THE CITY OF CALGARY
WATER SERVICES

City of Calgary Hotel Toilet Replacement Pilot Study

Final Report

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1.0 Executive Summary

In 2005, Calgary City Council adopted a Water Efficiency Plan. The goal of this plan is to accommodate future population and business growth without drawing any more water from the river than the City removed in 2003. This plan has set a course for how Calgary will deal with its fast pace of growth and increasing demand on the Bow and Elbow rivers that supply water for the City.

The Water Efficiency Plan identifies customer groups and the criteria used to adopt water conservation programming. One group identified is the Industrial, Commercial and Institutional (ICI) sector. The ICI sector accounts for 29% of water consumed in Calgary according to reports in 2007. Hotels/motels are part of the diverse ICI sector.

In fall 2007 a pilot study began to determine "What is the result of replacing high volume tank-type toilets (13 litres per flush or greater) with low-flush Maximum Performance Tested (MaP) toilets flushing 6 litres or less in hotel / motel style accommodations".

Calgary, like many other municipalities provides a rebate to encourage its citizens to replace older model, water-wasting toilets and to shorten the pay-back period. To date this rebate has only been available to residential and multi-unit property owners.

Toilets are consistently identified as one of the largest consumers of water in the hotel/motel industry. However, the degree to which toilets contribute to water consumption in this sector within Calgary is not exactly clear. A water use study conducted in 2003 (Golder) found the estimated pay back period to be lengthy for toilets in Calgary hotels. At an estimated water savings of 12.75m^3/toilet per year the report predicted it would take up to 5.5 years to recover the initial investment even after a $50.00 rebate/toilet on a $100.00 toilet at current water and sewer rates. In Golder's study, toilets were assumed to consume approximately 25% of the water used in an average hotel room. Meanwhile, other ICI water use studies (AWWA, 2000) found toilets to be responsible for 38-42% of indoor water use. To test these findings and determine the potential for water conservation through a hotel toilet replacement program, The City of Calgary partnered with Quality Inn - University to replace 117 toilets and monitor the results.

The success of this hotel pilot study suggests that hotel water consumption is impacted by toilets to an even greater degree than previously expected. After replacing two kitchen spray valves and 117 high volume toilets with low-flush maximum performance tested toilets, a 47% reduction in average daily water use was observed between 2007-2008 for the months of February - April. This was equivalent to an average monthly savings of $1100 resulting in a projected pay back period of 9-10 months on the cost (@ $140/toilet) of the new toilets after

rebate ($50/toilet). A portion of the water savings came directly from a decrease in average flush volumes from 15.3LPF to 6.3LPF and translated to a daily water savings of 0.086m^3/toilet/day. At this rate each toilet is estimated to conserve at least 31m^3/year. Further savings were achieved through elimination of toilet leakage which accounted for an estimated 7.66m^3/day.

Additional findings beyond the water savings included a reduction in toilet back-ups and significantly decreased time required for general maintenance. Also the cleaning staff noted that the toilet bowls are easier and quicker to clean. Although it was not quantified, cleaning staff anecdotally mentioned that they generally only have to flush once now to clear the sanitizing solution used in the bowls, where previously they had to flush more than once on many of the older toilets. In the six months following the installation, guests of the hotel have not made any comments to hotel staff regarding the toilets. This suggests the new toilets were correctly installed and are adequately serving guest's needs.

Summary of Findings

- 47% reduction in average daily water use
- Average savings of $1100.00 month
- Each toilet replaced saves 31m^3/year in water
- Toilet leakage elimination saved at least 23.90m^3/toilet/year
- Significant reduction in toilet back-ups/maintenance
- Easier, quicker cleaning
- No operational complaints

2.0 Site Description

The hotel selected for this pilot project had 105 rooms (one toilet per room), 6 public washrooms (12 toilets total), 1 pool, 1 hot tub. The facility also included a spa and a restaurant/kitchen. This hotel reported being very proactive in terms of maintenance and repair regarding toilets, faucets, showerheads making it a good candidate for the pilot study. In fact, showerheads had already been retrofitted with flow restrictors prior to the start of the pilot.

