MADISON STREAM TEAM WATER QUALITY MONITORING PROJECT
SAMPLING AND ANALYSIS PLAN

Prepared for the Montana Department of Environmental Quality

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List of Figures and Tables

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Introduction

This document constitutes the Sampling and Analysis Plan (SAP) for the completion of water quality sampling for three creeks (Moores Creek, Hot Springs Creek, and South Meadow Creek) in the Upper Madison TMDL planning area in Madison County Montana (

(Figure 1). This effort was initiated to increase education and outreach opportunities specific to water quality in the Madison Watershed. The supporting organizations recognize the value of collecting water quality and quantity data on impaired waterways that will add to the information which has already been used by Montana Department of Environmental Quality in making TMDL assessment determinations. Furthermore, this information will be used in assessing sources of impairments which will lead to identifying potential projects that will make improvements on impaired streams. This SAP outlines general field parameters and sampling for lab analysis that will take place in 2016. Additionally, the Madison Stream Team will conduct post-restoration photo point monitoring and turbidity monitoring, which each have their own respective SAPs.

Project Objectives

The goals of the project are:

- To increase community engagement in water resources and data collection to enhance understanding of local water resources.
- To increase volunteer capacity to participate in the upcoming Watershed Restoration Plan (WRP) process.
- Use existing data that has been collected in order to identify potential sources of impairments on South Meadow Creek, Moores Creek, and Hot Springs Creek.
- Using information on impairment sources, develop ideas for potential projects to address impairment issues.
- To foster a communication network between data collectors and land managers.

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

- Annual report containing data from current year with comparisons to data collected in previous years. Baseline conditions will be established by noting any extremes or incidences of exceedances of state standards. Annual report will be made publically available at the Madison Conservation District website.
- Report will contain discussion on water quality changes between stations and changes between years. This will provide opportunities to update engaged landowners and outreach to new landowners that may be influencing water quality conditions at specific sites.
- Summary of preliminary findings of the Madison Stream Team project will be presented to the general public and other pertinent audiences following the field season.

Sampling Design

The list of streams on the 2016 303d list in the Madison TMDL planning area (

(Figure 1) was evaluated along with additional information from the recent TMDL assessments by DEQ in order to come up with the streams and monitoring locations for the 2016 monitoring. Six of the sixteen streams on the 303d list were originally selected for the monitoring program in 2010 with the addition of

Blaine Spring Creek and Hot Springs Creek in later years. Sample sites for 2016 were selected based off of data collected in previous years in conjunction with the TMDL planning that is currently taking place. The sampling schedule is focused between July and September and is largely influenced by the availability of volunteers, many of whom reside in the watershed only during the summer months.

WATERBODY NAME / LOCATION	CAUSE NAME
ELK CREEK, headwaters to mouth (Madison River)	Nitrate/Nitrite (Nitrite + Nitrate as N)
ELK CREEK, headwaters to mouth (Madison River)	Nitrogen (Total)
ELK CREEK, headwaters to mouth (Madison River)	Phosphorus (Total)
HOT SPRINGS CREEK, headwaters to mouth (Madison River)	Nitrogen (Total)
HOT SPRINGS CREEK, headwaters to mouth (Madison River)	Phosphorus (Total)
BLAINE SPRING CREEK, headwaters to mouth (Madison River, T7S R1W S6)	Nitrogen (Total)
O'DELL SPRING CREEK, headwaters to mouth (Madison River)	Nitrogen (Total)
SOUTH MEADOW CREEK, headwaters to mouth (Ennis Lake)	Nitrogen (Total)
SOUTH MEADOW CREEK, headwaters to mouth (Ennis Lake)	Phosphorus (Total)
MOORE CREEK, springs to mouth (Fletcher Channel), T5S R1W S15	Nitrogen (Total)
MOORE CREEK, springs to mouth (Fletcher Channel), T5S R1W S15	Phosphorus (Total)

(Figure 1: Madison TMDL Planning Area stream segments on the MT DEQ 303d list for nutrient exceedances)

Sites on which monitoring and sampling will occur are outlined in Table 2. Data collection activities to be conducted at each site are listed in Table 1. On each visit to each site for each stream, collection will include: data from YSI 556 meter (air and water temperature, pH, specific conductance, and dissolved oxygen), discharge, photo point monitoring, and turbidity. Nuisance algae photos will occur at sites on particular streams once per year. Water samples will be collected for chemical analysis on each of these streams as well.

