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GEOS 206

## Clean Water: The Ultimate Resource

### Low-Flow Fixtures in Williams Hall



**Figure 1. A trickling faucet. Low-flow water fixtures can be both environmentally conscious and impractical for daily use.**

#### Introduction

The World Water Vision Report declares: "There is a water crisis today. But the crisis is not about having too little water to satisfy our needs. It is a crisis of managing water so badly that billions of people - and the environment - suffer badly" ("Water Crisis"). When people are not facing water scarcity, they forget that potable water is a luxury, and they tend to sit by idly as large quantities of this valuable resource, quite literally, go down the drain.

Approximately one third of the world's population lives in countries with moderate to high water stress due to mismanagement of this important resource. Water stress describes the imbalanced ratio of water use to water resources. Today, more than one out of six people in the world are without access to clean drinking water and more than two out of six lack proper sanitation ("Water Crisis")<sup>1</sup>. This mismanagement is going to cause greater problems in the next twenty years, as the demand for clean water will increase with projected growth in population, industry, urbanization, and agricultural development. If current management techniques do not change with increasing demand for potable water, the global supply of freshwater will be depleted ("Freshwater: About").



**Figure 2. Water stress has desiccated land and caused crop failure worldwide. (Source: <http://cache.daylife.com/imageserve/05Zsh2ueV57Xo/340x.jpg>)**

In the Discovery Channel's "How Stuff Works" series, the footage covering water waste prevention provides numbers that highlight average water waste in American households. In the United States, the average person uses up to 183 gallons of water for daily living. In a ten-minute shower, 25 gallons of water are used on average, and in many places, showerheads deliver at even higher rates. At Williams, water usage in dormitories accounts for nearly 40% of the

College's total water usage.<sup>2</sup> According to

"How Stuff Works," installing low-flow showerheads and aerators on faucets can reduce

<sup>1</sup> Estimation for 2002, by the [WHO/UNICEF JMP, 2004](http://www.who.int/unicef/jmp)

<sup>2</sup> <http://utilitydirect.schooldude.com/index.php?action=2000&report=240>

water usage by up to 50% in showers and sinks, which could result in saving 57 gallons of water daily! ("Go Green: Water Waste Prevention") With 40% of Williams students on a sports team (and others who are highly active on their own), it is likely that many students are showering more than once a day, increasing the College's potential to reduce consumption with new fixtures.

The Williamstown water system dates back to 1875 and has seen many changes in the past 133 years (Geology 1). Williamstown is not currently affected by water stress due to the large quantities of snow and rain we receive each year and moderate summer temperatures; however, being a member of the global community and consuming nearly 30% of the town of Williamstown's water supply<sup>3</sup>, Williams College has the duty to act responsibly with its resources. At Williams College there is a tremendous amount of water waste that can be reduced with the implementation of water saving technologies and conservation methods. This report examines the results of reducing water flow in residential dormitories on campus to reduce the overall water waste at Williams College.

### A 1994 Student Report

In 1994, students enrolled in a geology Winter Study course examined waste water on campus, specifically focusing their attention of water use in Sage Hall. The 1994 report found that, at that time, the college was using 52,441,542 gallons of water per year (current use is nearly 70,000,000<sup>4</sup>), which is split between the water converted to steam to heat campus buildings and personal water use. The annual total raw water cost for Williams College water usage in 1994 was \$123,966 (Geology Class 2). These figures

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<sup>3</sup> Interview with Ed Rondeau, Water/Sewer Superintendent of the Town of Williamstown. This estimation does not take into account seasonal variations and campus population during the summer.

<sup>4</sup> Rondeau, Ed.

were true even after the first low-flow installations were done in dorms in 1990. The 1990 installations were done in response to regulation and code changes at the state and federal, requiring that replaced fixtures use less water. (Jensen, Ken).

In the 1994 report, the class concluded that: “reduction in use can most easily occur by replacing water fixtures with low-flow units in residential buildings” due to the general sentiment that students were not willing to compromise or alter their water habits, because they do not directly feel the negative environmental effects and cost of their water use (Geology 2). The students found that the installation of low-flow water features in dorms across campus would result in the college saving \$24,426 per year (Geology 2).

### Project Report



**Figure 3. Faucet aerator.**  
(Source: [http://www.eartheasy.com/live\\_lowflow\\_aerators.htm](http://www.eartheasy.com/live_lowflow_aerators.htm))

The water reducing renovations suggested in the 1994 report have been set in place, but, by now, water-saving technology has progressed beyond the capabilities of the low-flow fixtures currently installed in residential buildings on campus; therefore, it is time to take a new look at reducing water usage in residential spaces on campus by examining the impact of installing the latest water saving aerators and showerheads.

