

SUMMARY

In the average household, the volume of water consumed for the purpose of flushing toilets is second only to that consumed for showers and baths.¹ An older toilet may use 13.2 litres of water or more per flush in contrast to a typical low-flush toilet that uses 6 litres of water per flush. A dual-flush toilet (see Photo 1, to the right) improves on the efficiency of a low-flush toilet by providing the user with the option for a 3-litre “half-flush” when evacuating liquid waste from the bowl.

This case study estimates the annual water consumption and savings (see Table 1, below) that can be realized by a family of four using a dual-flush toilet instead of a conventional 13.2-litre toilet, or 6-litre toilet.

Table 1: Estimated Annual Water Consumption (Family of four)

Description	Litres	Dual-Flush Savings (L)
13.2-Litre Toilet	96,360	68,254
6-Litre Toilet	43,800	15,694
Dual-Flush Toilet	28,106	-

By using a dual-flush toilet rather than a 13.2-litre toilet, the family can save 68,254 litres of water each year, which is enough water to fill the 20,000 litre swimming pool in Photo 2, to the right, 3.4 times.



Photo1: Dual-Flush Toilet



Photo 2: 20,000 Litre Pool

DETAILS

1. Toilet Identification

Chelini Marriot dual-flush toilet with round bowl (Item # 3274-200 at Home Hardware, Model No. B1215RTDF1246)

2. Background

Beginning in the early 1990's, “water saver” toilets using only 13.2 litres of water per flush were introduced to the market. (Prior to then, it was common for toilets to use 20 litres of water per flush).² Subsequently, low-flush toilets typically consuming 6 litres of water per flush

became available, albeit with mixed results - some models performed well but other models occasionally required the user to “double flush” to evacuate all the waste material from the bowl. These incidents were detrimental to the reputation of low-flush toilets and did little to help them gain market share. Today, toilet technology has improved and some 6-litre toilets actually perform better than their 13.2-litre counterparts. Furthermore, single-flush models that use only 4.5 litres per flush are becoming available.

The dual-flush toilet builds on the efficiency of a low-flush toilet by recognizing that less water is needed to remove liquid waste from the bowl than to remove solid waste. Hence, the user has the choice of using a half-flush or a full-flush, typically 3 litres or 6 litres of water respectfully. (In practice, a half-flush should be adequate to remove small quantities of toilet paper in addition to any liquid waste.) Since toilets are flushed more often to dispose of liquid wastes than solid wastes (often at a ratio of 3 or 4 to 1, a dual-flush toilet will save more water than its 6-litre single-flush counterpart.

3. Costs

The net cost of the Chelini Marriot dual-flush toilet profiled in this case study is summarized in Table 2, below.

Description	Cost (taxes incl.)
Dual-Flush Toilet	138.59
Seat	17.31
Wax Seal/Gasket	1.72
Installation (installed by homeowner)	0.00
Total	157.62
Less ecoEnergy for Homes Grant	65.00
Less PEI Energy Efficiency Grant (15 %)	23.64
Net Cost	68.98

At the time of purchase, in the spring of 2009, the homeowner was able to take advantage of energy efficiency incentives offered by the federal and provincial governments. The homeowner realized additional cost savings by installing the toilet himself, a task that would be within the capability of most people with basic home repair skills.

4. Method

The half-flush and full-flush volumes for the dual-flush toilet were measured by marking the position of the fill line inside the tank, turning off the feed water, flushing the toilet, and then measuring the volume of water required to refill the tank. The data was then used to estimate annual water consumption rates in comparison to 6-litre and 13.2-litre toilets.

5. Results and Discussion

- The nominal flush volumes of the Chelini Marriot dual-flush toilet are 6 litres for a full-flush and 3 litres for a half-flush. When the toilet was initially installed, the actual flush volumes were 5.3 and 3.8 litres. For reasons of performance and water conservation, the homeowner increased the volume of the full-flush to 5.5 litres and decreased the volume of the half-flush to 3.3 litres. (The flush mechanism, as per Photo 3 below, allows for adjustments in flush volumes).



