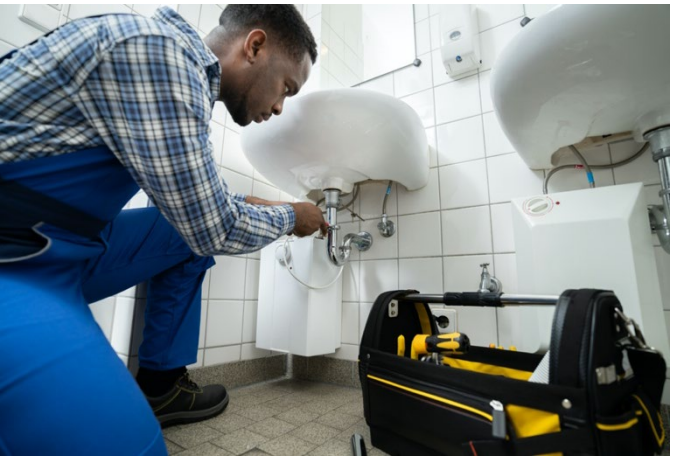

WaterSense at Work

Sanitary Fixtures and Equipment

3.1 Toilets (Water Closets)

Best Management Practices for Commercial and Institutional Facilities

EPA WaterSense

May 2023

WaterSense® is a voluntary partnership program sponsored by the U.S. Environmental Protection Agency (EPA) that seeks to protect the nation's water supply by transforming the market for water-efficient products, services, and practices.

WaterSense at Work is a compilation of water efficiency best management practices intended to help commercial and institutional facility owners and managers from multiple sectors understand and better manage their water use. It provides guidance to help establish an effective facility water management program and identify projects and practices that can reduce facility water use.

An overview of the sections in *WaterSense at Work* is below. This document, covering water efficiency for toilets, is part of **Section 3: Sanitary Fixtures and Equipment**. The complete list of best management practices is available at www.epa.gov/watersense/best-management-practices. WaterSense has also developed worksheets to assist with water management planning and case studies that highlight successful water efficiency efforts of building owners and facility managers throughout the country, available at www.epa.gov/watersense/commercial-buildings.

- **Section 1. Getting Started With Water Management**
- **Section 2. Water Use Monitoring**
- **Section 3. Sanitary Fixtures and Equipment**
- **Section 4. Commercial Kitchen Equipment**
- **Section 5. Outdoor Water Use**
- **Section 6. Mechanical Systems**
- **Section 7. Laboratory and Medical Equipment**
- **Section 8. Onsite Alternative Water Sources**

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Office of Water
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This document is one section from *WaterSense at Work: Best Management Practices for Commercial and Institutional Facilities* (EPA-832-F-23-003). Other sections can be downloaded from www.epa.gov/watersense/best-management-practices. Sections will be reviewed and periodically updated to reflect new information. The work was supported under contract 68HERC20D0026 with Eastern Research Group, Inc. (ERG).

Overview

Toilets, or water closets, can be found in nearly every commercial and institutional facility. Several types of toilet technologies are installed in commercial and institutional settings, including tank-type toilets, flushometer-valve toilets, and less commonly, composting toilets. Toilets currently on the market can perform well (i.e., adequately clear waste) while using much less water than older models installed before the Energy Policy Act (EPAct) of 1992 established maximum flush volume requirements.

Tank-type toilets are designed with tanks that store and dispense water to the toilet bowl to flush waste. Varieties of tank-type toilets include: the standard gravity type (found in most homes); pressure-assist (or flushometer-tank toilets); and electromechanical hydraulic toilets. Tank-type toilets are available as single-flush models or dual-flush models, which include a full flush for solids and a reduced flush for liquids. Tank-type toilets are commonly found in residential and light commercial settings.

