Flushing Out Water Waste at William and Mary
A proposal for reducing water use in campus urinals

I. Project Description

This project offers one method for conserving water at the College of William and Mary by reducing the amount of water used by urinals in campus restrooms. Williamsburg water rates are predicted to rise over the next two years according to a campus official, so reducing the amount of water used unnecessarily by standard 1 gallon per flush (gpf) urinals in men's restrooms will become a more enticing option economically as well as environmentally. Several water-saving urinal types are already available in the United States. Choosing the best option for the needs of William and Mary is the main goal of the project.

This proposal focuses on two of the more common types, the no-flush urinal and the pint flush urinal. They are compared in terms of costs and payback times and through testimonials from other universities that have installed them. In our cost-savings analysis, a no-flush model has a faster payback rate than a pint flush urinal. However, after reading online testimonials from other universities and public facilities and personally contacting officials at various schools, we have potential reservations with the no-flush models due to maintenance problems. Studies conducted on the newer pint-flush models suggest that they avoid the problems associated with the no-flush models. Since this style is the relative newcomer, however, the studies are more limited in number and time frame. Given this comparison of each model's advantages and disadvantages, we feel that the pint-flush urinal is the stronger candidate, though certainly subject to further review.

Action can still be taken by William and Mary facilities management to prepare for a study that will test the most promising option for our school once more studies become available. This trial project will include installing at least two urinals (in one or more restrooms) in a suitable campus building and monitoring water and cost savings, maintenance problems, and individual feedback over the period of one or two semesters. To reach this study period by the beginning of the 2009-2010 school year, work should be undertaken by the facilities management director of academic buildings to locate a good building for the study. The best way to reduce the costs of the study would be to select a building already designated to receive restroom renovations and urinal replacement in the next two years. In this scenario, the money that will be spent regardless can be used to procure urinals for the study if free samples cannot be obtained. After preparing for the study by calculating the amount of water currently used by the designated urinals, facilities management will be ready to install and monitor the trial urinals, which will be selected based on the information provided in this proposal and follow-up with other schools' buildings officials in the next year. The amount of time required for the study will vary depending on the model selected, but will not be nearly as costly as trying a large-scale product switch all at once. From this proactive effort, good data will be obtained about the feasibility and benefits of making more changes to campus urinals and where to begin these changes. Increased water rates do not have to be a burden on the College if the good examples of cost-effective conservation efforts already underway in facilities management are continued with urinals.

II. Need Assessment

With a campus of over 6000 students plus faculty and staff, a significant amount of water flows through the pipes of William and Mary each year. The college's current annual water use is approximately 1.5 million gallons per year at roughly six dollars per 1000 gallons for both water and sewage services. As a result of both increased demand from Williamsburg's population and the current state of drought, however, water costs are projected to rise 15% per year for at least the next two years, dramatically raising the College's water bill (Personal communication. WM Facilities Management Official. Williamsburg, VA. March 2008). Similar regional trends are leading many of William and Mary's colleague institutions to investigate ways to reduce and eliminate their own water needs. Though the College may indeed be able to foot the increased utilities charges, reducing the budget for general water consumption would obviously free those funds for other campus needs. That William and Mary would reduce its local environmental impact is also a noteworthy benefit, as water scarcity is now recognized as one of the most rapidly growing environmental problems (Speth, 2005).

Among the obvious contributors to the College's water consumption are its restrooms. As integral parts of daily life, restrooms are ideal focal points for conservation modifications. Several measures, such as the installation of faucet aerators and low-flow shower heads and the upgrade of some toilets to more water-efficient models, have already been implemented in various campus bathrooms (Personal communication. WM Facilities Management Official. Williamsburg, VA. March 2008; Durden, Chris. WM Residence Life. Williamsburg, VA. Transcript on file with author. 25 March 2008). Despite these steps, great potential exists for further conservation. Though William and Mary does not currently use bathroom-specific water meters, other institutions have estimated that toilets alone may account for a third or more of their domestic water use (Bass, 2008). The EPA describes over one half of domestic water use as bathroom-related; toilets represent 30% of that use (EPA website, 2008), though other studies indicate that the percentage of water use attributed to bathrooms may be as high as 75% (Mahler, 2008). A change in bathroom water use would thus greatly affect total water use in a system. Also intriguing is how visible conservation changes in bathrooms would be to the College community, particularly if signs detailing the environmental significance of the changes were posted. Such visibility would hopefully facilitate behavioral changes that could lead to even further conservation benefits.

