

## WATERLESS URINALS: FEATURES, BENEFITS, AND APPLICATIONS

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### ABSTRACT

Billions of gallons of water are used annually to flush toilets in the United States. Consequences of this usage include consumption of natural resources and construction of new infrastructure to treat and transmit potable water and wastewater. Waterless, or no-flush urinals, may help mitigate these effects and offer other advantages, including lower utility charges, improved restroom hygiene, and decreased fixture maintenance. Some notable caveats include possible lack of acceptance by users, odor control problems, and rejection by code officials.

As urine is about 96% liquid, no additional water is really needed to wash it down the drain. The waterless, urinal, looking much like its conventional counterpart, takes advantage of this concept with generally positive results.

This paper will discuss the design, applications, operation, maintenance, advantages, and disadvantages of waterless urinals. The results of two surveys of current users will be shared. A case study from a Texas school district will be also presented.

### DESIGN AND OPERATION

The waterless urinal appears and works like a conventional urinal, except that it does not flush and, therefore, requires no water. Like their traditional counterparts, waterless urinals are made of fiberglass or vitreous china, and are offered in white as well as various custom colors (Figure 1). ADA compliant models are also available. No-flush urinals can be installed virtually anywhere the conventional variety would be used.

Like ordinary urinals, waterless types are plumbed to a standard drain line, but obviously do not use a conventional water-filled trap. Waterless urinals utilize proprietary sealant liquids that act as a vapor trap. The liquids are composed primarily of natural oils that are lighter than water. Urine passes through this liquid and goes down the drain. The



Figure 1. Typical Cartridge-Type Urinal.

sealant liquid, except a minuscule amount that escapes with each use, remains in place to trap odors and prevent them from escaping into the restroom.

The various manufacturers of waterless urinals available in the U.S. use three types of drain trap designs. Two companies utilize a removable, recyclable plastic cartridge that is inserted into the fixture's drain hole. A typical design is shown in Figure 2, although they vary somewhat by manufacturer. Another maker employs an integral ceramic siphon that is cast into the urinal, and the last utilizes a built-in waste trap housed in the fixture drain. In all cases, whether removable or not, the drain trap is designed to contain the sealant liquid.

The removable cartridge, according to manufacturers' literature, serves two other purposes in addition to holding the sealant liquid. First, it acts as a strainer to keep unwanted materials such as

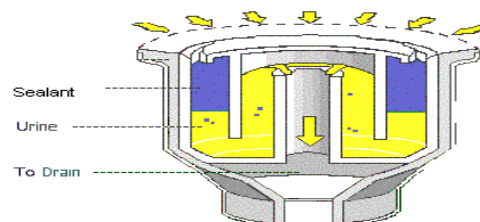


Figure 2. Typical Insertion Cartridge.

chewing gum and cigarette butts out of the drain. Also, it captures sediment from urine that would otherwise go down the drain and potentially create obstructions. Models with integral siphons do not have a strainer, so their manufacturer recommends flushing the drain line with water on a monthly basis. The built-in trap version has a drain cover that should catch larger items before they go down the drain.

For models with drain inserts or cartridges, the cover is twist-locked in place. A special tool supplied by the manufacturer is required to remove it, thus reducing the chance of unwanted removal and opportunities for vandalism.

## **APPLICATIONS**

No-flush urinals can be installed at virtually any location that conventional flush type urinals would go. Installation locations have included airports, schools, colleges and universities, offices, hospitals, stadiums, convention centers, parks, and rest areas.

Waterless urinals are suitable for both new construction and retrofits. In both applications these urinals are installed essentially like conventional ones, except that no water hookup is needed. However, some owners prefer to install water supply lines to the urinals' location and cap them in case they are not satisfied with the waterless urinals in the future. Some building officials are reportedly requiring this type installation as a condition of approval as well. Waterless urinals fit to standard 2-inch drain lines, but not copper. The urea in urine can react with copper to cause pitting and corrosion.

For retrofits the height of existing drain piping may need to be modified to allow mounting of the new waterless urinals at the proper heights. This adjustment is due to the fact that drain outlets on conventional and waterfree urinals are often at different locations relative to the fixture bottom. Also, one source recommends ensuring existing drain lines are clear of obstructions, snaking them if necessary, prior to installation. This removes any existing encrustations in the lines, which, according to no-flush urinal manufacturers, accumulate due to reactions between urine and water.

