

Bozeman Creek Volunteer Monitoring for *Escherichia coli*
SAMPLING AND ANALYSIS PLAN

Prepared for the Montana Department of Environmental Quality

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Introduction

This document constitutes the Sampling and Analysis Plan (SAP) for the completion of water quality sampling on Bozeman Creek (Sourdough) in the Lower Gallatin TMDL planning area in Gallatin County Montana. This effort was initiated by Montana State University Extension Water Quality (MSUEWQ) in collaboration with the Gallatin Local Water Quality District (GLWQD) and the Greater Gallatin Watershed Group (GGWC) to increase education and outreach specific to fecal contamination in waterways and *E.coli* concentrations in the rivers and streams. Bozeman Creek has been listed on the 303(d) list for *E.coli* impairment from Limestone Creek to the mouth since 2006. Prior work performed by Oasis Environmental in 2008, focused on establishing that Bozeman Creek does not meet attainment requirements. To meet attainment requirements, the geometric mean of *E.coli* may not exceed 126 colony forming units(cfu)/100mL and no more than 10% of the samples collected within a 30 day period may exceed 252 cfu/100mL between April 1 through October 31 (MT ARMS 17.30.624). Over 50% of the samples collected by Oasis Environmental in 2008 exceeded 126 cfu/100mL with the highest recorded concentration of 2420 cfu/100mL (Oasis 2009). The study did not investigate the potential sources of *E.coli*.

Today, it is still unclear what may be contributing to the high *E.coli* counts on Bozeman Creek. The 303(d) list states that unpermitted discharge and septic tanks are possible contributors. Through multiple testing sites along the length of Bozeman Creek, it will allow us to better refine our understanding of which areas are continually receiving high concentrations of *E.coli*. This will be accomplished by having volunteer monitors perform several synoptic sampling events along the length of Bozeman Creek from the headwaters to the mouth as well as sampling the tributaries and inflow pipes. If a location continues to have high *E.coli* counts after several synoptic sampling events, it will be beneficial to focus on possible contributors in that area.

Project Objectives

The goals of the project are:

- To develop a watershed *E.coli* educational campaign to increase community awareness about water quality issues in urbanizing areas.
- To increase volunteer capacity by engaging citizens in water quality data collection to enhance understanding of local water resources and best management practices connected with *E.coli* monitoring.
- To enhance the *E.coli* water quality data set for Bozeman Creek as a tool for educating land owners about water quality issues in urbanizing areas and watersheds with livestock agriculture.

Through the collection of *E.coli* water quality data, the project will provide the following products or opportunities:

- Annual report containing expenses, accomplishments, and any evaluation efforts that have been performed. Annual report will be emailed in PDF format to the DEQ technical project contact.

- Quarterly status reports will be emailed in PDF format to the DEQ technical project contact at the same time that invoices are submitted by the MSU Office of Sponsored Programs.
- At the end of the project, a stand-alone final report in PDF format will be emailed to the DEQ technical contact with a detailed description of efforts for the entire project including limitations, outcomes, impacts, evaluations, data reports, and 319 expenditures. Data generated under the project will be transferred into eWQX according to necessary protocols.
- After data collection the results will be graphed, summarized and potentially plotted in ArcMap. The data will be presented at a public meeting in winter 2012-13 and in the news media in 2013.
- A 5 minute video will be produced including coverage from the monitoring efforts, highlights from the results and information on what people can do to reduce fecal contamination of surface water. The video will be streamed from the MSUEWQ website and will be available to anyone who is interested in a digital copy for presentations.
- Other avenues of results and educational material distribution will also be pursued such as: Big Sky Small Acres magazine, the Montana Ag Live television show and other appropriate newsletters.

Sampling Design

The sample sites along Bozeman Creek were based on sample sites used in the Oasis Environmental study and based on conversations with Tammy Crone from the Gallatin Local Water Quality District. There are approximately 18 sample sites from the headwaters to the confluence with the East Gallatin River (table 2). These sites may be subject to change throughout the season. It is possible that after analyzing the data from several sampling events, we may deem it beneficial to create new sites or retire sites to best suit our goals. Sample sites were selected for the following reasons: changes in land use, areas before and after tributary confluences, and drainage pipe contributions. The majority of the sites are located on public land; and three sites are located on private property. The homeowners of these sites have been contacted and have agreed to allow volunteers to collect a water sample on their property. Property owners will be notified the day before each sampling event. The sampling schedule will be focused between May and September of 2012. With this sampling period, we will be able to capture both the rising and falling limbs on the hydrograph. If possible, we will try to hold at least one sampling event immediately after a precipitation event. Daily precipitation data will be downloaded from the Bozeman AgriMet station to be included with the data analysis and interpretation. The budget analysis is for 100 samples with an additional 20 samples to be used for blanks and duplicates for quality control purposes. The number of sampling events will depend on the number of sites sampled during each event. The number of sites sampled will depend on how many volunteers are able to help collect samples. Between May and September we will attempt to collect 120 samples to be analyzed. At a minimum, we will strive for a goal of 80% completeness.

At each site, a volunteer will collect a water sample in a 100 mL sterile bottle from a well-mixed portion of the stream and then transport the sample back to the Sigler Lab located in Marsh Labs where the sample will be processed for coliform and *E.coli*

most probable number (MPN) using the IDEXX Quanti-Tray system. For duplicate samples, the volunteer will be given two samples bottles and will take the samples at the same time and at the same location. Using a co-located approach will emphasize the amount of variability between samples instream. Using a split sample approach would introduce extra steps and bring in additional potential sources of contamination during processing that is not present for the regular samples. A duplicate sample will help to quantify instream variability, where as a split sample approach puts emphasis on quantifying the variability of the enumeration method. A few split samples may be collected to help quantify enumeration variability. Twenty percent of samples for each sampling event will be designated as quality control samples.

MPN is equivalent to cfu/100mL and the two are used interchangeably for recording purposes. “Standards for *E.coli* are based on...most probable number or equivalent membrane filter methods” (ARMS 17.30.620). MPN and CFU differ in their methodology, but both methods can detect down to 1 organism per 100mL. MPN is calculated through a series of dilutions which is done automatically with the IDEXX Quanti-Tray system as the Quanti-Tray sealer distributes samples into 97 wells of two different sizes. It is not an absolute number but an estimated mean density of viable colonies in a sample based on probability formulas. Colony forming units (cfu/100mL) is a count of the physical number of colonies that grow on a media plate. The IDEXX system is an EPA approved method for detection of coliforms and *E. coli*

