WaterSense® Draft Specification for Flushometer-Valve Water Closets Supporting Statement

I. Introduction

The U.S. Environmental Protection Agency's (EPA's) WaterSense program is releasing a draft specification for flushometer-valve water closets to promote and enhance the market for water-efficient models of this product. The intent of this specification is to help purchasers identify products that meet EPA's criteria for water efficiency and performance.

This draft specification addresses flushometer-valve water closets, including fixtures that receive liquid and solid waste and use water to convey waste through a trap seal into a gravity drainage system, as well as flushometer valves that deliver water to water closet fixtures via a pressurized water supply line.

Retrofit devices, including flushometer-valve handles or other aftermarket retrofit systems, are not covered by this specification.

II. Current Status of Flushometer-Valve Water Closets

There are approximately 27 million flushometer-valve water closets currently in use in the United States, and about 500,000 new flushometer-valve water closets are sold for installation in new buildings or for replacement of aging fixtures each year. The Energy Policy Act of 1992 (EPAct 1992) established a maximum flush volume of 1.6 gallons per flush (gpf) (6.0 liters per flush [Lpf]) for all water closets sold in the United States after January 1, 1997. These requirements are codified in the Code of Federal Regulations (CFR) at 10 CFR Part 430 (specifically §430.32[1] Water Closets). Of the existing flushometer-valve water closets, approximately 28 percent (7.6 million) have flush volumes exceeding the current federal standards; some have flush volumes as high as 3.0 to 7.0 gallons.[1]

Since the federal standards were enacted, manufacturers have developed flushometer-valve water closets that use less water than the standard 1.6-gpf fixtures. These high-efficiency models function at 1.28 gpf (4.8 Lpf) or less, saving at least 0.32 gpf compared to standard 1.6-gpf fixtures—approximately 780 gallons of water per flushometer-valve water closet each year. Replacing a pre-1997 3.5-gpf model with a new high-efficiency flushometer-valve water closet saves nearly 5,400 gallons of water annually. Replacing all inefficient, non-EPAct-compliant flushometer-valve water closets with high-efficiency models could save 41 billion gallons of water nationally each year.

WaterSense is confident in moving forward with a draft specification for flushometer-valve water closets for many reasons. The design of flushometer-valve water closets has improved significantly since the 1990s. Even when various bowls and valves are combined, the performance of many flushometer-valve water closet combinations meets, and often exceeds, the performance of residential water closets. Approximately 250 high-efficiency flushometer-

[1] D&R International, et al. September 30, 2005. *Plumbing Fixtures Market Overview: Water Savings Potential for Residential and Commercial Toilets and Urinals*.

valve water closet combinations have been tested to Maximum Performance (MaP) testing requirements, which assess advanced performance of plumbing fixtures.[2] In addition, a drainline carry study completed in 2012 by the Plumbing Efficiency Research Coalition (PERC), a collaborative network of six plumbing stakeholders,[3] indicates that drainline blockages are not of significant concern at 1.28-gpf,[4] a potential issue that was previously raised by WaterSense stakeholders.

WaterSense product research has shown that at least seven manufacturers offer high-efficiency flushometer valves and at least 17 offer high-efficiency water closet fixtures.[5]

III. WaterSense Specification for Flushometer-Valve Water Closets

Scope

WaterSense has developed this specification to address criteria for improving and promoting water-efficient, high-performing flushometer-valve water closets. Flushometer-valve water closets are a combination of a flushometer valve and a water closet fixture. The American Society of Mechanical Engineers (ASME) defines a water closet fixture (i.e., bowl) as "a device that receives water, waste matter, or both and directs these substances to the drainage system."[6] The American Society of Sanitary Engineers (ASSE) defines a flushometer valve as "a valve attached to a pressurized water supply pipe and so designed that when actuated, it opens the line for direct flow into the fixture at a rate and quantity to properly operate the fixture, and then gradually closes in order to avoid water hammer."[7] Because the flushometer valve and the water closet fixture both play an integral role in ensuring the efficiency and effectiveness of the water closet, this draft specification addresses both the flushometer valve and water closet fixture. It should be noted that neither the receiving water closet fixture nor the flushometer valve separately constitutes a complete, fully functioning water closet.