Pre-install inspection results indicated toilet flush volumes ranged from 7.4 – 21.5 Litres per flush averaging of 15.3 LPF. Also, 1 of 11 toilets inspected was found to be leaking into the overflow tube and 1 of 11 faucets inspected was also found to leak if not precisely reset by user. Post-install inspections were conducted 25 days after the installations were complete. The outcome showed toilets were flushing at 6.3L/flush on average. Some of the higher than expected post-install volume resulted from toilets which had not been set correctly during initial installation, but rather were installed and operated at preset levels 'out of the box'. Changes to levels in all the toilets were made to ensure they were flushing at 6.0L following the post-install inspection.

3.0 Toilet Selection

Selection of toilets was based primarily on Maximum Performance Tested ratings rather than on price to increase the likelihood that high quality components would extend the performance of the fixture for many years to come. MaP Testing was developed by independent consultants to identify how well popular toilet models perform using realistic test media and conditions. As a result of this testing regularly updated reports are produced to keep up with quickly changing technology from toilet manufacturers. Other critical criteria related to selecting the right toilet took into account the rough-in distance and footprint of the new model. The need for elongated bowls and open front seats for public toilets was a further requirement to meet the National Plumbing Code of Canada. Taking these considerations into account, the Quality Inn – University chose the Vitra Atlantis toilets as replacement fixtures in this pilot. These fixtures were 6.0LPF with a MaP rating of 750 grams and purchased at approximately $140/toilet.

Ensuring the use of MaP tested toilets in toilet replacement pilots or programs is important as The City of Calgary supports and promotes performance testing of toilets along with other municipalities by helping to set performance requirements and fund ongoing (MaP) Testing.

According to the MaP testing consultants, Veritec Consulting Inc. and Koeller & Company, the need for developing a standard MaP testing protocol was derived from ‘research in Canada and the US concluding that some certified and commercially available toilet models do not meet customer expectations’. They found the main concerns were in regards to toilets flushing with either too much or too little water, resulting in occasional multiple-flushes and water savings which are not sustained. Therefore, regularly updated MaP testing reports provide a means for customers to evaluate toilets based on quantifiable performance data in order to keep up with the continuous improvements being made in designing low-flush volume toilet models. Ultimately, the improvements being made have led to widespread adoption of low-flush toilets as the major component of water conservation efforts in North America.

4.0 Methodology

It was important that the site chosen for the pilot did not have low-flush maximum performance tested toilets previously installed and did not have large sources of undetermined water consumption (eg. significant leaks). Before the old, water-wasting toilets were replaced, a random selection of suites (11 of 105) were inspected to determine if any of the water fixtures were leaking and to measure the flush volume of the toilets prior to replacement. None of the public washrooms were inspected prior to the exchange, although two public toilets were inspected during the post-install inspection.

Inspections consisted of measuring the flow rate of the showerhead, sink faucet and toilet and recording any leaks observed. Flow rate of toilets was determined using a 'T5 Flushmeter[1]'. Faucets and showerheads were measured by capturing the flow from each fixture in 10 seconds intervals and multiplying the volume captured by six to calculate the flow in litres per minute.

Toilets were replaced following the pre-inspection and water consumption was tracked along with occupancy rates which were monitored to ensure that variances in occupancy were not impacting the interpretation of consumption results. As well, large losses of water (eg. pool maintenance/pipe breaks), which might be considered outside of normal daily operations for the hotel, were monitored and recorded. Finally, the pilot site did not utilize any outdoor irrigation which would otherwise impact water consumption during irrigation months.

It was also the intent of this project to determine the response (if any) of the hotel guests and staff relative to the change in toilet fixtures. Toilet related maintenance issues were discussed with the building maintenance manager who was able to report on any back-ups or other toilet related problems (complaints of multiple-flushing or incomplete flushing, leaks, etc). To maintain the hotel's high standard of customer service and satisfaction, the replacement of leaky or faulty faucets/showerheads continued on an 'as needed' basis throughout the course of the pilot project. The hotel's kitchen was also fitted with two new pre-rinse spray valves. These spray valves were expected to reduce the water use related to pre-rinse activities by 50% based on findings from the June 2008 Spray Valve Replacement Program report. This recently developed Spray Valve Program is already available to restaurants throughout the city.

