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Willingness to Pay for Wastewater Treatment Plants is Sensitive to Anchoring

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Abstract

Wastewater treatment plant upgrades that improve the capacity to deal with high rainfall levels are necessary to protect the health and safety of citizens, however, upgrades are expensive. Previous research indicates that people's willingness to pay (WTP) for tax increases is sensitive to anchoring – citizens use the estimated cost of the project as a heuristic to judge the appropriate amount of taxation. This study uses an online survey to investigate the effects of anchoring and environmental attitudes on an individual's WTP for wastewater treatment plant upgrades. First, we find that people's WTP for wastewater treatment plant upgrades is sensitive to anchoring. Second, we show that people who indicate apathy towards the protection of the environment are most sensitive to anchoring. We conclude our study with a discussion on policy and research implications – leveraging the anchoring effect by suggesting a higher quote is strategic for enhancing transparency and maximizing public support for proposed municipal tax increases, particularly amongst those with apathy towards environmental issues.

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Introduction

Water is essential to life on Earth, occupying approximately 71% of the Earth's surface; however, only 2.5% of this water is fresh and safe for consumption (Afolalu, et al., p. 3282, 2022). All around the world, pollutants are entering fresh water sources and threatening the lives of the people that rely upon these water supplies. Canada is particularly at risk, having one of the largest stocks of freshwater in the world (upwards of 20%) and 7% of the world's renewable water flow (Statistics Canada, 2018). One of the leading sources of pollution jeopardizing Canada's watersheds is municipal wastewater (Government of Canada, 2017). A common cause for wastewater pollution is the combined sewage infrastructure that handles the effluent and stormwater of many municipalities (Canadian Water Network, 2018). The total discharge volume by combined sewer systems in 2017 alone in Canada was approximately 165 billion litres (Statistics Canada, 2017). Massive discharge volumes have occurred for years leading to public advocacy from citizens, non-profit organizations, and municipalities to improve regulations and infrastructure for environmental and human health (Water Canada, 2009; Jones, 2018; The Canadian Press, 2018; Craggs, 2019; MacQueen, 2006). A few of the losses from wastewater overflows include revenue from tourism, swimming and fishing restrictions, and habitat degradation (Jones, 2018; The Canadian Press, 2018; Craggs, 2019; Harding, 2019).

On June 30, 2014, a high rainfall event overwhelmed the City of Regina, Saskatchewan, Canada's combined sewage system, forcing the City of Regina to discharge 335 million litres of untreated wastewater into Wascana Creek (CBC, 2014; Gousseau, 2015; City of Regina, 2017). This wastewater, which would have been a combination of stormwater and untreated raw sewage, was not treated for nutrients or human pathogens (Gousseau, 2015). In the Qu'Appelle Valley downstream of Wascana Creek beaches were forced to close due to high levels of E. coli bacteria (Harding, 2019). Community members in the Qu'Appelle were outraged with the closure and formed a non-profit organization to advocate for the health of the Qu'Appelle lakes and hold the City of Regina accountable. The expectation that storms with high rainfall will increase in frequency due to climate change increases the urgency to upgrade wastewater treatment plants (Sauchyn, 2010).

Wastewater treatment plant upgrades can be mega infrastructure projects and susceptible to cost overruns. Characteristics of mega infrastructure projects is that they cost over $100 million, have long-planning horizons, cross-disciplines and interests, and their scope can change over time (Flyvbjerg, 2009; Siemiatycki, 2015; Wachs, 1989). Many wastewater treatment plant upgrades in the world fit the bill of a mega project such as in Regina, SK, CA at $175 million (CBC News, 2016), Winnipeg, MB, CA at $1.8 billion (Kavanagh, 2021), Vancouver, BC, Canada at $1 billion (Chan, 2021; Labbe, 2021), and Victoria, BC, CA at $765 million (Thomas, 2019). Winnipeg, Vancouver, and Victoria are all experiencing cost overruns. The North Shore sewage plant in Vancouver was forecasted at $700 million and has jumped to $1 billion with completion delay to 2024 (Chan, 2021), while in Winnipeg their combined cost for upgrades has increased by $81.5 million (Kavanagh, 2021). Each project mentioned is cost sharing between all level of governments through the Investing in Canada Infrastructure Program (ICIP), and the extra costs

are either falling to taxpayers or impacting other areas of municipal budget (Kavanagh, 2021; Chan, 2021; Thomas, 2019). Research has shown that poor planning is a surface level excuse to massive overspending, while the over-optimism bias and forged estimates are the pathological reasons (Flyvbjerg, 2009; Wachs, 1989). When cost overruns become common it takes a toll on the public's confidence in government to accomplish complex projects as promised (Siemiatycki, 2015). The resulting skepticism and distrust can spill over into the next generation of critical infrastructure projects (Siemiatycki, 2015). Weakened trust is especially important given the volatility of public opinion on the environment. While many people care deeply about the environment, many others rank it low in priority.

In this paper, we conduct an experiment to determine the public's willingness to pay (WTP) for the expensive municipal wastewater treatment plant upgrades required by Federal Government National Standards. Our research also wants to understand if environmental values encourage or discourage an individual's WTP for these upgrades. Finally, this research also tests for an anchoring bias within the public to understand if this impacts their WTP.

Theory

Many experiments demonstrate that when people estimate numerical quantities, external information influences their answer (Kahneman & Tversky, 1974; Boo & Furnham, 2011; Ariely et al., 2002). A phenomenon that commonly causes this is the anchoring effect (Kahneman, 2011). The anchoring effect is shown when an individual who is making numerical judgements bases their guess on a particular value acting as an anchor (Kahneman, 2011; Mussweiler & Strack, 1999). In effect, an individual can give a higher or lower answer to the same question based on the value of the anchor (Kahneman & Tversky, 1974). For example, consider two car owners, who know that high-mileage (high miles per gallon) cars have lower operating costs and are buying new vehicles:

(1) Adam switches from a gas-guzzler of 12mpg to a slightly better car of 14mpg.
(2) Beth is environmentally conscious and switches from 30mpg to 40pmg.

If both drivers travel the same distance over a year, most people will think that Beth would save more gas, when in fact it is Adam who does (for 10, 000 miles: Adam reduces his consumption by 119 gallons, while Beth reduces her consumption by 83 gallons) (Kahneman & Tversky, 1974). The numbers provided act as an anchor and guide the individual into making a particular guess.

The anchor effect is a robust and diffuse psychological process that occurs in many contexts of judgement (Boo & Furnham, 2011). Research has found anchors present in judgement contexts of general knowledge (Mussweiler & Strack, 1999), valuation (Ariely et al., 2003; van Exel et al., 2006), negotiation, self-efficacy, and forecasting (Boo & Furnham, 2011). Research also found public administrators exhibiting an anchoring bias. In an anchoring experiment that focused on the proper timeline to respond to emails from the public, Belle, Belerdenille and Canteriii (2018) found that high and low anchors influenced the average time it took to respond. In another experiment spotlighting public managers and employees' performance ratings, Belle, Belerdenille and Canteriii (2017) found that anchoring also motivated their judgement.

The current understanding is that two different processes cause anchoring. One heuristic is called adjust-and-anchor and the other is confirmation-hypothesis-testing (Kahneman, 2011; Boo & Furnham, 2011). The adjust-and-anchor heuristic uses the anchor to compare and then mentally move the value up or down until the movement stops within a range of uncertainty (Kahneman, 2011). People underestimate or overestimate because they moved higher or lower than the anchor and entered the range of uncertainty from above or below. Kahneman (2011) describes adjust-and-anchor as deliberate and effortful, part of System 2 thinking.

The confirmation-hypothesis-testing is system 1 thinking. It works on belief, selection, and association (Kahneman, 2011). System 1 wants to believe that the anchor is correct, so it tests the anchors plausibility by trying to confirm the hypothesis that the anchor is correct (Kahneman, 2011). System 1 makes the appropriate information available to select and retrieve while in the process ignoring counterarguments (Kahneman, 2011). Experience impacts availability. People cling to anchors to make estimates because system 1 initially wants to believe before it can unbelieve (Kahneman, 2011).

Our experiment is testing the effect of an anchor on valuation, which differentiates it from a judgement experiment that uses general knowledge (Ariely et al.,2002; Boo & Furnham, 2011). General knowledge experiments use facts to direct the estimation of the participants to go higher or lower (Boo & Furnham, 2011). Both the anchor and the fact are external. This valuation experiment has an informative, external anchor, but participants are comparing the anchor with their subjective construction of environmental value to judge their WTP.

