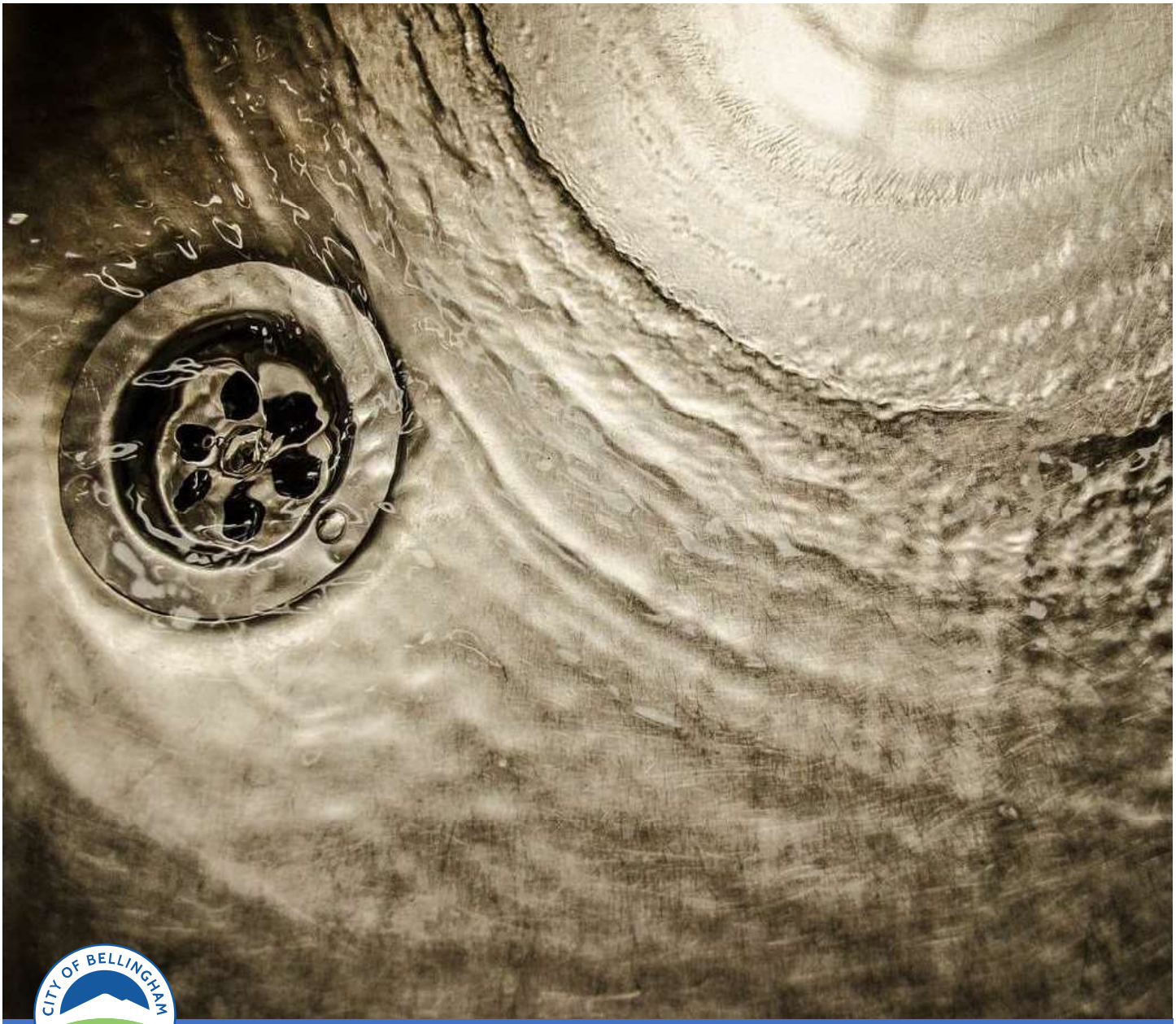

Water Use Efficiency Cost-Benefit Analysis

Preparing for 2020-2025 work plan

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City of Bellingham Public Works
Natural Resources