Flushometer-valve water closets are typically employed in commercial and public-use settings, including schools, dormitories, airports, bus and train terminals, stadiums and arenas, restaurants, office buildings, industrial facilities, shopping centers and malls, and other types of public restrooms. They are occasionally used in residential applications. The majority of these flushometer valves have single-flush capabilities—with one constant flush volume—though an increasing number of dual-flush flushometer valves are coming to market. Dual-flush water closets have two flush volumes—a full flush for solids and a reduced flush for liquids only.

[2] Gauley Associates, Ltd. and Koeller Co. "Maximum Performance (MaP)® of Toilet Fixtures: High Efficiency Flushometer Valve/Bowl Combinations." www.dev.map-testing.com/assets/files/2014-04-02-all_flushometer_hets.pdf.
[3] The six stakeholder groups that comprise PERC include the Alliance for Water Efficiency (AWE), International Association of Plumbing and Mechanical Officials (IAPMO), International Code Council (ICC), Plumbing-Heating-Cooling Contractors (PHCC) Association, American Society of Plumbing Engineers (ASPE), and Plumbing Manufacturers International (PMI).
[4] PERC. November 2012. *The Drainline Transport of Solid Waste in Buildings*. www.plumbingefficiencyresearchcoalition.org/wp-content/uploads/2012/12/Drainline-Transport-Study-PhaseOne.pdf.
[5] Gauley Associates, Ltd. and Koeller Co., *op. cit.*
[6] American Society of Mechanical Engineers (ASME)/Canadian Standards Association (CSA). *ASME A112.19.2-2013/CSA B45.1-13 Ceramic Plumbing Fixtures.*
[7] American Society of Sanitary Engineers (ASSE). *ASSE 1037-1990 Performance Requirements for Pressurized Flushing Devices (Flushometer) for Plumbing Fixtures.*

Tank-type water closets are excluded from this specification, as they are currently labeled under the *WaterSense Specification for Tank-Type Toilets*. Tank-type water closets are specified separately because of their differing design, patterns of use, and performance expectations.

Retrofit devices or other aftermarket retrofit systems, including flushometer-valve handles, are also excluded because the intent of the specification is to recognize and label complete, fully functioning fixtures or flushometer valves, not individual components.

Water Efficiency Criteria

To comply with the WaterSense water efficiency requirements, the manufacturer must specify a rated flush volume of the flushometer valve or water closet fixture. This rated flush volume must be equal to or less than 1.28 gpf (4.8 Lpf). The water consumption, tested in accordance with *ASME A112.19.2/Canadian Standards Association (CSA) B45.1 Ceramic Plumbing Fixtures*, *ASME A112.19.3/CSA B45.4 Stainless Steel Plumbing Fixtures*, or *International Association of Plumbing and Mechanical Officials (IAPMO)/American National Standards Institute (ANSI) Z124.4 Plastic Plumbing Fixtures* as applicable and evaluated in accordance with 10 CFR Part 429.30, must not exceed the manufacturer's rated flush volume, which in turn cannot exceed 1.28 gpf.

EPA is proposing a maximum allowable flush volume of 1.28 gpf because this value represents a 20 percent reduction from the current federally allowable maximum flush volume of 1.6 gpf established by EPAct 1992 and is consistent with WaterSense's goal of increasing product water efficiency by at least 20 percent. In addition, WaterSense structured the specification requirements such that the tested flush rate cannot exceed the manufacturer's rated flush rate, to ensure that flushometer-valve water closets do not deliver more water per flush than is advertised, particularly if the advertised flush volume is less than 1.28 gpf.