Flushometer-valve toilets are tankless fixtures with either wall- or floor-mounted bowls attached to a lever- or sensor-activated flushometer valve that releases a specific volume of water at a high flow rate directly from the water supply line to the bowl to remove (i.e., flush) waste. Unlike tank-type toilets, which store water in the tank to provide the necessary head pressure and flow to remove waste from the bowl, flushometer-valve toilets rely on larger diameter water supply piping and high water supply line pressures to remove waste. These fixtures are also available as single- or dual-flush models. Flushometer-valve toilets are used predominantly in public-use facilities and high-use commercial settings. Flushometer-valve toilets include bowls that operate with a siphonic action, common to most commercial restrooms, as well as blowout and rear discharge bowls that are commonly found in prisons or other types of institutional facilities.

Flushometer-valve toilet

Flushometer-valve toilets can be equipped with electronic sensors that trigger the flushing mechanism when a user has finished using the fixture. Sensors themselves provide no additional water efficiency benefits; however, they provide health and sanitation benefits in public-use facilities, since they offer a hands-free option. If not properly programmed, operated, and maintained, automatic flush sensors can cause unnecessary double or "phantom" flushing, which increases the water used at a facility. EPAct 1992 established the maximum allowable flush volume for gravity tank-type, flushometer tank (or pressure-

assist), electromechanical hydraulic, and flushometer-valve toilets sold in the United States at 1.6 gallons per flush (gpf) (6.1 liters per flush [lpf]). The maximum flush volume was set at 3.5 gpf (13.2 lpf) for blowout toilets, which are used primarily in locations subject to high traffic or heavy use such as prisons. Due to the long, useful life of toilets, many toilets in use today are older and have flush volumes of 3.5 gpf to 5.0 gpf (13.2 lpf to 18.9 lpf).

WaterSense labeled tank-type toilet

To further address efficiency and advances in toilet technology, the U.S. Environmental Protection Agency's (EPA's) WaterSense® program published the *WaterSense Specification for Tank-Type Toilets* and the *WaterSense Specification for Flushometer-Valve Water Closets*.[1, 2] WaterSense labeled tank-type toilets use 1.28 gpf (4.85 lpf) or less. For dual-flush tank-type toilet models, WaterSense labeled toilets can have a full flush up to 1.6 gpf (6.1 lpf); however, the reduced flush must use 1.1 gpf (4.2 lpf) or less to ensure that the average of one full flush and two reduced flushes is equal to or less than 1.28 gpf (4.85 lpf). All WaterSense labeled flushometer-valve toilets, including both single- and dual-flush models, must use no more than 1.28 gpf (4.85 lpf) and no less than 1.0 gpf (3.8 lpf) in full flush mode. WaterSense set a minimum flush volume for flushometer-valve toilets so that labeled models have enough flow to adequately clear commercial building drainlines. Both types of toilets are also independently certified to remove at least 350 grams of solid waste per flush, helping to ensure product performance.

While EPAct 1992 established the maximum allowable flush volume for toilets at the national level, some states and municipalities have adopted regulations mandating that toilets have a flush volume of 1.28 gpf (4.85 lpf) or less, consistent with the WaterSense specifications.[3] It is important to note that while some of these regulations establish flush volume criteria consistent with the WaterSense specifications, they may not require products to be WaterSense labeled or to meet WaterSense's performance criteria. Looking for the WaterSense label when purchasing toilets will ensure that the product meets both efficiency and performance criteria.

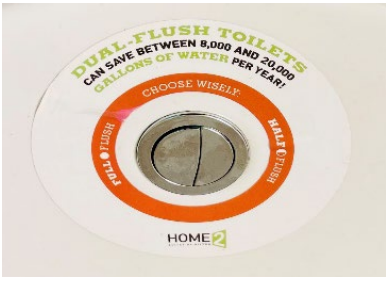
Composting toilets are a less common alternative to typical water-using toilets. They are toilets that include an anaerobic processing system that can treat waste using little to no flush water. These toilets do not send the waste through the sanitary sewer for treatment at a wastewater treatment plant, although some applications treat the toilet waste in an

[1] U.S. Environmental Protection Agency's (EPA's) WaterSense program. Residential Toilets. www.epa.gov/watersense/residential-toilets.
[2] EPA's WaterSense program. Commercial Toilets. www.epa.gov/watersense/commercial-toilets.
[3] Appliance Standards Awareness Project. State Standards. https://appliance-standards.org/states.

onsite septic system. Composting toilets are not included in the scope of the WaterSense toilet specifications.

