Enhancing the Value of Water through Rates, Billing, and Education

Completed for

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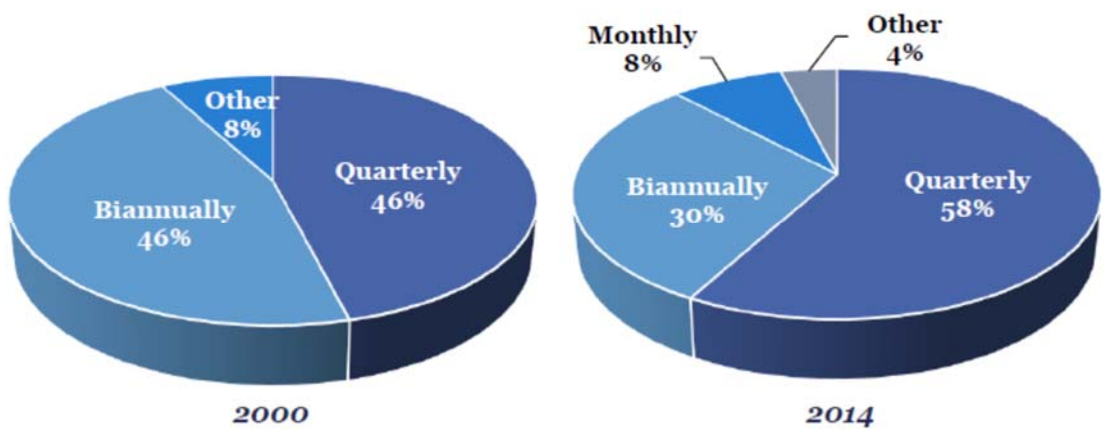
Executive Summary

The primary purpose of this project was to assess on a local level, for the Wareham Fire District (District), the value of water and what the residents of the District are willing to pay for this resource. The Board of Water Commissioners (BoWC) desire to maintain and improve the system while keeping it efficient (e.g. low UAW), safe and reliable. With several multimillion dollar projects looming, the question the BoWC's are currently wrestling with is whether or not generally accepted affordability criteria of water bills as 1.25% MHI (State criteria) or 2.5% MHI (Federal criteria) are the correct targets or is the consumer willing to afford something more. This is based entirely upon the customer's "value of water". Coupled with the above question, the BoWC would like more frequent billing as a means of further promoting an increased awareness (and appreciation for) the "value of water". A water rate survey was completed in 2014 of Massachusetts public water suppliers. In the survey, it was determined roughly 8% of the respondent's bill on a monthly basis with 88% billing quarterly or less (see **Figure ES-1**). Many other water suppliers have expressed interest in more frequent meter reading and billing, but little information is available.

Figure ES-1. Frequency of Billing by Public Water Suppliers in Massachusetts[1]

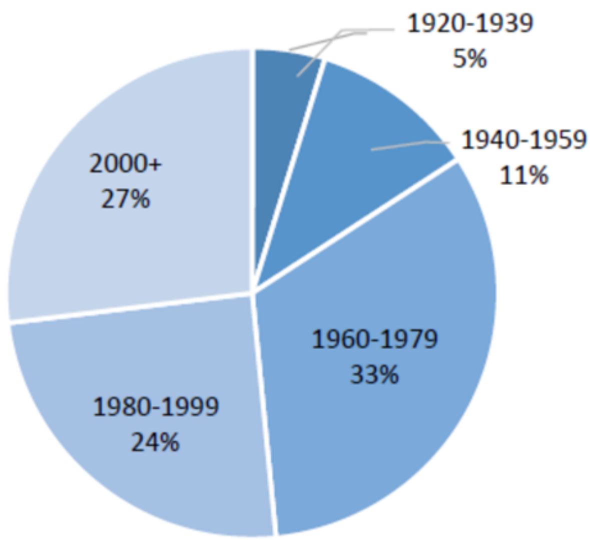


Currently the District issues bills on six-month intervals and is considering a more frequent billing cycle. Increased billing offers many benefits including increase in water conservation, improved cash flow, improved customer financial planning, improved customer satisfaction since they can better see the actual cost of water in comparison their other utilities (especially with monthly billing that is common to most other utilities), and reduction in water "losses" within customer's properties since they will get earlier notification of unusual usage that previously would go unnoticed for up to 6 months. Specifically, for the District, future withdrawals may exceed baseline and WMA permitted withdrawals within the 20-year planning period. More frequent billing will encourage water conservation as customers receive earlier notice of their water usage, especially during summer months. Coupled with this, consumers would be able to check their water usage online. These efforts would help the District to mitigate the impacts of the projected future withdrawals as well as how best to implement the program in a sustainable manner.

[1] Data from http://rates.tighebond.com/Downloads/2014%20MA%20Water%20Survey.pdf, August 2017.

Additionally, the District has historically struggled to reach the UAW goal of 10%. Calendar year 2016 was the first time in many years the District reached a value below 10%. This was due to internal efforts through past WMA grants as well as focused effort to better account for water coupled with master meter and residential meter testing. In 2016 the District hired a professional leak detection company and found limited leaks. In 2017 the District purchased their own leak detection equipment and have found few leaks as well. With 49% of the total pipe (over 170 miles total pipe) 40 years or more in age (pre-1979 as shown in **Figure ES-2**), the District finds it difficult to believe there are few leaking pipes and believes the sandy nature of much of the area makes it difficult to identify leaks. By owning leak detection equipment, the District can more immediately investigate suspect areas, potentially saving significant volumes of UAW that would otherwise occur while scheduling and awaiting the arrival of a professional leak detection company. These efforts demonstrate the high "value of water" that the District's leadership team embraces and wishes to foster among its customers.

Figure ES-2. Bin Classification for Pipes in District[2]



Pipe Material	AC	C.I.	Copper	D.I.	HDPE	PVC	Unknown
Percentage of Total Pipe	34.3	9.6	0.2	49.3	4.6	2.0	0.02

This WMA grant has helped the District to evaluate how the consumer values their water as well as how the consumer would receive the change from semi-annual billing to either quarterly or monthly billing. The District has received requests from customers to provide more frequent billing (1) from business that are better able to manage their own finances when receiving regular monthly bills and (2) from residents who only find out every six months if they have an undiscovered water leak which then results in an abnormally high water bill. Bill abatement requests are a regular occurrence at BoWC meetings, due to the potential accumulation of many months of inadvertently lost water without anyone's knowledge, with approximately $15,000 provided in abatements in FY17. Although the "leaks" on the customer side of the meter are "billable", they result in water loss that is truly avoidable especially with most customers having financial incentive to address leaks as soon as they are known.

[2] Data from Asset Management and Fiscal Sustainability Plan, August 2017

This project included evaluation of the change from semi-annual billing to quarterly or monthly billing, potential use of smart meters including AMI and AMR, completion of a value of water survey of the District's customers and conducting a smart meter pilot.

The customer opinion survey provided insights to the perceptions that the customer base has of the District, quality of their water and service, cost of the water, willingness to pay more for that water and opinions on more frequent billing. The feedback shows that should the District opt to either increase rates or change the billing frequency, they will need to conduct pubic education and outreach to demonstrate to the customers/voters that these are right for the District. A carefully constructed public relations campaign would help the District convey a more positive message. The District, like many public water suppliers, mainly keeps out of the public eye. Positive efforts go unrecognized, while any inconveniences such as water main breaks, get widely publicized through traditional newspapers and on-line social media forums. The District should consider initiating a public education program to inform the customers of all that is done to keep the water safe, reliable and affordable.

The project also included an evaluation of a change to quarterly or monthly billing using either AMR (Automatic Meter Reading) or AMI (Advanced Metering Infrastructure) systems. The analysis showed that the more financially advantageous billing system would be Quarterly Billing using either the AMR or AMI Systems as shown in **Table ES-1**.

Table ES-1. Comparison of Costs per Billing Frequency Type

Customer Billing Frequency	Semi-Annual Billing	Quarterly Billing	Quarterly Billing	Monthly Billing
Meter System Required	Manual Collection (Existing System)	Radio Read (AMR System)	Cellular Network (AMI System)	Cellular Network (AMI System)
Present Worth Costs (Capital & Annual) for Comparison of Life-Cycle Costs[1]	$5,160,000	$4,201,000	$4,562,000	$5,393,000

[1] Present worth of annual costs calculated assuming 15-year life-cycle with 3% escalation each year.

In addition to the financial cost comparison, non-quantitative factors were considered including (1) Billing Efficiency Improvement, (2) Cash Flow Improvement Potential, (3) Data Accessibility Improvement, (4) Water Conservation Improvement, (5) Leak/Backflow/Tamper Detection Ability, (6) Customer Web Portal Access to Information, (7) Customer Satisfaction Improvement, (8) Customer Financial Planning Improvement. Weighting the advantages each alternative had for these categories coupled with the cost analysis, it was determined that quarterly billing using the AMI system would be the most favorable option for the District. The next steps involve developing a strong public education campaign to inform voters, solicitation of multiple proposals for the meter system and installation and training of District staff on new equipment and software.

1.0 Introduction

This project has been financed partially with State Capital Funds from the Massachusetts Department of Environmental Protection (the Department) under a Water Management Act Grant. The contents do not necessarily reflect the views and policies of the Department, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

The primary purpose of the proposed project is to assess on a local basis for the Wareham Fire District, the value of water and what the residents of the District are willing to pay for this resource. Requests have been received from customers, including both businesses and residents, to provide more frequent billing. Many businesses feel they would be better able to manage their own finances when receiving regular monthly bills and residents who only find out every six months if they have an undiscovered water leak can encounter abnormally high water bills. As part of this assessment, the District will evaluate the change from semi-annual billing to quarterly or monthly billing. An increase in meter reading and billing is expected to foster a more direct connection between a customer's water use habits and personal finance implications (higher or lower bill), providing more immediate feedback and facilitating the changing of habits. In addition, increased billing offers many benefits including increase in water conservation, improved cash flow, improved customer financial planning, improved customer satisfaction since they can better see the actual cost of water in comparison to other utilities, and reduction in water "losses" within customer's properties due to an earlier notification of unusual usage. Due to the potential for leaks to occur and many months of lost water without anyone's knowledge, bill abatement requests are a regular occurrence for the BoWC. These leaks are "billable" on the customer side of the meter and it is in the best interest of the customer to address leaks as soon as they are known.

Other issues with leaks have contributed to the District's struggles to meet the unaccounted-for-water (UAW) value goal of 10%. The amount of funding the District can generate is in direct proportion to what infrastructure the District can maintain and ultimately the UAW values as well as people's conservation habits. Calendar year 16 was the first time in many years the goal was reached and it can be attributed to internal efforts as well as a better accountability for water coupled with master meter and residential meter testing. Previous attempts to locate leaks have been unsuccessful with a professional leak detection company and through District purchased leak detection equipment. Knowing 49% of the total pipe is 40 years or more in age, the District finds it difficult to believe there are few leaking pipes and believes the sandy nature of the area makes it difficult to identify the leaks. Hopefully future use of the District's leak detection equipment will allow immediate investigation of suspected areas to potentially save significant volumes of UAW.

1.1 Objectives and Goals

The purpose of this 2018 Water Management Act (WMA) Grant Project (BWR-2018-01) is to assess on a local basis for the Wareham Fire District, the value of water and what the residents of the District are willing to pay for this resource.

Specific tasks of this project included:

1. Evaluate the needed infrastructure, person power, and estimated cost to achieve a change to Quarterly and Monthly Billing with cooperation from Northern Data
2. Conduct customer opinion survey to allow customers to compare water to other common household spending categories ranging from housing to health care to entertainment and assess other billing and feedback factors
3. Complete cost/benefit analysis for AMR and/or AMI to assist in making procurement decisions for the customer's meters.
4. Complete AMR pilot on select commercial accounts to further evaluate the level of effort associated with a change to monthly billing

2.0 Evaluate Change to Quarterly and Monthly Billing

The goal of this portion of the project was to work with the Wareham Fire District (District) and Northern Data Systems (NDS) to evaluate the changes in infrastructure, person power, and estimated costs needed for a change from semi-annual billing to quarterly or monthly billing. NDS is the current company used by the District to provide billing services as well as a customer information management software. Currently, customers receive water bills every 6 months, however, they are sent in batches using a rolling system and households may receive them at different times. The District uses a manual collection system, in which, District employees must come in contact with the water meter system using a touch pad in order to collect data. There are two full time employees that do this and they are able to collect data for 900 to 1300 bills per month. For each employee, $50 an hour can be assumed to cover both pay and benefits. The data is then sent to NDS who mails double sided bills, printed in color, with a return envelope for the customer's payment all at a price of $0.70 per bill.

In order to accommodate quarterly or monthly billing, the water meters throughout the District will need to be replaced. The replacement of each meter and subsequent cost will depend on the meter size, 5/8", 3/4", 1", 1-1/2", or 2". The meters can be replaced with an Automated Meter Reading, AMR, system or Advanced Metering Infrastructure, AMI system. The AMR system is a radio read system that would require employees to drive in a car or truck outfitted with the required radio device in order for a collector to read and store the data from each customer. It can be assumed that all data could be collected by one employee driving around the District for 2 weeks. This system would be best suited for quarterly billing that is still maintained on a rolling system.

The other option is an Advanced Metering Infrastructure, AMI, system that will allow data from the meters to be collected remotely using a cellular network and no employees will be required to access and collect data. This system would allow data to be available in real time. It is noted that another public water supplier implemented an AMI system, and found that the transmitter system for each customer meter has a typical battery life around 10 years while a traditional or AMR meter would likely last 15 to 20 years. With a discount for sending bills in bulk, the District would save $0.02 per bill if quarterly or monthly billing was used. NDS also clarified that a switch to bills printed in black and white would save $0.065 to $0.07 per bill. The District needs to consider both the impact on the cost to collect the data from water meters and the cost from NDS to use the data to send out bills.

Refer to Section 4 for more details on the advantages and disadvantages of the AMI/AMR systems and costs associated with each.

A change from semi-annual billing to quarterly or monthly billing would require an investment to switch to the needed water meters (refer to Section 4 for meter costs). In addition, less person power would be required. The current system costs around $16,000 per month for the meter reading staff needed, which would decrease to around $4,000 for quarterly billing with a radio read type AMR system and no meter reading staff cost is needed for monthly billing with an AMI system. The cost per bill would slightly decrease due to a cost savings offered by NDS, but more bills are sent each month, so the overall annual cost will increase. A switch from color printed bills to black and white bills would also save some cost and is included for informational purposes. **Table 2-1** presents a summary of the costs associated with (1) remaining with semi-annual billing, (2) changing to quarterly billing, or (3) changing to monthly billing. Refer to Section 6 for a summary of the costs associated with a change in billing frequency and the capital costs associated with the meter types needed for more frequent billing.

Table 2-1. Cost Impact Associated with a Change from Semi-annual Billing to Quarterly or Monthly Billing, not including Meter Equipment

Customer Billing Frequency	Semi-Annual Billing (Manual Collection)[1]	Quarterly Billing (AMR or AMI)[2]	Monthly Billing (AMI)[3]
Labor Cost for Data Collection per month[4]	$16,000	$4,000	$0
Vehicle Purchase Cost Set Aside, Maintenance, Insurance and Fuel per month[5]	$460	$480	$0
Approximate Number of Bills Mailed per month	1,200	2,733	8,200
Cost per Bill in Color	$0.70	$0.68	$0.68
Cost per Bill in Black and White	$0.63	$0.61	$0.61
Rounded Cost per Month for Color Prints	$840	$1,900	$5,600
Rounded Cost per Month for Black and White Prints	$760	$1,700	$5,000
Total per Month for Color Prints[6,7]	$17,300	$6,380	$5,600

[1] Each customer is billed twice a year. However, entire customer base is billed on a rotating basis with about 1,200 customers of the total 8,200 customers receiving bills each month. The District has two staff dedicated to meter reading. It takes 6 months to read all meters with two employees.

[2] Quarterly billing requires replacement of the existing meters and reader system with AMR or AMI type system. The cost for meter upgrades is presented in Section 4. Summary costs for each option is presented in Section 5.

[3] Monthly billing requires replacement of the existing meters and reader system with AMI type system. The cost for meter upgrades is presented in Section 4. Summary costs for each option is presented in Section 5.

[4] Labor costs assume 2 full time staff for Existing System and reduced labor cost for Radio Read system since it is anticipated that the entire system could be read in two weeks using one truck and driver.

[5] Vehicle cost includes purchase cost set aside of $3,000 per year assuming vehicle would be kept for 10 years, maintenance cost of $1,000 per year, insurance cost of $1,500 per year and fuel cost of $3.5 per gallon and a conservative mileage rate of 10 miles per gallon to account for frequent starting/stopping required for this type of work.

[6] The District currently issues bills in color so the total is presented for color prints. The cost for black and white prints is provided for informational purposes only.

[7] Costs are based on the verbal quote from NDS received on June 14, 2018 to change to quarterly or monthly billing, essentially save 2 cents per bill.

3.0 Customer Opinion Survey

The Wareham Fire District (District) proposed this portion of the project to assess, on a local level, the value of water and what the customers of the District are willing to pay for this resource. As previously applied in other parts of the country, the District asked customers "Would you prioritize the bill for water above or below other household expenditures?" to get a better understanding of the residents' value of water. This will allow for more information on whether the generally accepted affordability criteria for drinking water, 1.25% of Median Household Income, MHI, (State criteria) or 2.5% MHI (Federal criteria), is right for the District or if a District specific affordability criterion should be developed. The Board of Water Commissioners (BoWC), which is balancing the financial impacts of several multimillion projects, can use this information to maintain and improve the system while equitably assessing the financial burden among its various customers.

3.1 Survey Results

A customer opinion survey was mailed to approximately 8,200 customers in the District and about 1,450 responses were returned. Survey questions included demographic information such as age, employment status, and total household income, which can be compared to demographics of the District. The majority of received responses are from retired or fixed income residents and represent the view of customers older than 60 years or more as compared with those that are younger. The District does not service the entire Town of Wareham as the Onset Fire District serves a small area, but general census data is only available for the total town population of 22,601 people. US Census Bureau data shows 34.2% of town residents are 55 years and older, 27.5% are 35 to 54 years old, and 19% are 18 to 34 years old, with the remainder less than 18 years old. The majority of residents that returned the survey were 60 years or older (66%), while 28% of returned surveys were completed by people between 40 and 59 and 6% were between the ages of 18 and 39. In addition, 52% of completed surveys were from customers that are retired and/or on a fixed income and another 41% were from customers employed full time (with the remainder selecting other categories such as part-time employment). Hence, the survey results and associated analysis will be skewed toward the feedback from the older population in the District.

Census data shows the MHI in Wareham is $65,641. Survey results show 51% of the responses received were from customers with a total annual household income less than $60,000 (42% represented household incomes between $20,001 to $60,000 and 9% from $0 to $20,000). The remaining responses were divided as follows: 29% from $60,001 to $100,000 and 20% were $100,001 or more. 46 respondents/customers also noted that they are summer or seasonal residents.

Through the survey, the District assessed customer views on the current water quality and services that they provide. In terms of water quality, 60% of respondents are satisfied with the quality of the water while 24% are highly satisfied and 16% are not satisfied. In terms of reliability of service provided by the District, 38% of respondents are highly satisfied, 59% are satisfied, and the remaining 3% are not satisfied. The data show the majority of customers do not have an issue with the water quality or service.

Considering the value of water, customers were asked to compare the amount paid in water bills with the service provided, and 17% felt it was of great value, 65% felt it was of average value, and 18% felt it was of poor value. Those that considered the value of water as average or great mainly felt it was because water is available when needed (68%), while 21% felt it was due to the District addressing problems quickly when they arise, and 11% felt it was due to their water bill being one of their lowest expenses. Looking at those that answered it was of poor value, 43% felt the cost is too much while 57% had issues with the water quality (33% did not like the taste and 24% said the water is discolored at times). After analyzing the personal comments left on surveys, 95 respondents had issues with chlorine or a chemical taste or smell, 79 respondents said they do not drink the water from the tap and buy bottled water or filter the water, and 33 respondents had issues with a brown color. Customers also compared other bills and services provided by other utilities to that of water and 61% felt that the District provided water quality and service is average value, 24% felt it was a better value and 15% felt it is a worse value.

Opinion on Billing Changes

Several other factors were evaluated in this survey including a change in the billing frequency, feedback on usage, and access to more current water use information. Regarding billing frequency, 77% of respondents are satisfied with the current system (twice a year billing), while 18% would prefer quarterly billing and 5% would prefer monthly billing. In addition to this, the District was able to evaluate paperless billing as an option, but 84% of respondents would prefer the current billing system (hard copy via mail). Survey results showed that 50% of respondents are not willing to pay more for water even if the quality of water improved and 45% are somewhat willing.

The survey inquired about the potential inclusion of comparative water usage information including how efficient a water consumer is in comparison to other District customers and whether that information would influence them to conserve water to improve their water use efficiency. A total of 21% of respondents felt they definitely would like this information and 38% thought the information would be good to have, but not necessary, while 41% did not want this information. Regarding conserving water, 16% said they would definitely use the information to conserve water, 33% felt they would try to be more efficient, and 51% said this information would not have an impact on water use. When asked about access to current water use information, 50% of respondents said they would never look at this data in electronic format, 37% felt they may reference the information electronically, but it is not needed, and the remainder said they definitely want to have the ability to get current data using a smart phone, tablet or laptop/computer.

The District is evaluating a change to a quarterly or monthly billing system to benefit the businesses and residents they service as well as potentially improving water conservation and cash flow. However, the results noted above showed that most survey respondents would prefer not to switch. Also, if the switch did occur, most survey respondents felt they would like to have information on how their usage compares to others, but most also felt the information would not have an impact on their usage. Therefore, educational information added to water bills or made available electronically may not influence the conservation efforts of as many customers as intended.

Figures showing the results of the survey responses for each question are provided at the end of this Section. Since the majority of respondents were in the 60 years and older group and the percentage responses would be skewed toward that demographic, the results were examined by age group. **Table 3-1** presents how the various age groups responded to the questions on billing changes and other questions. This information shows that the younger age groups have a greater interest in accessing electronic information.