Photo 3: Flush Mechanism

- The estimated annual water consumption for the three types of toilets and the savings by using a dual-flush toilet are presented in Table 3, below (see Appendix A for calculations).

Description	Litres	Dual-Flush Savings (L)
13.2-Litre Toilet	96,360	68,254
6-Litre Toilet	43,800	15,694
Dual-Flush Toilet	28,106	-

With savings of 68,254 litres, the dual-flush toilet uses 71 percent less water than the 13.2-litre toilet. Over a 20-year service life, this equates to savings of 1.36 million litres.

The dual-flush toilet also uses 36 percent less water (15,694 litres) in comparison to the 6-litre toilet which, over the same 20-year service life, would save almost 314 thousand litres of water.

6. Comments

- The home in this case study originally had two 13.2-litre toilets. Both were replaced with dual-flush toilets and were adjusted to provide the same flush volumes. (Note: this will not affect the case study because water consumption is based on the number of people living in the household which, in turn, determines the number of times the toilets are flushed. Having more or fewer toilets in the house should not influence the number of flushes per occupant per day.)
- The home in this case study obtains its water from a private well and is not connected to a municipal water supply system. Therefore, although conserving water will save the electricity that would otherwise have been required to operate the submersible pump, there is no financial benefit from saving the water itself.

If the home was connected to a municipal water system where residential water consumption was metered (which has been demonstrated to reduce water consumption), then there would be considerable savings from replacing a 13.2-litre toilet with a dual-flush toilet. The annual savings, for example, would be \$94 in Calgary; \$141 in Toronto; \$87 in Ottawa; and \$28 in Halifax. (See Appendix A for calculations).

- For municipal water and sewer customers, reducing water consumption (and therefore wastewater generation) leads to municipal electricity savings (as electricity is required to pump water and then pump and treat wastewater) and a reduction in carbon dioxide emissions (as most electricity is produced by burning fossil fuels).
- Toilet flushing is an example of a water consumption activity where even a marginal increase in efficiency can make a significant annual difference due to the high number of times a toilet is flushed. For example, lowering the tank level of a conventional toilet or displacing tank water with a water filled plastic container so that one litre of water is saved with each flush can annually

save 1,825 litres of water per person (1 litre x 5 flushes per day x 365 days = 1,825 litres).

- On their website (www.veritec.ca), Veritec Consulting Inc. provides free maximum performance (MaP) reports on new toilets which indicate the maximum number of grams of extruded soy (as a replication of human feces) that can be removed from the bowl with a single flush. By consulting the reports in advance, you can avoid purchasing a poorly performing toilet.

The MaP evaluation for the Chelini Marriot dual-flush toilet is 600 grams per flush when the toilet is fitted with a round bowl and only 400 grams per flush when the toilet is fitted with an elongated bowl. It is the observation of the four members of the household that the toilet is performing well (i.e., it is rarely necessary to double flush). However, this may not have been the case if the toilet had been installed with an elongated bowl.

- The homeowner faced a bit of a dilemma over what to do with the two 13.2-litre toilets that were taken out of service. If he dropped them off at the nearest disposal facility, there might be a chance that someone would acquire one or both of them for use in a cottage, in which case their continued use would be partially offsetting the water savings from the new dual-flush toilets. So, to eliminate this possibility, he used a hammer to break the tank and bowl of both toilets and then dropped them off at the nearest disposal facility.
- For this last comment, the author of this case study was going to expand on the reasons for conserving water. However, it may be more enlightening for the reader to clarify his or her position on water conservation by considering reasons for not conserving water. If you can't identify any reasons, then you likely support water conservation and a dual-flush toilet may be a good choice for you.

7. Conclusion

By replacing the 13.2-litre toilets with dual-flush toilets, the family of four in this case study will save 68,254 litres of water per year.

