FIRST ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT, 2016-2017

CCR LANDFILL
ANTELOPE VALLEY STATION
MERCER COUNTY, NORTH DAKOTA

January 24, 2018

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1.0 INTRODUCTION

This is the annual groundwater monitoring and corrective action report for 2016-2017 for the coal combustion residual (CCR) landfill at Antelope Valley Station (AVS) in Mercer County, North Dakota.

Section 1.0 provides background information on the power generating facility, the CCR unit(s) present at the facility, and the physical setting of the CCR unit(s), specifically with regard to groundwater conditions. Section 2.0 presents an overview of the groundwater monitoring and corrective action process and requirements in the CCR rule. Section 3.0 summarizes the groundwater monitoring and corrective action activities performed in calendar years 2016 and 2017, and references attachments to this report that contain detailed documentation of those activities. Section 4.0 provides an evaluation of the condition of the groundwater monitoring system. Section 5.0 summarizes the groundwater sampling and analysis conducted during the reporting period. Section 6.0 reviews the anticipated schedule for the CCR program. Section 7.0 reviews the methods and results of the statistical analysis of groundwater monitoring data. Section 8.0 provides a summary and conclusions.

1.1 Regulatory Background

The federal regulation 40 Code of Federal Regulations (CFR) Part 257, known as the CCR rule, became effective on October 19, 2015 and established standards for the disposal of CCR in landfills and surface impoundments (CCR units). In particular, the rule set forth groundwater monitoring and corrective action requirements for CCR units. The rule includes the requirement for an “annual groundwater monitoring and corrective action report” (annual report), with the first annual report due by January 31, 2018. The annual report is intended to document the status of the groundwater monitoring and corrective action program for each CCR unit, summarize key actions completed in the previous year, and project key activities for the upcoming year. This report is the first annual report, and includes activities performed in calendar years 2016 and 2017.

1.2 Facility Location and Operational History

Antelope Valley Station is a coal-fired power generating facility located near Beulah, North Dakota. The station began commercial operations in 1984 and has a generating capacity of 900 megawatts. CCR produced at AVS includes fly ash, bottom ash, and flue gas desulfurization (FGD) waste. The plant consists of two generating units constructed on a site bounded by land that has predominately been utilized for the open pit mining of lignite and has been reclaimed in compliance with the Surface Mining Control and Reclamation Act of 1977. This includes the offices of the Coteau Properties Company Freedom Mine to the north, reclaimed land that is currently planted with forage to the east, the Great Plains Synfuels plant to the south, and agricultural properties that are utilized for grazing to the west. The CCR landfill is situated in an area of mine reclamation and is located northeast of the station as presented on **Figure 1**.

Mixed fly ash and FGD waste is collected in filter receivers and transferred to a storage silo where the waste is loaded into haul trucks and disposed of at the CCR landfill. Bottom ash is transported using water to bins where it is dewatered and subsequently transported by haul truck to the CCR landfill for disposal. The location of the landfill relative to the station is illustrated on **Figure 1**. The general character of the unit is described below.

1.3 CCR Unit Description

The CCR landfill is located approximately 1.5 miles northeast of the AVS generating station (**Figure 1**). The Landfill currently encompasses approximately 160 acres surrounded by land that has been reclaimed after surface mining activities. The area occupied by the Landfill was originally permitted as part of the Coteau Properties Freedom Mine, and the Coteau Properties mining permit was revised in 1989 to allow for a parcel to be set aside as a landfill. The Landfill was constructed under NDDoH permit SP-160 that was issued in 1995 and is an engineered facility with a 2-foot clay liner and side-wall liners. The current Landfill configuration is presented as **Figure 2**. Leachate and contact runoff from the disposal area is collected in a composite-lined sump located in the central portion of the Landfill footprint.

1.4 Physical Setting

The AVS CCR Landfill is situated approximately 6-miles south of Lake Sakakawea at an elevation of roughly 2100 feet above mean sea level (ft, amsl). The topography of the surrounding areas consists of low rolling hills most of which are a result of mine reclamation. The majority of the reclaimed area is used primarily for agricultural and grazing purposes. The surrounding reclaimed areas have been developed such that precipitation outside of the landfill footprint is redirected as surface water runoff toward drainage ditches and culverts that drain to seasonal ponds located in the area.

The geology at the CCR Landfill is generally comprised of mine spoils underlain by the Sentinel Butte Formation. This formation is described as 1,000 feet or greater thickness of continental deposits consisting of dense clay, weakly cemented sandstone, and mudstone interlaced with lignite beds typically ranging between 5 and 10 feet thick.

The uppermost groundwater underlying the AVS CCR landfill is found within the uppermost unmined lignite present, known as the Spaer Bed. This lignite bed is present within the Sentinel Butte Formation at depths ranging from 178 to 258, feet below ground surface (ft, bgs), equivalent to 1853 to 1866 feet, above mean sea level (ft, amsl). Uppermost groundwater generally flows eastward. A representative potentiometric surface map with typical groundwater elevations and direction of flow is presented on **Figure 3**.

Aquifer testing completed at monitoring wells MW-16(s) and MW-19(s) indicates an average hydraulic conductivity of 8.26×10^{-5} cm/sec for the saturated materials.

2.0 GROUNDWATER MONITORING AND CORRECTIVE ACTION PROCESS OVERVIEW

The regulatory process for groundwater monitoring and corrective action is established by Parts 257.90 through 257.98 of the CCR Rule. The process includes a phased approach to groundwater monitoring, leading (if applicable) to the establishment of groundwater protection standards (GWPSs) for each CCR unit. Exceedances of the GWPSs that are determined to be statistically significant can trigger requirements for additional groundwater characterization and corrective action assessment followed by corrective action implementation. The following paragraphs summarize the activities performed to date, and the activities planned for future years.

Groundwater monitoring is performed using a network of monitoring wells that includes both wells to monitor background water quality that is not potentially influenced by the presence of the CCR unit, and wells placed at the downgradient boundary of waste disposal. **Table 1** presents the groundwater constituents by CCR rule Appendix and sampling program.

Table 1
CCR Monitoring Program Analytical Parameter List

Appendix III (Detection)	Appendix IV (Assessment)
pH	Antimony (Sb)
Total Dissolved Solids (TDS)	Arsenic (As)
Boron (B)	Barium (Ba)
Calcium (Ca)	Beryllium (Be)
Chloride (Cl)	Cadmium (Cd)
Fluoride (F)	Chromium (Cr)
Sulfate (SO_4)	Cobalt (Co)
	Fluoride (F)
	Lead (Pb)
	Lithium (Li)
	Mercury (Hg)
	Molybdenum (Mo)
	Selenium (Se)
	Thallium (Tl)
	Radium 226 and 228 (combined)

The first phase of groundwater monitoring is the detection monitoring phase. This phase evaluates the groundwater quality based on the constituents listed in Appendix III of the CCR rule (**Table 1**). If statistically significant increases (SSIs) of any of the Appendix III constituents relative to background conditions are detected in the downgradient waste boundary wells, and cannot be demonstrated to be associated with a source other than the CCR unit, then groundwater monitoring moves into the second phase, assessment monitoring.

The second phase of groundwater monitoring focuses on the constituents listed in Appendix IV of the CCR rule (**Table 1**). Concentrations of Appendix IV constituents in downgradient wells are compared to GWPSs. The GWPSs, established for Appendix IV constituents, are the higher of either the federal Safe Drinking Water Act maximum contaminant level (MCL) or the background concentration for each constituent.

