WaterSense® Specification for Flushometer-Valve Water Closets Supporting Statement

I. Introduction

The U.S. Environmental Protection Agency's (EPA's) WaterSense program released its specification for flushometer-valve water closets to further promote and enhance the market for water-efficient commercial restroom plumbing fixtures. The intent of this specification is to help purchasers identify products that meet EPA's criteria for water efficiency and performance.

This 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. Flushometer-valve water closets are typically employed in commercial and public-use restrooms.

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 26 percent (7 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 790 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 5,500 gallons of water annually. Replacing all inefficient, non-EPAct-compliant flushometer-valve water closets with high-efficiency models could save 39 billion gallons of water nationally each year.

EPA is labeling 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. More than 320 high-

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

efficiency flushometer-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.

Further, EPA product research has shown that at least eight 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

EPA 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) A112.19.2* and the *Canadian Standards Association (CSA) B45.1* standard define 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 specification applies to both siphonic and blowout water closet fixtures, as defined by the ASME/CSA standard. The tri-harmonized performance standard for pressurized flushing devices, prepared by the American Society of Sanitary Engineers (ASSE), ASME, and CSA, defines a flushometer valve as "a pressurized flushing device that is attached to a pressurized water supply pipe that, when actuated, opens the pipe for direct flow of water into the fixture at a rate and in a quantity that enables proper operation of the fixture. The valve then gradually closes to provide trap reseal in the fixture and 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 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

[2] Gauley Associates, Ltd. and Koeller Co. "Maximum Performance (MaP)® of Toilet Fixtures: High Efficiency Flushometer Valve/Bowl Combinations." www.map-testing.com/assets/files/2015-08-11-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)/ASME/CSA. *ASSE 1037-2015/ASME A112.1037-2015/CSA B125.37-15 Performance Requirements for Pressurized Flushing Devices for Plumbing Fixtures.*

closets have two flush volumes—a full flush for solids and a reduced flush for liquids only. EPA recognizes the opportunity to promote and enhance the market for water-efficient single- and dual-flush flushometer-valve water closets. Therefore, the specification establishes efficiency and performance criteria for both types of flushometer valves.

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, use patterns, and performance expectations.

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

Water Efficiency Criteria

To comply with EPA's water efficiency requirements, the manufacturer must specify a rated flush volume of the flushometer valve or water closet fixture. For flushometer valves with dual-flush capabilities, the manufacturer must specify the rated flush volume of the both the full-flush and reduced-flush modes. The(se) rated flush volume(s) must not exceed 1.28 gpf (4.8 Lpf). The water consumption, tested in accordance with *ASME A112.19.2/CSA B45.1 Ceramic Plumbing Fixtures*, *ASME A112.19.3/CSA B45.4 Stainless Steel Plumbing Fixtures*, or *CSA B45.5/International Association of Plumbing and Mechanical Officials (IAPMO) Z124 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. In addition, the rated flush volume must also not be less than 1.0 gpf (3.8 Lpf).

Under this specification, EPA is establishing 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, EPA structured the specification requirements such that the tested flush volume cannot exceed the manufacturer's rated flush volume, 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* and the *WaterSense Draft Specification for Flushometer-Valve Water Closets*, EPA 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). 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. However, EPA has determined that this approach for flushometer-valve water closets is appropriate for several reasons.

First, the U.S. Department of Energy (DOE) proposed a test method to account for the reduced average water use of a dual-flush water closet in a 2012 Notice of Proposed Rulemaking (NOPR) to amend the test procedures for showerheads, faucets, water closets, urinals, and pre-rinse spray valves. The test method would have allowed manufacturers to calculate the average

representative water use (i.e., the effective flush volume) using the composite average of two reduced flushes and one full flush. Commenters argued against the test method stating that the weighted average approach was unproven and that the particular ratio required further evaluation to confirm its representativeness. As a result of these and other comments, DOE ruled in 2013 that there was not sufficient evidence to base a test procedure for the average representative water use for dual-flush water closets.[8] In declining to adopt such a test procedure, manufacturers, distributors, retailers, and private labelers are not permitted to make any representations of water use that reflects an average of the full- and reduced-flush modes for dual-flush water closets. Essentially, DOE is prohibiting the use of an effective flush volume to market dual-flush water closets.

