BOZEMAN STORMWATER SURVEY REPORT

Abstract

This work reports the results of a stormwater survey developed by Montana State University's GPHY 491 class during the fall of 2020. The survey was developed in partnership with the City of Bozeman's Stormwater Division and sought to collect data about how Bozeman residents interact, view, and understand Bozeman's stormwater system and how it is managed by the Stormwater Division. The report was completed under the advisement of Dr. Sarah P. Church.

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I. Introduction

Bozeman, Montana, the county seat of Gallatin County in southwestern Montana, is the fastest growing micropolitan City in the nation, having experienced 23.8% population growth since 2010 (U.S. Census Bureau, 2018). This population growth can be attributed in large part due to in-migration (Headwaters Economics, 2020). Bozeman is not only adjacent to three blue ribbon trout fishing streams: the Madison, Gallatin, and Yellowstone Rivers, but also a short drive from Big Sky and Bridger Bowl, two ski resorts known for their cold smoke powder (Kendall, 2018). Bozeman's population has a median age of just 28, compared with the nation's median age of 38.5 (U.S. Census Bureau, 2018), and is well-educated, with 56.7% of the population holding a bachelor's degree or higher (U.S. Census Bureau, 2018). It is also important to point out that this number is likely influenced by Montana State University (MSU) located in the heart of Bozeman. Places with higher education rates, particularly within their workforce, tend to grow quickly, have higher annual income among their residents, and are less affected during economic slumps (Moretti, 2012). This is in line with the income statistics of Bozeman which indicate that the average earnings per job within the City has increased by 23.6% over the past two decades (ACS, 2018). The City has a total of 20,325 housing units, 40.6% of which are single-family detached homes, 22.9% duplexes or attached homes, 33.3% buildings of 3 or more units, and 3.2% mobile homes (ACS, 2018).

Sitting adjacent to the confluence of the Missouri River, the City is very dry with only 19.3" of annual rainfall, and an average temperature hovering around 45 degrees. The town itself sits at an elevation of almost 5000 ft (City of Bozeman, 2020). There is a plethora of waterways that interact with the City. The stormwater system of Bozeman is directly connected to three major waterways including Mandeville Creek, Bozeman Creek, and the East Gallatin River, and indirectly connected to many others (City of Bozeman, 2020). These creeks and rivers drain into larger waterways until they end up in the Missouri River. The City of Bozeman Stormwater Division's role is both mitigating pollution (including oil and grease, sediment, trash, fertilizers/pesticides, and animal waste) via the stormwater systems well as testing for these pollutants in local waterways. Bozeman's stormwater plan seeks to, "Improve waterway health, protect public safety, and comply with its MS4 permit through the collection of stormwater and waterway data points." (City of Bozeman, 2020, pg.47). Unlike sewage systems, stormwater in Bozeman is not treated and drains directly into local waterways. This can cause many problems including sediment to build up, runoff from yards and lawn clippings, along with the addition of warm water to the local cold-water systems (Papangelakis, 2019).

The MS4 permit for the City's storm/sewer system requires Bozeman's Stormwater Division to perform a number of tasks to protect water quality, including pollution mitigation, public education, and enforcement of onsite stormwater mitigation for new developments within the City. To facilitate compliance with these regulations, the City of Bozeman's Stormwater Division operates as a utility, with each landowner being billed according to the size of their lot and the proportion of their lot covered in impervious land cover such as asphalt and concrete

(City of Bozeman & Montana State University, 2019). There have been multiple projects implemented on the creeks from the City and private organizations alike. These projects include stream clean ups and a water quality measurement project, recently sponsored by MSU (Top, 2020). In 2016 the City approved the Bozeman Creek Enhancement at Bogart Park which added more ecologically friendly channeling to the stream along with more floodplain capacity during years with heavy snowpack (Top, 2020). Thus, it can be seen that initiative has been taken to help improve the waterways connected to the city's stormwater systems.

Recent programs carried out by the City of Bozeman include inventorying all stormwater assets and assessing their condition, the formulation of new rate models for collection of funding for the program, and the development of service timelines to fix issues associated with the system (City of Bozeman, 2020). The adopt a drain program was also implemented not only to help clean storm drains around the City, but also to include residents of the area and help educate them about stormwater. Through this program the City provides all the necessary tools and parts to properly clean around a stormwater drain. This project not only helps clean out drains, which in turn is better for the rivers into which the stormwater discharges, but also keeps the drains looking more presentable throughout the City (City of Bozeman, 2020). As Bozeman continues to grow and more impervious surfaces are constructed, the work of the Stormwater Division will only become more important to help keep the local waterways healthy, as these waterways are a part of City's larger community.

Accordingly, the City of Bozeman's Stormwater Division sought to collect more information about how their constituents viewed, understood, and interacted with the stormwater system. Our environmental planning class developed a survey to collect this information for the City and illustrate a partnership between MSU and the City of Bozeman Stormwater Division. The online survey was conducted to help inform the Stormwater Division on how the residents of Bozeman viewed and understood stormwaters management within the City. A link to the survey was included in the City's stormwater utility bill. The survey consisted of questions surrounding how Bozeman residents viewed, understood, and interacted with the stormwater system and its management. Consisting of thirty-six questions and two open response questions, the results suggest multiple useful takeaways for the City of Bozeman's Stormwater Division. Overall, we found the following key takeaways from the 76 survey respondents:

- **Effective Education Efforts:** Over the past two decades, the City has carried out education initiatives for their stormwater system. We contend these efforts have proven effective because respondents illustrated a good understanding that the City actively manages a stormwater system.
- **Disconnect of Interaction with Local Waterbodies:** Although respondents knew that stormwater pollution can negatively impact the local water system, and that Bozeman had a stormwater management system, they generally did not know where the water went after draining into the stormwater pipes. Just over fifty three percent of the respondents incorrectly thought that stormwater went through a water treatment plant before it was dumped back into local creeks and river.