Williams College currently has a few systems in place to monitor and reduce water use on campus. At present, each building is monitored for its water use by two systems: one that measures low-flow rates and the other that measures the high-flow rates. All

measurements are done in cubic feet. Combined, the two flow rates yield the total water use in cubic feet.



**Figure 4. Low-flow shower head.**

Currently, all faucets on campus are equipped with aerators (Figure 3). A faucet aerator mixes air into the water stream, reducing water flow per minute to 1.5-1.8 gallons while maintaining steady pressure. All of Gladden dorm is currently outfitted with the 1.5 gallon aerators. In addition to low-flow faucets, low-flow showerheads

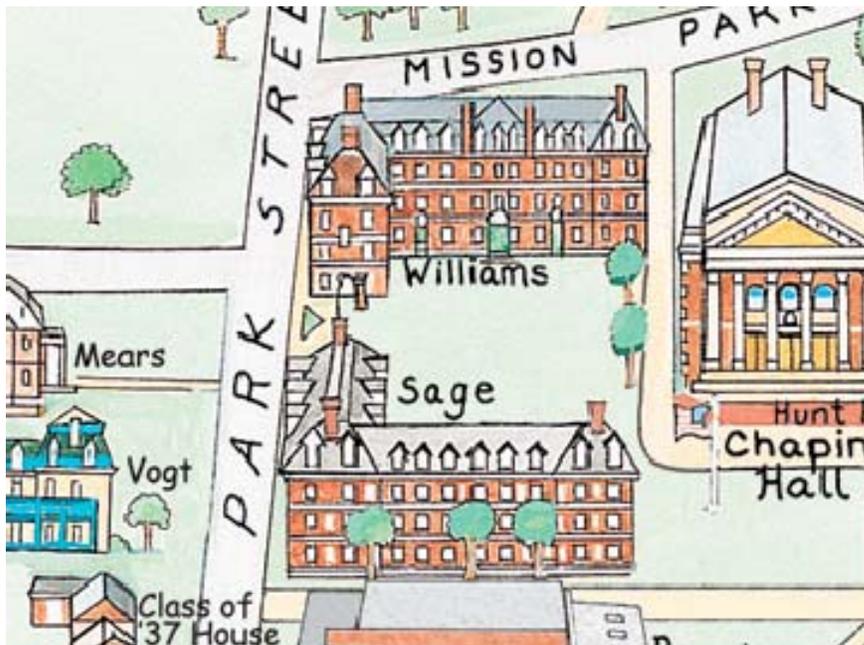
campus that reduced water flow per minute from 4 or 5 gallons per minute to 2.5 gallons per minute have already been installed throughout campus (Figure 4). The older low-flow showerhead technology has been outdated as older showerheads are likely to atomize the water, converting liquid water into a spray and using more energy. The new generation of showerheads does not atomize the water; therefore, the showers are theoretically more efficient and maintain a more consistent temperature (Jensen, Ken).

In addition to low-flow showerheads that are in place on campus as of now, the college has installed energy efficient laundering equipment. All of the washers and driers on campus are frontloading and save both water and energy, using only 16 gallons of water versus the conventional washer's 40 to 50 gallons of water (Jensen, Ken).

To ensure the proper state and care of the College's plumbing appliances and pipes, a preventative maintenance team from Facilities inspects each of the campus's buildings. Once a year, this team checks faucets, showers, toilets, urinals, washers, and

pipes in each building. Finding and fixing leaks is important as each trickle can result in a huge amount of waste over time that can be prevented with careful assessment.

Despite the strengths of the current water management systems on campus, there are still many efforts that can be made and several steps that can be taken to further reduce the amount of water waste on the Williams College campus. Consistent with the 1994 report, the greatest potential for the reduction of water and associated energy use on campus is in the residential dormitories where students use water to shower, wash, and do laundry without a clear sense of the environmental detriments or costs to the College from excessive use. This report focuses on reducing water use in showers and sinks by installing low-flow showerheads and sink aerators in Williams Hall to reduce water waste and save money.



