RESEARCH HIGHLIGHT

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Dual-Flush Toilet Testing

INTRODUCTION

CMHC, in partnership with 12 municipalities across Canada, conducted a pilot program to test dual-flush toilet technology in residential, commercial and institutional settings. Dual-flush toilet technology allows the user to select a short flush (three litres) or long flush (six litres). See Figure 1 and 2.

This study monitored water consumption, toilet performance and customer satisfaction with the dual-flush system. Moreover, a small number of single-flush 6-litre toilets were assessed as a comparison.

Background

The 1996 Ontario Building Code requires the installation of 6-litre toilets in new construction vs. earlier "watersaver" 13-litre toilets and even older 20+ litre toilets. The City of Vancouver has also mandated 6-litre toilets[1], however they are not required for the rest of the province. Although the use of 6-litre toilets is mandated across the entire United States and considered standard technology in most parts of Europe, Ontario is currently the only Canadian province with this requirement. Many municipalities across Canada have subsidized toilet replacement programs in an attempt to increase the market penetration of water-efficient toilets and reduce overall water consumption. Promoting or mandating 6-litre toilets, often called ultra-low-flush or ULF toilets, is often a key component in conservation programs since toilets account for approximately 30 per cent of total residential indoor water use.

Figure 1 and 2 Dual-Flush Toilet and Flush Selection

The dual-flush toilet, a technology first developed in the early 1980s, takes water-efficiency one step further by using 6 litres of water to flush solid waste but only 3 litres to flush liquid waste. While this technology is mandated in Australia and Singapore it is relatively new in North America.

RESEARCH

CMHC funded research to assess the performance and user acceptance of dual-flush toilets. The project had three objectives:

1. to determine public perception, acceptance and satisfaction with dual-flush toilets
2. to field-test the performance of dual-flush toilets compared to 6-litre and 13-litre toilets in terms of consumption rates and equipment performance
3. to determine the cost-effectiveness of dual-flush toilets compared to 6-litre and 13-litre toilets.

[1] City of Vancouver bylaws 1994 Part 2, Section on plumbing services

Methodology

A total of 70 toilets-56 Caroma dual-flush (*Caravelle* and *Tasman* models) and 14 single-flush ultra-low-flush toilets (9 TOTO *Drakes*, 4 Niagara *Flapperless* and 1 Western Pottery *Aris*)-were installed in various locations across Canada as follows[2]:

- Victoria, B.C. – 2 residential; 2 municipal office
- Vancouver, B.C. – 2 residential; 2 commercial; 1 institutional
- Calgary, Alta. – 2 residential; 2 in a waterworks office
- Regina, Sask. – 5 in a school; 3 at a golf course; 2 municipal office; 1 residential
- Gimli and Winnipeg, Man. – 3 in a school; 5 municipal office; 2 in public washrooms in a seniors' apartment building
- Waterloo Region, Ont. – 3 at a waste management centre
- Halton Region, Ont. – 2 at a landfill site; 2 at water treatment plant
- Toronto, Ont. – 1 commercial (Second Cup restaurant); 15 residential (apartments)
- Durham Region, Ont. - 6 municipal office
- Minto Properties, Toronto, Ont. – 1 residential (apartment)
- Québec City, Que. – 4 municipal office
- St. John's, Nfld. – 2 in water treatment plants.

Figure 3 Inline water meter for measuring flush volumes

Caroma dual-flush toilets use a "washdown" flush action versus the siphonic flush action more common in North American toilets. In washdown toilets the waste is "pushed" out of the bowl by the flush, while in siphonic toilets the waste is "pulled" or siphoned out by the flush.

Baseline Monitoring

Before installing a dual-flush or 6-litre toilet, the flush volume of the existing toilet was measured using an inline water meter (see Figure 3). The two flush volumes of the dual-flush toilet, or the single-flush volume of the 6-litre flush toilet, were also verified using the same methodology.

Water Consumption Monitoring

Two electronic flush counters were installed for each dual-flush toilet; one for measuring the larger volume flush and one for measuring the smaller volume. The single-flush toilets had one counter each. A significant increase in the number of daily flushes at any site would be an indication of "double-flushing." Existing toilets were monitored for one month prior to replacement followed by one to two months of post-installation monitoring.

Customer Satisfaction

Survey questionnaires were used to gauge user perception, acceptance and satisfaction.

Consumption/Performance

Average daily water consumption was calculated using the measured flush volumes and number of flushes per day. Significant changes in the number of flushes per day would be used as an indication of performance.

Cost Effectiveness

The relative cost effectiveness was determined by comparing water savings to purchase price for each type of toilet.

RESULTS

Customer Satisfaction

A total of 158 completed survey questionnaires provided feedback on user satisfaction:

- 121 Caroma
- 11 TOTO
- 13 Niagara
- 13 Western Pottery.

Not all questions were answered on every survey. All participants stated they liked the dual-flush option, for example, the option to choose between the two flush volumes. All toilets in the program received average ratings ranging between 7.2 and 7.9 out of 10 based on overall satisfaction as indicated below:

[2] Originally, five additional toilets were to be installed by Vernon, B.C.; however, logistical problems forced Vernon to withdraw from the program before the monitoring was completed.

