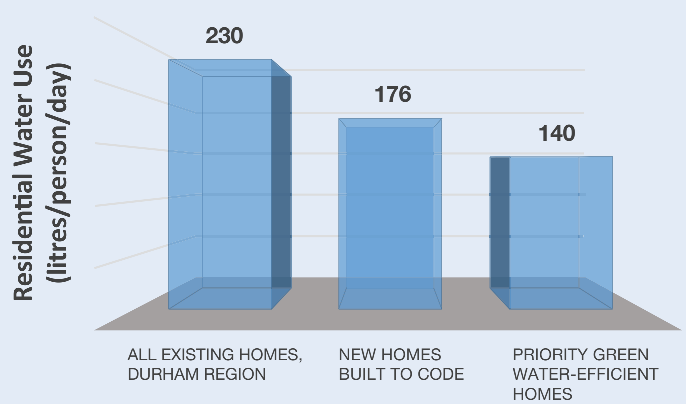

Figure 5.9: Comparison of residential water use intensity in homes in Clarington, ON

Source: Sustainable Edge, *Final Report for Priority Green Clarington - Water and Energy Demonstration Project*.

Notes: Value for "New homes built to Code" is based on metered data for 113 homes. Value for "Priority Green water-efficient homes" is based on metered data for indoor water use for six similar homes, adjusted upwards by 14% to account for outdoor water consumption (which was not metered).

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5.7 Reducing Outdoor Water Use

Managing the Summer Peak

Water use in most municipalities is much higher during the summer, largely due to outdoor water use, in particular, lawn watering (Figure 5.10). The size of the summer peak varies from year to year, and is greatest in hot, dry summers (Figure 5.11). System-wide water consumption in summer months is often 30% higher than in other seasons, with an even greater increase among single-family residential customers.

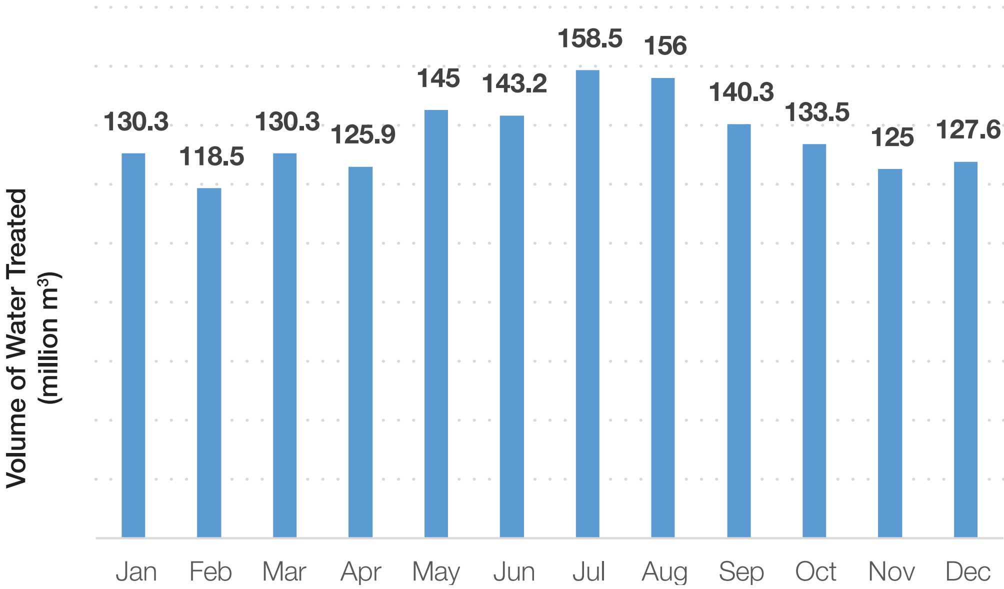

Figure 5.10: Monthly potable water production, Ontario municipal drinking water systems, 2013

Source: Statistics Canada, Table 153-0124 from *Survey of Drinking Water Plants, 2013* (2015).