Table 3-1. Summary of Survey Responses by Age Group

Age Group	18-39	40-59	60 and greater
Are you satisfied with the quality of your water?			
Highly Satisfied	20%	20%	26%
Satisfied	64%	63%	58%
Not Satisfied	16%	16%	16%
Are you satisfied with the reliability of service, related to water, provided by the District?			
Highly Satisfied	47%	33%	40%
Satisfied	50%	63%	57%
Not Satisfied	3%	4%	3%
Do you feel that the amount you pay for water is in line with the service provided?			
Great value	25%	16%	17%
Average value	62%	65%	66%
Poor value	13%	19%	17%
When you consider your other utility bills and services provided, do you feel that water is a better or worse value than these other utilities?			
Better value	33%	24%	23%
Average value	58%	59%	63%
Worse value	9%	17%	14%
How willing would you be to pay more for water as long as the quality of that water improves?			
Highly willing	8%	6%	5%
Somewhat willing	54%	41%	47%
Not at all willing	38%	53%	48%

Age Group	18-39	40-59	60 and greater
Water bills are currently sent twice a year. Would you prefer more frequent billing in order to better manage your finances?			
I would prefer monthly billing	16%	5%	4%
I would prefer quarterly billing	21%	23%	17%
I am satisfied with twice a year billing	63%	72%	80%
Would you prefer paperless billing?			
Yes	38%	19%	14%
No	62%	81%	86%
Should the District provide more frequent billing, would you like to see how efficient a water consumer you are in comparison to other District customers (all information would remain anonymous)?			
Definitely would like this information	50%	24%	17%
Good information to have but not necessary	32%	39%	39%
Really don’t need to know	18%	38%	44%
If you are provided with information on your water use in comparison to others, would this make you more likely to conserve water to improve your water use efficiency?			
Definitely would	35%	18%	14%
May try to be more efficient water consumer	49%	36%	30%
Wouldn’t have any impact on my water use	16%	46%	56%
Would you like to see more current information on your water use (monthly or more often) in an electronic (e.g. web access) format?			
Definitely want to have the ability to get current data using a smart phone, tablet or laptop/computer	37%	17%	9%
May reference electronic information but not needed	43%	39%	36%
Would never look at this data in electronic format	20%	43%	55%

Affordability: Spending Category Comparison

The customers were also asked to compare water to other common household spending categories ranging from housing to health care to entertainment in order to ascertain how the Districts' customers prioritize water. Respondents rated other spending categories as above water, below water, or about the same.

Several categories can be considered necessary for life including housing, food at home, electricity, gas and oil utilities, health and personal care, transportation, sanitary sewer utility, education, retirement savings and personal insurance, and in some ways clothing. In all of these essential categories, the majority of people considered water to have about the same value. In addition, looking at all but sanitary sewer utility and clothing, the remaining customers would value water below the other categories. However, respondents may have been confused by the wording of the question.

The remaining categories, telephone (home and/or cellular), cable and/or internet, entertainment, dining out, alcohol and tobacco, and in some part clothing, can be considered discretionary. More than half of the respondents value water more than alcohol and tobacco, dining out, and entertainment. Telephone services is the one discretionary category in which the majority of respondents value it equivalent to water, but more people do still value water above that category.

Essentially, the majority of respondents value water as about the same as other necessities and value water as more important than discretionary items.

3.2 Cost of Water

The water industry currently utilizes a percentage of the MHI as a theoretical target for establishing water rates. The generally accepted affordability criteria of water is 1.25% of MHI (State criteria) or 2.5% MHI (Federal criteria established pre-1970s). Since actual customer incomes vary greatly from the MHI, the District believes considering only the MHI may result in too high a cost for those lower income households. Census data showed the MHI in Wareham is $65,641. With a water bill of about $300 (lowest tier bill), this represents approximately 0.5% of the MHI.

Recent research has proposed the introduction of the Weighted Average Residential Index (WARi)[1] to account for a community's income distribution and the impact of necessity costs on income. The WARi is defined as the calculation of the weighted average financial burden across all income levels, in all census tracts in a given utility's service area. The WARi looks at a minimum of 53 data inputs for every census tract in the utility's service area. These surveys are customized for a particular utility and have not resulted in a proposed change to the affordability criteria for water that can be applied across the industry. Since such a survey would be quite extensive, the survey conducted for this project started at a lower level evaluation to assess customer opinion in terms of their perception of the value of water and its value relative to other spending categories.

[1] Mumm, J. and Ciaccia, J. *Improving the Narrative on Affordability and the Measurements We Need to Take Us There*, Journal American Water Works Association, 109:5, May 2017.

General Comparison of Water to Other Spending Categories

Since specific spending data on the local (Town of Wareham) or regional (Southeast Massachusetts) levels were not available, the United States Bureau of Labor Statistics data on average household consumer spending was utilized. This data is collected by larger regions and was specifically obtained for the Northeast United States. This data for 2016 is presented in **Table 3-2** for various categories for average households. Most of the spending categories are higher than the average water bill for the District of $520 in 2018, with spending on select discretionary items such as sugar and tobacco being less than the spending on water.

Table 3-2. Annual Spending by Category for US Households for Comparison with Cost of Water

Spending Category	Northeast Average Annual Spending[1]	Percent of District Survey Respondents that		
		Value Water Below each Spending Category	Value Water About the Same as each Spending Category	Value Water Above each Spending Category
Necessity / Essential Categories				
Housing, all items (the following list is not meant to sum to this total)	$21,462	33%	56%	11%
Housing, Shelter	$13,514	33%	56%	11%
Property Taxes	$3,298	--[2]	--	--
Cell Phone Service	$1,046	21%	47%	32%
Natural gas	$529	21%	66%	13%
Electricity	$1,334	22%	65%	13%
Telephone Service	$1,483	21%	47%	32%
Utilities, fuels, and public services	$3,995	21%	66%	13%
Water and other public services	$394	--	--	--
State and Local Income Taxes	$2,709	--	--	--
Apparel and services	$1,951	23%	39%	39%
Transportation	$8,128	30%	49%	22%
Transportation, Gas and motor oil	$1,591	30%	49%	22%
Healthcare	$4,655	31%	53%	16%
Personal insurance and pensions	$7,110	36%	45%	19%
Education	$1,949	31%	44%	25%
Food at home	$4,127	31%	57%	11%
Discretionary Categories				
Food away from home	$3,032	21%	26%	53%
Sugar and other sweets	$146	--	--	--
Alcoholic beverages	$567	20%	19%	62%
Tobacco products and smoking supplies	$367	20%	19%	62%
Entertainment	$2,783	21%	26%	54%

[1] Data from United States Bureau of Labor Statistics for the year 2016. List is not all inclusive but meant to provide basis of comparison with District's water bills.
[2] Items marked as -- were not included in the survey.

General Comparison of Cost of Water to Income

To assess the proportionate cost of water on the District's customer base, let's consider more readily available metrics including the (1) income per capita, (2) affordable housing income levels, (3) Twentieth income percentile, and (4) the number of hours at minimum wage to pay for water and sewer.

Income Per Capita

The normalized annual income per capita (total population includes adults and children) for Wareham is about $30,739. This value accounts for variation in household size that the MHI does not. Comparing this value to the lowest tier water bill of $300, results in the cost of water being about 1% of the normalized annual income per capita, or approximately double the impact when compare with the MHI.

Affordable Housing

Affordable housing definitions as established by Massachusetts could also be applied to evaluation of water affordability. Extremely low-income housing is directed to those earning at or below 30% of area median income, very low-income is defined as households earning between 31% and 50% of area median income, and low income generally refers to the range between 51% and 80% of area median income. In general, programs that subsidize rental units are targeted to households earning within 50% or 60% of median income, often including specific units for those earning below 30% of the area median. For Wareham, 30% and 50% of the MHI is approximately $19,692 and $32,820. Considering the lowest tier water bill of $300, this represents about 1.5% to 0.9% of these low-income households.

Interestingly, the relative cost of a lowest tier water bill on the average income per capita is very close to that on the low-income levels. This may be a potential metric to supplement the traditional use of percent of MHI.

Twentieth income percentile and Number of hours at minimum wage to pay for water and sewer

Another set of terms that have been emerging are affordability at the 20th income percentile or AR20 and the number of hours at minimum wage to pay for water and sewer or HM. The rules of thumb are AR20 should not exceed 10% (e.g. no more than 10% of disposable income) and HM should not exceed 8 hours[2].

Since data was not available locally, information from Table 3 (Appendix A) from Teodoro, 2018 was used for the 20th percentile annual income from Boston (Water and Sewer) at $14,913 and associated disposable monthly income of $618. Assuming a home used 5,000 cf over a six-month billing period which is the 80th percentile of the customers using water, the annual water bill would be $520 at the new District water rates. It should be noted that US. EPA indicated the national average for water and sewer usage is on the order of 250 gal/day. This calculates to about 6,100 cf of water consumption for a six-month period. While the 80th percentile may underestimate water use in the District due to seasonal residents, the 80th percentile number suggests that most of the water usage is due to normal consumption. A recent report by Kleinfelder suggested that roughly 20% of the residents were seasonal to the District.

[2] Teodoro, Manuel. Measuring Household Affordability for Water and Sewer Utilities, Journal American Water Works Association, 110:1, January 2018.

The current sewer charges are just under $600 annually. The total water and sewer bill is about $1,120 or $93.33/month. **Table 3-3** presents the cost of six months of water at the 80th percentile consumption rates. The estimated AR20 and HM for the District are provided in **Table 3-4**.

Table 3-3. Cost of Six Month of Water at 80th Percentile Consumption Rate in FY19 (Calendar '18/'19)

Rate	Rate	Cost - 5,000 CF consumption
Capital Improvement Fees	$2.698/HCF	$134.90
2000 cf	$120	$120.00
2001 to 4,000 cf	$0.85/HCF	$25.50
4001 to 10,000 cf	$3.40/HCF	---
Greater than 10,000 cf	$3.85/HCF	---
Total for Six Months[1]		$280

[1] Annual consumption cost for water averages $520 per year.

Table 3-4. Calculation of Affordability Criteria

Parameter	Sewer Bill	Water Bill	Disposal Income	Minimum Wage Rate	Calculated Value	Guide
AR20	$600	$520	$618	---	15.1%	10%
HM (current wage rate)	$600	$520	---	$11/hr	8.5	8.0
HM (proposed wage rate)	$600	$520	---	$15/hr	6.2	8.0

Note: Calculation provided below:

AR20 = $93.33/$618 x 100 = 15.1%

HM = $93.33 ÷ $11/hr = 8.5 hours

M = $93.33÷$15/hr = 6.2 hours (proposed legislation)

In comparison to the rules of thumb, the proposed water rate and current sewer rate is over the rule of thumb for AR20 but is very close to the guide for the HM. Looking at Figure 1 and 2 of Teodoro, 2018 for northern (cold climate and generally older infrastructure) locations in the United States, the District's AR20 and HM would be in line with those values. Note that the Town's sewer system is considering updating their rates, which would change the AR20 and HM used for this evaluation.

Comparison to Other Massachusetts Water Utility Charges

A regional historical approach to consider a public water supplier's water rates is comparison with what other utilities in the state are charging for a similar amount of water. This method cannot be considered a true "apples to apples" comparison when it come to affordability, as each community is unique in the needs and challenges they encounter. Plus, the surveys may not always account correctly for fees that are being charged in water bills but are not necessarily associated with the water rates. Additionally, some public water suppliers receive revenues through the town general tax fund, so this revenue is also not represented by the water rates. Other systems' water rates can provide a generate level of comparison of affordability on an aggregate basis. However, this method may not account for that part of the population that may be most vulnerable to rate increases, such as the twentieth income percentile and number of hours at minimum wage to pay for water and sewer.

Tighe and Bond recently released their 2017 water rate survey. In that survey the average cost of water for the state for 120 HCF at $595. The MWRA advisory also published a similar report in 2017 for 120 HCF of water consumption at an average bill of $605. A comparison of the proposed District water bill with surrounding communities is provided in **Table 3-5**.

Table 3-5. Comparison of Annual Water Bill for 5,000 cf of Water with State and MWRA

Location	Average 2017 Bill	Ratio to 10,000 cubic feet*	Inflation	2018 Bill
Wareham Water District	---	---	---	$520
Tighe and Bond State Survey*	$595	0.833	3%	$510
MWRA*	$605	0.833	3%	$519

Notes: Tighe and Bond State Survey and MWRA survey are based on 120 HCF annually and not the 80 percentile which is used here for Wareham at 100 HCF.

The results suggest, in aggregate, Wareham Water District is in line with providing affordable water.

Summary

When considering water affordability, it is necessary to account for the impact on low income households. Comparison of the water bill to the MHI does not account for these more at-risk households. The largest category of the respondents to the survey conducted for this project indicated an income level of less than $60,000, which is less than the MHI for the Town. This indicates that these lower income households have a stronger interest in the cost of water than higher income levels. Essentially, they took the time to respond to the survey since it means more to them and their bottom line month to month and year to year.

Comparison of the cost of water in the District to other income level indices including the (1) income per capita, (2) affordable housing income levels, (3) twentieth income percentile, and (4) the number of hours at minimum wage to pay for water and sewer show that the annual cost of water and sewer within the District are affordable given the available data. Additionally, comparison of the annual cost of water with other necessity and discretionary spending categories also indicates that the cost of water is affordable.

Ultimately, how the District utilizes this information in establishing rates is to be determined. Some water utilities opt to allow up to a certain volume of water use as part of the base rate, with increasingly higher cost per unit volume on usage above the base (increasing tier rates which helps to encourage conservation). Careful balancing of the cost for the base rate and increasing tiers can help to maintain water affordability for lower income households. As the District proceeds forward with major infrastructure projects, they should evaluate how those projects will impact the rates across all income levels.

Figure 3-1. Survey Results - Are you satisifed with the quality of your water?

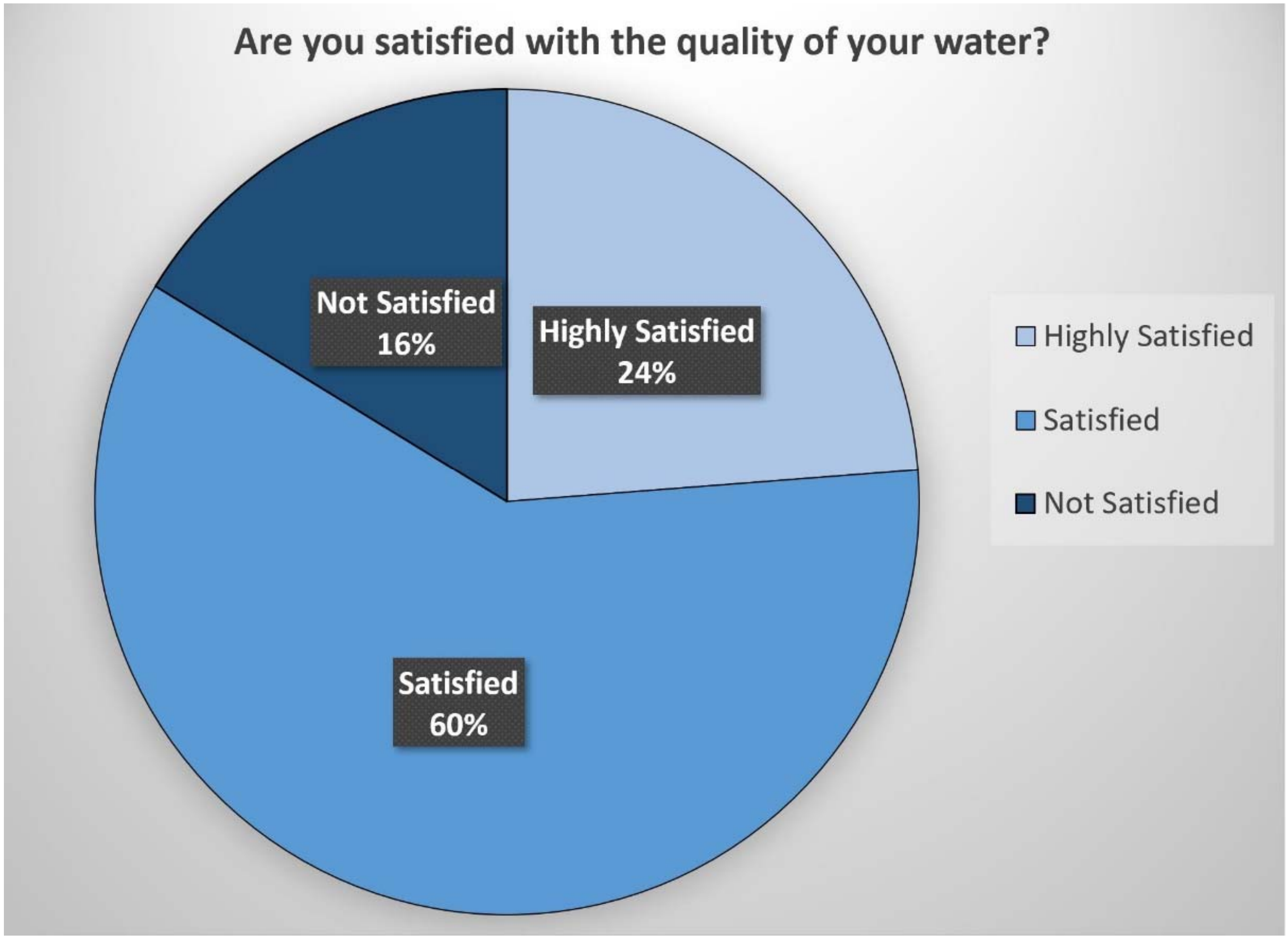


Figure 3-2. Survey Results - Are you satisifed with the reliability of service, related to water, provided by the District?

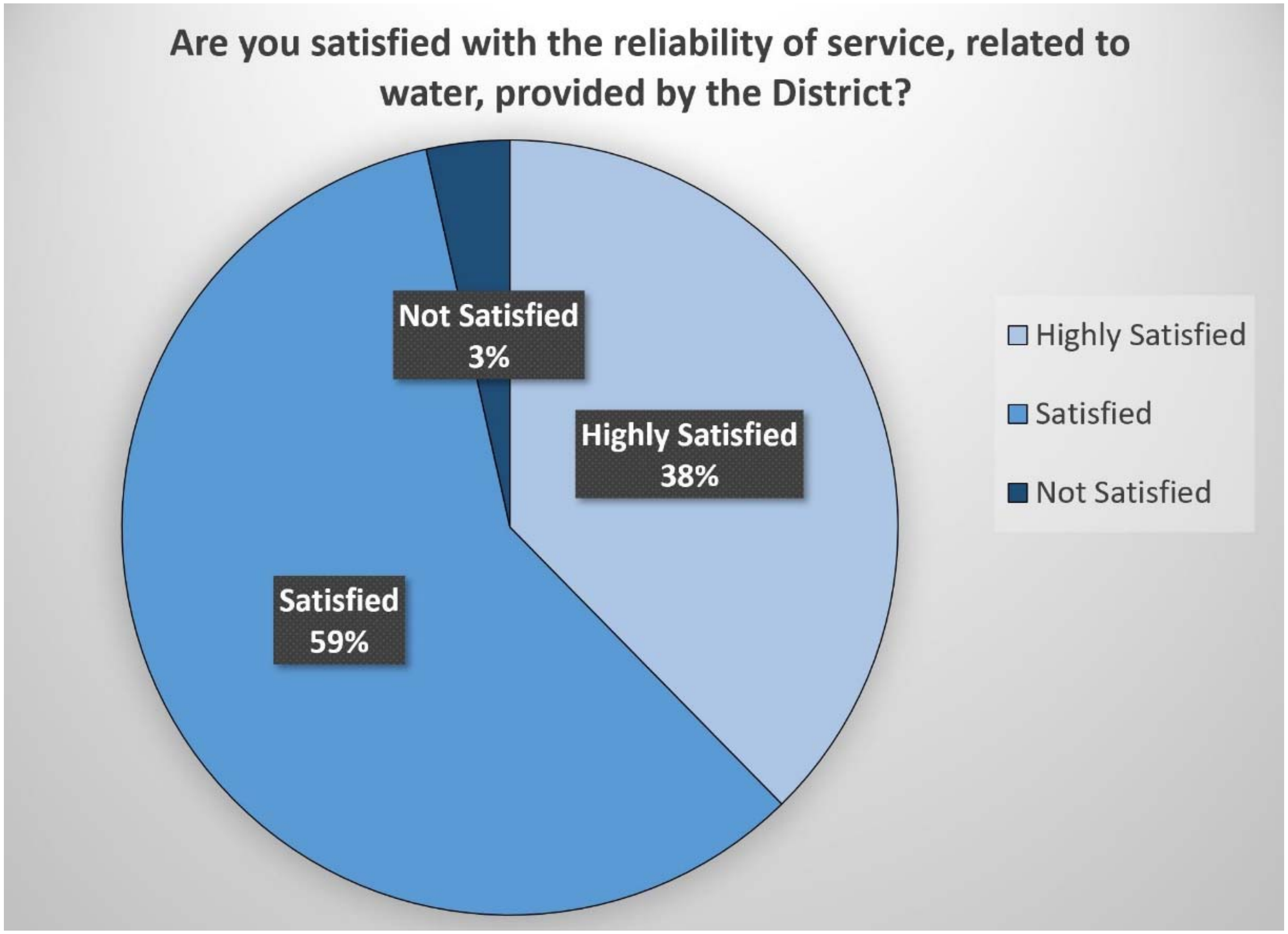


Figure 3-3. Survey Results – About how much do you spend on water from the District each year?

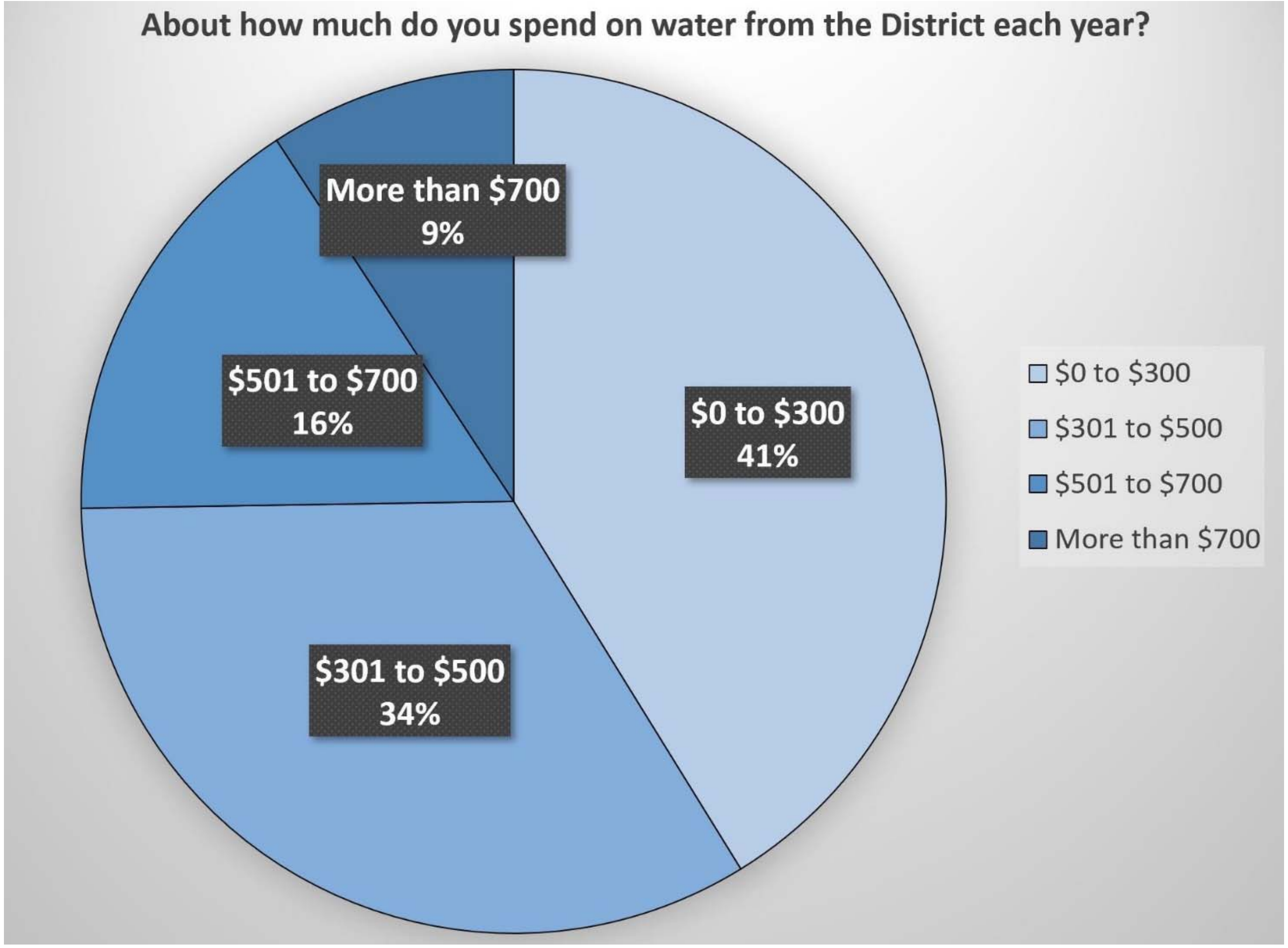


Figure 3-4. Survey Results – Do you feel that the amount you pay for water is in line with the service provided?

