Field Investigation
Data Summary Report

Focused Site Investigation Data Summary Report for the L-Bar Site near Chewelah, Washington

Prepared for
Northwest Alloys

CH2MHILL®

January 2014

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Contents

Acronyms

µs/cm	micro Siemens per centimeter
amsl	above mean sea level
bgs	below ground surface
btoc	below top of casing
cfm	cubic feet per minute
EC	electrical conductivity
Ecology	Washington State Department of Ecology
FB/FBR	flux bar or flux bar residue
ml/min	milliliters per minute
MRP	Magnesite Residue Pile
MTCA	Model Toxics Control Act
ppm	parts per million
PVC	polyvinyl chloride
SWBU	shallow water bearing unit
TOC	top of casing

1.0 Introduction

This section provides background information (project understanding), purpose and objectives, and regulatory coordination.

1.1 Project Understanding

CH2M HILL Engineers, Inc. (CH2M HILL) is under contract with Northwest Alloys to assist with Model Toxics Control Act (MTCA) cleanup actions and post-remedy monitoring at the L-Bar site located approximately 2 miles south of Chewelah, Washington (Figure 1). As part of that work, CH2M HILL completed a focused geophysical survey in 2012 at the site in accordance with the *Geophysical Investigation Work Plan for the L-Bar Site, Chewelah, Washington* (CH2M HILL, 2012a); results from this work were summarized and submitted to the project team in the *Data Summary Report for the Supplemental Geophysical Survey Work Conducted at the L-Bar Site near Chewelah, Washington* (hereafter 2012 Geophysical Survey) (CH2M HILL, 2012b).

As described in the 2012 Geophysical Survey, three areas of interest were identified in the southeastern corner of the Magnesite Residue Pile (MRP) to be potentially representative of residual source materials (such as flux bar or flux bar residue [FB/FBR]) that may not have been removed during prior source removal actions. However, the 2012 Geophysical Survey identified supplemental data needs to better understand the geophysical data response/results and to assist with management decisions regarding the need for potential supplemental source removal actions. This report describes the findings from a follow-on investigation conducted in June 2013 as recommended to complement the 2012 Geophysical Survey.

Functional details of the field installations and sampling methods as presented in this report are summarized in the *Focused Site Investigation Work Plan for the L-Bar Site, Chewelah, Washington* (hereafter the 2013 Work Plan) (CH2M HILL, 2013a). A more comprehensive summary of the site history, site conditions, and MTCA cleanup actions/requirements for the site is presented in the *Periodic Review, L-Bar Site, Washington State Department of Ecology* (Ecology, 2012).

1.2 Purpose and Objectives

This report summarizes the field methods, observations, and key findings in support of the following data needs that were identified from the 2012 Geophysical Survey:

- Installation of two shallow piezometers to depths of less than 8 feet below ground surface (bgs) completed in the shallow water-bearing unit (SWBU) to better define the groundwater flow direction near the southeastern end of the MRP.
- Testing of surface soils from grab samples using electrical conductance (EC) as a cost-effective indicator constituent to corroborate the 2012 Geophysical Survey in two perimeter areas located along the southeastern toe of the MRP.
- Installation of vapor sampling probes to shallow depths and collection of vapor samples tested for ammonia as an indicator constituent that may be correlated to the presence of potential source materials (for example, FB/FBR) in the MRP.

This report has been prepared for Northwest Alloys and Ecology as described in the *2013 Scope of Work and Fee Estimate for Environmental Consulting and Supplemental Site Characterization in Support of MTCA Cleanup at the L-Bar Site near Chewelah, Washington* (CH2M HILL, 2013b), and in accordance with the terms and conditions of (1) the *Master Agreement for Procurement of Environmental Consulting Services*, Number 900254, between Alcoa, Inc. and CH2M HILL dated November 17, 2009, and (2) Amendment Letter 2, *Environmental Consulting Services*. This document serves as the work deliverable specified under Task 3, Field Investigation Data Summary Report.

1.3 Regulatory Coordination

The 2012 Geophysical Survey was submitted to Ecology on October 23, 2012. Ecology replied on November 5, 2012, stating that they agreed with the 2012 Geophysical Survey findings and follow-on recommendations. Ecology requested that Northwest Alloys develop a work plan and schedule to implement the proposed follow-on work. In response to this request, the 2013 Work Plan was submitted to Ecology on May 2, 2013 (CH2M HILL, 2013a). Ecology provided written approval of the 2013 Work Plan on May 22, 2013 (Ecology, 2013).

2.0 Field Investigation Methods

This section provides a summary of the field installations, sampling methods, and results from the focused field investigation performed at the L-Bar site in June 2013 to support the data needs summarized in Section 1.2.

2.1 Field Investigation Overview

Field investigation activities were completed over a 4-day period from June 17 through June 20, 2013. Figure 1 shows the general investigation areas for the primary data needs. Figure 2 shows a more detailed layout of the investigation areas in the south end of the MRP, including the vapor probes, soil sampling areas, the two new piezometers, and the respective sampling identification names. Appendix A is a compilation of site photographs illustrating the primary field installation and sampling activities (with description).

An overview of the work performed as presented in this report is summarized as follows:

- Installation of two shallow piezometers (PZ-01-EP and PZ-02-SP) to better understand groundwater flow direction in the east and south perimeter areas in the southeastern corner of the MRP. Piezometers were installed via hand auger to depths of approximately 6 feet bgs in the SWBU.
- Installation of 16 vapor sampling probes and subsequent vapor sampling for ammonia in three areas of interest located in the southeastern corner of the MRP, west and southwest of Well SA-10 which showed an elevated response from the 2012 Geophysical Survey. Vapor sampling probes were installed via hand auger to depths of approximately 6 feet bgs in the MRP.
- Testing of 55 grab soil samples collected in gridded areas designated as east and south perimeter near the toe of the MRP using EC as an indicator constituent.