- **Stormwater Mitigation Techniques:** Respondents indicated that they were willing to participate in mitigation techniques, yet, their willingness dropped for activities related to increased taxes/fees.
- **Identify Heavily with Local Waterways:** Respondents made it clear that local waterbodies are an important aspect of their daily lives. Accordingly, the Stormwater Division should try and appeal to this sense of community within Bozeman.

II. Methods

We designed a survey to be distributed to customers of Bozeman's stormwater utility. The questions were developed as a collective class, then refined alongside Stormwater Division leadership. The survey sought to understand how City residents interacted, viewed, and understood the City's stormwater system and its management. The questions were written according to the best practices in survey design and were primarily ordinal multiple-choice questions with some open-ended questions (Dillman et al. 2014). Demographic information was asked for the purposes of analysis, but no identifying information was collected, and respondents remained anonymous. The demographic information was collected with MSU IRD approval under IRD SC092220-EX.

This survey was administered completely online, via Qualtrics online survey software, and was distributed initially to every stormwater utility customer (n=16,000) (Peoria and Mounsey, 2020). A link to the survey was included on the bill insert for those who received physical bills in the mail; for those who received online bills the link was included on the online bill insert. The survey was also shared via three other distribution methods including a news clip in the Montana State University Earth Sciences Department newsletter, a link shared to several Facebook groups, and by word-of-mouth from students in the GPHY 491 Environmental Planning and Management Toolkit class at MSU. The survey received a total of 76 responses including 56 surveys completed in full, and 20 surveys with at least one question answered. We are unable to calculate a response rate, because since the survey was a convenience sample and distributed with multiple platforms, we do not know the total number of people the survey reached.

III. Data Analysis

First, we cleaned the survey data. Cleaning included removing responses, particularly in the demographic section that did not apply to the survey (a common deleted response was "Why is this necessary"), and categorizing open-ended response for gender and race/ ethnicity, as well as computing respondent's ages. We used IBM SPSS software for data analysis, including calculating means, response numbers, non-responses, and frequencies. We then used Microsoft Excel to create tables. For ordinal and multiple-choice questions, each response correlated to a number (e.g.. 1= 'yes', 2= 'no', 3= 'unsure'). Questions with more response options followed a similar pattern with a larger range (e.g. 1= 'Facebook' 2= 'Instagram' 3= 'Water Bill Insert'). We were then able to use these data to understand how each question item was perceived by respondents.

The results presented below include tables with references to the survey question number. The survey consisted of closed and open-ended questions using the following skip pattern:

Question	Rules
Q4	If respondents answered 'yes' to Q4: *To the best of your knowledge does this City of Bozeman have a stormwater management program?* they moved on to Q5: *How did you hear about the City's stormwater management program?* Q23: *If you were to seek information about stormwater management, where are you likely to seek that information?* was only displayed if respondents answered 'yes' to Q4. If they answered 'No' or 'Unsure/Don't know' they skipped Q5 and move on to Q6: *To the best of knowledge, please indicate whether or not you think the City of Bozeman's stormwater drains into the following.*
Q10	If respondents answered 'yes' to Q10: *Do you pay a monthly bill for stormwater management?* they moved on to Q11: *In your opinion, the amount you pay on your stormwater bill on average, is?*. Q36: *Since taking this survey, has your opinion changed about how much you pay for your average monthly stormwater bill?* and the corresponding open response Q37: *Please share your reasoning for the choice you made above.* Were only displayed if respondents answered 'yes' to Q10. If they answered 'No' or 'Unsure/Don't know' they skipped Q11 and move on to Q12: *Before taking this survey, did you know that the City of Bozeman's Stormwater Division provided the following stormwater services?*
Q38	If respondents answered 'yes' to Q38: *Do you own or care for a dog?* they moved on to Q21: *Please indicate how influential, if at all, the following are on your motivation to pick up dog waste*. If they answered 'No' or 'Unsure/Don't know' they skipped Q21 and move on to Q23: *If you were to seek information about stormwater management, where are you likely to seek that information.*

Accordingly, the following skip pattern diminished the number of responses on specific questions, because the survey only asked them the question if the responded 'yes' to another question.

It is important to note that our survey was not a simple random sample of Bozeman's population. Accordingly, the survey results cannot be generalized to the entire City's population. The survey was voluntary. We hope the information collected proves useful to the City; however, please be aware that it is possible that respondents were proactive members of the municipality because they chose to participate in a survey that was not directly mailed/emailed to them and thus they may have had more interest and buy-in of the topic than non-respondents. The data reported here reflects these respondent's opinions, needs, and thoughts of Bozeman's municipal stormwater system. There were 76 respondents who answered at least one survey question. Although this number of responses provides and exploratory look at stormwater perceptions of the Bozeman community, we did not receive enough responses to properly account for bias and variation within the respondents.

IV. Results

Table 1. Understanding stormwater management in Bozeman: knowledge of the stormwater program

Corresponds to Q4: "To the best of your knowledge, does the City of Bozeman have a stormwater management program?"

	Yes	No	Unsure/Don't Know
	Frequeny (%) | n = 76		
Does the city have a stormwater management program?	69.7	3.9	26.3

Table 2. Understanding stormwater management in Bozeman: how heard about the stormwater management program

Corresponds to Q5: "How did you hear about the City's stormwater management program?"

		Yes	No
Source	n	Frequency (%)	
City of Bozeman website	35	56.1	43.9
Water bill insert	40	47.5	52.5
Conversation	53	46.3	53.7
Newsletters/brochures/fact sheets	53	44.7	55.3
Exhibits/displays at parks/natural areas	53	36.8	63.2
Newspapers/magazines	38	28.9	71.1
Workshops/public meetings	36	22.2	77.8
Neighborhood meetings	34	19.4	80.6
Nextdoor app	36	15.4	84.6
Local library	28	8.8	91.2
Instagram	38	5.7	94.3
Other website	36	3.6	96.4
Radio	34	2.9	97.1
Facebook	41	2.8	97.2

Table 3. Understanding stormwater management in Bozeman: where stormwater drains
Corresponds to Q6: Stormwater runoff generated from rain and snowmelt events that flow over land or impervious surfaces, such as paved streets, parking lots, and building rooftops, and does not soak into the ground. "To the best of your knowledge, please indicate whether or not you think the City of Bozeman's stormwater drains into the following:"

		Yes	No	Unsure/Don't Know
Catchments	n	Frequency (%)		
Bozeman Creek	66	72.2	6.1	21.2
East Gallatin River	66	65.2	9.1	25.8
Water Treatment Plant	64	56.3	26.6	17.2
Mandeville Creek	66	47.7	10.8	41.5
Madison River	65	25.0	49.9	29.1

Table 4. Understanding stormwater management in Bozeman: water quality pollution sources
Corresponds to Q7: The items listed below are sources of water quality pollution across the country. "In your opinion, how much of a problem, if at all, are the following sources in the Bozeman area?"

