ESLP

Education for Sustainable Living Program

Water

Final Report
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Executive Summary

UCLA is a leader in implementation of environmental policies. In order to help further our image the Education for Sustainable Living Program invited the Water Action Research Team to seek out ways to reach water consumption goals set by UC President Janet Napolitano and California Governor Brown. We, as a five-member team, have moved through research, collaboration, audits, calculations and analysis steps that have each gotten us closer to our goal of taking advantage of the low-hanging fruit of water efficient technology. Our methodology was relatively simple and straightforward. The five of us were able to use observation of individual sinks and the visitors to particular bathrooms to estimate the benefits of installing 0.5 gallon per minute aerators in bathrooms that do not already have them. Among the 531 sinks we looked at, only 184 had functional 0.5 gpm aerators. After performing a conservative cost-benefit analysis we discovered savings ranging from 12,000 to 15,000 gallons of water per year. Interestingly, the cost of labor is about twice the cost of the aerators themselves, but the payback time is still only about a year and a half. We have specific future plans of applying for funding and implementing the aerators next Fall. Ultimately we recommend that the 338 2.2 gpm aerated, 2.0 gpm aerated, and non-aerated faucets are updated. We also have high hopes for future teams to continue our efforts and implement more aerators across campus. There are many buildings that we did not have the time or resources to research.

In addition to these efforts, we utilized the Earth Day Fair publicity in order to hold a mini-educational campaign. The responses to our survey indicate the importance of drought management to the student body and provide the Education for Sustainable Living Program with opportunities for future work, like reducing water waste in beautification and among the dorms.

Our project has been a success in terms of teamwork and affecting change on campus, but there is more to be done.

Significance and Background

California is currently facing one of the worst droughts in its history—a staggering 98% of the state is in drought with 32% being in exceptional drought, the most severe classification of drought. This statewide water shortage is leading to reduced surface water and snowpack supplies as well as depleted groundwater basins. Governor Brown has mandated a 25% reduction in water consumption and UCLA has to do it's part. As a part of Governor Brown's Executive Order, "The Water Board shall impose restrictions to require that commercial, industrial, and institutional properties, such as campuses, golf courses, and cemeteries, immediately implement water efficiency measures to reduce potable water usage in an amount consistent with the reduction targets mandated by Directive 2 of this Executive Order." It is crucial that we identify areas of waste with manageable technological solutions. Thus, we have decided to demonstrate the gains we can achieve by the simplest of means: replacing faucet aerators.

Before we began, research into the work done by previous action research teams and the UCSB Water Action Plan proved extremely helpful in setting our goals for the two-quarters.

A. Previous Action Research Teams

Since the creation of the Action Research Teams in 2008, there have been four previous Water-focused teams. Many other teams have also detailed an impact of water-use reduction in conjunction with projects including LEED certification, biodiversity, and hospital audits. Not only did previous teams research the water aspect of landscaping, but also that initiative was deemed outside of the expertise of one of our stakeholders, Derek Gomez, the UCLA Plumbing

Shop Manager. Our own project is more similar to the 2013 Water Team because they also researched the plumbing fixtures on campus and provided future groups with a baseline model for the data. However, the 2014 report mentions a follow-up with the plumbing department that states that the restroom conversions were not feasible due to outdated infrastructure and sanitation regulations. These claims were supported by Derek in terms of toilets and manipulating the flow rates in older buildings. Thus, we agreed that the specificity of the faucet aerators was a more realistic project.

B. UCSB Water Action Plan

In addition to the past Action Research Teams our stakeholder Nurit Katz, Chief Sustainability Officer and Executive Director of Facilities Management for UCLA, put us in contact with two of the six Masters students who completed the UC Santa Barbara Water Action Plan for their Master's Thesis. We focused on a few key sections within their 132 page report that detailed the Methodology and Results behind their restroom fixture audits.

Although their research was more extensive than ours will be, primarily due to a greater amount of funding and a longer time frame to complete their research, the two former Masters students we interviewed via phone were very helpful in crafting our methodology and defining our scope of work. Specifically, Jewel Snavely advocated for the use of a Standard Operating Procedures in order to improve our efficiency as a team. These resources supported both the development and implementation of our project.

Conservation is the easiest approach to mitigating the intense over-consumption problem that plagues California. Therefore, all of this background information convinced us to focus our

efforts on the implementation of more efficient faucet aerators in bathrooms across the UCLA campus.

Objectives

Our original goal was to figure out a way to assist UCLA in its water conservation efforts. The objective of our research was to provide replacement/implementation recommendations based on cost-benefit analyses of different aerators in buildings across campus. Ultimately, we wanted to have the aerators replaced with lower gpms or add aerators to non-aerated sinks.

One of our goals was to audit plumbing fixtures. We decided to focus on auditing sinks specifically researching how many sinks were in each bathroom/building, which sinks had aerators and at what gpm. After initially auditing sinks in three buildings, we came up with a goal to audit as many sinks as possible in as many buildings as possible. We specifically checked for the implementation and functionality of faucet aerators in order to assess the care with which Facilities Management addresses water conservation.

Another goal was to add an educational component to our research. We did this at the Earth Day fair where we shared water conservation facts with the UCLA student body. We compared the water usage of different food products to show how much each used and which used the most. People were surprised by some of the results.

We also set a goal to apply for funding for both the aerators and the educational component. We would use this funding to purchase the aerators and pay for the installment of the aerators. Our team leaders will be applying for the funding in the fall. We also applied for

funding to buy shower timers to hand out during the sustainability fair as part of our educational component to our project. We received this funding, however we were unable to purchase the shower timers because they were out of stock. The funding we received for the shower timers will go towards purchasing the aerators.

Research Methodology

After meeting with our stakeholders and interviewing two authors of the UCSB Water Action Plan (WAP) during the first half of Winter Quarter our Team decided that it would be best to focus on auditing bathroom sinks across campus. The UCSB Water Action Plan authors recommended we verbally go over the Standard Operating Procedure as a team to make sure that everyone understands how to accurately and effectively audit the faucets. This helped us prevent any inconsistencies in our data collection. In addition, our interviewees also warned us that they had to re-audit some of their beginning audit locations because they had not defined their Standard Operating Procedure at the beginning of their audit.

In order to avoid bias, we asked our stakeholders to randomly select our first few buildings we were to audit. On our first day of auditing, our team explored Bunche Hall and Perloff Hall. We audited these two buildings together so that we could establish the Standard Operating Procedure for future data collection in different buildings. Our first data collection occurred in Bunche Hall, where we observed and collected data from all twelve floors, including the basement A-level. We recorded whether or not each faucet had an aerator, the flow of the faucet in gallons per minute (GPM), brand of aerator, and quantity of faucets per bathroom. To read the GPM label, we twisted the ring under the spout of the faucet and looked for the number that showed the flow of that specific faucet. To find the brand, we either observed what was

labeled on the top of the faucet or on the ring under the spout, the same ring that the GPM label was observed to be on. To determine whether or not the faucets were aerated, we turned on the faucets and observed the type of flow. A clear stream of water indicates the lack of an aerator, while a white, bubbly stream signifies a working aerator. Sometimes it was unclear whether the faucets were aerated or not, so we looked under the spout of the faucet and check to see for ourselves. We realized that sometimes the aerators were broken, meaning that the GPM was inaccurate for those specific sinks, so we made note of this in our records.

