Guideline for Writing the Monitoring and Quality Assurance Plan

Montana Department of Environmental Quality
Coal and Uranium Program

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This guidance is intended for use by the DEQ Coal Program and active coal mine permit holders/mine operators. It presents a template required for the monitoring and reporting of hydrologic data, and meets the requirements of ARM 17.24.314, ARM 17.24.633, ARM 17.24.645, and ARM 17.24.646 regarding the hydrologic monitoring plan and quality assurance program.

The Table of Contents and all numeric headings and section headings are an integral part of and must be maintained in all approved Monitoring and Quality Assurance Plans (MQAPs). In this guideline, template language is italicized and bracketed with <>. These statements are examples and may be copied directly by mine operators when preparing the MQAP. Portions of example tables are included in this document to illustrate how to fill in data tables. A more complete example can be found in the accompanying example Excel files.

Main Document

1.0 Project Description and Regulatory Requirements

<The Industrial Energy and Minerals Bureau (the Bureau) of the Montana Department of Environmental Quality (DEQ) is responsible for administering regulations for surface and underground coal mining operations in the state of Montana. The Montana Strip and Underground Mine Reclamation Act (MSUMRA, 82-4-201 et seq.) requires that coal mine operators monitor and report on the quality and quantity of surface and groundwater, and assess and evaluate the probable hydrologic consequences of mining operations. Monitoring is conducted and the results are reported to the Bureau in the Annual Hydrology Report.

This document constitutes the Monitoring and Quality Assurance Plan (MQAP) for surface water and groundwater data collected at the ***(insert Mine Name (SMP XXXXXX)).*** *The purpose of the MQAP is to document planning for data collection operations and to provide a plan for obtaining the type and quality of data needed to meet regulatory requirements. The MQAP integrates all planning, data collection, and reporting activities and specifies how quality assurance (QA) and quality control (QC) measures are applied to assure that the results obtained meet statutory requirements.*

The MQAP, accompanied with the Annual Hydrology Report (AHR), constitutes the quality assurance program for surface and groundwater data collected in accordance with 17.24.314, 17.24.633, 17.24.645, and 17.24.646, and meets the requirement that 'sampling and analysis must include a quality assurance program acceptable to the department.'

Data collection consists of surface and groundwater quality and quantity at monitoring stations within and outside of the ***(insert Mine Name (SMP XXXXXX))*** *permit boundary. Activities include water quality sampling of wells, streams, ponds and MPDES outfalls, monitoring of intermittent and ephemeral stream flows, monitoring of MPDES outfall flows, and monitoring of well and pond levels. Sampling locations, parameters, methods and other details regarding water monitoring design are in Section 2.0, Data Quality Objectives and Sampling Design.*

This MQAP does not provide requirements for the collection and analysis of MPDES-mandated water quality and quantity data. Permitted discharges are regulated under the state's MPDES Program and administered by the Water Quality Protection Bureau at the DEQ. Data collection and reporting activities mandated by MPDES permits must meet requirements established for MPDES data in accordance with ARM 17.24.633(4)&(5).>

2.0 Data Quality Objectives and Sampling Design

2.1 Data Quality Objectives

<Data quality objectives are established using a planning process designed to ensure that the type, quantity, and quality of environmental data used in decision making will be appropriate for its intended use. The intended use of data as prescribed in this MQAP is to inform decision-making regarding the following questions:

- *To what extent are impacts to the hydrologic balance occurring on or off the permit area as a result of mining or reclamation activity?*
- *Is 'material damage'[1] occurring as a result of mining or reclamation activity?*

Data and information needed to answer these questions come from an approved network of representative surface and groundwater quality and quantity monitoring sites within and outside of the mine permit boundary (Section 2.2). The sampling design and analytical analyses ensure that data is of sufficient quality (Section 5.0) to allow meaningful comparisons to applicable water quality standards and to allow analysis of long and short term water quality changes or trends. This MQAP has been designed to meet these data quality objectives.>

2.2 Surface and Groundwater Monitoring Design

<Surface and groundwater monitoring is conducted as required by statutory and administrative requirements (e.g. ARM 17.24.314, ARM 17.24.633, ARM 17.24.645, ARM 17.24.646) at approved surface and groundwater monitoring sites. Water quality and quantity sampling is conducted on the following surface and groundwater features:

- *Streams: perennial, intermittent, and ephemeral*
- *Springs*
- *Ponds and impoundments*
- *Wells*
- *MPDES outfall stations*

In addition to surface and groundwater sampling, precipitation/climate data is collected in support of hydrologic characterization, and is a requirement of all MPDES permits.>

Include map(s) showing all current monitoring locations: stream, spring, pond, MPDES groundwater, and climate. Current hydrologic monitoring sites are shown on a comprehensive map. Maps are subject to Department standards (ARM 17.24.305). Refer to the Submittal Guidelines for a list of requirements.

The following are standard spatial features to accompany the MQAP submittal in CAD or GIS format:

- Groundwater monitoring site locations (Point)
- Springs monitoring site locations (Point)
- Streams monitoring site locations (Point)
- Ponds monitoring site locations (Point)
- MPDES discharge locations (Point)

The monitoring sites map(s) should include, at a minimum, the following layers / features:

[1] Per MCA *82-4-20(31), "Material damage" means, with respect to protection of the hydrologic balance, degradation or reduction by coal mining and reclamation operations of the quality or quantity of water outside of the permit area in a manner or to an extent that land uses or beneficial uses of water are adversely affected, water quality standards are violated, or water rights are impacted. Violation of a water quality standard, whether or not an existing water use is affected, is material damage.*

- Groundwater monitoring site names and locations
  - The map should identify the aquifer monitored at each station. Some wells may have the aquifer identified in their name. If a well name does not identify the aquifer, use colors, symbols, or additional annotation to label designate the monitored aquifer(s).
- Springs monitoring site names and locations
- Streams monitoring site names and locations
- Ponds monitoring site names and locations
- MPDES discharge site names and locations
- Permit boundary
- Current streams and major tributaries
  - Label all streams
- Ponds and impoundments
  - Label all ponds

Changes to the monitoring plan must be approved by the department via a minor revision to be permit before implementation.

