

**An Investigation into High Performance Low-Flow Showerheads for use on University Campuses**

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# ***An Investigation into High Performance Low-Flow Showerheads for use on University Campuses***

***FINAL SUSTAINABILITY REPORT FOR:***

***APPLIED SCIENCE 262: TECHNOLOGY AND SOCIETY II***

***THE UNIVERSITY OF BRITISH COLUMBIA***

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## **ABSTRACT**

The following report provides recommendations to the Student Housing and Hospitality Services (SHHS) at UBC's Vancouver campus regarding which low-flow showerhead models to install in existing and new campus residences. This showerhead replacement program aims to reduce water consumption by replacing inefficient older showerhead models with newer models. Many other institutions have already successfully implemented a similar program. To determine which low-flow showerhead model should be installed in student residences a Triple Bottom Line (TBL) assessment and showerhead performance survey were conducted.

The TBL assessment consists of assessments regarding the social, environmental and economic impact of the showerhead replacement program. The research for these assessments was gathered through surveying UBC students, academic papers and websites. Social impact was measured by student satisfaction ratings on four low-flow showerhead models in an anonymous survey. The showerheads included in the survey were Waterpik Aquascape, Jetstream Atlas II, Bricor Eco-Bravo PC and High Sierra Classic. The environmental assessment consisted of estimating student water consumption for each showerhead model in the survey as well as conventional showerheads. To assess the economic impact of the showerhead replacement program, a life cycle cost analysis was conducted to determine the life cycle cost of each low-flow showerhead model.

Based on the results of the low-flow showerhead performance survey and TBL assessment, it is advantageous for SHHS to replace conventional showerheads with either the Waterpik Aquascape or Jetstream Atlas II showerhead models. Analysis of the survey data showed a positive relationship between user satisfaction ratings and market price of the showerhead.

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## GLOSSARY

- Life Cycle Cost Analysis:* A method for determining the most cost-effective option among different alternatives for a project, when each option can be implemented on technical grounds.
- Low-flow Showerhead:* Showerhead that conserves water, it typically has a flow rating of 2.5 gallons per minute or less.
- Optio-Flow:* A technology, which maintains normal water force even at low water pressure by channeling the water through the showerhead in an efficient manner.
- Optio-Spray:* A technology, which allows water channeling through the sleeve of the showerhead to the nozzle such that the spray diameter becomes wider.
- Watersense:* A program developed by the United States Environmental Protection Agency aimed at water conservation through the use of water efficient products. The Watersense label aims to guide consumers towards water efficient products.

## **LIST OF ABBREVIATIONS**

GPM	Gallons Per Minute
LCCA	Life Cycle Cost Analysis
SEEDS	Social Ecological Economic Development Studies
SHHS	Student Housing and Hospitality Services
TBL	Triple Bottom Line
UBC	University of British Columbia
USEPA	United States Environmental Protection Agency

## 1.0 INTRODUCTION

With the recent global focus on resource sustainability, many North American Universities have begun investing time and money into researching methods of implementing sustainable practices around their campuses. These sustainable practices include the installation of low-flow showerheads to conserve water. Currently, showers account for 13% of the water consumption on UBC's Vancouver campus (UBC Sustainability, 2011). Replacing the inefficient showerhead models currently installed in some campus residences with low-flow models would result in significant reductions in water consumption. This report focuses on determining which low-flow showerhead models are best suited to students living in residences at UBC.

With the numerous showerhead options available in the market our report compares four low-flow models, which have been installed at other university campuses. The showerhead models included in the report are the Waterpik Aquascape, Jetstream Atlas II, Bricor Eco-Bravo PC and High Sierra Classic. Students at the UBC Vancouver campus tested the showerheads and then completed a survey. The survey was completed to assess the performance of the showerheads.

Showerhead recommendations are presented in the report to provide guidance to the Student Housing and Hospitality Services (SHHS) at UBC so that they can decide on an appropriate low-flow showerhead model for students living in residences. Recommendations were made based on the results of the showerhead survey and a TBL analysis. A TBL assessment is used globally in corporations, municipalities and other universities to understand the impact of their project or policy on social, economic and environmental factors (Slaper & Hall, 2011). The TBL method of accounting was used in this report to assess the social, environmental and economic impact of replacing showerheads in UBC residences. User satisfaction ratings, water consumption and life cycle costs were used to assess the social, environmental and economic impact of each low-flow showerhead model tested.



## 2.0 METHODOLOGY

With numerous low-flow showerhead models on the market we did not have enough time or money to test all of them all. To determine which showerheads would perform best for our demographic and setting we researched case studies from other North American universities. We looked at universities that have already successfully installed low-flow showerheads on their campuses. Based on this research we narrowed down the list of showerhead models we would test on UBC students. The showerhead models with the flow rating in gallons per minute (GPM) that we tested on UBC students are shown below in Table 1.