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City of Bellingham Water Use Efficiency Program Cost-Benefit Analysis

Introduction

This report provides a summary of the findings of a cost-benefit analysis completed for the City of Bellingham's Water Use Efficiency program. The purpose of this this cost-benefit analysis is to look at the future of the City's water conservation programs now that the system is fully metered and there is more reliable data on consumption. The analysis considers current and projected water consumption data to identify the most cost-effective and beneficial water conservation programs to help inform the next 6-year work plan, 2020-2025.

Since the Washington State Department of Health Water Use Efficiency rule requires water providers to ensure a safe and reliable supply of drinking water to meet current and future needs, the major priority for the City of Bellingham's Water Use Efficiency program is to reduce water consumption. Not all conservation activities are considered equal in terms of costs - water savings from both the utility and customer point of view. Therefore, to select measures that maximize water savings while also being cost effective for both the utility and priorities savings for customers, a ranking structure was created based on the benefit-cost ratio for both the utility and costumers.

Water System Overview

The City of Bellingham's (hereafter "the City") water supply originates as rain and snow in the Lake Whatcom and the Middle Fork Nooksack River watersheds. Water from both sources is withdrawn from Lake Whatcom and treated at the water treatment plant, located in Whatcom Falls Park.

The City of Bellingham's water treatment plant provides drinking water to approximately 100,000 people with a large range of customers including residential, commercial, industrial, institutional and seven water districts. In 2018, over half (56%) of the water was used by residential customers, with only about a quarter (27%) used by commercial, industrial and institutional customers, 12% to water districts and only a small portion (5%) used by irrigation customers.

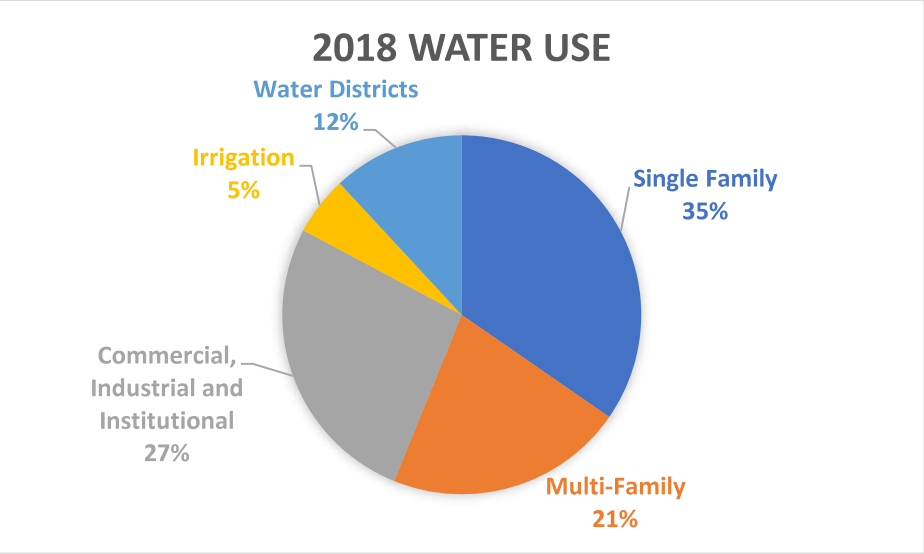

FIGURE 1. 2018 WATER USE

Water Use Efficiency Program Overview

In 2003 the Washington State Legislature passed Engrossed Substitute House Bill 1338, known as the Municipal Water Law (MWL) to address increasing demand on our state's water resources. The Washington State Department of Health (DOH) was directed to oversee and enforce a Water Use Efficiency Program[1] (WUE) to help support the collective goal of ensuring a safe and reliable drinking water supply by requiring water providers to ensure that their systems:

- Contribute to long-term water supply reliability and public health protection
- Promote good stewardship of the state's water resources
- Ensure efficient operation and management of water systems

Enacted January 22, 2007, pursuant with WAC 246-290, the DOH required all Group A water systems, whether public or private, to fulfill certain responsibilities. Applicable requirements specific to the City of Bellingham are listed in Table 1.