Appendix A: Data, Calculations and References

Estimated Annual Water Consumption

The annual water consumption for the 13.2-litre, 6-litre, and dual-flush toilets are calculated below. Nominal flush volumes were used for the 13.2-litre and 6-litre toilets and measured flush volumes were used for the dual-flush toilet.

Annual toilet usage: 4 people x 5 flushes per day x 365 days per year = 7,300 flushes

13.2-litre toilet

Annual water consumption = 13.2 litres per flush x 7,300 flushes per year = 96,360 litres

6-litre toilet

Annual water consumption = 6 litres per flush x 7,300 flushes per year = 43,800 litres

Dual-flush toilet

It is assumed that every fourth flush is used to evacuate solids from the bowl.

Annual water consumption to evacuate liquids = 3.3 litres per flush x (0.75 x 7,300 flushes) = 18,068 litres

Annual water consumption to evacuate solids = 5.5 litres per flush x (0.25 x 7,300 flushes) = 10,038 litres

Total annual water consumption = 18,068 + 10,038 litres = 28,106 litres

Savings with Dual-Flush Toilet

Compared to a 13.2-litre toilet

Annual water savings = 96,360 litres – 28,106 litres = 68,254 litres

20-year savings = 68,254 x 20 = 1,365,080 litres

Percent water savings = (68,254/96,360) x 100 = 70.8 percent

Compared to a 6-litre toilet

Annual water savings = 43,800 litres – 28,106 litres = 15,694 litres

20-year savings = 15,694 x 20 = 313,880 litres

Percent water savings = (15,694/43,800) x 100 = 35.8 percent

Visualization of Annual Water Savings

The above ground pool shown below in Photo 4 is 4.88 meters (16 ft) in diameter. At the current depth of 1.07 meters (42 inches), it contains 20,000 litres of water. In this case study, the dual-flush toilet will save 68,254 litres of water annually compared to a 13.2-litre toilet. This is enough water to fill the pool 3.4 times.

Calculations

Diameter = 16 ft = 4.88 m

Radius = 4.88 m/2 = 2.44 m

Depth = 42 in = 1.07 m

Area = $\pi R^2 = \pi (2.44)^2 = 18.7 \text{ m}^2$

Volume = Area x Depth = $18.7 \text{ m}^2 \times 1.07 \text{ m} = 20 \text{ m}^3$



Photo 4: 16-Foot Diameter Pool

$1 \text{ m}^3 = 1,000 \text{ litres}$ therefore $20 \text{ m}^3 = 20,000 \text{ litres}$
 $68,254 \text{ litres} / 20,000 \text{ litres} = 3.4$ “pool fulls” of water

Annual Savings in Jurisdictions with Consumption Charges

Across Canada, many municipal jurisdictions promote water conservation by imposing charges on customers (often in addition to flat service fees) for every cubic meter (m^3) of water consumed. Compared to a 13.2-litre toilet, the dual-flush toilet in this case study saves 68,254 litres annually (which is 68.25 cubic meters) and would annually save the following amounts in the cities listed below.

Calgary³

$$\$1.38 \text{ per m}^3 \times 68.25 \text{ m}^3 = \$94.19$$

Toronto⁴

$$\$2.06 \text{ per m}^3 \times 68.25 \text{ m}^3 = \$140.60$$

Ottawa⁵

$$\$1.27 \text{ per m}^3 \times 68.25 \text{ m}^3 = \$86.68$$

Halifax⁶

$$\$0.41 \text{ per m}^3 \times 68.25 \text{ m}^3 = \$27.98$$

As a point of interest, in Phoenix, Arizona, the rate per cubic meter is up to \$3.51 (USD) in the “high” months of June, July, August, September and \$5.27 per cubic meter to customers who have a municipal water connection but live outside the city limits.⁷ The consumption charges are in addition to a service fee.

References

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