Water Conservation – Urinal Systems

ISSUE

Installation and operating costs, water efficiency, sanitary concerns, and the impact on the environment.

A common water conservation opportunity is associated with male washroom urinals. Historically, the urinals could be the highest consumer of water in a school facility, it is estimated at 17.5% of the total water consumption at Edmonton Public School facilities.

Implementing water conservation in schools offers two-fold benefits; water is saved at the facility, and the students receive practical education and experience on the merits of water conservation. While the savings potential is considerable, implementation is sometimes impeded by budgetary restrictions of the schools. When selecting water efficient equipment, it is important to consider durability and tamper resistance wherever students have access to the fixtures, equipment and appliances. High schools are considered one of the most abusive environments for sanitary fixtures.

The intent of this analysis is to examine the potential opportunities of the different urinal systems commercially available.

The technology options vary in the costs and benefits, the decision of what technology combination to use is dependent upon the priority and importance:

1. Life Cycle Cost – installation, maintenance and water,

2. Sanitary – touch less,

3. Environmental – water consumption & impact to the environment.

The following tables demonstrates results dependent upon priority in a typical school (calculations are based upon a mid-size school, with 150 male students, with a total of 7 urinals provided) :

30 Year Costs - installation + Operating + Maintenance

Ref #	Type	Cost
6	High Eff. FV Manual Flush (1.9l/f)	$ 16,484
2	Flush Tank with Occupancy Sensor (5.4l/cycle)	$ 17,624
4	Low Flow FV Manual Flush (3.8l/f)	$ 24,717
5	Low Flow FV Occupancy Flush (3.8l/f)	$ 27,405
7	Waterless Liquid Sealant Flush	$ 31,965
1	Flush Tank Continuous 15min interval (5.4l/cycle)	$ 41,647
3	Std Flush Valve (FV) Manual Flush	$ 90,587

30 Year Water Costs

Ref #	Type	Cost
7	Waterless Liquid Sealant Flush	$ -
2	Flush Tank with Occupancy Sensor (5.4l/cycle)	$ 6,374
6	High Eff. FV Manual Flush (1.9l/f)	$ 8,234
4	Low Flow FV Manual Flush (3.8l/f)	$ 16,467
5	Low Flow FV Occupancy Flush (3.8l/f)	$ 16,467
1	Flush Tank Continuous 15min interval (5.4l/cycle)	$ 33,997
3	Std Flush Valve (FV) Manual Flush	$ 82,337

Sanitary

Ref #	Type	Risk
7	Waterless Liquid Sealant Flush	Lowest
2	Flush Tank with Occupancy Sensor (5.4l/cycle)	Low
1	Flush Tank Continuous 15min interval (5.4l/cycle)	Low
6	High Eff. FV Manual Flush (1.9l/f)	High
5	Low Flow FV Occupancy Flush (3.8l/f)	High
4	Low Flow FV Manual Flush (3.8l/f)	High
3	Std Flush Valve (FV) Manual Flush	High

Waterless urinals can offer a viable alternative to the conventional flush-type. Potential advantages include odor control, improved restroom cleanliness, water savings, and reduced environmental impacts. However, the implementation and annual operating costs were found to be higher than current practice.

Based upon the findings, consideration should be given the following priority when / if modernization, and/or retrofits are being undertaken:

- Waterless Urinals – although higher operating costs, meets all potential criteria, assumes priority given to environment and sanitary conditions. Best when full modernization of washroom.

- High Efficient Flush Valve Wall mounted Urinals – lowest cost, next best water savings, somewhat sanitary risk (not hands free), best retrofit option.

In either case, it is imperative that manufacturer recommended installations are followed, for example:

a) Waterless urinals - height, drain grade, downstream of sinks or other water to keep urine from pooling (corrodes pipes), and maintenance of sealant to eliminate odors.

b) High Efficient Flush Valve urinals - proper flush valve adjustments to keep volumes to a minimum.

DISTRICT IMPACT

Approximately 17.5% of the total water in the district is used by urinals.

- Existing annual operation and maintenance costs are ~ $210,256.

- Converting all the urinals to Waterless Urinals, would cost ~ $1,290,000 (not including installation), the annual operation and maintenance costs are estimated ~ $261,429. The annual operating and maintenance costs include ongoing servicing and “sealant” costs.

