Saving Money at the Tank:
WWU Water Assessment

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Table of Contents

1.0 Introduction

1.1 PURPOSE: The purpose of this study is focused on improving efficiency of water consumption on Western Washington University's campus and to induce awareness of primary and secondary stakeholders' usage habits. The student population at WWU represents approximately 1/6 the total population of the City of Bellingham, thus any improvements on campus will positively impact the Bellingham community through a transfer of knowledge and reduced usage of natural resources.

Western sets a high standard in implementing new innovations for sustainable development. Sustainable development takes into account current needs without imposing upon the dexterity of future generations to satisfy their needs. This form of development encompasses the "triple bottom line" which includes economic, ecological, and social considerations which are all interdependent of each other.

This investigation of WWU consumption habits is a continuation from the 2010 Winter quarter. Our prior study convinced facilities management to purchase a portable monitoring system as well as provide the funds to purchase Conservacaps to retrofit high water usage urinals and toilets. The main focus of this continuation is to see through the installation of Conservacaps to determine if they are in fact a fast, cost effective solution to reducing WWU's water usage and to provide baseline data on a pre and post retrofitted bathroom by using the portable water meter.

Promoting and implementing conservation strategies to reduce the use of natural resources is a logical practice to follow. However, due to the low cost of water and energy, there has been a lack of incentives to update the existing system to maximum efficiency. Though increased coordination and cooperation with various stakeholders and implementation of various sustainable projects, WWU will serve as a leading model for other Universities and communities to follow.

1.2 ENERGY POLICY ACT OF 1992: In 1992, the passage of the federal Energy Policy Act established water efficiency standards for nearly all toilets, urinals, showerheads, and faucets manufactured after January 1994. The Energy Policy Act has three basic components relating to water fixtures: the establishment of maximum water use standards for plumbing fixtures, product marketing and labeling requirements, and recommendation of state and local incentive programs to accelerate voluntary fixture replacement.

The present maximum water use standers are as follows:

- Toilets: 1.6 GPF (gallon per flush)
- Urinals: 1.0 GPF
- Showerheads: 2.5 GPM (gallon per minute)
- Faucets: 2.5 GPM

Most of the buildings on Western's campus were built before the passage of the 1992 Energy Policy Act, which means many of the fixtures in use today are still high volume water consumers. The old fixtures use about 3.5 GPF for toilets, 2.5 GPF for urinals, and 1.5 GPM for lavatory sinks. New fixtures that are installed after an old fixture breaks are about 1.6 GPF for toilets, between 0.5 to 1.0 GPF for urinals, and 1.0 GPM for lavatory sinks.

1.3 IMPORTANCE TO WWU: Western currently uses approximately 88 million gallons of water a year, which is a little over 133 Olympic sized swimming pools. Any small measures taken to reduce Western's water consumption by retrofitting old fixtures will collectively amount to several hundred-thousand gallons of water being saved every year. Benefits of conserving water for Western include:

PRIMARY:

-REDUCTION IN WATER AND SEWAGE BILL
-POTENTIAL REDUCTION IN MAINTENANCE
-INCREASING THE CAMPUS STANDING IN SUSTAINABLE STEWARDSHIP

SECONDARY:

-ESTABLISHING WATER CONSERVATION HABITS IN OUTGOING STUDENTS

2.0 Methodology

Our project is a continuation of our project from Winter Quarter. Nonetheless, we faced contact issues that we believed were overcome. We have had difficulty establishing a monitoring program that is crucial to our study.

2.1 CONTACTS AND MEETINGS: The first week of class we touched base with Ron Bailey (former Mgr Operations Support). Ron was interested in our progress from the previous quarter and provided us with some information on a portable hand-held water meter and asked us to find out if the meter would be beneficial to the university. Ron also gave us some suggestions on how to expand our study.

We also set up a meeting with Steve Morrow the first week of class. Steve is a maintenance specialist that deals with the plumbing. We discussed how to implement the water saving Conservacap. We decided to wait to install the caps until we had the portable water meter. We also discussed the potential for waterless urinals. There has been much apprehension in various plumbing publications as to the benefits and problems with waterless urinals. Steve asked us to research some of the newer technology involved with the fixtures.

Judy Howell is head of the company that manufactures and distributes the Conservacap. After a phone conversation with Judy, she agreed to send us six Conservacaps to install and monitor if we provided her the results from our test.

The City of Bellingham is another stake holder that we wanted to involve in our project. We set up a meeting with the City's water conservation specialist, Anitra Acceturro. She provided us with several years worth of data on water usage from meters on campus.

