2020 Annual Groundwater Monitoring and Corrective Action Report

LOS Ponds 2 and 3 Multi-unit

Leland Olds Station
Stanton, North Dakota
Basin Electric Power Cooperative

January 31, 2021
Project #60634880

Basin Electric Power Cooperative
Bismarck, North Dakota

Quality information

Prepared by	Checked by	Verified by	Approved by
Jason D. Lach	Jeremy Hurshman	Dennis P. Connair, P.G.	Jason D. Lach

Revision History

Revision	Revision date	Details	Authorized	Name	Position

Distribution List

# Hard Copies	PDF Required	Association / Company Name
Three	One	Kevin L. Solie, P.E., Basin Electric Power Cooperative

Prepared for:

Basin Electric Power Cooperative
Bismarck, North Dakota

Prepared by:

AECOM
525 Vine Street Suite 1800
Cincinnati, OH 45202
aecom.com

Table of Contents

Figures

Tables

Attachments

List of Acronyms

ACMs	Assessment of Corrective Measures
AECOM	AECOM Technical Services, Inc.
ASD	Alternative Source Demonstration
Basin	Basin Electric Power Cooperative
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
cm/sec	centimeters per second
FGD	Flue Gas Desulfurization
ft, amsl	feet above mean sea level
ft, bgs	feet below ground surface
ft/day	feet per day
GWPS	groundwater protection standard
LOS	Leland Olds Station
LPL	lower prediction limit
NDPDES	North Dakota Pollution Discharge and Elimination System
RCRA	Resource Conservation and Recovery Act
SSIs	statistically significant increases
SSLs	statistically significant levels
TDS	total dissolved solids
UPLs	upper prediction limits

Executive Summary

This report summarizes groundwater monitoring and corrective action activities completed between January 1 and December 31, 2020 at Ponds 2 and 3 Multi-unit at Leland Olds Station (LOS), as required by 40 Code of Federal Regulations (CFR) Section 257.90(e) of the United States Environmental Protection Agency (USEPA) Coal Combustion Residuals (CCR) Rule. A site figure presenting the location of the CCR units and program monitoring network for the CCR units, including supporting monitoring wells are presented as **Figures 1 and 2**, respectively. Two monitoring wells were installed for supplemental investigations. No program monitoring wells were modified or abandoned during the reporting period.

Detection-mode groundwater monitoring of the Multi-unit was initiated on November 11, 2019. Detection monitoring through October 2020 identified no statistically significant increases (SSIs) of Appendix III indicators of boron, calcium, chloride, fluoride, pH, sulfate, and total dissolved solids (TDS) in the downgradient monitoring wells MW-2017-2, MW-2017-4, MW-2017-4, MW-2017-5, MW-2017-6 and MW-2017-7.

An Alternative Source Demonstration (ASD) was completed in December 2020 to evaluate whether a source other than the Multi-unit was responsible for an unconfirmed SSI for pH identified at MW-2017-6 in August 2020. The ASD (reported herein) determined that the high pH values detected in the well resulted from its construction, specifically the effect of partially cured cement-bentonite grout in the well annular space and did not result from any effect of the Multi-unit.

The ASD determination did not alter the groundwater monitoring program, so Detection monitoring was in place at the start and the end of the current annual reporting period (2020). Assessment monitoring, Assessment of Corrective Measures (ACMs) and Selection of Remedy were not required during the current annual reporting period (2020).

Other activities and conditions for the 2020 annual reporting period include:

- Semiannual Detection-mode groundwater monitoring events were conducted in June and October. Monitoring involved sampling of two background monitoring wells and six downgradient monitoring wells.
- Installation of two new monitoring wells was completed in September for supplemental investigation of the Multi-unit.
- No well repair or decommissioning of the existing program monitoring networks was conducted.
- No program transitions (Detection to Assessment or vice versa) were triggered.
- No programmatic problems were encountered, so no remedies were required, but an ASD was required for the detection of elevated pH values in one well (MW-2017-6) as noted above.

Anticipated activities for the next annual reporting period include:

- Completion of two semiannual Detection-mode groundwater monitoring events.
- Statistical evaluation of groundwater data for Appendix III indicators.

1. Introduction

On behalf of Basin Electric Power Cooperative, (Basin), AECOM Technical Services, Inc. (AECOM) has prepared the 2020 annual report documenting groundwater monitoring and corrective action for the Coal Combustion Residuals (CCR) Ponds 2 and 3 Multi-unit at Basin's Leland Olds Station (LOS).

Chapter 1 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. Chapter 2 summarizes CCR groundwater monitoring activities conducted prior to January 2020. Chapter 3 summarizes the groundwater monitoring and corrective action activities completed between January and December 2020, and references attachments to this report that contain detailed documentation of those activities. Chapter 4 provides general information about the program including transitions and problems encountered in 2020 and actions planned for 2021, Chapter 5 presents summary and conclusions for the reporting period (January through December 2020). Chapter 6 lists references cited in this report.

Regulatory Background

The CCR rule effective on October 19, 2015, 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), submitted to the operating record annually on or before January 31 for inactive CCR Units including the Ponds 2 and 3 Multi-unit, henceforth referred to as the Multi-unit. The annual reports are 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 third annual report for the Multi-unit.

Facility Location and Operational History

LOS is a coal-based generating station located southeast of Stanton, North Dakota (**Figure 1**). The plant began operating in 1966 and consists of two power generating units with a total power output capacity of 669 megawatts.

CCR produced at LOS includes fly ash, bottom ash, and flue gas desulfurization (FGD) waste.

CCR Unit Description

The Multi-unit is located on the east side of the LOS generating station (**Figure 2**). Pond 2 was primarily used for the settling of bottom ash with process water directed through Pond 3 for eventual discharge in accordance with North Dakota Pollution Discharge and Elimination System (NDPDES) Permit ND-0025232. These inactive impoundments represent the last configuration of a larger impoundment complex **(Figure 1)**.

Physical Setting

The Multi-unit is situated in the valley of the Missouri River. The valley floor is relatively flat, with two relatively poorly defined terraces ranging from 1,670 feet above mean sea level (ft. amsl) to a maximum elevation of 1,715 ft. amsl near the southern property boundary. Seven of the CCR monitoring wells are located on the lower (first) terrace level, while one well is located on the upper (second) terrace **(Figure 2)**.

The geology underlying the Multi-unit is generally comprised of a minimum of 50 feet of alluvial silt, silty sand, and gravel deposits. The upper terrace level appears to be underlain by at least 25 more feet of alluvial deposits than is found adjacent to the Multi-unit. The alluvial deposits are underlain by the Sentinel Butte Formation, which is described as 1,000 feet or more of continental deposits consisting of dense clay, weakly cemented sandstone, and mudstone interlaced with occasional lignite beds that typically range from 5 to 10 feet in thickness.

Groundwater at the lower terrace locations is found within alluvial deposits comprised primarily of silty, fine to medium-grained sand at depths ranging roughly from 17 to 35 feet below ground surface (ft, bgs). Aquifer testing completed at monitoring wells MW-2017-3, MW-2017-4, MW-2017-5 and MW-2017-6 indicates hydraulic conductivity values within the monitored aquifer ranging from 1.28 x 10^{-2} to 6.94 x 10^{-4} centimeters per second (cm/sec) with a geometric mean of 2.0 x 10^{-3} cm/sec (5.67 feet per day [ft/day]). The potentiometric surface of the uppermost groundwater underlying the lower terrace area is typically encountered at approximately 1,664 ft. amsl. Although the direction of groundwater flow is highly influenced by changes in the elevation of the Missouri River, the net flow direction is expected to be eastward in the general direction of river flow with some flow northward into the river. Groundwater at the upper terrace is perched at a considerably higher elevation with limited hydraulic connection to the lower terrace. As a result, the groundwater from the upper terrace is expected to act as a limited background/upgradient influence on the uppermost aquifer at the Multi-unit.

2. CCR Groundwater Monitoring and Corrective Action Activities Prior to January 2020

The regulatory process for CCR groundwater monitoring and corrective action is established by 40 Code of Federal Regulations (CFR) Section 257.90 through 257.98. 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 Assessment of Corrective Measures (ACMs) followed by selection of remedy and remedy implementation.

The following paragraphs provide a brief summary of CCR groundwater monitoring activities performed prior to 2020. CCR groundwater monitoring activities performed between January and December 2020 are discussed in Chapter 3.

Groundwater monitoring at LOS 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 the unit (**Figure 2**). The hydrostratigraphic positions of the CCR monitoring wells selected for sampling background and downgradient groundwater quality for the LOS CCR unit is summarized below:

CCR unit	Background wells	Downgradient wells
Ponds 2 and 3 Multi-unit	MW-2017-1 and MW-2017-8	MW-2017-2, MW-2017-3, MW-2017-4, MW-2017-5, MW-2017-6, and MW-2017-7

Baseline Monitoring was initiated in September 2017, which involved sampling groundwater for 40 CFR Part 257 Appendix III and IV constituents over eight monitoring events. Baseline Monitoring events were performed in general accordance with procedures established in the site-specific Sampling and Analysis Plan (AECOM 2019a), which is included in the facility's Operating Record. The Sampling and Analysis Plan describes the procedures for equipment calibration, monitoring well water level measurement, monitoring well purging and sampling, sample custody, sample shipping, laboratory analysis and documentation requirements for each groundwater sample submitted. The results of Baseline Monitoring at LOS were presented and discussed in the First Annual Groundwater Monitoring and Corrective Action Report, Fall 2017-Spring 2019 (AECOM 2019b) issued on July 31, 2019. The LOS Multi-unit was placed in Detection monitoring in the fall of 2019 with first groundwater sampling event completed in November 2019 then twice annually thereafter. The results of Detection monitoring at LOS between August 1, 2019 and December 31, 2019 were presented and discussed in the Second Annual Groundwater Monitoring and Corrective Action Report (AECOM 2020) issued on January 31, 2020.

3. CCR Groundwater Monitoring and Corrective Action Activities (January-December 2020)

This chapter summarizes the groundwater monitoring and corrective action activities conducted at the LOS CCR Multi-unit between January 1, 2020 and December 31, 2020. To comply with the requirements of the CCR rule, this report presents:

- Groundwater Detection Monitoring Activities
  - monitoring system evaluation
  - groundwater monitoring completed June 2020
  - groundwater monitoring completed in October 2020
  - laboratory analysis for the June and October events
- Statistical analysis of the monitoring results
- Detection-mode Alternative Source Demonstration (ASD) for elevated pH observed at MW-2017-6.

Further details concerning each of these activities, including a brief discussion of work completed during the reporting period are provided below.

Detection Monitoring Activities

Monitoring System Evaluation

As described in the CCR Groundwater Monitoring System Report (AECOM 2019c), monitoring wells were installed around the CCR Multi-unit with appropriate total depth and placement of the well screen to: (1) facilitate collection of representative groundwater samples from the uppermost aquifer, and (2) accurately measure water table elevations to support evaluation of groundwater gradient and flow direction. All monitoring wells comprising the Multi-unit monitoring system were found to be in good condition during the Detection monitoring events conducted in June and October 2020.

Potentiometric surface maps were constructed using the depth-to-groundwater measurements obtained at the beginning of each Detection monitoring event as presented in **Attachment A**. The direction of groundwater flow observed in June 2020 was generally south-southwest away from the Missouri river then turning generally southeast to flow parallel to the Missouri River. The direction of groundwater flow observed in October 2020 was generally northeast toward the Missouri River. Baseline and Detection monitoring completed between fall of 2017 and fall of 2019 indicated that groundwater flow is generally northeast toward the Missouri River, but that reverse flow and parallel flow conditions, as observed during the June 2020 event are to be expected depending on prevailing river stage conditions (AECOM 2019b and AECOM 2020). The general groundwater flow direction determined during the 2020 Detection monitoring periods support the designation of the wells noted in Section 2 above to represent background groundwater quality and the quality of groundwater downgradient of the Multi-unit.

Groundwater Sampling and Analysis

The Detection monitoring events completed in 2020 included analysis of collected groundwater samples for the constituents listed in Part 257 Appendix III. The tabulated laboratory analytical results are presented in **Attachment A** along with potentiometric surface maps for the uppermost aquifer, inferred groundwater flow direction and estimated velocities, and a tabulated summary of field measurements.

Sampling and analysis was performed in general accordance with procedures established in the Sampling and Analysis Plan (AECOM 2019a). For 2020, the October monitoring included modification of the sampling procedures for downgradient wells MW-2017-5 and MW-2017-6 to address elevated pH readings. For this event the dedicated bladder pumps were removed in favor of higher flow controllable submersible pumps. Further details on the sampling procedure change are provided in the Detection-mode ASD discussion included later in this report.

Statistical Procedures and Analysis

The cumulative groundwater data collected for Appendix III indicator parameters at the LOS Multi-Unit was evaluated in accordance with the statistical procedures as certified on April 17, 2019 (AECOM 2019c). Statistical analysis of the results of Detection monitoring in 2020 using both MW-2017-1 and MW-2017-8 as background wells.

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 LOS Multi-unit, monitoring wells MW-2017-1 and MW-2017-8 are designated as background wells because they are consistently located in background positions whereas monitoring wells MW-2017-2, MW-2017-3, MW-2017-4, MW-2017-5, MW-2017-6 and MW-2017-7 are often located downgradient of the Multi-unit but may individually be upgradient or side-gradient during some events depending on the river influence on groundwater flow direction.

Prediction limits (i.e., parametric or nonparametric) 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. Analytical data from the background monitoring wells collected between September 2017 and October 2020 were used to develop upper and lower prediction limits (UPLs/LPLs) for the Appendix III constituents at 95 percent confidence. An LPL was also developed for pH because it is a two-sided parameter. ProUCL Version 5.1 was used to store the data and run the statistical analyses to calculate the UPLs.

Data from the downgradient monitoring wells for the same time period were compared to the UPL or LPL to identify statistically significant increases (SSIs) over background. Mann-Kendall trend analysis was used to identify statistically significant increasing trends for constituents with a verified SSI. The statistical analysis results indicate that calcium, chloride, fluoride, pH, sulfate and total dissolved solids (TDS) do not currently exhibit SSIs over background. The analysis also indicated that pH did not exhibit an SSI below background. The results of the analyses, including the UPLs (and LPL for pH) are summarized in **Table 1**. A summary of the SSIs above background is provided in **Table 2**.

Detection-mode ASD

A Detection-mode ASD was certified on December 4, 2020 and is provided as **Attachment B**. The ASD was completed in response to elevated pH measurements observed at MW-2017-6 that suggested an SSI for this indicator parameter. A similar condition was also observed in MW-2017-5 but had not yet suggested an SSI. The alternative to the CCR unit was identified as the cement used in the grout placed by the driller during the well construction. To test this alternative, the dedicated bladder pump was removed from MW-2017-6 and replaced with a submersible pump with flow controller to purge the well at a greater rate (than capable by the dedicated bladder pumps) until pH readings stabilized at values similar to that observed at the six remaining program wells present at the site. The ASD concluded that the additional pumping rate and volume removed was sufficient to overcome the localized influence of the cement impact. In response, the sampling procedure for both MW-2017-5 and MW-2017-6 has been changed to utilize a submersible pump for all future sample collections for as long as the alternative source persists at each location **(See Attachment B for further details)**.

