Final Design Report
ARCH 5150: Global Sustainability
Water Conservation in Student Dorms: Low Flow Aerators
Ana Aleman, Carolina Gutierrez, Viola Li
TA: Helena Khazdozian
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Abstract

For the Think Global Act Local project, our principal concern was reducing water consumption in Student Resident Dorms. High rates of water consumption can easily be found on grounds, especially in student dorms. This might be because students do not get to see a water bill while living in dorms, and they use the water available without being conscious of what are the possible consequences. As we consider that water is an essential resource in our world that is being threatened and depleted, we decided to tackle this issue and begin making a change that might positively affect this problem of water consumption. Thus, our goal was to lower the consumption of water in Student Resident Dorm Woody. We sent out a principal survey to Woody Dorms that covered some facts about the average daily use of water and the amount of water consumed by Woody dorms on an average, annual and monthly basis, with data obtained from the Energy & Utilities Division of the University of Virginia Facilities Management department. Through this survey, we were able to understand if the students were educated or not in the issue of water usage. The results from the surveys and water consumption data following the completion of the survey by the students showed a slight decrease in water consumption during the month of November in Woody. The next step of our project to get a more successful decrease in water consumption in Woody is to replace the water faucet aerators from 2.2 gpm to 0.5 gpm heavy duty and locking aerators. The estimated savings from such a reduction is approximately $2835.33 per academic year for the combined 11 McCormick Road dorms.

Introduction

There is growing realization among the public that the natural resources once taken for granted as unlimited are, in fact, finite, and many resources used are being threatened. In particular, water is a necessary resource that we use in our lives, and determining how to lower water consumption is crucial. As students who live on grounds don't have to pay for their utilities, they often take advantage of and use more of the resources available; faucets and showerheads are constantly left open wasting water. In fact, Mr. Andrew Green, the Sustainability Planner in the Office of the Architect for the University of Virginia, mentioned that our university consumes 495,200,000 gallons of water per year. Thus, there are many opportunities to work on grounds to lower the consumption. There is a concern for the amount of water that residential houses are using; being that there are many ways water consumption can be reduced, residential water consumption on grounds is the focus of this project.

The stakeholders involved in our problem definition include the residents of the dorms we intend to use during our trial run, their parents, the resident RAs, the utility engineers at UVa that oversee facilities and utilities, administrators of UVa, the utility companies that provide the utilities UVa uses as a university, and the Housing division. To specifically address each stakeholder, the residents of dorms and their parents pose the greatest possible obstacle for our project. We were informed that previous projects targeted towards reducing on grounds housing water consumption have included lowering the pressure of the showers in dorms that students used, and after enacting the changed, many parents and students complained to the Energy & Utilities department of UVa to express their discontent. We hope to minimize any negative

impacts upon the students, as they are the stakeholders most directly impacted by this project. Their needs are what matter most in terms of the project we hope to carry out. Thus, feedback from students is a vital part of our project and one that is incorporated into our project design. In terms of other stakeholders, resident RAs are vital in communicating the change to the students, and the Energy & Utilities Department has provided invaluable help regarding project design decisions, aerator choice, and general support to ensure our project is a feasible one. Utility companies' revenue from UVa may be lowered due to any resulting decrease in water consumption. They may be considered the "powerless" stakeholders, because as a utility company, they do not have a say in how UVa operates in terms of its utilities. We simply use the services they offer in exchange for payment. Finally, the Housing Department's input is necessary to formally execute our project in accordance with University guidelines and protocol.

Our problem of addressing on grounds housing water consumption is quantified through the data collected by the Energy & Utilities Department detailing how much water has been consumed by each dorm building on a monthly basis. These figures are reported in hGals (1 hGal equals 100 gallons). Based on the reduction, we will be able to quantify our project in terms of dollars saved and gallons conserved.

The stated goal of our project is an overarching one: to reduce water consumption in first-year, on grounds dorms. Our objectives detail the specific portion of water consumption we wish to address: to reduce water consumption used by faucets in first-year dorm bathrooms and to raise water conservation awareness among first-year students.

Project Design

Initial planning for this project resulted in a myriad of possible approaches to achieve our goals and objectives: the use and creation of an incentive system or contest for students in different dorms to compete in and reduce water use, the creation and use of green stickers or labels that will be placed in bathrooms with pithy water conservation awareness statements, changing the pressure of shower heads and water faucets in dorm bathrooms, installing automatic faucets that automatically shut off after being turned on, installing individual switches for multiple power outlets in dorms, the installation of automatic sensors for light in hallways and bathrooms, and the introduction of a filtration system that collects runoff and reroutes the water for use to flush toilets. Our specific approach of combining both low flow aerators and raising water conservation awareness was a direct result of working with community members and achieving a compromise through suggestions we received. Throughout the course of this class, we have learned that perhaps the single, most important aspect of any community service project is to listen to the community and understand their wants and needs.

In this way, we met with Energy & Utilities engineer Ms. Libba Williams to see which of our initial approaches would be best. She informed us that the installment of aerators would be the most cost effective and was an approach that the University had specifically stated interest in pursuing. Thus, our approach of installing 0.5 gpm aerators is in direct alignment with the University's needs and wishes (**see figure 1)**. In addition, our group wished to also address the heart of the water consumption issue: the mindset of the students. While the installment of low flow aerators will almost guarantee lower water usage, raising water conservation awareness will

further this initiative. With the introduction of low-flow aerators, increasing student awareness about water consumption issues is something that lends itself readily to our project as the students will be notified should any low-flow aerators be permanently installed. Thus, we decided to include water conservation awareness in our objective.

