

water efficiency

Water Management Options

SANITARY AND DOMESTIC USES

Often overlooked are the water and cost savings achievable in domestic water usage by commercial and industrial facilities. While water efficiency measures should begin with the highest water use operations such as cooling, cleaning, rinsing, heating, etc., many facilities miss the easy improvements that can be made in domestic water devices such as toilets, urinals, sink faucets, and showers.

Domestic water use at industrial and commercial facilities may range from a few percent at a food processing industry to more than 50 percent in an office setting. Average daily domestic demands in commercial/industrial settings range between 20 and 35 gallons per day (gpd) per employee, and a savings of 25 to 30 percent



in this domestic usage is readily achievable. Best-in-class domestic water use in business settings has been documented in the range of seven to 10 gpd per employee.

FIGURE 1

| Typical Water Consumption for Toilets | | |
|---------------------------------------|--------------------|-------------------|
| Years Manufactured | Gravity Tank Style | Flush Valve Style |
| Pre-1977 | 5.0-7.0 gpf | 4.5-5.0 gpf |
| 1977 to mid 1990s | 3.5 (some 5.0 gpf) | 3.5 gpf |
| Mid 1990s | 1.6 maximum | 1.6 maximum |

Toilets

Americans consume almost 4.8 billion gallons of water daily by flushing toilets and urinals. In a business office setting, toilet water usage alone can account for approximately one-third of all water used. A number of water efficiency options exist for toilets in most facilities constructed before 1994 that have not been renovated recently.

The three major types of toilets include gravity flush, flush valve, and pressurized tank type. Pre-1977 gravity toilets will consume five to seven gallons per flush (gpf). Pre-1977 flush valve toilets use 4.5 to 5.0 gallons per flush. Gravity and flush valve style toilets manufactured between 1977 and mid 1990s mostly use 3.5 gallons per flush, although some 5.0 gpf gravity flush toilets continued to be manufactured during that period. (See Figure 1.)

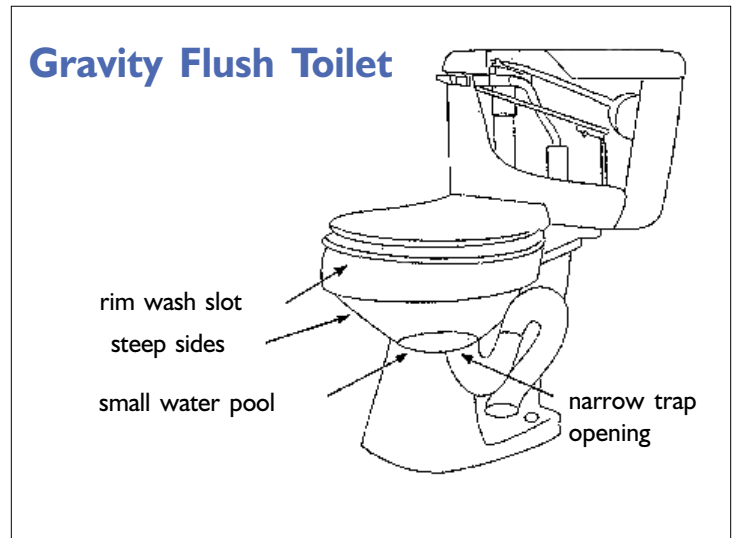


FIGURE 2

Maintenance Checklist for Gravity Flush and Flush Valve (Flushometer) Toilets

- Check for leaks every six months.
- Encourage employees to report leaks promptly.
- Adjust float valve to use as little water as possible without impeding waste removal or violating the manufacturer's recommendations.
- Periodically replace valves and ballcocks.

The 1.6 Gallons Per Flush Toilet

In the 1990s, toilet manufacturers introduced ultra-low-flush toilets (ULF) that use 1.6 gallons per flush. Federal regulations require that all toilets manufactured after January 1, 1994, consume no more than 1.6 gpf. Some of the original ULF models were associated with performance problems, but more recent models have improved designs and performance.

