



Final Report

SAND COULEE ACID MINE DRAINAGE SOURCE CONTROL

Abandoned Mine Reclamation Project



Cascade County, Montana

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1.0 Introduction

The Sand Coulee Source Control Project, Adit Discharge Monitoring and Hydrogeological Investigation, was completed under Task Order Number 7 issued pursuant to DEQ Contract No. 414026 between HydroSolutions Inc. (HydroSolutions) and the Montana Department of Environmental Quality (DEQ). The purpose of the Task Order was to install and monitor mine discharge flow monitoring stations and conduct a hydrogeological investigation at the Sand Coulee project area. A copy of task order descriptions is provided in Appendix A.

An initial feasibility evaluation to mitigate acid mine drainage (AMD) using horizontal and vertical gravity drainage wells to reduce drainage from the Kootenai aquifer overlying the abandoned underground coal mines in the vicinity of Sand Coulee, Montana, was completed in 2014 (HydroSolutions Inc 2014). The study area location is shown on Figure 1. As part of this project, HydroSolutions identified a preliminary location to pilot test a horizontal drainage well and assessed the potential reduction in the volume of AMD discharging from nearby mines resulting from the drainage wells. This work evaluated the concept of using gravity drainage wells to reduce AMD which was first investigated in the 1980's by the Montana Bureau of Mines and Geology (MBMG) (Osborne, Thomas J; Donovan, J; Sonderegger, J. L. 1983) (Osborne, Zaluski, et al. 1987). Comprehensive water quality investigations were completed in the Great Falls Coal Field by the U.S. Geological Survey (Karper 1998) and DEQ (Hydrometrics 2012a) (Hydrometrics 2012b).

The potential effectiveness of the pilot horizontal drainage well in reducing the amount of AMD discharging from nearby abandoned mines was analyzed using a Dupuit-Forchheimer model and the HWEEL Horizontal Well Model (Haitjema, et al. 2010) (Beljin and Lasonsky 1992). A vertical drainage well was simulated using the analytical element model AnAqSim (Fitts GeoSolutions 2013). The analysis focused on estimating the yield of drainage wells and potential reduction in the amount of water discharging from the abandoned mine workings using drainage wells. The models incorporated the hydrogeology of the Sand Coulee area to the extent known from existing information. The applicability of geophysical methods to characterize the distribution of vertical and horizontal fractures in the Kootenai Formation and determine lateral limits of the abandoned mine workings was also assessed.

1.1 Background

The Sand Coulee Basin is located primarily in east-central Cascade County, southeast of the city of Great Falls. Bituminous coal occurs at the top of the Morrison Formation of the Jurassic Period. The coal deposit includes iron-pyrite nodules up to 4-inches in diameter, which, during mining, were often discarded on the mine floor. Groundwater seeping through the coal and through the nodules on the mine floor results in AMD, which discharges from the former mine adits. This mechanism is the primary source of AMD in the Sand Coulee area (Osborne, Zaluski, et al. 1987). There are two sources of groundwater seeping into the abandoned mine workings:

- Infiltration from precipitation and snowmelt through the strata directly above the mine workings, and
- Groundwater originating from the regional flow system in the Kootenai aquifer.

The hydrologic source control methods evaluated by the MBMG in the 1980's were intended to reduce both of these sources. However, only the first control (infiltration reduction) was field tested. Field studies focused on a reduction in local infiltration to the coal mines by using intensified farming to control shallow recharge (Osborne, Thomas J; Donovan, J; Sonderegger, J. L. 1983) (Osborne, Zaluski, et al. 1987). The use of horizontal or angled groundwater interception wells was discussed in the 1987 MBMG report, but no field testing took place due to lack of available directional drilling contractors.

The Town of Sand Coulee is located in Section 13, T19N, R4E, as shown on Figure 1. A creek commonly referred to as Rusty Ditch and Straight Creek originates approximately 3.5 miles southwest of the town of Sand Coulee and flows northeast to its confluence with Sand Coulee Creek just north of Tracy. There are four abandoned coal mines that have continuous or intermittent discharges around Sand Coulee: the Gerber Mine, the Sand Coulee Mine, the Mount Oregon Mine, and the Nelson No. 1 Mine (Hydrometrics 2012a). An inventory of abandoned mine features in the Sand Coulee area conducted in the early 1980s identified 30 mine waste dumps, approximately 40 subsidence depressions, 10 acid mine discharges, 10 open adits, 22 collapsed adits, and two open air shafts (Hydrometrics 1983). Reclamation work has been completed in the area by DEQ to mitigate the hazards posed by the abandoned mines, but AMD discharges have not been addressed. The most recent study indicates that total flow of AMD from the aforementioned abandoned mines has varied from approximately 14 gallons per minute (gpm) to 184 gpm depending on the time of year and antecedent precipitation (Hydrometrics 2012a). Discharges from the abandoned mines to surface and groundwater have contaminated domestic wells and caused their abandonment as drinking water sources.

Adverse effects of AMD have been observed at Sand Coulee for well over 100 years. By 1902, AMD from the former Sand Coulee mine was reportedly corrosive to the point that it was not suitable for industrial boiler use (Rossillon, McCormick and Hufstetler 2009). All water quality studies conducted in the Great Falls coal field area over the past 40 years have documented continuing severe water quality impacts caused by the AMD. Monthly water quality and streamflow data were collected at mine discharge sites within Sand Coulee from July 1994 through September 1996 and August 2011 to September 2012 (Karper 1998) (Hydrometrics 2012a). The discharge monitoring sites included Mining Gulch, Sand Coulee Mine, Oregon Mine at Kate's Coulee, and Nelson Mine at Sand Coulee. The average pH of sampled mine discharge sites ranged from 2.6 to 3.1. The average concentrations of dissolved sulfate ranged from 2,633 to 10,562 milligrams per liter (mg/L), dissolved iron ranged from 284 to 1,525 mg/L, and dissolved aluminum ranged from 156 to 901 mg/L (Hydrometrics 2012a). DEQ-7 human health standards were exceeded for arsenic, beryllium, cadmium, chromium, fluoride, nickel, thallium and zinc. DEQ-7 aquatic life standards were exceeded for cadmium, copper, iron, nickel, selenium and zinc (Hydrometrics 2012a).

1.2 Hydrogeologic Setting

The topography around Sand Coulee is characterized by broad upland terraces sloping gently northward from the base of the Little Belt Mountains. These terraces are incised by narrow, steep sided coulees, which generally contain ephemeral streams. At Sand Coulee, the relief between the bottom of the coulee and the surrounding upland area is on the order of 200 feet. The geology of the area consists of a relatively flat lying sequence of sedimentary rocks that are exposed along the walls of the incised coulees. The formations slope gently to the north and west in the area (Hydrometrics 2012b).

The Kootenai Formation underlies the upland terraces surrounding Sand Coulee and is exposed in outcrop on the steep sidewalls of the coulee. Since the Kootenai Formation is stratigraphically above the area mine workings, it is not impacted by mine drainage (Hydrometrics 2012b). The Kootenai Formation is a calcareous cemented sandstone with alternating layers of mudstone. The upper portion of the Kootenai Formation has been eroded resulting in a thickness of 170 to 180 feet at the Sand Coulee well field (Hydrometrics 2012b) (Hydrometrics 2016). The Kootenai Formation generally yields moderate amounts of groundwater from 5 to 50 gpm (Wilke 1983).

The Kootenai Formation is subdivided into five members (Kk_1 – Kk_5). The basal member (Kk_1) forms the roof of the coal mines and serves as the historic source of potable water for the Sand Coulee Water District. Kk_1 is the target unit for this investigation. Generally, Kk_1 is a crossbedded, moderately well-sorted quartz arenite with an average thickness of 30 feet in the investigated area. The Kk_1 aquifer is confined southwest of the Sand Coulee Mine but becomes unconfined and is partially dewatered approaching the up-gradient edge of the abandoned mines (Osborne, Thomas J; Donovan, J; Sonderegger, J. L. 1983). The Kk_2 is predominantly a red mudstone which acts as an aquitard between the Kk_1 and Kk_3 . The Kk_3 is a well sorted resistant quartz arenite that is likely not an aquifer in the area. The upper Kootenai units (Kk_4 and Kk_5) range from red mudstone, limestone, and sandstone and are unsaturated in the area. The vertical gradients between the hydrostratigraphic units are large because flow has to pass through the mudstone unit in the Kootenai (Kk_2) which acts as an aquitard between the Kk_3 and Kk_1 (Osborne, Thomas J; Donovan, J; Sonderegger, J. L. 1983).

The Morrison Formation underlies the Kootenai Formation and is generally between 120 and 180 feet thick in the Great Falls area (Wilke 1983). The Morrison Formation is primarily mudstone containing lenses of limestone, sandstone, coal, and shale. The coal seam mined in Sand Coulee is located at the top of the Morrison Formation with an average thickness of 8.5 feet (Smith 2008).

The Morrison Formation is underlain by the Swift Formation, a calcareous sandstone with interbedded shale ranging from 0 to 40 feet thick in the Sand Coulee area (Hydrometrics 1983). Recent drilling conducted by DEQ for the construction of replacement public water supply wells for the Sand Coulee Water District indicated the Swift Formation is 15 to 30 feet thick and highly fractured (Hydrometrics 2012b) (Hydrometrics 2016). The Swift Formation is underlain by the Madison group Mission Canyon and Lodgepole Formations. The thickness of the Madison Limestone in the Great Falls area ranges from 1,200 to 1,700 feet (Smith 2008) and consists of massive- to thick-bedded limestone with thin, chert interbeds transitioning downward into thinner-bedded limestone and mudstone. Groundwater is present in the Madison where fractures or solution cavities have developed. Well yields from wells completed in the Madison

average 30 gpm in this area. The two public water supply wells constructed by DEQ (Wells 5 and 6) produced 150 gpm with minimal drawdown recorded, indicating the presence of a highly transmissive fracture system underlying the Sand Coulee well field (Hydrometrics 2012b) (Hydrometrics 2016).

Osborne, Zaluski, et al. (1987) determined that the abandoned coal mines have resulted in significant changes to the regional groundwater flow system. The old tunnels and rooms provide efficient groundwater drains, which dewater the Kootenai sandstone and convey the water to mine portals (Osborne, Thomas J; Donovan, J; Sonderegger, J. L. 1983). Previous tectonic events have resulted in extensive fracturing of the Kootenai sandstone. These fractures and related joint systems facilitate vertical groundwater movement through the Kootenai sandstone into the abandoned mines. The fracturing is likely enhanced by continued subsidence over the abandoned mines. The adits intercept groundwater flowing toward Sand Coulee from the regional recharge areas located to the southeast in the Little Belt Mountains (Osborne, Thomas J; Donovan, J; Sonderegger, J. L. 1983).

2.0 Adit Discharge Measurement

Previous work to characterize flow rates was conducted by the U.S. Geological Survey from 1994 through 1996 and included discharges in Sand Coulee, Centerville, Stockett, Tracy, and Belt. The USGS monitoring in Sand Coulee included 26 monthly flow measurements and water quality sampling from three of the four adits currently discharging (SC-1, SC-8, and SC-12). The USGS also monitored an adit in Sand Coulee (SC-3) located approximately 825 feet west-southwest of adit SC-3A. Previous investigations indicate average flow rates of 6.6, 13, 30, and 12 gpm for SC-1, SC-3, SC-8, and SC-12 (Hydrometrics 2012a). Site SC-3 was not discharging water during the current investigation. As part of this investigation, adits currently discharging in Sand Coulee and their site designations are summarized in Table 1.

Accurate measurement of adit flows was identified as valuable baseline data needed to help quantify reductions in flow which may result from groundwater interception using horizontal or vertical wells. However, the adit discharge rates are affected by factors including precipitation events and seasonal and long-term climatic patterns. Accordingly, automated measurement and datalogging of flows was identified as the preferred approach for the collection of baseline flow data. HydroSolutions and DEQ evaluated options for measuring adit flows. Site conditions, including freezing winter conditions and the extremely low turbidity of the discharged water favored a design employing non-contact water stage measurement.

HydroSolutions completed the construction and installation of adit discharge measurement equipment and continuous monitoring equipment at the four discharging adits in Sand Coulee. Two molded fiberglass polyester 0.6' HS-flumes were purchased by DEQ for measurement of flows at sites SC-3A and SC-12. One Parshall flume and one 0.5' H-flume were obtained at no charge from the Zortman-Landusky water treatment site. A description of installations at each site is described below. A summary of flume completion is provided in Table 1.

Table 1. Summary of Flume Completion

	SC-3A	SC-8	SC-12	SC-1
Mine Discharge	Gerber Mine	Mount Oregon Mine	Nelson No. 1 Mine	Sand Coulee Mine
Northing	1148644.577	1150215.464	1151389.348	1147545.701
Easting	1553001.924	1552782.679	1554679.487	1553259.154
Elevation	3550.10	3533.27	3547.62	3571.23
Flume	0.6' HS Flume Fiberglass Installed: 8/29/2017	3 inch Parshall Fiberglass Installed: 6/21/2017	0.6' HS Flume Fiberglass Installed: 8/29/2017	0.5' H Flume Plastic Installed: 4/19/2017
Logging Equipment	Senix ToughSonic Chem 10 Ultrasonic level sensor and Campbell Scientific CR300 data logger. Installed: 11/9/2017	Senix ToughSonic Chem 10 Ultrasonic level sensor and Campbell Scientific CR300 data logger. Installed: 10/12/2017	Senix ToughSonic Chem 10 Ultrasonic level sensor and Campbell Scientific CR300 data logger. Installed: 10/18/2017	Senix ToughSonic Chem 10 Ultrasonic level sensor and Campbell Scientific CR300 data logger. Installed: 6/7/2017
Notes	Gravel capture system installed then abandoned. Flume reinstalled 10/27/2017.	Flume set on channel downstream from adit discharge.	18 Inch sewer plug installed into cement pipe discharge.	Flume connected to bulkhead discharge pipe.

Northing and easting coordinates are state plan coordinates

Site SC-1, Mine Discharge in Mining Coulee.

The abandoned Sand Coulee Mine adit has a large concrete bulkhead at the opening with a six-inch diameter PVC pipe that collects and discharges water from the mine behind the bulkhead. This bulkhead was installed during previous reclamation work. HydroSolutions constructed a platform and installed a 0.5' H-Flume made of polyvinyl chloride (PVC) to measure mine discharge water. The flume was connected to the discharge pipe and set in concrete.

Site SC-8, Mount Oregon mine discharge in Kates Coulee.

The abandoned Mount Oregon mine adit discharges water into the Kates Coulee drainage. Water pools adjacent to the discharge point and creates a saturated area that is not suitable for effective installation of a flow measuring device. A site just downstream of this in Kates Coulee was selected to install a three-inch fiberglass Parshall flume constructed by Plastifab. Native soils were bermed from banks of the channel up to the edge of the flume to hold it in place, and the site provided sufficient drop for free-flow conditions through the flume. Although Kates Coulee is generally dry above the adit discharge point, the Cascade County Conservation District (CD) considers it a perennial stream, and a Stream Protection Act (SPA 124) permit was

obtained prior to any disturbance in the channel. DEQ obtained the permit through coordination with the CD and the Montana Department of Fish Wildlife and Parks.

Site SC-3A, Mine Discharge in Sand Coulee.

This abandoned Gerber Mine adit discharge emanates from a sink hole in the hillside above Sand Coulee. DEQ hired Boland Construction to install a gravel capture system that collected the discharge water into a six-inch PVC pipe. The system functioned properly for a short time, but then appeared to foul with fine sediment. DEQ modified the capture system and constructed a simple dam and pipe system that channels pooled discharge water into a six-inch diameter PVC pipe. The pipe is connected to a new fiberglass 0.6' HS flume constructed by Tracom and purchased by DEQ for this project. The discharge at this site has notably increased from measurements collected during previous years.

Site SC-12, Nelson Mine Discharge above Sand Coulee.

Constructed during previous reclamation efforts, the abandoned Nelson mine discharge water at this site is collected underground and emerges from the hillside in an eighteen-inch diameter concrete pipe. Discharge water then flows into a concrete lined ditch that traverses the hillside before draining into the "Rusty Ditch" through a buried pipe. To measure adit discharge at this site, HydroSolutions installed a new eighteen-inch inflatable Lansas flow-through plug inside the concrete pipe as it emerges from the hillside. The flow-through plug sealed off the larger pipe and directs water into a four-inch diameter PVC pipe which is connected to a new fiberglass 0.6' HS flume and used to measure discharge rate. Water from the flume discharges into the concrete lined channel to a perforated manhole drain at the south end of the channel. The manhole cover should be replaced with a grate to allow better drainage as the manhole cover routinely clogs with organic debris.

Water level measurement equipment and data loggers were installed at each adit discharge site to continuously measure and record volumetric discharges. The equipment was installed by HydroSolutions and DEQ. Monitoring equipment installed at each site includes Senix ToughSonic Chem10 Ultrasonic level sensors and Campbell Scientific CR300 data loggers. At each site, the ultrasonic level sensor was mounted above the staff gauge in the flume using three-quarter inch galvanized pipe and fittings. The sensor was then wired to the data logger through flexible electrical conduit. The data logger along with a power supply battery are housed in a weather proof enclosure mounted on a galvanized fence post nearby. The 12-volt battery is charged with a 10-watt solar panel that is also mounted on the fence post.

Prior to completing the installation of the ultrasonic level sensors and data loggers, adit mine discharges were measured at various times during the field season. A temporary flume measurement or volumetric measurements were collected and are shown in Table 2. Seasonal variation in flow is evident.

Table 2. Summary of Mine Discharge Measurements

Site	Mine Discharge	Date	Staff (feet)	Flow (gpm)	Notes
SC-3A	Gerber Mine	11/4/2016	0.08	2.0	temporary 0.5 H flume
		6/7/2017		37.0	Volumetric
		8/29/2017	0.28	18.9	0.6HS Flume Installed
		10/31/2017	0.21	10.3	
		11/9/2017	0.2	9.3	
SC-8	Mount Oregon Mine	11/4/2016	0.24	22.0	temporary 0.5 H flume
		6/21/2017	0.2	36.9	3 inch Parshall flume installed
		7/18/2017	0.2	36.9	
		8/29/2017	0.27	58.7	
		10/31/2017	0.4	107.9	Flume plugged
		11/9/2017	0.24	48.9	
SC-12	Nelson No. 1 Mine	11/4/2016		2.0	estimated
		6/7/2017		19.1	Volumetric
		8/29/2017	0.2	9.3	0.6HS Flume Installed
		10/11/2017	0.21	10.3	
		10/18/2017	0.2	9.3	
		10/31/2017	0.21	10.3	
		11/9/2017	0.2	9.3	
SC-1	Sand Coulee Mine	11/4/2016		13.2	Volumetric
		4/19/2017	0.12	6.5	
		5/11/2017	0.12	6.5	
		5/18/2017	0.12	6.5	0.5 H flume Installed
		5/24/2017	0.12	6.5	
		6/7/2017	0.12	6.5	
		6/21/2017	0.14	9.0	
		7/18/2017	0.17	13.6	
		8/29/2017	0.16	11.9	
		10/18/2017	0.16	11.9	
		10/31/2017	0.16	11.9	
		11/9/2017	0.18	15.4	

gpm gallons per minute

Ultrasonic level sensor data are provided in Appendix B. Complete downloaded data are provided in the electronic attachment. Data were downloaded by DEQ and includes the following:

SC-1	Through February 7, 2018
SC-3A	Through December 18, 2017
SC-8	Through February 7, 2018
SC-12	Through December 29, 2018

Evaluation of the data indicates additional calibration of the ultrasonic sensors is warranted to improve the accuracy of recorded data. However, measurements are being recorded and the equipment is operational. Future work will include additional assessment of adit discharge volumes.

3.0 Monitoring Wells

Four monitoring wells were installed at selected locations on private land in the Sand Coulee project area. Private landowners signed DEQ access agreements and were very cooperative and understanding with the project objectives. The project team minimized disturbance to personal activity and minimized any surface disturbance to the well location from drilling. Drill sites were restored to near pre-drilling conditions.

Field work prior to drilling new monitoring wells included several field visits to locate previously installed MBMG monitoring wells, locate private domestic and stock wells in the field area, and collect water level measurements and completion information from all accessible wells. All measured water levels collected during this investigation are compiled and provided in Appendix C. In addition, private landowners were contacted and access to proposed drilling locations was verified. Landowners also directed where to locate each monitoring well. Underground utilities were located prior to drilling.

Boland Construction drilled the wells using a Gardner Denver HPS1000 air rotary drilling rig. Two wells were completed in Sand Coulee and two wells were completed on the bench west and above Sand Coulee. The objective was to complete the wells in the basal Kootenai sandstone located immediately above the Morrison Formation, the host rock for the targeted coal seam. A summary of monitoring well locations and rationale is shown in Table 3.

Table 3. Monitoring Well Location and Rationale

Proposed Well and Completion Aquifer	Estimate Top of Formation Target (Feet)	Actual Target Total Depth (feet)	Screened Depth (feet)	Rationale/Location
MW-W101K Kootenai basal sand Kk1	234	242	222-242	Kk well on T. Wylder on up-gradient side of Mt Oregon mine (as mapped). (Possible location for paired Kk and Madison Group Mission Canyon Formation (Mm) wells). (Vertical drainage?) Need to find water in basal Kootenai. If dry, then not good site for vertical drainage well
MW-C102K Kootenai basal sand Kk1	73	Not encountered ¹	65-85	Kk well on K. Chartiers just south of LaRocque property line, and start of one potential H-well
MW-C103K Kootenai basal sand Kk1	159	86	66-86	Kk well on F. LaRocque in SW corner of Sec 23, potential terminus of H-wells.
MW-C104K Kootenai basal sand Kk1	229	247	227 to 247	Kk well on R. Chartiers near Hunter Road

Note: Top of target for Kk1 wells is considered to be top of Morrison coal bed.

Kk = Lower Cretaceous Kootenai Formation

Kk1 = Basal Kootenai Formation sandstone

¹ MW102K drilled to 158 feet bgs, but Kootenai basal sand and coal not encountered in borehole; location appears to be fault controlled

The location of these four new monitoring wells are shown on Figure 2. All four wells were completed in the Kootenai Formation. A description of lithology encountered in each new monitoring well is provided below. Well logs are included in Appendix D.

Monitoring Well MW-101K

Monitoring well MW-101K was drilled on August 1, 2017 and is located on the bench above Sand Coulee on T. Wylder property. The well was drilled to a depth of 242 feet below ground surface (bgs). A black siliceous clay and coal fragments were encountered from 238 feet to 242 feet bgs. Overlying this unit was alternating layers of fine-, medium-, and coarse-grained sands, generally light in color, with a dark gray, salt and pepper unit around 204 feet bgs. The sand units appear to dominate the lithology from about 175 feet bgs to the terminus of the borehole.

The monitoring well was completed using 4-inch diameter polyvinyl chloride (PVC) screen and riser pipe. Twenty feet of 20-slot screen was installed from 222 feet to 242 feet bgs and 10-20

silica sand filter pack was installed in the annular space, extending 5 feet above the top of the screen. PVC riser pipe was installed from the top of the screen to 2 feet above ground surface. Five feet of 6-inch steel protective casing with 2 feet of stick up was cemented in place. Bentonite chips were emplaced and formed an annular seal above the filter pack to within 1 foot of the surface. Concrete was then poured in the space above the grout to form a surface seal. The well was completed with the top of the PVC casing extending above the ground surface approximately 2 feet (stick-up completion) and inside the 6-inch diameter protective steel casing. A two foot by two foot cement pad was constructed.

Monitoring Well MW-102K

Monitoring well MW-102K drilling commenced on August 2, 2017 and drilling completed on August 3, 2017, and is located in Sand Coulee on K. Chartier property. The well was drilled to a depth of 158 feet below ground surface (bgs). Excessive caving and water was encountered from near surface to the bottom of the borehole. Steel casing was driven from surface to 58 feet bgs to keep the borehole open. Upon reaching the 158 foot depth, the drill tools were removed and the borehole caved back to 85 feet bgs.

The monitoring well was completed using 4-inch diameter PVC screen and riser pipe. Twenty feet of 20-slot screen was installed from 85 feet to 65 feet bgs. Fourteen bags of 10-20 sand filter pack was poured around the screen but did fill the void. Due to the large cavity created by the cave-in, thirty-five 5-gallon buckets of 3/8 inch washed gravel was poured around the screen section to about 2 feet from the top of the screen and the caved section appeared to be controlled. On top of the gravel, 10-20 silica sand filter pack was placed in the annular space extending approximately 3 feet above the top of the screen. PVC riser pipe was installed from the top of the screen to 2 feet above ground surface. Two feet of 6-inch steel protective casing was welded to the steel casing and cemented in place. Bentonite chips were emplaced in the steel casing above the filter pack to within 1 foot of the surface. Concrete was then poured in the space above the bentonite to form a surface seal. The well was completed with the top of the PVC casing extending above the ground surface approximately 2 feet (stick-up completion) and inside the 6-inch diameter protective steel casing. A two foot by two foot cement pad was constructed.

No siliceous shale or coal was encountered. Clay and clay-balls occurred frequently in drill cuttings. Medium- to fine-grained sandstone with variable chert was found intermittently below 100 feet. Based on nearby well logs, the coal unit was expected to be at approximately 100 feet bgs. Water discharging from the borehole during drilling remained clear and lacked black color indicative of coal unit. Based on unstable bedrock, presence of frequent clay and clay balls, and lack of coal unit, it appears that MW-102K was installed in an un-mapped fault along the west side of Sand Coulee.

Monitoring Well MW-103K

Monitoring well MW-103K drilling commenced on August 4, 2017 and was completed on August 7, 2017. This well is located in Sand Coulee on F. LaRocque property. The well was drilled to a depth of 86 feet below ground surface (bgs). A black siliceous clay and coal containing about 5 percent sulfides were encountered from 83 to 86 feet bgs. Overlying this unit were alternating layers of fine- to medium-grained sands, generally light in color, with a dark gray, salt and pepper unit between 65 and 83 feet bgs. Chert grains were estimated at 25 percent to 50

percent.

The monitoring well was completed using 6-inch diameter PVC screen and riser pipe. Twenty feet of 20-slot screen was installed from 86 feet to 66 feet bgs and 10-20 silica sand filter pack was installed in the annular space extending 5 feet above the top of the screen. PVC riser pipe was installed from the top of the screen to 2 feet above ground surface. Five feet of 8-inch steel protective casing with 2 feet of stick up was cemented in place. Bentonite chips were emplaced and formed an annular seal above the filter pack to within 1 foot of the surface. Concrete was then poured in the space above the grout to form a surface seal. The well was completed with the top of the PVC casing extending above the ground surface approximately 2 feet (stick-up completion) and inside the 8-inch diameter protective steel casing. A two foot by two foot cement pad was constructed.

Monitoring Well MW-104K

Monitoring well MW-104K was drilled on August 8, 2017 and is located on the bench above Sand Coulee on R. Chartier property. The well was drilled to a depth of 248 feet below ground surface (bgs). A black siliceous clay and coal fragments was encountered from 244 feet to 248 feet bgs. Overlying this unit were alternating layers of medium- and coarse-grained sands, generally light in color, with varying amounts of chert. A dark gray, salt and pepper unit was encountered from 115 feet to 244 feet bgs.

The monitoring well was completed using 4-inch diameter polyvinyl chloride (PVC) screen and riser pipe. Twenty feet of 20-slot screen was installed from 227 feet to 247 feet bgs and 10-20 silica sand filter pack was installed in the annular space, extending 3 feet above the top of the screen. PVC riser pipe was installed from the top of the screen to 2 feet above ground surface. Five feet of 6-inch steel protective casing with 2 feet of stick up was cemented in place. Bentonite chips were emplaced and formed an annular seal above the filter pack to within 1 feet of the surface. Concrete was then poured in the space above the grout to form a surface seal. The well was completed with the top of the PVC casing extending above the ground surface approximately 2 feet (stick-up completion) and inside the 6-inch diameter protective steel casing. A two foot by two foot cement pad was constructed.

A schematic cross section showing the relative relationship between the groundwater elevation, ground surface elevation, and elevation of the top of coal is shown in Figure 3. The coal seam appears to dip approximately 2 degrees to the west, and likely on the eastward limb of a north-south trending synclinal structure. Other unmapped joint structures likely control groundwater flow in the area.

An approximate potentiometric surface map of the Kootenai basal sandstone (Kk1) aquifer is provided in Figure 4. All lines are shown as dotted (approximate) due to the low density of data points and varying dates of measurement. Head data for the four new monitoring wells use Fall 2017 measurements. Head data for previous monitoring wells and private well obtained from measurements taken by HydroSolutions or MBMG on various dates as available.

Dewatering by the abandoned Nelson mine causes the sharp southward deflection in potentiometric contours on the southeast side of Sand Coulee. Dewatering by the Gerber and Mount Oregon abandoned mines cause the southwestward deflection in contours on the

northwest side of Sand Coulee. The west-dipping strata along with artesian head conditions in the Kk1 aquifer probably limited underground mining to the southwest of a line connecting MW-101K, MW-104K and MW-103K.

4.0 Aquifer Testing

Short-term yield tests were completed on each monitoring well following development. Longer term aquifer tests were completed on two monitoring wells following review and analysis of drilling lithology and yield tests. A description of each test and results are provided below.

4.1 Yield Testing-Four Hour

A four-hour yield test was completed on each new monitoring well following well development. The purpose of the yield tests were to establish water availability for drainage into a horizontal and vertical well. The yield test was used to evaluate the balance between the maximum amount of water that can be pumped from the well and the amount of water that recharges back into the well from the surrounding aquifer. A summary of the results from the well yield test are provided in Table 4.

Table 4. Four-Hour Well Yield Test Summary

Well	Date	Amount of Water in Casing before yield test (feet)	Pumping Rate During Yield Test (gpm)	Drawdown During Yield Test (feet)	Height of Water Column Above Pump Intake During Yield Test (feet)	Specific Capacity (gpm/foot drawdown)
MW-101K	8/11/2017	30.49	1 to 1.5	14.88	15.61	1.77E-01
MW-102K	8/9/2017	74.88	32	22.44	52.44	1.43
MW-103K	8/10/2017	51.78	2-3	52 (dry)	0 ¹	9.59E-02
MW-104K	8/10/2017	26.63	0.5-1	11.87	14.76	1.35E-01

¹ Well went dry after pumping rate increase from 2 to 3 gpm; may be able to withstand pumping at rate less than 3 gpm.
gpm = gallons per minute

Relatively low pumping rates were maintained in monitoring wells MW-101K, MW-103K, and MW-104K, ranging from 0.5 to 3 gpm. Monitoring well MW-101K and MW-104 K were drawn down about half of the available water column. Monitoring well MW-103K was pumped at a rate that resulted in drawing water level below the pump intake.

Monitoring well MW-102K was anomalous when compared to the other three monitoring well pumping rates and drawdowns. MW-102K was pumped at a rate of 32 gpm and was drawn down approximately one-third of the water column. This well is likely located in a fracture or fault zone and is not typical of other monitoring wells or domestic wells drilled in the immediate area.

4.2 Aquifer Testing

HydroSolutions completed two 24-hour aquifer tests on monitoring wells MW-102K and MW-103K. Boland Drilling installed the pump, generator, and discharge line for the aquifer test in each well. A 7½ horsepower Grundfos submersible pump was set at a depth of 65 feet in MW-102K using a 2-inch galvanized riser pipe with a check valve above the pump and a gate valve to set flow rate.

A ½ horsepower Grundfos submersible pump was set at a depth of 83 feet in monitoring well MW-103K using a 1-inch flexible riser hose with a check valve above the pump and a gate valve to set flow rate. HydroSolutions installed a 100 pounds per square inch (psi) In-Situ transducer/datalogger at a depth of 54.42 feet below static water level in pumping well MW-102 and a depth of 45.46 feet below static water in MW-103K to record water level fluctuations during testing. A Neptune ¾ inch totalizing flow meter was installed at the well head of pumping well MW-103K to measure discharge rates, and recorded at the beginning and end of each pumping test, as well as during pumping. A Seametrics 2-inch electromagnetic flow meter with data logger was installed at pumping well MW-102K. At monitoring well MW-103K, 1-inch diameter flexible hose diverted discharge water downgradient from the well head toward Sand Coulee Creek approximately 100 feet. At monitoring well MW-102K, 2-inch diameter PVC was laid from the well head to the east into Sand Coulee Creek to route discharge water during the pumping test to the existing surface water drainage approximately 160 feet downgradient.

HydroSolutions recorded background water level measurements and barometric data prior to and during the pumping tests. Water level measurements in the pumping well were recorded on a logarithmic schedule. Periodic manual water level measurements were taken with an electronic water level indicator for confirmation. Pumping of monitoring well MW-103K was started at 12:20 pm on October 11, 2017. An average constant pumping rate of 2.7 gpm was maintained throughout the 24-hour test. Pumping of monitoring well MW-102K was started at 1:52 pm on October 17, 2017. An average constant pumping rate of 39 gpm was maintained throughout the 24-hour test.

Several transducer/dataloggers were installed in selected monitoring wells during testing. A summary of the observed wells during pumping, distance from pumping well, and notes on observed drawdown are shown in Table 5. The location for pumping wells and observation wells are shown on Figure 2. All data collected from monitoring wells during pumping tests are included in the electronic files at the end of this report.

Table 5. Summary of Observation Wells Monitored During Aquifer Tests

Well Name	Distance from Pumping Well (Feet)	Notes on Possible Observed Drawdown in Observation Well
MW-103K	0	Pumping Well
C4	832	None
C5 Medium	770	Less than 0.05 feet; no recovery
H. LaRocque Domestic	505	None; domestic pump on and off
LaRocque Stock 1	1070	None; pump interference
LaRocque Stock 2	1445	None; pump interference
MW-102K	1560	None
L1 Deep	665	None; less than 0.1 feet
MW-104K	1445	0.2-0.3 feet
MW-101K	2140	0.4 feet
MW-102K	0	Pumping Well
C4	2155	None
C5 Med	2310	0.15 feet, but significant water level fluctuation throughout 24-hour test.
H. LaRocque Domestic	1065	None; domestic pump on and off
LaRocque Stock 1	480	None; pump interference
LaRocque Stock 2	165	None; pump interference
MW-103K	1560	0.14 feet
L1 Deep	1200	None
MW-104K	2625	0.236 feet
MW-101K	3230	0.264 feet

See Figure 2 for pumping and observation well locations

Water level data collected from the pumping wells were corrected for barometric changes and evaluated using AQTESOLV (v.4.50.002) to calculate the hydraulic properties of the aquifer. The data were analyzed using both confined solutions (Theis 1935) (Papadopoulos 1967) and a leaky solution (Hantush 1955). Both methods yield transmissivity estimates between 381 to 417 feet²/day for pumping well MW-102K and 6 to 39 feet²/day for pumping well MW-103K. Graphical curve matching results are provided in Appendix E. A summary of aquifer testing results is provided in Table 6.

Table 6. Summary of Aquifer Test Results

Pumped Well	Solution	Transmissivity (feet²/day)	Saturated Thickness (b) - Model Input	Hydraulic Conductivity (K) feet /day	Saturated Thickness (b) - Screen Length	Hydraulic Conductivity (K) feet /day
MW-102K	Confined Theis	416.8	75	5.56	20	20.84
	Leaky Hantush-Jacob	381.5	75	5.09	20	19.08
MW-103K	Confined Theis	38.83	52	0.75	20	1.94
	Confined Theis (recovery)	27.53	52	0.53	20	1.38
	Confined Papadopoulos-Cooper	11.79	52	0.68	20	0.59
	Leaky Hantush-Jacob	6.3	52	0.12	20	0.32

A well was not drilled into the Madison Formation. Drill logs from nearby wells indicate the top of the Madison was encountered at 357 feet at the LaRocque property (GWIC #125190), and at 390 feet at the Wylder property (GWIC 186474). The newly installed Sand Coulee PWS wells (Wells 5 and 6) are located approximately 1 mile north-northeast of monitoring well MW-101K and provided local hydrogeologic information. Well 5 was drilled in 2012. The top of the Madison was encountered at 390 feet bgs. Extensive fracturing in the lower Swift Formation and upper Madison Formation resulted in loss of air circulation during drilling. The first identified groundwater-bearing zone was encountered at 535 feet bgs. Well 5 was completed to 785 feet to enhance well productivity and well-bore storage. The static water level was 373 feet bgs (Hydrometrics 2012b).

Well 6 was drilled in 2016 approximately 100 feet northeast of Well 5. The top of the Madison was encountered at 375 feet bgs. The upper 50 feet of the formation was highly fractured and contained voids resulting in air circulation problems during drilling. Transmissive fractures containing groundwater were encountered at 453 feet bgs. Similar to Well 5, the static water level was 373 feet bgs (Hydrometrics 2016). These wells indicate that the Swift Formation and upper Madison Formation are generally highly fractured and unsaturated. These conditions appear to be advantageous to receive water from a vertical interception well producing from the Kootenai Sandstone.

5.0 Water Quality Data And Analysis

Water samples were collected from all four adit mine discharge locations and three out of four new monitoring wells installed during the 2017 field season. Analytical results are summarized below. Laboratory analytical reports are provided in Appendix F.

5.1 Adit Surface Water Results

Mine Discharge water was sampled by HydroSolutions on October 31, 2017. Mine discharge analytical results are shown in Table 7. Samples were collected using standard surface water sampling methods. Water quality parameters (temperature, specific conductance, pH, dissolved oxygen, and oxidation reduction potential) and adit discharge flow were recorded in the field.

Table 7. Adit Mine Discharge Analytical Results

Analyte	SC-3A	SC-1	SC-12	SC-8
Collection Date	10/31/2017	10/31/2017	10/31/2017	10/31/2017
Field Parameters				
pH	1.64	1.9	2.17	3.63
Temperature	9.04	10.3	10.72	10.29
Specific Conductivity	5357	8062	9410	2674
Dissolved Oxygen	4.65	0.082	1.59	4.18
Oxidation-Reduction Potential	445.9	437.7	405.6	320.2
Discharge (gpm)	10.3	11.9	10.3	NM-(plugged)
Laboratory Results				
pH (specific units)	2.6	2.6	2.5	3.8
Total Dissolved Solids mg/L	6210	13000	15200	3340
Inorganics (mg/L)				
Total Acidity as CaCO ₃	3400	7500	9100	1400
Chloride	5	2	2	4
Sulfate	4500	9570	11400	2330
Fluoride	<0.1	<0.1	<0.1	<0.1
Hardness as CaCO ₃	824	1160	1240	778
Total Metals (mg/L)				
Aluminum	347	764	875	157
Antimony	<0.0005	<0.0005	<0.0005	<0.0005
Arsenic	0.011	0.022	0.048	0.024
Barium	<0.003	<0.003	<0.003	0.014
Beryllium	0.039	0.083	0.100	0.0218
Cadmium	0.0548	0.0820	0.115	0.00649
Calcium	149	187	183	130
Chromium	0.136	0.304	0.309	0.022

Analyte	SC-3A	SC-1	SC-12	SC-8
Collection Date	10/31/2017	10/31/2017	10/31/2017	10/31/2017
Copper	0.082	0.136	0.298	<0.002
Iron	322	756	1070	201
Lead	0.0016	0.0004	0.0006	0.0018
Magnesium	110	168	191	110
Manganese	1.56	2.58	5.80	0.958
Nickel	2.66	5.20	3.84	1.15
Potassium	<1	<1	<1	4
Selenium	0.002	0.002	0.002	<0.001
Sodium	20	16	19	25
Strontium	0.99	0.95	1.32	0.99
Thallium	0.0016	0.0006	0.0019	0.0011
Zinc	11.5	20.5	13.6	4.67

mg/L milligram per liter

NM No measurement

At mine discharge sample locations, pH ranged from 2.5 to 3.8 s.u., TDS ranged between 3,340 to 15,200 mg/L, sulfate ranged from 2,330 to 11,400 mg/L, iron ranged from 201 to 1,070 mg/L, and aluminum ranged from 157 to 857 mg/L. Detected aluminum, arsenic, beryllium, cadmium, chromium, copper, iron, nickel, thallium, and zinc exceeded DEQ-7 criteria. These low pH values and high contaminant concentrations support the need to continue to work towards controlling acid mine drainage into Sand Coulee.

