



MS4 Wet Weather Sampling and Analysis Plan

City of Great Falls, Montana
Stormwater Management Plan
February 2023



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1 Introduction

1.1 Background

The City of Great Falls (City) operates its storm drainage system under the authorization of the Montana Pollution Discharge Elimination System (MPDES) General Permit for Stormwater Discharges Associated with Small Municipal Separate Storm Sewer Systems (MS4s), hereafter referred to as the MS4 General Permit. The current MS4 General Permit, issued by the Montana Department of Environmental Quality (MDEQ), is effective from April 1, 2022 through March 31, 2027.

In accordance with Part II of the MS4 General Permit, the City is required to perform semi-annual wet weather sampling, testing, and reporting of stormwater discharges from their MS4. Additionally, Appendix A of the MS4 General Permit instructs the City to evaluate potential impacts to impaired receiving waters and utilize monitoring to implement an adaptive management approach to minimize pollutant loads.

1.2 Purpose

The purpose of this sampling and analysis plan is to describe the City’s wet weather monitoring program for the current permit term. Additional specific details relating to the purpose of this plan are as follows:

- This plan will be implemented to identify and describe the selected monitoring locations associated with the self-monitoring requirements set forth in the MS4 General Permit.
- This plan describes how the City will use monitoring to evaluate potential impacts to impaired receiving waters, as required in Appendix A of the MS4 General Permit.
- This plan describes how the City will use monitoring to evaluate the effectiveness of BMPs implemented by the City.
- This document fulfills all monitoring requirements presented in the MS4 General Permit.

2 Great Falls’ MS4 Receiving Waterbodies

2.1 Receiving Waterbody Overview

Four surface waterbodies (three of which are impaired) receive stormwater discharges from the City’s MS4 outfalls (Montana Department of Environmental Quality, 2016). The receiving waterbodies and associated pollutants of impairment are identified in Table 2-1. Figure A.1 (Appendix A) provides a map of the City’s outfalls and associated receiving waterbodies.

Table 2-1. Summary of Great Falls’ MS4 Receiving Waterbodies

Waterbody	Location	Impaired	Approved TMDL	MS4 WLA	Pollutants of Impairment
Missouri River	Sheep Creek to Sun River	Yes	No	No	▪ Sedimentation/siltation

Missouri River	Sun River to Rainbow Dam	Yes	No	No	<ul style="list-style-type: none"> ▪ Chromium (total) ▪ Mercury ▪ Physical substrate habitat alterations ▪ Polychlorinated biphenyls (PCBs) ▪ Sedimentation/siltation ▪ Selenium ▪ Turbidity
Sand Coulee Creek	Confluence with Cottonwood Creek to the mouth (Missouri River)	Yes	No	No	<ul style="list-style-type: none"> ▪ Lead ▪ Salinity ▪ Zinc
Sun River	Muddy Creek to mouth (Missouri River)	Yes	Yes	No	<ul style="list-style-type: none"> ▪ Flow regime modification ▪ Nitrogen (total) ▪ Phosphorus (total) ▪ Sedimentation/siltation ▪ Total suspended solids

Table 2-1 shows that the Sun River is the only receiving waterbody with an approved total maximum daily load (TMDL) and that none of the receiving waterbodies have an MS4 assigned WLA.

3 Monitoring Design

The City will employ in-stream monitoring, stormwater system monitoring, and BMP monitoring, each of which is discussed in the following sub-sections. Analyses will be conducted for all MS4 General Permit Self-Monitoring required parameters (see Table 1 of Part II.C in the MS4 General Permit) and all feasible listed pollutants of impairment for receiving waterbodies. A map that displays all monitoring locations is provided in Figure A.2 (Appendix A).

3.1 In-Stream Monitoring

In-stream sample collection consists of obtaining samples from the MS4’s receiving waterbodies during wet-weather conditions. The goals of in-stream monitoring are to help the City understand:

- The ambient wet weather water quality status of the receiving waterbodies (Missouri River and Sun River)
- The trends in water quality observed for the receiving waterbodies
- How stormwater runoff is contributing pollutant loads to receiving waterbodies during representative storm events (evaluate how in-stream water quality changes from upstream of the MS4 to downstream of the City’s regulated MS4 area)

In-Stream Monitoring Applicable Permit Sections	
<input checked="" type="checkbox"/>	Part II.C: Self-Monitoring
<input checked="" type="checkbox"/>	Appendix A: TMDL Actions

3.1.1 In-Stream Sample Collection Methods

Collection of in-stream samples will be used to evaluate water quality entering the MS4 (in accordance with Self-Monitoring requirements) and to evaluate potential impacts to receiving waterbodies (in accordance with Appendix A requirements).

Grab samples will be collected during wet weather events. City staff members will safely wade into the stream and/or use an extension pole from the stream bank to obtain samples 10 to 15 feet from the edge of water. If collected in locations where the river is adequately mixed, grab samples will provide a reasonable representation of in-stream conditions². This approach is consistent with DEQ sampling procedures throughout the State of Montana (Kron, 2018).

Selection of sample locations is discussed in Section 3.1.2 and grab sample collection procedures are discussed in Section 4.1.1.

3.1.2 In-Stream Monitoring Locations

In-stream monitoring will be conducted at four locations in two of the City’s receiving waterbodies. The specific monitoring strategy associated with each waterbody is discussed below and a summary of the monitoring locations is provided in Table 3-1.

MISSOURI RIVER

Samples will be collected on the Missouri River upstream and downstream of the MS4 to evaluate the MS4’s impacts to the river. The Whitebear site, located upstream of MS4 outfalls, will assess water quality data for Missouri River flows prior to potential impacts from the MS4. The Black Eagle site is located downstream of all MS4 outfalls on the Missouri. It is anticipated that the MS4’s stormwater discharge flows will be adequately mixed with Missouri River prior to reaching the Black Eagle sample site, largely due to influence from Black Eagle Dam. The two outfalls located downstream of the Black Eagle Dam are on the same bank of the river as the sample site; therefore, samples gathered at this site should incorporate any influence that MS4 discharges have on Missouri River water quality.

SUN RIVER

Samples will be collected on the Sun River upstream and within the MS4 area to evaluate the MS4’s impacts to the river. The Sun site, located upstream of MS4 outfalls, will assess water quality data for Sun River flows prior to impacts from the MS4. The Sun River Downstream site is located just before the Sun River’s confluence with the Missouri River. Sample data from these two sites will be compared to evaluate changes in water quality that may be a result of MS4 discharges.

Table 3-1. In-Stream Monitoring Sample Collection Locations

Site ID	Waterbody	Location	Collection Method	Sample Parameters	Strategy
Whitebear	Missouri River	47.462576°N -111.305712°W	Grab	TSS, COD, Phosphorus (total), Nitrogen (total), pH, Copper, Lead, Zinc, Estimated Flow, Oil and Grease, Chromium, Mercury, Selenium	Assess the water quality on the Missouri River before entering the MS4 area
Black Eagle	Missouri River	47.536038°N -111.212400°W	Grab	TSS, COD, PCBs, Phosphorus (total), Nitrogen (total), pH, Copper, Lead, Zinc, Estimated Flow, Oil and Grease, Chromium, Mercury, Selenium	Sample downstream of the MS4 to assess the MS4s impacts to the Missouri River (if any)
Sun	Sun River	47.509350°N -111.376159°W	Grab	TSS, COD, Phosphorus (total), Nitrogen (total), pH, Copper, Lead, Zinc, Estimated Flow, Oil and Grease	Assess the water quality on the Sun River before entering the MS4 area

Sun River Down-stream	Sun River	47.491989°N -111.325089°W	Grab	TSS, COD, Phosphorus (total), Nitrogen (total), pH, Copper, Lead, Zinc, Estimated Flow, Oil and Grease	Sample in the MS4 area before the confluence with the Missouri River, to assess the Sun River water quality in the MS4 area
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3.2 Stormwater System Monitoring

Stormwater system monitoring consists of collection of samples in the City’s stormwater network (including samples at outfall locations). The goals of stormwater system monitoring are to:

- Understand how pollutant concentrations vary by land use (residential vs commercial)
- Evaluate reduction in pollutant loading over time as upstream BMPs are installed

Stormwater System Monitoring Applicable Permit Sections	
<input checked="" type="checkbox"/>	Part II.C: Self-Monitoring
<input checked="" type="checkbox"/>	Appendix A: TMDL Actions

3.2.1 Stormwater System Sample Collection Methods

Wet weather stormwater system monitoring efforts will collect sample data from selected locations representing drainage from both residential and commercial land use categories. Collection of stormwater system samples will facilitate the identification of pollutant sources, characterization of stormwater (based on land use), and indication of the effects that stormwater runoff may have on receiving water quality when compared with in-stream water quality data. Samples will be collected as grab samples during wet weather events for all parameters. Grab sample collection procedures are discussed in Section 4.1.1.