After finishing collecting data from all three floors of the second building we audited, Perloff Hall, our team decided to split into two groups to ensure more efficient data collection sessions. This allowed us to collect data from more buildings than we would have been able to as a single group. Paul, Satya, and Jacqueline became one group, and Amanda and Tony became the other group. Both groups needed someone of each gender in order to enter all the bathrooms. Our team then finished collecting data from Boelter Hall, Math Sciences Building, Kerckhoff Hall, Powell Library, Humanities Building, Geology Building, Slichter Hall, Young Hall, Royce Hall, and Haines Hall, Ackerman, Dodd Hall, and the Public Affairs Building,

With the data we collected from first auditing session in hand, our team decided it was best to create an excel spreadsheet so we could better organize our data. In our spreadsheet, data was divided into the following parameters: building name, floor, room number, faucet model, aerator presence, gender (male/female bathroom/unisex), type of faucet (manual/motion sensor/push), GPM, and number of aerated/non-aerated faucets in each bathroom. We also provided our stakeholders with a copy of our excel spreadsheet so they could review the numbers and compare the faucets in each building. We found that there was a total of 531 faucets that we

had audited, with 456 total aerated and 75 total non-aerated faucets. The total flow average of all the aerated faucets we collected data for was 1.311 GPM. This specific GPM was not found in any faucet, but the different flow amounts that our team came across were 0.5, 1,35, 2, 2.2, and 3 GPM. By collecting this quantitative data, we were able to bring statistical data to our stakeholders each meeting. In addition, our Standard Operating Procedure and data analysis helped us proceed in data collection and efficient auditing.

In spring quarter, we monitored some of the buildings we audited the previous quarter. We decided to monitor buildings we thought had the most saving potential in terms of both water and money. This potential was based on which bathrooms we knew were relatively busy and which bathrooms had the most non-aerated faucets or 2.2 GPM faucets, which is the highest aerated flow for faucets on campus. Using these determining factors, our team decided that the female bathroom in Haines 136 would be a good place to start. This bathroom is on the main level of Haines and has six 2.2 GPM faucets. We also decided to monitor the ground level female and male bathrooms in Powell Library, which have seven and four non-aerated faucets respectively. In the end, we ended up monitoring a total of seven bathrooms. The remaining female bathrooms we monitored were Kerckhoff 218 and Math Sciences 5209, and the remaining male bathrooms were Humanities A85, and Kerckhoff 114.

After we selected which bathrooms to monitor, our team came up with a plan that allowed us to measure water consumption in each bathroom as accurately as feasibly possible. The most accurate method would have been to monitor constantly throughout day, but this was unrealistic for our team. Instead, we decided to take shifts and count the number of people who used the faucets during passing period. We assumed that passing period, which we defined as a

15 minute time slot from the 50 minute mark of one hour to the 5 minute mark of the next, accounted for most of the water consumption in the hour. We also assumed that each person washed their hands for an average of 10 seconds, a statistic we acquired from the 2013 Water ART Final Report. We monitored each of the 7 bathrooms over the course of 4 passing periods, which were 9:50 am - 10:05 am, 11:50 am - 12:05 pm, 1:50 pm - 2:05 pm, and 3:50 pm - 4:05 pm. After counting the number of people who used the faucets during each of these times, we took the average. We used each bathroom's average to calculate the time for return on investment for each bathroom.

It is best to explain how we calculated the return on investment with a specific example. The female bathroom in Haines 136 had 27 users from 9:50 am - 10:05 am, 29 users from 11:50 am - 12:05 pm, 26 users from 1:50 pm - 2:05 pm, and 24 users from 3:50 pm - 4:05 pm. The average number of users during a given passing period is then 26.5. We multiplied 26.5 people by 8 hours because we assumed that there are 8 busy passing periods in the day (9:50-4:05) before people left campus for the day (26.5x8= 212). We multiplied 212 people by 1.5 to account for all the users during non-passing periods (212x1.5=318). We multiplied 318 by 10 seconds and then by multiplied again by the flow of the faucet, which was 2.2 gallons per minute (we converted to 0.0367 gallons per second). This gives us an average daily consumption of 116.6 gallons per day (26.5 people x 8 hours x 1.5 multiplier x 2.2 gallons per minute x 10 seconds per person x 60 seconds per minute).

To calculate the water savings potential, we went through these same calculations, except we used 0.05 GPM as the new flow instead of 2.2 GPM. If 0.5 GPM aerators replaced the 2.2 GPM aerators, only an average of 26.5 gallons of water would be used in this bathroom per day.

This gives a savings of 90.1 gallons per day. We multiplied this by 5 days per week, 10 weeks per quarter, and 3.5 quarters per year. We used 3.5 quarters per year because we assumed that bathrooms would be about half as busy during summer quarter compared to the regular school year. This gives us a total of 15,767.5 gallons of water saved per year in Haines 136 alone.
To calculate the time for return on investment, we assumed water costs $4.932 per hundred cubic feet (HCF). We converted this to gallons by using 1 HCF = 748 gallons. We multiplied this by the amount of water saved (15,767.5 gallons per year) to get a savings of $109.73 per year in this bathroom. The cost to install aerators is $9.50 for the aerator plus $18 to install each aerator. There are six aerators in Haines 136, so it would cost $165 to replace all the 2.2 GPM aerators with 0.05 GPM aerators. We divided cost of installment by annual savings to get 1.504 years as our return on investment. To calculate the return on investment if our team receives funding to buy aerators, which is very likely, we did the same calculation except excluded the $9.50 cost of installment. This would give us a 0.9842 year return on investment.

For bathrooms we monitored that had non-aerated faucets, we had to manually calculate flow. The Powell Library had the most non-aerated faucets, so we chose the male and female bathrooms there to measure flow. We brought a pot with tick marks to the library and ran the water for 10 seconds. We multiplied this volume of water by six to determine the flow per minute. After calculating flow, we were able to complete the same calculations for water consumption, water savings, and return on investment for Powell Library. We could use this method to make calculations for any bathroom we monitored with non-aerated faucets.