**Table 1.** Showerhead Models Tested

<b>Showerhead Model</b>	<b>Flow Rating (GPM)</b>
<i>Waterpik Aquascape</i>	2.5
<i>Jetstream Atlas II</i>	1.5
<i>Bricor Eco-Bravo PC</i>	1.5
<i>High Sierra Classic</i>	1.5

Each showerhead model was tested for one day at a fraternity house located on the University of British Columbia Vancouver campus. The fraternity house is home to approximately 32 male students ranging in age from 18 to 24 years old. The fraternity house was an ideal location to test the showerhead models because the residents are very active and take frequent showers. This meant that data collection could be completed in a shorter time span because each resident would have had the opportunity to test the showerhead model before we replaced it with a different showerhead model.

To evaluate the performance of each showerhead model a survey was conducted after the residents used the showerhead model for one day. A copy of the survey can be found in Appendix A. The survey was anonymous and asked six simple questions. The questions asked the user to rank the showerhead on its hair rinsing ability, face and body rinsing abilities, spray coverage and strength of spray. These factors were included on our survey because they were deemed the most important showerhead qualities based on a survey conducted on University of Waterloo students (Gauley et al., 2010).

### **3.0 SHOWERHEAD TECHNICAL SPECIFICATIONS**

Brief descriptions of the technical specifications of each low-flow showerhead model surveyed are presented in the following paragraphs. The technical specifications include patented features such as the Watersense label, flow rate, water pressure and spray settings. Other specifications such as the showerhead material, ease of maintenance and energy consumption are also described.

Watersense is a program developed by the United States Environmental Protection Agency (USEPA) aimed at water conservation through the use of water efficient products (2013). Under this program products that meet specifications set up by USEPA are given a Watersense label thereby differentiating them from the other products in the market in terms of water use efficiency. In order for a product to receive a Watersense label the manufacturer must apply for and pay for the Watersense label, therefore some showerheads may be energy efficient and conserve water but are not necessarily Watersense labeled.

#### **3.1 JETSTREAM ATLAS II**

Figure 1 shows the spray pattern of the Jetstream Atlas II. This showerhead model is Watersense labeled and “self-cleaning” according to the manufacturer. The Jetstream Atlas II also has a unique flow reduction option where the user can reduce the water flow while they are soaping. The specifications for the Jetstream Atlas II are summarized in Table 2. All the information provided in the table was obtained from the manufacturer website.



**Figure 1. Jetstream Atlas II Spray Pattern**

Source: Jet-Stream Showerheads, 2012 <[www.jet-streamshowerheads.net](http://www.jet-streamshowerheads.net)>

**Table 2. Jetstream Atlas II Technical Specifications**

<i>Flow rate</i>	1.5 gpm
<i>Water Pressure</i>	20 - 120 psi (+/- 5%)
<i>Type</i>	Precision engineered automatic flow rate & pressure control showerhead.
<i>Maintenance</i>	Self-cleaning, no mineral deposits.
<i>Spray type</i>	High pressure jet stream.
<i>Watersense</i>	Yes
<i>Material used</i>	Triple chrome plated solid brass.
<i>Weight</i>	5.5Oz
<i>Warranty</i>	20 year replacement warranty
<i>Angle</i>	Engaged at an angle of 45 degrees away from the body and flow reduction to 0.75 gpm on increasing the angle thereby saving water while soaping.
<i>Connection size</i>	0.5 inches

Source: Jet-Stream Showerheads, 2012 <[www.jet-streamshowerhead.net](http://www.jet-streamshowerhead.net)>

### 3.2 WATERPIK AQUASCAPE

Figure 2 shows the spray pattern of the Waterpik Aquascape. This showerhead model has the highest flow rating of all the showerhead models surveyed. It is also the only rain style showerhead tested. Table 3 presents a summary of the technical specifications of the Waterpik Aquascape.



**Figure 2.** Waterpik Aquascape Spray Pattern  
Source: Amazon, 2007 <www.amazon.com>

**Table 3.** Waterpik Aquascape Technical Specifications

<i>Flow Rate</i>	2.5 gpm
<i>Water Pressure</i>	30 - 90 psi
<i>Type</i>	Opti-Flow showerhead with 50% more spray coverage.
<i>Maintenance</i>	Easy clean anti-clog nozzle.
<i>Spray type</i>	Full massage, rain, vigorous and wide.
<i>Material</i>	Brass with chrome finish.
<i>Connection size</i>	0.5 inches
<i>Warranty</i>	Lifetime
<i>Spray patterns</i>	8 spray pattern options.
<i>Weight</i>	1.2 pounds

Source: Amazon, 2007 <www.amazon.com>

### 3.3 HIGH SIERRA CLASSIC

The High Sierra Classic is manufactured by High Sierra Showerheads. This showerhead model comes with an option to upgrade to the vandal resistant stainless steel version. The spray pattern of the High Sierra Classic is shown in Figure 3. A summary of the technical specifications for the High Sierra Classic is presented below in Table 4.



