

Raising Support for Potable Recycled Water with the Elaboration Likelihood Model

by

Li Qin Tan

Bachelor of Arts (Hons), Nanyang Technological University, 2015

A Thesis Submitted in Partial Fulfillment of the  
Requirements for the Degree of

MASTER OF SCIENCE

in the Department of Psychology

©Li Qin Tan, 2018

University of Victoria

All rights reserved. This thesis may not be reproduced in whole or in part,  
by photocopy or other means, without the permission of the author.

Raising Support for Potable Recycled Water with the Elaboration Likelihood Model

by

Li Qin Tan

Bachelor of Arts (Hons), Nanyang Technological University, 2015

**Supervisory Committee**

Dr. Robert Gifford, Supervisor

Department of Psychology

Dr. Graham Brown, Departmental Member

Department of Psychology

## Abstract

### **Supervisory Committee**

Dr. Robert Gifford, Supervisor

Department of Psychology

Dr. Graham Brown, Departmental Member

Department of Psychology

In spite of modern technological advancements that can convert wastewater into potable water, the acceptability of recycled water is generally low. This study examined strategies for increasing the public acceptability of recycled water. Based on the elaboration likelihood model, I hypothesized that issue relevance, argument quality, and delivery type would interact to produce differing levels of support for potable recycled water. Undergraduate students took part in a 2 (issue relevance: low, high) x 2 (argument quality: weak, strong) x 2 (delivery: textual, pictorial) online study relating to their opinion and support for the potential implementation of a potable recycled water system on campus. Issue relevance was manipulated by varying the completion date of implementing the system (low: five years; high: one year). Argument quality was manipulated by varying the complexity of the message presented (weak: point-form; strong: paragraph form). Delivery was manipulated by presenting water recycling processes in a textual or pictorial format. The hypotheses were not supported, although the means were in the predicted direction. Limitations and future directions are discussed.

## Table of Contents

Supervisory Committee.....	ii
Abstract.....	iii
Table of Contents.....	iv
List of Tables.....	v
Acknowledgements.....	vi
Chapter One: Introduction.....	1
Chapter Two: Method.....	12
Chapter Three: Results.....	18
Chapter Four: Discussion.....	21
References.....	27
Appendices.....	32
Appendix A.....	32
Appendix B.....	33
Appendix C.....	34
Appendix D.....	36

## List of Tables

Table 1: Distribution of Participants in Conditions.....	13
Table 2: Means and Standard Deviations of Issue Relevance x Argument Quality x Delivery on Support for Potable Recycled Water System.....	19
Table 3: Means and Standard Errors of Issue Relevance x Argument Quality x Delivery on Support for Potable Recycled Water System, Controlling for Need for Cognition.....	20

## Acknowledgements

Completing this thesis would not have been possible without the help of many others. I would like to express my deepest gratitude to my supervisor, Dr. Robert Gifford, and my committee member, Dr. Graham Brown, for their insightful comments throughout the various stages of preparing this thesis.

I would also like to thank my family in the Environmental, Personality, and Social Psychology Lab: Karine Lacroix, Devan Kronisch, and Peter Sugrue. Thank you for being with me throughout this journey, and for making the lab such a welcoming home.

I am indebted to my friends and family for their support and encouragement. To Cindy, thank you for checking in on me every so often and keeping me on track. Last but definitely not least, to my life partner, Maurice, thank you for being my source of strength and motivation.

## **Chapter One**

### **Introduction**

“The fact is there is enough water available to meet the world’s growing needs, but not without dramatically changing the way water is used, managed and shared.”—United Nations World Water Assessment Programme (2015, p. 7)

Fresh water is a limited natural resource—less than one percent of the water on Earth is available for consumption, with the remaining locked up in oceans and ice caps (National Ocean Service, 2017). Pressure is increasingly exerted on this limited natural resource because of various factors, such as rapid population growth. The world’s population has increased steadily in the past decades—2.5 billion in 1950, 7.6 billion presently, and a projection of 9.8 billion in 2050 (United Nations Department of Economic and Social Affairs, 2017). These rising population numbers imply that the need for fresh water has correspondingly increased. Evidently, the picture is not so simple; many other factors dynamically contribute to the growing need for fresh water.

However, what is clear is that a larger portion of the world’s population is under water scarcity than before—0.24 billion were water scarce in the 1900s, whereas 3.8 billion are currently water scarce (Kummu et al., 2016)—and this will only intensify with time if no steps are undertaken to ameliorate the situation. Water must thus be carefully managed so that the need for fresh water can be met.

Effective water management includes the use of alternative water sources, such as water produced from water recycling and desalination. Water recycling is the process of converting wastewater to fresh water through various filtration processes, whereas desalination is the process of converting seawater to fresh water through the removal of salt.

Water recycling and desalination differ in terms of cost. Water recycling is cheaper to implement because it is a less energy intensive process than desalination (Côte, Siverns, & Monti, 2005; Pearce, 2008). To illustrate, a cubic meter of recycled water costs US\$0.28

whereas the same amount of desalinated water costs US\$0.62 to produce (Côte et al., 2005). However, water recycling is often deemed to be a dubious source of water over desalination because of its associations with wastewater (Dolnicar & Schäfer, 2009; Drechsel, Mahjoub, & Keraita, 2015). Given that water recycling is a cheaper and more viable option over desalination, this study aimed to examine strategies for increasing the acceptability of recycled water.

## **Water Recycling**

### **Technical Processes**

The process of recycling water differs between recycling facilities, but it typically consists of many treatment processes including microfiltration, reverse osmosis, and ultraviolet disinfection (Benítez, Acero, Leal, & González, 2009; Côte et al., 2005; Ordóñez et al., 2014).

In Singapore for example, wastewater is first collected and treated before going through further treatment processes in the recycling facility (Public Utilities Board, 2017). The treated water then undergoes microfiltration, which is the process of filtering away particles and some bacteria. The water that passes through the microfiltration stage consists of dissolved salts and organic molecules. Next, the water is treated using reverse osmosis, which consists of a semi-permeable membrane that only allows water molecules and a minute amount of salts and organic molecules to pass through it. Finally, the water goes through ultraviolet disinfection to remove any remaining organisms, ensuring the cleanliness of the water produced. The water resulting from these processes can be safely consumed.

### **Uses and Users of Recycled Water**

Recycled water can be used in three ways: indirect potable use, non-potable use, and direct potable use (Chen, Ngo, & Guo, 2013; Rygaard, Bining, & Albrechtsen, 2011).

Indirect potable use refers to recycled water that is used to supplement water sources such as

a groundwater basin, with the water eventually being consumed by households. Non-potable use refers to recycled water that is used for purposes that do not involve human consumption, such as industrial use, household cleaning, and irrigation. Direct potable use refers to recycled water that is supplied directly to households and can be safely consumed.

Water recycling facilities can be found in many places, including California, Namibia, and Singapore. Interestingly, each of these places uses recycled water in a different way. In Orange County, California, recycled water is used to maintain the level of groundwater in their system (i.e., indirect potable use; Orange County Water District, n.d.). In Singapore, recycled water is mainly supplied to industries, but it is also used to supplement the water in reservoirs during dry periods (i.e., non-potable and indirect potable use; Public Utilities Board, 2017). In Windhoek, Namibia, recycled water is directly piped to households as drinking water (i.e., direct potable use; Lahnsteiner & Lempert, 2007).