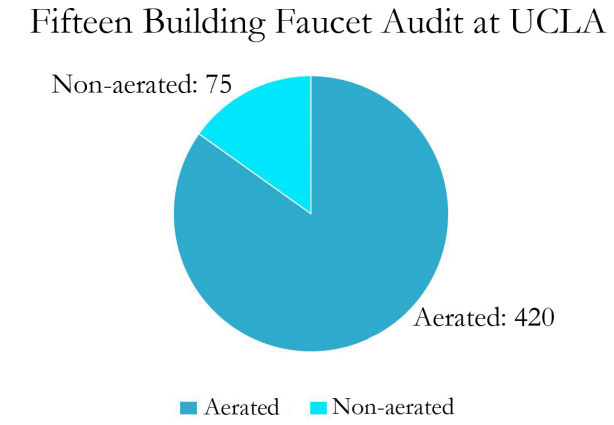
The last component of our project was an educational outreach section. Our team wanted to reach a large number of students and staff, so we decided to attend the Earth Day Fair. We

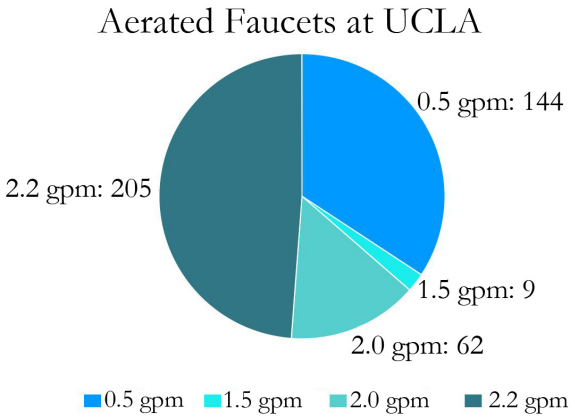
originally wanted to give everyone who stopped at our table a shower timer so they could be more aware of how much water they were wasting if they were still showering after the timer stopped. However, the shower timers we ordered sold out before we received them (we ended up using the $279.20 we received from The Green Initiative Fund for aerators instead). We recommend ordering these types of things at least three weeks in advance, because two weeks was not enough time for us. After realizing we would not be able to pass out shower timers, we had to come up with a new plan. Our goal for educational outreach was to give people the information they needed to make sustainable choices. We decided to focus on diet, because many people have high water consumption diets and are not aware of the small changes that can make a big difference. We created an interactive poster that tested people's knowledge of how much water was used to make different types of food. We also had a trivia game with question topics about the drought in California and personal water consumption.

Results

Our team audited for faucet aerators in a total of 15 buildings' bathrooms between Week 5 of Winter Quarter and Week 3 of Spring Quarter. These buildings were: Ackerman Student Union, Boelter Hall, Bunche Hall, Dodd Hall, Geology Building, Haines Hall, Humanities Building, Kerckhoff Hall, Math Sciences Building, Perloff Hall, Powell Library, Public Affairs Building, Royce Hall, Slichter Hall, and Young Hall. We chose to audit these buildings because they are both spread throughout the UCLA campus and are all heavily trafficked by students, faculty, and staff. In total we came across 531 faucets that varied in size, shape, and color. Seventy-five of the 531 faucets lacked aerators (14.12%), 198 faucets had 2.2 gpm aerators

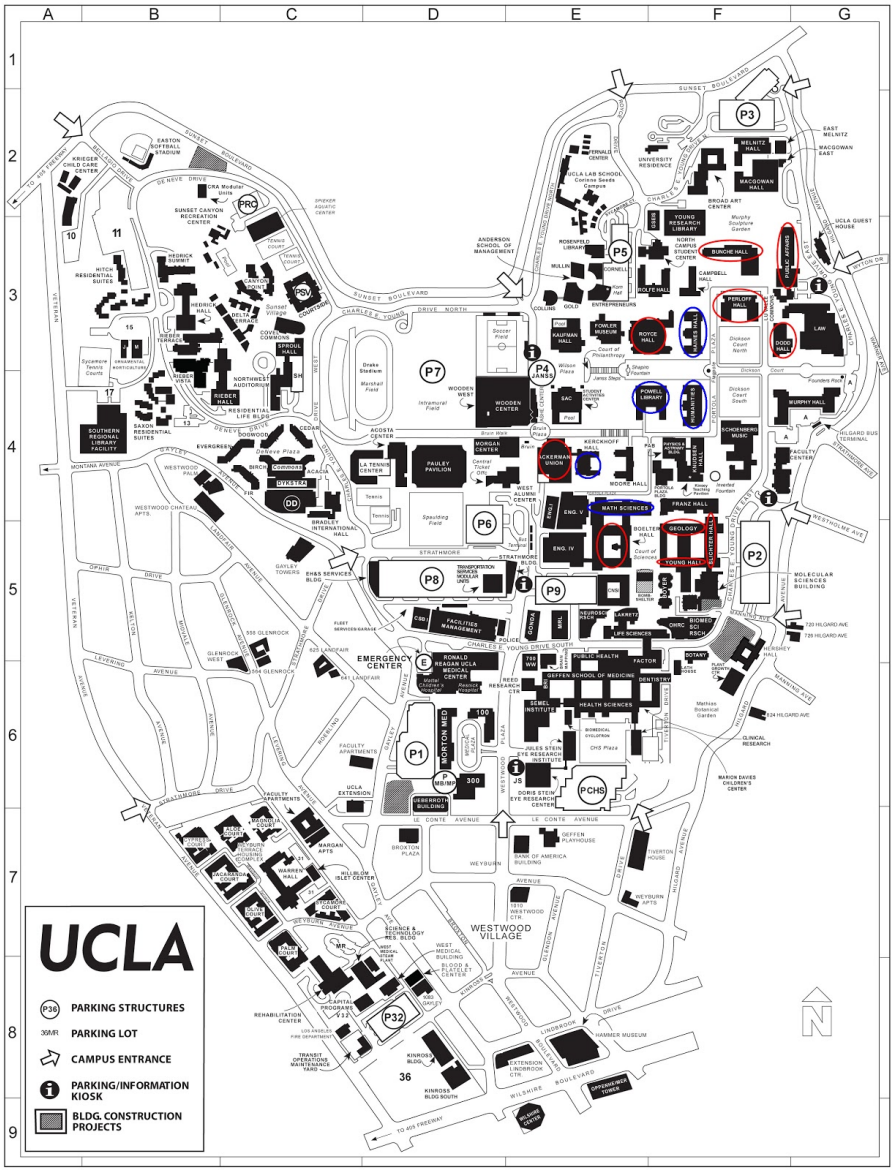
(37.29%), 65 faucets had 2.0 gpm aerators (12.24%), nine faucets had 1.5 gpm aerators (1.69%), and 184 faucets had 0.5 gpm aerators (34.66%). After finishing our auditing we moved on to monitoring and analyzing our data during Spring Quarter.





