

Water-Efficient Toilets: A Canadian Perspective

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Introduction

Water issues in Canada are becoming a frequent event, be it supply shortages or quality issues. Canada is the second highest consumer of water at 326 litres/person/day (72 imperial gallons), only next in line to the United States (425L/94 gal). Canadians are becoming more aware of the scarceness of potable water, not only through media reports, but through rising water rates, or private wells going dry. Effectively implementing water efficiency measures can extend the life of water and wastewater treatment plants, wells and septic systems.

Residential water consumption studies have indicated that almost 30% of indoor water consumption can be attributed to toilet use (40% in apartments). Historically in Canada, toilets installed prior to 1980 flushed with a range of 20 – 26 litres (4.4 – 5.7 gallons) of water. The Water Saver toilet was then introduced, flushing with 13 litres (2.9 gallons). In 1996 the Ontario Building Code was changed to incorporate the new ultra low flush technology using approximately 6 litres (1.3 gallons) of water per flush, while the rest of Canada remained with toilets flushing at 13 litres (2.9 gallons) or greater.

Elsewhere, technology exists that can save additional water per flush. Denmark and Singapore for example require toilets that flush with 4.5 litres (1 gallon). Australia has opted for a dual flush toilet with a 3-litre (.66 gallon) or 6-litre (1.3 gallon) option.

Some municipalities offer water efficiency programs. As the toilet is the largest user of indoor water use, it becomes strategic to target it for water reduction. Offering incentives or promoting toilet replacement has the largest potential for water savings – not only for the municipality but for the homeowner. This is based on the toilet technology working well.

In order to confirm the performance of the 6-litre/1.3 gallon toilets and the new-to-Canada dual flush toilet, southern Ontario municipalities assessed toilets through two different projects: the 6-litre independent toilet testing and the dual flush study. The results have proven to be of interest to municipal officials and homeowners alike. CMHC is Canada's housing agency with a mandate to help Canadians across the country gain access to quality, affordable housing. It is CMHC's role to provide healthy housing information to the residential sector.

Future toilet trends indicate a shift towards increased legislation, improved technologies and greater water savings.

Toilets and Municipal Programs

Many municipalities in Ontario have been very proactive in water demand management. Some target peak demand while some target maximum week demand. The largest water use sector is

residential at over 50%. When a system, be it water or wastewater, is reaching capacity, a water reduction plan is required to defer the costs of infrastructure expansion. Many municipalities find that while public education can increase conservation awareness, financial incentives can accelerate the uptake in participation. Irrigation for example uses a substantial amount of water in the hot summer months. Municipalities regulate the peak through watering bylaws, lessening the peak demand of a system. Year round, the toilet remains the number one user of indoor water use. Through residential toilet programs, a municipality can anticipate the largest return in its program investment, lowering the maximum week demand. As part of the Ontario Building Code (1996), all new home construction and new bathrooms must install 6-litre/1.3 gal toilets. For existing bathrooms, replacement toilets can be either 6-or 13-litres.

A Municipal Toilet Program Example

The Region of Waterloo, 100 km (62 miles) west of Toronto, Ontario is an example of a municipality offering an ongoing Toilet Replacement Program. In the late 1980s, a toilet dam program was offered to residents to reduce water consumption. Toilet dams were flexible rectangular plastic pieces installed in the tanks to trap water when flushed, lowering the water consumed. A follow-up study revealed a water savings of 0-9%, as many homeowners never installed them, or the dams reduced the performance of the toilet and were removed.

In 1992, a Toilet Replacement Program was designed and piloted in two of the seven municipalities the Region serves. Replacing a toilet is a long-term, permanent approach to reducing water consumption. As toilets can last upwards to 25 years or more, waiting for the general replacement of toilets can take a considerable amount of time before achieving 100% conversion. Instead, a bulk purchase of one model was made, and homeowners were given the opportunity to replace their toilets at a subsidized cost, installation included, coordinated with payments applied to their water bill. While successful, the administration of utilizing their water bills became labour intensive as the Region was not the water retailer, but the wholesaler.

