

## Six-Litre Toilet Performance Monitoring Program

### INTRODUCTION

Many municipalities, as part of their water efficiency initiatives, provide incentives for homeowners to replace existing 20 or 13L (4.4 or 2.8 U.K.gal.) toilets with 6L (1.3 U.K.gal.) toilets. However, research on ultra-low flow toilets (6L) in Tucson, Arizona—summarized in a report entitled *Flushing of Aging Low-Consumption Toilets in Tucson*—showed some erosion of water savings over time. Partly prompted by this study, the Regional Municipality of Durham, Ontario undertook a research study in 2001 to assess the performance of 6L toilets installed as part of its water efficiency programs. Canada Mortgage and Housing Corporation (CMHC) joined with Durham Region in funding the project, as the study has significance for all Canadian municipalities interested in improving water efficiency.

The initial purpose was to verify the flush volumes of 6L toilets installed during the five-year period from 1996 through 2000. Durham Region engaged Parmac Relationship Marketing Inc. to make initial contact with residents and hired Veritec Consulting Inc. to conduct the study. In the course of verifying flush volumes, it became apparent that many toilets were flushing with considerably less than 6L. 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.

For the purpose of this study, double flushing was defined as a second distinct flush within approximately one minute of the first flush. Flushing a second time before the first one was complete was considered a variation of holding down the handle.

This highlight outlines the results of both phases of the monitoring program.

### METHODOLOGY

Parmac contacted homeowners who had participated in the Region's toilet replacement programs over the years. It screened potential participants for the study and provided a list of 227 contacts, from which Veritec was able to successfully schedule 108 appointments to assess the performance of 148 toilets. A random sample of 108 homes from a total of 6,000 households that had participated in Durham's replacement programs provides a 95 per cent confidence rate that the results are accurate within plus or minus 10 per cent.

In the first phase, Veritec measured flush volumes in participants' homes using either a proprietary toilet flush volume meter, an inline meter installed on the toilet's water supply or the home's water meter. Flushing simply involved depressing and releasing the handle. During these site visits, the field technicians noted any improper installations, such as improperly adjusted tank water levels, floats, flappers and so forth. They also recorded any comments or concerns raised by the participants.

Monitoring in the second phase involved logging water meter data for eight toilets in five homes. This data captured actual flush volumes occurring in these homes, as opposed to the volumes resulting from test flushes by the field technicians in the first phase.

The toilets involved in the study were made by four manufacturers: American Standard, Crane, Mansfield and Western Pottery.

## RESULTS

### Phase I: Flush volume monitoring

Although Parmac or Veritec did not ask questions relating to quality issues during phone conversations, participants readily shared comments regarding their satisfaction or concerns about their toilets. Figure 1 summarizes these comments. The results show that over one-third were satisfied, however, more than another third had performance issues (although Durham staff had received very few complaints).

It should be noted that some participants said they had no concerns or problems when initially contacted by Parmac. Yet when contacted by Veritec, they expressed some level of dissatisfaction. This may be because the initial call was unexpected, whereas when contacted by Veritec, they had had time to reflect and perhaps were in a better position to provide a more accurate assessment of their experience and views. If this is correct, then the results of unexpected phone surveys may be skewed. That is, there may be more “no comment” responses than would otherwise occur if a participant had additional time to consider their response.

For the purpose of further analysis, the groups “Satisfied” and “No Comment” were combined, as it was assumed that those who had no comments were generally satisfied with their toilets. Likewise, the groups “Performance Issues” and “Leaks” were also combined.

The average flush volume for the “Satisfied/No Comment” group was 6.4L (1.41 U.K.gal.); 46 per cent of these toilets flushed with more than 6.5L (1.43 U.K.gal.). Most of the American Standard and Crane toilets in this group flushed with between 4 and 6L (0.88 and 1.32 U.K.gal.); most of the Western Pottery toilets flushed with more than 6L; and all Mansfield toilets flushed with more than 6L.

The most commonly reported performance-related issues included clogging, double flushing and the need to hold down the handle during flushing.

The average flush volume for the “Performance Issues/Leaks” group equaled 5.4L (1.19 U.K.gal.); 72 per cent of these toilets flushed with less than 6L and approximately one-third flushed with less than 4L. Toilets in this group did not appear to be flushing properly at these low flush volumes, given common reports of double flushing and holding down the handle. Holding the handle down can result in discharging the entire tank volume during a flush, which is approximately 13L of water. It was concluded that testing in Phase I, which simply involved depressing and releasing the handle, did not accurately reflect flush volumes in actual day-to-day use.

Although site visits revealed extreme variations in flush volumes, tank water levels were generally adjusted to the proper level. This indicated that variations in flush volumes were related more to flapper operation than to variations in the tank water level. All toilets installed through Durham’s replacement program were originally fitted with a proprietary early-closing flapper supplied by the manufacturer. These flappers are often not readily available in retail stores, which can lead to a significant problem when replacing a proprietary early-closing flapper with a standard flapper that is available. It was noted that some toilets flushing with more than 10L had replaced their original early-closing flapper with a standard one.