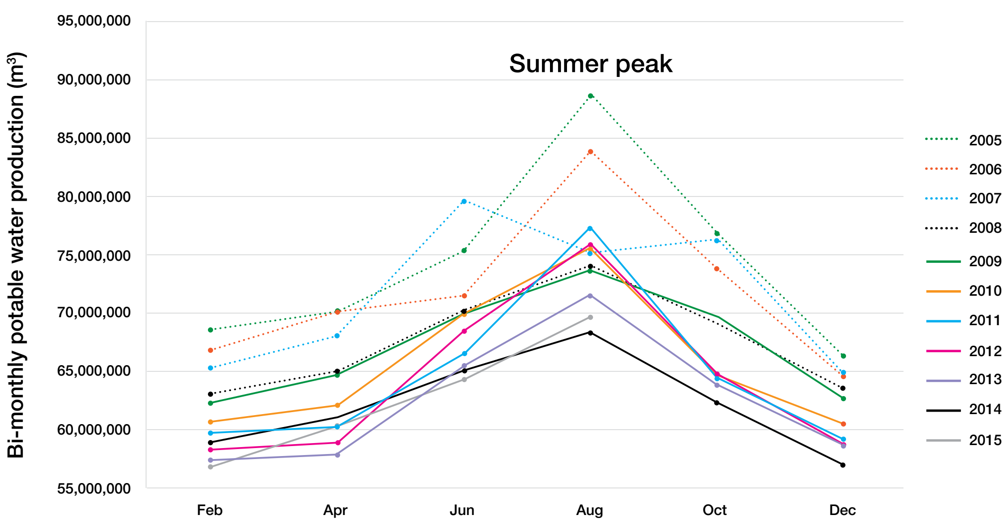

Figure 5.11: Toronto Water potable water production, 2005-2015

Source: City of Toronto

Reducing summer peak water use can deliver a triple benefit.

The peak in municipal water demand in dry summer conditions usually occurs at the same time as peak agricultural water demand, and as peak water stress in the natural environment, when streamflow rates and soil moisture levels are at their lowest. At such times, increased municipal water use is a further stress on natural ecosystems.

Summer water peaks also bring an infrastructure burden, paralleling the challenges of meeting peak demand in the electricity system.[48] Water system operators must continually keep water supply and demand in balance. Most water systems can absorb minor changes in demand, on the timescale of hours or days, by storing treated water in tanks and reservoirs. For any longer timeframe, water treatment and distribution systems must be sized to meet the summer peak. This means that peak summer water demand is disproportionately expensive to meet.

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Thus, reducing summer peak water use can deliver a triple benefit: energy savings, environmental benefits, and reduced infrastructure costs.

What Causes the Peak and How Can We Handle It?

Reducing outdoor water use is more difficult than indoor residential use, and involves more than water-efficient fixtures and appliances. In particular, outdoor water use varies dramatically between households and depends on factors such as landscape design and customer behaviour.

Two studies from the *Outdoor Water Use Reduction Manual*, prepared for the Ontario Water Works Association show how much outdoor water use varies.[49] Water use analysis from Kitchener showed that about 10% of homes were "superusers", who at least double their water use in the summer, while the other 90% had little change in water use in summer months. Superusers might have good opportunities to reduce water use, e.g., by mulching garden soils, increasing soil organic matter, or covering pools when not in use. Another study of 150 households found that households with automatic irrigation systems use ten times as much water as other users. While small, this study suggests that residential and ICI automatic irrigation systems could be an important conservation target.