In 1995, the Toilet Replacement Program was redesigned. Residents in all 7 municipalities connected to the municipal water supply were offered the \$75 (£33.25) rebates. Six-litre toilets generally retail for \$150 (£66.5). The response was so great, that the available 2,760 rebates were all allocated within 2 business days and a waiting list was started. The change to this program was that homeowners and landlords could purchase any 6-litre/1.3 gallon Canadian Standards Association (CSA) certified toilet from any plumbing or hardware store. This change was well received as the past program with the bulk buy did not allow for colours of other manufacturers to match a homeowners décor in some instances, and many wished to install the toilet themselves. (Regional Municipality of Waterloo, Toilet Replacement Program of 1995 Final Report, Waterloo, Ontario, Canada www.region.waterloo.on.ca) Waterloo continues to provide 5,000 rebates per year at \$40 (£17.75) each. Old toilets have been collected and crushed for road aggregate. Random inspections were chosen to ensure the toilets were in fact installed.

Other Successful Toilet Programs

Other Ontario municipalities have and are offering Toilet Replacement Programs. This would include Barrie, Toronto, Region of Durham, Sudbury, Guelph etc. Rebate amounts have varied.

Some municipalities, like Durham Region have targeted specific towns versus Region-wide offers to make the replacements more intensive. Other municipalities distributed toilets at no charge, such as the City of Barrie. Another municipality (City of Guelph) has targeted only high-water users. York Region has an extensive flapper replacement they deem successful with program delivery at a lower cost. In British Columbia, legislation was recently passed that municipalities could adopt a 6-litre toilet bylaw. The Capital Regional District in British Columbia as part of its water efficiency program offers a \$75/£33.25 toilet replacement rebate. Other Provinces and Territories in Canada either do not have toilet legislation in their plumbing code or still have the 13-litre toilet as its standard toilet.

Participants in these Programs

Many of the participants in these programs are landlords. As the toilet in apartment buildings can be attributed to 40% of indoor water use (as there isn't usually a washing machine and dishwasher in the unit), replacing the toilet can have many benefits:

- 1) reduction in water/wastewater bills
- 2) landlords have the opportunity to evaluate the fixtures and fix any leaks. (Tenants do not always report leaks as in many cases the cost of water is included in the rent.) Landlords have expressed how successful the program is with the rebate incentive as in some cases the toilets were silently leaking into the floor causing structural damage. This was a great opportunity to fix these types of problems.
- 3) additional reduction in water/wastewater bills through correcting leaks
- 4) the pay back period with the incentive for the toilets can be anywhere from 1 to 3 years
- 5) tenants benefit from a new toilet, although may not see reduction in rent due to water savings.

Homeowners given a large enough incentive can be encouraged to replace their old, water-guzzling toilets sooner than later. When the incentive is offered over a longer period of time participation begins to decline. A homeowner may purchase a new toilet only when the old one breaks or during a renovation. The incentive is still of value as the homeowner will then choose to purchase an ultra low flush model over the 13 litre/2.9 toilet. Homeowners not wishing to replace their toilet at this time, may do a small part of reducing water through placing a shampoo or pop bottle in the tank to displace some of the water. Bricks are strongly discouraged as they crumble and cause plumbing problems.

Municipal Challenges

Municipal staff have compared programs and agree these programs are successful. Homeowners wish to 'do their part for the environment', and the municipality benefits from the water reduction. While water efficiency staff strive for a high uptake on their programs, they still need to work in conjunction with finance staff. Revenues must be monitored because if they fall too much, then the rates will rise.

Encouraging the public to participate in this type of program requires a supply of high performing toilets. The ultra low flush toilets hold 13L/2.9 gal in the tank and flush with 6

litre/1.3 gal. Staff have found that there are very few complaints with these toilets, and from surveys given find the satisfaction level to be high.

With a large amount of public monies being allocated to Toilet Replacement Programs, municipalities were curious how well their savings estimates were comparing to the actuals. As it is difficult to accurately measure the small amount of water saved, several municipalities in Ontario joined together to test the 6-litre/1.3 gallon toilets.

Independent 6-litre Toilet Testing

The independent 6-litre toilet study was done in partnership with the Canadian Water and Wastewater Association, CMHC, the Region of Durham, Region of Halton, City of Toronto, Veritec Consulting and Region of Waterloo.

Staff visited retailers as a regular consumer, and purchased the toilets 'off the shelf'. This would represent what a homeowner would encounter. The toilets went through a variety of tests and the results indicate that while all toilets were CSA certified, not all perform the same. Over 50% flushed with more than 6-litres. A few were found to be broken. Some did not flush materials down satisfactorily. Inner parts such as the flapper and chain are sometimes substituted and reduce the performance of the toilet. The results of this study can be found through CMHC's Independent 6-Litre Toilet Testing, Research Highlight 01-143 (www.cmhc.ca).

Some municipalities now offer a short list of toilets available for rebate. This is due in part that municipalities must ensure they will be able to achieve their water reduction targets and also that consumers and the municipality are getting what they paid for.