Lab analysis in 2016 will include; total persulfate nitrogen, total phosphorus, and nitrate plus nitrite. Quality assurance and quality control samples (blank and duplicate samples) will be collected during the July sampling events. A detailed outline of the parameters which are to be analyzed at each site is presented in Table 1.

Table 1: Parameters to be analyzed for each stream during 2016.

Stream	***July***	***August***	***September***
South Meadow Creek	*Discharge, Field meter, Turbidity meter, Nutrients, QAQC(x2)*	*Discharge, Field meter, Turbidity Meter, Rock Chlorophyll photo, Nutrients*	*Discharge, Field meter, Turbidity Meter, Nutrients*
Moores Creek	*Discharge, Field meter, Turbidity Meter, Nutrients, SSC (X2), QAQC(x2)*	*Discharge, Field meter, Turbidity Meter, Rock Chlorophyll photo, Nutrients*	*Discharge, Field meter, Turbidity Meter, Nutrients*

Hot Springs Creek	*Discharge, Field meter, Turbidity Meter, Nutrients, QAQC*	*Discharge, Field meter, Turbidity Meter, Rock Chlorophyll photo, Nutrients*	*Discharge, Field meter, Turbidity Meter, Nutrients*

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

Stream	Site ID	Lat.	Long.	Site Description
Moores Creek	MC-SPQ	45.358784	-111.809461	On Spanish Q Ranch; near Centennial Drive
	MC-MAL	45.336552	-111.772178	Upstream of pond
	MC-POND	45.335506	-111.768096	Downstream of pond
	MC-NT	45.353914	-111.729578	North of Ennis
	MC-RST	45.361626	-111.728382	Downstream of 2015 restoration project
Hot Springs	HS-MF	45.555295	-111.80844	On Middle fork of Hot Springs Creek
	HS-SF	45.545003	-111.801664	On South Fork of Hot Springs Creek
	HS-STER	45.564836	-111.753886	At Sterling; Swayback RD. crossing
South Meadow	SM-NMCR	45.447037	-111.760649	At North Meadow Creek Road crossing
	SM-EDC	45.450967	-111.747217	At Endecott Cattle Co.
	SM-END	45.450463	-111.741839	Downstream end of Endecott Cattle Co.
	SM-HWYN	45.449172	-111.731864	Northern channel of S. Meadow at Hwy 287
	SM-HWY	45.448525	-111.731854	Middle channel of S. Meadow at Hwy 287
	SM-HWYS	45.448033	-111.731899	Southern channel of S. Meadow at Hwy 287
	SM-CR	45.444024	-111.719009	At Crumley Ranch near Ennis Lake Road

Table 3: Sample site selection rational

Site ID	Site Name	Rational for site selection
MC-SPQ	Spanish Q Ranch	Captures upland land uses
MC-MAL	Maloney Property	Before Moores Creek enters large pond
MC-POND	Below Pond	Just downstream of large pond
MC-NT	North of Town	Captures urban influences from Ennis
MC-RST	Restoration	Just downstream of ½ mile riparian fencing project
HS-MF	Middle Fork	Captures land uses from uplands distinct from South and North Forks
HS-SF	South Fork	Captures land uses from uplands distinct from Middle and North Forks
HS-STER	Sterling	Confluence of North Fork, Middle Fork, and South Fork of Hot Springs
SM-NMCR	North Meadow Cr. Rd.	Downstream of recent developments, and upstream of 2012 restoration project
SM-EDC	Endecott	Location of 2012 restoration project
SM-END	Endecott (downstream)	Just before South Meadow Creek braids into three distinct channels.
SM-HWYN	Highway North	Northern channel of South Meadow Creek at HWY 287 crossing
SM-HWY	Highway	Middle channel of South Meadow Creek at HWY 287 crossing
SM-HWYS	Highway South	Southern channel of South Meadow Creek at HWY 287 crossing
SM-CR	Crumley Ranch	Captures all upstream uses just before South Meadow Creek enters Ennis Lake

Instantaneous discharge (flow) will be measured for each site on each visit- so long as conditions allow for the safe measurement. TruTrack capacitance rods that measure hourly water height (mm), water temperature (C), and air temperature (C), will be deployed at SM-EDC.