All field installations and sampling were performed in accordance with the 2013 Work Plan. The only deviation to the work plan was that the "background" location for soil samples and one vapor probe were located within areas that yielded relatively low response from the 2012 Geophysical Survey (rather than establishing background conditions in areas outside the geophysical survey area as described in the 2013 Work Plan).

2.2 Field Installation Methods

The following subsections describe the details of the installation of shallow piezometers, vapor sampling probes, and soil samples.

2.2.1 Installation of Shallow Piezometers

Figure 2 shows the location of the two shallow piezometers installed in the east and south perimeter areas of the MRP (PZ-01-EP and PZ-02-SP). Borings were advanced to 6 feet bgs in the SWBU with a 4.25-inch-diameter stainless steel hand auger that created a 5-inch borehole.

Table 1 provides as-built construction details of the two piezometers. Piezometers were constructed with 1-inch-diameter, Schedule-40 polyvinyl chloride (PVC) and installed approximately 2 feet below the zone of saturation. The lowermost 2 feet of the PVC casing of each well were perforated with a hand saw to constitute a piezometer screen adjacent to the zone of saturation. The annular space adjacent to the screen zone was backfilled with No. 10x20 factory-packaged silica sand to approximately 1 foot above the top of the screen zone. The remaining annular space was backfilled with hydrated granular bentonite to constitute a well seal. Piezometers were completed with an approximate 2-foot stickup. Surface completions or protective steel casings (and bollards) were not installed because of the expected temporary nature of the piezometers.

Piezometers were developed after installation by surging and pumping to enhance hydraulic connection and to facilitate representative groundwater level readings. Development consisted of several iterations of surging the saturated interval, and then sustained pumping with a peristaltic low-flow pump which evacuated water at approximately 600 milliliters per minute (ml/min). Both wells were purged for approximately 15 minutes, resulting in approximately 7 gallons of purge water that was allowed to passively infiltrate to ground surface at each location. The water clarity (turbidity) of both piezometers was characterized as "clear" at the end of development and each location sustained the 600 ml/min purge rate. Collection of final water levels confirmed recovery (recharge) to predevelopment levels and demonstrated hydraulic connection with the SWBU.

Table 1 summarizes the as-built completion details and survey data. CH2M HILL field staff collected the horizontal survey coordinates using a hand-held Trimble GeoXH unit with sub-meter accuracy. Vertical top-of-casing survey elevation were obtained by Benthin and Associates using a GPS Trimble R8-3 on October 25, 2013.

2.2.2 Installation of Vapor Sampling Probes

Figure 2 shows the location of the 16 shallow vapor sampling probes that were installed in three primary areas of interest as determined in the 2012 Geophysical Survey. Five vapor probes were installed in each of three areas (15 probes). The remaining vapor probe was installed approximately 100 feet north of Area C and is considered to be background in comparison to the other areas of interest because it was delineated as a relatively low-conductivity response as described in the 2012 Geophysical Survey.

Vapor probes were advanced and installed as described in the 2013 Work Plan. Similar to the shallow piezometers, borings for the vapor probes were advanced with a 4.25-inch-diameter stainless steel hand auger that created a 5-inch diameter borehole to approximately 6 feet bgs. Materials encountered during hand auger advancement generally consisted of light gray to very dark gray densely packed fill materials inferred to be magnesite residue. Material was generally lightly moist and had a consistency of fine sand to silt. Source materials such as FB or FBR were not believed to be encountered during borehole advancement based on visual inspection of the fill materials and cuttings from hand augering.

Vapor probes were constructed with a 1-inch-diameter schedule 40 PVC casing with a screen that was manually cut with a hand saw in the lower 2 feet. The annular space adjacent to the screen zone was backfilled with No. 10x20 factory-packaged silica sand to 1 foot above the top of the screen zone. The remaining annular space was backfilled with hydrated granular bentonite to constitute the surface seal.

Following installation, all 16 vapor probes were purged with a Gast Oilless 1531Series vacuum pump connected to 0.25-inch poly tubing set near the center of the screen interval to withdraw stagnant air entrained in the borehole and screen zone during probe installation. The air purging was considered similar to well development in that it was intending to enhance the representativeness of subsurface vapors for subsequent vapor sampling. Each vapor probe was pumped for 5 to 10 minutes at an estimated flow rate of 0.75 cubic feet per minute (cfm). Upon completion of the air purging activities the vapor probes were sealed (capped) with a 1-inch PVC slip cap. Surveying of the vapor probes was performed with a hand-held Trimble GeoXH GPS unit after installation.

2.2.3 Soil Sampling Grid

Figure 2 shows the location of the sampling grids and soil sampling areas that were established in the east and south perimeter areas of the MRP. Sampling areas were established with grid spacing of approximately 20 feet from within the boundaries established in the east and south perimeter areas as described in the 2013 Work Plan. Sampling in the western end of the south perimeter area was constrained to one row (east-west) given the physical constraints of the sanitary lagoon to the south and the slope of the MRP to the north (as shown in Figure 2). Appendix A includes photographs of the sampling grids; sampling locations were flagged and located with the hand-held Trimble GeoXH GPS unit.

2.3 Field Sampling Methods

The following sections describe the field methods for collected groundwater elevations, vapor sampling, and soil sampling.

2.3.1 Groundwater Levels and Calculation of Groundwater Elevations

Static groundwater levels were initially measured on June 20, 2013, from the two new piezometers and from existing wells located in the southern end of the site around the MRP. These initial measurements were collected three days following their installation and well development activities to allow the saturated zone to recover and equilibrate with the SWBU. A follow-on round of water levels were then collected on August 13, 2013 from the two new piezometers and the existing compliance monitoring well network, which were used to calculate groundwater elevations and assess groundwater flow direction in the SWBU. Static groundwater levels were measured with a hand-held electronic sounder from the top of PVC casing and recorded to the nearest 0.01 foot.