After considering comments received on the *WaterSense Notice of Intent (NOI) to Develop a Draft Specification for Flushometer Valve Toilets*, WaterSense has also decided to move forward with requiring the full-flush mode of flushometer valves with dual-flush capabilities to meet the maximum allowable flush volume of 1.28 gpf (4.8 Lpf). Though this approach is different from the *WaterSense Specification for Tank-Type Toilets*, in which the effective flush volume (i.e., the average of one full and two reduced flushes) must not exceed 1.28 gpf, WaterSense has determined that focusing on the full-flush volume is appropriate for flushometer valve toilets for several reasons. First, water savings are largely based on user behavior and can be influenced by lack of user education, as well as design considerations (e.g., whether the reduced-flush mode requires the user to pull up or push down on the handle). To date, water savings from dual-flush flushometer-valve toilets has not been fully researched or documented. In a recent study performed at the University of Missouri, one dual-flush flushometer model only yielded a water savings of 12.1 percent, even after additional education materials were posted within the stall.[8] Establishing a 1.28-gpf full-flush maximum ensures a water savings of at least 20 percent from the current 1.6-gpf maximum regardless of how the fixture is operated, which is consistent with WaterSense's goals. Second, water savings from dual-flush flushometer-valve toilets are primarily limited to female restrooms or other restrooms excluding urinals, as males

[8] Arocha, Jade S. and Laura M. J. McCann. *Behavioral Economics and the Design of a Dual-Flush Toilet*. University of Missouri Department of Applied Agricultural Economics. October 15, 2012.

typically utilize urinals for liquid waste in commercial restrooms. This further limits potential water savings in most facilities. Third, WaterSense intends to impact the market for dual-flush water closets in commercial applications by recognizing those models that are more efficient. It should be noted, however, that with this water efficiency requirement for dual-flush flushometer-valve toilets, WaterSense is not dictating a maximum or minimum flush volume for the reduced flush as long as it does not exceed the 1.28-gpf maximum established in this specification.

General Water Closet Fixture Requirements

The specification requires conformance with the existing, applicable water closet fixture standards, including *ASME A112.19.2/CSA B45.1*, *ASME A112.19.3/CSA B45.4*, and *IAPMO/ANSI Z124.4*, with the exceptions stated below.

First, water closet fixtures must be tested with representative flushometer valves from three different manufacturers that have the same rated flush volume and meet the water efficiency and performance requirements for flushometer valves as outlined in the specification. Currently, *ASME A112.19.2/CSA B45.1* only requires water closet fixtures to be tested with one flushometer valve. Because of the prevalence of mixing and matching water closet fixtures and flushometer valves from different manufacturers in commercial applications, WaterSense intends that testing with three representative flushometer valves from different manufacturers will better ensure consistent performance and water efficiency across various combinations of WaterSense labeled flushometer valves and water closet fixtures. This approach is also consistent with the testing requirements for flushometer valves established under *ASSE 1037 Pressurized Flushing Devices (Flushometers) for Plumbing Fixtures* and the soon-to-be tri-harmonized standard for flushometer valves, *ASSE 1037/ASME 112.1037/CSA B125.37*.

Second, the specification also states that any fixture marked with a dual-consumption or consumption range marking must conform to the applicable requirements in *ASME A112.19.2/CSA B45.1* and the additional performance criteria identified in the specification when tested at the lowest flush volume to be marked on the water closet fixture. As discussed later in the supporting statement, the additional performance criteria requires the inclusion of a seat cover in the waste extraction test protocol. This requirement ensures that the fixture is able to perform at all flush volumes marked on the fixture.

General Flushometer Valve Requirements

Currently, flushometer valves used on water closet fixtures are subject to *ASSE 1037*. ASSE, in coordination with ASME and CSA, is in the process of revising this standard and establishing a tri-harmonized standard for flushometer valves, *ASSE 1037/ASME 112.1037/CSA B125.37*. WaterSense intends to require flushometer valves to conform to *ASSE 1037/ASME 112.1037/CSA B125.37* upon the standard's release.