Our Team decided to monitor seven reasonably trafficked bathrooms in seven of the buildings we had audited. We picked three bathrooms that had all 2.2 gpm aerators installed on the faucets and four bathrooms that entirely lacked aerators in order to avoid complication in doing our Return on Investment calculations. The three bathrooms with 2.2 gpm aerators we

monitored were Haines 136 (Girls' Bathroom), Humanities A85 (Boys' Bathrooms), and Kerckhoff 218 (Girls' Bathroom). The four bathrooms that lacked aerators entirely were Powell 40B (Boys' Bathroom), Powell 40C (Girls' Bathroom), Kerckhoff 114 (Boys' Bathroom), and Math Science 5209 (Girls' Bathroom).



Note: Blue circles indicate monitored and audited buildings while red circle indicate just audited buildings.

Discussion

Our Return on Investment times for the seven bathrooms we monitored ranged from 0.28 years in Math Sciences 5209 to 2.51 years in Powell 40B. It is the industry standard that any In total our Return on Investment calculations indicated that at least 82,251.97 gallons of water would be saved in these seven bathrooms, but this is quite a modest estimate. This would be done by installing just 38 vandal-proof 0.5 gpm aerators in these bathrooms. From our audits there are 338 faucets that would cost-effectively benefit from having a 0.5 gpm. That is to say, we monitored only 11.24% of all the 338 faucets we believe should have 0.5 gpm aerators installed and over 80,000 gallons would be saved; ideally aggregating to 100% of the 338 faucets and 731,779 gallons of water could potentially be saved each year through the simple installation of vandal-proof 0.5 gpm aerators. Of course some of these bathrooms that we hope to have vandal-proof 0.5 gpm aerators installed in are quite lowly trafficked, i.e. Young 6089, Geology 6695, and Math Sciences 8319.

Our Return on Investment calculations for the four bathrooms we monitored in Kerckhoff Hall and Powell Library are actually much greater than what they actually are. This is because in our assumptions we wanted to maintain uniformity. However, Kerckhoff Hall and Powell Library deviate from the norm because these are not classroom buildings; they function primarily as a study space or a workplace.

Additionally, our ART team ran into some setbacks early on in during Winter Quarter. We had a difficult time narrowing down the scope of our research. Oftentimes, starting is half the battle. In our case, starting took half of the entire quarter. If we had started our action research earlier, our team would have had more time for auditing. This would have increased our building

sample size and further cemented the validity of our data; we are still confident in our data's relevance regardless. Additionally, due to time constraints we were not able to apply for TGIF funding this school year in order to pay for the purchasing of 338 vandal-proof 0.5 gpm aerators. Fortunately, our leaders Amanda and Paul will be applying for that funding in the Fall of 2015.

Recommendations

Our team worked hard to audit sinks in as many buildings as possible. However, we were not able to audit sinks in every building on campus. In the Fall of 2015, our team leaders, Amanda and Paul will be applying for TGIF funding to purchase enough vandal-proof 0.5 gpm aerators to replace all 2.2 gpm and 2.0 gpm aerators and install aerators on non-aerated faucets that were audited. We recommend that the next team finish auditing the sinks in the rest of the buildings that we were not able to audit and then apply for funding to get all of the aerators replaced. Overall, there are 338 faucets with either a 2.2 gpm aerator, a 2.0 gpm aerator, or no aerator at all. Eventually, all of these should be replaced with vandal-proof 0.5 gpm aerators. Additionally, all the sinks at UCLA should probably have vandal-proof 0.5 gpm aerators saving not only water, but money. The next team could also check up on the sinks to make sure all of the sinks are functioning properly and that all aerators were replaced. They could also measure the flow of some of the sinks to make sure they are actually 0.5 gpm, ensuring quality control.

Another recommendation for the next team would be to analyze and research the water use of automatic versus non-automatic sinks. This could be done comparing the time people wash their hands with the time the automatic sinks stay on. The analysis and return on investment could be used to find out if it is worth replacing the sinks with one type or another. It

would be important to find out if one type of sink conserved more water than the other type in order to help continue conserving water in any way possible.

Along with that, toilets could also be audited. Some of the older toilets in older buildings may need to be updated to low-flow toilets in order to conserve water. Our team had planned to audit toilets at the beginning of Winter Quarter, however we decided to focus our project on auditing sinks. After interviewing Matt O'Carroll and Jewel Snavely, two authors of UCSB's Water Action Plan, we found out that there is a device that would make auditing toilets possible. The next team could research and acquire the device that can be used to measure the flow of the toilets. Auditing toilets would help with understanding how much water can be conserved if the toilets are replaced with low flow toilets.

Our stakeholders will continue to actively help us obtain the vandal-proof 0.5 gpm aerators and get them installed in the sinks we audited. We would recommend that our stakeholders allocate funding for the installation of the 338 aerators by Facilities Management employees. They will keep us updated on the implementation of the aerators.

Conclusion

Though UCLA has proven itself as an environmentally friendly campus, we believe that there is still some room for improvement, in terms of its water usage. With our data, calculations, and future goals proposed for the UCLA campus, we hope to push for a stronger effort to minimize water usage in campus buildings.

In order to understand how to develop our 2014 Water Action Plan, we had to analyze the UCLA water facilities system of the past and present in order to devise our Water Action Plan

for the future. Our Water Action Plan was created to reduce water waste and usage, but necessary funding, research, publicity, and calculations will be needed to achieve our ultimate goals for the UCLA campus. Future water reduction goals will also require the help of students and campus faculty as well as campus-wide advocacy programs and projects. Through these methods and guidelines, our team anticipates a greater reduction in water usage throughout the UCLA campus.