Measurement of field parameters is a basic operating procedure when other water quality data is collected and will provide context for interpreting basic stream conditions and other data. Samples collected for nutrients will be handled according to SOPs and shipped to the DEQ contracted laboratory (Energy Laboratories) for analysis. Nutrient concentration data will be compared to MT DEQ nutrient standards. Nutrient impairment will also be assessed by photographing rocks collected during the growing season for a qualitative assessment of algae/chlorophyll presence. Additionally, bottles will be filled at each site for analysis with a Hach 2100Q Portable Turbidimeter in order to assist in locating possible sources of sediment into each stream.

MST data (temperature, dissolved oxygen, pH, Nitrate+Nitrite, Total Nitrogen, Total Phosphorus) will be summarized in graphs to facilitate easy comparison to applicable standards (aquatic life standards) presented in Circular DEQ-7 and ARM 17.30.623 and MT DEQ nutrient criteria (Circular DEQ-12A). The streams within the Madison Watershed are classified as B-1 streams, and are contained within the Middle Rockies Level III Ecoregion. Water quality data along with chlorophyll photographs will facilitate discussion of future data collection priorities.

Project Team Responsibilities

The project manager will be the Water Programs Manager, Ethan Kunard. Responsibilities of the project manager include pre-season meeting, volunteer coordination, storage/maintenance of equipment, data management, data analysis, report composition, and reporting to project partners. The project manager will also join the volunteers on each site visit to ensure monitoring protocols are followed properly and to capture photo and video of the volunteer efforts. The project administration will be completed by the Madison Conservation District, which will include the accounting and financial management of the project. The project team responsibilities are provided in Table 4.

Table 4: Project team members and responsibilities

Name/Title	Project Responsibilities	Contact information
Ethan Kunard, Program Manager	Data Collection, coordination of educational events, equipment maintenance, volunteer recruitment, data analysis, report composition and field work.	PO Box 606 Ennis, MT 59729 406.682.7289; ethan@madisoncd.org
Janet Endecott; Madison Conservation District Supervisor	Financial Management	PO Box 606 Ennis, MT 59729 406.682.7289; madisoncd@3rivers.net
Adam Sigler; MSUEWQ Water Quality Specialist	Technical assistance as needed for equipment and data.	Sigler Lab, MSU, PO Box 173120, Bozeman, MT, 59717-3120 406.994.7381; asigler@montana.edu

Sampling Methods

Sampling will be conducted according to the standard operating procedures (SOP) outlined in the Madison Stream Team 2016 SOP. A Site Visit Form (see end of document) will be completed for each site visit and will include all field data collected and an inventory of samples collected for analysis at the DEQ contracted laboratory. Site locations will be corroborated using this document and/or a GPS and the method

will be specified on the field visit form. The GPS coordinate system datum will be NAD 1983 State Plane Montana, in decimal degrees to at least the fourth decimal. Photographs will be taken using a digital camera.

Field methods

Field parameter data will be collected with an YSI 556 meter, and turbidity samples will be analyzed with a Hach 2100Q Portable Turbidimeter. The meters will be calibrated according to manufacturer instructions on the same day prior to sampling, and calibration logs will be kept for each meter.

Table 5: Field instruments and performance characteristics

Parameter	Meter	Measurement Range	Resolution	Accuracy
Temperature	YSI 556	-5 to 45° C	0.01° C	±0.15° C
pH	YSI 556	0.0 to 14.00 units	0.01 units	±0.2 units
SC	YSI 556	0 to 200 mS/cm	0.001 mS/cm to 0.1 mS/cm	±0.5% of reading or 0.001 mS/cm
DO	YSI 556	0 to 50 mg/L	0.01 mg/L	±2% of the reading or 0.2 mg/L
Turbidity	Hach 2100Q	0-1000 NTU	.01 NTU	±2% of the reading

Flow (Discharge) Measurement

Stream discharge data will be collected at all water quality monitoring sites using the Marsh-McBirney Model 2000 Flo-Mate. The Flo-mate is a portable flow meter that uses an electromagnetic sensor to measure velocity. As resources are available, TruTrack capacitance rods will be installed from April to October and programmed to record hourly water height (mm), water temperature (C), and air temperature (C). Upon each subsequent site visit, data will be downloaded to a laptop computer equipped with Omnilog Software and saved as a Microsoft Excel file with site name, date, and time of download. Measured flow and recorded height will be used to create a stage/discharge relationship for each year data is collected. As suggested by DEQ staff, stage data for periods with air temperatures below freezing will be evaluated and data may be qualified based on DEQ observations that stage data accuracy decreases within this temperatures range.