TABLE 1. GROUP A WATER SYSTEM REQUIREMENTS

Requirements	Timeline
Water Use Efficiency Program -Goal Setting & Performance Measures	Every 6 years
Performance Reporting	Annually
Metering Requirements	January 22, 2017
Distribution Leakage Standard	2020

[1] WAC 246-290-810

Since its inception, the City's water use efficiency program successfully completed one 6-year work plan (2008-2013) and is nearing the end of the second (2014-2019). The City is currently in compliance with all required program elements and this cost-benefit analysis serves to complete one of the nine approved performance measures of the current six-year work plan.

Table 2 lists the City's adopted water conservation measures for the 2008-2013 reporting period and the associated water customer sectors they targeted. Table 3 lists the 2014-2019 measures and the current status.

TABLE 2. WATER USE EFFICIENCY PROGRAM ADOPTED MEASURES 2008-2013

2008-13 WUE Program Adopted Measures	Status
Measure	
1. Toilet retrofit program for SFR water customers	On-going
2. Toilet retrofit program for Multi-family water customers	On-going
3. Toilet retrofit program for Commercial customers	On-going
4. Develop and implement a water conservation education program for 6th-grade students	On-going
5. Create lawn-watering door hanger for distribution during peak demand periods to educate water customers about proper outdoor watering techniques	Complete
6. Evaluate and develop High-Efficiency Fixture Program	Complete
7. Develop future water rate structures with an emphasis on water conservation	Complete
8. Upgrade City Parks to high-efficiency irrigation systems	?
9. Continue existing public outreach measures	
a. Voluntary Metering Program	Complete
b. Residential Stormwater Retrofit Program	Complete
c. Rain Barrel Program	Complete
d. Events	Complete
e. Leak Detection	Complete
f. Print and Video outreach	On-going
g. Water Conservation Kits	On-going

TABLE 3. WATER USE EFFICIENCY PROGRAM ADOPTED MEASURES 2014-2019

2014-19 WUE Program Adopted Measures	Status
Measure	
1. Continue water efficiency rebates for single-family customers	On-going
2. Continue water efficiency rebates for commercial customers	On-going
3. Extend rebates to multi-unit water customers	On-going
4. Establish Best Management Practices for irrigation water customers	Complete
5. Establish Best Management Practices for industrial water customers	Complete
6. Establish Best Management Practices for institutional water customers	Complete
7. Engage partners to provide water use efficiency resources to targeted customer classes	On-going
8. Develop a system-wide water use efficiency cost-benefit analysis	Complete
9. Reduce Water Treatment Plant operational use via implementation of greater water efficient technology	Complete
10. Conduct sustainable water management demonstration projects with community partners	Complete

Additional Considerations

It is important to note that cost-benefit analyses cannot quantify all the benefits associated with education and outreach. Direct contact with customers is a critical component of a water conservation program and helps educate, build awareness, and improve utility/customer relations. Some additional program elements to be considered outside of this analysis include the rate structure and billing frequency. Lastly, the connection to energy reduction as part of the City's Climate Action Plan may have additional influence. For example, clothes washer rebates for single-family residential customers were not found to be cost-effective, but further analysis may find that the corresponding energy savings make them beneficial from an energy efficiency perspective.