Though there are many angles to attack resource conservation in bathrooms, this proposal will concentrate on decreasing water use in campus urinals. Since urinal fixtures are obviously integral to the everyday functioning of campus, we must then ask how to reduce their water use while maintaining functional effectiveness and user satisfaction. Advances in urinal technology allow for such a reduction, best exemplified in the complete removal of water (1 gpf in regular urinals) in no-flush urinals such as the Falcon and Waterless models. Though these models do require the periodic replacement of a filtration cartridge every 7000 uses, the savings based on elimination of water and sewage expenditures would allow for recompensation of the cost differential over a traditional urinal within two years and then continued return on the investment with water savings (see attached spreadsheet). For high-use areas, the installation of a more expensive but longer lasting filter unit is possible. Many of William and Mary's colleague institutions, including Duke University, the University of North Carolina at Chapel Hill, the University of Richmond, and Virginia Wesleyan, have joined various other institutions nationwide in installing no-flush units or are planning to do so in upcoming building projects (Personal communication. Duke Facilities Management Official. Durham, NC. 28 March 2008;

Pennel, 2007; Personal communication. VA Weslyan Biology Department Faculty. Hampton Roads, VA. 25 March 2008; NC Green Building website, 2008). UNC Chapel Hill, for example, has projected savings of 12 million gallons of water per year for its 300 no-flush Falcon urinals across campus (approximately 40,000 gallons per year per urinal) (NC Green Building website, 2008), and several other institutions have given very positive third-party reviews (Personal communication. VA Weslyan Biology Department Faculty. Hampton Roads, VA. 25 March 2008; Gerena, Rick. Personal communication. Oberlin College Trades Manager. Oberlin, Ohio. 27 March 2008.).

However, some institutions are now hesitating to either begin a no-flush urinal renovation or to continue buying them (Fulgham, Wade. Personal communication. NC State Energy Conservation Coordinator. Raleigh, NC. Transcript on file with author. 27 March 2008; Personal communication. Duke Facilities Management Official. Durham, NC. 28 March 2008; Personal communication. University of Maryland Office of Sustainability Staff. College Park, MD. 27 March 2008). Though no institution has denied that no-flush fixtures save water and have a relatively short payback period, these universities have expressed dissatisfaction with maintenance issues. The most worrisome issue is that no-flush urinals present a challenge to the maintenance staff, since they require very different upkeep techniques compared to traditional urinals. Specifically, this change in practice includes refilling the sealant within the urinal's cartridge every 1500 uses, and replacing the cartridge itself every 7000 uses (approximately every 3 months, varying for actual use). There is also controversy over the lifetime environmental effects of these cartridges, as they must be disposed of after use (Flores, 2008). In addition, cleaning practices are different for no-flush urinals, as the cartridge must be removed while cleaning the urinal. These issues could impose a learning curve for those responsible for urinal upkeep, and may further lead to piping problems if not addressed (Flores, 2008). Several sources have observed urine salt build-up in pipes draining these urinals, fostering concern over long-term maintenance issues. There is some discrepancy regarding the cause, as some of these sources claim that improper cleaning (not removing the cartridge beforehand) causes the problem, while others insinuate that this buildup is an unavoidable drawback to current designs (Fulgham, Wade. Personal communication. NC State Energy Conservation Coordinator. Raleigh, NC. Transcript on file with author. 27 March 2008). There is no clear conclusion regarding the cause, but third-party testimonials have indicated that such build-up does occur.

Other options besides no-flush urinals now exist for upgrading toilet water conservation. North Carolina State University is investigating urinals requiring only one pint (1/8 gallon) of water per flush. Though pint urinals are currently considerably more expensive than no-flush urinals, they still save 87.5% of water compared to 1 gpf urinals without requiring the periodic replacement of a cartridge or sealant, still allowing an approximate payback period of 6-7 years following this proposal's guidelines (see attached spreadsheet). The maintenance on pint urinals is essentially the same as a standard 1 gpf urinal, though some extra washing may be required to completely clear the bowl of particulate matter fall-in (Fulgham, Wade. Personal communication. NC State Energy Conservation Coordinator. Raleigh, NC. Transcript on file with author. 27 March 2008).