3.2.2 Stormwater System Wet Weather Monitoring Locations

Stormwater system monitoring will be conducted at five locations in drainage areas that discharge to the Missouri River and Sand Coulee Creek. The specific monitoring strategy associated with each sample location is discussed below and a summary of the monitoring locations is provided in Table 3-2.

EXPO

The Expo monitoring site is located in a drainage area that discharges to the Missouri River (Sun River to Rainbow Dam section). The drainage area is approximately 500 acres, comprised mostly of commercial land use. The City plans to use the monitoring data results from this site to evaluate how runoff from the City’s commercial areas may be affecting receiving waterbodies.

LOAF N JUG

The Loaf N Jug monitoring site is located in a drainage area that discharges to the Missouri River (Sun River to Rainbow Dam section). The drainage area is approximately 200 acres, comprised mostly of residential land use. The City plans to use the monitoring data results from this site to evaluate how runoff from the City’s residential areas may be affecting receiving waterbodies.

SAND COULEE 2

The Sand Coulee 2 sample site is at an outfall located within an open ditch downstream of the Mountain View pond. The pond has historically captured and retained the majority of runoff draining from the 350 acre drainage area. The primary goal associated with this sample location is to gather data that will be used to help the City evaluate the MS4’s potential impact to the water quality in Sand Coulee Creek. It is probable that during frequent storm events there will be no stormwater that discharges to Sand Coulee Creek. In such cases, this will be noted on the sample collection data sheet. Over time, the City may be able to develop an understanding of the storm event frequency which causes stormwater runoff to discharge to Sand Coulee Creek.

Table 3-2. Stormwater System Monitoring Sample Collection Locations

Site ID	Receiving Waterbody	Location	Collection Method	Sample Parameters	Strategy
Expo	Missouri River	47.510721°N -111.320415°W	Grab	TSS, COD, PCBs, Phosphorus (total), Nitrogen (total), pH, Copper, Lead, Zinc, Estimated Flow, Oil and Grease, Chromium, Mercury, Selenium	Evaluate runoff from a representative commercial drainage area
Loaf N Jug	Missouri River	47.525436°N -111.300061°W	Grab	TSS, COD, PCBs, Phosphorus (total), Nitrogen (total), pH, Copper, Lead, Zinc, Estimated Flow, Oil and Grease, Chromium, Mercury, Selenium	Evaluate runoff from a representative residential drainage area
Sand Coulee 2	Sand Coulee Creek	47.462997°N -111.246522°W	Grab	TSS, COD, Phosphorus (total), Nitrogen (total), pH, Copper, Lead, Zinc, Estimated Flow, Oil and Grease, Salinity	Assess the MS4 pollutant loading to Sand Coulee Creek

3.2.3 Stormwater System PCB Monitoring Locations

PCB monitoring will be conducted in areas that discharge to the Missouri River because the Missouri River is impaired for PCBs. DEQ’s listed probable causes include permitted industrial point source discharge and permitted industrial-commercial site stormwater discharge. The MS4 is not anticipating to be a contributor of PCBs. However, if future wet weather sampling events indicate elevated levels of PCBs, the sampling protocol outlined in Appendix C will be implemented.

BMP Monitoring

BMP monitoring consists of collection of samples immediately upstream and downstream of one of the City’s structural BMP’s. The goals of BMP monitoring are to:

- Assess the performance of the BMP for removal of a variety of pollutants in stormwater runoff
- Evaluate the effectiveness of the BMP to understand whether the BMP implementation is reducing the discharge of pollutants of concern from the MS4

BMP Monitoring Applicable Permit Sections	
<input checked="" type="checkbox"/>	Part II.C: Self-Monitoring
<input checked="" type="checkbox"/>	Appendix A: TMDL Actions

3.2.4 BMP Sample Collection Methods

BMP monitoring efforts will collect sample data from points located immediately upstream and downstream of a structural BMP. Samples will be collected as grab samples during wet weather events. Grab sample collection procedures are discussed in Section 4.1.1.

3.2.5 BMP Monitoring Locations

The City has a hydrodynamic separator installed in Verde Park. This area drains to the Missouri River (Sheep Creek to Sun River section). The City will conduct monitoring immediately upstream and downstream of the hydrodynamic separator in order to evaluate its effectiveness at removing sediment from MS4 wet weather discharges. Additional parameters will also be analyzed in accordance with Table 1. Small MS4 Monitoring Requirements, of Part II.C in the MS4 General Permit.

The results of this evaluation will be used to assist the City in making informed decisions about whether to install a hydrodynamic separator in other locations. A summary of the monitoring locations is provided in Table 3-4.

Table 3-4. BMP Monitoring Sample Collection Locations

Site ID	Receiving Waterbody	Location	Collection Method	Sample Parameters	Strategy
Verde Up	Missouri River	47.484702°N -111.310451°W	Grab	TSS, COD, Phosphorus (total), Nitrogen (total), pH, Copper, Lead, Zinc, Estimated Flow, Oil and Grease Chromium, Mercury, Selenium	Evaluate the effectiveness of the hydrodynamic separator BMP (in correlation with Verde Down site)
Verde Down	Missouri River	47.484682°N -111.310499°W	Grab	TSS, COD, Phosphorus (total), Nitrogen (total), pH, Copper, Lead, Zinc, Estimated Flow, Oil and Grease Chromium, Mercury, Selenium	Evaluate the effectiveness of the hydrodynamic separator BMP (in correlation with Verde Up site)

3.3 TMDL-Related Monitoring

In accordance with requirements presented in Part II of the MS4 General Permit, the City will evaluate its contribution to impairments during wet weather events and implement BMPs targeted at reducing discharges contributing to impairments for the pollutants identified in Table 2-1. The City will utilize the two (2) sampling locations on the Missouri River (see above) as well as the two (2) sampling location on the Sun River (see above) as its four (4) specific TMDL-related monitoring locations. However, sampling results from all locations will be utilized to evaluate the overall contribution to impairments. Results will be analyzed in accordance with this document (see Section 4.6)

Additionally, the results of wet weather monitoring conducted as described in this plan will be used to inform the City’s assessment of BMP performance and future BMP implementation plans. The City continues to develop and implement its MS4 program that encompasses all required minimum control measures (MCM-1 through MCM-6). Implementation of the MS4 program will target pollutants of impairment by evaluating potential impacts/sources to receiving waterbodies and determining the best course of action to address those impacts/sources. The City utilizes both administrative (implementation of the MS4 program) and structural (ponds other physical features, etc.) BMPs to specifically target removal of Total Phosphorous (TP), Total Nitrogen (TN), and Sediment. For example, the primary purpose for the temporary BMPs required in MCM-4 as well as permanent BMPs required in MCM-5 is to minimize erosion and discharge of sediment. Removal of sediment can also potentially aid in the removal of other types of potential pollutants (i.e. TN, TP, metals, etc.).