While they can be used almost anywhere, waterless urinals are a practical option where facilities are not connected to a sanitary sewer system. Since there is no flushing, septic systems or on-site treatment facilities do not fill with water from urinals. No-flush urinals may also be attractive in locations such as parks and rest areas where heating

is not provided in the winter, since freeze protection is not required.

## **ADVANTAGES AND DISADVANTAGES**

### Advantages

Water Savings. Toilets account for about half of a typical building's water consumption. In the United States, almost 5 billion gallons of water is used every day to flush toilets, according to the Environmental Protection Agency. Newer models of conventional flush-type urinals use about one gallon per flush. Older ones can use from three to five gallons. Since no-flush urinals use no water, one to five gallons of water is saved with each use.

Low Maintenance. Waterless urinals generally require little maintenance other than a few simple procedures that are outlined below (see Maintenance). The absence of a flush valve eliminates valve repairs and reduces opportunities for tampering. Additionally, overflow due to clogged drains and vandalism is not a problem since large amounts of water are not being flushed. According to the manufacturers, drain lines on waterless urinals are less susceptible to clogging as the mixture of water and urine, absent with no-flush urinals, causes encrustations to form in the pipes. Occasional flushing with a few gallons of water is recommended to keep lines clean.

Improved Hygiene. Many people have the impression that urine is an unclean substance. However, it is generally a sanitary liquid, composed mainly of dissolved metabolic waste and excess water. A person's urine normally does not contain harmful microorganisms unless they are harboring some type of urinary tract infection.

Water used by conventional urinals gives germs in the restroom the moist environment they need to grow. Manufacturers design waterless urinals to dry out between uses. This makes them hostile to bacteria and viruses. Also, since there is no handle, no-flush urinals are touch-free, reducing the spread of communicable diseases.

Charles P. Gerba, Ph.D., Professor of Environmental Microbiology at the University of Arizona, was asked by one manufacturer to assess the sanitation of flush-type vs. waterless urinals. Dr. Gerba has served on the faculty of other universities, as a member of the Pima County (Arizona) Board of Health, and as a consultant to the World Health

Organization. He has been involved in research dealing with restroom hygiene and transmission of diseases by public restrooms for some 30 years.

Gerba states in a report dated August 28, 2003, that, in his professional opinion, waterless urinals “would result in a significant improvement in public restroom hygiene”. Dr. Gerba goes on to say that, due to the presence of moisture, flush-type urinals harbor disease-causing bacteria. He also notes that flushing tends to send these microbes airborne, spreading them throughout the restroom where people can come in contact with them.

Odor Control. The absence of a water-urine blend in the bowl lessens the prevalence of odors often associated with urinals, according to at least one manufacturer. The sealant liquid filling the trap is designed to keep odors out of the restroom. However, some owners report that odors might become noticeable if the supply of sealant liquid is allowed to run out.

Environmentally Friendly. Waterless urinals contribute positively to the environment. First, the absence of water for flushing reduces the demand for water, an increasingly scarce commodity in some areas. Also, since no water goes down the drain, additional wastewater requiring treatment is not generated. Next, the special drain cartridges and inserts used in some models are recyclable. Finally, the sealant liquid composed of natural oils, is biodegradable.

Rebates and Incentives. Some water utility companies offer rebates and incentive payments to owners installing waterless urinals. Payments range from a partial to full reimbursement for the cost of no-flush urinals. In Texas cities participating in these type programs are generally in the central and western parts of the state such as Austin and El Paso. Some areas in the west, including many in the Seattle, Washington, region also offer incentives for no-flush urinal installation.

Energy Reduction. Widespread use of waterless urinals could result in an overall reduction in the use of energy. Cities and other water supply agencies would not have to treat and pump as much water.

“Green Building” Credits. Many new construction projects nowadays are earning certification as “green buildings” under the LEED program developed by the U.S. Green Building Council. Installation of waterless urinals helps gain water conservation points.

## Disadvantages

User acceptance. Some owners report reluctance on the part of users to accept the waterless urinals at first. Two universities reported that signs posted near the urinals explaining how they work and why they were installed seemed to increase favorable responses in these cases.