		Not a Problem(1)	Slight Problem(2)	Moderate Problem (3)	Severe Problem(4)	Unsure/Don't Know(5)		
Source	n	Frequency (%)					Mean	SD
Fertilizers and chemicals use on golf courses	61	0.0	13.1	37.7	49.2	0.0	3.4	0.708
Debris/Erosion from construction sites	58	1.7	13.8	39.7	44.8	0.0	3.3	0.768
Fertilizers and chemicals used in farm fields	61	0.0	12.9	45.2	41.9	0.0	3.3	0.687
Fertilizers and chemicals used in lawns	62	0.0	11.3	46.8	41.9	0.0	3.3	0.667
Fertilizers and chemicals used on non-residential landscaping	62	1.6	17.7	45.2	35.5	0.0	3.2	0.765
Trash and illegal dumping	59	0.0	32.2	37.3	30.5	0.0	3.0	0.884
Improperly maintained septic systems	54	7.4	29.6	31.5	31.5	0.0	2.9	0.953
Automotive fluids	61	1.6	31.1	41.0	26.2	0.0	2.9	0.952
Waste from domestic pets	63	9.5	22.2	38.1	30.2	0.0	2.9	0.94
Erosion from stream/riverbanks	60	6.7	20.0	53.3	20.0	0.0	2.9	0.812
Erosion from farm fields	62	1.6	29.5	47.5	21.3	0.0	2.9	0.755
Manure from farm animals	60	13.3	30.0	38.3	18.3	0.0	2.6	1.038
Discharge from industry	52	5.8	40.4	46.2	7.7	0.0	2.6	0.725
Grass clippings	59	20.3	37.3	28.8	13.6	0.0	2.4	0.961
Leaves	58	24.1	32.8	25.9	17.2	0.0	2.4	0.961
Car wash soap	57	15.8	38.6	35.1	10.5	0.0	2.4	0.80

Generally, respondents thought that the pollution sources listed in the question were at least a slight problem, as the answer 'not a problem' had a low proportion of responses. These results show that respondents think the largest source of pollution were golf courses (mean=3.5), and construction sites (mean=3.3), and that the sources of least pollution were from leaves in the fall (mean=2.4), and car wash soap (mean=2.4).

Table 5. Understanding stormwater management in Bozeman: stormwater pollution
Corresponds to Q8: In your opinion, how much pollution in Bozeman's waterways comes from stormwater, if any?"

	None(1)	A little(2)	Some(3)	A Lot(4)	All (5)		
	Frequency (%) | n=64					Mean	SD
How much pollution comes from stormwater?	0.0	9.4	39.1	50.0	1.6	3.4	0.940

Table 6. Understanding stormwater management in Bozeman: water quality consequences
Corresponds to Q9: Poor water quality can lead to a variety of consequences for communities. "In your opinion, how much of a problem, if at all, are the following issues in the Bozeman area?"

Issues	n	Not a Problem(1)	Slight Problem(2)	Moderate Problem (3)	Severe Problem(4)	Unsure/Don't Know(5)	n*	Mean	SD
		Frequency (%)							
Excessive aquatic plants or algae	61	1.6	24.6	45.9	21.3	6.6	57	2.9	0.892
Loss of desirable fish species	61	3.3	24.6	36.1	19.7	16.4	51	2.9	1.097
Reduced beauty of rivers or streams	61	13.1	41.0	19.7	21.3	4.9	58	2.5	1.111
Reduced quality of water recreation activities	61	14.8	39.3	29.5	14.8	1.6	60	2.5	0.977
Fish kills	61	3.3	45.9	31.1	4.9	14.8	52	2.4	1.163
Reduced opportunities for water recreation	61	21.3	41.0	21.3	13.1	3.3	59	2.3	1.065
Contaminated fish	61	13.1	42.6	18.0	8.2	18.0	50	2.3	1.32
Odor	60	35.0	45.0	10.0	1.7	8.3	55	1.8	1.134
Contaminated drinking water	60	46.7	45.0	3.3	0.0	5.0	57	1.5	0.94
Lower property values	61	55.7	16.4	9.8	1.6	16.4	51	1.5	1.493

n: Unsure/Don't Know responses were deleted in calculation of the mean*

Respondents generally did not think that these consequences of poor water quality were problems. They thought that excessive aquatic plants or algae life (mean=2.9) were the largest problem in the area, and that contaminated drinking water (mean=1.5) and lower property values (mean=1.5) were the least problematic issue in the area.

Table 7. Understanding stormwater management in Bozeman: stormwater bill
Corresponds to Q10: "Do you pay a monthly bill for stormwater management?"

	Yes	No	Unsure/ Don't Know
	Frequency (%) | n=61		
Do you pay a monthly bill for stormwater management?	45.9	26.2	27.9

Table 8. Understanding stormwater management in Bozeman: stormwater bill
Corresponds to Q11: "In your opinion, the amount you pay on your stormwater bill on average, is: (choose one)"

	n	Far too little(1)	Too little(2)	About Right(3)	Too much(4)	Far too much(5)	Unsure/Don't Know(6)	n*	Mean	SD
		Frequency (%)								
The amount one pays on their stormwater bill is on average	28	0.0	6.6	23.7	3.9	0.0	7.1	26	2.9	0.97

n: Unsure/Don't Know responses were deleted in calculation of the mean*

Table 9. Understanding stormwater management in Bozeman: stormwater services
Corresponds to Q12: "Before you took this survey, did you know that the City of Bozeman's Stormwater Division provided the following stormwater services?"