- Converting all the urinals to High Efficient Flush Valve 1.9 l/flush, would cost ~ $900,000 for manual, (not including installation), the annual operation and maintenance costs are estimated ~ $117,185. The annual operating and maintenance costs include annual servicing and water costs.

  Using automated was not included, as the retrofit cost would double, and annual maintenance would increase significantly. Performance to date has not been proven.

The following table summarizes the findings:

Urinal Water Consumption - Technology Comparison - District Comparison				
# of Male Students ~				37,500
# of Male Students ~ flush tank urinals				11,000
# of Male Students ~ Flush valve urinals				26,500
# of cycles per student				2
# of Days				225
Annual Potential Flush Cycles				16,875,000
Water - Supply $/m3				$ 1.13
Water - Sewage $/m3				$ 1.01
EXISTING				
Type of System	**Flush Tank with Occupancy Sensor**	**High Eff. FV Manual Flush (metering type)**	**Adjustable Flush Valves**	**Totals**
# of	900	100	1,000	2,000
% of totals	45%	5%	50%	100%
cuM/Yr	29,525	941	45,088	75,553
Water $ Cost/yr	$ 63,182	$ 2,013	$ 96,489	$ 161,684
Annual Maintenance $	$ 21,857	$ 2,429	$ 24,286	$ 48,571
Totals	**$ 85,040**	**$ 4,441**	**$ 120,775**	**$ 210,256**
Convert to ALL High Efficient Flush Valves 1.9 L/cycle				
Type of System		**High Eff. FV Manual Flush (metering type)**		**Totals**
# of		2,000		2,000
cuM/Yr		32,063		32,063
Water $ Cost/yr		$ 68,614		$ 68,614
Annual Maintenance $		$ 48,571		$ 48,571
Totals		**$ 117,185**		**$ 117,185**
Budget Retrofit Cost (materials only)		**$ 900,000**		**$ 900,000**
Convert to ALL Waterless Urinals				
Type of System	**Waterless Urinal**			**Totals**
# of	2,000			2,000
cuM/Yr	-			-
Water $ Cost/yr	$ -			$ -
Annual Maintenance - sealent/cartridge	$ 261,429			$ 261,429
Totals	**$ 261,429**			**$ 261,429**
Budget Retrofit Cost (materials only)	**$ 1,290,000**			**$ 1,290,000**
Assumptions				
Water Wolf Control	Cycles tank five minutes after occupancy sensed			
	Once per day for cleaning			
	assumes 27 cycles daily @ 5.4 l/cycle			
High Efficient Flush Valves - Metering Type	~ 1.9 l/flush, 10% of urinal tank poplulation			
Adjustable Flush Valves - Delta Tech II Type	~ adjusted to ~ 3.78 L/flush, predominate flushvalve			
	installed in district.			
District Urinal Control	~ 200 flush tanks c/w water wolf occupancy control			
	~ 10% replaced flush tanks during upgrades (stalls replaced)			
	~ 80% flushometers are Delta TechII, set to ~ 3.78l/cycle			
New Installations	~ it is assumed that cost to refit plumbing is similar for all system retrofits,			

BACKGROUND

Primary urinal flush strategies typically used to provide sanitary urinal services in schools:

1. Urinal Flush Tank System – where a common tank is provided, and 2 to 3 plus stalls are connected. The tank continually fills and dumps, with virtually no moving mechanical parts. The fill rate is adjusted manually. The actual cycling is continuous, depending upon the fill rate. The addition of controls reduces or eliminates continuous filling cycle to match actual

usage. This simple system insures a low sanitary risk, low maintenance solution, when coupled with automatic controls, very low water consumption. It should be noted, that market availability is limited, it appears system is being phased out by the market place. Current EPS practice is to replace the tank system and stalls, with suitable high efficient flush valve systems (metering type valves, manually operated).

2. Urinal Flush Valve System – each stall is equipped with a Flushometer, which when activated, utilizes pressure from the main water supply system to discharge a high volume of water very quickly into the bowl. The flow rates can be adjusted. The cycle is either manual or automatic. This system introduces higher sanitary risk (when not used, not hands free), higher volumes of water (i.e. pre-1980 = 19.8 l/flush, 1994 to current 3.8l/flush to new 1.5 l/flush) for every use, and medium to low maintenance (numerous variety of parts, and suppliers). Current EPS practice is to use standard product, high efficient < 1.9 l/cycle metering type flush valves during retrofits.