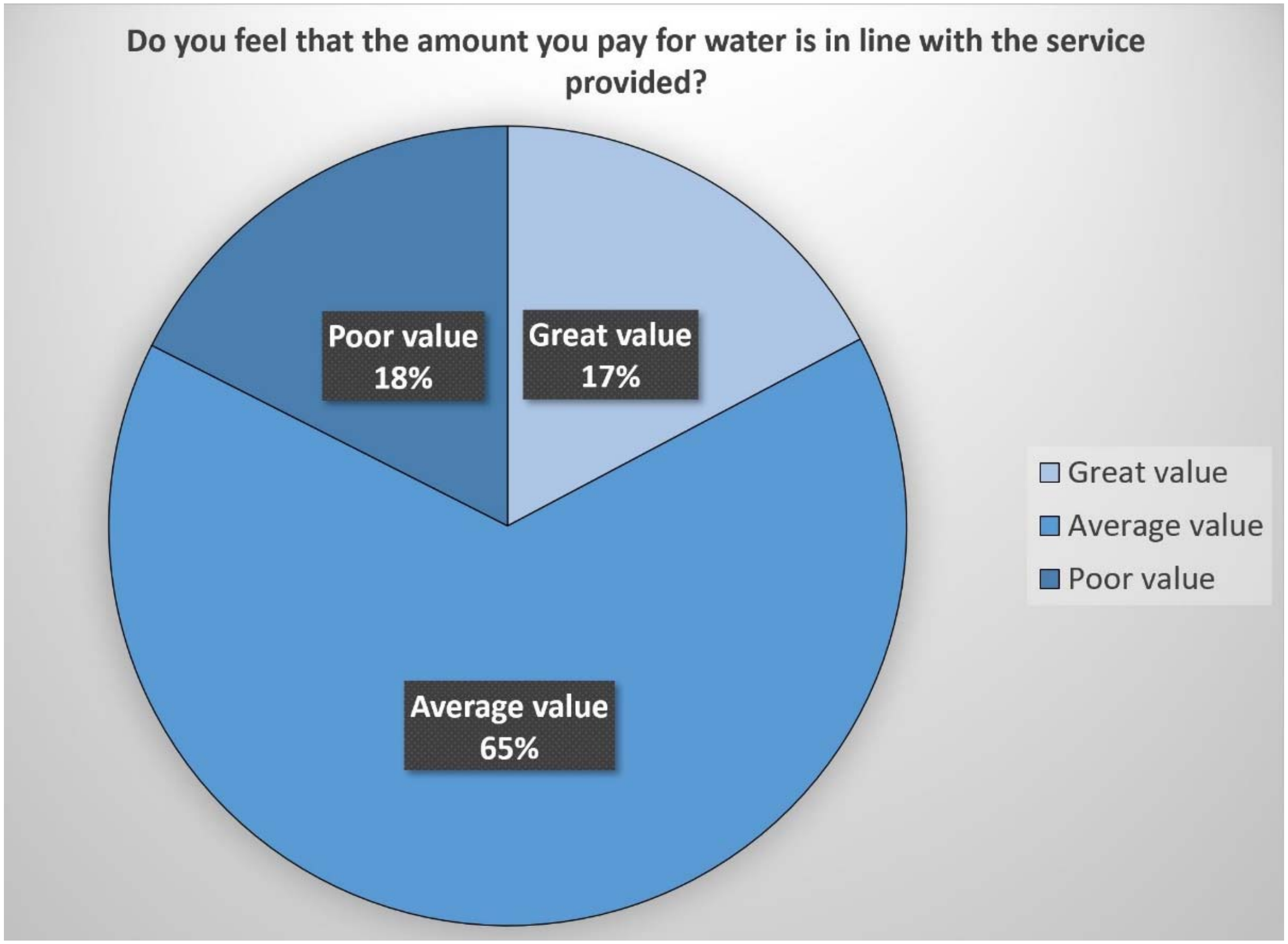


Figure 3-5. Survey Results – If you feel that the amount you pay for water is an averge or great value for the service provided, why?

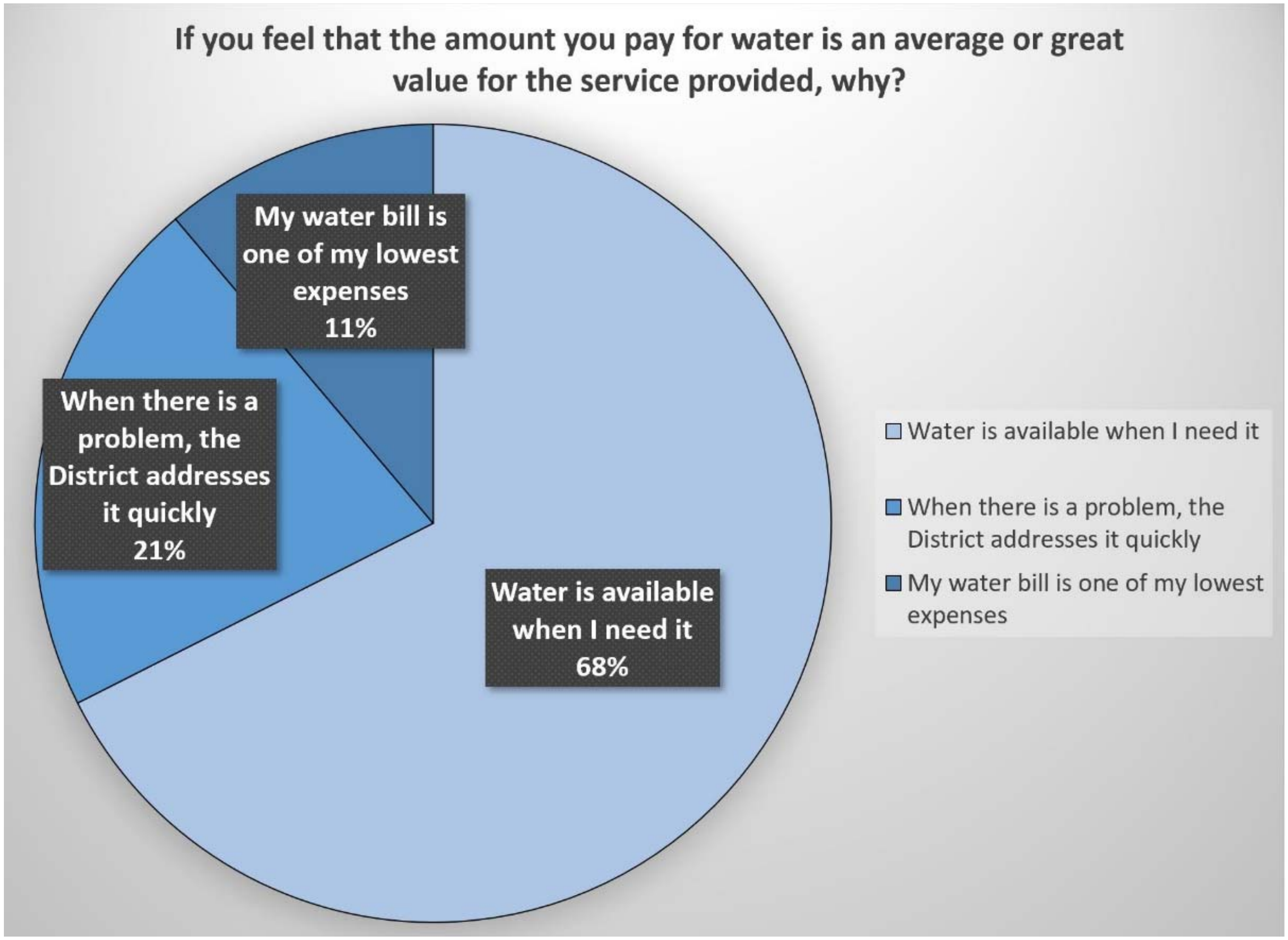


Figure 3-6. Survey Results – If you feel that the amount you pay for water is a poor value for the services provided, why?

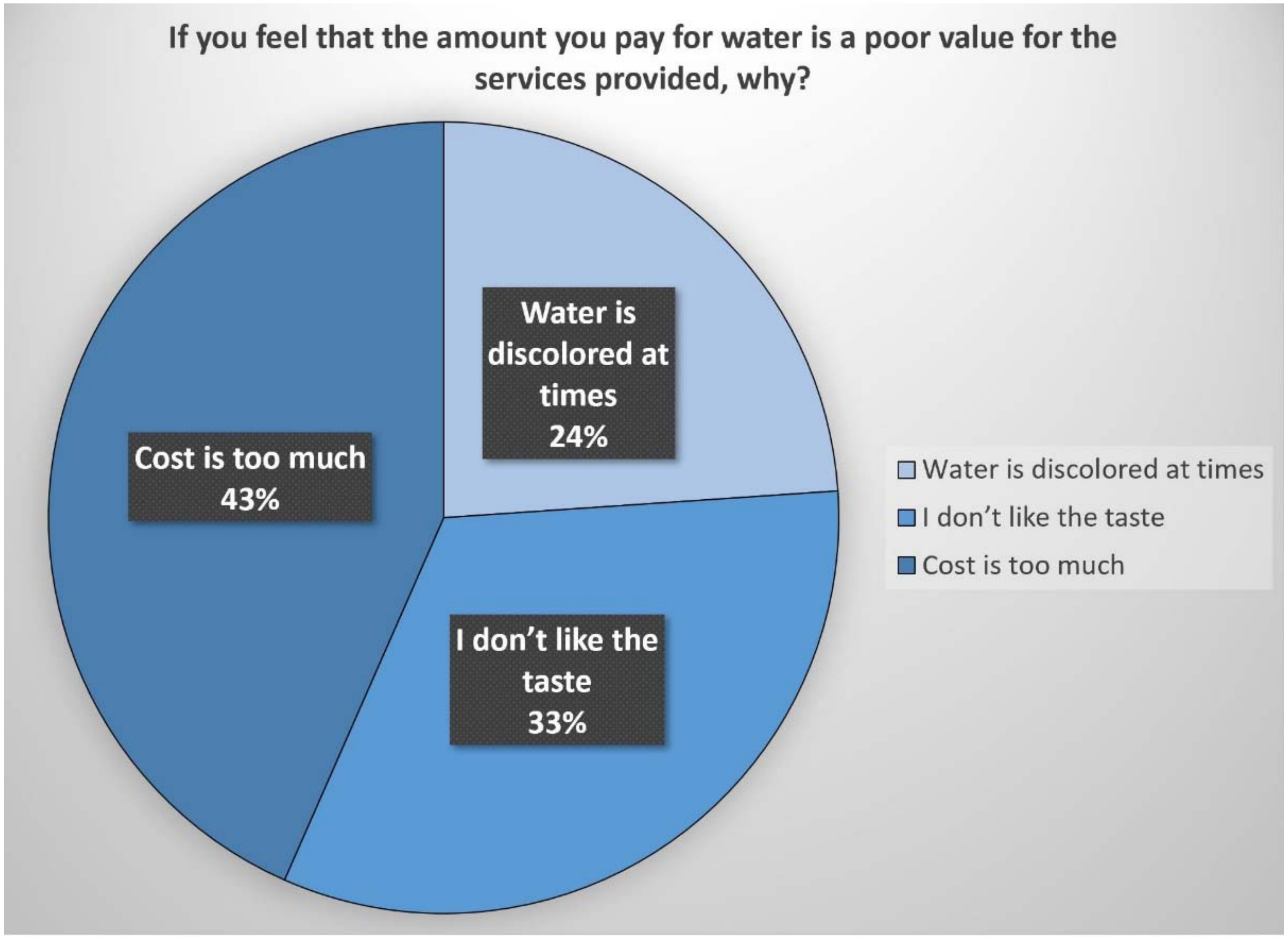


Figure 3-7. Survey Results – When you consider your other utility bills and services provided, do you feel that water is a better or worse value than these other utilities?

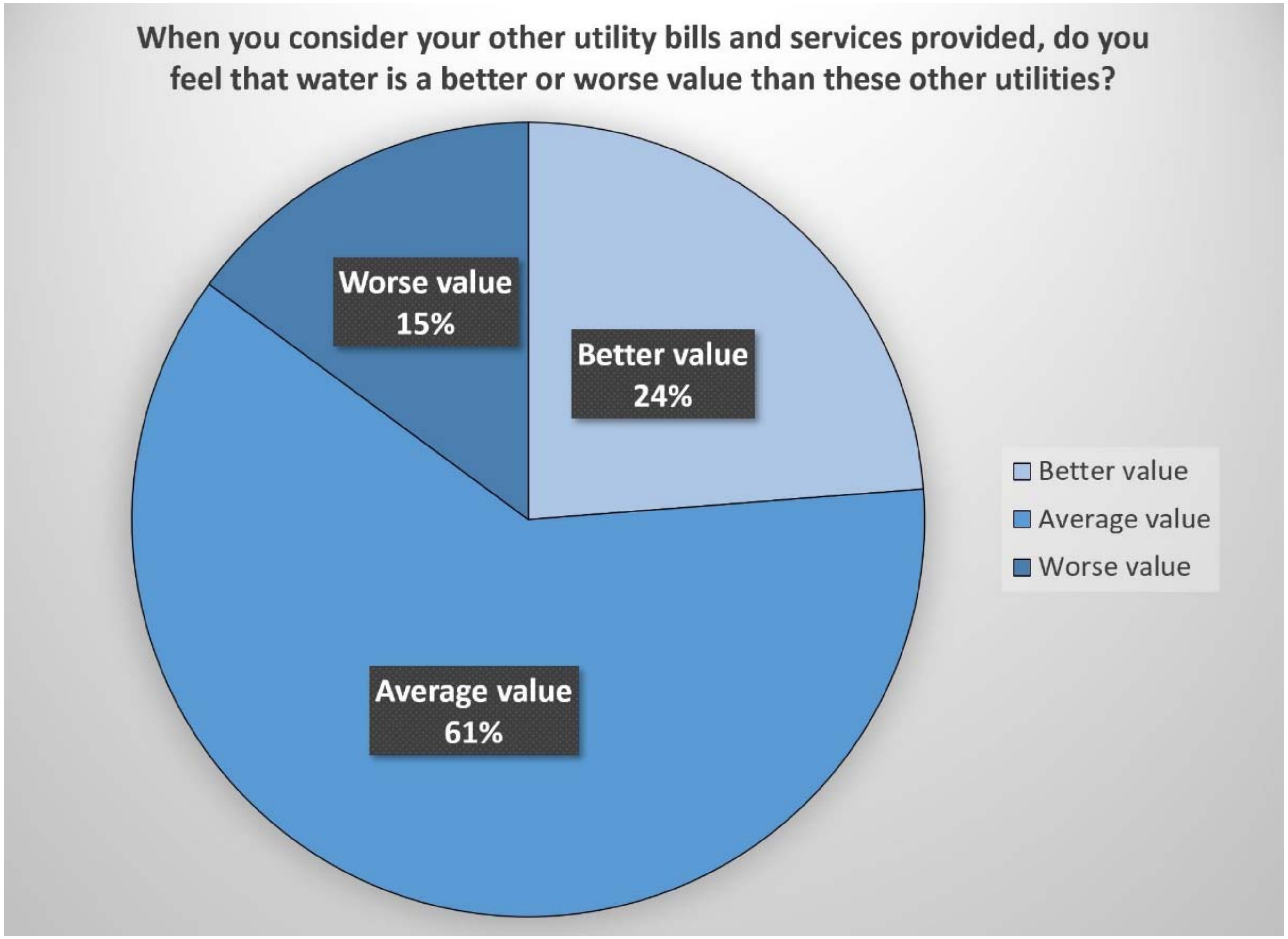


Figure 3-8. Survey Results – How willing would you be to pay more for water as long as the quality of that water improves?

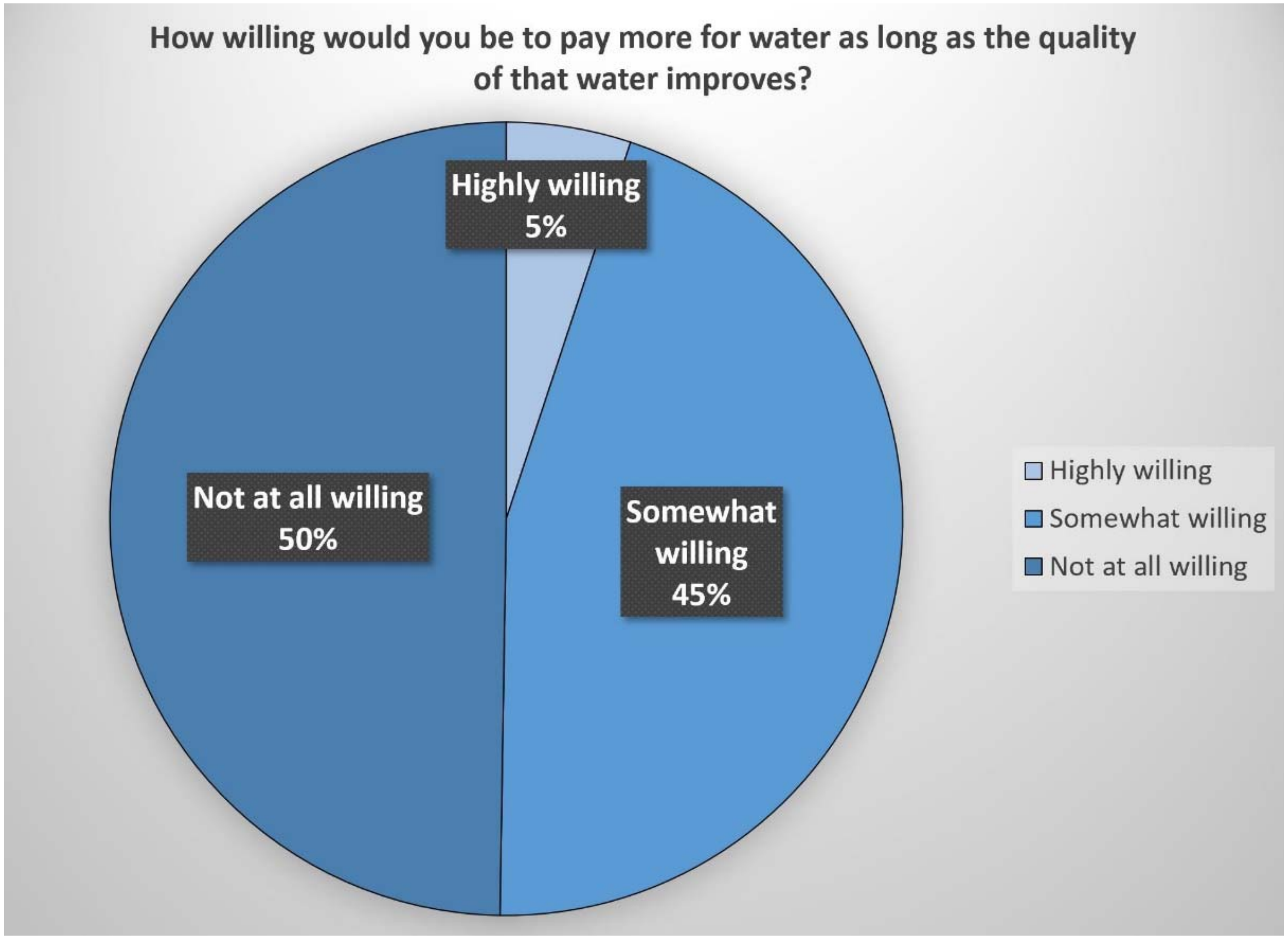


Figure 3-9. Survey Results – Water bills are currently sent twice a year. Would you prefer more frequent billing in order to better manage your finances?

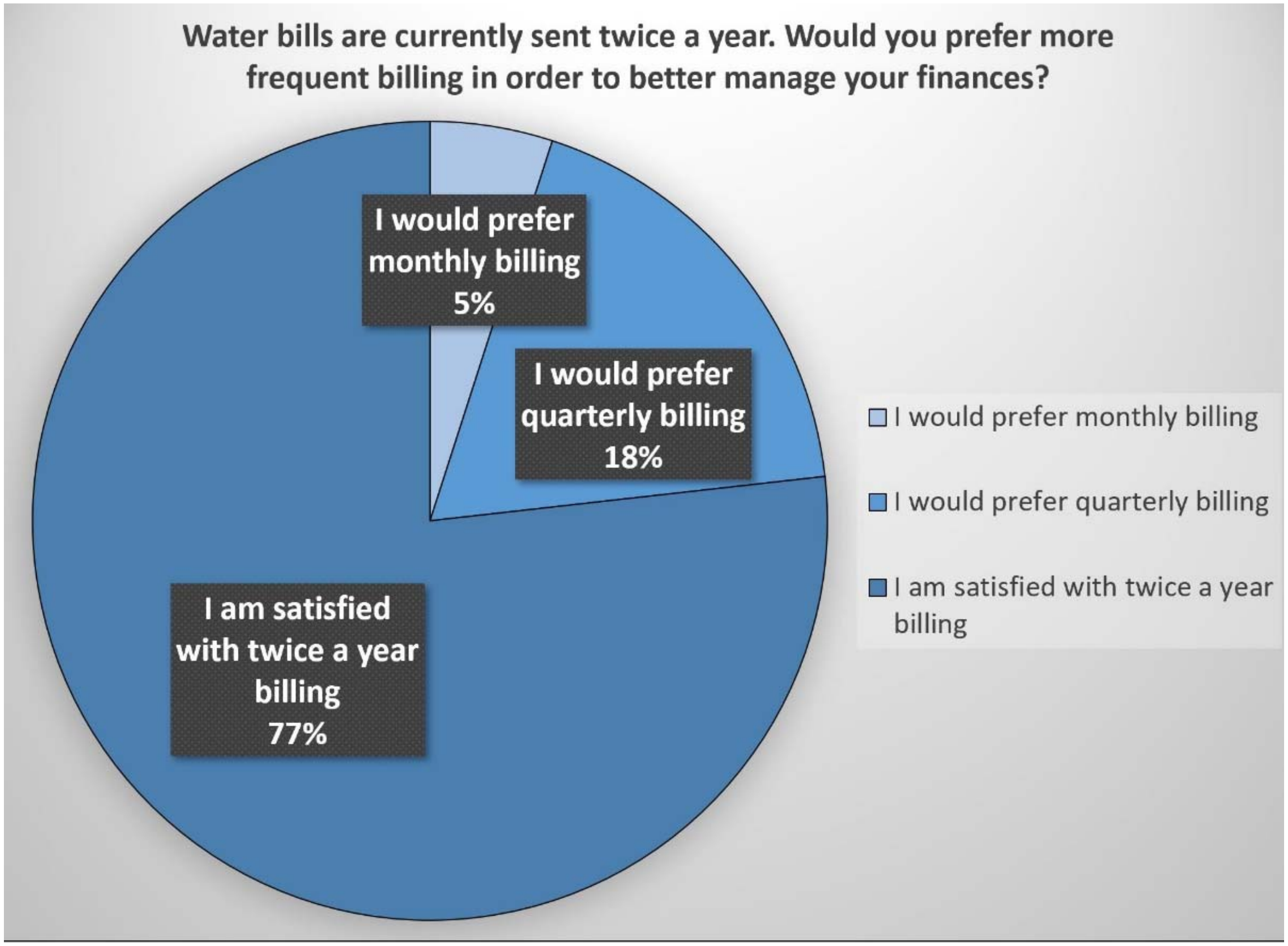


Figure 3-10. Survey Results – Would you prefer paperless billing?