5.2 Monitoring Well Results

Monitoring wells MW-103k and MW-102k were sampled by HydroSolutions during aquifer test pumping. Monitoring well analytical results are shown in Table 8. MW-103k was sampled on October 12, 2017 and MW-102k was sampled on October 18, 2018. Samples were collected using standard groundwater sampling methods. Water quality parameters (temperature, specific conductance, pH, dissolved oxygen, and oxidation reduction potential) were recorded. MW-101k was sampled by the DEQ on December 11, 2017. MW-104k has not been sampled at this time.

Table 8. Groundwater Analytical Results

Analyte	DEQ-7	MW-101K	MW-102K	MW-103K	MW-104K
Collection Date		12/11/2017	10/18/2017	10/12/2017	NS
Field Parameters					
pH	6.50 to 8.50		6.8	7.32	NM
Temperature			10.54	11.4	NM
Specific Conductivity			964	888	NM
Dissolved Oxygen (mg/L)			232	NM	NM
Oxidation-Reduction Potential			121.3	NM	NM
Laboratory Results					

Analyte	DEQ-7	MW-101K	MW-102K	MW-103K	MW-104K
Collection Date		12/11/2017	10/18/2017	10/12/2017	NS
pH	6.50 to 8.50	8.2	7.3	7.3	NS
Inorganics (mg/L)					
Total Alkalinity as CaCO ₃		330	390	370	NS
Chloride		8	22	15	NS
Sulfate		96	83	98	NS
Fluoride	4	0.8	0.9	0.8	NS
Hardness as CaCO ₃		367	489	NS	NS
Dissolved Metals (mg/L)					
Aluminum		<0.009	<0.009	<0.009	NS
Antimony	0.006	0.0005	<0.0005	<0.0005	NS
Arsenic	0.01	0.006	<0.001	0.006	NS
Barium	2	0.041	0.068	0.067	NS
Beryllium	0.004	<0.0008	<0.0008	<0.0008	NS
Cadmium	0.005	<0.00003	<0.00003	0.00034	NS
Calcium		67	90	89	NS
Chromium	0.1	<0.005	<0.005	<0.01	NS
Copper	1.3	<0.002	<0.002	0.007	NS
Iron		<0.02	<0.02	0.05	NS
Lead	0.015	<0.0003	<0.0003	0.0015	NS
Magnesium		49	64	59	NS
Manganese		0.026	0.061	0.016	NS
Nickel	0.1	0.007	<0.002	0.016	NS
Potassium		3	4	4	NS
Selenium	0.05	<0.001	0.001	0.001	NS
Sodium		15	19	17	NS
Strontium	4.0	0.44	0.47	0.48	NS
Thallium	0.002	<0.0002	<0.0002	<0.0002	NS
Zinc	2.0	<0.008	<0.008	0.045	NS

NS Not sampled

NM Not measured

Based on a comparison of groundwater samples from the Kk₁ aquifer with water samples collected from the Sand Coulee PWS well No. 5- Madison Formation water quality, water from the Kk₁ aquifer appears suitable for recharge into the unsaturated Madison Formation without adversely effecting Madison water quality (Hydrometrics 2012b). Laboratory analytical results indicate relatively good quality groundwater in the basal Kootenai sands. pH is slightly alkaline, hardness is moderate, and dissolved metals are low. No DEQ-7 groundwater exceedances were identified.

5.3 Ground And Well Survey Approach And Results

To assist in the field investigation, DOWL was hired by DEQ to perform a level survey at selected locations in the project area. The field work was completed on November 16, 2017. Surveyed locations include monitoring wells installed in 2017, historic monitoring wells, mine adit discharges, mine adit discharge flumes installed in 2017, selected ground elevations in Sand Coulee and Kates Coulee, and private wells located in the project area. Data from the survey were used to analyze potential sites for horizontal and vertical well locations. Survey results are included in Appendix G.

6.0 Analysis And Discussion

The potential effectiveness for horizontal and vertical interception wells and potential locations for each are described below.

6.1 AMD Source Control Effectiveness With Groundwater Interception

The concept underlying this project is to intercept uncontaminated groundwater up-gradient of the historic mine workings using gravity-driven drainage wells in the Kk₁, and thereby reduce the leakage into and AMD emanating from the old mine workings. Two well designs were considered, a horizontal or low angle well, and a vertical drainage well. A horizontal well design may include some angle above or below the horizontal, but it is much closer to horizontal than vertical in orientation, and would have to be installed using directional drilling technology. The vertical drainage well would be installed by a conventional water well contractor. The conceptual horizontal well is depicted in Figure 5 and the conceptual vertical drainage well depicted in Figure 6.

6.1.1 Pilot Horizontal Interception Well

Horizontal wells offer an effective alternative to vertical wells, due to the greater screen length and aquifer contact. In certain favorable site conditions, horizontal wells can be used to discharge groundwater to the surface using gravity-driven drainage. The horizontal well would be spudded at the lowest feasible elevation in Sand Coulee up-gradient (southwest) of the Gerber mine boundary. For the purpose of the current evaluation, the maximum practical horizontal well length was determined to be 1,500 to 2,000 feet in length and 4 to 6 inches in diameter based on cost considerations and a review of available literature on horizontal well completions (HydroSolutions Inc 2014). The screened interval would be within the confined Kk₁ and extend approximately 500 feet. The well would be completed with solid pipe from the screen to the well head in the coulee bottom, where drainage water could be discharged or shut-in with a valve.

The potentiometric head of the Kk₁ aquifer at the well screen must be sufficiently greater than the well head elevation to produce a target flow rate while overcoming friction losses within the well. The initial groundwater interception investigation (HydroSolutions 2014) found that, using two different modeling approaches and including friction loss, a 50-foot potentiometric head difference would result in an estimated flow rate of from 86 to 138 gpm for a 4-inch diameter well, and from 104 to 225 gpm for a 6-inch diameter well. Sensitivity analysis showed that varying the model parameters to conservative estimates could result in a flow rate as small as 11 gpm.

Subsequent analysis with the H-Well model of a 2,000-ft length well with a conservative aquifer

K value of 1.5 feet/day indicated that as little as 20-feet of available potentiometric head would be sufficient to produce a discharge about 10 gpm. Given a horizontal well location in lower Sand Coulee Creek, most of this intercepted water would otherwise likely report to the abandoned mines and become AMD. Thus, 20-feet of available potentiometric head was judged to be a practical cutoff value for evaluating the possible horizontal well configurations.

Preliminary hydrogeologic evaluation for this project led to identifying six potential horizontal well configurations, as shown in Figure 7. Subsequent installation of the four monitoring wells along with field verification and surveying of these and numerous other private wells and topographic features allowed the initial configurations to be rated as potentially feasible or not. The results of this evaluation are provided in Table 9.

Table 9. Potential Feasibility of Proposed Horizontal Well Configurations

Potential Horizontal Well	Horizontal Well Terminus Elevation (basis)	Head in Kk ₁ Relative to Top of Coal	Horizontal Well Surveyed Spud Elevation	Head in Kk ₁ over Spud Elevation in Feet	Horizontal Well Feasibility
H-1	3640 (interpolated)	-20 to +20	3629.5	-20 to +20	Borderline
H-2	3551 (Kunkel Kk ₁)	69	3634	- 14	No
H-3	3649 C-8	85	3679.8	54	Yes
H-4	3533 (MW104K)	26	3592	-33	No
H-5	3590 (interpolated)	95	3656	29	Yes
H-6	3590 (interpolated)	95	3634	51	Yes

Kk₁ Kootenai

The feasibility evaluation indicates that proposed horizontal well locations H-3, H-5 and H-6 are feasible, while horizontal well locations H-2 and H-4 are not. Horizontal well H-1 is borderline; uncertainty is due to lack of sufficient data in that area. The three best configurations would be feasible with either 6-inch or 4-inch diameter wells. Proposed horizontal well location H-3 and H-6 would be approximately 2,000 feet long, while proposed horizontal well location H-5 would be about 1,600 feet. Other configurations are possible, for example, a 1,500-foot horizontal well aligned along the axis of Sand Coulee similar to that depicted in the initial study (HydroSolutions 2014).

The H-Well model indicates that the three feasible configurations should yield from 15 to 100 gpm with a 4-inch diameter well with K varied from 1.5 to 15 feet/day, respectively. The 6-inch diameter well would have slightly greater (from 3 to 30 percent) yield.

6.1.2 Pilot Vertical Interception Well

Similar to the horizontal well application, the objective for the vertical interception well is a reduction in the volume of groundwater available for leakage into the historic mine workings. Gravity-driven vertical drainage wells provide additional installation opportunities when compared with gravity-driven horizontal wells at the locations evaluated because they are not as dependent upon spud elevations. Compared with the horizontal wells, a vertical drainage well is not dependent on elevations providing natural drainage at the spud location. Gravity-driven horizontal drainage wells require sufficient elevation change to allow for head in the selected aquifer to drain without pumping.

Previous work completed by HydroSolutions for DEQ evaluated the effectiveness of a vertical drainage well in Sand Coulee (HydroSolutions Inc 2014). The vertical well would be located at locations just up-gradient of abandoned mine workings where sufficient head exists in the Kk₁. The conceptual vertical drainage well is depicted in Figure 6. The well would be screened in the lower portion of Kk₁, cased through the Morrison and the Swift Formation, and completed as an open hole in the Mission Canyon Formation of the Madison Group. The Mission Canyon formation typically lies approximately 400 feet beneath the surface in the Sand Coulee area. Since the hydraulic head of the Kk₁ aquifer is anticipated to be approximately 200 feet greater than that of the Madison aquifer, groundwater would drain from the Kk₁ into the underlying Madison aquifer.

Current analysis of monitoring well installation and pumping tests results in the Kootenai Formation provided additional information to assess vertical drainage well effectiveness. Suitable locations exist to locate vertical drainage wells in more permeable or fractured zones, such as found at the location of monitoring well MW-102K. Extensive jointing observed in sandstone outcrops likely would provide secondary permeability that would increase flow into the drainage wells. Although a Madison Formation well was not drilled during this field evaluation, geologic information available from the Sand Coulee PWS Wells No. 5 and 6 and records of private wells in the GWIC database indicate suitable conditions exist to receive drainage from a vertical gravity-driven interception well.

The Madison Group is composed of massive to thin beds of gray, dense limestone with interbedded shale and some chert (Wilke 1983). In Cascade County, water wells penetrate the top of the Madison, which generally is porous and contains cavities. The porosity is secondary solution porosity that developed when the Madison was exposed to erosion following its deposition. This unsaturated zone is characterized by abundant solution cavities, fractures, and joints which provide a favorable environment for water intake (Wilke 1983).

Sand Coulee public water supply (PWS) Wells No. 5 and 6 provide relevant data for use in evaluating the potential for a vertical well. The top of the Madison limestone was encountered at 390 and 375 feet, respectively (Hydrometrics 2012b). Groundwater was encountered in the Madison limestone at a depth of 532 and 453 feet, respectively (Hydrometrics 2012b). Based on results from drilling, 78 to 142 feet of unsaturated Madison limestone is present before groundwater is encountered in the Madison Formation.

Review of private domestic and stock well logs in the project area that penetrate the Madison Group generally indicate favorable conditions for reception of drainage water. The log of GWIC 31898, which is located in the NWSW Section 23, T19N R4E, just up-gradient of the Upper

Carbon Mine, states “White Lime Reddish Cavern” from 456 to 515 feet. The log of GWIC 125190 in NESWSW Section 23, T19N R4E indicates gray, white and yellow limestone was encountered from 357 to 655 feet and the well produced 50 gpm, a good indication of permeable limestone. The log of GWIC 129230 in NWNENW Section 26, T19N R4E, up-gradient of the Gerber Mine indicates highly fractured rock, lost returns and voids up to 2 feet from 190 to 438 feet. Not all logs are favorable however. The log of GWIC 186474 in NESWNW Section 23, T19N R4E reported nothing but hard brown limestone from 390 to 702 feet, and produced just 12 gpm. Overall, published geologic reports and well logs in the project area indicate extensive karst development in the upper Madison Group, deemed favorable for vertical drainage wells.

Using the AnAqSim model (Fitts GeoSolutions 2013), HydroSolutions previously modeled discharge from a vertical gravity-driven drainage well with a constant head at the top of the Kk₁ aquifer to simulate drawdown while maintaining confined conditions (HydroSolutions Inc 2014). The well effectively simulated a vertical drain in the Kk₁ discharging to a highly transmissive interval in the underlying Mission Canyon Formation. The modeled volume of water draining into the Madison aquifer for one vertical drainage well was 10,000 feet³/day or 52 gpm. Two or more vertical drainage wells would increase the ability to capture additional groundwater from the Kk₁. The results were based on a simplified representation of hydrogeologic conditions within the study area (HydroSolutions Inc 2014).

A vertical drainage well connecting the Kk₁ aquifer directly to the Madison aquifer would be less expensive than a horizontal well. Given the surface elevations found within the drainages and the head encountered in Kk₁, more opportunities to locate pilot vertical interception wells exist up-gradient of all mines. Recommended locations include within Sand Coulee near MW-102K, the vicinity of MW-103K which is just up-gradient of the Gerber Mine workings, and possibly on the bench above Sand Coulee near MW-101K after additional geologic interpretation and modeling to evaluate the specific location is completed.

7.0 Drainage Well Permitting

7.1 Horizontal Drainage Wells

As discussed in this report, a horizontal drainage well would be constructed entirely within the Kootenai Formation and not cross-connect other aquifers. It is anticipated that a surface casing would be cemented into competent bedrock, as is typically done for conventional vertical wells. However, as a non-standard design, it is anticipated that the Montana Board of Water Well Contractors administrator within the DNRC would be notified in advance of installation. The purpose would be to ascertain whether any variance from the Board would be needed under ARM 36.21.680. If so, a variance request would be submitted for review and approval by the Board. Based on our current understanding, obtaining a variance is considered likely so long as a clear case is made to the Board and best practices for horizontal well construction are incorporated into the design and construction.

Water produced from a horizontal drainage well would not need a water right if the sole purpose were for dewatering. However, if any beneficial use of the produced water is anticipated, it would require that an Application for Beneficial Use Permit be submitted to the DNRC in advance of that use. Sand Coulee Creek is included in the Upper Missouri River

Basin Legislative Closure area which prohibits DNRC from processing or granting applications to appropriate water. There are exceptions to the closure for groundwater, non-consumptive uses and other purposes. In some cases, a new water right may be issued with an approved mitigation plan. For example, water right 41QJ 30066324 was issued to the Sand Coulee Water District in 2014 with an approved mitigation plan for beneficial use of groundwater from the Madison Formation.

7.2 Vertical Drainage Wells

A vertical drainage well, as discussed in this report, would hydraulically connect the Kootenai and Madison Group aquifers, and as such, would appear to require a variance from the Montana Board of Water Well Contractors under ARM 32.21.680, primarily due to the well sealing requirements embodied in ARM 36.21.654. Since the entire objective of a drainage well is to minimize the ongoing contamination of groundwater and surface waters from acid mine drainage, obtaining a variance is considered likely so long as a clear case is made to the Board and best practices for well construction are incorporated into the design.

Montana Code Annotated 75.5-401 governs Groundwater Exclusions from applications for permits to discharge sewage, industrial wastes or other wastes into state waters, and is administered by DEQ through the Board of Environmental Review. Our current understanding, based on review of the rule and consultation with DEQ, is that discharge from vertical drainage wells would likely meet the requirements under 75.5-401 (b) and be able to qualify for the exclusion. Official consultation and confirmation of such exclusion should be completed in advance of installation.

The Safe Drinking Water Act (SDWA) is the federal law that protects public drinking water supplies throughout the nation. Under the SDWA, EPA sets standards for drinking water quality and with its partners, and implements various technical and financial programs to ensure drinking water safety. SDWA also sets a framework for the Underground Injection Control (UIC) program to control the injection of wastes into ground water. In Montana, the UIC program is administered by the EPA.

EPA established minimum requirements to prevent injection wells from contaminating underground sources of drinking water (USDWs). Six classes of UIC wells have been established, with Class V wells being the type that inject non-hazardous fluids into or above USDWs, as is the case with the drainage wells under present consideration. In most cases Class V wells are "authorized by rule." "Authorized by rule" means that an injection well may be operated without a permit as long as the owners or operators:

- Submit inventory information to their permitting authority and verify that they are authorized (allowed) to inject. The permitting authority will review the information to be sure that the well will not endanger a USDW.
- Operate the wells in a way that does not endanger USDWs. The permitting authority will explain any specific requirements.
- Properly close their Class V well when it is no longer being used. The well should be closed in a way that prevents movement of any contaminated fluids into USDWs.

Vertical drainage wells could fit one of several Class V well types, including Special Drainage Wells, Aquifer Remediation Wells, or Aquifer Recharge/Recovery Wells. These wells currently are not subject to any specific regulations tailored just for them, but rather are subject to the UIC regulations that exist for all Class V wells. Under 40 CFR 144.12(a), owners or operators

of all injection wells are prohibited from engaging in any injection activity that allows the movement of fluids containing any contaminant into USDWs, “if the presence of that contaminant may cause a violation of any primary drinking water regulation . . . or may otherwise adversely affect the health of persons.”

The EPA UIC program manager for Montana should be contacted to clarify that a vertical drainage well would be covered by the UIC program, and to clarify the type category. If subject to the program, the planned inventory information should be submitted to the EPA for their review and their possible call for any further information or requirements. Since the purpose of the proposed drainage wells are to minimize existing contamination of groundwater and surface waters by acid mine drainage, it is anticipated that approval would ultimately be obtained, if required.

The natural water quality of the Kootenai Kk1 aquifer and the Madison Group limestone aquifer, while not identical, do not appear to be so dissimilar as to cause concerns related to contamination under 40 CFR 144.12(a). The water quality samples analyzed from three of the monitoring wells installed in this investigation did not indicate the exceedance of water quality standards for the parameters analyzed. Moreover, based on our preliminary review of available data, both the Kk1 aquifer and Madison Group aquifer in the Sand Coulee area appear to be Class I groundwater under Montana ARM 17.30.1006, classifications for ground waters. Class I ground waters are those with a natural specific conductance less than or equal to 1,000 microSiemens/cm at 25°C.

A vertical drainage well as described herein is essentially a means of dewatering and as such, will likely not require a Montana Beneficial Water Use Permit issued by the DNRC. The water captured by such a well would merge with other groundwater and not be put to beneficial use.

8.0 Conclusions And Recommendations

This hydrogeologic investigation, which included adit discharge monitoring, monitoring well installations, aquifer testing and water quality evaluation, has confirmed that gravity drainage wells are a feasible method of AMD source control in the Sand Coulee area. Use of gravity drainage wells requires favorable site-specific conditions which were evaluated in the vicinity of the Gerber, Mount Oregon and Nelson mines. Three of six potential horizontal well locations along Sand Coulee Creek are considered potentially feasible. Hydrogeologically favorable conditions for gravity-driven vertical drainage wells exist throughout the Sand Coulee area. Several candidate sites for such wells were identified immediately up-gradient from the Gerber and Mount Oregon mines.

The performance of gravity drainage wells is dependent on site-specific aquifer characteristics to a somewhat greater degree than conventional pumped wells. Groundwater monitoring and aquifer testing confirmed that the Kk₁ sandstone aquifer is non-homogeneous and anisotropic. Faulting, jointing, and lithologic variations affect the local hydraulic conductivity and well yields. The two wells on which aquifer tests were performed gave hydraulic conductivities that differed by about one order of magnitude, which would significantly affect the yield of drainage wells.

This investigation points to the desirability of obtaining detailed site-specific aquifer data to optimize yields. Drilling into the location of a previously unmapped fault at monitoring well MW-

102K illustrates the potential for such evaluation to help locate subsurface structures. Shallow geophysical methods such as seismic refraction or electrical resistivity could compliment the results of this investigation by helping to further refine the promising drainage well sites that have already been identified.

Several potential regulatory requirements were identified which would require pre-implementation consultation with state and federal agencies governing well construction and underground injection. Vertical drainage wells may require a variance from construction and sealing standards, and permit by rule under the federal UIC program.

Recommendations

It is recommended that one horizontal drainage well up to about 2,000 feet long and one to three vertical drainage wells be installed and tested in a subsequent phase of work. Horizontal wells are more technically challenging, and are more expensive but a single installation could have a larger effect on AMD prevention than any single vertical drainage well. Many more potential opportunities exist for vertical drainage wells which could be added incrementally to achieve a desired level of AMD control.

Use of gravity drainage wells would represent a new technology in AMD source control. It is recommended that consultation with potentially affected landowners, water users, and local organizations such as water utility boards and conservation districts be kept informed of these findings and any subsequent phases of work. Consultation with the EPA UIC program, DEQ water quality division and Montana Board of Water Well Contractors is recommended at an early stage in a design and permitting phase.

Suitable sites to test the effectiveness of a horizontal gravity drainage well include locations H-3, H-5, and H-6. Well H-3 is not currently proximate to existing private wells. Wells H-5 and H-6 have the potential to affect several existing Kk₁ wells used by landowners. However, adverse effects can be avoided because the well will be designed with a valve to control or prevent discharge if adverse effects to other users are observed, and if necessary a replacement well in the Madison Group aquifer would be a suitable alternative source. Such mitigating contingencies should be incorporated into horizontal well design and implementation.

Site selection for vertical drainage wells is more flexible, and a few proposed locations are described below.

- Approximately 30 feet of head in the Kootenai exists in monitoring well MW-101K just up-gradient of the Mt. Oregon Mine workings. Moving south towards a private residence, higher head in the Kootenai is encountered which indicates a draining effect on the aquifer by the mine. A series of vertical drainage wells could be installed to capture groundwater flow before it drains into the mine workings. Potential mitigation to any existing wells in the immediate vicinity would have to be evaluated.
- Approximately 48 feet of head in the Kootenai exists at monitoring well MW-103K. Locating one or more vertical drainage wells near monitoring well MW-103K would capture groundwater just prior to its draining into the Gerber Mine. The location for these vertical wells is also down-gradient of existing private wells and is not likely to adversely impact water availability to residents.

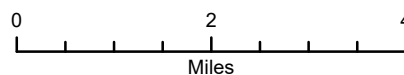
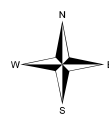
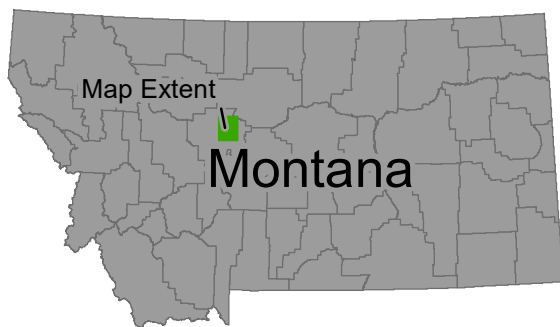
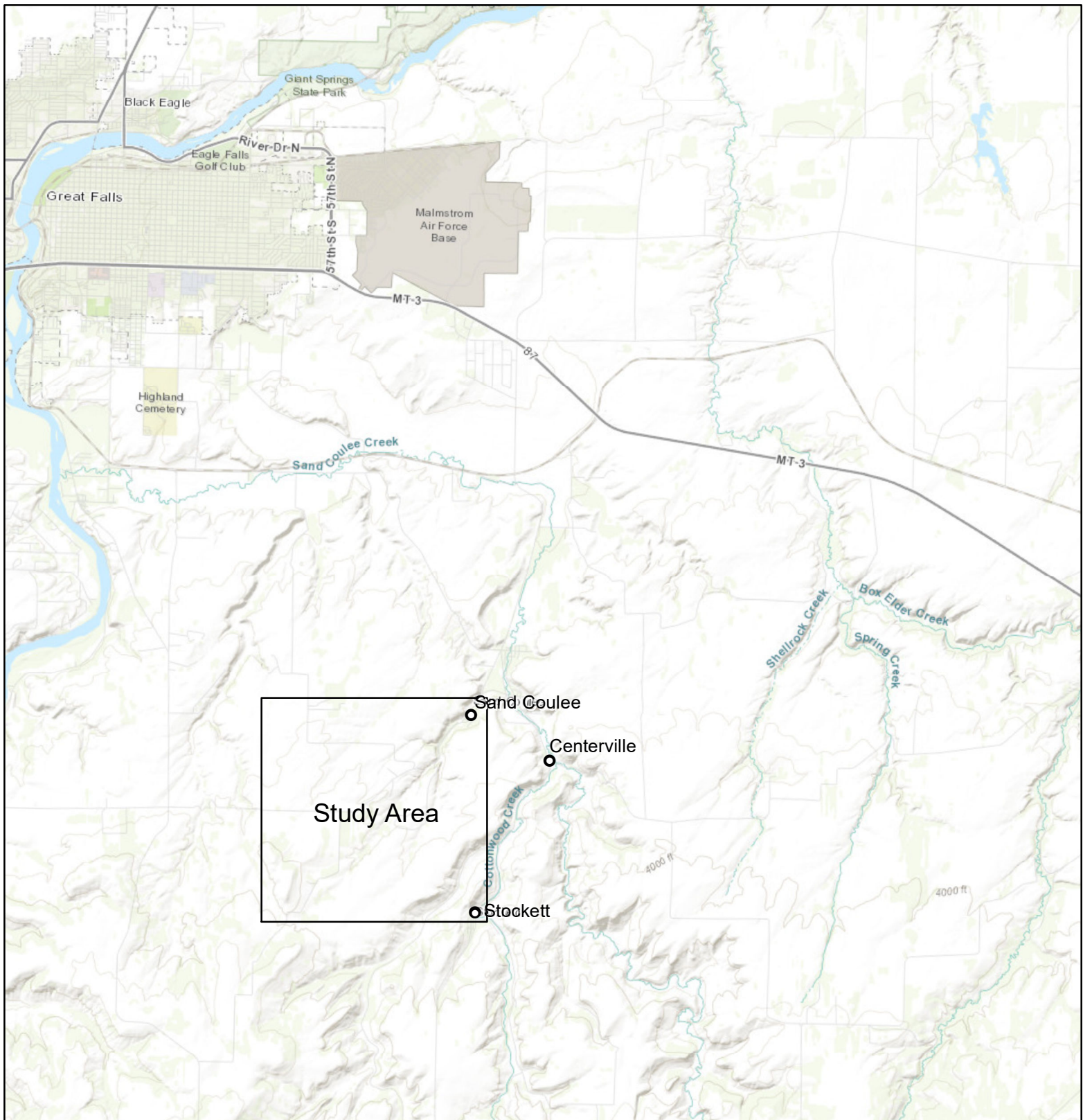
- Approximately 63 feet of head in the Kootenai exists at monitoring well MW-102K. Drilling results suggest a fault was responsible for displacing the coal seam at that location. However, a substantial amount of water is moving through the Kootenai Formation in this area. Given the amount of water, a vertical drainage well has a potential to have very little impact on domestic or irrigation wells down-gradient but still capture water draining to the abandoned Gerber Mine.
- Once a horizontal or vertical drainage well is located and designed, water rights will need to be evaluated to determine the permitting requirements. In general, a water right is not required solely for dewatering purposes. However, a permit is usually needed if any beneficial use is contemplated. Furthermore, a vertical drainage well will be capturing water from an overlying aquifer and discharging into a lower aquifer; therefore a variance for aquifer cross-connection, or possible permit for injection will need to be evaluated.
- Collect water quality sample from monitoring well MW-104.

9.0 References

- Beljin, M. S., and G. Lasonsky. 1992. "HWEELL: A Horizontal Well Model." *Solving Groundwater Problems with Models*. Dallas, Texas: NGWA/IGWMC . 45-54.
- Fischer, C.A. 1909. *Geology of the Great Falls Coal Field, Montana*. U.S. Geological Survey. Bulletin 365.
- Fitts GeoSolutions, LLC. 2013. AnAqSim Analytic Aquifer Simulator.
- Haitjema, H., S. Kuzin, V. Kelson, and D. Abrams. 2010. "Modeling Flow into Horizontal Wells in a Dupuit-Forchheimer Model." *Groundwater* 878-883.
- Hantush, M.S., and C.E. Jacob. 1955. *Non-steady radial flow in an infinite leaky aquifer*. American Geophysical Union Transaction, Volume 36, pp. 95-100.
- Hydrometrics. 1983. *Comprehensive Reclamation and Engineering Plan Sand Coulee Drainage - Cascade County, Montana. Phase I Reclamation Alternatives*. Helena: Department of State Lands, Abandoned Mine Lands Program.
- Hydrometrics. 2012a. *Great Falls Coal Field Water Treatment Assessment*. Helena: Montana Department of Environmental Quality. March.
- Hydrometrics. 2012b. "Well Completion Report for Sand Coulee Water District Public Water Supply Well No. 5." Montana Department Of Environmental Quality. July.
- Hydrometrics. 2016. *Well Completion Report for Sand Coulee Water District Public Water Supply Well No. 6*. Montana Department of Environmental Quality.
- HydroSolutions Inc. 2014. "Sand Coulee Acid Mine Drainage, Groundwater Interception Investigation."
- Karper, P.L. 1998. *Water Quality Data (July 1994 through September 1996) and Statistical Summaries of Data for Surface Water in Sand Coulee Coal Area, Montana*. Montana Open File Report 98-94., U.S. Geological Survey.
- Osborne, Thomas J, M. J Zaluski, B. J Harrison, and J. L Sonderegger. 1987. *Acid Mine Drainage Control in the Sand Coulee Creek and Belt Creek Watersheds, Montana, 1983-1987*. Montana Bureau of Mines and Geology, MBMG 197.
- Osborne, Thomas J; Donovan, J; Sonderegger, J. L. 1983. *Interaction Between Groundwater*

- and Surface Water Regimes and Mining-Induced Acid Mine Drainage in the Stockett-Sand Coulee Coal Field.* Montana Bureau of Mines and Geology.
- Papadopoulos, I.S., and H.H. Cooper. 1967. *Drawdown in a well of large diameter.* Water Resources Research, Volume 3, Number 1, pp. 241-244.
- Rossillon, M, M McCormick, and Hufstetler. 2009. "Great Falls Coal Field: Historic Overview." Montana Department of Environmental Quality, Mine Waste Cleanup Bureau.
- Smith, L.N. 2008. *Groundwater Atlas, part B Map 3.* Montana Bureau of Mines and Geology, Open file Version. September.
- Theis, C.V. 1935. *The relations between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage.* . American Geophysical Union Transaction, Volume 16, pp 519-524.
- Wilke, K.R. 1983. "Appraisal of water in bedrock aquifers, Northern Cascade county, Montana." MBMG Memoir 4.

FIGURES



Prepared By: R.Svingen
 Production Date: 12/21/2017
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Figure 1.
Project Location



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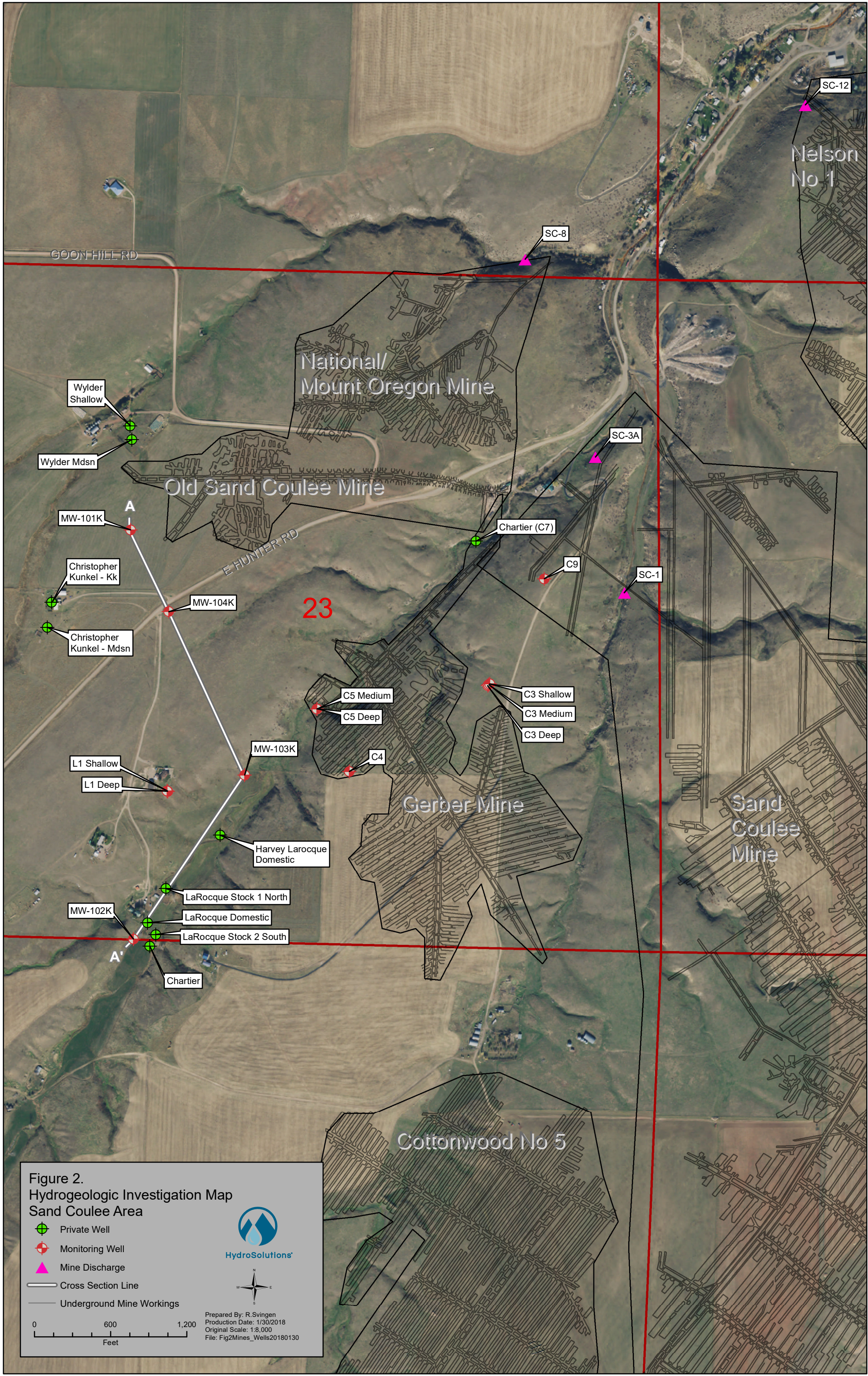
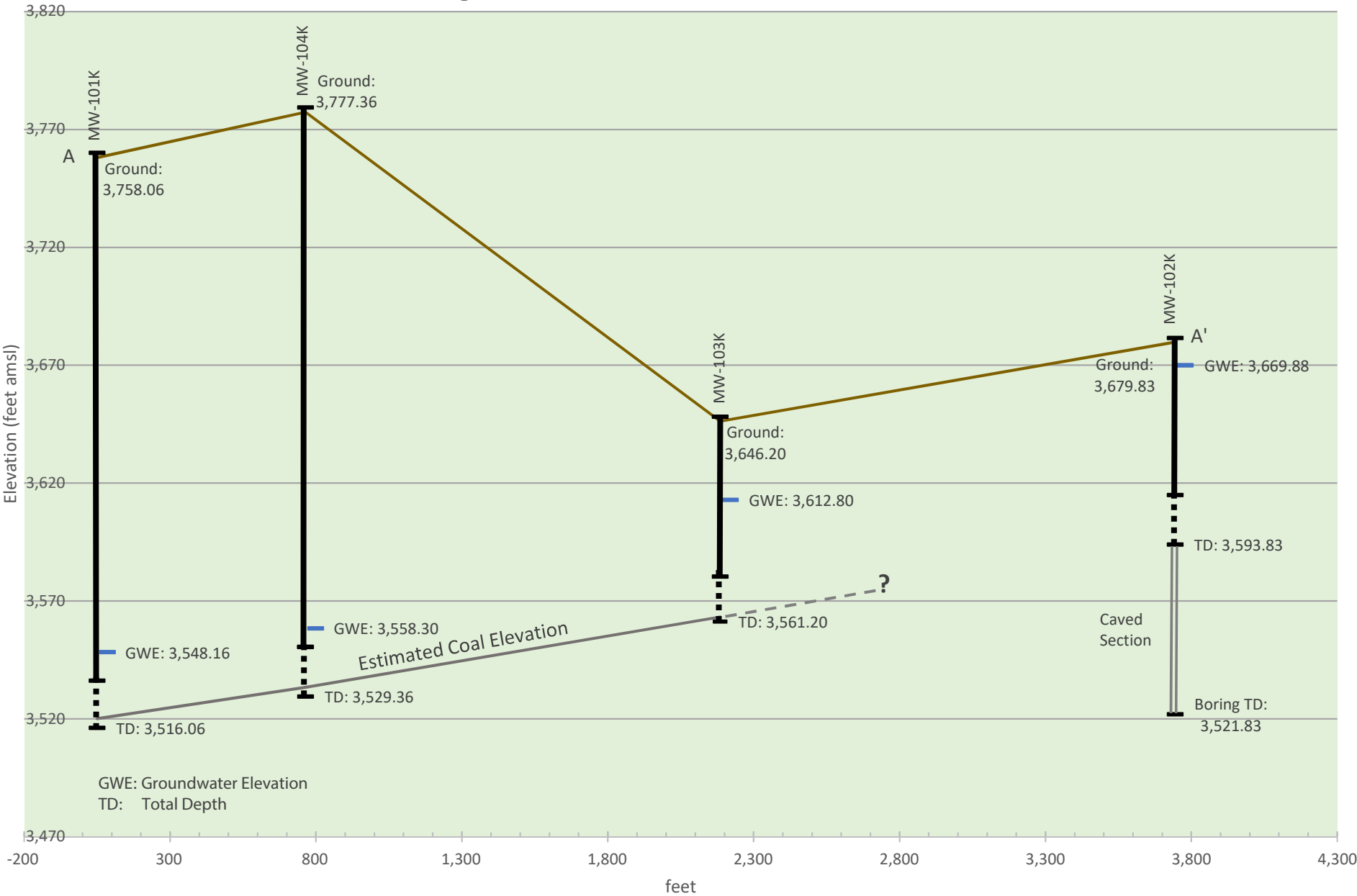
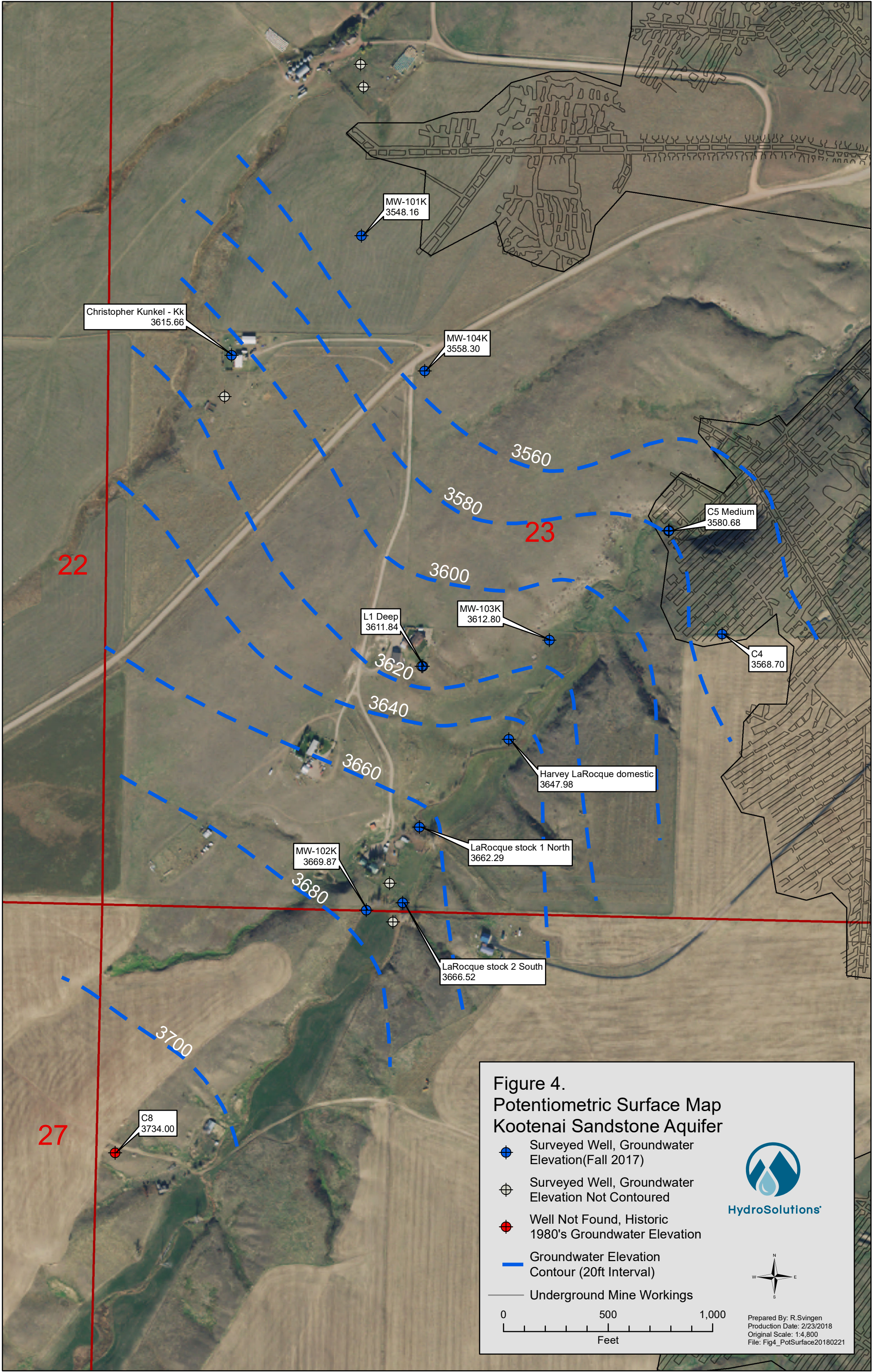
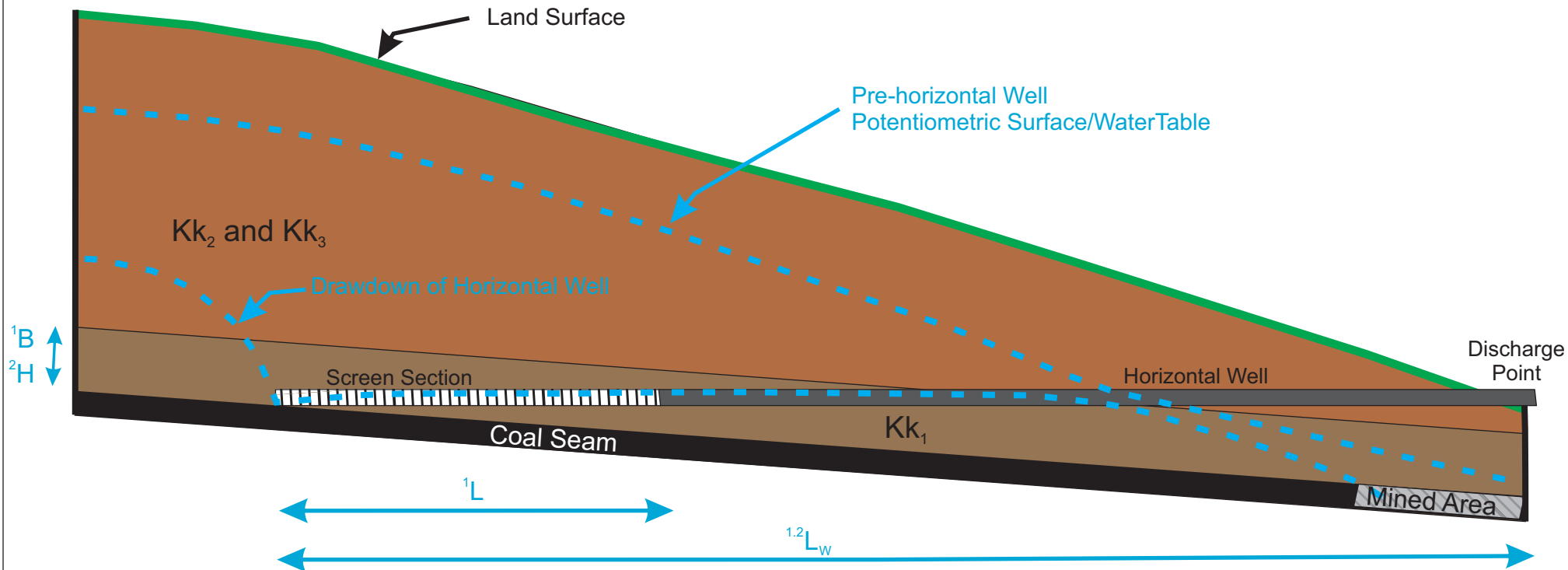