Gravity Flush Toilets

Gravity flush toilets are the most common of all toilets. Gravity flush toilets most likely are found in medium- to light-use business applications.

Water efficiency options for gravity flush toilets include improved maintenance, retrofit, and replacement options. (For a maintenance checklist, see Figure 2.)

Retrofit

Retrofit options of gravity flush systems are most effective on units that consume more than 3.5 gpf (pre-1980s models). For toilets that consume 3.5 gpf or less, retrofit options may hamper toilet performance or increase maintenance cost. Most retrofit options are available for less than \$20.

Displacement devices, including bags or bottles, can reduce water flow by approximately 0.75 gpf. They function by displacing flush water stored in the tank. The devices are inexpensive and easy to install, but do require regular maintenance. Bricks or other friable objects should never be used as displacement devices because granular contaminants can prevent proper closure of the flapper and damage flow valves.

Toilet dams are flexible inserts placed in a toilet tank to keep 0.5 to 1.0 gallon out of each flush cycle. Dams will last five to six years. A plumber should be consulted before installing such devices.

Early closure flapper valves replace the existing flush valve in the tank. These devices are adjustable to optimize performance and can save 0.5 to 2 gpf. Early closing flappers are inexpensive and usually can be installed in 10 to 15 minutes, barring other problems with the toilet's mechanisms.

Dual flush adapters allow users to use a standard flush for solids removal or a modified smaller flush for liquid and paper. Dual flush adapters have been more popular in Europe than the United States. Dual flush adapters can save between 0.6 to 1.2 gpf. To use this retrofit option, facility managers should provide user instructions about the proper use of these dual flush systems.

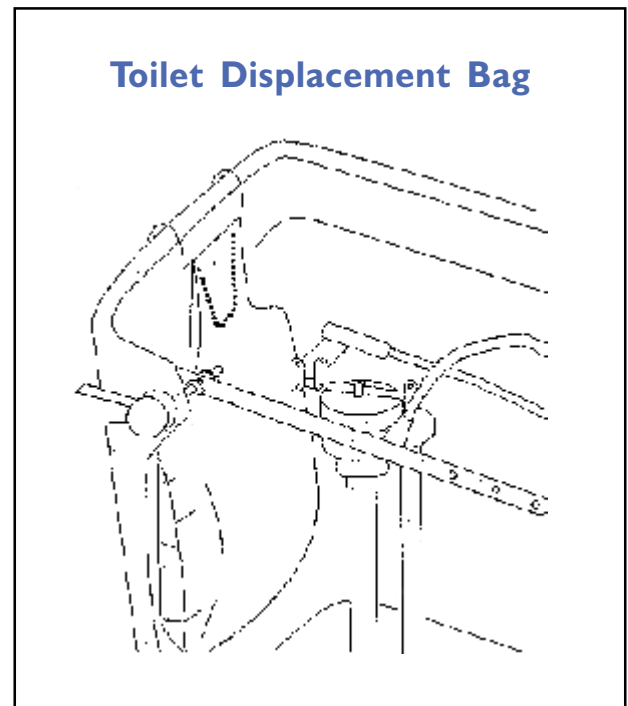
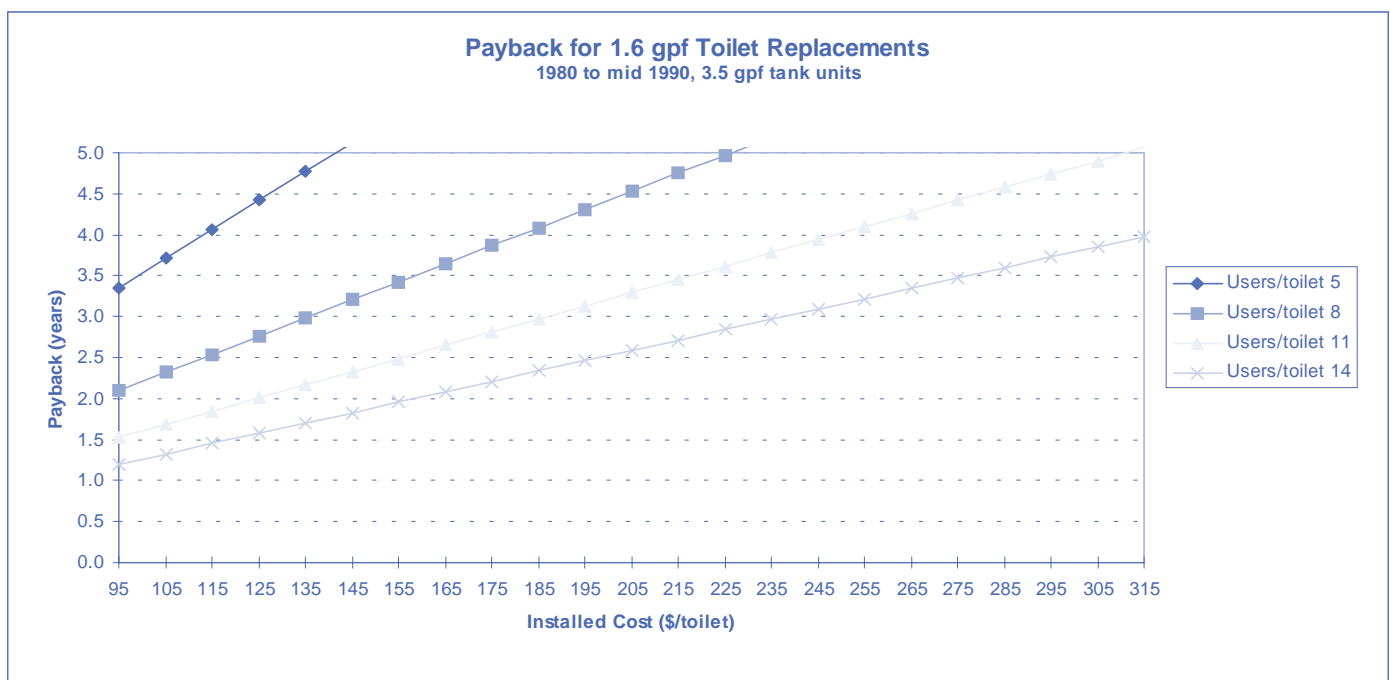