2.2.1 Stream Monitoring Design

Present the monitoring objectives and design for stream water quality and quantity. Include:

- Brief written narrative describing stream monitoring design considerations and data quality objectives met by the monitoring design
- Tables summarizing the monitoring plan (see "**monitoring_plan.xlsx/Stream**")
- QC sample collection - see Section 8.0 below
- Justification of the classification of the monitored stream reach. The classification should be for premine conditions at the location of the monitoring site (i.e. if an intermittent stream reach is now ephemeral due to ponds used for hydrologic control, the stream reach would still be classified as intermittent). For guidelines on how streams are classified, refer to ARM 17.30.606 – 17.30.617 for a detailed listing of the designation of waterbodies in Montana. ARM 17.24.301 gives a definition for ephemeral, intermittent, and perennial. Please consult with the Coal and Uranium program for help in determining the stream classification. Justification should include evidence based on collected data (stream flows, alluvial wells, baseline analysis, etc) supporting the designation of ephemeral, intermittent, or perennial.

2.2.2 Spring Monitoring Design

Present the monitoring objectives and design for spring water quality and quantity. Include:

- Brief written narrative describing stream monitoring design considerations and data quality objectives met by the monitoring design
- Tables summarizing the monitoring plan (see "**monitoring_plan.xlsx/Spring**")
- QC sample collection - see Section 8.0 below

2.2.3 Pond Monitoring Design

Present the monitoring objectives and design for pond water quality and quantity. Include:

- Brief written narrative describing stream monitoring design considerations and data quality objectives met by the monitoring design
- Tables summarizing the monitoring plan (see "**monitoring_plan.xlsx/Pond**")
- QC sample collection - see Section 8.0 below

2.2.4 Groundwater Monitoring Design

Present the monitoring objectives and design for well water quality and quantity. Include:

- Brief written narrative describing stream monitoring design considerations and data quality objectives met by the monitoring design
- Tables summarizing the monitoring plan (see "**monitoring_plan.xlsx/Groundwater**")
- QC sample collection - see Section 8.0 below

2.2.5 MPDES Outfall Monitoring Design

*<MPDES monitoring design is documented in MPDES Permit (**insert Permit number**). The MPDES permit includes information regarding analyte suite, monitoring frequency, sampling sites and additional MPDES monitoring requirements. For additional information regarding permit monitoring and reporting requirements, refer to (**Permit MTXXXXX**). **Table XX** includes a summary of MPDES stations referenced in **Permit MTXXXXX**.>* (see "**monitoring_plan.xlsx/MPDES**")

2.2.6 Climate Monitoring Design

Present the monitoring objectives and design for climate data. Include:

- Brief written narrative describing climate monitoring design

Example: Table 2-1. Stream water monitoring plan

Station	Waterbody	Stream Classification	Northing NAD83 StPlane ft	Easting NAD83 StPlane ft	Ground Elevation ft	Channel Shape / Design	Flow Measurement Instrumentation	Auto WQ Sampling Instrumentation	Continuous Recorder	Crest / Staff Gauge Measurement Frequency	Laboratory Water Quality Sampling Frequency	Field Parameter Sampling Frequency	WQ Parameters Suite	Purpose
St-1	Coal Creek	C-3 ephemeral	610000	2500100	3315	Natural (Rating Curve)	Crest gauge; staff gauge	Sediment Sampler		Monthly; Event-based	Semi-annually; Event-based	Semi-annually; Event-based	MQAP Table 5-1	Monitor background stream conditions on Coal Creek (upstream from permit)
St-5	Coal Creek	C-3 ephemeral	601000	2500040	3597	Natural (Rating Curve)	Crest gauge; staff gauge			Monthly; Event-based	Semi-annually; Event-based	Semi-annually; Event-based	MQAP Table 5-1	Monitor mine impacts downstream on Coal Creek
St-7	Deer Coulee	C-3 intermittent	600100	2510000	4059	Natural (Rating Curve)	Crest gauge; staff gauge			Semi-annually; Event-based			MQAP Table 5-1	Monitor mine impacts downstream on Deer Coulee
St-11	Oil Creek	B-2 perennial	600100	2500000	3301	36-in Parshall flume	Pressure transducer; staff gauge; crest gauge	Sediment Sampler	x	Quarterly; Event-based	Semi-annually; Event-based	Semi-annually; Event-based	MQAP Table 5-1	Monitor background stream conditions on Oil Creek (upstream from permit)

monitoring_plan.xlsx/Stream

Example: Table 2-2. Spring water monitoring plan

Station	Northing NAD83 StPlane (ft)	Easting NAD83 StPlane (ft)	Ground Elevation (ft)	Channel Shape / Design	Flow Measurement Instrumentation	Auto WQ Sampling Instrumentation	Continuous Recorder	Crest / Staff Gauge Measurement Frequency	Laboratory Water Quality Sampling Frequency	Field Parameter Sampling Frequency	WQ Parameters Suite	Purpose
S1	610000	2500100	3315	Natural	Staff gauge			Monthly	Semi-annually	Semi-annually	MQAP Table 5-1	Monitor rancher Smith's stock spring's water quality
S2	601000	2500040	3597	Natural	Staff gauge; Crest gauge			Semi-annually	Semi-annually	Semi-annually	MQAP Table 5-1	Monitor upgradient spring water quality
S5	608410	2500000	3301	Natural	Staff gauge		x		Semi-annually	Semi-annually	MQAP Table 5-1	Monitor downgradient spring water quality

