UC Davis Urinal Replacement Project

Joe Bendorf

Josh Heasell

Jeffrey Hwa

Andrea Monteiro

Abstract

Urinals are simple, convenient, and quick, which are important for the busy college student or professor. But urinals should not be expensive or wasteful. As concerned student of the University of California Davis, we have researched the potential water and monetary savings that can be achieved through the installation of waterless urinals on campus. There was difficulty in obtaining the adequate information (for there appears to be little documentation on the matter), but through consultation with the buildings maintenance director, we acquired what we needed to carry out our calculations. We calculated the costs of removal and installation for every high-flow and low-flow unit with low-flow or waterless units respectively, and then compared these to the benefits, which we obtained by using the undergraduate male attendance for Fall of 2011, the gallons per flush (gpf) of units, the number of days in the fall through spring quarters, and an average of 2.5 flushes per male student for 20 years. Our results indicated that the greatest savings would occur by replacing all units with waterless ones, providing a savings of 8,276,767 gallons per year and a present benefit over the next 20 years of $19,929,043. We conclude that all urinals should be replaced with waterless ones, beginning with the high-flow toilets located in the buildings on campus built before 2000.

Introduction

Everybody pees, and most people have grown up in families that flush after every bathroom adventure. However, urinals are not a very efficient way of disposing of waste. I grew up with mindset of “if it’s yellow, let it mellow.” Not because my mother taught it to me, but I decided for myself that it was most efficient. Of course, not every male student on campus “lets it mellow,” so there is a lot of flushing going on campus. As concerned environmentally-motivate students, we propose the idea of replacing urinals to ones that are more efficient, and so reduce the amount of water used for each flush. University of California Davis is known all over the country to be the most sustainable and eco-friendly college. To further maintain our honored status, we propose that UC Davis replace the current high-flow urinals with low-flow or waterless urinals. However, UC Davis has many restrooms that contain high-flow urinals. High-flow urinals use a lot of water, thus replacing them with low flush or waterless would be an easy way for the university to save water through a reduction in the volume of wastewater disposed. We believe that any way to conserve water should be pursued, despite the costs associated. What we hope to prove however is that replacing the urinals will not only be efficient in terms of water conserved, but also in terms of money saved.

Objective

The objective of our project is to show the monetary and watery savings that will occur through the replacement of older urinals with more efficient ones at the University of California Davis. Using data on the number of urinals on campus, the number of male students enrolled, and the specifications for the urinals, we will determine the costs and benefits of converting all of the high-flow units to low-flow and to waterless, as well as for converting all units to waterless. The costs will be in the form of a one-time amount, while the benefits will be yearly. As such, we will use equation 1.2 to determine the present benefits over 20 years of operation.

With the final results we will then use the amount of water and money each urinal saved and compare that against the cost of its installation and see if it is worth switching to waterless or low-flow urinals.

Hypothesis

Our hypothesis is that waterless urinals will be the most beneficial over 20 years of installation in terms of cost and water savings. For us to prove our hypothesis, we will do calculations from multiple collections of data provided by campus supervisors.

Data Sources

A variety of data sources were used for this project. Through e-mails with Cynthia Kranc, the building maintenance director of UC Davis, we obtained the following information: 1.2 gpf for high-flow urinals on campus, .8 gpf for low-flow urinals, sewage rate of $0.18 per gallon of wastewater, $1500 cost of waterless urinal, $900 cost for flush unit, and $1500 labor cost to remove and replace old urinal (Cynthia Kranc, personal communication, November 16, 2012).

The ratio of “older buildings” to “newer buildings” is used to estimate the probability of high-flow and low-flow urinal use. By going into buildings ourselves, we determined that there are 39 newer buildings out of 123 that we counted on a map of UC Davis.

By going into campus buildings and restrooms ourselves, we determined that there is on average 4 men’s restrooms per buildings, and 3 urinals per bathroom. We estimate that each male student flushes a urinal 2.5 times a day, and that there are 273 days in a year, for we are not including the summer sessions in our calculations.

Lastly, we used the total male undergraduate enrollment for Fall of 2011 to estimate the number of students on campus using the bathrooms. There are 11,300 (rounded up from 11,282; which

we assume is okay because there is a large male faculty we are not taking into consideration) male undergraduates at UC Davis (No Author, 2012)

Methods and Assumption

To determine the total cost of respective urinal replacement, the cost per urinal will be multiplied by the urinals per bathroom, the bathrooms per building, and the number of buildings with that type of urinal.