4 Monitoring Methods

Quality Assurance/Quality Control (QA/QC) is critical for accurate sampling. This section provides details of sampling methods, laboratory analytical methods, and QA/QC procedures to be used in sampling.

4.1 Field Sampling Methods

The City will use manual sample collection techniques to conduct monitoring activities at each site in the immediate future. In the coming years, automated samplers may be used to collect grab samples at locations yet to be determined (the City will evaluate which sites are best suited for use of automated samplers over the coming year). Each of these methods are discussed below.

4.1.1 Manual Sample Collection

Manual grab techniques will be used to collect samples at most sites. The samples will be collected by field personnel during measurable runoff events (that is, any rainfall or snow melt events that produce any volume of runoff flowing past/through the monitoring location that will allow a sample to be collected). Rainfall events will be monitored by weather surveillance radar so that field personnel can determine when to be present in the watershed during active events to obtain manual samples.³ Samples will be collected in clean, labeled bottles provided by the laboratory. If necessary, an extension pole, rope or other apparatus can be used to aid the field crew in safe sample collection, especially during high flow conditions.

4.1.2 Automated Sample Collection

The City owns two Teledyne ISO automated sampler devices. These devices may be used to collect grab samples in certain in-system (not in-stream) locations through the duration of this permit term. Locations will be selected based on applicability and access. The samplers will be programmed to collect a sample when flows at the site are at adequate depth to obtain a full sample.

4.1.3 Sampling Equipment Decontamination

Decontaminated sample collection bottles and lids will be provided by Energy Laboratories Inc. in Billings. The City will use various tools and equipment during sampling events, summarized as follows:

- Beaker
- Catch pole
- Rubber gloves
- pH meter
- Manhole pick
- Coolers
- AA Batteries

All sampling equipment will be decontaminated after each sample is collected. This will prevent cross contamination between monitoring sites and it will help improve the accuracy and reliability of the data. Any equipment that comes in contact with raw surface water will be washed with Liquinox™ cleaning detergent and rinsed with distilled water.

4.1.4 PCB Sediment Sample Collection

PCB sediment sample collection protocol is provided in Appendix C.

4.2 Sampling Parameters and Analytical Methods

The water quality samples collected will be analyzed for the listed pollutants of impairment in the specific receiving waterbody as well as the parameters listed in Table 1 of Part IV.A in the MS4 General Permit (Small MS4 Monitoring Requirements). Table 4-1 shows the parameters and standard analytical methods to be used.

Table 4-1. Analytical Methods

Parameter	Analytical Method	Required Reporting Limit (mg/L)	Volume Required & Sample Container (mL)	Preservative	Holding Time (days)
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Chemical Oxygen Demand	E410.4	5	50 mL plastic or glass	H ₂ SO ₄ to pH<2 Cool, ≤ 6°C	28
Chromium	E200.8	0.001	200 mL plastic or glass	HNO ₃ to pH<2	6 months
Copper	E200.8	0.001	250 mL plastic or glass	HNO ₃ to pH<2	6 months
Estimated Flow	N/A	N/A	N/A	N/A	N/A ²
Lead	E200.8	0.0003	250 mL plastic or glass	HNO ₃ to pH<2	6 months
Mercury	E245.1	0.000005	100 mL plastic or glass	HNO ₃ to pH<2	28
Total Nitrogen (Persulfate method)	A 4500 N-C	0.04	50 mL plastic or glass	Cool, ≤ 6°C	N/A
Nitrogen – Kjeldahl, total ¹	E351.2	0.225	500 mL plastic or glass	H ₂ SO ₄ to pH<2 Cool, ≤ 4°C	28
Nitrate & Nitrite, total ¹	E353.2	0.01	50 mL plastic or glass	H ₂ SO ₄ to pH<2 Cool, ≤ 6°C	28
Oil and Grease	E1664A A 5520 B	1	1 L glass (2)	H ₂ SO ₄ to pH<2 Cool, ≤ 6°C	28
pH	E150.1	0.1 unit	N/A	N/A	Analyze immediately ²
Total Phosphorus	E365.1	0.003	250 mL plastic or glass	H ₂ SO ₄ to pH<2 Cool, ≤ 6°C	28
Selenium	E200.8	0.001	250 mL plastic or glass	HNO ₃ to pH<2	6 months
Total Suspended Solids	A 2540 D	4	1 L plastic or glass	Cool, ≤ 6°C	7
Zinc	E200.7	0.008	250 mL plastic or glass	HNO ₃ to pH<2	6 months

¹Total Nitrogen is calculated from Nitrogen – Kjeldahl, total and Nitrate & Nitrite, total.

²The City analyze for estimated flow and pH onsite.

4.3 Sample Handling and Documentation

Automatic samplers will be serviced immediately following a storm event. Chain of custody forms will accompany all samples. A field log will be kept for each sampling site with details of the date, time, personnel, purpose of visit, weather/field conditions observed, samples collected, and actions performed.

4.4 Storm Events and Sample Frequency

Monitoring will be conducted every year throughout the General Permit cycle. Sampling will be attempted for any measurable runoff events (that is, any rainfall or snow melt events that produce any volume of runoff flowing past/through the monitoring location that will allow a sample to be collected). In accordance with Part II.C.1.b of the MS4 General Permit, a minimum of one sample will be collected at each site between January 1st and June 30th and a minimum of one sample will be collected at each site between July 1st and December 31st of each year. The City will attempt to collect four samples annually at each site. Four annual samples will provide greater assurance that data is representative. The monitoring plan and schedule will likely be revisited at the end of this General Permit term, based on permit requirements.

Precipitation will be monitored using a combination of on-site or web-based rain gauges⁴, and the radar managed by the National Oceanic and Atmospheric Administration’s Nation Weather Service.

This data may be used to delineate storm characteristics, if necessary (timing, duration, intensity, relative total rainfall, etc.).

4.5 Quality Assurance/Quality Control

Samples will be analyzed using the designated EPA Method or Standard Method as defined in Table 4-1. Chain-of-custody procedures will be followed for samples sent to the laboratory. All data should meet the precision, recovery, and accuracy requirements specified in the laboratory method used. The laboratory used for these analyses will maintain internal quality assurance/quality control procedures as documented in their laboratory quality assurance manual. The laboratory will use a combination of blanks, laboratory control matrix spikes, surrogates, and duplicates to evaluate the analytical results.

During each sampling event, the quality of the primary sample results will be evaluated in terms of sensitivity, precision, bias, and accuracy. Field duplicates and field blanks will be collected randomly for a minimum of 10% of all water quality grab samples. Instructions for collection of field blanks and field duplicates are provided in Appendix D.

These data quality indicators are quantitative criteria established for the data acquired within this design to assure it is of sufficient quality for its intended use. Descriptions of data qualifiers and common QC terms and acronyms are included in Appendix E.

4.5.1 Sensitivity

Sensitivity refers to the limit of a measurement to reliably detect a characteristic of a sample. For analytical methods, sensitivity is expressed as the method detection limit (MDL). Laboratories must determine their MDLs annually and routinely check each method's ability to achieve this level of sensitivity using negative controls (e.g., method blanks, calibration blanks, and laboratory reagent blanks). Sensitivity quality controls for laboratory methods will follow the frequency and criteria specified in the analytical method or as described in the laboratory's quality assurance plan (LQAP). The criteria used to assess field method sensitivity for water samples shall be:

$$\text{Field method controls (Field Blanks)} < \text{Reporting Limit}$$

Corrective Action: If analytical method controls fail the specified limit, check with the laboratory to see how they addressed the non-conformance and qualify data as necessary. If field blanks fail, qualify all associated project data < 10x the detected value with "B" flags.

