"RAISING THE BAR" IN TOILET PERFORMANCE

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INTRODUCTION

There are generally two phases in the consumer's purchasing process, at least insofar as plumbing fixtures are concerned—the research and decision phase, and the purchase phase. Although consumers may be content to expend considerable energy and time researching and investigating the various pros and cons associated with each product model considered, once they have actually made their purchase, they expect that product to perform as advertised. They do not anticipate expending any more energy wondering about the performance of the product.

Most consumers are savvy enough to know that manufacturers sometimes exaggerate their claims of how well a product performs (gasp!), but they do *expect a reasonable amount of honesty when it comes to certain characteristics. For example, a consumer would be shocked if he purchased a six-cylinder automobile and then found that it only had four cylinders, or if she purchased a five-cycle clothes washer and then found when it arrived home that it only operated with three cycles.*

WATER, WATER EVERYWHERE, BUT PLENTY GOING TO WASTE!

The U.S. and Canada are two of the worst water-wasting countries in the world—nothing to be proud of. It is not hard to see why. We use water-guzzling toilets and clothes washers, we like our vehicles to be clean and shiny, and we like our landscapes to be large and green. What's more, most of us are not willing to sacrifice lifestyle quality for increased efficiency.

This article deals with the one aspect of water use that most of us would just as soon avoid talking about: toilets.

Toilet flushing typically accounts for about 30 to 35 percent of all indoor water use in U.S. homes—often between 16–24 gallons per capita per day. Older toilets flush with between 3.5 and 5 gallons of water and, although that's an awful lot of water, most homes with these water-guzzlers installed *still* have a plunger close by! (Plungers, by the way, were invented *long before* the introduction of the water-efficient toilet.)

Water-efficient toilets, i.e., toilets that flush with only 1.6 gallons (6 litres) of water, have been successfully used for years in many European countries. When the U.S. government realized that we not only use a lot of water, but we actually *waste* much of that water as well, it began thinking of ways that we could improve the situation. Naturally, given how much water our toilets used and how little water the European toilets used, they decided that a good place to start was where most things end in waste—our toilets.

So, in an effort to save water and increase efficiency in municipal wastewater systems, the Energy Policy Act of 1992 (EPAct) was signed into law. Beginning in 1994, EPAct required all residential toilets to be manufactured to the 1.6-gallons-per-flush (gpf) standard vs. the earlier 3.5 and 5 gallons-per-flush behemoths. After all, what works in Europe would work here, right?

Well, not exactly. It seemed that no one in government stopped to consider that European toilets work quite differently from those installed in North America.

Let's consider some of the differences between European and North American toilets.

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North American toilets	European toilets
Siphonic bowl: Waste exits via the trap (or trapway) typically at the bottom rear of toilet bowl. The trap proceeds upwards for a short distance to create a weir to maintain a 2" trap seal, then circles back and discharges to the drain located beneath the bowl (see Figure 1).	**Washdown bowl:** Waste also exits via the trap at the bottom rear of toilet bowl, but, after creating a weir to maintain a minimum 2" trap seal, the trap plunges straight down to floor flange behind the bowl (see Figure 2).
Large water surface area: often about 60 to 80 square inches.	**Small water surface area:** often about 20 square inches.
12-inch rough-in: distance between the finished wall and the center of the floor flange is most commonly 12 inches (though some installations use 10 or 14 inches).	**5-inch rough-in:** distance between the finished wall and the center of the floor flange is 5 inches.
Closed rim bowl: rim is a channel surrounding the top of the bowl with a large number of carefully placed openings on the underside. Water discharging from these holes cleans inside walls of the bowl after each flush.	**Open rim bowl:** the rim is an open weir surrounding the top of the bowl. Flow of water is not restricted or "directed" into the bowl. Intent is to get water into bowl as quickly as possible to "push" the waste out and, at the same time, clean the inside walls of the bowl after each flush.
Jet: often used to assist the development of the siphon that is required to "pull" waste from the bowl.	**No Jet:** does not rely on development of a siphon and therefore does not require a jet.
Small diameter exit trapway: diameter of trap has to be small enough to enable a siphon to be created, but large enough to pass waste.	**Large diameter exit trapway:** large diameter is designed to offer as little restriction as possible to outflow of water and waste.