Prior to our actual design process, obtaining the approval of both the Water and Utilities department and the Housing department at UVa is necessary to implement our project. As of yet, the Housing department has been unable to provide us with feedback on our project due to the multitude of events that they are dealing with. We received a response from Area Coordinator Candice Clawson that we should hear back from the Housing department during the next semester.

The design process for the installation of 0.5 gpm aerators involves the purchase and installation of the aerators in a single student dorm to use as a trial run. Which aerators to purchase is the first and foremost decision to be made. Ms. Williams stressed to us the importance of having heavy duty and locking aerators, necessary to ensure that the aerators are tamperproof within the heavy commercial context of student dorms. Our group had initially contacted and received responses from the Charlottesville Water and Utilities department regarding the donation of free aerators to support our project. However, we learned that the aerators offered were 1 gpm aerators and lacked the heavy duty and locking quality necessary. After this failed approach, we turned to research which companies to purchase from that met the requirements we had. We decided on the 0.5 gpm aerators from the company Niagara, with a 10 year warranty, featuring tamperproof qualities that are “ideal for hotels and commercial use.”

The aerators are brass and chrome plated and are accompanied by locking keys to lock the aerators in place and prevent them from being taken off (**see figure 2**). The aerators cost $1.95 per aerator, or a six aerators for $9.95. It is likely that further consultation with the company, should the Housing Department choose to support our choice, will offer further discounts for the mass purchase of large quantities of their aerators. We chose this specific company and aerator design due to its low cost, positive feedback from consumers, and its specifications that meet our requirements. Thus, the first step of our design process, the research involved in deciding which aerators to purchase, was completed.

The second step in our design involves the actual purchase and installation of the aerators in the student dorm Woody. With the installation of aerators in only one dorm, we are able to use Woody's counterpart, Cauthen, as a comparison to calculate savings. From the floor plans (**see figure 3)** obtained from the Water and Utilities department, we determined that 40 aerators, which includes two extra aerators in case of malfunction, were necessary to retrofit the building of Woody. We were able to find many sources of documentation regarding the process of installing aerators, a process which will not require additional services from outside sources, as the process is relatively straightforward and simple, with online guides from various sources.

The actual installation of our aerators would ideally fall on either the start of a new semester or following an extended student holiday, such as Thanksgiving. From the feedback we received from our classmates, we realized the benefit of having students use the faucets with aerators after having been away from the dorms for several days, therefore drastically decreasing the immediate realization of a reduction in water flow.

A key portion of our project design is the withholding of information regarding the fact that low-flow aerators have actually been installed in dorm bathrooms from the students in the Woody dorm. Questions of ethicality were considered, resulting in the inclusion of Woody resident advisers (RAs) in our project plans. Through our e-mail correspondence with one of the RAs, Ms. Jennifer Riedel, we reached the conclusion that the withholding of information in this project design is something that is key to the success of our project, and in no way will directly harm any group of inviduals. Should the students be made aware of the change, the natural bias against the installation of 0.5 gpm aerators, regardless of whether or not the students will have noticed the changes on their own, could inhibit our project from moving forward. We addressed the issue of student feedback with the inclusion of a final survey that will be sent out to students regarding whether or not they noticed the aerator changes and whether or not they are in favor of such a change, given the amount of water saved. Following the installation of the aerators, data would be collected and sent to the Water and Utilities department. We plan to have the aerators installed for a complete month, as the data collected by the Water and Utilities department is reported month by month.

With the data collected, we will be able to determine how much water is saved through the use of aerators, and consequently, how much money has been saved for the University. This finding can be projected to predict savings for an entire school year.

Because the Housing division will be unable to review our proposal and hopefully extend their support of our purchase and installation of aerators for our project until the start of the next semester, we decided to calculate projected annual savings were the aerators to be installed. The

calculations performed are founded on the Environmental Protection Agency's (EPA) assumption regarding how much water would be saved with 0.5 gpm aerators: "Assuming that each building occupant washes his or her hands for 10 seconds four times per day and 250 days per year, the annual savings potential per occupant in changing from 2.2 gpm faucets to 0.5 gpm faucets would be 283 gallons per year" (U.S. EPA, "Lavatory Faucet Retrofits"). While these assumptions are not completely representative of student dorms, it is important to note that the final savings calculated will represent a minimum, as the use of faucets in residential dorms greatly exceeds the estimated usage used by the EPA.

The data used was provided from Ms. Williams regarding Cauthen and Woody's water consumption and bills during the 2009 to 2010 academic school year. Nine months' worth of data were used, September to May. While classes officially began on August 24, August was excluded due to the late start day of the month. The rates of water and sewage treatment costs used are $0.37/hGal and $0.64/hGal, respectively (**see figure 4)**. Thus, lowering water consumption saves not only water costs but also costs reflecting the need to treat the water once used.

Assuming that around 120 students live in a residential dorm building, one dorm building will save around $257.76 per academic school year.

With 11 dorms in that area with the similar layouts and generalizations, savings total $2835.33 per academic year (**see figure 5)**.

Assuming that the cost of purchasing aerators to retrofit bathroom faucets in one dorm will cost approximately $70, the total spent retrofitting all 11 dorms is $770. With the savings

generated from one academic year from the 11 retrofitted dorms combined, it will take less than one year to payback the money spent on the heavy duty, locking 0.5 gpm aerators.

As the calculations show, this is an opportunity worth investing in, both environmentally and economically.

Surveys

As for the awareness part of the project, we constructed a survey (**see figure 6**) with information regarding general water consumption facts juxtaposed with the water expenses and consumption rates for Woody provided to us by Ms. Williams. This survey not only informed us how knowledgeable students were about water consumption, but also served as an educational tool focused on raising awareness and decreasing ignorance towards the effects of high water consumption rates in student residence facilities. Being that we were unable to install the aerators on Woody's faucets as of this semester, the educational approach towards the water issue tackled and its results can be studied individually at its best.