5.0 Summary of Savings

- Water saved in 2008 over the previous year during February/March/April = 2499m^3

  Average water saved per month in 2008 = 833m^3

  2008 water and sewer rate for rate code W01A-W01K = \$1.32/m^3

  Savings per month = \$1100.00

- Capital cost of toilets (\$140.00/toilet x 117 toilets) = \$16,380.00

  Rebate (117 toilets x \$50.00 rebate/toilet) = \$5850.00

  Water utilities savings = \$1100.00/month

  Pay-back period = 9.6 months

[1] A patented technology and a custom-designed turbine meter to measure flush volumes. (Strategic Instruments Inc.)

5.1 Water Savings – Actual vs. Estimated

Based on inspection results conducted before and after the installation of 117 - 6L toilets it was estimated that the total daily water savings from toilet replacement would be approximately 10.02m^3 (Table 1). This estimate did not include leakage related savings or water savings from the two replacement kitchen spray valves. Leakage was estimated from inspection results indicating approximately 9.1% of the faucets and toilets on site would be leaking. Combining this with findings from Vickers (2001) suggested total leakage per day would account for approximately 8.04m^3 of water consumed. Meanwhile, the estimated savings from the two new kitchen spray valves, according to the City of Calgary Spray-Valve Replacement Program Report, would average 135L per valve for a total of 270L (0.27 m^3) per day.

Table 1. Estimated water conservation based on inspection results:

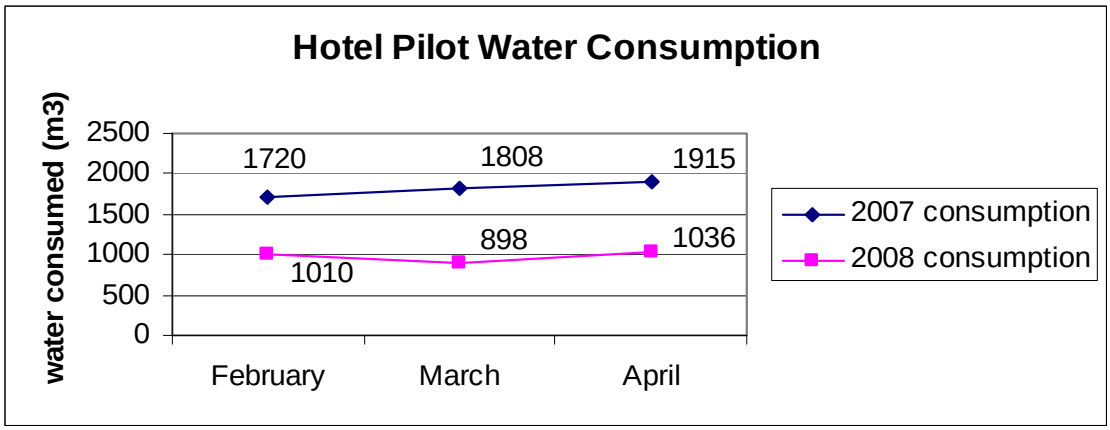
	Pre install	Post install	Difference (m^3)
rooms	105	105	
rooms rented (Feb-Apr)	5645	5624	
persons per room	3.5	3.5	
flushes per person/suite (i)	4.8	4.8	
litres per flush	15.3	6.3	
days	89	90	
litres per cubic meter	1000	1000	
total m^3 toilet water used in suites/day	16.30	6.61	9.69
public toilets	12	12	
public sinks	6	6	
public uses per day (ii)	30	20	
total m^3 toilet water used publicly/day	0.46	0.13	0.33
toilet per day water use (m^3)	**16.76**	**6.74**	**10.02**
% toilets leaking	9.1	0.0	
% faucets leaking	9.1	0.0	
m^3 consumed/leaking toilet (iii)	0.72	0.0	7.66
m^3 consumed/leaking faucet (iv)	0.04	0.0	0.38
total per day leakage			**8.04**
daily consumption (m^3) spray valves (v)	**0.54**	**0.27**	**0.27**
total per day water savings (m^3)			**18.33**