Services	Yes	No
	Frequency (%) | n=61)	
Maintains and repairs the public storm sewer	86.9	13.1
Monitors water quality	86.9	13.1
Educates the public about stormwater	70.5	29.5
Installs stormwater treatment devices	63.9	36.1
Regulates stormwater management in new development	62.3	37.7
Responds to pollution events	55.7	44.3
Sweeps and cleans streets	55.7	44.3
Completes flood control projects	47.5	52.5
Inspects construction sites	47.5	52.5

Table 10. Understanding stormwater management in Bozeman: Stormwater Division effectiveness

Corresponds to Q13: "In your opinion, how effective is the City of Bozeman's Stormwater Division at performing the following?"

Tasks	n	Not at all effective(1)	Slightly effective(2)	Somewhat effective(3)	Very effective(4)	Extremely effective(5)	Unsure/Don't Know(6)	n*	Mean	SD
		Frequency (%)								
Monitoring water quality	58	1.7	5.2	6.9	37.9	6.9	41.4	34	3.7	1.316
Maintaining and repairing the public storm	58	0.0	5.2	24.1	32.8	3.4	34.5	38	3.5	1.322
Sweeping and cleaning streets	58	3.4	6.9	22.4	34.5	8.6	24.1	44	3.5	1.373
Treating stormwater	58	3.4	1.7	22.4	19.0	1.7	51.7	28	3.3	1.501
Responding to pollution events	58	3.4	3.4	15.5	1.8	1.7	62.1	22	3.2	1.509
Managing pollution levels in local waterways	58	5.2	10.3	19.0	19.0	1.7	44.8	32	3.0	1.672
Managing flooding during rainfall	57	3.5	19.3	28.1	17.5	0.0	31.6	39	2.9	1.63
Inspecting construction sites	58	8.6	6.9	13.8	12.1	1.7	56.9	25	2.8	1.775
Educating the public about stormwater	58	8.6	34.5	41.4	5.2	0.0	10.3	52	2.5	1.295

n: Unsure/Don't Know responses were deleted in calculation of the mean*

Respondents indicated that they generally thought the City's Stormwater Division was somewhat effective at completing the tasks posed in the question. A low proportion answered that the City was 'extremely effective' in any of the tasks, but a low proportion of respondents also answered that the City was 'not at all effective'. The most successful at monitoring water quality (mean=3.7), and the least effective at educating the public about stormwater (mean=2.5).

Table 11. Understanding stormwater management in Bozeman: flooding events

Corresponds to Q14: "In the past 12 months, how many times if at all, have the following flooding events impacted you?"

Flood Event	n	Never (1)	1-2 times(2)	3-4 times(3)	5 or more times(4)	Not applicable(5)	n*	Mean	SD
		Frequency (%)							
Flooding in Bozeman's streets	59	42.4	40.7	10.2	5.1	1.7	58	1.8	0.931
Flooding in Bozeman's parking lots	58	58.6	27.6	5.2	3.4	5.2	55	1.5	1.079
Flooding in Bozeman's local parks	59	61	23.7	8.5	1.7	5.1	56	1.5	1.06
Flooding on Bozeman's sidewalks	59	69.5	28.8	1.7	0.0	0.0	58	1.3	0.663
Flooding in my basement	59	89.8	3.4	0.0	0.0	6.8	55	1.0	1.021
Flooding in my yard	59	94.9	3.4	0.0	0.0	1.7	58	1.0	0.548

n: Unsure/Don't Know responses were deleted in calculation of the mean*

Table 13. Connection to Bozeman's waterbodies: importance of waterbodies
Corresponds to Q16: Please indicate your level of agreement or disagreement with the statements below. "In general Bozeman's local waterbodies are important because they…"

Services	n	Strongly disagree(1)	Disagree(2)	Neither agree nor disagree(3)	Agree(4)	Strongly agree(5)	Unsure/Don't Know(6)	n*	Mean	SD
		Frequency (%)								
Provide Bozeman residents with clean drinking water	59	3.4	0	1.7	25.4	67.8	1.7	58	4.6	0.85
Provide good wildlife habitat	59	1.7	1.7	3.4	33.9	59.3	0.0	59	4.5	0.8
Provide good fish habitat	59	1.7	3.4	5.1	33.9	55.9	0.0	59	4.4	0.87
Provide good waterfowl habitat	59	3.4	1.7	3.4	33.9	54.2	3.4	57	4.4	0.95
Provide irrigation water for agricultural land	59	1.7	1.7	6.8	42.4	40.7	6.8	55	4.3	0.91
Are an important symbol of the City of Bozeman	59	1.7	0.0	13.6	40.7	42.4	1.7	58	4.2	0.85
Provide good fishing opportunities	59	1.7	5.1	3.4	52.5	35.6	1.7	58	4.2	0.89
Provide good places to float and boat	59	1.7	5.1	15.3	33.9	42.4	1.7	58	4.1	1
Provide good bird watching opportunities	59	1.7	5.1	22.0	37.3	25.4	8.5	54	3.9	1.09
Provide good places to swim	59	3.4	1.7	28.8	39.0	27.1	0.0	59	3.9	0.96

n: Unsure/Don't Know responses were deleted in calculation of the mean*

Respondents tended to agree with the statements about why Bozeman's waterbodies are important, as high proportions of respondents answered 'agree' or 'strongly agree' to services of the local waterbodies. Respondents thought Bozeman's local waterbodies were most important because the provide clean drinking water (mean=4.6) and the least important for providing good places to swim (mean=3.9).

Table 14. Connection to Bozeman's waterbodies: recreation
Corresponds to Q17: "In the last 12 months, how often, if at all, did you participate in the following activities in/adjacent to Bozeman Creek, the East Gallatin River, Mandeville Creek, or local ponds (e.g., Bozeman Beach)?"