FIGURE 3



Replacements

Replacing older commodes with 1.6 gpf models will provide the most water savings. Most 1.6-gpf replacements will offer a payback period of less than four years. Facilities may achieve quicker payback in these situations:

- Experience high water and/or sewer costs.
- Have a relatively high number of users per toilet.
- Currently use high water consuming (five to seven gpf) toilets.

(See Figure 3 for typical simple payback periods for 1.6 gpf toilet retrofits.)

Flush Valve (Flushometer)

Toilets

Flush valve, or flushometer, toilets use water line pressure to flush waste into the sanitary sewer system. They consist of a valve and a toilet bowl fixture. Most commercial/industrial facilities use flush valve toilets, especially in higher-use areas. (For maintenance checklist, see Figure 2.)



Energy Policy Act of 1992

The Energy Policy Act established water efficiency plumbing standards for certain plumbing devices. Prior to 1992, many states and municipalities concerned about water conservation were setting unique standards, which created difficulty for manufacturers and distributors trying to meet these numerous standards. The Energy Policy Act created a set of unified national standards.

Effective January 1, 1994, federal standards set for *maximum* water usage are:

| | |
|------------------|------------------|
| Toilets | 1.6 gpf |
| Urinals | 1.0 gpf |
| Showerheads | 2.5 gpm @ 80psi |
| Lavatory Faucets | 2.5 gpm @ 80 psi |
| Kitchen Faucets | 2.5 gpm @ 80 psi |

Commercial use of gravity tank type units manufactured between January 1, 1994, and January 1, 1997, could use 3.5 gpf.

The water efficiency standard was established to:

- Preserve and protect water supply sources, both surface and groundwater.
- Ensure water availability for all beneficial uses.
- Reduce water and energy costs.
- Regulate and standardize plumbing fixture trade.
- Protect health and the environment.