The province has not used the Ontario Building Code to address outdoor water use, perhaps due to doubts as to whether the Code can or should regulate lot-level practices outside the building envelope. However, on-site sewage systems are already included in the Ontario Code and legally considered part of the building, even if not physically connected. Los Angeles, California, is an example of a jurisdiction that uses its Building Code to address outdoor water use. It mandates covers on swimming pools, restricts use of potable water outdoors, and requires separate metering of indoor and outdoor water use.[50]

Some Ontario municipalities have tackled outdoor water use by:

- **Restricting non-essential outdoor water use**, either all summer or during periods of water stress, e.g., allowing residents to water lawns only on odd/even-numbered days. These bylaws are often weakly enforced.
- **Promoting gardens using plants with lower water requirements, in place of grass lawns**. Peel Region and several other municipalities offer the Fusion Gardening ® program, which offers a free landscaping consultation, and a 20% discount on water-efficient plants. Fusion Gardening ® also emphasizes on-site infiltration, to keep rainwater on-site and reduce runoff. York Region is currently conducting a pilot project in Kleinburg to quantify the water savings from this landscaping approach.
- **Promoting smart irrigation**. York, Halton, and Peel Regions have worked with Landscape Ontario to develop the Water Smart Irrigation Professional program. This training program for contractors

focuses on minimizing water waste in irrigation systems, including leak detection and smart controllers that use weather and/or soil moisture data to minimize overwatering.[51] A pilot project suggests that smart controllers can save 10,000 litres per day per acre of irrigated lawn. York is investigating whether it can mandate smart controllers for ICI facilities with in-ground automatic irrigation systems.[52]

- **Encouraging rainwater harvesting**, i.e., collecting rain in barrels or cisterns at a home or ICI facility. Rain barrels are usually placed at the end of a downspout to capture rainwater and typically collect 100-500 litres of water. This modest storage capacity can reduce stormwater runoff and combined sewer overflows, but may not significantly reduce potable water use for irrigation, for an average residential property.[53]

5.8 ECO Recommendations

To improve the water efficiency of new buildings, MMA should enhance standards for water conservation in the Ontario Building Code. The ECO recommends that the next Building Code address more efficient fixtures, outdoor water use, water metering in multi-unit buildings, and water reuse.

More efficient fixtures: MMA should evaluate tightening water efficiency levels for water fixtures, particularly toilets - to below 4.8lpf for residential buildings, and to 4.8lpf in non-residential buildings.[54]

Outdoor water use: The greatest water conservation benefits, environmental and financial, would come from reducing the summer peak in outdoor water use.

Metering in multi-unit buildings: A significant opportunity for water conservation is missed if units in MURBs are not individually metered, Ontario has already acted to advance metering of individual units for electricity, and should do the same for water.[55] Ontario should use the Ontario Building Code to mandate building plumbing designs that will support metering of individual units, whether through separate utility meters or sub-meters. Some analysis may be required to determine if there are specific building types for which this is not practical.

Water reuse: Given the demonstrated ability of greywater reuse to deliver large water savings, and the lost opportunity if greywater-compatibility is not considered at time of construction, MMA should evaluate mandating greywater-ready plumbing design in the Building Code. The ECO also supports MMA's intention to examine whether to set water quality standards for reclaimed water, which would likely apply to greywater and rainwater. It will be important for such a standard to examine and address legitimate health concerns. However, such a standard could effectively prevent water reuse if it imposes excessive and costly treatment and/or monitoring.

Recommendation: The Ministry of Municipal Affairs should amend the Ontario Building Code to place a greater emphasis on water efficiency and conservation, giving particular consideration to:

- ***Higher efficiency standards for fixtures, particularly toilets;***
- ***Reducing summer peak outdoor water use;***
- ***Ensuring that the plumbing design of multi-unit buildings is compatible with water metering of individual units;***
- ***Expanding opportunities for reuse of greywater and rainwater, including greywater-ready plumbing design.***

More also needs to be done to reduce water use in existing buildings, where water use is much higher than in new buildings. While the ECO is pleased that the Ministry of Energy has recently set point-of-sale energy efficiency standards for clothes washers and dishwashers, it is disappointing that MOECC has no plans to set standards for water fixtures (including toilets), and has not even undertaken any study of potential opportunities.[56] Toilets likely offer the largest opportunity, as they are the one product where models not meeting WaterSense efficiency levels still have significant market share. A number of American states have mandated the stricter 4.8 lpf standard, and there is no obvious reason why Ontario should not do so as well.[57]

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More also needs to be done to reduce water use in existing buildings.

