Water Conservation in Rainy Vancouver? Really?

A Water Conservation and Water Pollution Awareness Campaign

in conjunction with the Society Promoting Environmental Conservation (SPEC)

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Executive Summary

With Metro Vancouver's increasing fresh water demand, water conservation is becoming more important as our summers are becoming drier. Through the creation of a water conservation and water pollution prevention outreach campaign, the partnership between three students at the University of British Columbia and Society Promoting Environmental Conservation (SPEC) aims to raise awareness in Metro Vancouver and change behaviour related to water consumption through informative visuals and interactive activities. A total of four deliverables have been created to assist SPEC in teaching the public about water quality and water pollution: where water comes from, where water goes after people use it, what not to put down storm drains with and why, and how much water people can save if they conserve during their showers. The four deliverables include:

- An ***info-graphic*** highlighting Vancouver's water systems
- A How-To-Do-It-Yourself ***water conservation booklet***
- A citizen science ***water quality kit activity***
- A ***pollution jar activity*** that identifies pollutants in local urban waterways

The info-graphic poster and water conservation booklet provide answers to how water is brought to our homes and how it is taken away, highlighting the path of water. The info-graphic poster displays a general path of Metro Vancouver's potable water, beginning at the three reservoirs, going through the residential neighbourhoods, and ending at one of the five-wastewater treatment plants (Metro Vancouver, 2015). The accompanying booklet provides additional information on the path water takes, as well as

manageable tips on conserving water inside and outside the home. Our visuals were enhanced through the collection and analysis of raw data collected from thirteen participants who tracked their showering habits over a seven-day period. The main finding was that the average adult living in Metro Vancouver from our study consumes approximately 19,000 litres of water annually from showering.

The water quality testing kits are an interactive citizen science activity that are available to those who choose to participate, whether from business or community outreach events hosted by SPEC. The idea of the kits is to promote awareness of a few water quality parameters and link that to the potential hazards city pollutants can have on nearby watercourses.

For the pollution jar activity, our team chose five pollutants that are common in local storm drain systems; cement, sediment, paint, soap and oil. These pollutants have been incorporated into a pollution mix and match game. Each jar contains one of these pollutants and the objective is to guess which pollutant is in the jar, enabling SPEC to further educate members of the public on how to keep these pollutants from entering storm drains, using an accompanying script.

The various deliverables created for this water conservation and water pollution awareness outreach campaign will enhance the educational business- and eco-tours hosted by SPEC.

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1.1 Introduction

Under the pressures of a growing global population, the conservation of drinking water is an urgent and significant topic worldwide. Climate change has driven desertification, land degradation, and drought, which currently affect more than 1.5 billion people globally (Dore, 2015). Water conservation in Metro Vancouver, and in most of North America, is often viewed as simply saving water through limiting lawn-watering and taking shorter showers. However, water conservation is not just about implementing a few tasks to limit water usage. It is about changing how we understand, think, and act when it comes to using water. Water is essential to life so as citizens of Metro Vancouver, we must use it wisely and consider water conservation to be a central component of our everyday life.

In recent years, water has been a pressing issue for Metro Vancouver as we continue to experience lower water levels (especially in the summer, when there is little rainfall) paired with an increase in water consumption (Figure 1.1). In 2014, the Waterworks Utility for the City of Vancouver delivered over 112,700,000,000 Litres (L) of drinking water to the City of Vancouver, which was a 4% increase from the 2013 water consumption levels (City of Vancouver, 2015). In 2015, water levels in Metro Vancouver's reservoirs fell below their normal range thus stage 3 water restrictions were imposed, and the public was forced to limit their water consumption (Metro Vancouver, 2015), through neither watering their lawns nor washing their cars outdoors.

Indoor water use is divided, with bathrooms being the highest water-consuming room, the laundry room being the second, and the kitchen being the third. Table 1.1 displays the percentage of water use that is consumed in each indoor room. Referring to Figure 1.2, toilets, laundry machines, and faucets are the top three consumers of water inside the home. To demonstrate how individuals across Vancouver can conserve water, we decided to conduct a shower study, as we believed conserving water in the shower would be an easy activity for individuals to change their behaviour relative to decreasing the number of times they flush the toilet, the length of time or frequency of washing their hands (both are a concern to human health and hygiene) and the frequency of washing laundry (which would also be hard to convince people to do, although we advise people to do full loads of laundry in our info-graphic poster and informational booklet).

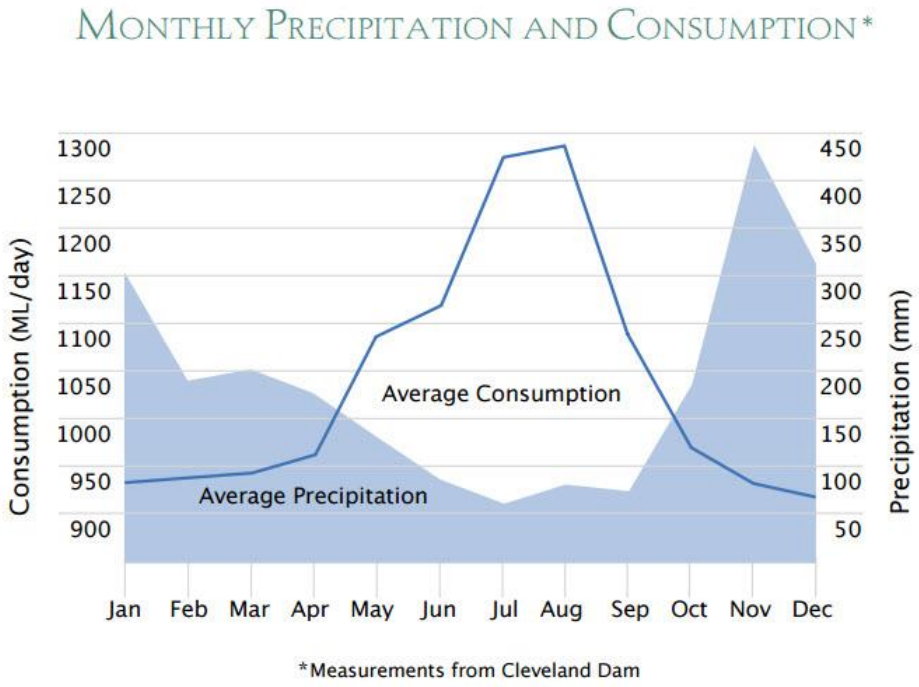

Figure 1.1. Average consumption vs. average precipitation throughout the year. Note that the time of year with the highest consumption is the time of the year with the lowest precipitation (the summer). Image from Greater Vancouver Regional District (2006).

Table 1.1. Estimates on indoor water use divided up into the rooms where water consumption takes place, not accounting for leaks and other causes around the house.