Methodology

AWE Conversation Tool Overview

To complete the cost benefit analysis, the Alliance for Water Efficiency's (AWE) Water Conservation Tracking Tool was used. The AWE is a nationally recognized membership-based organization that works to support and enhance water conservation efforts, providing benefits to water utilities, water conservation professionals, planners, regulators and consumers. The Tracking Tool is an Excel-based spreadsheet tool for evaluating the water savings, costs, and benefits for urban water conservation programs. The tool provides users a standardized methodology for water savings and cost-benefit accounting. The Tracking Tool has hundreds of registered users and has been employed by water utilities throughout the United States and Canada.

Inputs

The Tracking Tool requires a set of inputs that are then used to generate reports that analyze a number of outputs. Below is a brief description of all inputs.

Demographic and baseline demand data

A set of common assumptions are programed into the Tracking Tool that allow for detailed forecasts. This includes demographic information such as population and housing distribution, utility information such as number and type of customer accounts and financial assumptions. Model inputs also include climate data that would affect landscaping and outdoor water conservation measures. Additionally, the baseline inputs require demographic data related to the age of housing stock, persons per household, and average number of bathrooms per household. This is used to estimate the natural replacement of inefficient fixtures like toilets and the resulting water use reductions. The assumption here is that there would continue to be water conservation as customers upgrade old fixtures with new plumbing fixtures that are up to modern plumbing codes and therefore more water efficient.

System avoided cost data

Avoided costs are a key piece of a benefit cost analysis. These costs include variable operating costs such as energy used to pump, treat, and deliver potable water to customers. The goals is to implement programs that reduce water use at a cost less than the cost to deliver water. The Tracking Tool also includes avoided costs related to system capacity expansion. Water conservation can often allow water providers to completely avoid, defer, and/or downsize capacity expansion projects which can save millions of dollars. The Tracking Tool uses the water demand forecast to evaluate the highest peak season daily demand with the current system capacity. In this specific scenario capacity was not a factor as the existing peak season capacity is 24 million gallons per day (MGD) and the maximum future peak season daily use was forecasted to be 13.6 MGD.

Conservation measure data

Clearly the key piece of the Tracking Tool is defining the various conservation activities to be analyzed. The Tool comes with pre-defined activities that can be modified or new custom activities can be designed and entered. For this analysis, pre-defined activities were predominantly used and each activity was customized to reflect current or projected costs and water savings. Twenty-five conservation measures were included in this analysis. These measures are a combination of the activities that are currently part of the City's water conservation program and new activities to be considered.

- Indoor Water Efficiency Programs
    - Single-Family Residential
        - Residential survey (current) - Residential surveys include home visits by trained personnel who assess current water use practices and make recommendations for conservation practices and efficiency improvements.
        - Toilet rebate (current)
            - 3.5 gpf replaced with 1.28 gallons per flush (gpf) or less
            - 1.6 gpf replaced with 1.28 gpf

        - 1.6 gpf replaced with 0.8 gpf
      - Clothes washer rebate (current)
      - LF showerheads (current)
      - Hot water recirculation system rebate (new)
    - Multi-Family Residential
      - Residential survey (current)
      - Toilet rebate (current)
        - 3.5 gpf replaced with 1.28 gpf or less
        - 1.6 gpf replaced with 1.28 gpf
        - 1.6 gpf replaced with 0.8 gpf
      - Clothes washer rebate – common room only (current)
      - LF showerheads (current)
    - Commercial, Institutional and Industrial
      - Spray rinse nozzles (current)
      - Urinals (current)
      - Tank-type toilets (current)
        - 3.5 gpf replaced with 1.28 gpf or less
        - 1.6 gpf replaced with 0.8 gpf
      - Flush Valve-type toilets (current)
        - 3.5 gpf replaced with 1.28 gpf or less
      - Dishwashers (current)
      - Food steamers (current)
      - Cooling Towers (new)
- Outdoor Water Efficiency Programs
    - Turf replacement programs (new)
    - Irrigation controllers (new)
      - Residential
      - Large Landscape
    - Efficient nozzle installs (new)

Outputs

Water savings analysis

The Tracking Tool provides water savings estimates for each conservation measure and presents water savings totals for each customer class and the service area. Water savings are also included related to passive savings from code-driven replacements of toilets, showerheads, clothes washers and dishwashers. For this analysis, program activity was entered from 2017 through 2025. Table 4 shows the lifetime water savings of each measure in million gallons and is sorted highest to lowest savings. Lifetime water savings are from 2017 through 2076 (the total 60-year planning horizon, which is the extent of the tool's calculations). Not all measures have

savings that persist through the planning horizon. Savings reflect the estimated unit savings and the amount of activity scripted for each measure.