4.5.2 Precision

Precision refers to the degree of agreement among repeated measurements of the same characteristic. Analytical and field duplicates will be used to assess precision based on their relative percent difference (RPD).

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

Where:

D1 is first replicate result

D2 is second replicate result

LABORATORY PRECISION

Precision quality control for all laboratory methods will follow the frequency specified in the analytical method or as described in the LQAP. The precision laboratory goals are:

- 10% RPD for analytical controls
- 20% RPD for method batch controls

OVERALL PRECISION (FIELD DUPLICATES)

Frequency of field duplicates will be 10% of samples collected in the field. The criteria used to assess overall precision for these water samples shall be:

- 25% RPD for duplicate results > 5 times the RL

Corrective Action: If laboratory duplicates fail the above limit, check with the laboratory to see how they addressed or qualified the data and add additional qualifiers and notes as needed. If the field duplicates fail the above limit, qualify all associated results < 5x the concentration in the duplicate pair’s parent sample with a “J”.

A method validation process including precision and accuracy performance evaluations and method detection limit studies are required of all lab standard operating procedures. Method performance evaluations include quality control samples analyzed with a batch to ensure sample data integrity. Internal laboratory spikes and duplicates are all part of each laboratory’s quality assurance program. Laboratory QA/QC results generated from these programs is provided with the analytical results.

4.5.3 Bias and Accuracy

Bias is directional error from the true value. In this context, it is an extension of the representativeness concept applied to an individual sample. Bias can occur either at sample collection or during measurement.

Accuracy is the combination of high precision and low bias. Accuracy of individual measurements will be assessed by reviewing the analytical method controls (i.e., laboratory control sample, continuing calibration verification, laboratory fortified blank, standard reference material) and the analytical batch controls (i.e., matrix spike and matrix spike duplicate). The criteria used for this assessment will be the limits that each laboratory developed through control charting of each method’s performance or based on individual method requirements. Method QC descriptions are contained in Appendix E. Accuracy is determined by the percent recovery for each sample, determined as follows:

$$\text{Matrix Spike \% Recovery} = \frac{\text{Spiked Sample Result} - \text{Sample Result}}{\text{Spike Concentration}} \times 100$$

$$\text{Control Standard \% Recovery} = \frac{\text{Instrument Determined Concentration}}{\text{True Concentration}} \times 100$$

Corrective Action: For any QC value outside of the recovery range, check with the laboratory to see how they addressed the non-conformance and qualify data as necessary.

4.6 Analysis of Results

All sample results will be compiled into a spreadsheet containing the results for each parameter at every sample site. The analysis method will vary depending on the sample collection method and site objectives, which are described in the subsequent sections.

4.6.1 Sample Collection at Sites Verde Up and Verde Down

The objective at Verde Up and Verde Down is to compare influent and effluent data for the Vortechs® hydrodynamic separator. BMP effectiveness will be quantified by calculating the percent change in pollutant concentration between the two sample sites, using Equation 1. The calculated percent change for each sample collected will be presented on a graph (sample date vs. percent change) to assess the long-term performance of the BMP.

$$\text{Percent Change} = \frac{C_i - C_e}{C_i} \times 100$$

Where:

- C_i = Influent concentration (mg/L)
- C_e = Effluent concentration (mg/L)

4.6.2 Sample Collection at all Sites

A graph will be generated showing sample date (time) vs. concentration, for each parameter. These graphics will show the trend in water quality data over the period of time which samples are being collected. A downward trend will indicate that BMPs implemented upstream are effective, while a stagnant or upward trend would indicate the BMPs implemented upstream are not effective at reducing pollutants. A separate analysis of each parameter can be used to help understand the effectiveness of BMPs for a variety of parameters considered.

Table 4-2. Data Analysis Plan

Sample Collection Method	Monitoring Objective	Analysis Procedure
In-Stream Monitoring	Understand the ambient wet weather water quality status of the receiving waterbodies (Missouri River and Sun River)	Compare results to surface water quality standards
In-Stream Monitoring	Understand the trends in water quality observed for the receiving waterbodies	Evaluate results in a time series chart
In-Stream Monitoring	Understand how stormwater runoff is contributing pollutant loads to receiving waterbodies during representative storm events (evaluate how in-stream water quality changes from upstream of the MS4 to downstream of the City's regulated MS4 area)	Compare downstream to upstream results
Stormwater System Monitoring	Understand how pollutant concentrations vary by land use (residential vs commercial)	Directly compare residential and commercial results in time series
Stormwater System Monitoring	Evaluate reduction in pollutant loading over time as upstream BMPs are installed	Evaluate results in a time series chart
BMP Monitoring	Assess the performance of the BMP for removal of a variety of pollutants in stormwater runoff	Compare influent and effluent concentrations and calculate percent removal
BMP Monitoring	Evaluate the effectiveness of the BMP to understand whether the BMP implementation is reducing the discharge of pollutants of concern from the MS4	Compare influent and effluent concentrations and calculate percent removal

5 Records

The results from stormwater monitoring will be recorded and maintained at The City office in the Public Works Department; Environmental Division. Records will be retained for a period of at least five years from the date of sample, measurement, report, or application.

6 References

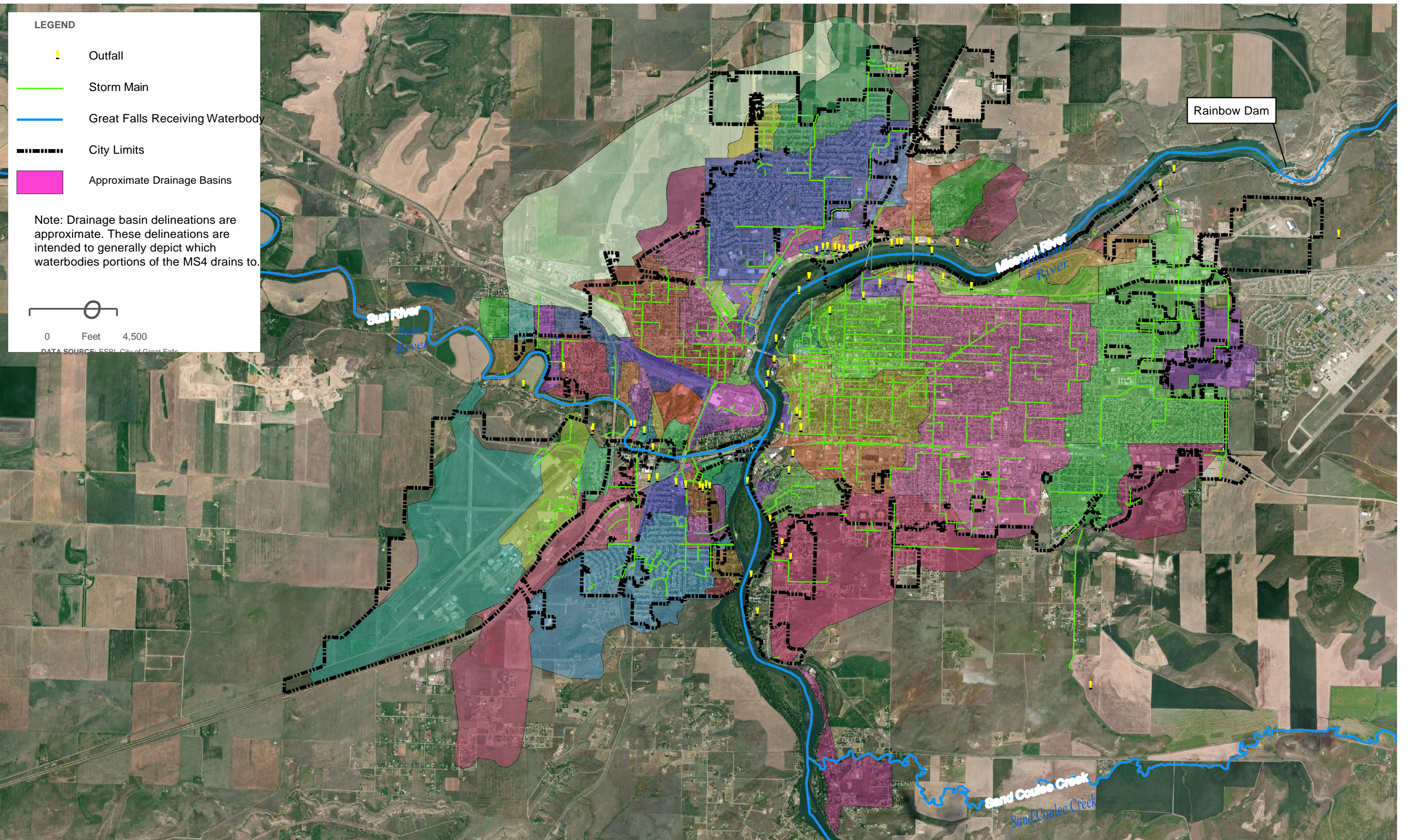
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Montana Department of Environmental Quality. (2012, February). *Water Quality Planning Bureau Field Procedures Manual for Water Quality Assessment Monitoring*. Retrieved from <http://deq.mt.gov/Portals/112/Water/WQPB/QAProgram/Documents/PDF/SOPs/WQPBWQM>