**Figure 5. The Freshman Quadrangle with the identical dormitories of Williams and Sage.**

Williams Hall, located in the Freshman Quadrangle, is virtually identical in structure and occupancy to Sage Hall, which is located across the central green (Figure

5). Williams Hall has just 13 more students--or 8%--than Sage and a few additional rooms located in the basement of the building. Because of the uniformity in size and population in Williams Hall and Sage Hall, they were perfect buildings to study in the experiment in order to see consistencies in similar buildings and the true effects of new installations given concurrent trends in water usage.

The project’s initial step required taking base readings in Williams Hall and Sage Hall. These readings were taken on April 15<sup>th</sup> and April 18<sup>th</sup> in both dorms and showed that Williams Hall was using 11,947.1 ft<sup>3</sup> of water per three days and that Sage Hall was using an average of 10,747.6 ft<sup>3</sup> of water per three days. Breaking down these numbers to on average student usage, each student in Williams Hall uses approximately 25.6 gallons of water per day whereas each student in Sage Hall uses 25.22 gallons of water per day, showing a close correspondence between water habits in both dorms. There is also a close relationship between the costs of water use between the two dorms. Water use in Williams Hall costs the college \$132.96 each day where Sage Hall water operations cost \$119.72 per day. Each Williams Hall student costs the college \$0.86 in water each day with each Sage Hall student costing the college \$0.84 (Table 1).

**Table 1. Base meter readings for water usage for Sage and Williams Hall on two dates:--April 15<sup>th</sup> and April 18<sup>th</sup>, 2008—along with total water usage per day per student and the cost of water use per day. A potential reason for the higher water usage in Williams Hall is that 8% more students reside in Williams than in Sage. This table does not include water that is converted to steam to heat the buildings.**

LOCATION	DATE	TIME OF READING	TOTAL FLOW RATE (combined high and low flow rates in ft <sup>3</sup> )	TOTAL WATER USE PER DAY PER STUDENT (gallons)	COST OF WATER USE PER DAY (dollars)
Sage Hall	4/15/08	11:30 am	10,060.09		
Sage Hall	4/18/08	11:30 am	10,075.25	25.22	\$119.72
Williams Hall	4/15/08	11:30 am	13,166.27		

Williams Hall	4/18/08	11:30 am	13,233.96	25.6	\$132.96
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On Monday, April 21<sup>st</sup>, Facilities replaced all of the faucets and showerheads in Williams Hall, installing 47 Sexauer© sink aerators that reduced water flow to 0.5 gallons per minute and 32 Sexauer© showerheads that reduced water flow to 1.6 gallons per minute.

With 11 hours of manual labor totaling \$374.00, showerheads totaling \$1,120.00, and aerators costing \$250.04, the overall cost of the installation sums to \$1,744.04.

(Table 2).

**Table 2. Cost of installing low flow faucet aerators and showerheads in Williams Hall.**

Labor	11 man hours	\$374.00
Material	Shower heads	\$1,120.00
	Aerators	\$250.04
<b>TOTAL COST OF INSTALLATION:</b>		<b>\$1,744.04</b>

After the installation of the 47 aerators and 32 showerheads, new measurements were taken at Williams Hall and Sage Hall that included the savings from the new fixtures. On April 22<sup>nd</sup> and April 25<sup>th</sup>, the readings showed that Williams Hall was using 9732.18 cubic feet of water per three days while Sage Hall was using an average 11,107.9 cubic feet of water per three days. Average water use per student in Williams Hall was reduced from 25.6 gallons of water per day to 20.8 gallons of water per day--a 4.8 gallon per day reduction. The dorm, as a whole, reduced its water use by 295.1 cubic feet of water per day. Sage Hall per student per day water use increased in this period from 25.22 gallons of water per day to 26.07 gallons of water per day (Table 3).

**Table 3. Meter readings for water usage in Williams and Sage Halls post-installation of the low flow faucets and showerheads. Both water usage per day per student and cost of water use per day decreased in Williams Hall post-installation.**

LOCATION	DATE	TIME OF READING	TOTAL FLOW RATE (Combination of High and Low Flow Rates in ft <sup>3</sup> )	TOTAL WATER USE PER DAY PER STUDENT (gallons)	COST OF WATER USE PER DAY (dollars)
Sage Hall	4/22/08	11:30 AM	10,095		
Sage Hall	4/25/08	11:30 AM	10,113	26.07	\$126.88
Williams Hall	4/22/08	11:30 AM	13,260		
Williams Hall	4/25/08	11:30 AM	13,275	20.8	\$111.17

Where the savings resulting from the installation in Williams Hall saved the college \$21.79 per day, as the total water cost in Williams Hall was reduced from a cost of \$132.96 to \$111.17 per day, Sage Hall water costs increased by \$7.16, as the cost of the dorms water operations rose from \$119.72 to \$126.88 per day (Table 4). Each day with the new fixtures, Williams Hall students are saving \$0.14 per person, since the cost of personal water use has dropped from \$0.86 to \$0.72. Sage Hall, on the other hand, has increased the cost of personal water use from \$0.84 to \$0.89, a \$0.05 increase in daily cost to the college.

