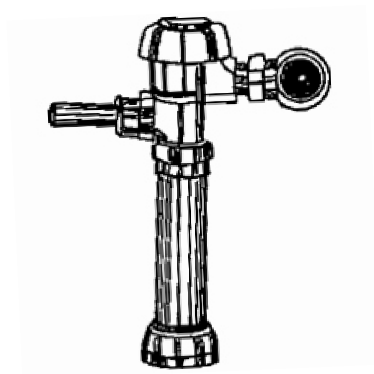
Testing of Popular Flushometer Valve/Bowl Combinations



Final Report

Prepared for

City of Toronto

with

Region of Durham & Region of Waterloo

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By

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Disclaimers

The information in this report is believed to be an accurate description of the units tested and the results obtained. Every effort was made to ensure the accuracy of the findings including, but not limited to, preparation of a detailed test protocol, careful selection and procurement of the products to be tested, and third-party oversight of testing protocol implementation. However, because only one sample of each combination was tested, these results should not be considered as fully representative of the typical or average production of the models tested. The results shown in this report should be viewed only as an indication of expected 'field' results.

Although the test protocol utilized a media whose physical properties closely resemble typical human waste, the reader is reminded that there is an enormous variation in human waste from person to person, and from one day to another.

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Neither the authors, reviewers, project supporters, sponsoring partners, nor their employees endorse products or manufacturers. Trade or manufacturers' names appear herein not as an endorsement but solely because they are considered important to the object of the project.

Readers are reminded that this report represents a 'snap shot' of the performance levels achieved by certain combinations of flushometers and bowls at a particular time and with particular trim. Manufacturers sometimes make permanent or temporary changes or improvements to products or to model designs without changing model names. As such, changes to models tested in this report may have occurred since the testing was completed.

The selection of flushometers and bowls tested as part of this program is in no way intended to represent all of the various makes and models available, nor is it intended to provide a comprehensive list of all flushometers and bowls that might be expected to perform either well or marginally in the field.

The results obtained during this testing program are not guarantees of performance.

Both consumers and manufacturers are encouraged to provide feedback to the authors of this report, especially regarding issues such as incorrect model numbers, models that are listed but are no longer available, etc.

Explanation of Report Revision

The first edition of this report (May 2005) stated that performance testing was being completed using a flowing pressure of 25 psi. Because of equipment malfunction, however, the performance testing portion of the project was actually completed at approximately 20 psi flowing pressure. (The authors would like to thank American Standard for identifying this discrepancy.) As such, it was decided to redo the performance testing at the originally intended flowing pressure of 25 psi.

Given the opportunity to retest the valves, it was decided to evaluate the effect that increasing flowing pressures has on peak flow rates and flush volumes. Further testing was also completed to assess how critical a high static supply pressure is on performance. The results of this additional testing are also included in this revision of the report.

Executive Summary

A large portion of the water savings targets of most municipal water-efficiency programs are related to the installation of water-efficient toilets. If target savings are to be realized and sustained, however, efficient toilets installed as part of these programs must flush with the appropriate flush volume (typically six litres) not only when installed but as they age and require adjusting or repair, and, if they are not to be double-flushed or removed, they must meet the customers' expectations for performance.

While there has been a significant level of research concerning flush volumes and performance of 'residential' toilets (typically gravity-operated), there has been very little research completed on 'commercial' toilets, i.e., flushometer bowl and valve combinations.

Specific concerns of rebating agencies regarding commercial toilets include:

- Performance: There is some question as to whether performance or water savings are affected by mixing and matching different flushometer bowls and valves.
- Long-term Savings: Can savings be assured/sustained if valves can be adjusted to flush with greater volumes, or 6-L pistons or diaphragms replaced with 13-L components?

The program goal was to identify performance variations between different bowl/valve combinations, and evaluate the potential for valves operating at greater than six litres of water.

SUMMARY OF PROGRAM RESULTS

- All valves included in the program flushed with approximately six litres when tested 'out of the box', i.e., projected water savings should be, at least initially, achieved.
- There was little variation in flush volume when static water supply pressures were varied from 35 psi to 80 psi, i.e., static water pressure has very little impact on flush volume.
- Increasing the flowing pressure (while keeping static pressure constant) affected some valves more than others. The Sloan Royal valve, for instance, flushed 5.6 litres at 20 psi flowing pressure but reduced to only 4.0 litres when the flowing pressure was increased to 40 psi; the Delta Teck II, on the other hand, ranged from a low of 3.9 litres at 20 psi flowing to a high of 7.5 litres at 40 psi flowing. Other valves, such as the TOTO, Sloan Crown, Zurn, and Sloan Regal had relatively constant flush volumes at all test pressures[1]. No changes to control stops or flush volume adjustment screws were made during flush volume vs. flowing pressure tests.
- Flush volumes could generally be varied by adjusting the control stop, turning the flush volume adjustment screw, or replacing the 6-L piston or diaphragm with 13-L units. Maximum flush volumes ranged from lows of approximately 6.0 litres (Sloan Royal, Gem, and Regal) to highs of 18 litres (Sloan Gem) and unlimited (Delta Teck II).
- Flush performance was measured using soybean paste[2], toilet paper, and paper toilet seat covers. The amount of soybean paste was increased in 50g increments until the bowl failed to clear 100% of the media in two of three attempts. This study found that bowl selection had a slightly greater impact on performance than valve selection. The floor-mounted

[1] Volumetric and peak flow rate tests were completed at flowing pressures of 20, 25, 30, 35, and 40 psi.
[2] Soybean paste is also as the primary test media in Maximum Performance (MaP) testing of toilets (Gauley & Koeller, 2003).

models out-performed the wall-mounted models with the exception of the wall-mounted Toto CT708 which was also a top performer.

CONCLUSIONS

Performance: The results of this program indicate that all bowl and valve combinations were able to meet performance expectations (i.e., pass greater than 250g of media, plus toilet paper and paper seat cover) if adequate flowing pressure is provided.

Long-term Savings: Water savings can best be sustained by installing non-adjustable 6-litre-only valves, i.e., where 13-L replacement components are not available.

1.0 BACKGROUND

Approximately 57% of the water savings associated with the City of Toronto's Water Efficiency Plan (WEP) is attributable to toilet change-out programs. Significant savings percentages are also expected in the water efficiency programs being developed by the Region of Durham and the Region of Waterloo. If these savings targets are to be realized and sustained, however, it is important that all rebated toilets (including those installed in non-residential applications) meet customer expectations for performance and continue to flush with six litres of water or less.

While all three funding municipalities have completed or supported extensive testing of gravity-operated toilets (the type typically found in residential installations) to ensure that performance and savings targets are maximized, to date there has been very little similar testing completed on flushometer (flush valve) toilets, the type typically found in commercial installations.