monitoring_plan.xlsx/Spring

Example: Table 2-3. Pond water monitoring plan

Station	Northing NAD83 StPlane (ft)	Easting NAD83 StPlane (ft)	Ground Elevation (ft)	Water Depth Instrumentation	WQ Sampling Instrumentation	Crest / Staff Gauge Measurement Frequency	Laboratory Water Quality Sampling Frequency	Field Parameter Sampling Frequency	WQ Parameters Suite	MPDES Outfall Number	Purpose
PO1	610050	2505100	3315	Staff gauge; crest gauge		Quarterly				Outfall 016	Internal water control
PO2	610150	2495100	3107	Staff gauge; crest gauge		Quarterly		Discharge Events	MPDES Suite 1	Outfall 017	Discharge to Coal Creek
PO3	610250	2515100	3483	Staff gauge; crest gauge				Discharge Events	MPDES Suite 2	Outfall 002	Discharge to Coal Creek

monitoring_plan.xlsx/Pond

Example: Table 2-4. Groundwater monitoring plan

Station	Northing NAD83 StPlane (ft)	Easting NAD83 StPlane (ft)	MP Elevation (ft)	Ground Elevation (ft)	Aquifer	Water Level Measurement Frequency	Laboratory Water Quality Sampling Frequency	Field Parameter Sampling Frequency	WQ Parameters Suite	Purpose
A1	600000	2500000	3050	3049	Alluvium	Quarterly	Semi-annually	Semi-annually	MQAP Table 5.2	Monitor alluvium downgradient from Area AA
A2	610000	2500040	3364.1	3363.5	Alluvium	Quarterly	Semi-annually	Semi-annually	MQAP Table 5.2	Monitor alluvium upgradient from Area AA
B1	601000	2510000	3571.6	3569	Spoils	Quarterly	Annually	Annually	MQAP Table 5.2	Monitor spoils in Area AB
B2	600100	2500100	4001	4000	Spoils; C Coal	Quarterly		Annually		Monitor C-coal in Area AA
C1	600000	2561000	3420.6	3420.1	C Coal	Quarterly		Annually		Monitor C-coal in Area AA
C2	615000	2584100	2905.6	2904	C Coal	Semi-annually				Monitor C-coal in Area AA
C3	615500	2584710	2581.6	2581.4	C Coal	Semi-annually				Monitor C-coal downgradient of Area AA
D3	615503	2584715	2581.8	2581.6	C Coal	Semi-annually	Semi-annually	Semi-annually	MQAP Table 5.2	Monitor C-coal downgradient of Area AA

monitoring_plan.xlsx/Groundwater

Example: Table 2-5. MPDES outfall monitoring plan

MPDES Station	Receiving Waterbody	Northing NAD83 StPlane (ft)	Easting NAD83 StPlane (ft)	Ground Elevation (ft)	Flow Measurement Instrumentation	WQ Parameters Suite
MP-1	Big Creek	610000	2500100	3315	36-in Parshall flume	see Permit MTXXXXX
MP-2	East Fork Big Creek	601000	2500040	3597	Flow meter	see Permit MTXXXXX
MP-3	trib to Big Creek	600100	2510000	4059	Flow meter	see Permit MTXXXXX
MP-4	trib to Big Creek	600100	2500000	3301	Flow meter	see Permit MTXXXXX

monitoring_plan.xlsx/MPDES

3.0 Sampling Methods

Describe all procedures and protocols followed for collecting groundwater and surface water samples, water levels and flow data. Include methods for downloading digital data and any data processing (including equations) used to deliver data in the final format. For surface water, all equations and rating curves used to calculate flows should be included in this section. Describe processes for evaluating accuracy of flow-monitoring devices (QA flow measurements, rating curve development, etc).

This section may be lengthy if custom protocols are employed by the mine operator. Standard protocols and methods are encouraged and should be included by reference to an established protocol or method. For instance, it is appropriate to reference established sampling methods for 1) surface water field and analytical sample collection, 2) surface water flow measurement and flow calculation, 3) groundwater field and analytical sample collection, and 4) groundwater well level monitoring.

DEQ has established field sampling protocols for **surface water data collection** that may be adopted by reference to the DEQ document, *WQPBWQM-020 Version 3, Field Procedures Manual 2012*. This document can be found on DEQ's website: http://deq.mt.gov/wqinfo/qaprogram/PDF/SOPs/WQPBWQM-020.pdf. Additional resources on sampling methods and protocols for water quality and quantity data collection can be found on-line the USGS website, http://water.usgs.gov/owq/methods.html.

4.0 Sample Handling and Custody

4.1 Packaging and Delivery

Describe the methods used for sample handling and custody from field collection to delivery at the analytical laboratory. Include any procedures used to maintain a temperature required by the analysis method.

4.2 Chain of Custody

State how the chain of custody for water quality samples will be maintained and checked.

<Chain-of-custody (COC) will be maintained for all samples, from collection until the analytical results are received. Sampling personnel initiate the chain-of-custody before samples are placed in cold storage (typically when crews return to their vehicle). Upon receipt by the analytical laboratory, the COC will be signed (by the lab coordinator) and checked for missing information. If any information is missing, the sampling coordinator will be contacted as soon as possible for resolution of the missing information.>

5.0 Analytical Methods

Include a table of the water quality parameter suite and the reporting limits used in water quality analyses. **Tables 5-1** and **5-2** are the required analyte suites for surface and groundwater monitoring. The groundwater monitoring suite may be used for spring water quality samples. Additional analytes may be added on a case-by-case basis, as approved by the Department.