FIGURE 1. North American siphonic-style bowl.

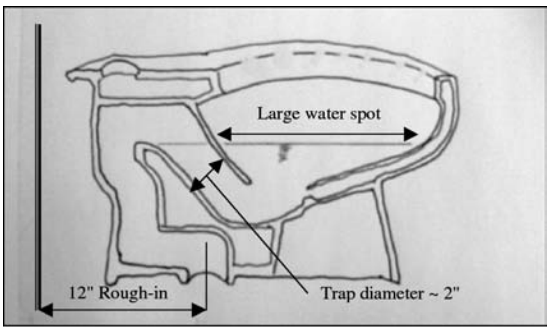
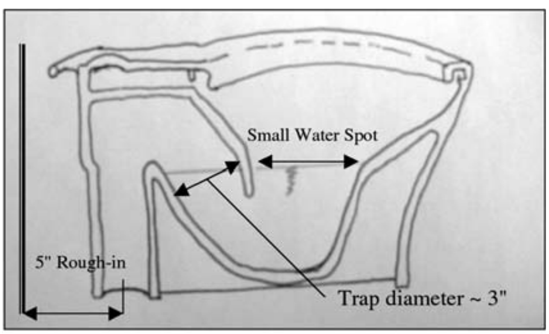


FIGURE 2. European washdown-style bowl.



Thus, a problem resulted. While we may have been able to live with the fact that European toilets function a little differently than our fixtures, we couldn't get past the fact that European toilets do not physically fit in our plumbing systems (5-in. rough-in vs. a 12-in. rough-in.).

As such, North American manufacturers were *not* able to fast-track their new siphonic bowl designs based directly on European designs. Instead, they were largely forced to re-design their existing 3.5-gpf siphonic models in an effort to get them to work properly with only 1.6 gallons of water. Some manufacturers were able to accomplish this much more effectively and speedily than others. Perhaps they spent more time and money, or perhaps they were just a little luckier when it came to their new designs.

Designing new toilet models that flushed with less than half the water of the previous versions was a serious challenge, and, in the end, two problems were often identified with these new "water-efficient" toilets.

Problems with First Generation 1.6-Gallon Toilets in North America

Although identifying problems with any first generation product is not uncommon, the problems ascribed to the first generation of siphonic toilets were greater than expected. These problems centered around two issues: flushing performance and flush volume.

Some manufacturers claimed that it was virtually impossible to make a siphonic toilet (vs. the European washdown models) flush properly with only 1.6 gallons, claiming that there was just not enough water. The implication being that although 1.6 gallons was sufficient to flush washdown models, it was certainly *not* enough to flush siphonic toilet models. Some manufacturers may have spent extraordinary amounts of time and money fighting the EPAct's 1.6-gallon requirement when they could have better spent those resources on the research needed to develop new and improved 1.6-gallon toilet models. (After all, if one believes that it is impossible to make a high-performance 1.6-gallon siphonic toilet, then why beat one's head against the wall trying to build one? And, as long as many others were in the same boat, i.e., producing marginal performers, then what was the incentive to aggressively forge ahead?)

As a result, many homeowners were dissatisfied with the poor flushing performance of their new "water-efficient" toilets, and water utilities and the government were dissatisfied because they weren't necessarily getting the savings that were expected. Unfortunately, the numerous toilet models that were actually functioning well (i.e., providing good flushing performance and sustained water savings) were being painted with the same black brush as the models that were failing on both accounts.