3. Waterless Urinal System – waterless urinals are similar in appearance to others, but require neither water nor a valve. Because urine is about 96% liquid, no additional water is needed to wash it down the drain. Instead, these fixtures have a cartridge that houses a sealant liquid (vegetable oil) which is less dense than water. Urine sinks below the sealant liquid and the weight of the liquid pushes the waste into the drainage pipe. When the sealant becomes depleted, the cartridge does not work effectively and may result in an unpleasant odor. This system introduces low sanitary risk (hands free operation), no water requirements, however, increases maintenance to insure seal and drainage is maintained. It should be noted that affect on building drainage systems is unknown as products are new, i.e. pipe corrosion where urine is not flushed or diluted with water. Currently EPS is piloting use.

The benefit of replacing urinals is highly dependent on frequency of use and the type of proposed urinal replacement. As described above, there are many options now for urinal replacements; from simply replacing the continuously cycling flush tanks, flush valves, reduced flows, to replacing the entire urinal to a zero water use model and integrated automatic occupancy flush controls.

As with all urinals in the educational sector, there are a few extras items to consider:

- Maintenance staff must be trained to only use the proper parts when servicing the flush valves or all water savings will be negated
- Sensor flushometer mechanisms often result in more frequent urinal flushing than manual flush valves. There is no evidence the sensors valves save water. High cost to purchase and maintain. There is no sanitary need for the urinal to be flushed after every use. Vandalism and maintenance/replacement costs are high.
- Waterless urinals - user acceptance, a reluctance to use, users tend to use the toilets.
- Drain line maintenance - 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, or insure design includes sink drain or water urinal upstream to flush drain pipes.
- Odor Control. The absence of a water-urine blend in the bowl lessens the prevalence of odors often associated with urinals, is common with all systems, usually due to vandalism. In waterless urinals the sealant liquid filling the trap is designed to keep odors out of the restroom, it is not known how this can affect maintenance costs.
- Maintenance costs are born by the school budgets, acceptance is critical at this point.
- Urinals are one the favorite targets of vandalism in schools. Extra considerations must be made to assure the selected replacement urinals and the installations are durable to withstand the abuse. Some schools have chosen non-water urinals as a means to combat vandalism and floor flooding.

- Flushvalves – since manual, drain traps can dry up and result in sewer gases entering the schools.
- Flush Tank System Maintenance – parts availability i.e. tanks are no longer readily available and are special order.
- Codes and Regulations – clarification will be needed, research has indicated no issues throughout the U.S.

EPS SELECTION PRACTICE

The urinal systems selection practice is dependent upon the existing installation and/or modernization projects:

a. New Construction/Major Modernization – waterless urinals, flush valves sized to meet code rates (higher then best case),

b. Retrofit – where washrooms are being upgraded, and/or urinal stalls and/or urinal tanks being replaced, 1.9 l/flush flushometers are being installed. The valves are either metering or diaphragm type. The application depends upon the site conditions, and retrofit. The DELTA metering type can be adjusted, whereas the Regal diaphragm type are fixed volumes, and are interchangeable with toilets. The type is dependent upon the situation. It should be noted, that the diaphragm components are interchangeable, and caution to insure low flow 1.9 l/flush is applied correctly, this is not common, as the water will overflow the urinal being retrofitted. Standing stalls and tanks are no longer used, as it has been found that any water leaks can cause hidden and unknown damage, while tanks are no longer readily available.

c. Existing Flush Tank Systems – where intact, occupancy control “water wolves” have been installed, which limit the flush cycling to match actual use. The units are programmed to cycle a flush if no occupancy sensed for 5 minutes. A cycle is done daily to cleanse and maintain traps (odor).

CONCLUSION

The technology options vary in the costs and benefits, the decision of what technology combination to use is dependent upon the priority and importance:

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Sanitary

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Based upon the findings, consideration should be given the following priority when / if modernization, and/or retrofits are being undertaken:

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- High Efficient Flush Valve Wall mounted Urinals – lowest cost, next best water savings, somewhat sanitary risk (not hands free), best retrofit option.