*<**Tables 5-1** and **5-2** detail the analytical methods, reporting limits, holding times and preservatives for surface and groundwater quality samples collected in accordance with the monitoring design in Section 2.0.>*

Table 5-1. Surface Water Quality Parameters and Analytical Methods TR/D = Total Recoverable and Dissolved fractions						
Physical Parameters	**Analytical Method**	**Alternate Method**	**Reporting Limit**	**Units**	**Holding Time (days)**	**Preservative**
Conductivity	Field Msmt		1	uS/cm	NA	NA
pH (lab)	EPA 150.2		0.1	s.u.	NA	NA
pH (field)	Field Msmt		0.1	s.u.	NA	NA
Specific Conductance	EPA 120.1	A2510-B	1	uS/cm	28	cool ≤ 6°C
Total Dissolved Solids	EPA 160.1	A2540-C	10000	ug/L	7	cool ≤ 6°C
Total Suspended Solids	EPA 160.2	A2540-D	1000	ug/L	7	cool ≤ 6°C
Temperature (water)	Field Msmt		0.1	C	NA	NA
Temperature (air)	Field Msmt		0.1	C	NA	NA
Oil & Grease	EPA 413.1	A5520-B, EPA 1664	1000	ug/L	28	Cool ≤6C, H2SO4 to pH<2
Common Ions	**Analytical Method**	**Alternate Method**	**Reporting Limit**	**Units**	**Holding Time (days)**	**Preservative**
Total Anions	Calculated			meq/L	NA	NA
Total Cations	Calculated			meq/L	NA	NA
Acidity (total as CaCO3)	A2310-B		5000	ug/L	14	cool ≤ 6°C
Alkalinity (total as CaCO3)	A2320-B		5000	ug/L	14	cool ≤ 6°C
Hardness (total as CaCO3)	A2340-B		1000	ug/L	NA	NA
Bicarbonate as HCO3	A2320-B	EPA 130.1	5000	ug/L	14	cool ≤ 6°C
Carbonate as CO3	A2320-B	EPA 130.1	5000	ug/L	14	cool ≤ 6°C
Cation/anion balance %	Calculated			%	NA	NA
Calcium	EPA 200.7		1000	ug/L	180	HNO_3 to pH<2
Chloride	EPA 300.0	A4500-CL B	1000	ug/L	28	None
Fluoride (TR/D)	A 45000-F C	EPA 300.0 (D)	100	ug/L	180	HNO_3 to pH<2
Magnesium	EPA 200.7	EPA 200.8	1000	ug/L	180	HNO_3 to pH<2
Potassium	EPA 200.7	EPA 200.8	1000	ug/L	180	HNO_3 to pH<2
SAR	Calculated		100	NA	NA	NA
Sodium	EPA 200.7	EPA 200.8	1000	ug/L	180	HNO_3 to pH<2
Sulfate	EPA 300.0		2000	ug/L	28	cool ≤ 6°C
Trace Metals	**Analytical Method**	**Alternate Method**	**Reporting Limit**	**Units**	**Holding Time (days)**	**Preservative**
Aluminum (TR/D)	EPA 200.7	EPA 200.8	30	ug/L	180	HNO_3 to pH<2
Arsenic (TR/D)	EPA 200.8		3	ug/L	180	HNO_3 to pH<2
Boron (TR/D)	EPA 200.7	EPA 200.8	30	ug/L	180	HNO_3 to pH<2
Cadmium (TR/D)	EPA 200.8		0.08	ug/L	180	HNO_3 to pH<2
Copper (TR/D)	EPA 200.8		1	ug/L	180	HNO_3 to pH<2
Iron (TR/D)	EPA 200.7	EPA 200.8	50	ug/L	180	HNO_3 to pH<2
Lead (TR/D)	EPA 200.8		0.5	ug/L	180	HNO_3 to pH<2
Manganese (TR/D)	EPA 200.7	EPA 200.8	5	ug/L	180	HNO_3 to pH<2
Nickel (TR/D)	EPA 200.7	EPA 200.8	10	ug/L	180	HNO_3 to pH<2
Selenium (TR/D)	EPA 200.8		1	ug/L	180	HNO_3 to pH<2
Vanadium (TR/D)	EPA 200.8		10	ug/L	180	HNO_3 to pH<2
Zinc (TR/D)	EPA 200.7	EPA 200.8	10	ug/L	180	HNO_3 to pH<2
Nutrients	**Analytical Method**	**Alternate Method**	**Reporting Limit**	**Units**	**Holding Time (days)**	**Preservative**
Total Nitrogen	SM 4500-N C	A 4500-N-B	50	ug/L	30	cool ≤ 6°C
Total Phosphorus	EPA 365.1	A 4500-P F	5	ug/L	28	Cool ≤6C, H_2SO4 to pH<2
Nitrate-Nitrite as N	EPA 353.2	A4500-NO3 F	10	ug/L	28	Cool ≤6C, H_2SO4 to pH<2
Total Ammonia as N	EPA 350.1	A4500-NH3	50	ug/L	28	Cool ≤6C, H_2SO4 to pH<2