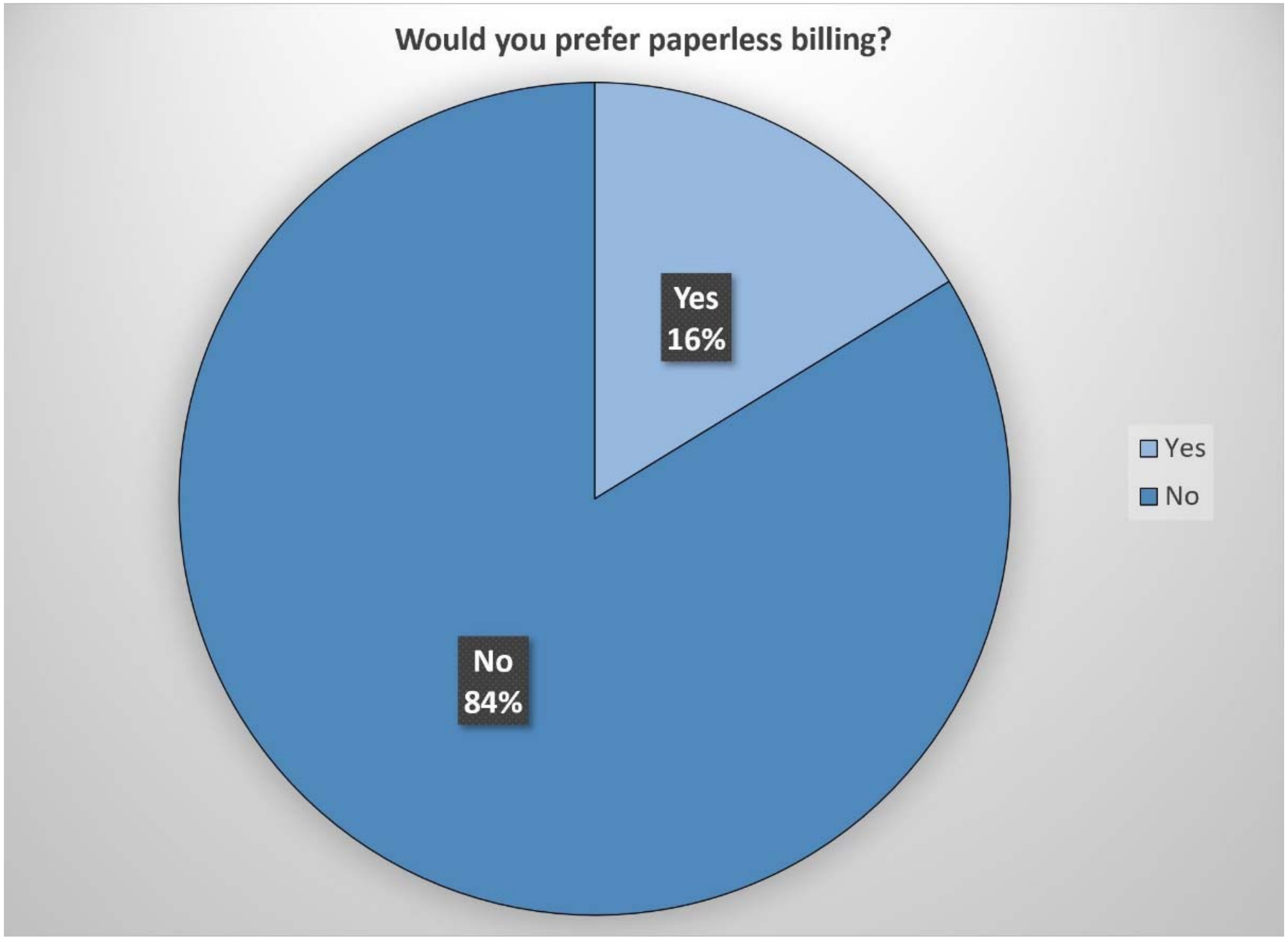


Figure 3-11. Survey Results – Should the District provide more frequent billing, would you like to see how efficient a water consumer you are in comparison to other District customers (all information would remain anonymous)?

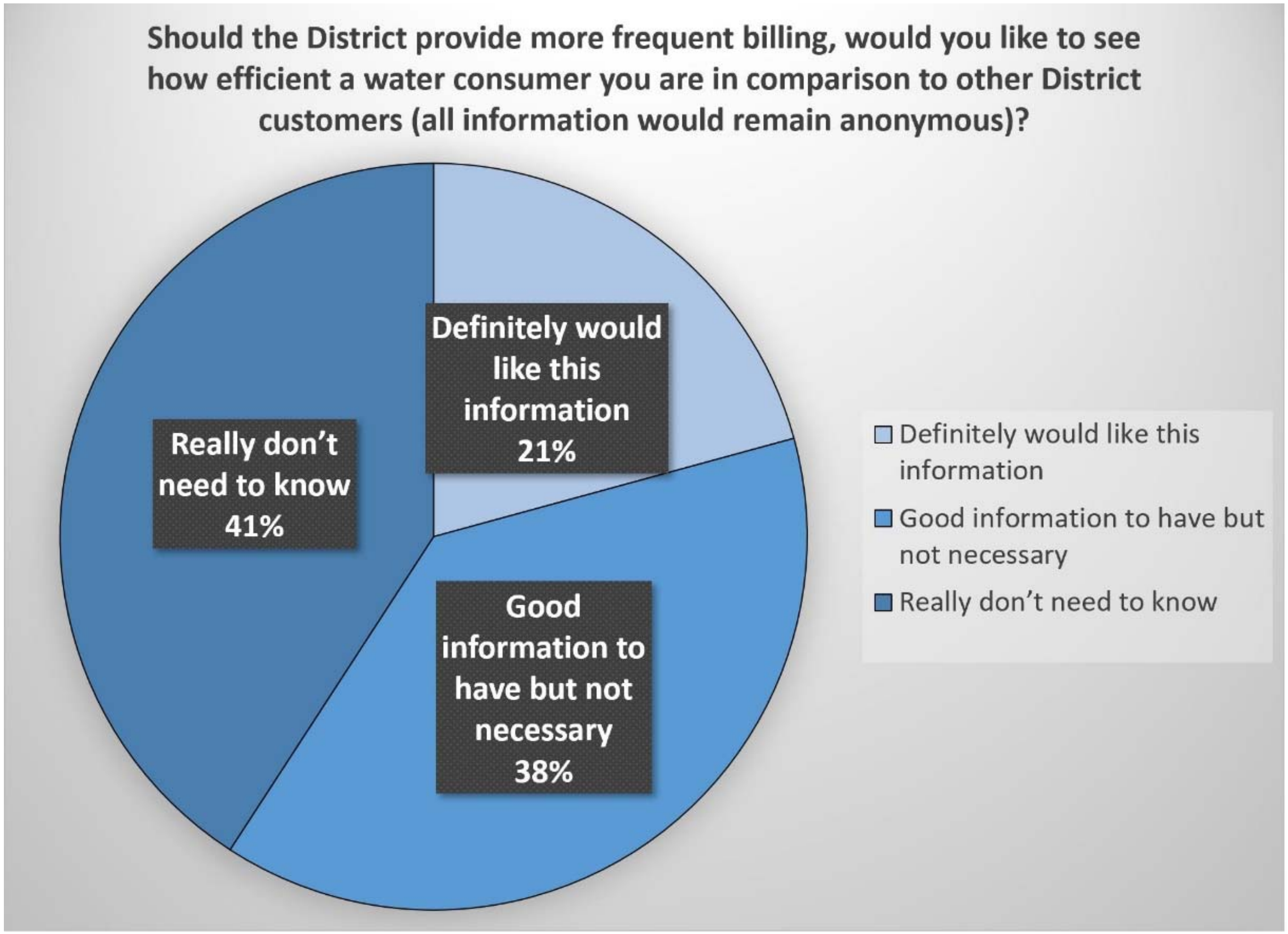


Figure 3-12. Survey Results – If you are provided with information on you water use in comparison to others, would this make you more likely to conserve water to improve your water use efficiency?

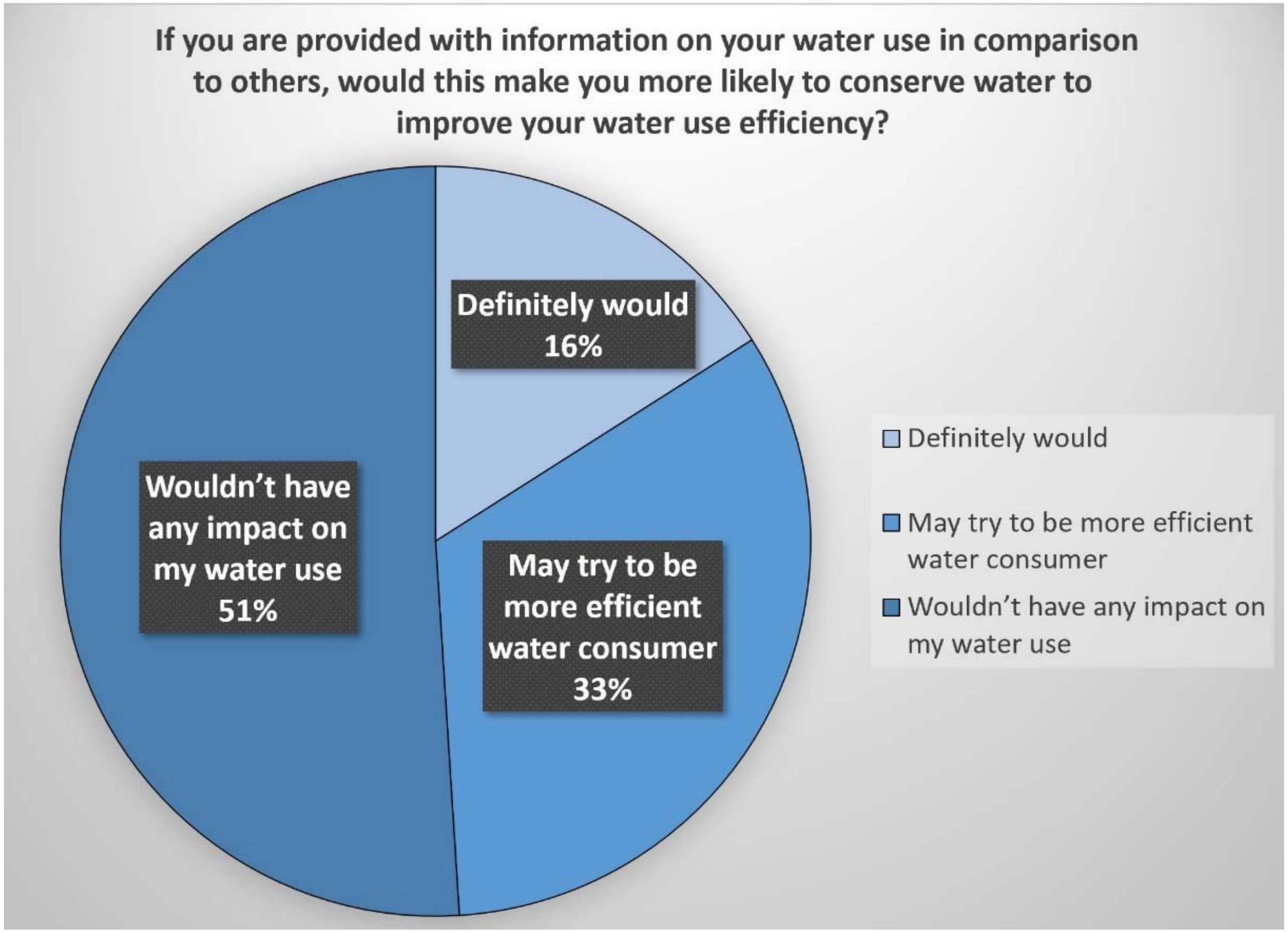


Figure 3-13. Survey Results – Would you like to see more current information on your water use (monthly or more often) in an electronic (e.g. web access) format?

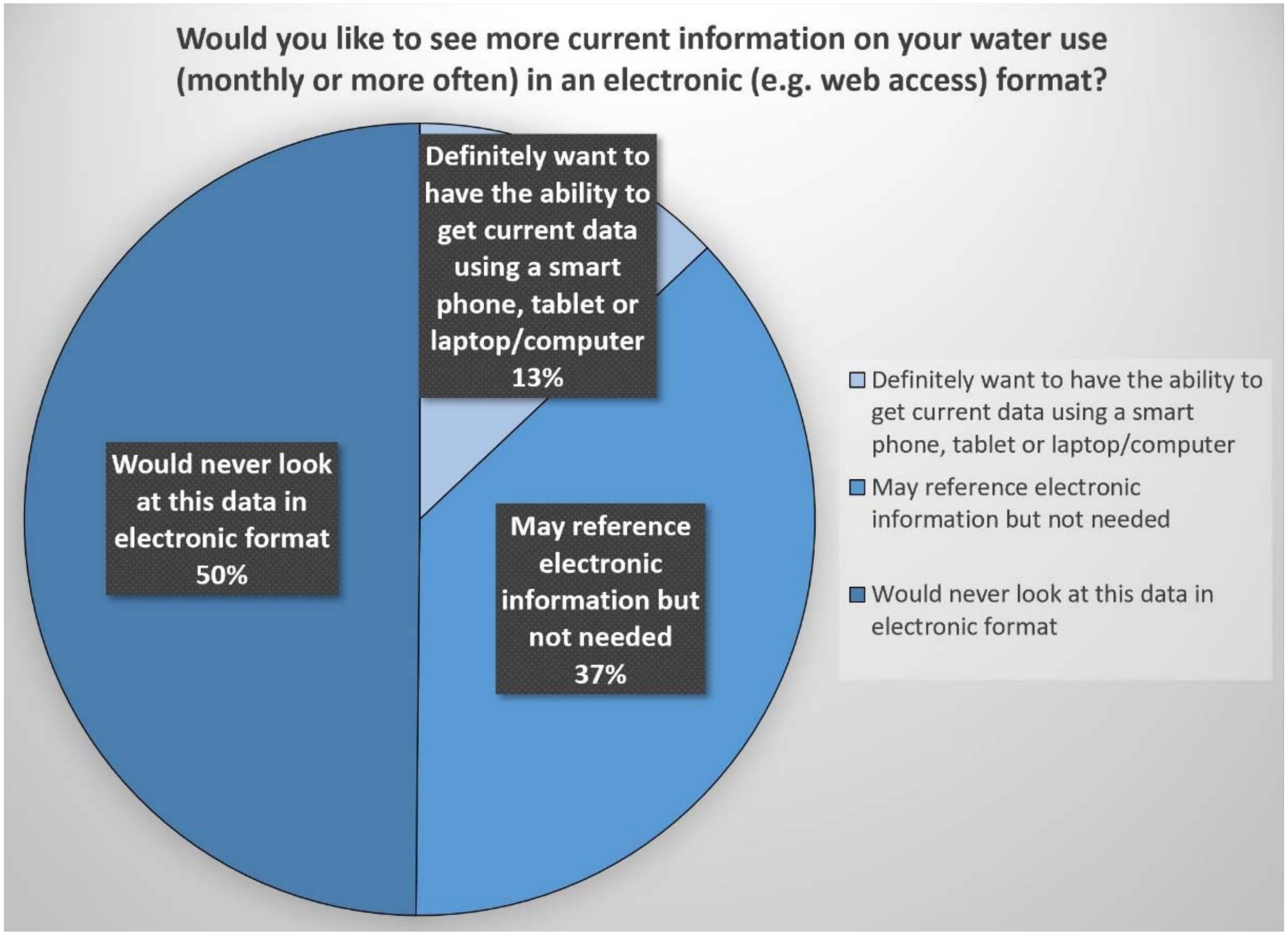


Figure 3-14. Survey Results – Comparison of Categories – Would you prioritize your water bill above, below, or about the same as other spending categories?

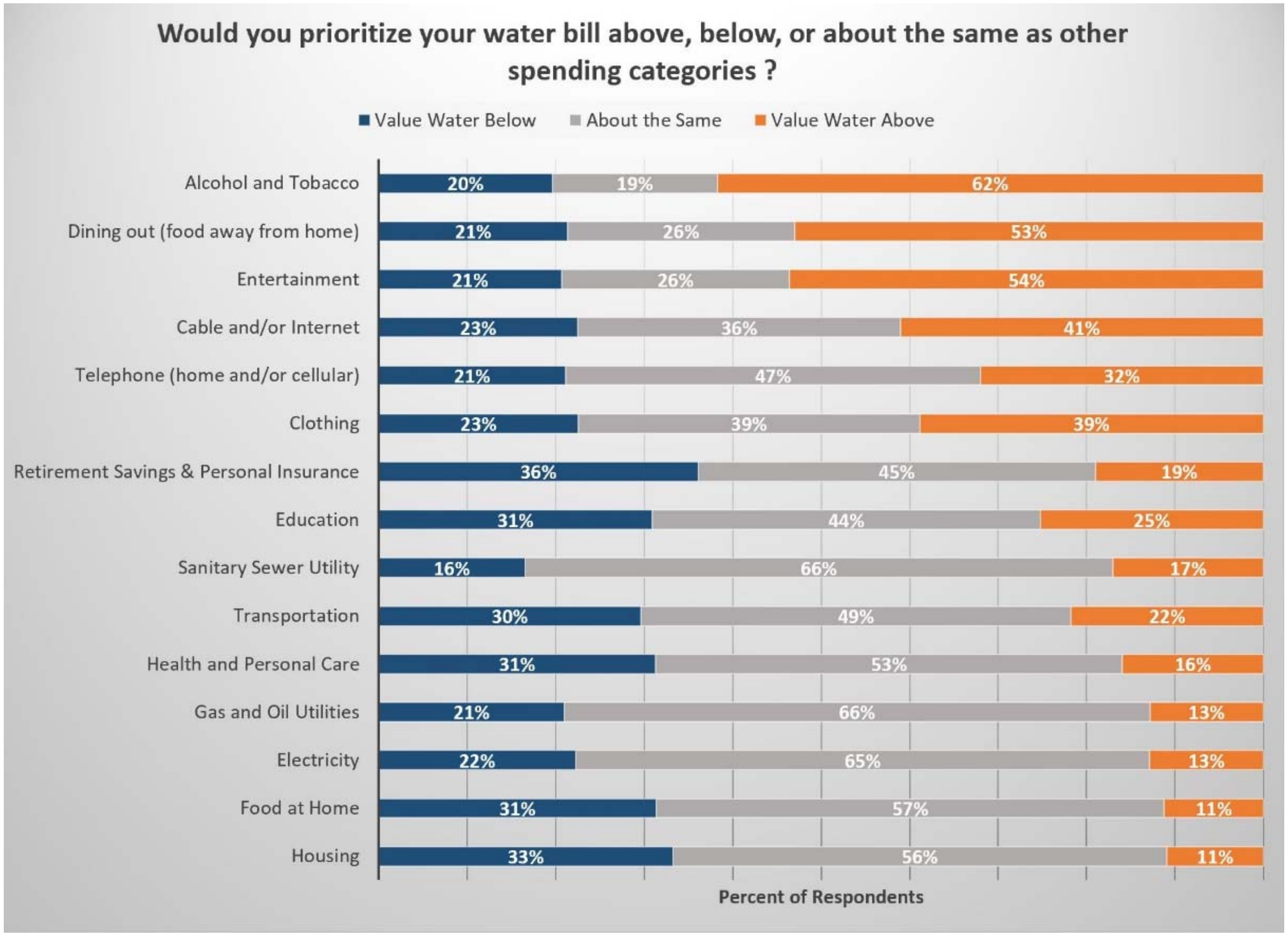


Figure 3-15. Survey Results – Would you prioritize your water bill above, below, or about the same as housing?