Toilets are not the only product where there is an opportunity for stricter water efficiency standards. MOECC should also scan other jurisdictions, particularly California, which passed aggressive standards in 2015 for urinals, faucets and showerheads as well as toilets.[58]

Recommendation: The Ministry of the Environment and Climate Change should set water efficiency standards for toilets that apply at point-of-sale.

The broader public sector should be required to add water consumption in buildings to their energy reports, just as large private buildings are required to do, and preferably through the same Portfolio Manager software (see Chapter 3). They should also be required to integrate water conservation into their energy conservation plans.

The provincial power to mandate water reporting and water conservation plans for the broader public sector is held by a different ministry, and stems from a different statute, than for energy. The *Water Opportunities Act, 2010* falls within the Minister of the Environment and Climate Change's authority for water reporting, whereas the *Green Energy Act, 2009* gives authority to the Minister of Energy to require energy reporting. The difference in authority should not matter to water users, especially if both reports can be filed using the same software, and if both conservation plans are combined.

Recommendation: The Ministry of the Environment and Climate Change should require water use reporting and water conservation plans for all broader public sector organizations and integrate this seamlessly with existing energy reporting requirements.

Given the variation in the value of water conservation across the province, the ECO believes that it makes sense for municipalities to continue to take the lead on voluntary water conservation programs. As mentioned in Chapter 4, however, each municipality should be required to determine the appropriate role for water conservation as part of its asset management plan for its water infrastructure, as was originally envisioned in the *Water Opportunities Act, 2010*.

In addition, cost savings are possible by piggybacking water onto provincial energy conservation programs. For example, the Independent Electricity System Operator and gas utilities are currently developing a whole home energy retrofit program, which will look for both electricity and natural gas savings in existing homes. At almost no incremental cost, this program could also identify water conservation opportunities. However, water conservation initiatives were ruled out of the pilot stage of this program, and a proposal by one local distribution company (Welland Hydro) to include water conservation measures in a whole home retrofit pilot was not approved by the Independent Electricity System Operator.[59] As this program moves past the pilot stage, the decision to exclude water conservation should be reconsidered.

Recommendation: The Independent Electricity System Operator and gas and electric utilities should assess opportunities to integrate delivery of water conservation initiatives with existing energy conservation programs, particularly for whole home retrofits.

Endnotes

1. The proportional energy reduction is slightly less, due to the fact that the energy needed for wastewater treatment depends not only on the volume of water, but on the organic content, which does not decline with water conservation.

2. Statistics Canada, *Potable water volumes processed by drinking water plants, by source water type for Canada, provinces, territories and drainage regions*, Table 153-0105 (Ottawa: Statistics Canada, 2013).

3. Environmental Commissioner of Ontario, "Signs of Stress: Declining Baseflows in Southern Ontario" in *Small Things Matter*, Annual Report 2014/2015 (Toronto: ECO, November 2015) at 88.

4. Environmental Commissioner of Ontario, "Water-Taking: Leave Something for the Fish" in *Losing Our Touch*, Annual Report 2011/2012 Part 2 (Toronto: ECO, October 2012) at 105.

5. Quinte Conservation Authority, News Release, "Level 3 Low Water Condition" (4 August 2016).

6. Dr. Ken Minns, "Ontario's Freshwater Ecosystems and Climate Change: Impacts and Responses" (presentation to Latornell Conference, 15 November 2007).