Figure 3. Schematic Cross Section







Kk-Kootenai Formation Stratigraphic Units
¹HWELL Model Parameters
²Dupuit-Forchheimer Model Parameters

Figure 5. Conceptual Cross Section for Horizontal Well Design

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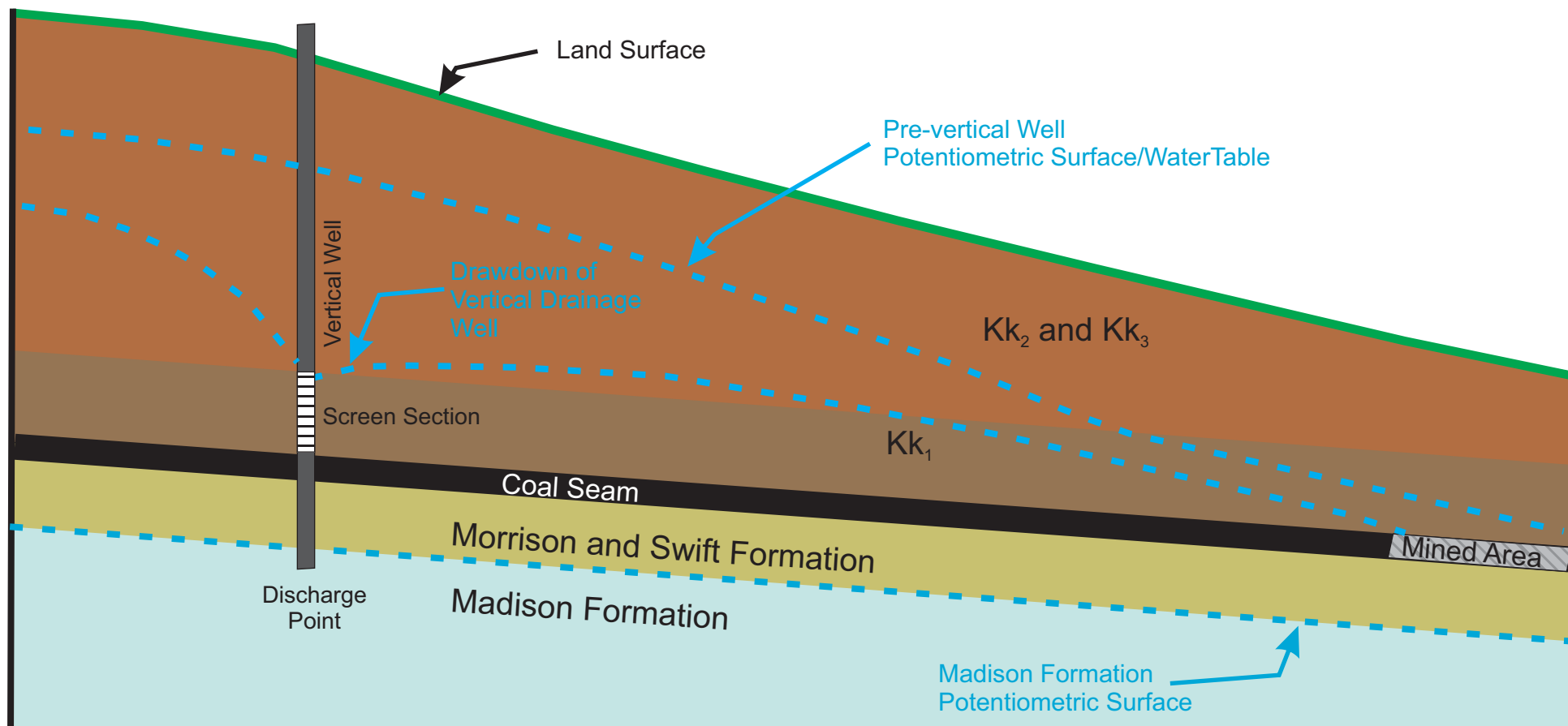


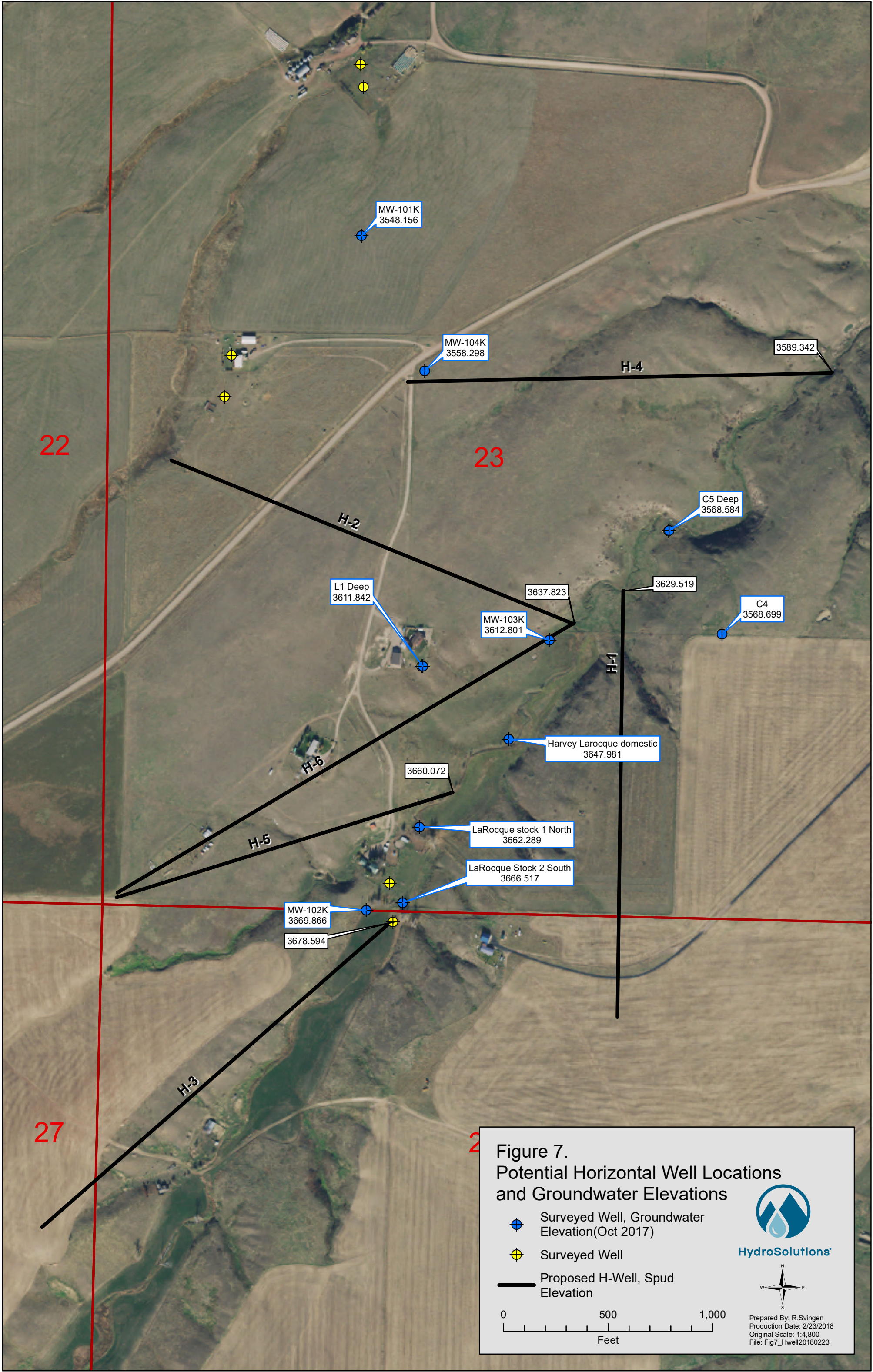
Figure 5. Conceptual Cross Section for Vertical Well Design



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Kk-Kootenai Formation Stratigraphic Units



APPENDICES

Appendix A

Task Order Description

Task Order Description

There were four original tasks included in Task Order Number 7 and are described below.

Task 1: Task Order Reports

Prepare Monthly Status Reports and the Closeout Report

Task 2: Adit Flow Monitoring

Four flow measurement modules and data loggers provided by DEQ will be installed to continuously measure volumetric discharges from four abandoned mine adits in Sand Coulee. The flow modules will be Teledyne ISCO model 2150 or equivalent. A adit discharge will be routed into a PVC discharge pipe.

Task 3: Hydrogeological Investigation

A hydrogeologic characterization will be performed to determine the aquifer characteristics of the Kootenai and Madison aquifers hydraulically upgradient (south) of Sand Coulee. The investigation will include the installation of four monitoring wells completed in the Kootenai aquifer. Well locations will be determined in consultation with DEQ. The wells are estimated to be approximately 200 feet in depth, and will be constructed using 4-inch diameter PVC. One monitoring well will be installed and completed in the Madison aquifer using 4-inch diameter PVC to an approximate depth of 500 feet. All wells will be developed and completed according to standards developed by the Montana Department of Natural Resources & Conservation (DNRC). All bid documents, bid requests, and bid evaluations will be completed. In consultation with DEQ, a drilling contractor will be selected.

Following well development, a short term, 4-hour well yield test will be performed on each well. In consultation with DEQ, a 72-hour aquifer test will be performed by pumping one of the newly constructed Kootenai aquifer monitoring wells and monitoring groundwater level fluctuations using pressure transducers installed in the remaining three Kootenai monitoring wells. Two pressure transducers provided by DEQ will be installed in two Kootenai monitoring wells for long term monitoring. Data from these two transducers will be downloaded on a monthly basis in coordination with the surface water flow monitoring as described in Task 2.

Water quality data will be collected from the 5 new monitoring wells and from the four surface water monitoring stations identified as part of Task 2 for three consecutive quarters between October 2016 and June 2017. The analysis will include field parameters, general inorganic chemistry, and selected metals. Water samples will be submitted to a DEQ-contracted laboratory.

Task 4: Report Preparation

Prepare a Source Control Investigation Report documenting field methods and presenting investigation results. The report will describe the measured flows from the monitored adits, aquifer testing and well-yield results, hydraulic properties of the Kootenai and Madison aquifers, and the hydraulic heads and saturated thickness of the Kootenai Aquifer. The report will evaluate the potential effectiveness of AMD source control resulting from groundwater

interception using a horizontal interception well and using a vertical interception well. Investigation results will incorporate the work performed under Task Order 2 pursuant to DEQ Contract No. 414026. The report will identify the recommended locations for a pilot horizontal interception well, a pilot vertical interception well, and define general design parameters for both wells, including anticipated length, borehole diameter, and well construction materials.

1.3 Modification A

During the course of the research and investigation phase completed during the fourth quarter 2016 and the first and second quarters of 2017, several significant questions were identified that required changes to the original task scope of work and were completed under the direction of DEQ. These involved changes to land ownership and new domestic wells, field location of numerous existing monitoring and domestic wells, data collection from existing wells and adit discharges, adit monitoring modifications to aid in installation of monitoring equipment, changes to the installation of flume and ultrasonic monitoring equipment, and omit installation of the Madison well. Based on these changes, a no-cost increase modification was prepared by DEQ to outline changes to and required completion schedule of Task 7. A description of Modification A includes the following:

Task 2: Adit Flow Monitoring

HydroSolutions researched and identified flow measurement equipment to continuously measure volumetric discharges from four abandoned mine adits in Sand Coulee. In coordination with DEQ, HydroSolutions ordered the necessary components and arranged for purchase. The equipment was selected to function properly for site conditions which includes elevated acidity and dissolved metals concentrations, low pH and turbidity of the mine discharges, and winter freezing conditions.

DEQ purchased the flow measurement equipment, including flumes, sensors, enclosures, and data loggers. HydroSolutions completed all necessary field work to install the flow measurement equipment, which included several site trips and earthwork to collect and route each adit discharge into the measurement area. HydroSolutions programmed the data loggers to measure and record flow on an hourly interval. All flow measurement equipment was securely installed to facilitate long-term flow monitoring. HydroSolutions verified the flow measurement equipment was functioning correctly and provide DEQ with instructions for accessing and downloading the measured data at all four locations

Task 3: Hydrogeological Investigation

Contractor inventoried private water wells and measured fluid levels to document baseline hydrologic conditions hydraulically upgradient (south) of Sand Coulee. Contractor used this information to identify target areas to intercept groundwater before it enters the abandoned mines. Contractor installed and completed four monitoring wells in the Kootenai aquifer. Well locations were determined in consultation with DEQ. The four wells were installed to depths of 85, 86, 242, and 247 feet below ground surface. Three of the wells were constructed using 4-inch diameter PVC and one well was constructed with 6-inch diameter PVC.

All groundwater monitoring wells were installed by August 30, 2017, and all wells were developed and completed by a licensed water well contractor (drilling contractor) according to statutory requirements and all regulations or other requirements developed by the Montana Department of Natural Resources & Conservation (DNRC) and the Board of Water Well Contractors.

Following well development, HydroSolutions performed a 4-hour well yield test on each well. In consultation with DEQ after review of information obtained from the 4-hour well yield tests, HydroSolutions conducted two 24-hour aquifer tests (instead of one 72-hour test) by pumping one of the newly constructed Kootenai aquifer monitoring wells and monitoring groundwater level fluctuations in the remaining three Kootenai monitoring wells and selected private wells. After completion of the two aquifers tests, data were downloaded from all transducers used in the testing.

Water quality samples were collected from each of the four new monitoring wells and from the four surface water monitoring stations identified for Task 2. Field parameters including pH, specific conductance, Eh (redox potential), alkalinity and temperature were collected and water samples were submitted to Energy Laboratories.

Task 4: Report Preparation

Draft and final versions of a Source Control Investigation Report (Report)

Document field methods and presenting investigation results.

The Report will describe the measured flows from the monitored adits, aquifer testing and well-yield results, hydraulic properties of the Kootenai and Madison aquifers, water quality data and analysis, and the hydraulic heads and saturated thickness of the Kootenai Aquifer.

The Report will evaluate the potential effectiveness of AMD source control resulting from groundwater interception using a horizontal interception well and using a vertical interception well.

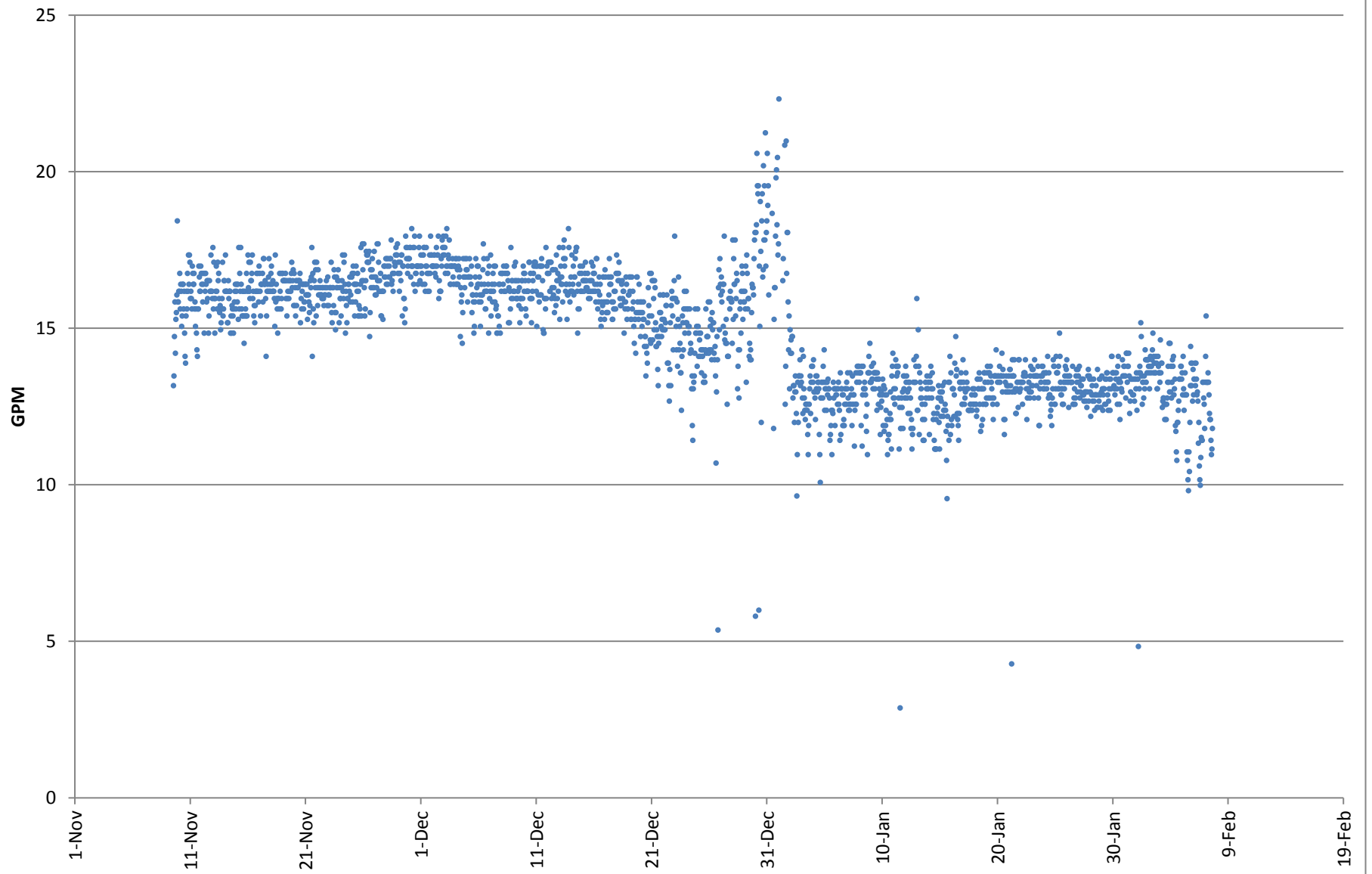
Investigation results will incorporate the work performed under Task Order 7 pursuant to DEQ Contract No. 414026.

The Report will assess feasibility and identify recommended locations for a pilot horizontal interception well, a pilot vertical interception well, and define general design parameters for both wells, including anticipated length, borehole diameter, well construction materials, identify any necessary permitting requirements and evaluate the potential of successfully securing necessary permits

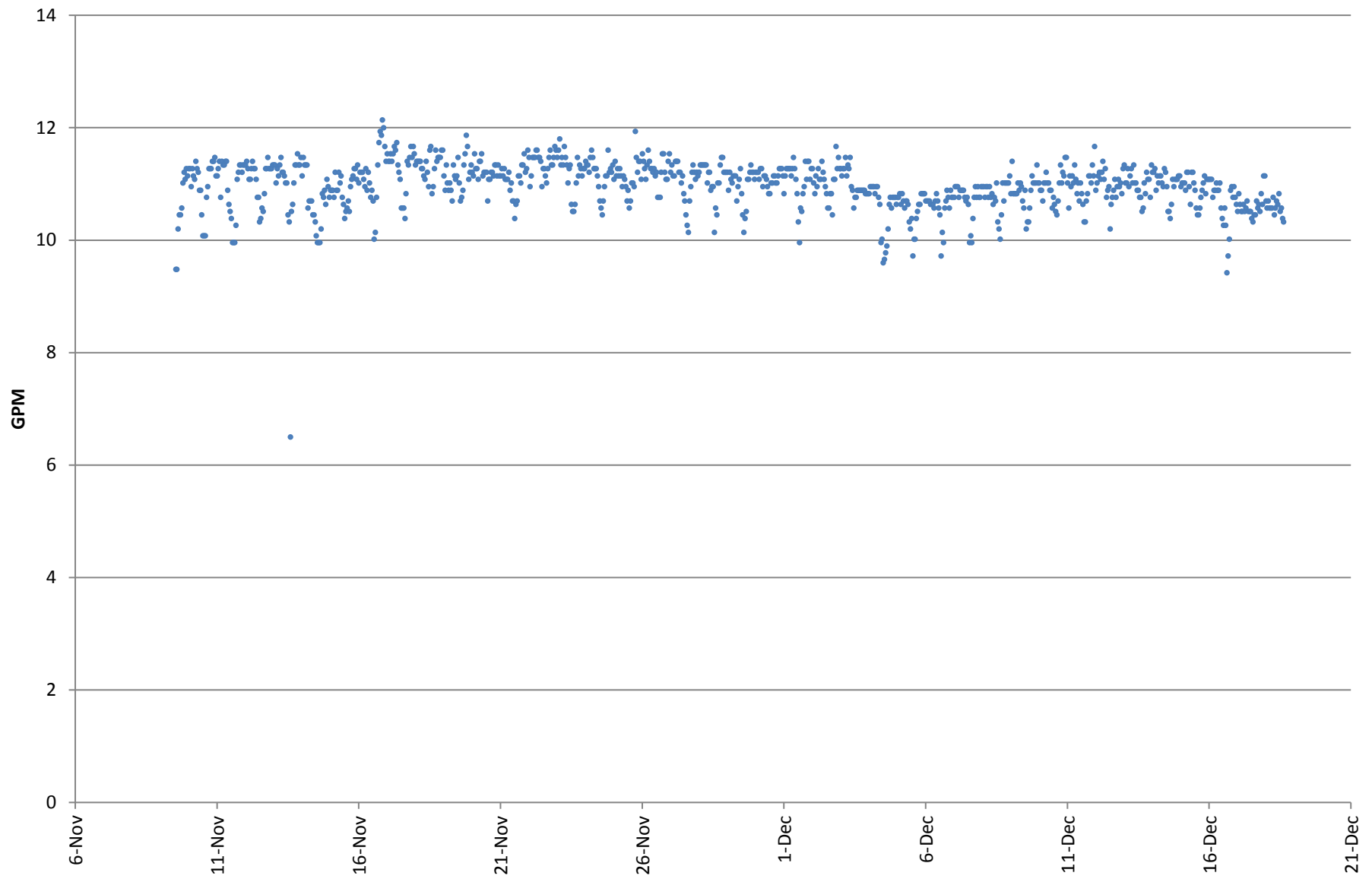
Appendix B

Adit Flow Monitoring Results

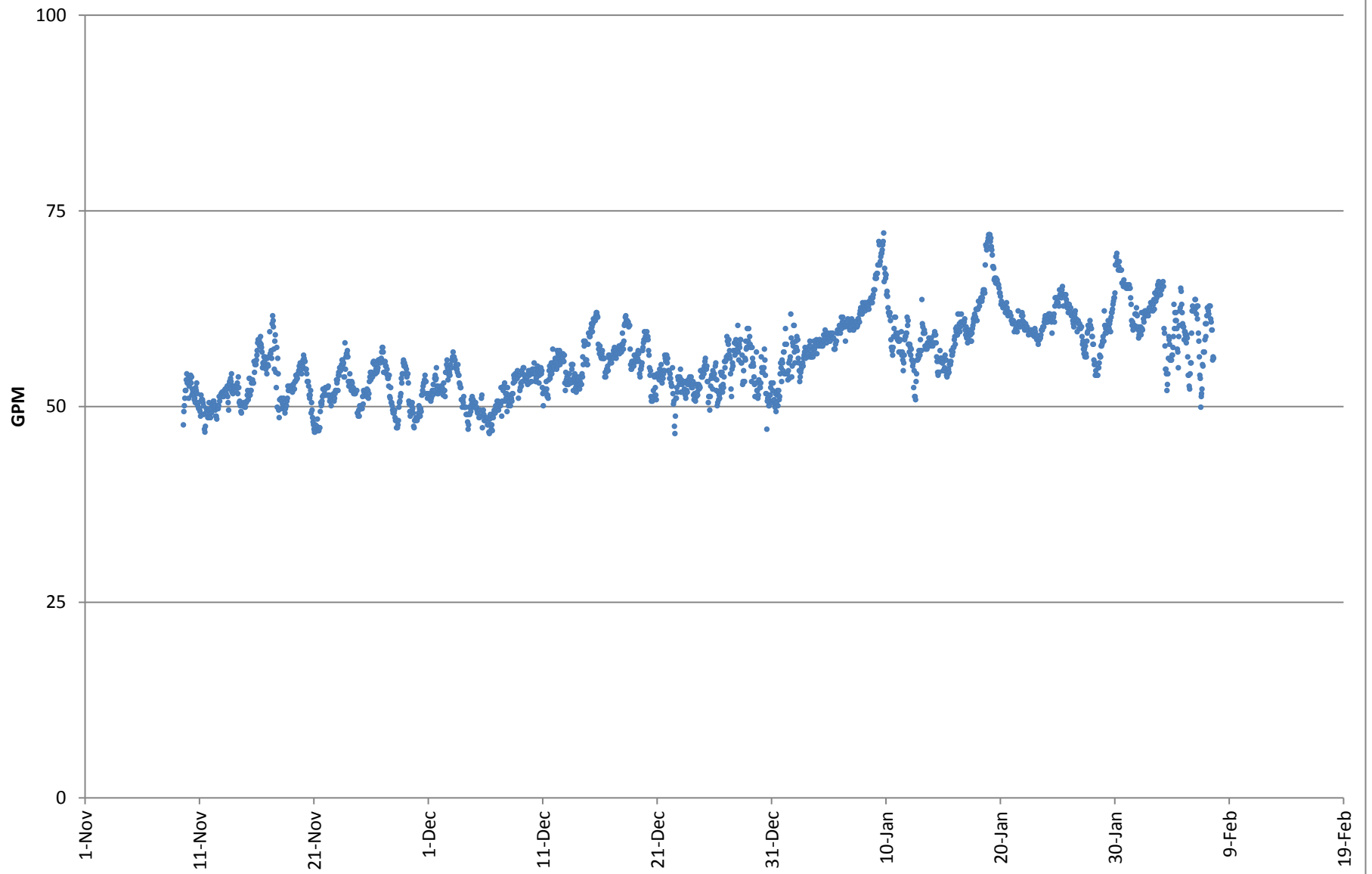
2017 - 2018 Miner's Coulee SC-1 Discharge



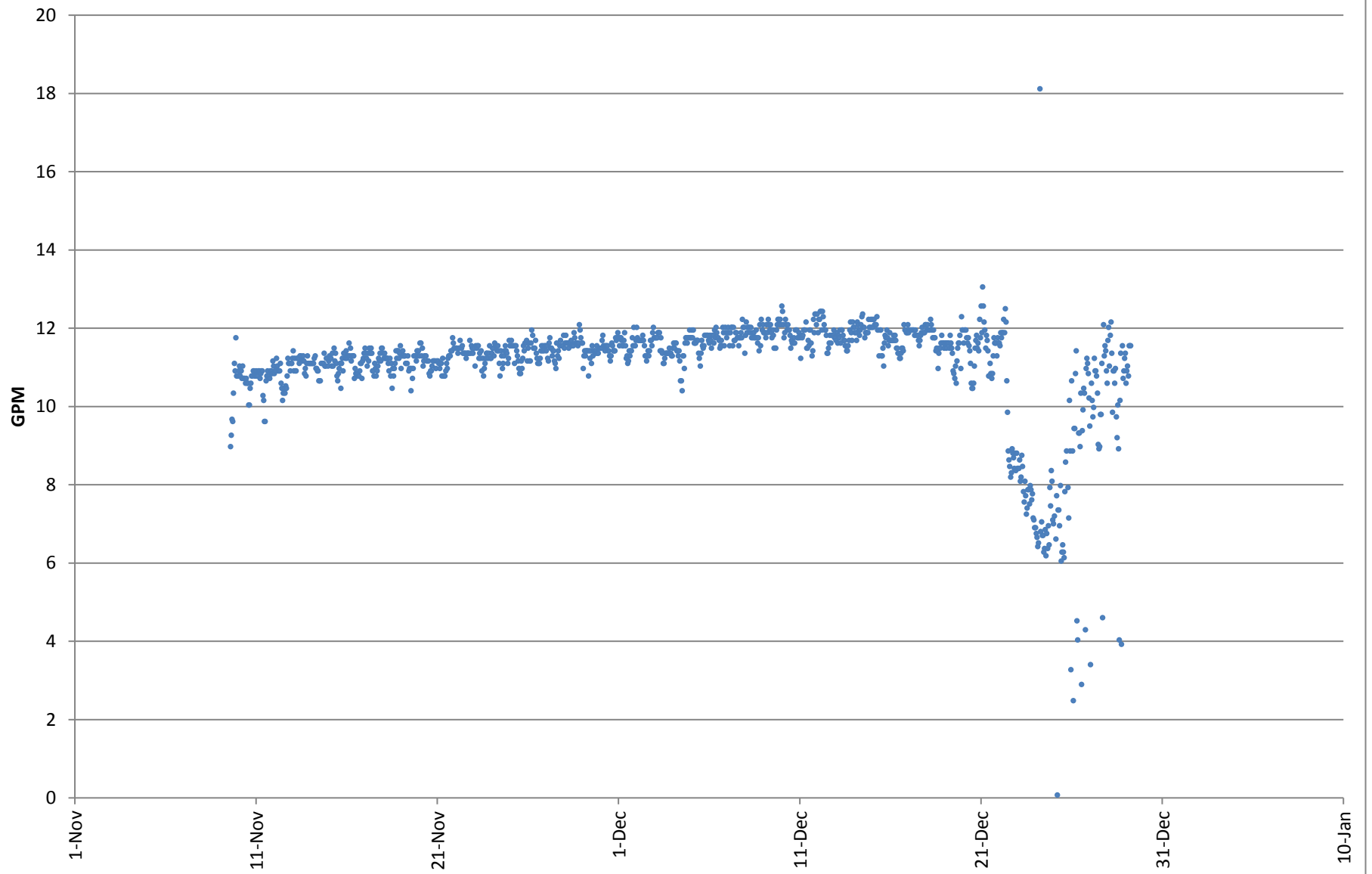
2017 SC-3A Discharge



2017-2018 Kate's Coulee SC-8 Discharge



2017 Nelson Drain SC-12 Discharge



Appendix C

Groundwater Levels

Measured Groundwater Levels at Selected Locations

Name	GWIC ID	Northing	Easting	MP Elevation (ft abmsl)	Ground Elevation (ft abmsl)	Total Depth (ft)	Date	Static Water Level (ft)	Groundwater Elevation (ft abmsl)
Surveyed Wells									
L1 Deep		1145984.269	1549663.477	3730.48	3728.57	160.5	10/12/2017 6/28/2017 8/29/2017 11/16/2017	118.64 117.88 118.32 116.41	3611.84 3612.60 3612.16 3614.07
L1 Shallow		1145986.460	1549658.661	3729.50	3729.03	40.85	10/12/2017 6/28/2017 8/29/2017 11/16/2017	33.18 31.51 32.97 32.95	3696.32 3697.99 3696.53 3696.55
C3 Deep	146925	1146814.393	1552183.852	3726.74	3725.39	168	10/12/2016	133.1	3593.64
C3 Medium		1146821.576	1552191.811	3726.65	3725.84	70	10/12/2016 6/28/2017	70.21 Dry	3656.44
C3 Shallow		1146829.118	1552199.118	3726.91	3725.86	34.75	10/12/2016 6/28/2017	Dry 29.09	3697.82
C4	146927	1146139.902	1551094.149	3735.49	3733.78	171	10/12/2016 6/28/2017 10/3/2017 11/16/2017	167.91 166.9 166.79 166.92	3567.58 3568.59 3568.70 3568.57
C5 Deep	146929	1146633.768	1550840.701	3624.05	3624.19	75.1	10/12/2016 6/28/2017 10/3/2017 11/16/2017	56.87 54.95 55.47 55.63	3567.18 3569.10 3568.58 3568.42
C5 Medium	2271	1146631.760	1550837.757	3623.83	3624.19	57	10/12/2016 11/16/2017	46.49 43.15	3577.34 3580.68
Chartier (C7)	158294	1147952.314	1552091.619	3578.03	3575.12	NM	10/12/2016 6/28/2017	>100 >200	
C9	146892	1147657.722	1552629.919	3714.67	3712.42	147	10/12/2016 6/28/2017	Dry Dry	
Christopher Kunkel - Kk	2272	1147471.840	1548749.806	3777.98	3778.36	NM	4/19/2017 11/16/2017	171.86 162.32	3606.12 3615.66

Measured Groundwater Levels at Selected Locations

Name	GWIC ID	Northing	Easting	MP Elevation (ft abmsl)	Ground Elevation (ft abmsl)	Total Depth (ft)	Date	Static Water Level (ft)	Groundwater Elevation (ft abmsl)
Christopher Kunkel - Mdsn		1147275.057	1548716.362	3774.35	3780.88	NM		NM	
Harvey Larocque domestic	240458	1145636.510	1550075.244	3655.39	3653.82	80	10/12/2016 6/28/2017 10/3/2017	9.61 4.72 7.41	3645.78 3650.67 3647.98
LaRocque new domestic		1144947.965	1549505.263	3678.23	3676.92	80	10/12/2016 6/28/2017	9.7 3.36	3668.53 3674.87
LaRocque Stock 2 South	193217	1144855.692	1549568.039	3676.81	3676.81	60	10/12/2016 6/28/2017 10/3/2017 10/17/2017	11.97 5.28 10.29 8.65	3664.84 3671.53 3666.52 3668.16
LaRocque stock 1 North		1145216.824	1549648.175	3667.73	3667.73	69.8	10/12/2016 6/28/2017 10/3/2017	9.03 0.3 5.44	3658.70 3667.43 3662.29
Wylder Mdsn	186474	1148754.178	1549380.467	3719.01	3717.65	702	9/12/2016	419.94	3299.07
Wylder Shallow	184413	1148862.530	1549367.379	3713.30	3712.80	35.5	9/12/2016 6/28/2017	12 12.36	3701.30 3700.94
MW-101K		1148042.939	1549371.269	3760.02	3758.43	242	8/8/2017 8/11/2017 8/29/2017 10/3/2017 10/4/2017 11/16/2017	211.51 211.44 211.51 211.86 211.65 210.95	3548.51 3548.58 3548.51 3548.16 3548.37 3549.07
MW-102K		1144818.937	1549393.850	3681.46	3680.31	85	8/8/2017 8/29/2017 10/3/2017 10/17/2017 11/16/2017	10.12 10.79 11.59 10.89 9.47	3671.34 3670.67 3669.87 3670.57 3671.99

Measured Groundwater Levels at Selected Locations

Name	GWIC ID	Northing	Easting	MP Elevation (ft abmsl)	Ground Elevation (ft abmsl)	Total Depth (ft)	Date	Static Water Level (ft)	Groundwater Elevation (ft abmsl)
MW-103K		1146110.295	1550269.005	3648.08	3646.62	86	8/9/2017	34.3	3613.78
							8/29/2017	34.6	3613.48
							10/3/2017	35.28	3612.80
							11/16/2017	34.6	3613.48
MW-104K		1147397.048	1549672.195	3779.28	3777.63	248	8/8/2017	220.37	3558.91
							8/29/2017	220.56	3558.72
							10/3/2017	220.98	3558.30
							11/16/2017	220.07	3559.21
Chartier		1144763.143	1549521.469	3679.19	3678.59	NM		NM	
Non-Surveyed Wells									
Travis Well		47.38771	-111.18023	3577.23	3577.23	NM	11/4/2016	>200	
							6/28/2017	239.5	
C-1A	2283	47.36766	-111.19220	3818.98	3818.28	14.52	3/30/2017	Dry	
C-1B		47.36766	-111.19220	3818.63	3818.28	14.52	3/30/2017	Dry	
C-1C		47.36766	-111.19220	3818.93	3818.28	NM	3/30/2017	138.49	
C-1D		47.36766	-111.19220	3819.03	3818.28	45.81	3/30/2017	14.67	
C2A	146923	47.37010	-111.18313	3803.09	3802.24	171.71	3/30/2017	Dry	
							6/28/2017	Dry	
C2B		47.37010	-111.18313	3803.99	3802.24	18.85	3/30/2017	Dry	
							6/28/2017	Dry	
C2C		47.37010	-111.18313	3803.24	3802.24	39.87	3/30/2017	39.87	
C6 Deep	146931	47.37619	-111.17119	3786.47	3784.37	197.5	3/30/2017	193.59	
C6 Shallow		47.37619	-111.17119	3784.37	3784.37	40.3	3/29/2017	28.63	

NM - Not Measured

Appendix D

Monitoring Well Lithologic Logs



HydroSolutions®

Well / Boring Number: MW-101K
 Client: Montana DEQ
 Project Name: Sand Coulee Source Control

Township: 19N Range: 4E
 Section: 23 Qtr Qtr: SWNW
 County: Cascade State: MT

Latitude: 1148042.939
 Longitude: 1549371.269
 GL Elevation: 3758.429
 TOSC Elevation: 3760.016
 Datum used: Survey NAD 83