The method used for obtaining the effect the survey had in terms of water consumption in student dorms is relatively simple. Since the survey was applied only to those living in Woody, one may use Cauthen as a control group. By keeping track of the gallons of water metered monthly for each residence facility, we were able to analyze whether the survey had a positive effect or not. Before the survey was sent, Woody had an estimated consumption of 1,707.96 hGals of water for the month of October. After sending the survey, the approximate water consumption for Woody in November decreased to 1,603.30 hGals. However, after studying the building's history of monthly water consumption, we noticed the amount of water used has a tendency to decrease around this same time of the year. For instance, it is recorded Woody consumed 1,811.71hGals of water in October 2008 and decreased to 1,591.56 hGals in

November of the same year. Yet again, the tendency is not constant. In 2006, the recorded consumption for October was 1,175.59 hGals but then increased to 1,706.98 hGals in November (**see figure 7**).

Because each year is different, it is best to use Cauthen's current information in order to determine how effective the survey was in terms of the decrease of water consumption. Also, the similarity in water consumption tendencies between Woody and Cauthen will prove the latter to be the most accurate source for comparison (**see figure 8**). In October, Cauthen consumed approximately 1,848.90 hGals of water and then, as occurred in Woody, decreased to 1,737.80 hGals in November. The total amount of water "saved" from October to November in Woody was 104.66 hGals; Cauthen decreased a total of 111.1 hGals of water (**see figure 9**).

As the results show, the survey unfortunately did not achieve the expected outcome and apparently had no effect on water consumption. However, one must take into consideration that there is a possibility that Woody's total amount of decrease in water consumption from October to November could have been less if the survey was not sent. Being this so, we continue to support any form of education that will raise the concern for water consumption, as the survey intends to do, as well as any other campaign focused on awareness regardless of how miniscule the effect may be.

The fact that the survey did not have an immediate result on the level of water consumption on the residence facility further enhances the notion that the water aerators are the best solution tackling the issue we wish to address.

Agents & Stakeholders

The resources used will be provided by the University's Energy & Utilities department, which has shown support for our project by offering to purchase aerators necessary for

implementation. The Housing department is also involved in the implementation of our project to ensure that we are following protocol and University guidelines. They pose as the key gateway community members; should they choose not to support our project, we will be unable to carry out our trial run. Resident advisors of the student dorms are also involved with our project, as we have kept them informed of any changes we wish to make. Indirectly, the first year students themselves are involved with our project, as they will be providing feedback on our project once implementation has been carried out.

Conclusion

So far, we have managed to determine the best solution for decreasing water consumption in student residence dorms is to install heavy duty locking aerators on the faucets. Because we were unable to install the aerators as of this semester, we were allowed the opportunity to study the effects student increase of awareness has on water consumption. After sending Woody's residents the survey designed to raise awareness by containing information regarding the building's water consumption expenses and rates, we studied the effects on the consumption prior to the survey as well as after and concluded the method was altogether not very successful. However, keeping things on the bright side, this result serves as evidence to our belief that aerators are the best and most feasible solution towards decreasing water consumption. The awareness study conducted with the survey therefore ultimately enhances our aerator proposal and project plan.

Motivated by our strong belief on the necessity of aerators in order to reduce water consumption, we have already contacted everybody necessary to complete the project and plan to proceed with it during the next year. To our advantage, thanks to Ms. Williams, the University's

Energy and Utilities Facilities Management Department demonstrates great interest and supports our project to the extent they even offered to fund it. Their support is key in achieving our goal of installing the aerators on the residence facilities since they will promote our project and assure its continuation. Another of our greatest achievements was obtaining consent and support from behalf of the Senior Residents and Resident Advisors of both Cauthen and Woody. Since the residents of the facilities are our most important stakeholders, having them on our side of the project increases our likelihood to succeed.

As of today, the only obstacle that is holding our project back from taking place is the University's Housing Division. They kindly informed us that due to various individual concerns of their own, they would rather not have us proceed with our project this current semester. However, we will continue to remind and insist them about the installation of the aerators in order to run the trial on Woody with the hopes of proving the projected savings. If the project provides an overall gain over loss in terms of cost and water consumption, then the possibility of applying aerators in all other residence facilities and further decreasing water consumption will increase.

In order to analyze the success of our project, keeping track of every action taken by filing it is essential. That is to say, all expenditures are to be recorded and labeled in charts so as to keep control of how much is being spent; this information will serve for future reference and will allow one to calculate if the project is cost effective. The dates of the implementation of the aerators must be recorded along with the monthly water consumption of the facilities with the purpose of comparing the result prior and after the changes and determine the total decrease in water consumption. Once all of this information is obtained and it hopefully proves an overall gain, it will be presented to the University's Housing Division with the goal of having them

install aerators on the rest of the student residence dorms. Since our project was originally the University's initiative and we already have the support from the majority of our stakeholders, achieving this goal is far from impossible.

Finally, what will ultimately determine our success is the feedback from behalf the students living in the dorms obtained by means of a survey sent after a month of implementing the changes in water pressure. If the students are overall satisfied with the changes and the water consumption decreases, then we will truthfully be able to name our project a successful one. After all, without our main stakeholder's satisfaction, the University's Housing Division would remove the aerators and our goals would not be achieved.

Future Work

Our principle project idea is to tackle the issue of water consumption on Student Dorms through the replacement of bathroom faucet aerators, something that our mentor Ms. Williams suggested from the beginning. We still need to implement the changes of the aerators. Fortunately, the Energy & Utilities division of the University of Virginia Facilities Management Department has expressed interest in implementing the aerators in all student dorms; we are going to have their support for our next part of our project.