Photo Point Monitoring

The conditions of each site will be documented by capturing photos in a repeatable format. Photo points are photographs that are always taken from the same position and oriented in the same direction with the same vertical angle. This is done with a goal of recreating the same scene within the picture so that minor and major changes in riparian condition can be documented. Camera operators must take extra precaution when taking photo points to ensure they are in the correct location and orientation, and to record the necessary photograph metadata.

Upon arrival a monitoring site, samplers will refer to the Photo Point Instruction Guide for that site. This will provide instructions on the specific photo points that are to be taken, including helpful notes and reference photographs that can be used to ensure photo uniformity from visit to visit.

Water Sample Collection and Handling for Laboratory Analysis

Grab samples will be collected for delivery to the DEQ contracted lab for chemistry analysis using acid washed, polyethylene bottles provided by the testing laboratory. Table 6 details the analytical methods and

handling procedures for each parameter. Table 1 lists parameters to be analyzed by stream, and a detailed parameter list for each stream is included in the SOP.

Bottles shall be rinsed three times with stream water prior to sampling. Samples will be collected in a well-mixed portion of each stream. During sampling, the sample bottle opening should face upstream and should be drawn through the water column once, carefully avoiding disturbance of bottom sediments. Samples will be preserved in the field and stored on ice until shipment to the lab.

Table 6: Lab parameter analytical methods, reporting limits, hold times, and preservatives.

Parameter	Preferred Method	Alternate Method	Req. Report Limit mg/L	Holding Time Days	Bottle	Preservative	Lid Color
Total Persulfate Nitrogen (TPN)	A 4500-N C	A4500-N B	0.04	28	250 ml HDPE	NA	White
Nitrate-Nitrite as N	EPA 353.2	A4500-NO3 F	0.01	28	250 ml HDPE	H_2SO_4, ≤6°C	Yellow
Total Phosphorus as P	EPA 365.1	A4500-P F	0.003	28	250 ml HDPE	H_2SO_4, ≤6°C	Yellow

Quality control (QC) samples consisting of blanks and duplicates will be collected at all streams during the first sample visit. The location and visit for QC sampling is indicated in the parameter tables in the SOPs. Field blanks will be provided by the laboratory and labeled according to the labeling methods. A duplicate sample is a second stream sample collected at the same time in the same way that the regular stream sample is collected. Duplicate and blank samples are labeled according to the labeling protocol below which does not identify which sample is which to the lab. Blank and duplicate samples are handled and delivered to the lab in the same manner that regular samples are handled.

Sample labels should be filled out with Company (Madison Conservation District or MCD), 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 = YearMonthDay-SiteID-Parameter ID-Sample Type Letter

- Sample Type Letter

  A = Regular sample

  B = Duplicate sample

  C = Blank sample

Sample ID Examples:

A **regular sample** collected at the Moore Creek Bricker site on August 15th, 2014 for Total Persulfate Nitrogen would be labeled:

- 20140815-MCBRK -R

A **duplicate** at the same place and time as above:

- 20140815-MCBRK- D

A **blank** at the same place and time as above:

- 20140815-MCBRK- B

Immediately following grab-sample collection, samples will be put on ice. The MT DEQ contract analytical lab chain of custody forms will be used to document and track all samples collected during the project. Chain of custody forms will be completed for each set of samples submitted to the laboratory.

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, duplicate and spike samples collected or created in the lab and/or the field for evaluation of quality indicators. Once the lab results are returned 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 three sites for each stream spread over the length of the streams. See Table 3 for a description of the rational for site selection. Efforts will be made to collect samples during June to produce high flow data, but the monitoring schedule is constrained by the availability of the volunteers. The bulk of monitoring will occur from July through September.