Table 5-2. Groundwater & Spring Quality Parameters and Analytical Methods						
Physical Parameters	**Analytical Method**	**Alternate Method**	**Reporting Limit**	**units**	**Holding Time (days)**	**Preservative**
Conductivity	Field Msmt		1	uS/cm	NA	NA
pH (lab)	EPA 150.2		0.1	s.u.	NA	NA
pH (field)	Field Msmt		0.1	s.u.	NA	NA
Specific Conductance	EPA 120.1	A2510-B	1	uS/cm	28	cool ≤ 6°C
Total Dissolved Solids (TDS)	EPA 160.1	A2540-C	10000	ug/L	7	cool ≤ 6°C
Temperature (water)	Field Msmt		0.1	C	NA	NA
Common Ions	**Analytical Method**	**Alternate Method**	**Reporting Limit**	**units**	**Holding Time (days)**	**Preservative**
Total Anions	Calculated			meq/L	NA	NA
Total Cations	Calculated			meq/L	NA	NA
Acidity (total as CaCO3)	A2310-B	EPA 130.1	5000	ug/L	14	cool ≤ 6°C
Alkalinity (total as CaCO3)	A2320-B	EPA 130.1	5000	ug/L	14	cool ≤ 6°C
Hardness (total as CaCO3)	A2340-B		1000	ug/L	NA	NA
Bicarbonate as HCO3	A2320-B	EPA 130.1	5000	ug/L	14	cool ≤ 6°C
Carbonate as CO3	A2320-B	EPA 130.1	5000	ug/L	14	cool ≤ 6°C
Cation/anion balance %	Calculated			%	NA	NA
Calcium	EPA 200.7	EPA 200.8	1000	ug/L	180	HNO_3 to pH<2
Chloride	EPA 300.0	A4500-CL B	1000	ug/L	28	None
Fluoride	A 45000-F C	EPA 300.0	100	ug/L	180	HNO_3 to pH<2
Magnesium	EPA 200.7	EPA 200.8	1000	ug/L	180	HNO_3 to pH<2
Potassium	EPA 200.7	EPA 200.8	1000	ug/L	180	HNO_3 to pH<2
SAR	Calculated		100	NA	NA	NA
Sodium	EPA 200.7	EPA 200.8	1000	ug/L	180	HNO_3 to pH<2
Sulfate	EPA 300.0		2000	ug/L	28	cool ≤ 6°C
Trace Metals (dissolved)	**Analytical Method**	**Alternate Method**	**Reporting Limit**	**units**	**Holding Time (days)**	**Preservative**
Aluminum	EPA 200.7	EPA 200.8	30	ug/L	180	HNO_3 to pH<2
Arsenic	EPA 200.8		3	ug/L	180	HNO_3 to pH<2
Boron	EPA 200.7	EPA 200.8	30	ug/L	180	HNO_3 to pH<2
Cadmium	EPA 200.8		0.08	ug/L	180	HNO_3 to pH<2
Copper	EPA 200.8		1	ug/L	180	HNO_3 to pH<2
Iron	EPA 200.7	EPA 200.8	50	ug/L	180	HNO_3 to pH<2
Lead	EPA 200.8		0.5	ug/L	180	HNO_3 to pH<2
Manganese	EPA 200.7	EPA 200.8	5	ug/L	180	HNO_3 to pH<2
Nickel	EPA 200.7	EPA 200.8	10	ug/L	180	HNO_3 to pH<2
Selenium	EPA 200.8		1	ug/L	180	HNO_3 to pH<2
Vanadium	EPA 200.8		10	ug/L	180	HNO_3 to pH<2
Zinc	EPA 200.7	EPA 200.8	10	ug/L	180	HNO_3 to pH<2
Nutrients	**Analytical Method**	**Alternate Method**	**Reporting Limit**	**units**	**Holding Time (days)**	**Preservative**
Nitrate-Nitrite as N	EPA 353.2	A4500-NO3 F	10	ug/L	28	Cool, ≤6C, H2SO4 to pH<2
Total Ammonia as N	EPA 350.1	A4500-NH3	50	ug/L	28	Cool, ≤6C, H2SO4 to pH<2

6.0 Data Quality Indicators and Performance Criteria

Reporting on data quality indicators provides an evaluation of the extent to which project data meets the data quality objectives and sampling design established in Section 2.0. This section describes how data quality is evaluated with respect to data quality indicators and provides a description of corrective actions taken where data quality indicators do not meet performance standards or criteria. The template language below provides performance criteria and corrective actions for data quality indicators.

<Data performance criteria are used to evaluate the quality of the field sampling and laboratory performance for each sampling event and are expressed in terms of analytical precision, accuracy, representativeness, completeness, comparability ,and sensitivity which are described in detail below.>

6.1 Precision

<Precision is the measure of variability among individual sample measurements under prescribed conditions. Precision in laboratory analyses is assessed by laboratory duplicates. Laboratories will automatically flag any samples that fail to meet internal precision criteria with a 'J' flag. Overall precision is assessed by the use of field duplicates. Overall precision is assessed by comparing the difference in duplicate samples using Relative Percent Difference (RPD). The RPD is calculated as follows:

$$RPD\ (\%) = \frac{(\text{sample result} - \text{duplicate result})}{(\text{sample result} + \text{duplicate result})/2} \times 100$$

***Performance Criteria**: 25 % RPD for duplicate results > 5 times the RL*

***Corrective Action**: If analytical laboratory or field duplicates fail to meet performance criteria, all associated data will be qualified with a 'J' and documented in the Annual Hydrology Report /Quality Assurance Summary Report.>*

6.2 Accuracy

<Accuracy is the relationship of a measurement to the true value of the parameter measured. Accuracy in laboratory samples is assessed by the use of laboratory control samples. Laboratories will automatically flag any samples that fail to meet internal accuracy criteria.

Accuracy of field measurements is the responsibility of the field sampling crew, and achieved through adherence to sampling methodologies, equipment calibration and sample handling procedures.

Accuracy of continual flow measuring devices (pressure transducers or other continuous recorders) is achieved through proper installation, calibration, and by manually measuring streamflow periodically, comparing measured flows to flow data generated by continuous recorders and adjusting rating curves to reflect manually-measured flows.

***Performance Criteria**: Accuracy of individual analytical (laboratory) measurements will be assessed by reviewing the laboratory's analytical method controls and the analytical batch controls. The criteria used*

for this assessment will be the limits that the analytical laboratory have developed through control charting of each method's performance, or based on individual method requirements.

The accuracy of field measurements is assessed by reviewing the field collection methods and noting and evaluating any deviations from approved sampling methods or sample handling protocols, or unusual environmental effects that may bias results. The accuracy of continual flow measuring devices is assessed by performing periodic manual flow measurements in the field using flow-meters, and comparing results against data generated by continuous flow recorders (reference Section 3.0 flow monitoring methods).