If exceedance of a GWPS is identified in one or more downgradient boundary wells at statistically significant levels (SSLs), and no alternative sources for the exceedances can be demonstrated, then both additional groundwater characterization and assessment of corrective measures will be initiated. Following assessment of corrective measures, a remedy (or set of remedies) will be selected for the groundwater corrective action program for the CCR unit. According to the CCR rule, groundwater corrective action will continue until compliance with the GWPS has been attained in all impacted wells, and sustained for a period of three consecutive years.

The process described above relies on appropriate sampling locations (wells), baseline data, and statistical methods to establish local background concentrations of the constituents in both Appendices III and IV, and to compare the concentrations in downgradient wells to background and/or MCLs. For each existing CCR unit that continued to receive CCR after October 2015, the rule requires that the following be performed prior to October 17, 2017, in order to support the process:

- Install and certify a groundwater monitoring system (GWMS) that is compliant with the rule, in the uppermost aquifer (and lower aquifers that are hydraulically interconnected to the uppermost aquifer) that underlies the unit; completed in 2017

- Develop a groundwater sampling and analysis program, including selection of statistical procedures; completed in 2017

- Collect and analyze a minimum of eight rounds of independent samples from the background and downgradient wells in the monitoring system; completed in 2017.

- Begin evaluating the data to support detection monitoring for the Appendix III constituents; completed in 2017.

The following activities will be performed in calendar year 2018:

- Conduct semi-annual monitoring of groundwater for Appendix III constituents, for detection monitoring purposes;

- Perform statistical evaluations to determine if SSIs of the Appendix III constituents are detected in downgradient wells; and

- Conduct an Alternative Source Demonstration, if necessary, to evaluate whether the SSI constituent(s) can be attributed to a source other than the CCR unit.

3.0 GROUNDWATER ACTIVITIES IN 2016-2017

The following section summarizes the tasks completed in support of the CCR rule that began in the spring of 2016 and continued through the summer of 2017 which consisted of the following activities:

- Monitoring Well Installation, Development, and Testing
  - Site review and preparation
  - Project Safety and Utilities
  - Well Installation
  - Well development
  - Well hydraulic testing
- Monitoring Activities
  - Well sampling
  - Laboratory analysis
  - Preparation of the CCR Groundwater Monitoring System Report, dated October 17, 2017

3.1 Monitoring Well Installation, Development, and Testing

Seven monitoring wells were installed between May 19 and November 16, 2016 by Cascade Drilling, LP (Cascade) in accordance with the Site Review and Recommendations Report provided to Basin Electric on October 17, 2015. One of these wells, identified as MW-14(s), was removed from the CCR monitoring network due to insufficient groundwater yield. Well locations are illustrated on **Figure 2**.

Aquifer testing was performed on October 6 and October 7, 2017 for monitoring wells MW-16(s) and MW-19(s). The results of the testing indicate a range of hydraulic conductivity within the uppermost aquifer at Antelope Valley Station ranging from 2.48E-9 to 1.652E-4 cm/sec.

The CCR Groundwater Monitoring System Report contains a complete record of the construction, development, and testing of the monitoring wells at the AVS CCR Landfill.

3.2 Monitoring Activities

Groundwater monitoring events for the reporting period include eight baseline detection monitoring events beginning with the first event in July 2016 and concluding with the eighth event in August 2017. Each event involved collection of representative samples from each a series of monitoring wells as detailed in the table below:

Table 2
AVS CCR Landfill Groundwater Sampling Event Summary, 2016-2017

Event Date	Background Samples	Downgradient Samples	QA/QC Samples	Monitoring Mode
7/13/16	2	3	1	Detection
2/1/17	1	1	1	Detection
2/23/17	2	4	1	Detection
3/21/17	2	4	1	Detection
4/19/17	2	4	1	Detection
5/23/17	2	4	1	Detection
6/28/17	2	4	1	Detection
7/24/17	2	4	1	Detection
8/16/17	2	4	1	Detection
10/11/17	2	4	0	Detection
10/12/17	2	4	0	Detection

Each of these monitoring events was conducted in general accordance with procedures established CCR Rule 257.93.

4.0 MONITORING SYSTEM EVALUATION

Wells are located in an aboveground locking steel casing set in a 2' X 2' concrete pad, and are protected by a minimum of three steel bollards. Well data sheets completed during the most recent sampling event completed August 18, 2017, noted all wells were in good condition with all dedicated sampling equipment in good working order.

Water level measurements collected during the period indicate a groundwater flow direction that was generally from the west to the east. This potentiometric surface was generally consistent for the background and downgradient monitoring of the CCR Landfill as presented in the CCR Groundwater Monitoring System Report, dated October 17, 2017. A representative potentiometric map depicting the typical surface elevation and direction of flow of the groundwater present within the uppermost aquifer at the CCR Landfill is presented as **Figure 3**. The complete set of potentiometric maps are provided in the CCR Groundwater Monitoring System Report dated October 17, 2017, located in Basin Electric's Operating Record.

The hydrostratigraphic positions of the CCR program monitoring wells relative to the CCR landfill for the 2016-2017 monitoring period are as follows:

- Background: MW-18(s), MW-19(s)
- Downgradient: MW-15(s), MW-16(s), MW-17(s), MW-20(s)

5.0 MONITORING RESULTS

The data obtained during the baseline monitoring events is provided in the Sampling and Analysis Report presented herein as **Attachment A**. This report presents the results for each of the monitoring events of the reporting period including presentation of the potentiometric surface for the uppermost aquifer, groundwater flow direction, field measurements, and results of the laboratory analysis for Appendix III and IV parameters. The general chemistry of the groundwater samples collected is generally consistent with groundwater found within a lignite aquifer.

6.0 CCR PROGRAM SCHEDULE

The next monitoring event at the Antelope Valley Station CCR Landfill will be for semiannual Detection Monitoring prior to mid-April 2018. This event will include the CCR rule Appendix III constituents for compliance with the detection monitoring phase of the CCR program. The results from this event will be evaluated for Statistically Significant Increase(s) in downgradient wells relative to background. If no SSI's are identified then Detection monitoring will continue on a semiannual basis. If an SSI is identified in a Detection Monitoring event the site will proceed with Assessment Monitoring for Appendix III and Appendix IV constituents and Alternative Source Demonstration.

7.0 STATISTICAL PROCEDURES AND RESULTS

The Appendix III groundwater quality data were evaluated using an interwell approach that statistically compares constituent concentrations at downgradient monitoring wells to those present at background monitoring wells. For the Antelope Valley Station, monitoring wells MW-18(S) and MW-19(S) are designated as the background wells because they are located upgradient of the ash landfill, whereas the remaining monitoring wells [MW-15(S), MW-16(S), MW-17(S), and MW-20(S)] are located downgradient of the facility.

Prediction limits (i.e., parametric or nonparametric) with retesting were developed for each constituent based on the frequency of non-detect values and whether the background data for that constituent exhibited a normal, lognormal, or nonparametric distribution. For the statistical analysis, non-detect values were represented as one-half the detection limit. No outliers were identified in the background data. Analytical data from the background monitoring wells collected between July 2016 and October 2017 were used to develop an upper prediction limit (UPL) for the Appendix III background data at 95 percent confidence. Data from the downgradient monitoring wells from the last monitoring event were compared to the UPL to identify statistically significant increases (SSIs) over background. Mann-Kendall trend analysis was used to identify statistically significant increasing trends for constituents with SSIs. ProUCL Version 5.1 was used to store the data and run the statistical analyses. The results of the analyses, including the UPLs, are provided in **Table 3**.