Although virtually all flushometer valves and bowls sold in Canada and the U.S. meet both the flush volume and performance requirements of the Canadian Standards Association (CSA) and the American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME), there remains some question as to whether all of these models meet the long-term water savings and performance expectations of rebating municipalities or agencies. What's more, many flushometer valves may be adjusted or altered to flush with more than the maximum volume required by code. In addition to this, certification testing offers only a pass/fail grading, thus there is no easy way to distinguish between superior and marginal flushometer toilet valve and bowl combinations available in the market.

Municipalities and water agencies offering rebates towards the installation of water-efficient toilet models need to be assured that both long-term water savings and customer expectations concerning flush performance are achieved if projected water savings are to be realized.

Specific concerns of rebating agencies include:

- <u>Performance</u>: Unlike gravity-flush models, where the tank and bowl are tested and certified as a single toilet model, flushometer valves and bowls can be 'mixed and matched' when installed in the field. There is some question as to whether performance or water savings are affected by mixing and matching.
- <u>Long-term Savings</u>: It is difficult for inspectors to determine if the proper components are utilized in a flushometer valve and if it is operating properly unless the valve is at least partially disassembled. Many valves can be adjusted to flush with greater than the design value, many valve bodies can be fitted with either 6-litre or 13-litre components (replacement diaphragms or pistons) meaning that continuing water savings cannot be assured, and some valves utilize plastic 'rings' that can be removed or reversed to provide slightly greater flush volumes without replacing the entire piston or diaphragm assembly.

Currently, however, there is no convenient way for a rebating municipality to ensure that intended water savings will be achieved. Savings can be lost by installing improper equipment, improper adjustment, or replacing internal valve components with 13-L components. While some manufacturers provide colour-coded valve components to facilitate identification of either 6-L or 13-L trim, in many cases, unless an inspector removes the valve cover there is no definite way to confirm if the proper components are installed. Some valves come with flush volume adjustment screws making it even more difficult to ensure that the valve will continue to operate at six litres on an ongoing basis.

While some manufacturers claim that at least some level of flush volume adjustability is beneficial or even necessary, at least one major manufacturer is producing a non-adjustable, tamper-proof valve designed to continue flushing with six litres for the life of the valve.

This flushometer testing program, which includes seven popular bowls and seven different flushometer valves (a total of 49 different bowl/valve combinations), is being completed to help ensure that the City of Toronto, the Region of Durham, and the Region of Waterloo achieve their target water savings and that the performance expectations of program participants are met. Flushometer valves that can be easily altered or adjusted to flush with more water may result in less than expected water savings, and bowls that don't meet customer expectations may result in a lower than expected customer participation rate.

2.0 RESULTS OF TWO PAST STUDIES

The 1996 study "A Performance Evaluation of 1.6 GPF Flush Valve Water Closets in Commercial Settings"[3] field-tested five models of bowls and two models of flushometer valves using paper toilet seat covers and balls of toilet paper and concluded "the most unequivocal, decisive, incontestable conclusion that was reached…was that good performance (or lack thereof) of these low consumption fixtures is arbitrary, inconsistent, and erratic. The actual factor or combination of factors that cause one toilet to perform extremely well and another to perform poorly, in a given set of circumstances, is still unclear."[4]

A 2003 field-testing program "Performance Testing of Wall Mount Siphon Jet Toilets at the University of Washington"[5] used toilet paper, blocks of tofu, and paper seat covers to evaluate performance[6]. The project tested eight bowl models and six valve models regarding out-of-the-box flush volumes, adjustability, and to note any obvious performance differences.

Unfortunately, because fixtures were installed in the field it was not practical to 'test to failure' and many models received identical scores on certain test parameters. For instance, seven of eight bowls scored 100% on tofu flushing, i.e., no differentiation in performance was identified between these models. The results showed there was little correlation between a toilet's ability to flush toilet paper vs. paper seat covers – the five models receiving the lowest scores on flushing toilet paper all scored higher than the second and third place models when it came to flushing seat covers. Surprisingly, given these results, study conclusions are based on flushing toilet paper alone.

[3] "A Performance Evaluation of 1.6 GPF Flush Valve Water Closets in Commercial Settings" by W.L. Corpening and Associates, December 1996, prepared for the Seattle Water Department
[4] Corpening, page 22
[5] "Performance Testing of Wall Mount Siphon jet Toilets at the University of Washington" by Roger E. van Gelder, P.E., June 2003, prepared for University of Washington Facilities, funded by Seattle Public Utilities, WA
[6] Seat covers were placed on dry toilet seats with tab hanging down onto the water spot of the bowl.

3.0 PROGRAM GOAL / SCOPE OF WORK

Program Goal: to identify any variation in performance between different bowl and valve combinations, and to evaluate the potential for flushometer valves operating at greater than six litres of water.

Scope of Work: a number of parameters were included, as follows:

- Measure flush volume 'out of the box' (i.e., prior to any adjustments) of flushometer valves,
- Measure effect of static and flowing pressure on flush volume and peak flow rate,
- Identify variability of flush volumes by making adjustments or replacing internal components (i.e., determine how 'tamper-proof' the valve is and the maximum flush volume), and
- Measure variability of flush performance under various valve/bowl combinations.

Measurement of Flush Volume: 'Out of the box' flush volumes were measured by connecting the flushometer valve to a bowl and recording flush volumes at various flowing pressures prior to making any adjustments to the valve assembly. As part of pre-project investigation it was determined that there was no significant difference in flush volume when valves were discharged to atmosphere or connected to a bowl, and there was no significant difference in flush volume when valves were tested on different bowl models.

Effect of Static and Flowing Pressure: Flush volumes were recorded under various water supply conditions to assess the effect of static and flowing pressures on flush volumes and peak flow rates[7].

Variability of Flush Volume: Flush volumes could generally be varied by a) adjusting the control stop (see **Figure 1**), b) turning a flush volume adjustment screw (see **Figure 1**), c) removing or reversing plastic flow rings contained in the valve, or d) replacing 6-L piston or diaphragm with 13-L unit (see **Figure 3**).

Flush Performance: The ability of a toilet to completely remove waste in a single flush without plugging or clogging is considered by many to be one of the most important test criteria. To obtain meaningful flush performance data it was decided that a realistic test media would be used[8]. Test media included flushing increasing loadings (in 50g increments) of a soybean paste[9] having similar physical properties (density, moisture content) to human waste[10], in combination with four loosely crumpled balls of six sheets each of toilet paper[11] and a single paper toilet seat cover[12] (the type commonly found in public washrooms) – see **Figure 2**. To ensure fair flush

[7] Flowing pressure was measured using a pressure gauge installed approximately 2.5 m (8 ft) upstream of the flush valve. No attempt was made to account for the headloss through this section of piping as the specific value of the flowing pressure was less important than the relationship between variations in the flowing pressure and flush volumes / peak flow rates.

[8] Earlier testing performed when developing the performance criteria for this study included the use of sponges and kraft paper wads (similar to the ASME testing media), however, results were observed to be rather random, e.g., a particular bowl/valve combination may easily remove almost all of the media for one flush, then fail to remove almost all of the media on the next flush. As such, sponges and paper wads were not included as performance test media in this study.