Pint urinals have also not yet exhibited the tendency to cause urine salt accumulation in pipes as no-flush models have. A University of Southern California study, albeit funded by Zurn (one of the primary producers of pint urinals), showed no salt accumulation over a six-month period in a location representative of area use and that was also frequented by maintenance staff who could comment on its effectiveness. Afterwards, USC adapted the Zurn model as their

standard for new construction (Ternan, 2007). True third-party testimonial (provided via Wade Fulgham, NC State University's Energy Conservation Coordinator) from Interface Engineering (a Portland consulting firm), the University of Washington, University of California Irvine, and Stanford University, all give very positive reviews of the Zurn. Interface Engineering now recommends pint urinals for its local area in light of water conservation measures. The University of Washington, which installed both pint and no-flush urinals in a single dormitory, further supported its review with its own independent research, stating that the pint urinals did not cause any salt accumulation while the no-flush urinals did. The pint urinal also did not exhibit any residual contamination in the trap post-flush, which, according to UW, indicated a more complete flush than some half-gallon urinals (Fulgham, Wade. Personal communication. NC State Energy Conservation Coordinator. Raleigh, NC. Transcript on file with author. 27 March 2008).

These results indicate a very positive potential for pint urinals at William and Mary. Even given lower utilities costs in Williamsburg than those of water-stressed California, where many of these initial studies and pilot tests on new urinals have been introduced in the United States, both the no-flush and pint urinals will clearly pay for themselves within a period of 2-7 years, depending on the model (see attached spreadsheet). By the same token, both will also clearly and significantly reduce water consumption at the College in a way very visible to the entire campus community.

To charge without preparation into expensive renovations by replacing all urinal fixtures at once, however, would certainly not be in the College's economic interest. As Virginia Weslyan University's Vice President of Operations Bruce Vaughan stressed in his seminar lecture on February 20, 2008, the best solutions for lowering resource consumption by universities do not deplete its budget. Such models must be avoided, so carefully projecting the costs and savings beforehand is a vital step to finding an economically viable alternative to traditional urinals. As relatively new products, both models are consequently expensive compared to standard urinals, especially the pint models. The attached spreadsheet offers preliminary calculations that should be verified by William and Mary Facilities Management. Beyond straightforward water savings versus installation cost, the no-flush urinals have continued to remain controversial for their maintenance issues, and pint urinals are still very much a new market product, despite their initial rave reviews (Fulgham, Wade. Personal communication. NC State Energy Conservation Coordinator. Raleigh, NC. Transcript on file with author. 27 March 2008). These considerations prove that we should balance progress with caution, as the issue of water conservation will become more important in upcoming years, and William and Mary needs to begin taking action now. A more detailed plan for a study that attempts to achieve this balance of planning and action is given in the following sections.

III. Objectives and Outcomes

Objective: Before any large-scale implementation of low-flow urinals, it is necessary to test their cost-effectiveness and operational consequences specific to William and Mary. The objective of this project is to evaluate an alternative model to 1 gpf urinals by undertaking a trial project within the next two years. According to other universities' testimonials regarding no-flush urinals and pint-flush urinals, the pint-flush urinals had fewer recorded problems, so we recommend that they be strongly considered as the model to be tested. Therefore, the first step in this project is to track the results of current pint urinal studies over the next year before deciding which model to test. Perhaps one company's model will receive more

recommendations or perhaps a flaw will be discovered that makes no-flush urinals a better option despite the maintenance-related reservations. Once the best alternative model is selected based on emerging studies, it can be implemented in limited quantities and evaluated over a five month to one year period in three areas:

1. water savings and cost efficiency
2. maintenance issues
3. user and staff feedback

Outcomes: This trial project will provide campus administration and facilities management with information on whether to install alternative urinal models in a larger number of buildings on campus and which types of buildings are best suited for them. The Mueller Report (Uhl in Bartlett and Chase, 2004) attests to the usefulness implementing small-scale projects rather than abrupt campus changes. If William and Mary starts small, investigating a urinal model with good reviews from other institutions and good projected cost savings, it will be more likely to find the best and most broadly applicable product for campus. Further, if problems arise during a small, pilot study, fewer resources will be lost in the process.

