



Groundwater Monitoring System Report

Slag Pond Area

Coyote Station

Beulah, North Dakota

Prepared for
Otter Tail Power Company

November 2016

Groundwater Monitoring System Report

Slag Pond Area
Coyote Station
Beulah, North Dakota

November 2016

Contents

| | | |
|---------|---|----|
| 1.0 | Introduction | 1 |
| 1.1 | Purpose | 1 |
| 1.2 | Scope of Work | 2 |
| 1.3 | Report Contents | 3 |
| 2.0 | Site Background | 4 |
| 2.1 | Coyote Station | 4 |
| 2.1.1 | Slag Pond Area History and Construction | 4 |
| 2.2 | Site Setting | 4 |
| 2.2.1 | Regional Geology | 4 |
| 2.2.2 | Regional Hydrogeology | 5 |
| 2.2.3 | Site Geology | 5 |
| 2.2.3.1 | Slag Pond Area | 6 |
| 2.2.4 | Site Hydrogeology | 6 |
| 2.2.4.1 | Slag Pond Area | 6 |
| 2.2.5 | Potential Groundwater Flow Receptors | 8 |
| 2.3 | Well Development | 8 |
| 3.0 | Conceptual Models | 10 |
| 3.1 | Slag Pond Area Site Conceptual Model | 10 |
| 3.2 | Release Conceptual Model | 10 |
| 3.2.1 | Release Conceptual Model for Slag Pond Area | 10 |
| 4.0 | CCR Groundwater Monitoring System | 11 |
| 5.0 | References | 13 |

List of Tables

| | | |
|---------|--|----|
| Table 1 | Slag Pond Area Slug Test Values | 7 |
| Table 2 | Slag Pond Area Laboratory Values (Coleharbor Formation)..... | 8 |
| Table 3 | Slag Pond Area Turbidity, Purge, and Recharge Field Measurements | 9 |
| Table 4 | Slag Pond Area Monitoring Well System Summary..... | 11 |
| Table 5 | Slag Pond Area CCR Monitoring Well Details | 12 |

List of Figures

| | |
|-----------|--|
| Figure 1 | Site Layout |
| Figure 2 | Slag Pond Area |
| Figure 3 | Surface Geology |
| Figure 4 | Well Hydrograph (Slag Pond Area) |
| Figure 5 | Groundwater Contours (Slag Pond Area) |
| Figure 6 | Cross-Section Locations (Slag Pond Area) |
| Figure 7 | Cross-Section A-A' (Slag Pond Area) |
| Figure 8 | Cross-Section B-B' (Slag Pond Area) |
| Figure 9 | Cross-Section C-C' (Slag Pond Area) |
| Figure 10 | Monitoring Well System (Slag Pond Area) |

List of Appendices

| | |
|------------|------------------------------|
| Appendix A | Boring Logs (Slag Pond) |
| Appendix B | Geotechnical Laboratory Data |
| Appendix C | Slug Test Results |

Certifications

I hereby certify that the monitoring system identified herein has been designed and constructed to meet the requirements of § 257.91, Groundwater monitoring systems, as included in 40 CFR Part 257, Subpart D, Disposal of Coal Combustion Residuals from Electric Utilities.

I hereby certify that this report was prepared by me or under my direct supervision, and that I am a duly registered Professional Engineer under the laws of the State of North Dakota.



Scott F. Korom, P.E.

PE #: 3835

November 15, 2016

Date



Scott F. Korom

2016.11.15 15:54:19 -06'00'

Acronyms

| Acronym | Description |
|----------------|---|
| bgs | Below Ground Surface |
| BMP | Below Measuring Point |
| B-Z | Beulah-Zap |
| CCR | Coal Combustion Residuals |
| EPA | Environmental Protection Agency |
| Facility | Coyote Station |
| FGD | Flue Gas Desulfurization |
| Lower B-Z | Lower Beulah-Zap lignite bed |
| NDAC | North Dakota Administrative Code |
| NTU | Nephelometric Turbidity Units |
| OTP | Otter Tail Power |
| SCM | Site Conceptual Model |
| Site | Ponds (Slag Pond, Sluice Outfall, and Nelsen Pond), landfills (Green Pit, Black Pit, and Blue Pit), and Plant |
| Slag Pond Area | Slag Pond, Sluice Outfall, Nelsen Pond, and surrounding area |
| TOR | Top of Riser |

1.0 Introduction

Otter Tail Power Company (OTP) owns and operates Coyote Station, a coal-fired generation unit in Beulah, North Dakota. The Site location is shown on Figure 1, which includes ponds (Slag Pond, Sluice Outfall, and Nelsen Pond) and landfills (Green Pit, Black Pit, Purple Pit, and Blue Pit).