In either case, it is imperative that manufacturer recommended installations are followed, for example:

c) Waterless urinals - height, drain grade, downstream of sinks or other water to keep urine from pooling (corrodes pipes), and maintenance of sealant to eliminate odors.

d) High Efficient Flush Valve urinals - proper flush valve adjustments to keep volumes to a minimum.

In either case, it is imperative that manufacturer recommended installations are followed – height, drain grade, downstream of sinks or other water to keep urine from pooling (corrodes pipes), flush valve adjustments, and maintenance of sealant to eliminate odors.

The following chart and graphs indicate a simple 30 life cycle.
The analysis includes all material, annual maintenance and water costs. Installation and plumbing are not included, as dynamic requirements are considered similar in cost. On “new” construction, waterless urinals would not require domestic water plumbing, thus could potentially lower first costs. Water use is based upon typical mid-size elementary school, 150 male students, seven urinals. Water consumption based upon male population requirements two uses per day.

Urinal Water Consumption - Technology Comparison - Simple 30 year Life Cycle Cost Comparison

Based upon typical mid-size elementary school, 150 male students, 7 urinals. Water consumption based upon population requirements, materials/maintenance based upon number of urinals.

Sorted by 30 Year total operating, maintenance and water costs

Ref#	Type	30 year Total $ Cost - material + maintenance + water
6*	High Eff. FV Manual Flush (1.9l/f)	$ 16,484
2*	Tank Occupancy Sensor (5.4 l/cycle)	$ 17,624
5	Low Flow FV Manual Flush (3.8l/f)	$ 24,717
4	Low Flow FV Occupancy Flush (l/f)	$ 27,405
7	Waterless Liquid Sealant Flush (7000 cycles/sealant)	$ 31,965
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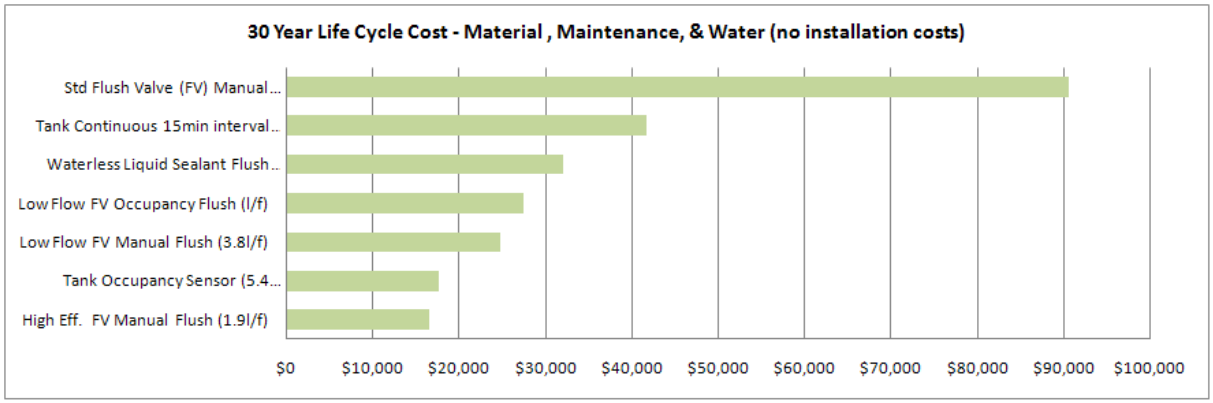

Sorted by 30 year Water Costs only.