2.3.2 Vapor Sampling

Vapor sampling was performed at each of the 16 vapor probes in accordance with the methods described in the 2013 Work Plan. Vapor sampling was performed on June 20, 2013—2 days following installation and initial air purging (described in Section 2.2.2). Vapor sampling was facilitated with an air pump that was connected to 0.25-inch poly tubing set near to the center of the screen interval of to withdraw air vapors into a sampling chamber.

Ammonia concentrations were measured in the field using a colorimetric indicator Drager tube (specific to ammonia) inserted into the vapor sampling chamber and operated with a Drager pump. As described in the 2013 Work Plan specifications, the sampling process included an initial stroke from the Drager pump to quantify ammonia vapor concentrations in the range of 50 to

700 parts per million (ppm) (if detected), followed by another 9 strokes (total of 10 strokes) to obtain concentrations in the range of 5 to 70 ppm. The initial vapor sample (one stroke) was initiated after allowing the air pump to purge for at least 40 seconds to enhance representativeness of the sample. The subsequent detection range (9 strokes) was then performed if the initial stroke was nondetect or below 5 ppm (the lowest detection level).

2.3.3 Soil Sampling

Figure 2 shows the soil sample locations. Samples were collected at ground surface (0-inch depth) and at approximately 6 inches bgs at each flagged sampling location established in the grid (Section 2.2.3). The established soil sampling grid resulted in samples from 55 locations (110 soil samples) that were collected and tested over two days (June 19 and 20, 2013). Samples were collected using a 1-inch-diameter stainless steel soil sampler that was pushed into the ground by hand (photographs provided in Appendix A). Approximately 10 grams of soil were extracted from the soil sampler and prepared into a mixture (slurry) consisting of one part sample and five parts laboratory-grade deionized water. The sample mixture was homogenized (mixed) in a 200-ml sample beaker.

The homogenized soil sample was then measured for EC with a hand-held YSI 63 multi-parameter probe. EC values were allowed to stabilize and the values recorded on field sheets in micro Siemens per centimeter (µS/cm). EC results and any notable observations were recorded on field sheets provided in Appendix B.

The YSI 63 meter was calibrated in accordance with the manufacturer specifications prior to performing sample measurements at the beginning of both days. Additionally, the EC meter was spot checked and calibrated periodically during the soil sampling and at the end sampling of both days to ensure accurate readings. Blank readings were also collected on the laboratory-grade deionized water prior to sampling and periodically during sampling to prevent drift in the readings. All calibration and blank readings are shown with soil results in Appendix B.

To prevent cross contamination, the EC meter and sampling beaker were cleaned between successive samples and depths with Alconox wash and rinsed with deionized water.

2.4 Field Investigation Results and Data Summary

This section provides a summary of the field investigation results respective of groundwater levels, vapor sampling, and soil sampling. A brief interpretive discussion of the results is provided in Section 3.

2.4.1 Groundwater Levels

Table 2 summarizes the groundwater level measurements and calculated groundwater elevations measured August 13, 2013. Figure 3 illustrates the groundwater elevations and the inferred groundwater flow direction for the SWBU.

2.4.2 Vapor Probe Sampling Results

Table 3 summarizes the vapor sampling results from the 16 vapor probes installed atop the MRP on June 20, 2013. As described in Section 2.3.2, the procedure included an initial measurement with one pump, followed by a second reading with another nine pumps (for a total of ten pumps) if vapors were non-detect from the initial reading. No concentrations of ammonia vapors were

detected at any of the vapor probes for the initial or final readings above the method detection level of 5 ppm.

2.4.3 Soil Testing Results

Appendix B summarizes the EC soils testing results from the east and south perimeter sample areas shown in Figure 2. The EC values were generally low with values ranging from 67 µS/cm to a high of 3,700 µS/cm. The average of all samples was 430µS/cm (excluding the background samples and the QC samples). Relatively few samples (9 percent, or 10 of the 109 samples) exceeded EC values of 1,000 µS/cm. All but 1 of these were below 2,000 µS/cm. Sample EC-35 was the most elevated sample at 3,700 uS/cm; it is located in the south perimeter area— prompting the collection of four additional samples about 4 feet to the north, east, south and west of EC-35 location. Of these extra samples, all were below 1,700 uS/cm.

3.0 Summary and Future Activities

A summary of field activities along with a limited interpretation of results, and a description of future follow-on activities are provided in the following sections.

3.1 Summary

This report has been prepared for Northwest Alloys and Ecology to assist with MTCA cleanup actions and post-remedy monitoring in support of the objectives of the Agreed Order DE-00TCPER-984 (effective June 12, 2000). The 2012 Geophysical Survey (CH2M HILL, 2012) and follow-on field investigation activities as presented in this report have been completed in accordance with their respective work plans. The technical approach and methods of the field investigation work were coordinated with and performed in approval of Northwest Alloys and Ecology. Collectively, these focused site investigations were conducted to determine if residual source materials (such as FB, or FB residue) could be identified in the southeastern end of the MRP that may help explain the observations of elevated and increasing concentrations of indicator constituents in groundwater at Well SA-10.

A brief narrative summary of the key findings developed from this report with respect to each of the data needs is provided in the following sections.

3.1.1 Soils Testing Results

Soil testing results from the east and south perimeter areas demonstrated relatively low values of EC. In contrast, specific conductance values routinely measured in the SWBU groundwater at Well SA-10 are consistently two or three orders of magnitude higher (greater than 40,000 uS/cm) than the EC values obtained from shallow soil sample (slurry mixtures) from the south and east perimeter areas (all values less than 3,700 us/cm).

Although these are not the same media (i.e., slurry mixture versus the SWBU), this comparative analysis supports the conclusion that the near-surface soils (to depths of 6 inches bgs) in east and south perimeter areas are not the likely cause of elevated EC observed at Well SA-10. This finding is consistent with expected conditions and supports the conclusion that the elevated EM response in the east and south perimeter areas that was described in the 2012 Geophysical Survey is not substantively contributing to the elevated EC conditions at Well SA-10.