7. Organization for Economic Cooperation and Development, "Abstractions of freshwater" in *OECD Factbook 2015-2016: Economic, Environmental and Social Statistics* (Paris: OECD Publishing, 2016).

8. Statistics Canada, *Survey of Drinking Water Plants*, Table 1-1 (Ottawa: Statistics Canada, 2015); Statistics Canada, *Industrial Water Survey*, Tables 5-1, 19 and 29 (Ottawa: Statistics Canada, 2013); Statistics Canada, *Agricultural Water Use in Canada*, water consumption data (Ottawa: Statistics Canada, 2013); Statistics Canada, *Population and Dwelling Count Highlight Tables*, 2011 Census (Ottawa: Statistics Canada, 2011).

9. Statistics Canada, *Potable water use by sector and average daily use for Canada, provinces and territories*, Table 153-0127, (Ottawa: Statistics Canada, 2013).

10. United Kingdom Environment Agency, *International comparisons of domestic per capita consumption* (Environment Agency, Bristol, 2008).

11. City of Guelph, *2016 Water Efficiency Strategy Update Version 5* (Guelph: City of Guelph, September 2016) at 10.

12. Statistics Canada, *Potable water volumes processed by drinking water plants, by source water type for Canada, provinces, territories and drainage regions*, Table 153-0105, (Ottawa: Statistics Canada, 2013); Statistics Canada, Population served by drinking water plants, by source water type for Canada, provinces, territories and drainage regions, Table 153-0106, (Ottawa: Statistics Canada, occasional).

13. Statistics Canada, *2007 Municipal Water Use Report: Municipal Water Use 2004 Statistics* (Ottawa: Statistics Canada, 2007) at 2; Statistics Canada, *2010 Municipal Water Use Report: Municipal Water Use 2006 Statistics* (Ottawa: Statistics Canada, 2007) at 4; Statistics Canada, *2011 Municipal Water Use Report: Municipal Water Use 2009 Statistics* (Ottawa: Statistics Canada 2011) at 6.

14. Statistics Canada, *Potable water use by sector and average daily use for Canada, provinces and territories*, Table 153-0127 (Ottawa: Statistics Canada, 2015).

15. Ontario Ministry of Municipal Affairs, *Overview Summary - Potential Changes to Ontario's Building Code* (Ontario: OMMA, 2016) at 1; Ontario Ministry of Municipal Affairs, information provided to the ECO in response to ECO inquiry (March 28, 2017).

16. Environmental Commissioner of Ontario, "Public Buildings" in *Conservation: Let's Get Serious*, Annual Energy Conservation Progress Report – 2015/2016 (Toronto: ECO, May 2016).

17. O Reg 20/17.

18. Economic Development Corporation of Wawa, *Wawa Energy Plan* (Ontario: Economic Development Corporation of Wawa, January 2016) at 10-11.

19. Economic Development Corporation of Wawa, *Five Year Energy Conservation and Demand Management Plan* (Ontario: Economic Development Corporation of Wawa, November 2016) at 19-20.

20. This is because extensive transmission networks exist for electricity and natural gas that connect sources of supply and demand, making the value of conservation similar in different parts of the province. These networks do not have unlimited ability to move energy from one area to another, so energy conservation programs can have more value in some regions than others, but these are exceptions rather than the general rule.

21. City of Hamilton, *Water, Wastewater and Stormwater Rate Structure Review* (Hamilton: City of Hamilton, June 2013) at 17.

22. City of Guelph, *2016 Water Efficiency Strategy Update* (Guelph: City of Guelph, September 2016) at ES-1.

23. This is best illustrated using a simplified example. Consider a water system with only two users, that recovers its costs by billing each user a charge per unit of water used. User A participates in a conservation program and reduces water use by 50%, while User B's water use remains unchanged. Because of the high proportion of fixed costs to operate the system, total system costs decline by only 5%. Water rates for both users increase by 27%, but user A's water bill drops by 37%, while user B's water bill rises by 27%. Some municipalities use a two-part water pricing mechanism (partially fixed, partially volumetric), which helps address this concern.