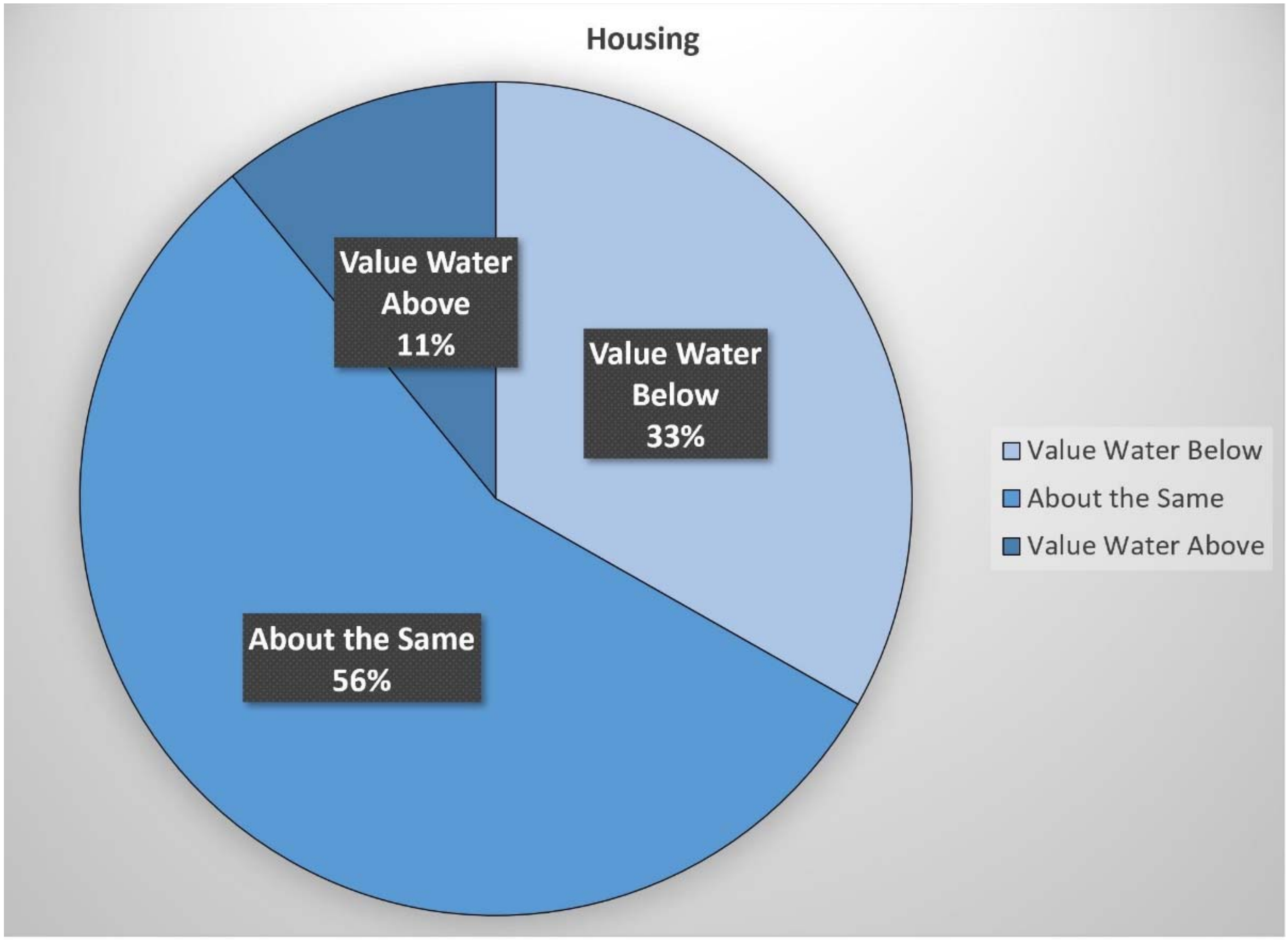


Figure 3-16. Survey Results – Would you prioritize your water bill above, below, or about the same as food at home?

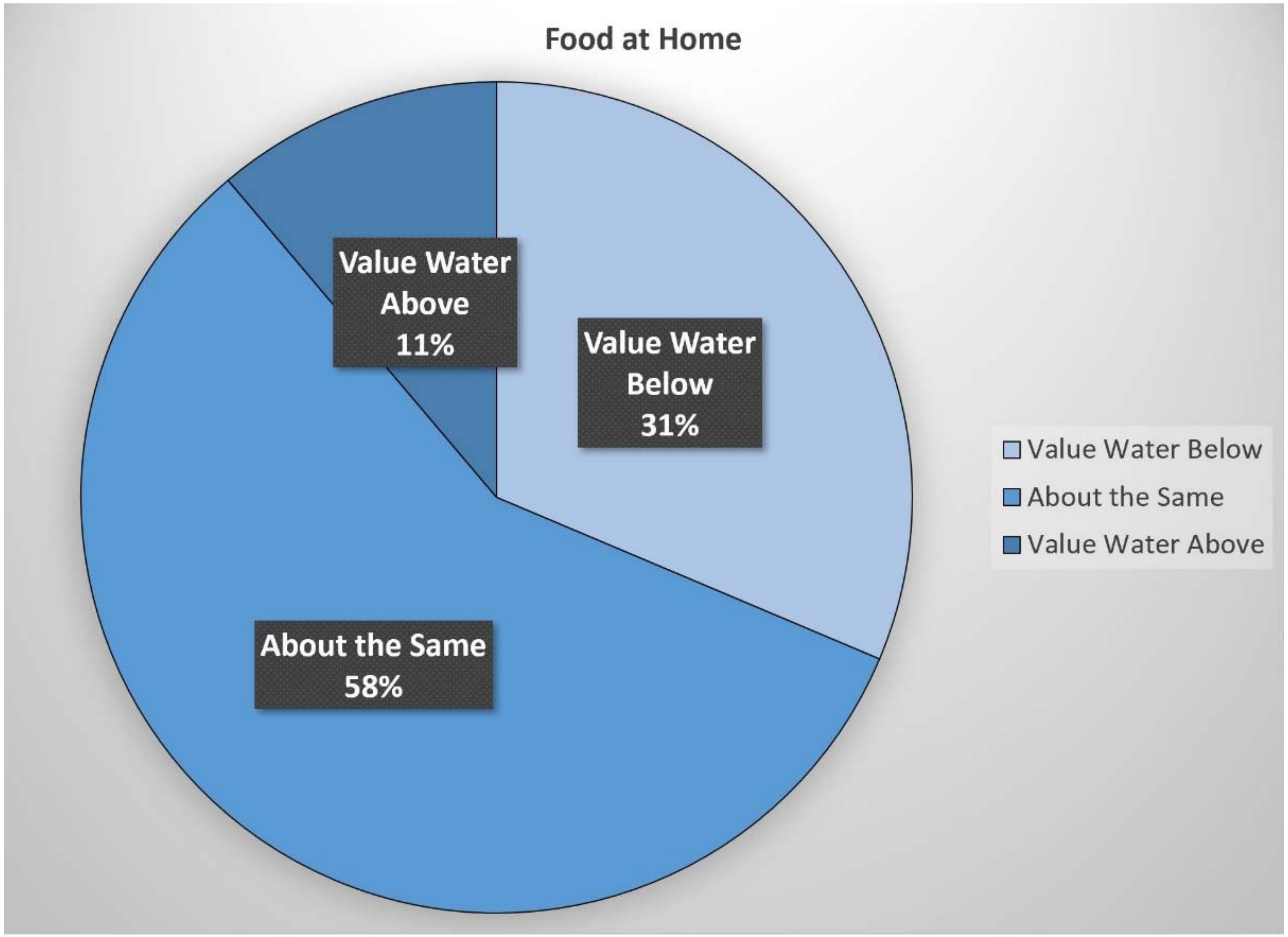


Figure 3-17. Survey Results – Would you prioritize your water bill above, below, or about the same as electricity?

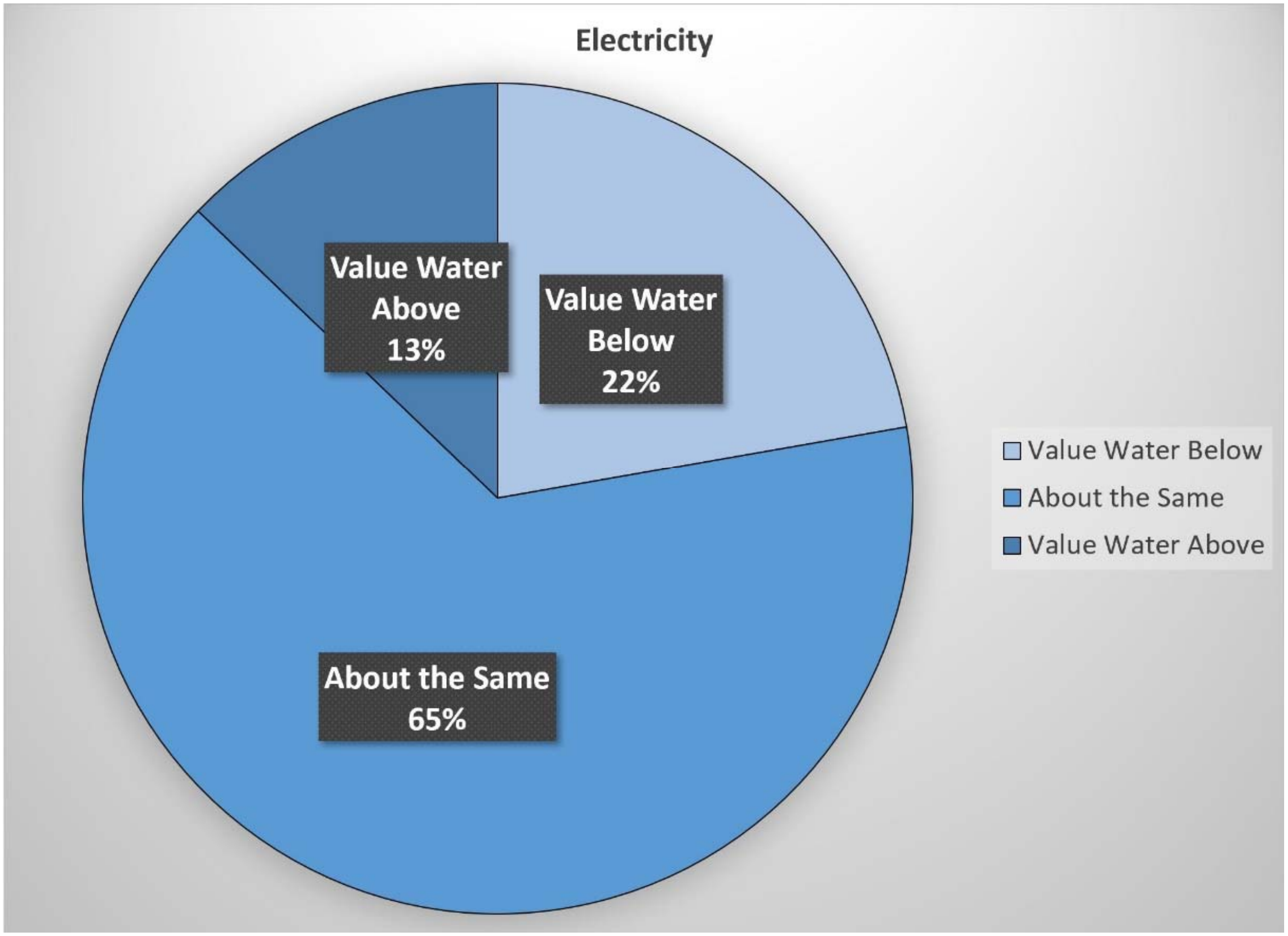


Figure 3-18. Survey Results – Would you prioritize your water bill above, below, or about the same as gas and oil utilities?

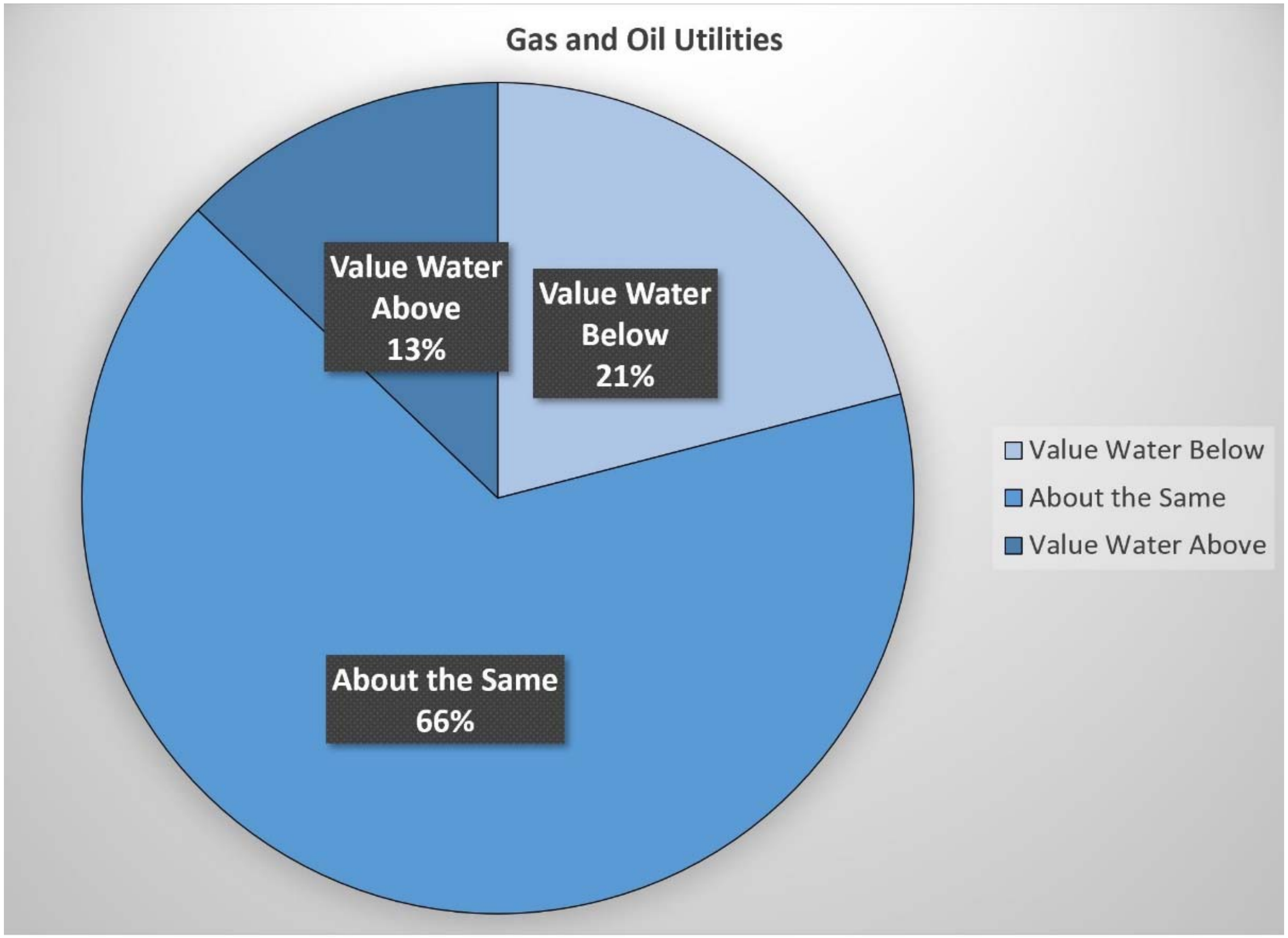


Figure 3-19. Survey Results – Would you prioritize your water bill above, below, or about the same as health and personal care?

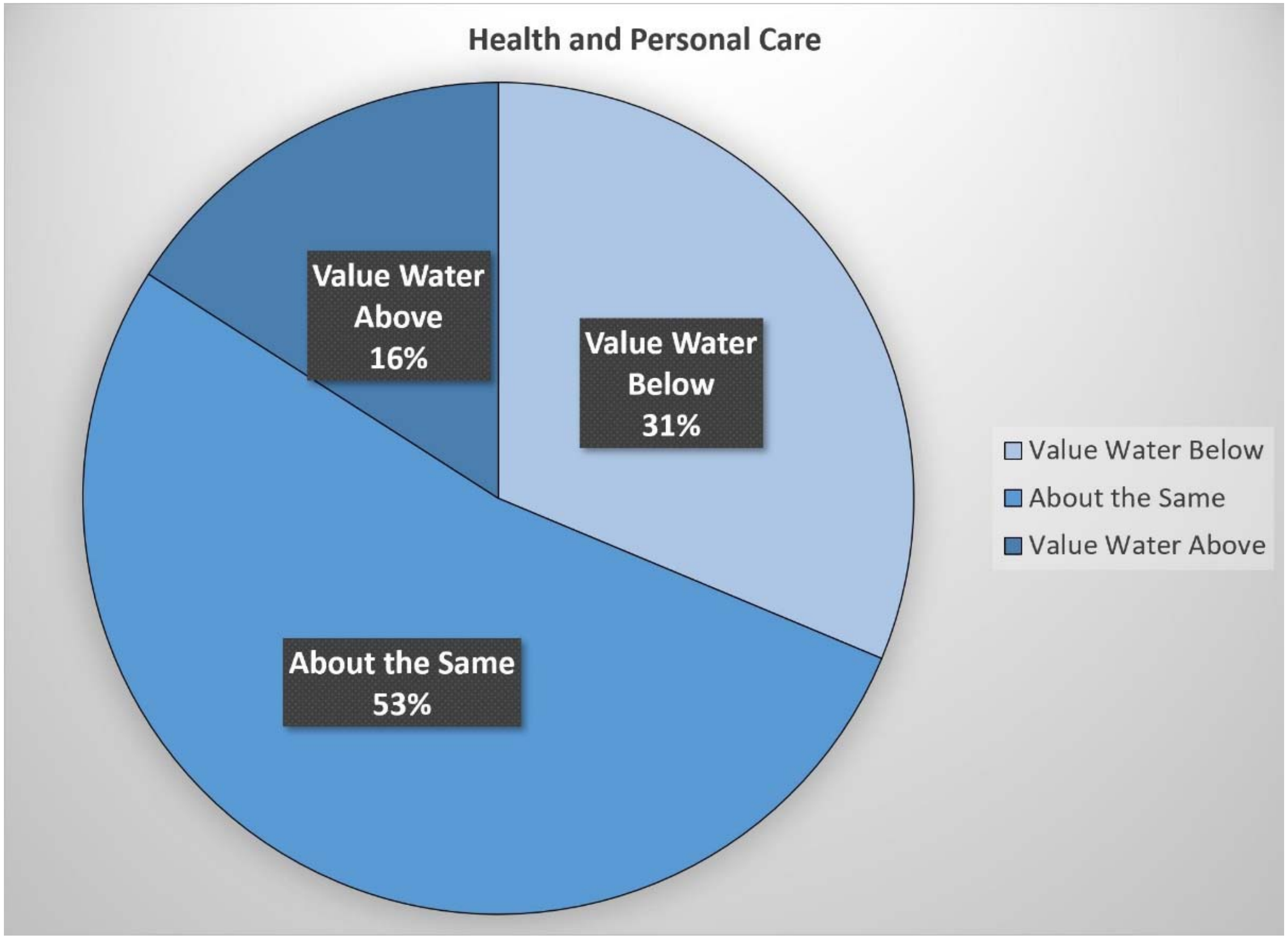


Figure 3-20. Survey Results – Would you prioritize your water bill above, below, or about the same as transportation?

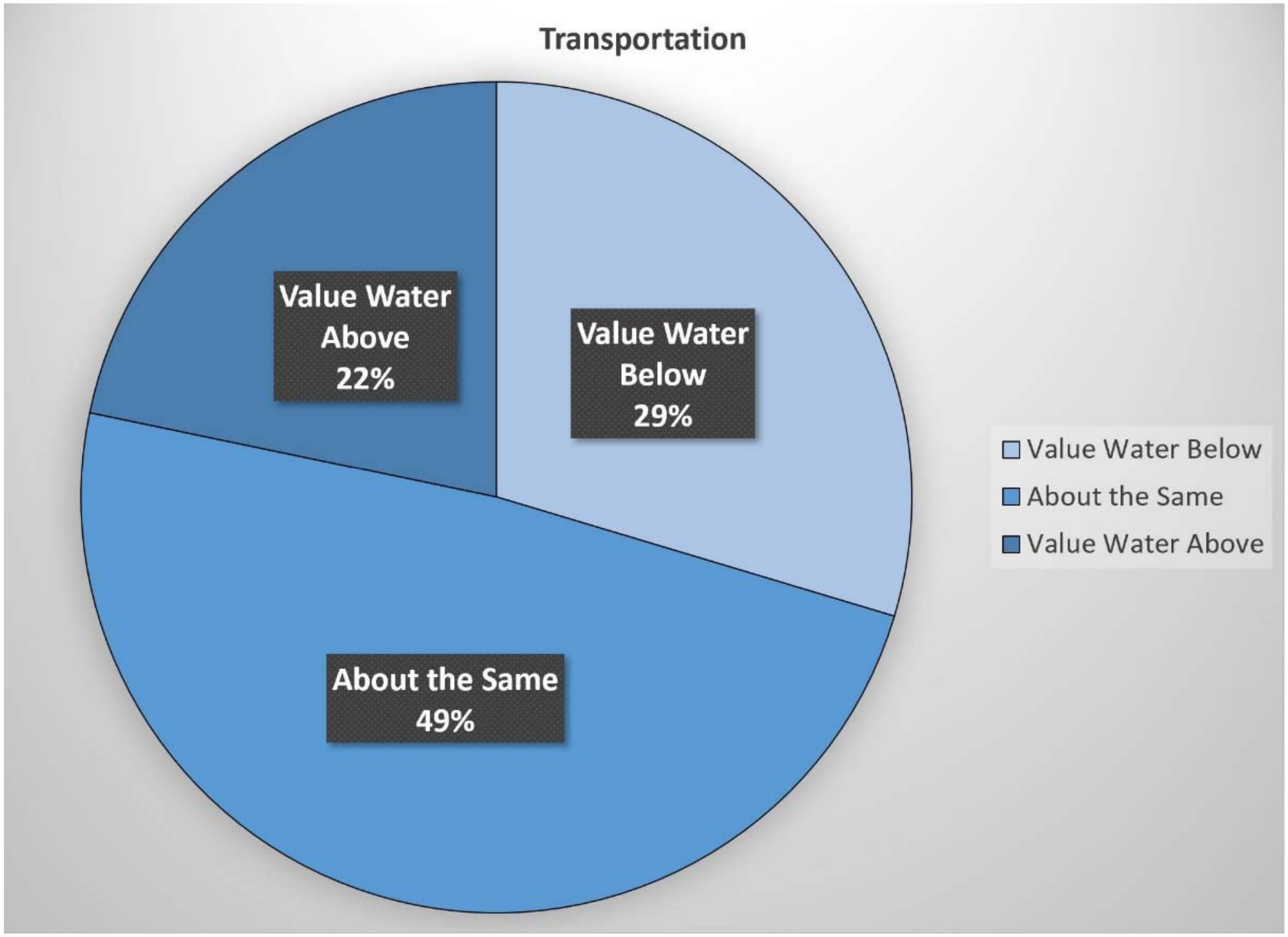


Figure 3-21. Survey Results – Would you prioritize your water bill above, below, or about the same as sanitary sewer utility?