2.2 CONSEVACAP RESEARCH: A Conservacap is a specially designed pressure cap that replaces manufacturer pressure caps. The Conservacap fits into the flushometer atop the diaphragm and reduces the flush time because of an increased cap diameter. According to United Energy, the company that manufactures the Conservacap, installing the cap reduces the water usage per flush between ½ gallon and 1 gallon depending on the flushometer.

2.3 ACADEMIC BUILDING FIXTURE AUDIT: In order to assess where on campus Conservacaps could be installed, we undertook the task of auditing toilets and urinals in older academic buildings. New and renovated buildings were omitted because fixtures in these buildings are water efficient. Although dorms use more water than academic buildings, we omitted them due to time and access constraints.

3.0 Case Studies

3.1 Case Study #1: Stanford University

Stanford University has created a water sustainability, efficiency, and conservation program which involves all groups on campus in the planning process. These groups include participation from academic, facilities, project management, student housing, dining, faculty/staff housing, and athletics departments. The goal of the program is to integrate appropriate water efficient technologies and practices across the various campus groups and to ensure Stanford's water supplies are available to support the university's mission for education and research. To accomplish this, a master water plan was created to implement water efficiency measures. Annually, the program awards funding for retrofit projects across campus, establishes water efficiency goals for new buildings and tests new water efficient technologies.

Results:

- Most academic, research, student housing, and athletics campus fixtures have been replaced with water efficient ones
- Non-potable water is used for irrigation
- Irrigation reduced by 25% by using evapo-transpiration irrigation controllers
- More than 1500 water meters
- Since 2000, Stanford has reduced their water consumption from 2.74 million gallons per day (mgd) to 2.15 mgd.

3.2 Case Study #2: Ferris State University

At Ferris State University located in Big Rapids, MI, the facility management staff set a goal to reduce the consumption of water as much as possible in the student housing without disrupting the functionality of the plumbing system. They also made it a point to make the students feel like they were getting enough water from the sinks and showers to avoid complaints. The renovation focused on toilets, showers, and bathroom sinks. The toilets were pre 1971 Sloan Flushometers which used 3.5 gallons of water per flush (GPF). They were retrofitted with Slone A-38-A repair kits and a special inside cover called a Conservacap. This retrofitting system shortens the flush cycle by a couple seconds, which saves close to a gallon per flush. Because the University only replaced the hardware of the toilets and not the whole fixture, the renovation was very cost effective. Showerheads were replaced that used 2.5 gallons of water per minute (GPM) to fixtures that used 2.0 GPM. New moderators were installed in the sinks which reduced the consumption from 2.0 GPM to 1.0 GPM.

Results:

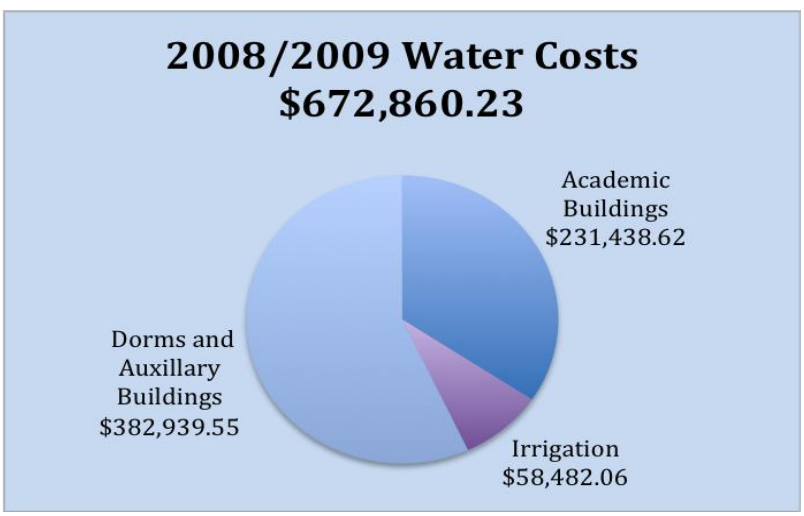
- Toilets saved over 38,000 gallons of water per month.
- Showers saved 51,000 gallons of water per month.
- Sinks saved 41,000 gallons of water per month.
- 910,000 gallons of water was saved in one year.
- At a water/sewer rate of $8.05 per thousand gallons, about $7,325 was saved in one year.

3.3 Case Study #3: Waterless Urinals: Features, Benefits, and Applications

Three engineers from a private firm performed a survey of 27 institutions that have installed waterless urinals. The survey included both advantages and disadvantages of waterless urinals. The survey found institutions that have installed the fixtures were generally pleased. The advantages included water saving, increased bathroom hygiene, lower maintenance costs, and overall reduction in the energy involved in pumping the water to fixtures. Some of the noted disadvantages included odor issues (many times from improper maintenance), installation issues, lack of acceptance by janitorial staff, and build-up of deposits in the line. Two convention centers that were surveyed had removed the waterless urinals. The main informational outcome of the survey found that in order for waterless urinals to be successful they must be properly maintained.