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Appendices

1. Faucet Auditing Data

	Building	Floor	Room number	Faucet Model	Aerator?	Female/Male	Manual, Motion Sensor, or Pusl	Gallons Per Minute (GPM	number of aeral	number of non-	GPM x #faucets
2	Bunche Hall	11	11-261	Moen	yes	female	manual	0.5	2		1
3	Bunche Hall	11	11-262	Moen	yes	male	manual	0.5	1		0.5
4	Bunche Hall	10	10-255	Moen	yes	female (there was no male bathroom)	manual	0.5	2		1
5	Bunche Hall	9	9354	Moen	yes	male	manual	0.5	2		1
6	Bunche Hall	9	9358	Moen	yes	female	manual	0.5	2		1
7	Bunche Hall	8	8-253	Moen	yes	unisex (public)	manual	0.5	2		1
8	Bunche Hall	7	7-253	Moen	yes	unisex (public)	manual	0.5	2		1
9	Bunche Hall	6	6-253	Moen	yes	male	manual	0.5	2		1
10	Bunche Hall	6	6-259	Moen	yes	female	manual	0.5	2		1
11	Bunche Hall	5	5-253	Moen	yes	male	manual	0.5	2		1
12	Bunche Hall	5	5-259	Moen	yes	female	manual	0.5	2		1
13	Bunche Hall	4	4251	Moen	yes	unisex (private)	manual	0.5	1		0.5
14	Bunche Hall	4	4350	Moen	yes	unisex(private)	manual	2.2	1		2.2
15	Bunche Hall	3	3350	Moen	yes	unisex (private)	manual	0.5	1		0.5
16	Bunche Hall	3	3253	Moen	yes	unisex (private)	manual	0.5	1		0.5
17	Bunche Hall	3	3203	Moen	yes	female	manual	0.5	4		2
18	Bunche Hall	3	3146	Moen	yes	male	manual	0.5	4		2
19	Bunche Hall	2	2-258	Moen	yes	male	manual	0.5	1		0.5
20	Bunche Hall	2	2-268	Moen	yes	female	manual	0.5		<--didn't check	0
21	Bunche Hall	2	2-203	Moen	yes	female	manual	0.5	4		2
22	Bunche Hall	2	2-146	Moen	yes	male	manual	0.5	4		2
23	Bunche Hall	1	1146	Moen	yes	male	manual	0.5	4		2
24	Bunche Hall	1	1-252	Moen	yes	male	manual	0.5			0
25	Bunche Hall	1	1-266	Moen	yes	female	manual	0.5		<--didn't check	0
26	Bunche Hall	A	A221	Moen	yes	female	manual	0.5	2		1
27	Bunche Hall	A	A227-B	Moen	yes	male	manual	0.5	3		1.5
28	Perloff Hall	B	B208	Moen	yes	female	manual	2.2	3		6.6
29	Perloff Hall	B	B420	Moen	yes	male	manual	2.2	3		6.6
30	Perloff Hall	1	1208	Moen	yes	female	manual	2.2	3		6.6
31	Perloff Hall	1	1240	Moen	yes	male	manual	2.2	3		6.6
32	Perloff Hall	2	cross from 2211)	Moen	yes	female	manual	2.2	3		6.6
33	Perloff Hall	2	2240	Moen	yes	male	manual	2.2	3		6.6
34	Boelter Hall	9	9429	Moen	yes	male	manual	0.5	2		1
35	Boelter Hall	9	9268	Moen	yes		manual	0.5			0
36	Powell Library	1	40B	SOFTFLO (Chic	no	female	manual	2		7	0
37	Powell Library	1	40C	SOFTFLO (Chic	no	male	manual	2		4	0
38	Powell Library	2	225	American Standa	no	female	manual	2.2		4	0
39	Powell Library	2	221	American Standa	yes	male	manual	2.2	4		8.8

40	Powell Library		3	333	American Standa	yes	female	manual	2.2	2		4.4
41	Powell Library		3	323	American Standa	1is, 1 isn't	male	manual	2.2	1	1	2.2
42	Humanities Builc		1	185	Masco	yes	female	manual	2.2	4		8.8
43	Humanities Builc		1		Masco	yes	male	manual	2.2	4		8.8
44	Humanities Builc		A	A83	Masco	yes	female	manual	2.2	4		8.8
45	Humanities Builc		A	A85	Masco	yes	male	manual	2.2	4		8.8
46	Humanities Builc		3	383	Masco	yes	female	manual	2.2	4		8.8
47	Humanities Builc		3	313	Moen	yes	male	manual	2.2	2		4.4
48	Humanities Builc		2	285	Masco	yes	female	manual	2.2	4		8.8
49	Humanities Builc		2	213	Masco	yes	male	manual	2.2	2		4.4
50	Geology Building		6	6695	Moen	yes	female	manual	2.2	2		4.4
51	Slichter Hall		5	5838	Chicago	yes	male	push start	0.5	1		0.5
52	Geology Building		5	5664	Moen	yes	male	manual	2.2	3		6.6
53	Geology Building		5	5668	Moen	yes	female	manual	2.2	2		4.4
54	Geology Building		4	4664	Moen	yes	male	manual	2.2	3		6.6
55	Geology Building		4	4690	Moen	yes	female	manual	2.2	3		6.6
56	Geology Building		4	4693	Moen	yes	male	manual	2.2	1		2.2
57	Geology Building		3	3690	Moen	yes	female	manual	2.2	3		6.6
58	Geology Building		3	3668	American Standa	yes	female	manual	2.2	4		8.8
59	Geology Building		3	3664	American Standa	yes	male	manual	2.2	3		6.6
60	Slichter Hall		3	3842	SOFTFLO (Chic	yes	male	manual	2	1		2
61	Slichter Hall		3	3842	SOFTFLO (Chic	yes	female	manual	2	1		2
62	Geology Building		2	2690	Moen	yes	male	manual	2.2	3		6.6
63	Slichter Hall		2	2838	locked							0
64	Geology Building		1	1690	Moen	yes	male	manual	2.2	3		6.6
65	Geology Building		1	1670	Moen	yes	female	manual	2.2	1		2.2
66	Young Hall		6	6407	American Standa	yes	male	manual	2.2	3		6.6
67	Young Hall		6	6089	American Standa	yes	female	manual	2.2	4		8.8
68	Young Hall		5	5313	American Standa	2 yes (0.5,2.2), 1	male	manual	1.35	2	1	2.7
69	Young Hall		5	5309	American Standa	yes	female	manual	2.2	1		2.2
70	Young Hall		5	5407	American Standa	yes	male	manual	2.2	2		4.4
71	Young Hall		5	5095	American Standa	yes	female	manual	2.2	2		4.4
72	Young Hall		4	4407	American Standa	yes	male	manual	2.2	2		4.4
73	Young Hall		4	4095	American Standa	1 yes, 1 broken a	female	manual	2.2	1	1	2.2
74	Young Hall		4	4311	American Standa	2 yes, 2 broken a	male	manual	2.2	2	2	4.4
75	Young Hall		4	4057	American Standa	2 yes, 1 broken a	female	manual	2.2	2	1	4.4
76	Young Hall		3	3311	American Standa	1 yes, 3 broken a	male	manual	2.2	1	3	2.2
77	Young Hall		3	3057	American Standa	yes	female	manual	2.2	6		13.2
78	Young Hall		3	3407	American Standa	yes	male	manual	2.2	2		4.4
79	Young Hall		3	3095	American Standa	yes	female	manual	2.2	2		4.4
80	Young Hall		2	2407	American Standa	2 yes, 1 is trickli	male	manual	2.2	1	1	2.2
81	Young Hall		2	2095	American Standa	yes	female	manual	2.2	2		4.4
82	Young Hall		2	2311	American Standa	4 broken aerator	male	manual	2.2	0	4	0
83	Young Hall		2	2057	American Standa	3 yes, 3 broken a	female	manual	2.2	3	3	6.6
84	Young Hall		1	1311	American Standa	1 yes, 3 broken a	male	manual	2.2	1	3	2.2
85	Young Hall		1	1057	American Standa	2 yes, 1 handle c	female	manual	2.2	2	4	4.4
86	Young Hall		1	1407	American Standa	yes	male	manual	2.2	2		4.4
87	Young Hall		1	1095	American Standa	1 yes, 1 trickling	female	manual	2.2	1	1	2.2
88	Young Hall		B	B085	American Standa	1 yes, 1 no aerat	female	manual	2.2	1	1	2.2
89	Young Hall		B	B407	American Standa	1 yes, 1 no aerat	male	manual	2.2	1	1	2.2
90	Royce	B		B72b	Kohler	yes, 2 broken	female	manual	2	9	2	18
91	Royce	B		B72a	Kohler	no	male	manual	0	0	9	0
92	Royce		2	214	Kohler	yes, 1 broken	female	manual	2	3	1	6
93	Royce		2	220	Kohler	yes	male	manual	2	2		4
94	Royce		3	351	Kohler	yes	female	manual	2	3		6
95	Royce		3	321a	Kohler	yes	male	manual	2	4		8
96	Haines		1	136	Moen	yes	female	manual	2.2	6		13.2
97	Haines	A		A34	Moen	yes, 2 unmarked	male	manual	2.2	5		11
98	Boelter Hall		9	9268	Moen	yes	female	manual	0.5	2		1
99	Boelter Hall		9	9429	Moen	yes	male	manual	0.5	2		1
100	Boelter Hall		7	7759	Moen	yes	female	manual	0.5	4		2
101	Boelter Hall		7	7269	Moen	yes	male	manual	0.5	4		2
102	Boelter Hall		7	7423	Moen	yes	female	manual	0.5	3		1.5
103	Boelter Hall		7	7754	Moen	yes	male	manual	0.5	3		1.5
104	Boelter Hall		6	6423	Moen	yes	female	manual	0.5	2		1
105	Boelter Hall		6	6550	Moen	yes	male	manual	0.5	4		2
106	Boelter Hall		6	6269	Moen	yes	male	manual	0.5	3		1.5
107	Boelter Hall		6	6754	Moen	yes	male	manual	0.5	3		1.5
108	Boelter Hall		5	5754	Moen	yes	male	manual	0.5	3		1.5
109	Boelter Hall		5	5423	Moen	yes	female	manual	0.5	2		1
110	Boelter Hall		5	5269	Moen	yes	male	manual	0.5	2		1
111	Boelter Hall		5	5559	Moen	yes	female	manual	0.5	4		2
112	Boelter Hall		4	4559	Moen	yes	female	manual	0.5	4		2
113	Boelter Hall		4	4271	Moen	yes	male	manual	0.5	1		0.5
114	Boelter Hall		4	4754	Moen	yes	male	manual	0.5	3		1.5
115	Boelter Hall		4	4423	Moen	yes	female	manual	0.5	2		1
116	Boelter Hall		3	3754	Moen	yes	male	manual	0.5	3		1.5
117	Boelter Hall		3	3423	Moen	yes	female	manual	0.5	4		2