2012 Parameters		
Stream	Parameters	Holding Time
Bozeman Creek	Total coliform, <i>E.coli</i>	6 hours

Table 1: 2012 parameters

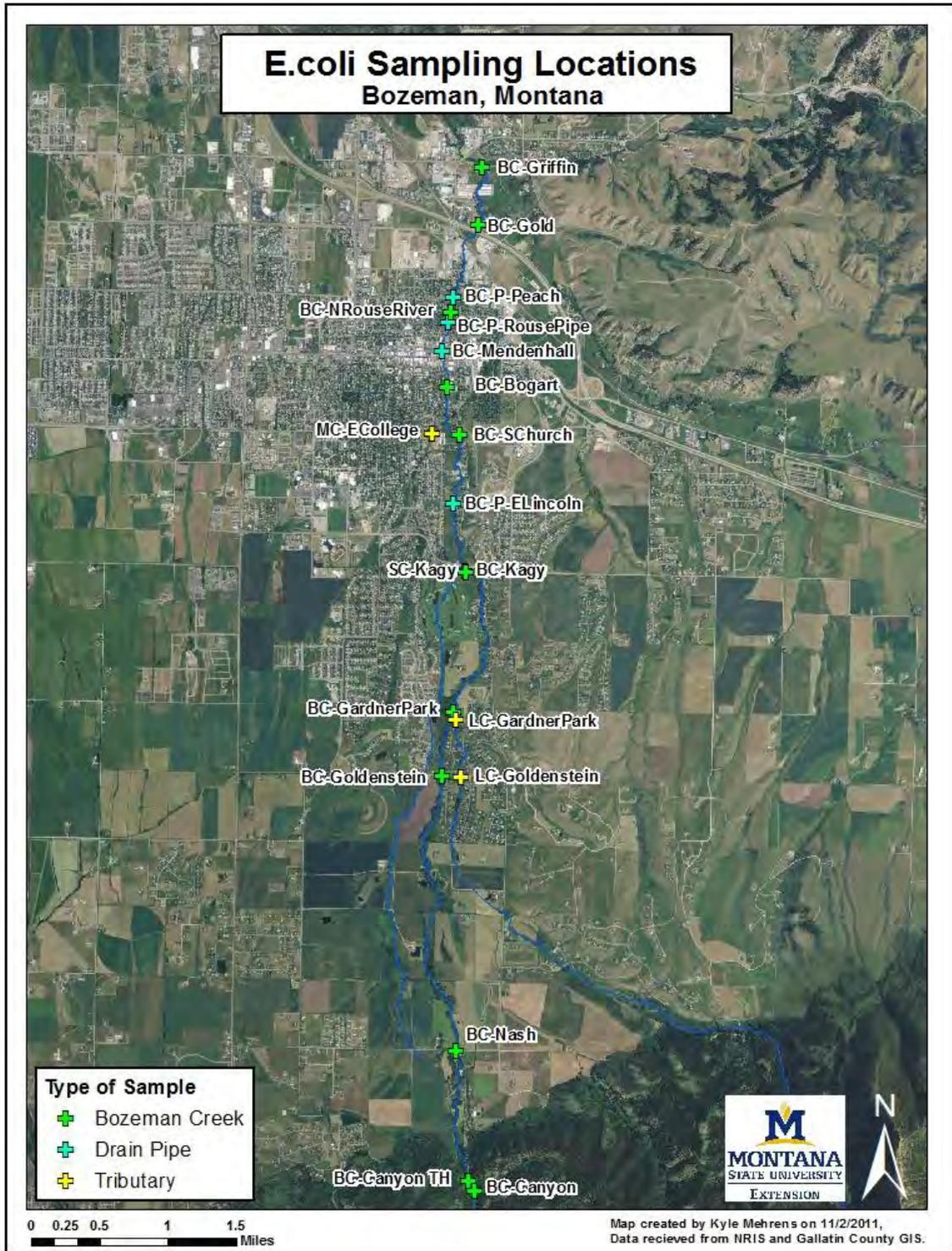


Figure 1: Sample site locations on Bozeman Creek

Site ID	Site Name	Latitude	Longitude	Site Description	Rational for site selection
BC-Canyon	Bozeman Creek Canyon	45.590734	-111.025367	0.1 miles South from the Bozeman Creek/Sourdough Canyon trail head	Headwaters site. Most upstream sample site location ~0.1 mile hike up the Bozeman Crk/Sourdough Trail
BC-Canyon TH	Bozeman Creek Canyon Trailhead	45.591838	-111.026453	Sample on Bozeman Creek from the trail parking lot	This site and BC-Canyon are above human influences, but could be impacted by pet waste due to proximity to trail
BC-Nash	Bozeman Creek at Nash Road	45.605567	-111.028691	Sample on south side of Nash road. ~120 meters west of Sourdough Canyon Road	First access to Bozeman Creek after it has left the canyon
BC-Goldenstein	Bozeman Creek at Goldenstein	45.634879	-111.031511	Sample on north side of Goldenstein ~ 68 meters west of Hitching Post Rd	This is the upstream site before it confluences with Limestone Creek
LC-Goldenstein	Limestone Creek at Goldenstein	45.634708	-111.028682	Sample on south side of Goldenstein, between the Hitching Post roads	Sample site on Limestone Crk after it passes through the Hitching Post subdivision which is an area of potential concern with septic effluent
LC-GardnerPark	Limestone at Gardner Park	45.640755	-111.029710	~36 meters north on Gardner Park Rd from the Gardner Park trail parking lot	Limestone Creek at the mouth. Look at potential cumulative impacts for Limestone Creek before it enters Bozeman Creek
BC-GardnerPark	Bozeman Creek at Gardner Park	45.641654	-111.030007	Before confluence of Limestone creek, sample upstream of foot bridge	Bozeman Creek above the confluence with Limestone Creek. To gage impacts prior to Limestone Creek water entering Bozeman Creek
BC-Kagy	Bozeman Creek at Kagy	45.656459	-111.028508	Private Property - Before confluence with Spring Creek just south of Kagy	Above the confluence with Spring Creek. To gage any impacts prior to Spring Creek water entering Bozeman Creek.
SC-Kagy	Spring Creek at Kagy	45.656585	-111.028742	Private Property - Before confluence with Bozeman Creek just south of Kagy	Spring Creek at the mouth. To evaluate water quality prior to entering Bozeman Creek.
BC-P-ELincoln	Bozeman Crk at E. Lincoln	45.663746	-111.030588	Private Property - Outflow pipe directly behind Bart Manion's place on E. Lincoln	Site selected to evaluate potential sources of <i>E. coli</i> from a stormwater outfall pipe that flows year-round.
BC-SChurch	Bozeman Creek at South Church	45.671136	-111.030002	East side of S. Church, ~190 meters north of Ice Pond Road	Bozeman Creek before the confluence with Matthew Bird Creek

Table 1: Sample site IDs, names, coordinates and descriptions

MC-ECollege	Matthew Bird Creek at East College	45.671214	-111.034095	On the Gallagator Linear trail ~140 m east of the E. College St trail head	Matthew Bird Creek at the mouth. Evaluate potential impacts prior to water entering Bozeman Creek
BC-Bogart	Bozeman Creek at Bogart Park	45.676099	-111.031972	Due west of the pavilion at Bogart Park, near the heavily eroded bank	Site used in the 2009 Oasis Environmental Study for the Lower Gallatin TMDL Planning Area Source Assessment.
BC-Mendenhall	Bozeman Creek at Mendenhall	45.679938	-111.032719	The parking lot directly behind Bar 9	Site used in 2009 Oasis Environmental Study for the Lower Gallatin TMDL Planning Area Source Assessment. Bozeman Creek emerges after traveling underground through downtown Bozeman. Potentially characterizing <i>E. coli</i> impacts through the most urban reach of Bozeman Creek.
BC-P-RousePipe	North Rouse Pipe at mouth into Bozeman Creek	45.683056	-111.032009	West side of Rouse, drain pipe that is ~170 meters north of Lamme on Rouse. Directly North of white house	Drainage pipe that discharges into Bozeman Creek. Sample site in the 2009 Oasis Environmental Study for the Lower Gallatin TMDL Planning Area Source Assessment. This site had the highest recorded <i>E.coli</i> numbers during previous sampling.
BC-NRouseRiver	Bozeman Creek at North Rouse	45.684077	-111.031675	East side of Rouse, directly downstream where Bozeman Creek goes under Rouse	Sample site breaks up a large stretch of Bozeman Creek between other sample sites
BC-P-Peach	Bozeman Creek at Peach	45.685772	-111.031186	Drainage pipe right off of Peach St next to Audrey's Pizza	Sample at concrete storm drain. Sample site in the 2009 Oasis Environmental Study for the Lower Gallatin TMDL Planning Area Source Assessment.
BC-Gold	Bozeman Creek at Gold St	45.693399	-111.027735	South side of Gold, before the Barnard Company driveway	Sample site in 2009 Oasis Environmental Study for the Lower Gallatin TMDL Planning Area Source Assessment.
BC-Griffin	Bozeman Creek at Griffin	45.699582	-111.027305	South side of Griffin, 300 meters east on Griffin Dr from N Rouse	Sample site in 2009 Oasis Environmental Study for the Lower Gallatin TMDL Planning Area Source Assessment., before the confluence with the East Gallatin River

Table 2: Sample site IDs, names, coordinates and descriptions

**These sites may be subject to change*

Project Team Responsibilities

The project manager will be Adam Sigler, Extension Water Quality Specialist and the project coordinator will be Katie Kleehammer, Water Quality Research Associate with MSUEWQ. Responsibilities of the project manager include project oversight on all components of the project. Responsibilities of the project coordinator include: volunteer recruitment, coordination and trainings, processing samples with IDEXX system, storage/maintenance of equipment, data management, data analysis, report composition. Watershed coordinators from the Gallatin and Madison areas will be involved with the SAP development and volunteer recruitment. The Montana Watercourse will be responsible for coordinating K-12 educational events. The project administration will be completed by MSUEWQ office, which will include the accounting and financial management of the project. The project team responsibilities are provided in Table 4.

Name/Title	Project Responsibilities	Contact information
Adam Sigler; MSUEWQ Water Quality Specialist	Project Manager: oversight on all components of the project	Sigler Lab, MSU, PO Box 173120, Bozeman, MT, 59717-3120 406.994.7381 asigler@montana.edu
Katie Kleehammer; MSUEWQ Water Quality Research Associate	SAP preparation, volunteer recruitment, coordination, and trainings. Sample processing, data management, and data management training for volunteers.	Sigler Lab, MSU, PO Box 173120, Bozeman, MT, 59717-3120 406.994.7381 kkleehammer@montana.edu
Marianne Pott Big Sky Water Corps	K-12 Educational sessions	Montana Watercourse PO Box 170570 Bozeman, MT 59717-0570 406.994.6732
Tammy Crone Water Quality Specialist	Assistance with SAP development	Gallatin Local Water Quality District 215 W. Mendenhall, Suite 300 Bozeman, MT 59715 406.582.3145 tammy.crone@gallatin.mt.gov
Sierra Harris Watershed Coordinator	Assistance with volunteer recruitment	Greater Gallatin Watershed Council P.O. Box 751 Bozeman, MT 59715-0751 406.551.0804 sharris@spottedbearconsulting.com

Table 3: Project team members and responsibilities

Sampling Methods

Sampling will be conducted according to the standard operating procedures (SOPs) outlined at the end of this document. Site locations have been documented with a survey grade centimeter accuracy GPS, Trimble XH Geo Explorer 2008. The GPS coordinate system datum is NAD 1983 State Plane Montana, in decimal degrees to the sixth decimal (10cm precision). Photographs of each site: upstream, downstream and cross section views along with driving directions are included in the appendix and will be provided to volunteers for each sample event.

Event and Field methods

Event Coordination and Sample Collection

Volunteers will be recruited through existing GGWC volunteer monitor lists, through the GGWC list serve, through high school science teachers, through MSU environmental science courses and through word of mouth. The relatively modest training and sampling time requirement will allow us to reach citizens who are interested in volunteer water quality monitoring but not willing to commit the time for the GGWC summer monitoring team efforts. Volunteers will convene at the MSUEWQ office before each sampling event and will receive a 30 minute training on why we care about bacteria sampling, what the results do and do not tell us, and how to properly collect a sample. Volunteers will be handed a sheet with photos and driving directions to their sample location, the time the sample is to be collected, sample bottles, gloves, a mini cooler, and a sampling stick if necessary. The sample bottles were purchased from IDEXX and are sterilized and contain sodium thiosulfate which neutralizes free chlorine in the water. See the appendix for sample collection standard operating procedures (SOPs). Once the water has been collected, the volunteer will return to MSUEWQ lab and the sample will be immediately processed with the IDEXX quanti-tray equipment. The sample will then be incubated for 24 hours and trays will be analyzed for most probably number (MPN) of total coliform and *E.coli*. See the appendix for SOPs on IDEXX MNP analytical methods.

Quality control (QC) samples consisting of blanks and duplicates will be collected for 20% of the samples. . A field blank is prepared by transporting sterilized (autoclaved) stream water to the field (provided by MSUEWQ) and pouring it into sample containers provided by the lab. The blank will be prepared at the same time that the samples are collected from the stream. A duplicate sample is a sample that is collected at the same location and time as the original sample. This ensures the sample is collected at the same time in the same way that the regular stream sample is collected. Duplicate and blank samples will be collected at the same site. The site that QC samples are collected at will rotate between events. Duplicate and blank samples are labeled according to the labeling protocol below. Blank and duplicate samples are handled in the same manner that regular samples are handled.