Room	**Percentage of indoor water use**
Kitchen	At least 2% of indoor water use, probably around **9%** (adding dishwashers and half of faucets)
Laundry room	**23%** of indoor water use
Bathroom	At least 50% of indoor water use, probably around **57%** (adding toilets, half of faucets, showers, baths)
Total	**89%** of indoor water use (not accounting for 10% for leaks and 1% for other causes)

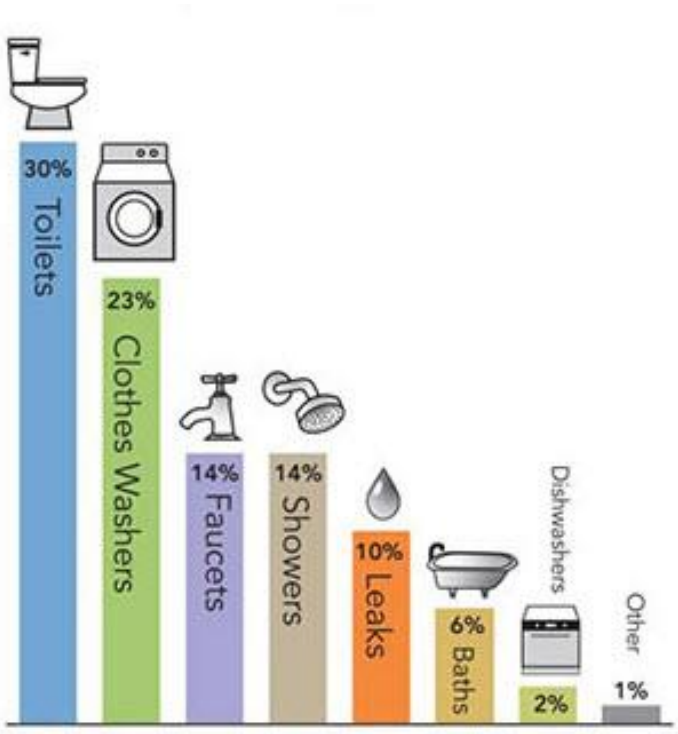

Figure 1.2. Indoor water use divided up by water consuming activities or appliances. From Metro Vancouver (2015).

In Vancouver, the average per capita water consumption ranges from 340 L to 470 L of water per day (Metro Vancouver, 2013 and 2015). This averages to about 1 billion litres of water used per day among the 2.4 million residents, and about 2 billion litres per day in the summer, as more water is needed outdoors. Canada and British Columbia's (B.C.) daily per capita water consumption is close to Metro Vancouver's water consumption range; Canada consumes about 326 L per day per person and B.C. consumes about 440 L per day per person (City of Ottawa, 2000). Table 1.2 compares water consumption across certain parts of Canada, France and the United States of America (USA). Based on daily per capita averages in 2000, Canada was not consuming as much water as the USA. However Canada and the USA consume more than double that of France. B.C. is the worst consumer of water among the provinces listed.

Table 1.2. Comparing Canada with the United States and France, and comparing BC with Alberta, Ontario, and Quebec. From City of Ottawa (2000).

Place	**Average Water Consumption**
Canada	326 L
United States	425 L
France	150 L
British Columbia	440 L
Alberta	257 L
Ontario	271 L
Quebec	386 L

To put the price of Metro Vancouver water into perspective, one unit of water (100 cubic feet, which is 2,831.6 litres) costs $2.584 in the rainy season (winter months) and $3.239 in the dry, summer season (City of Vancouver, 2015). That makes it about $0.91/1000 L in the winter and $1.14/1000 L in the summer, which averages to about $1.02/1000 L over the year. Leaks in a toilet can waste about 750 L a day, which equates to about $270 a year (City of Vancouver, 2015). Since Vancouver water is inexpensive, it is hard to get residents to change their water consumption behaviour using monetary savings as a motivator. However, showing water savings with how many litres you may save if you change specific behaviours (like shortening you shower) may have more of a shock-impact and at least make citizens think about changing their water consumption behaviours.

For many people, water is too inexpensive to feel the need to save, thus monetary value is a poor motivator (Syme et al., 2000). Thus, behavioural change around water conservation is harder than conserving more expensive utilities, such as electricity. People often view water shortages as local and temporary issues (i.e. droughts) and successfully conserve water in the short term during water crises, yet do not recognize that water conservation is important every day. People that are more familiar with drought conditions often use less water than people that are not familiar with water restrictions during droughts (Fielding et al., 2012). Metro Vancouver citizens are

generally not familiar with drought conditions because we receive a lot of rain during the winter months, which is why it is important to educate Metro Vancouver on the need for water conservation. For 2016, Metro Vancouver plans to implement stage 1 water restrictions earlier in the summer and extend them into the fall (Metro Vancouver, 2015), so that citizens can learn how to save their water and to prevent our reservoirs from reaching the same low levels as experienced in the summer of 2015. With increased water restrictions throughout the summer, it would be ideal if Vancouverites also learnt to limit their indoor water use for the rest of the year, even when it is rainy in the winter months.

In order to increase water conservation and water pollution prevention awareness, we worked in collaboration with our community partner, Oliver Lane, the operations manager of Society Promoting Environmental Conservation (SPEC). We provided SPEC with various interactive deliverables, which aim to increase citizen engagement and cause Vancouverites to think about their water use practices. The final four deliverables include the info-graphic poster highlighting Vancouver's water systems and providing tips on how to conserve water and prevent pollution indoors and outdoors at home; the How-To-Do-It-Yourself at home water conservation booklet; the water quality kits to be used by SPEC as a citizen science project; and an interactive activity for SPEC's eco-tours and community outreach events involving jars of polluted water. Our goal is to help SPEC inform Vancouverites about water conservation and sustainable water use.

2.0 The Authors

Our team is comprised of three students majoring in Environmental Sciences at the University of British Columbia. The students, April Liu, Andrew MacKinnon, and Melanie Mewhort, share common knowledge in sustainability, environmental stewardship and the dire need for water conservation. Additionally, each individual was able to bring forth unique skills and supplementary knowledge to the project through their various past coursework and work experiences.

April Liu has taken several courses related to water dynamics including groundwater hydrology, marine pollution, and the study of watersheds. Her marketing role at UBC's Stepping Bridge has allowed her to develop the necessary skills for media and public relations to promote the club's initiatives. Her skills and ideas have been essential for our water conservation and water pollution awareness campaign.

Andrew MacKinnon has taken multiple courses in ecology, ecohydrology, groundwater hydrology, and marine pollution. He has also worked as a research assistant with Dr. Leila Harris on the Program on Water Governance, where Andrew was able identify the policy gaps surrounding water conservation in Metro Vancouver. Additionally, Andrew has worked at Dillon Consulting Limited, where he worked to enhance and protect fish habitat through fieldwork, site assessments, and business certifications. Andrew brought communication, practical and technical skills to the project.

Melanie Mewhort has had coursework and fieldwork in oceanography and groundwater hydrology. Melanie was also a lakes' research assistant for UBC Oceanography/Civil Engineering, where she worked with freshwater data of several reservoirs around B.C. (including the Coquitlam Reservoir in Metro Vancouver). Additionally, Melanie has previous Adobe Photoshop experience which aided the creation of the info-graphic poster.

3.0 Deliverables

A total of four deliverables were created for SPEC to assist in educating the public, specifically those participating on the eco-tours hosted by Oliver Lane, SPEC's operations manager. The deliverables include:

- An ***info-graphic*** highlighting Vancouver's water systems
- A How-To-Do-It-Yourself ***water conservation booklet***
- A citizen science ***water quality kit activity***
- A ***pollution jar activity*** that identifies pollutants in local urban waterways

3.1 Info-graphic Poster

The info-graphic poster (see Appendix A) displays a simplified general path of Metro Vancouver's potable water, starting at the three water reservoirs (Capilano, Seymour and Coquitlam) on the North Shore mountains, going through one of the two water treatment plants, Seymour-Capilano Filtration Plant or Coquitlam Water Treatment Plant, before entering the city. After it leaves our homes, it goes to one of the five wastewater treatment plants (Lions Gate, Annacis Island, Lulu Island, Northwest Langley, and Iona Island), and ends up in the Burrard Inlet (Lions Gate), Fraser River (Annacis Island, Lulu Island, and Northwest Langley), or the Strait of Georgia (Iona Island) (Metro Vancouver Map Viewer, 2015). The poster has some Lower Mainland landmarks (such as the Lion Gate Bridge, Second Narrows' Bridge, Downtown, City of North Vancouver, UBC, YVR, and the Fraser River) to make the poster easier to understand and visualize spatially. The info-graphic poster displays a few Metro Vancouver facts about water consumption and several tips for water conservation.