Now, it is an old saying that if everyone on both sides of your particular issue is unhappy with you, you must be doing something right. Such was not the case, however, in the early days of 1.6-gallon toilets. Some homeowners had to endure terrible toilet performance, water agencies were not getting all of the water savings they were expecting (or paying for in the case of rebated or subsidized toilets), and the manufacturers that *were* producing the high-quality fixtures had to deal with the negative backlash caused by the inferior models being sold in the marketplace.

Clearly, the whole changeover to1.6-gallon toilets wasn't going exactly to plan. In the late 1990s, Senator Knollenberg (MI), citing thousands of complaint letters, went as far as trying to get the requirement for 1.6-gallon toilets repealed. He failed, but his efforts brought further negative attention to the issues surrounding water-efficient toilets.

Poor Flushing Performance. While many people were complaining about poor-performing 1.6-gallon fixtures, and longing for the return of the tried and true 3.5-gallon toilets, the truth is that many of the older 3.5-gallon toilets didn't flush much better than the new-fangled water-efficient models (remember the earlier comment about plungers being invented long before the introduction of water-efficient toilets).

Some 1.6-gallon toilet models appeared to be no more than old 3.5-gallon toilets fitted with an early-closing flapper and perhaps an adjustment to the tank water level. As expected, the flushing performance level of these models created much of the negative publicity. Countless anecdotal stories circulated about the constant plugging of 1.6-gallon toilets, and the need to double- or even triple-flush (and the associated loss of water savings), etc. I am sure that during the mid-1990s, even the most ardent environmentalist was thinking twice about installing a water-efficient model. We all support the need to use water more efficiently, but at what price? And if these new toilets weren't actually saving any water, then what was the point of the original EPAct legislation?

Loss of Water Savings. Clearly the intent of the EPAct was to ensure that toilets flushed with only 1.6 gallons of water (or less). But, toilets are made of clay, and clay has a tendency to shrink somewhat when it is fired in a kiln, so no one expected that every toilet produced would be identical and flush with exactly 1.6 gallons of water every time, but I think most of us expected something reasonably close. The reality was, however, that many models flushed with more than 1.6 gallons when adjusted according to manufacturer's instructions, and it was relatively easy in many other models for the homeowner or installer to adjust the fixture to flush with much more than 1.6 gallons—often with as much as the 3.5 gallon toilets that they were intended to replace. And, of course, when a 1.6 gallon toilet fails to perform satisfactorily, the homeowner is highly motivated to tamper with it and increase the flush volume if possible in an effort to bolster the performance.

Letter of the Law. As stated earlier, the intent of the EPAct legislation was to ensure toilets flushed with 1.6 gallons. Nowhere in the legislation did it state that toilets should not be adjustable, nor did it state that toilets must continue to flush with 1.6 gallons even after adjustments or trim component replacement. So, in effect, there is (and continues to be) a "loophole" in the requirements that allows manufacturers to meet the letter of the law without necessarily meeting the intent. As a result, water utilities have been forced to take matters into their own hands and develop their own set of restrictive clauses to prevent "adjustable" toilets with potentially excessive flush volumes from being rebated in their programs.

Certification Requirements. Let's consider the flushing performance—or lack thereof. EPAct was not developed with the intent to save water at the expense of consumer comfort. In fact, it is very likely that its authors thought that water-efficient toilets offered an ideal situation—they could flush with much less water and still work just as well—no consumer sacrifice at all.

The standards developed and used by the certification agencies are intended to ensure that all of the certified products (i.e., toilets) meet the minimum expectations of the end users (pun intended). The fact that so many end-users were unhappy with the performance of their new water-efficient toilets (remember Knollenberg) bears sufficient evidence that the certification standards were set too low, whereby inferior performing fixtures were still able to pass the requirements.

Unfortunately, even with all of the bad press received by water-efficient toilets in the 1990s, certification requirements for 1.6-gallon toilets have not changed significantly since they were developed, and they remain woefully minimal to this day.