-020.pdf

Montana Department of Environmental Quality. (2016). Appendix A - Impaired Waters. In *Final 2016 Water Quality Integrated Report*.

Appendix A. Supplemental Figures



LEGEND

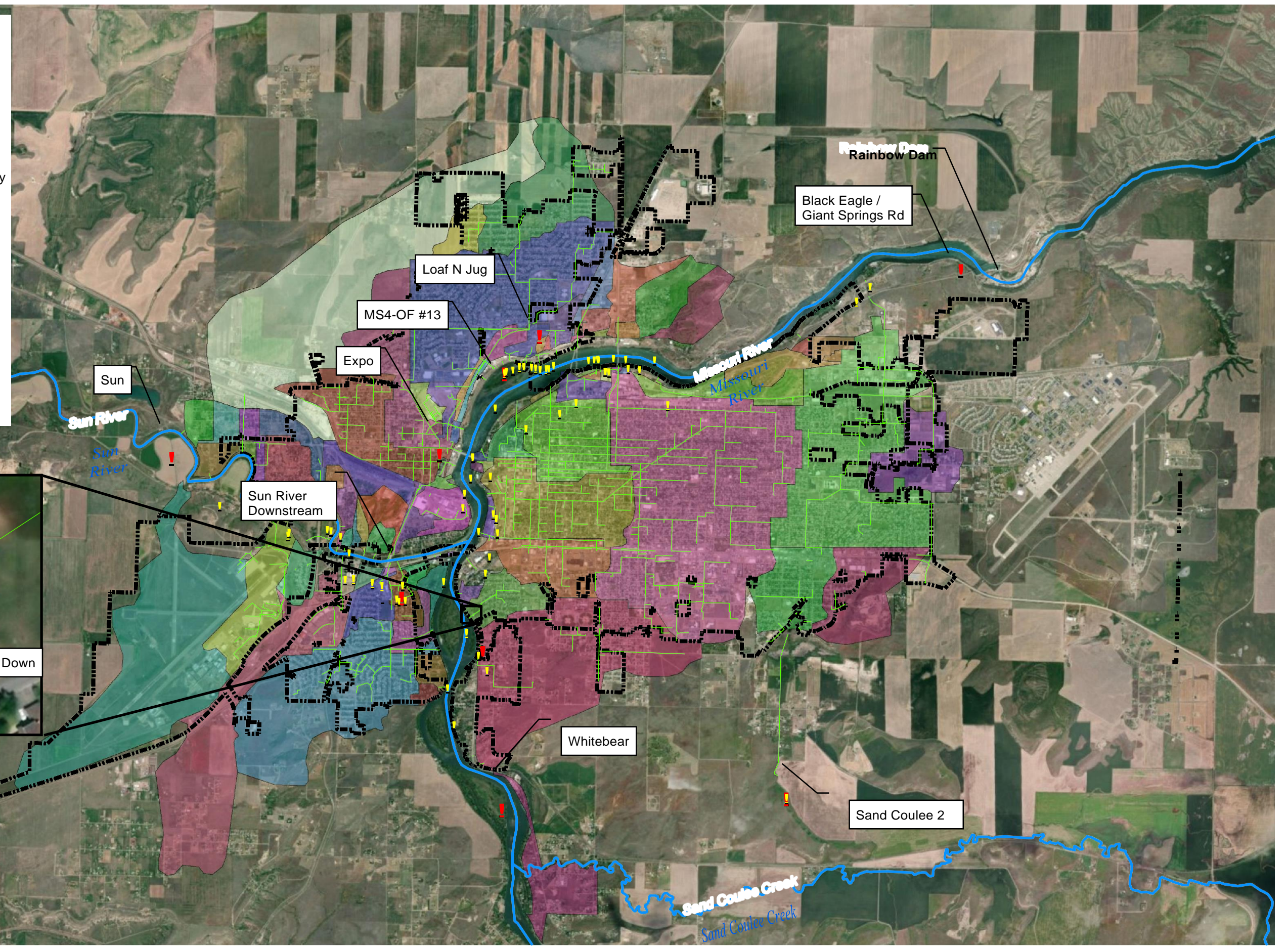
- ! Monitor Location
- ! Outfall
- Storm Main
- Great Falls Receiving Waterbody
- - - City Limits
- █ Approximate Drainage Basins

Note: Drainage basin delineations are approximate. These delineations are intended to generally depict which waterbodies portions of the MS4 drains to.