Second, in commercial restrooms, water savings from the use of dual-flush flushometer-valve water closets 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 water closets 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 educational materials were posted within the stall.[9] EPA reviewed two additional studies mentioned in public comments on the *WaterSense Draft Specification for Flushometer-Valve Water Closets: Flush: Examining the Efficacy of Water Conservation in Dual-Flush Toilets* and *Dual-flush Toilet Project*. These studies found full- to reduced-flush volume ratios of 1.6 to 1 and 1.7 to 1, respectively, for dual-flush flushometer-valve water closets in commercial restrooms.[10,11] Neither of these ratios are sufficient to achieve 20 percent savings that is consistent with WaterSense's goal.

Establishing a 1.28-gpf full-flush maximum for all operating modes of WaterSense labeled flushometer-valve water closets ensures a water savings of at least 20 percent from the current 1.6-gpf maximum regardless of how the fixture is operated. It also eliminates the need for an effective flush volume calculation, which is consistent with DOE's determination related to dual-flush water closets.

Third, water savings from dual-flush flushometer-valve water closets are primarily limited to female restrooms or other restrooms excluding urinals, as males typically use urinals for liquid waste in commercial restrooms. By instituting a 1.28-gpf full-flush maximum, EPA assures savings from all installations in both women's and men's restrooms. EPA intends to impact the market for dual-flush water closets in commercial applications by recognizing those models that are more efficient than conventional products available. It should be noted, however, that with this water efficiency requirement for dual-flush flushometer-valve water closets, EPA is not dictating a maximum flush volume for the reduced flush as long as it does not exceed the 1.28-gpf maximum established in this specification.

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[8] U.S. Department of Energy. Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Test Procedures for Showerheads, Faucets, Water Closets, Urinals, and Commercial Prerinse Sray Valves. Docket No. EERE-2011-BT-TP-0061. Federal Register, Volume 78, No. 205. October 23, 2013. www.gpo.gov/fdsys/pkg/FR-2013-10-23/pdf/2013-24347.pdf

[9] 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.

[10] Harrison, Masaye. *Flush: Examining the Efficacy of Water Conservation in Dual Flush Toilets.* University of Oregon Department of Architecture. 2010.

[11] Veritec Consulting Inc. *Dual-Flush Toilet Project.* Prepared for the Canada Mortgage and Housing Corporation. April 2002.

With the final *WaterSense Specification for Flushometer-Valve Water Closets,* EPA is also instituting a minimum flush volume of 1.0 gpf (3.8 Lpf), which is applicable to all modes of a flushometer-valve water closet, including the reduced flush of a dual-flush flushometer-valve water closet. This minimum is based on information presented in PERC's second phase of its study of solid waste transport in drainlines.[12] The study indicates that at 1.0 gpf and below, drainline performance becomes chaotic and can result in drainline blockages or performance issues.

While the PERC Phase 2.0 study "does not recommend the use of 1.0 gpf (or less) water closets in commercial applications that have long horizontal drains and that do not provide additional long-duration flows from other sources to assist with the drainline transport of solid waste," it goes on to say that "these models should perform well in their intended applications assuming additional long-duration flows from other water-consuming appliances, plumbing fixtures, and other devices are available to assist with the drainline transport of solid wastes." Because models with a flush volume of 1.0 gpf are tenable in some commercial building applications, EPA has determined that models flushing as low as 1.0 gpf are eligible for the WaterSense label. However, EPA emphasizes that the facility manager and/or a plumbing engineer should determine the minimum flush volume that is required for their building's plumbing system to properly function when specifying water closet fixtures and flushometer valves.

In establishing a minimum flush volume, it is not EPA's intent to limit the development of potentially successful water-efficient products. EPA has determined that at this time, a minimum flush volume is necessary to protect the WaterSense brand and address potential health and safety concerns with potential drainline blockages that were raised by commenters on the draft specification. However, because this is a potential health and safety issue, this measure is intended to be a transitional requirement until the applicable standards committees have a chance to respond to findings of the PERC Phase 2.0 study and make adjustments, as appropriate and necessary, to the relevant national standards.

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 *CSA B45.5/IAPMO Z124* when tested with a flushometer valve that has the same rated flush volume.

Further, the specification requires any fixture marked with a dual-consumption or consumption range marking (e.g., 1.1 gpf/1.6 gpf or 1.1 gpf to 1.6 gpf) to also conform to the applicable requirements in *ASME A112.19.2/CSA B45.1* and the flush performance criteria contained in the specification when tested at the lowest flush volume marked on the water closet fixture. This requirement ensures that the fixture is able to perform at all flush volumes marked on the fixture.

[12] PERC. September 2015. *The Drainline Transport of Solid Waste in Buildings—Phase 2.0*. www.plumbingefficiencyresearchcoalition.org/wp-content/uploads/2012/05/Report_PERC-2.0_FINAL_150922.pdf.