### **Benefits of Recycling Wastewater**

Water recycling has several benefits. First, the water self-sufficiency of an area is increased (Rodriguez et al., 2009). By recycling wastewater, individuals who live in inland areas away from water sources are able to build a reserve of water on which they can depend in times of need.

Second, reliance on the natural water cycle is decreased (Lafforgue & Lenouvel, 2015; Rygaard et al., 2011). The natural water cycle involves the processes of evaporation, condensation, and precipitation, and these processes in turn affect the rate of replenishment of water sources such as reservoirs. Water recycling shortens the time taken to replenish water sources, thereby reducing dependency on the natural water cycle.

Third, the amount of pollutants discarded into the ocean is reduced (Price, Fielding, Gardner, Leviston, & Green, 2015). The water recycling process separates waste material from water, ensuring that waste material can be properly discarded. Despite the many

advantages of water recycling, complete dependency on it is not possible because of the natural loss of water (e.g., through evaporation, pipe leakage, or other processes).

### **The Acceptability of Recycled Water**

In spite of modern technological advancements that can convert wastewater into potable water, the acceptability of recycled water is generally low (Dolnicar & Schäfer, 2009; Ormerod & Scott, 2012; Wester et al., 2015). Several reasons account for the low acceptability of recycled water: disgust (Menegaki, Hanley, & Tsagarakis, 2007; Wester et al., 2015; Wester, Timpano, Cek, & Broad, 2016), fear of contamination (Rozin, Haddad, Nemeroff, & Slovic, 2015), lack of trust in authorities (Dolnicar, Hurlimann, & Grun, 2011; Hurlimann, Hemphill, McKay, & Geursen, 2008; Menegaki et al., 2007; Ross, Fielding, & Louis, 2014), and perception of water quality as low (Dolnicar et al., 2011; Hurlimann et al., 2008).

A common finding is that the acceptability of recycled water decreases as human contact increases (Marks, Martin, & Zadaroznyj, 2008)—90% of individuals are willing to use recycled water for toilet flushing, 40% for showering, and 20% for drinking (Dolnicar & Schäfer, 2009). Given that the consumption of recycled water elicits the lowest rate of acceptability amongst other uses, this paper focused on examining the use of recycled water for drinking purposes.

Social psychological models such as the theory of planned behaviour have been applied to understanding the public's perceptions of recycled water (e.g., Nancarrow, Leviston, Po, Porter, & Tucker, 2008; Nancarrow, Leviston, & Tucker, 2009). The theory of planned behaviour (TPB; Ajzen, 1991) claims that behaviour is predicted by behavioural intention, which is in turn predicted by attitudes towards the behaviour, subjective norms about the behaviour, and perceived behavioural control over performing the behaviour.

However, the inclusion of subjective norms in the TPB poses a challenge to the application of the model to new behaviours with which individuals do not yet have experience. As such, the TPB might be a useful social psychological model in understanding the public's perceptions of recycled water in areas where recycled water exists, but it might not be appropriate for use prior to the implementation of a recycled water system. In such situations, the elaboration likelihood model (ELM) appears to be more suitable than the TPB because the ELM seems to influence the attitude formation process (i.e., social norms are not required; Carpenter, 2015). Petty and colleagues have also acknowledged that the ELM does not distinguish between attitude formation and attitude change (Petty, Wegener, Fabrigar, Priester, & Cacioppo, 1993). This study hence examined the public acceptability of recycled water using the ELM.

### **The Elaboration Likelihood Model and Recycled Water**

#### **The Elaboration Likelihood Model**

The ELM was developed by Petty and Cacioppo (1984a, 1984b, 1986a, 1986b), detailing two possible ways in which individuals process information according to certain characteristics of a given persuasive message. Differing degrees of persuasion in line with the intended effect of the message is produced depending on which one of the two ways information is processed by. The way information is processed is determined by elaboration likelihood.

**Elaboration likelihood.** *Elaboration likelihood* refers to the probability of cognitively processing information relevant to a persuasive message (Petty & Cacioppo, 1984a, 1984b, 1986a, 1986b). Elaboration likelihood exists on a continuum, where low elaboration likelihood means that information is processed with little cognitive effort, and high elaboration likelihood means that information is processed with much cognitive effort. According to the ELM, information will be processed by the *peripheral route* when

elaboration likelihood is low, and the same will be processed by the *central route* when elaboration likelihood is high. The peripheral and central routes are not actual neural routes that exist in the brain, but are merely names given to the way information is processed in the ELM.

Elaboration likelihood is influenced by an individual's motivation and ability to process information. This motivation is in turn said to be influenced by personal relevance, credibility, and attractiveness of the speaker (Petty & Cacioppo, 1984a, 1984b, 1986a, 1986b), whereas the ability to process information is influenced by an individual's need for cognition (Cacioppo & Petty, 1982; Cacioppo, Petty, Kao, & Rodriguez, 1986; Cacioppo, Petty, & Morris, 1983). The motivation to process information can be manipulated, but the ability to process information is an individual difference. The need for cognition is an individual difference that affects elaboration likelihood—the higher the need for cognition, the higher the probability of engaging in the central route of persuasion (Cacioppo et al., 1983, 1986)—and is hence a factor to be controlled for when examining the ELM.

**The peripheral route of persuasion.** When elaboration likelihood is low, information is likely processed by the peripheral route (Petty & Cacioppo, 1984a, 1984b, 1986a, 1986b). This usually occurs when the motivation and ability to process information are low—low personal relevance, high credibility, attractive speaker, and low need for cognition. Individuals are naturally inclined to disregard a message when it is of low personal relevance. In contrast, when a message presented appears credible or is given by an attractive speaker, individuals with a low need for cognition are swayed to believe the message without adequately processing it. Hence, the peripheral route is named as such because the individual is persuaded by the superficial aspects of the message rather than its core content. As a result of the little cognitive effort exerted in processing the message, little

or no change in attitude occurs, with the resulting attitude towards the message being weak and superficial.

**The central route of persuasion.** When elaboration likelihood is high, information is likely processed by the central route (Petty & Cacioppo, 1984a, 1984b, 1986a, 1986b). This usually occurs when the motivation and ability to process information are high—high personal relevance and high need for cognition. Peripheral aspects of a message, such as the attractiveness of the speaker, matter less. Instead, individuals are inclined to exert a large amount of cognitive effort to carefully process the message based on its actual content. Individuals are thereby strongly persuaded or dissuaded by the quality of the message content. This resulting strong attitude is resistant to change and predictive of subsequent behaviour.

**Key predictions of the ELM.** The relevance of a persuasive message interacts with argument quality to influence which route of persuasion is taken, leading to differing degrees of support for the message (Carpenter, 2015; Petty & Cacioppo, 1984a, 1984b, 1986a, 1986b; Petty, Cacioppo, & Goldman, 1981). Information processing is likely to occur via the central route when a persuasive message is of high relevance, whereas the peripheral route is more likely taken when the message is of low relevance. The quality of an argument influences attitude formation under the central route such that strong arguments are more likely to be supported than weak arguments, but does not influence attitude formation under the peripheral route. Taken together, strong support will result when a message is relevant and consists of strong arguments. However, weak support will result when a message is relevant and consists of weak arguments. Moderately weak support will result when a message is not relevant, regardless of argument quality.