Table 3. Statistical Analysis Methods and Background Upper Prediction Limits

Parameter (Units)	Number of Samples	Percent Nondetects	Normal/ Lognormal Distribution?	Statistical Method	Background Limit
Boron (mg/L)	17	88	No/No	Nonparametric 95% UPL	0.11
Calcium (mg/L)	17	0	Yes/No	Parametric 95% UPL	19
Chloride (mg/L)	17	29	No/No	Nonparametric 95% UPL	30
Fluoride (mg/L)	17	29	No/No	Nonparametric 95% UPL	5
pH (std units)	21	0	No/No	Nonparametric 95% UPL	10
Sulfate (mg/L)	17	0	No/No	Nonparametric 95% UPL	700
TDS (mg/L)	17	0	No/No	Nonparametric 95% UPL	2,000

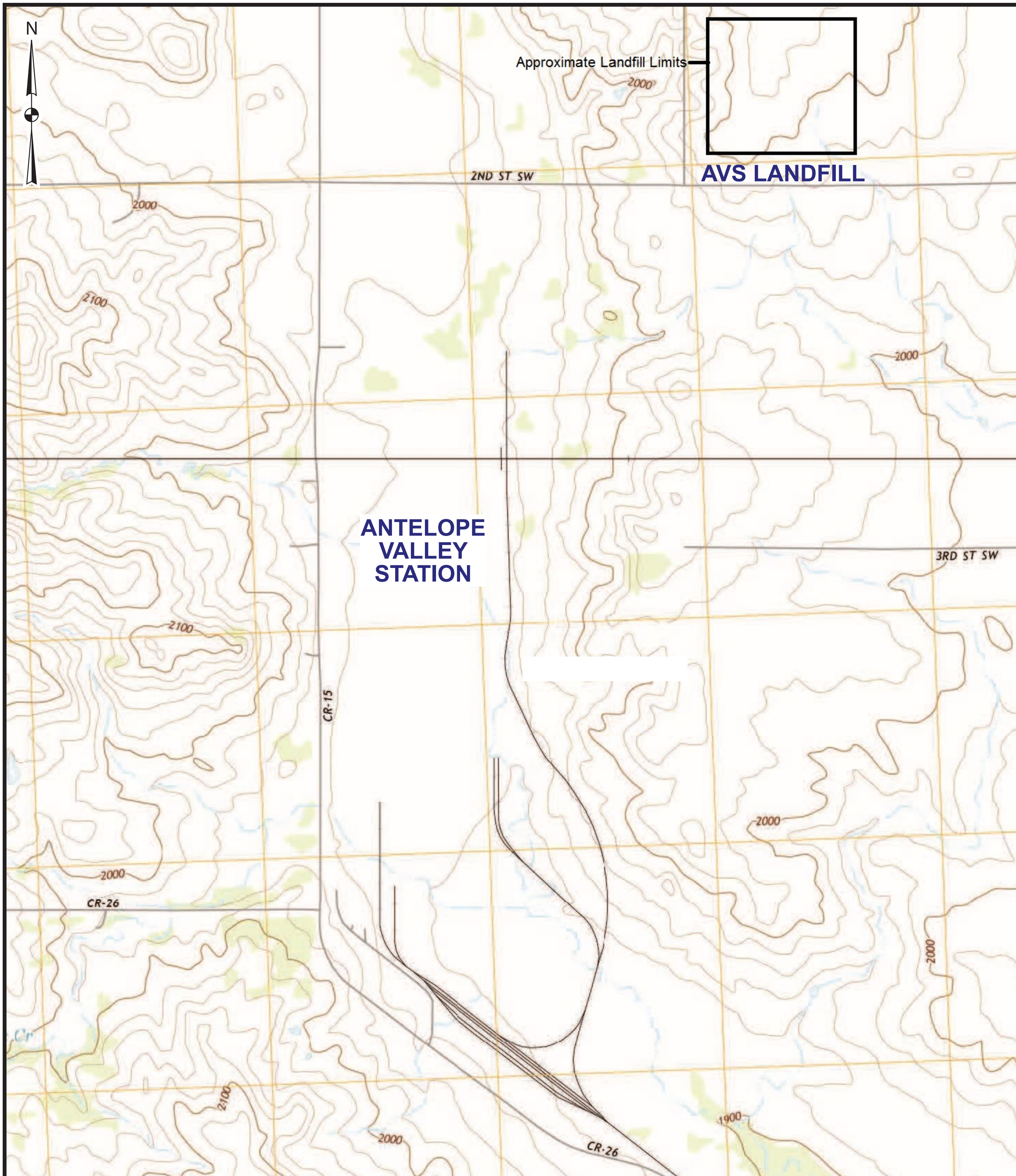
The statistical analysis results indicate that none of the Appendix III constituents exhibited SSIs over background or statistically significant increasing trends in constituent concentrations. Based on these results, assessment monitoring is not required at the Antelope Valley Station.

8.0 SUMMARY AND CONCLUSIONS

AECOM, on behalf of Basin Electric, oversaw the installation of a groundwater monitoring network between May 19 and November 16, 2016. Eight groundwater sampling events were completed to evaluate the groundwater chemistry of the uppermost aquifer background and downgradient of the AVS CCR Landfill. This data was obtained to establish baseline water quality for the CCR Rule Appendix III and Appendix IV constituents.

Statistical review of the baseline data has been completed with no SSIs identified. Detection Monitoring for the Appendix III constituents will be conducted within 90 days of this report.

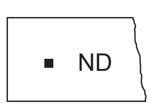
Figures



0 2,000 4,000

APPROXIMATE SCALE IN FEET

BASE MAP SOURCE: USGS 7½ minute topographic quadrangle maps: Beulah, North Dakota 2014; Beulah NE, North Dakota 2014.