Supplemental Site Investigation

AECOM mobilized a licensed driller to the site in October 2020 to install two new wells to evaluate background groundwater issues related to the Multi-unit.

The first well was installed to evaluate whether there might be a deeper groundwater influence on the monitored aquifer at the MW-2017-8 location. MW-2017-8 had been found to be monitor a relatively shallow depth in a perched groundwater zone on the upper terrace of the floodplain. This effort resulted in the installation of monitoring well MW-2017-8D. Dense clay “bedrock” was encountered at 38 ft, bgs that continued to 61.5 ft, bgs where a lignite bed was encountered. The lignite bed extended 2.5 feet to a depth of 64.0 ft, bgs where the lithology abruptly transitioned back to dense clay. A monitoring well was installed with the screen interval set at 61.5 to 71.5 ft, bgs to monitor the groundwater within the lignite bed.

The second well, MW-2017-9, was installed within the alluvial deposits on the southwest side of Multi-unit to test for an additional background monitoring position. This well location was selected as potentially more consistently and directly upgradient of the Multi-unit but it was not clear whether it would be outside the influence of alternative CCR sources, so the well will be monitored multiple times before it is proposed for addition to the monitoring network.

The locations of MW-2017-8D and MW-2017-9 relative to the LOS Multi-unit are illustrated on **Figure 2** with the boring logs presented in **Attachment C**.

4. General Information

The following subsections summarize any problems encountered in the LOS Multi-unit CCR program through 2020, any resolutions to those problems, if needed and upcoming actions planned for 2020.

Program Transitions 2020

There were no program transitions during the January - December 2020 monitoring period.

Problems Encountered

No problems were encountered during the January – December 2020 monitoring period, but an ASD was required for the detection of elevated pH values in one well as noted above.

Actions Planned for 2021

Basin plans on continuing the Detection monitoring program for the Multi-unit in 2021. The Detection monitoring program will include semi-annual groundwater sampling events and the required statistical evaluations.

5. Summary and Conclusions

Basin conducted two rounds of CCR groundwater Detection monitoring at the LOS Ponds 2 and 3 Multi-unit between January and December 2020. The results were used to establish background groundwater quality for Appendix III constituents in the uppermost aquifer, identify appropriate UPLs, and determine whether any UPLs were exceeded at statistically significant levels (SSLs) downgradient of the Multi-unit.

The statistical analysis results indicate that, with the exception of pH in MW-2017-6 (attributed to an alternative source), none of the Appendix III constituents had SSIs over background or statistically significant increasing trends in constituent concentrations. Based on these results, Assessment monitoring is not required at the LOS Pond 2 and Pond 3 Multi-unit. Detection monitoring will continue at the site in 2021.

6. References

AECOM. 2019a. Pond 2 and Pond 3 Multi-Unit Sampling and Analysis Plan, CCR Monitoring Program, Leland Olds Station, Stanton, North Dakota. Basin Electric Power Cooperative. April 2019.

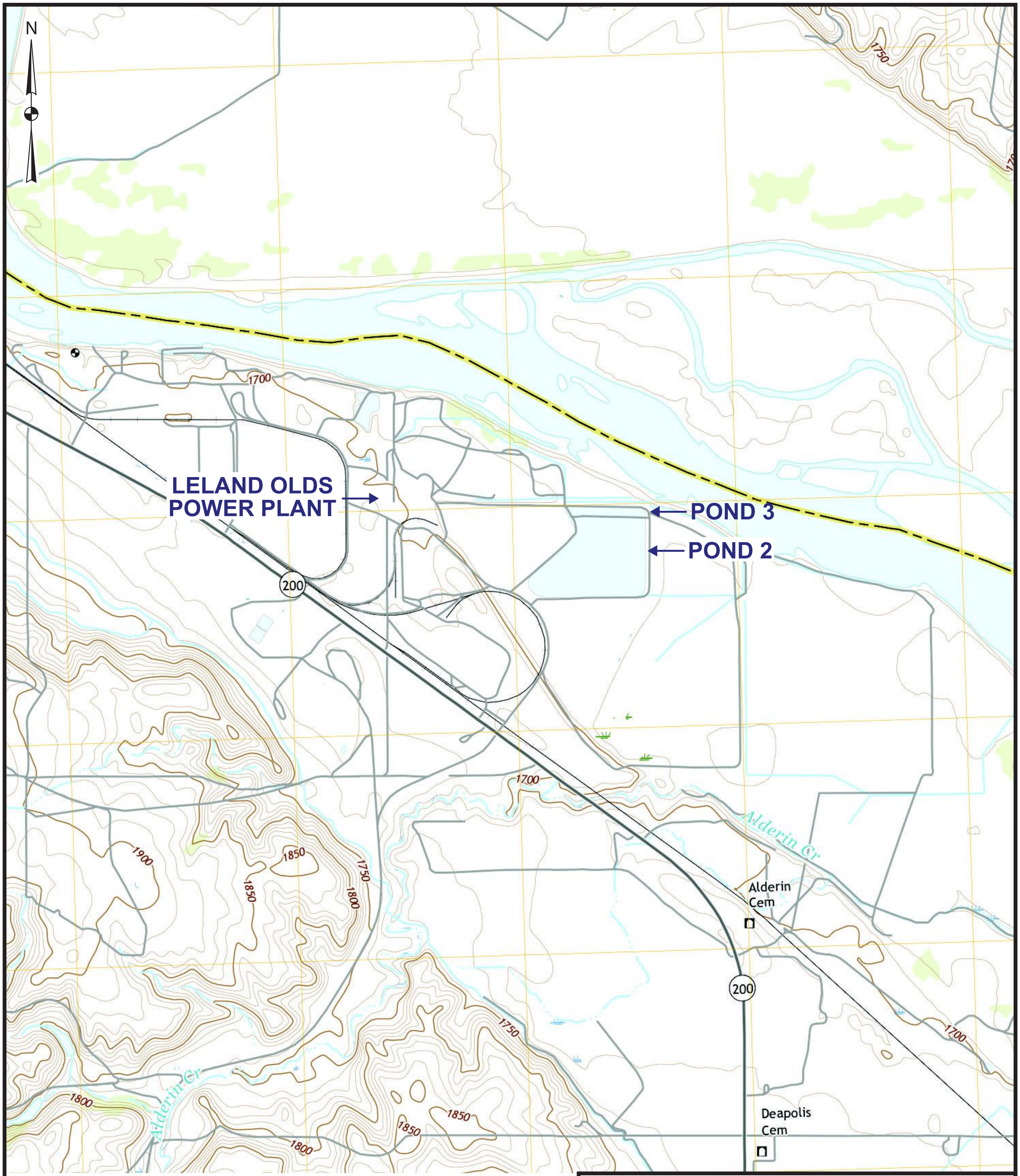
AECOM. 2019b. First Annual Groundwater Monitoring and Corrective Action Report, Fall 2017- Spring 2019, Pond 2 and Pond 3 Multi-Unit, Leland Olds Station, Stanton, North Dakota. Basin Electric Power Cooperative. July 31, 2019.

AECOM. 2019c. Pond 2 and Pond 3 Multi-unit CCR Groundwater Monitoring System Report, Leland Olds Station, Stanton, North Dakota. Basin Electric Power Cooperative. October 2017.

AECOM. 2020. Second Annual Groundwater Monitoring and Corrective Action Report (AECOM 2020) issued on January 31, 2020.

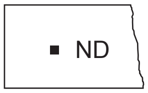
Figures

G:\Cincinnati\DCS\Projects\ENV\60558359_BE_LOS_P2\900-CAD-GIS\920-GIS or Graphics



0 2,000 4,000

APPROXIMATE SCALE IN FEET



Quadrangle Location

BASE MAP SOURCE: USGS 7½ minute topographic quadrangle mapStanton SE, North Dakota 2018.

BASIN ELECTRIC POWER COOPERATIVE

FIGURE 1
SITE VICINITY MAP
LOS POND 2 AND POND 3 MULTIUNIT

JOB NO. 60558359

AECOM

DRAWING: NORTH DAKOTA STATE PLANE NAD27 SOUTH ZONE-FT
PHOTO: NAIP MERCER COUNTY FALL OF 2017 / UTM NAD83 ZONE 14N-METERS

LEGEND

▲	MONITORING WELL
⊙	CCR RULE COMPLIANCE WELL
◉	INVESTIGATION WELL (2020)
▬	Geologic Cross Section A-A'
(144-84-2X-XXXX)	NOT USED FOR CONTOURING
▬	Terrace Boundary (Inferred)

BASIN ELECTRIC
POWER COOPERATIVE

LELAND OLDS STATION
STANTON, NORTH DAKOTA

FIGURE 2
WELL LOCATION MAP
LOS POND 2 AND POND 3 MULTIUNIT

JOB NO. 60634880

AECOM

Tables

TABLE 1

2020 Statistical Analysis Methods and Background Upper/Lower Prediction Limits
LOS Pond 2 and Pond 3 (Multi-unit) CCR Monitoring Well Network
Leland Olds Station – Stanton, North Dakota

Parameter (Units)	Number of Samples	Percent Nondetects	Normal or Lognormal Distribution?	Statistical Method	Background Prediction Limit
Boron (mg/L)	18	0	No/No	Nonparametric 95% UPL	2.37
Calcium (mg/L)	18	0	Yes/No	Parametric 95% UPL	167
Chloride (mg/L)	18	0	No/No	Nonparametric 95% UPL	25
Fluoride (mg/L)	18	83	No/No	Nonparametric 95% UPL	4.68
pH (std units)	18	0	Yes/Yes	Parametric 95% LPL/UPL	6.66/7.59
Sulfate (mg/L)	18	0	No/No	Nonparametric 95% UPL	2,100
TDS (mg/L)	18	0	No/No	Nonparametric 95% UPL	4,000

Note pH has both a lower prediction limit (LPL) and upper prediction limit (UPL); all other constituents only have an UPL

TABLE 2

2020 Statistical Method Analysis and Results
LOS Pond 2 and Pond 3 (Multi-unit) CCR Monitoring Well Network
Leland Olds Station – Stanton, North Dakota

Well	Location	B	Ca	Cl	F	pH (LPL/UPL)		SO4	TDS
MW-2017-2	Downgradient	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
MW-2017-3	Downgradient	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
MW-2017-4	Downgradient	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
MW-2017-5	Downgradient	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
MW-2017-6	Downgradient	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
MW-2017-7	Downgradient	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩

Notes:

SSIs determined using interwell upper prediction limits (UPLs) at background monitoring well MW-2017-1

🟩	Less than or equal to background upper prediction limit (UPL) or greater than lower prediction limit (LPL) for pH
🟨	Unverified statistically significant increase (SSI) over background UPL or below background LPL for pH
🟥	Verified SSI over background UPL or below background LPL for pH

Attachment A
Sampling and Analysis Report, 2020

2020 Sampling and Analysis Report, Pond 2 and LOS Pond 3 Multi-unit CCR Monitoring Program

Leland Olds Station
Stanton, North Dakota

Basin Electric Power Cooperative

January 31, 2021

Prepared for:

Basin Electric Power Cooperative
Bismarck, North Dakota

Prepared by:

AECOM
525 Vine Street
Suite 1800
Cincinnati, OH. 45202
aecom.com

Project #60634880

Table of Contents

Figure

Tables

List of Acronyms

AECOM	AECOM Technical Services, Inc.
Basin	Basin Electric Power Cooperative
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EPA	United States Environmental Protection Agency
LOS	Leland Olds Station
QA/QC	Quality assurance/quality control

1. Introduction

On behalf of Basin Electric Power Cooperative (Basin), AECOM Technical Services, Inc. (AECOM) prepared this Coal Combustion Residuals (CCR) Groundwater Sampling and Analysis Report for the Pond 2 and Pond 3 Multi-unit at Basin's Leland Olds Station (LOS). The objective of the report is to provide a description of the field and office activities performed between January and December of 2020.

This Sampling and Analysis Report was prepared to present the results of sampling and analysis of groundwater conducted for the monitoring requirements of the United States Environmental Protection Agency (EPA) CCR rule (Chapter 40 of the Code of Federal Regulations (CFR), Sections 257.90 to 257.98). Specifically, the report presents the data collected for the groundwater Detection Monitoring events conducted in June and October of 2020.

2. Groundwater Flow

As required by 40 CFR Section 257.93(c), groundwater elevations were measured for each well prior to purging each time groundwater was sampled. The measurements, presented in **Tables 1A and 1B**, were used to create a potentiometric surface map for the uppermost aquifer for the detection monitoring events completed in June and October 2020, respectively. The resulting potentiometric surface maps, presented as **Figures 1 and 2**, was used to evaluate the direction of groundwater flow and hydraulic gradient for the subject CCR unit for each event. The potentiometric maps illustrate varying patterns of groundwater flow indicative of seasonal variation. In June 2020, groundwater flow was generally to the south-southwest away from the Missouri River and then swinging broadly down-valley to the east-southeast. In October 2020, groundwater flow was generally northeast toward the Missouri River. The seasonal flow directions are generally consistent with those observed in the eight baseline monitoring events for the site between the fall of 2017 through Spring of 2019 and the first Detection monitoring event completed in November 2019. Groundwater flow velocities for the 2020 Detection monitoring events were calculated and are summarized in **Table 2**.

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

CCR unit	Background wells	Downgradient wells
Pond 2 and Pond 3 Multi-unit	MW-2017-1 and MW-2017-8	MW-2017-2, MW-2017-3, MW-2017-4, MW-2017-5, MW-2017-6, and MW-2017-7

Monitoring well MW-2017-8 is included from the groundwater monitoring network as a background well due to its upgradient location relative to the Multi-unit. Additional evaluation of MW-2017-8 was completed in 2020 including gauging, sampling, and installation of a deeper well to evaluate the underlying stratigraphy that was completed in October 2020. The deeper well, identified as MW-2017-8D, confirmed the clay at the bottom of MW-2017-8 corresponds to the top of bedrock at this location including a 2.5-foot-thick groundwater yielding lignite bed. MW-2017-8D was screened across this lignite to allow for further evaluation of the groundwater chemistry. One additional well, identified as MW-2017-9, was installed in October 2020 at a potential background location southwest of the Multi-unit. The surveyed location of each of these wells is provided in **Figure 2**.

3. Groundwater Quality

The analytical testing laboratory provided a report presenting the results of laboratory analysis for the June and October 2020 monitoring events. The laboratory report is included in the operating record and was reviewed for completeness against the project-required methods and the chain-of-custody forms. The laboratory report was also reviewed for holding times, and to check that the data was appropriately flagged based on the quality assurance/quality control (QA/QC) data provided. A data validation report was prepared for the monitoring event and is included in the operating record. The validated results were compiled into summary form as presented in **Table 3**.