Similarly, some maintenance personnel are hesitant to perform maintenance on the no-flush fixtures. They do not want to come in contact with the removable cartridges that contain small amounts of urine.

Retrofits. When replacing conventional urinals, removal of flush valves and capping of water supply lines will be necessary. Some remodeling may be required to lower the drain lines to bring the new waterless urinals to the proper mounting height.

Local Approval. Acceptance of no-flush urinals varies from city to city. Some municipalities allow them and offer incentives for installation, but others reject them. Code officials in some Texas, California, and Florida cities reportedly would not permit waterless urinals.

The latest edition of the International Plumbing Code requires in Section 301.4 that water be supplied to all fixtures needing it for proper operation. Section 401.2 prohibits water closets that are not thoroughly washed at each discharge. Further, some local plumbing codes require that all fixtures be connected to a water supply. All these requirements could and have been interpreted to exclude waterless urinals., A variance from the local authority could, however, override these limitations. Checking with local code officials early in the design process is, therefore, essential.

## **MAINTENANCE**

Waterless urinals are touted as reducing maintenance. As previously mentioned, flush valve repair and cleanup from clogged drains is eliminated. However, the fixtures do require some periodic attention. Regular upkeep includes cleaning all surfaces, and drain care, whether the drain contains a cartridge type trap or one cast into the urinal. Custodial staffs can perform these tasks.

Cleaning involves using a nonabrasive cleanser, followed by wiping with a sponge or “jonny mop”, and drying. Abrasive cleaners and harsh chemicals should be avoided as they can damage the finish and remove its water repellent characteristics. Some

makers supply their own products, which they recommend for use. According to the manufacturers, these products do not damage the fixtures' protective surfaces, which are designed to limit residual moisture and, thus, germ growth. Some users have noted that the waterless urinal may require cleaning slightly more often than conventional urinals since surfaces are not regularly flushed with water.

Large amounts of water should not be poured through the cartridge, as this tends to flush the sealant liquid down the drain. However, manufacturers do recommend flushing the drain with a bucket of water while the insert is removed during change out.

Care of the drain trap varies depending on the trap type involved. Even for the same type, maintenance requirements vary between manufacturers. For models with a removable cartridge trap, the trap must be replaced periodically. Replacement is required because the supply of sealant liquid becomes depleted and the cartridge fills with sediment from urine. One manufacturer's replaceable trap must be refilled with the special sealant liquid after every 1500 or so uses (approximately monthly for a typical elementary school). The cartridge itself is to be replaced one to six times a year depending on usage. Another manufacturer only requires replacing the insert about 4 times a year or every 7000 uses. Intermediate replenishment of the sealant liquid is not required. The manufacturer of models with an integral trap calls for flushing the drain with a hose monthly or after each 5000 uses, whichever comes first. This process clears the drain of sediment that may accumulate since there is no cartridge with a strainer or filter. After flushing the recommended amount of sealant liquid is added.

By all accounts from those familiar with waterless urinals, proper maintenance is the key to satisfaction. Since there is no flushing to clean the fixtures, they must be wiped down and cleaned regularly. Cleaning must be done according to manufacturer's instructions for the best results. Generally, this includes only spraying approved cleaners on the surface followed by a wipe-down. Per one manufacturer, the introduction of large amounts

of cleaner can react with the sealant to form unwanted coatings in drain lines. Also, the drain traps must remain filled with sealant liquid to prevent odors from escaping back into the restroom. Refilling and/or changing of cartridges at the proper intervals is essential to odor control.

### COSTS

Waterless urinal fixtures cost range from about the same to somewhat more than their conventional counterparts, depending on the model chosen. However, installation costs are lower if no water supply plumbing is installed. Therefore, initial costs for waterless urinals are generally less than for flush type urinals in new construction.

During renovation projects existing supply water piping must be cut off and securely capped. The height of drain piping may also need to be adjusted to allow mounting of the new waterless urinals at the proper heights. These alterations add slightly to the installation costs, but savings from reduced water usage and maintenance still leave the payback in the one to four year range.

Maintenance costs are nominal. Where required replenishing the sealant liquid costs \$1.50 to \$2.00 per application. Replacement drain inserts are \$5 to \$35 each, depending on the model. Labor costs for each of these is minimal. According to manufacturers, refilling a cartridge with sealant liquid takes less than one minute, and replacing a cartridge less than five.