In addition to complying with the *ASSE 1037/ASME 112.1037/CSA B125.37*, WaterSense has established three additional requirements for flushometer valves:

- The flushometer valve's primary actuator must be a non-hold-open design.

- The flushometer valve must not be adjustable as to its rated flush volume beyond a specified tolerance of 10 percent (i.e., ± 0.13 gpf [0.48 Lpf] for a 1.28-gpf flushometer valve).

- The flushometer valve must be designed such that replaceable or maintainable parts are not intended to be interchangeable with parts that would cause the flushometer valve to exceed its rated flush volume.

The non-hold-open requirement is intended to eliminate the ability to increase the volume of water released to the water closet fixture by holding the actuator open.

The adjustability requirement is intended to limit the degree of flush volume adjustment once a flushometer valve toilet is installed in the field. The proposed 10 percent tolerance in the draft specification is intended to balance the desire to maintain water consumption and ensure long-term water savings with the need to adjust the flush volume to facilitate maintenance; account for site-specific differences in water pressures; and fine-tune different flushometer valve and fixture combinations to achieve maximum performance. The 10 percent tolerance was chosen to be consistent with the allowable variance established under the life cycle test criteria within the upcoming *ASSE 1037/ASME 112.1037/CSA B125.37* standard.

WaterSense is also requiring that the flushometer valve be designed such that replaceable or maintainable parts are not interchangeable with parts that would cause the flushometer valve to exceed its rated flush volume. This requirement, to the extent it can be controlled through this specification, is designed to help prevent the intentional or unintentional change from the product's rated flush volume to a higher flush volume. This could not only reduce water savings, but it could also impact the product's performance as the flushometer valve and water closet fixture are no longer matched to perform with the same flush volume. Under the specification, the manufacturer must attest to the applicable certifying body that its products comply with this specific requirement rather than relying on the licensed certifying body to verify that the product meets this requirement. Manufacturer attestation shifts responsibility for ensuring compliance with this design intent to the manufacturer.

Many flushometer valves on the market today already incorporate features that meet these requirements and should therefore not encounter technical difficulties in complying with the specification. WaterSense has determined that all three of these requirements are essential for preserving the long-term efficiency and performance of WaterSense labeled flushometer-valve water closets.

Flush Performance Criteria

The draft specification requires flush performance of a single-flush flushometer valve or the full-flush mode of a dual-flush flushometer valve to be tested in accordance with the waste extraction test protocol provided in *ASME A112.19.2/CSA B45.1*, with one primary exception.

Because flushometer-valve water closets are typically used in commercial and public-use settings, they frequently must flush more difficult waste loads than would normally be found in residential settings. To address this concern, WaterSense evaluated the addition of various

types of test media beyond what is specified in the current *ASME A112.19.2/CSA B45.1*, including additional toilet paper, seat covers, paper towels, feminine products, and flushable wipes, either alone or in some combination. WaterSense also considered public comments submitted on this issue from the NOI, both in favor of and against the use of additional test media. Ultimately, WaterSense determined that the use and disposal of a single water closet seat cover is a likely occurrence for water closets in commercial restrooms, and represented some additional level of assurance for flushometer-valve toilet performance. WaterSense also determined that a seat cover could be added in a repeatable and reproducible manner such that testing could be done consistently among laboratories. Therefore, this specification includes an unwaxed paper water closet seat cover in the list of test media that shall be used during the waste extraction test of *ASME A112.19.2/CSA B45.1*. Application of the unwaxed water closet seat cover shall occur immediately following step "g" (the addition of toilet paper) of the waste extraction test procedure in Section 7.10.3 of *ASME A112.19.2/CSA B45.1*. The seat cover specifications were determined based a product survey conducted by WaterSense.