Figures

BASIN ELECTRIC
POWER COOPERATIVE

LELAND OLDS STATION
STANTON, NORTH DAKOTA

Figure 1
BASIN LELAND OLDS STATION
POTENTIOMETRIC SURFACE MAP
June 8, 2020

JOB NO. 60634880

AECOM

BASIN ELECTRIC
POWER COOPERATIVE

LELAND OLDS STATION
STANTON, NORTH DAKOTA

Figure 2
BASIN LELAND OLDS STATION
POTENTIOMETRIC SURFACE MAP
October 5, 2020

JOB NO. 60634880

AECOM

Tables

TABLE 1 A

GROUNDWATER MONITORING WATER LEVELS AND ELEVATIONS
CCR MONITORING WELLS

LOS POND 2 AND POND 3 - MULTIUNIT
STANTON, NORTH DAKOTA

Well ID	Reference Elevation Top of Casing (feet, NAVD 88)	June 8, 2020 Depth to Water (feet)	Groundwater Elevation (feet, NAVD 88)
MW-2017	1,683.86	23.31	1,660.55
MW-2017	1,681.03	20.50	1,660.53
MW-2017	1,682.36	21.85	1,660.51
MW-2017	1,684.13	23.93	1,660.20
MW-2017	1,691.72	31.50	1,660.22
MW-2017	1,693.44	33.06	1,660.38
MW-2017	1,698.25	37.80	1,660.45
MW-2017	1,717.23	28.90	1,688.33
Missouri River			1660.58

TABLE 1 B

GROUNDWATER MONITORING WATER LEVELS AND ELEVATIONS
CCR PROGRAM MONITORING WELLS

LELAND OLDS STATION - STANTON, NORTH DAKOTA
LOS POND 2 AND POND 3 - MULTIUNIT

Well ID	Reference Elevation Top of Casing (feet, NAVD 88)	October 5, 2020 Depth to Water (feet)	Groundwater Elevation (feet, NAVD 88)
MW-2017-1	1683.86	25.91	1657.95
MW-2017-2	1681.03	23.36	1657.67
MW-2017-3	1682.36	24.65	1657.71
MW-2017-4	1684.13	26.58	1657.55
MW-2017-5	1691.72	33.77	1657.95
MW-2017-6	1693.44	35.05	1658.39
MW-2017-7	1698.25	39.65	1658.60
MW-2017-8	1717.23	29.00	1688.23
MW-2017-8D*	1716.27	Not Measured	Not Measured
MW-2017-9*	1709.93	Not Measured	Not Measured
Missouri River			1657.13

TABLE 2

ESTIMATED GROUNDWATER GRADIENT AND SEEPAGE VELOCITY
CCR PROGRAM MONITORING WELLS
LELAND OLDS STATION POND 2 AND POND 3 MULTI-UNIT – STANTON, NORTH DAKOTA

Date of event	d_l (ft)	d_h (ft)	i (ft/ft)	n_e	K (ft/day)	v_s (ft/day)
3/12/2018	Insufficient Data: Limited site access due to high water					
4/17/2018	307	0.25	0.00081	0.33	1.16E+01	2.86E-02
6/14/2018*	493	0.25	0.00051	0.33	1.16E+01	1.78E-02
7/23/2018*	397	0.5	0.00126	0.33	1.16E+01	4.43E-02
9/27/2018*	480	0.25	0.00052	0.33	1.16E+01	1.83E-02
3/12/2019	337	0.5	0.00148	0.33	1.16E+01	5.22E-02
3/27/2019	300	0.5	0.00167	0.33	1.16E+01	5.86E-02
4/9/2019	303	0.75	0.00248	0.33	1.16E+01	8.70E-02
11/11/2019*	300	0.1	0.00033	0.33	1.16E+01	1.17E-02
6/8/2020*	960	0.29	0.00030	0.33	1.16E+01	1.06E-02
10/5/2020	810	0.6	0.00074	0.33	1.16E+01	2.60E-02

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 33%

K = Site average hydraulic conductivity of 11.6 ft/day from slug tests at site

v_s = Seepage Velocity (ft/day)

* = Groundwater flow direction during event was from river to aquifer

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

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

Table 3

Analytical Results Summary
LOS Pond 2 and Pond 3 (Multiunit) CCR Monitoring Well Network
Leland Olds Station - Stanton, North Dakota

			Appendix III Constituents						
Well ID	Event	Date	Boron mg/L	Calcium mg/L	Chloride mg/L	Fluoride mg/L	pH SU	Sulfate mg/L	TDS mg/L
MW-2017-1	Event 10	06/08/20	1.04	150	7.74	< 0.500 U	6.86	260	1050
MW-2017-2	Event 10	6/9/20	1.30	82.7	8.13	< 0.500 U	7.26	233	732
MW-2017-2 Dup	Event 10	6/9/20	1.31	83.2	8.10	< 0.500 U		233	770
MW-2017-3	Event 10	6/8/20	1.62	76.0	8.09	< 0.500 U	7.31	173	764
MW-2017-4	Event 10	6/8/20	1.23	118	7.89	0.622	6.3	281	836
MW-2017-5	Event 10	6/8/20	0.680	53.9	8.01	1.04	9.55	257	636
MW-2017-6	Event 10	6/8/20	1.61	54.5	7.98	0.505	8.05	205	610
MW-2017-7	Event 10	6/8/20	1.90	58.2	8.49	1.60	7.06	293	719
MW-2017-8	Event 06	6/8/20	0.453	133	20.8	4.68	7.29	1860	3800
MW-2017-1	Event 11	10/05/20	0.964	158	9.87	< 0.500 U	7.01	270	960
MW-2017-2	Event 11	10/6/20	1.18	91.7	10.1	< 0.500 U	7.05	269	803
MW-2017-3	Event 11	10/6/20	1.7	80.4	9.80	< 0.500 U	7.04	194	754
MW-2017-4	Event 11	10/6/20	1.45	134	9.10	0.509	6.8	291 F1	835
MW-2017-5	Event 11	10/20/20	0.811	77.7	8.66	0.897	7.22	272 H	676
MW-2017-6	Event 11	10/20/20	1.76	59.9	8.07	< 0.500 UH	7.49	267	640
MW-2017-7	Event 11	10/5/20	2.14	61.1	10.8	1.24	7.26	270	597
MW-2017-8	Event 07	10/6/20	0.48	137	24.6	4.57	7.16	1960	2960
MW-2017-8D	Event 01	10/21/20	0.699	13.4	11.8	0.555	7.8	354	1880
MW-2017-8D Dup	Event 01	10/21/20	0.659	17.1	11.4	0.520		332	1980
MW-2017-9	Event 01	10/20/20	7.06	71.1	9.79	< 0.500 U	7.27	221 H	1060

TDS = Total Dissolved Solids
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
H = Sample was prepped or analyzed beyond the specified holdilng time

Attachment B
Alternative Source Demonstration pH in MW-2017-6, December 2020

Alternative Source Demonstration pH in MW-2017-6

Coal Combustion Residuals (CCR) Detection-Mode Monitoring

LOS Pond 2 and Pond 3 Multi-unit

December 2020

Leland Olds Station, Stanton, North Dakota
Basin Electric Power Cooperative

Basin Electric Power Cooperative
Bismarck, North Dakota

Quality information

Prepared by	Checked by	Verified by	Approved by
Jason Lach Senior Project Manager	Dennis Connair Vice President	Daryl Beck, PE Project Engineer	Jason Lach Senior Project Manager

Revision History

Revision	Revision date	Details	Authorized	Name	Position

Distribution List

# Hard Copies	PDF Required	Association / Company Name
0	Yes	Mr. Kevin Solie / Basin Electric Power Cooperative

Prepared for:

Basin Electric Power Cooperative
Bismarck, North Dakota

Prepared by:

AECOM
525 Vine Street Suite 1800
Cincinnati, OH. 45202
aecom.com

Table of Contents

Figures

Table

Appendix

List of Acronyms

AECOM	AECOM Technical Services, Inc.
ASD	Alternative Source Demonstration
Basin Electric	Basin Electric Power Cooperative
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
cm/sec	centimeters per second
gpm	gallons per minute
GWPS	groundwater protection standard
LOS	Leland Olds Station
msl	mean sea level
SSI	statistically significant increase
SU	standard units
TDS	total dissolved solids

Executive Summary

AECOM Technical Services, Inc. (AECOM) was retained by Basin Electric Cooperative (Basin Electric) to prepare an Alternative Source Demonstration (ASD) to evaluate possible alternative sources for elevated pH values in groundwater monitored for the Ponds 2 and 3 (Multi-unit) at the Leland Olds Station (LOS) in Stanton, North Dakota.

There are 10 monitoring wells installed at the site including eight wells (MW-2017-1 through MW-2017-8) installed in 2017 to establish the Multi-unit program monitoring network and two investigation wells (MW-2017-8D and MW-2017-9) installed in September 2020 for a separate investigation to further evaluate the background conditions at the Multi-unit **(Figure 2)**.

Baseline and detection monitoring of the site identified the Appendix III indicator parameter, pH at elevated values relative to background, in monitoring well MW-2017-6 and to a lesser extent in MW-2017-5. The results indicated an apparent Statistically Significant Increase (SSI) above background in MW-2017-6.

Section 257.95(g)(3) of the Coal Combustion Residuals (CCR) Rule allows the Owner or Operator 90 days from the date of the verified SSI determination (for Appendix III parameters) to demonstrate that the source of the apparent SSI is other than the CCR unit(s) or resulted from errors in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Review of other Appendix III indicator and other general chemistry parameters at the site suggested the elevated pH observed is unlikely to be sourced from the CCR units.

The likely source of elevated pH (alkaline) conditions at groundwater wells is often the cement-bentonite grout used in well construction to fill the annular space above the well seal. If the grout did not fully cure, the cement component of the grout can leach into the adjacent aquifer and be pulled into the well screen by sample purging. To test this potential, the sampling procedure for the well(s) was modified to determine if the elevated pH observed in these wells could be lowered by increasing the purging rate prior to sampling. This was accomplished by replacing the dedicated bladder pumps with a submersible pump capable of increased flow rates. The additional purging capability of the submersible pump was found to lower the pH in these monitoring wells to values that are generally consistent with background for the site, This finding suggests that the source of the elevated pH is not the Ponds 2 and 3 Multi-unit, but rather the well construction materials.

To address this issue, Basin Electric has modified the sampling procedures for MW-2017-5 and MW-2017-6 to continue use of a submersible pump in lieu of the dedicated bladder pumps. The new sampling procedures for these wells increases the pumping rate to purge a greater volume of water from each well until pH values have stabilized at levels that are generally consistent with site background of between 7.00 and 7.50 standard units (SU). It is expected that the influence of the cement-bentonite grout will eventually diminish over time. During this period the revised sampling procedures for MW-2017-5 and MW-2017-6 meet all current requirements for quality assurance, so no additional corrective measures are required at this time.

This ASD will be placed in the facility's operating record and will be included as an attachment to the next Annual Groundwater Monitoring and Corrective Action report that will be issued to the operating record no later than January 31, 2021.

1. Introduction

At the request of Basin Electric Power Cooperative (Basin Electric) Leland Olds Station (LOS), AECOM Technical Services, Inc. (AECOM) has prepared this Detection-mode Alternative Source Demonstration (ASD) for the detection of elevated levels of the Appendix III parameter pH in groundwater sampled from monitoring well MW-2017-5 and MW-2017-6 at the LOS Coal Combustion Residuals (CCR) Ponds 2 and 3 (Multi-unit), located in Stanton, North Dakota **(Figure 1)**.

The Multi-unit groundwater monitoring well network was established to monitor groundwater at locations that have not been affected by leakage from the CCR unit (background or upgradient) and groundwater passing the downgradient waste boundary. Ten monitoring wells have been installed at the site in support of the CCR program. They include eight program network monitoring wells (MW-2017-1 through MW-2017-8) installed in November-December 2017 and two investigation wells (MW-2017-8D and MW-2017-9) installed in September 2020 for an independent investigation completed at the site to improve the site conceptual model and further evaluate background conditions **(Figure 2)**.

Program monitoring wells MW-2017-1 and MW-2018-8 are designated as background monitoring wells due to their consistent background positioning locations relative to the Multi-unit. The six remaining program monitoring wells (MW-2017-2 through MW-2017-7) are designated as downgradient of the Multi-unit; however, the hydraulic position of these individual wells varies through the course of the year depending on fluctuations in stage of the nearby Missouri River. Changes of a few feet of stage in the Missouri River can significantly alter the short-term groundwater flow direction at the site. Under stable river conditions, the groundwater potentiometric surface commonly slopes just a few tenths of a foot across the site. As a result, the downgradient flow direction, relative to the Multi-unit, changes frequently with flows that might be toward the river one day then away from the river the next (**Figure 3)**.

Detection Monitoring results for June 2020 indicate that monitoring wells MW-2017-5 and MW-2017-6 have elevated pH levels relative to background. These pH values are the subject of this Detection-mode ASD.

2. Background

The CCR rule 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 regulatory process for CCR groundwater monitoring and corrective action is established by Chapter 40 of the Code of Federal Regulations (CFR) Sections 257.90 through 257.98. The process includes a phased-approach to groundwater monitoring, leading (if applicable) to the establishment of groundwater protection standards (GWPSs) for each CCR unit or Multi-unit. Exceedances of the GWPS that are determined to be statistically significant can trigger requirements for additional groundwater characterization and corrective action assessment followed by corrective action implementation.

Groundwater monitoring is performed using a network of monitoring wells in accordance with the site-specific *Pond 2 and Pond 3 Multi-unit Sampling and Analysis Plan, dated April 17, 2019* (AECOM 2019A). The plan establishes the sampling procedures for both wells to monitor background water quality that are not potentially influenced by the presence of the CCR Unit(s), and wells placed at the downgradient boundary of waste disposal. Statistical procedures to evaluate the Multi-unit were developed and presented in the *Pond 2 and Pond 3 Multi-unit Annual Groundwater Monitoring and Corrective Action Report, dated July 31, 2019* (AECOM 2019B).

Detection Monitoring was initiated in November 2019 and repeated in June 2020 to evaluate groundwater quality based on the constituents listed in Appendix III of the CCR rule (boron, calcium, chloride, fluoride, field pH, total dissolved solids (TDS), and sulfate).

3. Summary of Statistically Significant Increases (SSIs)

Statistical analysis results for the November 2019 event presented as Attachment B of the *Pond 2 and Pond 3 Multi-unit Annual Groundwater Monitoring and Corrective Action Report, dated January 31, 2020* (AECOM, 2020) reported pH at an unverified Statistically Significant Increase (SSI) over background for Appendix III indicator in monitoring well MW-2017-6. No other Appendix III indicators were identified with an SSI over background in any of the downgradient monitoring wells at the Multi-unit.

The next groundwater monitoring event was completed on June 8, 2020. This event was a Detection Monitoring event for the analysis of the required Appendix III indicators and optional Appendix IV constituents. Statistical analysis of the results of this event verified pH at an SSI over background in monitoring well MW-2017-6 with no other Appendix III indicators identified at an SSI over background in any of the downgradient monitoring wells. The verification of the SSI at MW-2017-6 for pH requires either the identification of an alternative source or transition of the program to Assessment Monitoring.

4. Alternative Source Demonstration Under the CCR Rule

Section 257.95(g)(3) of the CCR Rule allows the Owner or Operator 90 days from the date of the verified SSI determination (for Appendix III parameters) to demonstrate that:

- A source other than the CCR unit caused the apparent SSI or;
- The apparent SSI resulted from errors in sampling, analysis, statistical evaluation, or natural variation in groundwater quality.

Accordingly, the potential for alternative sources of this sort to have affected the monitoring results was evaluated.

5. Alternative Source Demonstration Lines of Evidence

The following sections have been prepared in general accordance with the Electric Power Research Institute's guidance for the development of ASDs for CCR sites (EPRI 2017). This guidance presents lines of evidence that can be used to ascertain if an observed SSI is likely sourced from a CCR site or an alternative source.