Drilling Information

Drilling Company: Boland Drilling
 Drilling Method: Air Rotary
 Driller: Chris Boland
 Drilling Rig: GardnerDenver HPS1000 Air Rotary
 Logged By: D. Donohue
 LogPlot by: R.Svingen 11/29/2017

Date/Time:

Start Drilling: 08/01/2017 0810
 Bore Diam (1):(8 in) 08/01/2017 0810 0 ft to 242 ft
 Bore Diam (2):(NA in) NA NA ft to NA ft
 Finish Drilling: 08/01/2017 15:00 25 TD
 Well Development: 08/11/2017 11:00 1.5 hours

Well Construction Information

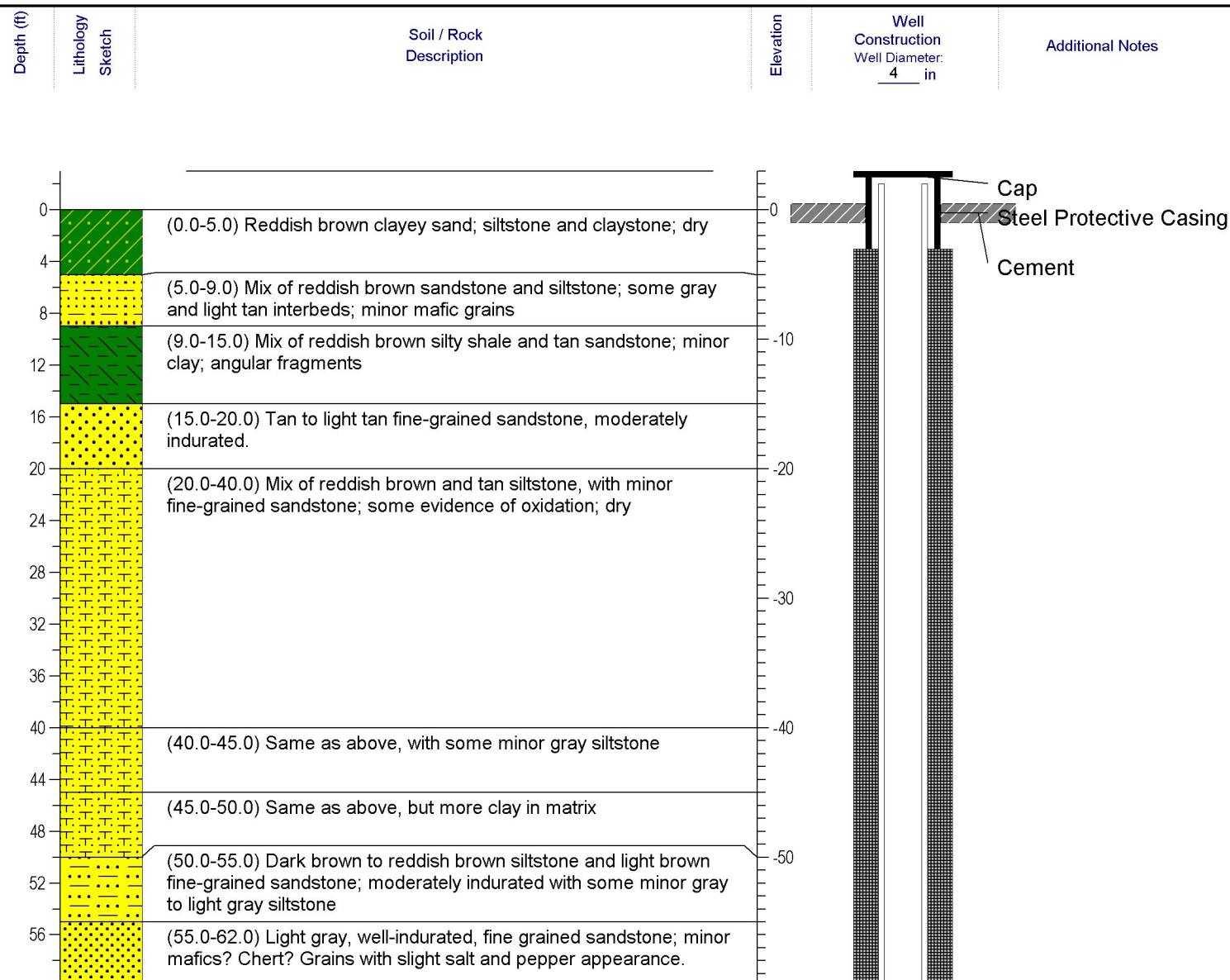
	<u>Dia. inches</u>	<u>Material</u>	<u>Specifications</u>
Protective Casing:	<u>6</u>	<u>6" Steel</u>	<u>5 ft</u>
Riser Pipe:	<u>4</u>	<u>Sch 40</u>	<u>224 ft</u>
Surface Seal:		<u>Concrete</u>	<u>1 ft Quickcrete</u>
Annular Seal:		<u>Bentonite</u>	<u>217 ft Size: Chips</u>
Filter Sand:		<u>Silica Sand</u>	<u>25 ft Grade: 10-20</u>
Well Screen:	<u>4</u>	<u>Sch 40</u>	<u>NA 20 slot</u>
Centralizer:		<u>Steel</u>	<u>5</u>
Endcap:	<u>4</u>	<u>Sch 40</u>	<u>0.2 ft</u>

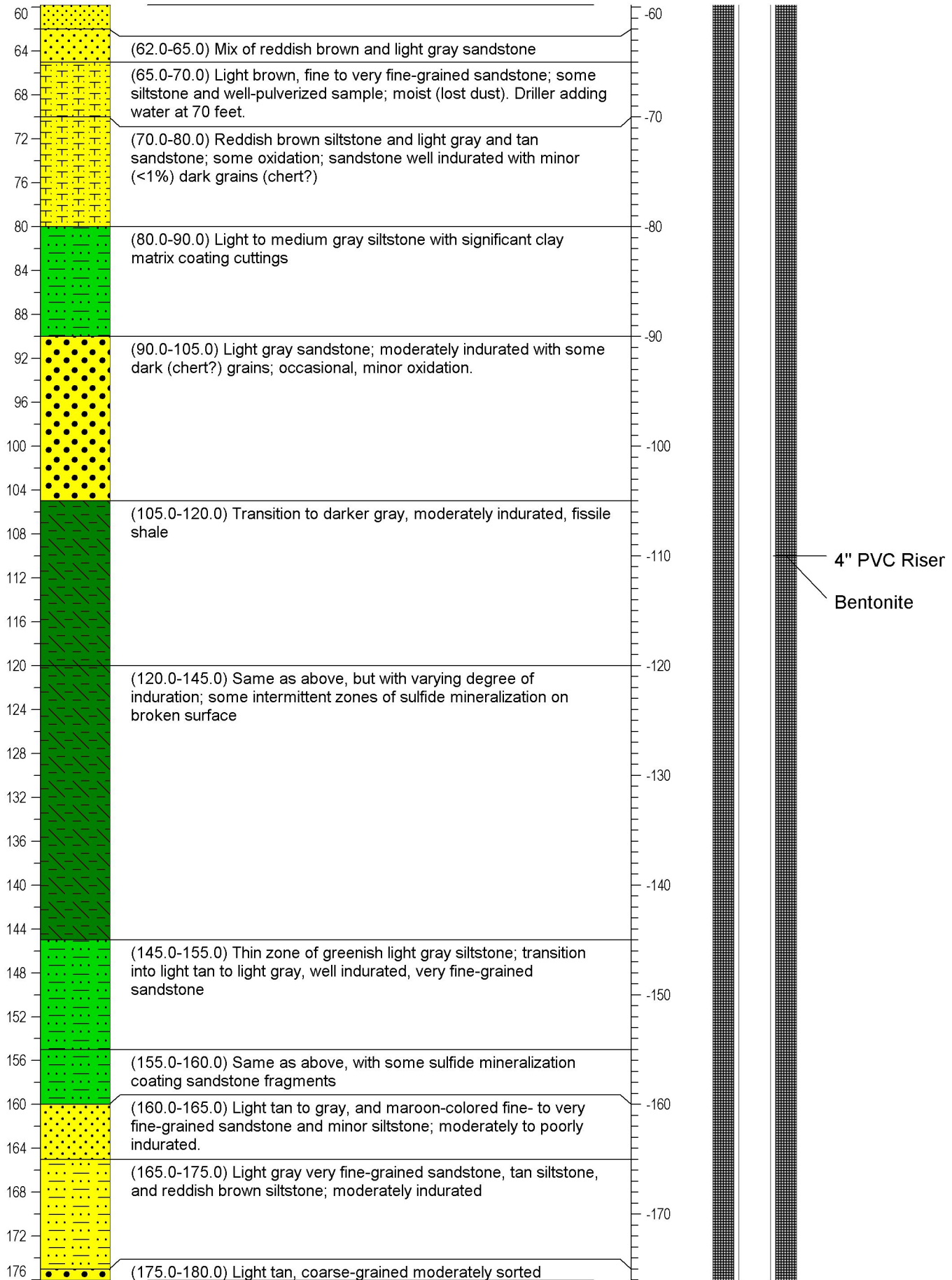
Water Levels

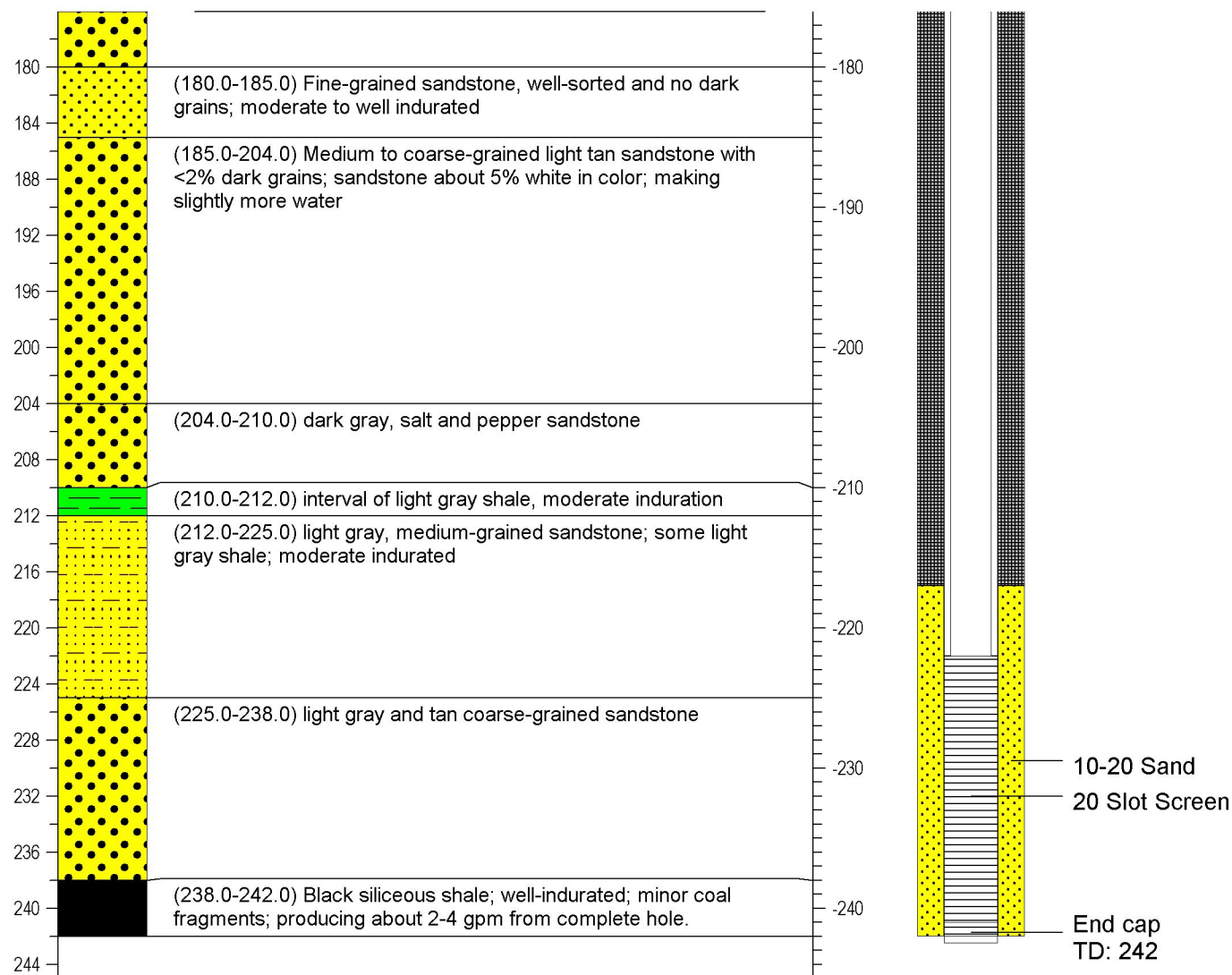
Date/Time: SWL ft

08/08/2017 15:00 211.5110/03/2017 15:20 211.86Comments

Groundwater monitoring well
 Source Control Investigation









HydroSolutions®

Well / Boring Number: MW-102K
 Client: Montana DEQ
 Project Name: Sand Coulee Source Control

Township: 19N Range: 4E
 Section: 23 Qtr Qtr: NESW
 County: Cascade State: MT

Latitude: 1144818.937
 Longitude: 1549393.850
 GL Elevation: 3680.313
 TOSC Elevation: 3681.456
 Datum used: Survey NAD 83

Drilling Information

Drilling Company: Boland Drilling
 Drilling Method: Air Rotary
 Driller: Chris Boland
 Drilling Rig: GardnerDenver HPS1000 Air Rotary
 Logged By: D. Donohue
 LogPlot by: R.Svingen 11/30/2017

Date/Time:

Start Drilling: 08/03/2017 0810
 Bore Diam (1):(10 in) 08/03/2017 0810 0 ft to 158 ft
 Bore Diam (2):(NA in) NA NA ft to NA ft
 Finish Drilling: NA 158 TD
 Well Development: 08/09/2017 15:30 1.5 hours

Well Construction Information

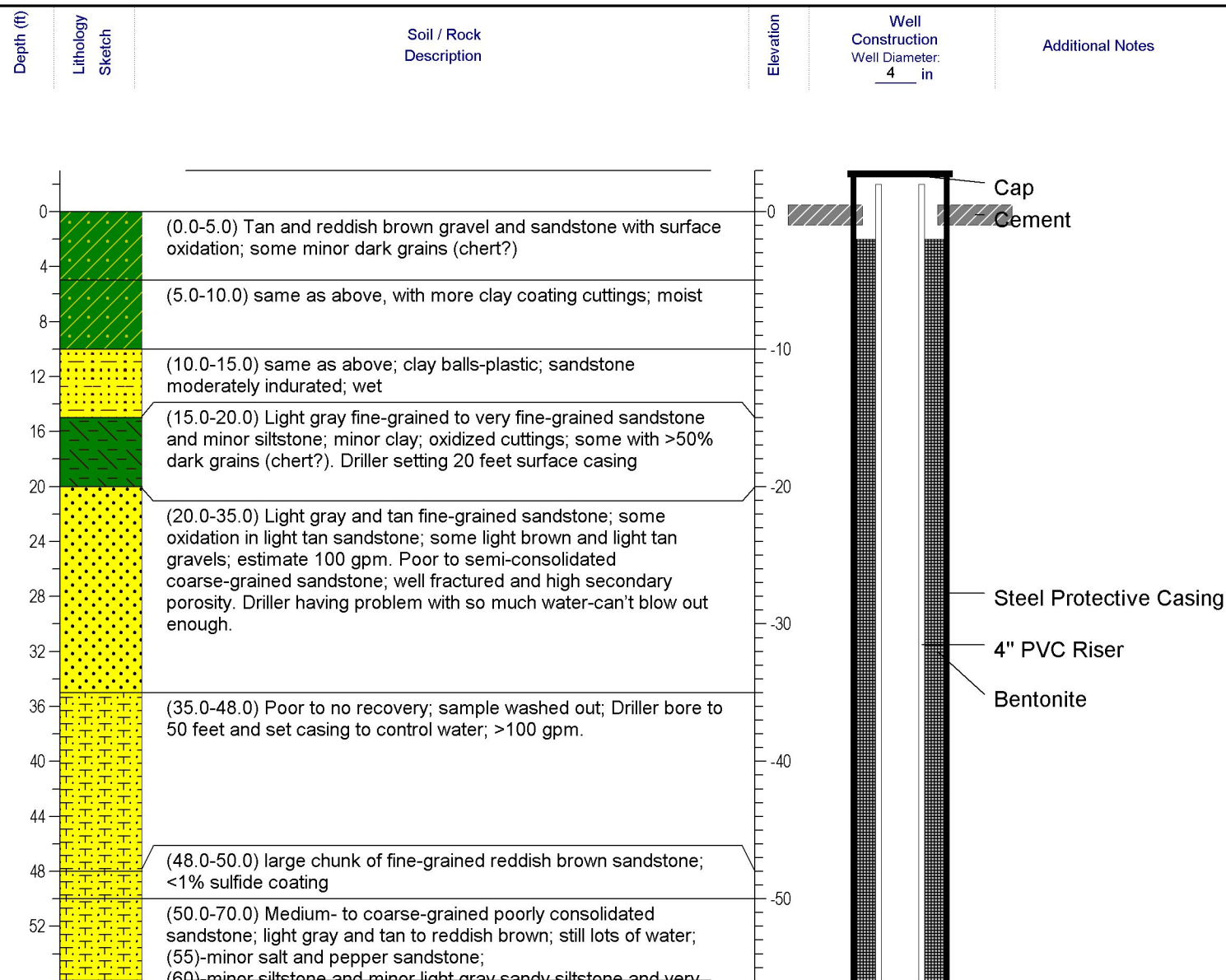
	<u>Dia. inches</u>	<u>Material</u>	<u>Specifications</u>
Protective Casing:	<u>6</u>	<u>6" Steel</u>	<u>58 ft</u>
Riser Pipe:	<u>4</u>	<u>Sch 40</u>	<u>67 ft</u>
Surface Seal:		<u>Concrete</u>	<u>1 ft</u> <u>Quickcrete</u>
Annular Seal:		<u>Bentonite</u>	<u>62 ft</u> <u>Size: Chips</u>
Filter Sand:	<u>3/8" gravel and Silica Sand</u>	<u>25 ft</u>	<u>Grade: 10-20</u>
Well Screen:	<u>4</u>	<u>Sch 40</u>	<u>NA</u> <u>20 slot</u>
Centralizer:		<u>NA</u>	<u>4</u> <u>Steel</u>
Endcap:	<u>4</u>	<u>Sch 40</u>	<u>0.2 ft</u>

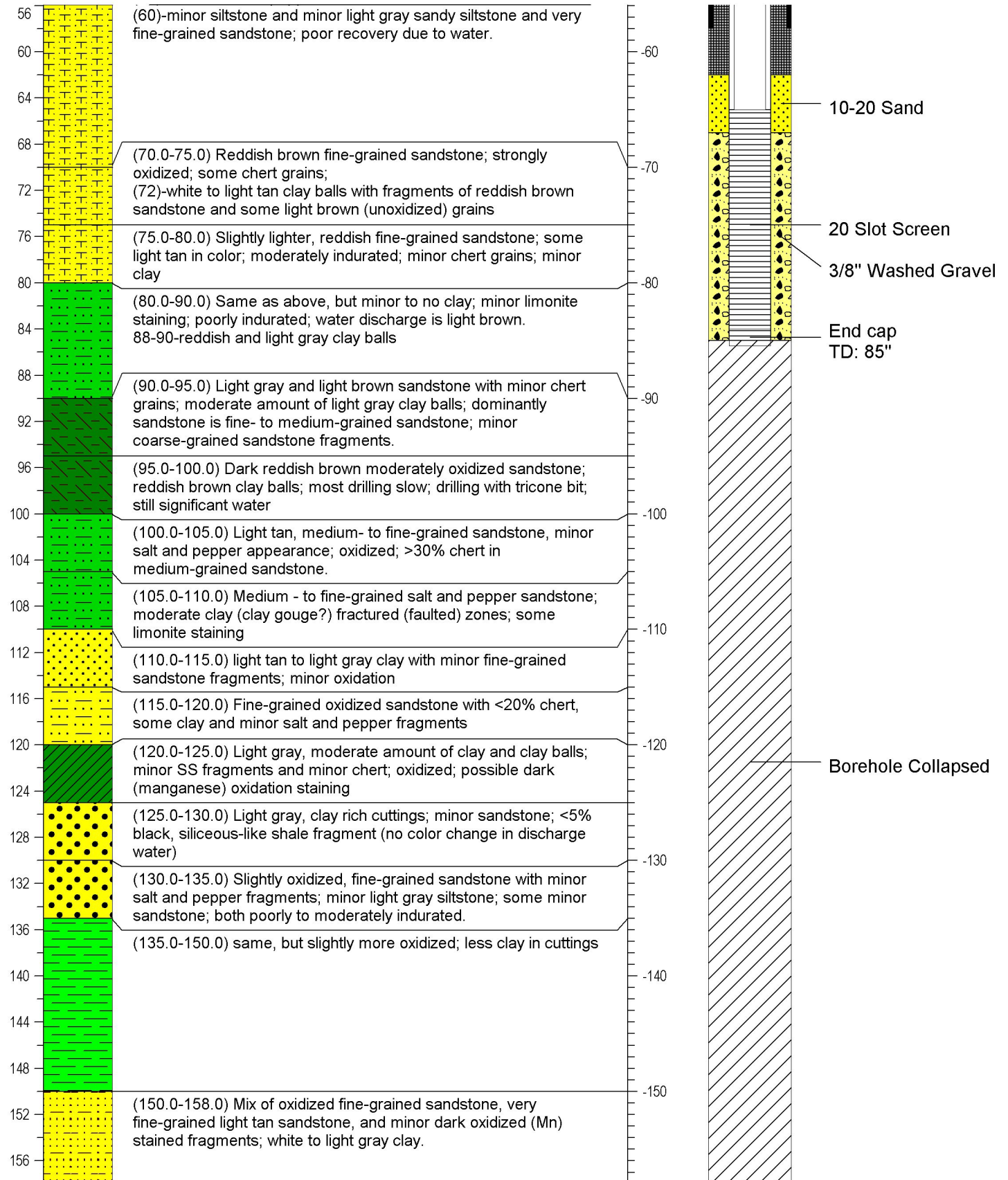
Water Levels

Date/Time: SWL ft
08/08/2017 15:20 10.12
10/03/2017 13:10 11.59

Comments

Groundwater monitoring well
 Source Control Investigation







HydroSolutions®

Well / Boring Number: MW-103K
 Client: Montana DEQ
 Project Name: Sand Coulee Source Control

Township: 19N Range: 4E
 Section: 23 Qtr Qtr: SESW
Cascade County State: MT

Latitude: 1144818.937
 Longitude: 1549393.850
 GL Elevation: 3646.616
 TOSC Elevation: 3681.456
 Datum used Survey NAD 83

Drilling Information

Drilling Company: Boland Drilling
 Drilling Method: Air Rotary
 Driller: Chris Boland
 Drilling Rig: GardnerDenver HPS1000 Air Rotary
 Logged By: D. Donohue
 LogPlot by: R.Svingen 11/30/2017

Date/Time:

Start Drilling: 08/07/2017 0810
 Bore Diam (1):(10 in) 08/07/2017 0810 0 ft to 86 ft
 Bore Diam (2):(NA in) NA NA ft to NA ft
 Finish Drilling: NA 86 TD
 Well Development 08/09/2017 1.5 hours

Well Construction Information

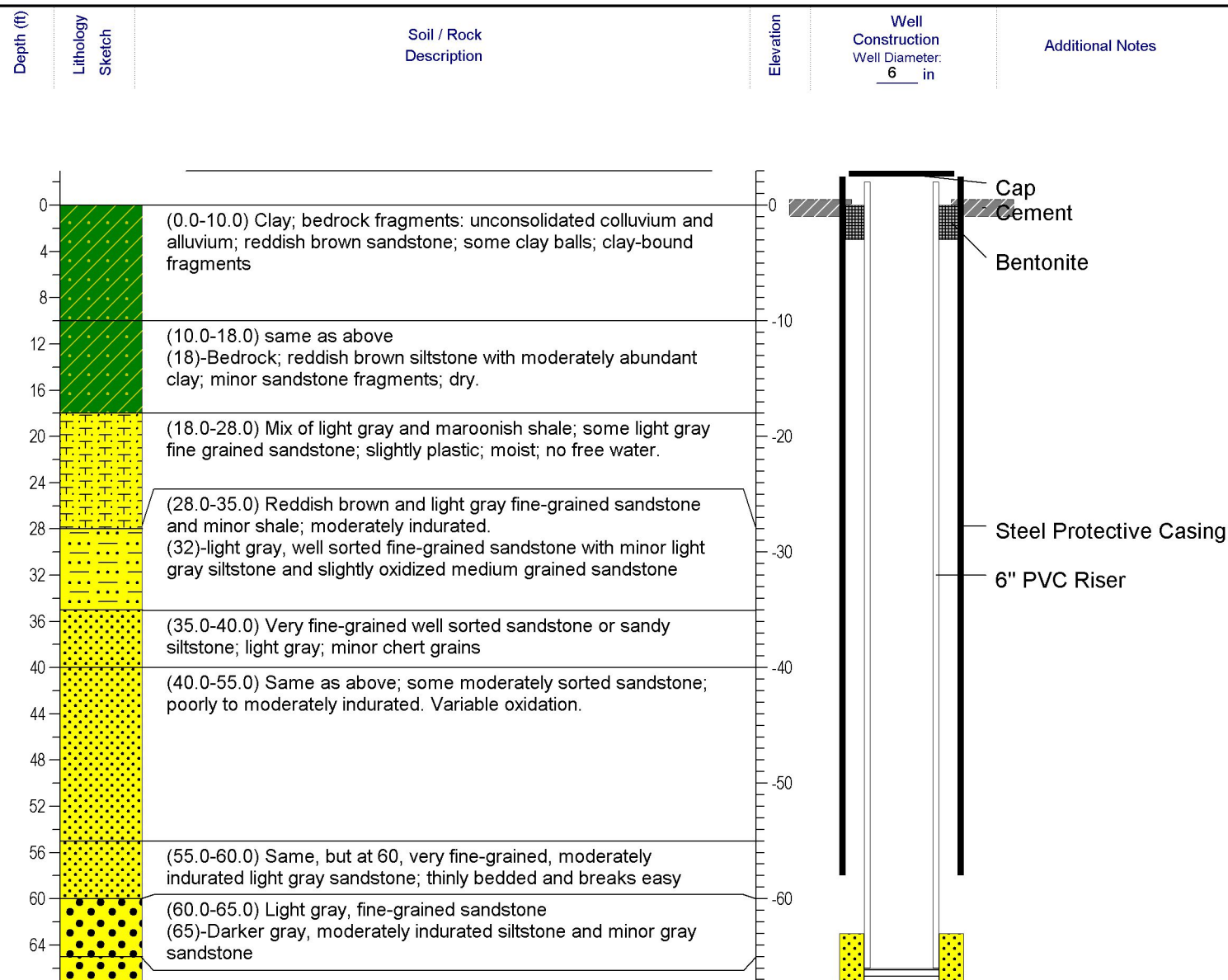
	<u>Dia. inches</u>	<u>Material</u>	<u>Specifications</u>
Protective Casing:	<u>8</u>	<u>10" Steel</u>	<u>58 ft</u>
Riser Pipe:	<u>6</u>	<u>Sch 40</u>	<u>60 ft</u>
Surface Seal:		<u>Concrete</u>	<u>1 ft</u> <u>Quickcrete</u>
Annular Seal:		<u>Bentonite</u>	<u>217 ft</u> <u>Size: Chips</u>
Filter Sand:		<u>Silica Sand</u>	<u>25 ft</u> <u>Grade: 10-20</u>
Well Screen:	<u>6</u>	<u>Sch 40</u>	<u>NA</u> <u>20 slot</u>
Centralizer:		<u>Steel</u>	<u>3</u>
Endcap:	<u>6</u>	<u>Sch 40</u>	<u>0.2 ft</u>

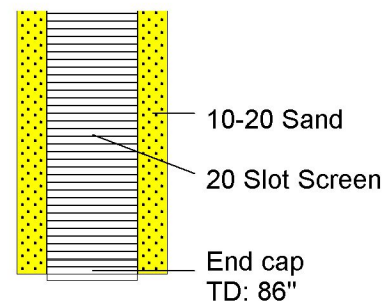
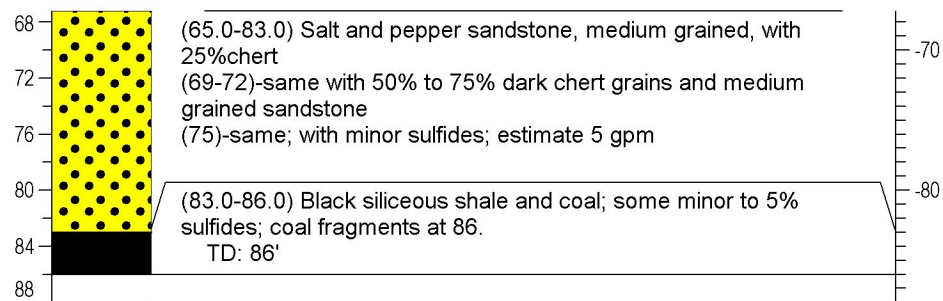
Water Levels

Date/Time: SWL ft
08/09/2017 15:25 34.30
10/03/2017 14:10 35.28

Comments

Groundwater monitoring well
 Source Control Investigation







HydroSolutions®

Well / Boring Number: MW-104K
 Client: Montana DEQ
 Project Name: Sand Coulee Source Control

Township: 19N Range: 4E
 Section: 23 Qtr Qtr: SESW
 County: Cascade State: MT

Latitude: 1147397.048
 Longitude: 1549672.195
 GL Elevation: 3777.626
 TOSC Elevation: 3779.278
 Datum used: Survey NAD 83

Drilling Information

Drilling Company: Boland Drilling
 Drilling Method: Air Rotary
 Driller: Chris Boland
 Drilling Rig: GardnerDenver HPS1000 Air Rotary
 Logged By: D. Donohue
 LogPlot by: R.Svingen 11/30/2017

Date/Time:

Start Drilling: 08/08/2017 0745
 Bore Diam (1):(8 in) 08/08/2017 0745 0 ft to 248 ft
 Bore Diam (2):(NA in) NA NA ft to NA ft
 Finish Drilling: NA 248 TD
 Well Development: 08/09/2017 15:30 1.5 hours

Well Construction Information

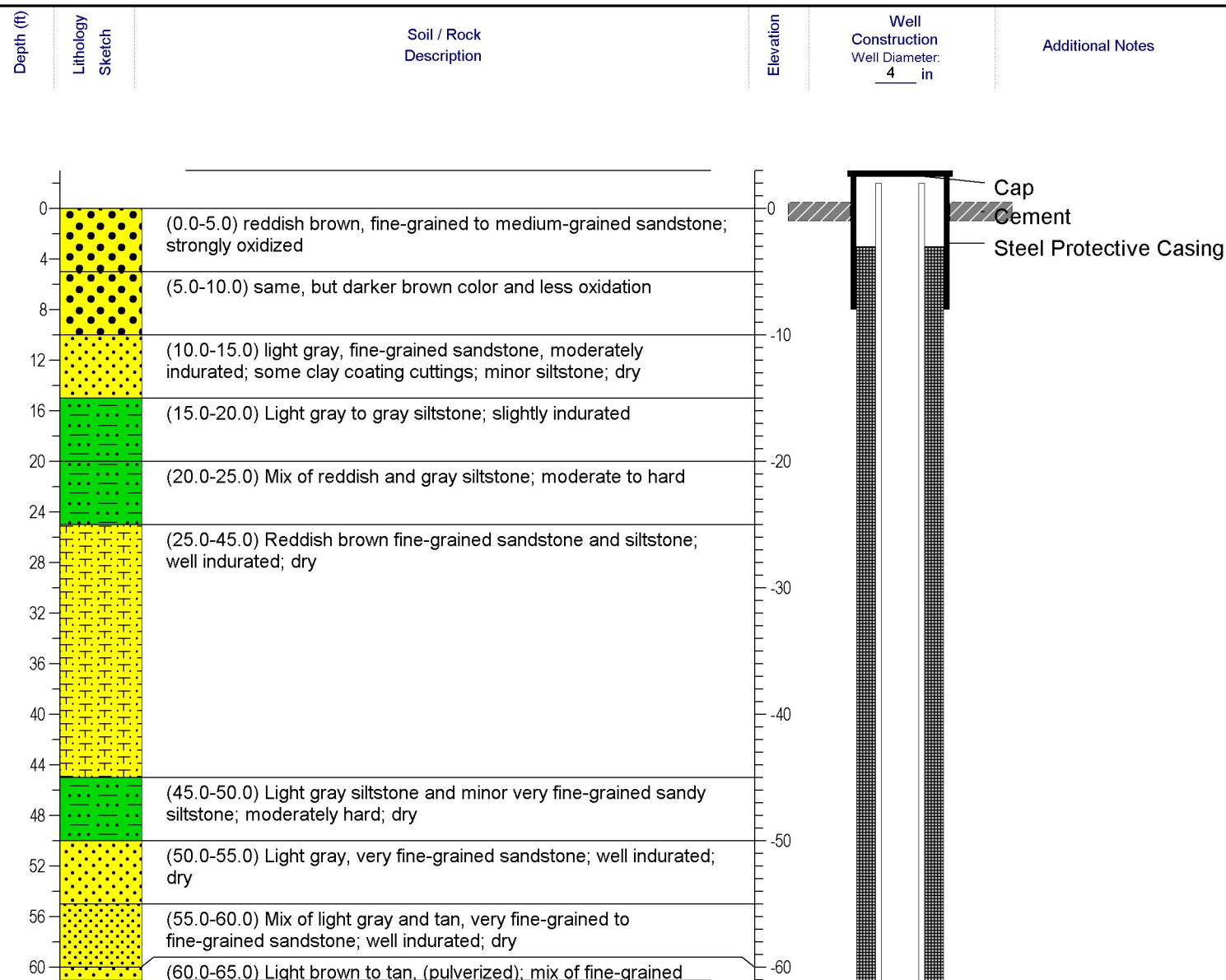
	<u>Dia. inches</u>	<u>Material</u>	<u>Specifications</u>
Protective Casing:	<u>4</u>	<u>6" Steel</u>	<u>229 ft</u>
Riser Pipe:	<u>4</u>	<u>Sch 40</u>	<u>224 ft</u>
Surface Seal:		<u>Concrete</u>	<u>1 ft Quickcrete</u>
Annular Seal:		<u>Bentonite</u>	<u>221 ft Size: Chips</u>
Filter Sand:		<u>Silica Sand</u>	<u>23 ft Grade: 10-20</u>
Well Screen:	<u>4</u>	<u>Sch 40</u>	<u>NA 20 slot</u>
Centralizer:		<u>Steel</u>	<u>5</u>
Endcap:	<u>4</u>	<u>Sch 40</u>	<u>0.2 ft</u>

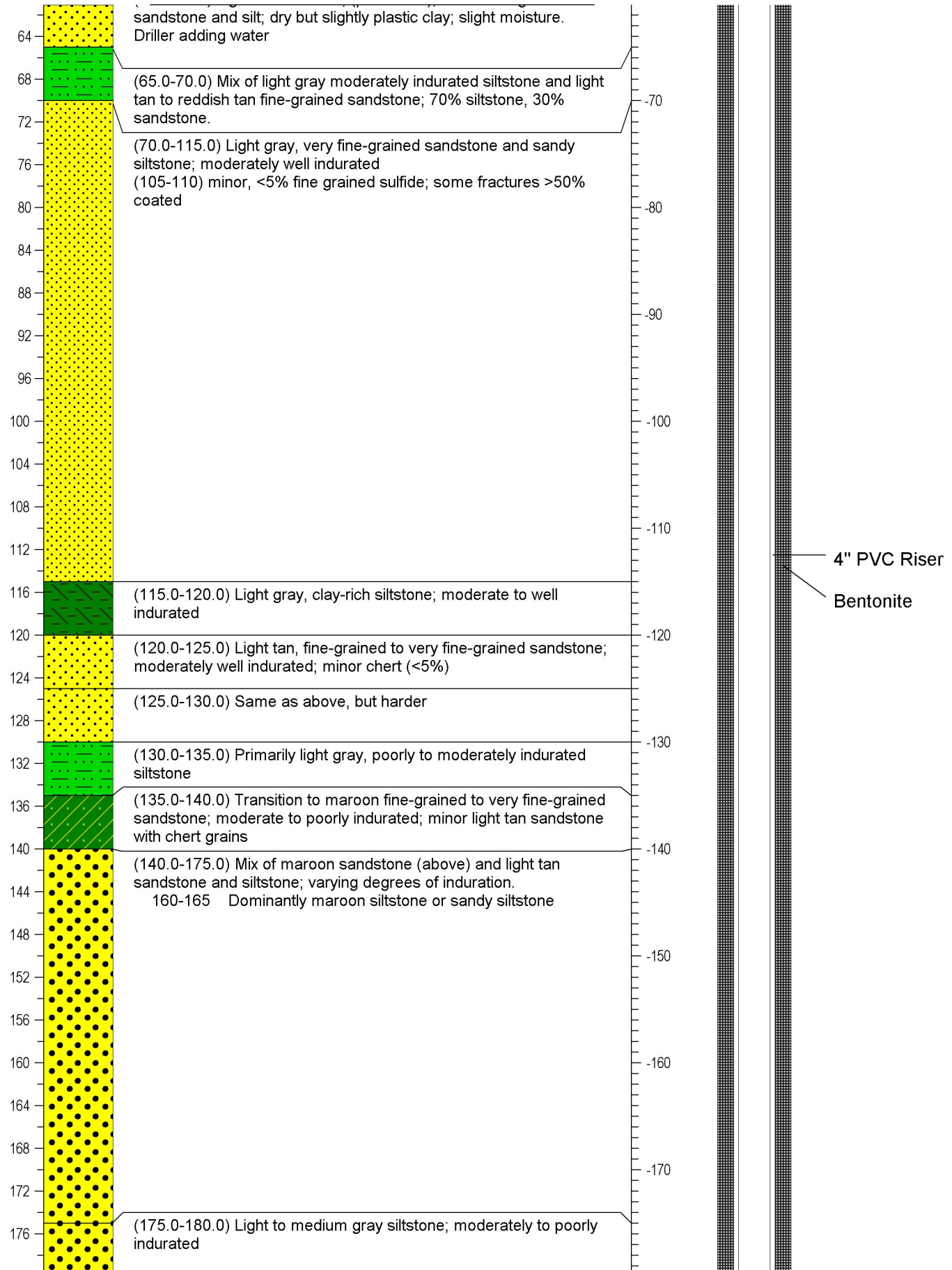
Water Levels

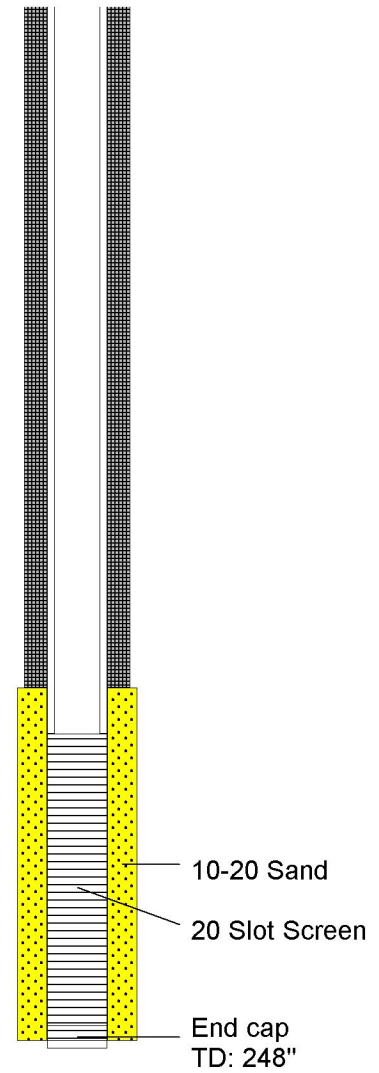
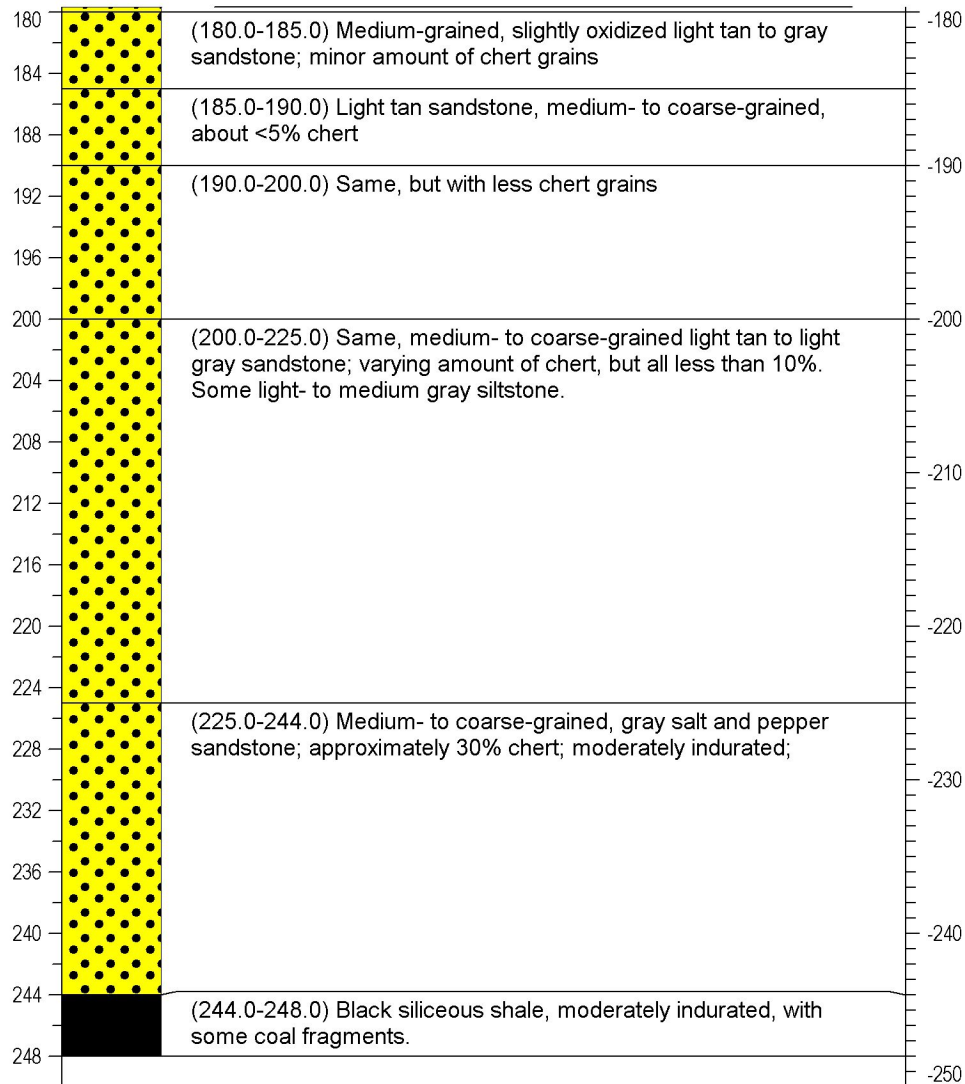
Date/Time: SWL ft

