Pond 2 and Pond 3 Multiunit CCR Groundwater Monitoring System Report

Leland Olds Station
Stanton, North Dakota

Basin Electric Power Cooperative

Project number: 60558359

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Quality information

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List of Acronyms

AECOM	AECOM Technical Services, Inc.
ANOVA	analysis of variance
Basin	Basin Electric Power Cooperative
bgs	below ground surface
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
cm/sec	Centimeters per second
EPA	United States Environmental Protection Agency
ft, amsl	feet, above mean sea level
GWPS	Groundwater Protection Standards
LOS	Leland Olds Station
MW	megawatt
NPDES	National Pollution Discharge Elimination System
PVC	polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
SSI	Statistically Significant Increase

Monitoring System Certification

Basin Electric Power Cooperative Leland Olds Station CCR Units: Pond 2 and Pond 3 Multiunit

AECOM Technical Services, Inc. ("Consultant") has been retained by Basin Electric Power Cooperative (Basin) to prepare the following certification that the statistical method(s) selected for the evaluation of groundwater monitoring data for the above-referenced inactive coal combustion residuals ("CCR") surface impoundment multiunit, consisting of Pond 2 and Pond 3, meets the requirements set out in 40 CFR § 257.93(f)(6).

BACKGROUND

Pursuant to 40 CFR § 257.100(e)(5)(i), owners and operators of inactive CCR surface impoundments must install a groundwater monitoring system no later than April 17, 2019. 40 CFR § 257.91 requires owners and operators of a CCR unit to install a groundwater monitoring system that, relying on site-specific technical information, consists of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that accurately represent the quality of background groundwater that has not been affected by leakage from the CCR unit and accurately represent the quality of groundwater passing the waste boundary of the CCR unit.

Pursuant to 40 CFR § 257.91(f), the owner or operator must obtain a certification from a qualified professional engineer stating that the groundwater monitoring system has been designed and constructed to meet the requirements of 40 CFR § 257.91, including the performance standards specified in 40 CFR § 257.91(a), based on the site-specific information specified in 40 CFR § 257.91(b). If the groundwater monitoring system includes only the minimum number of downgradient monitoring wells specified in 40 CFR § 257.91(c)(1), (three wells) the certification must document the basis supporting this determination.

In support of Consultant's assessment, Consultant evaluated of the groundwater monitoring system for the above-referenced CCR unit to determine that sufficient information is available to make the certification required under 40 CFR § 257.91(f).

LIMITATIONS

The signature of Consultant's authorized representative on this document represents that to the best of Consultant's knowledge, information, and belief in the exercise of its professional judgment, it is Consultant's professional opinion that the aforementioned information is accurate as of the date of such signature. Any opinion or decisions by Consultant are made on the basis of Consultant's experience, qualifications, and professional judgment and are not to be construed as warranties or guarantees. In addition, opinions relating to environmental, geologic, and geotechnical conditions or other estimates are based on available data, and actual conditions may vary from those encountered at the times and locations where data are obtained, despite the use of due care.

CERTIFICATION

I, Daryl R. Beck, PE, being a Registered Professional Engineer in the State of North Dakota, certify to the best of my knowledge, information, and belief, that the groundwater monitoring system(s) for the CCR unit(s) that is the subject of this certification has been designed and constructed to meet the requirements of 40 CFR § 257.91, and that this certification is true and correct and has been prepared in accordance with generally accepted good engineering practices.

SIGNATURE: ____________________
Daryl R. Beck, PE-10696
Senior Project Engineer

DATE: April 17, 2019

DARYL R. BECK
PE-10696
DATE 4-17-19

Statistical Method Certification

Basin Electric Power Cooperative Leland Olds Station CCR Unit: Pond 2 and Pond 3 Multiunit

AECOM Technical Services, Inc. ("Consultant") has been retained by Basin Electric Power Cooperative (Basin) to prepare the following certification that the statistical method(s) selected for the evaluation of groundwater monitoring data for the above-referenced inactive coal combustion residuals ("CCR") surface impoundment multiunit, consisting of Pond 2 and Pond 3, meets the requirements set out in 40 CFR § 257.93(f)(6).

BACKGROUND

40 CFR § 257.91 requires owners and operators of a CCR unit to install a groundwater monitoring system that, relying on site-specific technical information, consists of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that accurately represent the quality of background groundwater that has not been affected by leakage from the CCR unit and accurately represent the quality of groundwater passing the waste boundary of the CCR unit.

Pursuant to 40 CFR § 257.93(f), the owner or operator of the CCR unit must select one of the statistical methods specified in paragraphs (f)(1) through (5) of this section to be used in evaluating groundwater monitoring data for each specified constituent. The statistical test chosen shall be conducted separately for each constituent in each monitoring well, and shall comply with the performance standards specified in 40 CFR § 257.93(g). Per 40 CFR § 257.93(f)(6), the owner or operator must obtain a certification from a qualified professional engineer stating that the statistical method for the evaluation of groundwater monitoring data for the groundwater monitoring system meets the requirements of 40 CFR § 257.93(f)(6), including the performance standards specified in 40 CFR § 257.91(a), based on the site-specific information specified in 40 CFR § 257.91(b).

LIMITATIONS

The signature of Consultant's authorized representative on this document represents that to the best of Consultant's knowledge, information, and belief in the exercise of its professional judgment, it is Consultant's professional opinion that the aforementioned information is accurate as of the date of such signature. Any opinion or decisions by Consultant are made on the basis of Consultant's experience, qualifications, and professional judgment and are not to be construed as warranties or guaranties. In addition, opinions relating to environmental, geologic, and geotechnical conditions or other estimates are based on available data, and actual conditions may vary from those encountered at the times and locations where data are obtained, despite the use of due care.

CERTIFICATION

I, Daryl R. Beck, PE, being a Registered Professional Engineer in the State of North Dakota, certify to the best of my knowledge, information, and belief, that the statistical method selected for the evaluation of groundwater monitoring data for the groundwater monitoring system for the CCR unit that is the subject of this certification is appropriate for evaluating the groundwater monitoring data for the CCR management area comply with the performance standards specified in 40 CFR § 257.93(g), and that this certification is true and correct and has been prepared in accordance with generally accepted good engineering practices.

SIGNATURE: ______________________
Daryl R. Beck, PE-10696
Senior Project Engineer

DATE: April 17, 2019

DARYL R. BECK
PE-10696
DATE 4-17-19

1. Introduction

On behalf of Basin Electric Power Cooperative, (Basin), AECOM Technical Services, Inc. (AECOM) prepared this report documenting the Coal Combustion Residuals (CCR) groundwater monitoring system for the Pond 2 and Pond 3 CCR units at Basin's Leland Olds Station (LOS) located in Stanton, North Dakota, henceforth referred to as the Site (see **Figure 1**). This report addresses the requirement under Chapter 40 Code of Federal Regulations (CFR) Part 257.105(h) to provide in the Operating Record, as it becomes available, "documentation of the design, installation, development, and decommissioning of any monitoring wells, piezometers and other measurement, sampling, and analytical devices."

Pursuant to 40 CFR § 257.100(e)(5)(i), by April 17, 2019, an owner and operator of an inactive CCR surface impoundment must install a groundwater monitoring system that meets the requirements of 40 CFR § 257.91. The groundwater monitoring system must meet the CCR Rule's performance standard, which requires the system to consist of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that accurately represent the quality of:

1. Background groundwater that has not been affected by leakage from a CCR units; and
2. Groundwater passing the waste boundary of the CCR units—the downgradient monitoring system must be installed at the waste boundary that ensures detection of groundwater contamination in the uppermost aquifer and must monitor all potential contaminant pathways.

This report summarizes the procedures and field activities associated with drilling and installation of monitoring wells that comprise the CCR monitoring network at the Site, as well as the results of groundwater flow measurements to evaluate the network against the requirements of the Final Rule.

This report is organized as follows:

- Chapter 1 includes a brief introduction to this report;
- Chapter 2 provides a brief background with historical information concerning the Site;
- Chapter 3 describes the geological and hydrogeological setting of the Site;
- Chapter 4 describes selection and installation of the CCR monitoring well network for the Site, including the drilling and installation of monitoring wells to supplement existing monitoring wells should they be needed;
- Chapter 5 presents an evaluation of the Site groundwater flow conditions compared to the requirements of the CCR Rule;
- Chapter 6 describes the statistical methodology that will be used to evaluate CCR groundwater monitoring data;
- Chapter 7 describes the professional limitations that apply to this report; and
- Chapter 8 lists the references cited in this report.

Certifications pertaining to the design and construction of the groundwater monitoring system and selection of the statistical method for evaluating data acquired using the groundwater monitoring system, are presented before Chapter 1 in the Monitoring Well Certification Section.

2. Background

LOS is a coal-based generating station located in Mercer County near the city of Stanton, North Dakota. It has a total power output capacity of 669 megawatts (MW) from two coal-based units:

- Unit 1, with a rating of 222 net MW, which began operating in 1966; and
- Unit 2, with a rating of 447 net MW, which began operating in 1975.

CCR from these units is currently disposed of at LOS in the Glenharold Landfill 0143 located approximately 3 miles southwest of the generating units and office complex (**Figure 1**). This CCR landfill was permitted and began accepting CCR in 1992. Prior to the permitting of the Glenharold Landfill, CCR from the units was directed to four surface impoundments located on the southeast side of the property **(Figure 1**). Maintenance of these impoundments consisted of the periodic excavation of CCR materials that were disposed as fill south and southeast of the impoundments. With the construction of the Glenharold Landfill in 1992, the use of Pond 1 and Pond 4, was discontinued and these impoundments were closed-in-place. Pond 2 was retained for CCR handling and flows into Pond 3 before discharging through Outfall 003 in accordance with the National Pollution Discharge and Elimination System (NPDES) permit. Operation of Pond 2 and Pond 3 for CCR handling was discontinued in 2015, when LOS completed the station conversion to dry handling of all CCR materials.

Due to the presence of CCR, Pond 2 and Pond 3 at LOS are regulated by the CCR Rule, promulgated by the United States Environmental Protection Agency (EPA) under Chapter 40 CFR Part 257, Subtitle D of the Resource Conservation and Recovery Act (RCRA). The CCR Rule establishes requirements for CCR landfills and surface impoundments, including groundwater monitoring and corrective action. The groundwater monitoring provisions of the CCR Rule require the installation of a system of monitoring wells, the specification of procedures for sampling these wells, and analysis of the resulting data to detect the presence of hazardous constituents. A corrective action process is required in the event that hazardous constituents are detected above background concentrations at levels exceeding groundwater protection standards (GWPS).

3. Geological and Hydrogeological Setting

The geological and hydrogeological setting is important to understanding the groundwater environment in the vicinity of the LOS Pond 2 and Pond 3 multiunit (the Site). The geology underlying the Site includes alluvial deposits, associated with the Missouri River, underlain by the Sentinel Butte Formation. This formation is comprised of in excess of 1,000 feet of continental deposits consisting of dense clay, weakly cemented sandstone, mudstone and lignite.