5.1 Sampling Procedure and Laboratory Analysis Evaluation

Each of the sampling events was reviewed for completeness and accuracy. All instrument calibration records indicate a properly functioning water quality meter used during purging prior to sample collection. There were no anomalies discovered in the laboratories reporting of the indicators and other chemistry that support an alternative for the pH results. As such, the data is believed to be an accurate representation of the quality of the water that was collected during each of the events.

5.2 Geologic Evaluation

The subsurface of the site is described as approximately 20 feet of silt with some clay underlain by fine sand that grades to a gravelly sand. These unconsolidated sediments are underlain by the Sentinel Butte Formation comprised primarily of dense clay with the occasional lignite bed. **Figure 4** presents a geologic cross-section A-A' transecting from MW-2017-8 and MW-2017-4 to the Missouri River including MW-2017-5, MW-2017-6, MW-2017-7 (installed in 2017), and MW-2017-8D (installed in September 2020). As illustrated on the geologic cross section, with the exclusion of background well MW-2017-8, the monitoring wells comprising the network for the Ponds 2 and 3 Multi-unit are all screened within a few feet above mean sea level (msl) of each other indicating a relatively homogenous and productive alluvial aquifer. The potentiometric surface at these wells, excluding MW-2017-8, is commonly flat with less than a foot change in elevation across the site **(Figure 3)**.

5.3 Water Quality Evaluation

In accordance with the CCR Rule, each sampling event completed included Appendix III indicator parameters boron, calcium, chloride, fluoride, pH, TDS, and sulfate **(Table 1)**. Two of the events, completed in June and August of 2018, included additional laboratory analysis for magnesium, potassium, sodium and total alkalinity. These parameters combined with Appendix III indicators calcium, chloride and sulfate were used to evaluate the cations and anions in groundwater through the preparation of Piper and Stiff diagrams to allow for the visual comparison of water quality based on the balance of anion and cation milliequivalents. The diagrams for the June and August 2018 events are presented as **Figure 5a, 5b, 6a, and 6b**, respectively. The evaluation indicates that groundwater conditions at the site are relatively stable with some modest variation that can be reasonably expected due to spatial variability.

5.4 Pond 2 and Pond 3 Design

Review of historic information indicates that Pond 2 and Pond 3 were part of a complex of impoundments constructed for the handling of CCR through a combination of excavation, dike construction and impoundment lining with locally sourced silt and clay. Pond 2 and Pond 3 ceased operation in 2015 and both impoundments were Closed-in-Place in 2020. The design and operation of Pond 2 and Pond 3 did not preclude these impoundments as potential sources of the pH SSI indicated in MW-2017-6.

5.5 Review of Possible Natural and Anthropogenic Sources

Monitoring well construction procedures utilized in 2017 are a possible anthropogenic source for elevated pH for the reasons indicated in the following subsections.

5.5.1 Monitoring Well Installation Evaluation

Monitoring well installation procedures employed at the site in 2017 were focused on identifying the elevation of the upper-most water-bearing strata in the vicinity of the Ponds 2 and 3 Multi-unit. The Well Installation Report, which documents well installation activities and construction details, was presented in the *Pond 2 and Pond 3 Multi-unit CCR Groundwater Monitoring System Report dated April 17, 2019 (AECOM 2019A)*. The boring logs for MW-2017-5 and MW-2017-6 are presented as **Appendix A**. Each borehole was advanced by the licensed driller, and lithologic samples were inspected by the on-site geologist.

Each monitoring well was installed with the screened interval placed within the upper-most water-bearing strata. A sand pack was then placed by the driller from the base of the borehole around the well pipe up to roughly 2 feet above the top of the screened interval. The driller then placed a bentonite seal comprised of a minimum of 2-foot thick interval of bentonite chips allowed to hydrate per manufacturer specifications. Once hydrated, the driller then prepared a cement and bentonite grout comprised of a ratio of one 93-pound bag of neat cement to 5 pounds of powdered bentonite clay. These materials were mixed with water into a slurry and pumped by tremie pipe placed at the top of the hydrated bentonite seal. The grout was then pumped in lifts filling the annulus to ground surface and left to begin to cure. After at least 24 hours, the wells were completed by the driller through placement of a protective steel casing over the well secured in a 2-ft by 2-ft concrete surface pad and surrounded by four bollards. Once the surface protections had cured the drilling subcontractor returned to each well for development. The development utilized a decontaminated submersible pump to evacuate a minimum of five well volumes of water from each well to remove residual drilling water and soil cuttings that were generated during borehole advancement and well construction. Field parameters for pH, conductivity and turbidity were measured using calibrated water quality meters at regular intervals and purging extended as needed to obtain parameter stability for up to ten well volumes at each location.

In the event that the cement/bentonite grout does not set up properly because of incomplete mixing or other formulation difficulty, or if the well development is conducted before the grout has adequately set up, there is the potential for the cement component of the grout to alter the pH of the adjacent aquifer and the well samples collected from it.

5.5.2 Hydraulic Characteristics and Potentiometric Evaluation

Hydraulic testing in the form of slug tests was performed on November 8, 2018, at monitoring wells MW-2017-3, MW-2017-4, MW-2017-5, and MW-2017-6 to assess the hydraulic characteristics of the uppermost aquifer. These monitoring wells were selected to represent a range of the observed aquifer responses across the site based on observations made during well development and sampling. Prior to starting each aquifer test, water level and total well depth measurements were taken. A pressure transducer was lowered to approximately 3 feet below the static water level. Two rounds of slug-in and slug-out data were collected at each well. The test configuration and pressure transducer data were evaluated using the AQTESOLV software package (Duffield, 2007), which provides type curve solutions corresponding to various conceptual models, each with their own hydrologic assumptions. The estimated hydraulic conductivity results derived from this analysis ranged from $6.9 \text{ X } 10^{-4}$ centimeters per second [cm/sec] (MW-2017-3) to $1.3\text{x}10^{-2}$ cm/sec (MW-2017-6). Reports from the AQTESOLV slug test analyses were presented in the *Pond 2 and Pond 3 Multi-unit CCR Groundwater Monitoring System Report dated April 17, 2019 (AECOM 2019A)*.

Potentiometry for the site is evaluated semiannually as part of the Detection Monitoring program with the results including summary table and potentiometric surface maps presented in the Annual Groundwater Monitoring and Corrective Action reports. Potentiometric surface mapping of the site indicates a low groundwater gradient, commonly less than 1-foot elevation difference across the site with flow direction primarily dictated by elevation changes in the Missouri River.

This combination of relatively high hydraulic conductivity and low gradient suggest that the rate of flow through the aquifer is relatively low, which in turn may allow the grout-impacted, high-pH groundwater to linger in proximity of the affected well(s) sufficiently to alter the chemistry of samples collected from the well(s).

6. Alternatives Evaluation

To date, pH in MW-2017-6 is the only Appendix III indicator to have exhibited an SSI at the Multi-unit. A CCR source would likely result in SSIs for more than one of the Appendix III indicators. Thus, an alternative source for MW-2017-6 is likely.

As noted above, a potential alternative source of elevated pH observed in MW-2017-6 and to a lesser extent in MW-2017-5, is the cement-bentonite grout placed in by the licensed driller above the bentonite seal at the time the wells were constructed. If not properly cured, the neat cement used in the grout can leach a caustic liquid high in pH that is capable of being drawn into the well screen during sampling. Potentially compounding this effect is the low hydraulic gradient observed at the site. The resulting low aquifer flushing of the site would increase the residence time, magnifying the effect of the pH alteration to the water within the screen interval.

In this environment, the use of higher flow rate sampling procedures may be adequate to evacuate the pH altered water accumulated within the screened interval to obtain a representative sample. To test this alternative, the modified sampling procedure was employed at MW-2017-5 and MW-2017-6 in September 2020, The goal of this test was to determine if sustained purging at higher flow rates would reduce the field pH measured in MW-2017-5 and MW-2017-6 down to the range commonly observed in the six remaining wells that comprise the Multi-unit program monitoring network (7.00 to 7.50 Standard Units (SU).

AECOM returned to the Multi-unit with a controllable Proactive Monsoon© submersible pump and calibrated Myron L© water quality meter to simulate a groundwater sampling event by purging MW-2017-5 and MW-2017-6 at higher flow rates. The dedicated bladder pumps in both wells were temporarily removed and replaced with the submersible pump set to the same depth to conduct this test. During removal of the dedicated bladder pumps the field geologist observed what appeared to be carbonate scale encrustation on the pump installed at MW-2017-6 that was not observed on the pump dedicated to MW-2017-5.

The groundwater sampling event simulation was initiated at roughly 0.5 gallons per minute (gpm) to obtain an initial field pH measurement of 8.77 SU in MW-2017-5 and 10.03 SU in MW-2017-6. These measurements were generally consistent with pH recorded for previous monitoring events completed using the dedicated bladder pumps. The flow rate was then increased to between 1.0 and 1.5 (gpm) to establish a stable drawdown corresponding to the groundwater yield potential for each well, and field pH was then recorded at roughly 5-minute intervals. The pumping was continued for approximately 35 to 45 minutes during which the pH measured in both wells stabilized to between 7.30 and 7.50 SU. This pH range is generally consistent with values observed at the other program monitoring wells at the Multi-unit adding further support to the cement-bentonite grout alternative source. To evaluate for potential rebound, MW-2017-6 was left to rest for 2 hours and retested. The second test started at a pH of 8.81 SU decreasing over 40 minutes before stabilizing at a pH of 7.40 SU.

7. Conclusion

A review of available general chemistry data, details of well construction, and details of sampling procedures indicates the elevated pH observed in wells MW-2017-6 and to a lesser extent in MW-2017-5 is likely not indicative of impact from the Ponds 2 and 3 Multi-unit. The likely alternative source responsible for the elevated pH observed in the groundwater at these wells is a highly localized phenomenon resulting from the presence of improperly cured neat cement that was used in the bentonite grout placed above the bentonite seal during well construction.

8. Recommendations

AECOM recommends altering the sampling procedures to sample both wells using variable speed submersible pumps to increase flow rates to purge until pH values are lowered to levels representative of the aquifer prior to sampling. If this sampling procedure change is insufficient, AECOM recommends the abandonment and replacement of the affected well(s) completed with a bentonite grout that does not incorporate neat cement.

9. Certification Statement

In accordance with 40 CFR Section 257.94, the owner or operator of a CCR unit must prepare a written notification stating that an Assessment Monitoring program as required under 40 CFR Section 257.95 has been established. The statistical analysis for LOS Ponds 2 and 3 Multi-unit Detection Monitoring event conducted in June 2020, identified SSIs for the following Appendix III constituents in one or more of the downgradient CCR network monitoring wells:

pH in MW-2017-6

Basin Electric consultant (AECOM) conducted an alternative source investigation for Ponds 2 and 3 Multi-unit at LOS. Based on the results of this investigation, a source other than the Multi-unit for the SSI was confirmed and transition to Assessment Monitoring is not required.

I, Daryl Beck, being a Registered Professional Engineer, in accordance with the State of North Dakota Professional Engineer's Registration program, possessing the technical knowledge and experience to make the specific technical certifications required under 40 CFR Part 257, Subpart D, Standards for the Disposal of CCRs in Landfills and Surface Impoundments, and being licensed in the state where the CCR unit(s) is located, do hereby certify to the best of my knowledge, information, and belief, that this ASD document is true and accurate, and has been prepared in accordance with the requirements of 40 CFR Section 257.94 (e).

Daryl Beck
Printed Name

December 4, 2020
Date

DARYL R. BECK
PE-10696
DATE 12-4-2020

10. References

AECOM, 2019A. Pond 2 and Pond 3 Multi-unit Sampling and Analysis Plan dated April 17, 2019.

AECOM, 2019B. Pond 2 and Pond 3 Multi-unit Annual Groundwater Monitoring and Correction Action Report dated April 17, 2019.

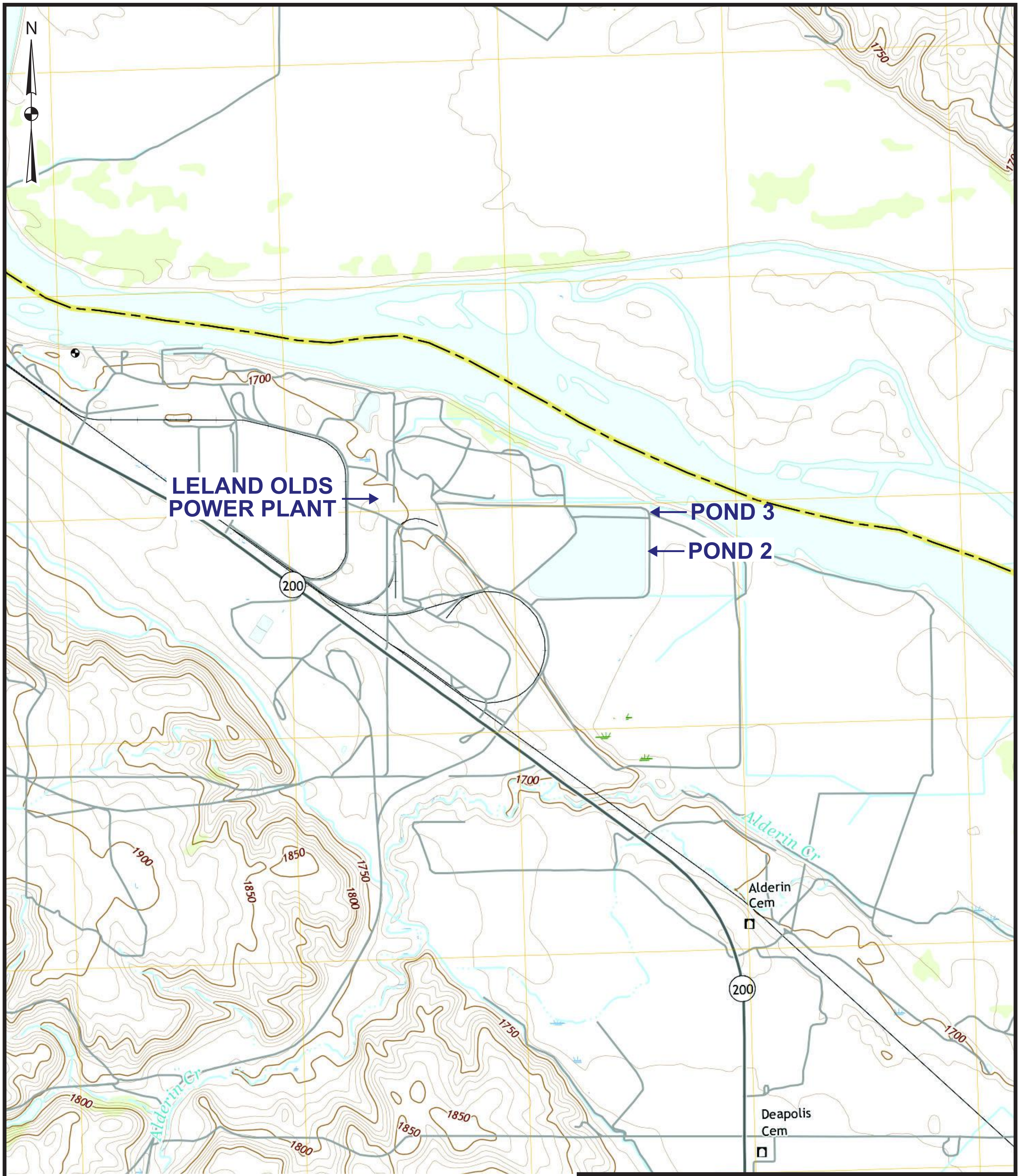
AECOM, 2020. Pond 2 and Pond 3 Multi-unit Annual Groundwater Monitoring and Corrective Action Report dated January 31, 2020.