[9] Soybean paste is also as the primary test media in Maximum Performance (MaP) testing of toilets (Gauley & Koeller, 2003).

[10] Soybean paste (moisture content 51.5 percent, pH 4.78, density 1.16 grams/mL) was extruded through a 7/8-inch (22-mm) die and cut into 50-gram specimens; each specimen approximately 100mm (4 in.) in length.

[11] Single ply toilet paper conforming to ASME A112.19.14–2001, section 3.2.5.1.2.

[12] Health Guards ® toilet seat covers, made with recycled materials, unwaxed, manufactured by HOSPECO.

performance comparisons, all adjustable flushometer valves were adjusted to flush at six litres prior to performance testing.

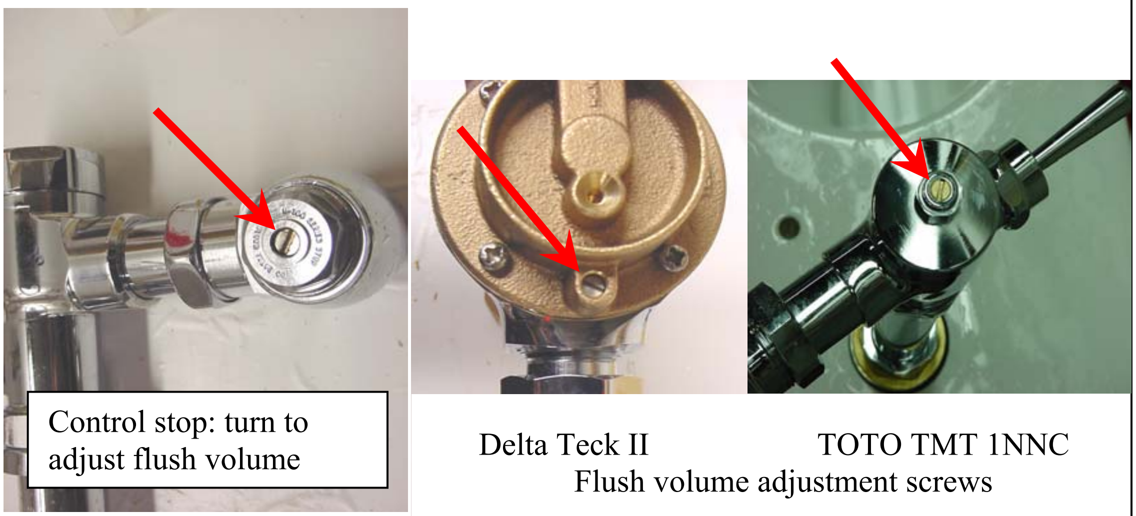

Figure 1

Figure 2: soybean paste and toilet paper in bowl (L), with paper seat cover added (R).

Figure 3 – Valve and Bowl Types

A total of seven different flushometer valves and bowls were included in this project, providing 49 different valve/bowl combinations. No specific selection process was employed when choosing which models of bowls and valves to include in this testing program other than that they be relatively popular in terms of sales and easily obtained.

Test products are identified in **Table 1** and **Table 2**.

Table 1: Flushometer Bowls

Make/Model	Bowl Installation
American Standard AFWALL	Wall-mounted
American Standard Madera	Floor-mounted
Crane 3816	Floor-mounted
Crane Placidus 3446	Wall-mounted
Toto CT705	Floor-mounted
Toto CT708	Wall-mounted
Vortens Vienna (Flux)	Floor-mounted

Table 2: Flushometer Valves

Make/Model	Valve Type
Delta Teck II – 81T201	Diaphragm
Sloan Crown II	Piston
Sloan Gem	Piston
Sloan Regal	Diaphragm
Sloan Royal	Diaphragm
Toto TMT1NNC	Piston
Zurn Z600AV-WS1	Diaphragm

4.0 PROGRAM RESULTS

4.1 Flush volumes 'out of the box'

Although the two testing programs mentioned in Section 2 identified a significant range in flushometer flush volumes, all sample valves in this study found flushed with approximately six litres of water prior to any adjustment (note that the Delta sample did not operate at all prior to adjusting the flush volume screw). Whether the consistency in flush volumes identified during this study is the result of better quality control during manufacturing or simply 'good luck' when selecting test samples is not known as only a single sample of each valve was tested.

All samples flushed with approximately six litres of water 'out of the box'.

4.2 Effect of static and flowing pressure on flush volumes and peak flow rates

4.2.1 Static Pressure

It was found that static pressure has very little effect on flush volumes or peak flow rates through the valve – see **Figure 4** below. Some valves showed virtually no change in flush volume as static water supply pressures were increased from 35 psi to 50 psi, then to 80 psi, while others showed only minor variations.