Operation, Maintenance, and User Education

Facility managers can reduce water use by taking simple steps to educate users on proper toilet use and maintenance. In addition, consider the following:



Example dual-flush signage

- Post signage and train users to report continuously flushing, leaking, or otherwise improperly operating toilets to the appropriate personnel.
- Educate and inform users with restroom signage and other means to avoid flushing inappropriate objects, such as feminine products, wrappers, paper towels, wipes, trash, or other objects. Make it easy for users to dispose these items that should not be flushed, and train custodial staff on how to handle the inappropriate disposal of such objects.
- If the facility uses dual-flush toilets, include educational signage about the use of the reduced flush for liquid waste. Make sure the proper directions for activating the full and reduced flushes are clearly labeled on the toilet itself or in the stall.

In addition, consider the operation and maintenance tips below specific to tank-type toilets and flushometer-valve toilets.

Tank-Type Toilets

- Periodically check to ensure fill valves are working properly and the water level is set correctly. Remove the toilet tank lid and check to see if water is flowing over the top of the overflow tube inside the tank. Ensure that the refill water level is set one inch below the top of the overflow tube. Adjust the float lower if the water level is too high. If the toilet continues to run after the float is adjusted, replace the fill valve. In order to prevent changes in tank water levels due to line water pressure fluctuations, only replace existing fill valves with pilot-type fill valves.
- Annually test toilets to ensure the flappers are not worn or allowing water to seep from the tank into the bowl and down the sewer. Drop a dye tablet or several drops of diluted food coloring in the tank. After 10 minutes, see if the dye has leaked into the bowl, which indicates water is also leaking into the bowl. Flush the toilet immediately after conducting this test to ensure the dye does not stain the tank or bowl. If there is a leak, check for a tangled chain in the tank or replace a worn flapper or the complete valve. When replacing a flapper, be sure to get the correct type for the toilet model. If leaking does not subside after a flapper is replaced,

consider replacing the flapper seat and overflow tub assembly, which could also be worn.

- Learn more by watching leak detection and repair videos posted on the WaterSense Fix a Leak Week web page at www.epa.gov/watersense/fix-leak-week.

Flushometer-Valve Toilets

- At least annually, inspect diaphragm or piston valves and replace any worn parts. To determine if the valve insert needs replacement, determine the time it takes to complete a flush cycle. The flush volume of a flushometer-valve toilet can be estimated by counting the number of seconds it takes from activation until the valve closes.[4] Use Equation 1 below. For example, a properly functioning 1.6 gpf (6.1 lpf) flush valve should not have a flush cycle longer than four seconds. If the calculated flush volume greatly exceeds the rated flush volume of the toilet, replace the diaphragm or piston valve insert.

Equation 1. Flush Volume of Flushometer-Valve Toilet (gallons per flush)[5]

= Time to Flush x 0.42

Where:

- Toilet Flush Volume: Gallons per flush
- Time to Flush: Seconds per flush

- If replacing valve inserts, make sure the replacements are consistent with the valve manufacturer's specifications, including the rated flush volume. If replacing the entire valve, make sure it has a rated flush volume consistent with manufacturer specifications for the existing bowl.
- Periodically check to ensure the control stop (which regulates the flow of water from the inlet pipe to the flushometer valve and is necessary for shutting off the flow of water during maintenance and replacement of the bowl or valve) is set to fully open during normal operation.
- Upon installation of a flushometer-valve toilet, adjust the flush volume following the manufacturer's instructions to ensure optimum operation for the facility's specific conditions. Periodically inspect the flush volume adjustment screw to ensure the flush volume setting has not been modified from the original settings; if it has, it could change the water use and performance of the product.