For the topic of water conservation, we put a few statistics on average water usage per household in Metro Vancouver. This information came from a combination of online resources (i.e. Metro Vancouver) and from an experiment we conducted on a small group of participants. The shower study (see section "Shower Study") consisted of 13 people who measured their time spent in the shower over the span of a week. The informational

tips on the info-graphic poster will be specifically directed at water conservation in the kitchen, laundry room, bathroom, and yard. Regarding water pollution, we showed a car and a storm drain accompanied with one tip on bringing your car to the carwash to prevent soap from entering your storm drain. More water conservation and water pollution prevention tips are shown in the water conservation booklet (see next section).

On the poster, we displayed a large house, which was divided into three 'rooms': kitchen, laundry/boiler room, and bathroom. These three rooms were chosen because they are the largest water consumers inside a residential home. Washing laundry is one of the largest users of water, accounting for 15% to 40% of the overall water consumption inside a typical household of four people (Home Water Works, 2011). Additionally, water use from toilets in the bathroom accounts for about one third of the total indoor water consumption – with at least five flushes per day per person (Home Water Works, 2011). We focused on water consumption in the shower because it is highly variable due to it being based off different showerhead flow rates and the time spent in the shower. Outdoor water consumption is also a significant consumer of water in the summer.

Many of our facts came from the Metro Vancouver webpage (see Table 3.1.1 for a full list of our facts accompanied by the source). We trusted the information from the webpage because it displayed reports for water consumption statistics and water quality for the public to read. We also trusted it because it was up to date and from the source of what we were most interested in. Looking through literature to find facts about Metro Vancouver's water system was difficult and most of the time, irrelevant. Our community partner wanted to educate the people (the business tours' clients and the attendees of community outreach events) who may not already know about the Metro Vancouver water information that is already out there about how to conserve water and how to prevent polluting water. For the everyday person who does not want to search through tabs on the webpage to read facts and reports about Metro Vancouver's water system, we chose the most interesting and relevant facts to display on our info-graphic poster. Since the poster design was very graphically busy, we could only display four facts about the water system and chose to use the rest of the space on the poster for tips around the house to save water. We only displayed two water pollution prevention tips on the poster

(indicated by the asterisk * in Table 3.1.1) but we put some more in the informational booklet.

Table 3.1.1. A breakdown of our facts/tips used in the info-graphic poster accompanied by the source.

Fact/Tip	Source
Vancouver's watersheds span over 600 square kilometres, which is about 150 times the size of Stanley Park.	Metro Vancouver - Taking Care of the Watersheds
Everyday, over 1 billion litres of water flows collectively through our taps in Metro Vancouver.	Metro Vancouver - Our Drinking Water Source
We produce about 440 billion litres of sewage each year. Some liquid waste products are human waste, oil, soap, and food scraps.	Metro Vancouver - How Wastewater is Treated
In Metro Vancouver, the average water consumption is 470 litres per	Metro Vancouver 2013 Water Consumption Statistics Report - used ANNUAL AVERAGE DAILY FLOWS for 2013 for the total system (average of the 19 municipalities)
Outdoor Tips	
Use a rain barrel to catch water and use it to water plants	SPEC
Plant drought resistant plants so you do not have to water them often	Metro Vancouver - Tips to Conserve Water at Home

Use hoses with shut-off valves when gardening	Metro Vancouver - Tips to Conserve Water at Home
During droughts, wash your car only for safety: wash windows, mirrors, and headlights with a sponge and bucket	Metro Vancouver - Tips to Conserve Water at Home
*Take your car to the car wash to avoid soap and chemicals from entering your storm drain	City of Surrey
Sweep your driveway rather than hosing it down	Metro Vancouver - Tips to Conserve Water at Home
*Anything that enters a storm drain is directly discharged untreated into rivers and the ocean	City of Surrey
1 hour of lawn watering can be as much as 25 toilet flushes, 5 laundry loads & 5 dishwasher loads combined	Maple Ridge Sprinkling Regulations
Solution: don't water your lawn, brown is the new green!	SPEC
Kitchen	
Switch to water efficient taps and dishwashers. Avoid pre-rinsing your dishes before using the dishwasher.	Home Water Works - Indoor Water Use

Laundry/Boiler Room	
Only use laundry machine and dishwasher when you have a full load of clothes or dishes.	Home Water Works - Indoor Water Use
Switch to a more water and energy efficient boiler.	Home Water Works - Indoor Water Use
Bathroom	
Turn the tap off when washing dishes or brushing teeth	Home Water Works - Indoor Water Use
Fix any leaks from your tap, showerhead or toilet	Home Water Works - Indoor Water Use
Install low flow toilets which use about 6 litres of water per flush	Home Water Works - Indoor Water Use and Home Depot
Install a low flow showerheads which use less than 0.158 litres per second	Home Water Works - Indoor Water Use
By reducing your shower by 2 minutes and only showering 5x a week, you will save a total of 4680 litres of water annually (12 trillion litres collectively for Metro Vancouver)	Our shower data, assuming that all 2.4 million citizens used the same showerhead as our participant with the highest-flow showerhead, assuming all citizens shower more than 5 times a week, and assuming that they shower for about 8 minutes originally, then decreasing their showerhead flow to 0.158 L/s, decreasing their frequency of showering to 5 times a week, and decreasing each shower by 2 minutes. In hindsight, we should have put a simpler

	finding (with much less assumptions) from our data onto the poster. People may notice that we use about 1-2 billion litres of water per day in Metro Vancouver and saving 12 trillion litres annually from showering alone does not make sense.
Change shower behaviour: 1) Shorten showers 2) Shower less often 3) Wash your hair less often 4) Turn off shower while using soap	We proposed these, knowing and trying different ways that we can lower our water consumption during showers

The daily per capita water consumption number that we displayed on the poster (470 Lpcd (litres per capita per day)) was based off the 2013 Metro Vancouver Water Consumption Statistics Report instead of the Metro Vancouver webpage. The Metro Vancouver webpage stated that Metro Vancouver citizens use about "340 litres of water per household each day, similar to the Canadian average" (Metro Vancouver, 2015) which seemed lower than other "per capita" numbers we saw in the report, which had data for the entire region from 1970-2013. However, this average is highly variable because the region is large with several municipalities and the methods for calculating it may vary - the 470 Lpcd from the report was rounded from 471 Lpcd and based off annual average daily flows of 2013. We chose a higher per capita average to give more of a shock to the public, as it encourages them to think about cutting down their 470 L per day.

We also trusted "Home Water Works – Indoor Water Use" as a reliable source. The Home Water Works, a project from the Alliance for Water Efficiency, is a stakeholder-based non-profit organization that aims to promote efficient and sustainable water use in North America. We trust the numbers and facts from the Alliance for Water Efficiency because user provides the data, and the indoor and outdoor water consumption is estimated by a series of mathematical calculations created by Aquacraft. Moreover,

the Alliance for Water Efficiency established seven main missions about home water conservation to promote household water saving and benefits. The source also provides an online water consumption calculator to show users' water consumption in their own geographical regions. The results from the Home Water Works calculator were then compared to an efficient home in that specific region. The Home Water Works website assisted in the completion of the info-graphic and booklet through providing household water and energy conservation tips.

3.2 The Water Conservation Booklet

The How-To-Do-It-Yourself water conservation booklet (see Appendix B) provides supplementary information to info-graphic poster of Metro Vancouver. The water conservation booklet contains facts on conserving water consumption and tips on how to use water wisely. The objective of the booklet is to provide citizens with information on how they can conserve water in their everyday lives, whether indoor or outdoor.