### **Applying the ELM to Recycled Water**

To the best of my knowledge, only one article has examined the predictions of the ELM in relation to potable recycled water. Using the ELM, Price and colleagues (2015)

investigated how the structure and content of persuasive messages influenced attitudes towards potable recycled water in Queensland, Australia in two related studies.

In the first study, Price and colleagues (2015) hypothesized a main effect of argument quality—strong arguments would be more effective than weak arguments at garnering support for a potable recycled water system. Argument quality was operationalized as message complexity; the more complex messages were deemed as strong arguments, whereas the less complex messages were deemed as weak arguments. Additionally, they hypothesized that pre-existing attitudes towards potable recycled water would influence responses to the persuasive messages presented such that those with neutral attitudes would be more influenced by the messages than those with positive or negative attitudes. Both hypotheses were supported; participants who were exposed to the more complex messages expressed significantly more support for the system than those exposed to the less complex messages, and pre-existing attitudes did influence responses to the messages presented.

In the second study, Price and colleagues (2015) examined whether the inclusion of information about risks or benefits influenced support for the potable recycled water system. Based on the ELM, they hypothesized that the more relevant the issue is to participants, the more likely the central route of persuasion would be activated. Because the potable recycled water system was only relevant to those living in Queensland and not those living in other areas in Australia, those living in Queensland were expected to use the central route of persuasion to process the risk and benefit information presented to them. Using a 2 (issue relevance: low, high) x 2 (risk information: none, low) x 2 (benefit information: none, high) study design, an interaction effect between issue relevance and risk information was found; the high issue relevance-low risk information condition produced greater support for the potable recycled water system than the high issue relevance-no risk information condition. In

addition, low issue relevance did not influence support for the system, regardless of the type of risk information given.

Although Price et al.'s (2015) study was informative, their study utilized only textual information. Given that pure textual information is unlikely to be used in a marketing campaign, I suggest that their study should be extended by including pictorial information. By doing so, the effectiveness of textual and pictorial information can be further examined.

**The role of textual and pictorial information.** The ELM's premise is based on the cognitive elaboration of information. Because textual information requires more cognitive effort to process and is easier to manipulate than pictorial information, textual information have been typically used in ELM studies exclusively (e.g., Petty & Cacioppo, 1984a; Price et al., 2015). Given that textual information requires more cognitive effort to process than pictorial information, I would expect textual information to be more convincing to those who are motivated to process information, such as those viewing a highly relevant message and strong arguments. Conversely, textual information should not appeal to those who are not motivated to process information, such as those viewing a message that is not relevant to them coupled with weak arguments. In contrast, given the ease of processing pictorial information compared to textual information, I would expect that pictorial information to be more compelling to those who are not motivated to process information, and less compelling to those who are motivated to process information.

### **The Present Study**

The present study aimed to contribute to the existing ELM and recycled water literature by building on Price and colleagues' (2015) study, further examining the application of the ELM in raising support for potable recycled water. The findings of this study are important to relevant policy-makers or marketing agencies because they can

maximize the effectiveness of the design of their promotional materials in raising support for potable recycled water.

The study took the form of an online survey, with a 2 (issue relevance: low, high) x 2 (argument quality: weak, strong) x 2 (delivery: textual, pictorial) study design, with need for cognition as a covariate, and support for the potential implementation of a potable recycled water system as a dependent variable. Manipulation of issue relevance was achieved by informing participants that the potable recycled water system could be implemented in five years (low relevance) or one year (high relevance). Manipulation of argument quality was achieved by varying the message complexity of arguments in support of implementing the potable recycled water system—weak arguments were presented in point-form statements, whereas strong arguments were presented in paragraphs with elaboration. Delivery was manipulated by presenting water recycling processes either in a textual or pictorial format. Support for potable recycled water was operationalized as agreement on a support scale (Nancarrow et al., 2009), and indication of willingness to sign a petition supporting the implementation of the potable recycled water system.

Two related sets of hypotheses were formulated. First, in line with the ELM's main predictions, when controlling for the need for cognition:

- 1a. High issue relevance will interact with strong argument quality to produce high support for the potable recycled water system;
- b. High issue relevance will interact with weak argument quality to produce low support for the potable recycled water system; and
- c. Low issue relevance will produce moderate support for a potable recycled water system regardless of argument quality.

Second, the method of delivery (textual or pictorial) will influence the relation between issue relevance and argument quality, such that when controlling for the need for cognition:

- 2a. Textual information will interact with high issue relevance and strong argument quality to produce the highest support for the potable recycled water system; and
- b. Pictorial information will interact with high issue relevance and weak argument quality to produce lowest support for the potable recycled water system.

## Chapter Two

### Method

#### Participants

According to a power analysis conducted using G\*Power (Faul, Erdfelder, Lang, & Buchner, 2007), 128 participants are required to detect a medium effect size of .25 at a .05 alpha level and .80 power if an analysis of covariance (ANCOVA) were performed in a 2 x 2 x 2 factorial design with one covariate.

One hundred and ninety-two undergraduate students were recruited from the online research participation system operated by the Department of Psychology at the University of Victoria. Sixty-five participants failed either the manipulation check or attention check, and were dropped. The remaining 127 participants ( $n_{male} = 27$ ,  $n_{female} = 99$ ,  $n_{other} = 1$ ;  $M_{age} = 22.11$  years,  $SD_{age} = 3.98$  years) were mostly in their second (40.9%) or third year (26.8%) of study at the university, followed by those in their fourth year (17.3%), first year (14.2%), and fifth year (0.8%). Approximately 80% of participants were Canadian, followed by American (7.2%), while the remaining were made up of various nationalities including Chinese, German, Indian, and Iranian. Most participants identified as Caucasian (72.4%), followed by Asian (15.0%) and Latino/Hispanic (1.6%), with the remaining 11% identifying as a mixture of two or more ethnicities. Approximately 71% were majoring in Psychology, 5.5% Linguistics, 4.7% Biology, 3.9% Kinesiology, 3.2% Chemistry, and 2.4% Sociology. The remaining participants were majoring in an assortment of humanities such as English, Geography, Political Science, Social Work, History, Economics, and Philosophy. The distribution of participants in the eight conditions is shown in Table 1.

Participants received one course credit as compensation for their time.

Table 1  
*Distribution of Participants in Conditions*

Issue Relevance	Argument Quality	Delivery	
		Textual	Pictorial
		<i>n</i>	<i>n</i>
Low	Weak	13	17
	Strong	18	17
High	Weak	21	15
	Strong	15	11

## Materials

An online survey was created on the Qualtrics platform, consisting of various components. Its specific components are elaborated below.

**Issue relevance scale.** The issue relevance scale was adapted from Frewer et al. (1997) and Price et al. (2015). It measures an individual's opinions of how relevant an issue is to them. The scale consists of two items scored from 1 (*very strongly disagree*) to 9 (*very strongly agree*) on a Likert-type scale. The two items are, "*I think that the information I have read about the recycled drinking water scheme is very relevant to me personally*" and "*I think that the recycled drinking water scheme is very relevant to me personally.*" The items were averaged to form a measure of issue relevance.