**Figure 3.** High Sierra Classic Spray Pattern

Source: High Sierra Showerheads, 2012 <[www.highsierrashowerheads.com](http://www.highsierrashowerheads.com)>

**Table 4.** High Sierra Classic Technical Specifications

<i>Flow Rate</i>	1.5 gpm
<i>Pressure</i>	30-90 psi
<i>Type</i>	Single orifice showerhead with Opti-Spray.
<i>Maintenance</i>	Non-clogging and fully drains after use inhibiting bacterial growth.
<i>Spray Type</i>	Strong and wide without stinging and misting.
<i>Material</i>	Metal body with chrome or stained nickel finish.
<i>Connection size</i>	0.5 inches
<i>Warranty</i>	5 years
<i>Weight</i>	1.6 Oz
<i>Spray Pattern</i>	Single full spray coverage spray of large droplets.

Source: High Sierra Showerheads, 2012 <[www.highsierrashowerheads.com](http://www.highsierrashowerheads.com)>

### 3.4 BRICOR ECO-BRAVO PC

The Bricor Eco-Bravo PC is a Watersense labeled showerhead. According to the manufacturer, the Eco-Bravo has an interior pressurized chamber that aerates and pressurizes the water before spraying it. Figure 4 shows the spray patter for the Bricor Eco-Bravo. The technical specifications for this showerhead are summarized below in Table 5.



**Figure 4.** Bricor Eco-Bravo PC Spray Pattern

Source: Bricor, 2013 <[www.bricor.com](http://www.bricor.com)>

**Table 5.** Bricor Eco-Bravo PC Technical Specifications

<i>Flow Rate</i>	1.5gpm
<i>Pressure</i>	50 psi
<i>Type</i>	Pressure compensated vacuum flow.
<i>Maintenance</i>	Negligible crystal formation due to smaller droplets and increased velocity.
<i>Material used</i>	70% solid brass and chrome ABS plastic.
<i>Weight</i>	6.5 oz
<i>Warranty</i>	2 years extended warranty