4.0 Research and Analysis

4.1 TOTAL CAMPUS USAGE:



The campus used ~ 88 million gallons of water between the dorms, auxiliary and academic buildings during the 2008/2009 school year. This does not include irrigation water usage.

As expected, the dormitories and auxiliary buildings use the most water. The irrigation was left out of the gallon calculation because the bills for those meters are calculated on different criteria than the building meters. This could be addressed in a further study on irrigation water usage.

During the 2008/2009 school year Western paid $1.22 per 748 gallons of water consumed and paid $3.16 per 748 gallons of sewage. There are also fixed charges for the meter potential, storm water, and watershed. As these charges increase, the small improvements made now will pay for themselves quickly.

4.2 FIXTURE AUDIT: We performed an observational audit of the older academic buildings on campus and found that there are several different types of flushometers. Many of these flushometers will accept the Conservacap. There was some uncertainty about the fixtures that could not accept the Conservacap and we estimate that approximately **78-100** flushometers are unable to be retrofitted. The flushometers that cannot accept the Conservacap would have to be replaced all together.

Academic Buildings that have flushometers that accept the Conservacap

	Toilets	Urinals
Artzen	32	16
Bond Hall	4	
Carver	Needs More Data	
College Hall	11	2
Environmental Studies	30	16
Fine Arts	3	
Humanities	3	1
Old Main	47	16
Ross ET	15	9
Wilson Library	31	
TOTAL	**176**	**60**

4.3 CHALLENGES

In the initial stage of this project we decided to monitor the flow of the Conservacaps in a closed system that we could control. We planned to use the portable handheld meter to measure the flow of water through an intake pipe in the basement of Environmental Studies building. Our test was to consist of installing the meter, then after closing off the bathroom to the public we would flush a toilet 20 times and extrapolate an average gallon per flush. We would then install the Conservacap and flush the toilet 20 more times. This would have proven once and for all if the Conservacap actually saves between ½ to 1 gallon of water per flush. However, we were unable to conduct this research because the handheld meter didn't arrive in time. We believe it is important for the school to finish this simple test before they invest in Conservacaps.

5.0 Conclusion

5.1 Environmental Studies Flushometer retrofitted with Conservacap

The "Conservacap" pressure cap combined with the Sloan A-38-A retrofit kit appears to be the most cost effective short term solution to conserving water and saving money. The "Conservacap" and Sloan A-38-A retrofit kit would cost ~$1800 to install in the ES building. Installing the cap and retrofit kit takes ~15-20 minutes per fixture and pays for itself in a year. Although major improvements to any building would require new fixtures under the Energy Conservation Act, at a cost of about $22,000 for the Environmental Studies building, WWU can begin saving money and water now with the "Conservacap."

<u>Estimated Weekly Savings with Conservacap in Environmental Studies</u>

	Flushes	Gallons Saved	$ Saved
Urinal	2057.030769	1550.769	10.30390632
Toilets	2172.270588	1637.64675	10.88115554
Total	4229.301357	**3188.41575**	**$21.18506187**

Projecting these numbers out for one year, WWU could expect to save ~144,000 gallons of water by retrofitting the ES building. The retrofit would pay for itself within a year. There are several other buildings on campus that are potential targets for further study.

5.2 Potential Savings from retrofitting academic buildings

Below we established a low estimate savings if the campus were to install the Conservacap on the 176 toilet flushomters and 60 urinal flushometers. This estimate was calculated without any raw data due to the lack of individual building meters.

	Urinal Savings	Toilet Savings	Total per year
Gallons	231412.5	382272	613,684.5
Money	1534.5	2534.852	$4069.352

These calculated savings were extrapolated from last quarter data assuming each urinal flushes 128 times per week and each toilet flushes 72 times per week. These numbers were multiplied by the total number of fixtures to be retrofitted (176 toilets and 60 urinals). We based our final savings on 40 weeks of use.

5.3 Monitoring

Monitoring the water usage on campus is a difficult task. There are more than 42 separate meters feeding the various buildings. Also complicating monitoring is the loop systems that many of the buildings are on, which use a combination of water lines to meet fluctuating water needs. The ability to monitor building water usage is critical. Estimates have been made that facilities lose 10% of their water through undetected leaks.