Duffield, 2007. AQTESOLV software package.

EPRI, 2017. Guidelines for the Development of Alternative Source Demonstrations at Coal Combustion Residuals Sites, Electric Power Research Institute, dated October 2017

Figures

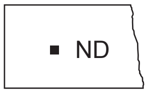
G:\Cincinnati\DCS\Projects\ENV\60558359_BE_LOS_P2\900-CAD-GIS\920-GIS or Graphics



0 2,000 4,000

APPROXIMATE SCALE IN FEET

BASE MAP SOURCE: USGS 7½ minute topographic quadrangle mapStanton SE, North Dakota 2018.



Quadrangle Location

BASIN ELECTRIC POWER COOPERATIVE

FIGURE 1
SITE VICINITY MAP
LOS POND 2 AND POND 3 MULTIUNIT

JOB NO. 60558359

AECOM

BASIN ELECTRIC
POWER COOPERATIVE

LELAND OLDS STATION
STANTON, NORTH DAKOTA

FIGURE 2
BASIN LELAND OLDS STATION
WELL LOCATION MAP

JOB NO. 60634880

AECOM

LEGEND

- ▲ MONITORING WELL
- ⊙ CCR RULE COMPLIANCE WELL
- ▬ Potentiometric Surface Contour in feet above mean sea level (dashed where inferred)
- (144-84-2X-XXXX) NOT USED FOR CONTOURING
- ▬ Terrace Boundary (Inferred)
- ➡ GROUNDWATER FLOW DIRECTION

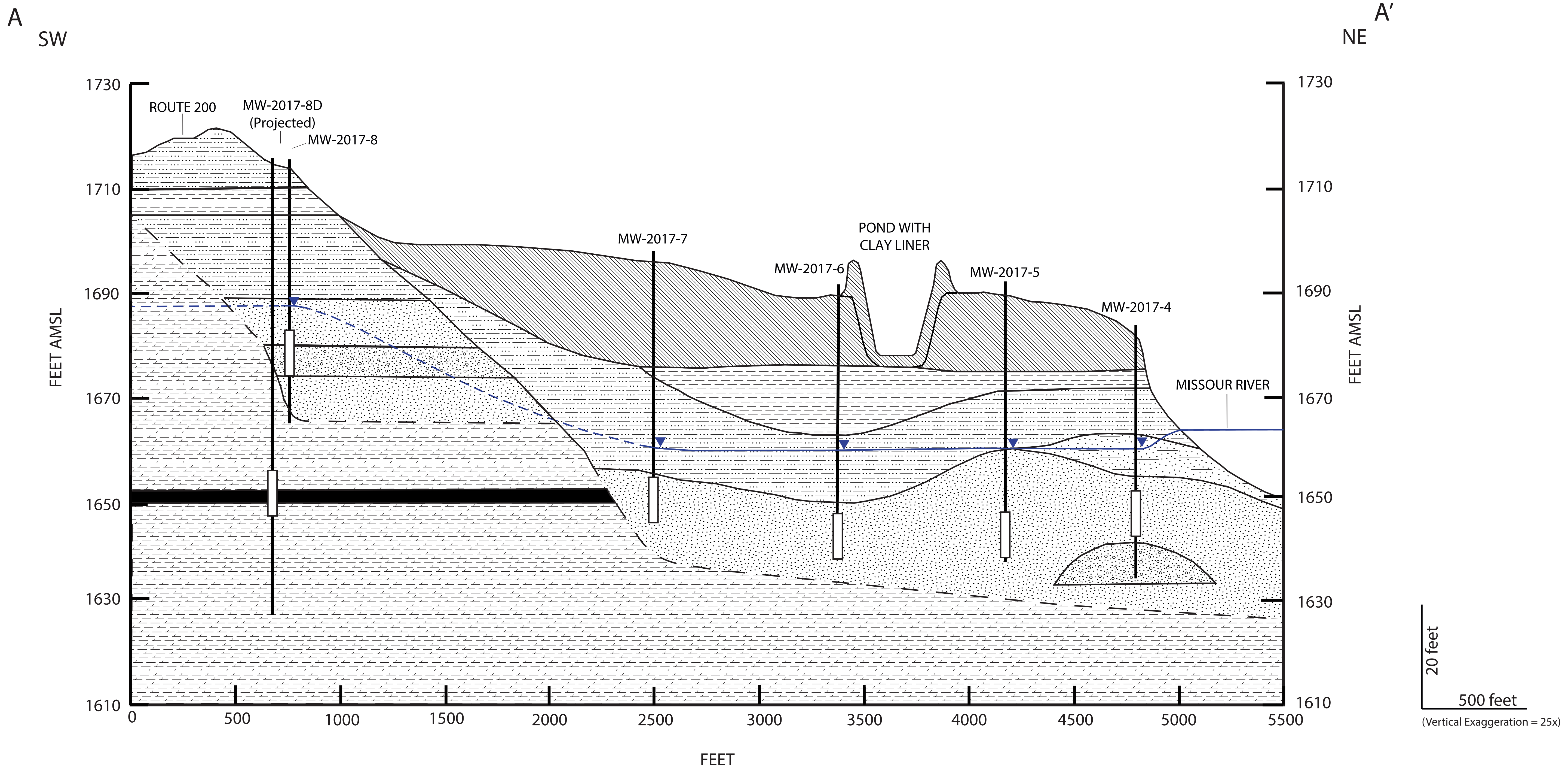
BASIN ELECTRIC
POWER COOPERATIVE

LELAND OLDS STATION
STANTON, NORTH DAKOTA

FIGURE 3
BASIN LELAND OLDS STATION
POTENTIOMETRIC SURFACE MAP
June 8, 2020

JOB NO. 60634880

AECOM



LEGEND

▨ Fill

▤ Silt and Clayey Silt

Silty Sand

Sentinel Butte Formation (Dashed where inferred)

■ Lignite

▤ Clay

Sand

Gravel

▼ Potentiometric Surface June 8, 2020 (Dashed where inferred)

MW-2017-8 MONITORING WELL LOCATION ID

MONITORING WELL RISER

MONITORING WELL SCREEN

BACKFILL / COLLAPSE

BASIN ELECTRIC
POWER COOPERATIVE

LELAND OLDS STATION
STANTON, NORTH DAKOTA

FIGURE 4
BASIN LELAND OLDS STATION
GEOLOGIC CROSS SECTION A-A'