To address the wastewater pollution problem, the Canadian Council of Ministers of the Environment (CCME) created the *Canada-wide Strategy for the Management of Municipal Effluent* (the CCME strategy) in 2009 (CCME, 2009). The goal of the strategy is to bring municipal wastewater treatment plants across Canada in compliance with the Wastewater Systems Effluent Regulations. It is a large undertaking with a 30-year timeline and an estimated cost of $10-13 billion (CCME, 2009). The high cost has had some municipalities worrying about their financial ability to enter compliance with the new regulations (Haller, 2009; Matusiak, 2014). With over 4,000 wastewater treatment plants in Canada (Globe and Mail, 2009), compliance has motivated many wastewater treatment plant projects, some of which are mega infrastructure projects costing over $100 million.

The conditions of the CCME strategy expose the public to a potentially strong anchoring effect through infrastructure forecast estimates of wastewater treatment plant upgrades. When the estimated cost of an infrastructure project is released to the public as a forecast it can have an anchoring effect because it is a particular value for an unknown quantity. Based on the forecast, an individual can estimate whether the infrastructure project will cost more, less, or the forecast amount. Informative anchors have strong effects when the participant has more uncertainty and the source is perceived as legitimate (van Exel et al., 2005). Forecasts of wastewater treatment plants have the potential to impose a strong anchoring bias on the public because the forecast is coming from a perceived legitimate expert and the wastewater knowledge is specialized.

To simulate a real wastewater treatment project, this experiment used a high and low forecast estimate as informative anchors. The forecasts are an expected monthly increase on the participants water bill. An aura of authority was attached to the anchor because the anchor was

presented as an 'initial quote' provided by the municipality in the scenario of the experiment. Wastewater treatment plants are niche facilities, so respondents are expected to have a low familiarity with the valuation of the treatment plant. However, the upgrades to the wastewater treatment plant represent a valuation of water quality, lakes, and environmental concern. Participants will presumably have subjective environmental values made in the past that could be referred to as they consider their WTP. The informative anchor acts as a representation of their subjective environmental values. According to the idea of representative judgement (Kahneman & Tvesrky, 1974), participants should compare their environmental values with the informative anchor to understand if it is representative and then decide if they are willing to pay more, less, or equal to the anchor. This means that anchors should not influence participants with more concern for environmental issues as much as they should for participants with lower concern for the environment.

We used a survey experiment with two treatments within an online survey to test how anchoring and concern for the environment affects WTP for wastewater treatment plant upgrades.[1] The survey started with four demographics questions that we thought might affect WTP: whether the participants were homeowners or paid a water bill, age, and annual income in 2020. This was followed by participants rating whether they agreed or disagreed with five statements from the New Ecological Paradigm (NEP) scale (Dunlap et al., 2000). The responses from these five questions were added together to obtain a NEP score from 5 to 25: 5 indicates lowest concern for the environment, while 25 indicates highest concern for the environment.

The intersection of environmental psychology and behavioural economics remains an important one. While the anchoring effect has been utilized within the field of environmental psychology, it has thus far not been used as a tool in conjunction with the New Ecological Paradigm (NEP) scale. Croson and Treich (2014) discuss the possibilities of combining best practices in environmental psychology and behavioural economics. They furthermore identify this intersection as being an area ripe for future research. Mariel and Arata (2021) expand on this gap through an evaluation of preferences regarding agri-environmental practices. These authors utilize measures of environmental attitudes drawn from the NEP scale and highlight the possibility of an anchoring effect in their data that requires further exploration. Our study helps fill a gap in the literature through a two-pronged approach that incorporates both the NEP Scale and the anchoring effect in the methods. The data suggests that environmental attitudes as displayed by the survey respondents may not necessarily play as much of an impact on the results as the anchoring effect itself (Figure 3 vs Figure 2). These findings cast light on the relationship between environmental attitudes and the anchoring effect specifically but requires further research to explore this relationship on a larger scale and across divergent contexts.

Next, the survey described a hypothetical scenario where a municipality was forced to discharge untreated sewage into a river, which lead to beach closures downstream due to high E. coli levels. The municipality planned to upgrade their wastewater treatment plant to prevent this from happening in the future. At this stage, the respondents were divided into two treatment groups: the low anchor group was told the initial quote for these upgrades would be an additional $7.48/month over five years on their water bill, while the high anchor group was told it would cost $27.71/month over five years on their water bill. Respondents were asked whether they would pay

[1] See our 'Methods' and 'Supplementary Material' sections for more information on our methods and to find our survey.

'more, less, or equal to' this initial quote. They were then asked to enter the maximum amount they would pay (WTP) per month over five years. Finally, we asked respondents to provide any additional comments they may have.

We had two main hypotheses:

1) Participants who saw the low anchor will report lower average WTP, relative to participants who saw the high anchor.
2) Participants with a high NEP score will have a smaller anchoring effect compared to those with a low NEP score.

Results

The average NEP score was 21.2 ± 0.5 and ranged from 10 to 25 (Figure 1). Higher NEP scores signify more pro-environmental attitudes, so our respondents tended to have more pro-environmental attitudes according to the NEP scores (Figure 1). WTP (across both treatments) was $28.47 ± 4.81 (CAD $) and ranged from $0 to $250/month (Supplementary Figure 5).

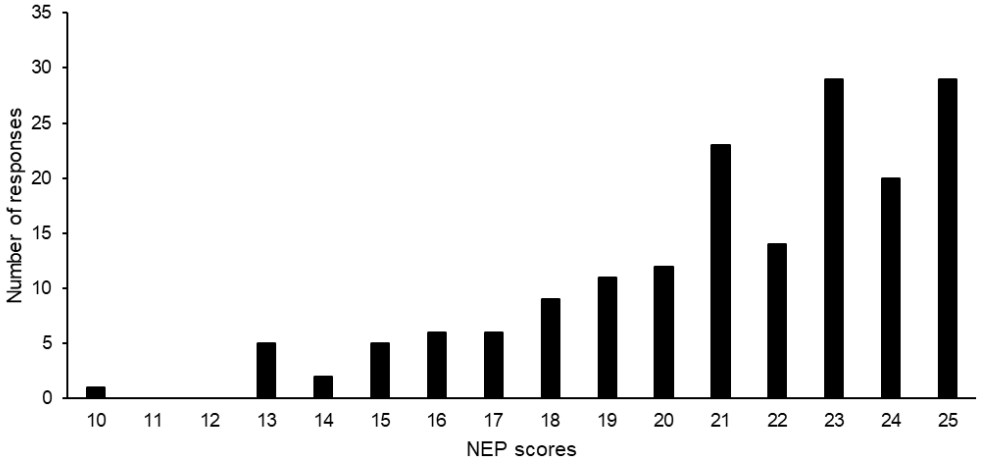

Figure 1: NEP score for all responses (both treatments), which ranged from 10 to 25. The average NEP score was 21.2 ± 0.5 (± margin of error for a 95% confidence interval.)

The effect of the anchoring treatment on WTP (Hypothesis 1)

Overall, those with the low anchor treatment had an average WTP of $19.38 ± 5.74, while those with the high anchor treatment had a significantly higher average WTP of $40.98 ± 7.35 (Table 1 and far left two bars of Figure 2, $p < 0.05$). This shows a clear overall anchoring effect, as we predicted in hypothesis 1.

Table 1: Mean willingness to pay (WTP), margin of error for 95% confidence interval (CI), standard deviation, and sample size of respondents for each anchor and 5 categories for the NEP scores. The means ± the margins of error are shown in Figure 1. WTP is in CAD $ per month for five years.

Mean	**Whole dataset**	**NEP from 10-18**	**NEP from 19-21**	**NEP from 22-23**	**NEP from 24-25**	**NEP from 24-25 (removed 3 outliers)**
Low anchor ($7.48)	$19.38	$9.34	$13.87	$15.75	$31.72	$20.50
High anchor ($27.71)	$40.98	$35.94	$35.43	$42.38	$50.45	$37.98
Margin of Error						
Low anchor ($7.48)	$5.74	$2.50	$3.52	$4.30	$16.34	$6.14
High anchor ($27.71)	$7.35	$12.02	$9.39	$8.13	$25.94	$9.24
Standard Deviation						
Low anchor ($7.48)	$29.01	$5.10	$9.50	$10.29	$47.16	$17.16
High anchor ($27.71)	$32.26	$26.02	$20.33	$19.01	$54.57	$18.86
Sample Size						
Low anchor ($7.48)	98	16	28	22	32	30
High anchor ($27.71)	74	18	18	21	17	16
Both treatments	172	34	46	43	49	46