General Flushometer-Valve Requirements

The specification requires conformance with the existing, applicable standard for flushometer valves, *ASSE 1037/ASME A112.1037/CSA B125.37*.

In addition to complying with the *ASSE 1037/ASME A112.1037/CSA B125.37*, EPA has established two 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 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 water closet is installed in the field. The 10 percent tolerance in the 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 *ASSE 1037/ASME A112.1037/CSA B125.37* standard.

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. Consistent with its specification for flushing urinals, EPA has determined that these requirements are essential for preserving the long-term efficiency and performance of WaterSense labeled flushometer-valve water closets.

Flush Performance Criteria

The 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*. The 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*.

The flush performance criteria established in the referenced standards have been developed through consensus of national standards committees to provide the minimum assurance that a flushometer-valve water closet can extract typical waste loads. Further, the test protocols have been vetted and tested to ensure they are repeatable and reproducible in independent laboratories. EPA intends to further explore the addition of a seat cover to the flush performance criteria and evaluate the opportunity for eventual inclusion of a seat cover testing protocol in future revisions of this specification. EPA will work with the relevant national standards committees to develop such a protocol. EPA maintains that the use and disposal of a single water closet seat cover is a likely occurrence for water closets in commercial restrooms.

Working through the committee to establish a testing protocol will ensure it is meaningful with respect to differentiating product performance and that it is also repeatable and reproducible in independent laboratories.

Product Marking

Fixture Marking

The specification requires fixtures and associated packaging to be marked in accordance with *ASME A112.19.2/CSA B45.1*, with three exceptions, discussed below. 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, EPA 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, EPA 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.

Lastly, EPA is requiring that the minimum flush volume marked on the fixture must not be less than the minimum flush volume allowed by the specification, 1.0 gpf [3.8 Lpf]. This marking requirement provides consistency with how the product was performance tested. In addition, it ensures that the fixture will not be advertised for use with flush volumes below those that EPA has currently deemed acceptable for assuring product and plumbing system performance.

Flushometer-Valve Marking

The specification requires flushometer valves and associated packaging to be marked in accordance with *ASSE 1037/ASME A112.1037/CSA B125.37*. The specification also clarifies that, for flushometer valves with dual-flush capabilities, the flushometer valve and associated packaging shall be marked with the rated flush volume for both the full-flush and reduced-flush modes. This ensures that information related to the flush volume of the reduced flush is also provided with the product.

Finally, the specification contains additional marking requirements designed to ensure the long-term water savings of flushometer-valve water closets once installed in the field. Product documentation shall clearly identify the specific maintenance instructions and shall identify replacement parts that should be used to ensure that the flushometer valve will not exceed its original rated flush volume. In addition, the flushometer valve, under no circumstances, can be packaged, marked, or provided with instructions directing the user to an alternative flush volume setting that would override the rated flush volume. These requirements are intended to limit, to the extent possible, product maintenance and the use of replacement parts that would result in increased water use.

IV. Cautionary Statement for Design Professionals and Facility Managers

Based on the results of the PERC studies on drainline transport, there is a direct correlation between flush volume and drainline transport distance. EPA is confident moving forward with a specification for labeling high-efficiency flushometer-valve water closets and has determined that these products, when installed, can be an effective way to reduce facility water use and maintain high performance. However, EPA is not recommending high-efficiency models, particularly models flushing below 1.28 gpf, for use in all existing commercial applications where flushometer-valve water closets are installed. Facility managers and/or plumbing engineers should use caution when deciding whether to retrofit existing water closets with high-efficiency models, first assessing the physical conditions of the existing drainlines to ensure they are suitable for this type of retrofit. Drainlines should be inspected for defects, root intrusions, sagging, or other conditions that could result in blockage with lower flush volumes. In addition, in both new construction and existing buildings, high-efficiency flushometer-valve water closets with flush volumes below 1.28 gpf should be situated downstream of additional long-duration flows from other water-consuming appliances, plumbing fixtures (e.g., lavatory faucets, flushing urinals, showerheads), and other devices that are available to assist with the drainline transport of solid wastes. For new construction, consistent with recommendations from the PERC Phase 2.0 study, before installing high-efficiency flushometer-valve water closets, particularly models that flush below 1.28 gpf, building designers should consider providing drainline slopes of greater than 1 percent. These design considerations should minimize potential for drainline problems.