Activity	Never (1)	1 time(2)	2-4 times(3)	5 or more times(4)	Mean	SD
	Frequency (%) | n=59					
Hiking/walking	6.8	3.4	25.4	64.4	3.5	0.858
Relaxing	15.3	11.9	27.1	45.8	3.0	1.098
Nature watching	32.2	3.4	16.9	47.5	2.8	1.336
Picnicking	42.4	13.6	32.2	11.9	2.1	1.106
Bird watching	55.9	10.2	22.0	11.9	1.9	1.125
Floating/boating	57.6	11.9	23.7	6.8	1.8	1.030
Fishing	67.8	8.5	13.6	10.2	1.7	1.060
Swimming/wading	49.2	10.2	22.0	18.6	1.2	1.213
Hunting	94.9	1.7	3.4	0.0	1.1	0.385

Table 15. Connection to Bozeman's waterbodies: willingness to adopt practices
Corresponds to Q19: "Please indicate which statement most accurately describes your level of willingness to do the practices listed below…"

Practice	n	I already do this practice(1)	Not at all willing(2)	Slightly willing(3)	Somewhat willing(4)	Very willing(5)	Not applicable to me(6)	n*	Mean	SD
		Frequency (%)								
Pick up and properly dispose of dog waste	56	46.4	0.0	1.8	1.8	28.6	21.4	44	4.8	2.223
Move vehicle on a set schedule to facilitate street sweeping	56	28.6	0.0	1.8	12.5	33.9	23.2	43	4.7	1.980
Apply pesticides at or below manufacturer guidelines during dry weather	56	33.9	0.0	1.8	5.4	25.0	33.9	37	4.7	2.180
Properly dispose of hazardous household waste	56	50.0	0.0	1.8	10.7	37.5	0.0	56	4.7	1.911
Keep fertilizer off roads, driveways, and sidewalks during dry weather	56	28.6	1.8	1.8	10.7	35.7	21.4	44	4.6	1.982
Apply fertilizer at or below manufacturer guidelines during dry weather	56	33.9	1.8	0.0	10.7	25.0	28.6	40	4.6	2.132
Keep grass clippings off road and on my yard or into a yard debris receptacle	56	46.4	1.8	1.8	107	25.0	14.3	48	4.5	2.083
Install rain barrell	56	3.6	12.5	14.3	25	33.9	10.7	50	3.9	1.327
Wash my car in a commercial car wash not in my driveway	56	37.5	7.1	19.6	3.6	30.4	1.8	55	3.9	1.738
Install a rain garden	56	0.0	12.5	16.1	33.9	21.4	15.1	47	3.8	1.237
Volunteer for a water clean-up event	56	1.8	10.7	25.0	37.5	25.0	0.0	56	3.8	1.018
Volunteer for a water monitoring event	56	1.8	21.4	19.6	28.6	28.6	0.0	56	3.7	1.171
Participate in the City of Bozeman's Adopt-A-Drain program	55	7.3	12.7	25.5	25.5	23.6	5.5	52	3.7	1.326
Install permeable pavement or bricks for driveways	56	1.8	21.4	12.5	25.0	16.1	23.2	43	3.5	1.567
Pay more for stormwater services	56	1.8	28.6	26.8	25.0	10.7	7.1	52	3.2	1.257

n: Unsure/Don't Know responses were deleted in calculation of the mean*

Respondents were generally somewhat willing to participate in the practices posed in the question, as there were low proportions for 'not willing at all' on most of the practices except for 'volunteering for a water monitoring event' and 'pay more for stormwater services'. Respondents were most willing to pick up and properly dispose of dog waste (mean=4.8) and move their vehicles on a set schedule (mean=4.7), and least willing to pay more for stormwater management services (mean=3.2). In calculating the mean of this question responses of 'Not Applicable' and 'I already do this practice' were deleted.

Table 16. Connection to Bozeman's waterbodies: actions and responsibilities
Corresponds to Q20: "Please indicate your level of agreement or disagreement with the statements below…"

Statements	Strongly disagree(1)	Disagree(2)	Neither agree nor disagree(3)	Agree(4)	Strongly agree(5)	Mean	SD
	Frequency (%)| n=52						
The way that I care for my yard can influence water quality in local streams.	0.0	0.0	5.8	38.5	55.8	4.5	0.610
It is my personal responsibility to help protect water quality.	0.0	1.9	1.9	38.5	57.7	4.5	0.641
My actions have an impact on water quality.	0.0	0.0	3.8	42.3	53.8	4.5	0.577
It is important for community members to take an active role in determining the future of Bozeman's creeks/rivers.	0.0	0.0	5.8	42.3	51.9	4.5	0.609
The quality of life in my community depends on good water quality in local rivers and stream.	0.0	1.9	3.8	48.1	46.2	4.4	0.661
I am willing to report pollution to the city.	0.0	1.9	7.7	63.5	26.9	4.2	0.638
I am willing to change the way I care for my yard because I am concerned about the quality of water for my downstream neighbors.	1.9	1.9	17.3	36.5	42.3	4.2	0.916
It is important to protect water quality even if it costs me more.	1.9	5.8	11.5	40.4	40.4	4.1	0.963
I am willing to pay more to improve water quality.	3.8	9.6	19.2	42.3	25.0	3.8	1.064
I am willing to talk to other people about how to protect water resources.	0.0	7.7	38.5	30.8	23.1	3.7	0.919
What I do on my land doesn't make much difference to overall water quality.	51.9	42.3	5.8	0.0	0.0	1.5	0.609
It is okay to reduce water quality to promote economic development.	65.4	23.1	7.7	3.8	0.0	1.5	0.804

Respondents tended to 'agree' or 'strongly agree' with the statements posed in this question particularly the ones regarding personal responsibility and environmental impact, including disagreeing with the two statements that "What I do on my land doesn't make much of a difference to overall water quality." and "It's okay to reduce water quality to promote economic success." Respondents most strongly agreed that 'the way they care for their yard can influence water quality' (mean=4.5) and disagreed that 'it would be okay to reduce water quality to promote economic success' (mean=1.5).

Table 17. Connection to Bozeman's waterbodies: caring for dogs
Corresponds to Q38: "Do you own or care for a dog?"