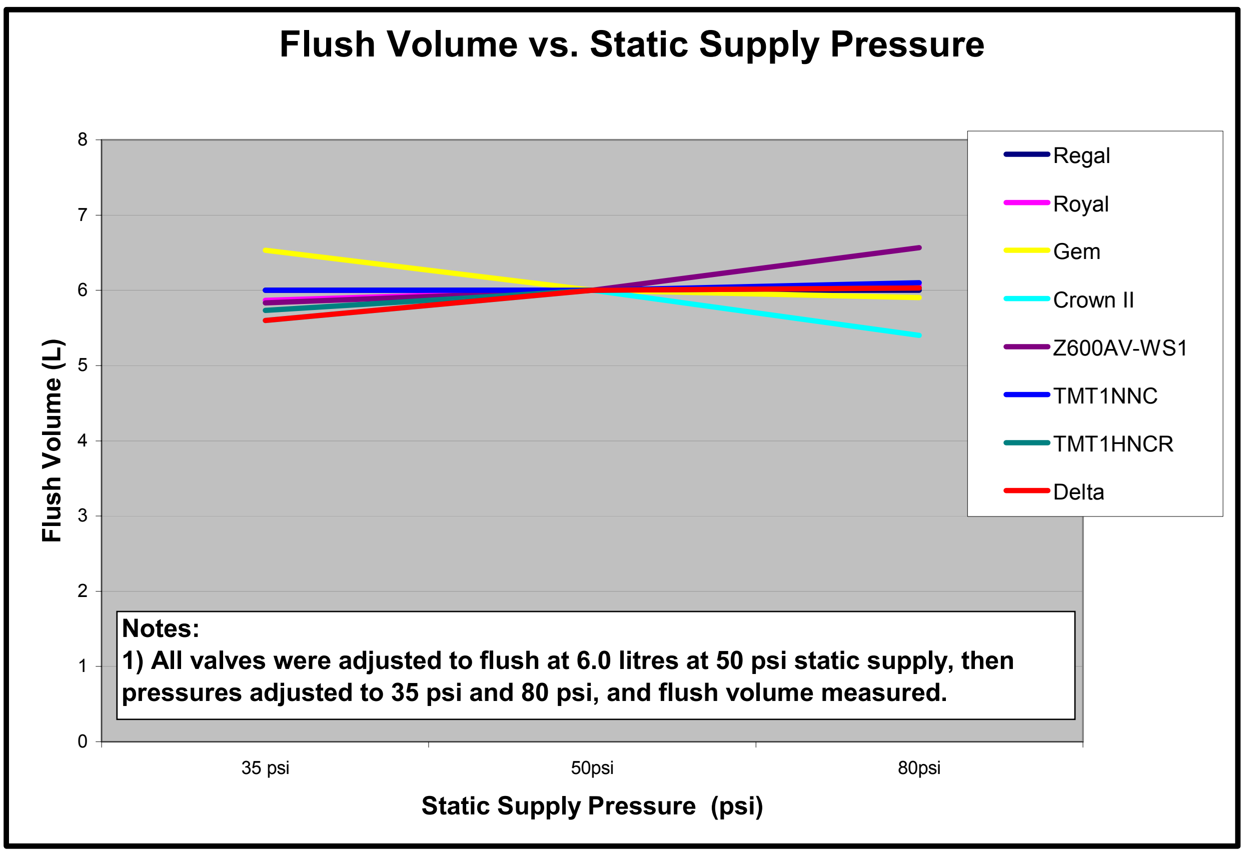

Figure 4

4.2.2 Flowing Pressure

Varying the flowing pressure affected the flush volumes of some of the valves and the peak flow rates of all of the valves - see **Figure 5** and **Figure 6** below.

During this testing the static supply pressure was kept constant at 80 psi, while flowing pressures were varied in 5 psi increments from a low of 20 psi to a high of 40 psi[13]. As can be seen, peak flow rates increased from an average of approximately 60 Lpm at 20 psi flowing pressure to an average of approximately 90 Lpm at 40 psi flowing pressure[14].

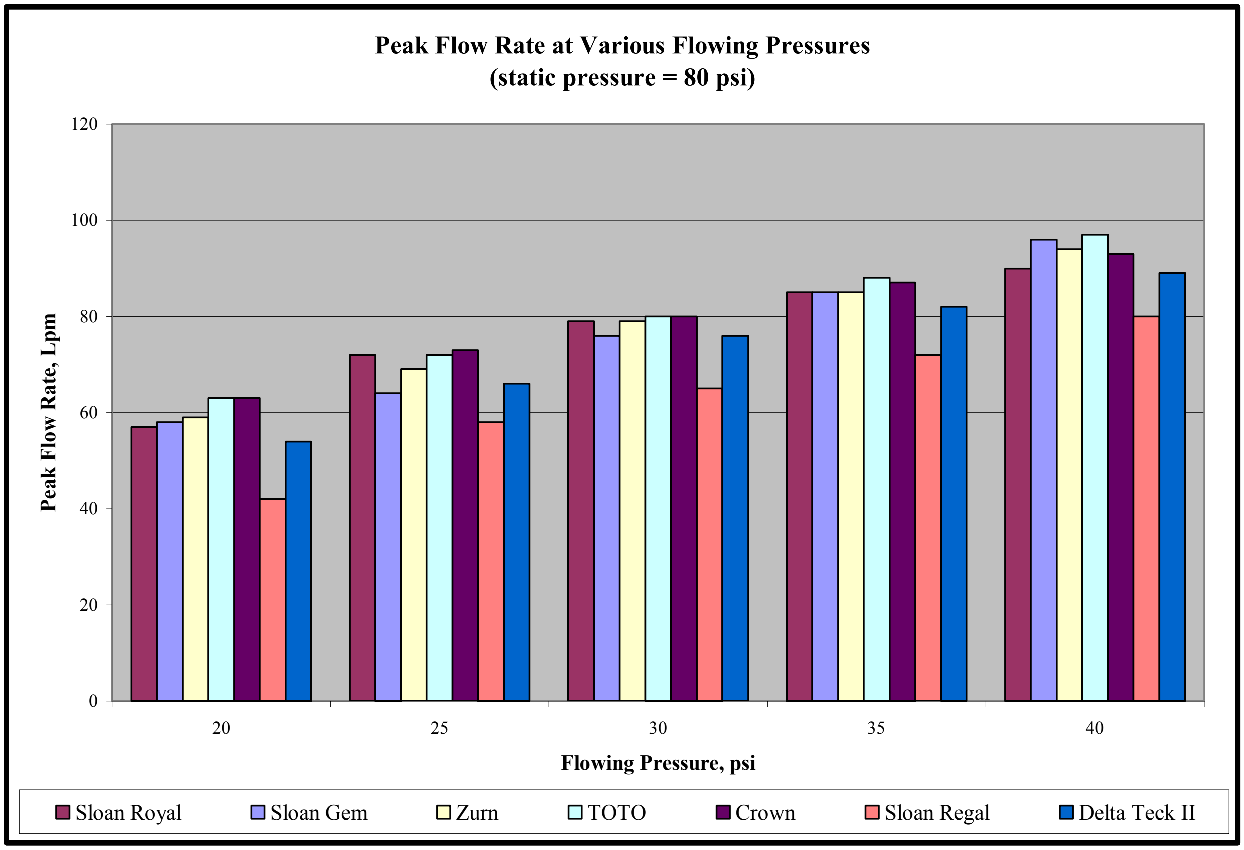

Figure 5

Although peak flow rates increased as flowing pressure increased for all valves, the same relationship was not observed for flush volumes. Figure 6 shows that the flush volume of one valve (Sloan Royal) actually decreased significantly as flowing pressure increased, while the flush volume of the Sloan Gem and the Delta Teck II increased significantly. The flush volumes of the other four valves included in this study remained relatively constant throughout the range of flowing pressures included in this study, despite changes in peak flow rates.

[13] Flowing pressures stated in this report are somewhat approximate as line pressures change throughout the flushing process, increasing as the valve begins to close.
[14] 16 gpm to 24 gpm

Valves that provide a relatively constant flush volume over a range of flowing pressures may offer a greater potential for retaining customer satisfaction regarding performance while ensuring that expected water savings are achieved.