What's more (and this always amazes me), the certification requirements do not require toilets to clear 100 percent of the test media to receive a passing score. To become certified a toilet model must only prove that it can completely flush 22 of 28 media[1] (about 79%) in the mixed media test.[2] Would any consumer be happy with a toilet that only removed 79% of the waste with each flush? Hardly!

There were concerns, then, about the water savings and concerns about flushing performance, yet, in an effort to reduce municipal water and wastewater demands (i.e., to reduce strain on existing system, eliminate or defer the need for infrastructure expansion, etc.), many water agencies are still offering rebates to customers replacing 3.5- and 5-gallon toilets with the new water-efficient 1.6-gallon models.

Water Agencies Take Matters into Own Hands. Some of the more progressive water utilities began making efforts to "weed out" poor performing or water-wasting toilet models by offering rebates only for acceptable models, i.e., models that met their requirements for sustained water savings and performance. But what constituted an acceptable model? How was acceptability determined? What criteria should be used? Since there was no "standard" criteria developed to identify *acceptable* toilet models, many utilities tried to develop their own criteria. Unfortunately, what was deemed acceptable for one municipality was not necessarily acceptable for another. This, then, led to a proliferation of "toilet lists" that formed the basis for the various rebate programs. The problem was that each toilet list was different.

Flush Performance. In 2002, Seattle Public Utilities and East Bay Municipal Utility District (Oakland, CA) commissioned the National Association of Home Builders Research Center (NAHBRC) to conduct a series of tests intended to finally, once and for all, rank a large number of popular toilet models in order of flushing performance.

The NAHBRC used sponges and paper wads as a test media (much like certification agencies did then and do now). Unlike the certification testing, however, the NAHBRC program also added small weights to some of the sponges in an effort to represent both sinking and floating waste. As part of the testing, each toilet was adjusted per manufacturers' instructions, e.g., installed on a level surface and the tank water level adjusted to the waterline. The test involved adding media to the bowl in increasing increments, then flushing and counting how many media failed to fully clear the toilet sample.

The NAHBRC study[3] produced toilet performance rankings with scores ranging from 0 to 82. A score of zero was considered the best, i.e., the toilet model left a total of zero media in the fixture during the entire test regime. The report was published on the web and received a great deal of interest.

Although this study was an important first step in providing an independent ranking of the performance levels of popular toilet models, there was still room for improvement. For example:

1. The test media used in the study (sponges and kraft paper) was not even remotely similar to what is actually flushed in a toilet. The use of realistic test media is important since, non-realistic media may not provide indicative results.
2. While the tank water level of all toilet samples was adjusted to the waterline, this did not result in all toilets flushing with 1.6 gallons of water. That is, the indicated waterline was incorrectly set by the manufacturer on several models. In fact, flush volumes ranged from 1.45 to 1.89 gallons. Identifying relative flush performance levels of different toilet models is only meaningful if flush volumes are the same, otherwise the comparison is not "apples to apples."
3. Although the study assigned scores of between 0 and 82, it failed to identify a definitive benchmark score for "acceptability." Did a toilet model have to score zero to be considered effective? Could it score 50 or 82 and still be considered effective? What's more, the scores assigned to each toilet model meant little in the real-life world of toilets. How would knowing a toilet model failed to flush a total of 28 sponges, for example, help the average consumer to understand whether or not to purchase the model?

Beginning in 2003, we were able to overcome all of these issues and develop a meaningful and realistic toilet performance testing protocol. Of the three issues identified above, the second issue was the easiest to address—all toilet samples could be adjusted to flush at their rated nominal flush volume regardless of whether the tank water level was slightly above or below the tank water level indicator mark. At the time of the study this volume was typically 1.6 gallons, although many toilets are currently certified to flush volumes significantly less than 1.6 gallons.

The first issue was a little more difficult to overcome, but it was eventually addressed. First, human waste is organic in nature, so our investigation avoided inorganic media such as plastic, rubber, wood, metal, etc., and instead focused on other types of organic matter such as mashed potatoes, mashed bananas, flour and water mixture, peanut butter, soybean paste, etc. In the end we found that a particular type of soybean paste provided the best simulation insofar as texture, density, moisture content, and (though this was not necessarily a requirement) physical appearance were concerned.