Provisions are in place to ensure **sensitivity** of data collected to differences in stream water quality and **comparability** of data collected to other datasets. These provisions include the collection of grab samples and field QC for submission to a certified laboratory and assessment of QC data relative to data quality indicators. 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 team leaders will fill out datasheets and review them before leaving a site. Ethan Kunard will review datasheets for completeness and will follow-up with volunteers if fields are not completed. A minimum of 60% completeness (2 out of 3 scheduled events) is the goal for the project for 2015 accounting 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. Methods are not perfect however, so 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

In 2016, QC samples will be collected for 33% (1 in 3) of all samples collected on a stream for the first visit. Each set of field QC samples will include a blank and a duplicate for each analyte being sampled for. Accuracy for field QC samples will be assessed by ensuring that blank samples return values less than the data quality indicator criteria specified in Table 7. If a blank sample returns a result greater than the threshold, all data for that parameter from that batch of samples 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.

RPD as % = ((D1 – D2)/((D1 + D2)/2)) x 100
Where: D1 is regular sample result, D2 is duplicate sample result

Table 7: Data quality indicator criteria for field QC samples

Parameter	Field Blank Threshold mg/L	Field Duplicate RPD
Total Persulfate Nitrogen	0.04	< 25% RPD
Nitrate-Nitrite as N	0.01	< 25% RPD
Total Phosphorus as P	0.003	< 25% RPD

Quality Assurance for Lab Quality Control Samples

Certified laboratories run QC samples for at least 10% of their sample volume. Integrity of laboratory data will be determined by comparing results for laboratory QC samples to the data quality indicator criteria in Table 8. Reports with lab QC results and data quality indicator calculations should be provided by the lab with each set of sample results. Each of the quality indicator criteria in Table 8 must be checked for each analyte for each batch of samples submitted to the lab. This process is easier if a matrix is used to systematically check the numbers. An example of a completed matrix is provided on page 30.

Table 8: Data quality indicator criteria for lab QC samples

Parameter	**Method**	**Method Blanks mg/L**	**Lab Duplicates (RPD)**	**Lab Control LCS/LFB** (percent recovery)	**Matrix Spike/ Matrix Spike Dup** (percent recovery)
Total Persulfate Nitrogen	A4500-N C or A4500-N B	0.04	< 10% RPD	90%-110%	90%-110%
Nitrate-Nitrite as N	A353.2 or A4500-NO3 F	0.01	< 10% RPD	90%-110%	90%-110%
Total Phosphorus as P	EPA 365.1 or 4500-P F	0.003	< 10% RPD	90%-110%	90%-110%

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 back of this document.

Training

A volunteer training day for 2016 is planned for early June. The classroom portion will cover watershed and water quality basics and a review of results from 2015. The classroom portion will also include information on aquatic invasive species and methods volunteers can adopt to reduce the risk of transport of these species during field work.

During the field portion of the training, volunteers will learn proper use of the YSI meter and GPS unit, measurement of discharge using the Marsh-McBirney FloMeter, completion of pebble counts, collection of rocks to photograph for nuisance algae assessment, photo documentation, collection of water quality samples for submission to a lab, completion of field visit sheets, and measurement of turbidity using secchi tubes.

Data Analysis, Record Keeping & Reporting Requirements

Copies of laboratory analytical reports and electronic data deliverable spreadsheets will be provided by the DEQ contract analytical lab to both the Project Manager and to DEQ. The Project Manager and Project Assistant will review the laboratory data to ensure lab results are within reporting limits (including the laboratory QA/QC samples) prior to data entry into MT EQUIS. A review of field and analytical data will be conducted following receipt of the laboratory data package that includes all items on the QC Checklist on page 19. Data qualifiers provided on page 24 will be assigned to data in both hardcopy and electronic form that does not meet these target quality control criteria. A brief synopsis of any SAP methodology derivations that occurred will also be drafted.

Data generated during this project will be stored on field forms and in laboratory reports obtained from the laboratories. Electronic copies of field photographs will also be taken. Site Visit and Chain of Custody forms will be properly completed for all samples. 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 the Montana Water Quality Exchange (EQUIS) database. Records of miles driven per volunteer monitor or monitoring crew will be kept to reimburse volunteers. Records of number of hours worked by volunteer monitoring crews will also be tracked for purposes of budget tracking.