Source: Bricor, 2013 <[www.bricor.com](http://www.bricor.com)>

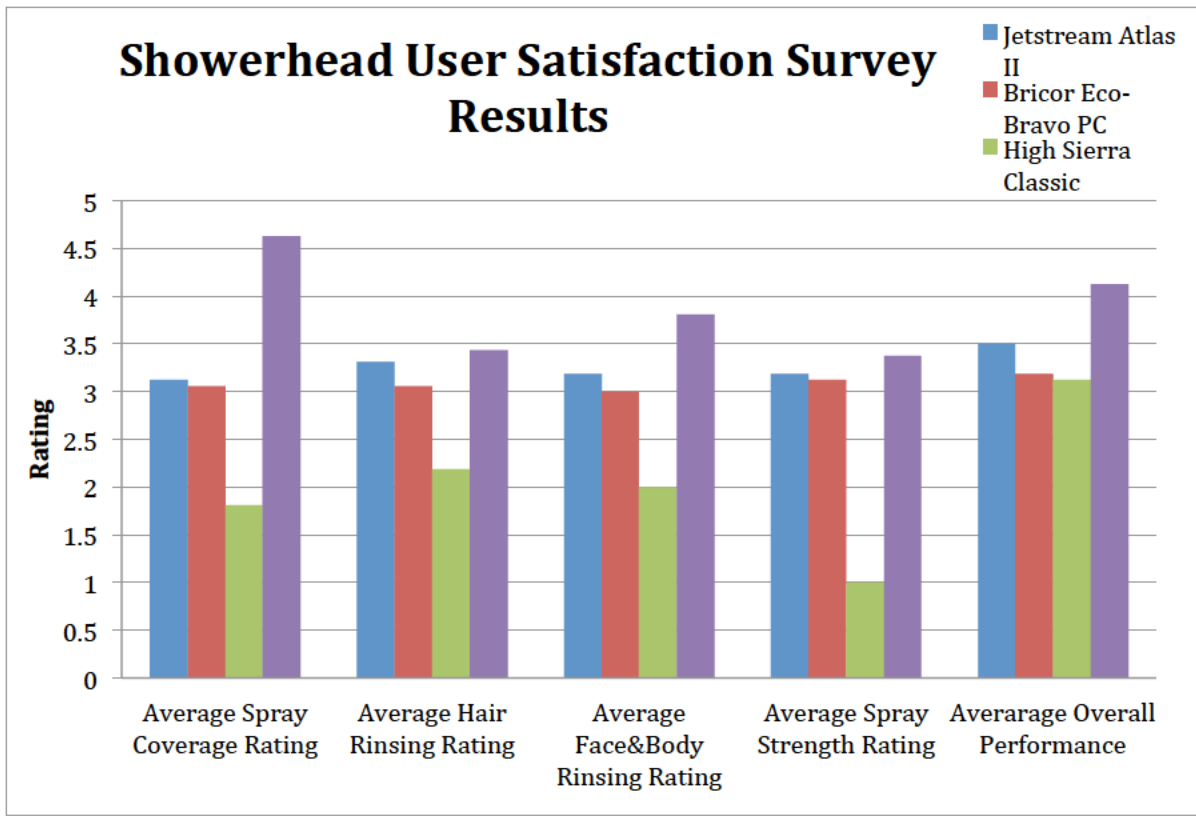
## 4.0 SURVEY RESULTS

The students were asked to rank each showerhead on its hair rinsing ability, face and body rinsing abilities, spray coverage, strength of spray and the overall performance of the showerhead. The students ranked each of these showerhead qualities on a scale of 1 to 5. The ranking scale is shown below in Table 6.

**Table 6.** Ranking Scale

<b>Rank</b>	<b>Meaning</b>
1	Very Poor
2	Poor
3	Moderate
4	Good
5	Very Good

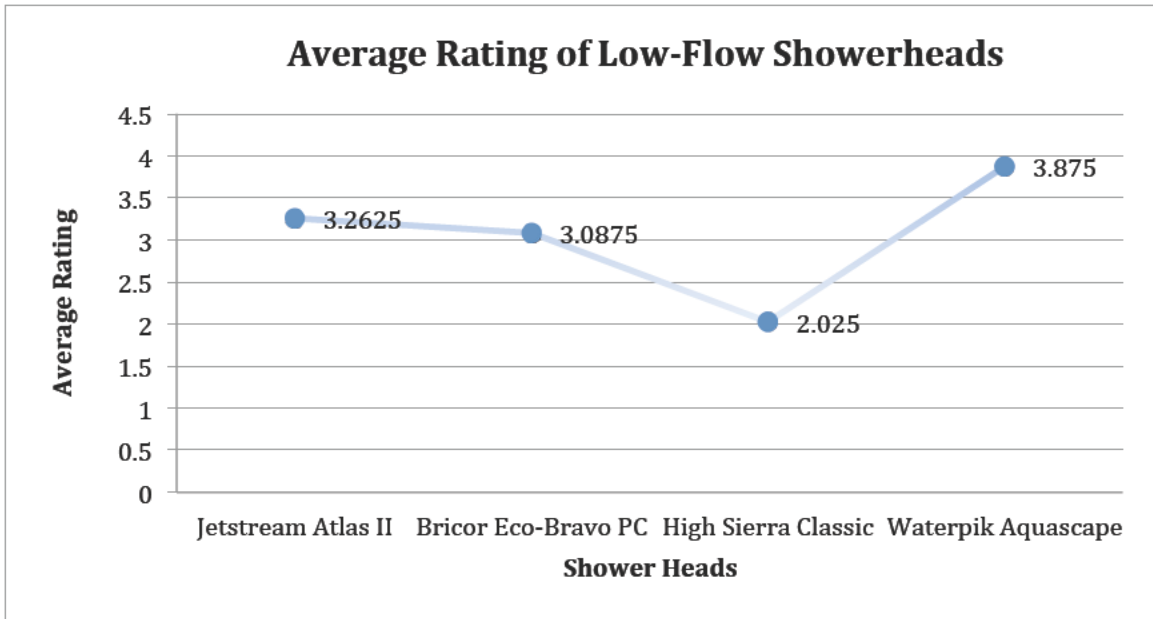
Studies by Gauley et al. found that students generally preferred showerheads with a higher GPM rating (2010). As shown from our results in Figure 5, Waterpik Aquascape had the highest user satisfaction and also had the highest flow rating.



**Figure 5.** Showerhead User Satisfaction Survey Results

The average rating for each category was determined by calculating the arithmetic average of the ratings in a given category. The overall average rating for each low-flow showerhead was calculated by taking the arithmetic average of the spray coverage, hair rinsing, face and body rinsing, spray strength and overall performance ratings. Figure 6 shows that Waterpik Aquascape had the highest average rating of 3.875.