The third aspect, that of identifying how much a toilet model *should* be able to flush, was a little more difficult to determine. For some reason (and the reader may find this hard to believe), there is a very limited amount of research available that explicitly identifies how much feces people produce at each sitting. That said, a British medical study[4] was found that quantified the deposits made by 10 men and 10 women eating normal diets during the study period. For those who are interested the average deposit in the study was approximately 130 grams. As expected, there is some variability between men and women and even from day to day among each study participant, but here are the highlights:

- 95% confidence level (men only) equates to a loading of 305 g;
- 99.5% confidence level (men only) equates to a loading of 346 g;
- greatest single "deposit" of the 20 study participants was approximately 450 g.

While it was important to set the benchmark performance level higher than the average deposit loading (a toilet that could only flush the average "loading" would be expected to "fail" half of the time), it was also important to ensure that the benchmark performance was set at a realistic value. As such, we decided to use the average maximum deposit of the men in the study as the criteria for establishing a minimum benchmark for performance, i.e., we set the minimum benchmark level at 250 g.

Our intention was not to pass or fail any particular number or percentage of toilet models, but to actually establish a realistic minimum performance level for toilets based on medical data and using realistic test media. We wanted to avoid the situation that the certification requirements were in, i.e., using non-realistic media and then needing to flush only 79% of it to receive a pass!

We received funding for the study from 22 American and Canadian water agencies and municipalities, each strongly committed to water efficiency in their service areas. We were on our way to building a better mousetrap. The Maximum Performance (MaP) testing program for toilets was born!

The NAHBRC was good enough to send us 30 of the toilet fixtures that they had tested in their study, and we purchased an additional 29 toilet models at local sources. Upon testing these 59 models, we found that 28 failed to meet the 250 g minimum performance threshold. Amazing! Approximately half of the models tested failed to meet what we had determined to be a realistic minimum flushing performance threshold. We were no longer surprised that so many consumers were dissatisfied with the performance of their toilets!

We published the results of our study and waited for the "soybean paste" to hit the fan.

We didn't have to wait long. Some manufacturers initially threatened to sue us. Fortunately, we had videotaped all of the performance tests and had kept all of the toilet test samples just in case of such an occurrence. Some manufacturers tried to argue that soybean paste was no more similar to human feces than the sponges that were being used for certification (a quick look at the two types of media, however, was enough for even the most skeptical person to disregard this argument).

In the end, the report was generally well received by the water utility industry, homebuilders, "green" building advocates, and consumers. Even those manufacturers that were unhappy with the test results couldn't argue that the choice of test media and the test methodology used were far more realistic than what had been used before and, therefore, that the study results were likely to be more indicative as well. Somewhat surprisingly, many manufacturers quickly began making design changes to their toilet models to allow them to flush with more force and better performance, at least insofar as MaP testing was concerned.

Now, it's an interesting thing that many of the criticisms manufacturers faced regarding the poor performance of the early generations of 1.6-gallon toilets were, in fact, the direct result of it simply being too easy to pass the certification requirements. By setting the requirements too low (i.e., below a level that would ensure toilet models would meet customer performance expectations) the plumbing industry had harmed themselves. Certification requirements that are too low are meaningless. It should have been no surprise when complaints about the poor performance of some early 1.6-gallon toilets started rolling in.