Authorities (e.g., states, local municipalities, code organizations, water utilities) intending to require or offer incentives for installation of WaterSense labeled flushometer-valve water closets in building renovations or other retrofit applications, should consider offering an exemption or allowance for existing buildings where a plumbing engineer has certified that the existing drainline is not suitable for high-efficiency water closets flushing at or below 1.28 gpf.

V. 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 nearly 5,500 gallons of water per year. By replacing old, inefficient flushometer-valve water closets with WaterSense labeled models, a 10-story office building with 1,000 occupants can save nearly 1,200,000 gallons of water and more than $10,000 in water costs per year. Of those savings, nearly 870,000 gallons of water and more than $7,600 in water costs per year can be achieved by replacing the water closets in the women's restrooms alone. In restrooms with higher daily usage, such as at airports, dormitories, stadiums, supermarkets, and restaurants, water savings could be significantly higher.

If all 7 million old, inefficient 3.5 gpf flushometer-valve water closets nationwide were replaced with WaterSense labeled models, nearly 39 billion gallons of water 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, EPA 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 15 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 could also yield significant nationwide water savings. If all 500,000 flushometer-valve water closets installed annually were WaterSense labeled, 400 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 averaging about $700 based on EPA 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 nearly $1,000 over the useful life of the flushometer-valve water closet.

VI. Certification and Labeling

EPA has established an independent, third-party product certification process, described in the *WaterSense Product Certification System*. 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, EPA 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, EPA 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 EPA 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 49.4 million commercial water closets installed in the United States are flushometer-valve water closets.[13,14]

- Approximately 26 percent of the 27.1 million flushometer-valve water closets (7.0 million flushometer-valve water closets) are pre-EPAct models flushing at 3.5 gpf or greater, and 74 percent (20.1 million flushometer-valve water closets) are EPAct-compliant models flushing at 1.6 gpf or less.[15,16] Of the EPAct-compliant models, EPA research suggests approximately 7 percent (1.4 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.[17,18]

- 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.[19]

- There are approximately 67.1 billion flushometer-valve water closet flushes that occur annually.[20]

Equation 1. Average Annual Flushes per Flushometer-Valve Water Closet (FVWC)
(67.1 billion flushes/year) ÷ (27.1 million FVWCs) = 2,470 flushes/FVWC/year

[13] Based on data presented in D&R International, *op. cit.*
[14] 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*.
[15] D&R International, *op. cit.*
[16] Whitehead, C. D., *op. cit.*,
[17] Based on presented in D&R International, *op. cit.*
[18] Whitehead, C. D., *op. cit.*,
[19] Amy Vickers. Handbook of Water Use and Conservation. WaterPlow Press, 2001.
[20] This estimate was developed by assessing the estimated water closet use in the commercial sector annually. EPA 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 122 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 67.1 billion flushometer-valve water closet flushes occur annually.

Equation 2. Annual Individual Water Savings From Replacing a 3.5 gpf FVWC With a WaterSense Labeled Model
(2,470 flushes/year) x (2.22 gallons saved/flush) = 5,480 gallons/year

Equation 3. Annual National Water Savings From Replacing All 3.5 gpf FVWCs With WaterSense Labeled Models
(7.0 million Pre-EPAct FVWCs) x (5,480 gallons/year/ Pre-EPAct FVWC) = 38.6 billion gallons/year

Equation 4. Annual Individual Water Savings From Replacing a 1.6 gpf FVWC With a WaterSense Labeled Model
(2,470 flushes/year) x (0.32 gallons saved/flush) = 790 gallons/year

Equation 5. Annual National Water Savings From Replacing All 1.6 gpf FVWCs With WaterSense Labeled Models
(18.7 million 1.6 gpf FVWCs) x (790 gallons/year/1.6 gpf FVWC) = 14.8 billion gallons/year

Equation 6. Annual National Water Savings Potential From Installation of WaterSense Labeled FVWCs in New Applications
(500,000 new FVWCs) x (2,470 flushes/FVWC/year) x (0.32 gallons saved/flush) = 399 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 for commercial facilities is $8.83/1000 gallons[21]

Equation 7. Annual Water Cost Savings From Replacing a 3.5 gpf FVWC With a WaterSense Labeled Model
(5,480 gallons/year) x ($8.83/1,000 gallons) = $48

Equation 8. Estimated Lifetime Water Cost Savings From Replacing a 3.5 gpf FVWC With a WaterSense Labeled Model
$48/year x 20 years useful life = $970

[21] Raftelis Financial Consulting, Inc. American Water Works Association. 2014. *Water and Wastewater Rate Survey*.