JOB NO. 60634880

AECOM

Figure 5A

Piper Diagram - Event 3, June 2018

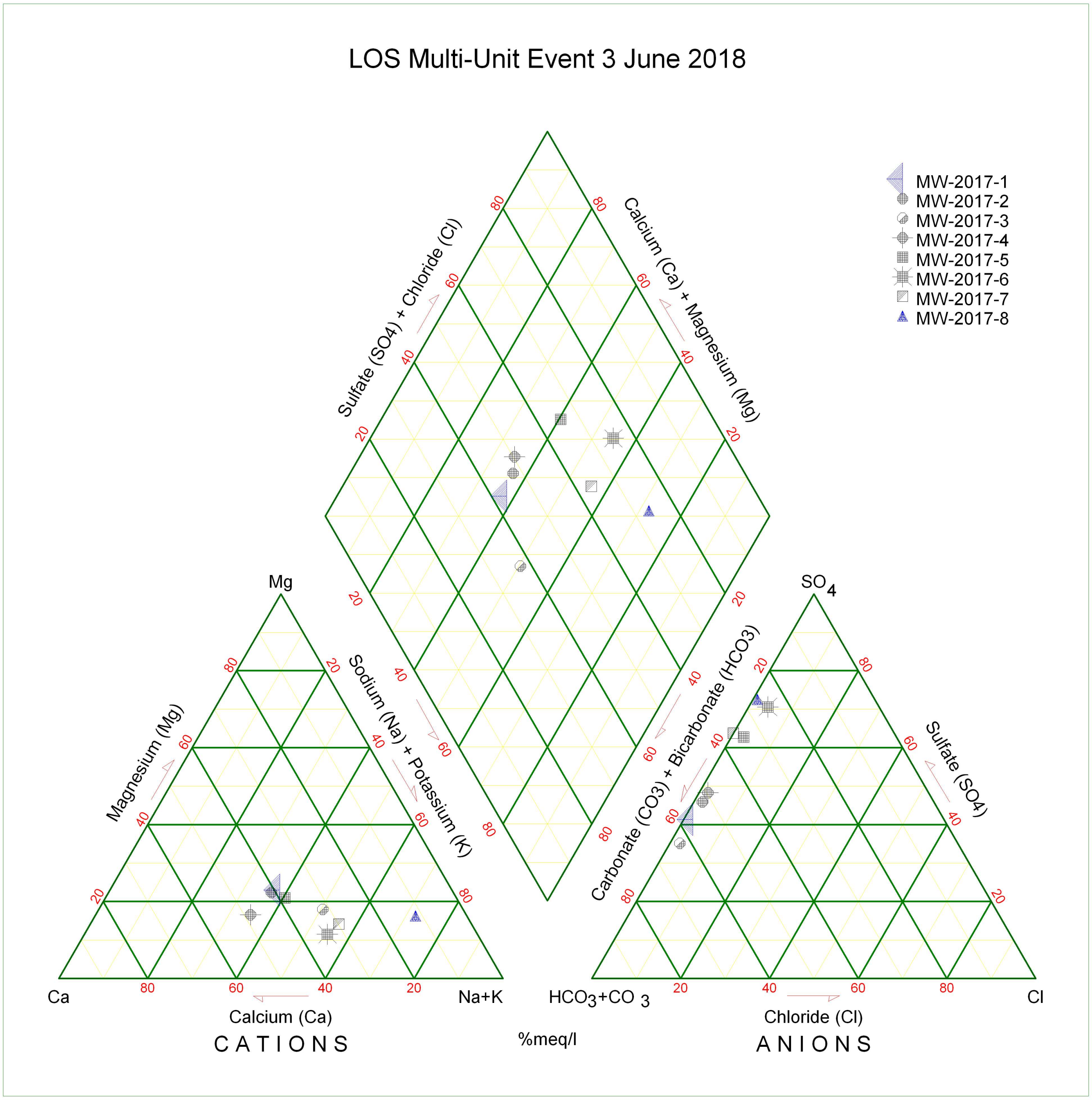


Figure 5B
Stiff Diagrams - Event 3, June 2018
Page 1 of 2

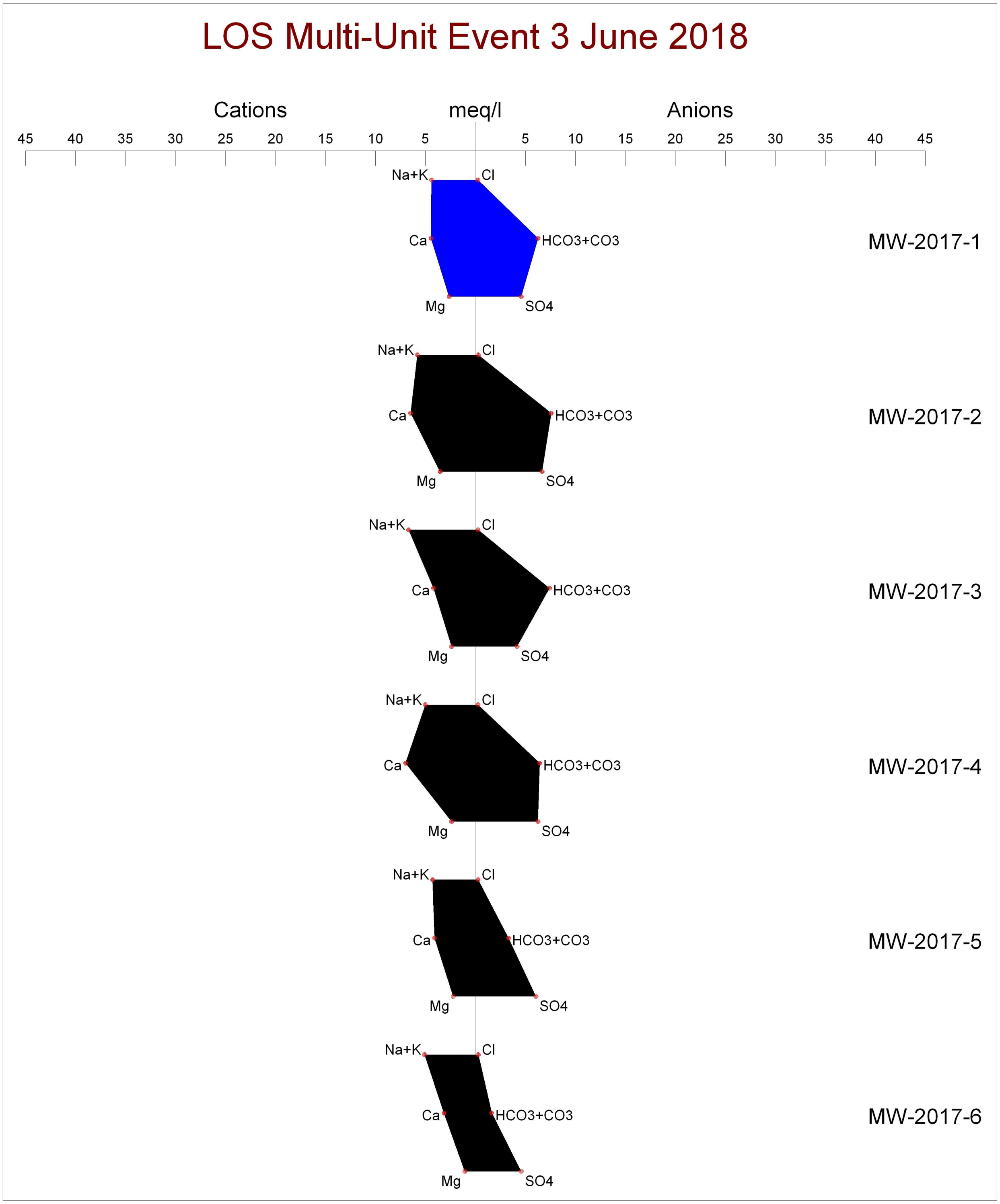


Figure 5B
Stiff Diagrams - Event 3, June 2018

Page 2 of 2

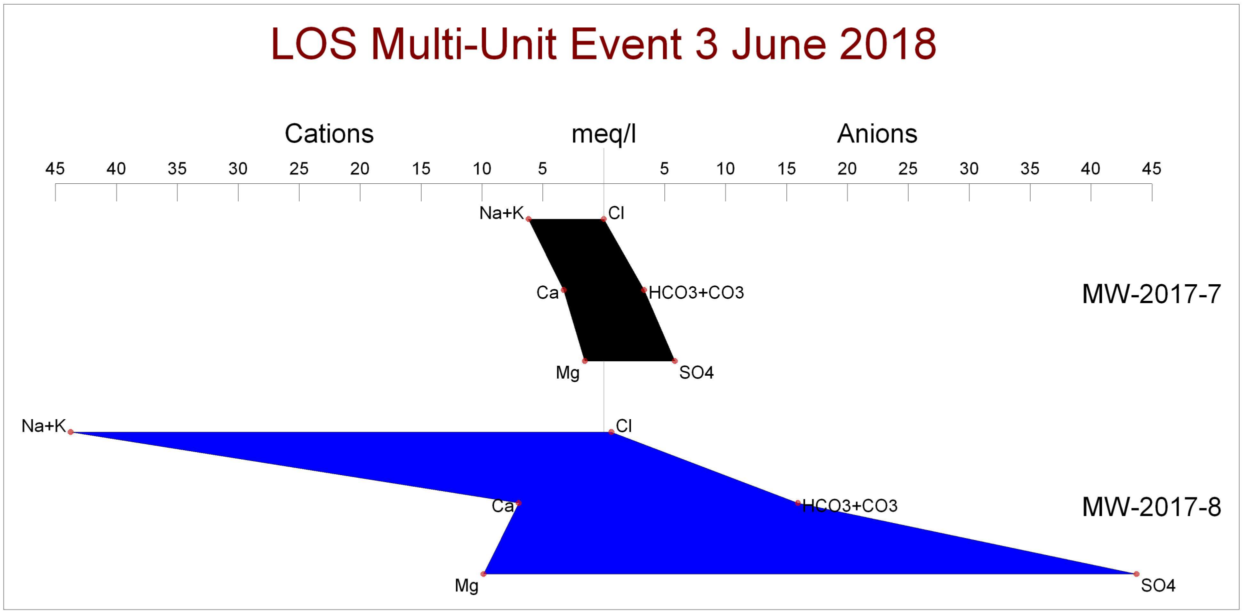


Figure 6A

Piper Diagram - Event 5, August 2018

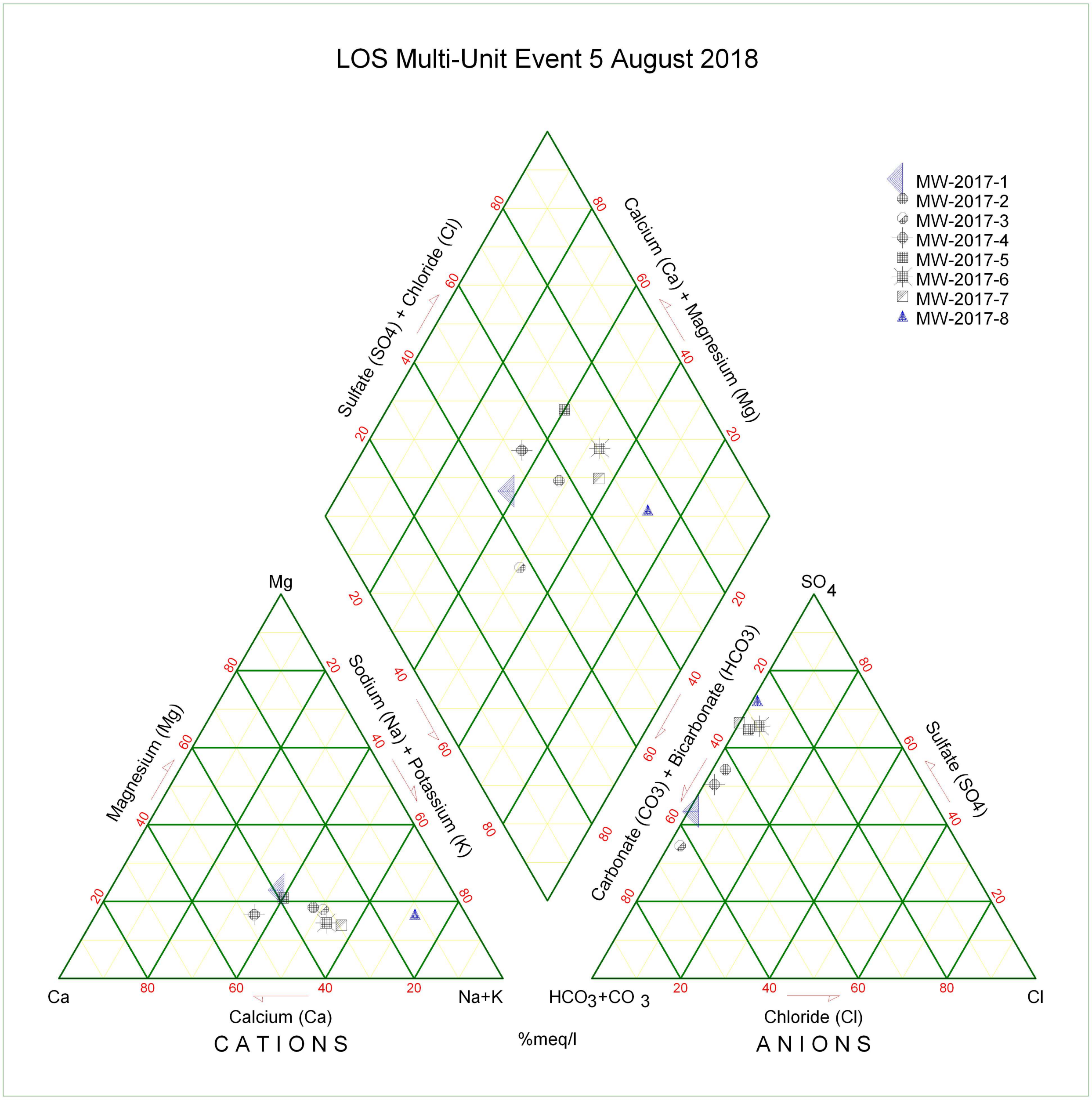


Figure 6B

Stiff Diagrams - Event 5, August 2018

Page 1 of 2

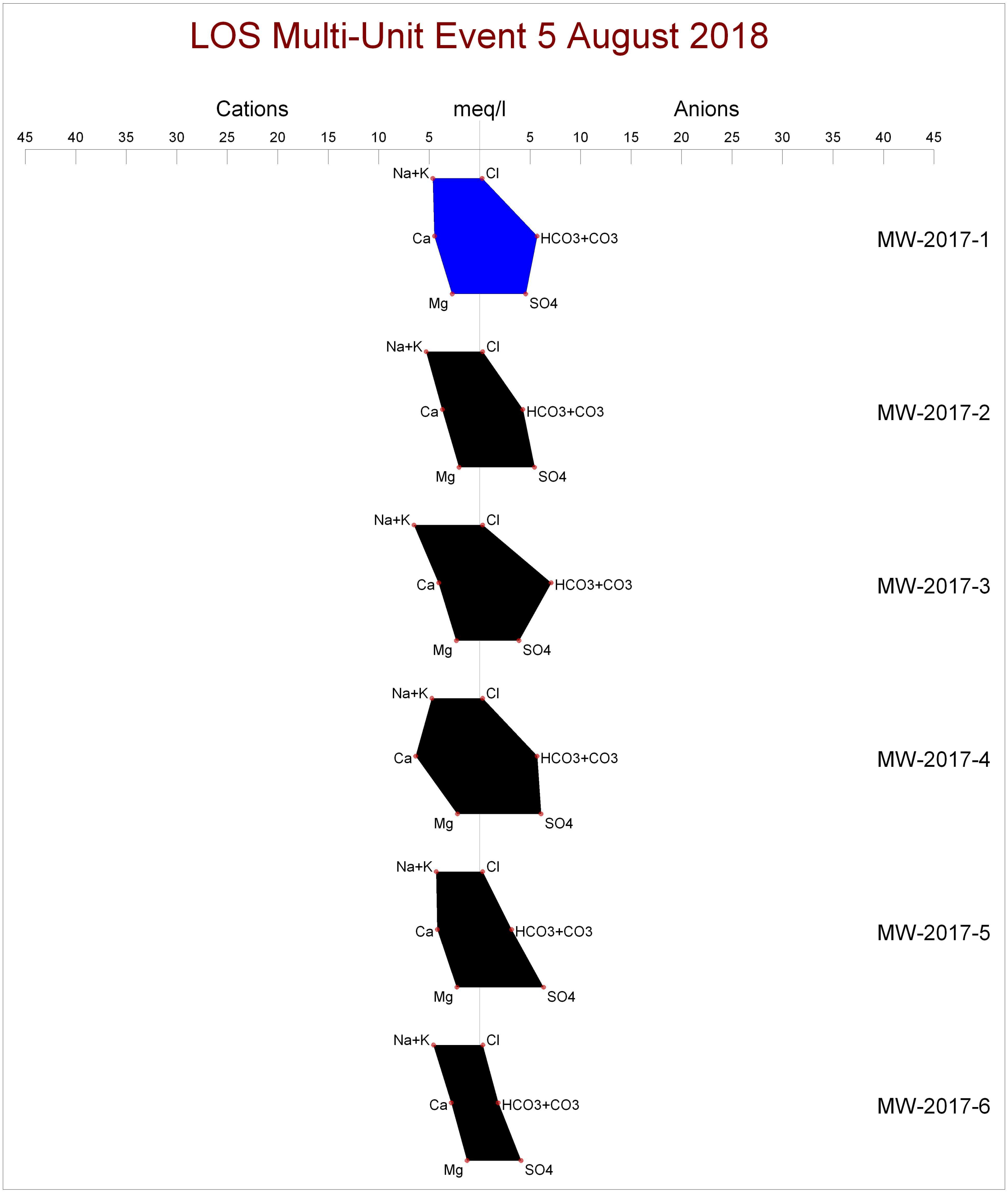
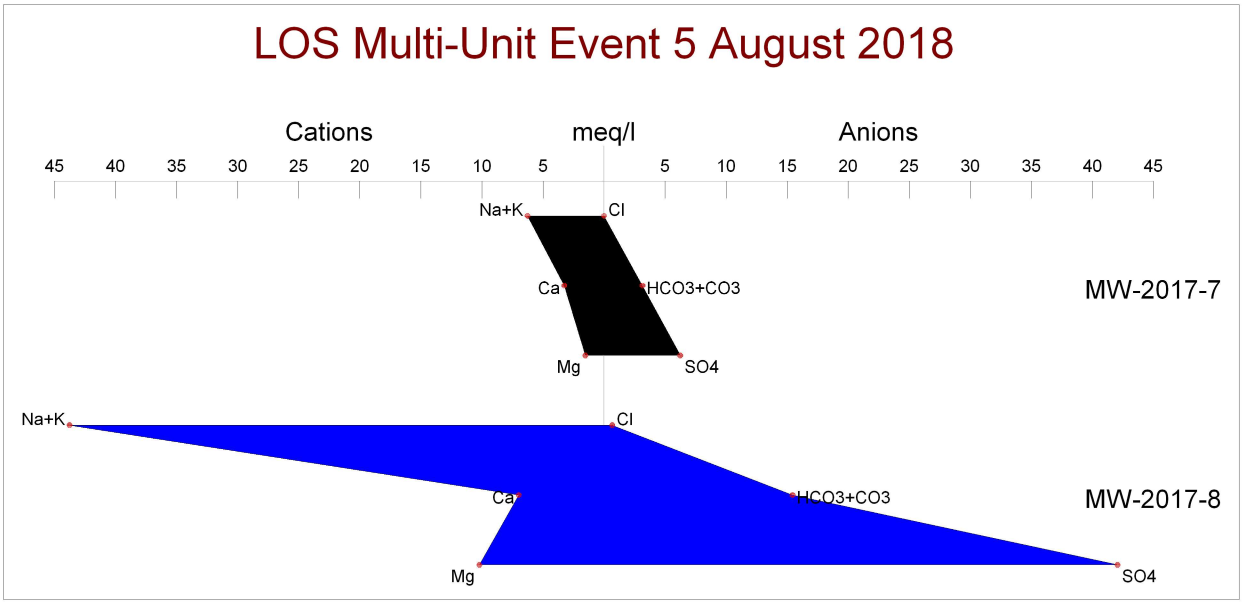


Figure 6B

Stiff Diagrams - Event 5, August 2018

Page 2 of 2



Table

Table 1

Analytical Results Summary
LOS Pond 2 and Pond 3 (Multiunit) CCR Monitoring Well Network
Leland Olds Station - Stanton, North Dakota

			Appendix III Constituents						
	Event	Date	Boron mg/L	Calcium mg/L	Chloride mg/L	Fluoride mg/L	pH SU	Sulfate mg/L	TDS mg/L
MW-2017-1	Event 01	3/12/18	2.0 F1	100	8.8	< 0.50 U	6.95	210	710
MW-2017-1	Event 02	4/17/18	2.1 F1	96	9.4	< 0.50 U	6.86	200	680
MW-2017-1	Event 03	6/14/18	2.2	89	8.2	< 0.50 U	7.06	220	690 H
MW-2017-1	Event 04	7/25/18	2.36 F1	91.1	8.73	< 0.500 U	7.21	218	710
MW-2017-1	Event 05	8/27/18	2.37	89.6	8.65	< 0.500 U	7.38	219	707
MW-2017-1	Event 06	3/12/19	2.15	103	8.50 H	< 0.500 UH	7.19	217 H	735
MW-2017-1	Event 07	3/27/19	2.02	98.3	8.53 HF1	< 0.500 UH	7.26	212 H	718
MW-2017-1	Event 08	4/9/19	2.02	107	8.91	< 0.500 U	7.23	221	761 H
MW-2017-1	Event 09	11/12/19	1.11	130	9.00	0.426	7.73	233	740
MW-2017-1	Event 10	6/8/20	1.04	150	7.74	<0.500 U	6.86	260	1050
MW-2017-1 Dup	Event 01	3/12/18	2.1	110	8.8	< 0.50 U	6.95	210	710 H
MW-2017-1 Dup	Event 02	4/17/18	2.1	97	8.7	< 0.50 U	6.86	190	720
MW-2017-1 Dup	Event 03	6/14/18	2.3	92	8.2	< 0.50 U		220	720
MW-2017-1 Dup	Event 04	7/25/18	2.34	90.3	8.74	< 0.500 U		215	710
MW-2017-1 Dup	Event 05	8/27/18	2.42	91.1	8.73	< 0.500 U		220	717
MW-2017-1 Dup	Event 06	3/12/19	2.18	106	9.23 H	< 0.500 UH		219 H	742
MW-2017-1 Dup	Event 07	3/27/19	2.25	106	8.46 H	< 0.500 UH		211 H	740
MW-2017-1 Dup	Event 08	4/9/19	2.02	109	9.00	< 0.500 U		218	773 H
MW-2017-2	Event 01	3/12/18	1.6	120	12	< 0.50 U	6.88	320	920
MW-2017-2	Event 02	4/17/18	1.4	130	12	< 0.50 U	7.37	330	930
MW-2017-2	Event 03	6/14/18	1.3	130	10	< 0.50 U	7.04	320	890 H
MW-2017-2	Event 04	7/23/18	1.60	73.7	10.6	0.608	7.19	262	690
MW-2017-2	Event 05	8/27/18	1.61	74.1	10.5	0.537	7.49	261	< 10.0 U
MW-2017-2	Event 06	3/12/19	1.18	120	11.8 H	< 0.500 UH	7.19	323 H	910
MW-2017-2	Event 07	3/27/19	1.13	122	11.2 H	< 0.500 UH	7.12	336 H	948
MW-2017-2	Event 08	4/9/19	1.22	121	11.3	< 0.500 U	7.25	308	853 H
MW-2017-2	Event 09	11/12/19	0.820	75.3	10.7	0.524	7.94	231	676
MW-2017-2	Event 10	6/9/20	1.30	82.7	8.13	<0.500 U	7.26	233	732
MW-2017-2 Dup	Event 10	6/9/20	1.31	83.2	8.10	<0.500 U		233	770
MW-2017-3	Event 01	3/12/18	1.6	84	11	0.50	6.71	190	760
MW-2017-3	Event 02	4/17/18	1.6	87	11	< 0.50 U	7.04	190	750
MW-2017-3	Event 03	6/14/18	1.6	84	9.4	< 0.50 U	7.1	200	750 H
MW-2017-3	Event 04	7/23/18	1.57	87.2	10.6	< 0.500 U	7.09	184	770
MW-2017-3	Event 05	8/27/18	1.61	81.4	10.5	< 0.500 U	7.35	187	765
MW-2017-3	Event 06	3/12/19	1.63	81.1	10.7 H	< 0.500 UH	7.25	190 H	765
MW-2017-3	Event 07	3/27/19	1.75 F1	80.3	10.6 H	0.516 H	7.15	182 H	756
MW-2017-3	Event 08	4/9/19	1.71	84.7	10.9	0.523	7.3	190	739 H
MW-2017-3	Event 09	11/11/19	1.45	72.4	10.6	0.498	7.86	184	710
MW-2017-3 Dup	Event 09	11/11/19	1.97	105	10.6	0.498	7.86	186	714
MW-2017-3	Event 10	6/8/20	1.62	76.0	8.09	<0.500 U	7.31	173	764
MW-2017-4	Event 01	3/12/18	1.4	140	9.8	0.75	6.82	300	830
MW-2017-4	Event 02	4/17/18	1.2	140	10	0.77	6.64	310	860
MW-2017-4	Event 03	6/14/18	1.2	140	9.3	0.59	7.02	300	870 H
MW-2017-4	Event 04	7/25/18	1.13	128	10.4	0.791	7.06	252	800
MW-2017-4	Event 05	8/28/18	1.15	127	10.3	0.790	7.31	292	818
MW-2017-4	Event 06	3/12/19	1.35	139	10.1 H	0.716 H	7.1	307 H	788
MW-2017-4	Event 07	3/27/19	1.47	133	9.55 H	0.725 H	7.06	294 H	850
MW-2017-4	Event 08	4/9/19	1.60	154	9.75	0.747	7.07	294	854 H
MW-2017-4	Event 09	11/11/19	1.74	78.5	10.4	0.768	7.78	289	832
MW-2017-4	Event 10	6/8/20	1.23	118	7.89	0.622	6.3	281	836