The American Water Works Association estimates nationwide savings of 6.5 billion gallons per day will be achieved by the year 2025 through these standards.

Retrofits

Valve inserts are available and can reduce flush volumes by 0.5 to 1.0 gpf. Some of these devices consist of plastic orifices, perforated with holes in a wheel and spoke pattern. Others actually replace the existing valve mechanisms of a 5 gpf unit with a 3.5 gpf valve without changing the toilet bowl fixture. Do not retrofit ultra-low valves (1.6 gpf) without changing a fixture bowl.

Replacement

Replacing inefficient units with an ultra low (1.6 gpf) flush valve mechanism and toilets will result in maximum water savings. It is important to note that both the low-flow valves and bowls should be replaced simultaneously. A 1.6-gpf valve must be used with an appropriately designed 1.6 gpf bowl, or the unit will not perform adequately.

FIGURE 4

| Public Facilities | Estimated Water Savings (gpd per toilet) |
|-------------------------|--|
| Fire Stations | 28 |
| Police Stations | 20 |
| Libraries | 76 |
| Recreational Facilities | 117 |

Source: Public Facilities Toilet Retrofits, A&T Technical Services, Inc., 1994, based on study of 70 public facilities in San Diego, California.

FIGURE 5

| Commercial/ Business Sector | Estimated Water Savings (gpd per toilet) |
|-----------------------------|--|
| Wholesale | 57 |
| Food Stores | 48 |
| Restaurants | 47 |
| Retail | 37 |
| Automotive | 36 |
| Multiple Use | 29 |
| Manufacturing | 23 |
| Health Care | 21 |
| Office | 20 |
| Hotel/Motel | 16 |

Source: The CII ULF Saving Study, 1997, California Urban Water Conservation Council. Survey of 452 organizations in California.

Pressurized tanks system toilets

The most modern and effectively designed toilet currently on the market is the pressurized tank toilet. These units perform very well at removing waste, but also are more costly. These toilets use water line pressure to compress air in a specially sealed tank in the toilet. When flushed, the compressed air greatly increases the flush water force.



Figures 4 and 5 show examples of water savings from implemented ULF retrofit programs in both public and commercial settings.

Other options: composting toilets

Where sewers or septic tanks are not available, composting and incinerating toilets are available. Before purchasing any of these toilets, make sure building inspection programs can approve such toilet systems.

Urinals

The typical water consumption for an urinal is two to three gpf. New federal standards require all urinals to use no more than 1.0 gpf. Urinals can have a flushometer valve or water tanks for both washdown and trough urinals. Waterless urinals exist that use a biodegradable liquid in place of water to provide flushing action. Waterless urinals are more popular in Europe.

Making a Toilet Replacement Project Successful

Factors to consider when installing new ULF fixtures:

- Replace highest use toilets first – highest use toilets will provide quickest payback.
- Carefully choose toilet type depending on use level and the potential for misuse.
- Know your sewer infrastructure. Older cast iron types with a larger diameter (4" and 6") may have more problems transporting waste with 1.6 gallons. Substandard waste water pipe grading should be addressed before installing water efficient toilets. Make sure the building's water pressure is adequate if switching from a gravity type to flushometer or pressurized tank toilets. Usually, 25 to 35 psi or more at the toilet is required for pressure dependant systems.
- ULF toilets cannot be used as trash cans. If flushing trash is a problem at the facility, employee education with the new toilet installation is necessary.
- Ask for references from the building manager, plumbers, or other users who have installed the manufactured products.
- Base decisions on the current models. Many design improvements continue to be made.
- Listen to noise levels of the model you are considering.
- A high cost does not automatically mean better performance.
- Ask about guarantees and returns especially for future leak problems.
- Choose a licensed plumber or contractor.
- Plan for the legal disposal of old toilets. Consult your local solid waste authority for recycling options or disposal requirements.