We provided related water-wise tips for each room to help readers of our informational booklet save water by changing their water use behaviour. For the "use water wisely" tips, we researched average in-home statistics for water usage and modeled some statistics using our shower study. The rest of the numbers we used in the booklet steam from research and literature review as presented in Table 3.2.1. The numbers we used in the booklet were based on what we believed would initiate a larger chance of change in citizen behaviour. The monetary savings from conserving water on an annual scale did not show significant savings, so we considered using water savings per individual and for the entire city on an annual scale. In the end, we used many Metro Vancouver-wide facts on annual scales to show the largest numbers, which hopefully will shock citizens into thinking about conserving water at home.

Table 3.2.1. A breakdown of our facts/tips used in the water conservation booklet accompanied by the source.

Fact/Tip	Source
There are over 2.4 million individuals in the Lower Mainland, and Metro Vancouver expects about 35,000 new residents every year, with an estimation of about 1 million new residents by 2040.	Metro Vancouver - Water Services, Water Conservation in a Rainy City
Everyday, over 1 billion litres of water flows collectively through our taps in Metro Vancouver.	Metro Vancouver - Our Drinking Water Source
On the most water-consumptive day per year, about 2 billion litres of water is collectively used. In the summer and early fall, Vancouver's water intake is around double of the average daily water intake for the rest of the year because of watering lawns, filling swimming pools, maintaining sports fields, and growing food (agricultural crops and personal gardens).	Metro Vancouver - Lawn Sprinkling Regulations
In the summer of 2015, Metro Vancouver experienced stage 3 water restrictions as our reservoirs were experiencing high demand coupled with lack of fresh water input.	Metro Vancouver
Map of watersheds	Metro Vancouver
The Source of our Water	

Vancouver's watersheds span over 600 square kilometres, which is about 150 times the size of Stanley Park.	Metro Vancouver - Taking Care of the Watersheds
Our three water reservoirs are: Capilano, Seymour and Coquitlam.	Metro Vancouver - Our Drinking Water Source
The Seymour-Capilano Filtration Plant (SCFP) and Coquitlam Water Treatment Plant (CWTP) both use UV radiation and chlorine to disinfect the water (source treatment)	Metro Vancouver - Drinking Water Treatment Processes
If you live far from the water source, your water may be additionally treated (secondary treatment) in which chlorine is added again into the water to keep bacteria from growing because chlorine gradually breaks down as it travels to your home	Metro Vancouver - Drinking Water Treatment Processes
In total, Vancouver has over 500 km of water mains, 15 water pumping stations to help water to get up hills, 8 rechlorination stations for secondary water treatment, and 22 in-system reservoirs for having water during peak-demand times	Metro Vancouver - Drinking Water Facilities

Wastewater Treatment	
Metro Vancouver residents produce about 440 billion litres of sewage each year. Some liquid waste products are human waste, oil, soap, and food scraps	Metro Vancouver - How Wastewater is Treated
To avoid wastewater flowing into our water bodies, which would threaten public health, recreation, habitats, and fisheries, we have two types of waste water treatment: • The primary treatment uses mechanical processes to take away 50-60% of sinking or floating materials • The secondary treatment uses bacteria to consume particles and 95% of dissolved organic materials in the wastewater, which takes place at Lulu Island, Annacis Island, and Northwest Langley wastewater treatment plants	Metro Vancouver - How Wastewater is Treated
Kitchen	
Replacing an old and inefficient dishwasher can reduce water consumption by 50% annually, all while saving energy through the efficient operation of the machine and by using less hot water	Home Water Works - Indoor Water Use

Run full loads of dishes only. Fix all faucet and pipe leaks to prevent unnecessary use of water.	Home Water Works - Indoor Water Use
Replace older model dishwashers with a newer, high-efficiency model to save water and energy.	Home Water Works - Indoor Water Use
Avoid pre-rinsing the dishes, as is not required with many new dishwashers. Read the instruction manual for your machine to determine if you can minimize rinse water usage.	Home Water Works - Indoor Water Use
Bathroom	
An Ultra Low Flush toilet flushes at a maximum of 6 litres per flush	Home Water Works - Indoor Water Use
A High Efficiency Toilet (HET) flushes at maximum of 5 litres per flush	Home Water Works - Indoor Water Use
Dual-Flush toilets are a type of HET with a full flush and a half flush capability. The average flush volume of a modern dual flush toilet is 4 litres or less	Home Water Works - Indoor Water Use
The average adult individual in Metro Vancouver spends about 8 minutes in the shower, which equates to 71 litres of water consumed	Based on our shower data

Reducing your shower by 2 minutes will save approximately 18 litres of water per shower, which after 3 showers is equivalent to the amount of gas required to fill the tank of your car.	Shower study analysis
If you reduce your shower by 2 minutes and shower only 5 times a week, you will save a total of 4680 L of water annually (12 trillion litres collectively for Metro Vancouver).	Our shower data, assuming that all 2.4 million citizens used the same showerhead as our participant with the highest-flow showerhead, assuming all citizens shower more than 5 times a week, and assuming that they shower for about 8 minutes originally, then decreasing their showerhead flow to 0.158 L/s, decreasing their frequency of showering to 5 times a week, and decreasing each shower by 2 minutes. In hindsight, we should have put a simpler finding (with much less assumptions) from our data onto the booklet. People may notice that we use about 1-2 billion litres of water per day in Metro Vancouver and saving 12 trillion litres annually from showering alone does not make sense.
A showerhead with a flow rate of less than 0.158L/s is considered “Low-Flow.” Be mindful showerheads often have multiple settings, ensure yours is set to the lowest setting for optimal water use.	Home Water Works - Indoor Water Use

Replace older model toilets with a newer, high efficiency model to save water.	Home Water Works - Indoor Water Use
Do not flush garbage or unnecessary items down the toilet.	Home Water Works - Indoor Water Use
If you hear the water running in the toilet tank for an unusual length of time, a simple adjustment can return it to normal operation.	Home Water Works - Indoor Water Use
Use the low volume flush mode on your toilet as much as possible, if you have a dual flush toilet.	Home Water Works - Indoor Water Use
Laundry Room	
Washing laundry accounts for 15-40% of total household water consumption	Home Water Works - Indoor Water Use
Most washers require about 150 litres of water per load, high-efficiency washers require less than 100 litres of water per load	Home Water Works - Indoor Water Use
Replacing old and inefficient washers can save 23 000 litres of water	Home Water Works - Indoor Water Use
Run full loads only, even if the washer has an adjustable load setting. A full load is the most efficient way to wash clothes.	Home Water Works - Indoor Water Use

Replace the old inefficient clothes washer with a new high-efficiency model to save water and energy.	Home Water Works - Indoor Water Use
Fix all faucet and pipe leaks immediately to prevent unnecessary use of water.	Home Water Works - Indoor Water Use
Yard/Outdoors	
Anything that enters a storm drain is directly discharged untreated into nearby rivers and the ocean	Metro Vancouver
This includes runoff from pesticides, debris and dirt and can have negative impacts on marine ecosystems	Metro Vancouver
Stormwater often contains motor oil, gasoline, sediment and fertilizers	Metro Vancouver
Keep your storm drain clear from debris such as sediment, leaves and small branches.	Metro Vancouver
Never pour anything down the storm drain aside from rainwater.	Metro Vancouver
Wash your vehicle only when necessary at an appropriate car wash depot	City of Surrey
Abide by Metro Vancouver's storm drain bylaws to ensure that fish habitat is protected.	City of Surrey

One hour of lawn watering is equivalent to 25 flushes in the bathroom	SPEC
Execute "WATER WISE GARDENING" by avoiding watering lawn as fertilizer runoff can be detrimental to marine ecosystems and planting drought-tolerant plants	SPEC

3.3 Water Quality Testing Kit

We have incorporated citizen science into our community project through our water quality kits. The involvement of the citizen participants in the water quality kit activity will result in a positive environmental impact (Cooper et al., 2007), as citizens will think about conserving water at home and become consciously aware of not polluting local waterways. These benefits were highlighted through the work of Devistor et al. (2010), who stated that there is a need to collect large quantities of data when investigating the aspects of global biodiversity change. Citizen science provides assistance in collecting large quantities of data, encourages citizen engagement through participating in educational initiatives, and has been incredibly successful in advancing scientific knowledge (Bonney et al., 2009). Citizen science research suggests that individuals who are a part of the data collection process are more likely to gain an interest and become more knowledgeable on the subject matter (Brossard et al., 2005), in our case water conservation and water pollution awareness in local urban streams.