Corrective Action: *For any quality control value outside of the recovery range for analytical samples, the laboratory records will be reviewed to see how the lab addressed the non-conformance (in accordance with the Laboratory Quality Assurance Plan (LQAP)). Data will be qualified as specified in the LQAP, and documented in the AHR/QA Summary Report.*

Field measurements that deviate from approved sampling methods or handling protocols will be qualitatively evaluated and documented in the AHR/QA Summary Report. Where field flow measurements deviate from data collected by continuous recorders, calculations and data conversions will be evaluated and adjusted as needed to ensure accurate flow data collection from continuous recorders. Activity will be documented in the AHR/QA Summary Report.>

6.3 Completeness

<Completeness is a measure of the amount of usable data actually collected in the water year compared to the data commitment in the MQAP. Completeness is assessed separately for water quality and water quantity parameters.

Completeness as % = (V / N) x 100

V= number of Valid measurements
N = total Number of measurements specified in the monitoring design

Performance Criteria*: The overall project goal is 100% completeness. Water quality data results qualified with H-flags (holding time exceeded) or R-flags (rejected) count against completeness. Data with B (analyte detected in field blank) and J flags will not affect completeness.*

Corrective Action: *Data completeness is calculated per sampling event for water quality parameters and groundwater levels. Stream water quantity data completeness is calculated for the entire reporting year. Data completeness is reported in a summary table in the QA Summary Report/AHR. The conditions that led to any incomplete data collection will be described, and plans to remedy or mitigate conditions that led to incomplete data collection will be presented in the AHR.>*

6.4 Representativeness

<Representativeness refers to the extent to which measurements represent an environmental condition in time and space. Spatial (monitoring sites chosen to adequately characterize the landscape and mining activities) and temporal (sampling schedule chosen to adequately characterize seasonal variation)

representation is established by following the approved monitoring plan. Spatial and temporal representation of environmental data is achieved as follows:>

Spatial Representation:
State how sampling design in Section 2.0 achieves spatial representativeness.

<Sampling sites were chosen to characterize water quality and quantity conditions above and below mine-impacted areas, and along permit boundaries in order to 1) assess impacts to the hydrologic balance specific to mine-related influences and to 2) assess whether 'material damage' has occurred due to mine-related activities.>

Temporal Representation:
State how sampling design in Section 2.0 achieves temporal representativeness.

<Performance Criteria: *Representativeness is assessed through adherence to the sampling design (site location and frequency of sampling) described in Section 3.0.>*

<Corrective Action: *Where sampling of water quality and water quantity is temporally and spatially deficient (i.e. completeness is less than 100%), or fails to meet the intent of the sampling design for spatial and temporal representativeness, a description/explanation of the conditions that led to deficiencies in data collection is described (with respect to representativeness) in the QA Summary Report/AHR. Any limitations regarding the ability of data to adequately assess conditions caused by deficiencies in spatial and/or temporal representativeness will be discussed in the QA Summary Report/AHR.>*

6.5 Comparability

<Comparability expresses the confidence with which one data set can be compared to another. This is achieved through the use of Standard Operating Procedures for field collection and the use of the appropriate analytical methods published by the EPA, APHA - Standard Methods, or USGS. Comparability also refers to the applicability of the project's data to its intended use.

Performance Criteria: *Comparability will be assessed through adherence to the sampling design (sampling methods, sample handling protocols, analytical methods) as described previously.*

Corrective Action: *Where sampling of water quality and water quantity is deficient or fails to meet the intent of the sampling design, comparability is compromised, and description of the conditions that led to deficiencies in data collection and reporting will be described in the QA Summary Report/AHR. >*

6.6 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 MDL's annually and routinely check each method's ability to achieve this level of sensitivity.

Performance Criteria: *Field method controls (Field Blank) < MDL*

Corrective Action: *For Field Blanks that fail performance criteria, all associated project data < 10x the detected value will be qualified with B flags, and failure of analytical controls documented in the QA Summary Report/AHR.>*

7.0 Quality Control

There is inherent variability in any environmental sampling, measurement, or analysis, with field activities generally contributing more variability than laboratory analyses. Quality control (QC) activities are those technical checks that are performed routinely, not to eliminate or minimize error or bias, but to measure or estimate their effect on overall data quality. This section describes the QC activities to be performed in order to assess reliability and confidence in the data being collected.

<Quality Control activities include a variety of field and laboratory processes designed to assess data quality indicators given in Section 6.0, and to evaluate variability inherent in environmental monitoring activities.>

7.1 Field Sampling Quality Control

<Field sampling quality control is assessed through the use and performance of field blanks and field duplicates.>

7.1.1 Field Blanks

Field blanks are required for all water quality samples taken on a regular sampling schedule. Samples collected during storm water or melt runoff events, including from auto or siphon samplers and from ephemeral stream reaches, do not require field blanks.

<Field blanks are water quality control samples that are analyzed with water quality samples to evaluate sensitivity of method detection limits, and to identify any errors or contamination in sample collection and analysis. Field blanks originate at the laboratory as reagent water (DI water) and sample bottles. During field sampling, a sample bottle is selected from the same lot used for field samples and is filled on-site with the laboratory reagent water. It is preserved in the field along with samples taken from the site. The field blank is returned to the laboratory for analysis along with the shipment of field samples.

Field blanks for groundwater and spring water monitoring are collected during each sampling event at a minimum 5% frequency. Field blanks for perennial stream, intermittent stream, and pond monitoring are collected during each sampling event at a minimum 10% frequency. A minimum of one field blank is collected during each sampling event. Performance criteria and corrective actions for field blanks that fail criteria are given in Section 6.6 Sensitivity.>

7.1.2 Field Duplicates

Field duplicates are required for all water quality samples taken on a regular sampling schedule. Samples collected during storm water or melt runoff events, including from auto or siphon samplers and from ephemeral stream reaches, do not require field duplicates.