Use Satisfaction

Some owners of early 1.6 ULF toilets reported dissatisfaction. Many improvements have been made in the 1.6 gpf toilet design to address these issues. It is important to remember that 1.6 gpf units are finely-tuned design systems that require proper use. The type of toilet should be chosen carefully for its level of use and application. Educating employees not to flush trash and of the importance of water efficiency will go a long way in improving user satisfaction. Actual customer satisfaction surveys conducted in Santa Rosa, California; Denver, Colorado; and New York City had a high customer satisfaction rate for customers installing ULF toilets. Less than 10 percent reported any dissatisfaction.

Siphon jet urinals

These common urinals are designed to accommodate relatively high-level usage. The siphon jet urinal has an elevated tank to provide the flushing action to remove foreign matter such as cigarette butts and gum wrappers. While these types of toilets are more sanitary than washout toilets and require little maintenance, the great disadvantage is that water runs through these units constantly.

All washout/washdown and blowout urinals are used in different traffic demand settings. Water efficiency options vary with each unit.

- Check for leaks every six months.
- Check flushometer valves for leaks. For tank-style urinals, check the rubber diaphragm for leaks or wear, and replace as needed.
- Use a timer. A timer can be installed to stop water flow when a facility is not occupied.
- Use electronic eye sensors to flush automatically.

CASE STUDY

Urinal Timer Adjustment

The Asheville Civic Center has several large banks of urinals to handle restroom traffic during large events. Sensors had been installed to continuously flush all urinals when the restroom doors were open. This system led to excess water use. After a water audit by Waste Reduction Resource Partners (WRRP), formerly called Waste Reduction Assistance and Technical Transfer (WRATT), a two-minute delay timer was added to the sensor so the urinals could not flush more frequently than every two minutes. This simple change saved almost 90 percent of urinal water use and reduced water consumption by 600,000 gallons per year.

Washout and washdown urinals

Replacement options

Some models can be retrofitted to use less water per flush by replacing a part in the flush valve or float levels in tanks. Make sure any retrofit will continue to allow adequate removal of liquid waste. Again, bowls and flush valves need to be compatible in design use to function properly. Installing new models that use 1.0 gpf can achieve the maximum water savings for urinals.

Special Note: Monitoring toilet usage patterns may indicate that replacing a toilet with a less water intensive urinal is possible.

Showerheads

Showerhead replacement or modification represents another water efficiency area that is very cost effective. Most conventional showerheads use three to seven gpm at 60 psi water pressure. New standards require showerheads to use no more than 2.5 gpm. These new water efficient showerheads come in many different models and features and typically perform very well. Water efficient showerheads also reduce energy consumption for hot water generation.



Plumbing modifications

Install flow restrictors. These washer-like disks fit inside the showerhead and limit water flow. Flow restrictors are very inexpensive (less than \$5) and are easy to install. Newer designs are not noisy at higher pressures.

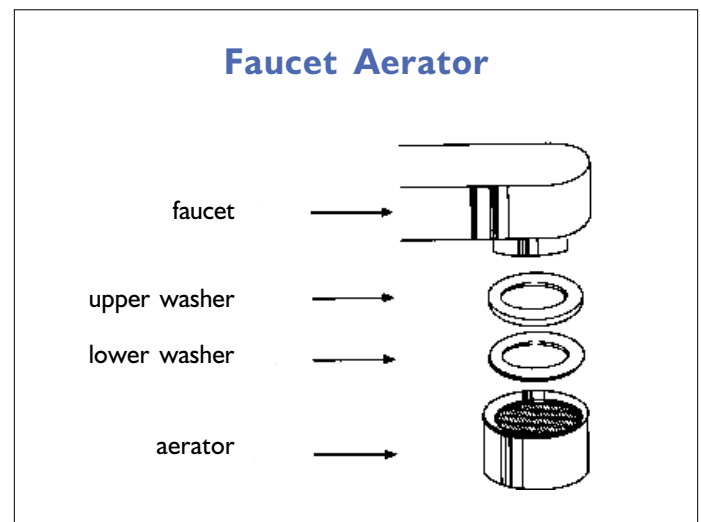
Temporary cut-off valves usually are attached to, or incorporated into, the showerheads to allow the user to temporarily turn off water while soaping, shampooing, or shaving. The water can be reactivated at the previous temperature without no need to re-adjust hot and cold water valves. Facility managers employing cutoff valve showerheads should be warned that water temperature may be hotter upon reactivation, which could cause unexpected burns.