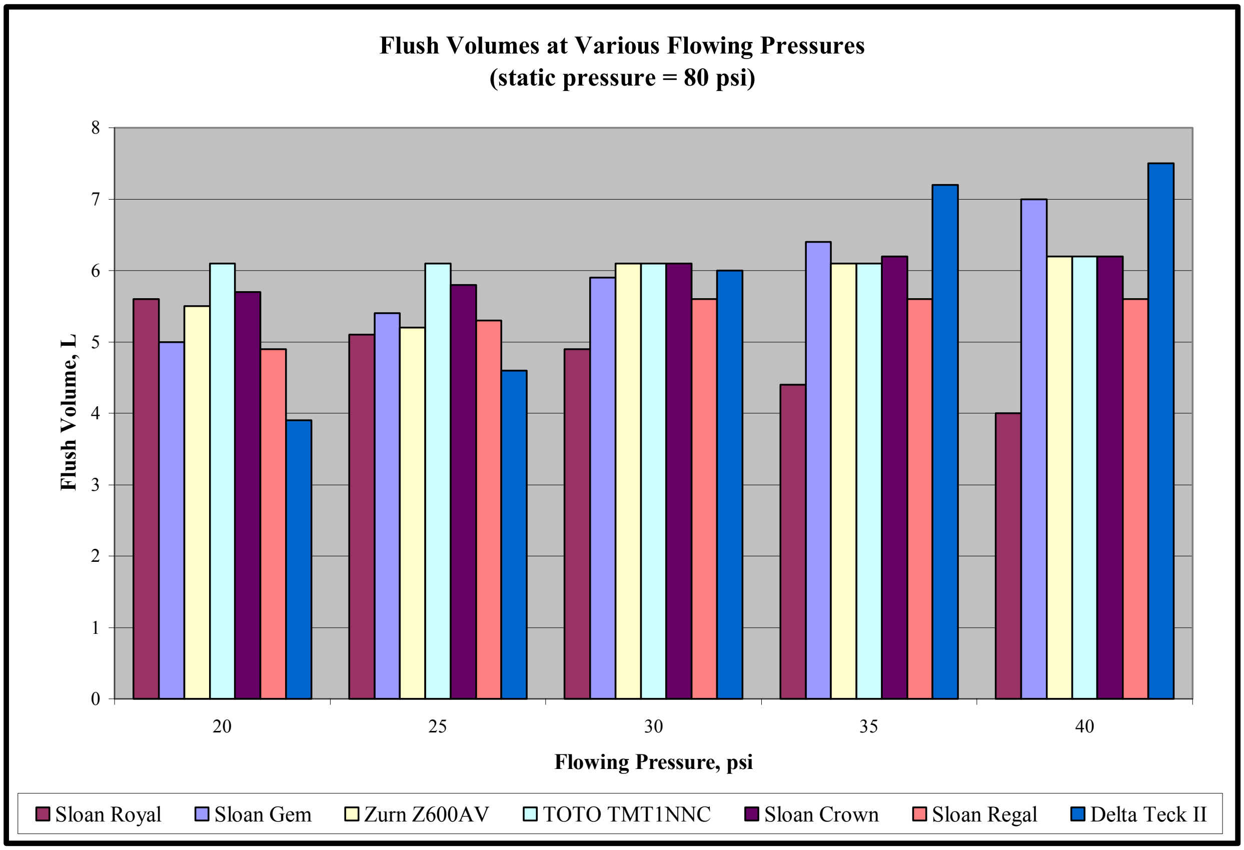

Figure 6

4.3 Flush volume variation

4.3.1 Valve characteristics

Table 3 identifies which test valves have flush volume adjustment screws (adjustable) and which offer non-six-litre replacement components (replaceable), as well as comments on each valve.

All valves tested as part of this study had the non-hold-down feature, i.e., valve closes after flushing proper volume of water even if actuator handle remains in 'on' position, however, this feature did not operate properly on the Delta Tech II valve, which would remain open as long as the valve was actuated.

Table 3 – Adjustable and/or Replaceable Components

Make	Model	Type	Adjustable	Replaceable	Comments
Delta	Tech II	diaphragm	Y	N	Flush volume adjustment screw enables volume to be adjusted to greater than 20 litres. Valve is also available with epoxy on the adjustment screw (designated with a '-6' after the model number), effectively making it non-adjustable. Non-hold-down feature did not function on test sample, i.e., valve remained open for as long as flush handle was activated.
Sloan	Crown II	piston	N	N	Crown piston offered only as a 6-L unit.
Sloan	Gem	piston	N	Y	Can replace colour-coded 6-L piston with 13-L unit.
Sloan	Regal	diaphragm	N	Y	Can replace colour-coded 6-L diaphragm with 13-L unit.
Sloan	Royal	diaphragm	N	Y	Can replace colour-coded 6-L diaphragm with 13-L unit.
Toto	TMT1NNC	piston	Y	N	Flush volume can be increased to approximately 9.0 litres by turning an external slot screw located at the top of the valve beneath a screw-on metal covering plug.
Zurn	Z600AV-WS1	diaphragm	N	Y	Physically very similar to Sloan Regal (same components fit in both valves).

4.3.2 Valve adjustment

In most cases adjusting the control stop (water supply to the valve) resulted in only minor flush volume variations (Sloan and Zurn valves), whereas the valves fitted with a flush volume adjustment screw could be adjusted to flush with a much wider range of flush volumes (TOTO and Delta valves) - see **Figure 7**.