<Field duplicates are samples collected at the same place, at the same time as the original sample. Field duplicates are used to assess both the reproducibility of the sampling technique and the precision of the analytical method.

Field duplicates for groundwater and spring water monitoring are collected during each sampling event at a minimum 5% frequency. Field duplicates for perennial stream, intermittent stream, and pond monitoring are collected during each sampling event at a minimum 10% frequency. A minimum of one field duplicate sample is collected during each sampling event. Performance criteria and corrective actions for field duplicates that fail criteria are given in Section 6.1 Precision.>

7.2 Laboratory Quality Control

<Laboratory quality control consists of a variety of internal laboratory controls including method blanks, spikes and replicates. For samples that fail laboratory acceptability criteria, corrective actions are taken, or data is qualified due to laboratory acceptability criteria not being met. The issues and affected data will be documented in the Annual Hydrology Report/QA Summary Report.>

7.3 Water Quantity Measurement Quality Control

Depending on the type of instrumentation used, describe how water quantity (pond levels, well levels, stream flows) monitoring will be checked and monitored for accuracy, the frequency of quality control checks, and the corrective actions that would occur if the monitoring equipment and methodology are found to be inaccurate.

8.0 Equipment Inspection, Testing, and Maintenance

8.1 Field & Equipment

State the frequency and methodology for checking and maintaining equipment used for hydrologic monitoring (e.g. meters, flumes, crest gages, transducers, etc). State the corrective action that will be taken upon discovery of malfunctioning equipment. Failure to perform and record calibration of field instruments may result in rejection or qualification of data.

8.2 Analytical Laboratories

<Analytical laboratories are responsible for the routine maintenance of their equipment per manufacturer's instructions. Procedures and frequency for equipment inspection and maintenance is described in the laboratories Laboratory Quality Assurance Plan (LQAP), and is available upon request.>

9.0 Non-Direct Measurements

Non-direct measurements are data collected using professional judgment and observation. Examples of these are photo-documentation, field notes, and other on-site observations recorded in field books or site visit summaries.

Describe any non-direct measurements taken, the frequency of the measurements, and how these observations will be recorded and reported in the AHR. Any unusual or unexpected environmental, maintenance, or other conditions that either preclude data collection, or that may be instrumental in interpreting sample results should be photographed as necessary and included with field visit notes in the Annual Hydrology Report.

10.0 Data Management

Discuss how records will be managed internally by the mine, and delivered to the DEQ.

11.0 Data Review, Verification, and Validation

This section describes the quality assurance activities that occur after data collection. Review of data determines whether or not data conform to the sampling design and data quality objectives in Section 2.0, and provides a final check on the acceptability of data deliverables.

11.1 Review by Analytical Laboratories

<It is the responsibility of the laboratory to provide analytical results conforming to the requirements of the methods that they perform. These methods are reported under a reference analytical method from EPA, Standard Methods, USGS, or other recognized organization. Where a substantial modification to a recognized method is being performed, the reference notes this by including "mod" or "modified" following the method citation.>

11.2 Review by Mine Staff

<The first review of field and laboratory data will be a quality control review performed by staff at ***(insert mine name)*** *or a designated agent/consultant. The review will include evaluating performance of all data quality indicators and quality control criteria in Sections 6.0 and 7.0 for field measurements and laboratory samples. Mine staff will apply corrective actions where appropriate, and report on the performance of Data Quality Indicators (Section 6.0), Quality Control elements (Section 7.0), and corrective actions taken in the Annual Hydrology Report/Quality Assurance Summary Report.>*

11.3 Review by DEQ Coal Program Staff

<Review, verification, and validation by the DEQ Coal Program staff of data deliverables and information in the Annual Hydrology Report will include a review of all data and the performance of all data quality indicators and quality control criteria to evaluate compliance with the project's data quality indicators given in Section 6.0 and Section 7.0.

*Upon completion of the review, DEQ Coal Program staff will provide **(insert mine name)** with the results of data and quality assurance review of Annual Hydrology Report deliverables. Where deficiencies in data collection, reporting, or quality control are identified, **(insert mine name)** will address and correct the deficiencies to the satisfaction of the Department before final approval and acceptance of the Annual Hydrology Report (Section 13.0).>*

12.0 Assessments and Response Actions

Assessment and response actions are those activities performed by the regulatory authority (DEQ) to ensure that the MQAP is implemented as prescribed. They may include a variety of periodic field, laboratory and data audits.

12.1 Assessment of Analytical Laboratories

<The State of Montana Department of Public Health and Human Services (DPHHS) administers a Laboratory Certification Program (http://www.dphhs.mt.gov/publichealth/lab/environmental/labcertification.shtml) to ensure that analytical laboratories meet strict quality guidelines for the analysis of water quality samples in accordance with regulatory requirements of the Safe Drinking Water Act. Qualified analytical laboratories are authorized by the State to analyze public water supplies in Montana, and to submit data that is of sufficient quality to be used to determine compliance with state and federal regulations.>

The DEQ Coal Program accepts analytical data produced by laboratories certified under this program, provided the analyses conform to the analytical requirement specified in this MQAP. State the analytical laboratory(s) used for sample analyses, and identify whether the analytical laboratory meets Laboratory Certification Program requirements (see above).