08/08/2017 16:20 220.3710/03/2017 13:10 220.98Comments

Groundwater monitoring well
 Source Control Investigation

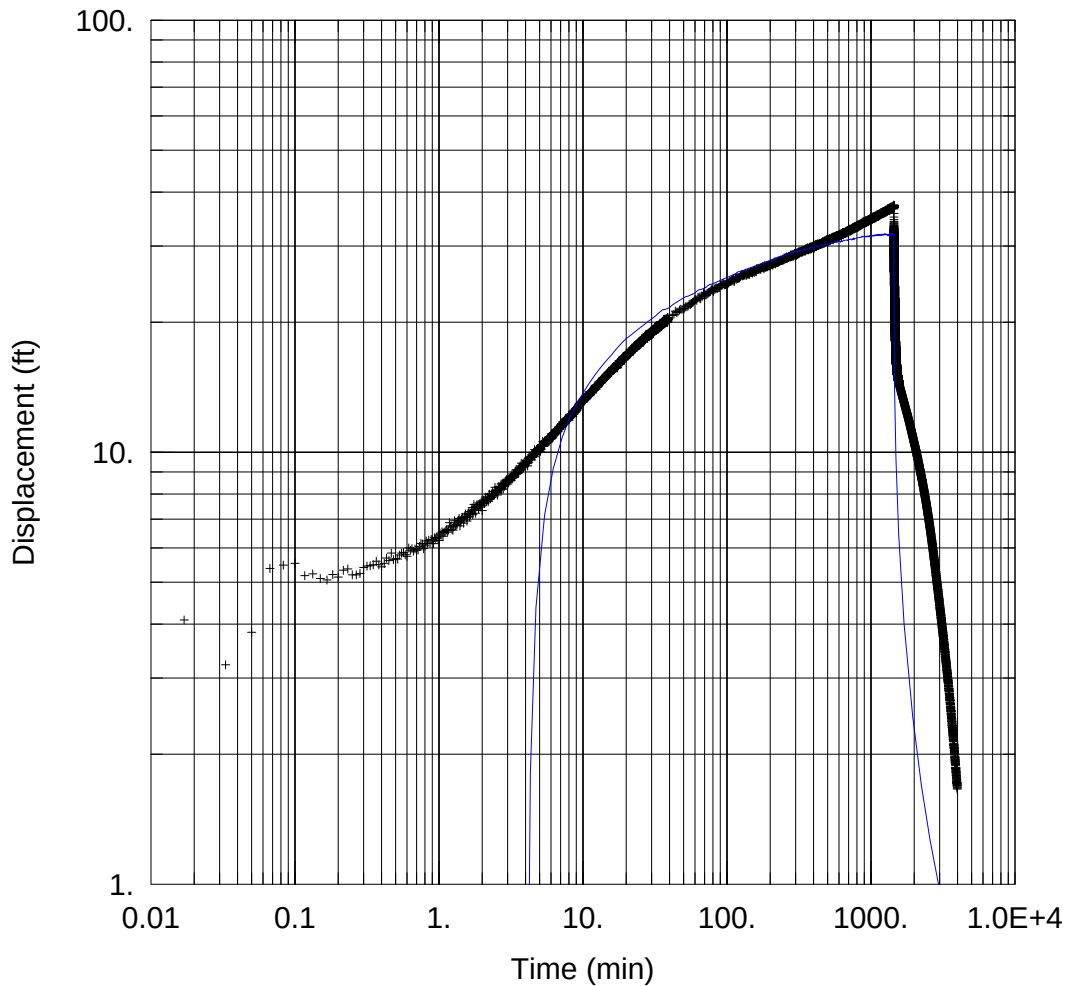






Appendix E

Aquifer Testing Graphical Logs



WELL TEST ANALYSIS

Data Set: H:\...\MW102K_24hrconfTheis.aqt

Date: 02/01/18

Time: 11:09:33

PROJECT INFORMATION

Company: HydroSolutions Inc

Client: DEQ

Location: Sand Coulee

Test Well: MW-103K

Test Date: 10/11/17

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
MW-102K	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
+ MW-102K	0	0

SOLUTION

Aquifer Model: Confined

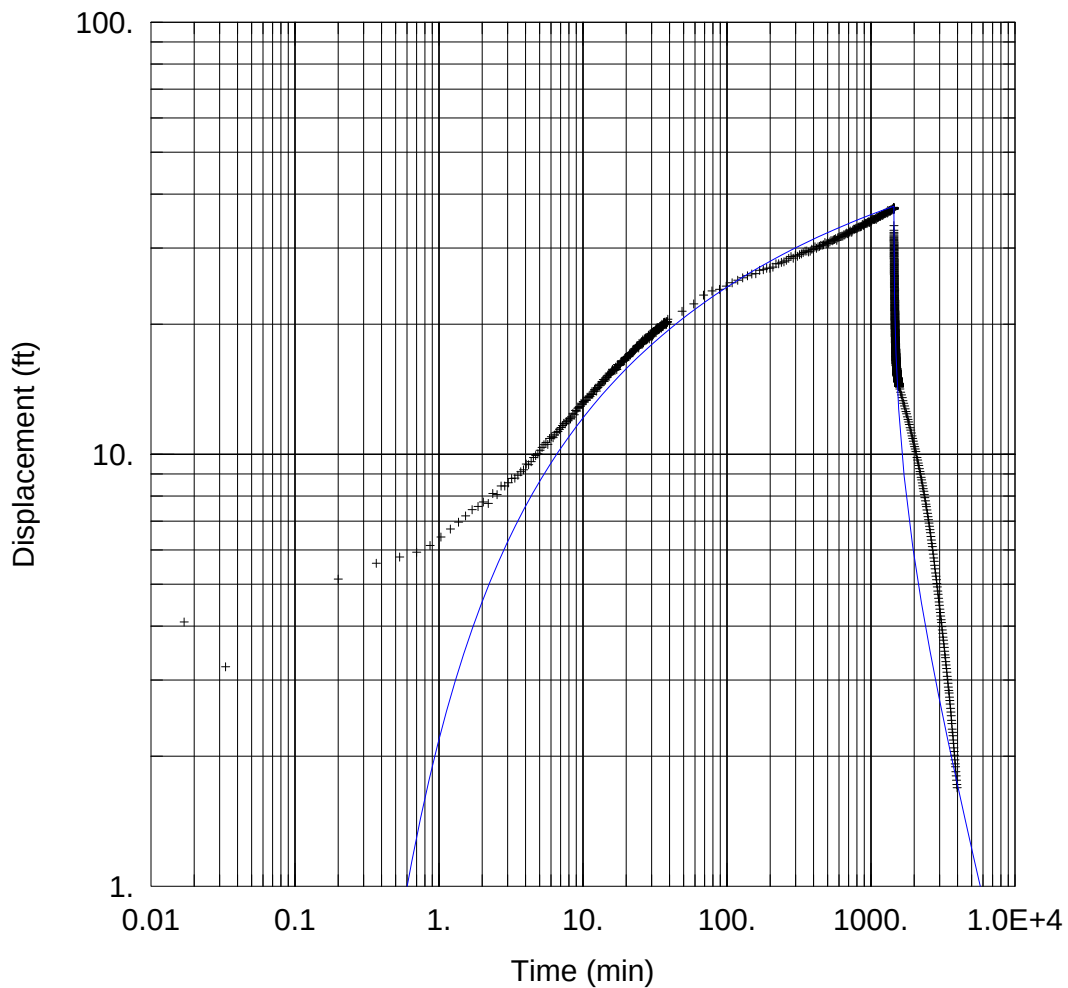
Solution Method: Theis

T = 416.8 ft²/day

S = 0.2792

Kz/Kr = 1.

b = 75. ft



WELL TEST ANALYSIS

Data Set: H:\...\MW102K_24hrHantush_Jacob_Leaky.aqt

Date: 02/01/18

Time: 10:54:52

PROJECT INFORMATION

Company: HydroSolutions Inc

Client: DEQ

Location: Sand Coulee

Test Well: MW-103K

Test Date: 10/11/17

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
MW-102K	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
+ <u>MW-102K</u>	0	0

SOLUTION

Aquifer Model: Leaky

Solution Method: Hantush-Jacob

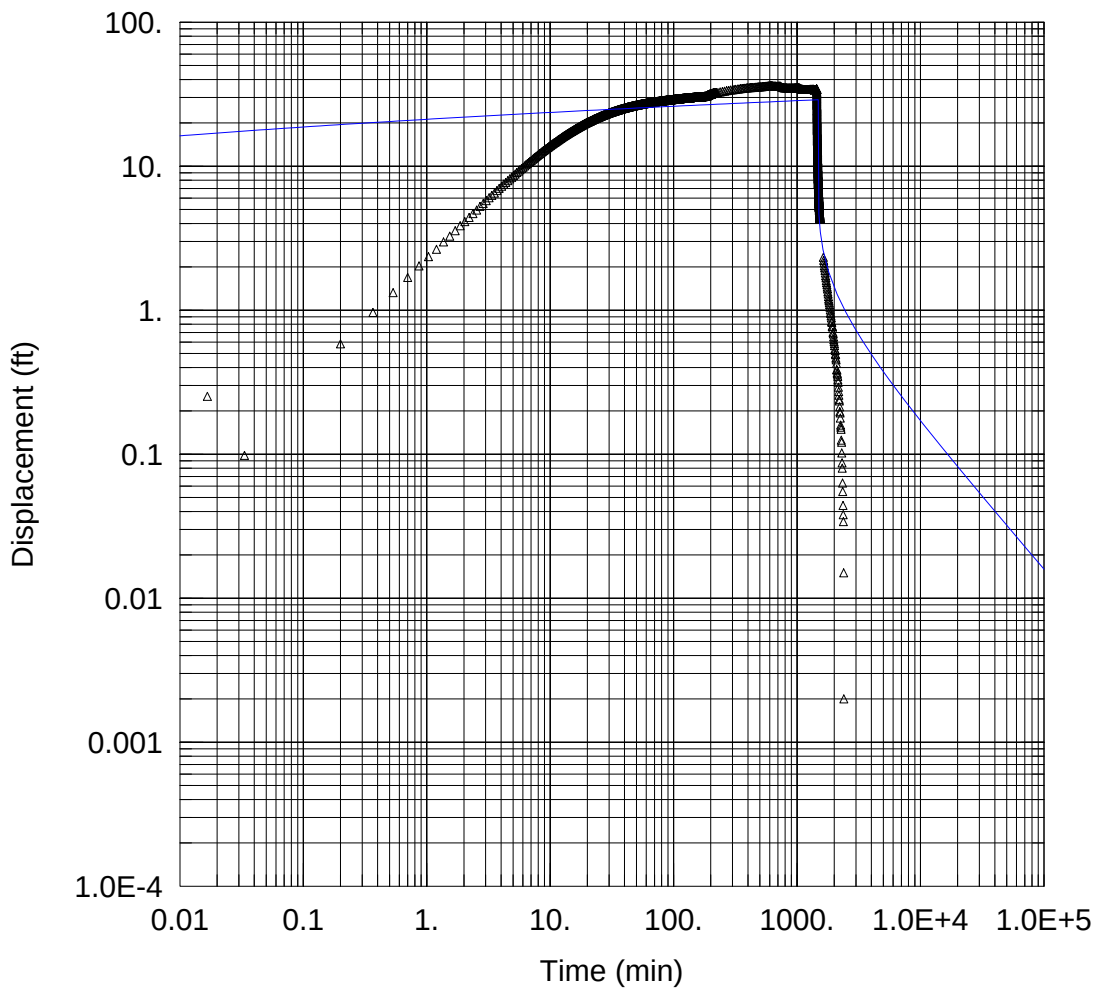
T = 381.5 ft²/day

S = 6.554

1/B = 3.03E-5 ft⁻¹

Kz/Kr = 1.

b = 75. ft



WELL TEST ANALYSIS

Data Set: H:\...\MW103K_24hr_final_TheisConf.aqt

Date: 02/01/18

Time: 10:59:46

PROJECT INFORMATION

Company: HydroSolutions Inc

Client: DEQ

Location: Sand Coulee

Test Well: MW-103K

Test Date: 10/11/17

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
MW-103K_PW	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
△ <u>MW-103K_PW</u>	0	0

SOLUTION

Aquifer Model: Confined

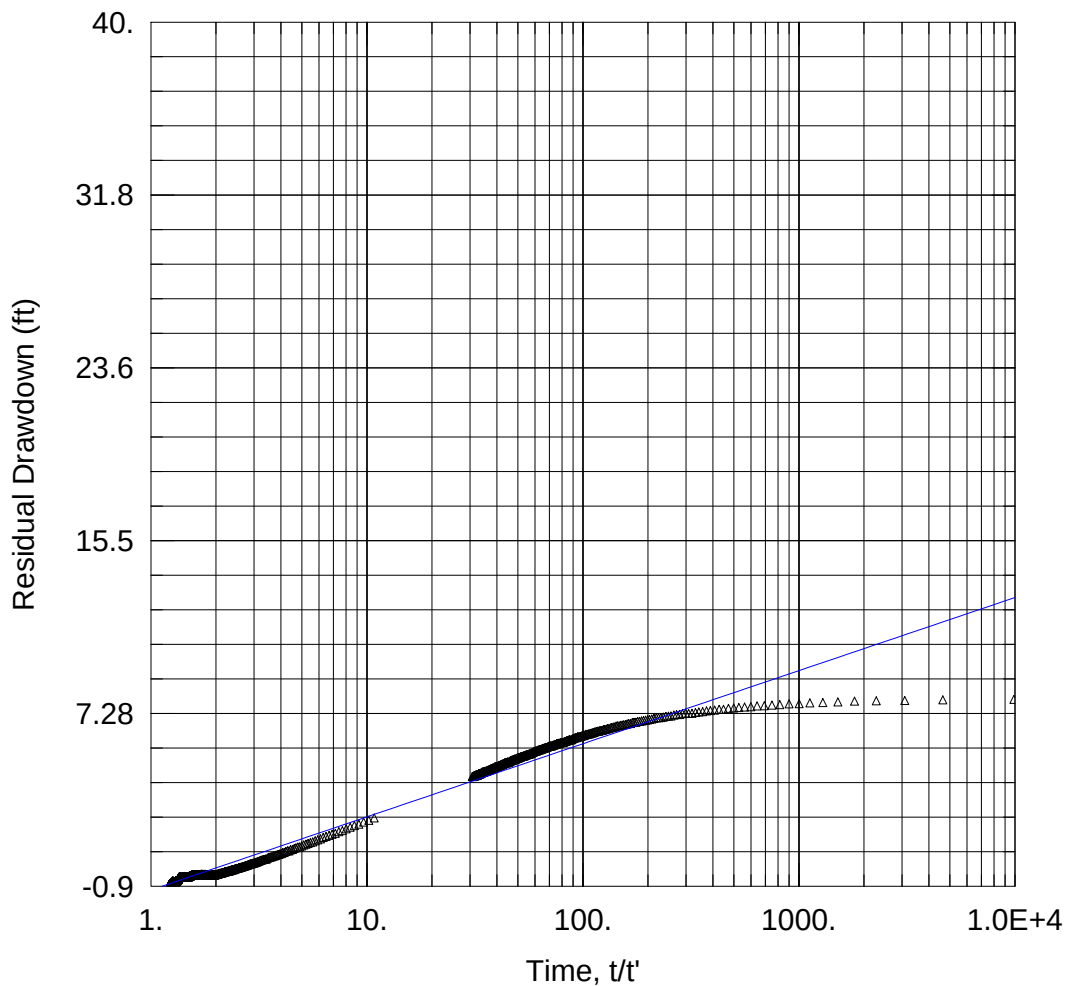
Solution Method: Theis

T = 38.83 ft²/day

S = 8.053E-10

Kz/Kr = 0.1949

b = 52. ft



WELL TEST ANALYSIS

Data Set: H:\...\MW103K_24hr_final_TheisConf_recov.aqt

Date: 02/01/18

Time: 11:04:17

PROJECT INFORMATION

Company: HydroSolutions Inc

Client: DEQ

Location: Sand Coulee

Test Well: MW-103K

Test Date: 10/11/17

AQUIFER DATA

Saturated Thickness: 52. ft

Anisotropy Ratio (K_z/K_r): 0.1949

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
MW-103K_PW	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
△ <u>MW-103K_PW</u>	0	0

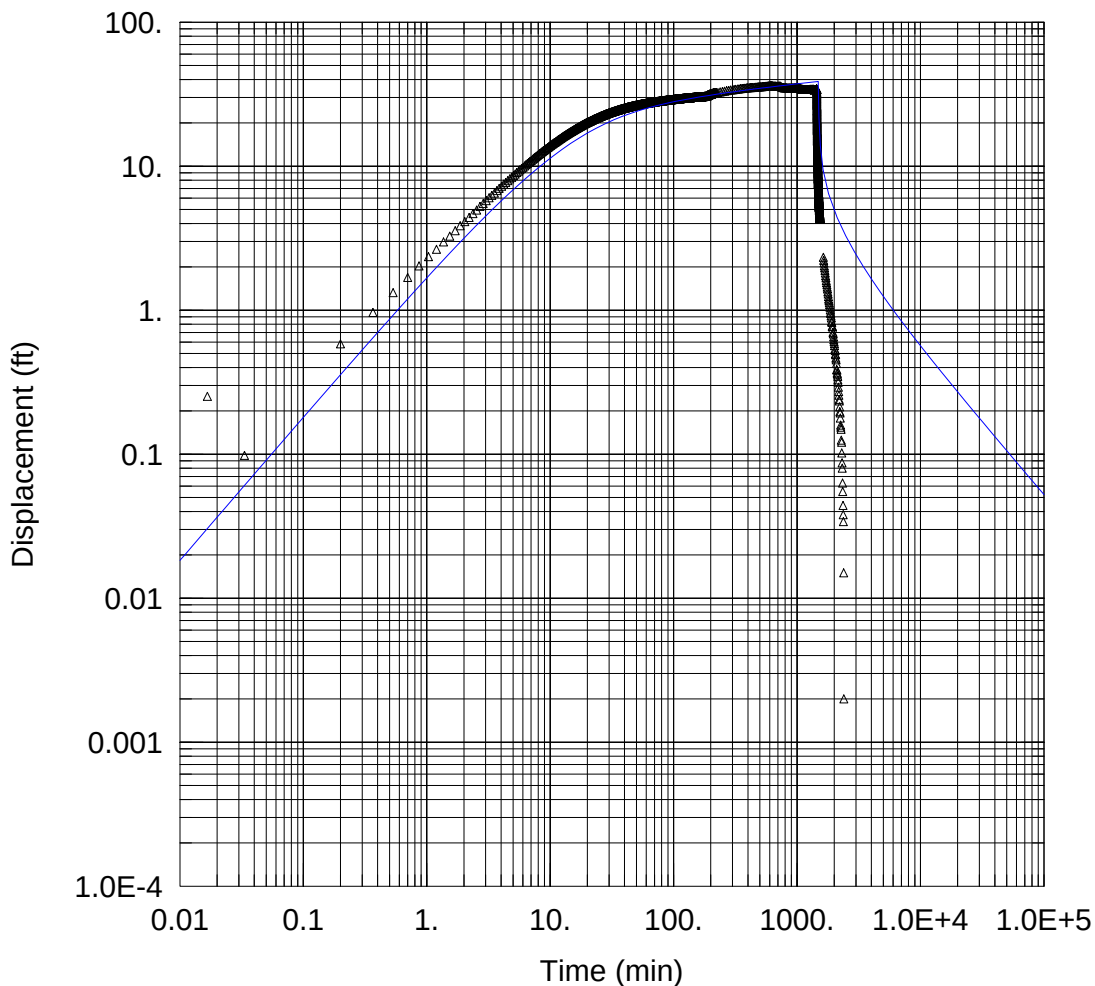
SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

$T = 27.53 \text{ ft}^2/\text{day}$

$S/S' = 2.047$



WELL TEST ANALYSIS

Data Set: H:\...\MW103K_24hr_final_TheisConf_papadopoulos_cooper.aqt

Date: 02/01/18

Time: 11:03:07

PROJECT INFORMATION

Company: HydroSolutions Inc

Client: DEQ

Location: Sand Coulee

Test Well: MW-103K

Test Date: 10/11/17

AQUIFER DATA

Saturated Thickness: 52. ft

Anisotropy Ratio (K_z/K_r): 0.1949

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
MW-103K_PW	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
△ <u>MW-103K_PW</u>	0	0

SOLUTION

Aquifer Model: Confined

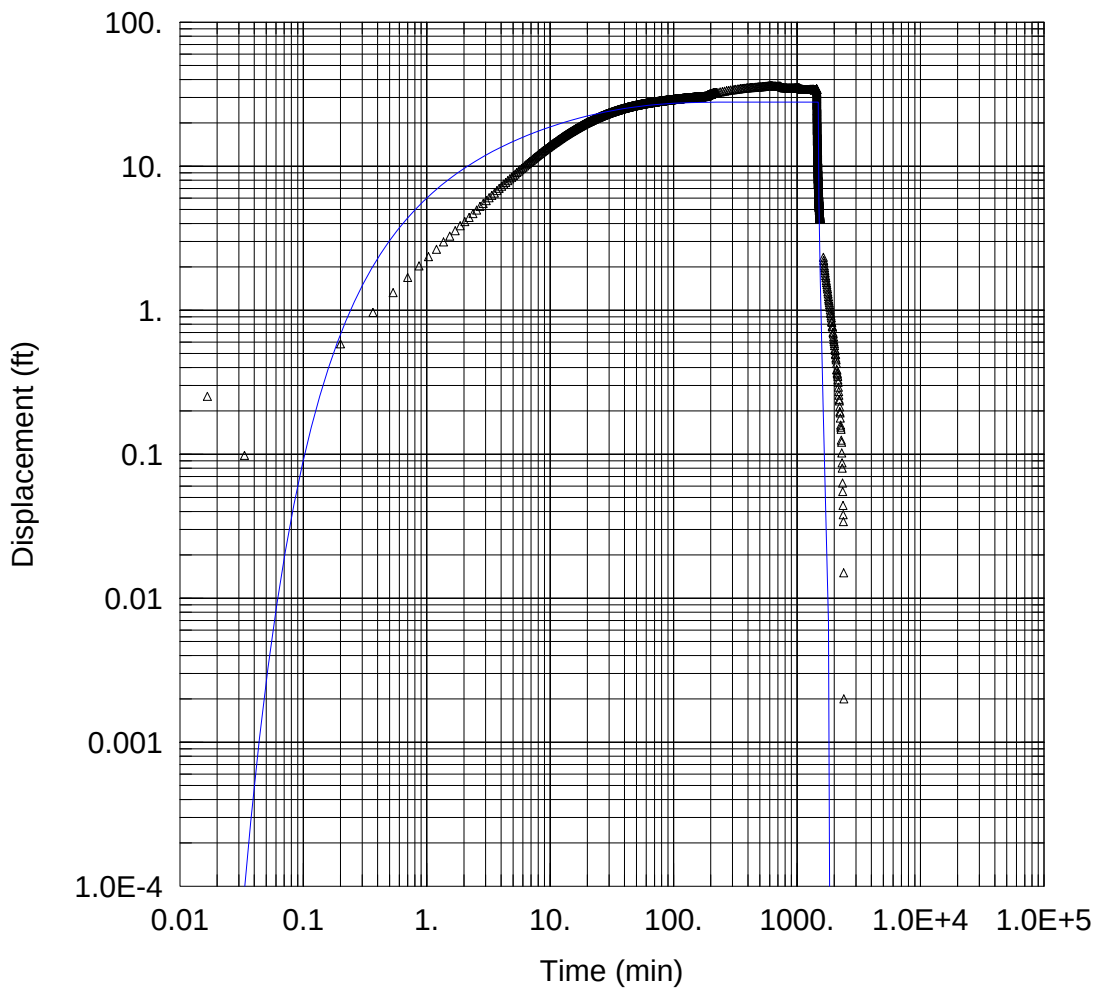
Solution Method: Papadopoulos-Cooper

$T = 11.79 \text{ ft}^2/\text{day}$

$S = 0.002406$

$r(w) = 0.42 \text{ ft}$

$r(c) = 0.25 \text{ ft}$



WELL TEST ANALYSIS

Data Set: H:\...\MW103K_24hr_final_Hantush_Jacob_Leaky.aqt
 Date: 02/01/18 Time: 10:58:29

PROJECT INFORMATION

Company: HydroSolutions Inc
 Client: DEQ
 Location: Sand Coulee
 Test Well: MW-103K
 Test Date: 10/11/17

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
MW-103K_PW	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
△ <u>MW-103K_PW</u>	0	0

SOLUTION

Aquifer Model: Leaky

Solution Method: Hantush-Jacob

T = 6.253 ft²/day
 1/B = 0.3301 ft⁻¹
 b = 52. ft

S = 0.0291
 Kz/Kr = 0.1949

Appendix F

Analytical Laboratory Reports



ANALYTICAL SUMMARY REPORT

November 13, 2017

MT DEQ-Abandoned Mines

PO Box 200901

Helena, MT 59620-0901

Work Order: H17110040

Project Name: Sand Coulee Source Control

Energy Laboratories Inc Helena MT received the following 4 samples for MT DEQ-Abandoned Mines on 11/2/2017 for analysis.

Lab ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
H17110040-001	SC-3A	10/31/17 14:20	11/02/17	Aqueous	Metals by ICP/ICPMS, Total Acidity, Total as CaCO ₃ Conductivity Fluoride Hardness Anions by Ion Chromatography pH Metals Digestion by EPA 200.2 Solids, Total Dissolved
H17110040-002	SC-1	10/31/17 14:45	11/02/17	Aqueous	Same As Above
H17110040-003	SC-12	10/31/17 15:25	11/02/17	Aqueous	Same As Above
H17110040-004	SC-8	10/31/17 16:00	11/02/17	Aqueous	Same As Above

The analyses presented in this report were performed by Energy Laboratories, Inc., 3161 E. Lyndale Ave., Helena, MT 59604, unless otherwise noted. Any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative.

The results as reported relate only to the item(s) submitted for testing.

If you have any questions regarding these test results, please call.

Report Approved By:



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control
Lab ID: H17110040-001
Client Sample ID: SC-3A

Report Date: 11/13/17
Collection Date: 10/31/17 14:20
Date Received: 11/02/17
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	2.6	s.u.	H	0.1		A4500-H B	11/02/17 15:22 / SRW
Solids, Total Dissolved TDS @ 180 C	6210	mg/L	D	70		A2540 C	11/03/17 14:22 / SRW
INORGANICS							
Acidity, Total as CaCO ₃	3400	mg/L		4.0		A2310 B	11/03/17 09:29 / SRW
Chloride	5	mg/L		1		E300.0	11/03/17 05:05 / kmd
Sulfate	4500	mg/L	D	2		E300.0	11/03/17 05:05 / kmd
Fluoride	ND	mg/L		0.1	4	A4500-F C	11/03/17 10:02 / kmd
Hardness as CaCO ₃	824	mg/L		1		A2340 B	11/10/17 11:07 / sld
METALS, TOTAL							
Aluminum	347	mg/L	D	0.04		E200.7	11/06/17 12:49 / sld
Antimony	ND	mg/L		0.0005		E200.8	11/06/17 16:07 / dck
Arsenic	0.011	mg/L		0.001		E200.8	11/06/17 16:07 / dck
Barium	ND	mg/L		0.003		E200.8	11/06/17 16:07 / dck
Beryllium	0.039	mg/L	D	0.005		E200.8	11/09/17 16:18 / dck
Cadmium	0.0548	mg/L	D	0.00005		E200.8	11/06/17 16:07 / dck
Calcium	149	mg/L		1		E200.7	11/06/17 12:49 / sld
Chromium	0.136	mg/L		0.005		E200.8	11/06/17 16:07 / dck
Copper	0.082	mg/L		0.002		E200.8	11/06/17 16:07 / dck
Iron	322	mg/L		0.02		E200.7	11/06/17 12:49 / sld
Lead	0.0016	mg/L		0.0003		E200.8	11/08/17 13:12 / dck
Magnesium	110	mg/L		1		E200.7	11/06/17 12:49 / sld
Manganese	1.56	mg/L		0.001		E200.7	11/06/17 12:49 / sld
Nickel	2.66	mg/L	D	0.003		E200.7	11/06/17 12:49 / sld
Potassium	ND	mg/L		1		E200.7	11/06/17 12:49 / sld
Selenium	0.002	mg/L		0.001		E200.8	11/08/17 13:12 / dck
Sodium	20	mg/L		1		E200.7	11/06/17 12:49 / sld
Strontium	0.99	mg/L		0.01		E200.7	11/06/17 12:49 / sld
Thallium	0.0016	mg/L		0.0002		E200.8	11/08/17 13:12 / dck
Zinc	11.5	mg/L		0.008		E200.7	11/06/17 12:49 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.

MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
H - Analysis performed past recommended holding time.



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control
Lab ID: H17110040-002
Client Sample ID: SC-1

Report Date: 11/13/17
Collection Date: 10/31/17 14:45
Date Received: 11/02/17
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	2.6	s.u.	H	0.1		A4500-H B	11/02/17 15:24 / SRW
Solids, Total Dissolved TDS @ 180 C	13000	mg/L	D	100		A2540 C	11/03/17 14:23 / SRW
INORGANICS							
Acidity, Total as CaCO ₃	7500	mg/L		4.0		A2310 B	11/03/17 09:29 / SRW
Chloride	2	mg/L		1		E300.0	11/03/17 05:20 / kmd
Sulfate	9570	mg/L	D	5		E300.0	11/03/17 05:20 / kmd
Fluoride	ND	mg/L		0.1	4	A4500-F C	11/03/17 10:08 / kmd
Hardness as CaCO ₃	1160	mg/L		1		A2340 B	11/10/17 11:07 / sld
METALS, TOTAL							
Aluminum	764	mg/L	D	0.1		E200.7	11/06/17 12:57 / sld
Antimony	ND	mg/L		0.0005		E200.8	11/06/17 16:08 / dck
Arsenic	0.022	mg/L		0.001		E200.8	11/06/17 16:08 / dck
Barium	ND	mg/L		0.003		E200.8	11/06/17 16:08 / dck
Beryllium	0.083	mg/L	D	0.005		E200.8	11/09/17 16:20 / dck
Cadmium	0.0820	mg/L	D	0.00004		E200.8	11/06/17 16:08 / dck
Calcium	187	mg/L		1		E200.7	11/06/17 12:57 / sld
Chromium	0.304	mg/L		0.005		E200.8	11/06/17 16:08 / dck
Copper	0.136	mg/L		0.002		E200.8	11/06/17 16:08 / dck
Iron	756	mg/L		0.02		E200.7	11/06/17 12:57 / sld
Lead	0.0004	mg/L		0.0003		E200.8	11/06/17 16:08 / dck
Magnesium	168	mg/L		1		E200.7	11/06/17 12:57 / sld
Manganese	2.58	mg/L	D	0.003		E200.7	11/06/17 12:57 / sld
Nickel	5.20	mg/L	D	0.007		E200.7	11/06/17 12:57 / sld
Potassium	ND	mg/L		1		E200.7	11/06/17 12:57 / sld
Selenium	0.002	mg/L		0.001		E200.8	11/08/17 13:14 / dck
Sodium	16	mg/L		1		E200.7	11/06/17 12:57 / sld
Strontium	0.95	mg/L		0.01		E200.7	11/06/17 12:57 / sld
Thallium	0.0006	mg/L		0.0002		E200.8	11/08/17 13:14 / dck
Zinc	20.5	mg/L		0.008		E200.7	11/06/17 12:57 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.

MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
H - Analysis performed past recommended holding time.



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control
Lab ID: H17110040-003
Client Sample ID: SC-12

Report Date: 11/13/17
Collection Date: 10/31/17 15:25
DateReceived: 11/02/17
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	2.5	s.u.	H	0.1		A4500-H B	11/02/17 15:26 / SRW
Solids, Total Dissolved TDS @ 180 C	15200	mg/L	D	100		A2540 C	11/03/17 14:23 / SRW
INORGANICS							
Acidity, Total as CaCO ₃	9100	mg/L		4.0		A2310 B	11/03/17 09:29 / SRW
Chloride	2	mg/L		1		E300.0	11/03/17 05:35 / kmd
Sulfate	11400	mg/L	D	5		E300.0	11/03/17 05:35 / kmd
Fluoride	ND	mg/L		0.1	4	A4500-F C	11/03/17 10:14 / kmd
Hardness as CaCO ₃	1240	mg/L		1		A2340 B	11/10/17 11:07 / sld
METALS, TOTAL							
Aluminum	875	mg/L	D	0.1		E200.7	11/06/17 13:04 / sld
Antimony	ND	mg/L		0.0005		E200.8	11/06/17 16:10 / dck
Arsenic	0.048	mg/L		0.001		E200.8	11/06/17 16:10 / dck
Barium	ND	mg/L		0.003		E200.8	11/06/17 16:10 / dck
Beryllium	0.100	mg/L	D	0.005		E200.8	11/09/17 16:22 / dck
Cadmium	0.115	mg/L	D	0.00004		E200.8	11/06/17 16:10 / dck
Calcium	183	mg/L		1		E200.7	11/06/17 13:04 / sld
Chromium	0.309	mg/L		0.005		E200.8	11/06/17 16:10 / dck
Copper	0.298	mg/L		0.002		E200.8	11/06/17 16:10 / dck
Iron	1070	mg/L		0.02		E200.7	11/06/17 13:04 / sld
Lead	0.0006	mg/L		0.0003		E200.8	11/06/17 16:10 / dck
Magnesium	191	mg/L		1		E200.7	11/06/17 13:04 / sld
Manganese	5.80	mg/L	D	0.003		E200.7	11/06/17 13:04 / sld
Nickel	3.84	mg/L	D	0.007		E200.7	11/06/17 13:04 / sld
Potassium	ND	mg/L		1		E200.7	11/06/17 13:04 / sld
Selenium	0.002	mg/L		0.001		E200.8	11/08/17 13:16 / dck
Sodium	19	mg/L		1		E200.7	11/06/17 13:04 / sld
Strontium	1.32	mg/L		0.01		E200.7	11/06/17 13:04 / sld
Thallium	0.0019	mg/L		0.0002		E200.8	11/08/17 13:16 / dck
Zinc	13.6	mg/L		0.008		E200.7	11/06/17 13:04 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.

MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
H - Analysis performed past recommended holding time.



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control
Lab ID: H17110040-004
Client Sample ID: SC-8

Report Date: 11/13/17
Collection Date: 10/31/17 16:00
Date Received: 11/02/17
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	3.8	s.u.	H	0.1		A4500-H B	11/02/17 15:28 / SRW
Solids, Total Dissolved TDS @ 180 C	3340	mg/L	D	70		A2540 C	11/03/17 14:23 / SRW
INORGANICS							
Acidity, Total as CaCO ₃	1400	mg/L		4.0		A2310 B	11/03/17 09:30 / SRW
Chloride	4	mg/L		1		E300.0	11/03/17 05:49 / kmd
Sulfate	2330	mg/L		1		E300.0	11/03/17 05:49 / kmd
Fluoride	ND	mg/L		0.1	4	A4500-F C	11/03/17 10:19 / kmd
Hardness as CaCO ₃	778	mg/L		1		A2340 B	11/09/17 14:31 / sld
METALS, TOTAL							
Aluminum	157	mg/L	D	0.02		E200.7	11/06/17 13:12 / sld
Antimony	ND	mg/L		0.0005		E200.8	11/06/17 16:12 / dck
Arsenic	0.024	mg/L		0.001		E200.8	11/06/17 16:12 / dck
Barium	0.014	mg/L		0.003		E200.8	11/06/17 16:12 / dck
Beryllium	0.0218	mg/L		0.0008		E200.8	11/08/17 20:51 / dck
Cadmium	0.00649	mg/L		0.00003		E200.8	11/06/17 16:12 / dck
Calcium	130	mg/L		1		E200.7	11/06/17 13:12 / sld
Chromium	0.022	mg/L		0.005		E200.8	11/06/17 16:12 / dck
Copper	ND	mg/L		0.002		E200.8	11/06/17 16:12 / dck
Iron	201	mg/L		0.02		E200.7	11/06/17 13:12 / sld
Lead	0.0018	mg/L		0.0003		E200.8	11/06/17 16:12 / dck
Magnesium	110	mg/L		1		E200.7	11/06/17 13:12 / sld
Manganese	0.958	mg/L		0.001		E200.7	11/06/17 13:12 / sld
Nickel	1.15	mg/L		0.002		E200.7	11/06/17 13:12 / sld
Potassium	4	mg/L		1		E200.7	11/06/17 13:12 / sld
Selenium	ND	mg/L		0.001		E200.8	11/08/17 13:18 / dck
Sodium	25	mg/L		1		E200.7	11/06/17 13:12 / sld
Strontium	0.99	mg/L		0.01		E200.7	11/06/17 13:12 / sld
Thallium	0.0011	mg/L		0.0002		E200.8	11/06/17 16:12 / dck
Zinc	4.67	mg/L		0.008		E200.7	11/06/17 13:12 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.

MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
H - Analysis performed past recommended holding time.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines

Report Date: 11/13/17

Project: Sand Coulee Source Control

Work Order: H17110040

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: A2310 B								Batch: ACID171103_A		
Lab ID: H17110040-001A DUP		Sample Duplicate				Run: MISC WC_171103A		11/03/17 09:29		
Acidity, Total as CaCO ₃		3400	mg/L	4.0				0.3	10	
Lab ID: LCS		Laboratory Control Sample				Run: MISC WC_171103A		11/03/17 09:29		
Acidity, Total as CaCO ₃		1300	mg/L	4.0	98	90	110			
Lab ID: MBLK		Method Blank				Run: MISC WC_171103A		11/03/17 09:29		
Acidity, Total as CaCO ₃		3	mg/L							

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 11/13/17
Work Order: H17110040

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: A2540 C										Batch: TDS171103A
Lab ID: MB-1_171103A										
Solids, Total Dissolved TDS @ 180 C		Method Blank				Run: ACCU-124 (14410200)_17110		11/03/17 14:22		
		ND	mg/L	2						
Lab ID: LCS-2_171103A										
Solids, Total Dissolved TDS @ 180 C		Laboratory Control Sample				Run: ACCU-124 (14410200)_17110		11/03/17 14:22		
		2000	mg/L	20	100	90	110			
Lab ID: H17110040-001A DUP										
Solids, Total Dissolved TDS @ 180 C		Sample Duplicate				Run: ACCU-124 (14410200)_17110		11/03/17 14:22		
		6210	mg/L	67				0.0	5	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 11/13/17
Work Order: H17110040

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: A4500-F C								Analytical Run: MANTECH 2_171103A		
Lab ID: ICV		Initial Calibration Verification Standard								11/03/17 09:26
Fluoride		0.8	mg/L	0.1	100	90	110			
Method: A4500-F C								Batch: R129945		
Lab ID: MBLK		Method Blank								11/03/17 09:32
Fluoride		0.02	mg/L	0.01						
Lab ID: H17110033-001AMS		Sample Matrix Spike								11/03/17 09:41
Fluoride		1.9	mg/L	0.1	87	85	115			
Lab ID: H17110034-001ADUP		Sample Duplicate								11/03/17 09:50
Fluoride		0.8	mg/L	0.1				2.4	10	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 11/13/17
Work Order: H17110040

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method:	A4500-H B							Analytical Run: PHSC_101-H_171102A		
Lab ID:	pH 7		Initial Calibration Verification Standard						11/02/17 08:51	
pH		7.0	s.u.	0.1	99	98	102			
Lab ID:	CCV - pH 7		Continuing Calibration Verification Standard						11/02/17 14:41	
pH		7.0	s.u.	0.1	100	98	102			
Method:	A4500-H B							Batch: R129860		
Lab ID:	H17110037-006ADUP		Sample Duplicate			Run: PHSC_101-H_171102A			11/02/17 15:18	
pH		4.2	s.u.	0.1				0.2	3	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 11/13/17
Work Order: H17110040

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7										Analytical Run: ICP2-HE_171106A
Lab ID: ICV	10	Initial Calibration Verification Standard								11/06/17 09:24
Aluminum		4.09	mg/L	0.10	102	95	105			
Calcium		39.6	mg/L	1.0	99	95	105			
Iron		4.00	mg/L	0.020	100	95	105			
Magnesium		39.6	mg/L	1.0	99	95	105			
Manganese		3.99	mg/L	0.010	100	95	105			
Nickel		0.812	mg/L	0.010	101	95	105			
Potassium		40.6	mg/L	1.0	101	95	105			
Sodium		40.6	mg/L	1.0	102	95	105			
Strontium		0.808	mg/L	0.10	101	95	105			
Zinc		0.800	mg/L	0.010	100	95	105			
Lab ID: CCV-1	10	Continuing Calibration Verification Standard								11/06/17 09:28
Aluminum		2.57	mg/L	0.10	103	95	105			
Calcium		25.0	mg/L	1.0	100	95	105			
Iron		2.52	mg/L	0.020	101	95	105			
Magnesium		24.6	mg/L	1.0	98	95	105			
Manganese		2.50	mg/L	0.010	100	95	105			
Nickel		2.53	mg/L	0.010	101	95	105			
Potassium		26.0	mg/L	1.0	104	95	105			
Sodium		26.1	mg/L	1.0	105	95	105			
Strontium		2.55	mg/L	0.10	102	95	105			
Zinc		2.51	mg/L	0.010	100	95	105			
Lab ID: ICSA	10	Interference Check Sample A								11/06/17 09:39
Aluminum		533	mg/L	0.10	107	80	120			
Calcium		471	mg/L	1.0	94	80	120			
Iron		185	mg/L	0.020	92	80	120			
Magnesium		530	mg/L	1.0	106	80	120			
Manganese		0.00770	mg/L	0.010		0	0			
Nickel		0.00522	mg/L	0.010		0	0			
Potassium		0.00174	mg/L	1.0		0	0			
Sodium		0.0261	mg/L	1.0		0	0			
Strontium		0.00471	mg/L	0.10		0	0			
Zinc		-0.00110	mg/L	0.010		0	0			
Lab ID: ICSAB	10	Interference Check Sample AB								11/06/17 09:43
Aluminum		544	mg/L	0.10	109	80	120			
Calcium		469	mg/L	1.0	94	80	120			
Iron		185	mg/L	0.020	92	80	120			
Magnesium		529	mg/L	1.0	106	80	120			
Manganese		0.495	mg/L	0.010	99	80	120			
Nickel		0.955	mg/L	0.010	95	80	120			
Potassium		19.9	mg/L	1.0	100	80	120			
Sodium		19.8	mg/L	1.0	99	80	120			
Strontium		1.04	mg/L	0.10	104	80	120			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines

Report Date: 11/13/17

Project: Sand Coulee Source Control

Work Order: H17110040

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7										Analytical Run: ICP2-HE_171106A
Lab ID: ICSAB	10	Interference Check Sample AB								11/06/17 09:43
Zinc		1.00	mg/L	0.010	100	80	120			
Lab ID: CCV	10	Continuing Calibration Verification Standard								11/06/17 12:30
Aluminum		2.65	mg/L	0.10	106	90	110			
Calcium		25.1	mg/L	1.0	100	90	110			
Iron		2.58	mg/L	0.020	103	90	110			
Magnesium		24.9	mg/L	1.0	100	90	110			
Manganese		2.51	mg/L	0.010	100	90	110			
Nickel		2.56	mg/L	0.010	102	90	110			
Potassium		26.4	mg/L	1.0	106	90	110			
Sodium		26.7	mg/L	1.0	107	90	110			
Strontium		2.63	mg/L	0.10	105	90	110			
Zinc		2.55	mg/L	0.010	102	90	110			
Method: E200.7										Batch: 39418
Lab ID: MB-39418	10	Method Blank								Run: ICP2-HE_171106A 11/06/17 11:07
Aluminum		ND	mg/L	0.003						
Calcium		0.06	mg/L	0.01						
Iron		ND	mg/L	0.003						
Magnesium		ND	mg/L	0.009						
Manganese		ND	mg/L	0.0006						
Nickel		ND	mg/L	0.001						
Potassium		ND	mg/L	0.05						
Sodium		0.05	mg/L	0.02						
Strontium		0.0003	mg/L	0.0002						
Zinc		0.003	mg/L	0.001						
Lab ID: LCS-39418	10	Laboratory Control Sample								Run: ICP2-HE_171106A 11/06/17 11:11
Aluminum		2.46	mg/L	0.030	98	85	115			
Calcium		24.2	mg/L	1.0	97	85	115			
Iron		2.44	mg/L	0.020	98	85	115			
Magnesium		24.1	mg/L	1.0	96	85	115			
Manganese		2.40	mg/L	0.0010	96	85	115			
Nickel		0.487	mg/L	0.0050	97	85	115			
Potassium		25.5	mg/L	1.0	102	85	115			
Sodium		25.6	mg/L	1.0	102	85	115			
Strontium		0.496	mg/L	0.010	99	85	115			
Zinc		0.491	mg/L	0.010	98	85	115			
Lab ID: H17110042-002ADIL	10	Serial Dilution								Run: ICP2-HE_171106A 11/06/17 11:52
Aluminum		0.0239	mg/L	0.030		0	0		10	N
Calcium		21.0	mg/L	1.0		0	0	5.7	10	
Iron		0.186	mg/L	0.020		0	0		10	N
Magnesium		5.47	mg/L	1.0		0	0	7.7	10	
Manganese		0.00994	mg/L	0.0031		0	0		10	N

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

N - The analyte concentration was not sufficiently high to calculate a RPD for the serial dilution test.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines

Report Date: 11/13/17

Project: Sand Coulee Source Control

Work Order: H17110040

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7										Batch: 39418
Lab ID: H17110042-002ADIL	10	Serial Dilution				Run: ICP2-HE_171106A				11/06/17 11:52
Nickel		0.0128	mg/L	0.0071		0	0		10	N
Potassium		0.804	mg/L	1.0		0	0		10	N
Sodium		4.19	mg/L	1.0		0	0	0.4	10	
Strontium		0.129	mg/L	0.010		0	0	4.6	10	
Zinc		0.134	mg/L	0.010		0	0		10	N
Lab ID: H17110034-001CMS3	10	Sample Matrix Spike				Run: ICP2-HE_171106A				11/06/17 12:23
Aluminum		2.48	mg/L	0.033	97	70	130			
Calcium		411	mg/L	1.0		70	130			A
Iron		2.48	mg/L	0.029	97	70	130			
Magnesium		607	mg/L	1.0		70	130			A
Manganese		2.74	mg/L	0.0063	95	70	130			
Nickel		0.464	mg/L	0.014	93	70	130			
Potassium		41.7	mg/L	1.0	101	70	130			
Sodium		6580	mg/L	2.5		70	130			A
Strontium		10.6	mg/L	0.010		70	130			A
Zinc		0.516	mg/L	0.014	100	70	130			
Lab ID: H17110034-001CMSD	10	Sample Matrix Spike Duplicate				Run: ICP2-HE_171106A				11/06/17 12:27
Aluminum		2.52	mg/L	0.033	99	70	130	1.8	20	
Calcium		410	mg/L	1.0		70	130	0.1	20	A
Iron		2.50	mg/L	0.029	98	70	130	0.8	20	
Magnesium		608	mg/L	1.0		70	130	0.2	20	A
Manganese		2.77	mg/L	0.0063	96	70	130	1.2	20	
Nickel		0.494	mg/L	0.014	99	70	130	6.3	20	
Potassium		42.0	mg/L	1.0	103	70	130	0.8	20	
Sodium		6600	mg/L	2.5		70	130	0.3	20	A
Strontium		10.6	mg/L	0.010		70	130	0.0	20	A
Zinc		0.522	mg/L	0.014	101	70	130	1.1	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

N - The analyte concentration was not sufficiently high to calculate a RPD for the serial dilution test.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 11/13/17
Work Order: H17110040

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8										Analytical Run: ICPMS205-H_171106A
Lab ID: ICSA	8	Interference Check Sample A								11/06/17 09:31
Antimony		0.000156	mg/L	0.050						
Arsenic		-1.77E-05	mg/L	0.0050						
Barium		6.08E-05	mg/L	0.10						
Cadmium		9.40E-06	mg/L	0.0010						
Chromium		0.000965	mg/L	0.010						
Copper		0.000165	mg/L	0.010						
Lead		0.000213	mg/L	0.010						
Thallium		-4.96E-06	mg/L	0.10						
Lab ID: ICSAB	8	Interference Check Sample AB								11/06/17 09:33
Antimony		6.90E-05	mg/L	0.050		0	0			
Arsenic		0.0114	mg/L	0.0050	114	70	130			
Barium		0.000179	mg/L	0.10		0	0			
Cadmium		0.0110	mg/L	0.0010	110	70	130			
Chromium		0.0232	mg/L	0.010	116	70	130			
Copper		0.0220	mg/L	0.010	110	70	130			
Lead		0.000210	mg/L	0.010		0	0			
Thallium		-1.91E-05	mg/L	0.10		0	0			
Lab ID: ICV	8	Initial Calibration Verification Standard								11/06/17 09:41
Antimony		0.0604	mg/L	0.050	101	90	110			
Arsenic		0.0588	mg/L	0.0050	98	90	110			
Barium		0.0597	mg/L	0.10	99	90	110			
Cadmium		0.0296	mg/L	0.0010	99	90	110			
Chromium		0.0590	mg/L	0.010	98	90	110			
Copper		0.0588	mg/L	0.010	98	90	110			
Lead		0.0577	mg/L	0.010	96	90	110			
Thallium		0.0574	mg/L	0.10	96	90	110			
Method: E200.8										Batch: 39418
Lab ID: MB-39418	10	Method Blank								Run: ICPMS205-H_171106A 11/06/17 10:46
Antimony		ND	mg/L	5E-05						
Arsenic		ND	mg/L	6E-05						
Barium		ND	mg/L	7E-05						
Beryllium		ND	mg/L	0.0001						
Cadmium		1E-05	mg/L	1.0E-05						
Chromium		0.0002	mg/L	5E-05						
Copper		ND	mg/L	7E-05						
Lead		ND	mg/L	9E-06						
Selenium		ND	mg/L	3E-05						
Thallium		ND	mg/L	7E-06						
Lab ID: LCS-39418	10	Laboratory Control Sample								Run: ICPMS205-H_171106A 11/06/17 11:08
Antimony		0.506	mg/L	0.0010	101	85	115			
Arsenic		0.481	mg/L	0.0010	96	85	115			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 11/13/17
Work Order: H17110040

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8										Batch: 39418
Lab ID: LCS-39418	10	Laboratory Control Sample				Run: ICPMS205-H_171106A			11/06/17 11:08	
Barium		0.484	mg/L	0.050	97	85	115			
Beryllium		0.232	mg/L	0.0010	93	85	115			
Cadmium		0.236	mg/L	0.0010	94	85	115			
Chromium		0.488	mg/L	0.0050	98	85	115			
Copper		0.477	mg/L	0.0050	95	85	115			
Lead		0.474	mg/L	0.0010	95	85	115			
Selenium		0.460	mg/L	0.0010	92	85	115			
Thallium		0.463	mg/L	0.00050	93	85	115			
Lab ID: H17110034-001CMS3	10	Sample Matrix Spike				Run: ICPMS205-H_171106A			11/06/17 15:19	
Antimony		0.526	mg/L	0.0010	105	70	130			
Arsenic		0.490	mg/L	0.0010	98	70	130			
Barium		0.411	mg/L	0.050	81	70	130			
Beryllium		0.185	mg/L	0.0010	74	70	130			
Cadmium		0.233	mg/L	0.0010	93	70	130			
Chromium		0.461	mg/L	0.0050	92	70	130			
Copper		0.436	mg/L	0.0050	87	70	130			
Lead		0.453	mg/L	0.0010	91	70	130			
Selenium		0.504	mg/L	0.0010	100	70	130			
Thallium		0.482	mg/L	0.00050	96	70	130			
Lab ID: H17110034-001CMSD	10	Sample Matrix Spike Duplicate				Run: ICPMS205-H_171106A			11/06/17 15:21	
Antimony		0.550	mg/L	0.0010	110	70	130	4.6	20	
Arsenic		0.513	mg/L	0.0010	103	70	130	4.6	20	
Barium		0.403	mg/L	0.050	79	70	130	1.9	20	
Beryllium		0.184	mg/L	0.0010	74	70	130	0.7	20	
Cadmium		0.247	mg/L	0.0010	99	70	130	5.5	20	
Chromium		0.474	mg/L	0.0050	95	70	130	2.9	20	
Copper		0.451	mg/L	0.0050	90	70	130	3.4	20	
Lead		0.471	mg/L	0.0010	94	70	130	4.0	20	
Selenium		0.515	mg/L	0.0010	102	70	130	2.2	20	
Thallium		0.512	mg/L	0.00050	102	70	130	6.0	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines

Report Date: 11/13/17

Project: Sand Coulee Source Control

Work Order: H17110040

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8								Analytical Run: ICPMS205-H_171108B		
Lab ID: ICV	4	Initial Calibration Verification Standard								11/08/17 10:32
Beryllium		0.0291	mg/L	0.0010	97	90	110			
Lead		0.0581	mg/L	0.010	97	90	110			
Selenium		0.0577	mg/L	0.0050	96	90	110			
Thallium		0.0572	mg/L	0.10	95	90	110			
Lab ID: ICSA	4	Interference Check Sample A								11/08/17 10:34
Beryllium		8.07E-06	mg/L	0.0010						
Lead		0.000221	mg/L	0.010						
Selenium		6.99E-05	mg/L	0.0050						
Thallium		3.55E-05	mg/L	0.10						
Lab ID: ICSAB	4	Interference Check Sample AB								11/08/17 10:36
Beryllium		8.44E-06	mg/L	0.0010		0	0			
Lead		0.000218	mg/L	0.010		0	0			
Selenium		0.0112	mg/L	0.0050	112	70	130			
Thallium		1.19E-05	mg/L	0.10		0	0			
Lab ID: ICV	4	Initial Calibration Verification Standard								11/08/17 17:21
Beryllium		0.0289	mg/L	0.0010	96	90	110			
Lead		0.0594	mg/L	0.010	99	90	110			
Selenium		0.0596	mg/L	0.0050	99	90	110			
Thallium		0.0579	mg/L	0.10	96	90	110			
Lab ID: ICSA	4	Interference Check Sample A								11/08/17 17:23
Beryllium		3.68E-05	mg/L	0.0010						
Lead		0.000222	mg/L	0.010						
Selenium		5.40E-05	mg/L	0.0050						
Thallium		2.98E-05	mg/L	0.10						
Lab ID: ICSAB	4	Interference Check Sample AB								11/08/17 17:25
Beryllium		-8.95E-06	mg/L	0.0010		0	0			
Lead		0.000223	mg/L	0.010		0	0			
Selenium		0.0116	mg/L	0.0050	116	70	130			
Thallium		1.52E-05	mg/L	0.10		0	0			
Method: E200.8								Batch: 39418		
Lab ID: MB-39418	10	Method Blank								Run: ICPMS205-H_171108B 11/08/17 12:54
Antimony		7E-05	mg/L	5E-05						
Arsenic		0.0001	mg/L	6E-05						
Barium		0.0002	mg/L	7E-05						
Beryllium		ND	mg/L	0.0001						
Cadmium		9E-05	mg/L	1.0E-05						
Chromium		0.0002	mg/L	5E-05						
Copper		0.0003	mg/L	7E-05						
Lead		9E-05	mg/L	9E-06						
Selenium		8E-05	mg/L	3E-05						

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 11/13/17
Work Order: H17110040

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8										Batch: 39418
Lab ID: MB-39418	10	Method Blank				Run: ICPMS205-H_171108B				11/08/17 12:54
Thallium		4E-05	mg/L	7E-06						
Method: E200.8										Analytical Run: ICPMS205-H_171109B
Lab ID: ICV		Initial Calibration Verification Standard								11/09/17 11:20
Beryllium		0.0289	mg/L	0.0010	96	90	110			
Lab ID: ICSA		Interference Check Sample A								11/09/17 11:22
Beryllium		-1.73E-05	mg/L	0.0010						
Lab ID: ICSAB		Interference Check Sample AB								11/09/17 11:24
Beryllium		-1.72E-05	mg/L	0.0010		0	0			
Method: E200.8										Batch: 39418
Lab ID: MB-39418	10	Method Blank				Run: ICPMS205-H_171109B				11/09/17 16:10
Antimony		ND	mg/L	5E-05						
Arsenic		ND	mg/L	6E-05						
Barium		ND	mg/L	7E-05						
Beryllium		ND	mg/L	0.0001						
Cadmium		4E-05	mg/L	1.0E-05						
Chromium		0.0003	mg/L	5E-05						
Copper		0.0003	mg/L	7E-05						
Lead		4E-05	mg/L	9E-06						
Selenium		ND	mg/L	3E-05						
Thallium		ND	mg/L	7E-06						

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 11/13/17
Work Order: H17110040

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E300.0								Analytical Run: IC METROHM_171102A		
Lab ID: ICV	2	Initial Calibration Verification Standard								11/02/17 15:00
Chloride		101	mg/L	1.0	101	90	110			
Sulfate		403	mg/L	1.0	101	90	110			
Lab ID: CCV	2	Continuing Calibration Verification Standard								11/03/17 02:55
Chloride		50.8	mg/L	1.0	102	90	110			
Sulfate		203	mg/L	1.0	102	90	110			
Method: E300.0								Batch: R129915		
Lab ID: ICB	2	Method Blank								Run: IC METROHM_171102A 11/02/17 14:46
Chloride		ND	mg/L	0.008						
Sulfate		ND	mg/L	0.08						
Lab ID: LFB	2	Laboratory Fortified Blank								Run: IC METROHM_171102A 11/02/17 15:15
Chloride		24.5	mg/L	1.0	98	90	110			
Sulfate		98.3	mg/L	1.0	98	90	110			
Lab ID: H17110040-004AMS	2	Sample Matrix Spike								Run: IC METROHM_171102A 11/03/17 06:04
Chloride		256	mg/L	1.0	101	90	110			
Sulfate		3330	mg/L	1.1	99	90	110			
Lab ID: H17110040-004AMSD	2	Sample Matrix Spike Duplicate								Run: IC METROHM_171102A 11/03/17 06:18
Chloride		254	mg/L	1.0	100	90	110	0.6	20	
Sulfate		3300	mg/L	1.1	97	90	110	0.7	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



Work Order Receipt Checklist

MT DEQ-Abandoned Mines

H17110040

Login completed by: Jessica C. Smith

Date Received: 11/2/2017

Reviewed by: BL2000\rtooke

Received by: RAT

Reviewed Date: 11/3/2017

Carrier name: Hand Del

Shipping container/cooler in good condition?	Yes ☒	No ☐	Not Present ☐
Custody seals intact on all shipping container(s)/cooler(s)?	Yes ☐	No ☐	Not Present ☒
Custody seals intact on all sample bottles?	Yes ☐	No ☐	Not Present ☒
Chain of custody present?	Yes ☒	No ☐	
Chain of custody signed when relinquished and received?	Yes ☒	No ☐	
Chain of custody agrees with sample labels?	Yes ☒	No ☐	
Samples in proper container/bottle?	Yes ☒	No ☐	
Sample containers intact?	Yes ☒	No ☐	
Sufficient sample volume for indicated test?	Yes ☒	No ☐	
All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.)	Yes ☒	No ☐	
Temp Blank received in all shipping container(s)/cooler(s)?	Yes ☒	No ☐	Not Applicable ☐
Container/Temp Blank temperature:	2.4°C On Ice		
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☒
Water - pH acceptable upon receipt?	Yes ☒	No ☐	Not Applicable ☐

Standard Reporting Procedures:

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

Contact and Corrective Action Comments:

Temp blank was received frozen, temp taken from sample. JCS 11/2/2017



Trust our People. Trust our Data.

Chain of Custody & Analytical Request Record

www.energylab.com

Account Information (Billing information)

Company/Name	DECC		
Contact	Tom Henderson		
Phone			
Mailing Address			
City, State, Zip			
Email	thenderson@mt.gov		
Receive Invoice	☐ Hard Copy	☒ Email	Receive Report
Purchase Order	Quote		☐ Hard Copy ☒ Email
			Bottle Order

Report Information (if different than Account Information)

Company/Name			
Contact			
Phone			
Mailing Address			
City, State, Zip			
Email			
Receive Report	☐ Hard Copy	☐ Email	
Special Report/Format:	☐ LEVEL IV ☐ NELAC ☐ EDD/EDT (contact laboratory) ☐ Other		

Comments

Page ____ of ____

Send email also to
Rye Swingen at
Ryes@hydrosci.com

Project Information

Project Name, PWSID, Permit, etc.	Sand Creek Source Control		
Sampler Name	Rye Swingen	Sampler Phone	406.671.2446
Sample Origin State	MT	EPA/State Compliance	☐ Yes ☒ No
MINING CLIENTS, please indicate sample type. *If one has been processed or refined, call before sending. ☐ Byproduct 11 (e)2 material ☐ Unprocessed ore (NOT ground or refined)*			

Matrix Codes

A - Air	
W - Water	
S - Solids	
V - Vegetation	
B - Bioassay	
O - Other	
DW - Drinking Water	

Analysis Requested

See Attached

All turnaround times are standard unless marked as RUSH.
Energy Laboratories MUST be contacted prior to RUSH sample submittal for charges and scheduling - See Instructions Page

EL LAB ID
Laboratory Use Only
H17110040

Sample Identification

Sample Identification (Name, Location, Interval, etc.)	Collection		Number of Containers	Matrix (See Codes Above)	Analysis Requested				RUSH TAT	EL LAB ID Laboratory Use Only
	Date	Time								
1 SC-3A	10/31/17	1420	2	W						
2 SC-1		1445								
3 SC-12		1525								
4 SC-4		1600								
5										
6										
7										
8										
9										
10										

Custody Record MUST be signed	Requester (print)	Date/Time	Signature	Received by (print)	Date/Time	Signature
	Rye Swingen	11/2/17 11:00	[Signature]		11/2/17 12:07	[Signature]

Shipped By	Cooler ID(s)	Custody Seals	Intact	Receipt Temp	Temp Blank	On Ice	CC	Cash	Check	Amount	Receipt Number (cash/check only)
Hand	Y	(N) C B	Y, N	2, 4 °C	(X) N	(X) N					

LABORATORY USE ONLY

Received by Laboratory (print)	Date/Time	Signature
Rye Swingen	11/2/17 12:07	[Signature]

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested.

This serves as notice of this possibility. All subcontracted data will be clearly notated on your analytical report.

~~Please run the following analyses on water sample MW 102K.~~

PHYSICAL PROPERTIES

pH ✓

TDS ✓

INORGANICS

Acidity, Total as CaCO_3 ✓

~~Alkalinity, Total as CaCO_3 ✓~~

Calcium, Magnesium, and Hardness as CaCO_3

Sulfate, Chloride, and Fluoride ✓

Sodium and Potassium ✓

Metals, ~~Dissolved~~ Total

Aluminum ✓

Antimony ✓

Arsenic ✓

Barium ✓

Beryllium ✓

Cadmium ✓

Chromium ✓

Copper ✓

Iron ✓

Lead ✓

Manganese ✓

Nickel ✓

Selenium ✓

Strontium ✓

Thallium ✓

Zinc ✓

Report Hardness

~~_____~~



ANALYTICAL SUMMARY REPORT

January 02, 2018

MT DEQ-Abandoned Mines

PO Box 200901

Helena, MT 59620-0901

Work Order: H17120178

Project Name: Sand Coulee Source Control

Energy Laboratories Inc Helena MT received the following 1 sample for MT DEQ-Abandoned Mines on 12/12/2017 for analysis.

Lab ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
H17120178-001	101K	12/11/17 13:53	12/12/17	Aqueous	Metals by ICP/ICPMS, Dissolved Alkalinity Conductivity Services Provided by Lab Fluoride Hardness Anions by Ion Chromatography pH Preparation, Dissolved Filtration

The analyses presented in this report were performed by Energy Laboratories, Inc., 3161 E. Lyndale Ave., Helena, MT 59604, unless otherwise noted. Any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative.

The results as reported relate only to the item(s) submitted for testing.

If you have any questions regarding these test results, please call.

Report Approved By:



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control
Lab ID: H17120178-001
Client Sample ID: 101K

Report Date: 01/02/18
Collection Date: 12/11/17 13:53
Date Received: 12/12/17
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	8.2	s.u.	H	0.1		A4500-H B	12/12/17 14:07 / SRW
INORGANICS							
Alkalinity, Total as CaCO ₃	330	mg/L		4		A2320 B	12/19/17 10:18 / SRW
Chloride	8	mg/L		1		E300.0	12/12/17 21:16 / SRW
Sulfate	96	mg/L		1		E300.0	12/19/17 21:18 / SRW
Fluoride	0.8	mg/L		0.1	4	A4500-F C	12/14/17 10:17 / kmd
Hardness as CaCO ₃	367	mg/L		1		A2340 B	12/20/17 12:15 / abc
METALS, DISSOLVED							
Aluminum	ND	mg/L		0.009		E200.8	12/22/17 16:03 / sld
Antimony	0.0005	mg/L		0.0005		E200.8	12/21/17 22:14 / dck
Arsenic	0.006	mg/L		0.001		E200.8	12/21/17 22:14 / dck
Barium	0.041	mg/L		0.003		E200.8	12/21/17 22:14 / dck
Beryllium	ND	mg/L		0.0008		E200.8	12/21/17 22:14 / dck
Cadmium	ND	mg/L		0.00003		E200.8	12/21/17 22:14 / dck
Calcium	67	mg/L		1		E200.7	12/20/17 12:15 / sld
Chromium	ND	mg/L		0.005		E200.8	12/21/17 22:14 / dck
Copper	ND	mg/L		0.002		E200.8	12/21/17 22:14 / dck
Iron	ND	mg/L		0.02		E200.7	12/15/17 12:31 / sld
Lead	ND	mg/L		0.0003		E200.8	12/21/17 22:14 / dck
Magnesium	49	mg/L		1		E200.7	12/20/17 12:15 / sld
Manganese	0.026	mg/L		0.001		E200.8	12/21/17 22:14 / dck
Nickel	0.007	mg/L		0.002		E200.8	12/21/17 22:14 / dck
Potassium	3	mg/L		1		E200.7	12/15/17 12:31 / sld
Selenium	ND	mg/L		0.001		E200.8	12/21/17 22:14 / dck
Sodium	15	mg/L		1		E200.7	12/15/17 12:31 / sld
Strontium	0.44	mg/L		0.01		E200.7	12/15/17 12:31 / sld
Thallium	ND	mg/L		0.0002		E200.8	12/21/17 22:14 / dck
Zinc	ND	mg/L		0.008		E200.8	12/21/17 22:14 / dck

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
H - Analysis performed past recommended holding time.

MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 01/02/18
Work Order: H17120178

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: A2320 B										Batch: R131091
Lab ID: MBLK										
Alkalinity, Total as CaCO ₃		2	mg/L	0.7						
Run: PHSC_101-H_171219A										
12/19/17 10:00										
Lab ID: LCS										
Alkalinity, Total as CaCO ₃		590	mg/L	4.0	98	90	110			
Run: PHSC_101-H_171219A										
12/19/17 10:06										
Lab ID: H17120178-001ADUP										
Alkalinity, Total as CaCO ₃		340	mg/L	4.0				1.2	10	
Run: PHSC_101-H_171219A										
12/19/17 10:29										

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 01/02/18
Work Order: H17120178

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: A4500-F C								Analytical Run: MANTECH 2_171214A		
Lab ID: ICV		Initial Calibration Verification Standard								12/14/17 09:43
Fluoride		0.8	mg/L	0.1	100	90	110			
Method: A4500-F C								Batch: R131005		
Lab ID: MBLK		Method Blank								12/14/17 09:49
Fluoride		0.02	mg/L	0.01						
Lab ID: H17120224-001AMS		Sample Matrix Spike								12/14/17 10:00
Fluoride		1.2	mg/L	0.1	106	85	115			
Lab ID: H17120224-002ADUP		Sample Duplicate								12/14/17 10:12
Fluoride		0.2	mg/L	0.1				0.0	10	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 01/02/18
Work Order: H17120178

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method:	A4500-H B							Analytical Run: PHSC_101-H_171212A		
Lab ID:	pH 7		Initial Calibration Verification Standard						12/12/17 08:45	
pH		7.0	s.u.	0.1	100	98	102			
Lab ID:	CCV - pH 7		Continuing Calibration Verification Standard						12/12/17 11:11	
pH		7.0	s.u.	0.1	100	98	102			
Method:	A4500-H B							Batch: R130912		
Lab ID:	H17120178-001ADUP		Sample Duplicate			Run: PHSC_101-H_171212A			12/12/17 14:09	
pH		8.2	s.u.	0.1				0.1	3	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 01/02/18
Work Order: H17120178

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7										Analytical Run: ICP2-HE_171215A
Lab ID: ICV	4	Initial Calibration Verification Standard								12/15/17 10:23
Iron		3.90	mg/L	0.020	98	95	105			
Potassium		39.8	mg/L	1.0	99	95	105			
Sodium		39.9	mg/L	1.0	100	95	105			
Strontium		0.787	mg/L	0.10	98	95	105			
Lab ID: CCV-1	4	Continuing Calibration Verification Standard								12/15/17 10:27
Iron		2.47	mg/L	0.020	99	95	105			
Potassium		24.7	mg/L	1.0	99	95	105			
Sodium		24.7	mg/L	1.0	99	95	105			
Strontium		2.48	mg/L	0.10	99	95	105			
Lab ID: ICSA	4	Interference Check Sample A								12/15/17 10:38
Iron		177	mg/L	0.020	89	80	120			
Potassium		-0.00528	mg/L	1.0		0	0			
Sodium		0.00893	mg/L	1.0		0	0			
Strontium		0.00459	mg/L	0.10		0	0			
Lab ID: ICSAB	4	Interference Check Sample AB								12/15/17 10:42
Iron		175	mg/L	0.020	88	80	120			
Potassium		20.1	mg/L	1.0	101	80	120			
Sodium		20.3	mg/L	1.0	101	80	120			
Strontium		0.976	mg/L	0.10	98	80	120			
Lab ID: CCV	4	Continuing Calibration Verification Standard								12/15/17 11:58
Iron		2.33	mg/L	0.020	93	90	110			
Potassium		26.5	mg/L	1.0	106	90	110			
Sodium		27.2	mg/L	1.0	109	90	110			
Strontium		2.42	mg/L	0.10	97	90	110			
Method: E200.7										Batch: R131063
Lab ID: MB	4	Method Blank							Run: ICP2-HE_171215A	12/15/17 10:50
Iron		ND	mg/L	0.002						
Potassium		ND	mg/L	0.05						
Sodium		ND	mg/L	0.02						
Strontium		ND	mg/L	0.0001						
Lab ID: LFB	4	Laboratory Fortified Blank							Run: ICP2-HE_171215A	12/15/17 10:53
Iron		4.81	mg/L	0.020	96	85	115			
Potassium		47.7	mg/L	1.0	95	85	115			
Sodium		47.7	mg/L	1.0	95	85	115			
Strontium		0.950	mg/L	0.10	95	85	115			
Lab ID: H17120208-002DMS2	4	Sample Matrix Spike							Run: ICP2-HE_171215A	12/15/17 12:58
Iron		9.24	mg/L	0.020	92	70	130			
Potassium		110	mg/L	1.0	106	70	130			
Sodium		643	mg/L	1.0		70	130			A

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 01/02/18
Work Order: H17120178

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7										Batch: R131063
Lab ID: H17120208-002DMS2	4	Sample Matrix Spike				Run: ICP2-HE_171215A				12/15/17 12:58
Strontium		4.55	mg/L	0.010	93	70	130			
Lab ID: H17120208-002DMSD	4	Sample Matrix Spike Duplicate				Run: ICP2-HE_171215A				12/15/17 13:02
Iron		9.19	mg/L	0.020	92	70	130	0.5	20	
Potassium		105	mg/L	1.0	101	70	130	4.6	20	
Sodium		620	mg/L	1.0		70	130	3.6	20	A
Strontium		4.47	mg/L	0.010	89	70	130	1.8	20	
Method: E200.7										Analytical Run: ICP2-HE_171220A
Lab ID: ICV	2	Initial Calibration Verification Standard								12/20/17 11:11
Calcium		39.3	mg/L	1.0	98	95	105			
Magnesium		38.8	mg/L	1.0	97	95	105			
Lab ID: CCV-1	2	Continuing Calibration Verification Standard								12/20/17 11:15
Calcium		24.9	mg/L	1.0	100	95	105			
Magnesium		24.2	mg/L	1.0	97	95	105			
Lab ID: ICSA	2	Interference Check Sample A								12/20/17 11:26
Calcium		414	mg/L	1.0	83	80	120			
Magnesium		473	mg/L	1.0	95	80	120			
Lab ID: ICSAB	2	Interference Check Sample AB								12/20/17 11:30
Calcium		418	mg/L	1.0	84	80	120			
Magnesium		478	mg/L	1.0	96	80	120			
Lab ID: CCV	2	Continuing Calibration Verification Standard								12/20/17 12:00
Calcium		23.4	mg/L	1.0	94	90	110			
Magnesium		22.9	mg/L	1.0	92	90	110			
Method: E200.7										Batch: R131158
Lab ID: MB	2	Method Blank				Run: ICP2-HE_171220A				12/20/17 11:38
Calcium		0.02	mg/L	0.01						
Magnesium		0.007	mg/L	0.005						
Lab ID: LFB	2	Laboratory Fortified Blank				Run: ICP2-HE_171220A				12/20/17 11:42
Calcium		45.4	mg/L	1.0	91	85	115			
Magnesium		46.1	mg/L	1.0	92	85	115			
Lab ID: H17120178-001BMS2	2	Sample Matrix Spike				Run: ICP2-HE_171220A				12/20/17 12:23
Calcium		112	mg/L	1.0	91	70	130			
Magnesium		96.4	mg/L	1.0	96	70	130			
Lab ID: H17120178-001BMSD	2	Sample Matrix Spike Duplicate				Run: ICP2-HE_171220A				12/20/17 12:26
Calcium		110	mg/L	1.0	87	70	130	1.8	20	
Magnesium		95.0	mg/L	1.0	93	70	130	1.6	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines

Report Date: 01/02/18

Project: Sand Coulee Source Control

Work Order: H17120178

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8								Analytical Run: ICPMS205-H_171221B		
Lab ID: ICV	13	Initial Calibration Verification Standard							12/21/17 10:02	
Antimony		0.0568	mg/L	0.050	95	90	110			
Arsenic		0.0578	mg/L	0.0050	96	90	110			
Barium		0.0583	mg/L	0.10	97	90	110			
Beryllium		0.0298	mg/L	0.0010	99	90	110			
Cadmium		0.0290	mg/L	0.0010	97	90	110			
Chromium		0.0581	mg/L	0.010	97	90	110			
Copper		0.0590	mg/L	0.010	98	90	110			
Lead		0.0572	mg/L	0.010	95	90	110			
Manganese		0.293	mg/L	0.010	98	90	110			
Nickel		0.0595	mg/L	0.010	99	90	110			
Selenium		0.0583	mg/L	0.0050	97	90	110			
Thallium		0.0594	mg/L	0.10	99	90	110			
Zinc		0.0598	mg/L	0.010	100	90	110			
Lab ID: ICSA	13	Interference Check Sample A							12/21/17 10:05	
Antimony		0.00133	mg/L	0.050						
Arsenic		0.000167	mg/L	0.0050						
Barium		0.000146	mg/L	0.10						
Beryllium		3.96E-05	mg/L	0.0010						
Cadmium		8.30E-05	mg/L	0.0010						
Chromium		0.00110	mg/L	0.010						
Copper		0.000177	mg/L	0.010						
Lead		0.000314	mg/L	0.010						
Manganese		0.000505	mg/L	0.010						
Nickel		0.000639	mg/L	0.010						
Selenium		0.000778	mg/L	0.0050						
Thallium		0.000145	mg/L	0.10						
Zinc		0.00113	mg/L	0.010						
Lab ID: ICSAB	13	Interference Check Sample AB							12/21/17 10:08	
Antimony		0.000472	mg/L	0.050		0	0			
Arsenic		0.0107	mg/L	0.0050	107	70	130			
Barium		0.000102	mg/L	0.10		0	0			
Beryllium		2.54E-05	mg/L	0.0010		0	0			
Cadmium		0.0103	mg/L	0.0010	103	70	130			
Chromium		0.0216	mg/L	0.010	108	70	130			
Copper		0.0205	mg/L	0.010	102	70	130			
Lead		0.000236	mg/L	0.010		0	0			
Manganese		0.0210	mg/L	0.010	105	70	130			
Nickel		0.0209	mg/L	0.010	105	70	130			
Selenium		0.0108	mg/L	0.0050	108	70	130			
Thallium		5.27E-05	mg/L	0.10		0	0			
Zinc		0.0114	mg/L	0.010	114	70	130			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines

Report Date: 01/02/18

Project: Sand Coulee Source Control

Work Order: H17120178

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8								Analytical Run: ICPMS205-H_171221B		
Lab ID: ICV	13	Initial Calibration Verification Standard							12/21/17 16:46	
Antimony		0.0584	mg/L	0.050	97	90	110			
Arsenic		0.0590	mg/L	0.0050	98	90	110			
Barium		0.0593	mg/L	0.10	99	90	110			
Beryllium		0.0281	mg/L	0.0010	94	90	110			
Cadmium		0.0296	mg/L	0.0010	99	90	110			
Chromium		0.0588	mg/L	0.010	98	90	110			
Copper		0.0594	mg/L	0.010	99	90	110			
Lead		0.0556	mg/L	0.010	93	90	110			
Manganese		0.298	mg/L	0.010	100	90	110			
Nickel		0.0594	mg/L	0.010	99	90	110			
Selenium		0.0578	mg/L	0.0050	96	90	110			
Thallium		0.0602	mg/L	0.10	100	90	110			
Zinc		0.0607	mg/L	0.010	101	90	110			
Lab ID: ICSA	13	Interference Check Sample A							12/21/17 16:48	
Antimony		0.00137	mg/L	0.050						
Arsenic		6.35E-05	mg/L	0.0050						
Barium		0.000172	mg/L	0.10						
Beryllium		5.80E-05	mg/L	0.0010						
Cadmium		3.20E-05	mg/L	0.0010						
Chromium		0.00118	mg/L	0.010						
Copper		0.000162	mg/L	0.010						
Lead		0.000301	mg/L	0.010						
Manganese		0.000416	mg/L	0.010						
Nickel		0.000628	mg/L	0.010						
Selenium		0.000688	mg/L	0.0050						
Thallium		0.000127	mg/L	0.10						
Zinc		0.000955	mg/L	0.010						
Lab ID: ICSAB	13	Interference Check Sample AB							12/21/17 16:51	
Antimony		0.000617	mg/L	0.050		0	0			
Arsenic		0.0110	mg/L	0.0050	110	70	130			
Barium		0.000269	mg/L	0.10		0	0			
Beryllium		0.000157	mg/L	0.0010		0	0			
Cadmium		0.0106	mg/L	0.0010	106	70	130			
Chromium		0.0221	mg/L	0.010	111	70	130			
Copper		0.0207	mg/L	0.010	103	70	130			
Lead		0.000388	mg/L	0.010		0	0			
Manganese		0.0216	mg/L	0.010	108	70	130			
Nickel		0.0211	mg/L	0.010	106	70	130			
Selenium		0.0112	mg/L	0.0050	112	70	130			
Thallium		0.000183	mg/L	0.10		0	0			
Zinc		0.0115	mg/L	0.010	115	70	130			

Method: E200.8

Batch: R131208

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines

Report Date: 01/02/18

Project: Sand Coulee Source Control

Work Order: H17120178

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8										Batch: R131208
Lab ID: LRB	13	Method Blank				Run: ICPMS205-H_171221B				12/21/17 10:22
Antimony		0.0001	mg/L	2E-05						
Arsenic		ND	mg/L	2E-05						
Barium		7E-05	mg/L	2E-05						
Beryllium		ND	mg/L	8E-05						
Cadmium		ND	mg/L	2E-05						
Chromium		ND	mg/L	3E-05						
Copper		0.0002	mg/L	4E-05						
Lead		2E-05	mg/L	1E-05						
Manganese		0.003	mg/L	3E-05						
Nickel		4E-05	mg/L	3E-05						
Selenium		ND	mg/L	3E-05						
Thallium		3E-05	mg/L	5E-06						
Zinc		0.0004	mg/L	0.0001						
Lab ID: LFB	13	Laboratory Fortified Blank				Run: ICPMS205-H_171221B				12/21/17 10:25
Antimony		0.0483	mg/L	0.050	96	85	115			
Arsenic		0.0492	mg/L	0.0050	98	85	115			
Barium		0.0485	mg/L	0.10	97	85	115			
Beryllium		0.0507	mg/L	0.0010	101	85	115			
Cadmium		0.0487	mg/L	0.0010	97	85	115			
Chromium		0.0492	mg/L	0.010	98	85	115			
Copper		0.0515	mg/L	0.010	102	85	115			
Lead		0.0479	mg/L	0.010	96	85	115			
Manganese		0.0492	mg/L	0.010	92	85	115			
Nickel		0.0505	mg/L	0.010	101	85	115			
Selenium		0.0483	mg/L	0.0050	97	85	115			
Thallium		0.0503	mg/L	0.10	100	85	115			
Zinc		0.0502	mg/L	0.010	100	85	115			
Lab ID: H17120208-001DMS	13	Sample Matrix Spike				Run: ICPMS205-H_171221B				12/21/17 22:23
Antimony		0.0495	mg/L	0.0010	99	70	130			
Arsenic		0.0537	mg/L	0.0010	103	70	130			
Barium		0.566	mg/L	0.050		70	130			A
Beryllium		0.0444	mg/L	0.0010	89	70	130			
Cadmium		0.0469	mg/L	0.0010	94	70	130			
Chromium		0.0470	mg/L	0.0050	94	70	130			
Copper		0.0466	mg/L	0.0050	92	70	130			
Lead		0.0446	mg/L	0.0010	89	70	130			
Manganese		0.996	mg/L	0.0010		70	130			A
Nickel		0.0463	mg/L	0.0050	92	70	130			
Selenium		0.0481	mg/L	0.0010	96	70	130			
Thallium		0.0502	mg/L	0.00050	100	70	130			
Zinc		0.0606	mg/L	0.010	98	70	130			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines

Report Date: 01/02/18

Project: Sand Coulee Source Control

Work Order: H17120178

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8										Batch: R131208
Lab ID:	H17120208-001DMSD	13	Sample Matrix Spike Duplicate		Run: ICPMS205-H_171221B				12/21/17 22:25	
Antimony		0.0497	mg/L	0.0010	99	70	130	0.4	20	
Arsenic		0.0540	mg/L	0.0010	103	70	130	0.6	20	
Barium		0.563	mg/L	0.050		70	130	0.5	20	A
Beryllium		0.0439	mg/L	0.0010	88	70	130	1.1	20	
Cadmium		0.0467	mg/L	0.0010	93	70	130	0.4	20	
Chromium		0.0475	mg/L	0.0050	95	70	130	1.0	20	
Copper		0.0471	mg/L	0.0050	93	70	130	1.1	20	
Lead		0.0449	mg/L	0.0010	90	70	130	0.6	20	
Manganese		0.991	mg/L	0.0010		70	130	0.5	20	A
Nickel		0.0471	mg/L	0.0050	93	70	130	1.8	20	
Selenium		0.0495	mg/L	0.0010	99	70	130	2.9	20	
Thallium		0.0504	mg/L	0.00050	101	70	130	0.5	20	
Zinc		0.0617	mg/L	0.010	100	70	130	1.7	20	
Method: E200.8										Analytical Run: ICPMS205-H_171222B
Lab ID:	ICV	Initial Calibration Verification Standard							12/22/17 10:44	
Aluminum		0.303	mg/L	0.10	101	90	110			
Lab ID:	ICSA	Interference Check Sample A							12/22/17 10:47	
Aluminum		42.6	mg/L	0.10	106	70	130			
Lab ID:	ICV	Initial Calibration Verification Standard							12/22/17 11:29	
Aluminum		0.293	mg/L	0.10	98	90	110			
Lab ID:	ICSA	Interference Check Sample A							12/22/17 11:32	
Aluminum		43.1	mg/L	0.10	108	70	130			
Lab ID:	ICSAB	Interference Check Sample AB							12/22/17 11:35	
Aluminum		42.2	mg/L	0.10	105	70	130			
Method: E200.8										Batch: R131247
Lab ID:	LRB	Method Blank		Run: ICPMS205-H_171222B				12/22/17 11:49		
Aluminum		0.004	mg/L	0.0007						
Lab ID:	LFB	Laboratory Fortified Blank		Run: ICPMS205-H_171222B				12/22/17 11:51		
Aluminum		0.0511	mg/L	0.10	95	85	115			
Lab ID:	H17120169-002BMS	Sample Matrix Spike		Run: ICPMS205-H_171222B				12/22/17 15:38		
Aluminum		0.0660	mg/L	0.030	72	70	130			
Lab ID:	H17120169-002BMSD	Sample Matrix Spike Duplicate		Run: ICPMS205-H_171222B				12/22/17 15:41		
Aluminum		0.0541	mg/L	0.030	48	70	130	20	20	S

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

S - Spike recovery outside of advisory limits.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 01/02/18
Work Order: H17120178

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E300.0										Analytical Run: IC METROHM_171212A
Lab ID: ICV		Initial Calibration Verification Standard								12/12/17 11:47
Chloride		103	mg/L	1.0	103	90	110			
Lab ID: CCV		Continuing Calibration Verification Standard								12/12/17 19:48
Chloride		51.1	mg/L	1.0	102	90	110			
Method: E300.0										Batch: R130972
Lab ID: ICB		Method Blank								12/12/17 11:33
Chloride		ND	mg/L	0.008						
Lab ID: LFB		Laboratory Fortified Blank								12/12/17 12:02
Chloride		24.6	mg/L	1.0	98	90	110			
Lab ID: H17120178-001AMS		Sample Matrix Spike								12/12/17 21:30
Chloride		33.6	mg/L	1.0	104	90	110			
Lab ID: H17120178-001AMSD		Sample Matrix Spike Duplicate								12/12/17 21:45
Chloride		33.4	mg/L	1.0	103	90	110	0.4	20	
Method: E300.0										Analytical Run: IC METROHM_171219A
Lab ID: ICV		Initial Calibration Verification Standard								12/19/17 09:24
Sulfate		412	mg/L	1.0	103	90	110			
Lab ID: CCV		Continuing Calibration Verification Standard								12/19/17 19:51
Sulfate		202	mg/L	1.0	101	90	110			
Method: E300.0										Batch: R131138
Lab ID: ICB		Method Blank								12/19/17 09:09
Sulfate		ND	mg/L	0.08						
Lab ID: LFB		Laboratory Fortified Blank								12/19/17 09:38
Sulfate		99.6	mg/L	1.0	100	90	110			
Lab ID: H17120178-001AMS		Sample Matrix Spike								12/19/17 21:33
Sulfate		198	mg/L	1.0	102	90	110			
Lab ID: H17120178-001AMSD		Sample Matrix Spike Duplicate								12/19/17 21:47
Sulfate		199	mg/L	1.0	103	90	110	0.4	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



Work Order Receipt Checklist

MT DEQ-Abandoned Mines

H17120178

Login completed by: Jessica C. Smith

Date Received: 12/12/2017

Reviewed by: BL2000\rtooke

Received by: TLL

Reviewed Date: 12/13/2017

Carrier name: Hand Del

Shipping container/cooler in good condition?	Yes ☒	No ☐	Not Present ☐
Custody seals intact on all shipping container(s)/cooler(s)?	Yes ☐	No ☐	Not Present ☒
Custody seals intact on all sample bottles?	Yes ☐	No ☐	Not Present ☒
Chain of custody present?	Yes ☒	No ☐	
Chain of custody signed when relinquished and received?	Yes ☒	No ☐	
Chain of custody agrees with sample labels?	Yes ☒	No ☐	
Samples in proper container/bottle?	Yes ☒	No ☐	
Sample containers intact?	Yes ☒	No ☐	
Sufficient sample volume for indicated test?	Yes ☒	No ☐	
All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.)	Yes ☒	No ☐	
Temp Blank received in all shipping container(s)/cooler(s)?	Yes ☒	No ☐	Not Applicable ☐
Container/Temp Blank temperature:	4.3°C On Ice		
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☒
Water - pH acceptable upon receipt?	Yes ☐	No ☒	Not Applicable ☐

Standard Reporting Procedures:

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

Contact and Corrective Action Comments:

Sample 101K for Dissolved Metals/Hardness was subsampled, filtered, and preserved to pH <2 with 2 mL of Nitric acid per 250 mL in the laboratory. According to 40CFR136, samples for Dissolved Metals should be filtered and preserved within 15 minutes of collection. Original metals bottle was preserved before filtration and per client that one should not be used. JCS 12/12/2107

Chain of Custody & Analytical Request Record

Account Information (Billing Information)

Company Name **DEA - AML**
 Contact **Tom Henderson**
 Phone **444-6492**
 Mailing Address
 City, State, Zip
 Email **thenderson@mt.gov**
 Receive Invoice ☐ Hard Copy ☒ Email
 Purchase Order ☐ Hard Copy ☐ Email
 Quote ☐ Bottle Order

Report Information (if different than Account Information)

Company Name **Scme**
 Contact
 Phone
 Mailing Address
 City, State, Zip
 Email
 Receive Report ☐ Hard Copy ☐ Email
 Special Report/Formats:
☐ LEVEL IV ☐ NELAC ☐ EDD/EDT (contact laboratory) ☐ Other

Comments

Project Information

Project Name, PWSID, Permit, etc. **Sand Cove State Control**
 Sampler Name **Sam Estabrook** Sampler Phone **444-6492**
 Sample Origin State **MT** EPA/State Compliance ☒ Yes ☐ No
 MINING CLIENTS, please indicate sample type:
☐ If one has been processed or refined, call before sending.
☐ Byproduct 11 (e)2 material ☐ Unprocessed ore (NOT ground or refined)*

Matrix Codes
 A - Air
 W - Water
 S - Soils/
 Solids
 V - Vegetation
 B - Bioassay
 O - Other
 DW - Drinking
 Water

Analysis Requested

See Attached

All turnaround times are standard unless marked as RUSH.
 Energy Laboratories MUST be contacted prior to RUSH sample submittal for charges and scheduling - See Instructions Page

ELI LAB ID
 Laboratory Use Only

H17120178

Sample Identification (Name, Location, Interval, etc.)	Collection		Number of Containers	Matrix (See Codes Above)	Analysis Requested		Signature	Date/Time
	Date	Time						
1 101K	12/11/17	1353	2	W	X	X		
2								
3								
4								
5								
6								
7								
8								
9								
10								

Custody Record MUST be signed
 Relinquished by (print) **Tom Henderson** Date/Time **12/11/17 1014A** Signature **[Signature]**
 Relinquished by (print) _____ Date/Time _____ Signature _____

LABORATORY USE ONLY

Shipped By **Hand** Cooler ID(s) **Y** Custody Seats **Y (N) C B** Intact **Y N** Receipt Temp **4.3 °C** Temp Blank **Y (N)** On Ice **Y (N)** Received by Laboratory (print) **[Signature]** Date/Time **12/11/17 9:42** Signature **[Signature]**
 Payment Type **Cash** Amount \$ _____ Receipt Number (attach check only) _____



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control
Lab ID: H17100405-001
Client Sample ID: MW102K

Report Date: 10/30/17
Collection Date: 10/18/17 12:00
Date Received: 10/19/17
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	7.3	s.u.	H	0.1		A4500-H B	10/19/17 14:09 / kmd
INORGANICS							
Alkalinity, Total as CaCO ₃	390	mg/L		4		A2320 B	10/20/17 09:06 / SRW
Chloride	22	mg/L		1		E300.0	10/20/17 10:09 / SRW
Sulfate	83	mg/L		1		E300.0	10/20/17 10:09 / SRW
Fluoride	0.9	mg/L		0.1	4	A4500-F C	10/20/17 09:10 / kmd
Hardness as CaCO ₃	489	mg/L		1		A2340 B	10/30/17 08:36 / sld
METALS, DISSOLVED							
Aluminum	ND	mg/L		0.009		E200.8	10/26/17 21:18 / dck
Antimony	ND	mg/L		0.0005		E200.8	10/25/17 17:21 / dck
Arsenic	ND	mg/L		0.001		E200.8	10/25/17 17:21 / dck
Barium	0.068	mg/L		0.003		E200.8	10/25/17 17:21 / dck
Beryllium	ND	mg/L		0.0008		E200.8	10/25/17 17:21 / dck
Cadmium	ND	mg/L		0.00003		E200.8	10/26/17 21:18 / dck
Calcium	90	mg/L		1		E200.7	10/27/17 14:25 / sld
Chromium	ND	mg/L		0.005		E200.8	10/25/17 17:21 / dck
Copper	ND	mg/L		0.002		E200.8	10/25/17 17:21 / dck
Iron	ND	mg/L		0.02		E200.8	10/25/17 17:21 / dck
Lead	ND	mg/L		0.0003		E200.8	10/25/17 17:21 / dck
Magnesium	64	mg/L		1		E200.7	10/27/17 14:25 / sld
Manganese	0.061	mg/L		0.001		E200.8	10/25/17 17:21 / dck
Nickel	ND	mg/L		0.002		E200.8	10/25/17 17:21 / dck
Potassium	4	mg/L		1		E200.8	10/25/17 17:21 / dck
Selenium	0.001	mg/L		0.001		E200.8	10/25/17 17:21 / dck
Sodium	19	mg/L		1		E200.8	10/26/17 21:18 / dck
Strontium	0.47	mg/L		0.01		E200.8	10/25/17 17:21 / dck
Thallium	ND	mg/L		0.0002		E200.8	10/25/17 17:21 / dck
Zinc	ND	mg/L		0.008		E200.8	10/25/17 17:21 / dck

Report Definitions: RL - Analyte reporting limit.
QCL - Quality control limit.
H - Analysis performed past recommended holding time.

MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.



ANALYTICAL SUMMARY REPORT

October 30, 2017

MT DEQ-Abandoned Mines

PO Box 200901

Helena, MT 59620-0901

Work Order: H17100405

Project Name: Sand Coulee Source Control

Energy Laboratories Inc Helena MT received the following 1 sample for MT DEQ-Abandoned Mines on 10/19/2017 for analysis.

Lab ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
H17100405-001	MW102K	10/18/17 12:00	10/19/17	Aqueous	Metals by ICP/ICPMS, Dissolved Alkalinity Conductivity Fluoride Hardness Anions by Ion Chromatography pH

The analyses presented in this report were performed by Energy Laboratories, Inc., 3161 E. Lyndale Ave., Helena, MT 59604, unless otherwise noted. Any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative.

The results as reported relate only to the item(s) submitted for testing.

If you have any questions regarding these test results, please call.

Report Approved By:



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control
Lab ID: H17100405-001
Client Sample ID: MW102K

Report Date: 10/30/17
Collection Date: 10/18/17 12:00
Date Received: 10/19/17
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	7.3	s.u.	H	0.1		A4500-H B	10/19/17 14:09 / kmd
INORGANICS							
Alkalinity, Total as CaCO ₃	390	mg/L		4		A2320 B	10/20/17 09:06 / SRW
Chloride	22	mg/L		1		E300.0	10/20/17 10:09 / SRW
Sulfate	83	mg/L		1		E300.0	10/20/17 10:09 / SRW
Fluoride	0.9	mg/L		0.1	4	A4500-F C	10/20/17 09:10 / kmd
Hardness as CaCO ₃	489	mg/L		1		A2340 B	10/30/17 08:36 / sld
METALS, DISSOLVED							
Aluminum	ND	mg/L		0.009		E200.8	10/26/17 21:18 / dck
Antimony	ND	mg/L		0.0005		E200.8	10/25/17 17:21 / dck
Arsenic	ND	mg/L		0.001		E200.8	10/25/17 17:21 / dck
Barium	0.068	mg/L		0.003		E200.8	10/25/17 17:21 / dck
Beryllium	ND	mg/L		0.0008		E200.8	10/25/17 17:21 / dck
Cadmium	ND	mg/L		0.00003		E200.8	10/26/17 21:18 / dck
Calcium	90	mg/L		1		E200.7	10/27/17 14:25 / sld
Chromium	ND	mg/L		0.005		E200.8	10/25/17 17:21 / dck
Copper	ND	mg/L		0.002		E200.8	10/25/17 17:21 / dck
Iron	ND	mg/L		0.02		E200.8	10/25/17 17:21 / dck
Lead	ND	mg/L		0.0003		E200.8	10/25/17 17:21 / dck
Magnesium	64	mg/L		1		E200.7	10/27/17 14:25 / sld
Manganese	0.061	mg/L		0.001		E200.8	10/25/17 17:21 / dck
Nickel	ND	mg/L		0.002		E200.8	10/25/17 17:21 / dck
Potassium	4	mg/L		1		E200.8	10/25/17 17:21 / dck
Selenium	0.001	mg/L		0.001		E200.8	10/25/17 17:21 / dck
Sodium	19	mg/L		1		E200.8	10/26/17 21:18 / dck
Strontium	0.47	mg/L		0.01		E200.8	10/25/17 17:21 / dck
Thallium	ND	mg/L		0.0002		E200.8	10/25/17 17:21 / dck
Zinc	ND	mg/L		0.008		E200.8	10/25/17 17:21 / dck

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
H - Analysis performed past recommended holding time.

MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 10/30/17
Work Order: H17100405

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: A2320 B										Batch: R129487
Lab ID: MBLK		Method Blank					Run: PHSC_101-H_171020A			10/20/17 08:49
Alkalinity, Total as CaCO ₃	2		mg/L	0.7						
Lab ID: LCS										10/20/17 08:55
Laboratory Control Sample							Run: PHSC_101-H_171020A			
Alkalinity, Total as CaCO ₃	580		mg/L	4.0	96	90	110			
Lab ID: H17100405-001ADUP										10/20/17 09:16
Sample Duplicate							Run: PHSC_101-H_171020A			
Alkalinity, Total as CaCO ₃	400		mg/L	4.0				2.8	10	
Lab ID: H17100428-015ADUP										10/20/17 11:11
Sample Duplicate							Run: PHSC_101-H_171020A			
Alkalinity, Total as CaCO ₃	140		mg/L	4.0				0.9	10	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 10/30/17
Work Order: H17100405

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method:	A4500-F C							Analytical Run: MANTECH 2_171019B		
Lab ID:	ICV	Initial Calibration Verification Standard							10/20/17 08:59	
Fluoride		0.8	mg/L	0.1	100	90	110			
Method:	A4500-F C							Batch: R129513		
Lab ID:	MBLK	Method Blank				Run: MANTECH 2_171019B			10/20/17 09:05	
Fluoride		0.02	mg/L	0.01						
Lab ID:	H17100405-001AMS	Sample Matrix Spike				Run: MANTECH 2_171019B			10/20/17 09:15	
Fluoride		1.9	mg/L	0.1	102	85	115			
Lab ID:	H17100428-001ADUP	Sample Duplicate				Run: MANTECH 2_171019B			10/20/17 09:27	
Fluoride		0.1	mg/L	0.1				0.0	10	
Lab ID:	H17100428-010ADUP	Sample Duplicate				Run: MANTECH 2_171019B			10/20/17 10:36	
Fluoride		0.3	mg/L	0.1				0.0	10	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 10/30/17
Work Order: H17100405

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method:	A4500-H B							Analytical Run: PHSC_101-H_171019A		
Lab ID:	pH 7		Initial Calibration Verification Standard						10/19/17 08:34	
pH		7.0	s.u.	0.1	99	98	102			
Lab ID:	CCV - pH 7		Continuing Calibration Verification Standard						10/19/17 13:44	
pH		7.0	s.u.	0.1	100	98	102			
Method:	A4500-H B							Batch: R129446		
Lab ID:	H17100414-019BDUP		Sample Duplicate			Run: PHSC_101-H_171019A			10/19/17 13:57	
pH		9.0	s.u.	0.1				0.0	3	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 10/30/17
Work Order: H17100405

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7										Analytical Run: ICP2-HE_171027B
Lab ID: ICV	2	Initial Calibration Verification Standard								10/27/17 09:42
Calcium		39.2	mg/L	1.0	98	95	105			
Magnesium		39.1	mg/L	1.0	98	95	105			
Lab ID: CCV-1	2	Continuing Calibration Verification Standard								10/27/17 09:46
Calcium		25.1	mg/L	1.0	101	95	105			
Magnesium		24.5	mg/L	1.0	98	95	105			
Lab ID: ICSA	2	Interference Check Sample A								10/27/17 09:57
Calcium		452	mg/L	1.0	90	80	120			
Magnesium		508	mg/L	1.0	102	80	120			
Lab ID: ICSAB	2	Interference Check Sample AB								10/27/17 10:01
Calcium		474	mg/L	1.0	95	80	120			
Magnesium		534	mg/L	1.0	107	80	120			
Lab ID: CCV	2	Continuing Calibration Verification Standard								10/27/17 14:02
Calcium		25.3	mg/L	1.0	101	90	110			
Magnesium		24.5	mg/L	1.0	98	90	110			
Method: E200.7										Batch: R129739
Lab ID: MB	2	Method Blank								Run: ICP2-HE_171027B 10/27/17 10:08
Calcium		0.03	mg/L	0.01						
Magnesium		0.008	mg/L	0.005						
Lab ID: LFB	2	Laboratory Fortified Blank								Run: ICP2-HE_171027B 10/27/17 10:12
Calcium		51.5	mg/L	1.0	103	85	115			
Magnesium		52.7	mg/L	1.0	105	85	115			
Lab ID: H17100405-001BMS2	2	Sample Matrix Spike								Run: ICP2-HE_171027B 10/27/17 14:32
Calcium		132	mg/L	1.0	85	70	130			
Magnesium		110	mg/L	1.0	91	70	130			
Lab ID: H17100405-001BMSD	2	Sample Matrix Spike Duplicate								Run: ICP2-HE_171027B 10/27/17 14:36
Calcium		140	mg/L	1.0	100	70	130	5.6	20	
Magnesium		117	mg/L	1.0	105	70	130	6.4	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines

Report Date: 10/30/17

Project: Sand Coulee Source Control

Work Order: H17100405

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8								Analytical Run: ICPMS205-H_171025A		
Lab ID: ICV	15	Initial Calibration Verification Standard							10/25/17 10:01	
Antimony		0.0629	mg/L	0.050	105	90	110			
Arsenic		0.0601	mg/L	0.0050	100	90	110			
Barium		0.0615	mg/L	0.10	102	90	110			
Beryllium		0.0302	mg/L	0.0010	101	90	110			
Chromium		0.0609	mg/L	0.010	102	90	110			
Copper		0.0610	mg/L	0.010	102	90	110			
Iron		0.310	mg/L	0.020	103	90	110			
Lead		0.0603	mg/L	0.010	101	90	110			
Manganese		0.309	mg/L	0.010	103	90	110			
Nickel		0.0619	mg/L	0.010	103	90	110			
Potassium		3.11	mg/L	0.50	104	90	110			
Selenium		0.0582	mg/L	0.0050	97	90	110			
Strontium		0.0605	mg/L	0.10	101	90	110			
Thallium		0.0600	mg/L	0.10	100	90	110			
Zinc		0.0621	mg/L	0.010	104	90	110			
Lab ID: ICSA	15	Interference Check Sample A							10/25/17 10:03	
Antimony		0.000277	mg/L	0.050						
Arsenic		1.84E-05	mg/L	0.0050						
Barium		0.000102	mg/L	0.10						
Beryllium		-3.33E-05	mg/L	0.0010						
Chromium		0.000967	mg/L	0.010						
Copper		0.000202	mg/L	0.010						
Iron		96.8	mg/L	0.020	97	70	130			
Lead		0.000204	mg/L	0.010						
Manganese		0.000227	mg/L	0.010						
Nickel		4.97E-05	mg/L	0.010						
Potassium		38.3	mg/L	0.50	96	70	130			
Selenium		0.000102	mg/L	0.0050						
Strontium		0.000366	mg/L	0.10						
Thallium		-1.01E-05	mg/L	0.10						
Zinc		0.000827	mg/L	0.010						
Lab ID: ICSAB	15	Interference Check Sample AB							10/25/17 10:05	
Antimony		9.06E-05	mg/L	0.050		0	0			
Arsenic		0.0114	mg/L	0.0050	114	70	130			
Barium		0.000259	mg/L	0.10		0	0			
Beryllium		-3.40E-05	mg/L	0.0010		0	0			
Chromium		0.0230	mg/L	0.010	115	70	130			
Copper		0.0221	mg/L	0.010	110	70	130			
Iron		96.9	mg/L	0.020	97	70	130			
Lead		0.000190	mg/L	0.010		0	0			
Manganese		0.0225	mg/L	0.010	112	70	130			
Nickel		0.0220	mg/L	0.010	110	70	130			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines

Report Date: 10/30/17

Project: Sand Coulee Source Control

Work Order: H17100405

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8						Analytical Run: ICPMS205-H_171025A				
Lab ID: ICSAB	15	Interference Check Sample AB							10/25/17 10:05	
Potassium		38.4	mg/L	0.50	96	70	130			
Selenium		0.0112	mg/L	0.0050	112	70	130			
Strontium		0.000412	mg/L	0.10		0	0			
Thallium		-3.66E-05	mg/L	0.10		0	0			
Zinc		0.0121	mg/L	0.010	121	70	130			
Lab ID: ICV	15	Initial Calibration Verification Standard							10/25/17 16:05	
Antimony		0.0596	mg/L	0.050	99	90	110			
Arsenic		0.0577	mg/L	0.0050	96	90	110			
Barium		0.0593	mg/L	0.10	99	90	110			
Beryllium		0.0296	mg/L	0.0010	99	90	110			
Chromium		0.0589	mg/L	0.010	98	90	110			
Copper		0.0591	mg/L	0.010	98	90	110			
Iron		0.296	mg/L	0.020	99	90	110			
Lead		0.0578	mg/L	0.010	96	90	110			
Manganese		0.297	mg/L	0.010	99	90	110			
Nickel		0.0600	mg/L	0.010	100	90	110			
Potassium		3.00	mg/L	0.50	100	90	110			
Selenium		0.0578	mg/L	0.0050	96	90	110			
Strontium		0.0586	mg/L	0.10	98	90	110			
Thallium		0.0562	mg/L	0.10	94	90	110			
Zinc		0.0602	mg/L	0.010	100	90	110			
Lab ID: ICSA	15	Interference Check Sample A							10/25/17 16:07	
Antimony		0.000277	mg/L	0.050						
Arsenic		2.51E-05	mg/L	0.0050						
Barium		0.000120	mg/L	0.10						
Beryllium		3.33E-05	mg/L	0.0010						
Chromium		0.00101	mg/L	0.010						
Copper		0.000221	mg/L	0.010						
Iron		98.3	mg/L	0.020	98	70	130			
Lead		0.000222	mg/L	0.010						
Manganese		0.000214	mg/L	0.010						
Nickel		0.000440	mg/L	0.010						
Potassium		39.4	mg/L	0.50	99	70	130			
Selenium		0.000102	mg/L	0.0050						
Strontium		0.000435	mg/L	0.10						
Thallium		2.70E-05	mg/L	0.10						
Zinc		0.000901	mg/L	0.010						
Lab ID: ICSAB	15	Interference Check Sample AB							10/25/17 16:09	
Antimony		0.000116	mg/L	0.050		0	0			
Arsenic		0.0114	mg/L	0.0050	114	70	130			
Barium		0.000212	mg/L	0.10		0	0			
Beryllium		4.74E-05	mg/L	0.0010		0	0			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines

Report Date: 10/30/17

Project: Sand Coulee Source Control

Work Order: H17100405

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method:	E200.8	Analytical Run: ICPMS205-H_171025A								
Lab ID:	ICSAB	15	Interference Check Sample AB							10/25/17 16:09
Chromium		0.0235	mg/L	0.010	118	70	130			
Copper		0.0222	mg/L	0.010	111	70	130			
Iron		98.6	mg/L	0.020	99	70	130			
Lead		0.000213	mg/L	0.010		0	0			
Manganese		0.0225	mg/L	0.010	113	70	130			
Nickel		0.0226	mg/L	0.010	113	70	130			
Potassium		39.3	mg/L	0.50	98	70	130			
Selenium		0.0111	mg/L	0.0050	111	70	130			
Strontium		0.000375	mg/L	0.10		0	0			
Thallium		1.46E-06	mg/L	0.10		0	0			
Zinc		0.0122	mg/L	0.010	122	70	130			
Method:	E200.8									Batch: R129639
Lab ID:	LFB	15	Laboratory Fortified Blank				Run: ICPMS205-H_171025A			10/25/17 10:47
Antimony		0.0518	mg/L	0.050	104	85	115			
Arsenic		0.0511	mg/L	0.0050	102	85	115			
Barium		0.0512	mg/L	0.10	102	85	115			
Beryllium		0.0538	mg/L	0.0010	108	85	115			
Chromium		0.0511	mg/L	0.010	102	85	115			
Copper		0.0526	mg/L	0.010	104	85	115			
Iron		0.157	mg/L	0.020	105	85	115			
Lead		0.0504	mg/L	0.010	101	85	115			
Manganese		0.0518	mg/L	0.010	103	85	115			
Nickel		0.0522	mg/L	0.010	104	85	115			
Potassium		1.00	mg/L	0.50	100	85	115			
Selenium		0.0500	mg/L	0.0050	100	85	115			
Strontium		0.0518	mg/L	0.10	104	85	115			
Thallium		0.0504	mg/L	0.10	101	85	115			
Zinc		0.0544	mg/L	0.010	108	85	115			
Lab ID:	LRB	15	Method Blank				Run: ICPMS205-H_171025A			10/25/17 17:07
Antimony		ND	mg/L	2E-05						
Arsenic		ND	mg/L	2E-05						
Barium		ND	mg/L	2E-05						
Beryllium		ND	mg/L	8E-05						
Chromium		3E-05	mg/L	3E-05						
Copper		ND	mg/L	4E-05						
Iron		ND	mg/L	0.002						
Lead		1E-05	mg/L	1E-05						
Manganese		ND	mg/L	3E-05						
Nickel		ND	mg/L	3E-05						
Potassium		ND	mg/L	0.009						
Selenium		4E-05	mg/L	3E-05						
Strontium		ND	mg/L	2E-05						

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines

Report Date: 10/30/17

Project: Sand Coulee Source Control

Work Order: H17100405

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8										Batch: R129639
Lab ID: LRB	15	Method Blank				Run: ICPMS205-H_171025A				10/25/17 17:07
Thallium		ND	mg/L	5E-06						
Zinc		0.0006	mg/L	0.0001						
Lab ID: H17100198-012BMS	15	Sample Matrix Spike				Run: ICPMS205-H_171025A				10/25/17 17:29
Antimony		0.0480	mg/L	0.0010	94	70	130			
Arsenic		0.0784	mg/L	0.0010	99	70	130			
Barium		0.0625	mg/L	0.050	92	70	130			
Beryllium		0.0471	mg/L	0.0010	94	70	130			
Chromium		0.0477	mg/L	0.0050	95	70	130			
Copper		0.0486	mg/L	0.0050	95	70	130			
Iron		0.144	mg/L	0.020	96	70	130			
Lead		0.0476	mg/L	0.0010	95	70	130			
Manganese		0.0512	mg/L	0.0010	95	70	130			
Nickel		0.0479	mg/L	0.0050	96	70	130			
Potassium		4.98	mg/L	1.0	100	70	130			
Selenium		0.0473	mg/L	0.0010	94	70	130			
Strontium		0.505	mg/L	0.010		70	130			A
Thallium		0.0466	mg/L	0.00050	93	70	130			
Zinc		0.0556	mg/L	0.010	98	70	130			
Lab ID: H17100198-012BMSD	15	Sample Matrix Spike Duplicate				Run: ICPMS205-H_171025A				10/25/17 17:31
Antimony		0.0494	mg/L	0.0010	97	70	130	2.9	20	
Arsenic		0.0800	mg/L	0.0010	102	70	130	2.0	20	
Barium		0.0647	mg/L	0.050	97	70	130	3.4	20	
Beryllium		0.0484	mg/L	0.0010	97	70	130	2.9	20	
Chromium		0.0492	mg/L	0.0050	98	70	130	3.1	20	
Copper		0.0498	mg/L	0.0050	98	70	130	2.4	20	
Iron		0.147	mg/L	0.020	98	70	130	2.4	20	
Lead		0.0484	mg/L	0.0010	97	70	130	1.6	20	
Manganese		0.0534	mg/L	0.0010	100	70	130	4.2	20	
Nickel		0.0491	mg/L	0.0050	98	70	130	2.6	20	
Potassium		5.08	mg/L	1.0	110	70	130	1.9	20	
Selenium		0.0494	mg/L	0.0010	98	70	130	4.3	20	
Strontium		0.513	mg/L	0.010		70	130	1.6	20	A
Thallium		0.0473	mg/L	0.00050	95	70	130	1.6	20	
Zinc		0.0580	mg/L	0.010	103	70	130	4.1	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines

Report Date: 10/30/17

Project: Sand Coulee Source Control

Work Order: H17100405

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8						Analytical Run: ICPMS205-H_171026A				
Lab ID: ICV	3	Initial Calibration Verification Standard								10/26/17 09:26
Aluminum		0.301	mg/L	0.10	100	90	110			
Cadmium		0.0291	mg/L	0.0010	97	90	110			
Sodium		2.90	mg/L	0.50	97	90	110			
Lab ID: ICSA	3	Interference Check Sample A								10/26/17 09:28
Aluminum		41.2	mg/L	0.10	103	70	130			
Cadmium		2.42E-05	mg/L	0.0010						
Sodium		98.2	mg/L	0.50	98	70	130			
Lab ID: ICSAB	3	Interference Check Sample AB								10/26/17 09:30
Aluminum		42.9	mg/L	0.10	107	70	130			
Cadmium		0.0109	mg/L	0.0010	109	70	130			
Sodium		98.5	mg/L	0.50	99	70	130			
Lab ID: ICV	3	Initial Calibration Verification Standard								10/26/17 14:41
Aluminum		0.294	mg/L	0.10	98	90	110			
Cadmium		0.0292	mg/L	0.0010	97	90	110			
Sodium		3.00	mg/L	0.50	100	90	110			
Lab ID: ICSA	3	Interference Check Sample A								10/26/17 14:43
Aluminum		38.6	mg/L	0.10	96	70	130			
Cadmium		7.26E-06	mg/L	0.0010						
Sodium		97.8	mg/L	0.50	98	70	130			
Lab ID: ICSAB	3	Interference Check Sample AB								10/26/17 14:45
Aluminum		38.4	mg/L	0.10	96	70	130			
Cadmium		0.0110	mg/L	0.0010	110	70	130			
Sodium		98.3	mg/L	0.50	98	70	130			
Method: E200.8						Batch: R129659				
Lab ID: LRB	3	Method Blank				Run: ICPMS205-H_171026A			10/26/17 09:45	
Aluminum		ND	mg/L	0.0007						
Cadmium		ND	mg/L	2E-05						
Sodium		ND	mg/L	0.006						
Lab ID: LFB	3	Laboratory Fortified Blank				Run: ICPMS205-H_171026A			10/26/17 09:47	
Aluminum		0.0471	mg/L	0.10	94	85	115			
Cadmium		0.0480	mg/L	0.0010	96	85	115			
Sodium		0.864	mg/L	0.50	86	85	115			
Lab ID: H17100428-014BMS	3	Sample Matrix Spike				Run: ICPMS205-H_171026A			10/26/17 21:44	
Aluminum		0.0445	mg/L	0.030	89	70	130			
Cadmium		0.0526	mg/L	0.0010	105	70	130			
Sodium		10.0	mg/L	1.0		70	130			A
Lab ID: H17100428-014BMSD	3	Sample Matrix Spike Duplicate				Run: ICPMS205-H_171026A			10/26/17 21:46	
Aluminum		0.0442	mg/L	0.030	88	70	130	0.7	20	

Qualifiers:

RL - Analyte reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines

Report Date: 10/30/17

Project: Sand Coulee Source Control

Work Order: H17100405

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8		Batch: R129659								
Lab ID: H17100428-014BMSD	3	Sample Matrix Spike Duplicate				Run: ICPMS205-H_171026A				10/26/17 21:46
Cadmium		0.0503	mg/L	0.0010	101	70	130	4.4	20	
Sodium		9.63	mg/L	1.0		70	130	4.2	20	A

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 10/30/17
Work Order: H17100405

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E300.0								Analytical Run: IC METROHM_171019A		
Lab ID: ICV	2	Initial Calibration Verification Standard								10/19/17 09:29
Chloride		101	mg/L	1.0	101	90	110			
Sulfate		416	mg/L	1.0	104	90	110			
Lab ID: CCV	2	Continuing Calibration Verification Standard								10/20/17 07:27
Chloride		53.8	mg/L	1.0	108	90	110			
Sulfate		220	mg/L	1.0	110	90	110			
Method: E300.0								Batch: R129504		
Lab ID: ICB	2	Method Blank								Run: IC METROHM_171019A 10/19/17 09:16
Chloride		0.01	mg/L	0.008						
Sulfate		ND	mg/L	0.08						
Lab ID: LFB	2	Laboratory Fortified Blank								Run: IC METROHM_171019A 10/19/17 09:43
Chloride		24.1	mg/L	1.0	96	90	110			
Sulfate		99.0	mg/L	1.0	99	90	110			
Lab ID: H17100405-001AMS	2	Sample Matrix Spike								Run: IC METROHM_171019A 10/20/17 10:23
Chloride		48.0	mg/L	1.0	105	90	110			
Sulfate		189	mg/L	1.0	106	90	110			
Lab ID: H17100405-001AMSD	2	Sample Matrix Spike Duplicate								Run: IC METROHM_171019A 10/20/17 10:36
Chloride		48.0	mg/L	1.0	105	90	110	0.2	20	
Sulfate		189	mg/L	1.0	107	90	110	0.1	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



Work Order Receipt Checklist

MT DEQ-Abandoned Mines

H17100405

Login completed by: Jessica C. Smith

Date Received: 10/19/2017

Reviewed by: BL2000\rtooke

Received by: TLL

Reviewed Date: 10/24/2017

Carrier name: Hand Del

Shipping container/cooler in good condition?	Yes ☒	No ☐	Not Present ☐
Custody seals intact on all shipping container(s)/cooler(s)?	Yes ☐	No ☐	Not Present ☒
Custody seals intact on all sample bottles?	Yes ☐	No ☐	Not Present ☒
Chain of custody present?	Yes ☒	No ☐	
Chain of custody signed when relinquished and received?	Yes ☒	No ☐	
Chain of custody agrees with sample labels?	Yes ☐	No ☒	
Samples in proper container/bottle?	Yes ☒	No ☐	
Sample containers intact?	Yes ☒	No ☐	
Sufficient sample volume for indicated test?	Yes ☒	No ☐	
All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.)	Yes ☒	No ☐	
Temp Blank received in all shipping container(s)/cooler(s)?	Yes ☒	No ☐	Not Applicable ☐
Container/Temp Blank temperature:	1.0°C On Ice		
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☒
Water - pH acceptable upon receipt?	Yes ☒	No ☐	Not Applicable ☐

Standard Reporting Procedures:

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

Contact and Corrective Action Comments:

ID on COC is MW102K -ID on sample is MW-102K. Used ID from COC. JCS 10/19/2017 Do not analyze for acidity per T. Henderson. wj 10/24/17



Trust our People. Trust our Data.