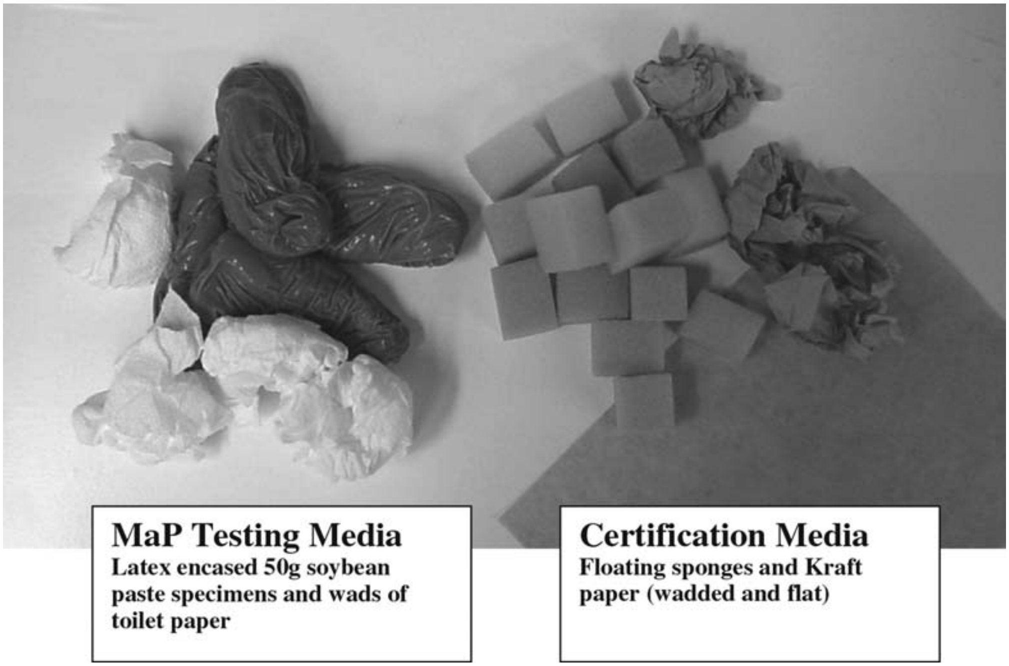
The other unfortunate fact that continues to this day is that the few remaining poor-performing water efficient toilet models give a black eye to ALL water-efficient toilets.

Certification requirements are Pass / Fail. You don't get any more "points" by being better than the absolute minimum. There is no way for the consumer to distinguish between the toilet that barely passes and the one that scored the highest marks. It is important to remember, however, that there is a difference between a certification process (intended to ensure products meet minimum requirements) and a ranking process (intended to identify relative or absolute performance levels). Pass/Fail scoring, however, doesn't help the consumer choose a better toilet, and it doesn't help the water utility identify which toilets will sustain water savings.

In the absence of meaningful test results, superior performance levels are often implied by indirect claim. For example, a toilet may have a fully glazed trapway or a larger diameter trapway than another toilet model, but this does not necessarily mean that it will perform better. A higher performance level is implied by these characteristics, but it is not substantiated. The only sure way to determine if a toilet model performs well is to test how well it flushes actual human waste. Since using actual human waste in product testing is not generally possible, the next best thing is to see how well the model flushes a very realistic simulated waste.

As a consequence of MaP testing, some manufacturers quickly made changes and improvements to their models that scored poorly. Some also developed entirely new models based on the MaP testing protocol. Most large manufacturers now test the performance level of new toilet model designs with the same type of soybean paste used in MaP testing. Furthermore, some very progressive manufacturers accepted the challenge and began developing models that not only met the minimum MaP criterion of 250 g but far exceeded this level by producing models that could flush 1,000 g or more.

The media used in MaP testing, as stated earlier, is extruded soybean paste and toilet paper. Because



the media could only be used a single time, the testing process was expensive, messy, and time consuming. With the popularity of MaP testing among the toilet manufacturers, the sheer volume of soybean paste consumed through these tests began to soar.

At the request of some manufacturers, we began looking for a more user-friendly test media. We tested different-sized sponges, plastic shapes, rubber shapes, different densities, etc., always comparing the results of the new test media with the accepted results of the extruded soybean paste media. Regardless of what type of inorganic media was evaluated, the results did not correspond with the soybean paste over a broad range of toilet styles, and we eventually concluded that meaningful results could not be obtained using inorganic test media (i.e., our first instinct not to use inorganic test media proved correct). In an effort to make the accepted soybean paste more user-friendly, we decided to encase it in a thin latex membrane that would permit each test specimen to be reused many times.