Replacement options

The best water efficiency option is to purchase new 2.5 gpm showerheads. The products vary in price, from \$3 to \$48. Good single-setting showerheads can be purchased for less than \$10. The newer code compliant showerheads have a narrower spray area and a greater mix of air and water than conventional showerheads. Wide arrays of spray patterns are available, including adjustable massage action. Fixed and flexible position models also are available.

Faucets

Conventional faucet flow rates can range from three to five gpm. A leaking faucet dripping one drip per second can waste 36 gallons of water a day. Federal



Behavioral modifications

- Encourage users to take shorter showers. User awareness is important, especially in institutional settings.
- Check regularly for leaks, and institute a program to have users or employees inform maintenance about leaks.

guidelines mandate that all lavatory and kitchen faucet and replacement aerators manufactured after January 1, 1994, consume no more than 2.5 gpm at 80 psi.

Modification

- Adjust flow valves to the faucet. Keep in mind this modification also can be easily changed by users.
- Check regularly for leaks.
- Use aerators for faucet flow controllers on existing faucets. Aerators screw onto the faucet head and add air to the water flow while reducing water flow. They are available at common ratings of 0.5, 0.75, and 1.0 gpm. Flow rates as low as 0.5 are adequate for hand wetting purposes in a bathroom setting. Higher flow rate kitchen aerators deliver water at 2.0 to 2.5 gpm for more general washing purposes. Aerators cost \$5 to \$10 installed and typically yield a payback within a few months.
- Install flow regulators. Flow regulators can be installed in the hot and cold water feed lines to the faucet. Common flow rate designs include 0.5, 0.75, 1.0, and 1.5 gpm. Flow restrictors can be used where aerators cannot or where there is faucet abuse (aerator removal is problematic). Flow restrictors can be installed for less than \$25 and also yield a payback within months.

Replacement

Any new faucet purchase must have a flow rate less than 2.5 gpm. Many types of faucet and water control systems are available for commercial faucets. These include:

- Automatic shutoff – once handle is released, valve shuts off.
- Metered shutoff – once new lever is depressed, the faucet delivers a water flow for a pre-set time period (e.g. five to 20 seconds), then automatically shuts off.

Infrared and Ultrasonic Sensors

“Electric eye” sensors are available for a number of plumbing applications including lavatory faucets, urinals, and toilets. These devices deliver a metered flow only when the fixture is in use. For faucets, both the flow rate and activation time can be adjusted. The “no-touch” activation also is helpful to prevent the spread of disease and is useful for users with disabilities. Sensored faucets, too, need to be checked for leaks and clogged flow controllers because of any water impurities. An infrared sensored faucet or urinal/toilet controls can be purchased for about \$200.

Water Spigots

Self-closing commercial valves are available for water spigots, like those installed in public areas. Shut-off cycles from four to 25 seconds typically are available.

Pressure Reducing Valves

Facilities should consider using a pressure-regulating valve when water line pressure is higher than 50 to 60 psi. Lowering excessively high-line pressure helps reduce the formation of leaks and will lower water flows from spigots, hoses, faucets, and water feed lines. A pressure reduction of 15 psi from 80 to 65 psi will reduce water flow by about 10 percent without sacrificing water service. A reduction from 80 to 50 psi will correspond to about a 25 percent water use reduction in light commercial settings. ♣