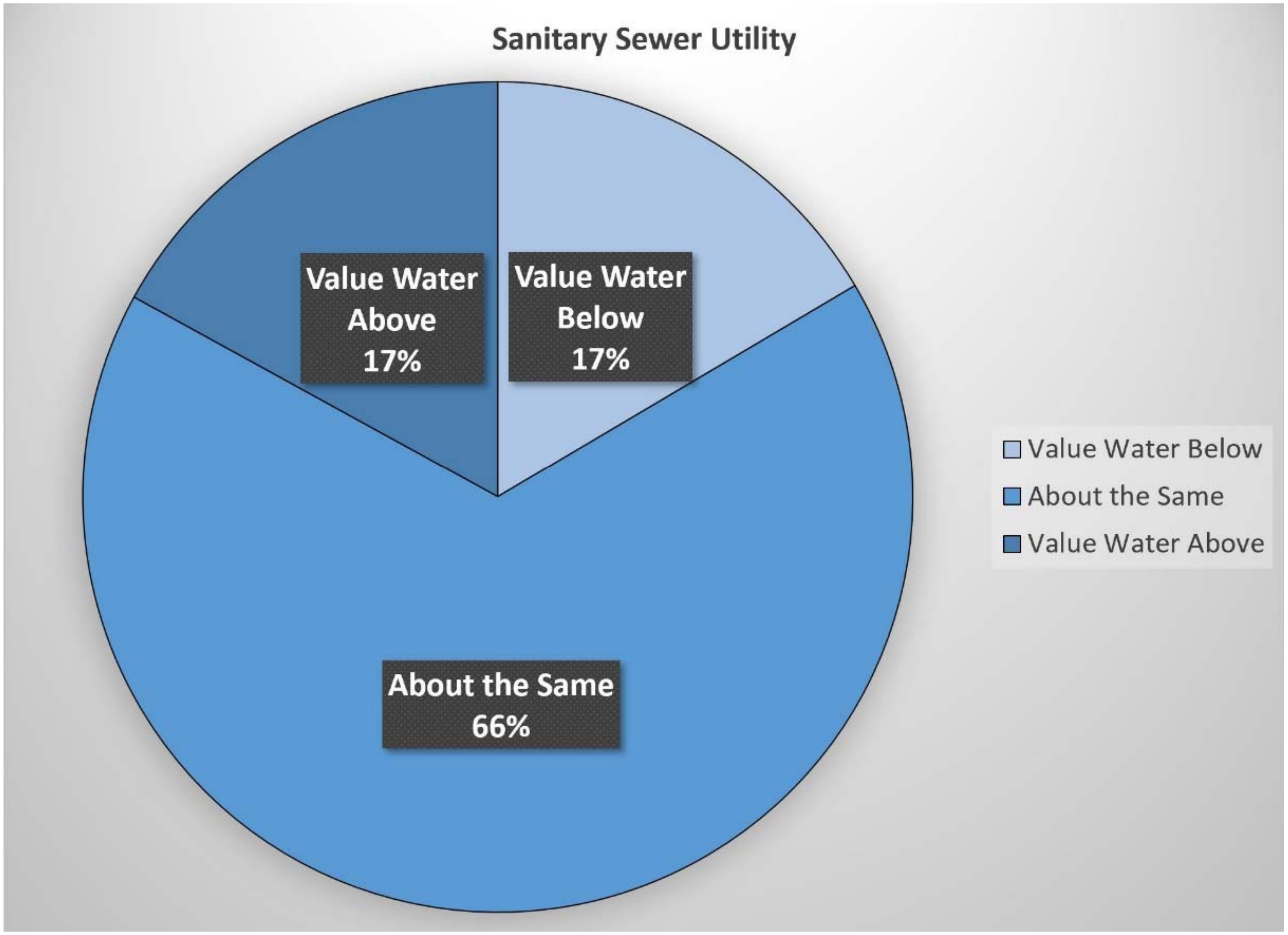


Figure 3-22. Survey Results – Would you prioritize your water bill above, below, or about the same as education?

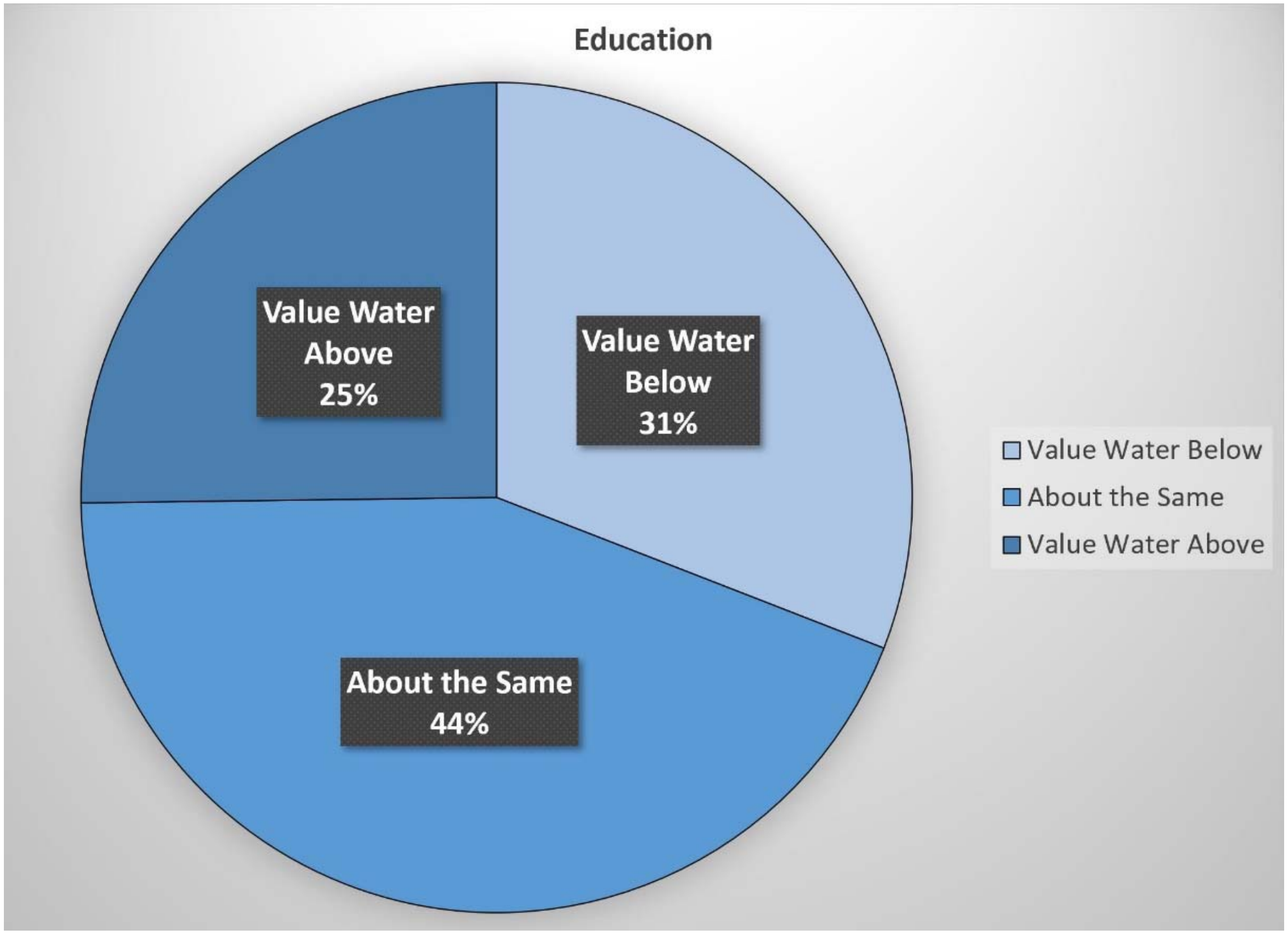


Figure 3-23. Survey Results – Would you prioritize your water bill above, below, or about the same as retirement savings and personal insurance?

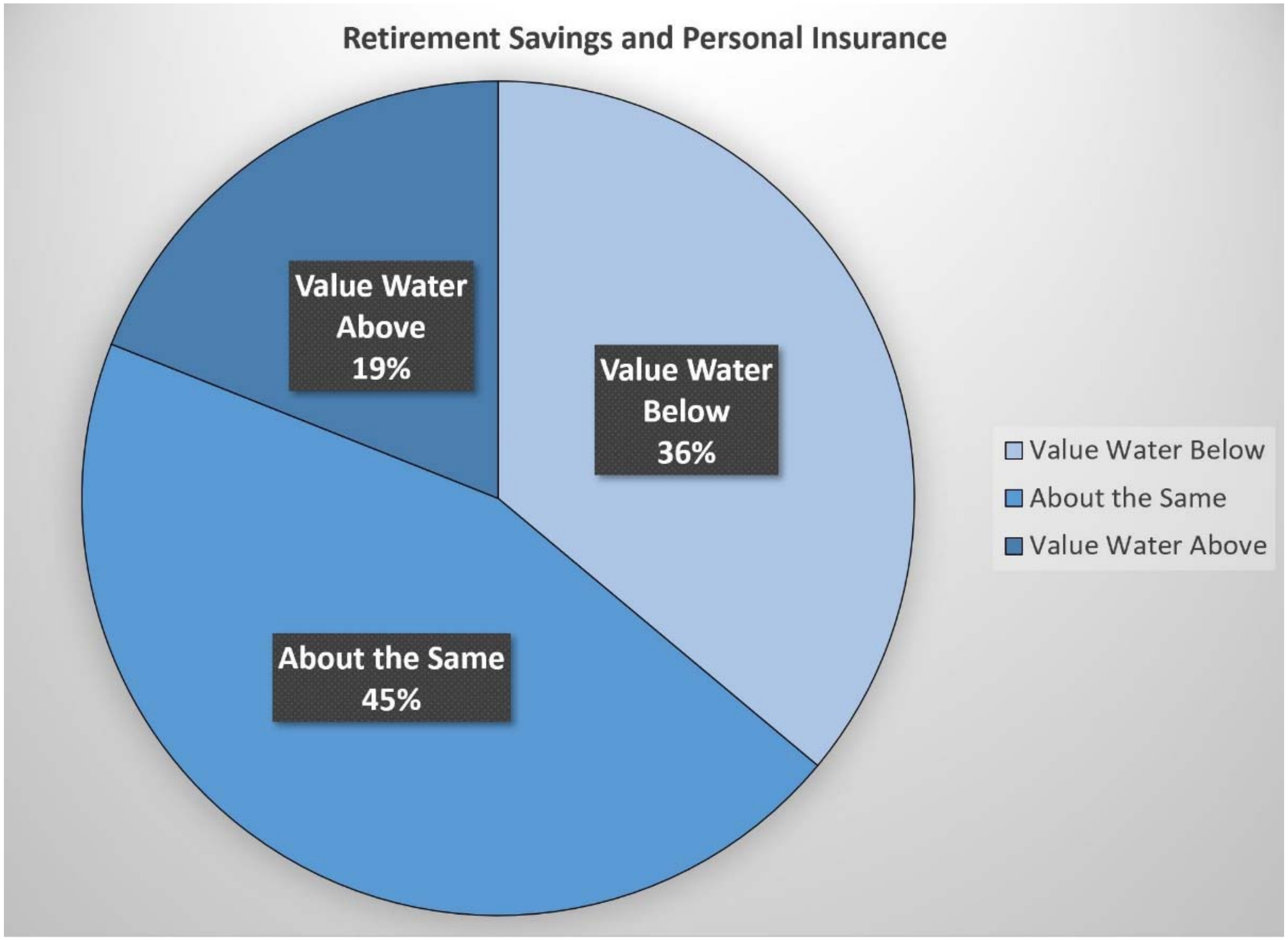


Figure 3-24. Survey Results – Would you prioritize your water bill above, below, or about the same as clothing?

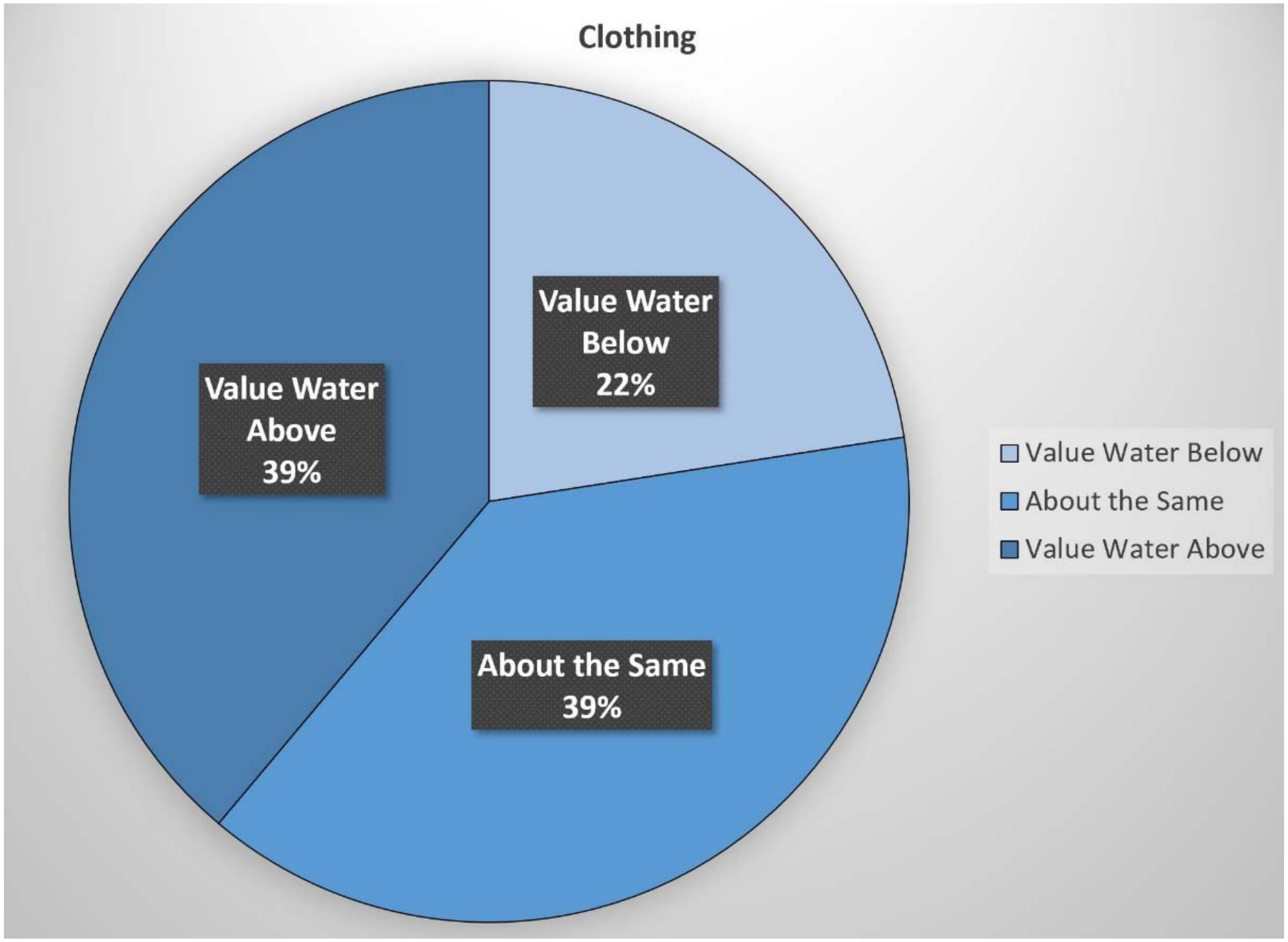


Figure 3-25. Survey Results – Would you prioritize your water bill above, below, or about the same as telephone (home and/or cellular)?

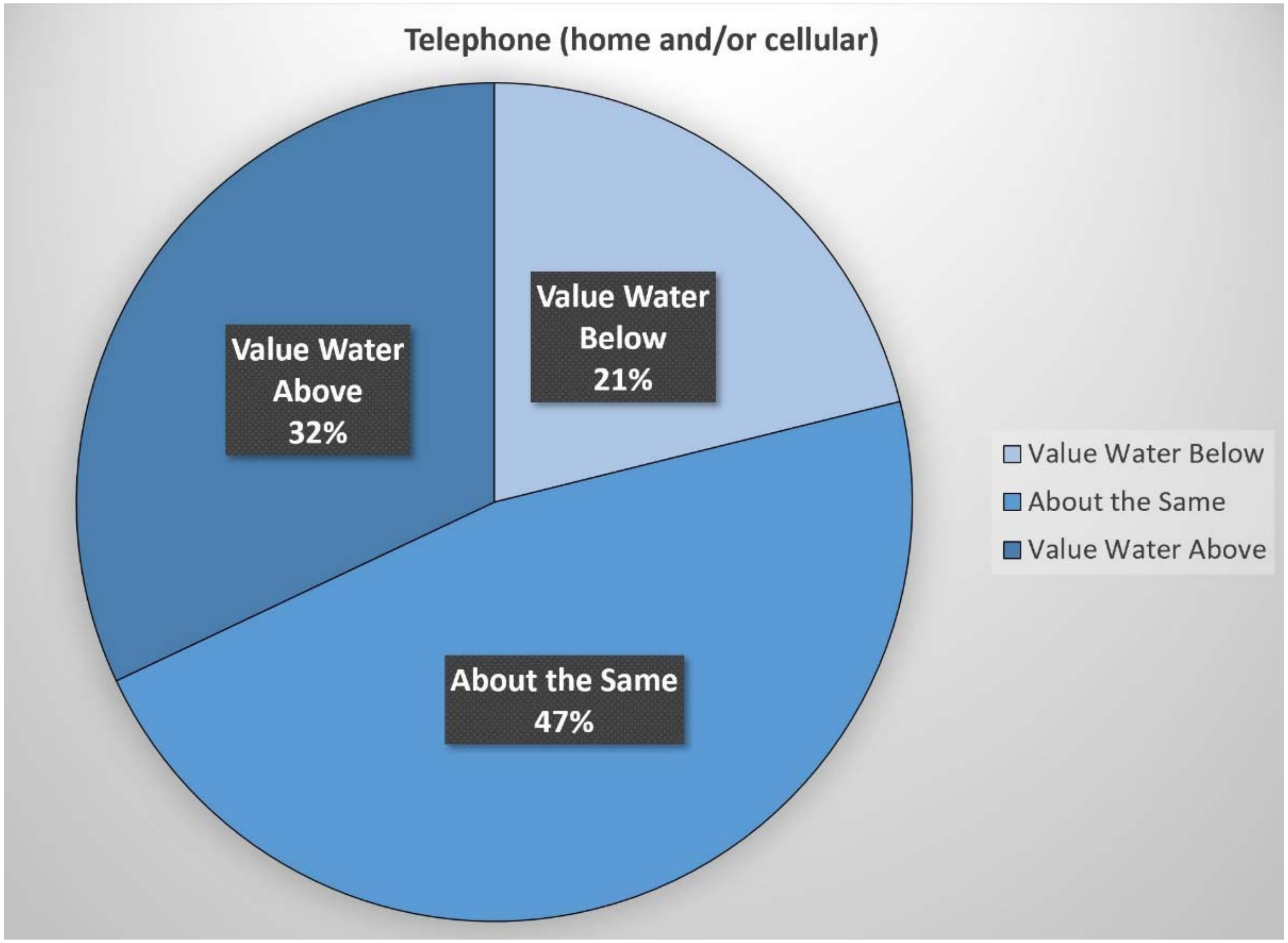


Figure 3-26. Survey Results – Would you prioritize your water bill above, below, or about the same as cable and/or internet?

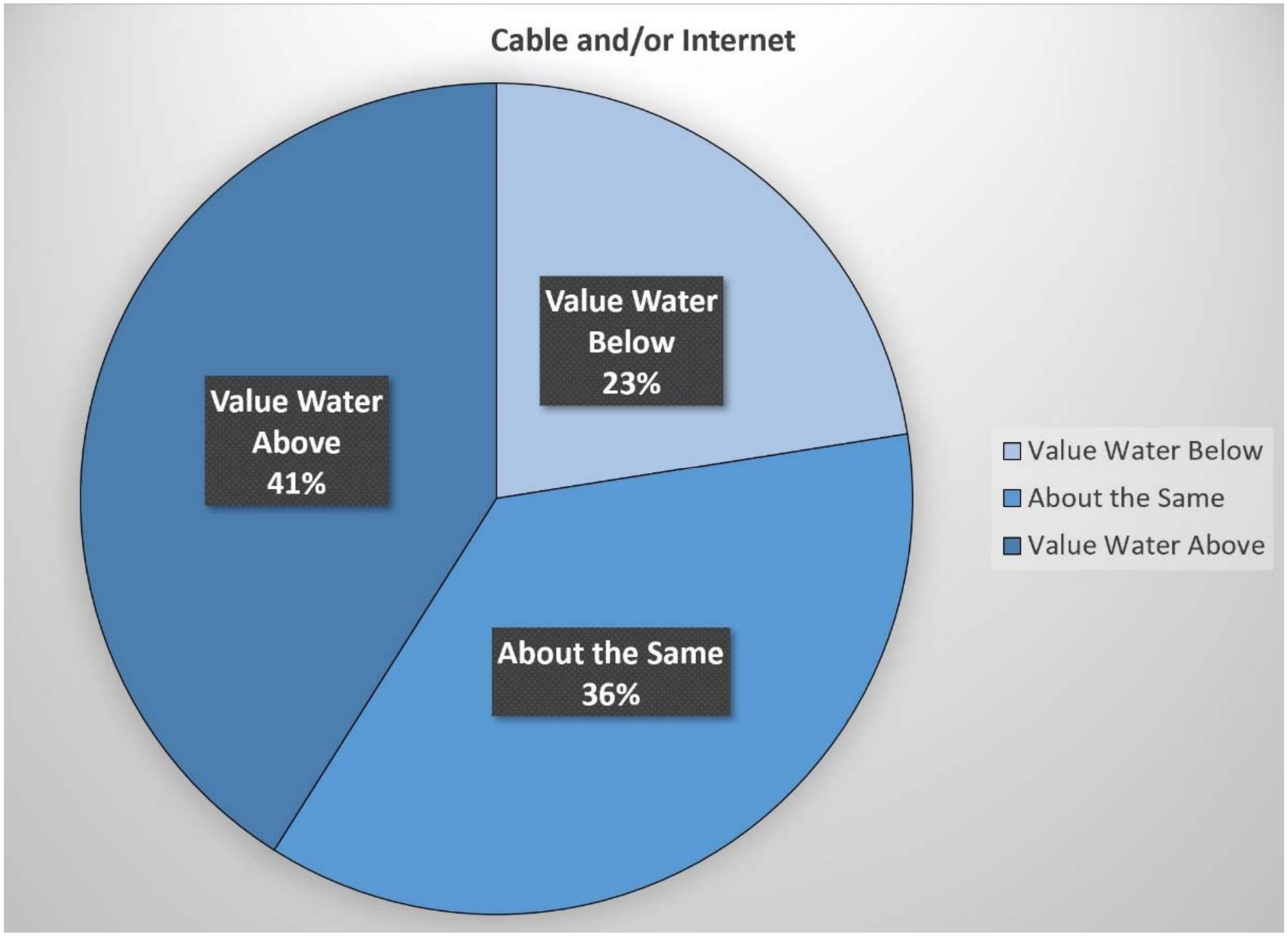


Figure 3-27. Survey Results – Would you prioritize your water bill above, below, or about the same as entertainment?