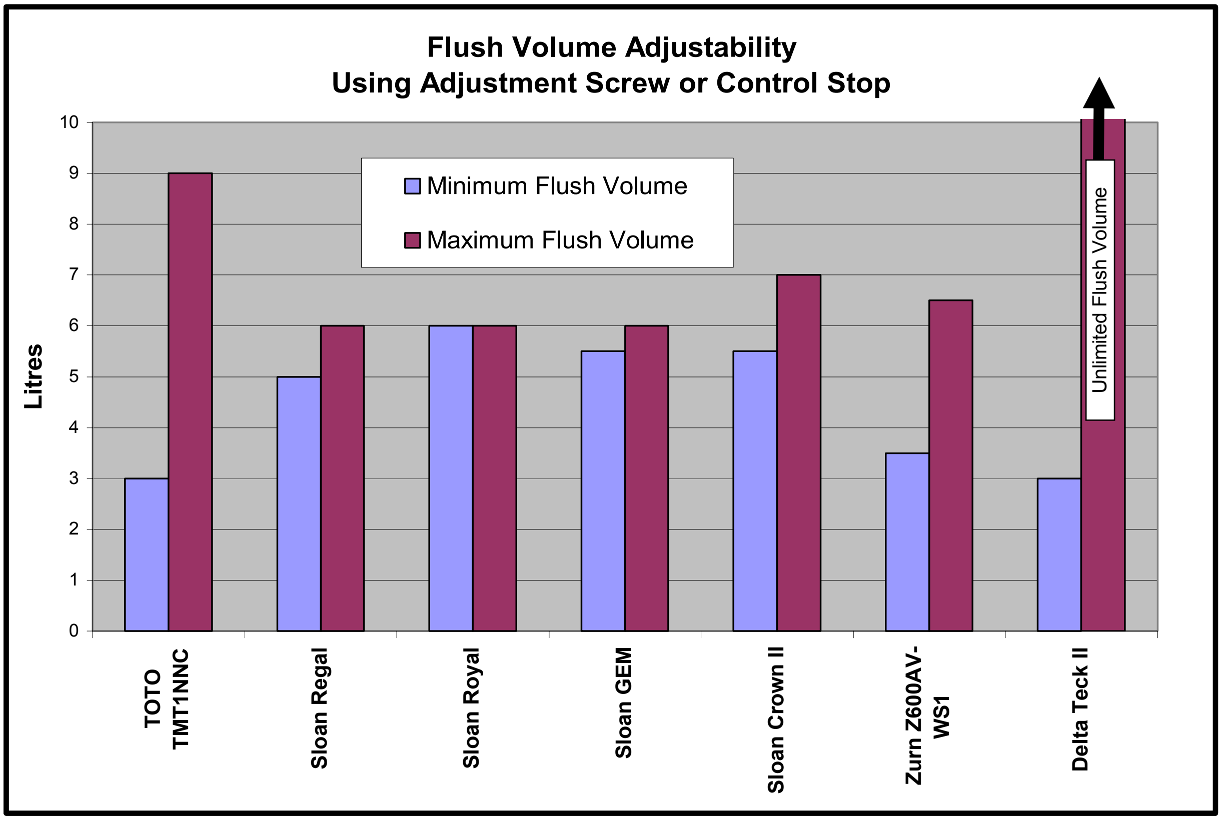

Figure 7

4.3.3 Valve component replacement

As mentioned earlier, some of the valve bodies tested in this project can be fitted with either 6-L or 13-L diaphragms or pistons. As such, it is a relatively easy matter to 'convert' some 6-L flushometer valves into 13-L units. It should be pointed out, however, that it is not the intent of this study to determine the likelihood that this type of conversion will actually be practiced in the field, but simply to identify that it can happen.

Sloan, for instance, colour-codes their valve components to facilitate easy identification between 6-L and 13-L operation (green components for 6-L and white for 13-L). As such, it is a relatively easy matter for an inspector to verify the nominal flush volume of the valve, although it still requires the removal of the valve cover, which can be somewhat time-consuming.

That said, the variation in flush volumes is even more dramatic for those valves with replaceable components (see **Figure 8**). Not all '13-litre conversions' resulted in flush volumes of approximately 13 litres; the Sloan Gem sample, for instance, flushed with more than 18 litres of water when a 13-L kit was installed.

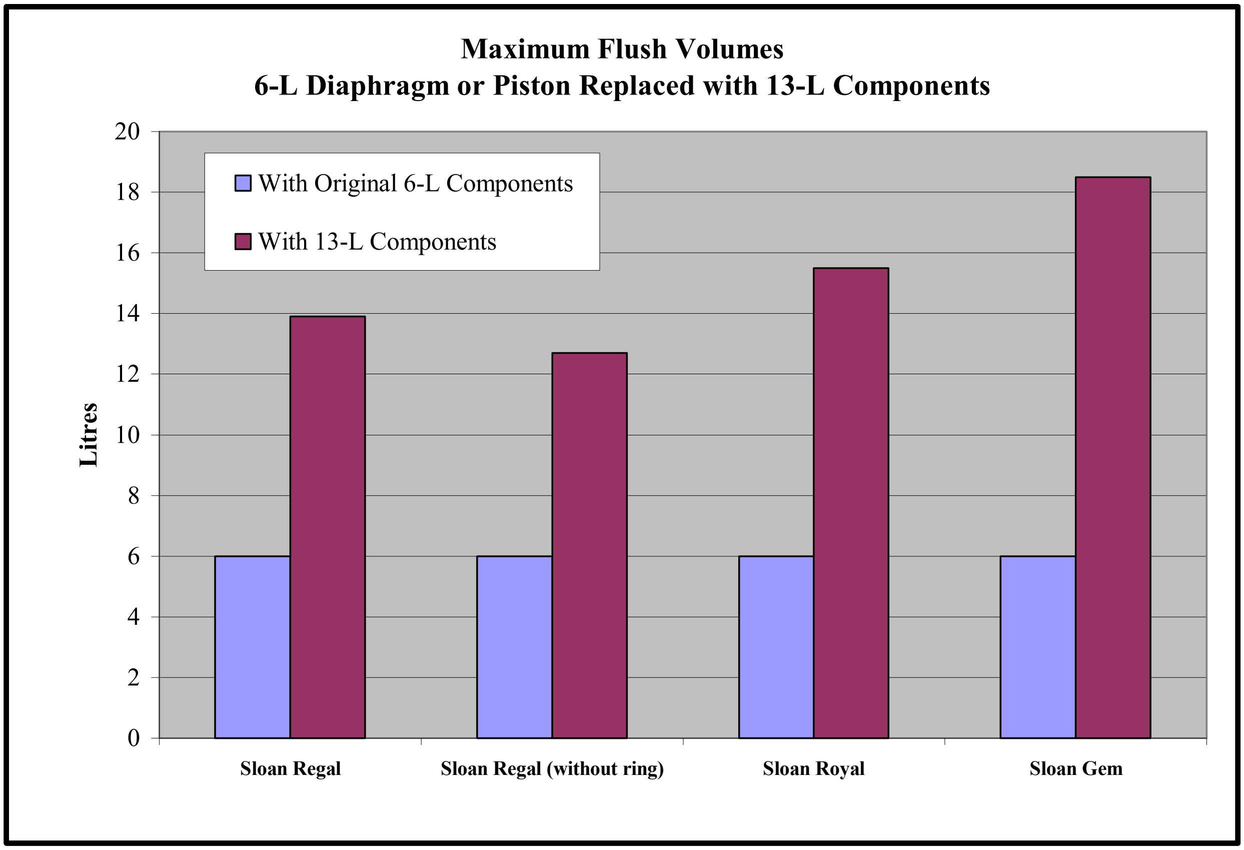

Figure 8

4.4 Flush performance of bowl/valve combinations

With seven flushometer valves and seven flushometer bowls included in the project, a total of 49 different bowl/valve combinations were performance-tested. Flushometer valves require a minimum flowing pressure to operate properly, i.e., flushing performance is impaired if flowing pressures are not adequate. To illustrate this relationship, performance testing was completed at flowing pressures of both 20 psi and 25 psi (**Table 4** and **Table 5**)[15]. Data contained in these tables indicate that a higher flowing pressure will result in greater level of performance. Poor flushing performance in the field may, therefore, be indicative of inadequate flowing pressures.

Figure 9 compares the flushing performance of the various valve/bowl combinations tested as part of this project.

Figure 10 and **Figure 11** illustrate the overall performance levels, tested at 25 psi flowing pressure, of each valve and bowl in the program. Based on these results, it appears that performance is more a function of bowl than of valve.

[15] Tests for splashing and water change-out were also completed. The splashing test involved placing a sheet of cardboard over the top of the bowl, flushing the toilet, and noting any water spots that 'splashed' on the cardboard. No significant or consistent splashing was observed, though it appeared that the incidence of splashing increased as flowing pressures increased. It is possible that splashing that is hardly observable may be easily felt by the user. Water change-out was determined by adding a brine solution to each bowl and using a hand-held conductivity meter to measure the concentration of solution remaining in the bowl following a flush. All bowls met the minimum certification water exchange requirements of 94% (i.e., a 17:1 change-out ratio).