FIGURE 6

| Water Efficiency Summary: Domestic Applications ^{1,2,3} | | | | | | |
|--|-----------------------------------|------------------------|---|------------------------|-------------------------------|--|
| Fixture | Current Syle/ Flow Rates | Ages | Water Efficiency Options/ Water Saving Estimates | Installed Cost (\$) | Typical Payback (years) | Comments |
| Toilets | Flushometer 3.5 gpf | 1977 to early 1990s | Install new 1.6 gpf ULF model. Saves 1.9 gpf. | \$115-\$300 | 1.5 – 6 | Must change both bowl and valve |
| | | | Consider valve inserts. Save 0.5 gpf | \$10-\$30 | 0.6 –2.5 | Usually not recommended by OEM |
| | Flushometer 4.5 gpf | Pre- 1980s | Install 3.5 gpf valve retrofit with no change to china bowl. Saves 1.0 gpf. | \$25-\$40 | 0.7 – 1.7 | Flushometer valves used in commercial high use areas. |
| | Tank-type gravity 1.6 gpf | 1992 and later | Best available option. | NA | NA | Ultra-low flush (<1.6 gpf) exist for special enviro- sensitive cases. |
| | Tank-type gravity - 3.5 gpf | 1977 to mid- 1990 | Install 1.6 gpf gravity toilet or other 1.6 gpf models. Saves 1.9 gpf. | \$115-\$300 | 1.5 - 6 | Displacement devices/dams not typically recommended for 3.5 gpf units. |
| | | | Consider early closing flapper. Saves from 0.5 to 1.0 gpf. | \$20 | 0.7-1.5 | Adjustable for quality performance |
| Urinals ⁴ | Tank-type - gravity 5-7 gpf | Pre-1980 devices | Install 1.6 gravity flush or other 1.6 gpf models. | \$115-\$300 | 0.7-4.5 | Consider pressurized tanks systems for high use areas. |
| | | | Consider dams, displacement devices, or early closure flapper. Saves 0.75-2 gpf. | \$20 | 0.4-0.9 | <u>Do not</u> use bricks. |
| | Flushometer 1.6 gpf | | Install repair valves to 1.0 or 0.5 gpf for non-pooling styles. Saves 0.6-1.1 gpf. | \$20-\$40 | 1.0 –3.5 | For non-pooling styles |
| | Flushometer 3.0 gpf | | Replace urinal fixture and retrofit valves to 1.0 gpf. Saves 2.0 gpf. | \$100-\$250 | 1.8 - 8.0 | |
| Showerhead ⁵ | 2.5 gpm | Post mid- 1990s | Currently Best Option – lower flow showerhead available for special condition (down to 1.5 gpm). | NA | NA | Rated at 60 psi pressure. |
| | 3-5 gpm | Post 1980 | Install 2.5 gpm showerhead. | <\$20 | 0.5-2.5 | Appropriate pressure needed |
| | 5-8 gpm | Pre-1980 devices | Install 2.5 gpm showerhead. | <\$20 | 0.25-0.5 | Appropriate pressure needed. |
| Kitchen Faucets ⁶ | 3-7 gpm | Pre 1980 devices | Install aerators to reduce flow to 2.5 gpm. | \$5-\$10 | 0.4-3.5 | No less than 2.5 gpm for kitchen applications. |
| Lavatory Faucets ⁷ | 3 - 7 gpm | Pre 1980 devices | Install aerators to reduce flow to 1.0 gpm or as little as 0.5 gpm. | \$5-\$10 | 0.05-0.7 | 0.5 gpm aerators suitable for bathroom wetting services. |

¹Based on an average water and sewer rate in North Carolina of \$3.97 per 1,000 gallons.

²Payback estimated for one shift operations. Divide payback period by two and three for two and three shift operations, respectively.

³Cost estimates are based on approximate installation cost using internal maintenance. Actual cost and payback periods may vary. Options based on widely available equipment believed not to reduce service quality or reliability.

⁴Urinal savings based on two uses per day per male employee.

⁵Showerhead savings base on two eight-minute showers per work day.

⁶Kitchen faucet savings based on three minutes of use per day.

⁷Lavatory faucet use based on 10 seconds of use per restroom visit.

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