Quadrangle Location

BASIN ELECTRIC POWER COOPERATIVE

FIGURE 1
SITE LOCATION MAP
AVS LANDFILL

JOB NO. 60495311

AECOM

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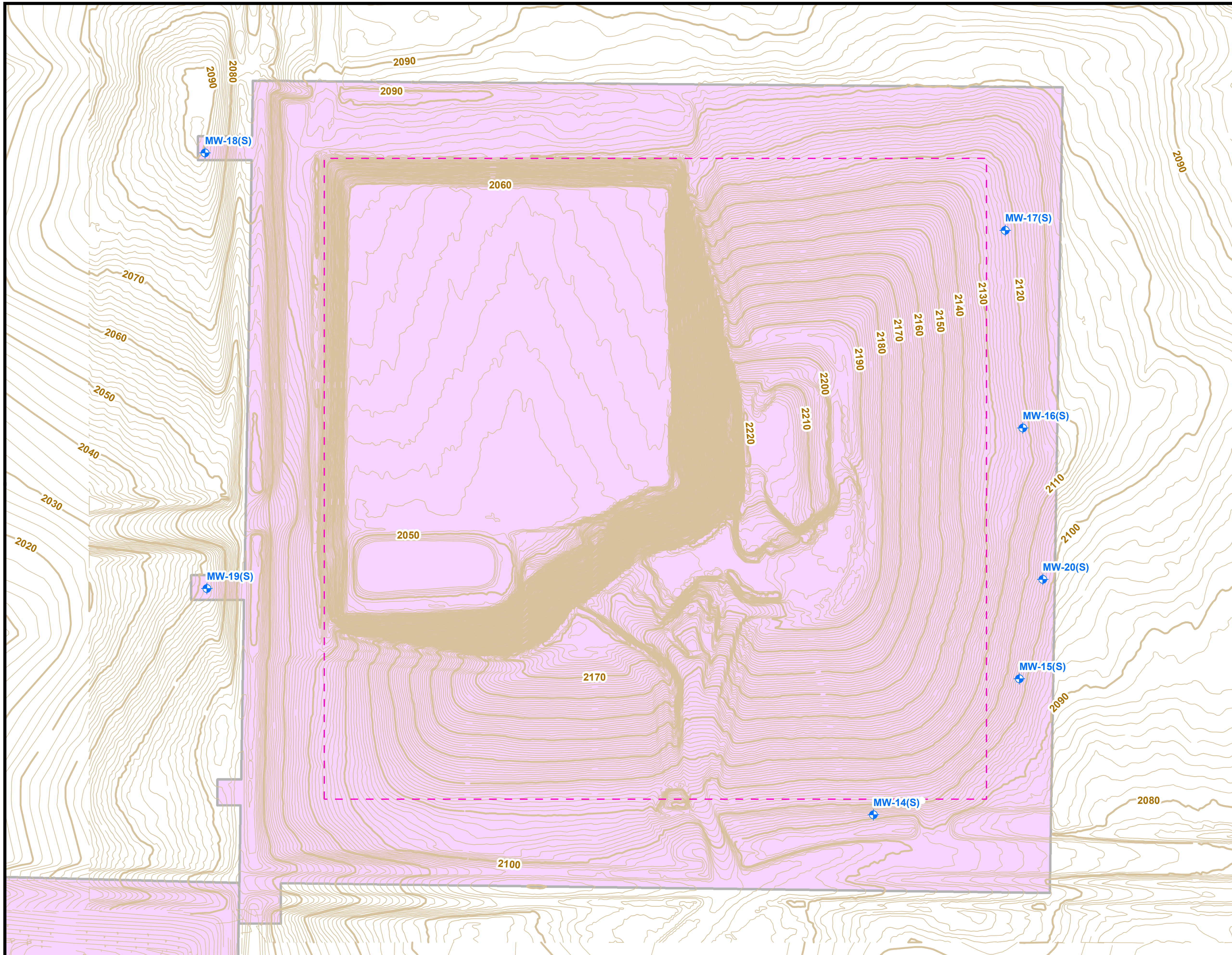


Legend

Monitoring Well

Limits of Ash

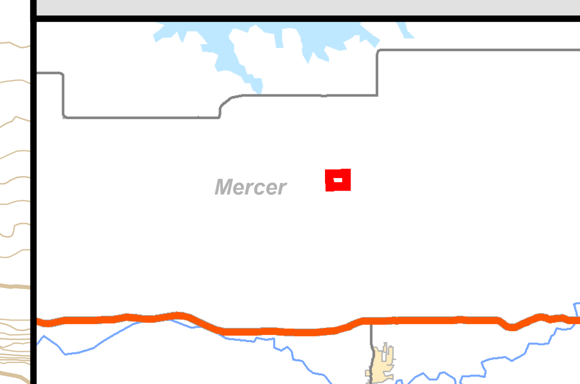
Surface Contours (2-foot interval)

Permit Boundary

N W E S

1 inch = 300 feet

0 0.05 0.1 Miles



BASIN ELECTRIC POWER COOPERATIVE

FIGURE 2
MONITORING WELL LOCATION MAP
AVS LANDFILL

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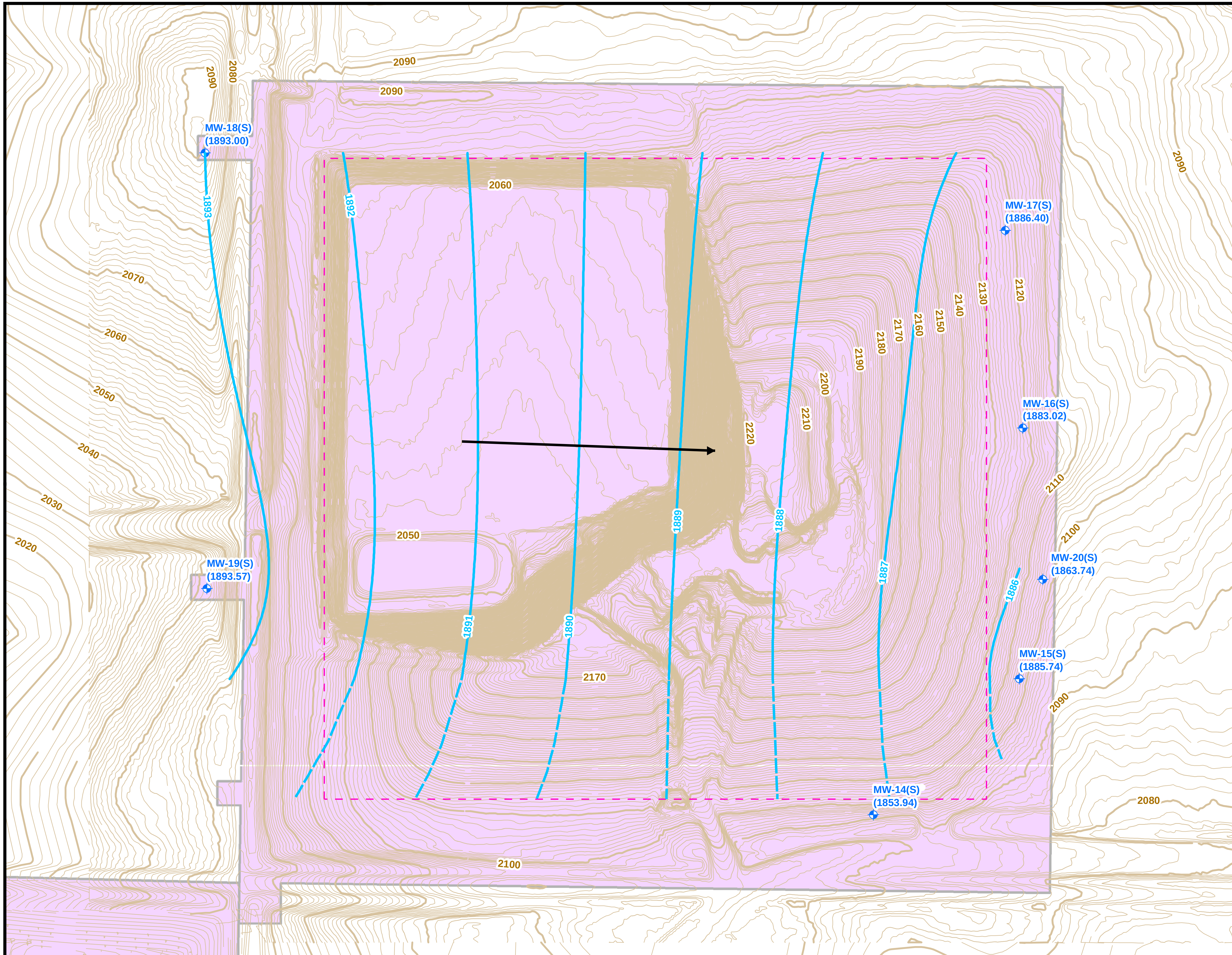

Legend

- Potentiometric Surface Contour (1-foot interval) August, 2017 (3rd quarter)
- Inferred Potentiometric Surface Contour
- Groundwater Flow Direction
- Monitoring Well
- Limits of Ash
- Surface Contours (2-foot interval)
- Permit Boundary

NOTE:
1. Groundwater elevations were obtained on August 16, 2017.

* Monitoring Well MW14(S), MW16(S), and MW20(S) were not at static and were not included in the calculation of the potentiometric contour map.