0 Feet 5,000

DATA SOURCE: ESRI, City of Great Falls



MS4 TMDL AND SELF-MONITORING LOCATIONS

CITY OF GREAT FALLS, MT --- FIGURE A.2

MS4 STORMWATER SAMPLING & ANALYSIS PLAN

Appendix B. Sample Collection Container Requirements

Table B-1. Sample Collection Container Requirements

Site ID	Required Analyses	Required Containers
Whitebear	TSS, COD, Phosphorus (total), Total Nitrogen (Persulfate method), pH, Copper, Lead, Zinc, Estimated Flow, Oil and Grease, Chromium, Mercury, Selenium	<input checked="" type="checkbox"/> One (1) – 1L unpreserved plastic bottle <input checked="" type="checkbox"/> One (1) – 500 mL plastic bottle preserved with H ₂ SO ₄ <input checked="" type="checkbox"/> One (1) – 250 mL plastic bottle preserved with HNO ₃ <input checked="" type="checkbox"/> Two (2) – 1 L clear glass bottles preserved with H ₂ SO ₄
Black Eagle	TSS, COD, Phosphorus (total), Total Nitrogen (Persulfate method), pH, Copper, Lead, Zinc, Estimated Flow, Oil and Grease, Chromium, Mercury, Selenium	<input checked="" type="checkbox"/> One (1) – 1L unpreserved plastic bottle <input checked="" type="checkbox"/> One (1) – 500 mL plastic bottle preserved with H ₂ SO ₄ <input checked="" type="checkbox"/> One (1) – 250 mL plastic bottle preserved with HNO ₃ <input checked="" type="checkbox"/> Two (2) – 1 L clear glass bottles preserved with H ₂ SO ₄
Sun	TSS, COD, Phosphorus (total), Total Nitrogen (Persulfate method), pH, Copper, Lead, Zinc, Estimated Flow, Oil and Grease	<input checked="" type="checkbox"/> One (1) – 1L unpreserved plastic bottle <input checked="" type="checkbox"/> One (1) – 500 mL plastic bottle preserved with H ₂ SO ₄ <input checked="" type="checkbox"/> One (1) – 250 mL plastic bottle preserved with HNO ₃ <input checked="" type="checkbox"/> Two (2) – 1 L clear glass bottles preserved with H ₂ SO ₄
Sun River Downstream	TSS, COD, Phosphorus (total), Total Nitrogen (Persulfate method), pH, Copper, Lead, Zinc, Estimated Flow, Oil and Grease	<input checked="" type="checkbox"/> One (1) – 1L unpreserved plastic bottle <input checked="" type="checkbox"/> One (1) – 500 mL plastic bottle preserved with H ₂ SO ₄ <input checked="" type="checkbox"/> One (1) – 250 mL plastic bottle preserved with HNO ₃ <input checked="" type="checkbox"/> Two (2) – 1 L clear glass bottles preserved with H ₂ SO ₄
Expo	TSS, COD, Phosphorus (total), Nitrogen (total), pH, Copper, Lead, Zinc, Estimated Flow, Oil and Grease, Chromium, Mercury, Selenium	<input checked="" type="checkbox"/> One (1) – 1L unpreserved plastic bottle <input checked="" type="checkbox"/> One (1) – 500 mL plastic bottle preserved with H ₂ SO ₄ <input checked="" type="checkbox"/> One (1) – 250 mL plastic bottle preserved with HNO ₃ <input checked="" type="checkbox"/> Two (2) – 1 L clear glass bottles preserved with H ₂ SO ₄
Loaf N Jug	TSS, COD, Phosphorus (total), Nitrogen (total), pH, Copper, Lead, Zinc, Estimated Flow, Oil and Grease, Chromium, Mercury, Selenium	<input checked="" type="checkbox"/> One (1) – 1L unpreserved plastic bottle <input checked="" type="checkbox"/> One (1) – 500 mL plastic bottle preserved with H ₂ SO ₄ <input checked="" type="checkbox"/> One (1) – 250 mL plastic bottle preserved with HNO ₃ <input checked="" type="checkbox"/> Two (2) – 1 L clear glass bottles preserved with H ₂ SO ₄
Sand Coulee 2	TSS, COD, Phosphorus (total), Nitrogen (total), pH, Copper, Lead, Zinc, Estimated Flow, Oil and Grease, Salinity	<input checked="" type="checkbox"/> One (1) – 1L unpreserved plastic bottle <input checked="" type="checkbox"/> One (1) – 500 mL plastic bottle preserved with H ₂ SO ₄ <input checked="" type="checkbox"/> One (1) – 500 mL unpreserved plastic bottle <input checked="" type="checkbox"/> One (1) – 250 mL plastic bottle preserved with HNO ₃ <input checked="" type="checkbox"/> Two (2) – 1 L clear glass bottles preserved with H ₂ SO ₄
Verde Up	TSS, COD, Phosphorus (total), Nitrogen (total), pH, Copper, Lead, Zinc, Estimated Flow, Oil and Grease, Chromium, Mercury, Selenium	<input checked="" type="checkbox"/> One (1) – 1L unpreserved plastic bottle <input checked="" type="checkbox"/> One (1) – 500 mL plastic bottle preserved with H ₂ SO ₄ <input checked="" type="checkbox"/> One (1) – 250 mL plastic bottle preserved with HNO ₃ <input checked="" type="checkbox"/> Two (2) – 1 L clear glass bottles preserved with H ₂ SO ₄

Site ID	Required Analyses	Required Containers
Verde Down	TSS, COD, Phosphorus (total), Nitrogen (total), pH, Copper, Lead, Zinc, Estimated Flow, Oil and Grease, Chromium, Mercury, Selenium	<input checked="" type="checkbox"/> One (1) – 1L unpreserved plastic bottle <input checked="" type="checkbox"/> One (1) – 500 mL plastic bottle preserved with H ₂ SO ₄ <input checked="" type="checkbox"/> One (1) – 250 mL plastic bottle preserved with HNO ₃ <input checked="" type="checkbox"/> Two (2) – 1 L clear glass bottles preserved with H ₂ SO ₄
MS4-OF #13	PCBs	See Appendix C
Giant Springs Rd	PCBs	See Appendix C

Appendix C. PCB Sampling Protocol

PCB Sampling Protocol

1 Introduction

The primary objective of this protocol is to conduct PCB monitoring at MS4 outfalls to assess whether the MS4 contributes PCBs to the Missouri River. Laboratory analyses are unable to attain low enough reporting/detection limits for PCBs in the water column, which precludes the usefulness of collecting water samples. The MS4 is not anticipating to be a contributor of PCBs. However, if future wet weather sampling events indicate elevated levels of PCBs, the sampling protocol outlined in Appendix C will be implemented.

PCB monitoring will be conducted in areas that discharge to the Missouri River because the Missouri River is impaired for PCBs. DEQ’s listed probable causes include permitted industrial point source discharge and permitted industrial-commercial site stormwater discharge. The MS4 is not anticipating to be a contributor of PCBs. However, if future wet weather sampling events indicate elevated levels of PCBs, the sampling protocol outlined in Appendix C will be implemented.

2 Sample Collection Locations

PCB monitoring will be conducted in areas that discharge to the Missouri River because the Missouri River is impaired for PCBs. Sediment samples will be gathered from areas that receive stormwater discharges from two of the MS4’s representative industrial areas because industrial areas are common sources of PCBs. PCB sample locations are provided in Table C-2-1.

Table C-2-1. PCB Sediment Sample Collection Locations

Name	Receiving Waterbody	Location	Collection Method ¹	Sample Parameters	Strategy
MS4 – OF #13	Missouri River	47.519084°N -111.307227°W	Sediment Composite	PCBs	Representative industrial area to assess potential for MS4 discharge of PCBs
Giant Springs Rd	Missouri River	47.536038°N -111.212400°W	Sediment Composite	PCBs	Downstream location from entire MS4 discharge of PCBs

3 Field Sampling Methods

3.1 Document the Site

Upon arrival at the designated sampling location, verify access to sediment depositional zones. If the site is deemed acceptable, record site identifier information on a field form, including site name, plot number, and latitude/longitude. A site is considered acceptable if at least five depositional zones of fine sediment (< 2.0mm) are accessible in water less than 2 feet deep. Take site photographs, and record the pertinent photo information.

3.2 Sediment Sampling Frame

Five sub-samples will be collected at each sample collection location. Identify an area at the site (sample frame) where sub-samples can be gathered. The goal of the sample frame is to gain a representation in areas most likely to be influenced by human activities (Kusnierz et al., 2013). Sediment in the sampling frame should be relatively homogenous to ensure data representativeness.

3.3 Collect the Sub-Samples

Identify five depositional zones in the sampling frame at each sampling site. Focus on obtaining samples of fine-grained surficial sediments from depositional zones during low-flow or no-flow conditions and on compositing samples from several depositional zones within a sampling frame.