The scale has high internal consistency of  $\alpha = .95$  (Price et al., 2015), and is comparable to that achieved in this study,  $\alpha = .88$ . The order in which the items were displayed was counterbalanced.

**Need for cognition scale (NCS).** The NCS consists of 18 items measuring an individual's desire to think of complex issues (see Appendix A for the NCS; Cacioppo, Petty, & Kao, 1984). Examples of items are, "*I really enjoy a task that involves coming up with new solutions to problems*" and "*I would prefer complex to simple problems.*" The NCS was originally scored on a nine-point Likert-type scale from -4 (*very strong disagreement*) to +4 (*very strong agreement*). To avoid confusion to participants, the anchors used in this study were changed to range from 1 (*very strongly disagree*) to 9 (*very strongly agree*). Half of the

items were negatively worded and required reverse scoring. The items were averaged to form a measure of need for cognition.

The NCS has high internal consistency of  $\alpha = .90$  (Cacioppo, Petty, & Kao, 1984), and is comparable to that achieved in this study,  $\alpha = .84$ . The order in which the items were displayed was counterbalanced.

**Support for potable recycled water.** Support for potable recycled water was the dependent variable in this study, and it was measured in two ways. The first was a behavioural intention scale consisting of seven items that measured support for the potable recycled water system (Nancarrow et al., 2009; see Appendix B for the scale). The items were scored from 1 (*strongly disagree*) to 6 (*strongly agree*) on a Likert-type scale. Examples of items are, “*I would drink the water that was provided by this recycling scheme*” and “*I believe that this recycling scheme will be safe to use.*” Four of the seven items were negatively worded and required reverse scoring. The internal consistency achieved in this study,  $\alpha = .91$ , was comparable to that of the original scale,  $\alpha = .95$  (Nancarrow et al., 2009). The order in which the items were displayed was counterbalanced. The items were averaged to form a measure of support for potable recycled water.

The second measure of support was the willingness to sign a petition in support of implementing the potable recycled water system. Participants were asked to indicate their willingness to sign a petition in support of implementing the potable recycled water system (i.e., *yes* or *no*). This dichotomous dependent variable was included to serve as a behavioural indicator of support for the potable recycled water system. Note that because of unforeseen technical issues, some participants were unable to sign the petition despite their willingness to do so.

**Manipulation check and attention check.** As a manipulation check, participants were asked to select the year in which the potable recycled water system would be

implemented. Participants were to select the year that corresponded to the issue relevance condition they were assigned to.

As an attention check, participants were asked whether they have told a lie before. Assuming that almost everyone would have told a lie in their life before, participants who responded in the negative were deemed to be inattentive. Participants who responded incorrectly for one of these two questions would be excluded from analysis.

### **Procedure**

Data collection took place in January 2018. An advertisement was posted on the online research participation system operated by the Department of Psychology at the University of Victoria. Participants could freely sign up for a timeslot to take part in the online survey conducted in a computer lab at the University of Victoria. Upon arrival at the computer lab, participants were led to a computer with the online survey displayed on the screen. Each study session consisted of approximately ten participants seated at least one computer table apart from each other. Participants took around 15 minutes to complete the study.

Participants were randomly assigned to one of eight experimental conditions via randomization on the Qualtrics platform: 2 (issue relevance: low, high) x 2 (argument quality: weak, strong) x 2 (delivery: textual, pictorial). The experimenter and participants were blind to the conditions during the study.

All participants were told that the Environmental, Social and Personality Lab of the Psychology Department at the University of Victoria was planning to make a considered suggestion to the University's Office of Campus Planning and Sustainability about the implementation of a potable recycled water system on campus.

Participants in the low issue relevance condition were told that if the suggestion is approved by the Office of Campus Planning and Sustainability, the implementation of the potable recycled water system might take place in five years (i.e., start of 2023):

Thank you for taking the time to take part in this study conducted by the Environmental, Social, and Personality Lab of the Psychology Department at the University of Victoria. This study concerns the use of purified recycled water for drinking purposes. **Purified recycled water is produced by taking water from waste water treatment plants, and using a series of processes to make it suitable for drinking.**

We are considering the feasibility of implementing a purified recycled water scheme on campus. **Specifically, we are studying the possibility of supplying the drinking fountains on campus with this new water source.** Hence, your opinions are extremely important in helping us give a carefully considered suggestion to the University's Office of Campus Planning and Sustainability.

**If our suggestion is successfully accepted, around 5 years will be needed to implement this scheme (i.e., start of 2023).** As this concerns our campus environment, we would like to know your thoughts. More information is given in the following section. (Words were bolded in the online survey)

Participants in the high issue relevance condition were told that if the suggestion was approved by the Office of Campus Planning and Sustainability, the implementation of the potable recycled water system might take place in one year (i.e., start of 2019):

Thank you for taking the time to take part in this study conducted by the Environmental, Social, and Personality Lab of the Psychology Department at the University of Victoria. This study concerns the use of purified recycled water for drinking purposes. **Purified recycled water is produced by taking water from**

**waste water treatment plants, and using a series of processes to make it suitable for drinking.**

We are considering the feasibility of implementing a purified recycled water scheme on campus. **Specifically, we are studying the possibility of supplying the drinking fountains on campus with this new water source.** Hence, your opinions are extremely important in helping us give a carefully considered suggestion to the University's Office of Campus Planning and Sustainability.

**If our suggestion is successfully accepted, around 1 year will be needed to implement this scheme (i.e., start of 2019).** As this concerns our campus environment, we would like to know your thoughts. More information is given in the following section. (Words were bolded in the online survey)

Participants in the weak argument quality condition were shown a point-form description of the advantages of implementing the potable recycled water system, whereas those in the strong argument quality condition were shown a detailed description of the advantages adapted from Price et al. (2015; refer to Appendix C).

Participants in the textual delivery condition were shown a description of the filtration processes involved in treating wastewater in textual format, whereas those in the pictorial delivery condition were shown a picture consisting of the various filtration processes (refer to Appendix D).

After viewing the manipulations, all participants completed both dependent measures for support for the potable recycled water system, followed by the NCS, manipulation check, attention check, and demographic questions. Participants then viewed a debriefing page, and those who indicated that they were willing to sign the petition were directed to the petition page to do so. Upon completion of the study, participants were thanked for their participation.

## Chapter Three

### Results

Of the 192 participants, those who did not pass either the manipulation check ( $n = 57$ ) or the attention check ( $n = 8$ ) were dropped, leaving 127 responses suitable for further analyses. The following analyses were based on these 127 responses.

### Descriptive Statistics

#### Prior Knowledge of Recycled Water

Thirty-five participants (29.9%) stated that they had some prior knowledge of recycled water. When asked to elaborate on their knowledge, most of them said they knew water recycling existed ( $n = 20$ ), some said they learnt of the basic processes of water recycling in school ( $n = 9$ ), a few had some kind of personal experience with water recycling such as touring a water treatment plant ( $n = 4$ ), and two had watched a documentary related to water recycling.