More than 40 toilet models were tested with both the uncased (raw) and cased soybean paste media, and the performance levels achieved under these two scenarios compared. We were pleased to find that both media provided similar performance results, and we were able to move easily into using the new, reusable cased media for all further MaP testing.

Although the MaP testing program was serving its purpose and identifying the performance levels of hundreds of toilet models, it was still only one test. There were other issues concerning the overall functioning of 1.6-gallon toilets that needed to be addressed, such as maximum flush volume, adjustability, the use of non-creeping fill valves, labeling, and more. Many of these issues were being addressed via the Los Angeles Supplemental Purchase Specification (SPS), and for some time many toilet rebating water agencies and municipalities were requiring subsidized toilet models to meet both the MaP and L.A. SPS requirements.

The Los Angeles SPS was developed and introduced in 2000 as a means through which Los Angeles and other water utilities could assure themselves that gravity-fed toilet fixtures had only limited adjustability when it came to the trim parts within the tank. As such, the SPS provided for a maximum allowable flush volume of 2.0 gallons when the flapper was replaced with a "standard" or buoyant flapper designed for a 3.5 gallon fixture, and all other parts within the tank were set to their maximum levels with respect to flush volume. The SPS also mandates a flapper that withstands immersion in a concentrated chlorine solution for a prescribed period of time. Recently, the SPS was amended to require only pilot-type fill valves, thus prohibiting typical pressure-sensitive (creeping) ballcock-type valves.

It quickly became clear that it made more sense to have all of the requisite criteria contained in a single document and, at the request of both water agencies and manufacturers, the Uniform North American Requirement (UNAR) for toilet fixtures was developed. UNAR incorporates the criteria of both the MaP testing and the SPS, i.e., a UNAR toilet would provide both a high level of flushing performance *and* sustained water savings for the life of the fixture. UNAR, however, would not publish specific test scores. Because the criteria for passing UNAR were deemed to be sufficiently rigorous to identify high quality toilet fixtures, it was decided that providing test scores was unnecessary.

During the development of UNAR, a somewhat significant parallel event occurred—the U.S. Environmental Protection Agency (EPA) began developing a water efficient product labeling program similar to the highly successful Energy Star™ program for energy. Initially, toilets were not going to be included in the program because of the high level of controversy surrounding them. But with the groundwork already completed for UNAR, and the support that UNAR was garnering from both water agencies and manufacturers, it became apparent that toilets, which offer perhaps the greatest potential for indoor water savings, would be a prime candidate for the EPA program. What's more, the EPA not only intended to include toilets in their program, but they intended to kick off the start of their program with toilets as the headliner (along with efficient landscape irrigation).

Even though the EPA was adopting the fundamental criteria of UNAR, their program would be a new "stand alone" program, and there was, therefore, an opportunity to make modifications to the criteria.

The first change was to include or label only High-Efficiency Toilets (HETs)—toilets with effective flush volumes of no more than 1.28 gallons,[5] i.e., toilet models that flush with only 80% or less than the current maximum of 1.6 gallons. The term "effective flush volume" can be defined two ways depending on the type of toilet under consideration.

- Single Flush Toilet—model must flush with no more than 1.28 gallons when properly adjusted.
- Dual-Flush Toilet—the average volume of three flushes consisting of two short or reduced flushes and one full flush, e.g., a dual flush toilet with a full flush of 1.6 gallons and a reduced flush volume of 1.1 gallons would have an effective flush volume of $(2 \times 1.1 + 1.6) \div 3 = 1.27$ gallons.