We recommend all new buildings and all renovation projects include a sub-meter. Furthermore, we propose that the building managers create a weekly monitoring program to establish a normal range of water usage. The monitoring program will take minimal time and will show abnormal consumption to alert maintenance of a potential problem. The portable meter can also be used to detect leaks and will help facilities management in determining normal water usage trends in buildings lacking a sub-meter.

Buildings that currently have individual meters:

Commissary	Communications Facility	Smate	Environmental Studies
Carver Gym	Biology	Administrative Services	Alumni
Chemistry	Buchanan	Campus Services	Higginson Hall
Mathes Hall	Highland Hall 1	Highland Hall 2	Student Rec

6 Future Work

6.1 DORMATORY ASSESSMENT

In order to produce a more complete study of water conservation strategies more data is required. We believe the next step to doing this is by taking more meter readings from sub-metered buildings. By increasing our data points we will be able to produce a more accurate account of the amount of water being consumed. Because the study focuses mainly on academic buildings, we suggest expanding this out to dormitories. One strategy we would like to implement is to take meter readings for a single dorm building for a month, then install A-38-A repair kits as well as "Conservacaps" in that building, then take another months worth of meter readings to determine if retrofitting old fixtures is worth the initial cost as well as getting a rough estimate of the amount of water Western could save.

6.2 WATERLESS URINALS

There are other ways Western can reduce their use of water such as installing waterless urinals. We researched the feasibility of waterless urinals during this project and found mixed reviews. The technology available for waterless urinals combined with the cost to install and maintain them may not be feasible to WWU at this time due to the low price of water. However, waterless technology is constantly improving and should be re-examined when new buildings and major renovations are proposed.

6.3 GREYWATER USE

The use of greywater (which is effluent from hand washing and bathing) for toilet flushing and irrigation would be another interesting way of potentially saving water and money. Currently WWU pays fees for intake and output of water. The output charge is more than 2x the input charge. Anitra Accetturo, the water conservation specialist for the City of Bellingham, is particularly interested in working with a group of students on this subject. Much research and cost analysis would need to be done in order to properly assess this type of system.

7 Appendix

7.1 List of Assumptions

Assumptions for Calculations:

- Average hand washing is ~ 30 seconds per person per event
- Average bathroom use 6 times per day per person
- Average urination 5 times a day per person (5/6) ~83%
- Average solid use 1 time a day per person (1/6) ~ 17%
- 50% males and 50% females
- 58% of flushes are from toilets
- 42% of flushes are from Urinals
- ~2000 gal of water is used in the labs/offices per week

Calculated Flushes:

To get the average total water usage in the bathrooms we first subtracted the lab/office water usage (2000 gal) of ES from each of our weekly total usage and then averaged the four weeks. (~16,000 gallons)

We took the average total bathroom water usage (16,000 gal) and divided it by 3.25 *(urinal usage (2.5) + sink usage (.75)).* We then multiplied that number by the flushes from urinals which is 42% (.42). This gave us 2068 flushes per week for urinals.

We took the average total bathroom water usage (16,000 gal) and divided it by 4.25 (*toilet usage (3.5) + sink usage (.75)).* We then multiplied that number by the flushes from toilets which is 58% (.58). This gave us 2184 flushes per week for toilets.

Calculated Savings:

The cost of water (incoming/outgoing) is $4.96/748 gallons. The Conservacap gives a minimum estimate of .75 gallons saved per flush. We multiplied the number of total flushes by .75 to get the gallons/week saved (~3188 gallons). To calculate the savings we subtracted .75

7.2 References

Conversation with Anitra Accetturo, City of Bellingham Water Conservation Specialist

Conversation with Ron Bailey, Manager of Operations Support at Western Washington University

Conversation with Steve Morrow, Maintenance Specialist Plumbing at Western Washington University

E-mail communication with Terry Cegielski, Assistant Director of Grounds and Sustainability University Residences at Purdue University, regarding Conservacap usage

Email communication with Troy Ragsdale, Western Washington University Program Coordinator, regarding class enrollment for campus

Email communication with Kathy Patrick, Admissions Advisor, regarding blanket email sent out to professors using labs in the ES building

Phone conversation with Judy Howell, President of United Energy, LLC.

Phone conversation with Jordan Sager, Head of Facilities Management at University of California Santa Barbra

E-mail communication with Tim Wynn, Head of Facilities Management at WWU

http://lbre.stanford.edu/sem/water_conservation_programs#facilities

http://www.conservacap.com/Project%20Succusses/ferrisState.pdf

http://www.cepis.ops-oms.org/muwww/fulltext/repind48/energy/energy.html

http://repository.tamu.edu/bitstream/handle/1969.1/4626/ESL-HH-04-05-26.pdf?sequence=4