[4] South Florida Water Management District. 2013. *Water Efficiency and Self-Conducted Water Audits at Commercial and Institutional Facilities: A Guide for Facility Managers*. www.sfwmd.gov/document/water-efficiency-and-self-conducted-water-audits-commercial-and-institutional-facilities.

[5] Multiply number of seconds by 1.59 to get liters per flush.

- Ensure that the line pressure serving the flushometer-valve toilet meets the minimum requirements specified by the fixture manufacturer.
- If automatic sensors are installed, check and adjust them to ensure proper settings and operation and avoid double or phantom flushing.

Retrofit Options

To retrofit an existing toilet to increase water efficiency, consider the following options for tank-type and flushometer-valve toilets:

Tank-Type Toilets

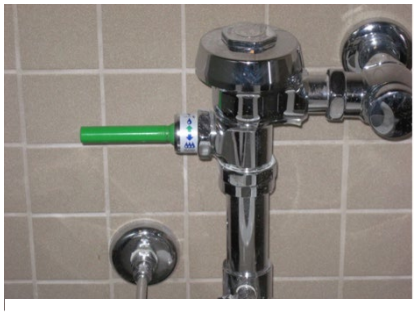
In general, avoid retrofitting existing tank-type toilets with displacement dams or bags, early-closing toilet flappers, or valves with different flush volumes, as these devices could impede overall performance and require increased operation and maintenance. In addition, using these devices and other retrofit products could actually increase water consumption and void manufacturer warranties.

Flushometer-Valve Toilets

Some recently developed bowls function satisfactorily at a range of flush volumes. For example, a 1.6 gpf (6.1 lpf) bowl may be coupled with either a 1.6 gpf (6.1 lpf) valve or a 1.28 gpf (4.85 lpf) valve. Similarly, a newer 1.28 gpf (4.85 lpf) bowl might perform satisfactorily at both 1.28 gpf and 1.1 gpf (4.85 lpf and 4.2 lpf). Review the markings on the bowl or check with the bowl manufacturer to determine if that is the case with the bowl being considered. If it is the case, consider installing valve inserts with a lower flush volume rating to reduce water use from flushometer-valve toilets. However, first consider piloting the retrofit in a limited number of toilets to ensure both toilet and drain line performance are maintained before expanding to the whole facility.

For older flushometer-valve toilets with higher flush volume (e.g., 3.5 gpf [13.2 lpf] or greater), it is generally best to avoid piecemeal retrofit options, such as valve inserts, that reduce the flush volume of flushometer-valve toilets. These products might not provide the expected performance if the original bowl is not designed to handle a reduced flush volume. In addition, the use of these devices could void manufacturer warranties.

Dual-flush conversion devices are available for flushometer-valve toilets. These devices usually replace the existing flush valve handle with a handle that provides a reduced flush volume for liquids and a standard flush for solids. When considering this type of retrofit, verify that the product has been certified to International Association of Plumbing and Mechanical Officials (IAPMO) PS 50-2019, *Flush Valves with Dual-Flush Device for Water Closets or Water Closet Tank with an Integral Flush Valves with a*



Dual-flush toilet handle

Dual-Flush Device. In addition, before initiating a full-scale retrofit, test the product on a select number of toilets to verify it achieves and maintains the desired performance.

Replacement handles come in two different designs: handles in which an upstroke is required to initiate the reduced flush, and the reverse, where the reduced flush is activated with a down stroke. Consider the behavior of the users when making a selection, because the correct design approach for your facility could have a significant effect upon water use. For example, some users, particularly in public or heavy traffic restrooms, may use their foot to depress the handle, so a reduced flush on a down stroke may be more appropriate. Monitoring the water usage after replacement or piloting different options may provide insight on the best choice. Educational signage communicating proper operation of dual-flush toilets is recommended.

Replacement Options

If installing a new toilet or replacing an older, inefficient toilet, consider the following replacement options:

Tank-Type Toilets

When installing new tank-type toilets or replacing older, inefficient tank-type toilets, choose WaterSense labeled models.[6] WaterSense labeled tank-type toilets are independently certified to have an effective flush volume of 1.28 gpf (4.85 lpf) or less and pass a performance test to remove at least 350 grams or more of solid waste per flush.