Precipitation supplies surface water that infiltrates down to a surficial aquifer that generally flows east-northeast to the Missouri River. Precipitation, in the form or rain, is relatively sparse in the region, so groundwater recharge is dominated by inflow from the Missouri River and infiltration of snow melt in the spring.

The base of the Site is underlain by approximately 10 feet of clay to clayey silt, which is underlain by 30 or more feet of sand with varying amounts of silt and clay overlying the Sentinel Butte Formation. The Sentinel Butte is comprised primarily of dense clay with trace very fine sand and beds of lignite typically ranging from 7- to 10-feet thick.

The uppermost aquifer is found within the sand and silt alluvial deposits. The depth of these deposits ranges from approximately 18 to 23 feet below ground surface (bgs) on the north side of Pond 3, to a depth of approximately 41 feet on the south side of Pond 2. The potentiometric surface of the uppermost groundwater is typically encountered at an elevation between 1660 to 1664 feet above mean sea level (ft, amsl). Groundwater elevation differences across the site are typically less than 4 inches in the vicinity of Pond 2 on any given day. Groundwater flow is generally east-northeast down river and toward the Missouri River. Due to the low gradient at the site, localized groundwater flow in the immediate vicinity of Pond 2 can vary, with northern portions of the Pond 2 area flowing more north toward the river while the central and southern portions flow generally east to even slightly southeast. The hydraulic gradient for the uppermost aquifer is locally controlled by site-specific composition of the alluvial deposits, with in hydraulic conductivity typically ranging from 10^{-2} to 10^{-4} centimeters per second (cm/sec).

4. Monitoring Well System Selection and Installation

A monitoring well system has been established at LOS to comply with the requirements of the EPA CCR Rule published in the Federal Register on April 17, 2015.

Monitoring Well Installation in 2017

Eight monitoring wells were installed at LOS during the fall of 2017 to help identify an appropriate monitoring system for the uppermost aquifer in the vicinity of the Site. Monitoring wells MW-2017-1 through MW-2017-8 were completed between November 13 and December 15, 2017 (**Figure 2**). The monitoring well locations were selected to evaluate the direction of groundwater flow in the vicinity of the unit, and provide a minimum of three downgradient monitoring wells and one background monitoring well to satisfy the CCR Rule requirements.

Monitoring well installation involved drilling and soil sampling, well construction and development, and aquifer testing as described below.

Drilling and Well Construction

Subsurface utilities in the vicinity of each planned monitoring well installation location were identified by utility representatives following the One-Call of North Dakota notification system. The uppermost 5 feet of each boring was excavated using a hand-auger as an additional precaution against utility strikes.

Monitoring well drilling and construction was initiated on November 13 and completed on December 15, 2017. The monitoring wells were installed using hollow-stem auger and sonic drilling methods. Soil cores recovered during drilling operations were logged by an AECOM geologist. Boring logs are included in **Appendix A**. Each boring was drilled through the alluvial deposits targeting the uppermost saturated sandy deposits.

Monitoring wells MW-2017-1 through MW-2017-8 were constructed of 2-inch-diameter, schedule 40 polyvinyl chloride (PVC) riser pipe and slotted screen. The screen interval was constructed using 10 feet of 0.010-inch factory-slotted PVC screen, set within the observed uppermost water-bearing unit. The annular space within the bore hole around the screen was filled with clean 10/20 silica sand filter pack to a minimum of 2 feet above top of screen. Three to 5 feet of bentonite chips were placed above the filter pack and hydrated with potable water to seal the filter pack from surface influence. The remaining annular space above the bentonite seal was filled with cement/bentonite grout or premix QuikGrout$^{©}$, and allowed to set for a minimum of 24 hours. Above-grade steel protective casings with lockable lids were installed to protect and secure the wellhead. Surface monuments were labeled with the well identification number and set within a 2-foot square concrete pad. Steel bollards were installed around wells located near traffic areas to enhance visibility and protect the wells. All bollards, protective casings and locking lids were painted yellow to help protect against corrosion and improve visibility. The location and elevation of the top-of-inner casing for each monitoring well was determined by Basin, North Dakota registered land surveyors. Well construction diagrams are included in **Appendix A**, and construction details, including survey information, are summarized in **Table 1**.

Well Development

Monitoring wells MW-2017-1 through MW-2017-8 were developed between November 21 and December 15, 2017. Well development activities included measuring the water level and total depth of the well, followed by surging by the lowering and raising of a submersible pump to suspend sediment into the water column followed by the activation of the submersible pump to purge the well. A minimum of five well volumes of water were removed from each monitoring well during well development. Field parameters (pH, temperature, specific conductance and turbidity) were measured and recorded at regular intervals during development. Purge water generated during well development was discharged to the adjacent ground surface. The submersible pump was decontaminated between uses with a phosphate-free detergent water solution followed by a distilled water rinse.

Aquifer Testing

Slug tests were 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.

Monitoring wells MW-2017-3, MW-2017-4, MW 2017-5 and MW-2017-6 were selected for testing to represent a range of anticipated aquifer responses across the site based on observations made during well development and sampling. (**Figure 2**). 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 slug was lowered approximately 2 feet below static water level and recovery of the water level was measured until approximately 95 percent of static water level was reached, at which time the slug was removed and recovery was measured until it reached approximately 95 percent of the static water level. Manual measurements were recorded on field aquifer testing forms (**Appendix B**) and electronic data was downloaded from the transducer and used for data evaluation.

Slug Test Analysis Process

Data from the slug tests performed at the Site were processed and analyzed using the AQTESOLV software package (Duffield, 2007), which provides type curve solutions corresponding to various conceptual models, each with their own hydrologic assumptions. Type curve solutions for pumping tests available in AQTESOLV typically require observation well data. In cases where observations from only the tested well are available, aquifer storage calculations are not usable; however, hydraulic conductivity calculations are still valid. Data were analyzed as single well recovery tests using the recovery solution for a slug test in a non-leaky confined aquifer (Bouwer-Rice, 1976). The Analysis involves matching a straight line to residual drawdown data collected after the termination of a slug test. The solution assumes a line source for the tested well and therefore neglects wellbore storage. An option in AQTESOLV also allows for variable flow rates during the testing period. The Theis solution utilizes the following assumptions:

- Aquifer has infinite areal extent;
- Aquifer is homogeneous, isotropic and of uniform thickness;
- Control well is fully penetrating;
- Flow to control well is horizontal;
- Aquifer is non-leaky confined;
- Flow is unsteady;
- Water is released instantaneously from storage with decline of hydraulic head;
- Diameter of pumping well is very small so that storage in the well can be neglected;
- Values of u' are small (i.e., r is small and t' is large)

Reports from the AQTESOLV slug test analyses are presented in **Appendix B**. The estimated hydraulic conductivity results ranged from 6.9 X 10^{-4}cm/sec (MW-2017-3) to 1.3x10^{-2} cm/sec (MW-2017-6).

5. System Evaluation

The Final CCR Rule establishes the following general performance standard for CCR groundwater monitoring systems:

- All groundwater monitoring systems must consist of a sufficient number of appropriately located wells (at least one background and three downgradient wells) in order to yield groundwater samples from the uppermost aquifer that represent the quality of background groundwater and the quality of groundwater passing the CCR waste boundary.
- The objective of a groundwater monitoring system is to intercept groundwater to determine whether the groundwater has been impacted by the CCR disposal unit. The number, spacing, and depths of the monitoring wells must be determined based on a thorough characterization of the site, including a number of specifically identified factors relating to the hydrogeology of the site.

The “uppermost aquifer” and “aquifer” are defined in the Final CCR Rule in § 257.53, as follows:

“Uppermost aquifer” means the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility’s property boundary. Upper limit is measured at a point nearest to the natural ground surface to which the aquifer rises during the wet season.

“Aquifer” means a geologic formation, group of formations, or portion of a formation capable of yielding usable quantities of groundwater to wells or springs.

As described in the drilling and well construction discussion in **Chapter 4**, drilling equipment and procedures were employed to identify the uppermost aquifer and ensure each new monitoring well was installed with appropriate total depth and placement of the well screen to: (1) facilitate collection of representative samples of the uppermost aquifer, and (2) accurately measure potentiometric elevations to support evaluation of groundwater gradient and flow direction.

The list of wells selected for sampling background and downgradient groundwater quality for each CCR unit is summarized below:

CCR unit	Background well	Downgradient well	Position Variable Wells
Pond 2	MW-2017-1	MW-2017-5	MW-2017-2, MW-2017-3, MW-2017-4, MW-2017-6, MW-2017-7

Potentiometric surface maps have been constructed using the depth-to-groundwater measurements obtained during baseline groundwater monitoring. Maps of the potentiometric surface for the representative normal and reverse flow events are presented as **Figures 3a and 3b**. The associated depth-to-groundwater measurements and calculated groundwater elevations are presented in **Table 2**. The potentiometric surface was calculated at each well by subtracting the measured depth-to-groundwater from the surveyed top-of-casing elevation. The potentiometric surface elevations for each monitoring well are posted on the figures, with inferred elevation contours of the groundwater potentiometric surface. The direction of groundwater flow is generally to the east-northeast, perpendicular to the potentiometric contour lines, with localized groundwater flow indicated to the north and east-southeast in some areas. **Figures 3a and 3b** illustrate the variability of groundwater flow beneath the site between events in response to seasonal changes in aquifer recharge and elevation of the Missouri River. The data evaluated for this report support the selection of the wells listed above to represent background groundwater quality and the quality of groundwater downgradient of the CCR units.

6. Statistical Methodology

Regulatory Guidance

Regulatory guidance provided in 40 CFR § 257.90 specifies that a CCR groundwater monitoring program include selection of the statistical procedures to be used for evaluating groundwater quality data as required by 40 CFR § 257.93. Groundwater quality monitoring data will be collected under the Detection monitoring program outlined in this plan and will include collection and analysis of a minimum of eight independent groundwater samples from each background and downgradient compliance well, for each CCR unit or multi-unit, as required by 40 CFR § 257.94(b). The groundwater samples will be analyzed for the constituents listed in 40 CFR Part 257 Appendices III and IV.

After the eight sets of groundwater samples are collected and analyzed, these data must be statistically evaluated to determine if there are any statistically significant increases (SSI) over background concentrations for the Appendix III and IV constituents. In determining whether an SSI has occurred, the constituent concentrations at the downgradient wells and the background wells for each unit/multi-unit will be compared using one or more of the statistical methods discussed below.