Our next goal is to replace the water faucets 2.2 gallons per minute aerators in Woody with 0.5 gallons per minute aerators that are heavy duty and locking. If they are not heavy duty they wouldn't serve for the purpose of dorms, because they are constantly in use by the students; furthermore, they also need to be locking so the students would not be able to take them out. Currently the dorms have aerators of 2.2 gpm, which would produce 132 gallons if the water faucets are left open for an hour. Instead, if we replace them by the 0.5 gpm aerators, they would

produce 30 gallons in one hour. It might seem small in number, but when they are going to be actively used during the year, they make a change on water consumption statistics.

Ms. Williams offered that the University of Virginia Facilities Management Department would help us fund the aerators for the next part of our project. We will need approximately 40 aerators for Woody, and we found that the best offer to buy heavy duty and locking 0.5 gpm aerators was to buy them in a pack of 6 aerators for the price of $9.95. As we need 40, we would buy 7 packs and we would have 42 aerators for the total price of $69.65 ("Energy and Water Conservation").

We would like to implement the new aerators before the next Spring Semester, but it all depends on the permission of Housing Department. Through our correspondence with Ms. Candice Clawson, the Area Coordinator of Alderman Road Residences North in the Office of Dean of Students, we were informed that the Housing Department is undergoing a time of transition, causing key people to have their attention focused elsewhere. We have acknowledged that they are extremely busy, and we were informed that permission would most likely be given regarding the implementation of 0.5 gpm aerator installment during the upcoming Spring Semester. Ms. Williams, our mentor, told us that she will purse the purchase and the installation of the aerators, so we only need the permission to continue with the project. If we are able to implement them during this winter break or after spring we will have a great success, as students are going to be coming to their dorms after a break and hopefully they will not remember the water pressure of the faucets. Thus, the replacement of the aerators will be a success without complaints of the students. If they know that we are changing the 2.2 gpm aerators for the 0.5

gpm, they will start complaining at the beginning.

After the new aerators are in place in Woody, we know that they will make a change on their own, even if students do not cooperate on changing their behavior towards water consumption. Yet, we re going to measure if the aerators make a real success in changing water consumption by comparing the monthly consumption of water on Woody and Cauthen. Both dorms are similar in size and have almost the same numbers of water faucets. By keeping track of the differences of their monthly water usage we are going to be able to see if aerators can make a big impact.

As students living in Woody would already have been educated on the water consumption, we hope that the changes would be very noticeable. As Woody then will have two different approaches together tackling water consumption, educated students, and 0.5gpm aerators. If students do not make a change, aerators will be making the change on their own. It's a win-win situation for reducing water consumption.

Following the implementation of our project, follow-up on our project would include the presentation of the information obtained to the Housing Department and Energy & Utilities division concerning our findings. Our hope is to create an impact, no matter how small, regarding water consumption savings. By relating the amount of water saved through the installation of these low-flow aerators to the larger world issue of water scarcity, we hope to give further support to the University announced plan to explore the use of low-flow aerators. With the data we will have obtained, the University will have even more reason to implement this rather inexpensive change, a change that can produce a big impact in the daily lives of our

students. We recognize that the important aspects of this presentation would include the quantification of saved water in the Woody dorm, the extrapolation of water saved from just the Woody dorm to potential savings from all of the on grounds student dorms, and a willingness to listen to the concerns of the University regarding the installation of low-flow aerators and moving forward to address those future concerns.

Lessons Learned

We encountered some big problems as accomplishing our primary goals for this project. Because of the problems faced, we had to change the whole idea of our project. Yet, we were able to manage and create alternatives that still worked to succeed our goal of reducing water consumption on student dorms. We had the whole project at the beginning, we knew we would implement the aerators to solve the problem of high rates of water consumption on grounds, and we had our mentor supporting the idea, and we had the funding. It was too good to be true, but this made us learned that the project was in the real world, and people always faces constraints and obstacles, and one is only able to succeed by learning from overcoming those obstacles.

The first problem that we encountered was about the funding of the aerators. We were in the early staged of our project, and as presenting to the class our idea about implementing the changes of 2.2gpm aerators by 0.5 gpm aerators, a fellow student told us that the City of Charlottesville donated aerators. We were having them as our principal funders of our project, until we contacted them and they said that they did not give a large amount of aerators, only usually 1 – 3 aerators per person. Yet, we presented the project of reducing water consumption of

dorms and explained that we needed 40 aerators, they decided that they will help and fund us with the aerators for our project. We send this information to our mentor Ms. Williams, and unfortunately she replied back to us that those aerators did not work. The aerators that the City of Charlottesville provided were 1 gpm, they only did not work because they were 1 gpm and not 0.5 gpm, but they were not heavy duty and locking. And if we wanted to replace the aerators we needed to have ones that were heavy duty and locking.

After that, Ms. Williams offered her help and she told us that her Department, UVa Facilities and Management Department, would help us with the funding and implementation of the project. So we continued to do further research about heavy duty and locking 0.5 gpm aerators and found ones that offered 42 aerators for $69.65. (e3living).

At this point, we thought everything was solved and our project would continue to be the same and it would be a success. Yet, we contacted the RA of Woody to give us permission of the implementation of the aerators, but she told us that we needed to get permission from Housing Division. Contacting Housing Division was really frustrating, they weren't answering, and finally they told us that they had a lot going on, and many changes were occurring, that most probably the permission to implement our project wouldn't happen this semester. So, we had to change the whole perspective of our project but still considering how to resolve the issue of water consumption on dorms.

Therefore, we decided to change our perspective and send out surveys to the students living in Woody to educate them about water consumption. Increasing their awareness so that they would have a change in their behavior and help reduce the water consumption on the dorms

by making simple changes when using the water faucets or taking shorter baths.