**Figure 6.** Average Rating of Low-Flow Showerheads

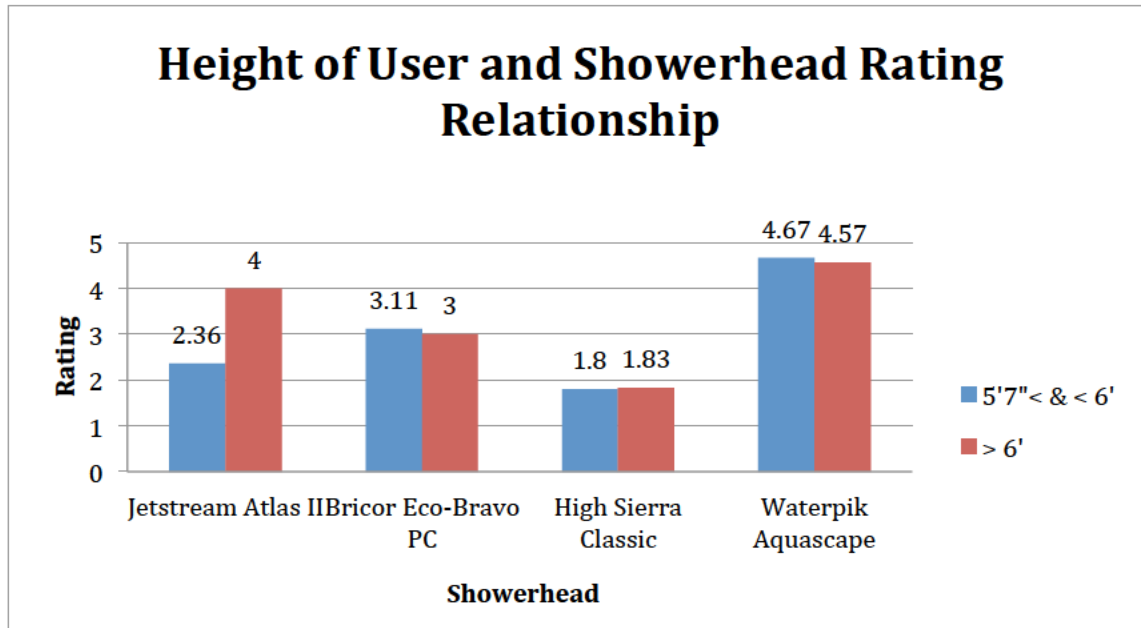
Table 7 ranks the tested showerheads from best performing to worst performing showerhead. The table shows that the Waterpik Aquascape was the best performing showerhead and the High Sierra Classic had poor performance according to our sample.

**Table 7.** Ranking of Showerhead Models from Survey Results

Best Overall Performance	Showerhead Model	GPM Rating
1	Waterpik Aquascape	2.5
2	Jetstream Atlas II	1.5
3	Bricor Eco-Bravo PC	1.5
4	High Sierra Classic	1.5

We also tried to determine whether the height of the user influenced the user satisfaction ratings. We separated the survey sample into two groups. One group was for individuals that were taller than six feet. The other group contained individuals who were less than six feet but taller than five foot seven inches. Since our sample contained male

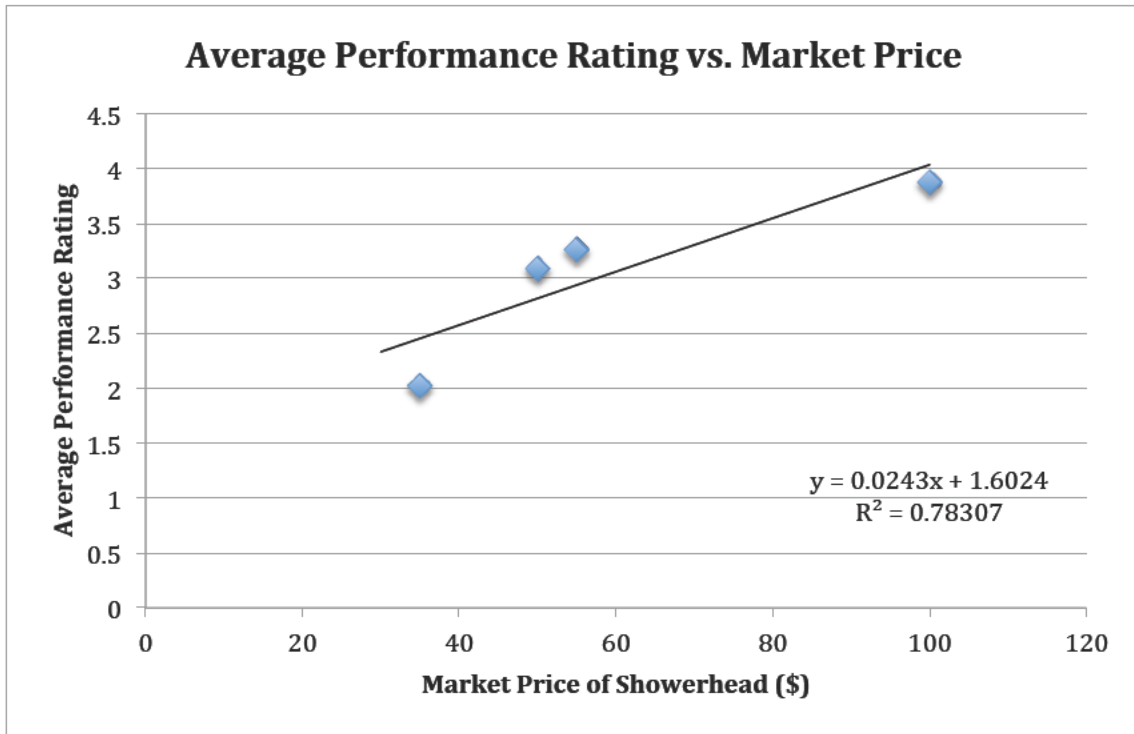
fraternity members, nobody in our sample was less than five foot seven inches. The arithmetic average overall showerhead performance rating was calculated for each showerhead model in each group. Our results are presented graphically in Figure 7.