40 CFR § 257.93(f) outlines the statistical methods available to evaluate groundwater monitoring data. The statistical test(s) chosen will be conducted separately for each constituent in each monitoring well and will be appropriate for the constituent data and their distribution. The available statistical methods include the following:

- A parametric analysis of variance (ANOVA) followed by multiple comparison procedures to identify statistically significant evidence of contamination. The method must include estimation and testing of the contrasts between each compliance well's mean and the background mean levels for each constituent;
- An ANOVA based on ranks, followed by multiple comparison procedures to identify statistically significant evidence of impacts. The method must include estimation and testing of the contrasts between each compliance well's median and the background median levels for each constituent;
- A tolerance or prediction interval procedure, in which an interval for each constituent is established from the distribution of the background data and the level of each constituent in each compliance well is compared to the upper tolerance or prediction limit;
- A control chart approach that gives control limits for each constituent; or
- Another statistical test method that meets the performance standards of 40 CFR § 257.94(g) outlined in the paragraph below.

The chosen statistical method will comply with the following performance standards, as appropriate, based on the statistical test method used. The performance standards include the following:

- The statistical method used to evaluate groundwater monitoring data will be appropriate for the constituent distribution (i.e., parametric or nonparametric).
- If an individual well comparison procedure is used to compare an individual compliance well constituent concentration with background constituent concentrations or a groundwater protection standard, the test shall be done at a Type I error level no less than 0.01 or 0.05, depending on the method chosen. This performance standard does not apply to tolerance intervals, prediction intervals, or control charts.
- If a control chart approach is used to evaluate groundwater monitoring data, the specific type of control chart and its associated parameter values shall be such that this approach is at least as effective as any of the other statistical analysis approaches specified above.
- If a tolerance interval or a prediction interval is used to evaluate groundwater monitoring data, the levels of confidence and, for tolerance intervals, the percentage of the population that the interval must contain, shall be such that this approach is at least as effective as any of the other statistical analysis approaches specified above.
- The statistical method must account for data below the limit of detection with one or more statistical procedures that shall be at least as effective as any of the other statistical analysis approaches specified above.

- If necessary, the statistical method must include procedures to control or correct for seasonal and spatial variability as well as temporal correlation in the data.

Per 40 CFR § 257.93(h)(2), statistical analysis of the first eight rounds of data must be completed within 90 days after completing the detection groundwater sampling and analysis to determine whether there has been an SSI over background for any constituent. The first eight rounds of groundwater sampling and analysis must be completed no later than April 17, 2019. In accordance with 40 CFR Part 257, LOS must obtain a certification from a qualified professional engineer stating that the selected statistical method is appropriate for evaluating the groundwater monitoring data for the CCR management area. The certification must include a narrative description of the statistical method selected to evaluate the groundwater monitoring data.

Assessment monitoring is required per 40 CFR § 257.95 whenever a SSI over background levels has been detected for one or more of the indicator parameters listed in 40 CFR Part 257 Appendix III. An Assessment monitoring program also includes annual groundwater sampling and analysis for the constituents listed in 40 CFR Part 257 Appendix IV. The purpose of Assessment monitoring is to determine if releases of CCR constituents have occurred.

The facility can return to Detection monitoring once Assessment monitoring results are at or below background values for two consecutive Assessment monitoring events. If the Assessment monitoring demonstrates an exceedance of a GWPS for any of the CCR constituents specified in 40 CFR Part 257 Appendices III and IV, groundwater corrective action must be initiated.

Statistical Analysis Approach

There is no single method of statistical analysis that is appropriate for each groundwater constituent dataset. It is most prudent to use a suite of statistical methods that are dependent on the data and their distributions. The statistical analyses will be based on an interwell and/or an intrawell approach for the purpose of determining if an LOS Pond 2 and Pond CCR multiunit has impacted groundwater quality. The statistical algorithms used for the interwell and intrawell approaches will be chosen based on the groundwater constituent data and their distributions as well as consideration of natural seasonally- or spatially-varying groundwater constituent concentrations.

Eight rounds of baseline groundwater monitoring data were collected and analyzed for the 40 CFR Part 257 Appendices III and IV constituents. These data will be used to represent background groundwater quality for the LOS Pond 2 CCR unit. The Detection monitoring data collected at the downgradient wells will be used to determine if the CCR unit has impacted groundwater quality. The initial eight rounds of Detection monitoring sampling and analysis were completed by the April 17, 2019 deadline established in the CCR Rule (40 CFR § 257.94).

A preliminary, exploratory statistical analysis was conducted after the eight rounds of baseline data were obtained to initially assess the constituent data and determine the most appropriate statistical approach(es) for the data. The data were examined for outliers and the percentage of non-detect values to verify that the data collected are suitable for statistical analysis. The data were also examined using goodness-of-fit tests to determine the most appropriate statistical distribution and time series plots and areal maps were used to determine if seasonal or spatial variations in constituent concentrations were present. Based on this preliminary evaluation of the data, an interwell statistical approach was selected as appropriate for evaluating groundwater at LOS Pond 2, as described below.

Per 40 CFR § 257.93(h)(2), statistical analysis of all eight rounds of data must be completed within 90 days after completing groundwater sampling and analysis to determine whether there has been an SSI over background for any Appendix III constituent.

Interwell Statistical Approach

Interwell tests compare the statistical differences between background and downgradient compliance wells. An interwell statistical approach will be used during Detection monitoring for the following reasons:

- Sufficient data are available in the background well to ensure adequate degrees of statistical power to detect real exceedances above background levels, and also reasonable control over the site-wide false positive rate so that spurious exceedances have little chance of being identified.

- Although there is evident spatial variation among most, if not all, of the Appendix III constituents, it is unclear to what extent the similarly evident variation among the downgradient wells is due strictly to natural differences in groundwater quality and/or other factors unrelated to management of the CCR. Because of this uncertainty, an interwell comparison strategy appears to be initially more appropriate for LOS.

As a caveat to this approach, for constituents that occur naturally and vary substantially in concentration across LOS Pond 2 due to natural hydrogeologic or geochemical factors — thus, exhibiting significant spatial variability — an interwell testing scheme will not always be helpful. Using an interwell approach, constituent concentrations greater than background might be attributed to anthropogenic contamination, when the differences are actually natural and due to locally varying distributions of groundwater constituents. In such cases, an intrawell approach may be warranted.

Furthermore, there is no requirement either in RCRA or the CCR Rule to use exactly the same statistical method or approach for every constituent. Depending on characteristics of LOS Pond 2 and data that are collected, a mix of interwell and intrawell tests may be warranted. At this site, the initial statistical screening suggests that interwell comparisons are most appropriate despite evident spatial variability. However, that conclusion could change as additional data are collected during future Detection monitoring. If new information indicates that constituent concentrations remain relatively stable and that the existing spatial variation is unrelated to the CCR unit, a modification of the statistical approach to intrawell testing may be recommended for one or more constituents.

Under an interwell statistical approach in Detection monitoring, the actual statistical method(s) chosen will be determined based on the constituent data distribution (as outlined below), which in turn is influenced both by the percentage and pattern of non-detect measurements as well as the temporal stability of the concentration levels.

When (1) the percentage of non-detects is low to moderate (i.e., less than 50 percent), (2) the background data can be normalized (perhaps via a standard transformation), and (3) the results are stationary (i.e., stable over time), the following statistical methods are highly recommended by EPA (2009):

- Parametric interwell prediction limit methods with retesting, or
- Interwell control charts with retesting.

When the background data cannot be normalized (perhaps due to a large percentage of non-detects, i.e., greater than 50 percent), but the data are stationary (i.e., stable over time), the following statistical method is recommended by EPA (2009):

- Non-parametric interwell prediction limits with retesting.

Note that the specific retesting method in each of these options will be chosen to account for the size of the well network, the amount of background data available, the number of constituents being monitored, the site-specific mix of intrawell and interwell tests, and the impact of these factors on the statistical power and accuracy of the test. At this site, the background wells relative to the number of downgradient wells to be tested on a semi-annual basis will enable use of a 1-of-2 retesting plan. This necessitates collection of a single independent resample at any location in which the initial routine measurement exceeds its respective statistical limit. A confirmed statistical exceedance will not be recorded unless both the initial measurement and resample value both exceed the statistical limit.

If the background data are non-stationary and thus exhibit a clear trend, it will suggest that factors unrelated to the CCR unit are impacting background groundwater quality. Three general scenarios will be considered:

- Older background data may no longer be representative of current site conditions and may need to be excluded from statistical calculations. In this case, the interwell statistical limits will be updated to include only the most representative background data.
- The compliance wells will be examined to see if similar trends are occurring downgradient. If so, a common trend component will be estimated across the site and removed from every well. The residual data will then be used to construct revised statistical limits and tested as described above.

- If the trend in background wells is not reflected in downgradient wells, further investigation may be needed to determine if the background data still serve as a reasonable background with which to compare downgradient compliance measurements. If not, the statistical approach will be modified to an appropriate intrawell strategy.

Because of the decision matrix needed to establish the correct statistical approach, the background data for each constituent will be periodically screened prior to construction of new or revised statistical limits. This screening will examine the proportion and pattern of outliers and potential data anomalies (perhaps due to laboratory or field sampling factors), the presence or absence of statistically significant trends over time, the presence or absence of statistically significant outliers, and the identification of an appropriate statistical distribution. In particular, any confirmed background outliers will be excluded from statistical calculations, so as not to unduly bias the statistical limits.

Proposed Statistical Methods for Appendix III Analytes

Table 3 provides a summary of the proposed statistical method by well for Appendix III analytes. The table is based on a preliminary screening of the background well data collected to date. The proposed statistical method may be modified when all of the background data has been statistically evaluated for the annual report to be submitted in August 1, 2019.

7. Limitations

The signature of AECOM’s (Consultant’s) authorized representative on this document represents that, to the best of Consultant’s knowledge, information, and belief in the exercise of its professional judgment, it is Consultant's professional opinion that the aforementioned information is accurate as of the date of such signature. Any opinion or decisions by Consultant are made on the basis of Consultant’s experience, qualifications, and professional judgment and are not to be construed as warranties or guaranties. In addition, opinions relating to environmental, geologic, and geotechnical conditions or other estimates are based on available data, and actual conditions may vary from those encountered at the times and locations where data are obtained, despite the use of due care.

8. References

Bouwer, H. and R.C. Rice, 1976. A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells, Water Resources Research, vol. 12, no. 3, pp. 423-428.

Duffield, G. M. 2007. AQTESOLV Version 4.50, s.l.: HydroSOLVE, Inc.

U.S. Environmental Protection Agency. 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities. Unified Guidance. EPA 530-R-09-007. March. 884 pp.