(i) Average flushes/person/day/room from submetered data in Irvine and Phoenix hotels AWWA-Commercial and Institutional End Uses of Water (2000) – *Includes guest and cleaning staff flushes.*
(ii) Estimates made by Quality Inn – University staff.
(iii) Vickers, 2001. Handbook of Water Use and Conservation. pgs.67-68 *Average of 13L and 20L toilet findings.*
(iv) Vickers, 2001. Handbook of Water Use and Conservation. Pg.110 *Maximum reported slow drip rate.*
(v) City of Calgary Pre-Rinse Spray Valve Replacement Program Final Report, June 2008. *Results for Quality Inn – Motel Village*

Based on sub-metered observations made by researchers in the Irvine and Phoenix hotels (AWWA, 2000), it was predicted that toilets would be flushed by each guest per rented room an average of 4.8 times per day. Flushes per day accounted for guest and cleaning staff operation of the toilets on a daily basis as

it could not be distinguished who was using the fixture. Meanwhile, public toilets (12 total) at the pilot site were estimated to be flushed 30 times daily before and 20 flushes per day after the toilets were replaced[2]. The difference in estimates being largely due to the flushes made daily by cleaning staff during cleaning. This reflects reports by cleaning staff that multiple-flushing during cleaning had occurred 'frequently' prior to the new installs and now occurred 'less frequently' according to the maintenance manager.

Actual daily water consumption reduced to 32.71m^3 from 61.16m^3 for an average monthly savings of 28.45m^3 per day between February and April 2008 (Figure 1). This was approximately one third more than the estimated savings of 18.33m^3 per day predicted following pre and post-install inspections (Table 1).



	2007 (m^3)	2008 (m^3)	Difference (m^3)
February	1720	1010	710
March	1808	898	910
April	1915	1036	879
Total **Daily**	5443 m^3 61.16m^3	2944 m^3 32.71 m^3	**2499 m^3** **28.45 m^3**

Figure 1. Actual water conservation observed February–April pre- and post-install

Appendix 1 describes where each portion of the savings were likely derived, indicating that toilet replacements were responsible for 35.22% of the 28.45m^3 saved per day. Meanwhile the estimated toilet leaks fixed by replacement were responsible for saving an additional 26.92%. Therefore, toilet replacement and estimated leaks combined for approximately 62.14% of the 28.45m^3 conserved. Other savings came from the kitchen spray-valve replacements which conserved 0.95% and repaired faucet leakage which saved another 1.86% of the observed daily savings of 28.45m^3. Slight occupancy variance from 2007 to 2008 was found to be responsible for only 0.77% of this savings as shown in Figure 2.

[2] Estimates by Tom Anderson, Maintenance Manager at Quality Inn-University

The origin of the remaining 34.28% (9.75m^3/day) of the observed water savings may have been related to changes in use (eg. reduced multiple-flushing by guests and staff and/or higher than estimated leakage), however the actual impact these factors had was difficult to quantify without the use of sub-metering technology.

Cleaning staff reported flushing less to clear cleaning solution from the bowl while cleaning public and guest suite toilets after the toilet replacement was completed. This would also likely be the case with guests using the fixtures during their stay. Estimates indicate multiple flushing would have had to occur approximately 35% of the time prior to the toilets being replaced in order to account for the 9.75m^3/day savings observed.

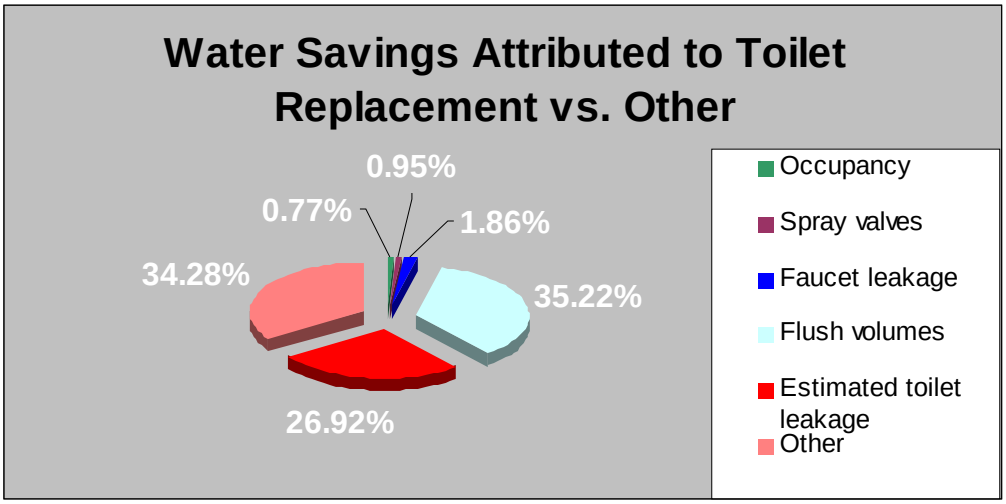


Figure 2. Water savings by origin.