Collect sub-samples of equal volumes of sediment from each of the five depositional zones in the sampling frame to form one composite sample:

- Use a stainless steel spoon to remove sediment from the depositional zone and place the sediment in a stainless steel bowl. A total volume of approximately 1.5 L of wet sediment from the five plots is desired (USGS 1994). Compositing will smooth the local scale variability and represent the average contaminant levels present at the site (USGS 1994).
- Collect sediment from the top 2-5 centimeters of the bed surface (USGS 1994; ORSANCO 2002; Wash. Dept. of Ecology 2003, 2007).
- Do not retain debris on the sediment surface.
- Sampling depth: Collect sub-samples from the nearshore zone in water less than 0.5 m deep as a safety measure and to minimize loss (wash-out) of surficial fine sediments as the sub-sample is drawn up through the water column (DEQ 2011; USFWS 2010).
- Sub-sampling: Subsample each depositional zone at a sampling site several times and composite all subsamples collected from depositional zones sampled at the same site. Base the number of samples from each zone on the areal size of each zone (that is, the larger the areal size of the zone, the greater the number of subsamples collected).
- Sampling timing: Unusually high flows can wash out, redistribute, or bury substantial parts of PCB deposits; therefore, sampling should be delayed following major discharge to allow fresh sediment to deposit. When sampling for bed sediment during summer or autumn, low-flow conditions are recommended to provide maximum direct access to the bed materials and to minimize seasonal streamflow variability (USGS 1994).
- Store this sample on ice (< 6°C) between sampling efforts at each depositional zone.

3.4 Composite and Sieve the Sub-Samples

Once all five depositional zones have been sampled and before transfer to the sample jars, use a stainless steel spoon to homogenize by stirring the composite sample to a uniform consistency and color (ORSANCO 2002; USEPA 2003; Puget Sound Water Quality Action Team 1997; Wash. Dept. of Ecology 2007, 2014).

Prior to collecting the final PCB and TOC sample in the field, use a stainless steel sieve (U.S. standard #10) to remove particles larger than 2mm:

- Agitate and stir with a stainless steel spoon and use the stainless steel spoon to add minimal additions of site native water only as needed to sieve the composite, homogenized sediment sample (from the stainless steel bowl) into a stainless steel bucket (ORSANCO 2002).
- Once sieved, use a stainless steel spoon and stainless steel funnel to transfer sieved sediments into a 1 liter (approx. 32 oz.) glass jar with a Teflon lid liner (ORSANCO 2002; Wash. Dept. of

Ecology 2007, 2014). It is preferable to fill the 1L jar if there is sufficient sample to do so; the lab needs a minimum of 250-300 grams of wet sample for the analyses (approx. 8oz. jar full).

- Tighten cap on jar and label with activity ID, waterbody name, sample type, collection date, and collector's name.

3.5 Decontamination of River/Stream Sediment Equipment

To avoid cross-contamination between sample sites, clean all collection equipment and supplies that may come into contact with the sample prior to use. A tiered approach to decontamination will be used in which a more thorough cleaning procedure is conducted before moving to a different sampling location (sampling frame) and a less-thorough procedure before moving on to a different depositional zone within the same sampling frame.

Between sub-sample collections at plots in the same sample collection location, clean all collection equipment used to collect sediment and obtain PCB sample (e.g., Ponar grab sampler, pans, spoons, scoops and compositing trays) that may come into contact with the sample prior to use as follows:

1. Scrub with a brush and phosphate-free Alconox[®] or Liquinox[™] Soap
2. Thoroughly rinse with in situ (site native) water
3. Perform secondary rinse with ASTM (distilled) water

Once all sub-sampling within a sample collection location complete, clean all collection equipment used to collect sediment and obtain PCB sample (e.g., pans, spoons, scoops and compositing trays) that may come into contact with the sample prior to use as follows:

1. Scrub with a brush and phosphate-free Alconox[®] or Liquinox[™] Soap
2. Thoroughly rinse with in situ (site native) water
3. Perform secondary rinse with ASTM (distilled) water
4. Perform tertiary rinse using certified ACS HPLC grade hexane. Decontamination with solvents should always be performed on an open deck of a vessel or outdoors if on land. All solvent and acid rinses should be followed by thorough rinses with analyte-free water. All decontamination fluids that include solvents or acid rinses should be properly contained and not allowed to enter the environment. Evaporation of small amounts of residual solvent into the air is acceptable (Puget Sound Water Quality Action Team 1997; ORSANCO 2002; Ohio EPA 2001).
5. Perform final rinse with ASTM (distilled) water
6. Allow to air dry
7. Wrap cleaned, decontaminated, and dried equipment in aluminum foil or seal in sealable plastic bags during transport to the next grid.

Rinse equipment again with distilled water after acid wash is complete.

4 Sample Containers, Preservation, and Holding Times

Table C-4-1 summarizes the amount of sample, the container, the preservation, storage, and holding time for each parameter being analyzed.

Table C-4-1. Sediment Sampling Volumes, Containers, Preservation, and Holding Times

Analyte	Sample Size ¹	Container	Preservation	Storage	Holding Time
PCB Aroclors (1016, 1232, 1242, 1248, 1254, 1260, 1262, 1268) ³	50 g	1 L (32 oz.) glass wide mouth jar with Teflon lid liner; fill if possible but 250-300g (8-10 oz.) minimum.	None	Store at <6°C	14 days (extraction); 40 days (analysis)
TOC	50 g	possible but 250-300g (8-10 oz.) minimum.			14 days
Particle Size	50 g	Sieve to 2mm.			6 months
% Moisture	50 g				-

¹ The lab needs 250-300 grams (8 oz. jar) total of sediment as a minimum, which would supply sufficient sample for QC and reruns if necessary. The lab uses 50 grams for PCB, 50 grams for TOC and 50 grams for particle size analysis, but needs extra of each to do QC.

5 Sample Handling Procedures

Field samples will be collected and preserved in accordance to Section 4. City monitoring team members will be responsible for proper labeling, sample custody documentation, and storage. Sediment samples will be delivered to Energy Laboratories, Inc. for analysis within the holding time specified in Table C-4-1. Sediment samples will be stored on ice in a cooler at < 6°C until delivery to the laboratory for analysis.

6 Laboratory Analytical Measurements

Sediment samples, as well as water samples serving as equipment blanks (rinse water), will be analyzed using the methods listed in Table C-6-1. In addition, Table C-6-1 lists the required reporting limits to effectively evaluate the data to meet the project objectives.

Table C-6-1. Analytical Methods and Required Reporting Limits

Analyte	Analytical Method	Reporting Limit (mg/L)
Sediment		
PCB Aroclors (1016, 1232, 1242, 1248, 1254, 1260, 1262, 1268)	SW 8082 (Extraction Method or 3540 or 3541)	0.017 mg/kg (dry wt.)
PCB Aroclor 1221		0.033 mg/kg (dry wt.)
TOC	ASA29-3	0.02%
Percent Moisture	D2974	0.2 wt%
Particle Size	ASA15-5	1%
Water (rinse water for equipment blanks only)		
PCB Aroclors (1016, 1232, 1242, 1248, 1254, 1260, 1262, 1268)	SW8082	0.5 ug/L

Note: The total PCB concentration in each sediment sample is calculated by summing dry-weight concentrations of all individual Aroclors.

7 Quality Assurance and Quality Control Requirements

7.1 Field Blanks

The main objective of the blanks is to trace sources of contamination. Sediment sampling generally does not require the use of field blanks. However, the issue of adequate equipment cleanup between samples can be addressed through the use of an equipment blank. Equipment blanks are samples of water that have been used to rinse the sampling equipment.

Two equipment blanks will be collected, one during the first sampling event and one during the second sampling event. The equipment blanks are collected after all of the equipment has been cleaned according to the decontamination procedures described in Section 3.5. To collect the equipment blank, the rinse process of sample collection equipment (including compositing trays, spoons, etc.) is repeated and the entire rinse is collected and submitted as a solution sample to the lab to be analyzed for the same parameter suite used on the sediment samples.

8 Schedule

Two PCB sampling events may occur during the current General Permit cycle (2022 to 2027).