Figures

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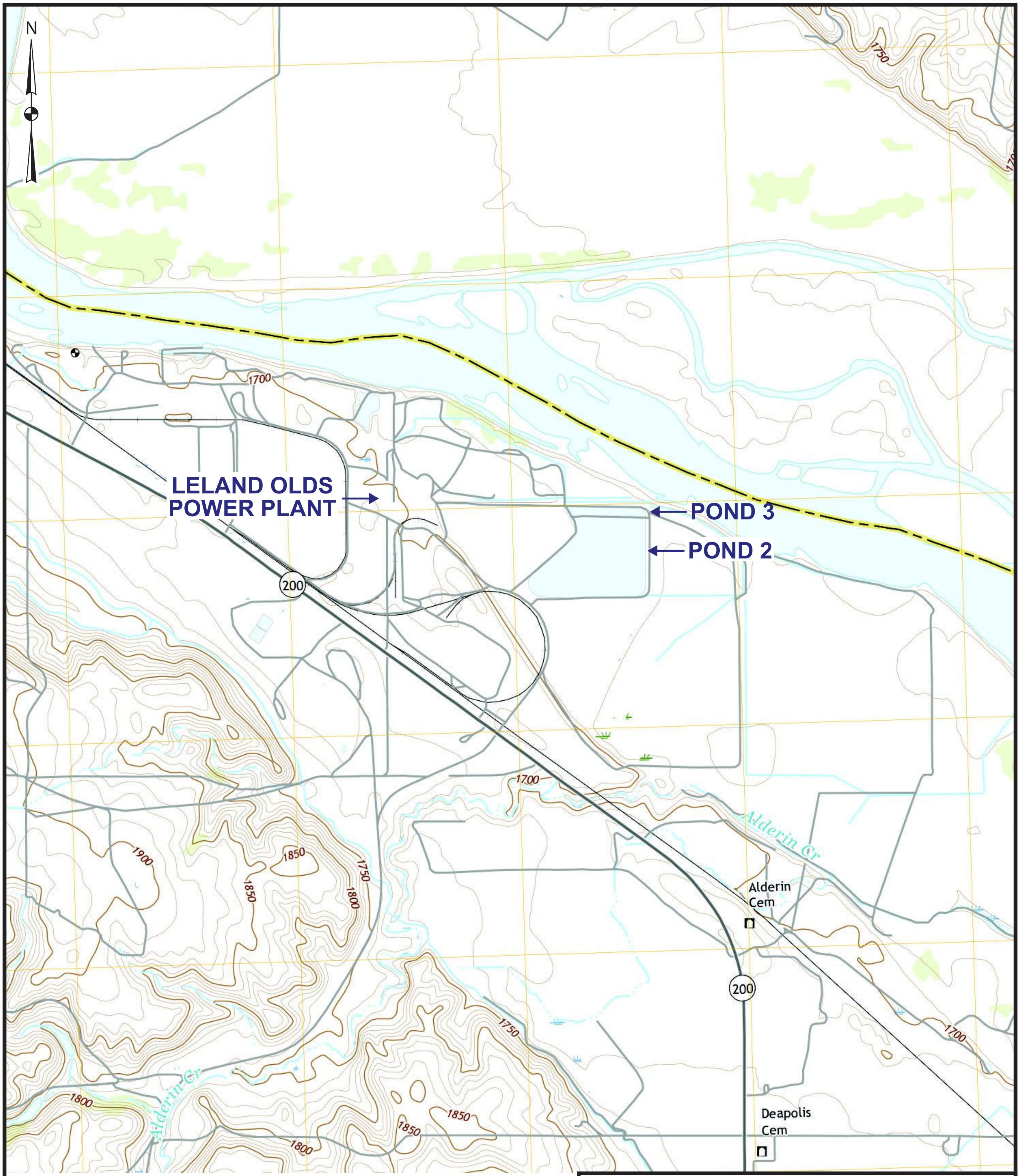
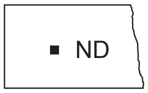


0 2,000 4,000

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

LEGEND

▲ MONITORING WELL

⊙ CCR RULE COMPLIANCE WELL

— Terrace Boundary (Inferred)

BASIN ELECTRIC
POWER COOPERATIVE

LELAND OLDS STATION
STANTON, NORTH DAKOTA

FIGURE 2
Monitoring Well Location Map

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
- ▬ POTENTIOMETRIC SURFACE CONTOUR (DASHED WHERE INFERRED) DECEMBER 4, 2018
- (144-84-22-DAA3 1659.55) ELEVATION NOT USED FOR CONTOURING
- ▬ Terrace Boundary (Inferred)
- ➡ GROUNDWATER FLOW DIRECTION

BASIN ELECTRIC
POWER COOPERATIVE

LELAND OLDS STATION
STANTON, NORTH DAKOTA

FIGURE 3a
Pool River Stage Potentiometric Map

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

▬ POTENTIOMETRIC SURFACE CONTOUR (DASHED WHERE INFERRED) JULY 23, 2018

(144-84-22-DAA3 1659.55) ELEVATION NOT USED FOR CONTOURING

▬ Terrace Boundary (Inferred)

➡ GROUNDWATER FLOW DIRECTION

BASIN ELECTRIC
POWER COOPERATIVE

LELAND OLDS STATION
STANTON, NORTH DAKOTA

FIGURE 3b
Elevated River Stage Potentiometric Map

JOB NO. 60558359

AECOM

Tables

Table 1
Monitoring Well Construction Details
CCR Monitoring Program Pond 2 and Pond 3 Multiunit
Leland Olds Station

Well Name	Location Relative to CCR Unit	Latitude/Longitude		Top of Casing Elevation ft amsl (ft amsl)	Total Depth (ft btoc)	Well Screen Interval (ft bgs)	Well Screen Lithology
		Northing	Easting				
Pond 2 and Pond 3 multiunit							
MW-2017-1	Upgradient Well	590239.57	1798915.70	1683.86	36.64	24-34	Sand/Silt
MW-2017-2	Downgradient well	590011.87	1799298.71	1681.03	41.25	24-34	Sand
MW-2017-3	Downgradient well	589984.83	1799546.56	1682.36	36.83	24-34	Silt/Sand
MW-2017-4	Downgradient well	589824.67	1800154.81	1684.13	41.34	28-38	Sand
MW-2017-5	Downgradient well	589203.47	1800107.89	1691.72	51.93	40-50	Sand
MW-2017-6	Downgradient well	588445.39	1799873.67	1693.44	52.39	40-50	Sand
MW-2017-7	Downgradient well	588409.57	1799017.23	1698.25	52.43	40-50	Sand
MW-2017-8	*	586971.82	1798084.51	1717.30	42.70	30-40	Gravel/Sand

Notes:

[1] Upgradient and downgradient relative locations will be verified during the first eight rounds of detection monitoring.

ft amsl = feet above mean sea level

ft btoc = feet below top of casing

CCR = Coal Combustion Residuals

* = MW-2017-8 was removed from the groundwater monitoring program in October 2018.

TABLE 2
Groundwater Monitoring Water Levels and Elevations
CCR Monitoring Wells
Leland Olds Station

Seventh Sampling Event - December 2018 (Pool River Stage, see Figure 3a)

Well ID	Reference Elevation Top of Casing (feet, NAVD 88)	December 4, 2018 Depth to Water (feet)	Groundwater Elevation (feet, NAVD 88)
MW-2017-1	1,683.86	24.12	1,659.74
MW-2017-2	1,681.03	21.55	1,659.48
MW-2017-3	1,682.36	22.80	1,659.56
MW-2017-4	1,684.13	24.85	1,659.28
MW-2017-5	1,691.72	31.88	1,659.84
MW-2017-6	1,693.44	33.40	1,660.04
MW-2017-7	1,698.25	38.07	1,660.18
MW-2017-8	1,693.44	NA	NA

Third Sampling Event - July 2018 (Elevated River Stage, see Figure 3b)

Well ID	Reference Elevation Top of Casing (feet, NAVD 88)	July 23, 2018 Depth to Water (feet)	Groundwater Elevation (feet, NAVD 88)
MW-2017-1	1,683.86	19.05	1,664.81
MW-2017-2	1,681.03	16.35	1,664.68
MW-2017-3	1,682.36	17.67	1,664.69
MW-2017-4	1,684.13	19.27	1,664.86
MW-2017-5	1,691.72	27.25	1,664.47
MW-2017-6	1,693.44	29.28	1,664.16
MW-2017-7	1,698.25	34.09	1,664.16
MW-2017-8	1,717.23	29.31	1,687.92

NA = Measurements not available

TABLE 3
Proposed Statistical Methods for Appendix III Consitutents
Background Well MW-2017-1
CCR Monitoring Wells
Leland Olds Station

Parameter	Background Well	Statistical Method
Boron	MW-2017-1	Parametric Prediction Limit
Calcium	MW-2017-1	Parametric Prediction Limit
Chloride	MW-2017-1	Nonparametric Prediction Limit
Fluoride	MW-2017-1	Nonparametric Prediction Limit
pH	MW-2017-1	Parametric Prediction Limit
Sulfate	MW-2017-1	Parametric Prediction Limit
Total Dissolved Solids	MW-2017-1	Nonparametric Prediction Limit

Appendix A

Boring Logs and Well Construction Diagrams

AECOM

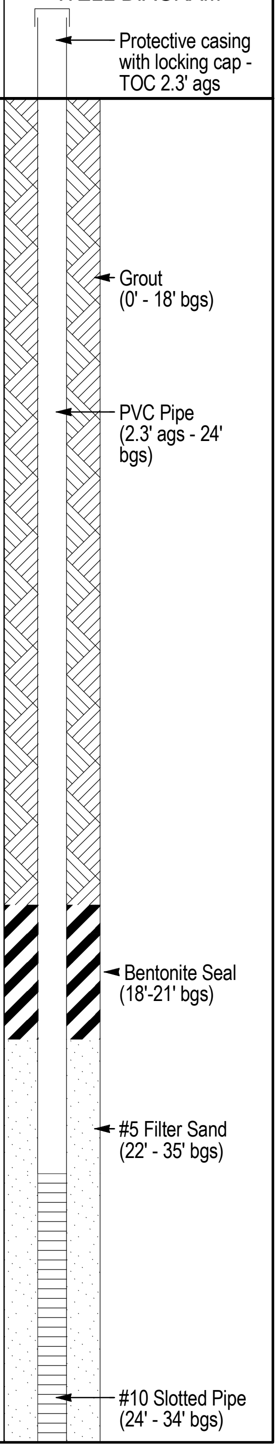
WELL NUMBER MW-2017-1

CLIENT Basin Electric
PROJECT NAME Lelands Olds Landfill - Pond 2
PROJECT NUMBER 60558359
PROJECT LOCATION Stanton, ND
DATE STARTED 11/13/2017 **COMPLETED** 11/13/2017
GROUND ELEVATION 1681.534 ft NAVD88
DRILLING CONTRACTOR Terracon
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 590239.765 N 1798915.674 E
AFTER DRILLING:

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	MATERIAL DESCRIPTION	
0						
0.5					TOPSOIL; brown	1681.0
4.0				SP-SM	SAND/SILT, fine; light brown	1677.5
6.0				CL-ML	SILTY CLAY; brown	1675.5
7.0				CL	CLAY; dark brown	1674.5
12.0				ML	SILT; dark brown mixed with thin gray silt horizons	1669.5
15.0				ML	SILT; light brown mottled with dark yellowish brown	1666.5
16.0				ML	SILT, wet; gray	1665.5
18.0				SP-SM	SAND/SILT, fine, dry; brown	1663.5
20.0	SS	0	-	ML	SILT, moist; gray	1661.5
21.5				ML	SILT, moist, trace sand, wet; gray	1660.0
26.0				SP-SM	SAND/SILT, very fine, wet; gray	1655.5
30				ML	SILT, saturated	

Casing Top Elev: 1683.872 (ft)
Casing Type: 2" Sch 40 PVC

WELL DIAGRAM



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WELL NUMBER MW-2017-1

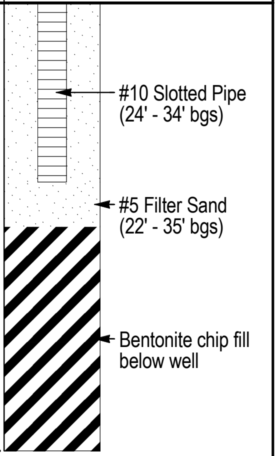
CLIENT Basin Electric

PROJECT NUMBER 60558359

PROJECT NAME Lelands Olds Landfill - Pond 2

PROJECT LOCATION Stanton, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
30						SILT, saturated*(continued)*	
35				ML			
40						40.0 1641.5	



Bottom of borehole at 40.0 feet.