Chain of Custody & Analytical Request Record

www.energylab.com

Account Information (Billing Information)

Company/Name	DEF		
Contact	Tom Henderson		
Phone			
Mailing Address			
City, State, Zip			
Email	Henderson@energylab.com		
Receive Invoice	☐ Hard Copy	☒ Email	Receivable Report ☐ Hard Copy ☒ Email
Purchase Order	Quote	Bottle Order	

Report Information (if different than Account Information)

Company/Name			
Contact			
Phone			
Mailing Address			
City, State, Zip			
Email			
Receive Report	☐ Hard Copy	☐ Email	Special Report/Forms:
			☐ LEVEL IV ☐ NELAC ☐ EDD/EDT (contact laboratory) ☐ Other

Comments

Page 1 of 1

Project Information

Project Name, PWSID, Permit, etc.	Sand Creek Service Contract		
Sampler Name	Rys Sungen	Sampler Phone	406 6712446
Sample Origin State	MT	EPA/State Compliance	☒ Yes ☐ No
MINING CLIENTS, please indicate sample type. If ore has been processed or refined, call before sending. ☐ Byproduct 11 (e2 material) ☐ Unprocessed ore (NOT ground or refined)*			

Matrix Codes

- A - Air
- W - Water
- S - Soils/Solids
- V - Vegetation
- B - Bioassay
- O - Other
- DW - Drinking Water

Analysis Requested

See Attached

All turnaround times are standard unless marked as RUSH.
Energy Laboratories MUST be contacted prior to RUSH sample submittal for charges and scheduling - See Instructions Page

ELU LAB ID

Laboratory Use Only

H17100405

Sample Identification

(Name, Location, Interval, etc.)

1 M1102K

10/19/17 1200

2

Per email Tom Henderson (attached)

Custody Record MUST be signed

Required by (print)

Rys Sungen

10/18/17 1745

Signature

Signature

Signature

Signature

Signature

Signature

Signature

Signature

Signature

Signature

Signature

Signature

Signature

Signature

Shipped By

Hard

Cooler ID(s)

Y

Custody Seals

Y

Intact

Y

Receipt Temp

1.0 °C

Temp Blank

Y

Office

CC

Cash

Check

Payment Type

Amount

Receipt Number (cash/check only)

Signature

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All subcontracted data will be clearly notated on your analytical report.

Please run the following analyses on water sample MW-102K:

PHYSICAL PROPERTIES

pH ✓

INORGANICS

Acidity, Total as CaCO_3 ✓

Alkalinity, Total as CaCO_3 ✓

Calcium, Magnesium, and Hardness as CaCO_3

Sulfate, Chloride, and Fluoride ✓

Sodium and Potassium ✓

Metals, Dissolved

Aluminum ✓

Antimony ✓

Arsenic ✓

Barium ✓

Beryllium ✓

Cadmium ✓

Chromium ✓

Copper ✓

Iron ✓

Lead ✓

Manganese ✓

Nickel ✓

Selenium ✓

Strontium ✓

Thallium ✓

Zinc ✓



ANALYTICAL SUMMARY REPORT

October 25, 2017

MT DEQ-Abandoned Mines

PO Box 200901

Helena, MT 59620-0901

Work Order: H17100299

Project Name: Sand Coulee Source Control

Energy Laboratories Inc Helena MT received the following 1 sample for MT DEQ-Abandoned Mines on 10/13/2017 for analysis.

Lab ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
H17100299-001	MW-103K	10/12/17 11:25	10/13/17	Aqueous	Metals by ICP/ICPMS, Dissolved Alkalinity Conductivity Fluoride Anions by Ion Chromatography pH

The analyses presented in this report were performed by Energy Laboratories, Inc., 3161 E. Lyndale Ave., Helena, MT 59604, unless otherwise noted. Any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative.

The results as reported relate only to the item(s) submitted for testing.

If you have any questions regarding these test results, please call.

Report Approved By:



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control
Lab ID: H17100299-001
Client Sample ID: MW-103K

Report Date: 10/25/17
Collection Date: 10/12/17 11:25
Date Received: 10/13/17
Matrix: Aqueous

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL PROPERTIES							
pH	7.2	s.u.	H	0.1		A4500-H B	10/13/17 16:14 / kmd
INORGANICS							
Alkalinity, Total as CaCO ₃	370	mg/L		4		A2320 B	10/16/17 14:27 / kmd
Chloride	15	mg/L		1		E300.0	10/14/17 18:13 / SRW
Sulfate	98	mg/L		1		E300.0	10/14/17 18:13 / SRW
Fluoride	0.8	mg/L		0.1	4	A4500-F C	10/16/17 12:24 / kmd
METALS, DISSOLVED							
Aluminum	ND	mg/L		0.009		E200.8	10/22/17 20:26 / sld
Antimony	ND	mg/L		0.0005		E200.8	10/22/17 20:26 / sld
Arsenic	0.006	mg/L		0.001		E200.8	10/22/17 20:26 / sld
Barium	0.067	mg/L		0.003		E200.8	10/22/17 20:26 / sld
Beryllium	ND	mg/L		0.0008		E200.8	10/22/17 20:26 / sld
Cadmium	0.00034	mg/L		0.00003		E200.8	10/24/17 16:57 / dck
Calcium	89	mg/L		1		E200.7	10/17/17 16:47 / sld
Chromium	ND	mg/L		0.01		E200.8	10/22/17 20:26 / sld
Copper	0.007	mg/L		0.002		E200.8	10/22/17 20:26 / sld
Iron	0.05	mg/L		0.02		E200.8	10/22/17 20:26 / sld
Lead	0.0015	mg/L		0.0003		E200.8	10/22/17 20:26 / sld
Magnesium	59	mg/L		1		E200.7	10/17/17 16:47 / sld
Manganese	0.016	mg/L		0.001		E200.8	10/22/17 20:26 / sld
Nickel	0.016	mg/L		0.002		E200.8	10/24/17 16:57 / dck
Potassium	4	mg/L		1		E200.7	10/17/17 16:47 / sld
Selenium	0.001	mg/L		0.001		E200.8	10/22/17 20:26 / sld
Sodium	17	mg/L		1		E200.7	10/17/17 16:47 / sld
Strontium	0.48	mg/L		0.02		E200.8	10/22/17 20:26 / sld
Thallium	ND	mg/L		0.0002		E200.8	10/22/17 20:26 / sld
Zinc	0.045	mg/L		0.008		E200.8	10/22/17 20:26 / sld

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
H - Analysis performed past recommended holding time.

MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 10/25/17
Work Order: H17100299

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: A2320 B										Batch: R129329
Lab ID: MBLK		Method Blank					Run: PHSC_101-H_171016A			10/16/17 12:48
Alkalinity, Total as CaCO ₃	2	mg/L		0.7						
Lab ID: LCS										10/16/17 12:54
Laboratory Control Sample							Run: PHSC_101-H_171016A			
Alkalinity, Total as CaCO ₃	570	mg/L		4.0	96	90	110			
Lab ID: H17100299-001ADUP										10/16/17 14:38
Sample Duplicate							Run: PHSC_101-H_171016A			
Alkalinity, Total as CaCO ₃	380	mg/L		4.0				2.3	10	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 10/25/17
Work Order: H17100299

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: A4500-F C								Analytical Run: MANTECH 2_171016A		
Lab ID: ICV		Initial Calibration Verification Standard								10/16/17 10:08
Fluoride		0.8	mg/L	0.1	100	90	110			
Lab ID: CCV 2		Continuing Calibration Verification Standard								10/16/17 11:28
Fluoride		1.0	mg/L	0.1	105	90	110			
Method: A4500-F C								Batch: R129347		
Lab ID: MBLK		Method Blank								10/16/17 10:13
Fluoride		0.02	mg/L	0.01				Run: MANTECH 2_171016A		
Lab ID: H17100262-001AMS		Sample Matrix Spike								10/16/17 10:24
Fluoride		1.1	mg/L	0.1	109	85	115	Run: MANTECH 2_171016A		
Lab ID: H17100262-002ADUP		Sample Duplicate								10/16/17 10:36
Fluoride		0.0	mg/L	0.1				Run: MANTECH 2_171016A		10
Lab ID: H17100262-011ADUP		Sample Duplicate								10/16/17 11:45
Fluoride		0.0	mg/L	0.1				Run: MANTECH 2_171016A		10

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines

Report Date: 10/25/17

Project: Sand Coulee Source Control

Work Order: H17100299

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method:	A4500-H B							Analytical Run: PHSC_101-H_171013A		
Lab ID:	pH 7	Initial Calibration Verification Standard							10/13/17 08:40	
pH		7.0	s.u.	0.1	99	98	102			
Lab ID:	CCV - pH 7	Continuing Calibration Verification Standard							10/13/17 10:11	
pH		7.0	s.u.	0.1	100	98	102			
Method:	A4500-H B							Batch: R129289		
Lab ID:	H17100299-001ADUP	Sample Duplicate				Run: PHSC_101-H_171013A				10/13/17 16:16
pH		7.2	s.u.	0.1				0.0	3	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines

Report Date: 10/25/17

Project: Sand Coulee Source Control

Work Order: H17100299

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7										Analytical Run: ICP2-HE_171017B
Lab ID: ICV	4	Initial Calibration Verification Standard								10/17/17 10:24
Calcium		39.1	mg/L	1.0	98	95	105			
Magnesium		39.3	mg/L	1.0	98	95	105			
Potassium		40.4	mg/L	1.0	101	95	105			
Sodium		40.4	mg/L	1.0	101	95	105			
Lab ID: CCV-1	4	Continuing Calibration Verification Standard								10/17/17 10:28
Calcium		24.6	mg/L	1.0	98	95	105			
Magnesium		24.3	mg/L	1.0	97	95	105			
Potassium		25.1	mg/L	1.0	100	95	105			
Sodium		25.1	mg/L	1.0	100	95	105			
Lab ID: ICSA	4	Interference Check Sample A								10/17/17 10:39
Calcium		429	mg/L	1.0	86	80	120			
Magnesium		481	mg/L	1.0	96	80	120			
Potassium		-0.0130	mg/L	1.0		0	0			
Sodium		0.0393	mg/L	1.0		0	0			
Lab ID: ICSAB	4	Interference Check Sample AB								10/17/17 10:43
Calcium		426	mg/L	1.0	85	80	120			
Magnesium		477	mg/L	1.0	95	80	120			
Potassium		20.7	mg/L	1.0	103	80	120			
Sodium		21.1	mg/L	1.0	106	80	120			
Lab ID: CCV	4	Continuing Calibration Verification Standard								10/17/17 16:21
Calcium		24.4	mg/L	1.0	98	90	110			
Magnesium		23.8	mg/L	1.0	95	90	110			
Potassium		24.0	mg/L	1.0	96	90	110			
Sodium		24.2	mg/L	1.0	97	90	110			
Method: E200.7										Batch: R129394
Lab ID: MB	4	Method Blank								Run: ICP2-HE_171017B 10/17/17 10:51
Calcium		0.04	mg/L	0.01						
Magnesium		0.02	mg/L	0.005						
Potassium		ND	mg/L	0.05						
Sodium		ND	mg/L	0.02						
Lab ID: LFB	4	Laboratory Fortified Blank								Run: ICP2-HE_171017B 10/17/17 10:54
Calcium		47.0	mg/L	1.0	94	85	115			
Magnesium		47.8	mg/L	1.0	96	85	115			
Potassium		50.9	mg/L	1.0	102	85	115			
Sodium		51.3	mg/L	1.0	103	85	115			
Lab ID: H17100316-002BMS2	4	Sample Matrix Spike								Run: ICP2-HE_171017B 10/17/17 17:03
Calcium		62.9	mg/L	1.0	97	70	130			
Magnesium		55.5	mg/L	1.0	99	70	130			
Potassium		49.4	mg/L	1.0	97	70	130			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines

Report Date: 10/25/17

Project: Sand Coulee Source Control

Work Order: H17100299

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7										Batch: R129394
Lab ID: H17100316-002BMS2	4	Sample Matrix Spike				Run: ICP2-HE_171017B				10/17/17 17:03
Sodium		51.5	mg/L	1.0	97	70	130			
Lab ID: H17100316-002BMSD	4	Sample Matrix Spike Duplicate				Run: ICP2-HE_171017B				10/17/17 17:14
Calcium		63.0	mg/L	1.0	97	70	130	0.2	20	
Magnesium		55.5	mg/L	1.0	99	70	130	0.0	20	
Potassium		49.9	mg/L	1.0	98	70	130	1.0	20	
Sodium		52.0	mg/L	1.0	98	70	130	0.9	20	

Qualifiers:

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ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines

Report Date: 10/25/17

Project: Sand Coulee Source Control

Work Order: H17100299

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8								Analytical Run: ICPMS205-H_171022B		
Lab ID: ICV	14	Initial Calibration Verification Standard							10/22/17 16:14	
Aluminum		0.286	mg/L	0.10	95	90	110			
Antimony		0.0594	mg/L	0.050	99	90	110			
Arsenic		0.0589	mg/L	0.0050	98	90	110			
Barium		0.0584	mg/L	0.10	97	90	110			
Beryllium		0.0297	mg/L	0.0010	99	90	110			
Chromium		0.0593	mg/L	0.010	99	90	110			
Copper		0.0589	mg/L	0.010	98	90	110			
Iron		0.303	mg/L	0.020	101	90	110			
Lead		0.0569	mg/L	0.010	95	90	110			
Manganese		0.299	mg/L	0.010	100	90	110			
Selenium		0.0580	mg/L	0.0050	97	90	110			
Strontium		0.0582	mg/L	0.10	97	90	110			
Thallium		0.0575	mg/L	0.10	96	90	110			
Zinc		0.0606	mg/L	0.010	101	90	110			
Lab ID: ICSA	14	Interference Check Sample A							10/22/17 16:16	
Aluminum		42.0	mg/L	0.10	105	70	130			
Antimony		0.000199	mg/L	0.050						
Arsenic		4.24E-05	mg/L	0.0050						
Barium		0.000101	mg/L	0.10						
Beryllium		2.33E-05	mg/L	0.0010						
Chromium		0.00106	mg/L	0.010						
Copper		0.000253	mg/L	0.010						
Iron		105	mg/L	0.020	105	70	130			
Lead		0.000230	mg/L	0.010						
Manganese		0.000301	mg/L	0.010						
Selenium		6.51E-05	mg/L	0.0050						
Strontium		0.000420	mg/L	0.10						
Thallium		2.23E-07	mg/L	0.10						
Zinc		0.000962	mg/L	0.010						
Lab ID: ICSAB	14	Interference Check Sample AB							10/22/17 16:18	
Aluminum		39.9	mg/L	0.10	100	70	130			
Antimony		9.28E-05	mg/L	0.050		0	0			
Arsenic		0.0118	mg/L	0.0050	118	70	130			
Barium		0.000480	mg/L	0.10		0	0			
Beryllium		-5.42E-05	mg/L	0.0010		0	0			
Chromium		0.0238	mg/L	0.010	119	70	130			
Copper		0.0226	mg/L	0.010	113	70	130			
Iron		101	mg/L	0.020	101	70	130			
Lead		0.000211	mg/L	0.010		0	0			
Manganese		0.0230	mg/L	0.010	115	70	130			
Selenium		0.0114	mg/L	0.0050	115	70	130			
Strontium		0.000425	mg/L	0.10		0	0			

Qualifiers:

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QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines

Report Date: 10/25/17

Project: Sand Coulee Source Control

Work Order: H17100299

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8								Analytical Run: ICPMS205-H_171022B		
Lab ID: ICSAB	14	Interference Check Sample AB							10/22/17 16:18	
Thallium		-2.22E-05	mg/L	0.10		0	0			
Zinc		0.0125	mg/L	0.010	125	70	130			
Method: E200.8								Batch: R129538		
Lab ID: LRB	14	Method Blank							Run: ICPMS205-H_171022B 10/22/17 16:42	
Aluminum		ND	mg/L	0.0007						
Antimony		2E-05	mg/L	2E-05						
Arsenic		ND	mg/L	2E-05						
Barium		ND	mg/L	2E-05						
Beryllium		ND	mg/L	8E-05						
Chromium		ND	mg/L	3E-05						
Copper		ND	mg/L	4E-05						
Iron		ND	mg/L	0.002						
Lead		1E-05	mg/L	1E-05						
Manganese		ND	mg/L	3E-05						
Selenium		ND	mg/L	3E-05						
Strontium		ND	mg/L	2E-05						
Thallium		ND	mg/L	5E-06						
Zinc		ND	mg/L	0.0001						
Lab ID: LFB	14	Laboratory Fortified Blank							Run: ICPMS205-H_171022B 10/22/17 16:44	
Aluminum		0.0460	mg/L	0.10	92	85	115			
Antimony		0.0493	mg/L	0.050	99	85	115			
Arsenic		0.0493	mg/L	0.0050	99	85	115			
Barium		0.0500	mg/L	0.10	100	85	115			
Beryllium		0.0485	mg/L	0.0010	97	85	115			
Chromium		0.0498	mg/L	0.010	100	85	115			
Copper		0.0498	mg/L	0.010	100	85	115			
Iron		0.150	mg/L	0.020	100	85	115			
Lead		0.0487	mg/L	0.010	97	85	115			
Manganese		0.0498	mg/L	0.010	100	85	115			
Selenium		0.0492	mg/L	0.0050	98	85	115			
Strontium		0.0500	mg/L	0.10	100	85	115			
Thallium		0.0482	mg/L	0.10	96	85	115			
Zinc		0.0508	mg/L	0.010	102	85	115			
Lab ID: H17100293-001BMS	14	Sample Matrix Spike							Run: ICPMS205-H_171022B 10/22/17 20:06	
Aluminum		0.0499	mg/L	0.030	100	70	130			
Antimony		0.0506	mg/L	0.0010	101	70	130			
Arsenic		0.0512	mg/L	0.0010	101	70	130			
Barium		0.348	mg/L	0.050		70	130			A
Beryllium		0.0518	mg/L	0.0010	104	70	130			
Chromium		0.0503	mg/L	0.0050	99	70	130			
Copper		0.0500	mg/L	0.0050	98	70	130			
Iron		0.148	mg/L	0.020	99	70	130			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 10/25/17
Work Order: H17100299

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8										Batch: R129538
Lab ID: H17100293-001BMS	14	Sample Matrix Spike				Run: ICPMS205-H_171022B				10/22/17 20:06
Lead		0.0495	mg/L	0.0010	99	70	130			
Manganese		0.0504	mg/L	0.0010	100	70	130			
Selenium		0.0508	mg/L	0.0010	101	70	130			
Strontium		0.162	mg/L	0.010	98	70	130			
Thallium		0.0497	mg/L	0.00050	99	70	130			
Zinc		0.0518	mg/L	0.010	101	70	130			
Lab ID: H17100293-001BMSD	14	Sample Matrix Spike Duplicate				Run: ICPMS205-H_171022B				10/22/17 20:08
Aluminum		0.0490	mg/L	0.030	98	70	130	1.9	20	
Antimony		0.0506	mg/L	0.0010	101	70	130	0.2	20	
Arsenic		0.0515	mg/L	0.0010	102	70	130	0.5	20	
Barium		0.347	mg/L	0.050		70	130	0.0	20	A
Beryllium		0.0505	mg/L	0.0010	101	70	130	2.4	20	
Chromium		0.0504	mg/L	0.0050	99	70	130	0.1	20	
Copper		0.0503	mg/L	0.0050	99	70	130	0.7	20	
Iron		0.148	mg/L	0.020	99	70	130	0.2	20	
Lead		0.0495	mg/L	0.0010	99	70	130	0.0	20	
Manganese		0.0499	mg/L	0.0010	99	70	130	0.9	20	
Selenium		0.0514	mg/L	0.0010	102	70	130	1.0	20	
Strontium		0.163	mg/L	0.010	100	70	130	0.5	20	
Thallium		0.0497	mg/L	0.00050	99	70	130	0.0	20	
Zinc		0.0513	mg/L	0.010	100	70	130	0.9	20	

Qualifiers:

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ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 10/25/17
Work Order: H17100299

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8							Analytical Run: ICPMS205-H_171024A			
Lab ID: ICV	2	Initial Calibration Verification Standard								10/24/17 13:14
Cadmium		0.0290	mg/L	0.0010	97	90	110			
Nickel		0.0589	mg/L	0.010	98	90	110			
Lab ID: ICSA	2	Interference Check Sample A								10/24/17 13:16
Cadmium		1.93E-05	mg/L	0.0010						
Nickel		0.000115	mg/L	0.010						
Lab ID: ICSAB	2	Interference Check Sample AB								10/24/17 13:18
Cadmium		0.0110	mg/L	0.0010	110	70	130			
Nickel		0.0225	mg/L	0.010	112	70	130			
Method: E200.8							Batch: R129607			
Lab ID: LRB	2	Method Blank								Run: ICPMS205-H_171024A 10/24/17 13:33
Cadmium		ND	mg/L	2E-05						
Nickel		ND	mg/L	3E-05						
Lab ID: LFB	2	Laboratory Fortified Blank								Run: ICPMS205-H_171024A 10/24/17 13:36
Cadmium		0.0490	mg/L	0.0010	98	85	115			
Nickel		0.0497	mg/L	0.010	99	85	115			
Lab ID: H17100293-002BMS	2	Sample Matrix Spike								Run: ICPMS205-H_171024A 10/24/17 16:35
Cadmium		0.0483	mg/L	0.0010	96	70	130			
Nickel		0.0651	mg/L	0.0050	95	70	130			
Lab ID: H17100293-002BMSD	2	Sample Matrix Spike Duplicate								Run: ICPMS205-H_171024A 10/24/17 16:37
Cadmium		0.0484	mg/L	0.0010	96	70	130	0.1	20	
Nickel		0.0652	mg/L	0.0050	96	70	130	0.1	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



QA/QC Summary Report

Prepared by Helena, MT Branch

Client: MT DEQ-Abandoned Mines
Project: Sand Coulee Source Control

Report Date: 10/25/17
Work Order: H17100299

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E300.0								Analytical Run: IC METROHM_171013A		
Lab ID: ICV	2	Initial Calibration Verification Standard								10/13/17 10:18
Chloride		102	mg/L	1.0	102	90	110			
Sulfate		420	mg/L	1.0	105	90	110			
Lab ID: CCV	2	Continuing Calibration Verification Standard								10/14/17 15:44
Chloride		52.5	mg/L	1.0	105	90	110			
Sulfate		214	mg/L	1.0	107	90	110			
Method: E300.0								Batch: R129330		
Lab ID: ICB	2	Method Blank								Run: IC METROHM_171013A 10/13/17 10:05
Chloride		0.01	mg/L	0.008						
Sulfate		ND	mg/L	0.08						
Lab ID: LFB	2	Laboratory Fortified Blank								Run: IC METROHM_171013A 10/13/17 10:32
Chloride		24.1	mg/L	1.0	96	90	110			
Sulfate		98.5	mg/L	1.0	98	90	110			
Lab ID: H17100291-009HMS	2	Sample Matrix Spike								Run: IC METROHM_171013A 10/14/17 16:52
Chloride		25.5	mg/L	1.0	102	90	110			
Sulfate		105	mg/L	1.0	105	90	110			
Lab ID: H17100291-009HMSD	2	Sample Matrix Spike Duplicate								Run: IC METROHM_171013A 10/14/17 17:05
Chloride		25.5	mg/L	1.0	102	90	110	0.0	20	
Sulfate		105	mg/L	1.0	105	90	110	0.1	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



Work Order Receipt Checklist

MT DEQ-Abandoned Mines

H17100299

Login completed by: Jessica C. Smith

Date Received: 10/13/2017

Reviewed by: BL2000\wjohnson

Received by: TLL

Reviewed Date: 10/18/2017

Carrier name: Hand Del

Shipping container/cooler in good condition?	Yes ☒	No ☐	Not Present ☐
Custody seals intact on all shipping container(s)/cooler(s)?	Yes ☐	No ☐	Not Present ☒
Custody seals intact on all sample bottles?	Yes ☐	No ☐	Not Present ☒
Chain of custody present?	Yes ☒	No ☐	
Chain of custody signed when relinquished and received?	Yes ☒	No ☐	
Chain of custody agrees with sample labels?	Yes ☒	No ☐	
Samples in proper container/bottle?	Yes ☒	No ☐	
Sample containers intact?	Yes ☒	No ☐	
Sufficient sample volume for indicated test?	Yes ☒	No ☐	
All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.)	Yes ☒	No ☐	
Temp Blank received in all shipping container(s)/cooler(s)?	Yes ☒	No ☐	Not Applicable ☐
Container/Temp Blank temperature:	1.3°C On Ice		
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☒
Water - pH acceptable upon receipt?	Yes ☒	No ☐	Not Applicable ☐

Standard Reporting Procedures:

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

Contact and Corrective Action Comments:

Per client Acidity does not need to be analyzed. wj 10/16/17

Account Information *(Billing information)*

Company Name Same

Contact _____

Phone _____

Mailing Address _____

City, State, Zip _____

Email _____

Receive Report ☐ Hard Copy ☐ Email

Special Report/Forms: ☐ LEVEL IV ☐ NELAC ☐ ED/EDT (contact laboratory) ☐ Other _____

Page 1 of 1

Matrix Codes

A - Air
W - Water
S - Soils/ Solids
V - Vegetation
B - Bioassay
O - Other
DW - Drinking Water

Collection		Number of Containers	Matrix (See Codes)
Date	Time		

[illegible]

All turnaround times are standard unless marked as RUSH.

Energy Laboratories
MUST be contacted prior to RUSH sample submittal for charges and scheduling – See Instructions Page

**RUSH
TAT**

ELI LAB ID

Laboratory Use Only

This serves as notice of this possibility. All subcontracted data will be clearly notated on your analytical report.

Tracy Lorash

From: Henderson, Thomas <THenderson@mt.gov>
Sent: Friday, October 13, 2017 1:45 PM
To: Wanda Johnson; tlorash@energylab.com
Subject: Water sample MW-103K

Please run the following analyses on water sample MW-103K, delivered at 1145 this morning:

PHYSICAL PROPERTIES
pH

INORGANICS
Acidity, Total as CaCO₃ ✓
Alkalinity, Total as CaCO₃ ✓
Calcium, Magnesium, and Hardness as CaCO₃
Sulfate, Chloride, and Fluoride
Sodium and Potassium

Metals, Dissolved
Aluminum ✓
Antimony ✓
Arsenic ✓
Barium ✓
Beryllium ✓
Cadmium ✓
Chromium ✓
Copper ✓
Iron ✓
Lead ✓
Manganese ✓
Nickel ✓
Selenium ✓
Strontium ✓
Thallium ✓
Zinc ✓

Thank you!

Tom

Tom Henderson
Abandoned Mines Section
Montana DEQ Remediation Division
(406) 444-6492
thenderson@mt.gov

Appendix G

Survey Results

BASIS OF CONTROL

HORIZONTAL DATUM: NAD83 (NA2011) (EPOCH 2010.0000).

MONTANA STATE PLANE COORDINATE SYSTEM INTERNATIONAL FEET

ALL DISTANCES, BEARINGS AND COORDINATES ARE GRID VALUES

VERTICAL DATUM: NAVD88 US SURVEY FEET

1	1148315.606	1551809.737	3675.911	SURV PPC
2	1147402.107	1549631.567	3779.513	PROP ALCAP2" KENDALL 18576S
2000	1147395.763	1549671.239	3777.357	GRND
2001	1147396.132	1549671.674	3777.626	CONC
2002	1147397.048	1549672.195	3779.278	WELL MW-104K
2003	1148615.877	1553032.162	3557.985	SC-3A - MINE ADIT
2004	1148626.337	1553022.268	3553.198	CL STRM
2005	1148640.232	1553008.483	3550.832	TOP DAM
2006	1148640.227	1553009.241	3550.163	INVERT PIPE
2007	1148644.577	1553001.924	3550.104	OUTLET
2008	1148653.230	1552990.476	3547.747	OUTLET
2009	1150208.126	1552708.347	3537.563	SC-8 - MINE ADIT
2010	1150230.610	1552726.352	3535.929	K_BOTTOM 1
2011	1150158.625	1552439.325	3557.058	K_BOTTOM 2
2012	1150161.629	1552195.650	3569.466	K_BOTTOM 3
2013	1150151.722	1552216.639	3567.629	GRND
2014	1150141.119	1552261.102	3566.294	GRND
2015	1150141.381	1552313.152	3562.861	GRND
2016	1150142.623	1552364.065	3560.808	GRND
2017	1150153.715	1552408.022	3558.180	GRND
2018	1150158.332	1552441.400	3556.460	GRND
2019	1150169.094	1552472.040	3550.949	GRND
2020	1150173.965	1552478.735	3541.833	GRND @POOL
2021	1150202.992	1552527.013	3541.816	GRND
2022	1150233.509	1552569.575	3541.068	GRND
2023	1150236.657	1552613.339	3539.326	GRND
2024	1150238.377	1552667.167	3537.417	GRND
2025	1150215.477	1552782.141	3532.952	GRND
2026	1150215.464	1552782.679	3533.269	WEIR
2027	1150203.516	1552839.633	3529.541	GRND
2028	1150201.952	1552905.925	3528.763	GRND
2029	1147473.982	1548749.864	3778.361	GRND
2030	1147471.840	1548749.806	3777.977	KUNKEL - 2 WELLS - MW - PRIVATE SHALLOW
2031	1147275.057	1548716.362	3774.348	KUNKEL - 2 WELLS - MW - PRIVATE DEEP
2032	1147275.418	1548715.836	3780.877	TOP CONC
2033	1147275.918	1548715.836	3780.477	GRND
2034	1145985.705	1549663.106	3728.567	GRND
2035	1145984.269	1549663.477	3730.482	L1 DEEP - MW L1-172
2036	1145986.460	1549658.661	3729.498	L1-40
2037	1145986.129	1549658.894	3729.029	GRND
2040	1145216.824	1549648.175	3667.729	LARAQUE STOCK NORTH
2043	1144855.692	1549568.039	3676.807	LARAQUE STOCK SOUTH
2044	1144816.179	1549392.883	3679.828	GRND
2045	1144818.011	1549393.705	3680.313	CONC
2046	1144818.937	1549393.850	3681.456	MW-102K

BASIS OF CONTROL

HORIZONTAL DATUM: NAD83 (NA2011) (EPOCH 2010.0000).

MONTANA STATE PLANE COORDINATE SYSTEM INTERNATIONAL FEET

ALL DISTANCES, BEARINGS AND COORDINATES ARE GRID VALUES

VERTICAL DATUM: NAVD88 US SURVEY FEET

2047	1144762.311	1549520.760	3678.594	GRND
2048	1144763.143	1549521.469	3679.187	WELL CHARTIER ON-LIP
2049	1144749.233	1549552.019	3676.767	GRND
2050	1144947.483	1549504.940	3676.917	GRND
2051	1144947.965	1549505.263	3678.226	WELL LAROQUE DOMESTIC SOUTH ON-LIP
2052	1144954.228	1549644.305	3670.532	GRND
2053	1145106.063	1549704.825	3668.381	GRND
2054	1145380.781	1549808.935	3660.072	GRND
2055	1145551.263	1549884.170	3656.225	SC_BOTTOM 9
2056	1145616.666	1550095.737	3651.681	GRND
2057	1145635.659	1550073.839	3653.819	GRND
2058	1145636.510	1550075.244	3655.391	HARVEY LA ROCQUE DOMESTIC - MW - PRIVATE
2059	1145734.453	1550172.868	3649.990	GRND
2060	1145801.394	1550135.048	3648.621	GRND
2061	1145865.849	1550226.078	3646.376	GRND
2062	1145959.793	1550363.382	3644.192	GRND
2063	1146110.295	1550269.005	3648.081	MW-103K
2064	1146108.750	1550268.011	3646.202	GRND
2065	1146109.151	1550268.541	3646.616	CONC
2066	1146147.350	1550447.272	3639.179	SC_BOTTOM 8
2067	1146192.685	1550388.884	3637.823	GRND
2068	1146138.496	1551093.378	3733.784	GRND
2069	1146139.902	1551094.149	3735.489	C4 - MW
2070	1146349.138	1550626.842	3629.519	SC_BOTTOM 7
2071	1146432.045	1550658.591	3628.338	GRND
2072	1146468.987	1550675.837	3626.942	GRND
2073	1146641.425	1550709.301	3624.864	GRND
2074	1146708.242	1550808.240	3620.443	SC_BOTTOM 6
2075	1146631.760	1550837.757	3623.825	C5 - MW SHALLOW
2076	1146633.768	1550840.701	3624.054	C5 DEEP - MW
2077	1146633.698	1550837.843	3624.190	GRND
2078	1146604.949	1550964.480	3615.551	GRND
2079	1146602.861	1551038.817	3613.826	GRND
2080	1146667.931	1551186.103	3612.026	GRND
2081	1146735.557	1551228.234	3610.196	GRND
2082	1147001.981	1551156.993	3605.676	GRND
2083	1147085.245	1551149.727	3603.849	SC_BOTTOM 5
2084	1147083.201	1551165.516	3605.060	SINKHOLE
2085	1147171.503	1551234.354	3601.379	GRND
2086	1147206.470	1551376.071	3597.766	GRND
2087	1147336.241	1551439.669	3594.016	GRND
2088	1147368.652	1551493.749	3592.240	SC_BOTTOM 4
2089	1147391.042	1551621.332	3589.342	GRND
2090	1147456.601	1551636.331	3586.724	SC_BOTTOM 3
2091	1147503.368	1551699.446	3584.862	GRND
2092	1147574.526	1551742.525	3583.443	GRND

BASIS OF CONTROL

HORIZONTAL DATUM: NAD83 (NA2011) (EPOCH 2010.0000).

MONTANA STATE PLANE COORDINATE SYSTEM INTERNATIONAL FEET

ALL DISTANCES, BEARINGS AND COORDINATES ARE GRID VALUES

VERTICAL DATUM: NAVD88 US SURVEY FEET

2093	1147595.080	1551765.058	3583.045	SC_BOTTOM 2
2094	1147633.794	1551911.856	3580.636	GRND
2095	1147951.656	1552090.414	3575.123	GRND
2096	1147952.314	1552091.619	3578.034	C7 - MW
2097	1146829.118	1552199.118	3726.914	C3 SHALLOW - MW
2098	1146821.576	1552191.811	3726.645	C3 MEDIUM - MW
2099	1146828.622	1552198.628	3725.863	GRND
2100	1146821.615	1552191.332	3725.836	GRND
2101	1146813.404	1552182.835	3725.385	GRND
2102	1146814.393	1552183.852	3726.744	C3 DEEP - MW
2103	1147656.507	1552629.073	3712.419	GRND
2104	1147657.722	1552629.919	3714.672	MW C9
2105	1147536.977	1553268.437	3574.584	SC-1 - MINE ADIT @TOP-CONC
2106	1147545.701	1553259.154	3571.225	INVERT
2107	1151387.773	1554684.150	3546.890	SC-12 - MINE ADIT @BOTTOM-CONC
2108	1151389.348	1554679.487	3547.617	INVERT
2109	1148862.530	1549367.379	3713.300	WYLDER - NORTH
2110	1148861.237	1549366.491	3712.143	GRND
2111	1148861.545	1549366.878	3712.797	CONC
2112	1148754.178	1549380.467	3719.012	WYLDER - SOUTH @LIP
2113	1148754.433	1549380.904	3717.649	GRND
2114	1148042.939	1549371.269	3760.016	MW-101K
2115	1148041.761	1549369.811	3758.063	GRND
2116	1148042.235	1549370.156	3758.429	CONC
2300	1148650.637	1552859.909	3548.306	CL STREAM
2301	1148653.240	1552808.291	3550.978	CL STREAM
2302	1148577.982	1552719.391	3552.362	CL STREAM
2303	1148461.346	1552557.006	3554.468	CL STREAM
2304	1148393.197	1552468.584	3557.323	CL STREAM
2305	1148336.778	1552389.986	3565.328	CL STREAM
2306	1148149.319	1552311.069	3566.197	CL STREAM
2307	1148069.788	1552259.982	3565.586	CL STREAM
2308	1148004.344	1552234.184	3566.597	CL STREAM
2309	1147952.372	1552173.447	3568.329	CL STREAM
2310	1147931.942	1552108.284	3570.526	CL STREAM
2311	1147939.679	1552056.490	3571.997	CL STREAM
2312	1147949.951	1551977.665	3574.106	CL STREAM
2313	1147927.089	1551941.462	3574.886	CL STREAM
2314	1147869.612	1551932.995	3575.778	CL STREAM
2315	1147797.273	1551934.190	3576.606	CL STREAM
2316	1147727.112	1551937.816	3579.237	CL STREAM
2317	1147692.925	1551931.930	3579.871	CL STREAM

#4627.12088.01

SAND COULEE
DEQ

MW-101K - #2114
 WYLDER SOUTH - #2112
 WYLDER NORTH - #2109

ADIT SC12 @ 1E CONC PIPE - #2107

MW 104K - #2002

KUNKEL SHALLOW - #2030

KUNKEL MADDISON - #2031

LAROCQUE LI 172 - #2035

LAROCQUE LI 40 - #2036

LAROCQUE STOCK N = 5' FROM #2038 + 055

↳ 280-20 = #2040 - CALC

LAROCQUE STOCKS = 5' FROM #2041 + 025

↳ 315-35 = #2042 - CALC*

MW-102K - #2046

SHARTEK WELL ON LIP - #2048

SOUTH - LAROCQUE DOMESTIC ON LIP - #2051

NORTH - LAROCQUE DOMESTIC - #2058

MW 103K - #2063

C4-MW #2069

C5 Shallow #2075

C5 Deep #2076

MW C7 - #2096

MW C3 SHALLOW #2097

ADIT - SC3A #2003 @ SPRING DAYLIGHT

ADIT - SC8 #2009 @ SPRING DAYLIGHT

MW C3 MEDIUM - #2098

MW C3 DEEP - #2102

MW C9 - #2104

ADIT - SC1 - #2105 @ TOP CONC

① 2017-11-16, THURS 40
T. REED/F. MERCILL
TEAM RB/RIO/TS3

WIND

TO 1 SURV PPC

MU 1688 M 554 FT 5538 FT

At 9:17 AM At 2:00 PM

STAT FILE: 22653200

#1 = SET 1/2" x 18" q REB W/ PPC

ON E. SIDE OF RD @ TURNOUT

MID SLOPE - 4' WEST OF CORNER POST

~~** ASSUMED X, Y, Z @ CP #1~~

~~LAT: 47-23-15 ³⁷⁴¹¹ N~~

~~LONG: 111-10-59 ⁷⁴⁴²⁴ W~~

~~EL HT: 3615 ⁶³⁸~~

OPUS @ #1

✓ 47-23-15 ³²⁷⁵⁶

✓ 111-10-59 ⁷⁰⁶¹⁹

✓ #0 3630 ⁷¹⁴⁵

#2 = FND 2" q ALCAP STAMPED:

"KENDALL LAND SURVEY

PROPERTY CORNER 185765"

ON E. SIDE RD S. FACE OF PP.

#2000-2116

TOPO

2300-2317