TABLE 4. LIFETIME WATER SAVINGS OF ACTIVE CONSERVATION PROGRAMS (MILLION GALLONS)

	Conservation Measure	Customer Class	Lifetime Savings (MG)
1	Residential High Efficiency Toilets	Multi Family	129.84
2	Residential High Efficiency Toilets	Single Family	69.27
3	Residential Surveys	Single Family	27.99
4	Spray Rinse Valve	CII*	11.28
5	Tank-Type High Efficiency Toilet	CII	11.06
6	Valve-Type High Efficiency Toilet	CII	11.06
7	Residential Low Flow Showerhead	Single Family	7.73
8	Residential Surveys	Multi Family	7.30
9	Residential Low Flow Showerhead	Multi Family	7.11
10	Dishwasher	CII	6.93
11	Cooling Tower	CII	6.30
12	1.6 gpf toilet with High Efficiency Toilets	Single Family	5.05
13	Residential 4.0 Water Factor Washer	Single Family	2.82
14	Large Land. Irrigation Controller	Irrigation	2.68
15	Food Steamer	CII	2.45
16	1.6 gpf toilet with High Efficiency Toilets	Multi Family	2.22
17	Residential 4.0 Washer, Common Area	Multi Family	2.19
18	1.6 gpf toilet with 0.8 gpf	Single Family	1.85
19	1.6 gpf toilet with 0.8 gpf	Multi Family	1.84
20	Residential Turf Replacement	Single Family	1.67
21	Residential Hot Water Recirculation System	Single Family	1.28
22	1/2 Gallon Urinal	CII	0.93
23	1.6 gpf toilet with 0.8 gpf	CII	0.66
24	Residential Efficient Irrigation Nozzles	Single Family	0.30
25	Residential Irrigation Controller	Single Family	0.09
Total Active Lifetime Water Savings (MG)			**321.89**

*Commercial, Institutional, and Industrial

Benefit-cost analysis

The Tracking Tool summarizes benefits and costs of water conservation measures for the utility as well as the benefits and costs for customers. These are each broken down separately and the Tracking Tool depicts the total program costs and benefits for each measure and also shows the net present value (NPV) and the benefit-cost ratio (B/C ratio) for the conservation activities as programmed. NPV is the present value benefits minus present value costs. In other words, the NPV sums all of the avoided costs generated over the life of a measure (benefits), expresses them in 2017-dollar terms and then subtracts the summed cost of implementing a measure expressed over its life in 2017 dollars. The B/C ratio is the present value benefits divided by the present value costs. Ideally, the B/C ratio will be greater than 1, indicating the benefits are greater than the costs. Both are

measures of the conservation activity's economic value. A positive NPV and a B/C ratio greater than one indicate the conservation activity would make the utility or customers better off. That is, from a utility perspective, the present value of future utility costs would be lower with the conservation activity than without it.

Revenue and rate impacts

The Tracking Tool also summarizes impacts of the conservation program on utility revenue requirement, average customer bill and the average volumetric rate for water. For the purpose of this analysis, these outputs are not detailed as these will be considered during the water system planning and rate study process, to begin in 2020 or 2021.

Greenhouse gas and energy savings

In addition to other outputs, the Tracking Tool summarizes the calculated reduction in CO_2-equivalent emissions resulting from plumbing/appliance standards and planned active conservation measures. CO_2-equivalent emission reductions are calculated for the customer side and utility side. Table 5 contains CO_2-equivalent emission reductions for the planned active conservation measures.