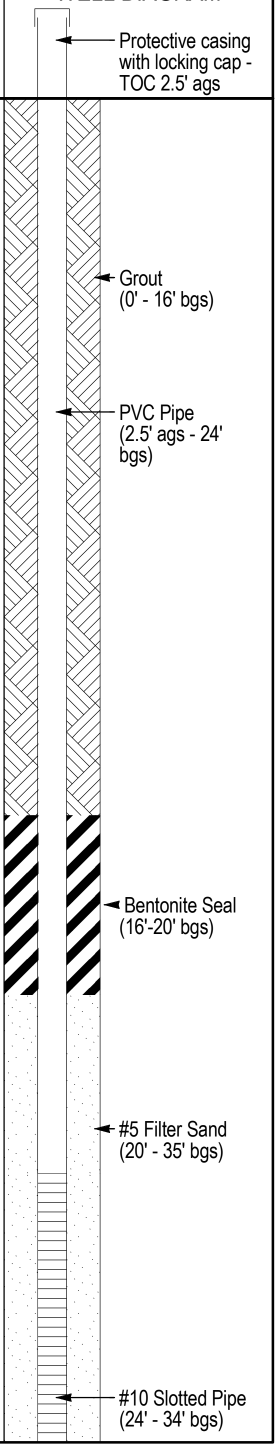
WELL NUMBER MW-2017-2

CLIENT Basin Electric
PROJECT NAME Lelands Olds Landfill - Pond 2
PROJECT NUMBER 60558359
PROJECT LOCATION Stanton, ND
DATE STARTED 11/13/2017 **COMPLETED** 11/13/2017
GROUND ELEVATION 1678.639 ft NAVD88
DRILLING CONTRACTOR Terracon
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING: **22' bgs 11/13/2018 9:45:00 AM**
LOGGED BY R. Klute **CHECKED BY** J. Lach
AT END OF DRILLING:
COORDINATES 590012.062 N 1799298.905 E
AFTER DRILLING:

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0						TOPSOIL; brown 0.5 1678.1
5				SP-SM		SAND/SILT, fine; pale brown 5.5 1673.1
				ML		SILT; grayish brown with yellowish red clay 7.0 1671.6
				CL-ML		SILTY CLAY, moist, sticky; grayish brown 9.0 1669.6
10				ML		SILT, moist, with fine sand; grayish brown 11.0 1667.6
				CL-ML		SILTY CLAY, wet, trace fine sand; mottled with yellowish red clay 14.5 1664.1
15 20	SS	0	-	ML		SILT, saturation; gray 22.0 ▽ 1656.6
25				SP-SM		SAND/SILT, fine, saturated; gray 28.0 1650.6
30				SP		SAND, fine

Casing Top Elev: 1681.121 (ft)
Casing Type: 2" Sch 40 PVC

WELL DIAGRAM



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CLIENT Basin Electric

PROJECT NUMBER 60558359

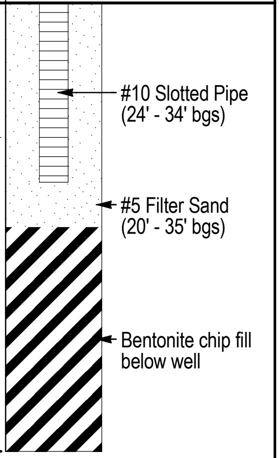
PROJECT NAME Lelands Olds Landfill - Pond 2

PROJECT LOCATION Stanton, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
30				SP		SAND, fine*(continued)*	
					33.0		1645.6
35				GW		GRAVEL/CHERT, well sorted	
40					40.0		1638.6

Bottom of borehole at 40.0 feet.

WELL DIAGRAM



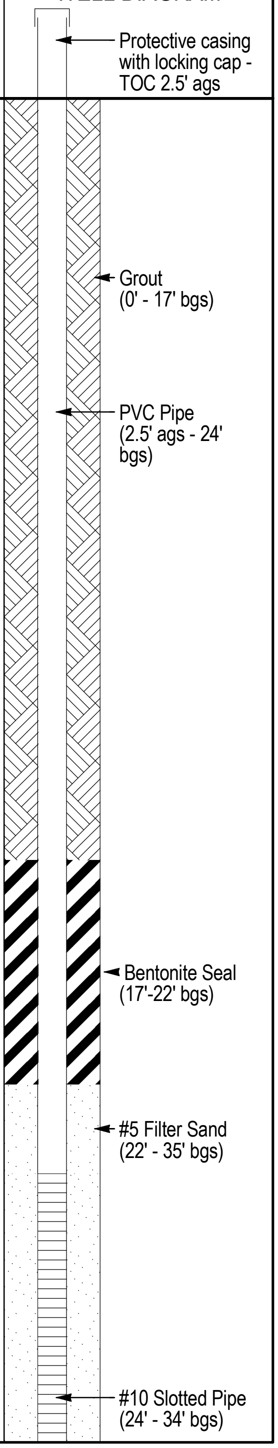
WELL NUMBER MW-2017-3

CLIENT Basin Electric
PROJECT NAME Lelands Olds Landfill - Pond 2
PROJECT NUMBER 60558359
PROJECT LOCATION Stanton, ND
DATE STARTED 11/15/2017 **COMPLETED** 11/15/2017
GROUND ELEVATION 1680.062 ft NAVD88
DRILLING CONTRACTOR Terracon
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING: **21.75' bgs 11/15/2017 4:45:00 PM**
LOGGED BY R. Klute **CHECKED BY** J. Lach
AT END OF DRILLING:
COORDINATES 589985.093 N 1799546.516 E
AFTER DRILLING:

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	MATERIAL DESCRIPTION		
0 5				SP	SAND, fine, poorly graded; brown	5.5	1674.6
				CL-ML	SILTY CLAY; mottled dark gray and yellowish red	7.5	1672.6
10				CL	CLAY; very dark grayish brown	12.0	1668.1
				CL	SANDY CLAY	13.0	1667.1
				SP	SAND, poorly graded, trace silt; light olive brown	13.5	1666.6
				ML	SILT; olive brown	14.5	1665.6
15				SP-SM	SAND/SILT, moist; mottled olive brown and olive	15.5	1664.6
20	SS	0	-	CL-ML	SILTY CLAY, wet, very soft; gray ∇	23.0	1657.1
25 30				ML	SILT, saturated, with very fine sand; gray		

Casing Top Elev: 1682.53 (ft)
Casing Type: 2" Sch 40 PVC

WELL DIAGRAM



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WELL NUMBER MW-2017-3

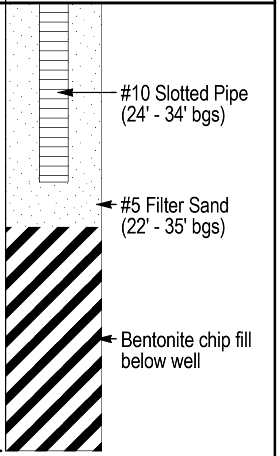
CLIENT Basin Electric

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	WELL DIAGRAM
30						SILT, saturated, with very fine sand; gray*(continued)*	
35				ML			
40						40.0 1640.1	
						Bottom of borehole at 40.0 feet.	



AECOM

WELL NUMBER MW-2017-4

PAGE 1 OF 2

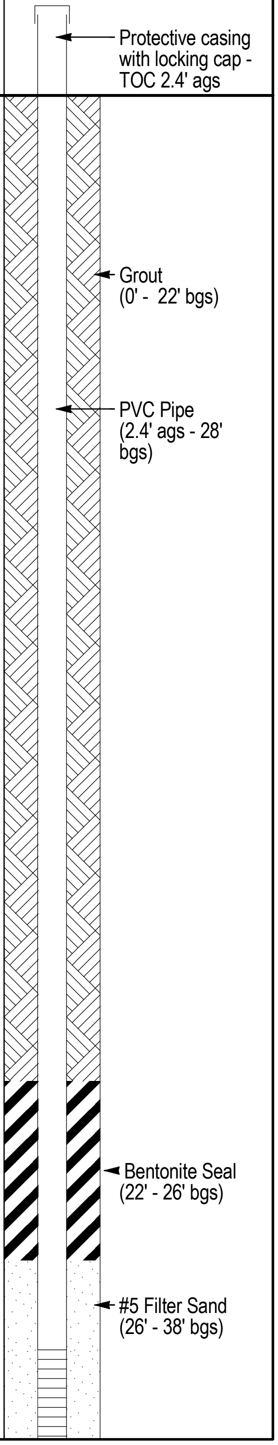
CLIENT Basin Electric
PROJECT NAME Lelands Olds Landfill - Pond 2
PROJECT NUMBER 60558359
PROJECT LOCATION Stanton, ND
DATE STARTED 11/16/2017 **COMPLETED** 11/16/2017
GROUND ELEVATION 1681.737 ft NAVD88
DRILLING CONTRACTOR Terracon
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING: **24' bgs 11/16/2017 2:50:00 PM**
LOGGED BY R. Klute **CHECKED BY** J. Lach
AT END OF DRILLING:
COORDINATES 589824.865 N 1800154.899 E
AFTER DRILLING:

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	MATERIAL DESCRIPTION
0				SM	SILTY SAND; yellowish brown
3.0				CL	CLAY; very dark grayish brown
4.0				SP-SM	SAND/SILT, fine; brown
5.5				CL	CLAY, trace sand, silt; dark brown
7.5				CL	CLAY, very firm; dark grayish brown
9.5				CL-ML	SILTY CLAY, firm; mottled with light olive brown silt
13.5				CL-ML	SILTY CLAY, firm; mottled with dark yellow brown clay
17.0				ML	SILT, very soft, wet; gray
18.0	SS	0	-	SM	SILTY SAND, very fine; gray becomes wet at 20' bgs ▽
27.0				SP	SAND, fine, wet, poorly-graded, trace silt; gray 10' heave on 28.5' - 29.5' bgs

Depth	Elevation
3.0	1678.7
4.0	1677.7
5.5	1676.2
7.5	1674.2
9.5	1672.2
13.5	1668.2
17.0	1664.7
18.0	1663.7
27.0	1654.7

Casing Top Elev: 1684.153 (ft)
Casing Type: 2" Sch 40 PVC

WELL DIAGRAM



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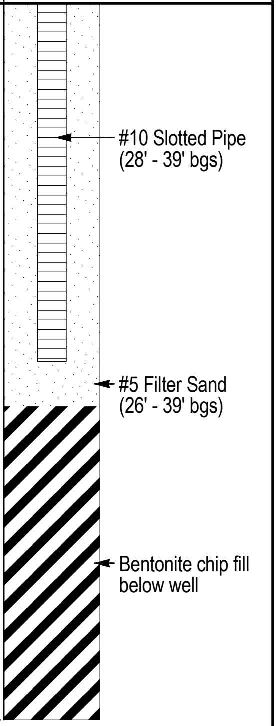
WELL NUMBER MW-2017-4

CLIENT Basin Electric
PROJECT NAME Lelands Olds Landfill - Pond 2
PROJECT NUMBER 60558359
PROJECT LOCATION Stanton, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
30				SP		SAND, fine, wet, poorly-graded, trace silt; gray*(continued)*	
38.5				GW		GRAVEL, well graded lignite fragments/gravel at 39' bgs	1643.2
40.0				GW		GRAVEL, well graded, with coarse sand	1641.7
46.0							1635.7

Bottom of borehole at 46.0 feet.

WELL DIAGRAM



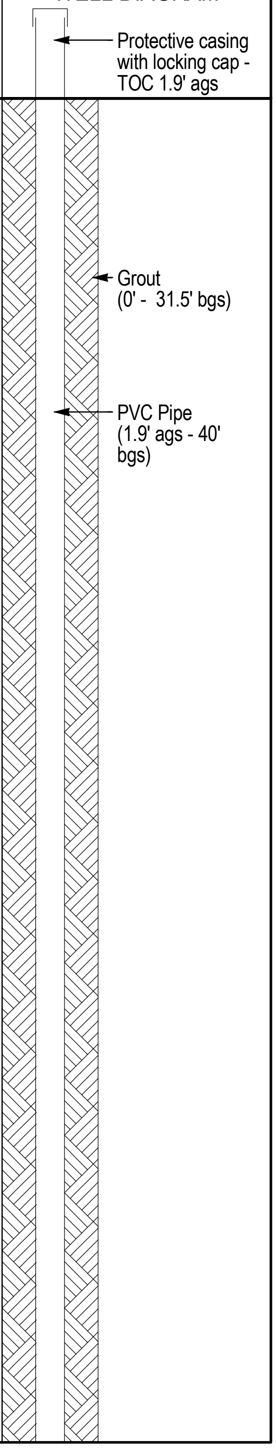
WELL NUMBER MW-2017-5

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		5.0	CLAY, very firm; olive brown	1684.8
5				ML		6.0	SILT, with black ash, trace sand; dark yellowish brown	1683.8
				ML		7.0	SILT, crumbly; dark yellowish brown	1682.8
				CL		8.5	CLAY, with bottom ash, fly ash, wet; dark grayish brown	1681.3
10				CL		12.5	CLAY, with fly ash, moist to wet; dark yellowish brown	1677.3
				ML		13.5	SILT, with fine sand, dry; brown	1676.3
				CL		15.0	CLAY, firm, dry; dark gray mottled with brown	1674.8
15				SW		15.5	SAND, fine; olive brown	1674.3
				CL		19.0	CLAY, firm, dry; dark gray mottled with brown	1670.8
20							SILTY CLAY, trace fine sand, saturated; brown	
							▽	
25	SS	0	-	CL-ML		30.0		1659.8
30								

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

WELL DIAGRAM



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CLIENT Basin Electric

PROJECT NAME Lelands Olds Landfill - Pond 2

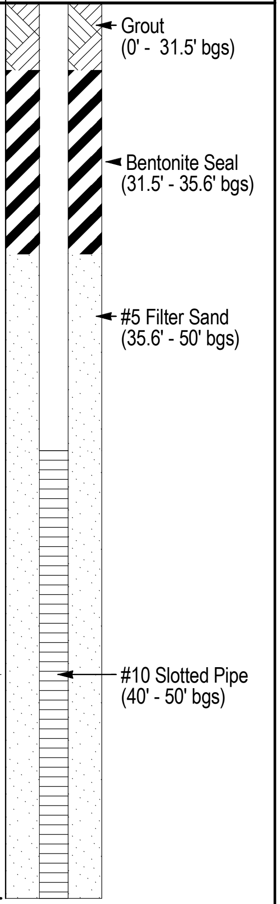
PROJECT NUMBER 60558359

PROJECT LOCATION Stanton, ND

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

Bottom of borehole at 50.0 feet.

WELL DIAGRAM



AECOM

WELL NUMBER MW-2017-6

PAGE 1 OF 2

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

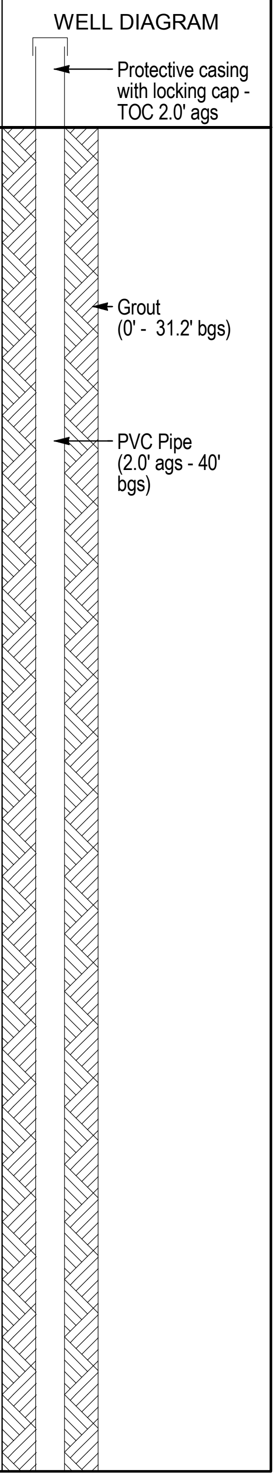
AT END OF DRILLING:

COORDINATES 589203.705 N 1800107.822 E

AFTER DRILLING:

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

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



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Report: SOIL-WELL LOG; File Cincinnati\DCS\Projects\B\Basin Electric Coop\General; 5/17/2018 12:04:58 PM

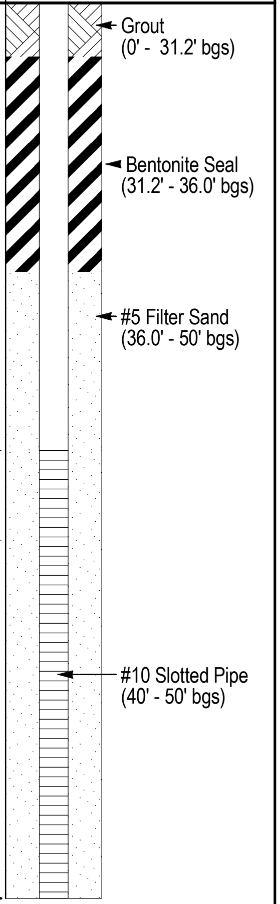
WELL NUMBER MW-2017-6

CLIENT Basin Electric

PROJECT NAME Lelands Olds Landfill - Pond 2

PROJECT NUMBER 60558359

PROJECT LOCATION Stanton, ND

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

Bottom of borehole at 50.0 feet.

AECOM

WELL NUMBER MW-2017-7

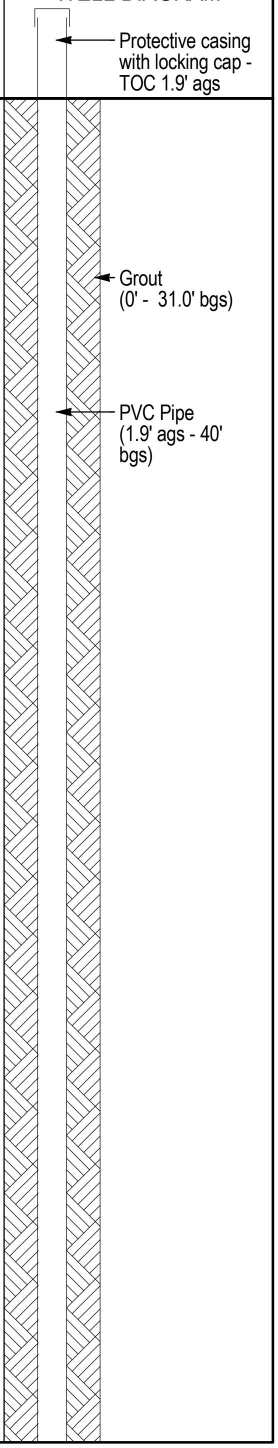
PAGE 1 OF 2

CLIENT Basin Electric
PROJECT NAME Lelands Olds Landfill - Pond 2
PROJECT NUMBER 60558359
PROJECT LOCATION Stanton, ND
DATE STARTED 11/20/2017 **COMPLETED** 12/6/2017
GROUND ELEVATION 1696.448 ft NAVD88
DRILLING CONTRACTOR Terracon (11/17/18) Cascade (12/6/18)
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 588409.786 N 1799017.348 E
AFTER DRILLING:

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	MATERIAL DESCRIPTION	
0				SC	SANDY CLAY, with ash; olive brown	
4.5				CL-ML	SILTY CLAY, crumbly; olive brown	1691.9
5.0					FLY ASH; black	1691.4
5.5					FLY ASH; grayish brown	1690.9
7.5					FLY ASH, saturated; grayish brown	1688.9
12.5						1683.9
21.0				CL	CLAY, firm, dry; very dark gray	1675.4
22.5				CL-ML	SILTY CLAY, saturated; gray	1673.9
25	SS	0	-			
30						

Casing Top Elev: 1698.329 (ft)
Casing Type: 2" Sch 40 PVC

WELL DIAGRAM



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WELL NUMBER MW-2017-7

CLIENT Basin Electric

PROJECT NAME Lelands Olds Landfill - Pond 2

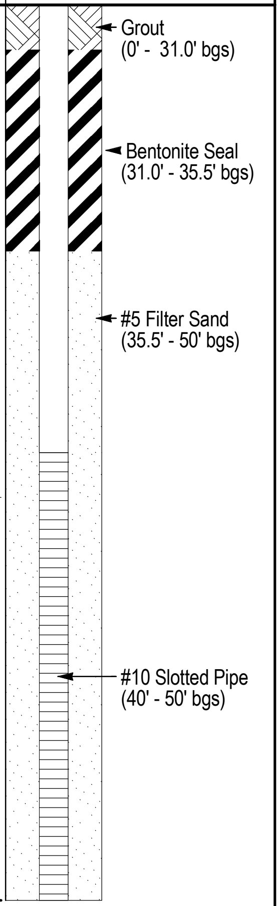
PROJECT NUMBER 60558359

PROJECT LOCATION Stanton, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
30				CL-ML		SILTY CLAY, saturated; gray*(continued)*
35						
40						41.0 1655.4
				SW		SAND, fine, trace medium sand, wet; brown
45						
50						50.0 1646.4

Bottom of borehole at 50.0 feet.