118	Boelter Hall	3	3269	Moen	yes	male	manual	0.5	1		0.5
119	Boelter Hall	3	3557	Moen	yes	female	manual	0.5	2		1
120	Boelter Hall	3	3269	Chicago	yes	male	manual	2.2	1		2.2
121	Boelter Hall	2	2553	Moen	yes	male	manual	0.5	2		1
122	Boelter Hall	1	1553	Moen	yes	female	manual	0.5	2		1
123	Boelter Hall	1	1765	Moen	yes	male	manual	0.5	2		1
124	Math Sciences	8	8319	Chicago	yes	male	manual	2.2	3		6.6
125	Math Sciences	8	8922	Chicago	yes	male	manual	2.2	2		4.4
126	Math Sciences	7	7922	Chicago	yes	male	manual	2.2	2		4.4
127	Math Sciences	7	7319	Chicago	yes	male	manual	2.2	3		6.6
128	Math Sciences	7	7205	Chicago	yes	male	manual	2.2	3		6.6
129	Math Sciences	7	7211	Chicago	yes	male	manual	2.2	2		4.4
130	Math Sciences	6	6317	Chicago	yes	female	manual	2.2	3		
131	Math Sciences	6	6923	Chicago	yes	male	manual	2.2	2		
132	Math Sciences	6	6209	Chicago	yes	female	manual	2.2	2		
133	Math Sciences	6	6213	Chicago	yes	male	manual	2.2	2		
134	Math Sciences	5	5209	Chicago	yes	male	manual	2.2	1		
135	Math Sciences	5	5317	Chicago	yes	female	manual	2.2	3		
136	Math Sciences	5	5922	Chicago	yes	male	manual	2.2	2		
137	Math Sciences	5	5209	SOFTFLO (Chic	yes	male	manual	2	3		
138	Math Sciences	4	4211	Chicago	yes	male	manual	2.2	5		
139	Math Sciences	3	3317	Chicago	yes	female	manual	2.2	3		
140	Math Sciences	3	3922	Chicago	yes	male	manual	2.2	2		
141	Math Sciences	2	2317	Chicago	yes	female	manual	2.2	3		
142	Math Sciences	2	2922	SOFTFLO (Chic	yes	male	manual	2	2		
143	Math Sciences	1	1347	Moen	yes	female	manual	0.5	3		
144	Kerckhoff Hall	4	416A	Masco	yes	unisex	manual	2.2	2		4.4
145	Kerckhoff Hall	4	416A	not visible	no	unisex	manual	0		1	0
146	Kerckhoff Hall	4	413A	CRI-FAU CO	no	unisex	manual	0		2	0
147	Kerckhoff Hall	3	345A	SOFTFLO (Chic	yes	female	manual	2	4		8
148	Kerckhoff Hall	3	345A	SOFTFLO (Chic	no (broken)	female	manual	2	1		2
149	Kerckhoff Hall	3	312A	SOFTFLO (Chic	yes	male	manual	2	4		8
150	Kerckhoff Hall	3	312A	SOFTFLO (Chic	no	male	manual	2	1		2
151	Kerckhoff Hall	1	114	Moen	no	male	manual	2		3	0
152	Kerckhoff Hall	1	156	Chicago	yes	female	manual	2.2	2		4.4
153	Kerckhoff Hall	1	156	not visible	no	female	manual	0		2	0
154	Ackerman	3	3512	Delta (Masco)	no	female	manual	2		4	0
155	Ackerman	3	3512	Moen	yes	female	manual	2	8		16
156	Ackerman	3	3512	Moen	no	female	manual	2		3	0
157	Ackerman	3	3508C	Moen	yes	male	manual	2	6		12
158	Ackerman	3	3508C	Moen	no	male	manual	2	12		24
159	Ackerman	1	1309	Moen	yes	male	manual	2.2	4		8.8
160	Ackerman	A	A212	Delta	yes	male	manual	1.5	7		10.5
161	Ackerman	1	1313	Moen (?)	yes	female	manual	2.2	2		4.4
162	Ackerman	1	1313	Moen (?)	no	female	manual	2.2		2	0
163	Ackerman	1	1313	Moen (?)	yes	female	manual	2.2	1		2.2
164	Ackerman	1	1313	Masco	no	female	manual	2.2		1	0
165	Ackerman	1	1313	not visible	yes	female	manual	2	1		2
166	Ackerman	1	1313	Masco	yes	female	manual	2.2	1		2.2
167	Ackerman	1	1313	not visible	no	female	manual	2.2		1	0
168	Dodd	1	186	Moen	2 yes, 1 broken a	female	manual	0.5	2	1	1
169	Dodd	2	280A	Moen	yes	female	manual	1.066666667	3		3.2
170	Dodd	3	313	Moen	yes	female	manual	0.5	3		1.5
171	Dodd	2	205	4 Moen, 1 unmai	yes	male	manual	0.84	5		4.2
172	Dodd	3	305	Moen	yes	male	manual	0.5	2		1
173	Dodd	3	387	Moen	yes	male	manual	0.5	2		1
174	Public Affairs	1	1269	Moen	3 yes, 1 no aerat	male	manual	0.5	3	1	1.5
175	Public Affairs	2	2269	Moen	yes	male	manual	0.5	4		2
176	Public Affairs	3	3379	Moen	yes	male	manual	0.5	4		2
177	Public Affairs	4	4328	Moen	yes	male	manual	0.5	4		2
178	Public Affairs	5	5267	Moen	yes	male	manual	0.5	2		1
179	Public Affairs	5	5530	Moen	yes	male	manual	0.5	2		1
180	Public Affairs	6	6332	Moen	yes	male	manual	0.5	2		1
181	Public Affairs	6	6267	Moen	yes	male	manual	0.5	2		1
182	Public Affairs	1		Moen	yes	female	manual	0.5	4		2
183	Public Affairs	2	2283	Moen	yes	female	manual	0.5	3		1.5
184	Public Affairs	2	2330	Moen	yes	female	manual	0.5	4		2
185	Public Affairs	3	3328	Moen	yes	female	manual	0.5	4		2
186	Public Affairs	4	4372	Moen	yes	female	manual	0.5	4		2
187	Public Affairs	5	5229	Moen	yes	female	manual	0.5	2		1
188	Public Affairs	6	6231	Moen	yes	female	manual	0.5	2		1