When MaP testing was first initiated in 2003, approximately half of the toilet models tested failed to pass the 250 g minimum performance threshold. Today, many models exceed 1,000 g in performance! The EPA decided that if they were to support a toilet initiative their labeled models should flush with less water than the typical 1.6-gallon model and meet a greater minimum performance level than that identified by the MaP testing protocol. As such, only HETs (1.28 gallon flush volume or less) that score at least 350 g (vs. 250 g in MaP testing) are recognized in the program, i.e., EPA labeled toilet models offer superior flushing performance and superior and sustained water savings.

With the EPA setting the minimum benchmark performance level at 350 g, there is now some discussion that, for the sake of harmonization, the UNAR performance level be increased from 250 g to 350 g. The outcome of this discussion has not yet been finalized.

From the humble beginnings of trying to find a way to distinguish toilets that work well from those that do not, a large national program is being founded that will almost certainly affect the marketplace and raise the bar on toilet performance and water savings, possibly even affecting certification criteria.

At the end of the day, significant improvements have been made regarding toilet flushing performance and sustained water savings. In the mid- to late-1990s the intent of the EPAct for toilet legislation was not met—manufacturers produced toilets that could easily be adjusted to flush with more than 1.6 gallons of water, and certification requirements were set so low that there was no guarantee that passing models would meet customer expectations for performance.

Improvements were made to overall toilet performance between 1996 and 2002, and many new and better models were introduced to the marketplace. The most significant advancements in toilet performance, however, came hard on the heels of the initial MaP testing program. Once a meaningful methodology was developed to distinguish between poor performers and top performers, it was easier for manufacturers to design toilet models to meet the higher requirements.

By offering rebates or subsidies towards the purchase and installation of only high-performing water-efficient toilet models, the water utilities have some influence over product development. The utilities demanded better products and, because they were providing some level of funding, they got them. Would these better products have been developed without the financial incentives offered by water agencies? We can't know for sure. The EPAct provided legislation (the "stick" approach) to achieve its water savings goals, and this didn't work too well. The water utilities provided financial incentives (the "carrot" approach) to achieve the same goals and this seemed to work much better.

There is a lesson to learn here. The necessary homework must be done to ensure that we are not subsidizing or mandating the use of inferior products, and that the consumer is not paying the ultimate price for poor performance. We must operate more efficiently, but we shouldn't have to sacrifice our standard of comfort unless there are dire circumstances (e.g., droughts and other emergencies).

Now that we have successfully tackled toilets, who knows what is next?

Although we make it a habit of never recommending specific toilet models, we do have some suggestions for consumers to consider when purchasing a toilet:

1. Gravity-flushing models fitted with 3-inch flappers (or flush valves) tend to out-perform models with the more traditional 2-inch flappers.
2. Pressure-assisted models tend to offer a high level of flushing performance and sustained water savings, though they are also typically a little louder and more expensive.
3. Performance and price do not go hand-in-hand—some inexpensive models perform very well.
4. Rely on MaP test results for performance vs. less direct claims (e.g., "model can flush 30 golf balls," "model has fully glazed trapway," etc.) which are usually little more than marketing gimmicks.
5. Consider specific models rather than specific manufacturers (many manufacturers offer both high-performing and low-performing models).

For readers interested in purchasing a new toilet, the most recent MaP report can be found at: http://www.cuwcc.org/MaPTesting.lasso (follow link to CURRENT FULL MaP™ TESTING REPORT), or www.veritec.ca (click on reports, then click on most recent MaP report).

NOTES

1. Includes 20 small floating sponges plus eight crumpled paper balls.
2. The other performance test involves flushing small floating plastic granules and 1/4-in. sinking plastic balls (about 45 grams total weight)—but even on these tests 100 percent removal is not required.
3. http://www.cuwcc.org/Uploads/product/NAHB-ToiletReport.pdf.
4. J. B. Wyman, K. W. Heaton, A. P. Manning, and A. C. B. Wicks of the University Department of Medicine, Bristol Royal Infirmary, "Variability of colonic function in healthy subjects" (1978).
5. Some agencies round this value off to 1.3 gallons.