WELL DIAGRAM



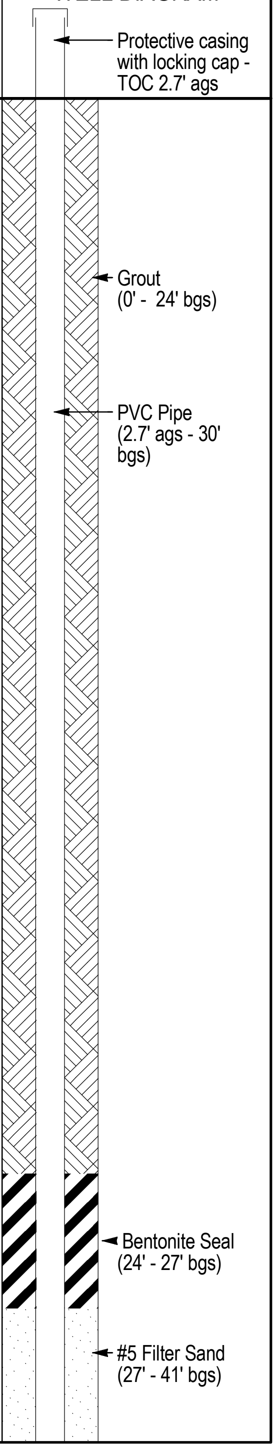
WELL NUMBER MW-2017-8

CLIENT Basin Electric
PROJECT NAME Lelands Olds Landfill - Pond 2
PROJECT NUMBER 60558359
PROJECT LOCATION Stanton, ND
DATE STARTED 11/14/2017 **COMPLETED** 11/14/2017
GROUND ELEVATION 1714.621 ft NAVD88
DRILLING CONTRACTOR Terracon
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING: **26' bgs 11/14/2017 7:05:00 AM**
LOGGED BY R. Klute **CHECKED BY** J. Lach
AT END OF DRILLING:
COORDINATES 586971.816 N 1798084.508 E
AFTER DRILLING:

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0				ML		SILT, trace clay; brown 4.0 1710.6
5				CL		CLAY; dark gray mottled yellowish red 5.5 1709.1
				CL		CLAY; very dark brown 6.0 1708.6
				SP		SAND, fine; poorly sorted; very dark grayish brown 7.0 1707.6
				CL		CLAY; dark gray mottled with yellowish red 9.5 1705.1
10				CL-ML		SILTY CLAY, very soft; dark grayish brown 15.0 1699.6
15 20				ML		SILT, very soft; dark grayish brown 21.5 1693.1
				SC		CLAYEY SAND; dark grayish brown 22.0 1692.6
				CL		CLAY, very soft; olive brown 25.0 1689.6
25	SS	0	-	SC		CLAYEY SAND, wet; very dark grayish brown 25.5 1689.1
				SW		∇ SAND, well graded, with gravel; dark brown 27.0 1687.6
30				SW		SAND, fine to medium, well graded, wet; dark brown 30.0 1684.6

Casing Top Elev: 1717.302 (ft)
Casing Type: 2" Sch 40 PVC

WELL DIAGRAM



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AECOM

WELL NUMBER MW-2017-8

CLIENT Basin Electric

PROJECT NAME Lelands Olds Landfill - Pond 2

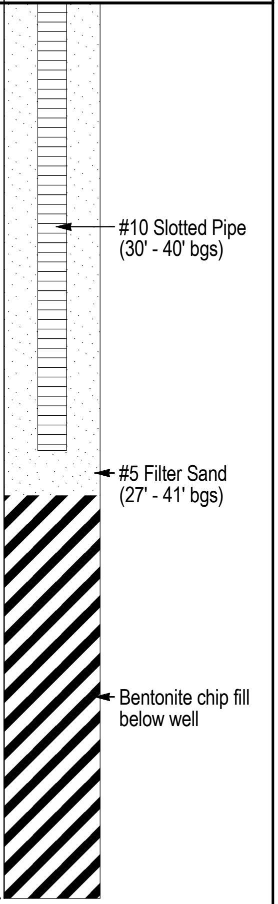
PROJECT NUMBER 60558359

PROJECT LOCATION Stanton, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
30							
30.3				GW		GRAVEL, oxidized; yellowish red (3")	1684.4
33.5				SW		SAND, fine to medium, well graded, wet; dark brown	1681.1
40.0				GW		GRAVEL, with fine to medium sand, well graded, wet	1674.6
43.0				SP		SAND, fine to medium, poorly graded, wet, trace silt	1671.6
47.0				SW		SAND, coarse, well graded	1667.6
49.5				SW		SAND, medium, trace fine sand and silt, well graded	1665.1
50.0				CL-ML		SILTY CLAY, very hard, crumbly; gray	1664.6

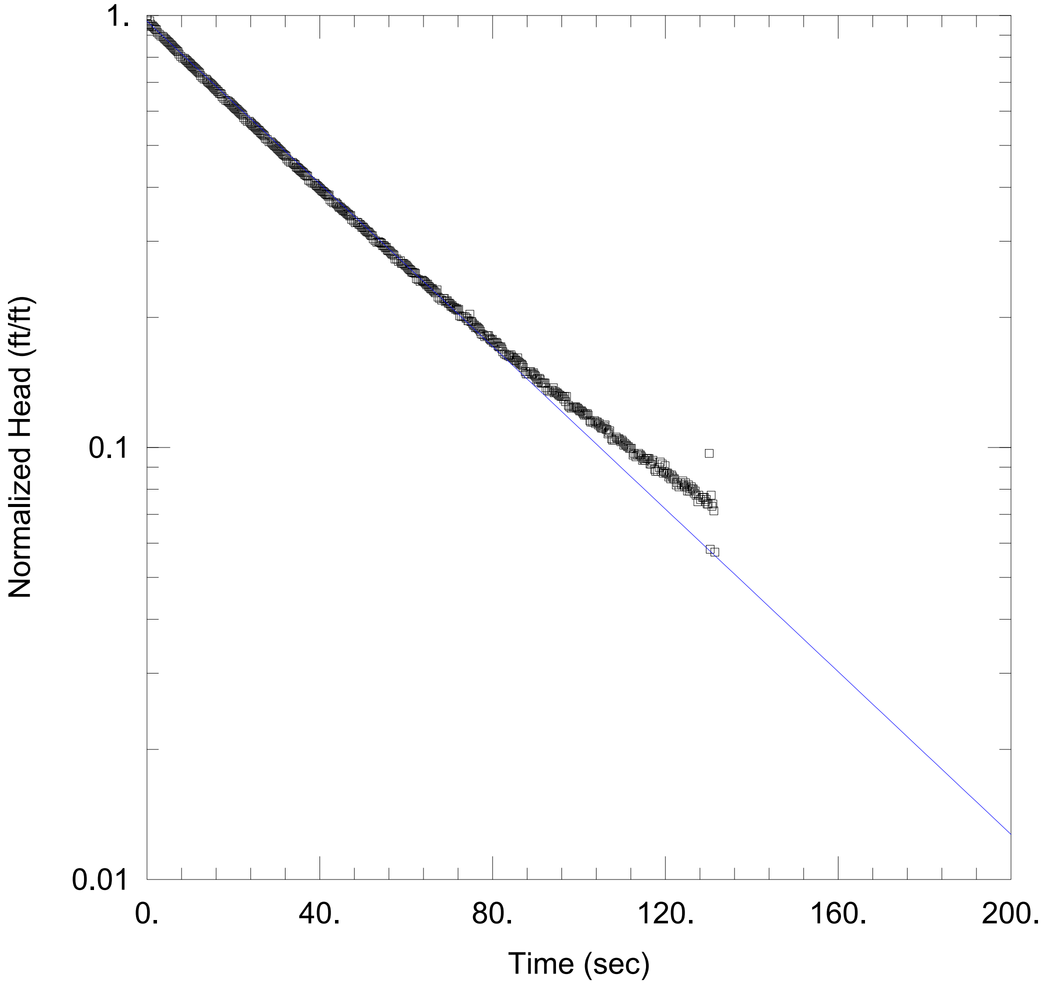
Bottom of borehole at 50.0 feet.

WELL DIAGRAM



Appendix B

Aquifer Test Procedures, Data and Analysis



WELL TEST ANALYSIS

Data Set: \...\MW-2017-3_F1.aqt
Date: 03/20/19 Time: 13:44:30

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: Lelands Olds Landfill - Pond 2
Location: Stanton, ND
Test Date: 11/8/2018