2. Bathroom Monitoring Data and Aerator Return on Investment Calculations

Math Sciences 5209 (Girls' Bathroom)	known: two non-aerators estimated at 2.8125 gpm	assumptions:	passing periods (x:50-x:05) are peak times.
			10 second hand washing period applied based on data collected from previous ART Water project.
times audited	users		These 4 peak times are averaged per hour, multiplied by 8 for 8 hours, and multipled by 1.5 to encompass
9:50-10:05	18		Multiplying total users observed gives a conservative estimate of daily use.
11:50-12:05	27		Mon-Fri are busiest days
1:50-2:05	21		10 busy weeks. Finals week is negligible for most bathrooms that are in class buildings.
3:50-4:05	25		All of summer is half of a quarter's use
low estimate daily users	273		3 quarters + summer = approx 3.5 quarters use
		LADWP water rate:	https://www.ladwp.com/ladwp/faces/wcnav_externalId/a-fr-schedul-c-comm-ind-gov?_adf.ctrl-state=yt5
gallons saved daily If converted from 2.2 to 0.5 gpm aerators:	105.2188		
gallons saved quarterly	5,260.94		
gallons saved yearly	18,413.28		
LADWP Tier 1 Commercial Rate - May, 2015	$4.932/HCF		
Note: 1 HCF = 748 gallons	6959358/gal		
Money saved by all 4 aerators annually	128.1446		
saved by 1 aerator	64.07231		
Cost of 1 aerator ($9.5 for vandal proof) and installation ($18)	27.5		
Return on Investment per aerator funding at all (years)	**0.429203**		
Return on Investment per aerator if free aerator through TGIF funding but not free installation	**0.280933**		

Haines 136 (Girls' Bathroom)	known: six 2.2 gpm aerators	assumptions:	passing periods (x:50-x:05) are peak times.
			10 second hand washing period applied based on data collected from previous ART Water project.
times audited	users		These 4 peak times are averaged per hour, multiplied by 8 for 8 hours, and multipled by 1.5 to encompass
9:50-10:05	27		Multiplying total users observed gives a conservative estimate of daily use.
11:50-12:05	29		Mon-Fri are busiest days
1:50-2:05	26		10 busy weeks. Finals week is negligible for most bathrooms that are in class buildings.
3:50-4:05	24		All of summer is half of a quarter's use
low estimate daily users	318		3 quarters + summer = approx 3.5 quarters use
		LADWP water rate:	https://www.ladwp.com/ladwp/faces/wcnav_externalId/a-fr-schedul-c-comm-ind-gov?_adf.ctrl-state=yt5
gallons saved daily If converted from 2.2 to 0.5 gpm aerators:	90.1		
gallons saved quarterly	4,505.00		
gallons saved yearly	15,767.50		
LADWP Tier 1 Commercial Rate - May, 2015	$4.932/HCF		
Note: 1 HCF = 748 gallons	$0.006959358/gal		
Money saved by all 6 aerators annually	109.7316773		
saved by 1 aerator	18.28861288		
Cost of 1 aerator ($9.5 for vandal proof) and installation ($18)	27.5		
Return on Investment per aerator funding at all (years)	**1.503667893**		
Return on Investment per aerator if free aerator through TGIF funding but not free installation	**0.984218985**		

Powell 40C (Girls' Bathroom)	known:seven non-aerated estimated at 3.33 gpm	**assumptions:**	passing periods (x:50-x:05) are peak times.
			10 second hand washing period applied based on data collected from previous ART Water project.
times audited	users		These 4 peak times are averaged per hour, multiplied by 8 for 8 hours, and multipled by 1.5 to encompass
9:50-10:05	10		Multiplying total users observed gives a conservative estimate of daily use.
11:50-12:05	24		Mon-Fri are busiest days
1:50-2:05	7		10 busy weeks. Finals week is negligible for most bathrooms that are in class buildings.
3:50-4:05	9		All of summer is half of a quarter's use
low estimate daily users	150		3 quarters + summer = approx 3.5 quarters use
		LADWP water rate:	https://www.ladwp.com/ladwp/faces/wcnav_externalId/a-fr-schedul-c-comm-ind-gov?_adf.ctrl-state=yt5
gallons saved daily If converted from 3.33 to 0.5 gpm aerators:	70.75		
gallons saved quarterly	3,537.50		
gallons saved yearly	12,381.25		
LADWP Tier 1 Commercial Rate - May, 2015	$4.932/HCF		
Note: 1 HCF = 748 gallons	$0.006959358/gal		
Money saved by all 4 aerators annually	86.16555124		
saved by 1 aerator	12.30936446		
Cost of 1 aerator ($9.5 for vandal proof) and installation ($18)	27.5		
Return on Investment per aerator funding at all (years)	**2.234071473**		
Return on Investment per aerator if free aerator through TGIF funding but not free installation	**1.462301328**		