3.1.2 Vapor Sampling Results

Vapor sampling performed in the areas of interest revealed no detectable concentrations of ammonia above the method detection level of 5 ppm (via the Drager tube screening method). Vapor probes were installed to the target depths of 6 feet bgs, sealed at the surface with bentonite to enhance the representativeness of vapor samples within the MRP, and purged after installation to evacuate stagnant air entrained during the installation process. The target depth of 6 feet bgs was based on the results of the 2012 Geophysical Survey, which suggested a more prominent signature from the EM-31 geophysical survey method.

3.1.3 Groundwater Levels and Groundwater Flow Direction

As described in Section 2.4.1 and illustrated in Figure 3, the groundwater flow direction of the SWBU is to the north and discharging to the Colville River along the northern margin of the site. The general north to northwesterly flow direction is supported by the highest groundwater elevations in the southern portion of the site (in the range of approximately 1640 to 1644 feet amsl from Wells P-09, P-12, P-13, SA-10, SA-11, SA-12, and the two new piezometers), and the lowest elevations observed in the north field area near the Colville River (with groundwater elevations in the range of 1633 to 1635 feet amsl in Wells P-25, -20B, P-19, P-05, P-06, and P-27). In the vicinity Well SA-10 the groundwater flow is to the northeast or east toward the main ditch. The main ditch was closed in 2003 and filled with coarse-grained materials as part of remedial activities, and is believed to serve as a localized discharge zone and enhance the groundwater flow toward this feature. Installation of the two new piezometers helped confirm the general flow direction in this area is to the east.

3.2 Future Activities

At the conclusion of the project and in cooperation with Northwest Alloys and Ecology, it is anticipated that the temporary piezometers and vapor probes will be abandoned (decommissioned) in accordance with methods in Chapter 173-160-460 of the WAC, *Decommissioning Process for Resource Protection Wells*. The decommissioning methods, procedures, and approvals will be coordinated through Ecology in advance of decommissioning efforts.

Findings from the 2012 Geophysical Survey (CH2M HILL, 2012) and the follow-on work (herein) were not believed to positively identify the presence of residual FB/FBR source within the southwestern corner of MRP. It is believed that the delayed response and increasing trends of selected indicator constituents in well SA-10 could simply represent a remnant slug of impacted groundwater from when FB/FBR was still present (pre 2003), that is slowly migrating past well SA-10 and now moving toward the main ditch. This explanation is supported by recent groundwater quality data in well SA-10, which suggests a shift from increasing to decreasing trends for key indicator constituents (like chloride and total dissolved solids) as summarized in the *2013 Year-end Groundwater Data Submittal* (CH2M HILL 2014). Based on the focused investigations performed in 2012-2013 and recent observations in groundwater, Northwest Alloys recommends continued (compliance) monitoring to confirm a transition in well SA-10 from increasing to decreasing trends for indicator constituents (like chloride, ammonia, and TDS).

Continued groundwater monitoring in 2014 and 2015 (another 4 data points) is believed sufficient to provide scientific evidence of changing conditions in groundwater in well SA-10, and would align with the next 5-year review period where (statistical) trend analyses will be re-generated following the most-recent trend testing performed in 2010. Provided that Ecology is in agreement with this approach, future activities will be to continue the (compliance) monitoring and reporting elements as detailed in the updated *L-Bar Site Compliance Monitoring Program Sampling and Analysis Work Plan, Addendum No. 1, May 2012* (CH2M HILL, 2012c). In support of the next periodic 5-year review effort, Northwest Alloys will coordinate with Ecology to assess performance of the remedy and progress in groundwater toward achievement of cleanup levels.

4.0 References

CH2M HILL. 2012a Geophysical Investigation Work Plan for the L-Bar Site, Chewelah, Washington, May.

CH2M HILL. 2012b. Data Summary Report for the Supplemental Geophysical Survey Work Conducted at the L-Bar Site near Chewelah, Washington. Prepared for Northwest Alloys, Inc. October.

CH2M HILL. 2012c. L-Bar Site Compliance Monitoring Program Sampling and Analysis Work Plan, Addendum No. 1, May.

CH2M HILL. 2013a. Focused Site Investigation Work Plan for the L-Bar Site, Chewelah, Washington. April.

CH2M HILL 2013b. Scope of Work and Fee Estimate for Environmental Consulting and Supplemental Site Characterization in Support of MTCA Cleanup at the L-Bar Site near Chewelah, Washington. January.

CH2M HILL. 2014. 2013 Year-End Groundwater Data Submittal. January.

Washington State Department of Ecology. 2012. Periodic Review, L-Bar Site, Washington State Department of Ecology. Washington State Department of Ecology. 2013. Approval letter from Washington State Department of Ecology to Northwest Alloys. May 22.

Tables

TABLE 1
Piezometer Construction Details
L-Bar Focused Site Investigation

Piezometer ID	Boring Depth (feet bgs)	Screen Interval (feet bgs)	Filter Sand Interval (feet bgs)	Coordinates X-Y [1]	Top of PVC Elevation (NAVD88) [2]
PZ-01-EP	6.0	4.0 – 2.0	6.0 – 1.0	48° 15' 14.768" N, 117° 43' 00.172" W	1647.19
PZ-02-SP	6.0	6.0 – 4.0	6.0 – 3.0	48° 15' 13.064" N, 117° 43' 02.154" W	1647.88

1. Horizontal survey datum in NAD83.
2. Vertical survey datum obtained from Benthin and Associates on October 25, 2013.

TABLE 2
Depth to Water Measurements and Elevations
L-Bar Focused Site Investigation

Piezometer ID	TOC Reference Elevation[1] (feet)	Measured Depth to Water[2] (feet btoc)	Groundwater Elevation[2] (amsl)
PZ-01-EP	1647.19	4.37	1642.82
PZ-02-SP	1647.88	5.18	1642.70
P-05	1642.99	8.44	1634.55
P-06	1642.33	7.07	1635.26
P-09	1643.81	2.49	1641.32
P-12	1649.43	6.90	1642.53
P-13	1645.98	5.03	1640.95
P-19	1640.03	6.00	1634.03
P-20B	1642.25	6.53	1635.72
P-25	1639.41	5.60	1633.81
P-27	1642.19	7.67	1634.52
SA-10	1672.07	28.63	1643.44
SA-11	1668.27	24.87	1643.40
SA-14	1666.85	25.89	1640.96

Footnotes:
[1] Feet above mean sea level; vertical survey datum in NAVD88.
[2] Groundwater levels measured August 13, 2013.