12.2 Assessment of Field Activities

<The DEQ Coal Program staff conducts monthly inspections of Montana coal mines, during which sampling stations, equipment and instrumentation may be inspected for compliance with approved MQAP methods and procedures. Additionally, hydrologists from the DEQ's Coal Program may conduct periodic audits of water quality sampling activities to evaluate compliance with approved the Monitoring and Quality Assurance Plan.>

12.3 Assessment of Data Management and Reporting Activity

*<Data is managed by **(insert mine name)**, and reported semi-annually to the DEQ Coal Program in a semi-annual data submittal, and annually in an Annual Hydrology Report. DEQ Coal Program staff review data and report submittals for quality assurance and compliance with Annual Hydrology Report content and format guidelines.>*

13.0 Reports to the Regulatory Authority (DEQ)

<Results of annual water quality and quantity sampling are reported to DEQ both in a semi-annual data submittal and in an Annual Hydrology Report. The semi-annual data submittal is water quality and quantity data from the first six months of the monitoring period, whereas the Annual Hydrology Report includes a comprehensive report documenting the results of all water quality and quantity data collected in accordance with this MQAP. Additionally, the Annual Hydrology Report includes a Quality Assurance Summary Report that reports on the performance of data quality indicators (Sections 6.0 & 7.0) and summarizes any annual deviations or operational modifications to the approved MQAP.

The Annual Hydrology Report is delivered to the Montana DEQ Coal Program on or before December 31st. Annual Hydrology Reports, along with accompanying data, maps and other supporting information is retained by the DEQ Coal Program.>

Appendix

Appendix A – Historic Hydrologic Monitoring Locations

Historic Monitoring Sites

The historic monitoring plan is a list of all sites previously used to monitor groundwater or surface water. In addition to noting the location of previous monitoring sites, the historic monitoring plan tables serve to document the status of site reclamation.

Include the following tables taking care to note the status of the sites. Keep these tables up to date along with the current monitoring plan.

- Historic spring monitoring sites are recorded in "**historicmonitoring_plan.xlsx/Spring**"
- Historic stream monitoring sites are recorded in "**historicmonitoring_plan.xlsx/Stream**"
- Historic pond monitoring sites are recorded in "**historicmonitoring_plan.xlsx/Pond**"
- Historic groundwater monitoring sites are recorded in "**historicmonitoring_plan.xlsx/Groundwater**"
- Historic MPDES monitoring sites are recorded in "**historicmonitoring_plan.xlsx/MPDES**"

Hydrologic Monitoring Sites Map

The Hydrologic Monitoring Sites map should show all historic hydrologic monitoring locations and differentiate between the two. Both surface water and groundwater sites should be included. Label all sites with the monitoring station name.

Background: As-built topo (minimum 10' Contours with labels) or most current aerial photograph

Layers:

- Groundwater monitoring site names and locations
    - The map should identify the aquifer being sampled at each station. Some wells may have the aquifer identified in their name. If a well name does not identify the aquifer, use colors, symbols, or additional annotation to label designate the monitored aquifer(s).
- Springs monitoring site names and locations
- Streams monitoring site names and locations
- Ponds monitoring site names and locations
- MPDES discharge locations
- Permit boundary
- Current streams and major tributaries
    - Label all streams

- Ponds and impoundments
    - Label all ponds

Example: Historic Stream Monitoring Sites

Station	Waterbody	Stream Classification	Status	Northing NAD83 StPlane ft	Easting NAD83 StPlane ft	Ground Elevation ft	Channel Shape / Design	Flow Measurement Instrumentation	WQ Sampling Instrumentation	Continuous Recorder	Purpose	Inclusive Years of Flow Measurements	Inclusive Years of Water Quality Samples
CL-45	Coal Creek	C-3 ephemeral	Inactive	615508	2584737	3022	V-notch weir	Stevens recorder		x	Monitoring upstream flow on Coal Creek	1997-1999; 2002	
CL-46	Coal Creek	C-3 ephemeral	Abandoned	615521	2584777	3037	V-notch weir; Natural	Stevens recorder; Pressure transducer	Sediment sampler at 12 inches	x	Monitoring upstream flow on Coal Creek	1995-2005	1995; 2000-2008

Historicmonitoring.xlsx/Stream

Example: Historic Spring Monitoring Sites

Station	Status	Northing NAD83 StPlane (ft)	Easting NAD83 StPlane (ft)	Ground Elevation (ft)	Channel Shape / Design	Flow Measurement Instrumentation	WQ Sampling Instrumentation	Continuous Recorder	Purpose	Inclusive Years of Flow Measurements	Inclusive Years of Water Quality Samples
S88	Transferred	615600	2585281	3288	Natural	Crest gauge			Monitor water quantity downgradient of mining	2009-2011	

Historicmonitoring.xlsx/Spring

Example: Historic Pond Monitoring Sites

Station	Status	Northing NAD83 StPlane (ft)	Easting NAD83 StPlane (ft)	Ground Elevation (ft)	Water Depth Instrumentation	WQ Sampling Instrumentation	Purpose	Inclusive Years of Water Levels	Inclusive Years of Water Quality Samples
PO-910	Destroyed	615723	2585287	2358	Staff gauge		Monitor water and sediment levels in sediment trap	2001-2011	

Historicmonitoring.xlsx/Pond

Example: Historic Groundwater Monitoring Sites

Station	Status	Northing NAD83 StPlane ft	Easting NAD83 StPlane ft	MP Elevation ft	Ground Elevation ft	Aquifer	Purpose	Inclusive Years of Water Levels	Inclusive Years of Water Quality Samples
D3	Inactive	615503	2584715	2581.8	2581.6	C Coal	Monitor C-coal downgradient of Area AA	1979 - 1988	1984-1988

Historicmonitoring.xlsx/Groundwater

Example: Historic MPDES Monitoring Sites

Station	Receiving Waterbody	Status	Northing NAD83 StPlane ft	Easting NAD83 StPlane ft	Ground Elevation ft	Flow Measurement Instrumentation	Inclusive Years as Discharge Point
MM-001A	Spring Creek	Abandoned	615308	2584716	2897	Flow meter	1991-2010
MM-001B	Spring Creek	Abandoned	615328	2584711	3027	Flow meter	1991-2008

Historicmonitoring.xlsx/MPDES