5.2 Leakage

It is known that leakage can often account for a significant amount of daily water consumption from toilets and sink faucets. Vickers (2001) states that, leaky toilets can result in up to 200 gallons per day (757L) of water wastage and leaky faucets can waste an additional 5-55 gallons per day depending on the severity of the leak.

Although the pilot hotel was chosen based on its high level of attention toward maintenance of water fixtures, some of the difference between actual and estimated water savings observed was due to pre-existing leakage. This leakage was eliminated once the new toilets were installed. Pre-installation inspections of the site did predict some leakage from an estimated 9.1% of toilets and faucets prior to installation of the new 6L toilets (Table 1). As a result it was estimated that approximately 7.66m^3 of water may have been conserved strictly by replacing the old leaky toilets with the new low-flush models. In fact, including estimated toilet leakage results in daily toilet water use was as high as 39.9% of the 61.16m^3 consumed before new installs compared to 20.6% of the 32.71m^3

consumed after the new installs were completed (Appendix 1). Leaking faucets should also have been observed and repaired while the maintenance staff was in each suite replacing the toilet, saving another 0.38m^3 per day.

The total potential daily leakage estimated at 8.04m^3 (Table 1) does not account for the 34.28% difference in water savings observed between actual and estimated water savings. Another explanation for this difference (9.75m^3) may be in relation to the number of toilets estimated to be leaking according to the pre-inspection had been 25 rather then 11. Certainly, a higher than estimated leakage rate was possible and may have been discovered upon a more detailed inspection (eg. all 117 toilets). An increase in the number of leaking toilets could explain the bulk of the observed savings that was not otherwise accounted for. Based on the total water savings observed, it is predicted then that the number of leaking toilets was higher than estimated and accounted for a portion of the difference between estimated and actual water savings.

5.3 Water Use Trends

Daily average water use trends were tracked for six months of 2007 and 2008 (Figure 3.) Results show that water consumption dropped significantly since the installation of low-flush toilets at the Quality Inn – University was completed on January 18th, 2008. As the trend lines indicate, average daily water use leveled off in 2008 over the same period of time when average daily water consumption generally increased in 2007. The difference in average daily consumption was lowest in January resulting from toilet installation being completed in the middle of the month in 2008. Excluding January, the difference in average daily water use over the five months came to approximately 28m^3 which remained consistent with our findings in Figure 1 for the months of February to April. Therefore, savings have remained fairly consistent month to month.

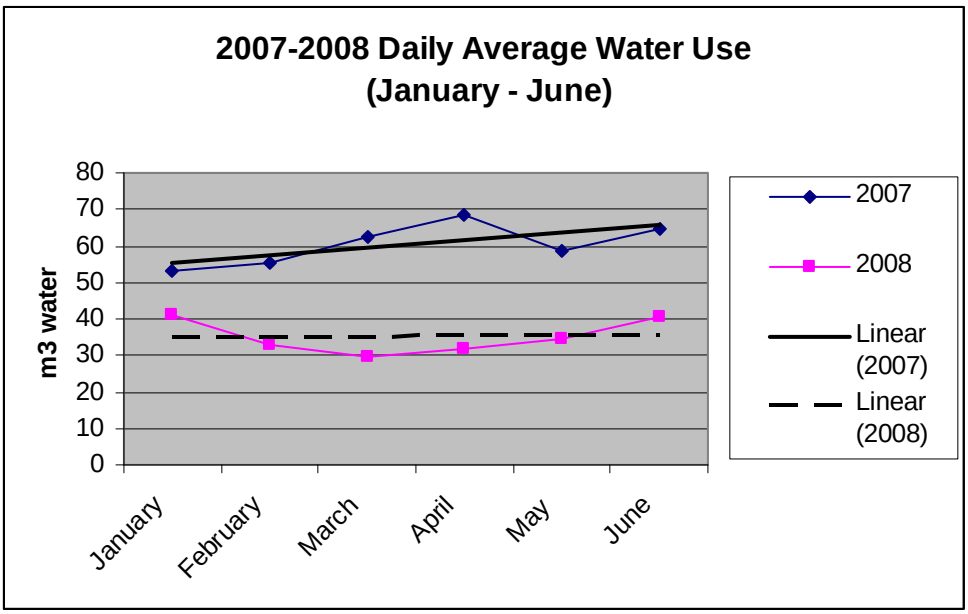


Figure 3. Water consumption patterns.