Six-litre Toilet Performance Monitoring Program

Durham Region initiated a program to evaluate the flush volumes of 6-litre/1.3 gal toilets that were installed in programs over a five year period. Participants were initially contacted through a marketing company, followed by a home visit from a consultant. In the course of verifying flush volumes it became apparent that many toilets were flushing with considerably less than six litres. Conversations with homeowners revealed that many of them resolved flush volume problems by routinely holding down the handle or double flushing when disposing of solid waste. Some participants stated that they understood this to be the normal practice for water-efficient toilets. As a result of this discovery, the scope of the project was modified to include a second phase involving monitoring of extremely low flush volume toilets in five homes. This study is available from the CMHC web site as a Research Highlight #01-144.

From the results, the stakeholders approached CSA to open a dialogue to understand why these certified toilets were not performing as they should. CSA is investigating this discrepancy. In the meantime, the City of Toronto is an example of a municipality that has a list of acceptable toilets eligible for rebates. Through this avenue, it is hoped that manufacturers will ensure that all 6-litre/1.3 gallons toilets flush well, and at no more than 6-litres/1.3 gallons.

Dual Flush Toilet Testing

The dual flush toilet is an innovative technology that has recently emerged on the North American market. The design features a choice of a 3L/.66 gal or 6L/1.3 gal flush using a wash down flush instead of the traditional siphonic flush. Australia was first to utilize this technology in 1984 mandating the use of a dual flush toilet (4.5/9L (1.2-2.4 gal) per flush). This technology was improved upon, and in 1996 Australia's building code was revised to mandate a toilet to flush with 3L or 6L. One line of dual flush toilets, by Caroma International, is slowly being introduced in Canada, and has met with CSA approval. The manufacturer claims additional savings of 40% over the current 6L technology.

The goals were threefold:

1. public perception, acceptance and satisfaction with dual flush toilets;
2. field testing their effectiveness (water savings compared to 6L/1.3 gal or 13L/2.9 gal toilets); and
3. determining their cost-effectiveness compared to 6L or 13L toilets.

The results show that most participants/users readily accept the dual flush technology, and feel that the toilets perform as well or better than their existing toilets. Even though dual flush toilets appear to save more water than conventional 6-litre toilets (the study shows an additional savings of approximately 22%), it is not yet certain whether the public will be willing to pay the higher costs associated with purchasing a dual flush toilet. The dual flush application may be more suited for high-use areas such as restaurants, schools, etc., where the additional water savings related to the "short" flush offset the higher marginal costs. See Appendix A.

Future prospects of toilets in Canada

While the 6-litre toilet is still working towards wide acceptance, newer certified technologies are working their way onto the Canadian market. The dual flush toilet a highly approved of technology, may become more commonplace once the price is more competitive. The four-litre/.88 gallons pressure assist toilet is currently being evaluated in labs in Canada and in field studies in the United States. Preliminary results are positive.

Ontario Water Works Association and some municipalities are working towards lobbying the Provincial Government to mandate all toilets available for retail be, at most, six litres per flush; thus eliminating 13-litre toilets from the market. One municipality has recommended that builders be required to installed municipal approved toilets, so that the toilets will function well for the new homeowners.

Some municipalities and consultants are sharing test results with their United States equivalents. Their current goal is to try and get harmonized toilet standards and testing in North America. CSA in conjunction with the Greater Toronto Water Efficiency Working Group, CMHC and CWWA are lobbying to improve testing standards.

Public perception must be changed in order to facilitate an accelerated toilet replacement of existing homes. Homeowners wishing to replace their existing toilets are requesting information on the various toilet technologies. It is through the testing of these toilets and disseminating the results, CMHC and its partners can educate the consumer as to which toilets perform well, and at the same time indirectly encourage manufacturers to offer a reliable, quality product.

Appendix A

Dual Flush Toilet Testing

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Project Goals

With this in mind, in 2001 the Canada Mortgage and Housing Corporation (CMHC) proposed a nationwide project to evaluate dual flush toilet technology with regards to:

1. public perception, acceptance and satisfaction with dual flush toilets;
2. field testing their effectiveness (water savings compared to 6L/1.3 gal or 13L/2.9 gal toilets); and
3. determining their cost-effectiveness compared to 6L or 13L toilets.

Methodology:

Twelve participating municipalities across Canada, together with CMHC undertook a dual flush toilet pilot project, in residential, commercial and municipal buildings. Approximately 60 toilets were tested in various locations. The assessment was done through measuring the flush volume, calculating the water savings, and providing a self-administered user survey.