IV. Resources

The trial project may or may not require some up-front funding. N.C. State was given two sample pint urinals from the company Zurn to test out in their student recreation center (Fulgham, Wade. Personal communication. NC State Energy Conservation Coordinator. Raleigh, NC. Transcript on file with author. 27 March 2008), so the startup costs for the study includes only the time to install it. If William and Mary buys two or three urinals without help from the company, the payback times will vary. The attached spreadsheet shows how the payback time depends on the Williamsburg water and sewer rates ("Water Services" website, 2008). If the water rate goes up 15% from the 2008 rate in 2009 and another 15% in 2010 (Personal communication. W&M Facilities Management. Williamsburg, VA. March 2008), the payback times for the urinals will go down by approximately one year between 2008 and 2010. The spreadsheet calculations do not include potential model-dependent costs, like batteries for automatic flushing, or putting a water meter on the urinals before and during the study.

Comparison between Scenarios 1 and 2 on the spreadsheet shows another way to reduce the up-front cost for testing the new urinals: using money already allotted for replacing campus urinals (either for scheduled renovations or because the urinals no longer work). This is shown to reduce the payback time by 8 to 9 years, again depending on the water rates, for the urinal with the shortest payback time, the Waterless brand no-flush urinal. Conducting the study in a restroom already slated to replace urinals will also mean that money and time have already been factored in the plan.

This project would be conducted primarily by the facilities management department responsible for the building selected. Only the cleaning staff assigned to the test restroom(s) will need to be briefed on the project. If a no-flush urinal is trialed, the staff will need to be instructed on how to add more sealant and change the cartridge, requiring a few hours. Other responsibilities for proper general maintenance will include periodically washing the urinal out with warm water with the trap removed in order to avoid salt buildup in the pipes. If a pint-flush urinal is trialled, the staff will not need to be taught new cleaning methods because they are the same. In both cases, facilities management will have to install the urinals, likely a 1-2 hour job, and inspect the pipes at the end of the trial period, another 1-2 hour job. Additional resources for this project include signs to be put above the urinals explaining the project and sheets for user,

staff, and maintenance comments. These are explained in the next section. Someone will also need to periodically collect feedback sheets posted in the restroom and submitted by the cleaning staff and facilities maintenance workers. A member of the Student Environmental Action Coalition could be recruited to collect these sheets from designated boxes and compile the comments, which would only take about 1 hr/wk. The leader of the study – the facilities management director in charge of the building – would need to select a building, number of urinals and restroom(s) to be included in the study, brief workers, read feedback, and compute costs and savings to arrive at the final decisions. The work would be spread out over the course of the study, but the most work will come at the beginning and the end of the study period.

V. Implementation Plan and Timeline

1. Selecting location for trial project: Summer and Fall 2008

Finding the right location for a pilot project is an important step with several necessary considerations. The best location for a trial of no-flush urinals would not be a high-use area since other universities have reported more problems from no-flush urinals installed in such areas. Constant surveillance of the amount of sealant in the filter cartridge would be needed (unless a permanent cartridge type was selected for trial), which could be stressful for the facilities staff while they are adjusting to the new cleaning schedule and method. Pint-flush urinals have more flexibility since they do not have to be refilled, but putting them in a very high-use area could be problematic if something malfunctioned unexpectedly. We have not found a rigid formula for defining 'high-use' areas, but certainly some campus buildings, like William and Mary Hall or Phi Beta Kappa Hall, can have a lot of visitors in a short amount of time. Residential halls have a more predictable number of people using their bathrooms, but the bathrooms are sometimes spread out and harder to monitor (Personal communication. Administrator in W&M Residence Life. March 2008), and are often exposed to more intense uses (Fulgham, Wade. Personal communication. NC State Energy Conservation Coordinator. Raleigh, NC. Transcript on file with author. 27 March 2008). Academic buildings seem to have more regular use patterns than other public buildings and more accessible bathrooms than residential buildings, so they are potentially good test locations. The selected academic building would need to have at least one urinal per men's room. If there were two urinals in the same men's room, only one restroom would need to be included, otherwise, at least two separate restrooms would be involved, though this could be a benefit because it could receive more feedback.