Look for WaterSense Labeled Toilets

When replacing old, inefficient toilets or purchasing new toilets look for the WaterSense label. A product with the label uses at least 20 percent less water than standard models and is independently certified for performance. Looking for the label is a simple way to quickly identify toilets that save water and perform well. Facilities can also use WaterSense's Product Search Tool to find labeled toilets. Go to www.epa.gov/watersense/product_search to get started.

Flushometer-Valve Toilets

When installing new or replacing older, inefficient flushometer-valve toilets, choose WaterSense labeled models.[6] WaterSense labeled flushometer-valve toilets, including both single-flush models and the full flush of dual-flush models, use no more than 1.28 gpf (4.85 lpf), which is 20 percent less than the federal standard of 1.6 gpf (6.1 lpf). WaterSense labeled models are also required to be independently certified for performance. In some commercial facilities, there may be concerns about the ability of drainlines to carry waste; however a study of drainline carry conducted by the Plumbing Efficiency Research Coalition (PERC), a collaborative network of six plumbing stakeholders, indicated that drainline blockages are not of significant concern at 1.28 gpf

[6] Use WaterSense's product search tool at www.epa.gov/watersense/product-search to help identify WaterSense labeled models.

(4.85 lpf) flush volumes.[7] WaterSense included a minimum flush volume of 1.0 gpf (3.9 lpf) in its specification to help ensure labeled models have enough water flow to adequately clear commercial building drainlines.

A follow-on study also done by PERC examined the impacts of other drainline characteristics (e.g., pipe diameter, pipe slope) on drainline performance. The study found that a steeper drainline slope (2 percent instead of 1 percent) performed better at lower flush volumes.[8] Facility managers, especially in older buildings or buildings with existing plumbing system issues, should consult a plumbing engineer to determine the suitability of the existing drainlines and plumbing system before installing flushometer-valve toilets with lower flush volumes. A plumbing engineer can help carefully evaluate the physical conditions of existing drainlines and the availability of supplemental water flow upstream from the toilet fixtures to make sure that the conditions are appropriate for effective waste transport. Facility managers should also consider conducting a pilot project to replace toilets in one or two restrooms to ensure adequate performance before implementing a full-scale replacement.

WaterSense labeled flushometer-valve toilet

Composting Toilets

Consider installing composting toilets in facilities where connecting to a plumbing system is cost-prohibitive or unavailable.

Savings Potential

Water savings can be achieved by replacing existing tank-type and flushometer-valve toilets. To estimate facility-specific water savings and payback, use the following information:

Tank-Type Toilet Replacement

Current Water Use

To estimate the current water use of an existing tank-type toilet, identify the following information and use Equation 2 on the next page:

[7] Plumbing Efficiency Research Coalition (PERC). November 2012. *The Drainline Transport of Solid Waste in Buildings*. www.plumbingefficiencyresearchcoalition.org/projects/drainline-transport-of-solid-waste-in-buildings/.

[8] PERC. March 2016. *The Drainline Transport of Solid Waste in Buildings – Phase 2.0. (Including Supplemental report on PERC Phase 2.1)*. www.plumbingefficiencyresearchcoalition.org/projects/drainline-transport-of-solid-waste-in-buildings/.

- Flush volume of the existing tank-type toilet: Toilets installed after the mid-1970s typically have standard flush volumes of 3.5 gpf or 5.0 gpf (13.2 lpf or 18.9 lpf).[9] Toilets installed in 1994 or later have standard flush volumes of 1.6 gpf (6.1 lpf).
- Average number of times the toilet is flushed per day, which will be dependent on the facility's male-to-female ratio: Female building occupants use the toilet three times per day on average, while male building occupants use the toilet once per day on average.[10]
- Days of facility operation per year.