If we had made something different to achieve our project, probably we would have contact the RA as soon as possible; thus, getting in touch with Housing Division earlier in the semester. Maybe if we would have asked permission to Housing Division earlier, probably they would have had more time to consider our project and we would have been able to implement the changes of the aerator before the Semester ended.

We acknowledge that working and implementing projects to make a change are difficult. Sometimes you might have a great idea, but getting the support and permission of others are somewhat difficult. It takes a lot of people to get the goals achieved, and if you are not on top of it, fighting for it to get it done and make it happen, it probably will not succeed. Yet, even though it is difficult to achieve your goals because of so many obstacles, one is able to learn from overcoming the problems and having alternative solutions to the same problem. It helps you to obtain a broader scope of the problem and to have an open mind when solving issues. Problems may be solved from different perspectives, and it is important that you have back-up plans in case one solution doesn't work.

Appendices

Bibliography

Energy and Water Conservation. .5 Gallons Per Minute Low Flow Faucet Aerator|E3living. Web.

"Lavatory Faucet Retrofits | Greening EPA | US EPA." *US Environmental Protection Agency*. Web. 25 Nov. 2010.

Costs and Budget

Costs of Aerators

Item	Unit Price	Amount Bought
0.5gpm Aerator	6 for $9.95	7 six packs = 42 aerators
Total: $69.65		

(Source: Energy and Water Conservation: 0.5 Gallons Per Minute Low Flow Faucet Aerator)

Figures and Diagrams

PERFORMANCE GOALS FOR WATER-EFFICIENT EQUIPMENT IN NEW OR RENOVATED UNIVERSITY BUILDINGS			
TYPE OF BUILDING	**TYPE of FIXTURE or EQUIPMENT**	**PLUMBING CODE (maximum allowed) or STANDARD WATER USE (GALS/USE)**	**GOAL: WATER EFFICIENT EQUIPMENT (GALLONS/USE)**
Academic, Other Research, Athletics, Non-residential Buildings	Public bathroom faucets	0.5 gpm	0.5 gpm
Student Dorm, Residential, Academic, Other Research, Athletics	Residential faucets	2.2 gpm	0.5 gpm
Café, Cafeteria, Large & Small Kitchens, Student Dorm, Academic, Other Research, Athletics	Kitchen faucets	2.2 gpm	2.2 gpm
Student Dorm, Residential, Academic, Other Research, Athletics	Toilets	1.6 gpf	Dual-plumb new buildings for Recycled Water for High Efficiency Toilets (HETs): <1.28 gallon per flush(gpf)
Student Dorm, Residential, Academic, Other Research, Athletics	Urinals	1.0 gpf	Dual-plumb new buildings for Recycled Water for High Efficiency Urinals (HEUs): 0.125 gpf
Student Dorm, Residential, Academic, Other Research, Athletics	Showerheads	2.5 gpm	<2 gpm (need to specify building water pressure before ordering; tamper resistant)
Student Dorm, Residential, Academic, Other Research, Athletics	Washing machines	40 gals/load	15 gals/load
Student Dorm, Residential, Academic, Other Research, Athletics	Dish washers	6.5 gals/load	< 5 gals/load
Café, Cafeteria, large kitchen	Pre-rinse nozzles; need to pass Food Service Tech Center certification (FSTC)	1.6 gpm	1.15 gpm (must be tested by FSTC)
Café, Cafeteria, large kitchen	Food Steamers; need to pass Food Service Tech Center certification (FSTC)	Use once-through tap water (continuously added, ~ 30 gals/hr) to cook	Use recirculating steam to heat steamers, also called "boilerless steamers". Steamers must be tested by FSTC, use < 2 gals/hr
Café, Cafeteria, large kitchen	Ice machines; need to pass Food Service Tech Center certification (FSTC)	Water-cooled uses 200 gallons for cooling each pound of ice	Once-through tap water cooling prohibited; Use re-circulating closed-loop chilled water or air
Café, Cafeteria, large kitchen	Commercial, industrial dishwashers	More than 1 gallon per rack	Maximum of 1 gallon per rack. Retrofit of nozzles to be efficient - Use Optirinse (Hobart) or comparable
Academic, Other Research	House vacuum system: liquid ring (wet) vs. dry vacuum pumps	Liquid ring (domestic water continuously added)	Use dry vacuum pumps
Academic, Other Research	Glass ware washers	Inefficient glassware washers	Purchase efficient units, such as HAMO brand
Academic, Other Research	Lasers, electron microscopes, or other research equipment needing cooling	Once-through water-cooled	Use re-circulating closed-loop chilled water for cooling. Once-through tap or chilled water cooling prohibited.
Academic, Other Research	Autoclaves, sterilizers: without mizers vs. with mizers	Domestic water runs continuously at 2.2gpm 24 hrs, 7 days, all year	Install water mizers. Quench water runs only when >140 F wash wastewater detected (typically <6 hrs per day). If available, use recycled water for quenching.
Academic, Other Research	Reverse Osmosis/water treatment system standard 50% efficiency vs. with re-use of reject water	RO reject wastewater to sewer, no re-use	Capture RO reject water for non-potable re-use. RO reject water could be used for non-potable uses, e.g., quenching, toilet flushing, sewer trap priming.
All Buildings	Condensate from Large Air Handling Units	N/A	Cooling coil condensate should be drained to condenser water systems or landscaping.
For more information please contact: www.fm.Virginia.edu or www.epa.gov/watersense			

Fig. 1. Expressed performance goals for the University of Virginia. Student dorm buildings, the area of interest for our project, have stated goals of installing 0.5 gpm aerators. In this way, our project choice is one that is made to be best accommodating for the community at hand; we wish to satisfy the needs of our stakeholders to the best of our ability above all else.
(Source: *Performance Goals for Water-Efficient Equipment in New or Renovated University Buildings*. University of Virginia Sustainability, 2010. PDF.)