Table 4: Grams of Media Successfully Flushed – approx. 20 psi flowing pressure

Bowls / Valves	TOTO TMT1NNC	Sloan Regal	Sloan Royal	Sloan GEM	Sloan Crown II	Zurn Z600AV-WS1	Delta Teck II	Average
CRANE PLACIDUS 3446 (W)	200	200	200	200	200	200	200	**200**
AM. STD AFWALL EL (W)	200	200	200	200	200	250	250	**214**
TOTO CT708 EL (W)	400	400	600	500	450	450	500	**471**
AM. STD MADERA EL (F)	450	400	500	450	450	550	500	**471**
TOTO CT705 EL (F)	450	400	450	600	600	500	500	**500**
VORTENS VIENNA (F)	450	400	500	400	400	450	500	**443**
CRANE 3816 (F)	300	300	300	300	300	300	300	**300**
Average	**350**	**329**	**393**	**379**	**371**	**386**	**393**	**-**

Table 5: Grams of Media Successfully Flushed – approx. 25 psi flowing pressure

Bowls / Valves	TOTO TMT1NNC	Sloan Regal	Sloan Royal	Sloan GEM	Sloan Crown II	Zurn Z600AV-WS1	Delta Teck II	Average
CRANE PLACIDUS 3446 (W)	450	350	500	500	350	350	350	**407**
AM. STD AFWALL EL (W)	450	350	350	400	450	400	350	**393**
TOTO CT708 EL (W)	600	450	700	600	500	500	550	**557**
AM. STD MADERA EL (F)	500	500	550	450	450	550	500	**500**
TOTO CT705 EL (F)	650	550	500	600	600	500	500	**557**
VORTENS VIENNA (F)	550	500	550	500	450	500	600	**521**
CRANE 3816 (F)	500	450	450	400	350	400	450	**429**
Average	**529**	**450**	**514**	**493**	**450**	**457**	**471**	**-**