	Yes	No
	Frequency (%) | n=53	
Do you own or care for a dog?	52.8	47.2

Table 18. Connection to Bozeman's waterbodies: dog waste
Corresponds to Q21: "Please indicate how influential, if at all, the following are on your motivation to pick up dog waste…"

Motivations	Not influential at all(1)	Slightly influential(2)	Somewhat influential(3)	Very Influential(4)	Extremely Influential(5)	Not applicable to me(6)	Mean	SD
	Frequency (%)| n=29							
To Protect Water Quality	7.1	7.1	25.0	25.0	35.7	0.0	3.8	1.236
So I don't have to See or Smell It	10.3	3.4	17.2	41.4	27.6	0.0	3.7	1.222
What my Neighbors Think	17.2	10.3	20.7	27.6	24.1	0.0	3.3	1.417
What my Family Thinks	17.2	13.8	17.2	31.0	20.7	0.0	3.2	1.405
Availability of Dog Waste Receptacles	27.6	10.3	24.1	13.8	24.1	0.0	3.0	1.546
Availability of Dog Waste Bags	24.1	13.8	20.7	17.2	24.1	0.0	3.0	1.523
Bozeman's Dog Waste Signage	27.6	13.8	24.1	24.1	10.3	0.0	2.8	1.380
Bozeman's "Cleaning up after Animals" Ordinance	37.9	6.9	27.6	20.7	6.9	0.0	2.5	1.379

Survey respondents only received this question if they answered yes to Q38: "Do you own or care for a dog?". Respondents were generally somewhat influenced by the motivation statements listed in the question. They were most influenced to pick up dog waster to protect water quality (mean=3.8), but only slightly influenced to pick up dog waste because of Bozeman's 'cleaning up after animals' ordinance (mean=2.5).

Table 19. Connection to Bozeman's waterbodies: information seeking
Corresponds to Q23: "If you were to seek information about stormwater management, where are you likely to seek that information?"

Information Sources	n	Yes	No	Maybe
		Frequency (%)		
City of Bozeman website	39	87.2	2.6	10.3
Water bill insert	37	78.4	13.5	8.1
Newsletters/brochures/fact sheets	37	64.9	21.6	13.5
Exhibits or displays at parks or natural areas	38	57.9	15.8	26.3
Newspapers/magazines	37	48.6	48.6	2.7
Workshops/public meetings	38	36.8	31.6	31.6
Neighborhood meetings	36	30.6	44.4	25.0
Volunteer event	36	30.6	44.4	25.0
Local library	37	21.6	51.4	27.0
Radio	36	16.7	61.1	22.2
Nextdoor app	37	16.2	75.7	8.1
Conversations with other people	38	13.2	44.7	42.1
Facebook	37	10.8	64.9	24.3
Podcast	36	8.3	80.6	11.1
Instagram	37	8.1	81.1	10.8
Other website	18	0.0	83.3	16.7

Table 20. Respondent home and lawn care decision making
Corresponds to Q25: "Do you make the home and lawn care decision in your household?"

	Yes	No
	Frequency (%) | n=54)	
Do you make the home and lawn care decisions in your household?	72.2	27.8

Table 21. Respondent grounds management
Corresponds to Q26: "Please select the statement below that most accurately describes who manages the grounds around your home?"

	Percentage of Respondents
	Frequency (%) | n=54
I maintain the grounds around my home	61.1
A landlord/property manager maintains the grounds around my home	20.4
A lawn company maintains the grounds around my home	18.5

Table 22. Respondent average lot size
Corresponds to Q27: "What is the approximate size of your residential lot in Bozeman?"

	1/4 acre or less(1)	More than 1/4 acre less than 1 acre(2)	1 acre to less than 5 acres (3)	5 acres or more(4)		
	Frequency (%) | n=54				Mean	SD
Approximate size of respondent's residential lot	81.5	16.7	1.9	0.0	1.2	0.451

Table 23. Respondent home ownership
Corresponds to Q28: "Do you own or rent your home?"

	Percentage of Respondents
	Frequency (%) | n=54
Own	64.8
Rent	35.2

Table 24. Respondent age
Corresponds to Q29: "What year were you born?"

Respondents Age							
20-29 years	30-39 years	40-49 years	50-59 years	60-69 years	70-79 years		
Frequency (%) | n=51						Median	Range
27.5	11.8	15.7	19.5	23.5	2.0	47	21-74

Table 25. Respondent gender identification
Corresponds to Q30: "What is your gender?"

	Gender
	Frequency (%) | n=52
Female	57.6
Male	40.4
Non-binary	2.0

Table 26. Respondent ethnicity
Corresponds to Q31: "What racial or ethnic group do you most closely identify with?"

	Racial/Ethnic Group
	Frequency (%) | n=49
White	96.0
White and Ashkenazim	2.0
White and Asian	2.0

Table 27. Respondent education level

Corresponds to Q32: "What is your highest level of formal education

	Some formal schooling(1)	High school diploma/GED(2)	Some college(3)	2 year college degree(4)	4 year college degree(5)	Post-graduate degree(6)	Mean	SD
	Frequency (%) | n=53							
Respondent's highest level of formal education	0.0	0.0	24.5	0.0	43.4	32.1	4.8	1.139

Table 28. Respondent resident years living in Bozeman

Corresponds to Q33: "About how many years have you lived in Bozeman?"

Number of Years Respondents have lived in Bozeman							
0-10 years	11-20 years	21-30 years	31-40 years	41-50 years	51-60 years	Median	Range
Frequency (%) | n=51							
53.7	20.4	14.8	5.6	1.9	3.6	10	.5-60

Table 29. Respondent zip code

Corresponds to Q34: "What is your zip code?"

	59715	59718
	Frequency (%) | n=53	
Zipcode	62.3	37.7

Table 30. Respondent household income

Corresponds to Q35: "What was your total household income for the last year, before taxes?"