Tamperproof 0.5 GPM Aerator

Ideal for hotels and commercial use!

A MEMBER OF THE
WATER SMART™
FAMILY OF PRODUCTS

- Choose from Female or Male Threads
- 0.5 GPM needle spray
- Saves 77% more water and energy*
- Brass/chrome plated
- 10 year guarantee
- Meets or exceeds ASME standards
- California Energy Commission Certified
- Works well on both kitchen and bathroom faucets
- Each case of aerators comes with locking key

AP-N3205FTP
AP-N3205MTP

Annual Savings Using the 1.5 GPM Faucet Aerator

Electric Water Heat	13,260 gal	$142 - 750 kWh
Gas Water Heat	13,260 gal	$103 - 42 therms

* Water treatment costs calculated at $4/1,000 gallons (includes waste water.) Electric savings calculated at $0.12 per kWh. Energy and water savings based on DOE/FEMP calculator data. 0.5 gpm tamperproof faucet aerator vs. standard 2.2 gpm faucet aerator.

AQUA PRO™ SOLUTIONS LLC
water conservation, purification & management
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aquaprosolutions.com info@aquaprosolutions.com
828.255.0772 P.O. Box 160, Swannanoa, NC 28806

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Fig. 2. The aerators necessary for our project must be both locking and heavy duty to meet the heavy usage they will be subject to within student dorms. These were the aerators that we suggested based on our research comparing prices and searching for aerators that meet our two requirements.
(Source: *Tamperproof 0.5 GPM Aerator*. Aqua Pro Solutions LLC. PDF.)

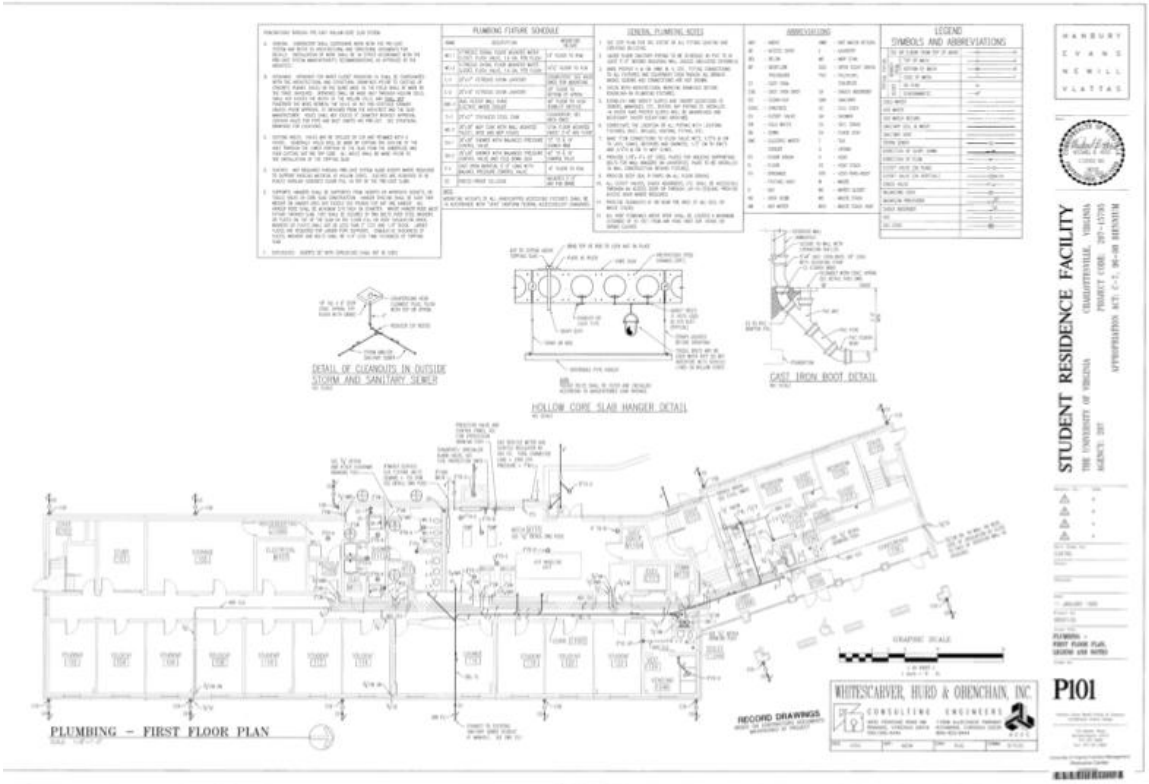

Fig. 3. An example of one of the floor plans we were given from the Utilities & Facilities department for the Woody residence. These were used to determine how many aerators would be necessary to retrofit just one building. (Source: *Plumbing - First Floor Plan, Legend, and Notes (The University of Virginia).* Whitescarver, Hurd & Obenchain, Inc., 1999. PDF.)