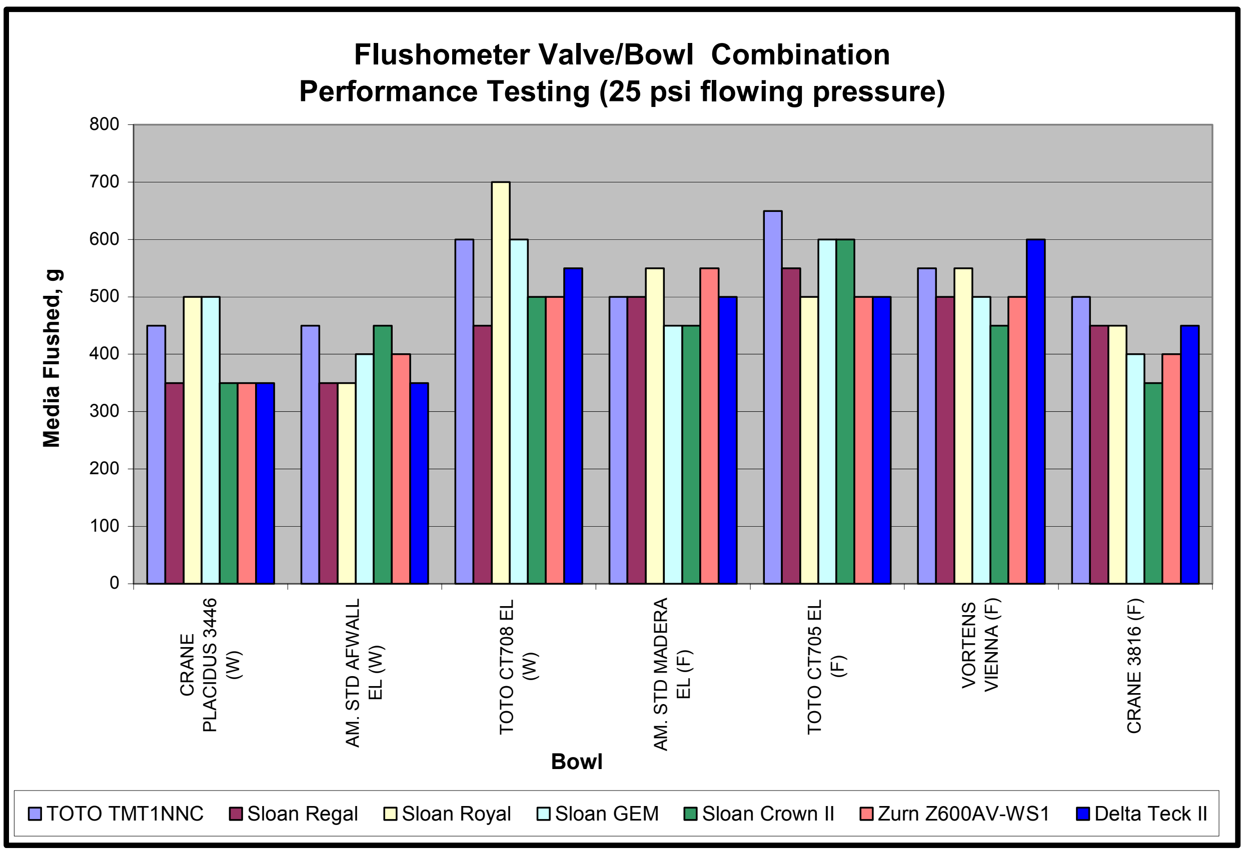

Figure 9

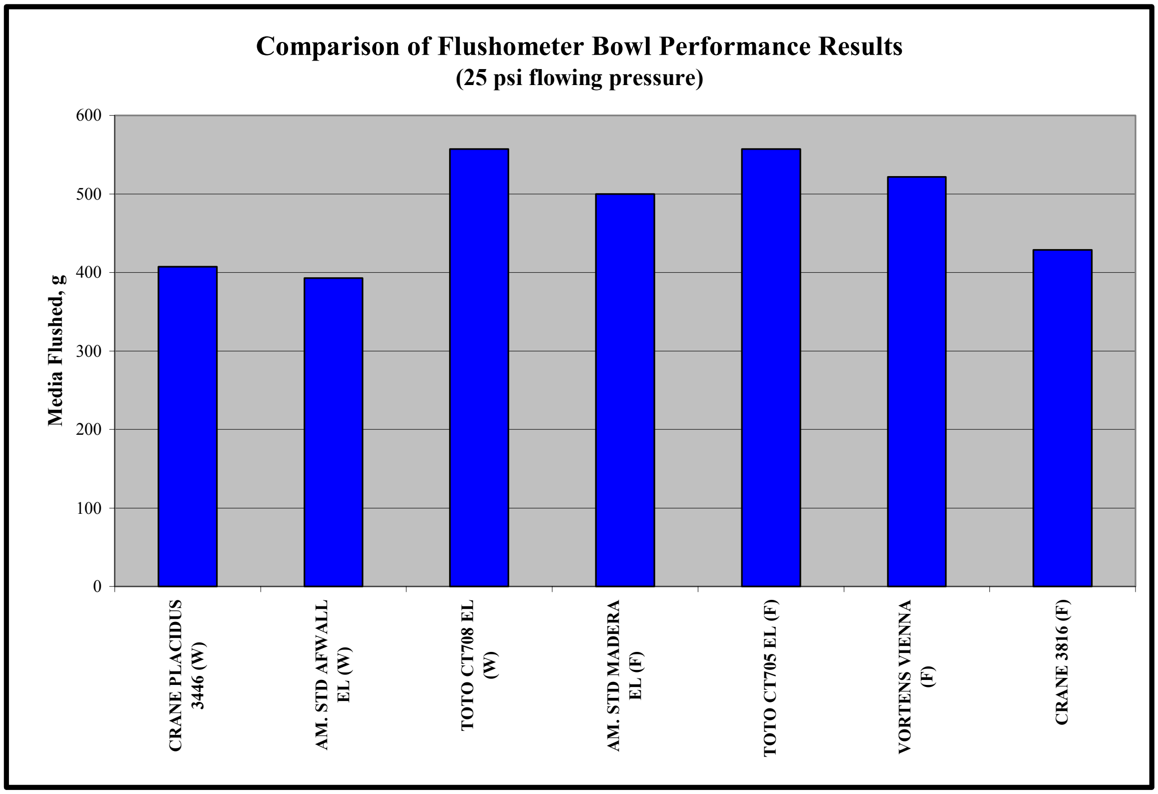

Figure 10

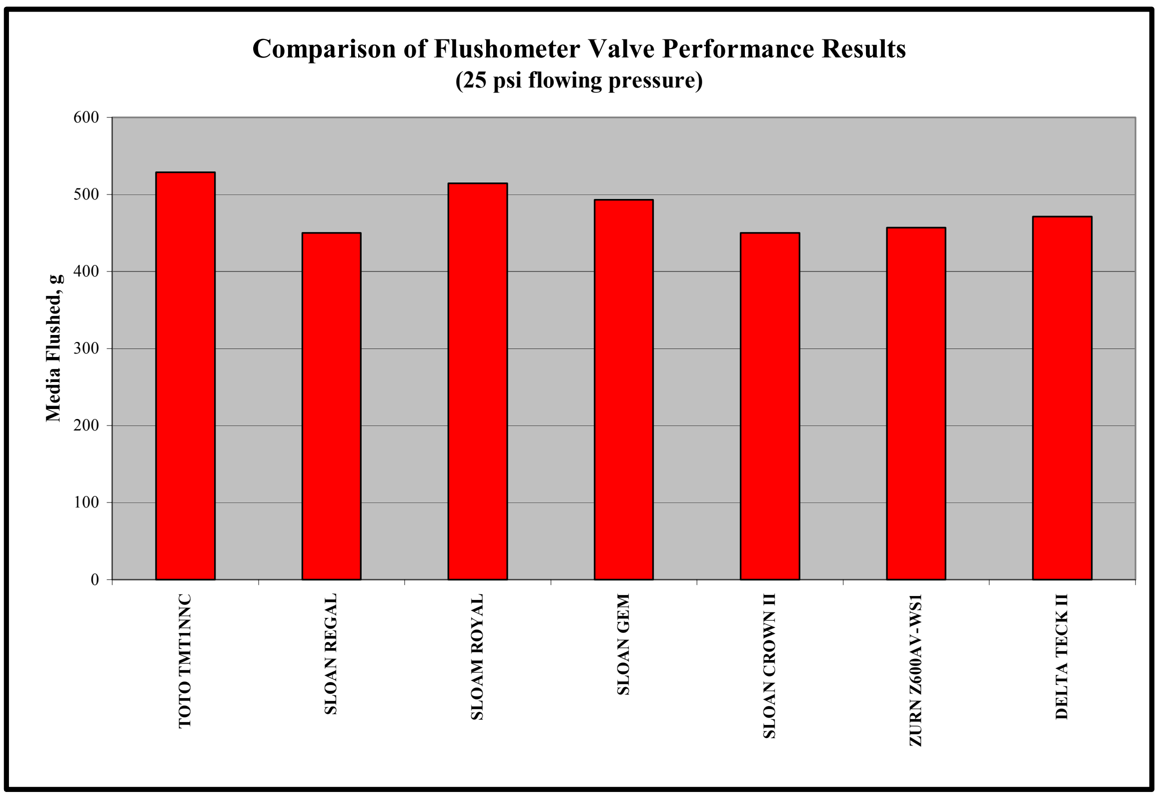

Figure 11

5.0 CONCLUSIONS

- All flushometer valve samples tested as part of this project flushed with approximately six litres of water when installed 'out of the box'. Because of the small number of samples tested as part of this project, however, these results may or may not be indicative of typical installations.
- Variations in static water supply pressures had very little effect on flush volumes. All flushometer valve samples tested as part of this program flushed with between approximately 5.3 litres and 6.6 litres of water when subjected to static water supply pressures ranging from 35 psi to 80 psi.
- Variations in flowing pressures had a significant effect on peak flow rates through the valve – higher flowing pressures equalled higher peak flow rates on all valves.
- Higher flowing pressures did not necessarily result in higher flush volumes. For example, increasing the flowing pressures tended to increase the flush volume of the Sloan Gem and Delta Teck II valves, to decrease the flush volume of the Sloan Royal valve, and to have little or no effect (i.e., less than one litre) on the Sloan Crown, Sloan Regal, TOTO TMT1NNC, and Zurn Z600AV valves.
- Depending on the valve, flush volumes could be adjusted via the control stop, flush volume adjustment screw, replacing piston or diaphragm, or altering/removing internal flow rings.
    - Flush volumes could generally be adjusted slightly via the control stop.
    - Flush volumes of two of the valves could be adjusted significantly with flush volume adjustment screws: up to 9.0 litres for the TOTO TMT1NNC and to greater than 20 litres for the Delta Teck II[16].
    - Potential water savings could be lost if 6-L pistons/diaphragms were replaced with 13-L components in Sloan (except for the Crown II) and Zurn valves.
- There was only a minor difference in the flush performance levels of the flushometer valves – the lowest rated valve scoring 85% of the highest rated valve. All valves tested should provide adequate levels of performance.
- There was a more significant difference in the performance levels of the flushometer bowls. The floor-mounted bowls tended to perform better than the wall-hung models, with the exception of the Toto CT708 wall-hung model which performed as well as the floor-mounted models. All of the bowls tested in this project were able to clear greater than 250g of media when tested with 25 psi flowing pressure.

While different levels of performance were achieved by different valve and bowl combinations, all combinations were capable of meeting the minimum flush performance requirements of 250g of test media.

[16] A Delta Teck II model 81T201-6 (with epoxy covering the adjustment screw) was not tested.

It is possible to adjust or alter all of the valves tested as part of this project, save the Sloan Crown II, to flush with greater than six litres of water. As such, water savings can best be achieved and sustained by installing non-adjustable six-litre-only valves.

Based on the results of this project, municipalities may wish to offer tiered rebates for flushometer valve and bowl combinations, i.e., offer greater rebates for valves that cannot be adjusted (e.g., Sloan Crown valves), lesser rebates for valves that accept both 6-L and 13-L pistons or diaphragms, and, possibly, no rebates for valves where flush volumes can be adjusted with a screwdriver.

Please contact me should you have any questions regarding the testing program or this report.

Sincerely,

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