To calculate the yearly benefit of urinal replacement, the cost per gallon of wastewater will be multiplied by the number of gallons per flush, flushes per student, the number of students per day and the days per year. We are not counting either summer session in our calculation of benefits, so the total benefits will not include monetary savings that would happen during the summer. A conversion factor is included to reflect the likely percentage of use of older and newer buildings to the total number of buildings; there is a ratio of 39 newer buildings to 84 older buildings, so the usage of urinals will be assumed to be 39/123 (.317 of total) for low-flow urinals and 84/123 (.683 of total) for high-flow urinals

To determine the present benefits of monetary savings through reduction in water use, we will use equation 1.2 as provided in Exercise 3 of the ESM 121 class:

$A*[((1+i)t-1)/(i*(1+i)t)]$

Assuming an interest rate of 4.5% over the next 20 years, i = .045 and t= 20

We will finally determine the amount of water saved by multiplying the gallons per flush conserved, the number of flushes per student, the number of students per day, the number of

days per year and the number of years.

We will also do a cost-benefit analysis by subtracting the total cost of each scenario by their respective benefits.

Calculation/Results

Cost of Urinal Replacement	Cost / urinal	Urinals / bathroom	Bathrooms/ building	Buildings	*Total Cost*
Old -> new	$2400	3	4	84	*$2,419,200*
Old -> waterless	$3000	3	4	84	*$3,024,000*
All -> waterless	$3000	3	4	123	*$4,418,000*

Benefit of urinal replacement	Cost / gallon	Gallons / flush saved	Flushes / student	Students / day	Days / year	Ratio Factor	*Yearly Benefit*
Old -> new	$.18	.4	2.5	11,300	273	.683	*$379,258*
Old -> waterless	$.18	1.2	2.5	11,300	273	.683	*$1,173,773*
New -> waterless	$.18	.8	2.5	11,300	273	.317	*$349,295*

The cost of replacing all urinals with waterless one would equal the sum of replacing the old urinals with waterless with the cost of replacing the new urinals with waterless ones:

$394,295/year + $1,137,773/year = $1,532,068/year

$1,532,068/year

Present Benefits

A*[((1+i)t-1)/(i*(1+i)t)]

Assuming an interest rate of 4.5% over the next 20 years, i = .045 and t= 20

The present benefit of replacing old urinals with new ones is calculated with A= $379,258 / year

Thus the present benefit is $4,933,364

The present benefit of replacing old urinals with waterless ones is calculated with A= $1*,173,773 / year*

Present benefit of $14,800,079

The present benefit of replacing all urinals with waterless ones is calculated with A= $1,532,068 / year

Present benefit of $19,929,043

Amount of water saved

High -> low

.4 gallons/flush * 2.5 flushes/student * 11,300 students/day * 273 days/year * .683 =

2,106,987 gallons/year

High -> waterless

1.2 gallons/flush * 2.5 flushes/student * 11,300 students/day * 273 days/year * .683 =

6,320,960 gallons/year

All -> waterless

.8 gallons/flush * 2.5 flushes/student * 11,300 students/day * 273 days/year * .317 +

benefit of replacing old urinals with waterless ones =

1,955,827 gallons/year + 6,320,960 gallons/year =

8,276,787 gallons/year

Benefits - Costs

High -> low = $4,933,364 - $2,419,200 = *$2,514,164*

High -> waterless = $14,800,079 - $3,024,000 = *$11,776,079*

All -> waterless = $19,929,043 - $4,418,000 = *$15,511,043*

Conclusions

Looking back at our final calculations, we can successfully conclude that our hypothesis is true. Replacing all of the urinals with waterless units will save approximately 13 million more dollars and 4 million more gallons per year than by replacing all high-flow units with low-flow ones.

Recommendation/Limitations

Our recommendation is that the University of California Davis funds a project to replace every single urinal on campus with waterless ones. Furthermore, we recommend that all buildings, residential, business, etc. replace all of their older toilets and urinals with the most current low-flow toilets to save money and conserve water. While the principal cost of replacement is steep, the long-term benefits are great enough to dissipate hesitation on

commencing. UC Davis should begin replacing their high-flow urinals with waterless ones, and slowly integrate waterless units into every bathroom.

This project can easily be forwarded to other colleges looking to be more eco-friendly. If companies start to see that this project can easily benefit the environment, this might get global attention and many other people will start changing urinals.

References

1. No Author. (2012). “UC Davis Profile.” UC Davis News and Information, <http://facts.ucdavis.edu/profile.lasso> (Nov. 10, 2012)