The water quality testing kit is an interactive activity that will be available to those who choose to participate following a business or community outreach event hosted by SPEC. The idea of the kits is to promote awareness of water quality using a few key parameters in nearby watercourses. The design resembles the City of Surrey's "Take the Dip" challenge, where members of the general public sign out the kits and take water quality samples from their neighbourhood streams (City of Surrey, 2015). Our kits will be designed to be adaptable to both fresh and saltwater bodies of water as requested by

SPEC. More emphasis will be placed on citizen engagement through the use of these water quality kits instead of the level of accuracy for the parameter measurements.

The kits will include simplified scientific tests that enable the general public to test water parameters, such as pH, alkalinity, hardness and the concentrations of nitrate, nitrite, and dissolved oxygen. Inside the kit, we will include an instant analytic testing strip, which will measure most of the parameters. There will also be a simplified dissolved oxygen (DO) test specifically for fresh water systems. The DO test will involve a small vial and tablet, which when dissolved will change colour to indicate the approximate level of DO found within the stream. Completion of the water quality tests will not take longer than twenty minutes, providing an efficient and easily manageable kit. A B.C. government website which includes some of our water quality parameters will be given to Oliver so that he can tell the clients that they can check whether the parameters are in a normal range (Table 3.3.1). For a visual of the water quality kit, see Appendix C.

Table 3.3.1. Supplementary information given to SPEC to allow citizens to compare their water quality results with what is considered the "normal range," as identified by the Government.

Parameter	Website
Hardness	a) http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/library/ground_fact_sheets/pdfs/hardness(020715)_fin2.pdf b) http://healthycanadians.gc.ca/publications/healthy-living-vie-saine/water-hardness-durete-eau/index-eng.php
Alkalinity	a) #8 on https://www.for.gov.bc.ca/hts/risc/pubs/aquatic/interp/interp-01.htm
pH	a) http://yourwatermatters.com/vancouver-water/metro-vancouver-tap-water-ph-adjustments-no-longer-acidic/ b) Page 9-10 of report: http://vancouver.ca/files/cov/water-quality-report.pdf c) http://www.env.gov.bc.ca/wat/wq/BCguidelines/phtech.pdf

Nitrite	a) http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/waterqualityguidesobjs/approved-wat-qual-guides/nitrogen/nitrogen-overview.pdf
Nitrate	
Dissolved Oxygen	a) http://www.env.gov.bc.ca/wat/wq/BCguidelines/do/do_over.html

We supplied SPEC with four full starter kits and additional materials for restocking, as well as the contact information for ordering additional supplies (Table 3.3.2). As previously mentioned, data collected by the individuals will be passed along to SPEC upon the return of the kits, where the information will be inputted onto an excel spreadsheet which SPEC may choose to put out on their website to show the water quality results of this citizen science project.

Table 3.3.2. A breakdown of the source and cost for additional water quality kit supplies.

Product	Cost per unit ($)	Product Company	Catalog Number
5-Way Insta-Test Analytic Test Strips (25 strips per factor)	18.74 (USD)	Fisher Scientific	03-920-421
Dissolved Oxygen in Water Test Kit (15 tests)	17.80 CAD	Flinn Scientific Canada	AP6138
32oz NAT ROUND Wide-Mouth Jar	1.60 CAD	Uline .ca	S-18072
Rope and Cable Ties	6.44 CAD (Total)	Dollar Store	N/A
Pencils & Cardstock	20.41 CAD (Total)	Staples Business Depot	N/A

3.4 Pollution Jar Activity

The pollution jar activity is an interactive demonstration that will hopefully encourage citizens to think about local water pollution prevention. The activity will be showcased during SPEC's business tours as well as other community outreach events. This activity will show various pollutants that are commonly found in storm drains. We provided basic scientific information on the pollutants as supplementary information, which will be presenting during the demonstration of the pollution jar activity. This information will include the source of the pollution/whether the pollutant is the result of anthropogenic activity, preventive actions for reduction of discharge and the current status of the pollutants in Vancouver. A script (see Appendix D) will be provided to SPEC to ensure that the correct information regarding each pollutant is conveyed to the audience.

This activity aims to promote water pollution control for Vancouver citizens. In recent years, with the development of industrialization, more and more areas are experiencing water pollution issues. Currently, around 3.3 billion people in the world live in urban areas, and around 5 billion people are expected to be living in towns and cities by the year 2030 (Armstrong, 2009). Water quality directly influences the health of citizens so water pollution control is an urgent issue for all citizens. Governments undertake this by establishing an appropriate set of organizations and launching specific programs. In Vancouver, the City of Vancouver established instruments to monitor and protect the quality of Vancouver's drinking water. In the Vancouver Water Utility Annual Report, 2027 drinking water samples were collected in the City of Vancouver in 2014, and all samples met the bacterial standards as listed under the Water Quality Standards for Potable Water within the B.C. Drinking Water Protection Regulation (City of Vancouver, 2014). All the analysis results for the chemical and physical parameters, disinfection by-products, and metals were within acceptable ranges (City of Vancouver, 2014).

The chosen five pollutants (cement, sediment, paint, soap and oil) are major pollutants commonly found in localized urban water systems. The reason we chose these five pollutants is because they are highly related to urbanization and anthropogenic activities in Vancouver. Cement is a common construction material in urban areas and its

manufacturing production is the third largest pollution source for both air and water environment (EPA, 2015). Also when runoff carries cement from the surface to the storm drain, it mixes with the water to damage sensitive habitats in the streams resulting in a lower dissolved oxygen concentration. A lower dissolved oxygen concentration will suffocate fish and other aquatic species. Keeping cement clean on the streets can be a way to prevent cement from entering water system. Rivers downstream to the Ocean can transport sediment. Sediments in aquatic ecosystems will lead to loss of unique and sensitive habitats, decrease in biodiversity and much more. Paint usually contains toxins or biocides such as resin, pigments, solvents and additives. It enters the local water system through incorrect disposal of leftover paint and improper cleansing of paintbrushes over storm drains. Soaps and other detergents often contain artificial fragrances and colours from various chemicals. Certain concentrations of detergent will destroy the external mucus layers of fish and other aquatic organisms. Runoff soaps from washing your vehicle enter streams directly through storm drains without treatment and will change the pH of the stream (making it more basic in large concentrations). Oil cannot dissolve in water and will form a thick sludge in aquatic systems. The formation of the thick sludge layer of oil in large quantities can suffocate fish and block light from reaching photosynthetic aquatic plants. About 88% of oil pollution in water system is directly from leaking boats, individual runoff from land vehicles and inappropriate disposal. A more thorough explanation of each pollutant can be found in the Appendix.

4.0 – Supplementary Studies

Two studies were conducted to supplement our project. The first, a study testing the clarity and quality of our water quality kit instruction booklet, was conducted using ten participants. The second, a study that tracked water use in the shower of thirteen participants, was conducted over a seven-day period. Both studies went through and were approved by UBC's Behavioural Research Ethics Board (BREB).