5.4 Occupancy vs. consumption

Comparing February-April of 2007 and 2008, occupancy varied only slightly, and averaged 60% capacity throughout the study period (Figure 4). Meanwhile, actual water consumption was reduced by an average of 47% during this same period. Looking at detailed changes in occupancy indicates that an average of 7 more rooms per month were rented out in 2007 between February and April over the same period in 2008 (Table 1). This means an estimated 24 more people stayed in the hotel per month during this period in 2007 compared to 2008 (Appendix 1). Adjusting for the difference in the number of guests, accounts for an estimated 6.72m^3 of water used per month in 2007 or 0.22m^3 per day.

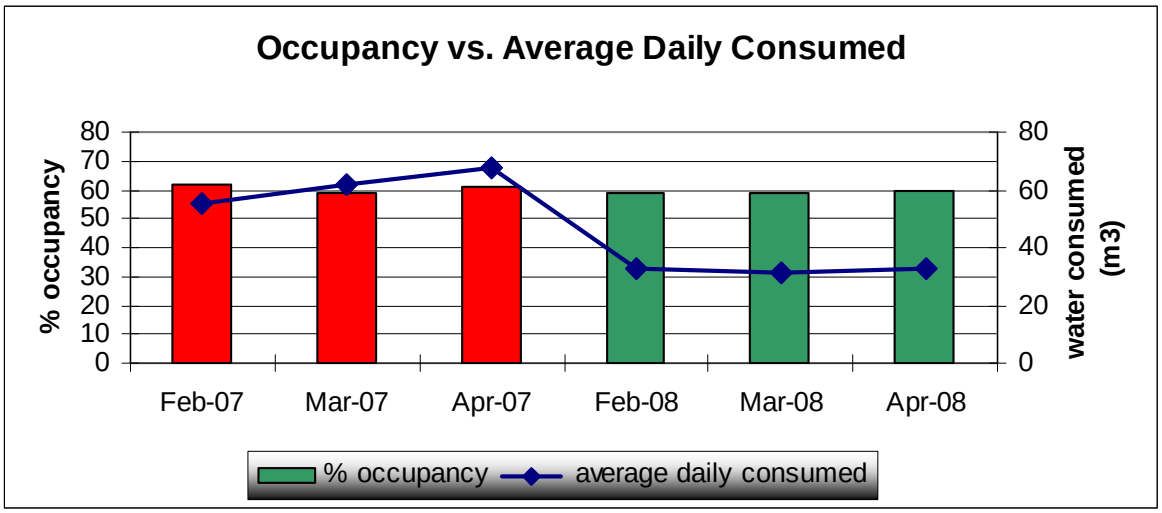


Figure 4. Consumption changes due to occupancy rates.

5.5 Reduced operating costs

During the project, daily water usage per guest reduced from 0.28m^3 to 0.15m^3 (Appendix 2) saving the hotel operator nearly half of the water related charges per occupant per day. Overall post-install water consumption decreased by an average of 833m^3/month resulting in a savings of $1098.06 per month in water and sewer charges. These actual savings were 33% more than the estimated savings which predicted 18.33m^3/day would be conserved for a reduction in water charges of $734.95/month (Appendix 2).

In addition to water related charges being reduced it was discovered that time was also being saved. For the purpose of this study it was not quantified, however the site's maintenance manager reported toilet back-up maintenance calls reduced to two incidents in six months following the toilet replacement from an estimated 'once a day' in the previous six months. This has significantly reduced the time which building maintenance has spent on toilet back-ups. This outcome suggests toilet performance has been significantly improved over the previous fixtures. In fact, the two back-ups which did occur after low-flush toilets were installed resulted from flushing objects which were not intended to be disposed of in this manner (eg. children's toy/toilet paper roll).