Table: Hypothetical Impact of Water Conservation on Customer Rates and Bills

	Before Water Conservation			After Water Conservation		
Water System Costs ($)						
Fixed	$85			$85		
Variable	$20			$15		
Total	$105			$100 (-5%)		
Customer Rates and Bills						
	Water Use (m^3)	**Water Rate ($/$m^3$ of water)**	**Water Bill ($)**	**Water Use (m^3)**	**Water Rate ($/$m^3$ of water)**	**Water Bill ($)**
User A (conserver)	50	$1.05	$52.50	25	1.33 (+27%)	$33.33 (-37%)
User B (non-conserver)	50	$1.05	$52.50	50	1.33 (+27%)	$66.67 (+27%)

24. Ontario Sewer and Watermain Construction Association, *Bringing Sustainability to Ontario's Water Systems* by Michael Fenn and Harry Kitchen (Ontario: OSWCA, 2016) at 39.

25. *Ibid* at 38.

26. Ministry of the Environment and Climate Change, *Showcasing Water Innovation, Communities Adopting Innovative and Sustainable Water Management*, final report, one page project summaries (Toronto: MOECC, 2015) at 19.

27. 32,674 out of 70,156 starts in 2015 were "apartment or other", see: Canadian Mortgage and Housing Corporation, *Canadian Housing Statistics 2015* (Ottawa: Canadian Mortgage and Housing Corporation, 2016) at 18.

28. "Submetering Introduction", online: Alliance for Water Efficiency <www.allianceforwaterefficiency.org/submetering.aspx> [Accessed 26 April 2017].

29. Mike Kazmaier, "A Case Study in Water Submetering", *Condominium Manager* (Spring 2013) at 57.

30. City of Hamilton, *Sewer and Water Permit Process* (Hamilton: City of Hamilton, January 2017) at 3.

31. For example, "MyWaterToronto", online: City of Toronto <www1.toronto.ca/wps/portal/contentonly?vgnextoid=ae3d143ac42c2510VgnVCM10000071d60f89RCRD> [Accessed 26 April 2017].

32. Ontario Ministry of Energy, information provided in response to ECO inquiry (24 March 2017).

33. Arnaud Reynaud, Steven Renzetti and Michel Villeneuve, "Pricing Structure Choices and Residential Water Demand in Canada" (2005) 41:11 Water Resources Research at 1110.

34. Environmental Commissioner of Ontario, "Fourteen Years After Walkerton: Drinking Water Systems Not at Cost Recovery" in *Managing New Challenges*, Annual Report 2013/2014 (Toronto: ECO, October 2014) at 158.

35. For example, York, Guelph and Toronto. See: "Capacity Buyback Program", online: City of Toronto <www1.toronto.ca/wps/portal/contentonly?vgnextoid=390907ceb6f8e310VgnVCM10000071d60f89RCRD&vgnextchannel=ff3cd4818444f310VgnVCM10000071d60f89RCRD> [Accessed 26 July 2017].

36. GMP Research, *US Market Penetration of WaterSense Shower Heads, Lavatory Faucets and Toilets* (South Carolina: GMP Research, July 2015) at 18-19.

37. Environmental Commissioner of Ontario, "Codes and Standards" in Conservation: *Let's Get Serious*, Annual Energy Conservation Progress Report – 2015/2016 (Toronto: ECO, May 2016) at 107.

38. Environmental Registry Regulation Decision #012-7871, *Proposal to amend O.Reg. 404/12 (Energy Efficiency – Appliances and Products) under the Green Energy Act, 2009 ("Efficiency Regulation")* (27 December 2016).

39. Plumbing Efficiency Research Coalition, *The Drainline Transport of Solid Waste in Buildings* (USA: PERC, November 2012) at 7.