4.1 Short Study: Clarity of the Water Quality Kit Instructions

Many of the individuals using the water quality kits from SPEC will have no previous experience with water quality sampling, as the aim of this activity is to use citizen science to make people think about water quality. Thus, we had to make sure our instructions for the kits were easily understood and could be completed by any adult member of the general public. We tested the level of clarity and feasibility of our kits by having a select group of UBC students collect water quality samples using our instructions (see Appendix E) and recording cards (see Appendix F). The participants were asked to perform the water quality tests individually without the help of anyone else. Upon completion of the water quality tests, participants were asked to complete a short survey regarding the level of clarity of the instructions, their experience with the kits, and their suggestions for improvements in the instructions of the kits. The surveys identified the level of previous scientific experience the participant had and whether the activity increased their level of interest in water quality.

Table 4.1.1. The response "yes" to seven statements (listed below) by the ten participants regarding their previous experience.

Participant	Faculty	Year	1	2	3	4	5	6	7
1	Science	4			Y	Y	Y		
2	Science	4	Y	Y	Y		Y		
3	Arts	3			Y	Y			
4	Business	4							
5	Business	4							
6	Arts	3			Y	Y	Y		
7	Business	4							
8	Engineering	3			Y		Y		
9	Arts	5			Y	Y	Y		
10	Science	4			Y		Y		

The numbers along the top of Table 4.1.1, are statements from Part 2 of the survey. A copy of the survey can be found in Appendix G. The statements are as follows:

1. I have had previous experience in collecting field samples.
2. I have specifically collected water quality samples in the past.
3. I am familiar with the importance of following strict scientific procedure when collecting samples in the field.
4. I have had previous experience with water quality testing using test strip indicators.
5. I have previously interpreted the results of scientific data.
6. I have had previously participated in a citizen science project.
7. I am familiar with the term "citizen science."

In this study, our participants had a range of background knowledge:

- Zero participants had previously participated in a citizen science project
- Zero participants were familiar with the term citizen science
- Only one participant had experience collecting field samples and experience collecting water samples

- Seven out of ten participants were familiar with the importance of following strict scientific procedure when collecting samples in the field; the three that were not familiar with it were in the Faculty of Business
- Four out of ten had used test strip indicators in the past
- Six out of ten had previously interpreted results of scientific data
- The three Business students in our study circled "no" for all the statements

Table 4.1.2 presents the participants' opinions on the clarity of the instructions, using the scale strongly disagree (1) to strongly agree (5).

Table 4.1.2. The responses ranging from strongly disagree to strongly agree to ten statements (listed below) by the ten participants regarding their feelings about the clarity of the instructions and the overall experience of the activity.

Participant	A	B	C	D	E	F	G	H	I	J
1	2	5	4	2	1	1	5	2	5	4
2	3	3	5	3	4	4	5	1	3	4
3	5	2	4	4	3	2	4	2	2	5
4	4	2	3	4	1	1	5	2	1	4
5	4	3	3	4	3	1	3	3	2	3
6	5	3	4	5	1	1	2	2	2	3
7	4	2	5	2	3	2	4	2	2	3
8	5	3	2	5	1	3	4	4	4	4
9	4	4	3	5	3	1	3	3	3	3
10	5	1	4	4	3	4	3	2	1	3

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

The statements A-J (previously 1-10 found in the water quality kit survey) are as follows:

A. I enjoyed collecting the water quality samples.
B. I found the process to collect the water samples frustrating.
C. The instructions were easily understood.

D. I was able to complete the water sampling without assistance.

E. I required assistance from one of the investigators on more than one occasion while collecting the water quality samples.

F. I required assistance when using the test strip indicators.

G. I understood the purpose of collecting the water quality samples.

H. The instructions lacked detail or were too vague.

I. The process of collecting the water samples was challenging.

J. Participating in citizen science, specifically this water quality testing increases my interest in the importance of water quality in Metro Vancouver.

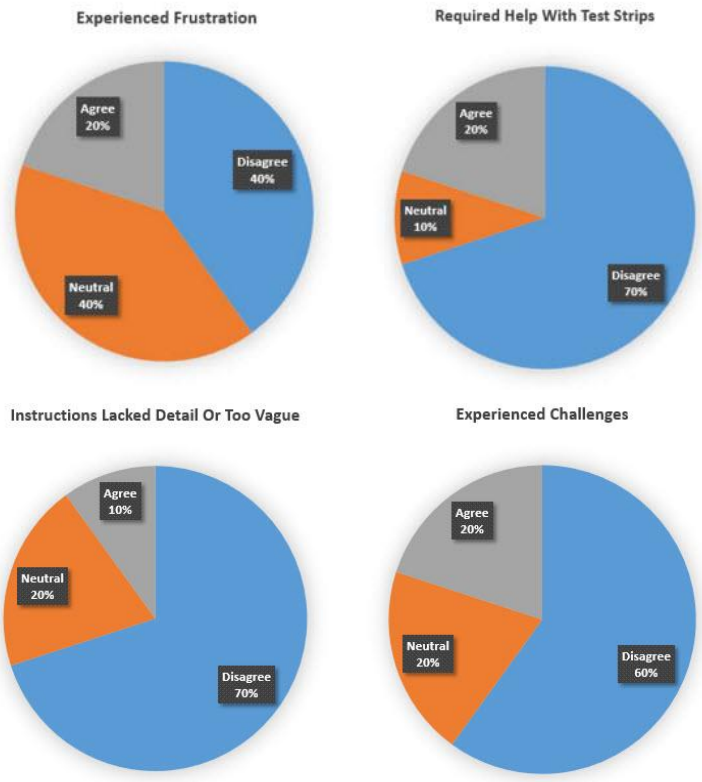

Figure 4.1.1. The responses based on statements B, F, H, and I in Table 4.1.2 by ten participants regarding their feelings about the clarity of the instructions and the overall experience of our activity.

Based on the responses in Table 4.1.2, we chose to show statements B, F, H, and I (previously 2, 6, 8, 9 in the original survey) in pie charts, coupling strongly agree and agree as just "agree", and coupling strongly disagree and disagree as "disagree" (Figure 4.1.1). Neutral stayed the same. We chose these statements because they provided the most insight on how our participants felt about the overall experience and the clarity of the instructions. To summarize our findings:

- To statement B (I found the process to collect the water samples frustrating), the majority of the participants did not feel frustrated or they felt neutral in terms of frustration by the activity. Two participants agreed to this statement about being frustrated.
- To statement F (I required assistance when using the test strip indicators), seven of the ten participants felt that they did not need help with the test strip indicators. The three who agreed or felt neutral to the statement may have been the participants who made comments about the test strip section clarity in the open-ended section.
- To statement H (The instructions lacked detail or were too vague), only one participant agreed and thought the instructions were too vague.
- To statement I (The process of collecting the water samples was challenging), two participants thought the activity was challenging while six participants did not.

Three open-ended questions were asked at the end of the questionnaire regarding the citizen science activity.

1. What was one component of the instructions that you found useful, if any?
2. What was one component of the instructions that you felt needed clarity?
3. Describe your overall experience with the water quality kits and the accompanying instructions.

The feedback for the first question (what the participants found most useful) said that the instructions were generally good, simple and the steps were clear, and didn't contain any jargon. Some participants liked the labels "before testing" and "start testing", and one participant liked the second part of the instructions for the water quality strips.

The feedback for the second question (what part of the instructions that the participants thought needed more clarity) were that some of the instructions were too long, that there was a typo (vial was spelt vile in these instructions), and that one step seemed unnecessary. One person explicitly wrote down that they thought the clarity was fine. Others were confused with what to do with the oxygen tablets (wait for 5 minutes for the tablet to dissolve or wait 5 minutes after the tablet is dissolved and what "dissolved oxygen vile" meant) and the test strips (some did not know that the test strips were in the test strip tube, and that you had to compare the test strip colour to the colour comparison chart on the tube).