Sample labels should be filled out with Company (MSUEWQ), the date, the time and the sample ID. The sample ID is very important and includes the year, the month, the day, the site ID and a letter indicating they type of sample (regular, blank or duplicate).

Sample ID = Year-Month-Day-SiteID-Sample-Type Letter

- A = Regular Sample
- B = Duplicate Sample
- C = Blank Sample

Sample ID Examples:

A regular sample collected at the Kagy site on June 6th, 2012 would be labeled:

20120611-BC-Kagy-A

A duplicate at the same place and time as above:

20120611-BC-Kagy-B
A blank at the same place and time as above:
20120611-BC-Kagy-C

Following grab-sample collection, samples will be transported back to Marsh Labs for immediate analysis. The holding time *E.coli* is 6 hours. The samples will be processed well within the holding time.

Quality Assurance and Quality Control Requirements

In order for water quality data to be useful, it needs to be an accurate representation of conditions in the water body at the time the samples were collected. This requires proper sample handling and processing and then assessment of data to ensure quality. Data quality objectives (DQOs) state the required quality of data for the intended use and data quality indicators (DQIs) are the specific criteria that data are assessed by to determine quality. Definitions and a list of DQIs are included in the glossary. These indicators are assessed by collecting quality control (QC) samples and then performing quality assurance (QA) checks on those samples.

QC samples are blank and duplicate samples collected in the field for evaluation of quality indicators. Once the results are processed for the QC samples, QA is the process of assessing the data through use of indicators to determine data quality.

Data Quality Objectives

Efforts have been made to produce a **spatially representative** dataset by selecting 18 sites spread over the length of the Bozeman Creek. However, *E.coli* counts are inherently variable in a stream; this variability will be calculated by looking at the differences between the duplicate samples that are collected at a site. To attempt to reduce the amount of instream spatial variability, volunteers will collect samples from the thalweg, to obtain a well-mixed water sample. See Table 2 for a description of the rationale for site selection. Efforts will be made to collect samples from May through September of 2012 to capture data from high and low flow events.

Provisions are in place to ensure **sensitivity** of data collected from the different sample locations and **comparability** of data collected to other sample events. These provisions include the collection field QC samples and use of the EPA approved IDEXX enumeration method. Data that does not meet quality criteria will be qualified appropriately in the annual report and during the MT EQUIS submission process.

In order to ensure the highest degree of data **completeness** possible, the project coordinator will check the samples for proper labeling on return to the lab. A minimum of 80% completeness (8 out of 10 scheduled events) is the goal for the project; which accounts for possible weather, access, and volunteer availability challenges.

Data Quality Indicators

Quality assurance and quality control (QAQC) can be broken down into a field and a laboratory component. The field component consists of collection of blank and duplicate samples and comparison of data to criteria. The laboratory component consists of assessment of data for blanks as well as a variety of duplicate and spiked samples

analyzed by the lab. Blank samples should ideally yield results indicating “no detection” of the analyte in question. Duplicate samples should ideally produce identical results and analysis of spiked samples should recover exactly the amount of analyte added; however, spiked samples are not conducted for bacteria analysis. Bacteria concentrations are inherently variable, and the criteria outlined in the following two sections are used to assess if data is of acceptable quality.

Quality Assurance for Field Quality Control Samples

Field quality control samples will be collected for 20% of all samples collected; this means every 2 in 10 samples will be a QC sample. Because we may not have the same number of volunteers available to collect a grab sample per each sampling event, we will assign 20% of samples per each sampling event to be a QC sample. This will be approximately 2-3 samples per event. Each set of field QC samples will include a blank and a duplicate. Accuracy for field QC samples will be assessed by ensuring that blank samples return a no detection value for coliform and *E.coli* readings. If a blank sample returns a result greater than a non-detect, the data from that event may need to be qualified. The exception is that data with a value greater than 10 times the detected value in the blank does not need to be qualified. Precision for field QC samples will be assessed by ensuring that relative percent difference (RPD) between duplicates is less than 25%. RPD is calculated using the equation below. In addition to these accuracy/precision checks, it will be necessary to check that all samples were processed within their specified hold times.

Quality Assurance for Lab Quality Control Samples

Due to the variability of bacteria sampling, duplicate and spike samples are not traditionally used as quality control measures. However, we will run a lab blank on sterilized stream water. This will check that the sterilized water is in fact sterile.

$$RPD \text{ as } \% = ((D1 - D2)/((D1 + D2)/2)) \times 100$$

Where: D1 is first replicate result, D2 is second replicate result

Parameter	Field Blank Threshold	Field Duplicate RPD
Total Coliform	0	< 25% RPD
<i>E.coli</i>	0	< 25% RPD

Table 4 Data quality indicator criteria for field QC samples

Qualifying Data that fails data quality criteria

If any of the data quality objectives for field or laboratory QC samples fail the criteria above, all data for that analyte for that sample batch must be qualified accordingly. Note that a blank which exceeds the threshold does not automatically mean all data for that sample batch must be qualified. Sample results with values greater than 10 times the detected value in the blank do not need to be qualified. A narrative in the annual sampling report should outline what data was qualified and for what reason. The

data will also need to be qualified during the process of uploading to MT EQUIS using the appropriate qualifier codes. A list of data qualifier codes is provided in the appendix.

Volunteer Recruitment and Trainings

A main focus of this volunteer project will be to target pet, livestock and homeowners of septic systems whose actions are directly connected to nonpoint source fecal contamination of water resources. We expect to involve a minimum of 10 volunteers and 20 students, with a hope of recruiting 20 volunteers. The volunteers will be able to help process the water samples using the IDEXX system which is non-intimidating and easy to use. Volunteers will add a Colilert nutrient packet to the sample, transfer the sample to a Quanti Tray, seal the tray with the sealer and incubate the sample. After 24 hours of incubation, the volunteer can return to assess their Quanti Tray. A yellow colored well indicates coliform presence whereas fluorescence (determined with the help of black light) indicates *E.coli* presence. The volunteers will count the number of yellow and fluorescing wells to determine the most probable number. See Lab SOPs in the appendix for in-depth directions on this process and picture of a sample Quanti Tray (page 26).

Volunteer recruitment will be done through announcements in the Bozeman Daily Chronicle and fliers that will be posted around town. The volunteer base for the Greater Gallatin Watershed Council will be contacted through email. We will work to engage MSU students as well as high school students for a few sampling events. It will be ideal to have a large enough volunteer base so that there are enough participants to visit each site. If at any of the events we do not have enough volunteers to collect samples from every site, we will still hold the event and sample the most pertinent sites and/or have a few volunteers collect samples at two proximate locations in quick succession. Trainings will be short and succinct, 30-45 minutes and will be held before each sampling event. Returnee volunteers will only need to attend the last 10 minutes to get their site assignment and sample bottles. Trainings will cover general water quality background information with a focus non-point source pollution and *E.coli*. Trainers will familiarize the volunteers with the sample sites with the assistance of GIS maps and photographs of each site. The volunteers will be taught how to properly collect a sample, how to label a sample, how to take a field and lab QC sample, and how to process the samples with the IDEXX equipment. Detailed instructions on sample collection and analysis methods are outlined in the SOP.

Data Analysis, Record Keeping & Reporting Requirements

Most probably number (MPN) data for coliform and *E.coli* counts from each sample will be kept in an Excel worksheet that will be maintained by MSUEWQ staff. The MSUEWQ coordinator will review the data to ensure all information is recorded properly (including the QA/QC samples) prior to data entry into MT EQUIS and the VOEIS online database. The results from the IDEXX Quanti-Tray analyses will be double checked by the MSUEWQ coordinator to ensure the MPN is properly recorded. Data qualifiers provided on page 29 will be assigned to data in both hardcopy and electronic form that does not meet these target quality control criteria.

Data generated during this project will be stored on field and lab forms as well as in a master Excel database that MSUEWQ will administer. Written field notes, field

forms, and digital photos will be processed by field staff following QA/QC procedures to screen for data entry errors. Data from all sampling events will be entered into EQUIS and VOIES.

The numerical data resulting from this project will not be compared to the water quality standards because we will not be sampling within the required timeframes. However, we will use the numbers in the standards as benchmarks to assess our data as a means of determining what constitutes a high reading (ie: over 126 cfu). The main purpose of this project is to engage citizens in volunteering and to increase community awareness about water quality issues in urbanizing areas. This project will focus on educating the public and users of Bozeman Creek about fecal contamination and how *E.coli* and coliforms are transported into our waterways. It will increase volunteer capacity by engaging citizens in water quality data collection in addition to covering best management practices connected with reducing *E.coli* transportation into surface waters.

References

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APPENDIX:

Quality Control Checklist

- ___ Condition of samples upon receipt
- ___ Proper collection containers
- ___ All containers intact
- ___ All field documentation complete. If incomplete areas cannot be completed, document the issue.
- ___ Holding times met
- ___ Field duplicates collected at the proper frequency (specified in SAP)
- ___ Field blanks collected at the proper frequency (specified in SAP)
- ___ All sample IDs match those provided in the SAP. Field duplicates are clearly marked on samples and noted as such in lab results.
- ___ Analyses carried out as described within the SAP (e.g. analytical methods, photo documentation, field protocols)
- ___ All blanks were less than the project-required detection limit
- ___ If any blanks exceeded the project-required detection limit, associated data is flagged
- ___ Laboratory blank samples were analyzed at a rate of 1 per event and returned results below detection
- ___ Project DQOs and DQIs were met (as described in SAP)
- ___ Summary of results of QC analysis, issues encountered, and how issues were addressed (corrective action)
- ___ Completed QC checklist before MT-EQUIS upload

QA/QC Terms

Accuracy. A data quality indicator, accuracy is the extent of agreement between an observed value (sampling result) and the accepted, or true, value of the parameter being measured. High accuracy can be defined as a combination of high precision and low bias.