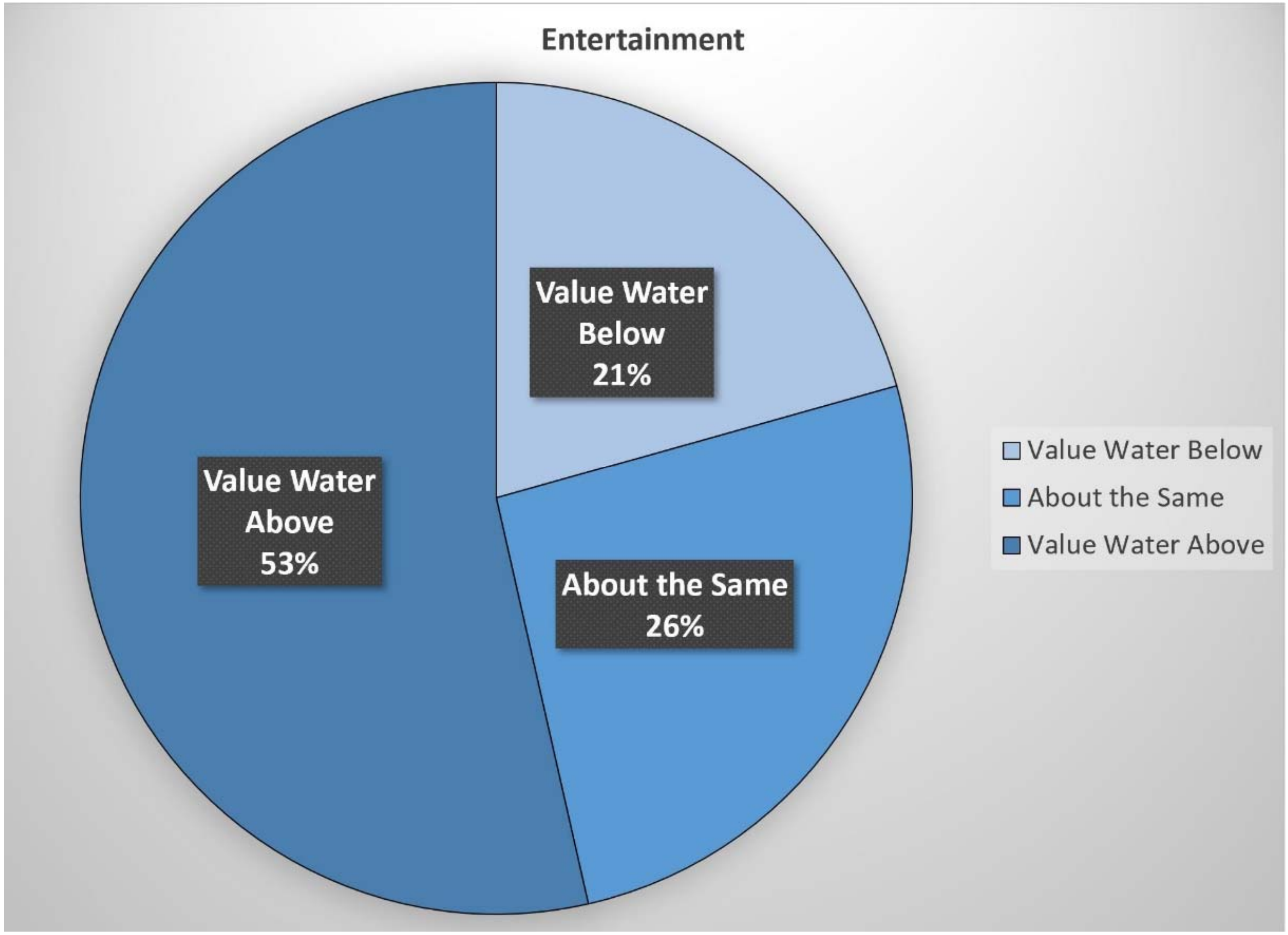


Figure 3-28. Survey Results – Would you prioritize your water bill above, below, or about the same as dining out (food away from home)?

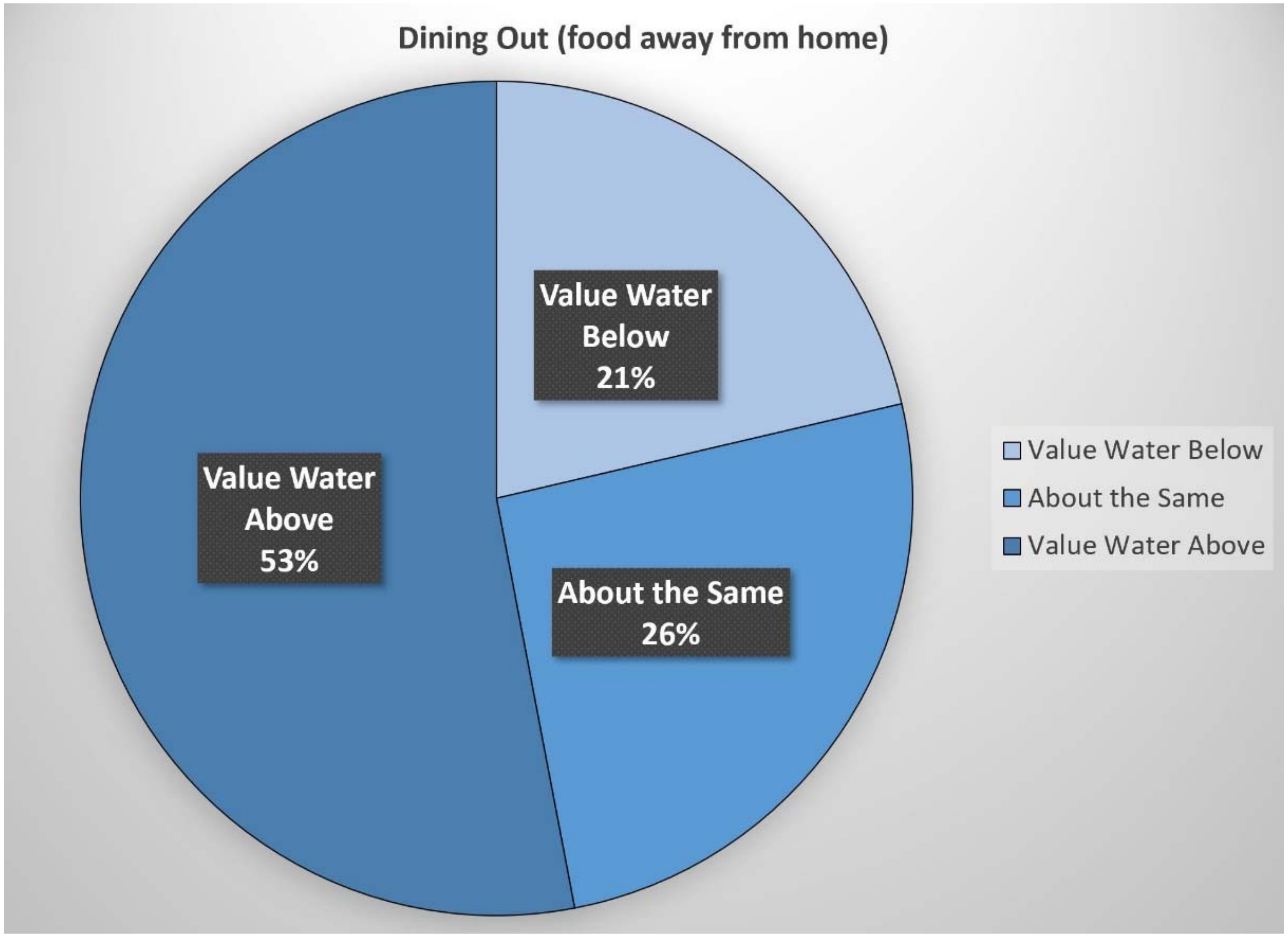


Figure 3-29. Survey Results – Would you prioritize your water bill above, below, or about the same as alcohol and tobacco?

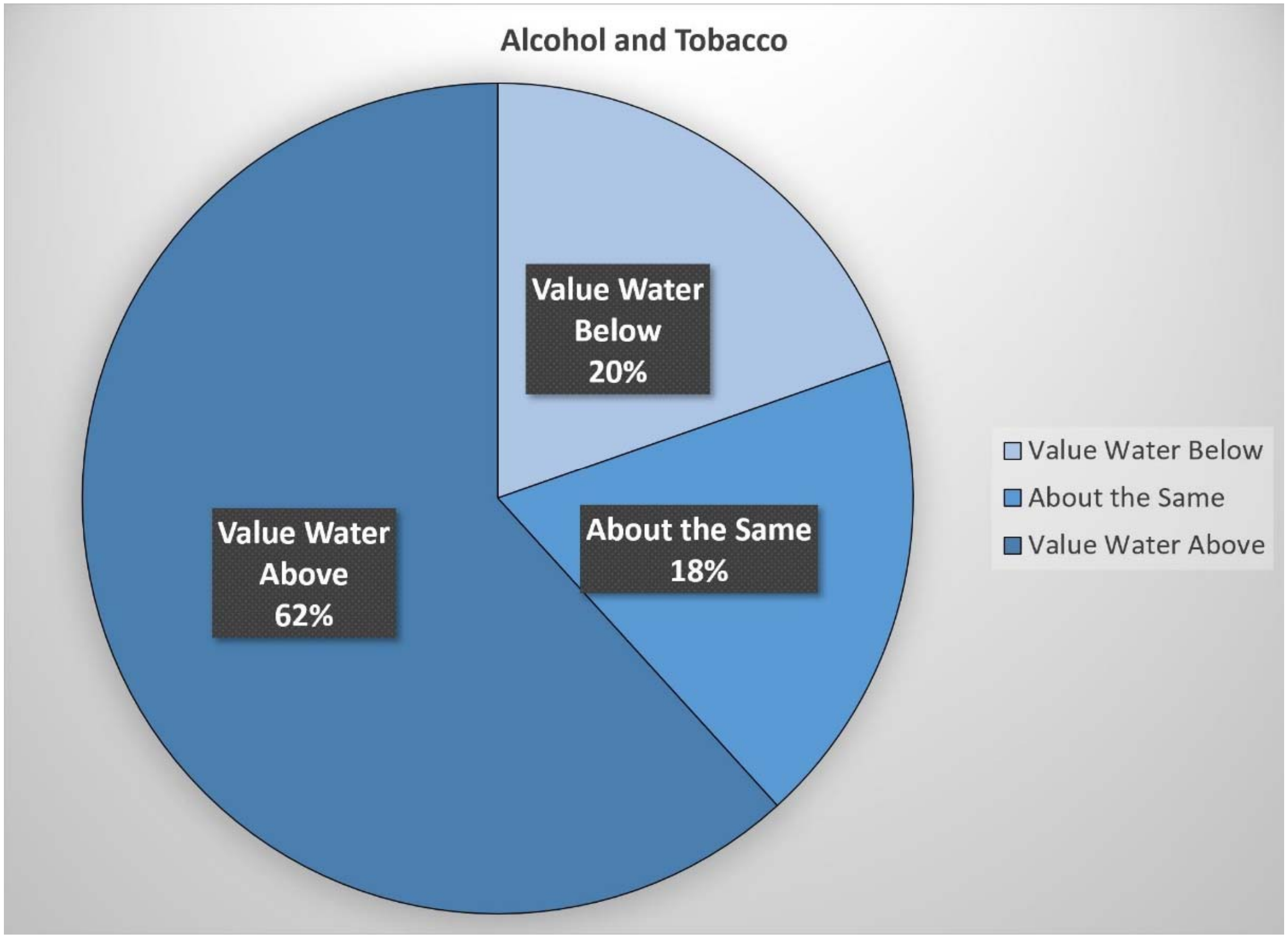


Figure 3-30. Survey Results – What is your age?

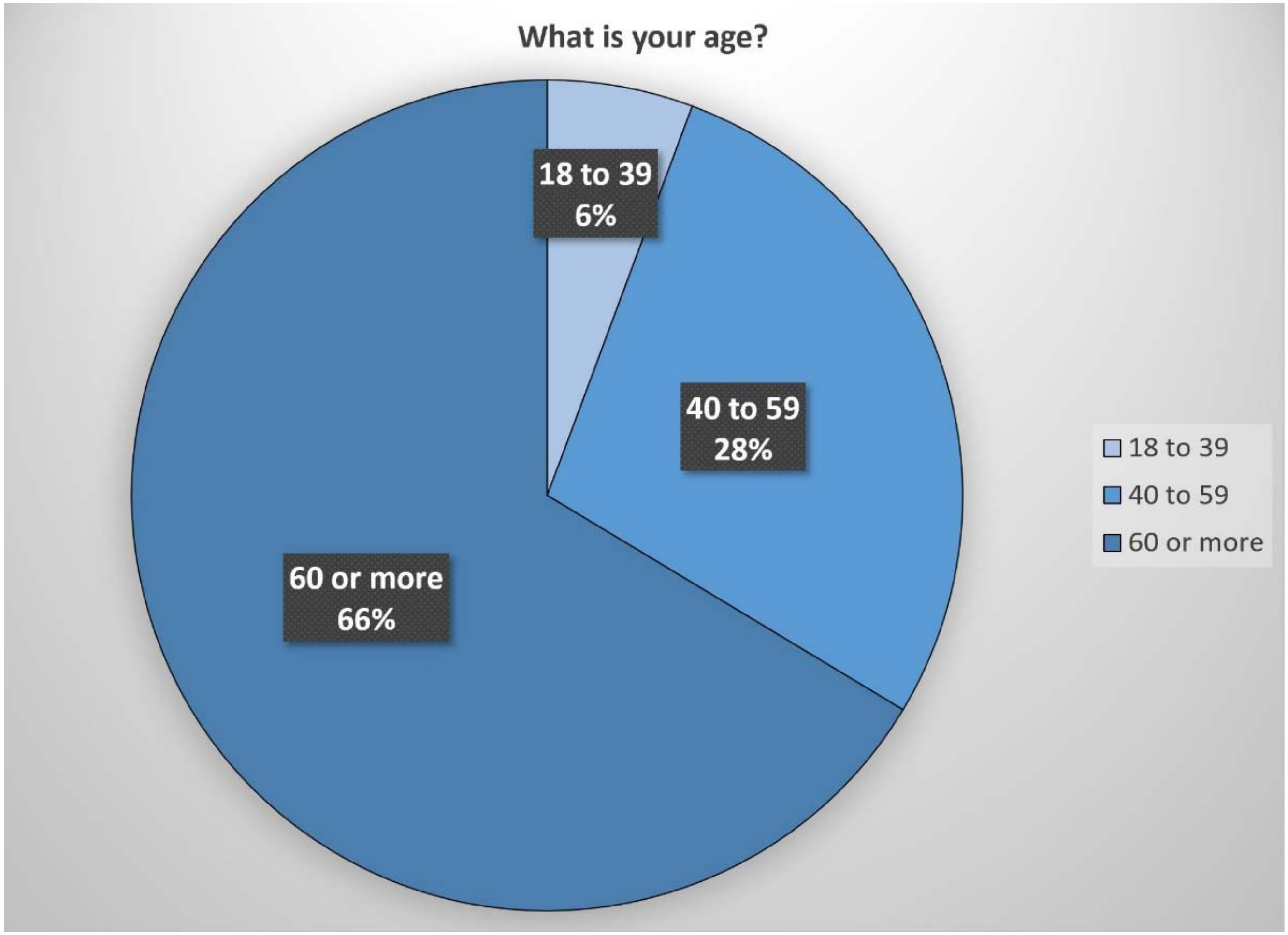


Figure 3-31. Survey Results – What is your employment status?

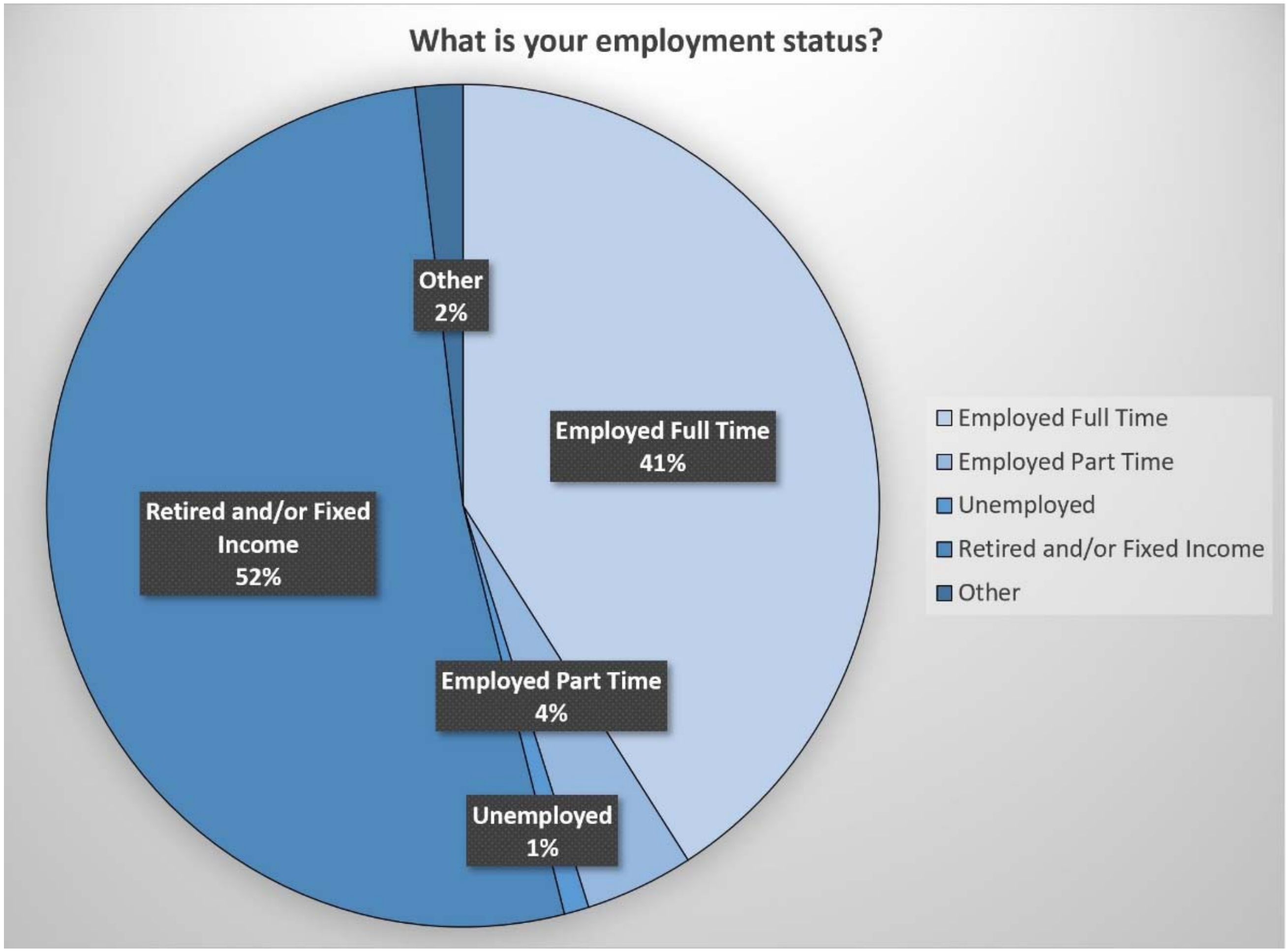
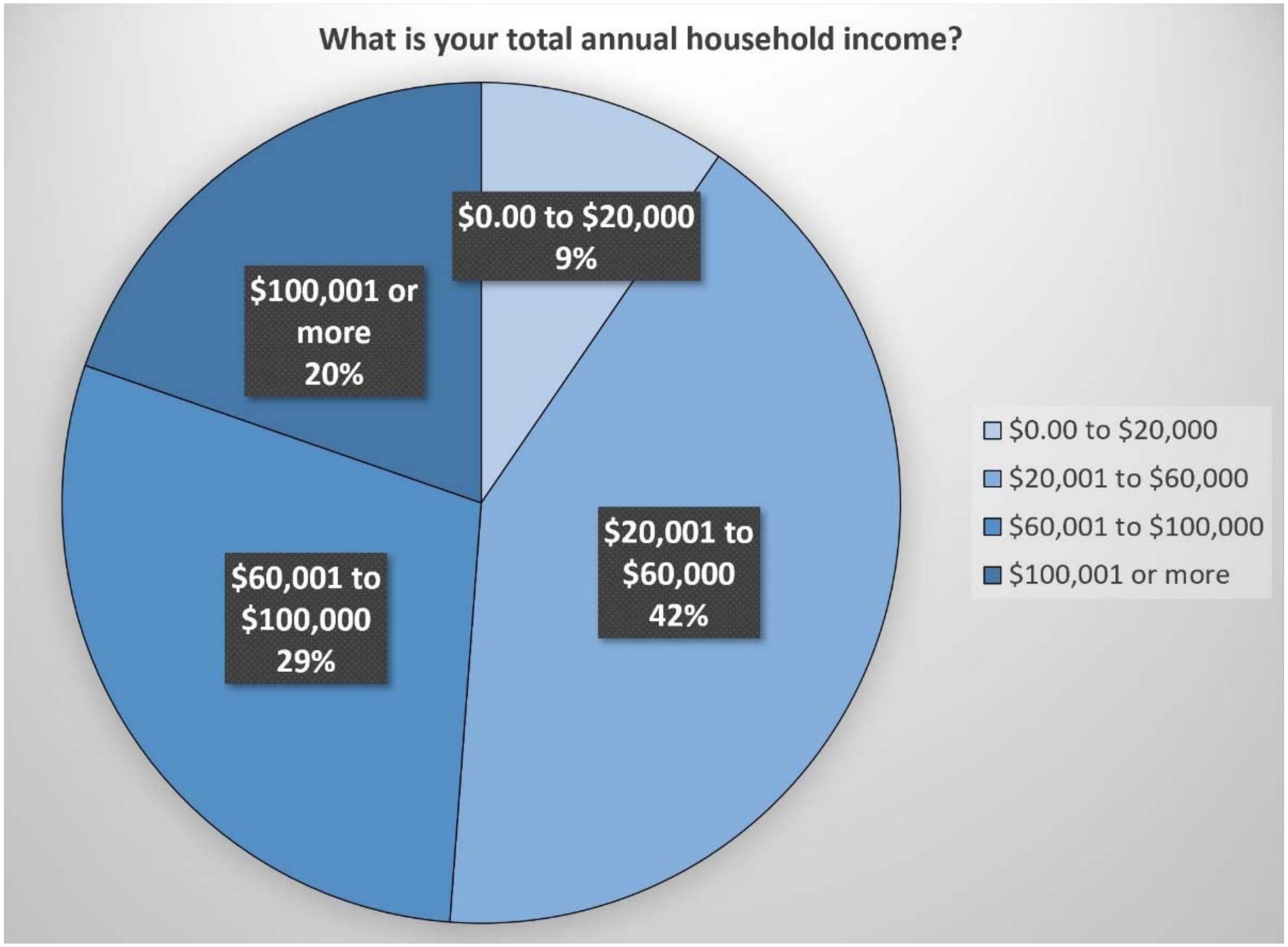


Figure 3-32. Survey Results – What is your total annual household income?



4.0 AMR and AMI Comparison

The District currently has an assortment of meters that will be replaced over time with smart meters for compatibility with advanced AMR (Automatic Meter Reading) and AMI (Advanced Metering Infrastructure) systems. The key motivations and goals of converting from a manual system to either an AMR or AMI system include: (1) improving water conservation, (2) improving customer service, and (3) decreasing operating and billing costs. Water conservation may be improved since the AMR/AMI systems have the ability to notify the PWS and customer about leaks and atypical usage patterns; additionally, data collected via the AMR/AMI systems may be distributed to customers to inform them on their water usage compared to other users which could decrease water demand through conservation awareness. Customer service could also be improved; AMR/AMI systems can provide customers with access to web portals, provide more accurate meter readings, and provide more frequent billing. This can reduce many issues regarding billing discrepancies which are common under a manual system. Finally, AMR/AMI systems can significantly decrease the operating and billing costs; reduce claims and injuries associated with employees entering private properties to take meter readings; reduce labor costs associated with manually collecting meter data; reduce the occurrence and/or duration of leaks, breaks, backflow, theft, and tampering.