#### Support for Potable Recycled Water System

**Willingness to sign petition.** Ninety-seven participants (76.4%) indicated that they were willing to sign the petition in support of implementing the recycled water system on campus. In reality, 68 signatures were obtained, resulting in a 70.1% correspondence rate. Taking into account that a number of participants reported having difficulty signing the petition due to technical issues, this correspondence rate should be taken as a conservative estimate of the consistency between reported intention and behaviour.

**Support for potable recycled water scale.** Support for potable recycled water was generally high across the eight conditions, averaging around five to six on the support scale (six being the maximum score; see Table 2 for means and standard deviations).

The weakest levels of support came from the low issue relevance x weak argument quality x textual delivery and the high issue relevance x weak argument quality x pictorial

delivery conditions. The strongest levels of support came from the low issue relevance x weak argument quality x pictorial and the high issue relevance x strong argument quality x textual delivery conditions.

Table 2  
*Means and Standard Deviations of Issue Relevance x Argument Quality x Delivery on Support for Potable Recycled Water System*

Issue Relevance	Argument Quality	Delivery	
		Textual <i>M(SD)</i>	Pictorial <i>M(SD)</i>
Low	Weak	5.02 (0.86)	5.44 (0.59)
	Strong	5.14 (0.59)	5.17 (0.99)
High	Weak	5.20 (0.84)	5.05 (0.95)
	Strong	5.64 (0.39)	5.32 (0.85)

### Inferential Statistics

Before running an analysis of covariance (ANCOVA) to test the hypotheses, I first ascertained that certain statistical assumptions were satisfied: existence of correlation between the covariate and the dependent variable, homogeneity of variance, and normality. The first assumption was satisfied; need for cognition ( $M = 6.09$ ,  $SD = 0.90$ ) and support for the potable recycled water system ( $M = 5.25$ ,  $SD = 0.78$ ) were positively correlated,  $r = .36$ ,  $p < .05$ . The second assumption was found to be satisfied using Levene's test,  $F(7, 119) = 1.62$ ,  $p = .14$ . The third assumption was not satisfied; QQ-plots revealed that the normality assumption was slightly violated across all conditions. Given that the third assumption was not satisfied, results of the following analysis should be interpreted with some caution.

To determine whether the hypotheses were supported, a 2 (issue relevance: low, high) x 2 (argument quality: weak, strong) x 2 (delivery: textual, pictorial) between-subjects ANCOVA was conducted with support for the potable recycled water system as the dependent variable, and need for cognition as the covariate. No main effect was found for issue relevance,  $F(1, 118) = 1.01$ ,  $p > .05$ ,  $\eta_p^2 = .01$ , argument quality,  $F(1, 118) = 0.64$ ,  $p > .05$ ,  $\eta_p^2 = .01$ , and delivery,  $F(1, 118) = 0.17$ ,  $p > .05$ ,  $\eta_p^2 = .00$ . The interaction between issue relevance and argument quality was not statistically significant, implying that the first

set of hypotheses was not supported,  $F(1, 118) = 2.02, p > .05, \eta_p^2 = .17$ . Similarly, the interaction between issue relevance, argument quality, and delivery was not statistically significant, indicating that the second set of hypotheses was not supported,  $F(1, 118) = 0.13, p > .05, \eta_p^2 = .00$ .

Even though the interactions were not statistically significant as predicted, the adjusted means were in the hypothesized direction (see Table 3).

Table 3  
*Means and Standard Errors of Issue Relevance x Argument Quality x Delivery on Support for Potable Recycled Water System, Controlling for Need for Cognition*

Issue Relevance	Argument Quality	Delivery			
		Textual		Pictorial	
		<i>M(SE)</i>	<i>95% CI</i>	<i>M(SE)</i>	<i>95% CI</i>
Low	Weak	5.07 (0.20)	4.67, 5.47	5.38 (0.18)	5.02, 5.73
	Strong	5.19 (0.17)	4.85, 5.54	5.09 (0.18)	4.74, 5.44
High	Weak	5.22 (0.16)	4.90, 5.54	5.12 (0.19)	4.74, 5.49
	Strong	5.62 (0.19)	5.25, 6.00	5.30 (0.22)	4.87, 5.74

## **Chapter Four**

### **Discussion**

The aim of this study was to examine strategies for increasing the public acceptability of recycled water, specifically investigating the ELM's applicability in raising support for the implementation of a potable recycled water system. I hypothesized that issue relevance, argument quality, and delivery type would interact to produce differing levels of support for the potable recycled water system.

#### **Main Predictions and Findings**

Two sets of related predictions were made. First, issue relevance and argument quality will interact such that when the need for cognition is controlled for, (a) high issue relevance and strong argument quality will produce high support for the system; (b) high issue relevance and weak argument quality will produce low support for the system; and (c) low issue relevance will produce moderate support for the system regardless of argument quality. Second, issue relevance, argument quality, and method of delivery will interact such that when the need for cognition is controlled for, (a) textual information will further increase support for the system when issue relevance is high and argument quality is strong; and (b) pictorial information will further decrease support for the system when issue relevance is high and argument quality is weak.

Although neither set of hypotheses were supported, the means were generally in line with the hypothesized direction. The strongest support for the potable recycled water system resulted from the high issue relevance x strong argument quality x textual delivery condition (Hypothesis 2a). In contrast, one of the weakest levels of support for the potable recycled water system came from the high issue relevance x weak argument quality x pictorial delivery condition (Hypothesis 2b).

An interesting and unexpected finding was that low issue relevance, coupled with weak argument quality and pictorial delivery, produced the second highest level of support for the potable recycled water system. The ELM predicts that when issue relevance is low, low to moderate levels of support would be produced regardless of argument quality (Petty & Cacioppo, 1984a, 1984b, 1986a, 1986b)—this was seen in three of the four low issue relevance conditions. Pictorial delivery appeared to have a uniquely positive influence on support when issue relevance was low and argument quality was weak, implying that pictures could be an effective method of delivery when the level of cognitive engagement with an audience is low.

Several reasons could account for the failure to find support for the hypotheses—ineffective manipulation, insufficient power, and a ceiling effect for support.

**Ineffective manipulation.** Perhaps the manipulation was not strong enough to produce a detectable effect. Fifty-seven out of 192 participants had to be dropped because they did not pass the manipulation check, meaning that the issue relevance manipulation did not capture the attention of nearly 30% of participants. Even though the key words of the issue relevance were bolded to attract attention, this appeared to be limited in effectiveness. Future researchers could consider providing issue relevance information in person, such as a one-to-one conversation or in small groups, to increase the strength of manipulation.

**Insufficient power.** Perhaps the study had insufficient power to detect an effect. Although effort was made to recruit more participants than required, only 127 usable responses were obtained after those who failed the manipulation and attention checks were removed.

In addition, the effect size could have been smaller than the expected .25, implying that more than 128 participants would have been required to detect it. According to the software G\*Power, a minimum of 787 participants would be needed to detect a small effect

size of .10 if the same statistical test were to be run (Faul et al., 2007). However, running such a large number of participants was not possible in this study because of limited resources. Moreover, if indeed such a large number of participants were needed to detect a statistically significant effect in this study, perhaps a better approach should be devised for use in future instances.

**Ceiling effect of support.** Another explanation is the possible ceiling effect of support for the potable recycled water system. Support was generally high across conditions, ranging from five to six on the support scale (six being the maximum score), and could have contributed to the inability to tease apart the differences between the eight conditions.