References

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MT DEQ. 2011. MT DEQ. Clean Water Act Information Center, Jack Creek Water Quality Assessment. http://cwaic.mt.gov/wqrep/2010/assmtrec/MT41F004_050.pdf
URL confirmed: 5/10/2011

MT DEQ. 2014. Montana Base Numeric Nutrient Standards, Department Circular DEQ-12A. Montana Department of Environmental Quality. http://deq.mt.gov/wqinfo/Standards/default.mcpx
URL confirmed: 4/27/2015

Restoration Photo Monitoring				
Restoration Photo Monitoring Staff Time	n/a	Total Hours	Rate	Total
South Meadow - Endecott		11	$22.00	$242.00
Moores Creek - Goggins		10	$22.00	$220.00
O'Dell Creek - Granger & Longhorn		12	$22.00	$264.00
Jack Creek - Sanford		11	$22.00	$242.00
West Fork - Cooperative Fencing		10	$22.00	$220.00
Jack Creek - Lower Landowners		12	$22.00	$264.00
		Subtotal		$1,452.00
Restoration Photo Monitoring Volunteer Time (In Kind)	# of Trips	Hours	Rate	Total
South Meadow - Endecott_Volunteer Time (X2 Volunteers)	2	3	$15.00	$180.00
Moores Creek - Goggins_Volunteer Time (X2 Volunteers)	2	3	$15.00	$180.00
O'Dell Creek - Granger & Longhorn_Volunteer Time (X2 Volunteers)	2	3	$15.00	$180.00
Jack Creek - Sanford_Volunteer Time (X2 Volunteers)	2	3	$15.00	$180.00
West Fork - Cooperative Fencing_Volunteer Time (X2 Volunteers)	2	3	$15.00	$180.00
Jack Creek - Lower Landowners_Volunteer Time (X2 Volunteers)	2	3	$15.00	$180.00
		Subtotal		$1,080.00
Restoration Photo Monitoring Mileage (Staff + Volunteer)	# of Trips	Miles	Rate	Total
South Meadow - Endecott	7	15	$0.54	$56.70
Moores Creek - Goggins	7	2	$0.54	$7.56
O'Dell Creek - Granger & Longhorn	7	20	$0.54	$75.60
Jack Creek - Sanford	7	25	$0.54	$94.50
West Fork - Cooperative Fencing	3	70	$0.54	$113.40
Jack Creek - Lower Landowners	4	10	$0.54	$21.60
		Subtotal		$369.36
Field Parameter and Nutrient Sampling				
Field Parameters & Nutrient Sampling Staff Hours	# of Trips	Hours	Rate	Total
South Meadow (7 sites)	3	9	$22.00	$594.00
Moores Creek (5 sites)	3	7	$22.00	$462.00
Hot Springs Creek (3 sites)	3	6	$22.00	$396.00
		Subtotal		$1,452.00
Field Parameters & Nutrient Sampling Volunteer Hours (In-Kind)	# of Trips	Hours	Rate	Total
South Meadow (X2 Volunteers)	3	8	$15.00	$360.00
Moores Creek (X2 Volunteers)	3	6	$15.00	$270.00
Hot Springs Creek (X2 Volunteers)	3	5	$15.00	$225.00
		Subtotal		$855.00
Field Parameters & Nutrient Sampling Mileage	# of Trips	Miles	Rate	Total
South Meadow (7 sites)	4	30	$0.54	$64.80
Moores Creek (5 sites)	4	25	$0.54	$54.00
Hot Springs Creek (3 sites)	4	55	$0.54	$118.80
		Subtotal		$237.60
Turbidity Sampling				
Turbidity Sampling Staff Hours	# of Trips	Hours	Rate	Total
North Meadow Creek	2	4	$22.00	$176.00
Moores Creek	2	4	$22.00	$176.00
Elk Creek	2	4	$22.00	$176.00
South Meadow Creek	2	4	$22.00	$176.00
		Subtotal		$704.00
Turbidity Sampling Volunteer Hours (In Kind)	# of Trips	Hours	Rate	Total
North Meadow Creek (X2 Volunteers)	4	4	$15.00	$240.00
Moores Creek (X2 Volunteers)	4	4	$15.00	$240.00
Elk Creek (X2 Volunteers)	4	4	$15.00	$240.00
South Meadow Creek (X2 Volunteers)	4	4	$15.00	$240.00