Another factor that should be considered in selecting a location for a trial project is existing need for plumbing renovations or replacing the urinal fixtures. As described earlier, this reduces the start-up costs that facilities management would need to procure in order to finance the trial project. Since these plans are set up in advance, it is important to find out which buildings are due for renovations in before the 2009-2010 school year. Curtis Powell, the Facilities Management director of academic buildings, would be the best person to undertake this first step. If, however, an Office of Sustainability is set up, it could help find out this information and set up the study.

2. Establishing a basis for comparison and selecting a model to be studied: Spring 2009

After selecting a location for the trial project, the next step is calculating the average number of uses (and water) per urinal over a certain amount of time. Without establishing a base number of gallons of water used by the urinals at the trial location, payback for the urinals and overall cost-effectiveness cannot be estimated. This could be done by installing a water meter

for a period of time under normal use conditions or estimating the number of uses based on the average number of people in the building throughout the day.

Urinal model selection should be made after contacting other schools that have finished testing the pint urinals, such as N.C. State, the University of Washington, and the University of Southern California. If they report negative results or problems, a no-flush model should be considered. If the schools have positive results regarding maintenance and feedback of the pint-flush urinals, however, one of these models may be worth the extra up-front cost in the interest of avoiding long-term problems. It is also possible that the prices of these models will have decreased by spring 2009 if more companies start to produce pint models and compete for customers. The companies producing the models with the best combination of results and cost savings should also be contacted to see if they offer free samples for trials.

3. Install urinals: Summer 2009

Replacing the regular urinals with the trial urinals would be a good project for the summer or long winter break. With fewer student-related issues to deal with during breaks, maintenance and housekeeping would have more time to be briefed on proper care of the urinal. Each model has certain recommendations from the manufacturer, and following correct cleaning regimens could make a substantial difference in controlling the potential downsides to waterless or high efficiency urinals. Although the frequency of cleaning would likely increase once students returned, the staff should be given time to adjust to the new products before handling regular schedules. Also, while problems due to the fixtures themselves are not likely, it would be best to catch them before regular use.

4. Complete study of trial urinals: Fall 2009, possibly Spring 2010

Though the urinals should be installed while most students are away, the study should be completed once students have returned in order to reflect normal use patterns. An important part of the study will be notifying users of the change, the reasons behind it, and how to properly use the urinals. This can be done simply by hanging signs above the trial urinals during the project. These signs should include what not to do with the fixtures, such as flush more than once or put foreign objects in the urinals. The study could last from August to December. If the urinals are found to successfully reduce water use and save money without causing too many maintenance and user problems, then more urinals can be installed over winter break before the second projected increase in Williamsburg water rates. If the data is not conclusive, the trial can be extended into the spring semester.

VI. Evaluation Plan

Each of the three areas listed under the "Objective" section of part III must be evaluated.

1. The study must produce data about the number of gallons of water saved, which can be calculated by knowing or estimating the number of uses per urinal (to be measured in Spring 2009). Then, the total savings from water and sewer costs can be calculated.
2. Obtaining the number and type of any maintenance problems during the study period will also be important, so plumbers and facilities staff should be provided a way to log problems with the director of the study. One possibility is to provide a binder for the staff to record any problems. An analysis of urinal piping for salt accumulation after the study period would also be critical. This assessment would require maintenance staff to remove the pipes and examine them. This would be an excellent opportunity to invite other facilities management personnel or administrators for the College or other

Williamsburg officials to view the urinals and decide whether they would also like to use them in their facilities.

3. The last measure of success for the trial urinals is direct feedback from users and facilities staff. When Stanford installed some trial pint urinals, they put comment sheets for restroom users ("Water Conservation" Website, 2008). These sheets would need to be collected on a regular basis. Staff feedback should also be obtained through a survey sheet and at regular meetings during the study period.