Household income before taxes	Frequency (%)
$0-$19,999	7.8
$20,000-$29,999	5.9
$30,000-$39,999	11.8
$40,000-$49,999	2.0
$50,000-$59,999	13.7
$60,000-$74,999	5.9
$75,000-$99,999	15.7
> $100,000	27.5
Unsure/Don't Know	9.8

Table 31. Respondent opinion change on stormwater bill

Corresponds to Q36: "Earlier in the survey, you indicated the amount you pay on your stormwater bill on average is (far too little, too little, about right, too much, far too much, unsure/don't know). Since taking this survey, has your opinion changed about how much you pay for your average monthly stormwater bill?"

	n	No, I still pay too little(1)	No, I still pay the right amount(2)	No, I still pay too much(3)	Yes, I should pay less(4)	Yes, I pay the right amount(5)	Yes, I should pay more(5)	Unsure/Don't Know(6)	n*	Mean	SD
		Frequency (%)									
Has your opinion changed about how much you pay for your average monthly sotrmwater bill?	25	12.0	32.0	8.0	0.0	20.0	16.0	12.0	22	3.4	2.121

Comments 1. Respondent comments about stormwater utility
Corresponds to Q36: "Please share your reasoning for the choice you made above." Answers listed are verbatim.

1. "Seems Right."
2. "I'm willing to pay more if you actually go out and enforce things. I have seen Bozeman Creek and the E Gallatin River get noticeably more silty just over the last two years!"
3. "feel that bozeman overall is overtaxed, cant fully support more taxes/fees even if for important things"
4. "I pay a stormwater fee on residential property that I maintain with well water. That's OK. I pay a stormwater fee on commercial property with no water supply at all and no pavement. That's OK. We can only do so much with hydrodynamic separators, its a good start. We have the best drinking water in the nation, head waters. Should down stream users help us keep their water clean?"
5. "Because the city mismanages money. They could do better with what they have"
6. "Without knowing what issues aren't being addressed with current funding and not living here very long, it is easy to assume based on what we've seen that funding is appropriate."
7. "I am taxed to death living in Bozeman, Maybe there should be some cuts to other line items of the budget which can be put towards things like water treatment."
8. "We need to better fund the Stormwater Program"
9. "I don't know how much I pay. I would have to look it up. But I don't have trouble paying the bill, it seems fair."
10. "I am very interested in water quality and want to do my part to make sure that Bozeman has every chance to mitigate the pollution. I would be willing to pay a higher stormwater bill if it meant that it was easier to accomplish this."
11. "It all depends on what services are offered in paying higher taxes."
12. "I don't want to pay more- but if all of us paid a little bit more it would make a big difference in what we could get done"
13. "Impact fees from new construction should cover more of the overall stormwater costs."

Comments 2. Respondent extra comments about Bozeman's stormwater management
Corresponds to Q38: "Please use the space below for any additional comments you may have about the survey, stormwater management, or Bozeman's local waterbodies". Answers listed are verbatim.

1. "As we continue to see massive population influx the potential for diminished water quantity and quality is increased"
2. "Make these surveys shorter holy hell I feel like I wasted 20 minutes of my life. If you make a survey 5 minutes or less I think you'll attract more people to fill them out and get better data."
3. "great survey, {name}"
4. "I have noticed Bozeman Creek and the E Gallatin River get much more silty over the last two years. Death by 1000 cuts. Bozeman blew it's opportunity to have a beautiful greenway through the center of town, and instead has a channelized and underground creek running through it. The improvements at Bogert Park were a small but notable exception"
5. "It would be awesome for the water management of Bozeman to get involved with service Saturday events at MSU to get in contact with more MSU students who are interested in learning and volunteering with them"
6. "My property has paid taxes since 1922. We still have the same curbs which are now crumbling. Most of the unwanted debris from this property is due to the crumbling curbs and the non paved alley. I am not particularly interested in paying more when the city won't maintain current infrastructure but keeps on adding new infrastructure. It seems that existing properties are subsidizing new build and are not being maintained."
7. "I am happy with the quality of Bozeman tap water. I think we do a very good job of treating water for our down stream neighbors, which they pay nothing for. I live across the street from the Bozeman High school and I am thankful for the attention to Mandeville Creek, finally. I have been watching Bozeman Creek behind my property on Rouse for 45 years, it has improved over the years but I would not yet eat a fish from this creek."
8. "My opinion is that flood happens most when storm drains are clogged with ice. That could be better managed"
9. "I live in the Norton Ranch subdivision. I feel the developers do not have an interest in water conservation in the public walking areas. The sprinklers run almost daily and often flood the walking paths to the point that there are puddles and they can't be used. Residents frequently bring this up at HOA meetings and we get a nod from the developers, but no action. I don't know what else to do."
10. "Need to do something about all the dog poop that is not picked up. I have read that teaching school kids about how awful dog poop is for our waterways helps with more waste pick up. Our neighborhood has that problem and also cat poop."

11. “Thank you for offering this survey. I am relatively new to Bozeman (arrived 12/31/2020) and our outdoor activities around local water bodies have been less frequent due to the pandemic (ie floating, swimming, bird watching). We appreciate Bozeman's natural resources as an important part of our quality of life.”
12. “Initially I didn't know about the program, but as I answered questions, of course there is a stormwater division. As far as I know they have been responsive to needs of the community”
13. “I think the signage at Bozeman creek is excellent for communicating the importance of picking up dog waste. I wonder if volunteer efforts have been organized or could be organized to help pick up dog waste in that area and other areas that are vital for watershed health (Hyalite).”
14. “I hope to see the results of the survey and also hope they have some impact on stormwater education”
15. “As a young, renting, new resident to Bozeman I’m not sure what I can do to help nor about many programs but with more information/PR would love to learn more.”
16. “A creek borders our property. There are multiple utility cables that cross the creek. Some are cut so they aren’t even in use. The cables collect all of the trash that runs down the creek.”
17. “Survey too long”
18. “Wish we could open up and protect Bozeman Creek. It’s a gem, but it’s not accessible to most.”
19. “Educating is great but please, no more taxes.”
20. “Need to do a better job encouraging mulching of both grass and leaves. Encourage more rain cutoff devices on irrigation systems. I frequently see wasted water during rainfall including city property. Need to explain how to measure water application rates. Need to encourage pressure regulation on irrigation systems. I'm guessing that 50% or less of irrigation water is effectively used because of wind and misting sprinkler heads.”