Analyte. Within a medium, such as water, an analyte is a property or substance to be measured. Examples of analytes would include pH, dissolved oxygen, bacteria, and heavy metals.

Bias. Often used as a data quality indicator, bias is the degree of systematic error present in the assessment or analysis process. When bias is present, the sampling result value will differ from the accepted, or true, value of the parameter being assessed.

Blind sample. A type of sample used for quality control purposes, a blind sample is a sample submitted to an analyst without their knowledge of its identity or composition. Blind samples are used to test the analyst's or laboratory's expertise in performing the sample analysis.

Comparability. A data quality indicator, comparability is the degree to which different methods, data sets, and/or decisions agree or are similar.

Completeness. A data quality indicator that is generally expressed as a percentage, completeness is the amount of valid data obtained compared to the amount of data planned.

Data users. The group(s) that will be applying the data results for some purpose. Data users can include the monitors themselves as well as government agencies, schools, universities, businesses, watershed organizations, and community groups.

Data quality indicators (DQIs). DQIs are attributes of samples that allow for assessment of data quality. These include precision, accuracy, bias, sensitivity, comparability, representativeness and completeness.

Data quality objectives (DQOs). Data quality objectives are quantitative and qualitative statements describing the degree of the data's acceptability or utility to the data user(s). They include data quality indicators (DQIs) such as accuracy, precision, representativeness, comparability, and completeness. DQOs specify the quality of the data needed in order to meet the monitoring project's goals. The planning process for ensuring environmental data are of the type, quality, and quantity needed for decision making is called the **DQO process**.

Detection limit. Applied to both methods and equipment, detection limits are the lowest concentration of a target analyte that a given method or piece of equipment can reliably ascertain and report as greater than zero.

Duplicate sample. Used for quality control purposes, duplicate samples are two samples taken at the same time from, and representative of, the same site that are carried through all assessment and analytical procedures in an identical manner. Duplicate samples are used to measure natural variability as well as the precision of a method, monitor, and/or analyst. More than two duplicate samples are referred to as *replicate samples*.

Environmental sample. An environmental sample is a specimen of any material collected from an environmental source, such as water or macroinvertebrates collected from a stream, lake, or estuary.

Equipment or rinsate blank. Used for quality control purposes, equipment or rinsate blanks are types of field blanks used to check specifically for carryover contamination from reuse of the same sampling equipment (see *field blank*).

Field blank. Used for quality control purposes, a field blank is a “clean” sample (e.g., distilled water) that is otherwise treated the same as other samples taken from the field. Field blanks are submitted to the analyst along with all other samples and are used to detect any contaminants that may be introduced during sample collection, storage, analysis, and transport.

Instrument detection limit. The instrument detection limit is the lowest concentration of a given substance or analyte that can be reliably detected by analytical equipment or instruments (see *detection limit*).

Matrix. A matrix is a specific type of medium, such as surface water or sediment, in which the analyte of interest may be contained.

Measurement Range. The measurement range is the extent of reliable readings of an instrument or measuring device, as specified by the manufacturer.

Method detection limit (MDL). The MDL is the lowest concentration of a given substance or analyte that can be reliably detected by an analytical procedure (see *detection limit*).

Precision. A data quality indicator, precision measures the level of agreement or variability among a set of repeated measurements, obtained under similar conditions. Relative percent difference (RPD) is an example of a way to calculate precision by looking at the difference between results for two duplicate samples.

Protocols. Protocols are detailed, written, standardized procedures for field and/or laboratory operations.

Quality assurance (QA). QA is the process of ensuring quality in data collection including: developing a plan, using established procedures, documenting field activities,

implementing planned activities, assessing and improving the data collection process and assessing data quality by evaluating field and lab quality control (QC) samples.

Quality assurance project plan (QAPP). A QAPP is a formal written document describing the detailed *quality control* procedures that will be used to achieve a specific project's data quality requirements. This is an overarching document that might cover a number of smaller projects a group is working on. A QAPP may have a number of sample analysis plans (SAPs) that operate underneath it.

Quality control (QC). QC samples are the blank, duplicate and spike samples that are collected in the field and/or created in the lab for analysis to ensure the integrity of samples and the quality of the data produced by the lab.

Relative percent difference (RPD). RPD is an alternative to *standard deviation*, expressed as a percentage and used to determine precision when only two measurement values are available. Calculated with the following formula:

$$\text{RPD as \%} = ((D1 - D2)/((D1 + D2)/2)) \times 100$$

Where:

D1 is first replicate result

D2 is second replicate result

Replicate samples. See duplicate samples.

Representativeness. A data quality indicator, representativeness is the degree to which data accurately and precisely portray the actual or true environmental condition measured.

Sample analysis plan (SAP). A SAP is a document outlining objectives, data collection schedule, methods and data quality assurance measures for a project.

Sensitivity. Related to *detection limits*, sensitivity refers to the capability of a method or instrument to discriminate between measurement responses representing different levels of a variable of interest. The more sensitive a method is, the better able it is to detect lower concentrations of a variable.

Spiked samples. Used for quality control purposes, a spiked sample is a sample to which a known concentration of the target analyte has been added. When analyzed, the difference between an environmental sample and the analyte's concentration in a spiked sample should be equivalent to the amount added to the spiked sample.

Split sample. Used for quality control purposes, a split sample is one that has been equally divided into two or more subsamples. Splits are submitted to different analysts or laboratories and are used to measure the precision of the analytical methods.

Standard reference materials (SRM). An SRM is a certified material or substance with an established, known and accepted value for the analyte or property of interest.

Employed in the determination of bias, SRMs are used as a gauge to correctly calibrate instruments or assess measurement methods. SRMs are produced by the U. S. National Institute of Standards and Technology (NIST) and characterized for absolute content independent of any analytical method.

Standard operating procedures (SOPs). An SOP is a written document detailing the prescribed and established methods used for performing project operations, analyses, or actions.

True value. In the determination of accuracy, observed measurement values are often compared to true, or standard, values. A true value is one that has been sufficiently well established to be used for the calibration of instruments, evaluation of assessment methods or the assignment of values to materials.

Data qualifiers and descriptions

Result Qualifier	Result Qualifier Description
B	Detection in field and/or trip blank
D	Reporting limit (RL) increased due to sample matrix interference (sample dilution)
H	EPA Holding Time Exceeded
J	Estimated: The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.
R	Rejected: The sample results are unusable due to the quality of the data generated because certain criteria were not met. The analyte may or may not be present in the sample.
U	Not Detected: The analyte was analyzed for, but was not detected at a level greater than or equal to the level of the adjusted Contract Required Quantitation Limit (CRQL) for sample and method.
UJ	Not Detected/Estimated: The analyte was not detected at a level greater than or equal to the adjusted CRQL or the reported adjusted CRQL is approximate and may be inaccurate or imprecise.

Standard Operating Procedures (SOPs)

Field SOPs: Water Sample Collection

- Put on a clean pair of disposable nitrile gloves.
- Properly label the sample bottle with site name, date, and time with a permanent marker
- Wade into the channel as far as you feel comfortable or sample from the bank and/or use a sample stick if the water is too high to enter.
- Choose a spot that is in the middle of the stream and well-mixed (as long as it is safe to do so), do not sample from eddies or backwater or shallow areas
- Position yourself so that you face upstream
- Break the seal on the bacteria bottle making sure not to touch the inside of the cap or bottle, this will help the bottle to remain sterile and reduce contamination from outside sources.
- Do not rinse the bottle; it contains sodium thiosulphate which neutralizes free chlorine in the water.
- Face the opening of the bottle down towards the stream and dip the sterile bottle about 12 cm below the surface of the water in front of you and fill the bottle to the 100 mL line directly from the stream. – **do not rinse the bottle**
- Carefully replace the cap and tighten
- Transport the bottles in an insulated package to Marsh Labs for analysis. The sample needs to be processed within 6 hours from the collection time.

Lab SOPs: IDEXX *E.coli* sample analysis

Concept

E.coli is a bacteria which is an indicator organism for fecal contamination of water. The amount of *E.coli* present in the water is used to estimate the risk of pathogens being present in the water which can cause disease. IDEXX uses a powdered media which provides food for bacteria and produces color and fluorescence changes when *E.coli* is present in the sample. The Quanti Tray method takes a 100 mL sample and splits it into a number of smaller samples to allow for a calculation of the most probable number (MPN) of bacteria present in the sample.

Equipment List

- Samples
- Colilert media packets
- UV light-6 watt, 365 nm
- Quanti-Tray/2000 (this gives you counts of 2,419/100mL without dilution)
- Quanti-Tray/2000 sealer
- Incubator at 35°C ±0.5°C
- Color comparator
- MPN calculation table
- Germicide
- Nitrile gloves
- Goggles

- Lab coat

Procedure

1. Turn the Quanti-tray sealer on.
2. Clean the counter with disinfectant spray.
3. Samples for *E.coli* must be processed the same day they are collected.
4. Samples must be read between 24 and 28 hours from the time they are placed in the incubator.
5. Turn on the incubator and set it to 35 degrees C.
6. Remove samples from the field cooler and line them up on the counter in the order that they were collected in.
7. Put on a clean pair of nitrile gloves.
8. Get out enough Quanti Trays for all samples. Use a permanent marker for labeling but not a fine point because it could puncture the trays. Label trays on the back side with a permanent marker with the:
 - a. Sample location
 - b. Sample date and time
 - c. Time the samples are placed in the incubator
9. Lay out one Colilert nutrient packet for each sample next to the bottle.
10. Add the Colilert powder to the bottles and mix for 30 seconds or until the powder is dissolved.
11. Use one hand to hold a Quanti-Tray upright with the well side facing the palm. Squeeze the upper part of the Quanti-Tray so that the tray bends toward the palm. If someone assists with holding the tray, they should wear gloves too. 
12. Gently pull the foil tab up and out to separate the foil from the tray. Avoid touching the inside of the foil or tray. Avoid separating too far which will cause leakage.
13. Pour the reagent/sample mixture directly into the Quanti-Tray, avoiding contact with the foil tab.
14. Tap the tray to remove air bubbles.
15. Place the sample-filled Quanti-Tray onto the Quanti-Tray rubber insert for the sealer with the well side facing down.
16. Gently push the tray through the Quanti-Tray sealer to seal the tray.
17. Start filling out the *E.coli* datasheet with the sample IDs and the time into the incubator.
18. Place the samples in the incubator and note the time on a IDEXX *E.coli* Lab Data Sheet . Do not stack trays unless necessary.
19. Allow the samples to incubate for 24 to 28 hours before removing them to read.
20. Count the number of small and large cells which have a color equal to or more yellow than the color comparator. Record these numbers on the Lab Data Sheet and use the MPN table to determine the most probably number of total coliform present. Record this number on the Lab Data Sheet along with the times that the samples went into the incubator and were read.