**Figure 7.** Height of User and Showerhead Rating Relationship

Figure 7 indicates that the height of the user does not affect the satisfaction rating. We could not determine a relationship between the height of the user and the height of the shower head as the Jetstream Atlas II and High Sierra Classic received a better rating from users taller than 6’ whereas Bricor Eco-Bravo PC and Waterpik Aquascape received a higher rating from users between 5’7" and 6’0". Regardless of the height of the user, the best overall performance ranking was still the same as the one listed above in Table 7, with Waterpik Aquascape having the best overall user satisfaction and High Sierra Classic having the lowest overall user satisfaction.

We were able to establish a relationship between market price and user satisfaction. As shown in Figure 8, the market price of the showerhead and the performance rating of the showerhead are positively related. The correlation for this relationship is 0.78.



**Figure 8.** The Effect of Market Price on Performance Rating

The results from our study show that the height of the user does not affect the showerhead rating. It also shows that there is a positive relationship between purchase price and user satisfaction ratings. The Waterpik Aquascape had the highest GPM rating of 2.5, received the best overall user satisfaction of 3.875 and had the highest market price out of the other showerheads surveyed.

## 5.0 TRIPLE BOTTOM LINE ANALYSIS

Triple Bottom Line is an accounting framework, which includes social, economic and environmental dimensions to provide a measure of the performance of a system (Slaper & Hall, 2011). More importantly it provides a measure of the sustainability of a project by evaluating the impact of the project on the environment.

We conducted a TBL analysis to gauge the social, environmental and economic impact of showerhead replacement on UBC's Vancouver campus. To assess the social impact of the project we measured user satisfaction with the low-flow showerhead

models. Water consumption for showering was estimated in order to assess the environmental impact of the showerhead replacement project. A life cycle cost analysis was conducted to measure the economical impact of the project. The following paragraphs provide the results of our social, environmental and economic assessment of the showerhead replacement project.

## 5.1 SOCIAL ASSESSMENT

To analyze the social impact of replacing conventional showerheads with low-flow showerheads we measured user satisfaction of low-flow showerheads. User satisfaction was measured from surveys. Detailed results of the survey were previously shown in section 4.0. A summary of the results is presented below in Table 8.

**Table 8.** Summary of User Satisfaction Results

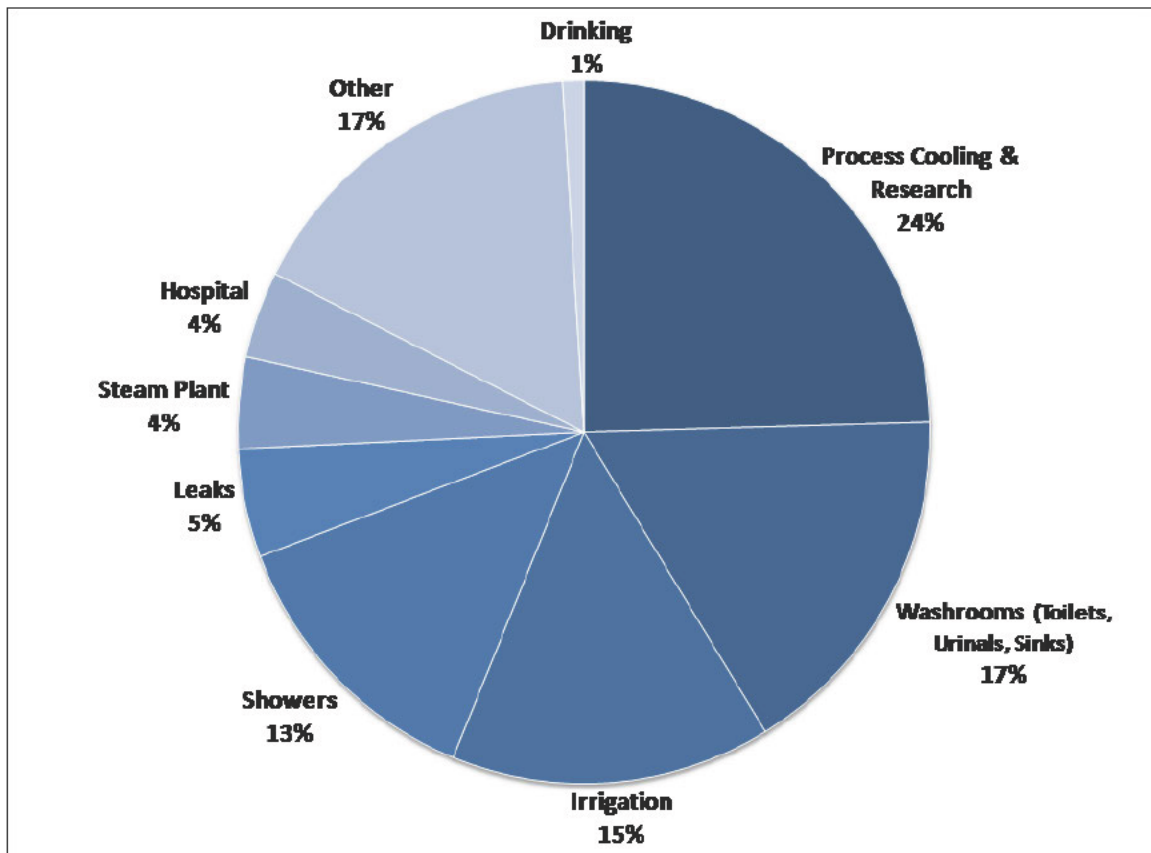
<b>Showerhead Model</b>	<b>Flow Rating (GPM)</b>	<b>Average Overall Performance Rating</b>
<i>Waterpik Aquascape</i>	2.5	3.875
<i>Jetstream Atlas II</i>	1.5	3.2625
<i>Bricor Eco-Bravo PC</i>	1.5	3.0875
<i>High Sierra Classic</i>	1.5	2.025