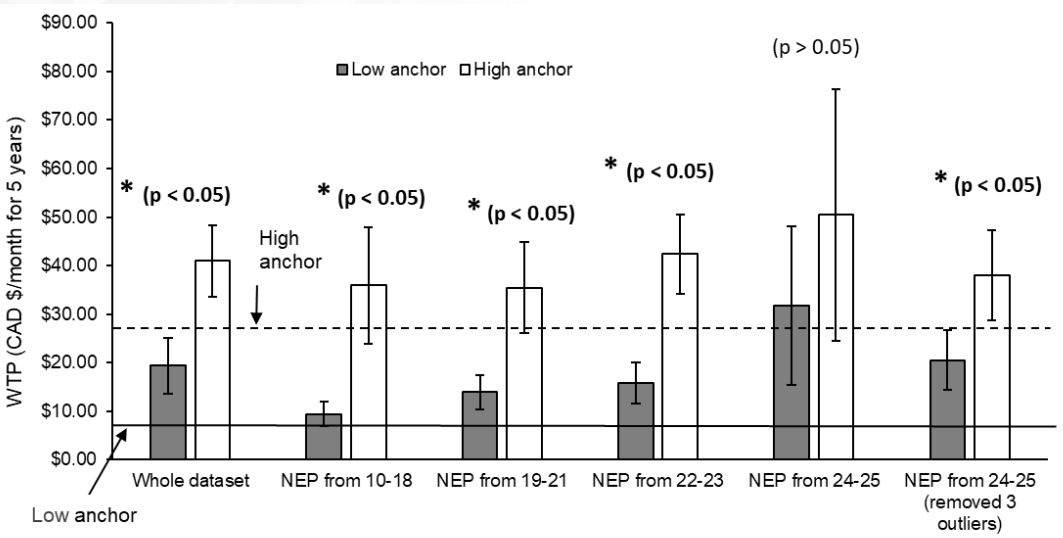

Figure 2: Difference in WTP (willingness to pay) for the high and low anchor treatments (see legend). The two bars at the far-left show data from the whole dataset, the other bars show five different categories for the NEP scores (see Table 1 and Figure 2 for the # of respondents for each NEP category.) NEP scores from 24-25 are represented both with and without 3 outliers. Error bars represent 95% confidence intervals. * and $p < 0.05$ indicate a significant difference between the two treatments according to a t-test. $P > 0.05$ indicates the differences were not significant. The low anchor of $7.48 is shown by the solid line while the high anchor of $27.71 is shown by the dashed line.

Effect of NEP scores on anchoring (Hypothesis 2)

NEP scores ranged from 10 to 25, with a much higher number of respondents with high NEP scores (Figure 1). Based on this distribution of NEP scores, we divided our data into four categories that had roughly equal sample sizes: NEP from 10-18 (sample size = 34), NEP from 19-21 (sample size = 46), NEP from 22-23 (sample size = 43), and NEP from 24-25 (sample size = 46) (Table 1). These categories are shown in Figure 2. There were significant differences between the low and high anchors for NEP scores from 10-18, 19-21 and 22-23 (Figure 2), showing a clear anchoring effect at these lower NEP scores.

There was no significant difference between the low and high anchor treatments for the highest NEP scores from 24-25 ($p > 0.05$); however, the error bars show high variation (Figure 2). A scatterplot of NEP scores vs WTP shows three high values for WTP at the highest NEP scores (Figure 3): two for the low anchor at $200 (Figure 3b) and one for the high anchor at $250 (Figure 3c.) These three values are outliers, meaning they were more than 2 standard deviations away from the mean (Table 1). We chose to leave these outliers in for our initial analyses because they were similar, suggesting that their answers were genuine. In addition, respondent 21, who had the NEP score of 25 and WTP of $200 in the low anchor treatment, said they would "gladly pay all that I can", suggesting that their WTP of $200/month was sincere and not a typo. However, if these three outliers are removed, then there is a significant difference between the low and high anchors for NEP from 24-25 ($p < 0.05$; Figure 2), demonstrating how a few outliers can affect whether an anchoring effect is significant or not.

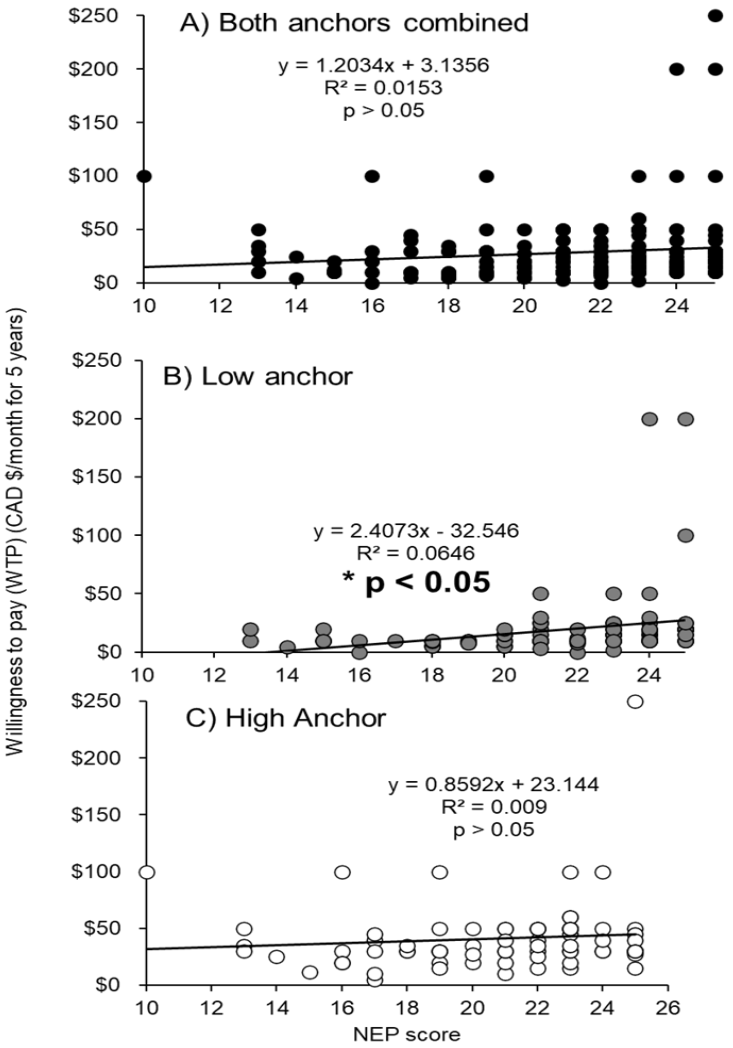

Figure 3: The relationships between NEP scores and willingness to pay (WTP). A) has both treatments combined and shown as black circles, B) shows the low anchor treatment as gray circles and C) shows the high anchor treatment as white circles.

Regardless of whether there was a significant difference between the low and high anchors for NEP from 24-25, we do see less of an anchoring effect for this high NEP category compared to the lower NEP categories. Therefore, this provides support for our second hypothesis, suggesting that anchoring had less of an impact on respondents with pro-environmental attitudes as shown by high NEP scores. As mentioned in the later 'limitations of our study' section, further research is needed to provide additional support for this hypothesis.

Effect of NEP scores on WTP (Hypothesis 3)

Figure 2 provides tentative evidence of WTP increasing from low to high NEP scores, particularly in the low anchor treatment. However, the error bars overlap, so it is not clear from

Figure 2 whether this was a significant increase. We studied this further using scatterplots plotting NEP scores vs WTP (Figure 3). For the low anchor treatment there was a statistically significant relationship between NEP scores and WTP ($p < 0.05$, Figure 3b). However, there was no significant relationship for the high anchor treatment or both treatments combined ($p > 0.05$, Figures 3a and c). A visual inspection of Figure 3c) shows three outliers in the high anchor treatment where those with lower NEP

scores still had a high WTP (at NEP scores of 10, 16 and 19). If these outliers were not present the relationship in Figure 3c) may have been stronger.

Discussion

In an online survey experiment, we find evidence of the anchoring effect in WTP for wastewater treatment plant upgrades. The average WTP was significantly higher in the high anchor compared to the low anchor in the whole dataset (Figure 2), which supports our first hypothesis. Anchoring was also shown to influence WTP for NEP scores from 10-18, 19-21, and 22-23 (Figure 2). However, anchoring had less of an impact on NEP scores from 24-25 (Figure 2). This confirms our second hypothesis that those with a greater concern for the environment would be less affected by the anchoring effect.

The anchoring effect has previously been explored as a tool, specifically in its utilization as a nudge, to increase funding and/or donations within specific contexts (Thaler & Sunstein, 2008). Nelson, Partelow, and Sclüter (2019) provide experimental evidence on how the anchoring effect can be used to nudge tourists in maximizing monetary donations to coastal conservation initiatives. Similarly, Kim and Hyun (2021) have shown how the anchoring effect can also positively impact public perceptions on aviation green taxes, thus contributing to long-term sustainable tourism. The results of our present study indicate that the anchoring effect does indeed have an impact on the public's willingness to pay in respect to wastewater infrastructure development (Figure 1). The increase in citizen's willingness to pay for wastewater treatment plant upgrades as a direct result of anchoring strategies thus expands the scope of the anchoring effect's use as a nudge to increase funding and/or public donations from its contexts of coastal conservation and sustainable tourism to the field of policy and wastewater management.