TABLE 5. CO_2-EQUIVALENT EMISSION REDUCTIONS FOR ACTIVE CONSERVATION MEASURES (TONS)

CO_2 Equivalent Reductions (Tons)	2017	2020	2025	2030	2035	2040	2045	2050
Utility Side	4	19	38	21	17	15	13	12
Customer Side	12	61	141	80	45	31	5	3
Total	16	80	179	101	62	47	18	14
Cumulative Total	16	87	908	1,548	1,930	2,202	2,349	2,429

Summary of Findings

Indoor Water Efficiency Findings

Single-Family Residential

Currently, the City implements residential surveys, toilet and clothes washer rebates and distributes free low-flow showerheads. This analysis includes exploring the possibility of adding hot water recirculation systems to the rebate program. Table 6 shows the Net Present Value and Benefit-Cost Ratios for the five conservation measures considered in the analysis for single-family residential customers. These measures were selected based on best practices utilized by water purveyors throughout the United States.

TABLE 6. SINGLE-FAMILY RESIDENTIAL RESULTS

Conservation Measure	Utility Net Present Value	Utility Benefit-Cost Ratio	Customer Net Present Value	Customer Benefit-Cost Ratio
Residential Surveys	-$87,392	0.1	$78,022	NA
Residential HET Rebate	$3,015	1.2	$54,595	5.3
SF 1.6 gpf Toilet with HET	-$3,336	0.3	$1,612	1.2
SF 1.6 gpf Toilet with 0.8 gpf	-$1,141	0.4	$1,280	1.7
Residential LF Showerhead	$886	1.4	$36,437	NA
Clothes Washer	-$4,525	0.2	-$8,189	0.6
Residential Hot Water Recirculation	-$2,342	0.2	-$4,759	0.3

Multi-Family Residential

Table 7 shows the results for both the NPV and B/C Ratio for multi-family programs. These rebate programs were the most recent addition to the WUE program and have the unique opportunity of providing high efficiency fixtures for rental properties, which provide a split benefit of assisting with the installation of newer fixtures for many low-income residents but also saving the property owners costs, allowing less of the property improvement costs to passed along to the tenants.

TABLE 7. MULTI-FAMILY RESIDENTIAL RESULTS

Conservation Measure	Utility Net Present Value	Utility Benefit-Cost Ratio	Customer Net Present Value	Customer Benefit-Cost Ratio
Residential Surveys	-$42,055	0.1	$64,251	NA
Residential HE Toilets	$15,959	1.9	$396,975	28.0
MF 1.6 gpf toilet with HET	-$1,307	0.2	$1,759	1.9
MF 1.6 gpf toilet with 0.8 gpf	-$608	0.5	$8,994	8.3
Residential LF Showerhead	$640	1.3	$66,225	NA
Common Area Clothes Washer	-$337	0.7	$15,710	4.4

Commercial, Institutional and Industrial

Commercial, institutional and industrial customers make up an important economic segment of our community and account for about a quarter of the water consumption in the City, so providing rebates to these customers saves water while also bolstering the local economy. Table 8 displays the results for the NPV and B/C of the existing program which includes spray rinse nozzle, urinal, toilet, dishwasher and food steamer rebates as well as the possible new addition of cooling tower rebates.