Toilet	Rating out of 10
Niagara *Flapperless* (6L)	7.9
Caroma *Tasman/Caravelle* (dual flush)	7.8
TOTO *Drake* (6L)	7.6
Western Pottery *Aris* (6L)	7.2

The Caroma dual-flush toilet received a rating of 7/10 or greater from 82 per cent of the respondents. Although most comments for the Caroma dual-flush toilet were positive, there were several comments about bowl "streaking," even among those who expressed support for the toilet.

In terms of appearance, clearing solids, and clearing liquids, more than 85 per cent of the dual-flush surveys obtained average ratings of either "good" or "satisfactory," and 66 per cent of the respondents said they would definitely recommend dual-flush toilets to others.

Respondents indicated they were willing to pay an average premium of $46 for a Caroma toilet, $45 for a *Drake*, $25 for a *Flapperless*, and $23 for an *Aris*.

Water Consumption Rates

A significant water savings was achieved in this project by replacing existing toilets with dual-flush toilets. Flush volumes were reduced by 68 per cent in single-family dwellings, 56 per cent in office washrooms, and 52 per cent in the participating restaurant. Total water savings will vary depending on frequency of use (for example, a coffee shop registered an average of 143 flushes per day).

As well, dual-flush toilets were found to save an average of 26 per cent more water than the single-flush 6-litre toilets when used to replace non-efficient toilets. Savings were slightly less in washrooms with urinals.

The study found that a range of flush volumes existed for all toilets used in the program. Most of the existing toilets were the older 13 and 20-litre styles with a flush volume range of 6.2 to 29.4 litres. The Caroma dual-flush toilets long flush volumes ranged from 5.0 to 7.2 litres and the short flush volumes ranged from 2.5 to 4.3 litres.

The TOTO 6-litre flush volumes ranged from 5.4 to 6.6 litres. The Niagara 6-litre flush volumes ranged from 5.6 to 6.7 litres. The single Western Pottery *Aris* toilets flushed with 7.5 litres; it was later learned that a large number of *Aris* toilets were shipped with the wrong flapper, causing the toilet to flush with too great a volume. A flush volume of 7.5 litres therefore, may not be indicative of what could be expected in further tests of *Aris* toilets.

Flush Frequency

The data showed a small increase in the average number of flushes per day at sites where dual-flush toilets were installed (5 per cent more flushes), and a decrease at sites where TOTO *Drakes* and Niagara *Flapperless* toilets were installed (14 per cent and 39 per cent fewer flushes respectively). There is insufficient data, however, to ascertain whether the increase in flush rates at dual-flush sites is related to flush performance (need for double flushing), or simply due to participant curiousity about the toilet.

There did not appear to be any correlation between flush volumes and changes in flush frequency nor between type of facility and flush frequency. However the CMHC study *Six-Litre Toilet Performance Monitoring Program (**Research Highlight** Technical Series 01-144) found a correlation between toilets flushing with less than 6 litres and an increase in double flushing or "holding the handle down."

Cost Effectiveness

The cost effectiveness of a toilet is based on purchase price vs. water savings associated with the toilet; however, more expensive toilets do not necessarily flush with less water. Purchase price and consumer preference are also affected by design, colour, performance and special features. Cost effectiveness of a toilet is therefore a somewhat arbitrary factor.

Toilets purchased from retail outlets can cost from as little as $70 to more than $1,000. Again, the difference in cost is more related to design than to performance. The retail costs of the toilets used for this project were approximately $160 for the *Aris* 6-litre, $170 for the *Flapperless* 6-litre, $300 for the *Drake*, $300 for the *Tasman* dual-flush and $400 for the *Caravelle* dual-flush.

Based on a simple payback period, calculations for single-family dwellings show that a $300 dual-flush toilet will have a payback period of approximately 8.5 years[3]. A five-year payback period would be achieved (using the same criteria) if the cost of water was increased to $1.70 per m^3 or the cost of the toilet was reduced to $176.

[3] Based on an average combined savings of 9.7 litres/flush, flushing 10 times per day and a combined water/sewer cost of $1.00 per m^3.

CONCLUSIONS

Dual-flush toilets perform well in comparison to 6-litre and 13-litre toilets based on water consumption rates, saving an average of approximately 26 per cent more water than single-flush 6-litre toilets when used in replacement programs. Despite some complaints about bowl streaking, all survey respondents indicated they liked the dual-flush option. Caroma is currently investigating the bowl streaking issue.

In terms of market penetration, dual-flush toilets are likely to compete best with upper-end 6-litre toilets given the similarity in cost and the emphasis on water savings. While reduced water consumption is most likely only one of several factors considered by those purchasing a new toilet, the fact that dual-flush toilets save more water than single-flush 6-litre toilets presents an added benefit that could be promoted.

A further study has been initiated based on the findings of CMHC's work. Durham region is currently evaluating 107 newly installed dual-flush toilets in an apartment complex. The results of this work will be available in 2003.

For more information on 6-litre toilets, please refer to CMHC's *Research Highlights*:

- *Independent 6-Litre Toilet Testing Program (Technical Series*) 01-143
- *Six-Litre Toilet Performance Monitoring Program (Technical Series)* 01-144.

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Research Report: *Dual-Flush Toilet Project,* 2002

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Housing Research at CMHC

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