FiscalYear	BillMonth	Building	Consumption	Units	Cost	WONUM	Relationship	Plant
2011	11/1/10	2360	1,737.80	hGals	647.68	U02142	Consumer - Primary	Water Pumping Stations
2011	11/1/10	2360	1,737.80	hGals	1110.98	U02141	Consumer - Primary	Water Pumping Stations
2011	10/1/10	2360	1,848.90	hGals	689.09	U02142	Consumer - Primary	Water Pumping Stations
2011	10/1/10	2360	1,848.90	hGals	1182	U02141	Consumer - Primary	Water Pumping Stations
2011	9/1/10	2360	751.70	hGals	280.16	U02142	Consumer - Primary	Water Pumping Stations
2011	9/1/10	2360	751.70	hGals	480.56	U02141	Consumer - Primary	Water Pumping Stations
2011	8/1/10	2360	797.80	hGals	297.34	U02142	Consumer - Primary	Water Pumping Stations
2011	8/1/10	2360	797.80	hGals	510.03	U02141	Consumer - Primary	Water Pumping Stations
2011	7/1/10	2360	95.80	hGals	35.7	U02142	Consumer - Primary	Water Pumping Stations
2011	7/1/10	2360	95.80	hGals	61.24	U02141	Consumer - Primary	Water Pumping Stations
2010	6/1/10	2360	631.30	hGals	241.98	U02142	Consumer - Primary	Water Pumping Stations
2010	6/1/10	2360	631.30	hGals	338.57	U02141	Consumer - Primary	Water Pumping Stations
2010	5/1/10	2360	1,741.80	hGals	667.63	U02142	Consumer - Primary	Water Pumping Stations
2010	5/1/10	2360	1,741.80	hGals	934.13	U02141	Consumer - Primary	Water Pumping Stations
2010	4/1/10	2360	1,249.70	hGals	479.01	U02142	Consumer - Primary	Water Pumping Stations
2010	4/1/10	2360	1,249.70	hGals	670.21	U02141	Consumer - Primary	Water Pumping Stations
2010	3/1/10	2360	1,583.30	hGals	606.88	U02142	Consumer - Primary	Water Pumping Stations
2010	3/1/10	2360	1,583.30	hGals	849.12	U02141	Consumer - Primary	Water Pumping Stations
2010	2/1/10	2360	876.80	hGals	336.08	U02142	Consumer - Primary	Water Pumping Stations

Fig. 4. A portion of the data received by the Energy & Utilities department. The data shown is the most recent data received from water consumption meters for the Woody dorm building. The first cost listed are costs from consuming the water, while the second cost listed are costs from treatment of the water once it has been used. (Source: Water Consumption Data for Woody Dorm. 2010. Raw data. The University of Virginia Energy & Utilties.)

September	893.30
October	1707.96
November	1603.30
December	1380.81
January	941.57
February	809.22
March	1426.50
April	1243.67
May	1509.20
Average monthly consumption	1279.50
Average monthly cost (water)	476.87
Average monthly cost (sewage)	817.99
Water cost per hGal	$0.37
Sewage cost per hGal	$0.64
EPA savings per person per month	0.23583333
Monthly savings (hGal)	28.3
Average monthly consumption (w/)	1251.20
Average monthly cost* (water)	$466.32
Average monthly cost* (sewage)	$799.90
Monthly water savings	$10.55
Monthly sewage savings	$18.09
Monthly total savings	$28.64
Total savings per academic year	**$257.76**

Fig. 5. Calculations to predict how much money would be saved per academic year (September through May) for one student dorm with 40 bathroom faucets being retrofitted. Calculations were based on EPA reported savings from switching to 0.5 gpm aerators from 2.2 gpm aerators and the data received from Ms. Williams.

Timestamp	If you leave the faucet in your dorm running for one hour, approximately how many gallons of water will have been wasted down the drain?	How many gallons of water does an average person need to survive on a daily basis?	How many people can get their daily intake of water if you leave a bathroom faucet running for just one hour?	Approximately how many gallons of water do you think your dorm consumes during a typical year?	Approximately how much do you think energy and utilities cost for your dorm during a typical year?
11/11/2010 16:22:40	130 gallons	0.5 gallons	260	13,500 hGals	$100000
			50		
	130 gallons	.5 gallons	260	13,500 hgals	100000
	60 gallons	.5 gallon	120	126,900 gal	100000
	45 gallons	.25 gallons	180	18000	50000
	130!	see above	see above	see above	see above
	70	2	35	200690	15000
	130!	0.5	260	holy crap lots- 15,000 hGals	200k
	140	10	300	500000	200000
	50	3	30	100000	120000
	100 gallons	8 cups	200	20000 gallons	$150000
	more then 100	about 25	about 10 people	over 3000 gallons	more than $1000
	50	.5 gallons	100	100000	$100000
	over 100 gallons	about 8 cups a day	75	100000	175000
11/15/2010	250 gallons	Less than one	250 people	200000 gallons	$300000
	300	.25 gallon	350	200000	100000
	215	7 cups	100	400000	600000
	300	.25 gallon	900	500000	10000
	60	1	60	500000	10000
	70	0.5	100	200000	2500000
	250	2	125	200000	2000000

Fig. 6. Survey containing educational information expected to raise awareness. The data regarding the consumption rates and expenses was provided by Ms. Libba Williams; the rest was obtained by general knowledge and basic calculations.