The average overall performance rating of the showerhead can range from 2.025-3.875, on a scale of 1-5. Table 8 shows that students were satisfied with the performance of the Waterpik Aquascape and Jetstream Atlas II.

We also tried to establish a relationship between the flow rating of the showerhead and user satisfaction. We were not able to establish a statistically significant relationship between flow rating and user satisfaction because of our small sample size and the small deviation between flow ratings of the showerheads tested. However, studies conducted by Gauley *et al.* show that user satisfaction ratings from university students are positively related to the flow rating of the showerhead (2010). This could explain why students preferred the Waterpik Aquascape to the other showerhead models tested.

## 5.2 ENVIRONMENTAL ASSESSMENT

Currently, showers make up 13% of UBC water consumption on the Vancouver campus (Figure 9). By replacing the conventional showerheads that are currently installed in some campus residences, the fraction of water being consumed for showers can be reduced.



**Figure 9.** Water Usage at UBC  
Source: UBC Sustainability, 2011 <[www.sustain.ubc.ca](http://www.sustain.ubc.ca)>

To assess the environmental impact of replacing showerheads in student residences, the weekly volume of water consumed per student for showering was estimated for each showerhead. A comparison of water consumption for each showerhead is shown below in Table 9.

**Table 9.** Expected Water Consumption with each Showerhead Model

<b>Showerhead Model</b>	<b>Flow Rate (gpm)</b>	<b>Water Consumption per Student (gallons per week)</b>
<i>Waterpik Aquascape</i>	2.5	195
<i>High Sierra Classic</i>	1.5	117
<i>Bricor Eco-Bravo PC</i>	1.5	117
<i>Jetstream Atlas II</i>	1.5	117
<i>Conventional Models</i>	5	390

The estimated values of water consumption presented in table 9 were calculated using an average shower time of 13 minutes for each student and assuming each student showered six times a week. Shower duration was assumed to be the same for each showerhead models. The assumptions were based on results from a survey conducted by Cannon Design found that College and University students showered on average six times a week (2013). They also found that the average shower duration for a student was 13 minutes, on average female students had the longest shower duration at 14 minutes while male students had the shortest showers at 11 minutes (Cuevas, 2013).

### **5.3 ECONOMIC ASSESSMENT**

To assess the economic impact of replacing showerheads on UBC residences we conducted a life cycle cost analysis (LCCA). LCCA allowed us to compare the cost of project alternatives. To replace all the showerheads in a UBC residence it requires a large initial capital investment to purchase the showerheads. However, the total project cost includes factors other than just the initial capital investment. LCCA presents a more realistic view of the expected project costs because it takes into consideration the expected useful life of the showerhead, duration of the warranty, maintenance costs and installation costs. Table 10 presents the results of our LCCA.