General Notes:
feet btoc = Reference point measured in feet below top of well casing
amsl = above mean sea level

TABLE 3
Vapor Probe Sample Results
L-Bar Focused Site Investigation

Vapor Probe ID	Coordinates X-Y[a]	Initial Reading at 30 to 40 seconds (1 Pump)[b] 50 to 700 ppm Range	Final Reading (10 Pumps)[c] 5 to 70 ppm Range	Notes
VP-D1	48° 15' 13.064" N, 117° 43' 02.154" W	0	0	Background vapor location
AREA A VAPOR POINTS				
VP-A1	48° 15' 14.768" N, 117° 43' 00.172" W	0	0	Purged for 75 seconds before initial reading
VP-A2	48° 15' 13.064" N, 117° 43' 02.154" W	0	0	
VP-A3	48° 15' 13.064" N, 117° 43' 02.154" W	0	0	
VP-A4	48° 15' 13.064" N, 117° 43' 02.154" W	0	0	
VP-A5	48° 15' 13.064" N, 117° 43' 02.154" W	0	0	Purged for 75 seconds before initial reading
AREA B VAPOR POINTS				
VP-B1	48° 15' 13.064" N, 117° 43' 02.154" W	0	0	Possible faint color change
VP-B2	48° 15' 13.064" N, 117° 43' 02.154" W	0	0	
VP-B3	48° 15' 13.064" N, 117° 43' 02.154" W	0	0	
VP-B4	48° 15' 13.064" N, 117° 43' 02.154" W	0	0	
VP-B5	48° 15' 13.064" N, 117° 43' 02.154" W	0	0	
AREA C VAPOR POINTS				
VP-C1	48° 15' 13.064" N, 117° 43' 02.154" W	0	0	Possible faint color change
VP-C2	48° 15' 13.064" N, 117° 43' 02.154" W	0	0	
VP-C3	48° 15' 13.064" N, 117° 43' 02.154" W	0	0	
VP-C4	48° 15' 13.064" N, 117° 43' 02.154" W	0	0	
VP-C5	48° 15' 13.064" N, 117° 43' 02.154" W	0	0	

[a] Horizontal survey datum in NAD83

[b] One pump for the initial reading; if detected the result was multiplied by 10 to yield values in the range of 50 to 700 ppm.

[c] Ten pumps performed if nondetect from the initial reading; if detected the method yield values in the range of 5 to 70 ppm.

Figures

N

0 100 200 300

SCALE 1" = 200'

UPSTREAM WEST DITCH

WEST DITCH

MOUTH OF WEST DITCH

D3

D2

CR3
(300' DOWNSTREAM OF WEST DITCH MOUTH)

P-25

P-20B

P-19

P-05

P-27

P-12

P-13

SA-14

SA-11

SA-10

FORMER STOCKPILES OF FLUX BAR AND FLUX BAR RESIDUE (REMOVED 1997-1999)

SOUTH PERIMETER REMOVAL ACTION (1997)

MAGNESITE RESIDUE PILE

Area A

Area B

Area C

South Perimeter

East Perimeter

SANITARY LAGOON

LOGAN ROAD

MAIN DITCH (CLOSED)

COLVILLE RIVER

SPRAY EVAPORATION POND

HOLDING POND

NORTH FIELD

P-09

P-06

MONITORING WELL P-08
ABANDONED IN NOVEMBER, 2003
DURING COVERED PILE REMOVAL

FORMER COVERED FLUX BAR RESIDUE PILE (REMOVED 1999-2003)