Madison Stream Team Nutrient and Field Parameter Sites

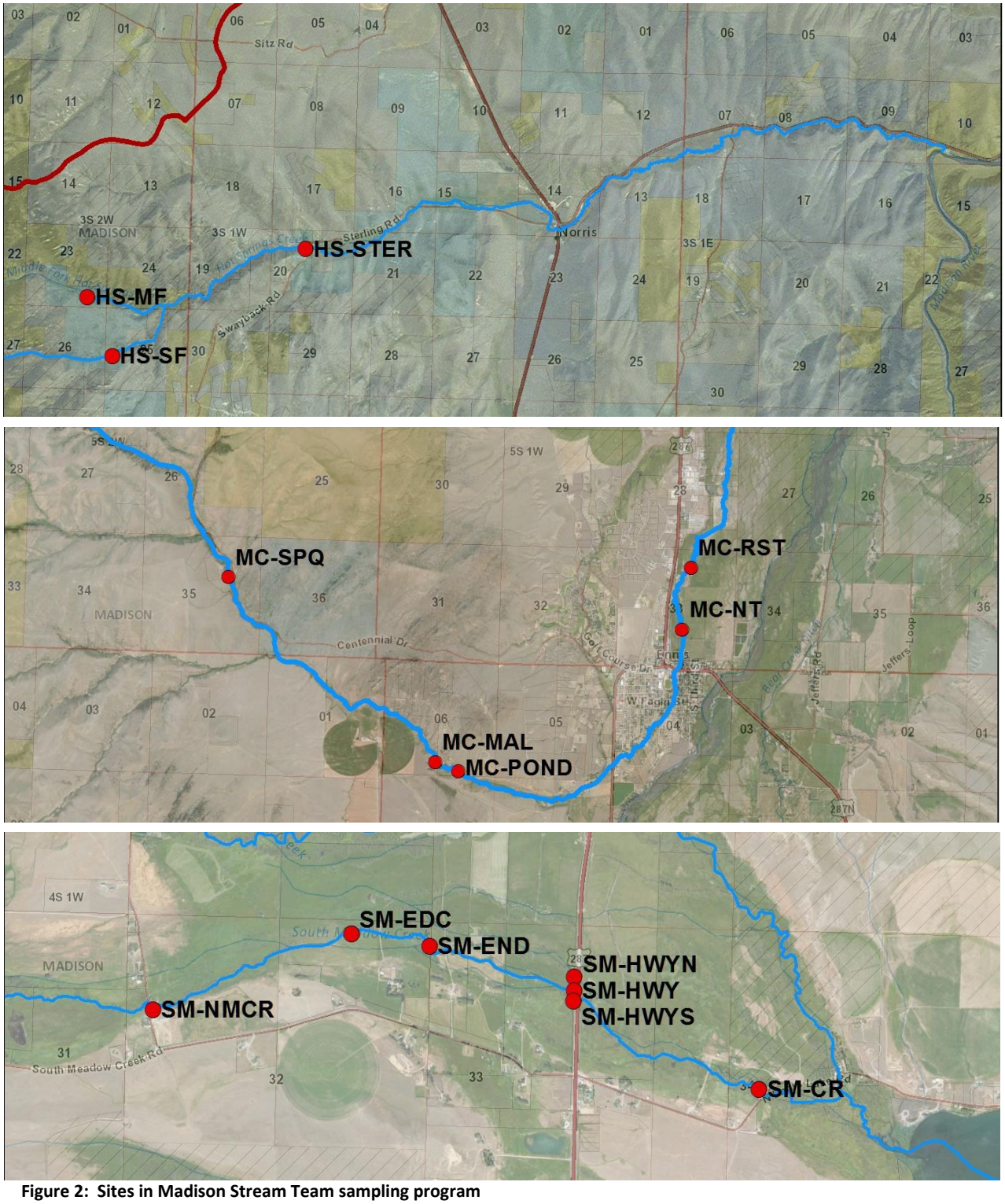

Figure 2: Sites in Madison Stream Team sampling program

Quality Control Checklist

___Condition of samples upon receipt
___Cooler/sample temperature
___Proper collection containers
___All containers intact
___Sample pH of acidified samples <2
___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)
___Reporting detection limit met the project-required detection limit
___All blanks were less than the project-required detection limit
___If any blanks exceeded the project-required detection limit, associated data is flagged
___Laboratory blanks/duplicates/matrix spikes/lab control samples were analyzed at a minimum 10% frequency
___Laboratory blanks/duplicates/matrix spikes/lab control samples were all within the required control limits defined within the SAP
___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 an additional sample 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.