4.1 AMR/AMI System Components & Advantages and Disadvantages

AMR systems are relatively simple to install, and do not require an extensive installation plan because the individual units are not part of a larger physical network. AMR systems are typically radio frequency-based, commonly known as a Radio-Read System; the radio frequency (RF) systems can be two-way or one-way. In a two-way RF system, the meter reader sends a signal to the meter transmitter to send the data back to the meter reader. In a one-way RF system, the meter transmitter is continuously broadcasting data so that the meter reader can receive it. This technology eliminates the need for employees to enter private property to access a touch pad. AMR systems can be either handheld, mobile, or fixed/satellite network. For handheld and mobile systems, data is collected by an employee on “walk-by” or “drive-by” visits, respectively. Fixed/mobile networks allow data to be sent through a fixed or mobile satellite network; the satellite transmitter, which communicates with the meter transmitter, can be installed in the vicinity of existing meters. Fixed/mobile networks are best suited for smaller amounts of meters in an area with a clear view to the sky (not suitable for the entire District system). AMR data collection is typically performed on a rotating basis and the frequency often depends on the availability of meter reading staff. A summary of advantages and disadvantages included with an AMR system is presented in **Table 4-1**.

Table 4-1. AMR System Advantages and Disadvantages

Advantages	Disadvantages
• Does not require a large physical network; fixed system with only two meter components • Meter data collected using drive-by approach rather than having to manually collect with touchpad technology • Improved work efficiency and safety • Potentially provides more accurate meter readings and associated billings • Improved detection of Leak/tamper/reverse flow • Customer web portal ability	• May require purchasing data management software to view and analyze data recorded by meter reader • Software cannot communicate with meter transmitter directly • Meter readings must be taken via walk-by/drive-by visits (frequency depending on staff) as compared with AMI system • Billings may not be as frequent as with AMI system, depends on meter reading frequency • Data may not be available until staff is available to take readings, resulting in delayed response time to leaks when compared with AMI system, tampering, and reverse flow alerts • Information available to customers via customer portal is limited when compared with AMI system

AMI systems utilize cellular networks to transmit data, eliminating the need for either a touchpad or radio read components. AMI systems are more complex to install than AMR systems, and require large physical networks. AMI systems typically requires a meter reading and network management software and hosting company which provides visibility and control of the entire system. User consumption data can be accessed in real-time; billing can be integrated into the software; issues regarding leaks, backflow and tampering can be monitored; and add-ons are available to allow the consumer to access information including consumption data, alerts, potential leaks via a smartphone, computer, app, email, or SMS texts. AMI systems typically require the installation of three meter components: the smart meter, a cellular endpoint, and an encoder register. The smart meter, which can be compatible with both AMR and AMI systems, is attached to the encoder register which takes meter readings and monitors any discrepancies including leaks, cut-wires, reverse-flow, no usage, encoder errors, and low battery. The cellular endpoint then communicates with the encoder register and captures meter readings and meter status information; this data, along with the endpoint serial number, is then broadcasted at a predetermined interval to the software using a cellular network. The software can also typically communicate back to the cellular endpoint for programming, clock synchronization, firmware updates, and requesting additional information. Additionally, cellular endpoints can also store several weeks of data which has been recorded at frequent intervals.

This system relays data to the water utility in real time, thus eliminating individual property visits. AMI also allows for customer web portals, faster resolution of billing disputes, and real-time diagnostic operation and maintenance reports. A summary of advantages and disadvantages included with an AMI system is presented in **Table 4-2**.

Table 4-2. AMI System Advantages and Disadvantages

Advantages	**Disadvantages**
• Software can communicate with cellular endpoint directly as compared with AMR system • Meter readings can be logged by the encoder register as frequently as 15 minutes (eliminates dedicated meter reading staff) • Meter readings are remotely sent, on a predetermined interval, to the software via a cellular network in real-time • Improved work efficiency and safety; nearly eliminates labor costs associated with in-field meter readings (still need to go on-site to field check and/or replace faulty meters) • Accurate and frequent meter readings generate accurate and frequent billings • Billings can be done per gallon instead of per 1,000 gallons • Billing dates can be automated • Leak/tamper/reverse flow detection is available in real-time; no delays in response time • Enhanced customer web portal ability as compared with AMR system	• Requires a cellular network with three meter components • Requires purchasing network management and hosting software to view and analyze data transmitted from the cellular endpoint

The following **Figure 4-1** and **Figure 4-2** show flow schematics for the AMR and AMI systems.

Figure 4-1. AMR Flow Schematic

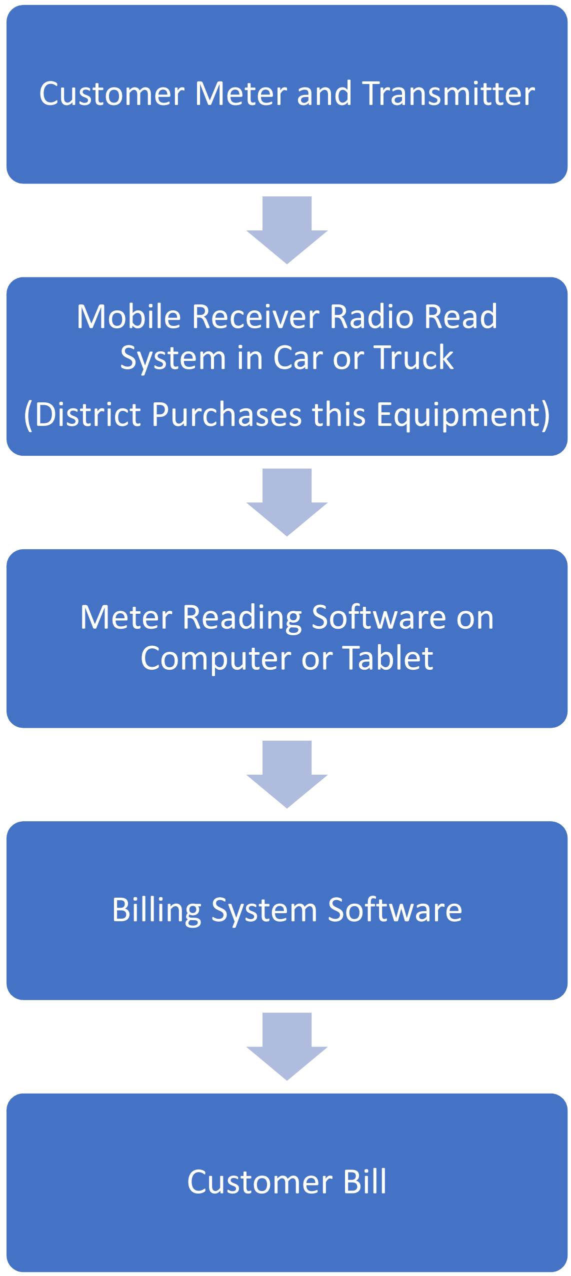
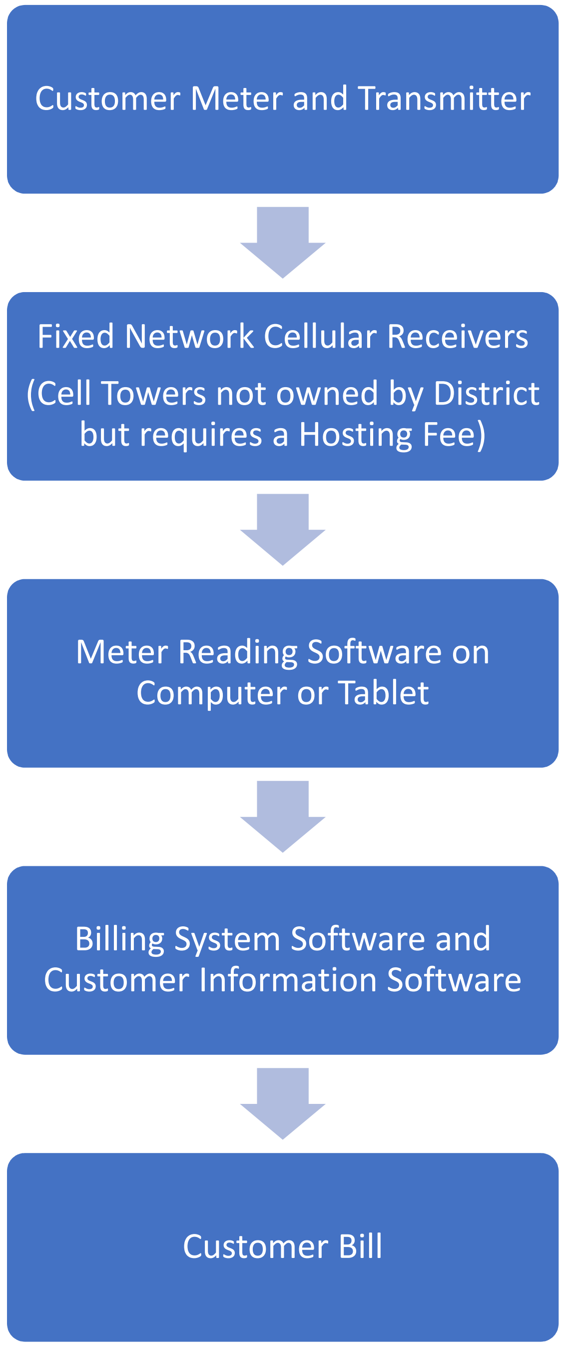


Figure 4-2. AMI Flow Schematic



4.2 AMR/AMI Supplier Options

USI (AMR Installer)
USI Services Inc. specializes in installation of AMR (Radio Read) systems. Their services include development and implement of installation plans, as well as customer outreach. USI offers to provide communication with District customers, including distributing information about the project and meeting with property owners to ensure satisfactory meter installation. They also offer the USIConnect Software application, which allows employees to view work schedules, routes, and cycle status.

Badger (AMR and AMI Meter and Reading Systems Supplier)
Badger Meter is a supplier of equipment for both the AMR and AMI systems. For the AMR systems, Badger charges a monthly mobile hosting fee of $0.06 per meter. For the AMI systems, Badger charges a monthly fee for hosting the cellular service for each meter. Note that for the meter pilot this fee is $0.89 per month per meter. For a larger number of meters, it is anticipated that this fee may be reduced, especially if the services are publicly bid. Both options offer data security, with system endpoints that are encrypted to ensure data is reliably transmitted and received, integrity is maintained, and data cannot be altered.

As mentioned above, AMI systems allow for real-time flow readings which are submitted to a server accessible to the user. The BEACON software provided by Badger allows users to track customer usage in real-time, including detection of leaks and reverse-flow. Additionally, the EyeOnWater® application provided by Badger enhances consumer engagement by providing them access to information such as personal consumption data, alerts, and potential leaks via the EyeOnWater website, smartphone mobile app, email, or SMS text alerts.

Zenner (AMR and AMI Meter and Reading Systems Supplier)
Zenner is a supplier of equipment for both the AMR and AMI systems. They offer both wired and wireless meter systems for remote meter reading. Zenner offers software for their meter system solutions. This software must be purchased from Zenner.

Neptune (AMR and AMI Meter and Reading Systems Supplier)
Neptune Technology Group is a supplier of equipment for both the AMR and AMI systems. Similar to the Badger system described above, this network relies on public cellular networks to operate, thus eliminating costs associated with network infrastructure installation, however, they also charge a monthly hosting fee for the cellular services. It otherwise provides the same features as a fixed AMI system, including real-time readings and two-way communication.

4.3 AMR/AMI Cost/Benefit Analysis

The American Association of Cost Engineers has defined levels of accuracy that are commonly used by professional cost estimators. Three categories of accuracy include: (1) order-of- magnitude, (2) budget, and (3) definitive estimates. The estimates of comparative cost presented in this report are considered order-of-magnitude and are based on a budget provided by a meter supplier (Stiles Company). Our cost estimates are based on June 2018 costs scaled forward to reflect June 2019 construction costs (assuming 3% inflation per year). The costs must be re-evaluated prior to appropriating funds, since material and construction costs increase steadily each year. **Table 4-3** presents the order-of-magnitude costs for the alternatives.

Table 4-3. Meter Reading Systems Order-of-Magnitude Costs

Costs	Existing Manual Read System	Radio Read (AMR) System	Cellular Network (AMI) System
Meters[1]	$1,190,000	$433,000	$433,000
Recorder/Transmitter[1]		$1,219,000	$1,260,000
Installation[2]	$970,000	$970,000	$970,000
Radio Reader for Truck (Trimble and Tablet)[1]	--	$19,000	$0
Total Capital Costs	$2,160,000	*$2,641,000*	*$2,663,000*
Annual Fees (Hosting, licensing, etc.)[3]	$0	$7,600	$79,300
Estimated Annual Labor Costs for Meter Reading[4]	$192,000	$48,000	$0

[1] Meter, Recorder & Transmitter, Radio Reader costs based on quotes received from Stiles Company for the Badger meter systems.
[2] Installation cost assumes an average cost of $140 per meter to account for cost variations for different sizes.
[3] Annual fees for monthly hosting fee and annual licensing fees based on quotes received from Stiles Company.
[4] Estimated annual labor costs for (1) existing system assumes two full time staff dedicated to meter reading, (2) for radio read system assumes quarterly meter reads, (3) for cellular system assumes no meter reading staff.

Each alternative has advantages and disadvantages as described and associated capital and O&M costs. Deciding which alternative to incorporate involves evaluation of various factors including costs, improved billing efficiency, more access to data, potential to resolve leaks more quickly, improved water conservation, etc. We have developed a decision matrix to assist with determining the best fit solution through evaluation of the key factors. The following **Table 4-4** decision matrix presents the key factors involved in the selection process. Each factor was rated as 1 = less favorable or 2 = moderately favorable or 3 = highly favorable. The factors were weighted as shown. The Relative Score is the Sum of the Factor Ratings times the Factor Weight. Based on the factors, relative importance, and rating the AMI system is the most favorable alternative.

Table 4-4. AMR/AMI System Cost/Benefit Analysis

Factors	Factor Weight	Existing System	AMR System	AMI System
Impact of Meter Capital Costs	25%	3	1	1
Impact of Operation & Maintenance Costs	20%	1	2	3
Billing Efficiency Improvement	5%	1	2	3
Cash Flow Improvement Potential	5%	1	2	3
Data Accessibility Improvement	10%	1	2	3
Water Conservation Improvement	10%	1	2	3
Leak/Backflow/Tamper Detection Ability	10%	1	2	3
Customer Web Portal Access to Information	5%	1	2	3
Customer Satisfaction Improvement	5%	1	2	3
Customer Financial Planning Improvement	5%	1	2	3
Relative Weight	**100%**	**1.5**	**1.75**	**2.5**

Score Rating:
1 = Less Favorable
2 = Moderately Favorable
3 = Highly Favorable

5.0 AMR/AMI Pilot for Commercial Accounts

The District recognizes that a considerable number of the commercial meters are nearing or past their 10-year replacement date. It is also recognized that these meters tend to have a wide variation in flow and can be prone to not properly tracking water use. Part of the District's match on this project was to purchase a select number of meters for commercial accounts equipped with AMR/AMI equipment (purchased through Stiles Company). This task included installation of these meters, vendor costs associated with data collection (Badger Beacon Advance Metering Analytics cellular monthly hosting fee) and data processing (through District's existing water billing vendor, Northern Data Systems).

Table 5-1 presents a summary of the meters installed for the meter pilot. The District purchased the meters as part of their in-kind match toward this project. The meters selected for the pilot were Badger disc meters with HRE register and Orion cellular endpoint. Badger's Beacon Advance Metering Analytics service completes the equipment and services needed to operate as an AMI system capable of providing hourly data to the District.

Table 5-1. List of Meters for Meter Pilot

Account Number	Name/Address	Size of Meter	Quantity
50600	Siesta Village	1 ½ inch	2
57000	Ripleys Mobile Homes	¾ inch 1 inch	1 1
25630	Decas School	2 inch	1
50880	Greentree Estates	1 ½ inch 1 inch	1 1
51500	Garden Homes North	1 ½ inch	2
58000	Royal Crest	1 ½ inch	1
54600	Great Hill Corp.	1 ½ inch	2
21655	Tobey Hospital	2 inch	1
53040	Morgans Park	1 ½ inch	1
54000	Red Wings Estates	1 ½ inch	1
57500	Holly Heights	1 ½ inch	1

Data collection and analysis will be performed to identify any issues that may arise from this process and integration with the billing software system.

6.0 Summary

The focus of this project was to access the value of water within the Wareham Fire District (District). A customer opinion survey was conducted. The results indicate that customers are generally satisfied with the quality and service of the District. There were reoccurring comments on the water appearance and taste relative to discolored water. These issues may be addressed through the construction of a new iron and manganese removal facility currently underway. The survey also provided information on customer opinion with regards to billing frequency, current technology and cost of water in comparison to other spending categories. The data indicate that customers are generally satisfied with the current billing of twice a year. This demonstrates that if the District sees value in more frequent billing and upgrades to the meter reading equipment, then the District will need to conduct a customer education campaign on the value and benefits of an improved billing system. This campaign will be a necessity since a change of meter system will be a significant capital investment on which the customers would vote.

A change from semi-annual billing to quarterly or monthly billing would require an investment to switch to the needed water meters. Since the options have significantly different capital costs and annual costs, a present worth analysis was completed for comparison of the life-cycle costs. The present worth analysis provides the present worth or value of the present day capital costs plus the present value of 15-years worth of annual O&M costs. The present day capital costs were presented in **Table 4-1** and the present worth analysis uses the capital costs "as is" no additional calculation needed. The present value of 15-years worth of annual O&M costs is more complicated. Essentially, these annual costs need to be projected forward using an annual escalation, totaled and brought back to the present to be added to the present value capital cost. This calculation is particularly helpful when options have significantly different capital and O&M costs. For example, one option may have low capital costs but high annual O&M costs and the other option has high capital costs and low annual O&M costs. This analysis allows for a way to compare the life-cycle costs of these options.

Engineering Economics tables and equations were used to obtain the future value of the repeated annual costs, assuming the escalation will be 3% per year for 15-years. Then the future value of those annual costs was converted to a present worth. **Table 6-1** presents the capital and ongoing annual costs for each of the options. This analysis is helpful in determining the true cost for each alternative based upon a 15-year planning horizon. The final row of this table provides the Present Worth of the Capital and 15-years of Annual Costs, essentially the Life-Cycle Costs. The more financially advantageous billing system would be Quarterly Billing using either the Radio Read (AMR) or Cellular Network (AMI) Systems. Note that the Cellular Network System (AMI) offers added features and benefits not capable with the Radio Read System. These include more frequent data feedback to the District on potential customer leaks which would help reduce the magnitude of bill abatements.

Table 6-1. Comparison of Costs per Billing Frequency Type

Customer Billing Frequency	Semi-Annual Billing	Quarterly Billing	Quarterly Billing	Monthly Billing
Meter System Required	Manual Collection (Existing System)	Radio Read (AMR System)	Cellular Network (AMI System)	Cellular Network (AMI System)
Capital Costs (from Table 4-1)				
Total Capital Costs[1]	$1,190,000	$2,641,000	$2,663,000	$2,663,000
Annual Costs				
Employee Cost for Data Collection (Labor Costs)[2]	$192,000	$48,000	$0	$0
Vehicle Purchase Cost Set Aside, Maintenance, Insurance and Fuel[3]	$11,200	$5,700	$0	$0
Meter System Annual Fees (Hosting, licensing, etc.)[4]	$0	$7,600	$79,300	$79,300
Bill Processing and Mailing Fee[5]	$10,080	$22,800	$22,800	$67,200
Total Annual Costs	$213,280	$84,100	$102,100	$146,500
Present Worth Costs				
Present Day Capital Costs[1]	$1,190,000	$2,641,000	$2,641,000	$2,663,000
Present Value of 15 Year Annual Costs[6]	$3,970,000	$1,560,000	$1,899,000	$2,730,000
Present Worth Costs (Capital & Annual) for Comparison of Life-Cycle Costs[7]	$5,160,000	$4,201,000	$4,562,000	$5,393,000

[1] Present Day Capital Costs for installation in 2018, refer to Table 4-1 for additional information.

[2] Labor costs assume 2 full time staff for Existing System and reduced labor cost for Radio Read system since it is anticipated that the entire system could be read in two weeks using one truck and driver.

[3] Vehicle cost includes purchase cost set aside of $3,000 per year assuming vehicle would be kept for 10 years, maintenance cost of $1,000 per year, insurance cost of $1,500 per year and fuel cost of $3.50 per gallon and a conservative mileage rate of 10 miles per gallon to account for frequent starting/stopping required for this type of work. For Existing System, assumes two vehicles. For Radio Read System assumes one vehicle.

[4] Annual fees for monthly hosting fee and annual licensing fees based on quotes received from Stiles Company.

[5] Bill processing and mailing fees based on estimates from Northern Data Systems for color print bills.

[6] Present Value of the 15-Year Annual Costs assumes increase in costs by 3% each year. Present Value of the 15-Year Annual Costs does not include loan payment since this cost is in the capital cost.

[7] Present worth costs include present day capital costs and present value of the 15-year annual costs.

Each alternative has advantages and disadvantages as described and associated capital and O&M costs. Deciding which alternative to incorporate involves evaluation of various factors including costs, improved billing efficiency, more access to data, potential to resolve leaks more quickly, improved water conservation, etc. We have developed a decision matrix to assist with determining the best fit solution through evaluation of the key factors. The following **Table 6-2** decision matrix presents the key factors involved in the selection process. Each factor was rated as 1 = less favorable or 2 = moderately favorable or 3 = highly favorable. The factors were weighted as shown. The Relative Score is the Sum of the Factor Ratings times the Factor Weight. Based on the factors, relative importance, and rating Quarterly Billing using the AMI system is the most favorable alternative.

Table 6-2. Billing Frequency and Meter Technology Cost/Benefit Analysis

Customer Billing Frequency		Semi-Annual Billing	Quarterly Billing	Quarterly Billing	Monthly Billing
Meter System Required		**Manual Collection (Existing System)**	**Radio Read (AMR System)**	**Cellular Network (AMI System)**	**Cellular Network (AMI System)**
Factors	**Factor Weight**	**Rating**			
Impact of Meter Capital Costs	25%	3	1	1	1
Impact of Operation & Maintenance Costs	20%	1	3	3	2
Billing Efficiency Improvement	5%	1	2	3	3
Cash Flow Improvement Potential	5%	1	2	2	3
Data Accessibility Improvement	10%	1	2	3	3
Water Conservation Improvement	10%	1	2	3	3
Leak/Backflow/Tamper Detection Ability	10%	1	2	3	3
Customer Web Portal Access to Information	5%	1	2	3	3
Customer Satisfaction Improvement	5%	1	2	3	3
Customer Financial Planning Improvement	5%	1	2	3	3
Relative Weight	**100%**	**1.5**	**1.95**	**2.45**	**2.3**

Score Rating:
1 = Less Favorable
2 = Moderately Favorable
3 = Highly Favorable