### **Other Findings and Implications**

**Prior knowledge of recycled water.** Prior knowledge of recycled water appeared to be very low. Only approximately 30% of participants stated that they had some prior knowledge of recycled water. When prompted further, more than half of these participants simply mentioned that they knew of the existence of water recycling whereas the remaining participants actually had some basic knowledge or personal experience with recycled water. Participants that possessed some knowledge of water recycling typically mentioned that they had learned about it in biology or chemistry classes. This suggests that the education system is a good way of transmitting knowledge. If a campus or a region were to implement water recycling in future, a lecture or even a course on water recycling could be given so as to increase understanding of water recycling.

**High support for potable recycled water.** Support for the potable recycled water system was generally high across all conditions. One explanation for this high support could be social desirability. Participants might have felt obligated to present themselves in a positive manner given that they were taking part in the study in person. However, this explanation seems unlikely because all responses were anonymous; participants did not have

to enter their name or any participant code in the online survey. Still, some possible ways to overcome the possible effect of social desirability could be to conduct the experiment in a room without the experimenter and other participants, or to let participants access the online study from the comfort of their home.

A more likely explanation could be the environmentally supportive climate of the city of Victoria, or the province of British Columbia in general. Of the ten most sustainable campuses in Canada, three were from British Columbia—the University of Victoria included (Corporate Knights, 2017). Hence, the social norm of being environmentally conscious may have driven the high support seen in this study. The high support seen across conditions implies that if the University of Victoria were to implement a potable recycled water system in the near future, students would be generally supportive of the initiative.

### **Limitations and Future Directions**

Some limitations were faced in this study. One limitation was that the intention-behaviour consistency could not be computed accurately due to technical issues with the online petition site. Some participants reported difficulty in signing the petition because the petition site was unable to process their signatures. Although the petition site was tested prior to conducting the study, this situation was still unavoidable. Researchers could consider asking participants to physically sign the petition on paper to avoid such technical issues in future.

Another limitation was that the actual behaviour of drinking recycled water was not included as a dependent variable of support. The measurement of actual behaviour is advocated over self-reported behaviour whenever possible, because of inconsistencies between self-reported behaviour and actual behaviour (Gifford, 2014). Effort was made to include the consumption of recycled water in this study for two reasons—to raise awareness among participants, and to increase the accuracy of measuring actual behaviour. However,

despite obtaining approval for procuring bottles of recycled water from the Public Utilities Board in Singapore, exportation of the water from Singapore was not possible because of exportation restrictions on liquids. Future researchers should take this into logistical consideration in mind when attempting to import recycled water from other countries.

Additionally, researchers should attempt, to the best of their ability, to measure actual behaviour instead of relying on self-reported behaviour in designing studies. One could examine perceptions and decision-making when faced with ostensibly different sources of water, such as a taste test. Although this study relied on self-reported behaviour to measure support for potable recycled water, it also included behavioural indicators such as the willingness to sign a petition and the actual signing of a petition.

Moving forward, more should be done to clarify the relation between issue relevance, argument quality, and delivery type. Delivery type seems to be a moderator of the relation between issue relevance and argument quality, and this relation should be further investigated. Notably, pictures appear to have a unique influence on garnering support in situations of low cognitive engagement, whereas text appears to be effective in garnering support in situations of high cognitive engagement.

### **Concluding Remarks**

The limited amount of water on our planet is sufficient to meet our needs, but only with the practice of effective water management (United Nations World Water Assessment Programme, 2015). Part of effective water management involves the use of alternative water sources such as recycled water, and such alternative sources are often subjected to issues of public acceptability. Although research on public acceptability of recycled water is not new, it is not a common area of research among social scientists. Through this paper, I tried to raise awareness of the importance of research on this topic.

One might question the purpose of conducting research on the public acceptability of recycled water: Does public acceptability really matter when taps run dry and people are desperate for water? At that point in time, most if not all will drink water from any alternative source of water available just to survive. Alas, if we do reach that juncture, it would be too late for change to happen. Building infrastructure required for water recycling plants require time, and more importantly, these plants require water to operate. Waiting for a crisis to strike before making preparations is simply not feasible, though the job of convincing others of the need to prepare would be much easier then.

As a final note, although water recycling was proposed as a way to meet the need for freshwater in this paper, it is not meant to be treated as a panacea to our water crisis. Ultimately, the Earth's water is a resource shared among us, and only through the careful and responsible use of water can we then work towards the goal of a water-sustainable future together.

## References

- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*, 179-211.
- Benítez, F. J., Acero, J. L., Leal, A. I., & González, M. (2009). The use of ultrafiltration and nanofiltration membranes for the purification of cork processing wastewater. *Journal of Hazardous Materials*, *162*, 1438-1445. doi:10.1016/j.jhazmat.2008.06.036
- Cacioppo, J. T., & Petty, R. E. (1982). The need for cognition. *Journal of Personality and Social Psychology*, *42*, 116-131.
- Cacioppo, J. T., Petty, R. E., & Kao, C. F. (1984). The efficient assessment of need for cognition. *Journal of Personality Assessment*, *48*, 306-307.
- Cacioppo, J. T., Petty, R. E., Kao, C. F., & Rodriguez, R. (1986). Central and peripheral routes to persuasion: An individual difference perspective. *Journal of Personality and Social Psychology*, *51*, 1032-1043.
- Cacioppo, J. T., Petty, R. E., & Morris, K. J. (1983). Effects of need for cognition on message evaluation, recall, and persuasion. *Journal of Personality and Social Psychology*, *45*, 805-818.
- Carpenter, C. J. (2015). A meta-analysis of the ELM's argument quality x processing type predictions. *Human Communication Research*, *41*, 501-534. doi:10.1111/hcre.12054
- Chen, Z., Ngo, H. H., & Guo, W. (2013). A critical review on the end uses of recycled water. *Critical Reviews in Environmental Science and Technology*, *43*, 1446-1516. doi:10.1080/10643389.2011.647788
- Corporate Knights (2017). 2017 greenest campuses in Canada index. Retrieved from <http://www.corporateknights.com/reports/greenest-campuses-in-canada-index/2017-greenest-campuses-canada-index-15093720/>

- Côte, P., Siverns, S., & Monti, S. (2005). Comparison of membrane-based solutions for water reclamation and desalination. *Desalination*, *182*, 251-257.  
doi:10.1016/j.desal.2005.04.015
- Dolnicar, S., Hurlimann, A., & Grun, B. (2011). What affects public acceptance of recycled and desalinated water? *Water Research*, *45*, 933-943.
- Dolnicar, S., & Schäfer, A. I. (2009). Desalinated versus recycled water: Public perceptions and profiles of the accepters. *Journal of Environmental Management*, *90*, 888-900.
- Drechsel, P., Mahjoub, O., & Keraita, B. (2015). Social and cultural dimensions in wastewater use. In P. Drechsel, M. Qadir, & D. Wichelns (Eds.), *Wastewater: Economic asset in an urbanizing world* (pp. 75-92). New York, NY: Springer.
- Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G\*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*, 175-191.
- Frewer, L. J., Howard, C., Hedderley, D., & Shepherd, R. (1997). The elaboration likelihood model and communication about food risks. *Risk Analysis*, *17*, 759-770.  
doi:10.1111/j.1539-6924.1997.tb01281.x
- Gifford, R. (2014). Environmental psychology matters. *The Annual Review of Psychology*, *65*, 541-579. doi:10.1146/annurev-psych-010213-115048
- Hurlimann, A., Hemphill, E., McKay, J., & Geursen, G. (2008). Establishing components of community satisfaction with recycled water use through a structural equation model. *Journal of Environmental Management*, *88*, 1221-1232.
- Kummu, M., Guillaume, J. H. A., de Moel, H., Eisner, S., Florke, M., Porkka, M., ... Ward, P. J. (2016). The world's road to water scarcity: Shortage and stress in the 20<sup>th</sup> century and pathways towards sustainability. *Scientific Reports*, *6*, 38495.  
doi:10.1038/srep38495