21. Use the UV light box to count the number of small and large cells that fluoresce equal to or more intensely than the comparator. Record these numbers on the Lab Data Sheet and use the MPN table to determine the most probably number of *E.coli* in the sample. Record this number on the Lab Data Sheet along with the times that the samples went into the incubator and were read.

Less yellow than the comparator	Negative for total coliforms and <i>E.coli</i>
Yellow equal to or greater than the comparator	Positive for total coliform
Yellow and fluorescence equal to or greater than comparator	Positive for coliform and <i>E.coli</i>

Table 1. Result Interpretation Table



Image 1: Picture of Quanti Tray

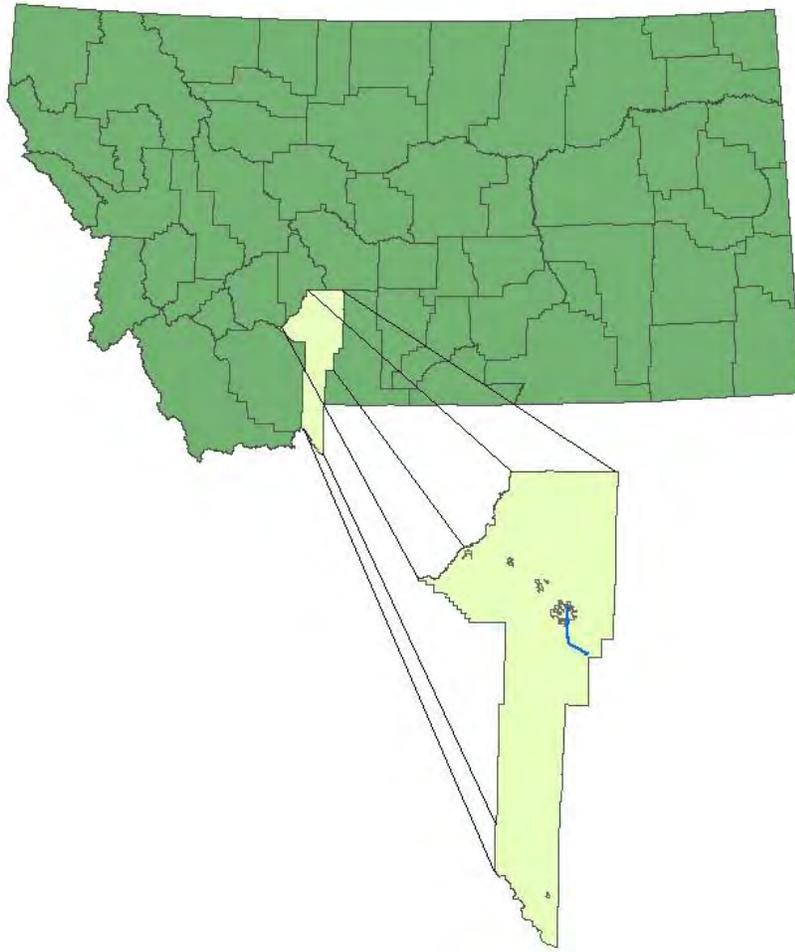
22. After trays have all been checked against datasheets for recording errors, place in autoclave bags and autoclave for 45 minutes at 121°C.
23. The autoclaved bags will then be properly disposed

Bozeman Creek Volunteer Monitoring for E. coli

Sampling Location Guide

Prepared for the Montana Department of Environmental Quality

April 17, 2012



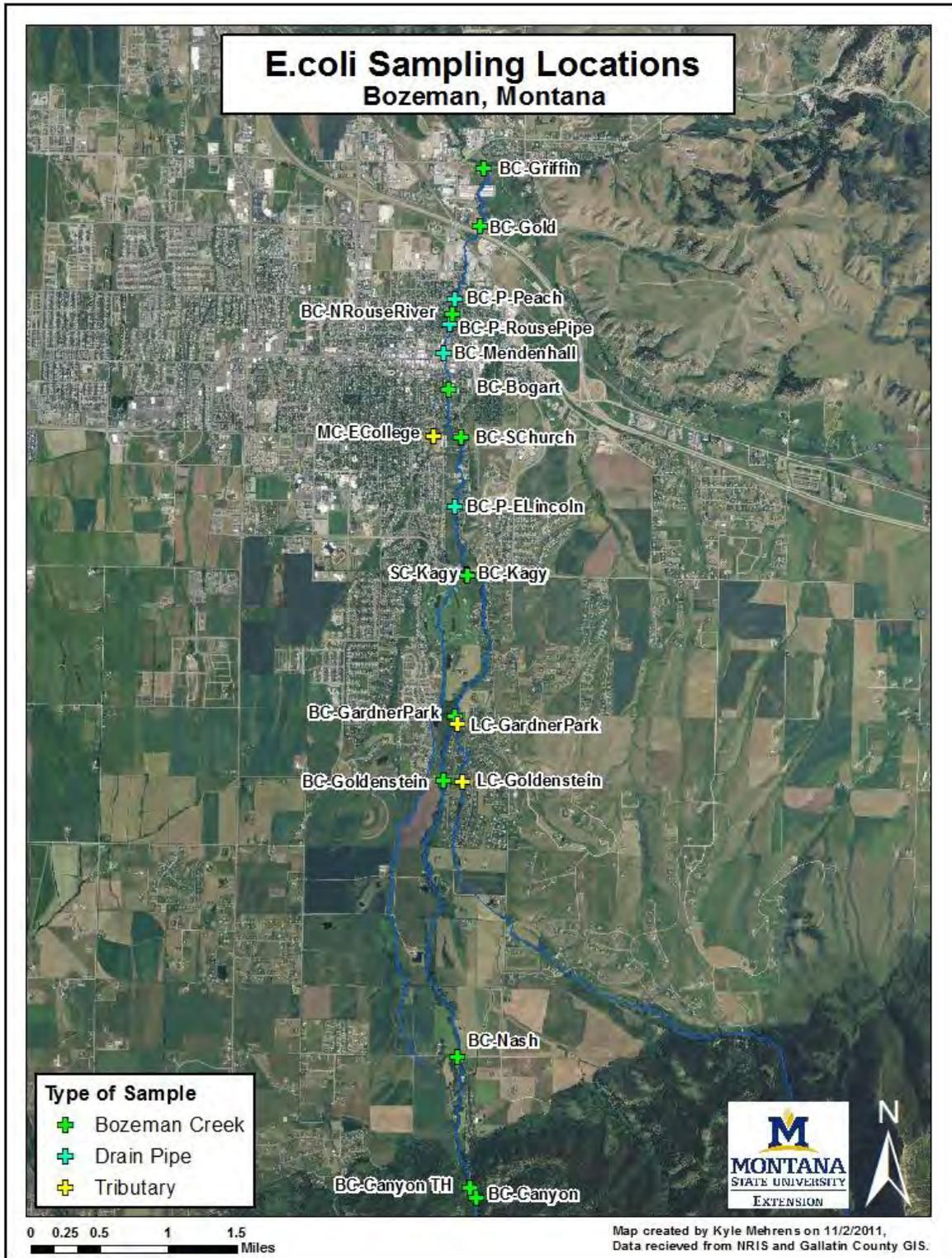
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Area Overview



1. Bridger Creek Canyon

Site ID: BC-Canyon



Figure 1 Sampling Location



Figure 2 South View



Figure 3 North View

Description: Sample site BC-Canyon is ~0.1 miles south of the trailhead on the Bozeman Creek/Sourdough Canyon trail. Walking up the maintained trail ~0.1 miles until you see the river location identified by the images above. Caution: this portion of Bozeman Creek has the potential to run very high and fast, use caution while taking samples. If the river is too high, use the alternate sample location next to the trailhead parking area.

Attributes:

Land Owner – Public

Parking Lot - Gravel Lot

Approach – .1 Mile Walk/Easy Access

Erosion – Chance for erosion on river bank when wet.

Waders – Yes

Sample Location – River Sample

Notes – Use alternative location during spring.

**1 (Alternate). Bridger Creek Canyon at Trailhead
Site ID: BC-Canyon TH**



Figure 1 Sample Location



Figure 2 East View



Figure 3 South View

Description: Sample site BC-Canyon-TH is at the west side of the Bozeman Creek/Sourdough Canyon trail parking lot. Walk through the parking lot until you see the river location identified by the images above. This sample site is to be used in the event that that water is too high to sample form BC-Canyon.

Attributes:

Land Owner – Public

Parking Lot - Gravel Lot

Approach – Easy Access

Erosion – Chance for erosion on river bank when wet.

Waders – Yes

Sample Location –River Sample

Notes – Use if Water is high.

2. Bridger Creek at Nash Road Site ID: BC-Nash



Figure 1 Sampling Location



Figure 2 West View



Figure 3 East View

Description: Sample site BC-Nash lies ~0.08 miles west of the intersection of Sourdough Canyon and Nash Road. The sample location is found on the south side of Nash (Sourdough Canyon side). The river may be covered by brush and debris so locating the sample site may be difficult. Caution: The river approach to this site may be difficult depending on height of water and brush conditions. Also use caution on roadway. Park on the south side of the road, ~20 ft west of the river (see pictures above).