The draft specification also requires flush performance of the reduced-flush mode of a dual-flush flushometer valve to be tested in accordance with the flush performance test protocol provided in *ASME A112.19.14,* with a similar exception as described above for the full-flush mode. WaterSense determined that the use and disposal of a single water closet seat cover is also likely for the reduced-flush mode of a dual-flush water closet in commercial restrooms. Accordingly, the specification requires the inclusion of an unwaxed paper water closet seat cover as part of the test media used during the reduced flush performance test of *ASME A112.19.14*. Application of the unwaxed water closet seat cover shall occur immediately following the addition of the toilet paper under Section 3.2.4.2 of *ASME A112.19.14.*

Product Marking

Fixture Marking

The draft specification requires fixtures to be marked in accordance with *ASME A112.19.2/CSA B45.1*, with two exceptions. The standard currently states that when a bowl is tested with tanks or valves with lower consumption levels, the manufacturer has the option of including the words "or less," a dual-consumption marking, or a consumption range to indicate compatibility with flushometer valves of varying consumption levels.

First, WaterSense is requiring that water closet fixtures intended to be used with flushometer valves of varying flush volumes be marked to indicate the range of compatible flush volumes (i.e., the requirement is not optional as it is in the standard). For example, if a water closet fixture is compatible with 1.1-gpf, 1.28-gpf, and 1.6-gpf flushometer valves, the fixture can be marked as either "1.1 gpf to 1.6 gpf" or "1.1, 1.28, and 1.6 gpf." As long as the fixture has been tested to meet the specification requirements, and the rated flush volume (e.g., 1.28 gpf) falls somewhere within the range of flush volumes marked on the product, the fixture can obtain the WaterSense label. Requiring marking in this manner recognizes that many water closet fixtures can perform across a range of flush volumes and allows for continued manufacturing flexibility. It also conveys the specific range of flush volumes for which the water closet fixture is compatible in terms of performance and helps purchasers and specifiers more easily match WaterSense labeled flushometer valves and water closet fixtures.

Second, WaterSense is explicitly prohibiting the use of the words "or less" as a marking option. Placing a marking on the bowl that identifies a maximum flush volume along with the words "or less" could imply that the water closet fixture is compatible with flushometer valves of any flush volume, potentially below the minimum flush volumes with which the fixture was certified to perform.

Flushometer Valve Marking

As currently drafted, *ASSE 1037/ASME 112.1037/CSA B125.37* will require flushometer valves to be marked with the rated flush volume. WaterSense intends to require flushometer valves to conform to the marking requirements within *ASSE 1037/ASME 112.1037/CSA B125.37*, upon its release.

The specification also contains two additional marking requirements designed to ensure the long-term water savings of flushometer valve water closets once installed in the field. First, the specification prohibits manufacturers from marking, packaging, or providing instructions directing the user to an alternative flush volume setting that would override the rated flush volume of the flushometer valve. Second, product documentation must clearly identify the specific maintenance/replacement part instructions and identification of correct replacement parts that should be used to ensure that the flushometer valve will not exceed its original rated flush volume. Under no circumstances can manufacturers provide maintenance instructions or advertise the use of any replacement parts that would cause the flushometer valve to exceed its rated flush volume.

IV. Potential Savings and Cost-Effectiveness

Note: Refer to Appendix A for the assumptions and calculations used to derive these estimates.

Potential Water Savings

Flushometer-valve water closets with a flush volume of 1.28 gpf or less have the potential to save significant amounts of water. On average, replacing a single 3.5-gpf water closet with a WaterSense labeled 1.28-gpf model could save more than 5,400 gallons of water per year. In restrooms with higher daily usage, such as at airports, dormitories, stadiums, supermarkets, and restaurants, water savings could be significantly higher.