Kerckhoff 114 (Boys' Bathroom)	known: three non-aerators estimated at 1.725 gpm	**assumptions:**	passing periods (x:50-x:05) are peak times.
			10 second hand washing period applied based on data collected from previous ART Water project.
times audited	users		These 4 peak times are averaged per hour, multiplied by 8 for 8 hours, and multipled by 1.5 to encompass
9:50-10:05	11		Multiplying total users observed gives a conservative estimate of daily use.
11:50-12:05	16		Mon-Fri are busiest days
1:50-2:05	8		10 busy weeks. Finals week is negligible for most bathrooms that are in class buildings.
3:50-4:05	10		All of summer is half of a quarter's use
low estimate daily users	135		3 quarters + summer = approx 3.5 quarters use
		LADWP water rate:	https://www.ladwp.com/ladwp/faces/wcnav_externalId/a-fr-schedul-c-comm-ind-gov?_adf.ctrl-state=yt5
gallons saved daily If converted from 2.2 to 0.5 gpm aerators:	27.5625		
gallons saved quarterly	1,378.13		
gallons saved yearly	4,823.44		
LADWP Tier 1 Commercial Rate - May, 2015	$4.932/HCF		
Note: 1 HCF = 748 gallons	$0.006959358/gal		
Money saved by all 4 aerators annually	33.56802835		
saved by 1 aerator	11.18934278		
Cost of 1 aerator ($9.5 for vandal proof) and installation ($18)	27.5		
Return on Investment per aerator funding at all (years)	**2.457695732**		
Return on Investment per aerator if free aerator through TGIF funding but not free installation	**1.60867357**		

Kerckhoff 218 (Girls' Bathroom)	known: three 2.2 gpm aerators		assumptions:	passing periods (x:50-x:05) are peak times.
				10 second hand washing period applied based on data collected from previous ART Water project.
times audited	users			These 4 peak times are averaged per hour, multiplied by 8 for 8 hours, and multipled by 1.5 to encompass
9:50-10:05	32			Multiplying total users observed gives a conservative estimate of daily use.
11:50-12:05	42			Mon-Fri are busiest days
1:50-2:05	38			10 busy weeks. Finals week is negligible for most bathrooms that are in class buildings.
3:50-4:05	18			All of summer is half of a quarter's use
low estimate daily users	390			3 quarters + summer = approx 3.5 quarters use
			LADWP water rate:	https://www.ladwp.com/ladwp/faces/wcnav_externalId/a-fr-schedul-c-comm-ind-gov?_adf.ctrl-state=yt5
gallons saved daily If converted from 2.2 to 0.5 gpm aerators:	110.5			
gallons saved quarterly	5,525.00			
gallons saved yearly	19,337.50			
LADWP Tier 1 Commercial Rate - May, 2015	$4.932/HCF			
Note: 1 HCF = 748 gallons	$0.006959358/gal			
Money saved by all 4 aerators annually	134.5765853			
saved by 1 aerator	44.85886178			
Cost of 1 aerator ($9.5 for vandal proof) and installation ($18)	27.5			
Return on Investment per aerator funding at all (years)	**0.613033833**			
Return on Investment per aerator if free aerator through TGIF funding but not free installation	**0.401258509**			

Powell 40B (Boys' Bathroom)	known: six non-aerated estimated at 1.97 gpm		assumptions:	passing periods (x:50-x:05) are peak times.
				10 second hand washing period applied based on data collected from previous ART Water project.
times audited	users			These 4 peak times are averaged per hour, multiplied by 8 for 8 hours, and multipled by 1.5 to encompass
9:50-10:05	8			Multiplying total users observed gives a conservative estimate of daily use.
11:50-12:05	9			Mon-Fri are busiest days
1:50-2:05	10			10 busy weeks. Finals week is negligible for most bathrooms that are in class buildings.
3:50-4:05	21			All of summer is half of a quarter's use
low estimate daily users	144			3 quarters + summer = approx 3.5 quarters use
			LADWP water rate:	https://www.ladwp.com/ladwp/faces/wcnav_externalId/a-fr-schedul-c-comm-ind-gov?_adf.ctrl-state=yt5
gallons saved daily If converted from 3.33 to 0.5 gpm aerators:	35.28			
gallons saved quarterly	1,764.00			
gallons saved yearly	6,174.00			
LADWP Tier 1 Commercial Rate - May, 2015	$4.932/HCF			
Note: 1 HCF = 748 gallons	$0.006959358/gal			
Money saved by all 4 aerators annually	42.96707629			
saved by 1 aerator	7.161179382			
Cost of 1 aerator ($9.5 for vandal proof) and installation ($18)	27.5			
Return on Investment per aerator funding at all (years)	**3.840149581**			
Return on Investment per aerator if free aerator through TGIF funding but not free installation	**2.513552453**			

Humanites A85 (Boys' Bathroom)	known: four 2.2 gpm aerators		**assumptions:**	passing periods (x:50-x:05) are peak times.
				10 second hand washing period applied based on data collected from previous ART Water project.
times audited	users			These 4 peak times are averaged per hour, multiplied by 8 for 8 hours, and multipled by 1.5 to encompass
9:50-10:05	5			Multiplying total users observed gives a conservative estimate of daily use.
11:50-12:05	3			Mon-Fri are busiest days
1:50-2:05	22			10 busy weeks. Finals week is negligible for most bathrooms that are in class buildings.
3:50-4:05	6			All of summer is half of a quarter's use
low estimate daily users	108			3 quarters + summer = approx 3.5 quarters use
			LADWP water rate:	https://www.ladwp.com/ladwp/faces/wcnav_externalId/a-fr-schedul-c-comm-ind-gov?_adf.ctrl-state=yt5
gallons saved daily If converted from 2.2 to 0.5 gpm aerators:	30.6			
gallons saved quarterly	1,530.00			
gallons saved yearly	5,355.00			
LADWP Tier 1 Commercial Rate - May, 2015	$4.932/HCF			
Note: 1 HCF = 748 gallons	$0.006959358/gal			
Money saved by all 4 aerators annually	37.26736209			
saved by 1 aerator	9.316840523			
Cost of 1 aerator ($9.5 for vandal proof) and installation ($18)	27.5			
Return on Investment per aerator funding at all (years)	**2.951644383**			
Return on Investment per aerator if free aerator through TGIF funding but not free installation	**1.931985415**			