### SAVINGS

Repair of flush valves due to use, failure, or vandalism will not be required. Neither is cleanup resulting from backed up drains and overflows. Therefore, labor costs for no-flush urinals should be less than for flush-types. The costs of replacement cartridges can outweigh the maintenance labor savings. However, given the potential reduction in water costs, overall annual costs should still be less. As water costs, labor rates, and specific operational differences, exact savings may vary.

Table 1 shows an example of potential savings installing no-flush urinals in a new elementary school

School days	Gallons/flush	Flushes/day	Flushes/year	Gallons/year	Water & sewer cost/1000 gallons	Waterless Urinal First Cost Savings	Annual Savings		
							Water	Maint.	Total
180	1.0	450	81,000	81,000	\$ 5	\$384	\$405	-\$31	\$374
180	3.0	450	81,000	243,000	\$ 5	\$384	\$1215	-\$31	\$1184

with 300 males and 8 urinals where each male student uses a urinal twice daily. (It was assumed that 25% of the males will use toilets due to crowding at the urinals.) The first-cost savings is based on a vitreous china fixture of the type requiring cartridge replacement (but not periodic sealant refilling). Cartridges are assumed to be replaced every 7,000 uses per manufacturer's instructions at a cost of \$35 each. In this example, cartridge replacement is assumed twice yearly. The maintenance savings shown is the difference in conventional urinal maintenance – repair and replacing of flush valves as well as cleanup due to clogs and overflows – and waterless urinal maintenance, essentially only cartridge replacement.

### MANUFACTURERS

Waterless urinals are currently available in the United States from four manufacturers. Two of them are American makers, located in California. The remaining two companies are European based, one in Germany and the other in Denmark.

### SURVEYS

#### Estes, McClure & Associates, Inc.

A survey was conducted by sending a questionnaire to users of waterless urinals in some 20 states across the country. A total of 79 survey forms were sent out. 27 were returned, for a response rate of 34%, from about 10 states.

Respondents reported installing waterless urinals in a variety of locations, including schools, universities, recreation centers, offices, and convention centers. The vast majority of installations were vitreous china fixtures in retrofit applications; however, a small number were fiberglass/acrylic. All urinals installed were the cartridge type.

Some of the findings of the survey are as follows:

Frequency of maintenance (Taking into account valid responses only. Some respondents listed "as needed".):

Activity	Mean
Cleaning	Daily
Refilling sealant*	1.8 months
Replacing cartridge	3.3 months

\*If required

The most reported reason, given by 85% of users, for installing waterless urinals was water cost savings

followed by reduced maintenance at 52%. Improved restroom hygiene, odor control, and utility rebate were rarely cited.

Other significant comments:

- (2) reported having problems receiving approval from local building officials. [Building officials in some locations have reportedly been reluctant or refused to approve installation of no-flush urinals.] In both cases the waterless urinals were installed anyway.
- (10) noted that they had experienced at least some problem with odor control. However, several users reporting this problem also noted that improved maintenance helped alleviate it.
- (1) mentioned the lack of durability of fiberglass fixtures.
- (1) noted a buildup of deposits in drain lines.
- No-flush urinals were removed at (2) facilities, both convention centers.
- (5) reported that it took time to train the custodial staff to properly care for the urinals.

Respondents were asked to rate their experience with waterless urinal fixtures in each of several areas from 1 (very poor) to 5 (excellent). The averages of all valid responses received are as follows:

Area	Mean
Odor control	3.0
Durability of fixtures	4.2
User acceptance	3.5
Ease of installation	3.6
Ease of maintenance	3.6
Ease of cleaning	3.6
Overall performance	3.6
Overall satisfaction	3.4

#### Seattle Public Utilities

The Seattle Public Utilities department conducted a similar survey in March 2003. Personnel from 22 facilities contacted in the Seattle area known to have installed waterless urinals responded.

Respondents were asked to rate their facility's experience with no-flush urinals in several areas on a scale from 1 (unacceptable) to 5 (excellent). The areas rated and their mean scores were as follows:

Area	Mean
Overall experience	3.5
Plumbing maintenance (vs. flush-type)	3.5
Custodial care requirements (vs. flush type)	3.1
User acceptance	4.2

Frequency of maintenance:

<b>Activity</b>	<b>Mean</b>
Cleaning	Daily
Refilling sealant*	2 weeks
Replacing cartridge**	2.9 months

\*If required

\*\* One user reported removing, cleaning, refilling, and reusing the same cartridge for over two years.