If all 7.6 million old, inefficient 3.5 gpf flushometer-valve water closets nationwide were replaced with WaterSense labeled models, more than 41 billion gallons could be saved annually. It is important to note that an undetermined number of the existing inefficient flushometer-valve water closets have flush volumes significantly higher than 3.5 gpf. Since the exact breakdown of all existing flushometer-valve water closets is unknown, WaterSense is assuming a 3.5-gpf flush volume as a conservative estimate. The actual water savings potential could be much higher. Furthermore, replacing all existing 1.6-gpf flushometer-valve water closets with WaterSense labeled models could save nearly 14 billion additional gallons annually.

Installing WaterSense labeled flushometer-valve water closets instead of standard, EPAct-compliant, 1.6 gpf models in new construction, major renovations, and natural replacement projects also could yield significant nationwide water savings. If all 500,000 flushometer-valve

water closets installed annually were WaterSense labeled, more than 390 million gallons of water could be saved per year compared to standard, EPAct-compliant models.

Cost-Effectiveness

Flushometer-valve water closets are relatively expensive when compared to other restroom plumbing fixtures, with the combination of the flushometer valve and water closet fixture cost averaging about $700 based on WaterSense product research. However, there is little to no price difference between high-efficiency fixtures and flushometer valves and their standard EPAct-compliant counterparts. In fact, some water closet fixtures are marketed to be compatible with both standard 1.6-gpf flushometer valves and high-efficiency 1.28-gpf flushometer valves. Similarly, many models of the flushometer valves are available in 1.28 gpf or 1.6 gpf version for the same price. Because there is no cost difference between the standard and high-efficiency models, installing high-efficiency flushometer-valve water closets in new construction or as part of the normal replacement process is cost-effective with immediate payback and realized water and sewer cost savings. Replacing one 3.5-gpf flushometer-valve water closet with a 1.28-gpf WaterSense labeled flushometer-valve water closet will save more than $1,000 over the useful life of the flushometer-valve water closet.

V. Certification and Labeling

WaterSense has established an independent, third-party product certification process, described on the WaterSense website at www.epa.gov/watersense/partners/certification.html. Under this process, products are certified to conform to applicable WaterSense specifications by accredited licensed certifying bodies. Manufacturers are authorized by licensed certifying bodies to use the WaterSense label in conjunction with labeled products.

With flushometer-valve water closets, it is not uncommon for a company to manufacture only the water closet fixture and to require the use of another company's flushometer valve. Correspondingly, there are some manufacturers that only make flushometer valves that can be used with other manufacturers' water closet fixtures.

Under this specification, WaterSense is allowing each water closet fixture and flushometer valve to be labeled as either a complete system or independently as a water closet fixture or flushometer valve. For products labeled separately, WaterSense will require manufacturers to clearly indicate on product documentation that the fixture or flushometer valve should be used with a WaterSense labeled counterpart with a compatible flush volume to ensure that the entire system meets the requirements of this specification for water efficiency and performance. This approach is the common industry practice and ensures that WaterSense is not significantly increasing the burden associated with the certification of high-efficiency flushometer-valve water closets. It also enables purchasers to easily identify and match labeled components with the same rated flush volumes.

Appendix A: Calculations and Key Assumptions

Potential Water Savings Calculations

Assumptions:

- All pre-EPAct water closets have a 3.5-gpf flush volume, and a WaterSense labeled flushometer-valve water closet has a 1.28-gpf flush volume. This provides a conservative water savings estimate, as it does not account for potential additional water savings from installation of WaterSense labeled flushometer-valve water closets that have a flush volume less than 1.28-gpf or that have a dual-flush function.

- Fifty-five percent of the estimated 48.5 million commercial water closets installed in the United States are flushometer-valve water closets.[9,10]

- Approximately 28 percent of the 26.7 million flushometer valve water closets (7.6 million flushometer valve water closets) are pre-EPAct models flushing at 3.5 gpf or greater, and 72 percent (19.2 million flushometer valve water closets) are EPAct-compliant models flushing at 1.6 gpf or less.[11,12] Of the EPAct-compliant models, WaterSense research suggests approximately 7 percent (1.3 million flushometer valve water closets) are estimated to have flush volumes of 1.28 gpf.