Our results show that NEP scores had a significant effect on WTP, but this was only true in the case of the low anchor treatment (Figure 3). This was an unexpected result given that we had hypothesized the NEP scores would have a significant effect on WTP in both treatments. However, it does make intuitive sense that those with a high NEP score would be willing to pay significantly more than the low anchor as opposed to the high anchor, especially considering the large gap between both as presented in the surveys. The data by itself is noteworthy in that, so far as the dataset at hand shows, the public is willing to pay a significant amount for infrastructure development as it relates to water quality and climate change. The utilization of both the anchoring effect and the NEP scale together would be insightful to explore across divergent scales and contexts to collect further data that can then inform both the literature and the policy sphere.

Several themes emerged from the qualitative survey feedback which bear strong relevance for policy makers in the area of wastewater infrastructure development. The most prominent of

these themes includes a distrust of government and an emphasis on public accountability, both of which respondents said had strong impacts on their WTP. A number of survey respondents communicated that their WTP would have been greater had there been greater transparency in the development of the forecasts that led to both the high and low anchors. This may have constrained the anchoring effect as shown in the data. These findings highlight the key role that public transparency and accountability plays within large infrastructure development projects, such as wastewater treatment plants. This leads us to recommend that future public engagement sessions led by policy makers not only utilize the anchoring effect by suggesting a higher initial quote to maximize public support for proposed municipal tax increases, but also ensure sufficient public transparency in forecasting to further maximize WTP and to minimize potential cost overruns.

We found that anchoring held true in our survey; individuals were inclined to consider values of unknown quantities prior to expressing their own estimation. These elements were key to gauging the public's awareness and concern about protecting the environment by preventing pollution discharge into rivers and lakes. In addition, focusing on these aspects led to further understanding of the effects of anchoring on the public's willingness to contribute financially to expensive wastewater treatment plant upgrades, which is a major environmental policy issue in Saskatchewan and Canada.

Areas of Further Study

There are some boundaries associated with the findings of our study which provide avenues for future research. We chose to use a shortened 5-item version of the revised 15-item NEP scale to maximize the efficiency of the survey at the risk of possibly impacting the generalizability of the data. The NEP scale was first developed in 1978 as a 12-item questionnaire (Dunlap & Van Liere, 1978). Since its initial inception, an additional 15-item revised questionnaire was developed as an improvement on the original (Dunlap et al., 2000). As per the meta-analysis performed by Hawcroft and Milfont (2010), the use of the NEP scale in the scholarly field since its development in 1978 is replete with many variations of these divergent scales. This presents an inherent challenge in establishing generalizability in research findings across the field, though it remains useful for its initial purpose as a tool to measure environmental attitudes. However, if we wanted to make this survey more generalizable to other studies, we could use the full 15-item NEP scale in the future.

Furthermore, our conclusion for our second hypothesis was that there was less of an anchoring effect for the highest NEP scores of 24 and 25 (see Figure 2). Whether this anchoring effect was significant or not depends on whether three outliers were included. If this survey were redone with a larger sample size, say at least 50 respondents in both treatments at each NEP score, we could better demonstrate how changes in the NEP score affected anchoring. While our sample sizes for NEP = 24 and 25 were high compared to the NEP scores below 20, the sample sizes were still small for a t-test comparison at 20 respondents for NEP = 24 and 29 respondents for NEP = 25, leading to 49 total (see Figure 1). The respondents were also split unevenly between the two treatments at NEP = 24 and 25, with 32 in the low anchor and 17 in the high anchor (see Table 1), making a comparison difficult. Therefore, if this survey were redone with a larger sample size, we could better demonstrate whether anchoring was occurring at these highest NEP scores.

Factors worth exploring in future studies would include a greater range of incomes, including higher incomes, which can better inform our understanding of the relationship between income and WTP (see Supplementary Figure 8). Furthermore, a greater range of NEP scores, including lower NEP scores, could also more specifically determine the scope of the impact that NEP has on WTP or WTP/income (see Supplementary Figures 8 and 9). More intensive statistical methods, such as multivariate statistics, could also be used to examine the interaction of the variables measured in this study–be that age, homeownership, water bills, annual income, NEP scores, and the anchor treatments–and their effect on WTP. Additional variables worth exploring that extend beyond the scope of our study include education levels, use of lakes for recreational purposes, and the ownership of property, such as cottages, on the lakes. Finally, a field experiment may be beneficial as well.

Methods

Distribution of variables in the sample population

190 people filled out our online survey. Of those, we used 172 responses as some responses were incomplete or considered untrustworthy outliers (see 'statistical analysis in the methods for more on deleted responses). 98 people received the low anchor treatment ($7.48/month for five years) while 74 people received the high anchor treatment ($27.71/month for five years).

51% of the respondents were homeowners, 49% were not (Supplementary Figure 1). 60% of the respondents paid a water bill, while 40% did not (Supplementary Figure 2). The average age was 39 ± 2 years, ranging from 19 to 81 years (all answers ± margin of error for a 95% confidence interval, Supplementary Figure 3). Average annual income was $65 073 ± 7036 (CAD $), ranging from $1000 to $250,000 (Supplementary Figure 4).

Justification for the (WTP) survey

The anchor was placed in a survey, which is part of the contingent valuation family (Ariely et al., 2002). WTP is a common economic method to establish a price for environmental value and common pool resources (van Exel et al., 2005). This method was used so that participants would not suspect that they were being deceived and start trying to guess the hypothesis of the experiment, which could influence results (Grady, n.d.). A WTP survey hides the anchor in plain sight and evokes sincerity in the participants, even though it's a set-up. Sincerity, or truthfulness, adds justification to the results (Price, Jhangiani, & Chiang, 2013). The method provides the possibility to represent the high and low anchors as an estimated price to upgrade a waste-water treatment plant and to isolate them as independent variables.

The anchors for this experiment are informative so that participants could reasonably believe the anchor could represent a real increase. The figures of the anchors were calculated for an estimated cost based on the cost of the waste-water treatment plant upgrades in Regina (see Supplementary Material for more info). The equation has flaws, but it at least provides an estimate so that participants are given an informative anchor. Random anchors have been successful in other experiments and effectively validate the anchoring effect (Kahneman & Tversky, 1976; Boo & Furnham, 2011). Plausibility and practicality were chosen to validate the anchoring effect instead of a random anchor. People who rent suites in apartments usually do not have to pay a water bill

in Saskatchewan, so people were asked if they pay a water bill to account for that potential extraneous variable.

Survey: demographic questions

Our experiment was operationalized using a short survey (approximately 5 minutes long) in the SurveyMonkey software. See 'supplementary material' for the full survey. It began with demographic related questions, for the purpose of differentiating participants based on the following factors: whether they are homeowners, whether they pay a water bill, what their age is, and what their income level is. Income is an extraneous variable because it can influence a person's WTP (Ariely et al., 2003), so knowing the respondent's income level is important for interpreting the results. We also thought age, homeownership and whether participants paid a water bill might influence their WTP.

Survey: NEP (New Ecological paradigm) questions

The New Ecological Paradigm (NEP) questionnaire measures environmental concern using 15 questions to calculate a score from 15 to 75, with a score of 75 representing the highest environmental concern (Dunlap et al., 2000). Since we wanted to keep our survey to 5 minutes or less, we included 5 of these 15 questions in our survey. The NEP scale is divided into five categories (Dunlap et al., 2000), so we picked one question from each category. Participants were asked whether they Strongly Disagree (1), Mildly Disagree (2), are Unsure (3), Mildly Agree (4) or Strongly Agree (5) with a series of statements. These numbers (1-5) were not included in the actual survey so that they would not influence the anchoring portion of the experiment. Three of the questions (indicated in the survey in supplementary material) were reverse scored (1 became 5, 2 became 4, etc.). The scores from the five questions were then added together so that potential scores ranged from 5 (lowest environmental concern) to 25 (highest environmental concern).

Survey: hypothetical scenario

After the NEP questions, participants had to read about a hypothetical scenario of environmental pollution (question 3 of the survey in Supplementary Material). There was heavy rain in a fictional municipality that forced the city to dump untreated sewage into an outflowing creek because the maximum capacity at the waste-water treatment plant was reached. The city did this to avoid flooding within the city, however that action caused E.coli to flourish in downstream lakes, forcing closure of beaches. To solve that problem for the future, the city plans to upgrade the waste-water treatment plant and provides a cost estimate to the public. This hypothetical scenario was based on a real event that occurred in Regina, Saskatchewan in 2014 (Gousseau, 2015).