VII. Appendix/Attachments/References

1. Explanation and limitations of cost analysis spreadsheet

The attached spreadsheet compares the costs and savings of installing several types of no-flush and pint-flush urinals under different water rates and installation plans. Its limitations include the estimations of urinal use per year and the cost of installing the current model used on campus. The number of uses per year varies according to the location of the urinal in the building and the location and type of building. Since we did not have a specific building in mind when writing this proposal, we made our savings and payback time calculations assuming 7800 flushes per year, or 30 times per day for 260 days. This model is used in cost saving calculations by the Department of Energy's Federal Energy Management Program, which seeks to reduce resource use in government agencies ("FEMP" website, 2008). Since this program deals with public facilities, their target numbers seem reasonable proxies for William and Mary, but clearly more precise estimations should be made, either by extrapolating the number of people in the buildings or by collecting data from one restroom, before the trial project begins. The cost of the urinals presently used on campus also varies because different buildings may have different models. Since the UC urinals have been retrofitted with Toto brand automatic flushers, we added the cost of the flusher valve to the cost of a relatively inexpensive basic urinal to attain a proxy value for a typical campus urinal. A Toto representative told us that these urinals are likely 1 gal/flush, so the model urinal is 1 gal/flush (Personal communication. March 2008). Although these values would need to be verified for a more detailed cost analysis, the spreadsheet provides a range of values that can help predict payback times.

Spreadsheet attached at end

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Appendix: Cost Analysis Spreadsheet

Estimated Water and Sewer Rates for William and Mary

Williamsburg Water Rate per 1000 gal. 2008	$3.30
Water Rate per 1000 gal 2009 (15% increase from 2008)	$3.80
Water Rate per 1000 gal. 2010 (30% increase from 2008)	$4.29
Williamsburg Sewer Rate per 1000 gal 2008 (1st 22500 gal/mo)	$2.65
Williamsburg Sewer Rate 2008 (after 22500 gal/mo)	$2.39
Combined Water and Sewer Cost per 1000 gal 2008	$5.95
Combined Water and Sewer Cost per 1000 gal 2010	$6.94

Estimated costs for current 1 gallon flush urinals on campus	
water and sewer cost per 1000 gal, 2008 rates	$5.95
water and sewer cost per 1000 gal, 2010 rates	$6.94
cost of Toto automatic flush valve (www.autoflushers.com)	$175.00
cost of cheapest Kohler urinal (www.homedepot.com)	$142.00
total cost of urinal fixture	$317.00
Scenario #1: Replacing functioning 1 gal flush urinal with no-flush urinal	
ex: Waterless brand No-Flush Urinal	
sealant cost per 1000 uses (3oz/1500) (www.waterless.com)	$1.02
Ecotrap cartridge cost per 1000 uses (www.waterless.com)	$0.79
total cost of supplies per 1000 uses	$1.81
savings per 1000 uses with 2008 water and sewer rates	$4.14
savings per 1000 uses with 2010 water and sewer rates	$5.13
cost of Waterless #2102 Sierra No-Flush Urinal (www.plumbersurplus.com)	$377.00
payback in flushes or gallons	
assuming 2008 water and sewer rates	90,969
assuming 2010 rates	73,428
payback in years assuming 7800 flushes/yr*	
2008 rates	11.7
2010 rates	9.4
*based on FEMP calculations, see proposal	
Scenario #2: installing no-flush urinal instead of replacing non-functioning flush urinal	
cost difference between replacing with current urinal style v. installing Waterless no-flush	$60.00
payback in flushes or gallons	
2008 rates	14,478
2010 rates	11,686
payback in years	
2008 rates	1.9
2010 rates	1.5
Scenario #3: installing Zurn pint flush urinal instead of replacing non-functioning flush urinal	
water and sewer cost per 1000 gal, 2008 rates	$0.74
water and sewer cost per 1000 gal, 2010 rates	$0.87
savings per 1000 gal in 2008	$5.21
savings per 1000 gal in 2010	$6.14
cost of fixture	$600.00
difference between replacing with current urinal style v. pint flush	$283.00

payback in flushes or gallons	
2008 rates	54,319
2010 rates	46,091
payback in years	
2008 rates	7.0
2010 rates	5.9