The feedback for the third question (the overall experience for the participants) were that the kits were easy to use and the instructions were clear and helpful. One participant thought the instructions were somewhat clear but could be improved. Another participant thought the activity was confusing. Other participants said the overall experience of the experiment was good, interesting, fun, and made them think more about the environment. One comment was that the participant would have liked to see expected values of the parameters, which we have not added to the instructions or the recording cards, but we have included links for each parameter in this report so that Oliver can provide these links to SPEC's clients if they want to see the expected values or read up on the relevance of the parameters in water.

From this feedback, we learned about some of the common challenges while using our water quality kit instructions, mainly with the testing strips (in the tube) and the dissolved oxygen tablets and vials. We changed the instructions by fixing the vial typo, by adding in another step in the "Before Testing" section which indicated that the test strips were found in the tube (to clarify that for the people who may be confused by that), by adding another sentence to instruction 3 in "Start Testing" indicating that you can refer to the colour chart on the tube to make the test strip recordings, and we shifted the

third part of the instructions up so that the last sentence was not cut off (which only one person in our study noticed). Other than that, we kept the same layout, design, and instructions as in our original instructions. We did not make many additions or changes because we had a space constraint, as our font size for the size of paper was the largest we could make it, and we were unwilling to make the font size smaller.

We also made some changes to the recording card by rearranging the order of the parameters (to that of the order of the parameters tested in the experiment), by adding the yes/no statement "Has participating in citizen science, increased your interest in the importance of water quality in Metro Vancouver?", and by adding a short "comments" section (rather than an "observations" section that almost none of the participants used) for SPEC's clients to use for observations, feedback, or questions.

One of our specific interests of the short study was to see if the citizen science activity increased an interest in water quality. Some participants who took part in our water quality testing kit citizen science activity reported that the activity increased their interest in water quality. Of the ten participants who did the activity and filled out our questionnaire, five participants agreed that the activity increased their interest in water quality (Figure 4.1.2). The other five participants felt neutral to the statement. No participants reported that they felt less interested in water quality after the activity.

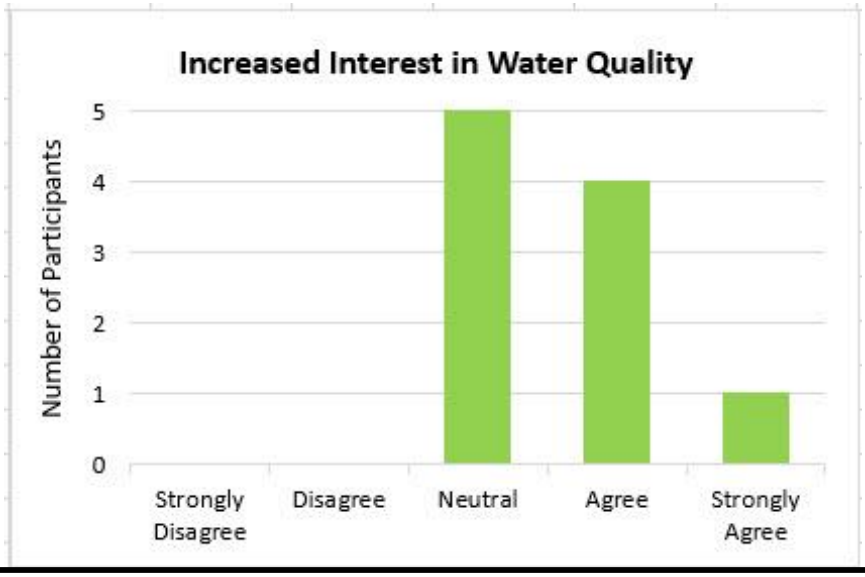

Figure 4.1.2. The responses to the statement, "Participating in citizen science, specifically this water quality testing, increases my interest in the importance of water quality in Metro Vancouver". Half the participants felt neutral towards the statement, while the other half agreed.

4.2 Shower Study

To supplement our info-graphic poster and accompanying booklet, a shower study was conducted to collect data on the behaviour of adults in Metro and Vancouver and to determine the most effective method to conserve water while showering. A lack of understanding exists regarding the link between the environment and water conservation (Willis et al., 2011); the aim of this project is to narrow that gap. The information from the shower study provided a benchmark for the average consumption of water used by an individual in Metro Vancouver, this value would then be used a target goal. Individuals above this threshold would be encouraged to reduce water consumption below the average after being exposed to the info-graphic and educated by a SPEC representative at their outreach events. The objective of the shower study was to collect information on the current showering patterns of individuals, which would then be presented in the educational and interactive info-graphic as an outreach for individuals to reduce their water consumption. Further research is needed to determine whether these deliverables were effective in communicating the need to reduce water use as individual become more conscious of their consumption in the home, specifically the shower. We chose to highlight shower behaviour, as we felt this was the most feasible change individuals could make in the bathroom - it would be harder to change toilet-flushing behaviour, because it could pose as a health and hygiene concern. Simply turning the knob to low-flow or reducing the time spent in the shower seemed more applicable for average individual than switching from a high-flow to a low-flow toilet. A large percentage of the average daily consumption of water for Canadians is consumed in the shower with 19% of the 329 litres consumed daily (Gibbons, 2008).

For the shower study, a total of thirteen participants from nine homes participated, all of which were volunteers recruited during classroom announcements at UBC or through word of mouth. The conditions of the participants required that they resided in Metro Vancouver, were above the age of nineteen and their only method of bathing was consisted of a shower taken while standing. Once qualified for the study, one of three researchers measured the flow rate of the participants' showerheads. A bucket and stopwatch were used to measure the flow rate, a method chosen for its simplicity and cost-effectiveness. The three researchers agreed upon a fill line in the bucket of 8500 mL

and a bucket with a large enough size that splash from the bucket would be minimized. Each researcher measured the flow rate of a shower in the presence of one another to ensure that the same procedural steps would be followed when measuring the showers at the homes of the participants. A showerhead with a flow rate of less than 0.158 L/s is considered low-flow (Reduce Hot Water Use for Energy Savings, (n.d.)), and any rate above this is considered high-flow. To determine water usage for showering, we measured the flow rate of each participant's showerhead, and asked the participants to record the length of each shower over a seven-day period from January 18th-24th, 2016. A recording sheet was provided to each of the participants (see Appendix H), where individuals were also asked to fill out the time (AM or PM) and date of each shower.

Table 4.2.1. Showerhead flow rates for the 9 showers used by the 13 participants. A value <0.158L/s is considered a "Low-Flow" showerhead.

Showerhead Flow Rate (L/s)	Low-Flow Showerhead (Y/N)
0.161	Yes
0.291	No
0.151	Yes
0.157	Yes
0.138	Yes
0.202	No
0.131	Yes
0.174	Yes
0.086	Yes
Average: 0.166	

Our study found that 80% of households (Table 4.2.1) use a low-flow showerhead, a value higher than the estimated 57% of Canadians who were using a low-flow showerhead in 2006 (Gibbons, 2008). Given our small sample size, the 80% of households in our study may not be representative of the national population. There is

limited research analyzing whether or not social norms are causing individuals to switch to low-flow showerheads. One observation in our study was that participants who had high-flow showerheads were not aware of the multiple settings on the shower faucet. If individuals turned the dial, their showerhead would become low-flow. For the purpose of our study, we asked individuals to undergo routine shower procedures leaving the flow rate set at the same position before the introduction of our project. There was no follow-up regarding whether or not individuals switched their showerheads to the low-flow setting after the seven-day period, as this was not the purpose of our data collection.