**Table 4. The savings in both dollars and gallons from the new low flow faucets and aerators.**

	WATER USE PER DAY PER STUDENT (gallons)	COST OF WATER PER DAY
Base readings	25.60	\$132.96
Post-Installation	20.80	\$111.17
<b><u>SAVINGS/DIFFERENCE</u></b>	<b>4.8</b>	<b>\$21.79</b>

The results of the readings show that the installation of low-flow showerheads and faucet aerators has decreased the water consumption of Williams Hall and all of the dorms inhabitants. Though the amount of water used in Sage Hall increased slightly since the time of the installation, there is no relationship between Sage Hall's increase and the fact that low-flow fixtures were installed in Williams Hall. Daily use of water is likely to vary depending on a wide variety of factors such as weather, athletic practices, student schedules, etc.

The results also suggest that for the 238 days that the dorm is occupied full-time, the College will spend an estimated \$26,458.46 on water in Williams Hall compared with the projected \$31,644.48 from the initial reading. Those who record water usage have not yet studied the data for seasonal variation; thus, this estimate is based on three days of water usage in April only. The installation could save the college \$5,186.02 each academic year for this building alone. With these savings, it will only take about 80 days to see a return on the initial purchasing and installation investment of \$1,744.04.

#### Water Reduction at Peer Institutions

Williams College is not the only institution facing the problem of excessive water use by students. As students tend not to pay for their individual water use, other colleges and universities have faced the same difficulties decreasing water waste and have implemented new fixtures and plant to reduce water use.

At Princeton, an aggressive look at reducing water use in dorms is being taken. Across the Princeton campus, dual flush toilets, that provide users the choice of using more or less water when flushing their waste, have been installed as well as low-flow



**Figure 5. An example of a dual-flush toilet with options to flush at lower rates. (Source: [http://lo528flow.com/images/IMG\\_3758.jpg](http://lo528flow.com/images/IMG_3758.jpg)).**

showerheads. According to The Daily Princetonian, “By 2020, the University aims to decrease per capita water usage to 25 percent below current levels,” which is an ambitious aim (Ackerman).

At Bowdoin College, steps have been taken in their

LEED certified residence halls to insure that the toilets on campus use only 1.6-gallons of water per flush, the faucets use 2.2-gallons of water per minute, and the showers release 1.8-gallons of water per minute. In addition to the installation of low-flow fixtures, Bowdoin has recently gone above and beyond. The College has installed a rainwater system that traps and holds rainwater in a large tank where it is purified by ultraviolet radiation and pumped to the dormitory’s toilets. The use of rainwater in toilets conserves and reduces the waste of treated potable water (“Bowdoin Builds LEED Resident Halls”). Unfortunately, the cost of installing a new plumbing system that runs rainwater into the toilets in a currently existing residential hall on the Williams campus would be extraordinary. The building would have to be stripped of all of the currently plumbing systems to reroute water flow. While this is not an economically feasible plan for Williams College buildings, smaller scale grey water systems would be beneficial to reducing the waste of treated potable water in new buildings.

Amherst College also has a multifaceted approach to reducing consumption of water throughout their campus. Like Williams, Amherst has implemented frontloading washing machines in the dorms and has succeeded since 2005 in installing low-flow showerheads. On a larger scale, Amherst installed an automatic field irrigation system



**Figure 6.** A frontloading washing machine on the Amherst College campus. (Source: <https://cms.amherst.edu/greenamherst/uploaded-files/node/9834>).

for all athletic fields, providing water to several zones (between 5 a.m. and 7 a.m.) for five to fifteen minutes per increment on a daily basis. There are also rain sensors that disable the system in the event of a substantial rain. It is estimated that the irrigation system provides in excess of 50% water savings over the manual method. This careful method of irrigation is perhaps one that

Williams should consider when renovating Weston Field.