TABLE 8. COMMERICAL, INSTITUTIONAL AND INDUSTRIAL RESULTS

Conservation Measure	Utility Net Present Value	Utility Benefit-Cost Ratio	Customer Net Present Value	Customer Benefit-Cost Ratio
CII 1/2 Gallon Urinal	-$307	0.5	$4,734	10.4
CII Tank-Type HE Toilet	$101	1.0	$40,269	11.7
CII Valve-Type HE Toilet	$101	1.0	$40,269	11.7
CII 1.6 gpf toilet with 0.8 gpf	-$399	0.4	$3,234	7.4
CII Spray Rinse Valve	$3,445	5.0	$95,044	NA
CII Dishwasher	-$5,137	0.3	$82,655	15.8
CII Food Steamer	-$315	0.8	$30,881	18.6
CII Cooling Tower	-$773	0.8	$31,909	3.6

Outdoor Water Efficiency Findings

Currently the Water Use Efficiency program does not offer rebate programs for outdoor water efficiency, so this analysis looked at three possible new programs which included a residential irrigation controller program, residential turf replacement program, free residential efficient nozzle replacements, and large landscape irrigation controller rebates. Table 7 details the results of the NPV and the B/C ratio for these four measures.

TABLE 4. NET PRESETN VALUE AND BENEFIT COST RATIO OF OUTDOOR WATER EFFICIENCY MEASURES

Customer Class	Conservation Measure	Utility Net Present Value	Utility Benefit-Cost Ratio	Customer Net Present Value	Customer Benefit-Cost Ratio
Single Family	Irrigation Controller	-$2,594	0.005	-$7,052	0.02
Single Family	Turf Replacement	-$157,440	0.001	-$312,131	0.01
Single Family	Efficient Irrigation Nozzles	-$1,592	0.02	$602	NA
Irrigation	Large Land. Irrigation Controller	-$10,324	0.03	-$17,366	0.29

Recommendations

Since the Washington State Department of Health Water Use Efficiency rule requires water providers to ensure a safe and reliable supply of drinking water to meet current and future needs, the major priority for the City of Bellingham's Water Use Efficiency program is to reduce water consumption. However, financial considerations are still important and utility and customer benefits should be a key consideration. Therefore, to select measures that maximize water savings while also providing benefits to the utility and the participating customers, the programs were ranked 1-25 for water savings and 1-25 based on the sum of utility and customer NPV values. Figure 2 is an X,Y scatter chart that has Conservation Measure Discounted Water Savings as the vertical (X) axis, and the Sum of Utility and Customer Net Present Values on the horizontal (Y) axis. The chart is separated into 4 quadrants. The upper right quadrant contains measures that have a high water savings rank

and a high NPV rank, and thus are the most beneficial overall given this method. It is important to note the Residential Survey measure for single-family customers has a high water savings rank but a lower NPV rank. This measure is still worth pursuing as it has the added benefit of customer education and improving customer/utility relations.

The ranking presented in Figure 2 illustrates water savings and the sum of utility and customer benefits. The customer benefits specifically pertain to program participants. Measures that fall into the upper right hand quadrant are the most optimal. As has already been stated, other program benefits such as direct contact with customers should be considered. Ultimately, the following water conservation measures appear to be the most beneficial:

- Indoor Water Efficiency Programs
    - Single-Family Residential
        - Residential survey (current)
        - Toilet rebates (current)
        - LF showerheads (current)
    - Multi-Family Residential
        - Residential survey (current)
        - Toilet rebates (current)
        - Clothes washer rebate – common room only (current)
        - LF showerheads (current)
    - Commercial, Institutional and Industrial
        - Spray rinse nozzles (current)
        - Urinals, tank and valve toilets (current)
        - Dishwashers (current)
        - Cooling Towers (new)

The following rebates are currently offered but did not rank highly in this cost-benefit analysis. However, it is recommended they are continued based on the additional greenhouse gas emissions reduction associated with the upgrading of these appliances. Analysis of this additional factor was outside the scope of this project.

- Single- and multi-family clothes washers (single unit only)
- Commercial, Institutional and Industrial food steamers

It is worth mentioning that none of the outdoor water conservation measures that were included in the analysis ranked high enough for recommendation.