Project Results:

The project commenced May 2001 with initial sites chosen for residential, commercial and municipal applications. Landfill sites, apartment buildings, houses, coffee shops etc. were selected by the participants.

An inline water meter (Figure 1), electronic counter (Figure 2) and accompanying documentation was sent to each participant so that they could

- a) measure the flush volume of the existing toilets, and
- b) determine the baseline traffic pattern for those toilets.



Figure 1: In-line water meter



Figure 2: Electronic flush counter

The counters were connected within the toilet tank for a period of one month (Figures 3 and 4).



Figures 3 and 4 – Electronic flush counter connected to original toilet.
Waterloo Landfill, Ontario

One month after the initial monitoring, the new toilets were shipped to each location and installed (Figures 5 and 6). Plumbers installing the dual flush toilets found the installation challenging as the bowl doesn't bolt to the flange as it would with a standard toilet, but instead it bolts to the floor. The flush volume was recorded, and the meter was removed.



Figure 5 (left)
Caroma's
Caravelle
dual flush toilet

Figure 6 (right)
Two buttons on
top of tank to
activate flush.

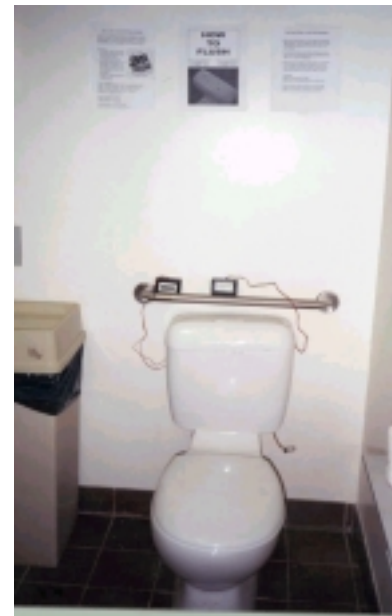


The participants each chose a post-installation monitoring period from one to three months. Two electronic flush counters were installed to independently count the number of 3L and 6L flushes (Figure 7). Counters during the project were hidden from view.



Figure 7 – Dual Flush Toilet
Region of Waterloo, Ontario
Waterloo Landfill Site

Figure 8 – Dual Flush Toilet
City of Toronto, Ontario
Second Cup Coffee Shop



Where applicable, the site coordinator met with staff to explain the pilot project and how to operate the new toilet. A poster was developed to illustrate 'How to Flush' the toilet in locations where the users were the general public (Figure 8).

Three surveys were developed for the different locations and were distributed to the participants. Residential, commercial or municipal surveys were discretely left for users to voluntarily complete. Questions ranged from appearance of toilet, operation of toilet, willingness to pay, performance (double flushing etc), and performance versus original toilet.

Some delays were encountered with toilets being broken via shipping, plumbers requiring booking of 3-4 weeks in advance, and water coordinators dealing with summer drought issues.

The three primary objectives, as stated earlier, associated with this project were:

1. to determine the public perception, acceptance, and satisfaction with dual flush toilets;
2. to field test the effectiveness of dual flush toilets compared to 6L/1.3 gal or 13L/2.9 gal toilets; and
3. to determine the cost-effectiveness of dual flush toilets compared to 6L or 13L toilets.

The **first** objective was achieved by having participants and users complete survey questionnaires.

Survey results indicate that the average user/participant:

- finds that the dual flush toilet is *Average to Pleasing* in appearance,
- feels that the dual flush option is good,
- feels that the flush performance is as good or better than their existing toilet,
- would *Perhaps to Definitely* recommend this toilet to others,
- rate dual flush toilets between 7 to 10 (on a scale from 1 to 10),
- would be willing to pay \$25/£11, \$45/£20 more for a dual flush toilet versus a standard 6L 1.3 gallon toilet in a residential setting, and
- would be willing to pay up to \$150/£67 more for a dual flush toilet in high traffic, commercial locations.

The **second** objective was achieved by physically measuring the two parameters that contribute to the total water demands related to toilet flushing:

1. Flush Volume - the flush volumes of the existing toilets as well as both flush volumes of the dual flush toilets were physically measured using an inline water meter,
2. Number of Flushes – electronic flush counters were installed in the existing toilets and during the ‘pre’ monitoring and in the dual flush toilets during the ‘post’ monitoring. A significant change in the flush rate between ‘pre’ and ‘post’ monitoring would indicate either a) an increase in the incidence of double-flushing, b) that users were avoiding having to use the dual flush toilet, or c) there were problems with the existing toilet.