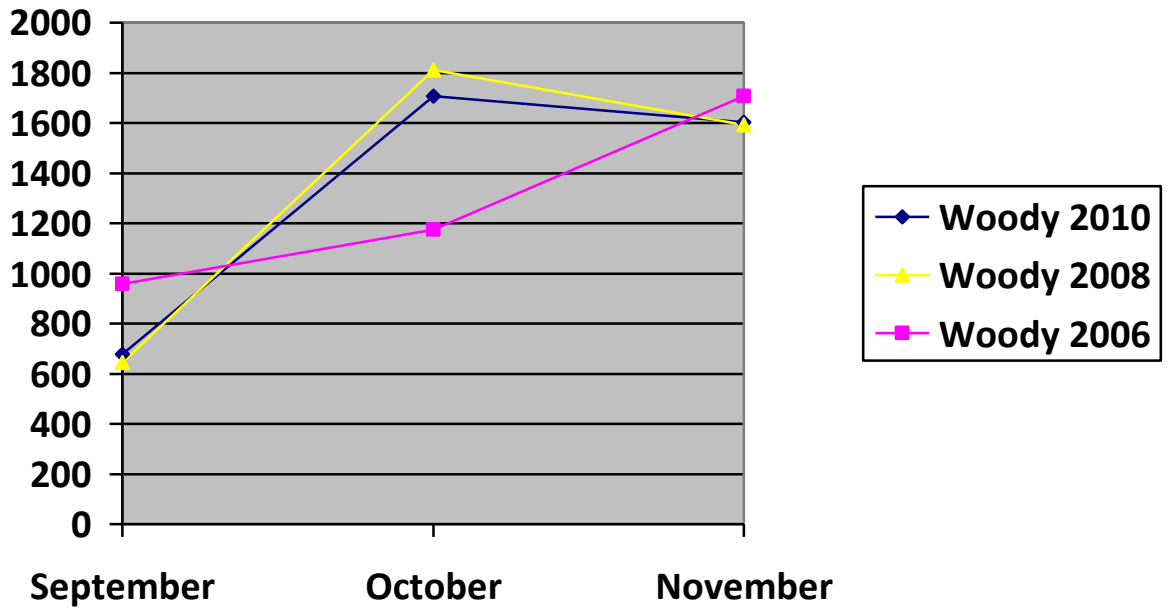

Fig. 7. Chart diagraming the water consumption tendencies in Woody during the months of September, October and November. The numbers on the Y axis represent hGals of water. The information was obtained from the University's Energy and Utilities Department.

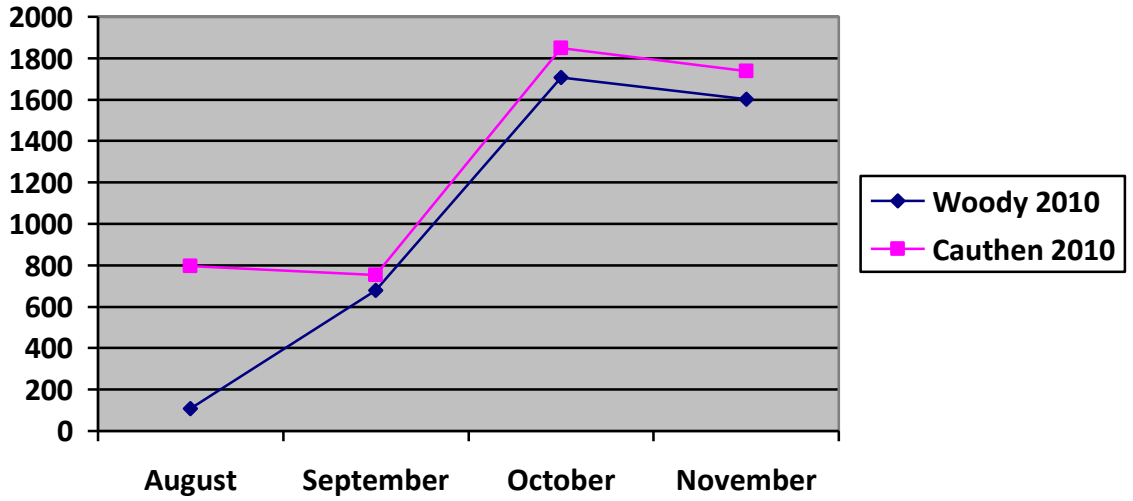

Fig. 8. Chart demonstrating the similarity in water consumption tendencies between Woody and Cauthen. The numbers represent hGals of water consumed. The data was provided by the University's Energy and Utilities Department.

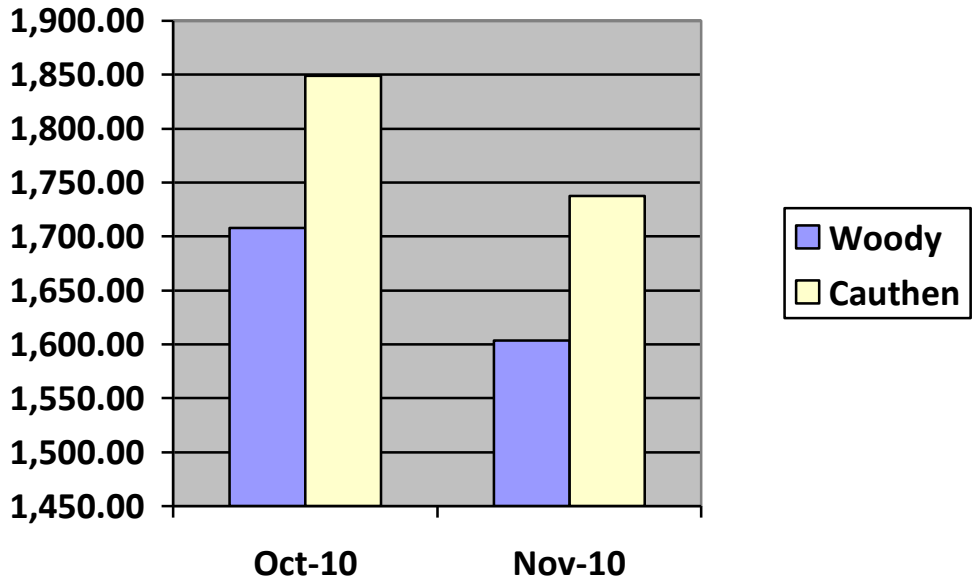

Fig. 9. Chart comparing the decrease of water consumption from October to November. In the case of Woody, the survey's result is reflected in November. The numbers represent hGals of water. The source for this table is the University's Energy and Utilities Department.

Acknowledgments

We appreciate the help of our mentor Ms. Libba Williams from UVa Facilities Management. She helped us from the beginning with different ideas for our proposed solution and was always in contact sending us different information to help us achieve our project.

We also want to thank our discussion group; the different opinions and ideas they shared with us were valuable for our project's success.