Survey: low and high anchor treatments

Following the hypothetical scenario, participants were randomly divided into two treatment groups. All participants read that the cost to upgrade the wastewater treatment plant would increase their water bill, but the cost varied. The low anchor treatment group was told that the cost would be $7.48/month over five years, while the high anchor treatment group was told $27.71/month over five years. The lower anchor considered the actual cost of upgrades in Regina if funding from the provincial and federal government through the *Investing in Canada*

Infrastructure Program (ICIP) was available (Government of Canada, 2021). The higher anchor considered costs if this funding was not available. See 'Supplementary Material' for further information and calculations explaining how we determined the price of these anchors based on this funding program.

Participants were then asked two follow-up questions (questions 5 and 8): would you pay more, less or equal to that amount? Followed by questions 6 and 9: what is the maximum that you would be willing to pay for upgrades (see survey for exact wording)? The follow-up questions prime the anchoring effect; the first question motivates participants to compare their value judgement with the low or high anchor and the second question tests if anchoring is occurring. The amount of uncertainty around the cost for waste-water treatment plant is too high to give a rational answer, so participants will also judge how much they are willing to pay to prevent E.coli from infecting lakes. Both values are highly uncertain, so participants will state their value in relation to the anchor.

Survey: open-ended response

The last question in our survey asked participants if they had any additional comments (question 10). We added this qualitative question to see if participants would clarify their answers or give additional information about what affected their WTP.

Survey format

Questions were formatted using multiple choice (yes/no, more/less/equal to), single textboxes (____), and matrix/rating scales (1-5; strongly disagree to strongly agree). Each section of the survey was carefully designed to require only one response to each question for the purpose of ensuring enough data was collected. Throughout the survey, sections of important information to guide the participant was included. As this information was not always accompanied by a required question, participants were required to select 'OK' to acknowledge they read the text and understood its contents. Page breaks were set to separate and cluster relevant survey questions. They were also intended to prevent participants from returning to previously answered questions and changing their responses upon learning new information. Page breaks allowed us to use 'blocking' to randomly divide participants into two groups to be provided only one of two estimated quotes (anchors). There were restrictions on some questions that guided the participants as to what type of response was required (ie. a four-digit number in the form of a year). Throughout the survey, key words and phrases were emphasized by using bolded, italicized, and red coloured text. Questions were re-numbered (ie. 1, 2, 3) at the beginning of each page to ensure participants did not know that there were two estimated quotes randomly assigned and that they were only being shown one.

Distribution of our survey

The survey link was distributed online to the participants through several social media platforms (twitter, facebook, instagram, linkedin), as well as graduate and undergraduate students from the University of Saskatchewan and the University of Regina. University classes were selected to ensure that age, wealth, and homeownership were diverse in the population sample.

Ethics

Implications were addressed in the participant consent form and this research project was approved on ethical grounds by Dr. Peter WB Phillips, using delegated authority from the University of Saskatchewan Behavioural Research Ethics Board, prior to distribution of the survey. The formal approval is BEH 2946 A.[2]

Statistical analysis

The results from our survey were downloaded off SurveyMonkey into an excel file to create figures and use the 'data analysis tools' for statistical analysis. We used a two-sample t-test to test for significant statistical differences between the low and high anchor treatments for the whole dataset (Figure 2) to address our first hypothesis (effect of anchoring on WTP).

We also divided participant responses into four categories of NEP scores to address our second hypothesis (whether NEP scores affected the extent of the anchoring treatment). As our participants tended to have high NEP scores (Figure 1), the four categories of NEP scores we chose were: NEP from 10-18, 19-21, 22-23 and 24-25. We chose these four categories to obtain sample sizes in each category that were as equal as possible (Table 1). Two-sample t-tests were then conducted on these four NEP categories (Figure 2). Given the high variation in the highest NEP category (24-25), we also conducted a t-test for that category after removing 3 outliers (Figure 2).

Regressions were conducted in excel to obtain p values that examined the effect NEP scores had on WTP for both treatments combined and the separate treatments (Figure 3). We used a significance level of $\alpha = 0.05$ (i.e. p values < 0.05 were considered statistically significant). The same regression analysis was conducted to look at the effects of income on WTP (Supplementary Figure 8) and the effects of NEP scores on WTP as a proportion of income (WTP/income; Supplementary Figure 9).

We downloaded 190 responses off SurveyMonkey: of those, 18 were removed from the analyses for the following reasons. Some responses were incomplete (reported by SurveyMonkey or they wrote 'NA' for one of the required responses). One participant reported annual income as '0': while this may have been a valid response (this may have been a student), we deleted this response as we could not divide WTP by an income of 0 for Supplementary Figure 9.

Another participant in the high anchor treatment (respondent #162) gave a WTP of $1662, which we deleted as we did not find this response trustworthy for the following reasons. Firstly, this was an outlier as it was more than 2 standard deviations away from the mean. However, unlike other outliers for WTP that we chose to consider in our analyses (respondent #88 said $250 in the high anchor and respondents #21 and #16 said $200 in the low anchor), the price of $1662 was an order of magnitude greater than any other response. In addition, respondents #88, 21 and 16 all had high NEP scores of either 24 or 25 which made their high WTP seem genuine, while respondent #162 had a low NEP score of 14.

[2] See the full ethics consent form in the 'supplementary material' section.

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Supplementary Material

Justification for the Low and High Anchors

To come up with informative low and high anchors that were realistic but also had the potential to have an anchoring effect, we considered a hypothetical scenario where the City of Regina would have applied to the *Investing in Canada Infrastructure Program* (ICIP) to upgrade its wastewater treatment plant. This is a bilateral agreement that offers funding opportunities for municipal governments in water infrastructure development (Government of Canada, 2021; McNeill, 2020). Similar projects, such as planned upgrades to the wastewater treatment plant in Humboldt, Saskatchewan, were able to access this funding stream (City of Humboldt, 2021; McNeill, 2020). Ultimately, development expenses would be borne in part by the federal government at 40% of total costs, the provincial government at 33%, and the municipality at 27% (Government of Canada, 2021; McNeill, 2020). This means that, in the best-case scenario where the City of Regina leveraged this funding stream, the municipality would have been responsible for 27 percent of total costs.

In terms of the municipality, the City of Regina's annual budget for 2021 includes forecasted revenue from a number of distinct sources (City of Regina, 2021). Property taxation as a source of revenue composed roughly 57 percent of total revenue for the City of Regina, with the remaining 43 percent of municipal revenue being derived from other sources such as but not limited to program fees, charges, government grants, and reserve transfers (City of Regina, 2021). There are roughly 60,000 property owners–a tally which includes residences such as houses, apartment complexes, and duplexes–in the city capable of bearing these expenses (Odum, 2016).

It is with these numbers in mind that approximate calculations, assuming a 5-year payment period, were made to forecast possible expenses in the surveys shared with research participants:

$175M = Total capital cost of Wastewater Treatment Plant Upgrades for the City of Regina (CBC News, 2016)
27% = City of Regina's share of costs as per the ICIP program
57% = proportion of municipal revenue in Regina deriving from taxpayer dollars

$175M x 0.27 x 0.57 ÷ 5 years ÷ 12 months ÷ 60,000 taxpayers
= $7.48/month per average taxpayer over 5 years

Or, where the City of Regina is unable to leverage ICIP funding:

$175M = Total capital cost of Wastewater Treatment Plant Upgrades for the City of Regina (CBC News, 2016)
100% = City of Regina's share of costs if unable to access ICIP program
57% = proportion of municipal revenue in Regina deriving from taxpayer dollars

$175M x 1.00 x 0.57 ÷ 5 years ÷ 12 months ÷ 60,000 taxpayers
= $27.71/month per average taxpayer over 5 years

Survey

1. Please answer the following questions:
    a. Are you a homeowner? (yes/no)
    b. Do you pay a water bill? (yes/no)
    c. In what year were you born? (Fill in.)
    d. What was your approximate income in 2020 before taxes (CAD$)? (Fill in.)

2. Now we would like to get your opinion on a wide range of environmental issues. For each of the following statements please indicate the extent to which you agree or disagree:

    Strongly Disagree, Mildly Disagree, Unsure, Mildly Agree, Strongly Agree

    1. The earth has only limited room and resources (*Reality of limits to growth subscale*).
    2. Plants and animals have as much right as humans to exist (*Antianthropocentricism).*
    3. The balance of nature is strong enough to cope with the impacts of modern industrial nations (*Fragility of Nature's Balance, reverse scored).*
    4. Humans will eventually learn enough about how nature works to be able to control it (*Rejection of Exemptionalism, reverse scored).*
    5. Human destruction of the natural environment has been greatly exaggerated (*The Possibility of Ecocrisis, reverse scored).*

Note: the category for each question and whether they were reverse scored was not included in the survey sent out to participants. It is provided here for the reader's information.

3. Next, we're going to ask about your opinion on wastewater treatment in municipalities.

Imagine there was recently a large storm in your municipality with record high amounts of rainfall.