Ref#	Type	30 year Water $ Cost
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2*	Tank Occupancy Sensor (5.4 l/cycle)	$ 6,374
6*	High Eff. FV Manual Flush (1.9l/f)	$ 8,234
0	Low Flow FV Manual Flush (3.8l/f)	$ 16,467
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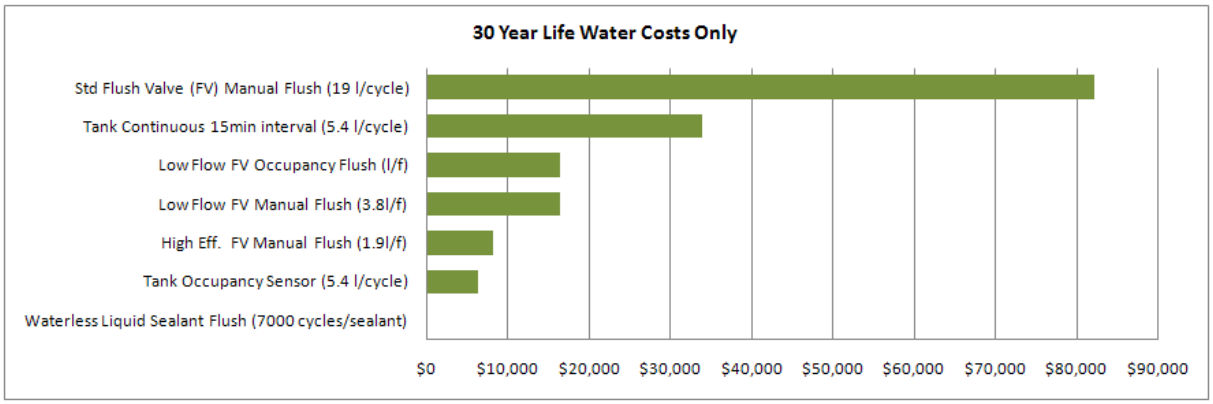

KEY CONTACTS

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ATTACHMENTS & REFERENCES

Urinal Water Consumption - Technology Comparison - Simple 30 year Life Cycle Cost Comparison
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Urinal Water Consumption - Technology Comparison - Simple 30 year Life Cycle Cost Comparison

Based upon typical mid-size elementary school, 150 male students, 7 urinals. Water consumption based upon population requirements, materials/maintenance based upon number of urinals ("*" denotes current EPS practise).

Ref#	1	2*	3	4	5	6*	7
Type	Tank	Tank	Std Flush Valve (FV)	Low Flow FV	Low Flow FV	High Eff. FV	Waterless
Control	Continuous 15min	Occupancy	Manual	Manual	Occupancy	Manual	Liquid Sealant
Volume/Cycle (Litres)	5.4	5.4	19.0	3.8	3.8	1.9	-
# of units	3 tanks, 7 stalls	3 tanks, 7 stalls	7 stalls	7 stalls	7 stalls	7 stalls	7 stalls
# of Male Students	150	150	150	150	150	150	150
# of cycles per student	2	2	2	2	2	2	2
# of Flush Cycles per day	144	27	300	300	300	300	300
# of Days	225	225	225	225	225	225	225
Annual Flush Cycles	97,200	18,225	67,500	67,500	67,500	67,500	67,500
Water - Supply $/m3	$ 1.13	$ 1.13	$ 1.13	$ 1.13	$ 1.13	$ 1.13	$ 1.13
Water - Sewage $/m3	$ 1.01	$ 1.01	$ 1.01	$ 1.01	$ 1.01	$ 1.01	$ 1.01
Total Annual Water Use L/yr	**530**	**99**	**1,283**	**257**	**257**	**128**	-
Total Annual Water Cost	**$ 1,133**	**$ 212**	**$ 2,745**	**$ 549**	**$ 549**	**$ 274**	$ -
Maintenance (costs spread across 7 urinals)							
Seasonal Check (2 hrs)	$ 170	$ 170	$ 170	$ 170	$ 170	$ 170	$ 170
Sealent Liquid	$ -	$ -	$ -	$ -	$ -	$ -	$ 745
Total	**$ 170**	**$ 170**	**$ 170**	**$ 170**	**$ 170**	**$ 170**	**$ 915**
Annual Operating Costs							
Maintenance	$ 170	$ 170	$ 170	$ 170	$ 170	$ 170	$ 915
Water	$ 1,133	$ 212	$ 2,745	$ 549	$ 549	$ 274	$ -
Total	**$ 1,303**	**$ 382**	**$ 2,915**	**$ 719**	**$ 719**	**$ 444**	**$ 915**
Implementation Costs (costs spread across 7 urinals, assumes plumbing in place)							
Tank	$ 450	$ 450	$ -	$ -	$ -	$ -	$ -
Stall Urinal Fixture	$ 2,100	$ 2,100	$ 2,100	$ 2,100	$ 2,100	$ 2,100	$ 4,200
Controls where app.	$ -	$ 3,600	$ -	$ -	$ 2,688	$ -	$ 315
Valves where app.	$ -	$ -	$ 1,050	$ 1,050	$ 1,050	$ 1,050	$ -
Add. Labor Install	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total	**$ 2,550**	**$ 6,150**	**$ 3,150**	**$ 3,150**	**$ 5,838**	**$ 3,150**	**$ 4,515**
					$ 1,668,000	$ 900,000	