1 inch = 300 feet

0 0.05 0.1 Miles

BASIN ELECTRIC POWER COOPERATIVE
FIGURE 3
POTENTIOMETRIC SURFACE MAP
AUGUST 2017
AVS LANDFILL

JOB NO. 60495311

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Attachments

Attachment A

Sampling and Analysis Report, 2016-2017

SAMPLING AND ANALYSIS REPORT
CCR MONITORING PROGRAM

CCR LANDFILL
ANTELOPE VALLEY STATION
MERCER COUNTY, NORTH DAKOTA

January 24, 2018

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List of Appendices

I. Groundwater Elevations
II. Representative Potentiometric Surface Map
III. Analytical Results Summary

1.0 INTRODUCTION

This Coal Combustion Residuals (CCR) groundwater Sampling and Analysis Report was developed by AECOM Technical Services, Inc. (AECOM) for the Basin Electric Power Cooperative (Basin Electric) Antelope Valley Station (AVS) CCR Landfill henceforth referred to as the Landfill.

This document was prepared to present the results of sampling and analysis of groundwater conducted for the monitoring requirements of the CCR rule (40 CFR 257.90 to 98); specifically, the data collected for the eight Baseline Monitoring events conducted prior to October 17, 2017.

2.0 GROUNDWATER FLOW

As required by 40 CFR 257.93(c), groundwater elevations were measured in each well immediately prior to purging, each time groundwater was sampled. The measurements, as presented in **Appendix I**, were used to create potentiometric surface maps for the uppermost aquifer for each of the monitoring events. The maps were used to evaluate the direction and rate of groundwater flow for the subject CCR unit as summarized on the table below. A representative potentiometric map is included here in **Appendix II**. The complete set of potentiometric maps are provided in the CCR Groundwater Monitoring System Report dated October 17, 2017, located in Basin Electric's Operating Record.

Table 1. Landfill Groundwater Gradient and Seepage Velocity

Date of event	d_l (ft)	d_h (ft)	i (ft/ft)	n_e	K (ft/day)	v_s (ft/day)
7/13/2016	1050	3	2.86E-03	0.185	0.234	3.62E-03
2/22/2017	1140	3	2.63E-03	0.185	0.234	3.33E-03
3/21/2017	1020	2	1.96E-03	0.185	0.234	2.48E-03
4/19/2017	1050	3	2.86E-03	0.185	0.234	3.62E-03
5/23/2017	1230	3	2.44E-03	0.185	0.234	3.09E-03
6/28/2017	1020	3	2.94E-03	0.185	0.234	3.72E-03
7/24/2017	1110	3	2.70E-03	0.185	0.234	3.42E-03
8/16/2017	1410	3	2.13E-03	0.185	0.234	2.69E-03

d_l = Horizontal separation between upgradient and downgradient locations perpendicular to potentiometric contours
d_h = Change in hydraulic head between upgradient and downgradient locations
i = Hydraulic gradient (change in elevation over distance)
n_e = Site average porosity of 18.5%
K = Site average hydraulic conductivity of 2.34 E-01 ft/day from slug and pumping tests at site
v_s = Seepage Velocity (ft/day)

Hydraulic Gradient Governing Equation[1] – $i = -{dh}/{dl}$

Seepage Velocity Governing Equation[2] – $v_s = {-K * i}/{n_e}$

1. In textbook form, d_h is a negative number as hydraulic head is reported as the higher value subtracted from the lower value.
2. Negative operation performed as in textbook form hydraulic gradient is negative.

Based on the groundwater flow conditions documented in this section the relative function of the monitoring wells employed in the groundwater monitoring system is as follows:

Table 2. Landfill Monitoring System	
Background Wells	MW-18(s), MW-19(s)
Downgradient Wells	MW-15(s), MW-16(s), MW-17(s), MW-20(s)

3.0 GROUNDWATER QUALITY

The groundwater quality data collected during the reporting period are included on laboratory reports located in Basin Electric's Operating Record. The laboratory reports were reviewed for completeness against the project-required methods and the chain-of-custody forms. Reports were also reviewed for holding times, and that the data was appropriately flagged based on the quality assurance/quality control (QA/QC) data provided. The validated results were then compiled into summary form contained in **Appendix III**.

Appendix I
Groundwater Elevations

GROUNDWATER MONITORING WATER LEVELS AND ELEVATIONS
CCR MONITORING WELLS - JULY 13, 2016
FIRST BASELINE EVENT
ANTELOPE VALLEY STATION - BEULAH, ND

Well ID	Reference Elevation Top of Casing* (feet, NAVD 88)	July 13, 2016 Depth to Water (feet)	Groundwater Elevation (feet, NAVD 88)
MW-14(S)	2093.54	232.39	1861.15
MW-15(S)	2104.89	219.19	1885.70
MW-16(S)	2123.70	243.12	1880.58
MW-17(S)	2125.06	238.60	1886.46
MW-18(S)	2091.70	198.75	1892.95
MW-19(S)	2042.68	149.15	1893.53
MW-20(S)	NA	NA	NA

NA = Measurement not available. Well did not exist at this time.

GROUNDWATER MONITORING WATER LEVELS AND ELEVATIONS
CCR MONITORING WELLS -FEBRUARY 22, 2017
SECOND BASELINE EVENT
ANTELOPE VALLEY STATION - BEULAH, ND

Well ID	Reference Elevation Top of Casing* (feet, NAVD 88)	February 22, 2017 Depth to Water (feet)	Groundwater Elevation (feet, NAVD 88)
MW-14(S)	2093.54	205.53	1888.01
MW-15(S)	2104.89	219.25	1885.64
MW-16(S)	2123.70	236.95	1886.75
MW-17(S)	2125.06	238.69	1886.37
MW-18(S)	2091.70	198.61	1893.09
MW-19(S)	2042.68	149.34	1893.34
MW-20(S)	2107.57	234.45	1873.12

GROUNDWATER MONITORING WATER LEVELS AND ELEVATIONS
CCR MONITORING WELLS -MARCH 21, 2017
THIRD BASELINE EVENT
ANTELOPE VALLEY STATION - BEULAH, ND

Well ID	Reference Elevation Top of Casing* (feet, NAVD 88)	March 21, 2017 Depth to Water (feet)	Groundwater Elevation (feet, NAVD 88)
MW-14(S)	2093.54	232.66	1860.88
MW-15(S)	2104.89	219.50	1885.39
MW-16(S)	2123.70	238.15	1885.55
MW-17(S)	2125.06	239.91	1885.15
MW-18(S)	2091.70	199.05	1892.65
MW-19(S)	2042.68	149.39	1893.29
MW-20(S)	2107.57	233.79	1873.78

GROUNDWATER MONITORING WATER LEVELS AND ELEVATIONS
CCR MONITORING WELLS -APRIL 19, 2017
FOURTH BASELINE EVENT
ANTELOPE VALLEY STATION - BEULAH, ND

Well ID	Reference Elevation Top of Casing* (feet, NAVD 88)	April 19, 2017 Depth to Water (feet)	Groundwater Elevation (feet, NAVD 88)
MW-14(S)	2093.54	235.53	1858.01
MW-15(S)	2104.89	219.12	1885.77
MW-16(S)	2123.70	244.76	1878.94
MW-17(S)	2125.06	238.62	1886.44
MW-18(S)	2091.70	198.59	1893.11
MW-19(S)	2042.68	149.00	1893.68
MW-20(S)	2107.57	231.44	1876.13

GROUNDWATER MONITORING WATER LEVELS AND ELEVATIONS
CCR MONITORING WELLS MAY 23, 2017
FIFTH BASELINE EVENT
ANTELOPE VALLEY STATION - BEULAH, ND