V. Conclusions

The demographics of the survey aligned with that of the City of Bozeman in some areas but not in others. Of the 49 respondents who answered the question of their race, a majority were White and almost 60% of the respondents were female. According to the American Community survey, Bozeman is 92.4% White, yet the population is 53.2% male. As a result, our survey did not receive a proportionally accurate sample of the gender distribution in Bozeman which could have affected the results (ACS, 2018). The average amount of time that respondents had lived in Bozeman was calculated at 13.89 years, and a majority of them had received education higher than a high school level. Although our survey had a low number of respondents, the age and household income statistics were quite evenly distributed.

The survey results suggest that the City of Bozeman has successfully educated the local population that their municipal government runs a stormwater management program. Respondents also indicated that the City of Bozeman's website was the most widely used application to learn more about the stormwater program, which indicates that the City should continuing using their website to educate its populous. Moreover, almost 90% of the respondents understood that stormwater contributed to pollution in local waterways. This suggests that respondents understand why stormwater management is important, because research suggests that municipal stormwater systems do influence adjacent waterways (Papangelakis, 2019). The survey results also made it clear that residents of Bozeman identify with the local waterbodies as an important part of the community for outdoor recreation activities including hiking and fishing over the past year.

Not all of the responses illustrated good news for the City's stormwater management division. Research conducted by Amanda Cettner (2013) indicates that there can be clear disconnects between City residents and their stormwater programs. Applying that to Bozeman, the residents knew little of what exactly happened to the water after it drained in the stormwater pipes. In fact, 56.3% thought that the stormwater entered a water treatment plant before it was dumped in the local waterbodies, which is not the case. Respondents also tended to blame stormwater pollution more heavily on construction and golf courses, giving the lowest scores grass and leave clipping pollution from individuals yards, which also negatively affect stormwater. In 2019 the City reported that the street sweeping vehicles picked up 1 cubic yard of leaves (Top, 2020). Moreover, respondents pointed out that they were willing to partake in activities to help the stormwater division, as long as they did not revolve around the raising of taxes/fees to Bozeman residents. Thus, the disconnect between the City and people of Bozeman revolves around what happens to the stormwater after it is funneled into the stormwater drains and how specific activities could affect the stormwater system.

These takeaways are both interesting, because survey responses made it clear that outdoor activities are a large part of the community of Bozeman. With that said, many of the residents who determined that stormwater creates pollution within nearby rivers and streams, did not know that the stormwater in their City does not go through a treatment plant before entering local waterways. These findings lead us to the following recommendations.

VI. Recommendations

1. Street Drain Artwork

Many of the City's storm drains are already marked "Drains to river: dump no waste" to inform residents that the waste dumped into the drains directly flows into the adjacent waterbodies. Traveling into other cities such as Boulder, CO their storm drains are surrounded by local artist's artwork which catch the eye of anyone passing by. The artwork not only enhances the aesthetic of the drains, but also clearly indicates their correlation with the local waterbodies as most of the artwork consists of a nature/fish theme. In high traffic areas of Bozeman, this strategy could prove effective at educating the population of the stormwater systems connection to the Gallatin Watershed in an artistic way.

2.Increase Outreach to New Residents and College Students

Pradhanaga and Davenport (2017) found that residents are more likely to engage in activities that protect water quality if they can connect it with their neighbors or feel more of an attachment to their neighborhood. Accordingly, as Bozeman is quickly growing and a large proportion of the population attends MSU, residents might by less likely to identify with Bozeman's Stormwater Division. On average our survey respondents had lived in the City for almost 14 years. Further analysis should be done to help understand how short-term residents identify and interact with the stormwater system and the neighborhoods they reside in. As such, we would encourage more participation of college classes in the education of students about what they could do to protect waterways in Bozeman and their hometowns alike. The City could also accomplish this task through informational packets sent out to new bill payers.

3.Increased Implementation and Advertisement of Volunteer Opportunities

The survey results indicated that residents are interested in volunteering for clean-up and water monitoring events. As such, we recommend the Stormwater Division implement more volunteer opportunities for Bozeman residents and advertise them in a way which affirms the need for these projects for the health of Bozeman's waterways. As we have seen throughout this survey, Bozeman's populace cares about water quality and is overall willing to help, and as such we believe more opportunities in which people could feel they are making a difference could increase overall accountability regarding waterway health and pollution mitigation.

4. Seasonal information blurbs

The survey found that over half of the respondents heard of the stormwater program and get their information about the program through the City of Bozeman Website. The City of Bozeman could distribute spring and fall flyers/newsletters on their website to Bozeman residents to help inform them of proper practices they could participate in to help mitigate stormwater pollution. The survey also found that 45% of the respondents get their information from newsletters, accordingly, the City could also send out seasonal flyers/newsletter. In the article by Coffman (2007), it is made clear that if the public is educated about what they can do

to help City programs, they are more willing to take part in the effort. While education of course is not the sole component to behavior changes, it would certainly prevail as a good first step to increase the willingness of Bozeman residents to assist the stormwater division by doing things such as moving their cars and collecting their grass clippings.

5. Appeal to the Outdoors

The survey indicated that Bozeman residents enjoy the natural aspects of the town particularly including the nearby waterways as all the means to the question 'Bozeman's local waterbodies are important because.' scored high on the scale of agreement. The respondents tend to hike and fish the most among the local waterways. The Stormwater Division could use this to their advantage and appeal to this sense of community. The City may be missing a key outreach component by not relating water cleanups to healthier rivers and beneficial outcomes like healthy fish populations. Overall, the Stormwater Division should consider linking stormwater pollution mitigating activities that benefit the outdoor recreation community.

Overall, our survey results suggest that the City of Bozeman's Stormwater Division has adequately educated their population of the stormwater management program and the risks stormwater pollution poses to the local waterbodies. Yet, these results show a disconnect between what the respondents knew about stormwater once it funneled into City drains. Thus, the next step for the City revolves taking the above recommendations under consideration.

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