### Considering Politics

It is feasible for Williams to install low-flow fixtures in all of the dorms to significantly reduce water use in residential spaces on campus and with a payback period of only 80 days, it is an economically sound and environmentally beneficial investment. However, despite the obvious economic and environmental benefits of installing 0.5-

gallon per minute faucet aerators and 1.6-gallon per minute showerheads, the College's political environment must be considered when making the decisions that affect daily life. It is important to have student support behind the new water-reducing plan—support which the institution is currently lacking.

A recent article in the Williams Record outlines student complaints about the newly installed water fixtures in Williams Hall. The article states: “Even though the new showerheads and faucets yield substantial environmental and economic benefits, some students have been unhappy about these new changes.” Residents in Williams Hall have submitted complaints to their Junior Advisors, the Class of 2011 College Council Representative, and one student, Sarah Weber, began a petition against the low-flow fixtures. Students have cited difficulties washing shampoo from their hair, filling their water bottles, shaving, and washing their faces (Zheng, Sasha).

Sarah Weber's petition resulted in over 60 signatures of residents of Williams Hall. In an email she says, “I understand that saving water is important, but I really find that the new fixtures put out too little water for all the things we use the sinks and showers for (i.e.: filling water bottles, washing long hair, etc.) [...] I put up some petitions against the new fixtures in Williams Hall and got a lot of signatures agreeing with me. [...] I think there is a place for these new faucets - in academic buildings and the gym, for example, where only a quick hand wash or rinsing shower is needed. But in dorm buildings, [low-flow fixtures] do not provide a sufficient amount of water.”

There has been even more student upset against the imposition of sustainability on campus. A newly formed student coalition, self-titled The Williams College Quality of Life Defense Council, has started a campaign against “any supposedly environmentalist

measure that REDUCES the campus quality of life”. The manifesto of the group, as posted on Facebook, states: “The Council asserts that by paying tuition Williams students gain the right to a say in what they're buying” and goes on to demand that the opinion of the student body be polled and taken into consideration when making institutional change (“Williams, Ephraim”).

In addition to The Williams College Quality of Life Defense Council, there have been several blogs on Williams Students Online in which students have been discussing the recent decision made by the administration to remove trays from all dining halls on campus. Students cite the difficulty in navigating dining halls with several plates, the lack of cleanliness of the dining tables, and the lack of student consultation in making campus decisions. Despite student opposition, the administration has made several decisions within the past few years that are seen as impositions on campus life, including the installation of the Neighborhood System, changes in event planning registration that make social organization more difficult, and the closing of Paresky at 2am every night even though the space was built with the intention of being open 24 hours. The lack of consideration of student opinion by the administration is irking many.

Students see the changes to water flow in dorms as just another nuisance handed down from the administration. As a result, Green change is seen as an inconvenience and is becoming a point of contention. There are great benefits to going green, both environmental and, as is seen in this report, economical, but moderate and slow change is important in the revolution towards sustainability on campus. Students do not appreciate that changes in water fixtures have affected their daily shower quality and abilities to fill water bottles—all without their notice or consent. The impact that reducing the College’s

water consumption may have on the town of Williamstown should also be taken into account. When the college installed 1.8-gallon flush toilets, the rates for water use and disposal for the town residents increased; therefore, gradual changes that do not burden the local residents will perhaps be the most effective.

Considering a student's personal water use costs the college a mere \$0.86 per day, it seems that students' happiness is worth more than the \$0.14 the college would save per student per day with the installation of low-flow fixtures in all dorms (especially bearing in mind that college tuition has reached an all time high of \$47,530 per year). While the College does need to take an aggressive stance on reducing consumption of natural resources, imposing changes in fixtures that strongly impact the quality of student life is perhaps not the most effective way to go about it.

Considering low-flow features are already installed in all bathrooms across the campus, rather than install Sexauer© sink aerators that reduced water flow to 0.5-gallons per minute and showerheads that reduced water flow to 1.6-gallons per minute, Williams College should encourage personal conservation techniques. Turning off the faucet when the sink is not in use, limiting shower times, loading washers fully when doing laundry, and flushing less frequently would reduce water use on campus. These methods can be *suggested* to students rather than *imposed*. Until students are educated about the benefits of reducing water waste and there is a majority vote in which students declare that they are dedicated to reducing water waste on campus, the administration should stop making green changes that aggravate the student body. Ultimately, student satisfaction is a necessary component to the success of the institution and all of the policies and fixtures it puts in place.

**Editor's note:** David Dethier and Katie White edited this paper.

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