L-BAR PRODUCTION WELL

GRAVEL ACCESS ROAD

ASPHALT PAVEMENT

GATE

CR1

U.S. 395

US-95

Legend

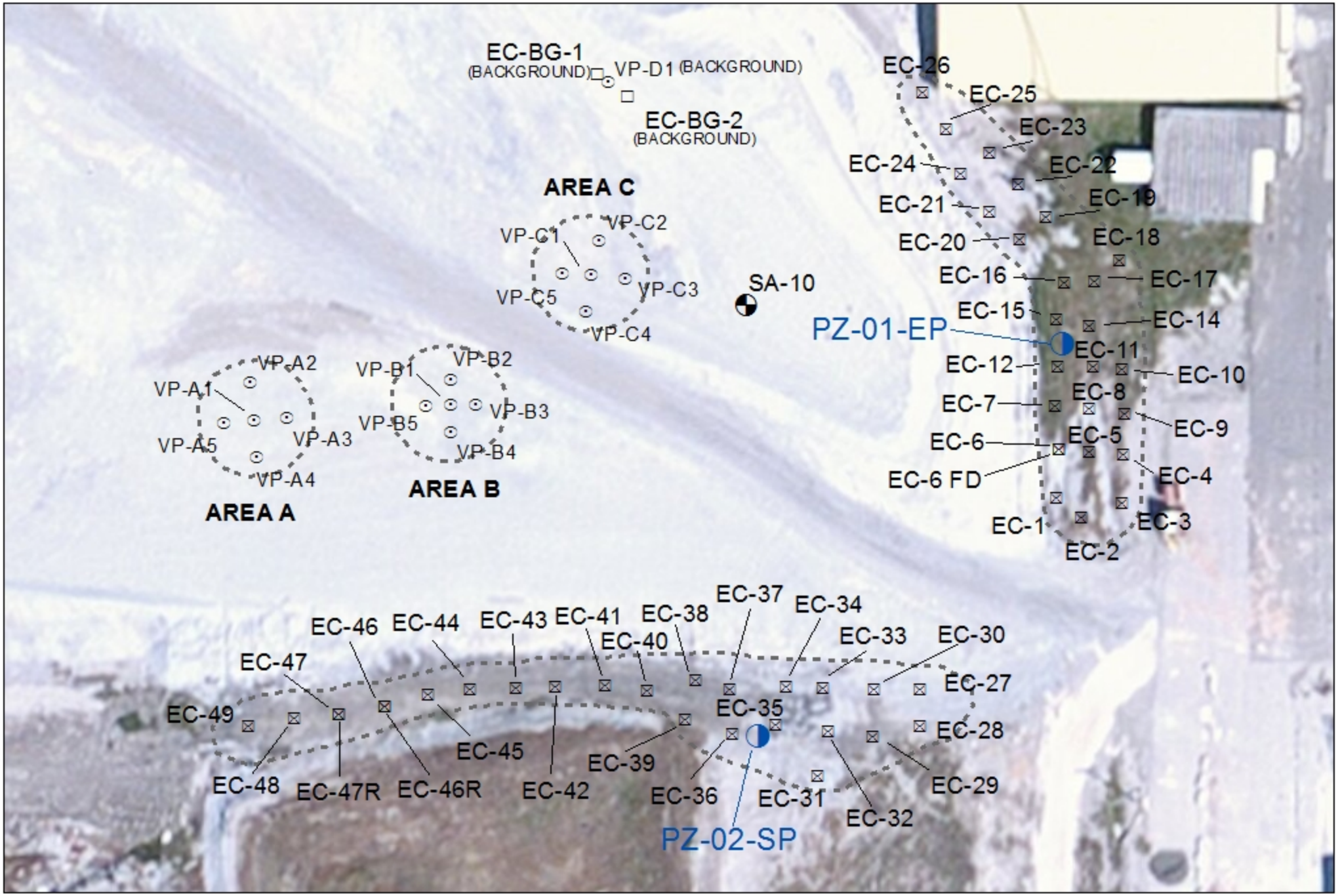
EXISTING FEATURES		2013 FIELD INVESTIGATION AREAS/FEATURES	
P-05	COMPLIANCE MONITORING WELL LOCATION		SHALLOW PIEZOMETERS
D2	COMPLIANCE SURFACE WATER SAMPLING STATION		SOIL SAMPLING AREAS
	MAJOR SOURCE REMOVAL AREA		AMMONIA VAPOR SAMPLING AREAS

FIGURE 1
SITE MAP
LBAR SITE - FOCUSED SITE INVESTIGATION

CH2MHILL

1:25,39.4,63.4,82.64
3:64

\bbh\proj\Alcoainc\353079\CAD\Drawings\p10d054fAA_Gen.dgn 27-FEB-2007



Legend

Monitoring Well
Background Soil
Soil Sample
Area Border
Piezometer
Vapor Probe

0 25 50 100 150 200 Feet

1:1,000

FIGURE 2
FIELD INVESTIGATION LOCATIONS
LBAR SITE - FOCUSED SITE INVESTIGATION

N

0 100 200 300

SCALE 1" = 200'

1640

WEST DITCH

1638'

1636'

1634'

P-25
1633.81

SA-14
1641.96

P-20B
1635.72

P-13
1640.95

1642'

MAGNESITE RESIDUE PILE

SA-11
1643.40

MAIN DITCH (CLOSED)

P-19
1634.03

COLVILLE

SPRAY EVAPORATION POND

P-12
1642.53

SANITARY LAGOON

P-27
1634.52

P-05
1634.55

EVAPORATION POND

GRAVEL ACCESS ROAD

NORTH FIELD

RIVER

SA-10
1643.44

PZ-02-SP
1642.70

P-09
1641.32

FORMER COVERED FLUX BAR RESIDUE PILE

P-06
1635.26

PZ-01-EP
1642.82

L-BAR PRODUCTION WELL

ASPHALT PAVEMENT

GRAVEL ACCESS ROAD

GATE

GATE

U.S. 395

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LEGEND

P-05
1634.55

COMPLIANCE MONITORING WELL LOCATION AND GROUNDWATER ELEVATION (FEET)

PZ-01-EP

TEMPORARY 1 INCH SHALLOW PIEZOMETER AND GROUNDWATER ELEVATION

1638

APPROXIMATE GROUNDWATER ELEVATION CONTOUR AND INFERRED FLOW DIRECTION

NOTE: GROUNDWATER LEVELS MEASURED ON AUGUST 13, 2013.

FIGURE 3

GROUNDWATER ELEVATIONS AND GROUNDWATER FLOW MAP
LBAR SITE - FOCUSED SITE INVESTIGATION

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Appendix A
Selected Site Photographs with Annotated Descriptions

Photo 1: **PZ-02-SP** – Construction of shallow piezometer located south of magnesite pile. Two shallow borings were completed to approximately 6 feet bgs via hand auger and completed as 1-inch piezometers. Piezometer PZ-01-EP was installed at the east toe of the magnesite pile.

Photo 2: **PZ-02-SP** – View to the west. Location of piezometer PZ-02-SP. PZ-02-SP was located northeast of former site sanitary lagoon. Note berm of lagoon in background. Toe of magnesite pile is in upper right corner.

Photo 3: Screen intervals for the 1-inch diameter piezometers and vapor monitoring probes were created using a hacksaw. Individual slots were cut approximately 1-inch apart. Screen intervals were generally 2 feet long for both piezometers and vapor probes

Photo 4: View of Area C vapor probe installations in the southeast section of the magnesite pile. View is to the northeast. Note well SA-10 in the background in the upper right. Berm in foreground is the edge of the ‘access road’ to the top of the pile.