6.0 Projected City Savings

According to the Calgary Hotel Association 84 hotels/motels and 13,000 rooms are currently operating in Calgary. Estimated water savings observed at the Quality Inn – University predict an average savings of 86L/toilet/day (Appendix 2). At this rate, for every 1000 toilets replaced in Calgary hotels, The City would conserve approximately 31,390m^3/year (31ML/yr) assuming occupancy rates and current flush volumes in the participating hotels are close to the averages observed at the pilot site.

7.0 Potential Program Barriers and Opportunities

Barriers may be similar to those being observed in the multi-unit and residential rebate programs where property owners are reluctant to replace old, functioning toilets with new, low-flush toilets. According to owners and managers of multi-unit buildings, the basis for their reluctance is most often the perceived rate of return on the initial cost of purchasing and installing the new toilets. As well, property owners often state that they may also be hesitant because they are uncertain whether the 6L technology will meet the performance requirements of their tenants. However, all of these concerns are addressed in this and other related reports which indicate the return on investment period for toilet replacement is quite short. Meanwhile, regularly updated MaP testing reports are indicating that toilet flush technology is improving rapidly to meet or exceed user expectations.

One concern of multi-unit building owners which should be limited for hotel owners is the logistics of renovations conducted while suites are inhabited. As this study suggests, vacancy rates (averaging 40% daily) would allow for a rotation of suites for rent and alleviate this concern.

Program promotion may occur through direct contact with program facilitators in The City of Calgary's Water Resources division. As well, membership associations such as the Calgary Hotel Association and Alberta Hotel Association may provide good exposure through website links/email listings and membership luncheons/seminars. Alignment of a program with pre-existing incentive programs may assist in raising the participation rate as well. For instance, the Hotel Association of Canada has created a 'Green Key Eco-Rating Program'[2] where hotels submit an environmental audit of their own facilities. From the results of this audit hotels are granted a status level from 1 to 5 'green keys' based on the points attained from green initiatives they have taken part in. A toilet rebate program for Calgary hotels may help facilitate a hotel's toilet retro-fit and reductions in water use. In turn this should help participant hotel's to obtain additional points with the Green Key Eco-Rating Program if they have chosen to participate.

[2] http://www.hacgreenhotels.com/index.htm

Ultimately, the city-wide savings from a rebate program aimed at hotel toilet exchanges would be largely dependant on the level of participation. An analysis of the potential market for a toilet rebate program would be advisable to determine what percentage of the 13,000 suites in Calgary have not yet changed their toilets from water-wasting models to more water efficient ones.

8.0 Conclusions

Actual water saved at the Quality Inn – University during this pilot project averaged 28.45m^3 per day. This was a savings of 0.13m^3 per visitor per day. Total annual water savings from this single hotel pilot alone should be over 10,000m^3 in 2008,equivalent to water use needs in 37 new homes in Calgary(3).

Regardless of whether the bulk of the savings originated from lower flush volumes, leakage recovery or changes in toilet use (eg. reduced double flushing), it is certain the toilet replacement was responsible for the majority of the savings observed during this study. This suggests that even under good maintenance schedules, toilets in hotels are likely responsible for the majority of wasted water.

According to this study's findings, hotel toilet replacement alone will save an estimated 31m^3/toilet exchanged annually. With leakage recovered from toilets included, the annual savings may increase to 55m^3/toilet exchanged annually when 9% of the toilets are found to be leaking. It is predicted that many hotels may be leaking at a rate greater than 9%, therefore the potential savings for participants of a hotel toilet replacement program could be even higher. To further increase savings, water conservation initiatives (eg. kitchen spray valve replacement) would have to be implemented, such as in the case of our pilot. In addition to water savings and related reductions to operational costs, the findings also suggest that hotels may benefit from reduced toilet maintenance. For instance, staff feedback indicated that the newer toilets were quicker and easier to clean as well as being easier to maintain in good operating condition.

Based on the results of this pilot study The City of Calgary may consider the hotel industry a good target for water conservation initiatives such as a toilet replacement incentive program. From an economic stand point, The City of Calgary could be expected to save over 155m^3 per $50 rebate over 5 years(4). This would mean the investment required to save a cubic meter of water through the hotel industry should be approximately $0.32/$m^3$/year. The fact that hotels are publicly used facilities and therefore sensitive to public perception also make this group particularly attractive for a replacement incentive program.