- The infrastructure to deal with this increased rainfall is ***outdated***.
- The municipality was therefore forced to ***discharge untreated sewage into a river that eventually flows into lakes downstream.***
- A few days after the storm, beaches at several lakes downstream from your municipality were forced to ***close*** due to high levels of E. coli bacteria.
- Scientists predict that storms like these will ***increase*** in the future due to climate change.

4. Treatment 1:
    Your municipality is planning to upgrade their infrastructure to prevent raw sewage from being discharged during future storms. An initial quote suggests these upgrades would cost residents an additional **$7.48/month over five years** on their water bill.

5. Would you be willing to pay more, less, or equal to the initial quote of $7.48/month over five years?

    More Less Equal to

6. In the event that the upgrades cost more or less than this initial quote of $7.48/month over five years, what is the maximum amount ($CAD/month) you'd be willing to pay per month over five years on your water bill to prevent raw sewage from being discharged into the river?

   Please enter a number._____

7. Treatment 2:

   Your municipality is planning to upgrade their infrastructure to prevent raw sewage from being discharged during future storms. An initial quote suggests these upgrades would cost residents an additional **$21.71/month over five years** on their water bill.

8. Would you be willing to pay more, less, or equal to the initial quote of $27.71/month over five years?

   More Less Equal to

9. In the event that the upgrades cost more or less than this initial quote of $27.71/month over five years, what is the maximum amount ($CAD/month) you'd be willing to pay per month over five years on your water bill to prevent raw sewage from being discharged into the river?

   Please enter a number.

10. Please let us know if you have any additional comments.

    Thank you for your participation in this survey!

Ethics Consent Form

Participant Consent Form

Student Researcher(s):
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You are invited to participate in a research study entitled: Willingness to pay for Environmental Damage.

This survey is about your environmental values and your willingness to pay for environmental damage. The survey will ask you a range of questions to measure how you value the environment and require you to use your judgement to estimate a cost for environmental damage. The survey should take 5-10 minutes.

You can decide not to participate at any time by closing your browser, or choose not to answer any questions you do not feel comfortable with. Survey responses will remain anonymous. Since the survey is anonymous, once it is submitted it cannot be removed.

Confidentiality:
Your confidentiality will remain anonymous throughout the process of the survey as well as if this research gets published in an academic journal.

The survey will be hosted by SurveyMonkey. For researchers at Canadian institutions, Qualtrics stores their data in Ireland. For more information on Qualtrics' privacy policy click here.

Questions or Concerns:
Contact the researcher(s) using the information at the top of page 1.

This research project has been approved on ethical grounds by Dr. Peter WB Phillips, using delegated authority from the University of Saskatchewan Behavioural Research Ethics Board. The

formal approval is BEH 2946 A. Any questions regarding your rights as a participant may be addressed to Dr. Phillips at 306-966-4021 or peter.phillips@usask.ca. If you want further information on the nature of the delegation and the ethical guidelines rules, you can contact the Research Ethics Office: ethics.office@usask.ca; 306-966-2975; out of town participants may call toll free 1-888-966-2975.

By completing and submitting this questionnaire, **your free and informed consent is implied** and indicates that you understand the above conditions of participation in this study.

Supplementary Results

Effect of income on WTP

We wondered whether income was affecting WTP more so than NEP, as other studies have shown income to be an important predictor of WTP (Ariely et al., 2003). So, we also plotted income vs WTP (Supplementary Figure 8). While there was a positive relationship between income and WTP for both treatments and the combined treatments, these relationships were not significant ($p>0.05$).

Effect of NEP scores on WTP/income

Another possibility we considered was that NEP scores may have a stronger relationship with WTP as a proportion of income instead of just WTP. For example, those who have low income, but high NEP scores may give a low WTP, but that WTP may be a high percentage of their income. To look at this, we plotted NEP scores vs

WTP/income for both treatments and the combined treatments (Supplementary Figure 9). However, these were not significant ($p > 0.05$) relationships, and they were negative, while we were expecting significant positive relationships. Part of the reason for this odd negative relationship may have been the higher number of respondents with high NEP scores (Figure 1).

Effect of the combination of high income and NEP scores on WTP

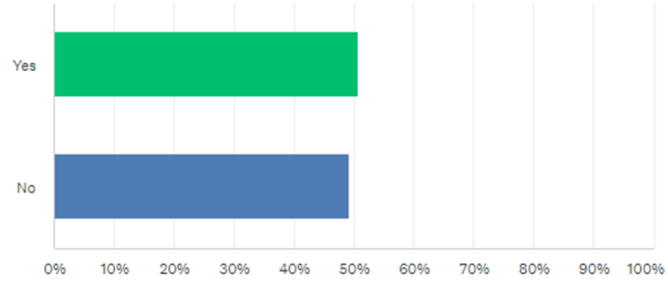
With one exception in the low anchor, all participants with a high income ($80,000 and above) and a NEP score of 25 were willing to pay more than the anchor given (9 respondents; data not shown). The one exception who said they would pay equal to the low anchor value (and gave a WTP of $15.00) said they did not suggest a higher amount because they were not aware of what a reasonable price for a wastewater treatment plant would be, but they were theoretically willing to pay more (Respondent #160).

With one exception in the high anchor, all participants with a high income and a 25 NEP score were willing to pay either more (1 respondent) or equal to the suggested amount (5 respondents; data not shown). The one exception (Respondent #189) did not give any additional comments; however, they do not pay a water bill.

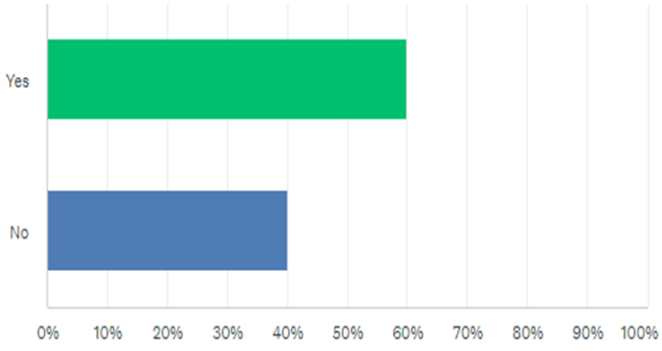
Open-ended responses (Question 18 in the survey)

Overall, 47 people (out of 172) gave an open-ended response to our last question. Many responses were useful as they gave insight into what impacted respondents' WTP. 10 people said they were willing to pay more due to reasons related to sustainability. 8 people suggested that they would pay more if they did not have income constraints. 2 respondents said that more information about how much the upgrades would cost or more information about the benefits of the project would influence their willingness to pay more; and 2 respondents said that they would pay more if other environmental factors and socio-economic factors on households were considered. 16 respondents touched on transparency, accountability, and trust in government actions and overlapped with respondents requesting more information about the wastewater treatment plant project. Some of the respondents said the government/municipalities should take more responsibilities in finding a solution to this issue, others said that they will pay nothing because it is entirely the government's responsibility to pay for the wastewater treatment plant and some said they would expect updates and information about the wastewater treatment plant project.