- An average of approximately 500,000 new flushometer-valve water closets are installed per year through new construction, major renovation, and natural replacement.[13,14]

- Within the employment, K-12 educational, college undergraduate and graduate, and military sectors, it is assumed that the female population flushes a commercial water closet three times per person per day, whereas the male population flushes a commercial water closet once per person per day.[15]

- There are approximately 65.1 billion flushometer-valve water closet flushes that occur annually.[16]

[9] Based on data presented in D&R International, *op. cit.*
[10] Whitehead, C. D., et al. Lawrence Berkeley National Laboratory. 2009. *Review of Literature for Inputs to the National Water Savings Model and Spreadsheet Tool—Commercial/Institutional*.
[11] D&R International, *op. cit.*
[12] Whitehead, C. D., *op. cit.*,
[13] Based on presented in D&R International, *op. cit.*
[14] Whitehead, C. D., *op. cit.*,
[15] Amy Vickers. Handbook of Water Use and Conservation. WaterPlow Press, 2001.
[16] This estimate was developed by assessing the estimated water closet use in the commercial sector annually. WaterSense analyzed statistics from the U.S. Census Bureau, U.S. Department of Education, and U.S. Department of Labor to develop an estimate for annual commercial water closet use, which include use from employed civilians, K-12 students, military personnel, as well as guests at restaurants, retail stores, and hospitals. Based on this analysis, approximately 118 billion flushes occur annually in the commercial sector, a conservative estimate because flushes occurring within high-volume restrooms, such as public restrooms, airports, stadiums, and colleges and universities, were unaccounted for. Because only 55 percent of commercial water closets are flushometer-valve water closets, approximately 65.1 billion flushometer-valve water closet flushes occur annually.

Equation 1. Average Annual Flushes per Flushometer-Valve Water Closet (FVWC)
(65.1 billion flushes/year) ÷ (26.7 million FVWCs) = 2,440 flushes/FVWC/year

Equation 2. Annual Individual Water Savings From Replacing a 3.5 gpf FVWC with a WaterSense Labeled Model
(2,440 flushes/year) x (2.22 gallons saved/flush) = 5,400 gallons/year

Equation 3. Annual National Water Savings From Replacing All 3.5 gpf FVWCs with WaterSense Labeled Models
(7.6 million Pre-EPAct FVWCs) x (5,418 gallons/year/ Pre-EPAct FVWC) = 41 billion gallons/year

Equation 4. Annual Individual Water Savings From Replacing a 1.6 gpf FVWC with a WaterSense Labeled Model
(2,440 flushes/year) x (0.32 gallons saved/flush) = 780 gallons/year

Equation 5. Annual National Water Savings From Replacing All 1.6 gpf FVWCs with WaterSense Labeled Models
(17.9 million 1.6 gpf FVWCs) x (780 gallons/year/1.6 gpf FVWC) = 14 billion gallons/year

Equation 6. Annual National Water Savings Potential From Installation of WaterSense Labeled FVWCs in New Applications
(500,000 new FVWCs) x (2,440 flushes/FVWC/year) x (0.32 gallons saved/flush) = 390 million gallons/year

Cost-Effectiveness Calculations

Assumptions:

- Useful life of the flushometer-valve water closet is 20 years
- Price of water supply and wastewater treatment is $9.30/1000 gallons[17]

Equation 7. Annual Water Cost Savings From Replacing a 3.5 gpf FVWC with a WaterSense Labeled Model
(5,400 gallons/year) x ($9.30/1,000 gallons) = $50

Equation 8. Estimated Lifetime Water Cost Savings From Replacing a 3.5 gpf FVWC with a WaterSense Labeled Model
$50/year x 20 years useful life = $1000

[17] Raftelis Financial Consulting, Inc. American Water Works Association. 2012. *Water and Wastewater Rate Survey*.