- Lafforgue, M., & Lenouvel, V. (2015). Closing the urban water loop: Lessons from Singapore and Windhoek. *Environmental Science: Water Research and Technology*, *1*, 622-631. doi:10.1039/c5ew00056d
- Lahnsteiner, J., & Lempert, G. (2007). Water management in Windhoek, Namibia. *Water Science & Technology*, *55*, 441-448.
- Marks, J. S., Martin, B., Zadaroznyj, M. (2008). How Australians order acceptance of recycled water: National baseline data. *Journal of Sociology*, *44*, 83-99. doi:10.1177/1440783307085844
- Menegaki, A. N., Hanley, N., & Tsagarakis, K. P. (2007). The social acceptability and valuation of recycled water in Crete: A study of consumers' and farmers' attitudes. *Ecological Economics*, *62*, 7-18.
- Nancarrow, B. E., Leviston, Z., Po, M., Porter, N. B., & Tucker, D. I. (2008). What drives communities' decisions and behaviours in the reuse of wastewater. *Water Science & Technology*, *57*, 485-491.
- Nancarrow, B. E., Leviston, Z., & Tucker, D. I. (2009). Measuring the predictors of communities' behavioural decisions for potable reuse of wastewater. *Water Science & Technology*, *60*, 3199-3209.
- National Ocean Service. (2017). How much water is in the ocean? Retrieved from <https://oceanservice.noaa.gov/facts/oceanwater.html>
- Orange County Water District. (n.d.). About GWRS. Retrieved from <https://www.ocwd.com/gwrs/about-gwrs/>
- Ordóñez, R., Hermosilla, D., Merayo, N., Gascó, A., Negro, C., & Blanco, A. (2014). Application of multi-barrier membrane filtration technologies to reclaim municipal wastewater for industrial use. *Separation & Purification Reviews*, *43*, 263-310. doi:10.1080/15422119.2012.758638

- Ormerod, K. J., & Scott, C. A. (2012). Drinking wastewater: Public trust in potable reuse. *Science, Technology, & Human Values, 38*, 351-373.
- Pearce, G. K. (2008). UF/MF pre-treatment to RO in seawater and wastewater reuse applications: A comparison of energy costs. *Desalination, 222*, 66-73.  
doi:10.1016/j.desal.2007.05.029
- Petty, R. E., & Cacioppo, J. T. (1984a). Source factors and the elaboration likelihood model of persuasion. *Advances in Consumer Research, 11*, 668-672.
- Petty, R. E., & Cacioppo, J. T. (1984b). The elaboration likelihood model of persuasion. *Advances in Consumer Research, 11*, 673-675.
- Petty, R. E., & Cacioppo, J. T. (1986a). *Communication and persuasion: Central and peripheral routes to attitude change*. New York, NY: Springer.
- Petty, R. E., & Cacioppo, J. T. (1986b). The elaboration likelihood model of persuasion. *Advances in Experimental Social Psychology, 19*, 123-205.
- Petty, R. E., Cacioppo, J. T., & Goldman, R. (1981). Personal involvement as a determinant of argument-based persuasion. *Journal of Personality and Social Psychology, 41*, 847-855.
- Petty, R. E., Wegener, D. T., Fabrigar, L. R., Priester, J. R., & Cacioppo, J. T. (1993). Conceptual and methodological issues in the elaboration likelihood model: A reply to the Michigan state critics. *Communication Theory, 3*, 336-362.
- Price, J., Fielding, K. S., Gardner, J., Leviston, Z., & Green, M. (2015). Developing effective messages about potable recycled water: The importance of message structure and content. *Water Resources Research, 51*, 2174-2187.
- Public Utilities Board. (2017). NEWater. Retrieved from <https://www.pub.gov.sg/watersupply/fournationaltaps/newater>

- Rodriguez, C., Buynder, P. V., Lugg, R., Blair, P., Devine, B., Cook, A., & Weinstein, P. (2009). Indirect potable reuse: A sustainable water supply alternative. *International Journal of Environmental Research and Public Health*, *6*, 1174-1209.  
doi:10.3390/ijerph6031174
- Ross, V. L., Fielding, K. S., & Louis, W. R. (2014). Social trust, risk perceptions and public acceptance of recycled water: Testing a social-psychological model. *Journal of Environmental Management*, *137*, 61-68. doi:10.1016/j.jenvman.2014.01.039
- Rozin, P., Haddad, B., Nemeroff, C., & Slovic, P. (2015). Psychological aspects of the rejection of recycled water: Contamination, purification and disgust. *Judgment and Decision Making*, *10*, 50-63.
- Rygaard, M., Binning, P. J., & Albrechtsen, H. (2011). Increasing urban water self-sufficiency: New era, new challenges. *Journal of Environmental Management*, *92*, 185-194. doi:10.1016/j.jenvman.2010.09.009
- United Nations Department of Economic and Social Affairs. (2017). World population prospects: The 2017 revision. Retrieved from  
<https://esa.un.org/unpd/wpp/Graphs/Probabilistic/POP/TOT/>
- United Nations World Water Assessment Programme. (2015). The United Nations world water development report 2015: Water for a sustainable world. Paris: UNESCO.
- Wester, J., Timpano, K. R., Cek, D., Lieberman, D., Fieldstone, S. C., & Broad, K. (2015). Psychological and social factors associated with wastewater reuse emotional discomfort. *Journal of Environmental Psychology*, *42*, 16-23.
- Wester, J., Timpano, K. R., Cek, D., & Broad, K. (2016). The psychology of recycled water: Factors predicting disgust and willingness to use. *Water Resources Research*, *52*, 3212-3226.

## Appendices

**Appendix A: Need for Cognition Scale (Cacioppo, Petty, & Kao, 1984)**

1. I would prefer complex to simple problems.
2. I like to have the responsibility of handling a situation that requires a lot of thinking.
3. Thinking is not my idea of fun.\*
4. I would rather do something that requires little thought than something that is sure to challenge my thinking abilities.\*
5. I try to anticipate and avoid situations where there is a likely chance I will have to think in depth about something.\*
6. I find satisfaction in deliberating hard and for long hours.
7. I only think as hard as I have to.\*
8. I prefer to think about small, daily projects to long-term ones.\*
9. I like tasks that require little thought once I've learned them.\*
10. The idea of relying on thought to make my way to the top appeals to me.
11. I really enjoy a task that involves coming up with new solutions to problems.
12. Learning new ways to think doesn't excite me very much.\*
13. I prefer my life to be filled with puzzles that I must solve.
14. The notion of thinking abstractly is appealing to me.
15. I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought.
16. I feel relief rather than satisfaction after completing a task that required a lot of mental effort.\*
17. It's enough for me that something gets the job done, I don't care how or why it works.\*
18. I usually end up deliberating about issues even when they do not affect me personally.