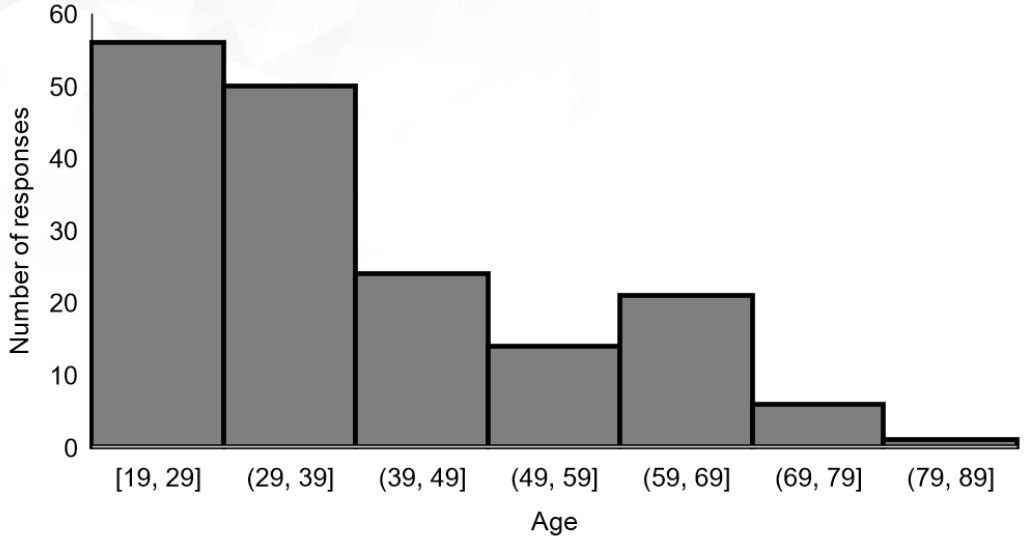
Supplementary Figures



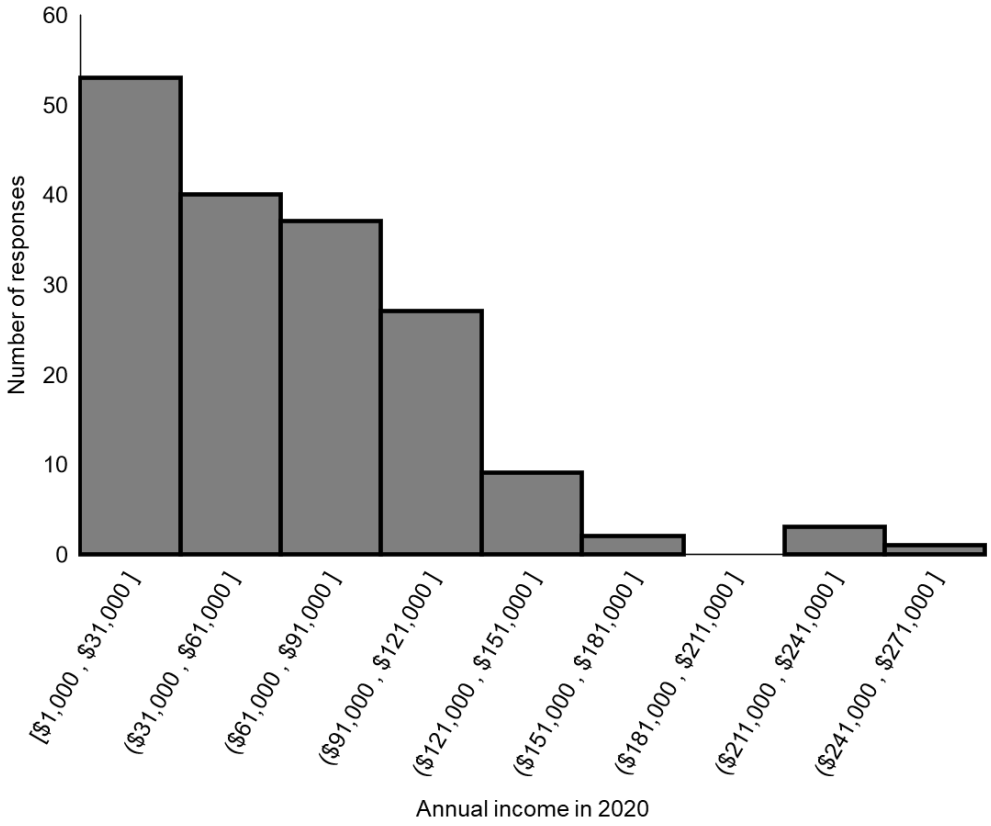
Supplementary Figure 1: Responses to Question 1: Are you a homeowner? 51% of the respondents said 'yes', 49% said 'no.'



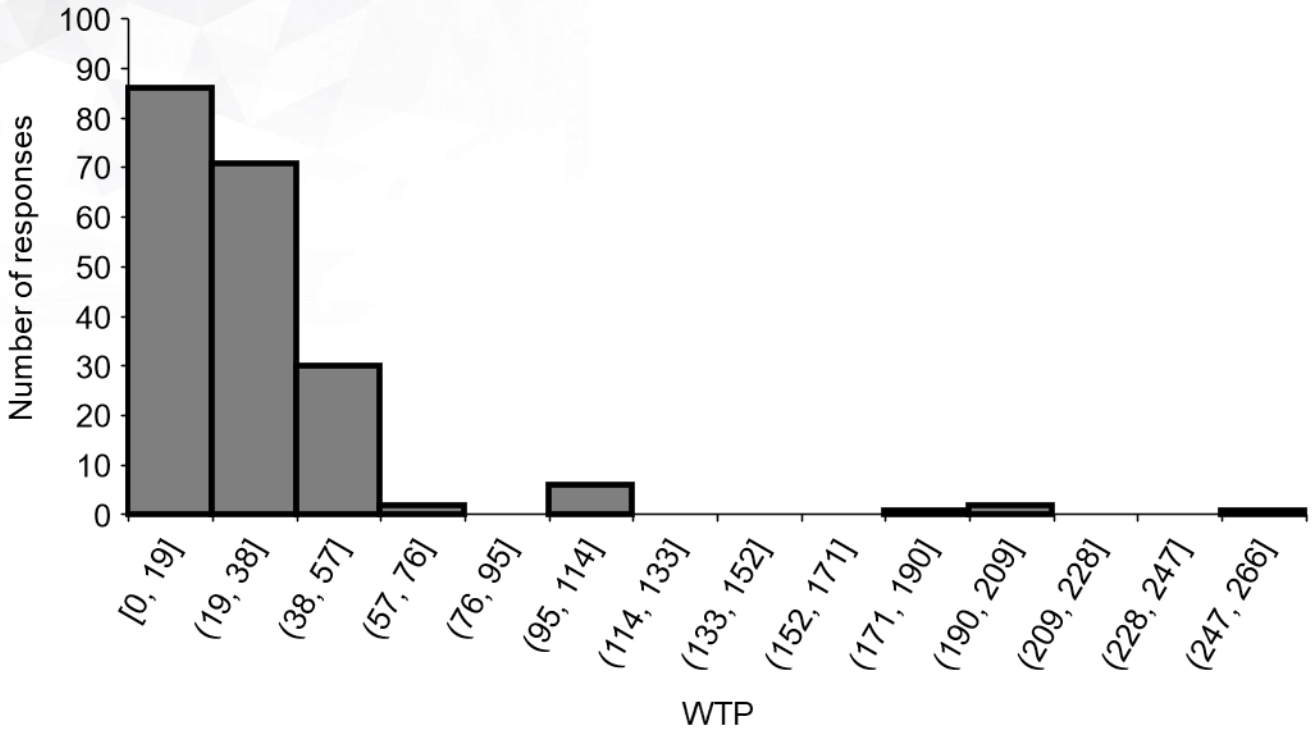
Supplementary Figure 2: Responses to our Question 2: 'Do you pay a water bill'? 60% said 'yes', 40% said 'no'.



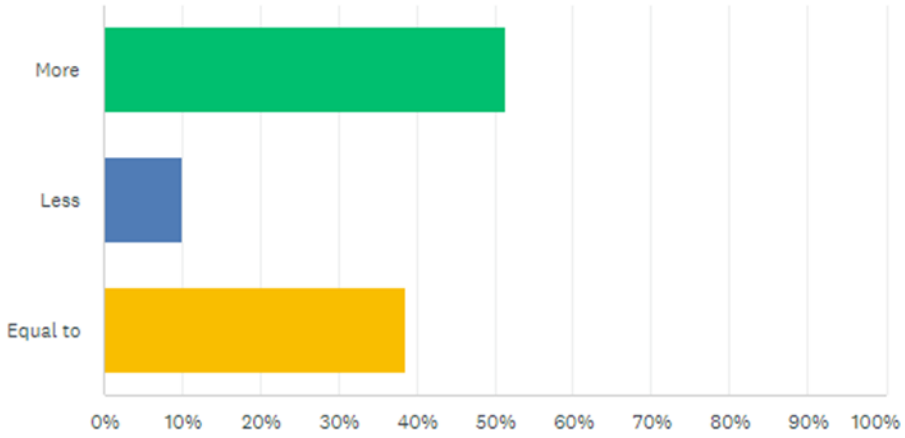
Supplementary Figure 3: Distribution of ages amongst all responses, which ranged from 19 to 81 (range of 62 years.) The average age was 39 ± 2.3 years (± margin of error for a 95% confidence interval.)



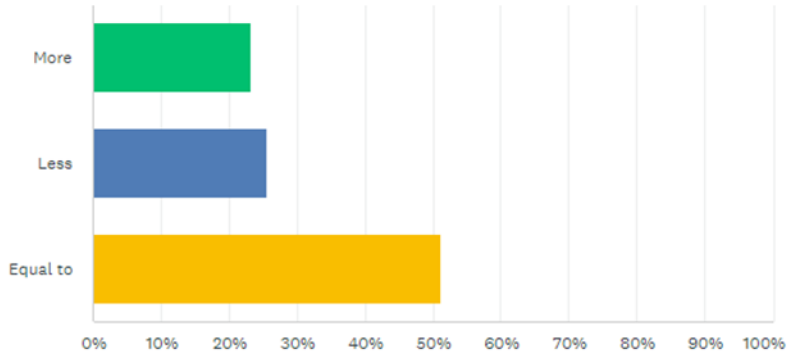
Supplementary Figure 4: Distribution of annual income amongst all responses, which ranged from $1000 to $250,000. The average was $65 073 ± 7036 (CAD $) (± margin of error for a 95% confidence interval.)