Equation 2. Water Use of Toilet (gallons or liters per year)

= Toilet Flush Volume x Number of Flushes x Days of Facility Operation

Where:

- Toilet Flush Volume: Gallons or liters per flush
- Number of Flushes: Flushes per day
- Days of Facility Operation: Days per year

Water Use After Replacement

To estimate the water use of a WaterSense labeled replacement tank-type toilet, use Equation 2, substituting the flush volume of the replacement tank-type toilet. WaterSense labeled toilets use no more than 1.28 gpf (4.85 lpf) on average, with some models flushing 1.0 gpf (3.8 lpf) or less.[11]

Water Savings

To calculate the water savings that can be achieved from replacing an existing tank-type toilet, identify the following information and use Equation 3 on the next page:

- Current water use as calculated using Equation 2.
- Water use after replacement as calculated using Equation 2.

[9] North Carolina Department of Environment and Natural Resources. May 2009. *Water Efficiency Manual for Commercial, Industrial and Institutional Facilities*. Page 28. www.deq.nc.gov/watereducation/water-efficiency-business-2/download.
[10] Vickers, Amy. 2001. *Handbook of Water Use and Conservation*. WaterPlow Press.
[11] For dual-flush models, calculate the flush volume by averaging the volume of one full flush and two reduced flushes.

Equation 3. Water Savings From Toilet Replacement (gallons or liters per year)

= Current Water Use of Toilet – Water Use of Toilet After Replacement

Where:

- Current Water Use of Toilet: Gallons or liters per year
- Water Use of Toilet After Replacement: Gallons or liters per year

Payback

To calculate the simple payback from the water savings associated with replacing an existing tank-type toilet, consider the equipment and installation cost of the replacement tank-type toilet (including any rebates or incentives obtained from a utility that may reduce the incurred cost), the water savings as calculated using Equation 3, and the facility-specific cost of water and wastewater.

Flushometer-Valve Toilet Replacement

Current Water Use

To estimate the current water use of an existing flushometer-valve toilet, use Equation 2, substituting the flush volume of the existing flushometer-valve toilet. Toilets installed after the mid-1970s typically have standard flush volumes of 3.5 gpf or 5.0 gpf (13.2 lpf or 18.9 lpf).[12] Toilets installed in 1997 or later have standard flush volumes of 1.6 gpf (6.1 lpf).

Water Use After Replacement

To estimate the water use of a replacement flushometer-valve toilet, use Equation 2, substituting the flush volume of the replacement flushometer-valve toilet. WaterSense labeled flushometer-valve toilets—both single- and dual-flush models—use no more than 1.28 gpf (4.85 lpf) in full flush mode.

Water Savings

To calculate water savings that can be achieved from replacing an existing flushometer-valve toilet, use Equation 3.

Payback

To calculate the simple payback from the water savings associated with replacing an existing flushometer-valve toilet, consider the equipment and installation cost of the

[12] North Carolina Department of Environment and Natural Resources, *op. cit.*

replacement flushometer-valve toilet, the water savings as calculated using Equation 3, and the facility-specific cost of water and wastewater.

Additional Resources

Alliance for Water Efficiency. Toilets (Tank Type and Flush Valve). www.allianceforwaterefficiency.org/resources/topic/toilets-tank-type-and-flush-valve.

EPA's WaterSense program. Commercial Toilets. www.epa.gov/watersense/commercial-toilets.

EPA's WaterSense program. Fix a Leak Week. www.epa.gov/watersense/fix-leak-week.

EPA's WaterSense program. Residential Toilets. www.epa.gov/watersense/residential-toilets.

Maximum Performance (MaP) Testing. https://map-testing.com/

North Carolina Department of Environment and Natural Resources, et al. May 2009. *Water Efficiency Manual for Commercial, Industrial and Institutional Facilities*. www.deq.nc.gov/watereducation/water-efficiency-business-2/download.

Texas Water Development Board. May 2018. *Best Management Practices for Commercial and Institutional Water Users*. www.twdb.texas.gov/conservation/BMPs/CI/index.asp.

U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Federal Energy Management Program. Best Management Practice #6: Toilets and Urinals. www.energy.gov/eere/femp/best-management-practice-6-toilets-and-urinals.

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