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:
RPD as % = ((D1 – D2)/((D1 + D2)/2)) x 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.

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

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.

Example QAQC matrix

Below is an example of a matrix for use in addressing whether all data quality criteria are met for each analyte for each batch of samples. This table can be created using the thresholds from tables 7 and 8 in this SAP. QC numbers from the lab and calculated from the field are filled in, and compared to thresholds to perform QC checks.

2011-10-25-SMC-LKRD-A,B,C

DQ Indicator	Arsenic		Cadmium		Calcium		Copper		Iron		Lead		Magnesium	
Criteria	Criteria	Value	Criteria	Value	Criteria	Value	Criteria	Value	Criteria	Value	Criteria	Value	Criteria	Value
Method	EPA 200.8	✓	EPA 200.8	✓	EPA 200.7	✓	EPA 200.8	✓	EPA 200.7	✓	EPA 200.8	✓	EPA 200.7	✓
Method Blank	3 µg/L	ND, ND	0.08 µg/L	ND, ND	1000 µg/L	ND, ND	1 µg/L	ND, ND	50 µg/L	ND, 0.7	0.5 µg/L	ND, ND	1000 µg/L	ND, ND
Lab Duplicates (RPD)	< 10% RPD	.05, 2.56	< 10% RPD	1.56, 1.52	< 10% RPD	0.71, 2.3	< 10% RPD	1.8, 1.4	< 10% RPD	2.4, 3.8	< 10% RPD	0.9, 0	< 10% RPD	0.7, 2.32
Lab Control LCS/LFB (% rec)	85% - 115%	102/96	85% - 115%	102/96	85% - 115%	104/91	85% - 115%	103/94	85% - 115%	102/90	85% - 115%	104/98	85% - 115%	99/88
Matrix Spike/Matrix Spike Dup (% rec)	70% - 130%	98/99 116/113	70% - 130%	88/90 93/92	70% - 130%	106/104 114/105	70% - 130%	104/106 100/99	70% - 130%	-/- 104/97	70% - 130%	106/106 97/97	70% - 130%	101/100 97/86
Field Blank Threshold	3 µg/L	ND	0.08 µg/L	ND	1000 µg/L	ND	1 µg/L	ND	50 µg/L	ND	0.5 µg/L	ND	1000 µg/L	ND
Field Blank Dup	< 25% RPD	ND	< 25% RPD	ND	< 25% RPD	4.25	< 25% RPD	200	< 25% RPD	5.13	< 25% RPD	ND	< 25% RPD	0

	Zinc		Hardness as CaCO3		TSS		Total persulfate N		Nitrate-Nitrite as N		Total Phosphorus	
	Criteria	Value	Criteria	Value	Criteria	Value	Criteria	Value	Criteria	Value	Criteria	Value
Method	EPA 200.7	✓	A2340 B		EPA 160.2		A4500-N C or A4500-N B		EPA 200.8		EPA 200.7	
Method Blank	10 µg/L	1.0, 0.3	See Ca & Mg		4000 µg/L		50 µg/L		0.5 µg/L		1000 µg/L	
Lab Duplicates (RPD)	< 10% RPD	102/94	< 10% RPD		< 10% RPD		< 10% RPD		< 10% RPD		< 10% RPD	
Lab Control LCS/LFB (% rec)	85% - 115%	0.76, 1.7	See Ca & Mg		70% - 130%		85% - 115%		85% - 115%		85% - 115%	
Matrix Spike/Matrix Spike Dup (% rec)	70% - 130%	102/102 102/100	See Ca & Mg		-		70% - 130%		70% - 130%		70% - 130%	
Field Blank Threshold	10 µg/L	ND	See Ca & Mg		4000 µg/L		50 µg/L		0.5 µg/L		1000 µg/L	
Field Duplicates RPD	< 25% RPD	ND	< 25% RPD		< 25% RPD		< 25% RPD		< 25% RPD		< 25% RPD	