AQUIFER DATA

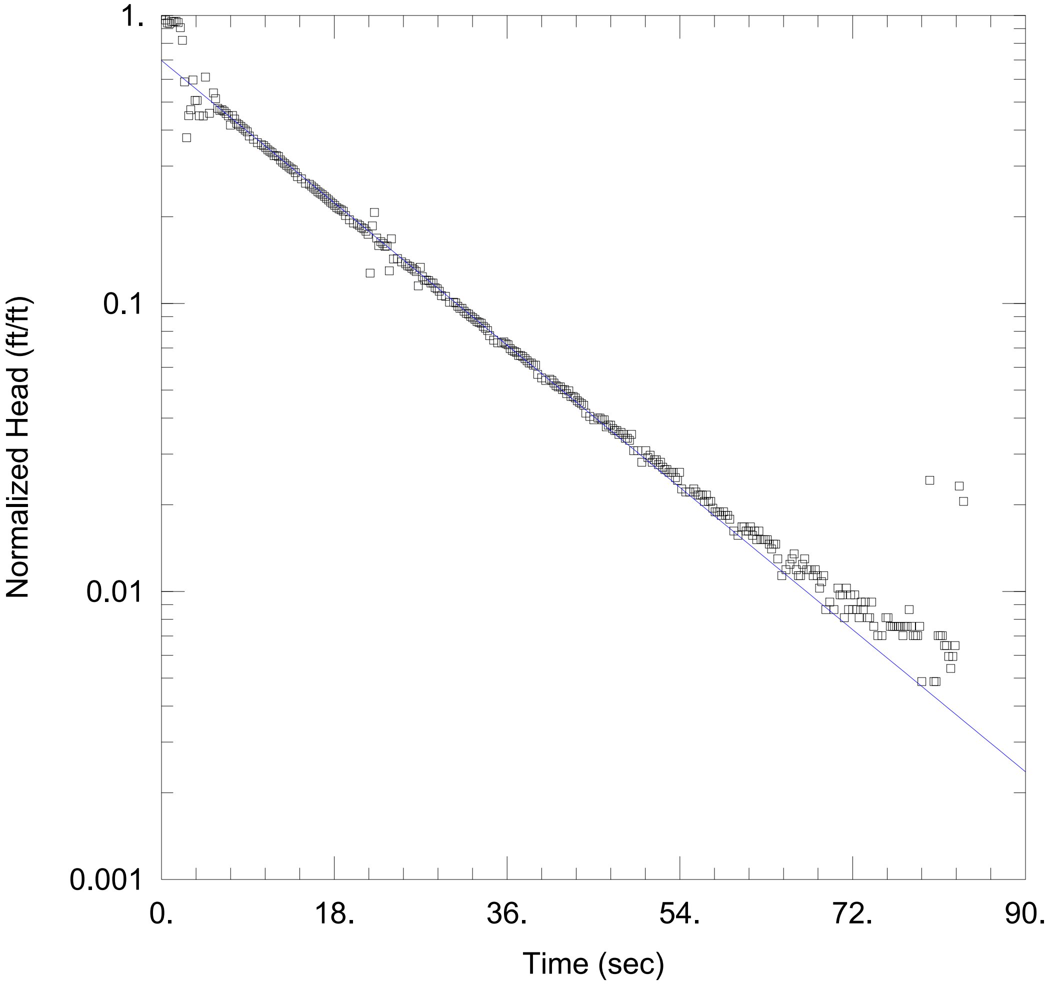
Saturated Thickness: 17. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-2017-3)

Initial Displacement: 1.136 ft
Static Water Column Height: 23.26 ft
Total Well Penetration Depth: 23.26 ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.3438 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.0006943 cm/sec
y0 = 1.101 ft



WELL TEST ANALYSIS

Data Set: \...\MW-2017-4_F1.aqt

Date: 03/20/19 Time: 13:52:28

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: Lelands Olds Landfill - Pond 2
Location: Stanton, ND
Test Date: 11/8/2018

AQUIFER DATA

Saturated Thickness: 18.5 ft Anisotropy Ratio (Kz/Kr): 1.

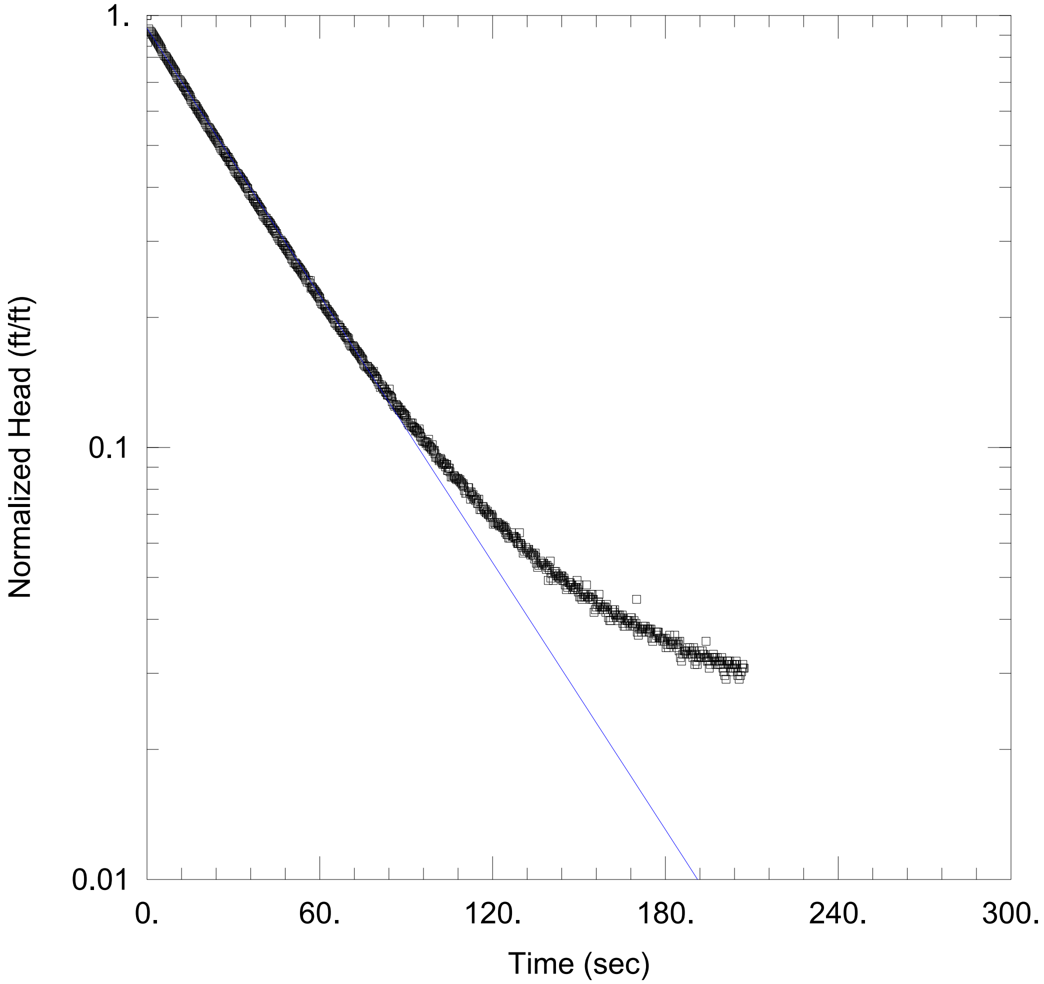
WELL DATA (MW-2017-4)

Initial Displacement: 1.851 ft
Static Water Column Height: 25.7 ft
Total Well Penetration Depth: 25.7 ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.3438 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.002062 cm/sec
y0 = 1.291 ft



WELL TEST ANALYSIS

Data Set: \...\MW-2017-5_F2.aqt

Date: 03/20/19 Time: 14:00:34

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: Lelands Olds Landfill - Pond 2
Location: Stanton, ND
Test Date: 11/8/2018

AQUIFER DATA

Saturated Thickness: 31. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-2017-5)

Initial Displacement: 1.686 ft
Total Well Penetration Depth: 32.57 ft
Casing Radius: 0.083 ft

Static Water Column Height: 32.55 ft
Screen Length: 10. ft
Well Radius: 0.3438 ft

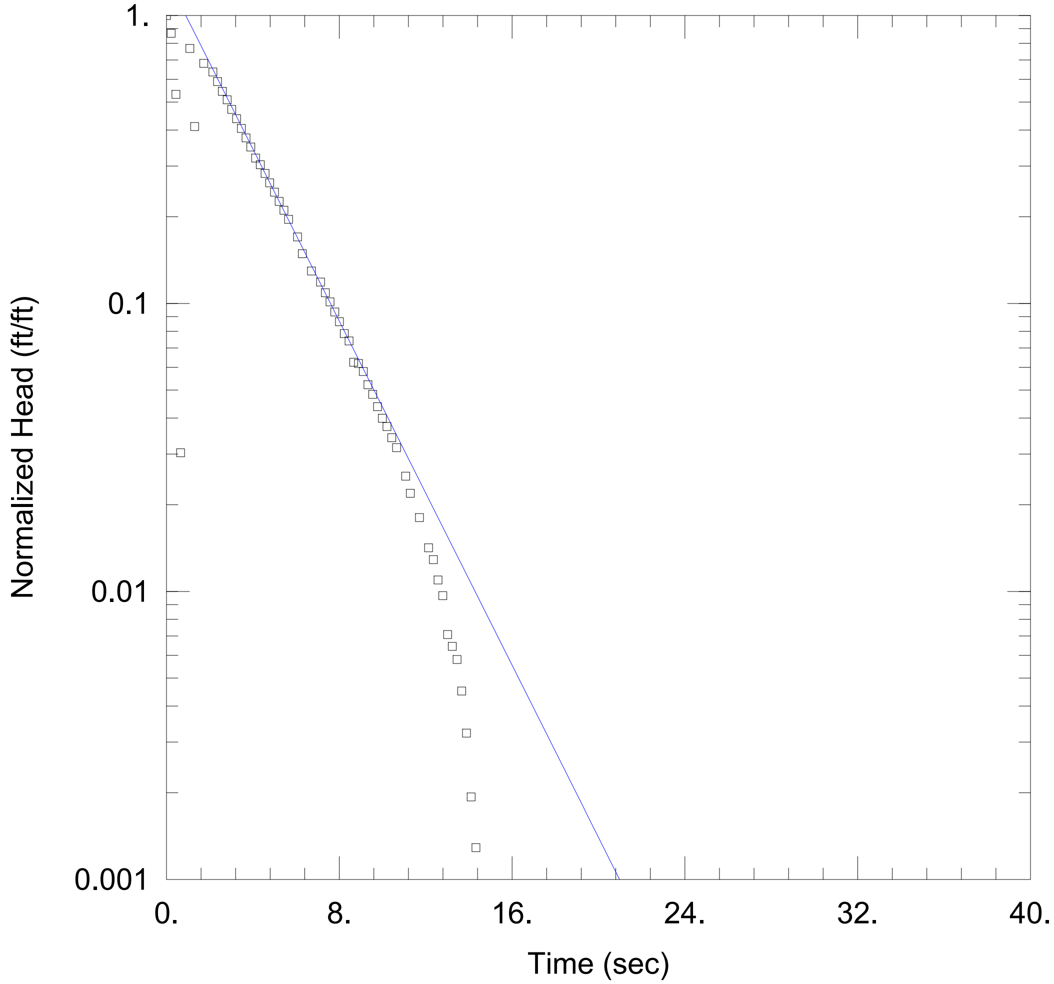
SOLUTION

Aquifer Model: Confined

Solution Method: Bouwer-Rice

K = 0.0008079 cm/sec

y0 = 1.574 ft



WELL TEST ANALYSIS

Data Set: C:\Users\marjory.fure\Desktop\Basin Electric\Output files\MW-2017-6_R2.aqt
Date: 03/13/19 Time: 10:25:46

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: Lelands Olds Landfill - Pond 2
Location: Stanton, ND
Test Date: 11/8/2018

AQUIFER DATA

Saturated Thickness: 20. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-2017-6)

Initial Displacement: -1.552 ft
Static Water Column Height: 33.32 ft
Total Well Penetration Depth: 33.32 ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.01279 cm/sec
y0 = -2.11 ft

AECOM
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Bismarck, ND 58503
aecom.com