\*Indicates reverse-scored items.

## Appendix B: Support for Recycled Water System

(Adapted from Nancarrow et al., 2009)

1. I support adding purified recycled water to our water supply *on campus*.
2. I do not want purified recycled water to be mixed with my drinking water.\*
3. I would drink the water that was provided by this recycling scheme.
4. I would protest against purified recycled water being added to my drinking water.\*
5. Given the choice, I would not drink water that contained purified recycled water.\*
6. I would complain to the *Office of Campus Planning and Sustainability* if purified recycled water was added to our drinking water *on campus*.\*
7. I believe that this recycling scheme will be safe to use.

\*Indicates reverse-scored items.

Italicised words indicate words that have been changed.

**Appendix C: Weak Argument Quality Condition (Adapted from Price et al., 2015)**

Purified recycled water has many advantages.

It provides a secure water supply.

It reduces the amount of harmful chemicals going into Victoria's shoreline.

It requires less energy than desalination.

The purification process makes the water safe.

Research studies have not shown any negative health effects.

The advanced technologies being used are all proven and in use around the world.

### **Strong Argument Quality Condition (Adapted from Price et al., 2015)**

#### Purified recycled water has many advantages.

First, it provides a secure water supply. Recycled drinking water ensures future water demands can be met. The combination of population growth and variability in rainfall means that the region's water supply is vulnerable. According to recent census data from Statistics Canada, the population of metropolitan Victoria has increased by 6.7% since the previous census in 2011. This growth rate is much higher than the 5.0% national growth rate across Canada. The high growth rate means that less water will be available to meet Victoria's demand for water. Recycled drinking water provides a secure water supply for the region.

Second, it reduces the amount of harmful chemicals going into Victoria's shoreline. Currently, raw waste water is disposed of at Macauley Point and Clover Point, flowing directly into the Salish Sea and the Strait of Juan de Fuca. Purified recycled water would benefit the environment by reducing the amount of nutrients and environmentally harmful compounds (e.g., nitrogen & phosphorous) going into the shoreline by up to 57%.

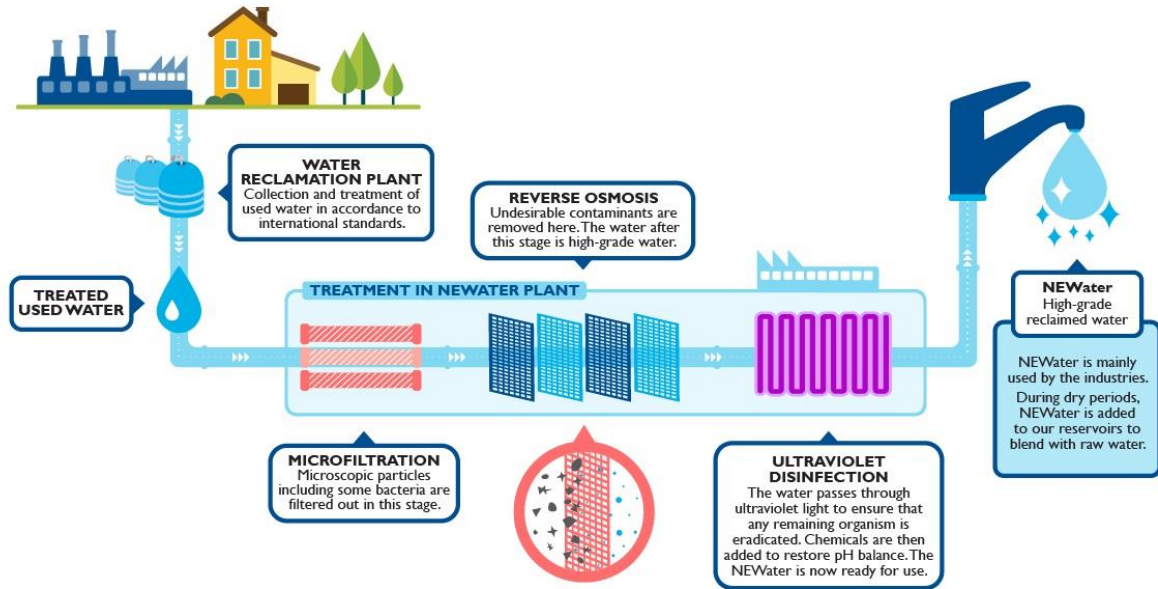
Third, it requires less energy than desalination, which is the process of converting seawater into drinking water. Purified recycled water requires less energy to operate than desalination. For example, it takes one megawatt hour of electricity to produce one megalitre of purified recycled water compared to five megawatts hours of electricity to produce the same amount of desalinated water.

Fourth, the purification process makes the water safe. Waste water treatment technology has been developed over the past 50 years, and is now a very sophisticated technology. Pharmaceuticals, hormones, and industrial chemicals are completely removed or reduced to undetectable levels (i.e., few parts per trillion or less) through several different treatment processes, and are well within health guideline values.

Fifth, research has not identified any negative health effects of recycled water. Studies of potable recycling schemes (i.e., recycled water used for drinking water purposes) in use around the world for the past 50 years show no negative health effects.

Sixth, the advanced technologies being used (microfiltration, reverse osmosis, and ultraviolet disinfection) are all proven and in use across the world and similar schemes operate around the world.

### Appendix D: Pictorial Delivery Condition (Public Utilities Board, 2017)



## **Textual Delivery Condition (Public Utilities Board, 2017)**

### **Pre-Treatment**

Waste water is collected and treated in accordance to international standards in the water reclamation plant.

### **Stage 1 – Microfiltration**

The first stage of the NEWater production process is known as Microfiltration (MF). In this process, the treated waste water is passed through membranes to filter out and retained on the membrane surface suspended solids, colloidal particles, disease-causing bacteria, some viruses and protozoan cysts. The filtered water that goes through the membrane contains only dissolved salts and organic molecules.

### **Stage 2 – Reverse Osmosis**

The second stage of the NEWater production process is known as Reverse Osmosis (RO). In RO, a semi-permeable membrane is used. The semi-permeable membrane has very small pores which only allow very small molecules like water molecules to pass through. Consequently, undesirable contaminants such as bacteria, viruses, heavy metals, nitrate, chloride, sulphate, disinfection by-products, aromatic hydrocarbons, pesticides etc, cannot pass through the membrane. Hence, NEWater is RO water and is free from viruses, bacteria and contains negligible amount of salts and organic matters.

### **Stage 3 – UV Disinfection**

At this stage, the water is already of a high grade water quality. The third stage of the NEWater production process really acts as a further safety back-up to the RO. In this stage, ultraviolet or UV disinfection is used to ensure that all organisms are inactivated and the purity of the product water guaranteed.

### **Before Storing NEWater in Water Tanks – Balance the pH in NEWater**

With the addition of some alkaline chemicals to restore the acid-alkali or pH balance, the NEWater is now ready to be piped off to its wide range of applications