Table 1

Analytical Results Summary
LOS Pond 2 and Pond 3 (Multiunit) CCR Monitoring Well Network
Leland Olds Station - Stanton, North Dakota

			Appendix III Constituents						
	Event	Date	Boron mg/L	Calcium mg/L	Chloride mg/L	Fluoride mg/L	pH SU	Sulfate mg/L	TDS mg/L
MW-2017-5	Event 02	4/18/18	0.64	82	11	< 0.50 U	7.17	300	660
MW-2017-5	Event 03	6/14/18	0.74	82	9.5	< 0.50 U	6.98	290	650 H
MW-2017-5	Event 04	7/25/18	0.753	82.2	10.5	< 0.500 U	7.04	361	670
MW-2017-5	Event 05	8/28/18	0.870	84.1	10.4	0.514	7.34	304	676
MW-2017-5	Event 06	3/12/19	0.890	86.8	10.7 H	0.711 H	7.7	315 H	685
MW-2017-5	Event 07	3/27/19	0.897	79.7	11.1 H	0.778 H	7.49	314 H	659
MW-2017-5	Event 08	4/9/19	0.963	87.6	11.3	0.784	7.4	310	668 H
MW-2017-5	Event 09	11/11/19	1.78	82.3	11.0	0.812	7.42	293	628
MW-2017-5	Event Supp	11/1/18	0.930	85.4	10.8	0.640	7.22	321	1130
MW-2017-5	Event 10	6/8/20	0.680	53.9	8.01	1.04	**8.91**	257	636
MW-2017-6	Event 02	4/18/18	2.6	87	8.3	< 0.50 U	**11.79**	220	630
MW-2017-6	Event 03	6/14/18	1.2	63	10	< 0.50 U	**11.66**	220	430 H
MW-2017-6	Event 04	7/25/18	1.06	65.8	11.0	0.503	**10.08**	212	470
MW-2017-6	Event 05	8/28/18	1.05	56.4	11.1	0.540	**10.05**	197	490
MW-2017-6	Event 06	3/12/19	1.26	55.5	11.1 H	0.545 H	**9.52**	205 H	534
MW-2017-6	Event 07	3/27/19	11.4	60.6	5.03 H	0.634 H	**11.52**	502 H	619
MW-2017-6	Event 08	4/9/19	5.06	46.5	9.17	< 0.500 U	**11.81**	270	618 H
MW-2017-6	Event 09	11/11/19	1.77	39.4	10.4	0.513	**9.57**	218	552
MW-2017-6	Event Supp	11/1/18	1.10	53.9	11.7	< 0.500 U	**10.02**	221	435
MW-2017-6	Event 10	6/8/20	1.61	54.5	7.98	0.505	**8.03**	205	610
MW-2017-7	Event 01	3/14/18	1.9	65	11	1.0	6.58	310	690
MW-2017-7	Event 02	4/17/18	2.0	70	11	1.0	7.35	320	690
MW-2017-7	Event 03	6/15/18	1.9	66	< 30 U	< 5.0 U	7.54	280	720 H
MW-2017-7	Event 04	7/25/18	2.00	67.5	< 15.0 U	< 2.50 U	7.48	291	750
MW-2017-7	Event 05	8/28/18	2.07	65.2	< 30.0 U	< 5.00 U	7.78	300	696
MW-2017-7	Event 06	3/12/19	2.05	67.8	11.1 H	1.26 H	7.34	315 H	722
MW-2017-7	Event 07	3/27/19	1.96	63.1	11.1 H	1.39 H	7.96	302 H	701
MW-2017-7	Event 08	4/9/19	2.04	67.2	< 300 U	< 50.0 U	7.37	1030	896 H
MW-2017-7	Event 09	11/11/19	2.16	59.4	10.6	1.37	7.49	309	686
MW-2017-7	Event 10	6/8/20	1.90	58.2	8.49	1.60	7.06	293	719
MW-2017-8	Event 01	3/14/18	0.48	150	25	< 1.0 U	7.03	2000	3800
MW-2017-8	Event 02	4/18/18	0.46	150	25	< 1.0 U	7.38	2100	4000
MW-2017-8	Event 03	6/15/18	0.46	140	22	< 1.0 U	7.19	2100	4000 H
MW-2017-8	Event 04	7/25/18	0.465	145	24.3	< 1.00 U	7.23	2010	3900
MW-2017-8	Event 05	8/28/18	0.468	140	24.0	< 1.00 U	7.52	2020	3880 H
MW-2017-8	Event 10	6/8/20	0.453	133	20.8	4.68	7.29	1860	3800

TDS = Total Dissolved Solids
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
H = Sample was prepped or analyzed beyond the specified holdilng time

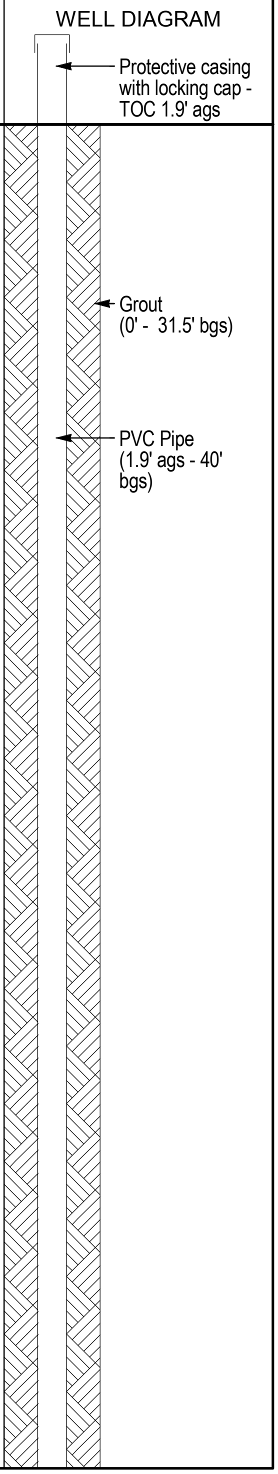
Appendix A
Boring Logs MW-2017-5 and MW-2017-6

WELL NUMBER MW-2017-5

CLIENT Basin Electric
PROJECT NAME Lelands Olds Landfill - Pond 2
PROJECT NUMBER 60558359
PROJECT LOCATION Stanton, ND
DATE STARTED 12/7/2017 **COMPLETED** 12/7/2017
GROUND ELEVATION 1689.793 ft NAVD88
DRILLING CONTRACTOR Cascade Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING: **23' bgs 11/20/2017**
LOGGED BY R. Klute **CHECKED BY** J. Lach
AT END OF DRILLING:
COORDINATES 589203.705 N 1800107.822 E
AFTER DRILLING:

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		
0				CL	▨	CLAY, very firm; olive brown	5.0	1684.8
				ML		SILT, with black ash, trace sand; dark yellowish brown	6.0	1683.8
				ML		SILT, crumbly; dark yellowish brown	7.0	1682.8
				CL	▨	CLAY, with bottom ash, fly ash, wet; dark grayish brown	8.5	1681.3
				CL	▨	CLAY, with fly ash, moist to wet; dark yellowish brown	12.5	1677.3
				ML		SILT, with fine sand, dry; brown	13.5	1676.3
				CL	▨	CLAY, firm, dry; dark gray mottled with brown	15.0	1674.8
				SW		SAND, fine; olive brown	15.5	1674.3
				CL	▨	CLAY, firm, dry; dark gray mottled with brown	19.0	1670.8
				CL-ML		SILTY CLAY, trace fine sand, saturated; brown ▽		
25	SS	0	-					
30							30.0	1659.8

Casing Top Elev: 1691.709 (ft)
Casing Type: 2" Sch 40 PVC



(Continued Next Page)

WELL NUMBER MW-2017-5

CLIENT Basin Electric

PROJECT NAME Lelands Olds Landfill - Pond 2

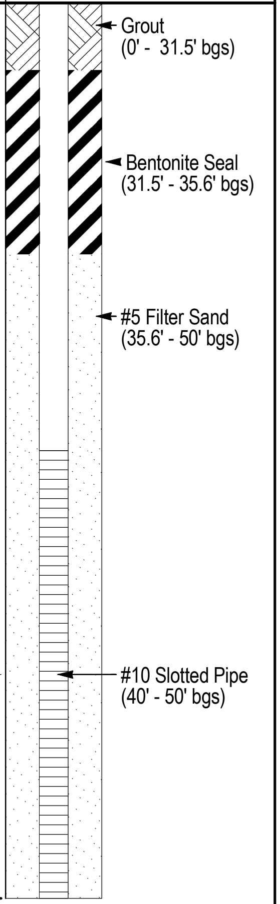
PROJECT NUMBER 60558359

PROJECT LOCATION Stanton, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENETROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
30				SW		SAND, fine, trace medium sand, wet; brown	
35							
40							
45				SW		45.0 SAND, medium, wet; brown	1644.8
50						50.0	1639.8

Bottom of borehole at 50.0 feet.

WELL DIAGRAM



WELL NUMBER MW-2017-6

CLIENT Basin Electric

PROJECT NAME Lelands Olds Landfill - Pond 2

PROJECT NUMBER 60558359

PROJECT LOCATION Stanton, ND

DATE STARTED 11/17/2017 **COMPLETED** 12/7/2017

GROUND ELEVATION 1689.793 ft NAVD88

DRILLING CONTRACTOR Terracon (11/17/18)
Cascade (12/7/18)

GROUND WATER LEVELS:

DRILLING METHOD Hollow Stem Auger

AT TIME OF DRILLING:

LOGGED BY R. Klute **CHECKED BY** J. Lach

AT END OF DRILLING:

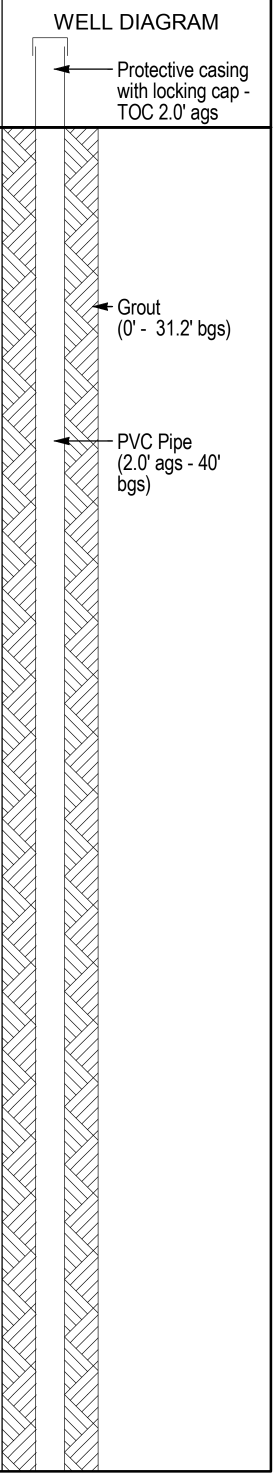
COORDINATES 589203.705 N 1800107.822 E

AFTER DRILLING:

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0				CL		CLAY, trace sand; dark olive brown mottling	
5.5				SP-SM		SAND/SILT, fine; light olive brown	1684.3
7.0				CL-ML		SILTY CLAY, wet; olive brown saturated	1682.8
12.0						FLY ASH, dry; very dark gray	1677.8
12.5				CL		CLAY, moist; olive brown	1677.3
14.5				CL		CLAY, moist; dark gray	1675.3
17.0				CL		CLAY, dry; dark gray, some light brown mottling	1672.8
22.0				CL		CLAY, dry; olive brown mottling	1667.8
25	SS	0	-				
27.0				CL-ML		SILTY CLAY, soft, wet; very dark gray	1662.8
30.0							1659.8

Casing Top Elev: 1693.55 (ft)
Casing Type: 2" Sch 40 PVC

WELL DIAGRAM



(Continued Next Page)

WELL NUMBER MW-2017-6

CLIENT Basin Electric

PROJECT NAME Lelands Olds Landfill - Pond 2

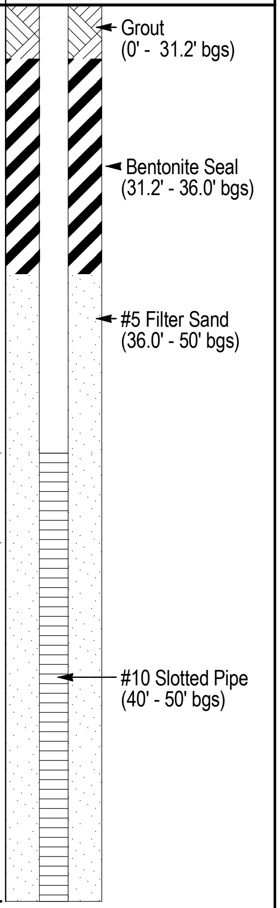
PROJECT NUMBER 60558359

PROJECT LOCATION Stanton, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENETROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
30						SILT, soft, wet; very dark gray
35				ML		
40						40.0 1649.8
				SW		SAND, trace silt, medium to coarse, well graded, wet; gray
						42.0 1647.8
						SAND, fine to medium, well graded; dark grayish brown
45				SW		
50						50.0 1639.8

Bottom of borehole at 50.0 feet.