30 Life Cycle Cost - does not including "fit-up plumbing and labor".

Cost Rating	7	2	6	4	3	1	5
Total Cost for 30 years	$ 41,647	$ 17,624	$ 90,587	$ 24,717	$ 27,405	$ 16,484	$ 31,965

Water Consumption Rating	6	2	7	5	4	3	1
Total Water Cost for 30 years	$ 33,997	$ 6,374	$ 82,337	$ 16,467	$ 16,467	$ 8,234	$ -

Notes

Odors	low	low	high potential	high potential	high potential	high potential	low
Sanitary	low risk - no touch	low risk - no touch	high-risk -manual	high-risk -manual	low risk - no touch	high-risk -manual	low risk - no touch
Water Use	High - always cycling	Low - cycles as needed	High - volume	Medium - volume	Medium - volume	low - volume	No water used
Install	Simple - limited availability of tanks		Simple	Simple	Simple	Simple	Complex
Maintenance	low	low	high potential	high potential	high potential	high potential	high cost of sealent
Other		high initial cost	no longer used, legacy		power/battery issues	simple	user acceptance issues
	a typical tank = 2 to 3 urinals unknown problems under stalls						concerns over build-up of urine solids in the drainlines behind these fixtures.

Annual operationg Cost - does not including "fit-up plumbing and labor".

Cost Rating	7	2	6	4	3	1	5
Total Cost for 30 years	$ 3,853	$ 6,532	$ 6,065	$ 3,869	$ 6,557	$ 3,594	$ 5,430

URINE PROPERTIES

Urine contains urea, ammonia and other compounds of nitrogen as well as salts, phosphates and sulphates. Ammonia will corrode copper and copper alloys. In moist conditions, including those in urinals, ammonia rapidly attacks copper. This may lead to corrosion and stress cracking of sewer pipes. Copper pipes should be replaced with PVC pipes before installing waterless urinals. Bacteria can precipitate calcium from human urine, causing a build-up of hard calcium scale on urinals and plumbing fittings. This can increase if water does not frequently flush away urine.

Allowing scale to build up can cause odours and reduce the capacity of your pipes. It can be a costly problem to fix, especially in older buildings where sewer pipes may be inaccessible, or their location unknown. Because urine can cause scale build up it is also important to consider the age, design and condition of the sewer pipes servicing your urinal. It is important to confirm that sewer pipes have sufficient fall to allow urine to drain freely away without causing a build up of sludge or scale in pipes. It is recommended that the fall of pipes draining urinals should be at least two degrees, and preferably more. Bacteria can also cause chemical reactions and produce ammonia, which can be corrosive, and create a very unpleasant odour for users. In confined spaces a high level of ammonia gas may also present a health hazard. Older pipes may already have these problems, which will become more apparent when they are no longer being flushed with water.

To avoid odour, urinals should have a physical barrier between the plumbing system and the user, and ventilation should be high.

WATERLESS URINAL OPERATION

Waterless urinals have been in operation since 1992, primarliy in Australia and Asia.

Waterless urinals all use basically the same science. Urine flows down the bowl of the urinal past a debris-catching strainer. The urine then passes through a sealing liquid, usually a specially designed oil based fluid or simply vegetable oil, and collects in the waste pipe below. The different densities of urine and oil (urine is denser than oil - oil floats!) mean that the urine sinks through the sealing liquid and the oil floats on top of the layer of urine below. Any air bubbles rise to the top and escape leaving the urine in a relatively low oxygen environment

It is important that the urine is slowed sufficiently before it hits the oil so that laminar flow displacement doesn't move the oil to the bottom of the waste pipe. If the urine is slowed sufficiently this is not a problem. After the urine is in the waste pipe it is a simple matter of displacement that sends the urine into the regular plumbing system.

There are two varieties of waterless urinal: cartridge based and non cartridge based units. Cartridge based units use a replaceable cartridge pre-filled with sealing liquid. These units are periodically replaced as the sealing liquid is slowly eroded or degraded. Non cartridge based systems work by simply introducing the sealing liquid into the drain hole and allowing it to naturally settle into the correct position.