Well ID	Reference Elevation Top of Casing* (feet, NAVD 88)	May 23, 2017 Depth to Water (feet)	Groundwater Elevation (feet, NAVD 88)
MW-14(S)	2093.54	233.11	1860.43
MW-15(S)	2104.89	219.09	1885.80
MW-16(S)	2123.70	242.72	1880.98
MW-17(S)	2125.06	238.47	1886.59
MW-18(S)	2091.70	198.60	1893.10
MW-19(S)	2042.68	148.00	1894.68
MW-20(S)	2107.57	231.56	1876.01

GROUNDWATER MONITORING WATER LEVELS AND ELEVATIONS
CCR MONITORING WELLS JUNE 28, 2017
SIXTH BASELINE EVENT
ANTELOPE VALLEY STATION - BEULAH, ND

Well ID	Reference Elevation Top of Casing* (feet, NAVD 88)	June 28, 2017 Depth to Water (feet)	Groundwater Elevation (feet, NAVD 88)
MW-14(S)	2093.54	230.57	1862.97
MW-15(S)	2104.89	219.05	1885.84
MW-16(S)	2123.70	240.85	1882.85
MW-17(S)	2125.06	238.56	1886.50
MW-18(S)	2091.70	198.47	1893.23
MW-19(S)	2042.68	148.89	1893.79
MW-20(S)	2107.57	237.21	1870.36

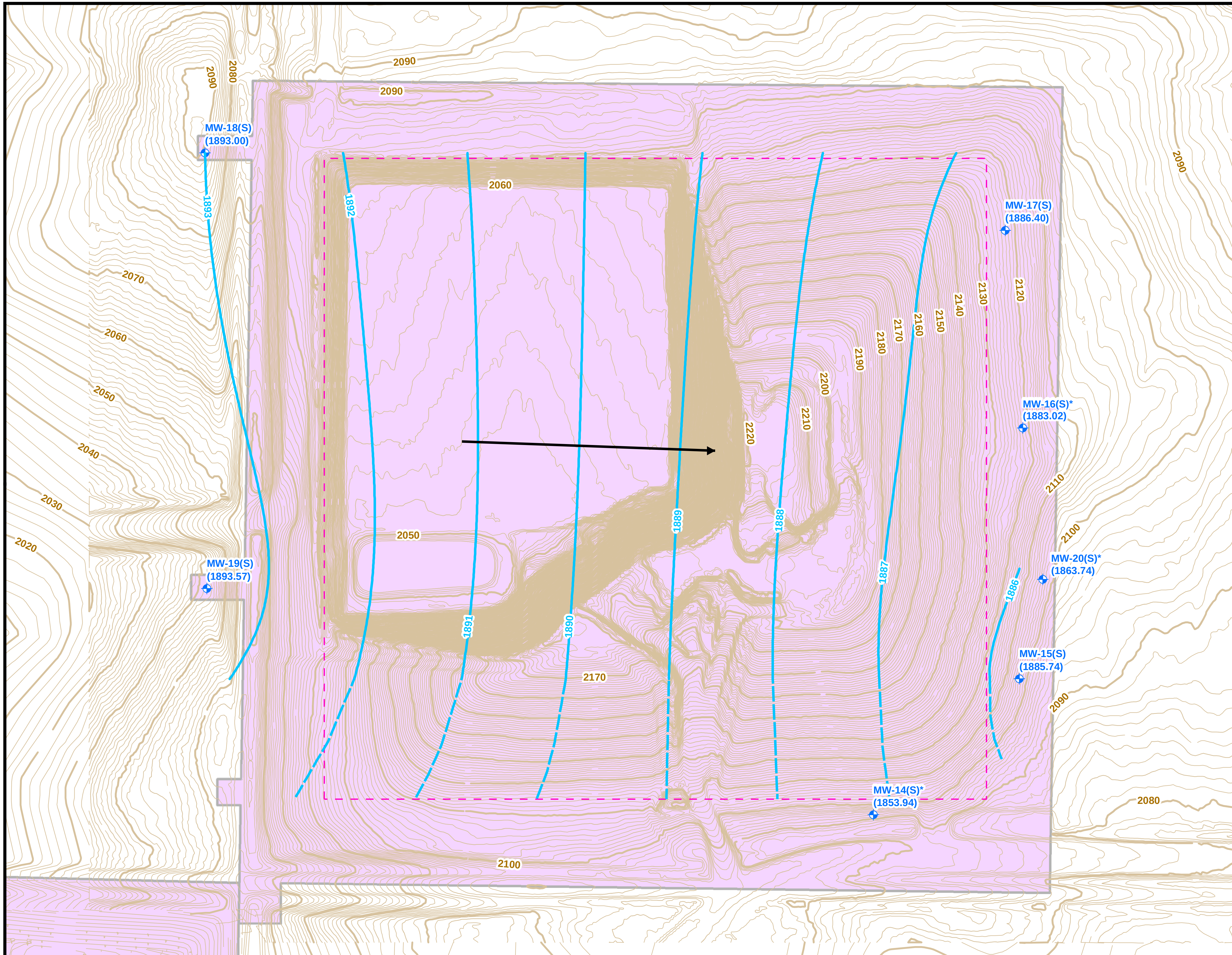
GROUNDWATER MONITORING WATER LEVELS AND ELEVATIONS
CCR MONITORING WELLS JULY 24, 2017
SEVENTH BASELINE EVENT
ANTELOPE VALLEY STATION - BEULAH, ND

Well ID	Reference Elevation Top of Casing* (feet, NAVD 88)	July 24, 2017 Depth to Water (feet)	Groundwater Elevation (feet, NAVD 88)
MW-14(S)	2093.54	236.97	1856.57
MW-15(S)	2104.89	219.14	1885.75
MW-16(S)	2123.70	240.51	1883.19
MW-17(S)	2125.06	238.64	1886.42
MW-18(S)	2091.70	198.70	1893.00
MW-19(S)	2042.68	149.12	1893.56
MW-20(S)	2107.57	242.88	1864.69

GROUNDWATER MONITORING WATER LEVELS AND ELEVATIONS
CCR MONITORING WELLS AUGUST 16, 2017
EIGHTH BASELINE EVENT
ANTELOPE VALLEY STATION - BEULAH, ND

Well ID	Reference Elevation Top of Casing* (feet, NAVD 88)	August 16, 2017 Depth to Water (feet)	Groundwater Elevation (feet, NAVD 88)
MW-14(S)	2093.54	239.60	1853.94
MW-15(S)	2104.89	219.15	1885.74
MW-16(S)	2123.70	240.68	1883.02
MW-17(S)	2125.06	238.66	1886.40
MW-18(S)	2091.70	198.70	1893.00
MW-19(S)	2042.68	149.11	1893.57
MW-20(S)	2107.57	243.83	1863.74

Appendix II
Representative Potentiometric Surface Map



Legend

Potentiometric Surface Contour (1-foot interval) August, 2017 (3rd quarter)

Inferred Potentiometric Surface Contour

Groundwater Flow Direction

Monitoring Well

Limits of Ash

Surface Contours (2-foot interval)

Permit Boundary

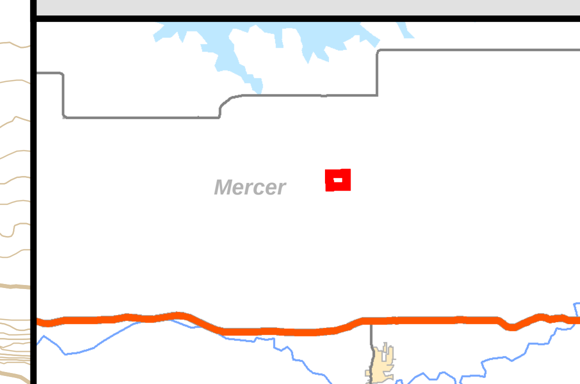
NOTE:
1. Groundwater elevations were obtained on August 16, 2017.