As an example, the following results are from three participants representing three different types of facilities – all of the sites show distinct water savings. Table 1 shows the ‘pre’ monitoring statistics of the existing toilets. Table 2 shows ‘post’ data with dual flush toilets installed. Table 3 shows the water savings results.

Table 1: Pre Data (Existing Toilets):

Location	Flush Volume, litres (gallons)	Flushes/day	Volume/day, litres (gallons)
City of Toronto: Second Cup Coffee Shop	10.9 (2.4)	128	139 (31)
Region of Waterloo: Waste Management Centre Mens Room	15.7 (3.5)	17.6	276 (61)
Region of Waterloo: Waste Management Centre Womens Room	16.0 (3.5)	33.5	276 (61)
City of Calgary: Private Household	14.0 (3.1)	8.1	114 (25.1)

Table 2: Post Data (With Dual Flush Toilet Installation):

Location	Flush Volume litres (gallons)		Flushes/day		Volume/day, litres (gallons)		Total Volume/day litres (gallons)
	'Short'	'Long'	'Short'	'Long'	'Short'	'Long'	
City of Toronto: Second Cup Coffee Shop	3.4 (0.8)	6.3 (1.4)	82	61	279 (61.4)	384 (84.5)	663 (146)
Region of Waterloo: Waste Management Centre Mens Room	3.2 (0.7)	6.2 (1.4)	17.8	7.6	56.8 (12.5)	47.4 (10.4)	104 (23)
Region of Waterloo: Waste Management Centre Womens Room	3.1 (0.7)	6.1 (1.3)	30.4	9.9	94.1(21)	60.3 (13.3)	154 (34)
City of Calgary: Private Household	3.5 (0.77)	6.0 (1.3)	3.4	1.5	11.9 (2.6)	9.0 (2)	20.9 (4.6)

Table 3: Saving Results:

Location	Daily Water Savings litres (gallons)	Additional Savings vs. Conventional ULFT	Flushes/day vs. Pre Data
City of Toronto: Second Cup Coffee Shop	733 (161) 52.5%	213 (47) 22.5%	11.7% increase
Region of Waterloo: Waste Management Centre Mens Room	172 (38) 62.3%	48.2 (11) 31.6%	44.3% increase
Region of Waterloo: Waste Management Centre Womens Room	122 (27) 44.2%	87.0 (19) 36.0%	20.3% increase
City of Calgary: Private Household	93.1 (21) 81.7%	8.5 (2) 28.9%	39.5% decrease

The **third** objective was achieved by comparing the total water demands associated with the existing toilets (i.e., flush volume times number of flushes) to that of the dual-flush toilets. By knowing the associated water demands and the relative cost of both 'standard' 1.3 gallon toilets and the Caroma dual-flush toilets it was possible to determine the cost-effectiveness associated with embracing the dual-flush technology.

A standard, two-piece toilet retails approximately for \$150/£67. The dual flush toilet retails between \$350-\$500/£155-£222. The payback period differs significantly for homeowners wishing a short payback period. Some consumers priorities function and design over cost, and in this case the payback period is not an issue. For landlords, currently the cost is still high, and the streaking issue may hinder bulk orders until this issue is remedied.

Summary of Results and Water Savings

Average flush volume of existing toilets	16.4 litres (3.6 gallons)
Average flush volume of 'short' flush	3.5 litres (0.78 gallons)
Average flush volume of 'long' flush	6.2 litres (1.4 gallons)
Average water savings using Dual-Flush	68.0%
Additional savings vs. conventional 6L toilet	22.2 %

Costs

Innovative monitoring methods used in this program (i.e., the use of inline meters to physically measure the flush volumes of the toilets involved and the use of electronic flush counters) yielded highly accurate data at a significantly reduced associated cost – i.e., the entire project was completed for approximately \$50,000 Cdn (£22,000).

Summary of Dual Flush Toilet Study

Results show that most participants/users readily accept the dual flush technology, and feel that the toilets perform as well or better than their existing toilets. Even though dual flush toilets appear to save more water than conventional 6-litre/1.3 gallon toilets (the study shows an additional savings of approximately 22%), it is not yet certain whether the public will be willing to pay the higher costs associated with purchasing a dual flush toilet. The dual flush application may be more suited for high-use areas such as restaurants, schools, etc., where the additional water savings related to the "short" flush offset the higher marginal costs.