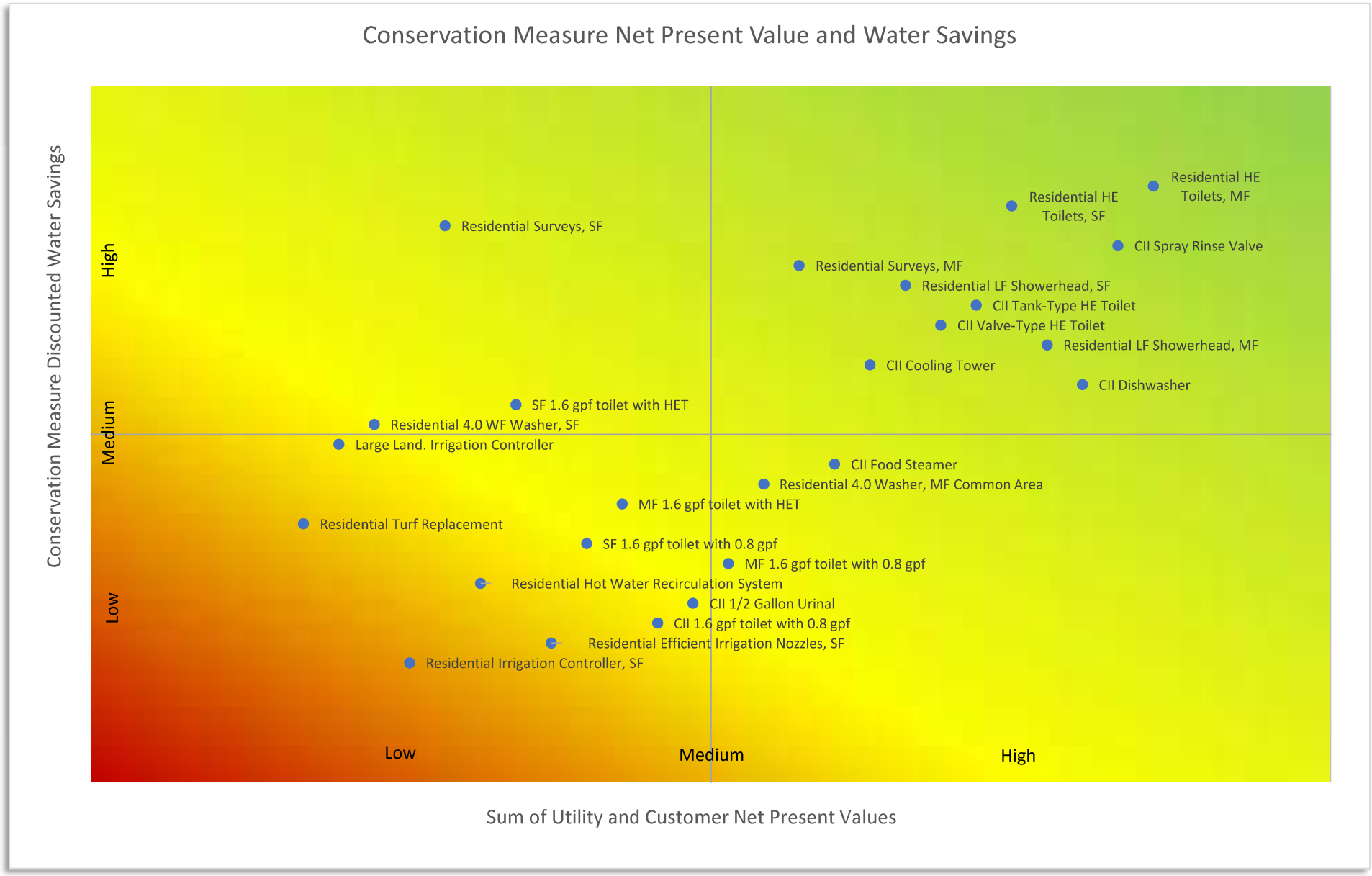

FIGURE 2. CONSERVATION MEASURE NET PRESENT VALUE AND WATER SAVINGS