* Monitoring Well MW14(S), MW16(S), and MW20(S) were not at static and were not included in the calculation of the potentiometric contour map.

N
W E
S

1 inch = 300 feet

0 0.05 0.1 Miles



BASIN ELECTRIC POWER COOPERATIVE
REPRESENTATIVE POTENTIOMETRIC SURFACE MAP
AUGUST 2017
AVS LANDFILL

JOB NO. 60495311

AECOM

Appendix III
Analytical Results Summary

Analytical Results Summary

			Appendix III Constituents												Appendix IV Constituents																													
Analyte Name			Boron		Calcium		Chloride		Fluoride		pH	Sulfate		TDS	Antimony		Arsenic		Barium		Beryllium		Cadmium		Chromium		Cobalt		Fluoride		Lead		Lithium		Mercury		Molybdenum		Selenium		Thallium		Radium 226/228	
Unit			mg/L		mg/L		mg/L		mg/L		S.U.	mg/L		mg/L	µg/L		µg/L		µg/L		µg/L		µg/L		µg/L		µg/L		mg/L		µg/L		µg/L		µg/L		µg/L		µg/L		µg/L		pCi/L	
Downgradient	MW-14S	1	0.18		3.0	B	13		0.57		7.90	380	H	1600	2	J F1	2	J	110		1	U	1	U	3.3		0.94	J	0.57		1.3		13	J	0.2	U	61		5	U	0.13	J B	4.03	
		2	0.20	U	19.0		60	U	10	U	NA	380		2200	16		5.5		240	^	1	U	1	U	59		6.2		10	U	9.7		20	U	0.2	U	43		5	U	1	U	1.36	
		3	0.20	U	13.0		15	U	2.5	U	NA	420		1100	2	U	5	U	180		1	U	1	U	32		4.6		2.5	U	7.1		20	U	0.2	U	36		5	U	1	U	3.01	
		4	0.23		29.0		30	U	5	U	8.90	460		2200	18		9		500		1	U	1	U	82		11		5	U	27		33		0.2	U	37		5	U	1	U	4.71	
		5	0.20	U	9.8		11		0.92		7.55	430		1900	2	U	5	U	64		1	U	1	U	4.6		1.1		0.92		1	U	20	U	0.2	U	24		5	U	1	U	0.149	U
		6	0.20	U	9.4		11	1	1	1	7.46	440	1	1900	2.4		5	U	82		1	U	1	U	18		2		1	1	1.9		20	U	0.2	U	22		5	U	1	U	-0.0429	U
		7	0.20	U	8.7		12	2	1.1	2	7.23	460	2	1900	2	U	5	U	71		1	U	1	U	9.1		2.2		1.1	2	1.8		20		0.2	U	21		5	U	1	U	1.14	
		8	0.20	U	8.8		12	H	1.1	H	7.15	440		1900	2	U	5	U	87		1	U	1	U	12		2.4		1.1		2.1		20	U	0.2	U	22		5	U	1	U	1.77	U
	MW-15S	1	0.14		19.0	B	13		1		7.82	310		1700	2		1.2	J	95		0.15	J	1	U	5.7		1.1		1		1.5		24		0.2	U	39		5	U	1	U	0.64	U
		2	0.20	U	18.0		30	U	5	U	8.06	250		1800	2	U	5	U	85	^	1	U	1	U	7		1.2		5	U	1.4		21		0.2	U	37		5	U	1	U	0.688	U
		3	0.20	U	9.7		16		2.5	U	7.77	280		1700	2	U	5	U	58		1	U	1	U	4.4		1	U	2.5	U	1.1		25		0.2	U	26		5	U	1	U	0.249	U
		4	0.20	U	11.0		15	U	2.5	U	7.46	360		1800	2	U	5	U	51		1	U	1	U	20	U	1	U	2.5	U	1	U	24		0.2	U	30		5	U	1	U	0.176	U
		5	0.20	U	13.0		12		0.99		7.10	320		1800	2	U	5	U	60		1	U	1	U	2	U	1	U	0.99		1	U	21		0.2	U	34		5	U	1	U	0.0815	U
		6	0.20	U	6.5		12	1	1.1	1	7.49	370	1	1700	2	U	5	U	39		1	U	1	U	2	U	1	U	1.1	1	1	U	20	U	0.2	U	18		5	U	1	U	0.411	
		7	0.20	U	6.5		11	2	1.4	2	7.39	410	2	1800	2	U	5	U	43		1	U	1	U	2	U	1	U	1.4	2	1	U	29		0.2	U	14		5	U	1	U	0.105	U
		8	0.20	U	5.5		11	H	1.3	H	7.40	400	H	1700	2	U	5	U	41		1	U	1	U	2	U	1	U	1.3	H	1	U	31		0.2	U	11		5	U	1	U	0.441	
	MW-16S	1	0.14		18.0	B	10		1.6		9.43	96		800	4		15		49		0.17	J	1	U	13		0.87	J	1.6		2.2		20	U	0.2	U	59		4.5	J	1	U	0.521	U
		2	0.20	U	20.0		30	U	5	U	7.80	79		1500	2	U	5.6		140	^	1	U	1	U	32		4.8		5	U	5.8		20	U	0.2	U	39		5	U	1	U	0.954	
		3	0.20	U	10.0		18		2.5	U	7.76	48		1200	6		13		38		1	U	1	U	6.6		1.2		2.5	U	2.4		20	U	0.2	U	43		5	U	1	U	0.434	U
		4	0.20	U	5.2		16		2.5	U	8.64	80		1300	5.2		17		32		1	U	1	U	16		1.3		2.5	U	1.8		20	U	0.2	U	79		5	U	1	U	-0.0892	U
		5	0.20	U	7.8		13		1.1		8.51	140		1300	4.2		8.6		37		1	U	1	U	6.4		1	U	1.1		1	U	20	U	0.2	U	39		5	U	1	U	0.201	U
		6	0.20	U	8.2		17	1	1.2	1	7.57	40	1	1500	2	U	5	U	40		1	U	1	U	2.3		1	U	1.2	1	1	U	20	U	0.2	U	42		5	U	1	U	0.232	
		7	0.20	U	7.6		17	2	1.3	2	7.48	73	2	1600	2	U	5	U	35		1	U	1	U	2	U	1	U	1.3	2	1	U	20	U	0.2	U	41		5	U	1	U	0.147	U
		8	0.20	U	7.3		15	H	1.3	H	7.51	130	H	1500	2	U	5	U	38		1	U	1	U	2	U	1	U	1.3	H	1	U	20	U	0.2	U	44		5	U	1	U	0.356	
	MW-17S	1	0.15		25.0	B	11		0.92		7.62	310		1500	1.2	J	2.3	J	160	^	0.33	J	0.34	J	26		2.8		0.92		3		11	J	0.2	U	42		1.9	J	0.10	J B	1.54	U
		2	0.20	U	16.0		30	U	5	U	8.28	290		1600	2	U	5	U	110	^	1	U	1	U	17		3		5	U	3.3		20	U	0.2	U	31		5	U	1	U	1.71	
		3	0.20	U	16.0		15	U	2.5	U	7.61	270		1600	2	U	5	U	96		1	U	1	U	12		2.3		2.5	U	2.4		20	U	0.2	U	33		5	U	1	U	0.639	U
		4	0.20	U	12.0		15	U	2.5	U	8.35	290		1700	2.2		5	U	60		1	U	1	U	3.3		1	U	2.5	U	1	U	20	U	0.2	U	41		5	U	1	U	0.326	U