Note: 15 of the 22 respondents reported flushing the drain line with water when changing the cartridge. Two of these added enzymes or line cleaner as well.

Other significant responses noted:

- Of (7) facilities inspecting their pipes, (6) reported a buildup of salts in the waste line.
- (3) facilities reported regular snaking is required to keep pipes open.
- (3) facilities reported yellowing of acrylic fixtures.
- Urinals were removed in (6) facilities; however, in (2) of these they were replaced with another brand.
- (6) facilities owners expressed a desire to install additional waterless urinals.

Reported “lessons learned” from survey participants:

- Keep cartridges filled with sealant liquid to reduce odor problems.
- Cartridges should be changed.
- Use enzymes and hot water to flush traps [drain lines].
- [Some manufacturers’] cartridges may be reused after rinsing.
- Train maintenance personnel not to pour water into urinals. [Water may be used to clean drains with trap cartridges removed.]

User comments encompassed both ends of the spectrum, very positive and quite negative. While some reported odor problems, others said odor was no problem. Examples of other positive aspects were making the restroom seem cleaner and good public acceptance. On the negative side were concerns about buildup in pipes; cost, frequency, and difficulty of cartridge replacement; and yellowing of fiberglass fixtures.

From both surveys it is apparent that owners must make a commitment to properly clean, service

and maintain waterless urinals for them to perform satisfactorily.

#### **ADDITIONAL OBSERVATIONS**

Since beginning this paper and conducting the surveys referenced above, the authors have become more aware of restroom sanitation in general. The following general observations, in restrooms with flush-type water urinals, have been made recently:

- A significant number of people do not wash their hands before leaving the restroom.
- Although not a high percentage, some urinals with defective flush valves are observed that run continuously.
- Many men’s public restrooms have unpleasant odors.
- A sizeable number of public restrooms are not properly cleaned and maintained.

Some, if not all, of these problem areas might be improved by the use of waterless urinals that are properly installed and cared for. While handwashing should be a part of every restroom visit, no-flush urinals limit one’s exposure to disease-causing germs by eliminating a handle to touch and spray from flushing. Well-maintained waterless urinals can reduce odor problems and enhance overall restroom appearance and sanitation.

#### **CASE STUDY**

Due to an environmentally conscious superintendent, waterless urinals were installed at the new intermediate school in a Texas coastal area school district. Sixteen fixtures were bid and installed as an add alternate at the facility.

Early on, school personnel reported odor problems from the waterless urinals. In one instance, a subsequent investigation revealed that the odor was due to a defective trap primer, not the urinals. More recently, in conversations with school maintenance personnel, they noted that the restrooms with no-flush urinals are cleaner since there is no water splashing from flushing urinals. Any odor problems that were present have apparently been eliminated with improved maintenance procedures. The one concern expressed was the approximate \$40 cost of replacement cartridges, which require changing about every 90 days. Monitoring of the installations is ongoing to track the performance of the urinals.

#### **SUMMARY**

Waterless urinals can offer a viable alternative to the conventional flush-type. Potential advantages include odor control and improved restroom

cleanliness, water savings, reduced maintenance, and environmental friendliness.

The results of two surveys cited, while not scientific, found users generally at least moderately satisfied overall with their no-flush urinals. However, a number expressed concerns of one type or another. Reported problems included odors and line encrustations.

Before installing waterless urinals throughout a building, campus, or district, a pilot program for evaluation is recommended. This allows owners to become familiar with and gain confidence in the product and properly train their personnel. Many users surveyed observed that there can be a significant learning curve for maintenance and custodial staffs to understand proper care of the fixtures. Also, a life cycle cost analysis should be done to determine actual cost savings. Finally, contact building officials early in the process to find out if the use of waterless urinals is allowed by local codes.

Widespread use of waterless urinals can produce a domino effect of conservation. Since no water is required, water utilities will not need to treat and pump as much water. Also, the absence of flushing means that less wastewater is generated requiring treatment. Smaller quantities of water pumped leads to energy savings. Therefore, water is conserved as are resources needed to generate electricity.

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