The shower study found that the average person spends approximately 8 minutes in the shower, equating to 71 litres of water consumed per shower. The average participant consumed approximately 367.2 litres of water during showering over the course of the seven-day period (Figure 4.2.1). This equates to approximately 19 000 litres of water spent on showering annually, which is only 4000 less litres than the data from Statistics Canada (Gibbons, 2008). Despite a small sample size, our information is consistent with that of a nation wide study focusing on water consumption in the shower. The bars in Figure 4.2.1 demonstrate the total quantity of water consumed over a week, keeping in mind that individuals had different showerhead flow rates, number of showers over the week, and length of each shower. The information from our study was helpful in determining the most effective method for individuals to conserve water in the shower. Table 4.2.2 presents the different behavioural changes individuals could adapt and relates it to the total amount of water Vancouver would save annually, assuming a population of 2.4 million people. For the first method, switching from a high-flow showerhead, it is assumed that they would switch to showerhead with a flow rate of 0.158L/s, which is the maximum flow rate of a low-flow showerhead. It is also assumed that the only individuals reducing the flow-rate of their showerhead are individuals currently using a high-flow showerhead. For the second method, reducing you shower by two minutes, the target time is the same as that provided through Home Water Works (Home Water Works, 2011), an alliance for water efficiency. In our study the shortest shower was just under three minutes, so reducing a shower by two minutes would not provide any negative shower time. For the third method, where Vancouverites take one less shower a week, the average water consumed per shower for each individual was

calculated. This average value was then subtracted from the total amount of water consumed over a week, and then projected to an annual saving for the whole of Metro Vancouver. The shower study concludes that the most impactful single method to reduce Metro Vancouver's annual water consumption via showering is to reduce each shower by two minutes.

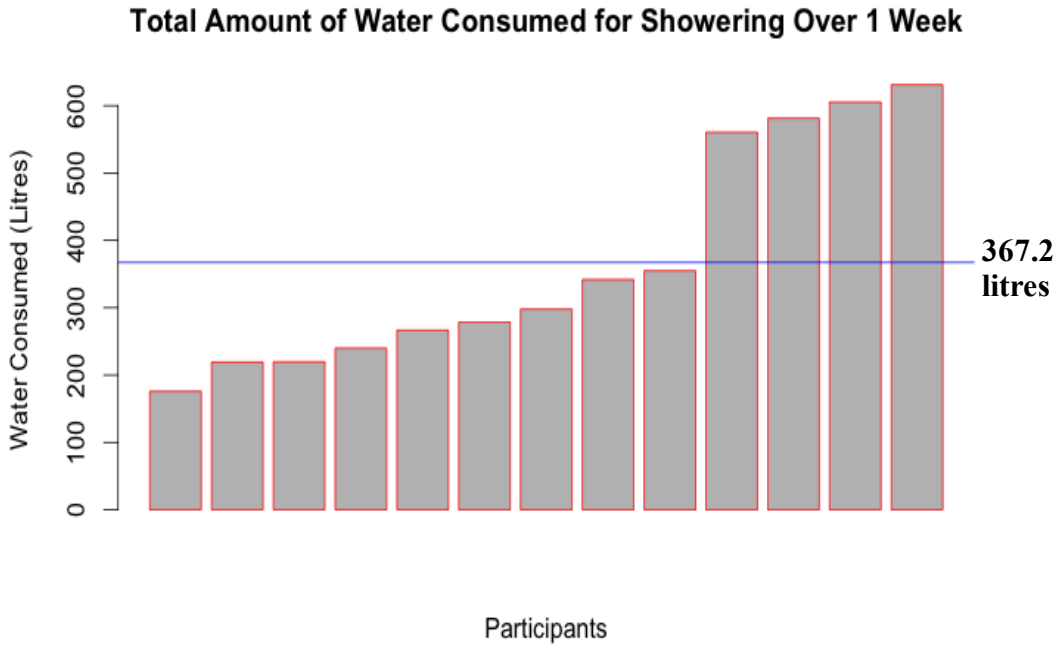

Figure 4.2.1. The total quantity of water consumed by each of the thirteen participants during their showers over a 7-day period. The blue line represents the average weekly water consumption among the participants.

Table 4.2.2. Showerhead flow rates for the 9 showers used by the 13 participants. A value <0.158L/s is considered a "Low-Flow" showerhead.

Behavioural Change	**Quantity of Water Conserved Annually (Litres)**
i) Vancouverites using a high-flow showerhead switching to a low-flow showerhead	4.9 billion
ii) Vancouverites reducing each shower by two minutes	13 billion
iii) Vancouverites taking one less shower a week	9.8 billion

The shower study also looked at whether or not there was a difference in water consumption amongst the seven days in the week (i.e. weekend days versus week days) and whether consumption was variable with the day of day the shower was taken (morning or night). Both of these parameters yielded no significant difference among our thirteen participants. Our study also considered whether presenting the financial incentive to conserve water would change the habits of individuals. However, Vancouver's current cost for water is inexpensive, as $1 is the cost for 1097.52 Litres in the winter months and 873.95 Litres during the summer months (City of Vancouver, n.d.). This means that, on average, if you reduce your shower by 2 minutes, you will save approximately 2 cents per shower. For an individual whom showers five days a week, that's a total of 5.20$ per year, which is not an influential financial incentive. After consulting with SPEC, it was agreed that this information would neither be presented on the info-graphic nor in the booklet.

Acquiring this information from the shower study assisted us with our project, which aims at promoting water conservation and water pollution prevention. The data collected is presented in our deliverables and encourages individuals to conserve water in

the home, specifically while showering. Demonstrating the impact Vancouver can have on conserving water collectively will hopefully encourage individuals to make a difference. Jorgensen et al. (2009) argue that individuals will not save water if they feel others are not minimizing their water use, suggesting that inter-personal trust plays a role in household water consumption. Publicizing our results through SPEC will allow individuals to compare their showering habits with others across the region, in hopes to become more water conscious when showering.

5.0 Conclusion

With our four deliverables: the info-graphic poster, the informational booklet, the water quality testing kit citizen science program, and the pollution jar activity, we provided SPEC with tools to spread water conservation and water pollution prevention awareness within Metro Vancouver and to make citizens think about changing their water-related behaviour. Although behavioural change is hard, we hope that our deliverables will at least make people think "should I shorten my shower?"; "should I invest in low flow appliances?"; or "should I go to a car wash instead of washing my car at home and risk soap getting into the storm drain near my house?"

Using our info-graphic poster and informational booklet, we hope that SPEC's clients will become more interested in water conservation and water quality. We hope that SPEC's clients choose to participate in the water quality citizen science program, and that the activity is used frequently and successfully for water quality data collection around Metro Vancouver. We anticipate that SPEC clients will learn from being a part of a citizen science program, as literature review claims that citizen science programs will increase citizen engagement and interest in environmental issues. For the pollution jar activity, we hope that SPEC's clients learn something new about storm drain pollutants and avoid polluting their storm drains in the future.

Our shower study gave us raw data to compare with current statistics of Metro Vancouver water consumption to display on our poster and inside our booklet. Although, our shower study does not provide us with much data, it provided us with a rough estimate of the quantity of water consumed during showering for a small subset of Vancouverites. The aim was for SPEC's clients to compare their water consumption to that of our participants and think more about their water consumption practices. We also were able to predict and compare the amount of water that could be saved if everyone in Metro Vancouver switched to low-flow alternatives, decreased their shower time to 2 minutes less than their normal shower time, or showered one less time per week.

The four deliverables and this report will be given to SPEC where they will use the deliverables at future business tours and community outreach events. This report will answer any background questions on the process of producing these deliverables.

6.0 Acknowledgements

We gratefully acknowledge the Society Promoting Environmental Conservation (SPEC) for funding for our project. We thank Oliver Lane of SPEC for giving his time to meet with us and provide guidance for our project. We also thank Sara Harris for providing feedback and suggestions for our project from start to finish. We thank the ENVR 400 class, including Tara Ivanochko, Bernardo Ranieri, and our peers for their support and feedback. We thank the participants who were a part of our shower study and water quality testing kit questionnaire for their time and cooperation. We thank Sam Liu, a friend of one of our group members, who assisted in designing an earlier version of the info-graphic poster.

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