		5	0.20	U	9.0		11		0.99		7.51	250		1700	2	U	5	U	47		1	U	1	U	2.3		1	U	0.99		1	U	20	U	0.2	U	20		5	U	1	U	0.401	U
		6	0.20	U	8.6		12	1	1	1	7.37	260	1	1600	2	U	5	U	42		1	U	1	U	3.5		1	U	1	1	1	U	20	U	0.2	U	21		5	U	1	U	0.209	U
		7	0.20	U	7.8		12	2	1.2	2	7.47	270	2	1600	2	U	5	U	40		1	U	1	U	2.1		1	U	1.2	2	1	U	20	U	0.2	U	18		5	U	1	U	0.278	U
		8	0.20	U	8.3		12	H	1.3	H	7.41	260	H	1600	2	U	5	U	43		1	U	1	U	2.4		1	U	1.3	H	1	U	20	U	0.2	U	19		5	U	1	U	0.275	U
	MW-20S	1a Supp	0.20	U	31.0		18		0.78		NA	160		1300	2	U	5	U	110		1	U	1	U	20		3.1		0.78		3.3		20	U	0.2	U	100		5	U	1	U	0.97	
		2	0.20	U	21.0		30	U	5	U	7.53	280		1900	2	U	5	U	110	^	1	U	1	U	26		3.4		5	U	4.3		20	U	0.2	U	78		5	U	1	U	0.589	U
		3	0.20	U	6.0		15	U	2.5	U	7.61	690		1900	2	U	5	U	65		1	U	1	U	2	U	1	U	2.5	U	1	U	40		0.2	U	10	U	5	U	1	U	0.0589	U
		4	0.20	U	17.0		20		2.5	U	8.15	230		2000	2	U	5	U	75		1	U	1	U	22		2.9		2.5	U	2.8		20	U	0.2	U	59		5	U	1	U	0.203	U
		5	0.20	U	12.0		17		1.1		7.33	270		1800	2	U	5	U	50		1	U	1	U	3.9		1	U	1.1		1	U	27		0.2	U	42		5	U	1	U	0.269	U
		6	0.20	U	11.0		27	1	1.1	1	7.60	73	1	1800	2	U	5	U	58		1	U	1	U	8.7		1.6		1.1	1	1.5		20	U	0.2	U	50		5	U	1	U	0.626	
		7	0.20	U	8.8		26	2	1.2	2	9.74	120	2	1800	2	U	5	U	83		1	U	1	U	22		2.9		1.2	2	2.9		22		0.2	U	53		5	U	1	U	0.466	U
		8	0.20	U	12.0		23	H	1.1		7.29	190	H	2300	2	U	5	U	120		1	U	1	U	48		5.1		190	H	4.7		22		0.2	U	42		5	U	1	U	1.88	
Background	MW-18S	1	0.11		12.0	B	5.6		1.2		9.97	370		1600	0.41	J	1.4	J	24		0.11	J	1	U	2		0.43	J	1.2		0.53	J	30		0.2	U	4.7	J	5	U	1	U	0.321	U
		2	0.20	U	21.0		30	U	5.0	U	9.85	330		1100	2	U	5	U	34		1	U	1	U	4.6		1.1		5	U	3		20	U	0.2	U	27		5	U	1	U	0.607	U
		3	0.20	U	21.0		15	U	2.5	U	9.34	360		1400	2	U	5	U	40		1	U	1	U	5		1	U	2.5	U	2.6		20	U	0.2	U	13		5	U	1	U	0.585	U
		4	0.20	U	13.0		15	U	2.5	U	10.03	390		1400	2	U	5	U	27		1	U	1	U	3.2		1	U	2.5	U	1.8		20	U	0.2	U	12		5	U	1	U	0.237	U
		5	0.20	U	12.0		5.4		1.7		8.86	350		1400	2	U	5	U	25		1	U	1	U	3		1	U	1.7		1.5		20	U	0.2	U	10	U	5	U	1	U	-0.0325	U
		6	0.20	U	12.0		5.6	1	1.6	1	9.10	360	1	1300	2	U	5	U	25		1	U	1	U	3.3		1	U	1.6	1	1.5		20	U	0.2	U	10	U	5	U	1	U	0.659	
		0.33	0.20	U	12.0		5.8	2	1.9	2	8.91	360	2	1400	2	U	5	U	28		1	U	1	U	2.9		1	U	1.9	2	1.4		20	U	0.2	U	10	U	5	U	1	U	0.33	
		8	0.20	U	9.7		5.4	H	1.8	H	8.92	370	H	1300	2	U	5	U	24		1	U	1	U	3.2		1	U	1.8	H	20	U	20	U	0.2	U	10	U	5	U	1	U	0.402	U
	MW-19S	1	0.11		12.0	B	12	F1	0.5		7.93	680		1900	2	U	1.4	J	25	^	1	U	1	U	1.9	J	0.43	J	0.5		0.54	J	33		0.2	U	5.1	J	5	U	1	U	0.608	U
		1a Supp	0.20	U	5.4		12		0.58		7.80	670		2000	2	U	5	U	70		1	U	1	U	2	U	1	U	0.58		1	U	45		0.2	U	10	U	5	U	1	U	0.218	U
		2	0.20	U	5.5		12		0.56		7.73	700		2000	2	U	5	U	56		1	U	1	U	2	U	1	U	0.56		1	U	36		0.2	U	10	U	5	U	1	U	0.343	U
		3	0.20	U	6.9		15	U	2.5	U	7.77	690		1900	2	U	5	U	55		1	U	1	U	2	U	1	U	2.5	U	1	U	20	U	0.2	U	10	U	5	U	1	U	0.236	U
		4	0.20	U	5.9		15	U	2.5	U	8.80	630		2000	2	U	5	U	51		1	U	1	U	2	U	1	U	2.5	U	1	U	33		0.2	U	19		5	U	1	U	0.171	U
		5	0.20	U	5.6		11		0.51		7.61	630		2000	2	U	5	U	53		1	U	1	U	2	U	1	U	0.51		1	U	42		0.2	U	15		5	U	1	U	0.443	U
		6	0.20	U	5.7		12	1	0.56	1	7.59	660	1	1900	2	U	5	U	48		1	U	1	U	2	U	1	U	0.56	1	1	U	28		0.2	U	17		5	U	1	U	0.208	U
		7	0.20	U	5.0		12	2	0.65	2	7.33	670	2	1900	2	U	5	U	54		1	U	1	U	2	U	1	U	0.65	2	1	U	37		0.2	U	14		5	U	1	U	0.0939	U
		8	0.20	U	4.9		12	H	0.64	H	7.40	620	H	1800	2	U	5	U	56		1	U	1	U	2	U	1	U	0.64	H	1	U	42		0.2	U	10	U	5	U	1	U	0.319	U

TDS = Total Dissolved Solids
NE = Not Established
mg/L = milligrams per liter
S.U. = Standard Units
pCi/L = picoCurie/liter
U = Analyte analyzed for but not detected
F1 = MS and/or MSD Recovery is outside acceptance limits
J = Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value
B = Compound was found in the blank and sample.
^ = ICV,CCV,ICB,CCB, ISA, ISB, CRI, CRA, DLCK or MRL standard: Instrument related QC is outside acceptance limits.
H = Sample was prepped or analyzed beyond the specified holding time
NA = Measurements not available/Sample not analyzed for
1 = Samples collected on 10-11-17 and 10-12-17 to fill data gap during original sampling event #6
2 = Samples collected on 10-12-17 and 10-13-17 to fill data gap during original sampling event #7