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Appendix D. Field Blanks and Field Duplicates Protocol

As presented in Montana DEQ's *Water Quality Planning Bureau Field Procedures Manual for Water Quality Assessment Monitoring* (2012)

5.4 QUALITY ASSURANCE AND QUALITY CONTROL – FIELD BLANKS

5.4.1 Description

Field Blanks are collected according to SAP/QAPP guidelines for all water chemistry samples to assess potential for false positive results due to site contamination, preservative and/or container contamination. Field blank results will verify that false positive results from site conditions or cross-contamination during transport will not result in erroneous beneficial use support determinations.

5.4.2 Preparation, Transport, and Submittal

- The analytical laboratory will provide distilled water in a large (≥ 4 liter) sealed HDPE container. Field personnel must keep several liters (enough to triple rinse and refill an entire set of bottles used for routine water chemistry sampling) of distilled water in clean 1L HDPE bottles in the vehicle where it is not exposed to excessive dust, mud, or other equipment. Label these bottles “distilled water” to avoid accidental contamination and triple rinse the bottles with distilled water prior to (re)filling.
- Prepare field blanks in the field each time samples are to be delivered to the analytical laboratory. For example, prepare field blanks after sampling the last site of a multi-site sampling “trip”, or “mid-trip” if sample holding times require samples to be delivered to the lab part-way through a multi-site sampling trip.
- At the sampling site, prepare a set of bottles – the same number and size bottles as used for routine sampling – by rinsing each bottle three times with the distilled water. Fill each sample bottle with distilled water as during routine sampling except pour or filter (with a 60cc syringe and 0.45um filter unit) *distilled* water instead of *stream* water (**Section 5.2**).
- Add the appropriate preservative to each sample bottle, securely affix the lid and mix the sample by gently inverting 3-5 times (**Table 5-1**).
- Affix to each bottle a label containing the following information and cover it with clear tape:
 - Activity ID
 - Collector’s name
 - Collection date
 - Sample type
 - Write “Field Blank” in place of waterbody name on the label
- Ensure lids are tight and will not leak. Store samples completely surrounded with ice in a cooler until delivery to the laboratory along with routine samples for analysis. **Field blanks must be handled identically (e.g., preservation, holding time) to their respective sample counterparts.**
- Fill out a *separate* Site Visit Form for field blanks. Fill this new form the same as the initial Site Visit Form (**Section 4.3**), except use a distinct Activity ID (i.e., site visit code) and write “Field Blanks” in the “Site Visit Comments” field. Use the same medium code as the initial samples (e.g., “W” for water, “SED” for sediment) (**Attachments C and D**, lines 7-17). Refer to the project plan (SAP/QAPP) for quality control criteria.

5.5 QUALITY ASSURANCE AND QUALITY CONTROL – FIELD DUPLICATES

5.5.1 Description

To assess both precision and representativeness of the sampling technique, DEQ collects duplicate samples for all chemistry (except in situ physical) parameters. The number of duplicate samples to collect will depend on sampling frequency per parameter throughout the field season; **generally, collect duplicate samples for at least 10% of the total number of samples per parameter.** Duplicate sample results will verify that field personnel collect samples consistently and that method and site variability is understood.

5.5.2 Sample Collection and Submittal

- Select a site that allows for two samples to be taken side-by-side upstream from any previous disturbances. When collecting duplicate samples, repeat all steps performed in collecting one sample (or set of samples) so that TWO IDENTICAL samples (or sets of samples) have been collected at the SAME site.
- Add the appropriate preservative to each sample bottle, securely affix the lid and mix the sample by gently inverting 3-5 times (**Table 5-1**).
- Affix to each bottle a label containing the following information and cover it with clear tape:
 - Activity ID
 - Collector's name
 - Collection date
 - Sample type
 - Waterbody name (write "Duplicate Sample" next to waterbody name on the label)
- Ensure lids are tight and will not leak. Store samples completely surrounded with ice in a cooler until delivery to the laboratory along with routine samples for analysis. **Duplicate samples must be handled identically (e.g., preservation, holding time) to their respective sample counterparts.**
- Fill out a *separate* Site Visit Form for duplicate samples. Fill this new form the same as the initial Site Visit Form (**Section 4.3**), except use a distinct Activity ID (i.e., site visit code) and write "Duplicate Samples" in the "Site Visit Comments" field. Use the same medium code as the initial samples (e.g., "W" for water, "SED" for sediment) (**Attachments C and D**, lines 7-17). Refer to the project plan (SAP/QAPP) for quality control criteria.

Appendix E. Data Qualifiers

Table E-1. 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.

Table E-2. Quality Control Terminology and Descriptions

FIELD QC		
Term	Description	Purpose/Usage
Field Blank	Reagent water exposed to field sampling conditions	Monitors contamination resulting from field activities and/or ambient levels of analytes present at time of sampling.

Field Duplicate	Two independent samples taken under the same conditions. For solids; tow samples which are co-located (taken side by side). Water samples would be two independent samples taken at the same location at the same time.	To determine the homogeneity of the samples collected.
Field Replicate	A single sample is obtained, homogenized, and then split into multiple samples.	Monitors laboratory precision independent of laboratory operations.

LABORATORY BATCH QC

Acronym	Description	Definition
LRB/Method Blank	Laboratory Reagent Blank	An aliquot of reagent water or other blank matrices that are treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, and internal standards that are used with other samples. The LRB is used to determine if method analytes or other interferences are present.
LFB/LCS	Laboratory Fortified Blank; Laboratory Control Sample	Reagent water spiked with a known amount of analyte. Ideally treated exactly like a MS/LFM. Control used to determine bias is sample spikes.
MS/LFM	Matrix Spike/Laboratory Fortified Matrix	An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The LFM is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the LFM corrected for background concentrations.

MSD/LFMD	Matrix Spike Duplicate/Laboratory Fortified Matrix Duplicate	Determine method precision in sample concentrations are < 5X the RL.
DUP	Duplicate	Determine method precision in sample concentrations are >5X the RL.
QCS	Quality Control Sample	A solution of method analytes of known concentrations which is used to fortify an aliquot of reagent water or sample matrix. The QCS is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check either laboratory or instrument performance.
SRM	Standard Reference Material	Primarily used as a QCS to verify instrument calibration.

LABORATORY ANALYSIS QC

Acronym	Description	Definition
ICB	Initial Calibration Blank	Monitors instrument drift at low end of calibration curve.
CCB	Continuing Calibration Blank	Monitors instrument drift at low end of calibration curve.
ICV	Initial Calibration Blank	Monitors instrument drift at a defined concentration near the mid-range of the calibration curve.
CCV	Continuing Calibration Blank	Monitors instrument drift at a defined concentration near the mid-range of the calibration curve.
IPC	Instrument Performance Check	Monitors instrument drift at a defined concentration near the mid-range of the calibration curve.

MS/LFM	Matrix Spike Duplicate/Laboratory Fortified Matrix	An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The LFM is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the LFM corrected for background concentrations.
MSD/LFMD	Matrix Spike Duplicate/Laboratory Fortified Matrix Duplicate	Determine method precision in sample concentration are <5X the RL.
DUP	Duplicate	Determine method precision in sample concentrations are >5X the RL.
QCS	Quality Control Sample	A solution of method analytes of known concentrations which is used to fortify an aliquot of reagent water or sample matrix. The QCS is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check either laboratory or instrument performance.
SRM	Standard Reference material	Primarily used as a QCS to verify instrument calibration.
IDL	Instrument Detection Limit	Signal just above baseline. 3-5X the STD DEV of 7 replicates of a blank. Not used for quantification.
MDL	Method Detection Limit	Statistical determination of the lowest concentration of an analyte with 95% certainty the analyte is present.
PQL	Practical Quantitation Limit	3-5X the MDL. Lowest level that quantification is determined.
RL	Reporting Limit	Value a laboratory reports results. Usually the PQL.