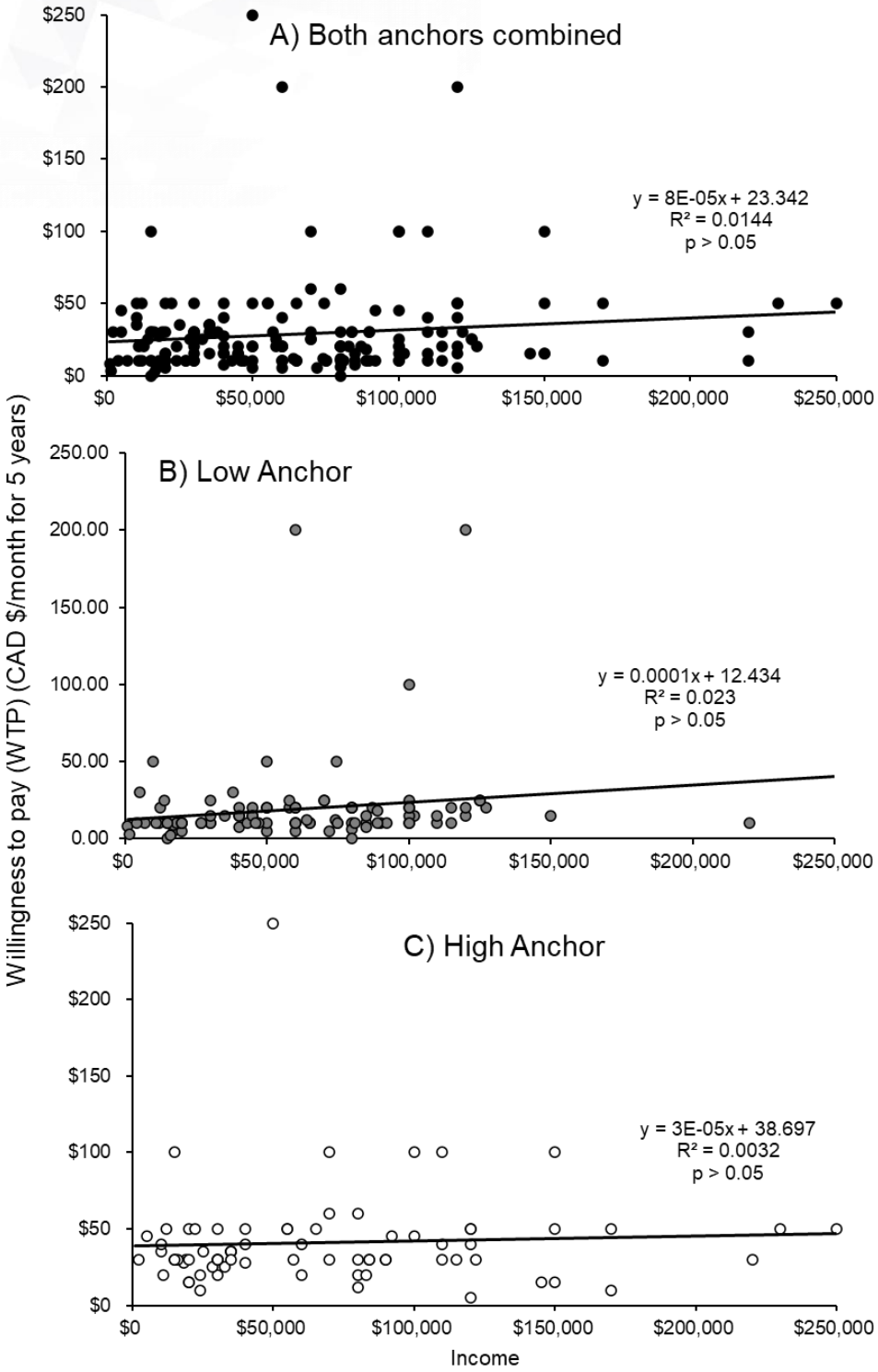
Supplementary Figure 5: Willingness to pay (WTP) for all responses (both treatments), which ranged from $0 to $250/month. The average was $28.47 ± 4.81 (CAD $) (± margin of error for a 95% confidence interval.)



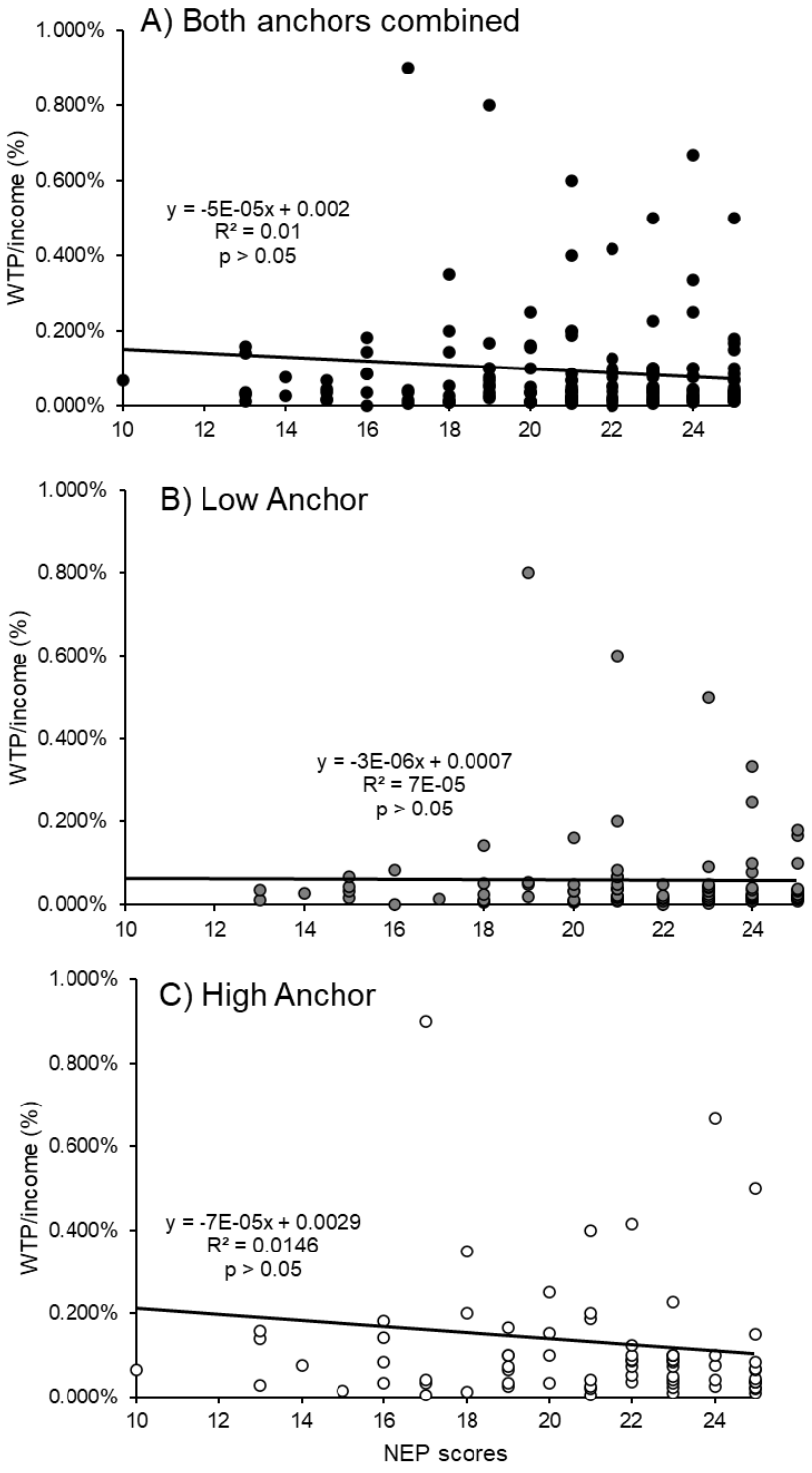
Supplementary Figure 6: Responses to question 12: "Would you be willing to pay more, less, or equal to the initial quote of $7.48/month over five years?" 51% said 'more', 10% said 'less', and 39% said 'equal to.'



Supplementary Figure 7: Responses to question 16: "Would you be willing to pay more, less, or equal to the initial quote of $7.48/month over five years?" 23% said 'more', 26% said 'less', and 51% said 'equal to.'



Supplementary Figure 8: The relationships between annual income in 2020 and willingness to pay (WTP). **A)** has both treatments combined and shown as black circles, **B)** shows the low anchor treatment as gray circles and **C)** shows the high anchor treatment as white circles.



Supplementary Figure 9: The relationships between NEP scores and WTP/annual income as a %. **A)** has both treatments combined and shown as black circles, **B)** shows the low anchor treatment as gray circles and **C)** shows the high anchor treatment as white circles.