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[3] Based on average of 3.2 occupants/home and 7 cubic meters of water consumed per occupant/month.

[4] According to Vickers (2001), toilet flappers are commonly the first part of a toilet to malfunction causing a loss in water conservation at a minimum of 5 years even if made with high quality rubber or plastic. (31m^3 x 5 years = 155m^3)

As well, being a relatively small market (84 hotels/motels in Calgary) increases the likelihood that The City would be able to provide adequate exposure and access to a proposed hotel toilet replacement program, quickly and efficiently. It is estimated that a water demand reduction of at least 0.17ML/day would be achievable through a hotel toilet replacement program with roughly 15% of the 13,000 suites available in Calgary exchanging old water-wasting toilets for new, efficient 6L toilets.

References

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2. Veritec Consulting Inc, Koeller and Company (2007) CWWA-ACEPU, Maximum Performance Testing of Popular Toilet Models, 10th Edition
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Appendix 1

Daily Consumption Comparison

Pre-install

Average total daily water consumption at Quality Inn-University = 61.16m^3

Estimated total per day water use for toilets = 16.76m^3

Estimated toilets leakage = 7.66m^3

Percent water consumed by toilets daily = 16.76m^3/61.16m^3 = 27.40%

- With toilet leakage included = 7.66 m^3 + 16.76m^3/61.16m^3 = 39.92%

Percent water consumed by spray valves = 0.54m^3/61.16 m^3 = 0.89%

Percent water consumed by faucet leaks = 0.38m^3/61.16m^3 = 0.62%

Post-Install

Average total daily water consumption at Quality Inn-University = 32.71m^3

Estimated total per day water use for toilets = 6.74m^3

Estimated toilet leakage = 0.00m^3

Percent water consumed by toilets daily = 6.74m^3/32.71m^3 = 20.6%

Percent water consumed by spray valves = 0.27m^3/32.71m^3 = 0.83%

Percent saved by faucet leak repair = 0.38m^3/28.45m^3 = 1.86%

Percent saved by spray valve replacement = 0.27m^3/28.45m^3 = 0.95%

Percent saved by toilet replacement = 10.02m^3/28.45m^3 = 35.22%

Percent saved by toilet leak repair via replacement = 7.66m^3/28.45m^3 = 26.92%

Appendix 1 continued

Occupancy Adjusted Savings

February-April	2007	2008	Difference
Rooms rented/monthly	1882	1875	**7 rooms**
Avg. guests/room	3.5	3.5	
Guests/month	6587	6563	**24 guests**
Water/guest/day	$0.28m^3$	$0.15m^3$	**$0.13m^3$**

An average of 24 guests/month more visited the hotel in 2007. In 2007 water was used @ $0.28m^3$/day. Total water consumed at the hotel was $6.72m^3$/month higher in 2007 over the same period in 2008.

2008 daily savings due to occupancy = $6.72m^3$/30 days = $0.22m^3$/day

Percent savings in 2008 due to occupancy = $0.22m^3/28.45m^3$ = 0.77%

Appendix 2

Estimated vs. Actual Savings

Water savings per guest:

	Pre-install	Post-install
Rooms rented/day	63.4	62.5
Guests per room/day	3.5	3.5
Total guests/day	222	219
Total water use/day (m^3)	61.16	32.71
Water use per guest/day (m^3)	**0.28**	**0.15**

Water savings per toilet: $\frac{10.02 m^3/day}{117 \text{ toilets}}$ = **$0.086 m^3$/toilet per day**

Cost savings:

Pre-install average monthly charges = $1814 m^3$/month x $\$1.3182/m^3$ = $2391.65

Post-install average monthly charges = $981 m^3$/month x $\$1.3182/m^3$ = $1293.59

Actual monthly savings =

$2391.65
-$1293.59
$1098.06

Estimated monthly savings = $18.33 m^3$/day x 365 days = $\frac{6690.45 m^3/year}{12 \text{ months}}$

= $557.54 m^3$/month @$\$1.3182/m^3$

= $734.95/month