Photo 5: After the vapor probes were installed, each probe was ‘developed’ to remove any entrained air captured during probe installation. Each probe was pumped for approximately 5 minutes. GPS coordinates were collected at each probe location.

Photo 6: Vapor Monitoring Probe sampling setup. Air was pumped from the sealed probe via a ¼” diameter tubing located near the center of the two foot screen interval. From the pump, the air was pushed through to the sampling chamber allowing for a ‘composite’ air sample collected by dragger tubes.

Photo 7: A plastic container with lid was used as the air sample chamber to collect dragger tube samples. Air from the well was pumped into the chamber and the air sample was collected by inserting the tip of the dragger tube in the drilled hole in the lid of the container.

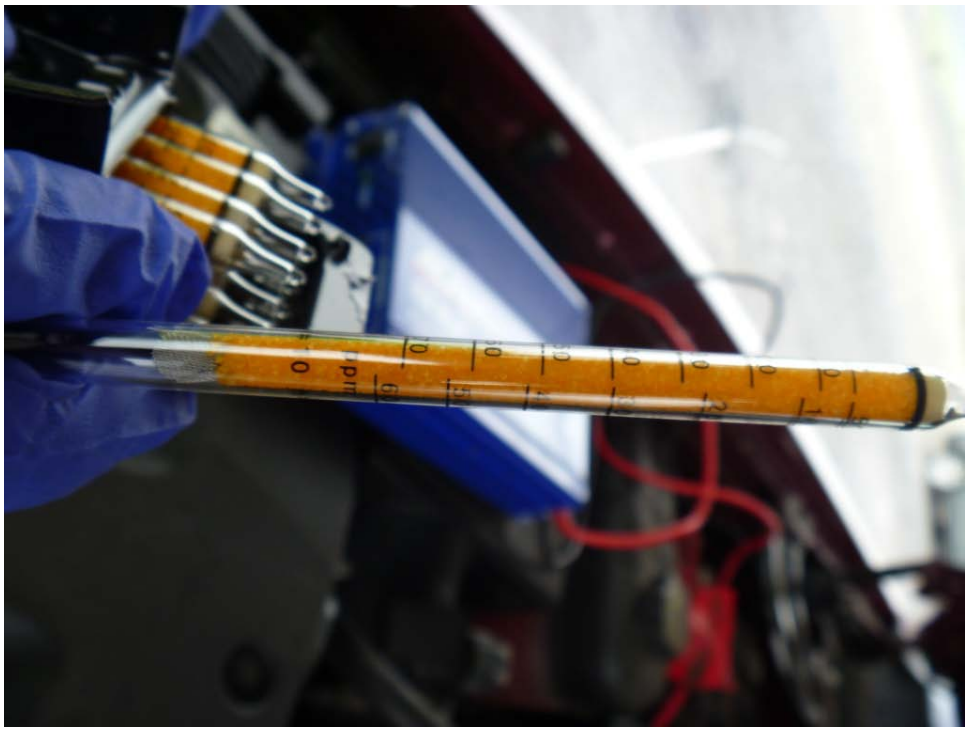

Photo 8: Example Drager tube used for ammonia vapor air monitoring. Ammonia detection range of the tubes was from 5 ppm to 60 ppm or 50 to 600 ppm. Range values are determined by the number of pump strokes of the dragger pump.

Photo 9: **Soil EC Sampling Locations – South of Pile.** – View to the west – View of area south of the pile for shallow soil sampling. Surface and shallow soil sampling locations are identified with pink and yellow pin flags. Note location of shallow piezometer PZ-02-SP near center of photo. A total of 26 locations were sampled for the area south of the pile.

Photo 10: **Soil EC Sampling Locations – South of Pile.** View to the west. Yellow pin flags mark the location of the surface (0”) and shallow (6”) soil sampling locations in the western section of the soil sampling area, south of the magnesite pile (right). The toe of the lagoon berm is visible in the left section of the photo.

Photo 11: **Soil EC Sampling Locations – East of Pile** – View to the north. Yellow and pink pin flags mark the location of the surface (0”) and shallow (6”) soil sampling locations east of the magnesite pile. Note the location of shallow piezeometer PZ-01-EP located east of the toe of the magnesite pile in the grass in the upper left area of the photo.

Photo 12: **Soil EC Sampling Locations – East of Pile** – Photo of EC soil sampling locations east of the pile. The sampling area ‘doglegs’ to the northwest in the northern section of the sampling area. Pink and red pin flags identify soil sampling locations. A total of 26 locations were sampled for the east pile area.

Photo 13: Soil samples were collected using a 1-inch diameter drive soil sampler. Samples were collected from the surface (0”) and from approximately 6” below ground surface (bgs).

Photo 14: A small amount of soil was placed in a graduated cylinder to the 10 or 15 ml line. Lab grade de-ionized water was added to the soil at a ratio of 5 to 1. The solution was then vigorously shaken and a probe was inserted to collect the conductivity reading, as shown above.