Attributes:

Land Owner – Public
Parking Lot –Grassy Pullout
Approach - Medium/Hard Approach
Erosion – Chance for erosion on river bank when wet.

Waders – Yes
Sample Location – River Sample
Notes – Use caution on roadway.

3. Bridger Creek at Goldenstein Site ID: BC-Goldenstein



Park here next to the trail



Figure 1 West View



Figure 2 East View



Figure 3 Sampling Location

Description: The sample site, BC-Goldenstein, is where Bozeman Creek flows under Goldenstein. The sample site is found on the north side of the road (Bozeman side). Parking can be found at a small pullout on the north side of Goldenstein, just west of the bridge, near the trail head. You can park here for LC-Goldenstein site too and walk to that site. Approach is through tall grass on a sparse trail. Caution: This sample site is easily accessible, but use caution during high water periods.

Attributes:

Land Owner – Public
 Parking Lot – Grassy Pullout
 Approach – Easy Approach
 Erosion – None

Waders – Yes
 Sample Location – River Sample
 Notes – Use caution on roadway.

4. Limestone Creek at Goldenstein
Site ID: LC-Goldenstein



Park here next to the trail



Figure 1 Parking Area by BC-Goldenstein



Figure 2 Sampling Location/West View



Figure 3 Sampling Location/East View

Description: Sample site LC-Goldenstein lies 0.14 miles to the east of sample site BC-Goldenstein. The site is located where Limestone Creek flows under Goldenstein Lane. The sample location is on the south side of the roadway. Stay parked at the same place as in BC-Goldenstein and walk down to the sample site. Caution: Cars are traveling very fast through this area, please be very careful when walking to this site!!

Attributes:

Land Owner – Public
 Parking Lot – Gravel Pullout
 Approach – Easy Approach
 Erosion – Minimal erosion potential.

Waders – Yes
 Sample Location – Tributary
 Notes – Use caution on roadway.

5. Limestone Creek at Gardner Park
Site ID: LC-GardnerPark

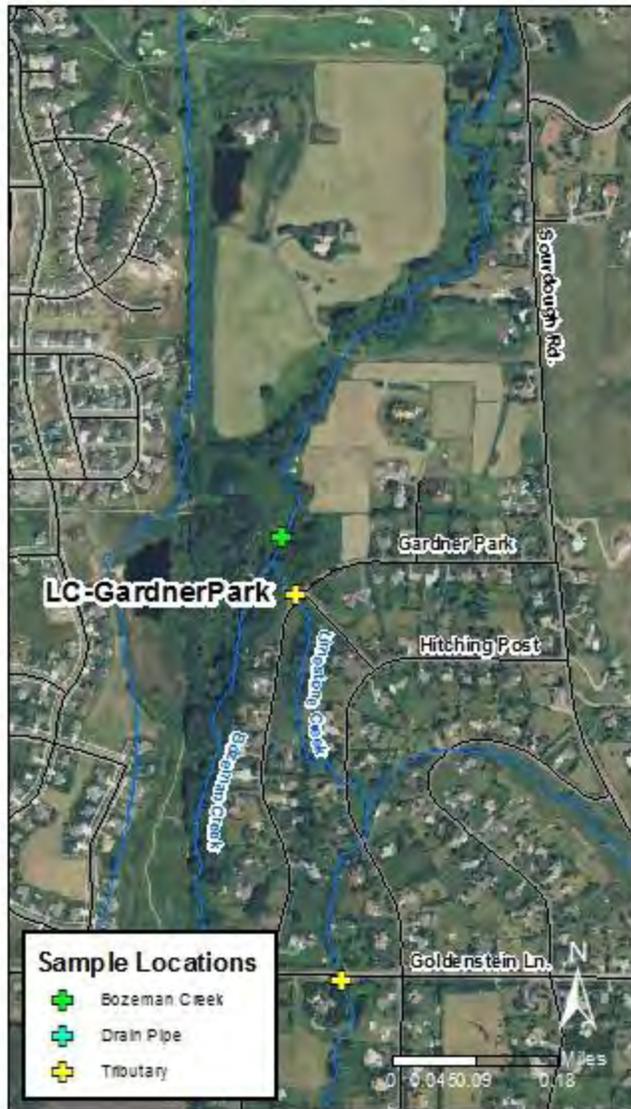


Figure 1 Sampling Location



Figure 2 South View



Figure 3 Parking Area

Description: Drive south down 19th and turn left on Goldenstein and drive for 1.6 miles. Make a left onto Gardner Park Dr. Drive 0.42 miles north and park at the Gardner Park Connector trailhead parking lot, walk ~ 50 feet north on Gardner Park Dr and on the west side of the road (on your left) you will see Limestone Creek. The sample location has heavy brush that must be passed through. This heavy brush also makes the creek a little difficult to see so look carefully.

Attributes:

Land Owner – Public
Parking Lot –Gravel Lot/Trailhead Parking Lot
Approach –Easy Approach
Erosion – None

Waders – Yes
Sample Location – Tributary
Notes – Prepare for heavy brush.

6. Bozeman Creek and Gardner Park Site ID: BC-GardnerPark

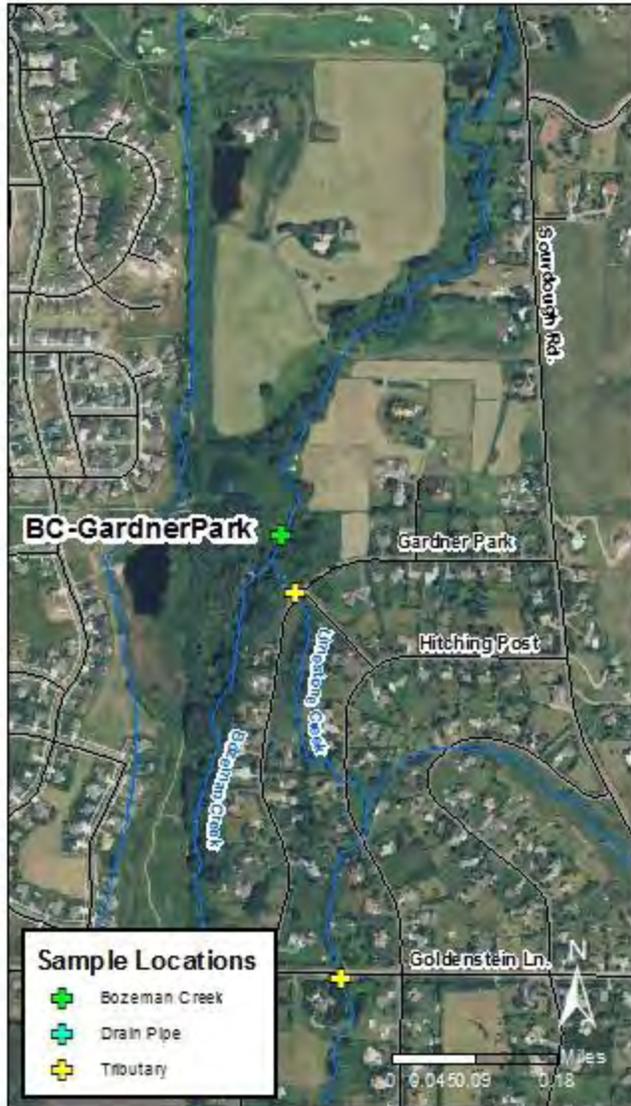


Figure 1: Sampling Location



Figure 2: North View



Figure 3: Parking Area

Description: Park at the Gardner Park Connector trailhead parking lot which is approximately 0.42 miles north on Gardner Park Drive from Goldenstein. Follow the Gardner Park trail head west for ~ 0.1 miles; you will come to a foot bridge crossing Bozeman Creek. This is the sample location. Samples should be taken on the south side of the bridge (upstream of the bridge). Use caution when water is high, this area can be deep and fast moving.

Attributes:

Land Owner – Public

Parking Lot –Gravel Lot/Trailhead Parking Lot

Approach – .1 mile walk down a maintained trail

Erosion – Minimal erosion potential

Waders – Yes

Sample Location – River Sample

Notes – Sample at bridge crossing

7. Bozeman Creek and Kagy Site ID: BC-Kagy

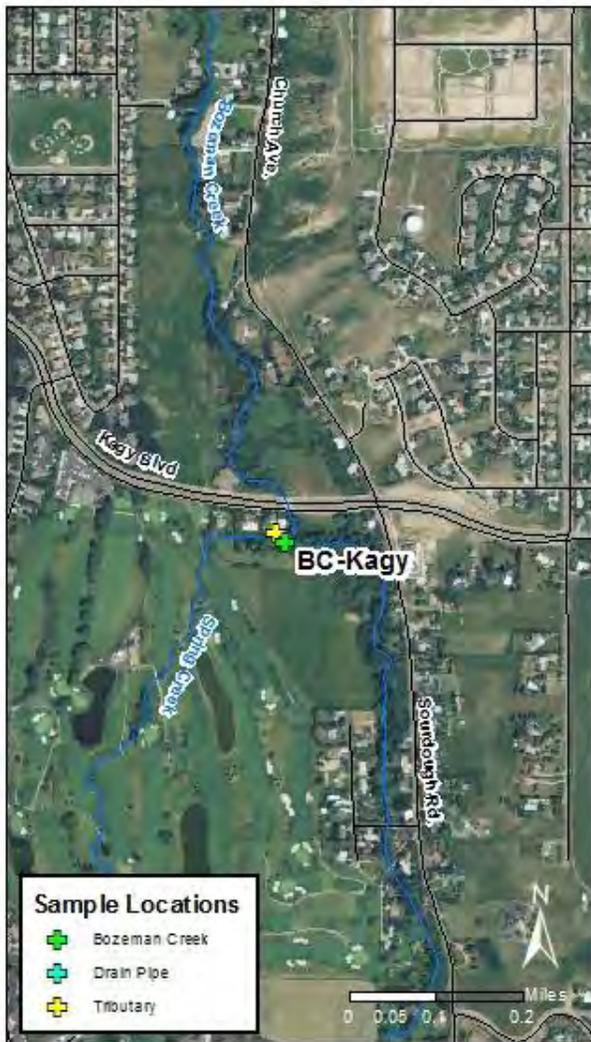


Figure 1: Side of the house. Use to access backyard



Figure 2: Spring Creek behind the house



Figure 3: Bozeman Creek at the side of the house

Description: This site is on private property. Make sure you have the Property Access Form with you. The owner, Kayle Jackson, has allowed the volunteers to access the streams behind his house. The address is 546 E. Kagy. Turn right off of Kagy at the “Jackson Law Office” sign, the driveway is shared with the neighbor; go to the left towards the purple house. Park and make sure not to block any of the cars in the driveway. Go along the West side of the house towards the back yard (figure 1). The Spring Creek runs along the backyard. Cross the foot bridge and walk east towards Bozeman Creek. Take a sample upstream of where the Spring Creek and Bozeman Creek mix.