**Table 10. Life Cycle Cost Analysis**

<b>Showerhead Model</b>	<b>Cost (\$)</b>	<b>Cost of Installation (\$)</b>	<b>Cost of Replacement (\$)</b>	<b>Cost of Maintenance (\$)</b>	<b>Life Cycle Cost (\$)</b>
<i>Jetstream Atlas II</i>	55	13.33	0	40	108.33
<i>Waterpik Aquascape</i>	100	13.33	0	40	153.33
<i>High Sierra Classic</i>	35	13.33	96.66	40	184.99
<i>Bricor Eco-Bravo PC</i>	50	13.33	379.98	40	483.31

The second column of the table shows the advertised market price of the showerhead model, this price was obtained from the company website. The third column presents the cost of installation for one showerhead. The cost of installation was estimated by assuming a wage of \$40 per hour for UBC Building Operations and assuming it only takes one person to install a showerhead. To be conservative, we assumed it took 20 minutes to install a showerhead, and that each model required the same length of time to install. The method used to calculate replacement costs is shown in Table 11. Cost of maintenance is based on the fact that each showerhead must be cleaned annually to ensure optimal performance. Maintenance includes removal of mineral deposits that build-up on the interior of the showerhead as well as cleaning the showerhead filter. To be conservative, we assumed each showerhead requires one hour of maintenance a year. Adding up the values in columns two, three, four and five give you the life cycle cost of each showerhead.

**Table 11.** Calculation of Expected Replacement Cost

<b>Showerhead Model</b>	<b>Cost (\$)</b>	<b>Expected Useful Life</b>	<b>Expected Replacement Cost (\$)</b>
<i>Jetstream Atlas II</i>	55	20 Years	0
<i>Waterpik Aquascape</i>	100	Lifetime Warranty	0
<i>High Sierra Classic</i>	35	5 Years	96.66
<i>Bricor Eco-Bravo PC</i>	50	2 Years	379.98

In order to calculate the expected replacement cost for each showerhead we had to determine the expected useful life of each showerhead. The expected useful life of each showerhead was assumed to be the same as the warranty. We assumed the showerheads would be used for 15 years in student residences, based on this assumption we calculated the expected replacement cost. The replacement cost is calculated for one shower and includes the cost of installation to replace the showerhead. The Jetstream Atlas II and the Waterpik Aquascape have an expected replacement cost of \$0 because both those showerheads have a warranty greater than 15 years. Therefore, during the 15 year period the Jetstream or Waterpik showerhead will be used for they are not expected to breakdown.

Life cycle costs were conservatively estimated. The cost of each showerhead model was obtained from the company's official website. However, most manufacturers offer quantity discounts therefore the true life-cycle cost is most likely lower than the value presented in the table.

Based on the life cycle cost analysis presented above, the Jetstream Atlas II is the most economic showerhead option. The Bricor Eco Bravo PC is the most expensive showerhead option due to the high replacement cost. It is important to note that the two showerheads with the largest initial capital investment – Waterpik Aquascape and Jetstream Atlas II – actually have the lowest life cycle costs.



## 6.0 CONCLUSION AND RECOMMENDATIONS

The results of our survey indicate that the Waterpik Aquascape and Jetstream Atlas II are the top performing low-flow showerheads out of the showerhead models we tested. These showerheads were also the most expensive showerheads, in terms of purchase price. We were able to establish a relationship between user satisfaction and market price of the showerhead. Our study suggests that user satisfaction ratings are positively related to market price of the showerhead. No relationship was found between user height and showerhead performance rating.

Since we were only able to obtain the opinion of male students, we would recommend conducting the same survey on female students. The results could then be compared with the results of our study to determine which showerhead model residents living on campus prefer to use.

If additional surveying cannot be conducted then we would recommend installing the Waterpik Aquascape in residence showers because it had the highest performance ratings. Additionally, showerhead performance studies conducted by Gauley *et al.* found that the most important showerhead quality for female users was the hair rinsing ability of the showerhead (2010). Since the Waterpik Aquascape had the highest hair rinsing ability ratings, it is reasonable to infer that female students would also enjoy this showerhead model. Some residences on campus have male specific bathrooms; we would recommend replacing the showerheads in the male specific showers with the Waterpik Aquascape, since it had the highest performance reviews from male students.

The Waterpik Aquascape has the highest flow rating and requires the largest initial capital investment. If SHHS wants to maximize savings and water conservation, then we would recommend installing the Jetstream Atlas II because it has the lowest life cycle cost and has a lower flow rating than the Waterpik Aquascape.

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## **APPENDICES**

## APPENDIX A: SURVEY QUESTIONS

Height =

Q1) How was the hair rinsing ability of the showerhead?

1 (very poor)  2 (poor)  3 (moderate)  4 (good)  5 (very good)

Q2) How was the face and body rinsing ability of the showerhead?

1 (very poor)  2 (poor)  3 (moderate)  4 (good)  5 (very good)

Q3) How was the spray coverage of the showerhead?

1 (very poor)  2 (poor)  3 (moderate)  4 (good)  5 (very good)

Q4) How was the strength of the spray?

1 (very poor)  2 (poor)  3 (moderate)  4 (good)  5 (very good)

Q5) Please rank the overall performance of this showerhead.

1 (very poor)  2 (poor)  3 (moderate)  4 (good)  5 (very good)