The field technicians observed that different techniques used by participants to flush a toilet had some effect on flush volumes. For instance, they made the following observations:

- A toilet with a measured flush volume of 2.8L (0.62 U.K.gal.) used 6.7L (1.47 U.K.gal.) when the handle was held until the bowl cleared.
- A toilet with a measured flush of 6L used 10L when homeowners demonstrated their normal method of flushing.

**Table 1** Summary of participant’s comments

Manufacturer	Satisfied	Performance Issues	Leaks	No Comment	Totals
American Standard	15 (31%)	24 (49%)	2 (4%)	8 (16%)	<b>49 (33%)</b>
Crane	21 (37%)	24 (42%)	1 (2%)	11 (19%)	<b>57 (39%)</b>
Mansfield	4 (44%)	3 (33%)	0 (0%)	2 (22%)	<b>9 (6%)</b>
Western Pottery	15 (45%)	2 (6%)	1 (3%)	15 (45%)	<b>33 (22%)</b>
<b>Totals</b>	<b>55 (37%)</b>	<b>53 (36%)</b>	<b>4 (3%)</b>	<b>36 (24%)</b>	<b>148 (100%)</b>

## Phase II: Detailed water demand monitoring

This phase demonstrated the extent to which people's method of flushing affects flush volumes. Veritec collected data on eight, 6L toilets in five homes to determine flush volumes resulting from holding the handle down and double flushing. Figure 2 shows the maximum, minimum and average flush volumes for the eight toilets.

**Table 2** Flush volumes of eight, 6L toilets

Toilet #	Maximum (L/U.K.gal.)	Minimum (L/U.K.gal.)	Average (L/U.K.gal.)
T1	11.0 (2.42)	3.7 (0.81)	5.3 (1.17)
T2	9.9 (2.18)	3.9 (0.86)	4.5 (0.99)
T3	11.4 (2.51)	2.8 (0.62)	6.2 (1.36)
T4	8.3 (1.83)	2.6 (0.57)	4.4 (0.97)

The results of this monitoring phase show that flush volume is affected by whether the toilet handle is held down during the flush and for how long. Variations in volume were wholly dependent on the participants' method of flushing. This is further emphasized by three very different flush profiles obtained for a single toilet in one of the participating homes:

- A flush volume of 2.9L suggested the flapper closed almost instantly, as was the case when the toilet was originally tested and the measured flush volume equaled 2.8L.
- A second flush of 6L represented what would be considered a "proper" flush profile.
- A third profile indicated additional water consumption when the handle was held down.

In the first monitoring phase, the average flush volume of all eight toilets was 3.6L, while the average flush volume for the second phase was 4.8L. The difference between these two values is additional verification that holding down the handle affects the amount of water used. The flush volumes identified in Figure 2 also suggest that participants sometimes held the handle down until the tank emptied, resulting in the greatest amount of water consumption.

Veritec also analyzed the data to determine if there was a high incidence of double flushing. It was concluded that double flushing occurred approximately 20 per cent of the time.

## RECOMMENDATIONS

Based on results from both Phase I and Phase II of this study, the consultant made several recommendations to help improve the effectiveness of Durham's water-efficient toilet replacement programs in the future:

1. Ensure installers are properly trained in installing 6L toilets.
2. Conduct post-installation inspection of toilets.
3. Provide sufficient information to participants about the program. For example, they should be informed that 6L toilets should perform satisfactorily and not require double flushing or holding down the handle.
4. Ensure participants in the Region's toilet replacement program know where to report any problems encountered with their new fixtures.
5. Use only high-quality toilets that are expected to perform well in the field and achieve expected water savings.
6. Consider following up with other participants regarding their satisfaction with the Region's toilet replacement program.
7. Consider working with retailers to ensure they stock proper replacement components for the various types of toilets installed through the Region's program.

## CONCLUSIONS

Testing in Phase 1 highlighted a significant variability in toilet flush volumes, despite all toilets being 6L ULF models. Site inspections revealed that most toilets had properly adjusted tank water levels, indicating that the high or low flush volumes were related to improperly adjusted or manufactured flappers, or to some other quality control problems.

Phase I also revealed a significant degree of customer dissatisfaction with the performance of 6L toilets (over one-third of those contacted). Many participants believed that all water-efficient toilets perform poorly because of their own experience.

Testing in Phase II indicated that, as a result of poorly performing toilets, many participants developed inefficient water consumption habits, such as holding down the handle and, to a lesser extent, double flushing.

The research revealed that several toilets had been installed improperly, for example, floats set to the wrong level. This was surprising given that all toilets were installed by professional contractors and not by the homeowners themselves. Improperly adjusted toilets can lead to customer dissatisfaction and a loss of water savings, as well as casting a negative light on water efficiency in general, and more specifically, 6-litre toilets.

The results indicate that when toilets are not functioning well there is a tendency for homeowners to adjust their flushing technique rather than replace a toilet or report a problem.

## Research Highlight

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Six-Litre Toilet Performance Monitoring Program

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### Housing Research at CMHC

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