40. Greywater does not include wastewater from toilets, and usually does not include wastewater from kitchen sinks and dishwashers. The high organic content of these wastewater streams means that they are generally not suitable for residential reuse, at least without more intensive treatment and safety precautions.

41. The treatment process usually includes a filter that removes hair, soap and other large particles followed by an adsorption process (similar to the activated charcoal in filtered water pitcher) that removes the rest of the impurities.

42. Canadian Mortgage and Housing Corporation, *Collecting and Using Rainwater at Home* (Ottawa: CMHC, January 2013).

43. Stakeholder meeting, March 2017 and April 2017. Cost will depend on home size and number of storeys

44. Ontario Ministry of Municipal Affairs, information provided in response to ECO inquiry (28 March 2017).

45. It is notable that the quality of the reclaimed water in the greywater systems used in the Priority Green project in Clarington did not meet the water quality targets in the Health Canada Guidelines. See: Sustainable Edge, *Final Report for Priority Green Clarington - Water and Energy Demonstration Project* (Toronto: Sustainable Edge, 16 February 2016) at 22.

46. *Ibid*.

47. Only indoor water use was metered in the Priority Green houses. Metered use was increased by 14% to account for outdoor water consumption, to allow for a fair comparison with Code-built houses.

48. Environmental Commissioner of Ontario, "Measuring the Value of Energy Conservation" in *Conservation: Let's Get Serious*, Annual Energy Conservation Progress Report – 2015/2016 (Toronto: ECO, May 2016).

49. Ontario Water Works Association, *Outdoor Water Use Reduction Manual* by Bill Gauley (Toronto: OWWA, June 2008) at 7 and 35.

50. City of Los Angeles, by-law No 184,692, Official City of Los Angeles Municipal Code (31 December 2013) s 99.04.304.

51. A WaterSense specification exists for weather-based irrigation controllers, and is in development for soil-moisture based controllers.

52. York Region, *Long Term Water Conservation Strategy Update 2016* (York Region: York Region, March 2016) at 12 and 17.

53. Ontario Water Works Association, *Outdoor Water Use Reduction Manual* by Bill Gauley (Toronto: OWWA, June 2008at 29.

54. In Ontario, only "group C" buildings require 4.8 lpf toilets, in other building categories, the minimum efficiency level is 6 lpf.

55. Ontario mandated metering of individual residential units in new buildings through the *Energy Consumer Protection Act, 2010*, SO 2010, c8 (supported by O Reg 389/10), which can be undertaken by the electric distribution utility or submetering providers. See: Environmental Commissioner of Ontario, "Taking Ownership of Electricity Bills: Suite Metering in Multi-Unit Residential Buildings" in *Managing a Complex Energy System*, Annual Energy Conservation Progress Report – 2010, Volume One (Toronto: ECO, June 2011).

56. Ontario Ministry of the Environment and Climate Change, information provided in response to ECO inquiry (30 March 2017).

57. California, Colorado, Georgia and Texas have mandated 1.28 gallon per flush toilets (equivalent to 4.8 litres per flush). See: "Water-Efficient Plumbing Fixtures", online: National Conference of State Legislatures <www.ncsl.org/research/environment-and-natural-resources/water-efficient-plumbing-fixtures635433474.aspx#California> [10 November 2015]

58. California Energy Commission standards (developed in two waves in April and August 2015) for water fixtures go beyond WaterSense levels for urinals (0.5 lpf), faucets (4.5 litres per minute, 1.9 litres per minute in public lavatories), and toilets (4.8 lpf in all buildings, with the exception of prisons and mental health facilities). See: California Energy Commission, *Appliance Efficiency Regulations, California Code of Regulations, Title 20, Sections 1601 Through 1608, Toilets, Urinals, and Faucets Regulations Effective January 1, 2016* (Sacramento: California Energy Commission, April 2015).

59. Independent Electricity System Operator, information provided in response to ECO inquiry (31 March 2017).