Appendix B
EC Summary Results Table

Appendix B
Soil EC Sample Locations and Results
L-Bar Focused Site Investigation

Sample ID	Latitude	Longitude	Surface (0") Result/Calibration and Blank Result (0") µS/cm	Shallow Result (6" bgs) µS/cm	Notes:
Initial Calibration	-	-	998	-	1000 µS/cm solution
Lab Blank	-	-	19.4	-	Lab measured: 0.75 µS/cm
EC-BG-1	48° 15' 15.946" N	117° 43' 03.199" W	200	110	Background Sample
EC-BG-2	48° 15' 15.846" N	117° 43' 03.002" W	120	120	Background Sample
EC-1	48° 15' 14.102" N	117° 43' 00.206" W	148	122	
EC-2	48° 15' 14.017" N	117° 43' 00.041" W	388	178	
EC-3	48° 15' 14.078" N	117° 42' 59.780" W	140	124	
EC-4	48° 15' 14.291" N	117° 42' 59.768" W	162	75	
EC-5	48° 15' 14.302" N	117° 42' 59.995" W	608	193	
EC-6	48° 15' 14.314" N	117° 43' 00.190" W	230	168	
EC-6R	48° 15' 14.314" N	117° 43' 00.190" W	228	148	Replicate Sample
EC-7	48° 15' 14.501" N	117° 43' 00.216" W	219	64	
EC-8	48° 15' 14.491" N	117° 42' 59.992" W	504	275	
EC-9	48° 15' 14.471" N	117° 42' 59.756" W	199	132	
Lab Blank	-	-	5.4	-	Lab measured: 0.75 µS/cm
EC-10	48° 15' 14.661" N	117° 42' 59.776" W	277	389	
EC-11	48° 15' 14.671" N	117° 42' 59.969" W	253	576	
EC-12	48° 15' 14.674" N	117° 43' 00.201" W	234	419	
EC-13	48° 15' 14.856" N	117° 43' 59.747" W	506	377	
Calibration Check	-	-	1002	-	1000 µS/cm solution
Lab Blank	-	-	5.7	-	Lab measured: 0.75 µS/cm
EC-14	48° 15' 14.851" N	117° 42' 59.990" W	701	794	Contains 1/2" gravel
EC-15	48° 15' 14.876" N	117° 43' 00.207" W	155	115	
EC-16	48° 15' 15.038" N	117° 43' 00.153" W	487	266	
EC-17	48° 15' 15.046" N	117° 42' 59.953" W	135	-	Composite of 1-4"
EC-18	48° 15' 15.138" N	117° 42' 59.796" W	265	348	
EC-19	48° 15' 15.325" N	117° 43' 00.272" W	240	235	
EC-20	48° 15' 15.227" N	117° 43' 00.441" W	217	195	
EC-21	48° 15' 15.347" N	117° 43.00.638" W	181	224	
EC-22	48° 15' 15.465" N	117° 43' 00.456" W	108	430	
EC-23	48° 15' 15.602" N	117° 43' 00.645" W	129	240	
EC-24	48° 15' 15.512" N	117° 43' 00.827" W	120	185	
EC-25	48° 15' 15.704" N	117° 43' 00.924" W	172	200	
EC-26	48° 15' 15.863" N	117° 43' 01.080" W	120	293	
Lab Blank	-	-	11.6	-	Lab measured: 0.75 µS/cm
Calibration Check	-	-	1022	-	1000 µS/cm solution
Initial Calibration	-	-	1.0 mS/cm	-	1000 µS/cm solution
EC-27	48° 15' 13.272" N	117° 43' 01.097" W	187	537	
EC-28	48° 15' 13.110" N	117° 43' 01.100" W	269	158	
EC-29	48° 15' 13.066" N	117° 43' 01.403" W	1930	467	
EC-30	48° 15' 13.270" N	117° 43' 01.398" W	140	259	
EC-31	48° 15' 12.893" N	117° 43' 01.764" W	174	160	
EC-32	48° 15' 13.091" N	117° 43' 01.693" W	158	198	
EC-33	48° 15' 13.276" N	117° 43' 01.729" W	1094	273	
EC-34	48° 15' 13.285" N	117° 43' 01.968" W	299	208	
EC-35	48° 15' 13.120" N	117° 43' 02.040" W	3700	188	
EC-36	48° 15' 13.079" N	117° 43' 02.316" W	117	199	
EC-37	48° 15' 13.273" N	117° 43' 02.336" W	342	149	

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L-Bar Focused Site Investigation

Sample ID	Latitude	Longitude	Surface (0") Result/Calibration and Blank Result (0") µS/cm	Shallow Result (6" bgs) µS/cm	Notes:
Lab Blank	-	-	6.8	-	Lab measured: 0.75 µS/cm
Calibration Check	-	-	928	-	1000 µS/cm solution. Calibrated to 1,000
EC-38	48° 15' 13.309" N	117° 43' 02.556" W	1980	1580	
EC-39	48° 15' 13.140" N	117° 43' 02.630" W	550	610	
EC-40	48° 15' 13.265" N	117° 43' 02.878" W	360	330	
EC-41	48° 15' 13.286" N	117° 43' 03.147" W	660	460	
EC-42	48° 15' 13.280" N	117° 43' 03.473" W	1060	830	
EC-43	48° 15' 13.277" N	117° 43' 03.730" W	610	440	
EC-44	48° 15' 13.272" N	117° 43' 04.031" W	180	620	
Calibration Check	-	-	995	-	1000 µS/cm solution.
EC-45	48° 15' 13.247" N	117° 43' 04.305" W	139	283	
EC-46	48° 15' 13.197" N	117° 43' 04.588" W	433	382	
EC-46R	48° 15' 13.197" N	117° 43' 04.588" W	520	452	Replicate Sample
EC-47	48° 15' 13.165" N	117° 43' 04.893" W	366	506	
EC-47R	48° 15' 13.165" N	117° 43' 04.893" W	290	537	Replicate Sample
EC-48	48° 15' 16.145" N	117° 43' 05.180" W	256	291	
EC-49	48° 15' 13.110" N	117° 43' 05.480" W	248	580	
Lab Blank	-	-	7.7	-	Lab measured: 0.75 µS/cm
Calibration Check	-	-	944	-	1000 µS/cm solution. Calibrated to 1,000
EC-50	-	-	167	1660	
EC-51	-	-	1060	1542	
EC-52	-	-	519	1295	
EC-53	-	-	104	143	
Lab Blank	-	-	22.2	-	Lab measured: 0.75 µS/cm
Calibration Check	-	-	1.0 mS/cm	-	1000 µS/cm solution. Meter reading in milisiemens for calibration

Notes:
No GPS data for samples EC-50 through EC-53 due to close proximity to EC-35
Horizontal survey datum (Lat/Long) in NAD83
bgs: below ground surface
µS/cm: micro siemens per centimeter
mS/cm: mili siemens per centimeter