WELL DIAGRAM



AECOM
525 Vine Street, Suite 1800
Cincinnati, Ohio 45202
aecom.com

Attachment C
Boring Logs for MW-2017-8D and MW-2017-9, October 2020

AECOM

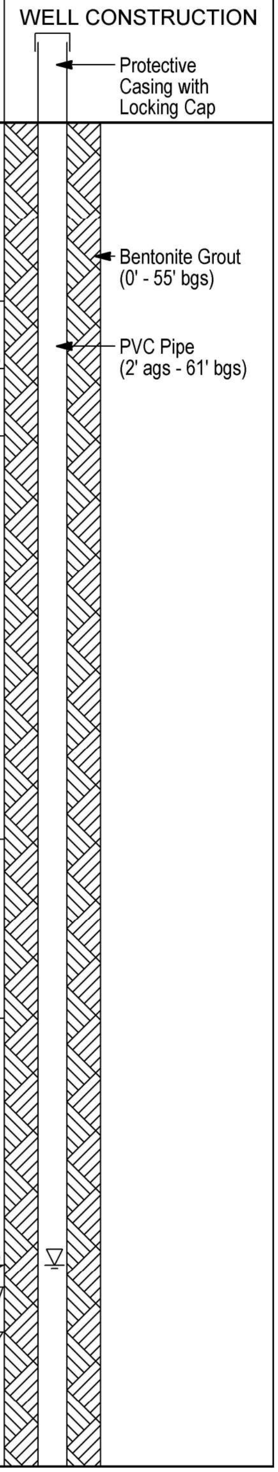
WELL NUMBER MW-2017-8D

PAGE 1 OF 3

CLIENT Basin Electric Power Cooperative
PROJECT NAME Leland Olds Station
PROJECT NUMBER 60634880
PROJECT LOCATION Stanton, North Dakota
DATE STARTED 9/29/2020 **COMPLETED** 9/30/2020
GROUND ELEVATION 1714.05 ft NAVD 88 **TOC ELEVATION** 1716.27 ft NAVD 88
DRILLING CONTRACTOR Cascade Drilling
GROUND WATER LEVELS: Measured bgs or from top of casing, as noted
DRILLING METHOD Rotosonic
▽ AT TIME OF DRILLING 25.5 ft bgs / Elev. 1688.55 ft above msl
LOGGED BY J Hurshman **CHECKED BY** J Lach
▼ AT END OF DRILLING 61.5 ft bgs / Elev. 1652.55 ft above msl
COORDINATES 586979.712 N 1798074.533 E
AFTER DRILLING None Encountered AD

SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	Depth, bgs	MATERIAL DESCRIPTION	Elevation
HA 1	100	NA	ML	4.0	SILT - dark brown, with clay - becomes light brown	1710.1
			CL	5.5	CLAY - brown to dark brown, trace orange mottling, low plasticity	1708.6
SONIC 2	100	NA	SP	7.0	SAND - very dark brown to brown, fine to medium, moist	1707.1
			CL	16.0	CLAY - mottled light brown to brown, with silt low to medium plasticity, moist to wet	1698.1
SONIC 3		NA	CL-ML	20.0	SILTY CLAY - brown, medium plasticity, moist	1694.1
			CL	25.5	CLAY - brown, with silt, low plasticity, soft, moist - becomes medium stiff - becomes stiff	1688.6
			SW	26.0	SAND - orange, with rounded to subrounded gravel and some interbedded silt, moist to wet	1688.1
			CL-ML	27.0	SILTY CLAY - brown, with few sand, very soft, wet	1687.1
			SP		SILTY SAND - brown, fine to medium, soft, wet - 3" silty clay interbed	

WELL CONSTRUCTION

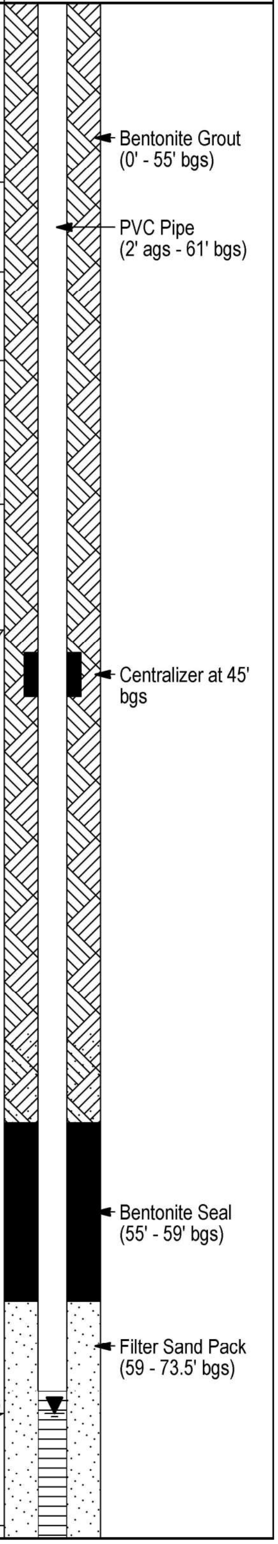


(Continued Next Page)

CLIENT Basin Electric Power Cooperative
PROJECT NAME Leland Olds Station
PROJECT NUMBER 60634880
PROJECT LOCATION Stanton, North Dakota

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	Depth, bgs	MATERIAL DESCRIPTION	Elevation
30	SONIC 4	100	NA	SP	34.0	- becomes oxidized iron-colored orange - becomes brown	1680.1
35				SP	36.0	SAND - gray and brown, coarse, with coarse subrounded to rounded gravel, wet - with 3" cobbles	1678.1
	SONIC 5	100	NA	GP	38.0	GRAVEL - gray and brown, coarse, subrounded to rounded, with coarse sand, wet	1676.1
40				CL	41.2	CLAY - bluish gray, with silt, low plasticity, high density, very stiff, dry; TOP OF BEDROCK	1672.9
				CL-ML	44.0	SILTY CLAY - brown and gray, moderately stiff, dry - becomes dark brown - becomes dark brown and gray mottled, stiff	1670.1
45 50 55 60	SONIC 6 SONIC 7	60 100	NA NA	CL	61.5	CLAY - light gray, with silt, low plasticity, high density, stiff, crumbly, dry - becomes gray - becomes light gray, very stiff - 1" silt lens - becomes with hard, fissile, shale-like, fine gravel-sized fragments - no recovery - becomes light greenish gray with few silt - becomes olive gray, stiff - grades dark olive gray with lignite coal	1652.6
					64.0	LIGNITE - black, finely layered 2-4mm beds, crumbly, dry	1650.1
				CL			

WELL CONSTRUCTION



(Continued Next Page)

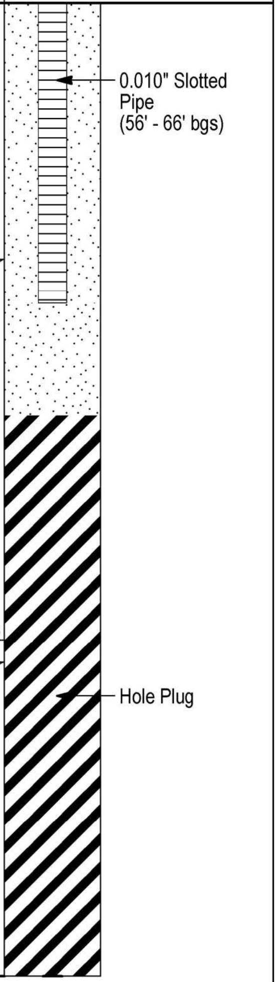
WELL NUMBER MW-2017-8D

CLIENT Basin Electric Power Cooperative
PROJECT NAME Leland Olds Station
PROJECT NUMBER 60634880
PROJECT LOCATION Stanton, North Dakota

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	Depth, bgs	MATERIAL DESCRIPTION	Elevation
65				CL		CLAY - brown, with silt, low plasticity, with trace fine sand-sized lignite fragments, very soft, dense, dry - becomes mottled light tan to light gray, with 1 cm lignite coal fragments, stiff - with increasing lignite coal lenses - without lignite coal lenses	
70	SONIC 8		NA		70.0		1644.1
75				CL		CLAY - mottled dark brown and gray, low plasticity, with few silt lenses, few fine gravel-sized lignite fragments, stiff, dry - becomes dark gray with abundant thinly bedded silt-rich lenses within clay - becomes without silt lenses	
					78.5		1635.6
				SP-SM	79.0	SAND - gray, fine, with silt, moist	1635.1
80	SONIC 9	100	NA	CL		CLAY - dark brown, with silt, low plasticity, very dense, very stiff, moist - 6" lens of gray fine sand and silt, soft, moist - grades with few finely laminated light silt lenses - grades without silt lenses	
85					86.0		1628.1

Bottom of borehole at 86.0 feet.

WELL CONSTRUCTION



AECOM

WELL NUMBER MW-2017-9

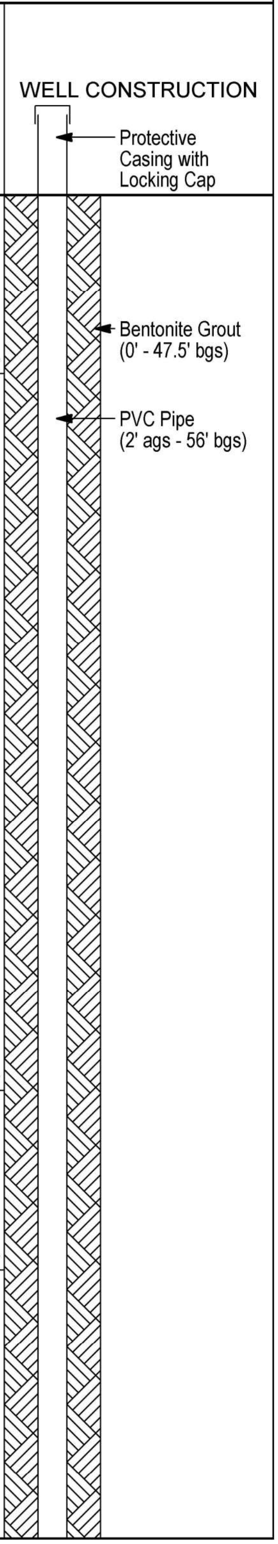
PAGE 1 OF 3

CLIENT Basin Electric Power Cooperative
PROJECT NAME Leland Olds Station
PROJECT NUMBER 60634880
PROJECT LOCATION Stanton, North Dakota
DATE STARTED 9/30/2020 **COMPLETED** 9/30/2020
GROUND ELEVATION 1707.67 ft NAVD 88 **TOC ELEVATION** 1709.93 ft NAVD 88
DRILLING CONTRACTOR Cascade Drilling
GROUND WATER LEVELS: Measured bgs or from top of casing, as noted
DRILLING METHOD Rotosonic
▽ AT TIME OF DRILLING 38.4 ft bgs / Elev. 1669.27 ft above msl
LOGGED BY J Hurshman **CHECKED BY** J Lach
AT END OF DRILLING None Encountered EOD
COORDINATES 588718.314 N 1798044.173 E
AFTER DRILLING None Encountered AD

SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF
HA 1	100	NA
SONIC 2	100	NA
SONIC 3	80	NA
SONIC 4		NA
SONIC 5	100	NA

U.S.C.S.	Depth, bgs	MATERIAL DESCRIPTION	Elevation
		FILL - mottled brown and gray silty clay, few fine gravel sized coal fragments, stiff	
	4.0		1703.7
		FILL - dark brown to black bottom ash, medium grained, granular texture, very light, dry - becomes black	
	20.0		1687.7
		FILL - gray to olive gray and black silty clay with few fine gravel sized coal fragments, few organic roots, stiff, moist; with thin ash laminations	
	24.0		1683.7
CL		CLAY - mottled brown and gray, with silt, low to moderate plasticity, stiff, moist	

DEPTH (ft): 0, 5, 10, 15, 20, 25, 30

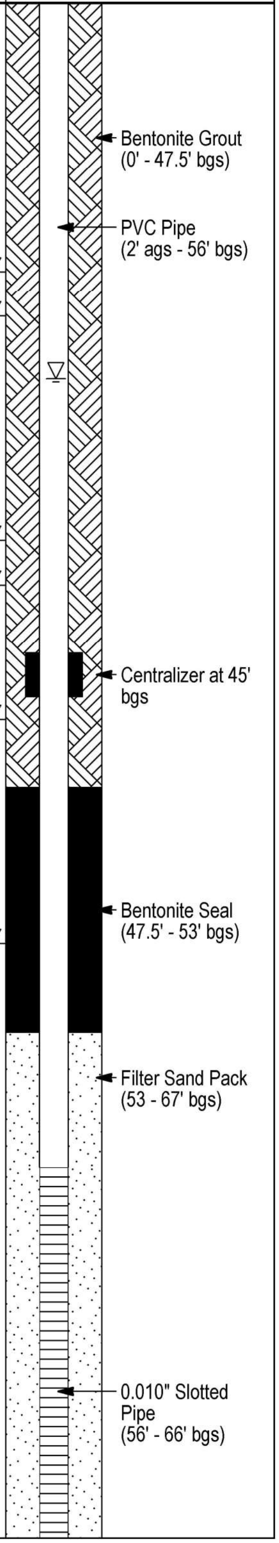


(Continued Next Page)

CLIENT Basin Electric Power Cooperative
PROJECT NAME Leland Olds Station
PROJECT NUMBER 60634880
PROJECT LOCATION Stanton, North Dakota

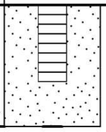
DEPTH (ft) 30	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	Depth, bgs	MATERIAL DESCRIPTION	Elevation
35	SONIC 6	50	NA	CL		36.0		1671.7
	SONIC 7	100	NA	CL-ML		37.0	SILTY CLAY - mottled brown and gray, low to moderate plasticity, stiff, moist	1670.7
40				ML		42.0	SILT - brown, with very fine sand, dry - becomes moist to wet	1665.7
				CL-ML		43.0	SILTY CLAY - dark gray, high plasticity, soft, moist to wet	1664.7
45				SP-SM		46.0	SAND - dark gray, with silt, very fine, moist to wet	1661.7
50	SONIC 8	100	NA	SM		51.0	SILTY SAND - brown, very fine, soft, moist - grades with less silt	1656.7
55				SP			SAND- gray, fine, wet	
60	SONIC 9	100	NA				- becomes dark gray with thin interbedded black organic material - organics become more thin, 2mm	

WELL CONSTRUCTION



(Continued Next Page)

CLIENT Basin Electric Power Cooperative
PROJECT NUMBER 60634880
PROJECT NAME Leland Olds Station
PROJECT LOCATION Stanton, North Dakota

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	Depth, bgs	MATERIAL DESCRIPTION	Elevation	WELL CONSTRUCTION
65				SP			- becomes olive gray		
	SONIC 10	0	NA			67.0	- becomes dark gray	1640.7	
							Bottom of borehole at 67.0 feet.		