Attributes:

Land Owner – Private
Parking Lot – 546 E. Kagy, driveway
Approach – Easy
Erosion – Minimal erosion potential

Waders – Yes
Sample Location – River Sample
Notes – River is deep in spots

8. Spring Creek and Kagy Site ID: SC-Kagy

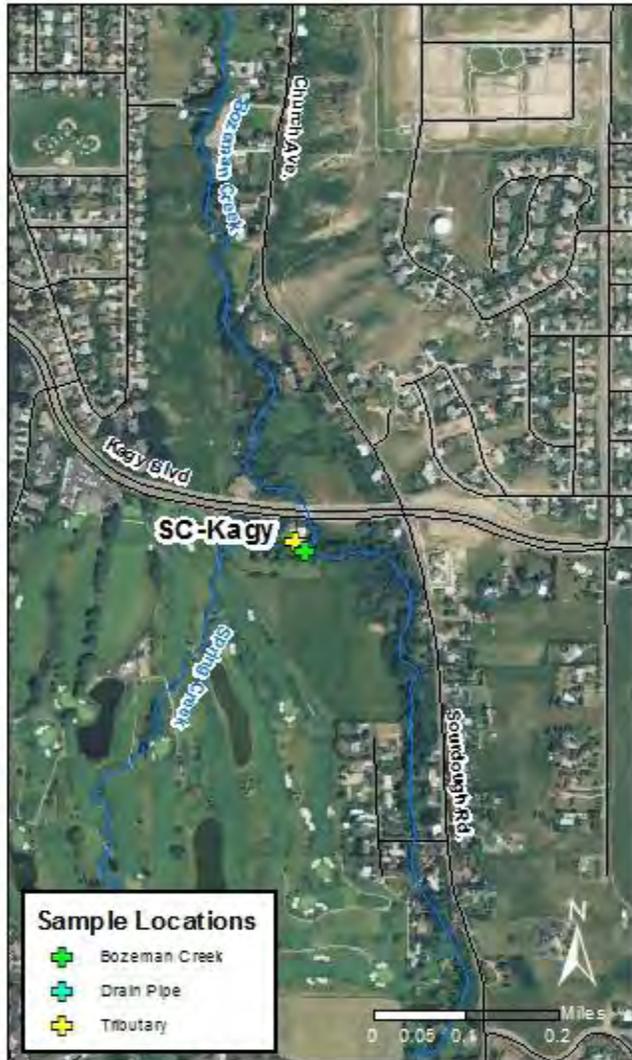


Figure 1: Side of the house. Use to access backyard



Figure 2: Sample upstream of moose



Figure 3: Spring Creek looking downstream

Description: This site is on private property. Make sure you have the Property Access Form with you. The owner, Kayle Jackson, has allowed the volunteers to access the streams behind his house. The address is 546 E. Kagy. Turn right off of Kagy at the “Jackson Law Office” sign, the driveway is shared with the neighbor; go to the left towards the purple house. Park and make sure not to block any of the cars in the driveway. Go along the West side of the house towards the back yard (figure 1). Go upstream of the bridge and the metal moose. This is Spring Creek, take the sample from a well-mixed portion of the stream.

Attributes:

Land Owner – Private
Parking Lot – 546 E. Kagy, driveway
Approach – Easy
Erosion – Minimal erosion potential

Waders – Yes
Sample Location – River Sample
Notes – River is deep in spots

9. Bozeman Creek and East Lincoln
Site ID: BC-P-ELincoln



Figure 1: Pipe for Sample/East View



Figure 2: Approach Trail/South View



Figure 3: Approach Trail

Description: Sample site BC-P-ELincoln is found approximately 300 yards from the end of East Lincoln Street. The approach is through private land. The landowner will be notified of each sampling event, make sure to have the signed Property Access Form with you. Walk past the two houses until you reach the river. Once at the river look up stream (south) until a large metal drain pipe is located. Sample the water as it is flowing out of the pipe. Please respect the privacy of owners.

Attributes:

Land Owner – Private
 Parking Lot – Park at the end of East Lincoln.
 Approach – Easy Approach
 Erosion – None

Waders – Yes
 Sample Location – Drain Pipe
 Notes – Obtain Permission from Landowner

10. Bozeman Creek and South Church
Site ID: BC-SChurch



Figure 1: South View

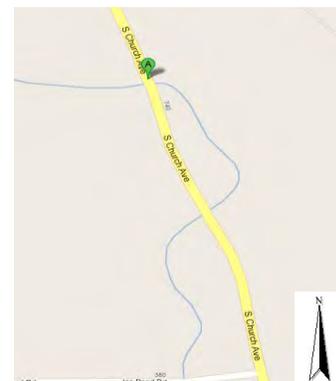


Figure 2: Sample Location



Figure 3: Sample Location/East side of bridge on Church

Description: Sample site BC-SChurch is found approximately 1 mile north of the intersection of Kagy Blvd. and South Church. Travel east on Kagy and turn left (north) on Sourdough (Church). When traveling north on Church from Kagy, Bozeman Creek crosses Church twice. Sample on the east side of the road, at the second crossing (the northern most crossing). Park in the parking lot of the greyish apartment buildings directly to the north and west of the sample site. Take a sample on the east side of the road (Peet’s Hill side). Caution: Church is a narrow busy road with blind corners, use caution on roadway.

Attributes:

Land Owner – Public
 Parking Lot – Park in Apartment Parking Lot
 Approach – Easy Approach
 Erosion – None

Waders – Yes
 Sample Location – River Sample
 Notes – Watch for traffic on road

11. Matthew Bird Creek and East College Site ID: MC-ECollege



Figure 1: East View



Figure 2: Sampling Location



Figure 3: Sampling Location/North View

Description: Park at the intersection of S. Black and E. College and look for the Galligator Trail on the east side of Black St. Follow the trail and look for a little bridge crossing. After the bridge crossing, take a left and the sample site is near the park bench and the large trees shown in the picture above. It should be easy to enter the stream here. Sample upstream of the large tree.

Attributes:

Land Owner – Public
 Parking Lot – E. College and S. Black
 Approach – Walk down maintained trails easy approach
 Erosion – Minimal erosion potential

Waders – Yes
 Sample Location – Matthew Bird Creek
 Notes – Sample by large tree

12. Bozeman Creek and Bogart Park
Site ID: BC-Bogart

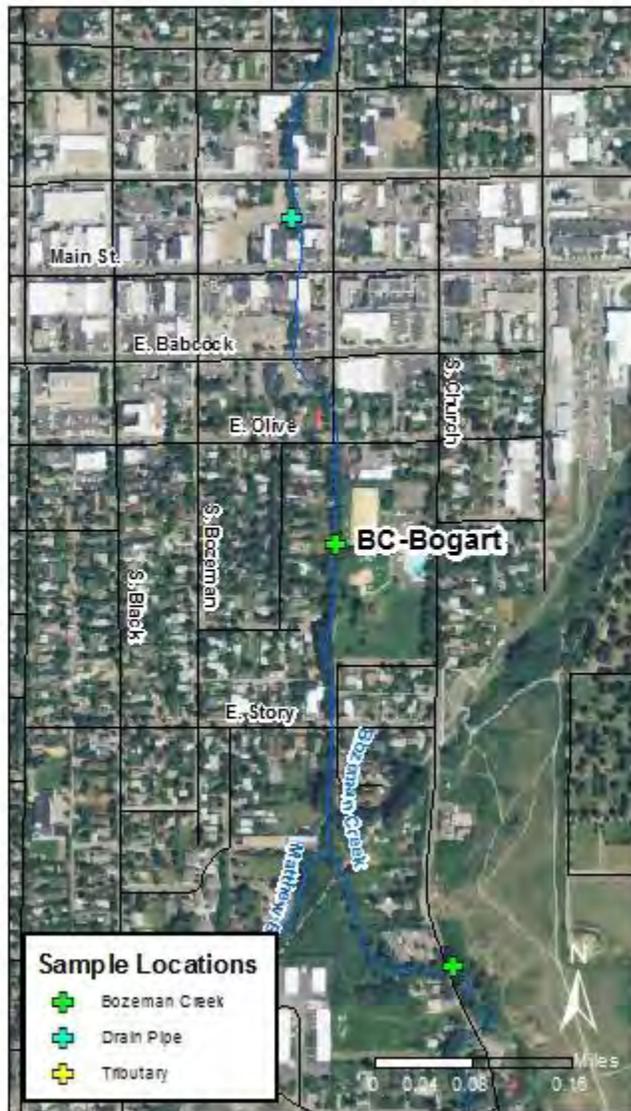


Figure 1: Sampling Location/ North View



Figure 2: Sampling Location/South View



Figure 3: Overview of Area

Description: Sample site BC-Bogart is located in Bogart Park on the west of the pavilion. Parking for this area can be found in the large parking lot adjacent to the community pool. Walk west to approach river and sample south of the pavilion where it is easy to enter the creek. The river is deep and strong in this area. Use caution during high flows.

Attributes:

Land Owner – Public
 Parking Lot – Park next to pavilion
 Approach – Walk across grass to river/easy approach
 Erosion – Minimal erosion potential

Waders – Yes
 Sample Location – Bozeman Creek
 Notes – none

13. Bozeman Creek and Mendenhall
Site ID: BC-Mendenhall

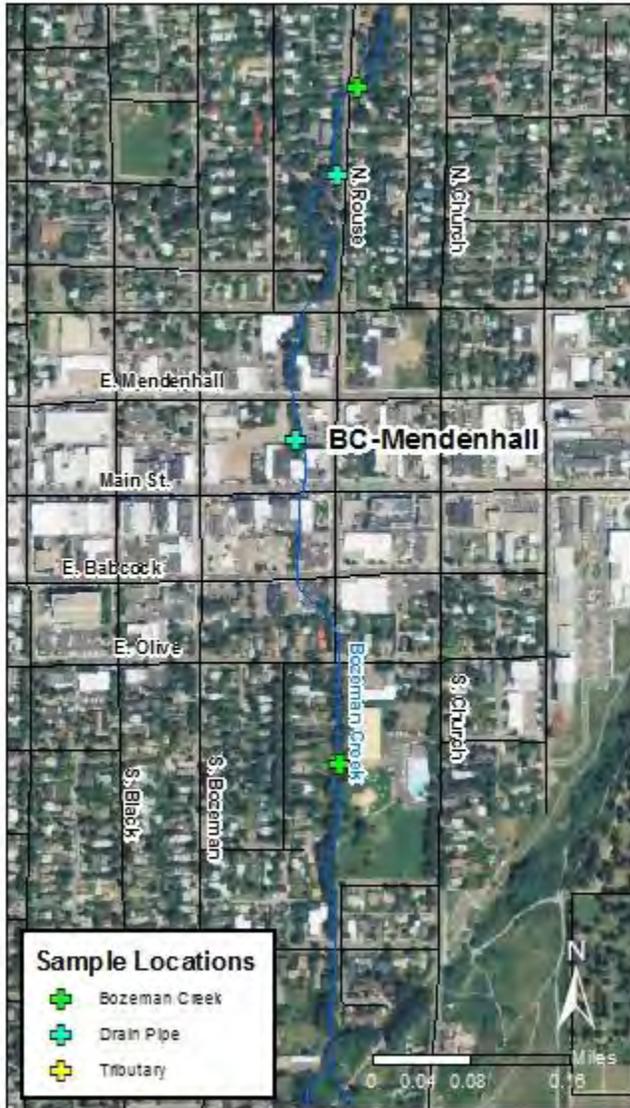


Figure 1: Sampling Location



Figure 2: East View



Figure 3: Parking Area

Description: Sample site BC-Mendenhall is found after the river reappears from traveling under the city. Park behind Bar 9 and ArtCraft Printers. Access the creek on the north side of the alley road that runs behind all of the businesses on Main St. It may be difficult to get in or deep. Bring a sampling stick during high flows.

Attributes:

Land Owner – Public

Parking Lot – Park behind the Pour House

Approach – Climb down rock bank of river medium approach

Erosion – Minimal erosion potential

Waders – Yes

Sample Location – Drain Pipe

Notes – Use caution in high water

14. Bozeman Creek and North Rouse
Site ID: BC-P-RousePipe



Figure 1: North View



Figure 2: South View



Figure 3: Drain Pipe

Description: Sample site BC-P-RousePipe is approximately .25 miles north from the intersection of North Rouse and Main. Take the sample from the drain pipe located at the prominent bend in the river, directly north of the white house. A sampling stick may be required to reach into the pipe for a sample. Park on the east side of Rouse in front of the Ski Way apartments. From here you can walk to the BC-NRouse River site too. Caution: Rouse is an extremely busy roadway. Also the river is extremely fast in this stretch of river so use caution when sampling.

Attributes:

Land Owner – Public
 Parking Lot – Park on Rouse by Ski Way Apartments
 Approach – Easy approach
 Erosion – Minimal erosion potential

Waders – Yes
 Sample Location – Drain Pipe
 Notes – Sampling Stick may be needed

15. Bozeman Creek and Rouse
Site ID: BC-NRouseRiver



Figure 1: Parking Area on Bridge



Figure 2: South View



Figure 3: Sampling Location

Description: Sample site BC-NRouseRiver is where Bozeman Creek crosses N. Rouse, approximately 0.3 miles from the intersection of Main and Rouse. Parking is easiest directly on top of the bridge that crosses Bozeman Creek or park at the site used for BC-P-RousePipe and walk to the site. Sample should be taken on the east side of North Rouse. Caution: Rouse is an extremely busy road. Also use caution if river is high. River flows in this area have the potential to be very fast and dangerous. Use a sampling stick if needed.

Attributes:

Land Owner – Public
Parking Lot – Park on Bridge above river on Rouse
Approach – Easy approach
Erosion – Minimal erosion potential

Waders – Yes
Sample Location – Bozeman Creek
Notes – Sampling Stick may be needed

16. Bozeman Creek and Peach
Site ID: BC-P-Peach

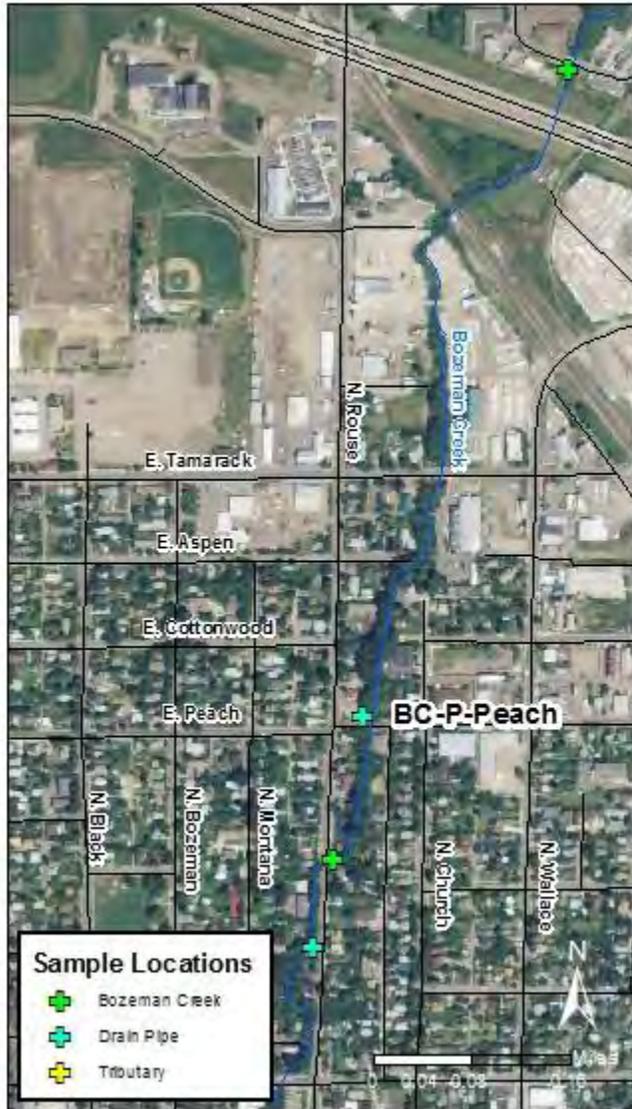


Figure 1: Sampling Location



Figure 2: Drain Pipe



Figure 3: Parking Location

Description: Sample site BC-P-Peach located just east of Audrey’s Pizza off of the corner of Rouse and Peach. Sample should be taken from the drain pipe found directly off the road next to the bridge. Caution: The River at this location may be moving quickly. Use caution and use a sampling stick if the water is too deep to stand in safely.

Attributes:

Land Owner – Public
 Parking Lot – Park on Bridge above river on Peach
 Approach – Easy approach
 Erosion – Minimal erosion potential

Waders – Yes
 Sample Location – Sample from Pipe
 Notes – Sampling Stick may be needed

17. Bozeman Creek and Gold Site ID: BC-Gold



Figure 1: Sample Location



Figure 2: Parking Area



Figure 3: Sampling Location Entrance

Description: Take North Rouse and turn right (east) on Bond Street. Turn right at Gold Street (south). Follow this road until you see the Barnard sign, park in little cul-de-sac before this sign. Bozeman Creek crosses under the bridge that leads to the Barnard Construction. Enter the creek on the south side of the road from the west.

Attributes:

Land Owner – Public
Parking Lot – Pullout before the bridge on Gold
Approach –Grassy trail to river
Erosion – Minimal erosion potential

Waders – Yes
Sample Location – Bozeman Creek
Notes – Be aware of Private Property

18. Bozeman Creek and Griffin
Site ID: BC-Griffin



Figure 1: Parking Area



Figure 2: Sample Location/South View

Description: Sample site BC-Griffin is found approximately 0.2 miles east on Griffin after turning east bound at the intersection of Griffin and North Rouse. This site is found at the confluence of Rock creek and Bozeman Creek. The sample should be taken on the South side of the bridge. Use caution while accessing the river. Heavy brush and barbed wire is found along the banks.

Attributes:

Land Owner – Public
Parking Lot – Pullout before bridge on west side
Approach – Brushy approach/medium difficulty
Erosion – Minimal erosion potential

Waders – Yes
Sample Location – Bozeman Creek
Notes – Be aware of barbed wire

Acknowledgements/Notes:

- Data for maps received from NRIS and Gallatin County GIS. GPS data was received using receivers from the Montana State University GPS Lab managed by Dianna Cooksey.
- Question and comments regarding the data above should be directed to Montana State University Extension Water Quality. Telephone number: **Tel: (406) 994-7381**
- This guide is a **GUIDE**, exact sampling locations, property ownership, river locations, and safety factors are subject to change without notice. Use extreme caution when sampling especially in times of high water or busy traffic on roadways.
- Please respect the property and land traveled on while gathering data for this project. Long term project goals and good relations with landowners and state officials is key in the longevity of this study.