The Slag Pond, Sluice Outfall, and Nelsen Pond are existing CCR surface impoundments and the Blue Pit is an existing CCR landfill at Coyote Station that are required to comply with the provisions of the US EPA Coal Combustion Residuals (CCR) Rule (40 CFR Parts 257 and 261 Disposal of Coal Combustion Residuals From Electric Utilities). The Green Pit, Purple Pit and Black Pit landfills are not regulated by the CCR Rule. The Blue Pit Area is discussed in a separate report.

The Slag Pond Area consists of the Slag Pond, Sluice Outfall, and Nelsen Pond and the area around the ponds in which the monitoring system is located. The Slag Pond Area is shown on Figure 2. The proposed monitoring well system is a Multiunit Groundwater Monitoring System, as allowed in §257.91 (d). It is not feasible to install a separate groundwater monitoring system for each CCR subunit.

This report has been prepared to document hydrogeologic and monitoring system information as required by the CCR Rule. It describes:

- July, August, and September 2016 field activities
- The site hydrogeology
- The CCR groundwater monitoring system meeting the requirements of the CCR Rule (40 CFR Part 257, US EPA, 2015) at Coyote Station (Facility)

1.1 Purpose

This document has been prepared to describe the groundwater monitoring system for the Coyote Station Slag Pond Area and how it has been designed to meet the requirements of the CCR Rule (Rule). Specific requirements for groundwater monitoring systems are established in § 257.91, "Groundwater monitoring systems," as follows:

(a) Performance standard. The owner or operator of a CCR unit must install a groundwater monitoring system that consists of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that:

(1) Accurately represent the quality of background groundwater that has not been affected by leakage from a CCR unit. A determination of background quality may include sampling of wells that are not hydraulically upgradient of the CCR management area where:

(i) Hydrogeologic conditions do not allow the owner or operator of the CCR unit to determine what wells are hydraulically upgradient; or

(ii) Sampling at other wells will provide an indication of background groundwater quality that is as representative or more representative than that provided by the upgradient wells; and

(2) Accurately represent the quality of groundwater passing the waste boundary of the CCR unit. The downgradient monitoring system must be installed at the waste boundary that ensures detection of groundwater contamination in the uppermost aquifer. All potential contaminant pathways must be monitored.

(b) The number, spacing, and depths of monitoring systems shall be determined based upon site-specific technical information that must include thorough characterization of:

(1) Aquifer thickness, groundwater flow rate, groundwater flow direction including seasonal and temporal fluctuations in groundwater flow; and

(2) Saturated and unsaturated geologic units and fill materials overlying the uppermost aquifer, materials comprising the uppermost aquifer, and materials comprising the confining unit defining the lower boundary of the uppermost aquifer, including, but not limited to, thicknesses, stratigraphy, lithology, hydraulic conductivities, porosities and effective porosities.

1.2 Scope of Work

The scope of work performed for this project includes:

- Collect and review existing information regarding each CCR unit to provide the information required by the Rule, with respect to the groundwater monitoring system.
- Establish and document the groundwater site conceptual model (SCM) that can be used to evaluate site data and design the monitoring system.
- Identify gaps in the existing data and perform additional field tasks to establish a monitoring system as required by the Rule.
- Observe field investigation consisting of the following subtasks:
 - Installation of monitoring well POND 16S at the Slag Pond
 - Develop monitoring wells proposed to become part of the CCR monitoring system
 - Collect geotechnical samples for analysis of parameters such as grain size analysis, vertical hydraulic conductivity, and horizontal hydraulic conductivity
 - Collect water level data to document groundwater flow directions
 - Perform slug tests on select wells to estimate horizontal hydraulic conductivity

1.3 Report Contents

Based on the requirements of the CCR Rule, this report contains:

- Section 1.0 Introduction (this section) which provides an overview.
- Section 2.0 Site Background which provides background information on the Site, including Site operations and setting, and geologic and hydrogeological information.
- Section 3.0 Conceptual Models provides a summary of the site conceptual model for the Slag Pond Area.
- Section 4.0 Groundwater Monitoring Well System which provides a description of the CCR monitoring system.
- Section 5.0 References.

2.0 Site Background

2.1 Coyote Station

Coyote Station (Facility; Figure 1) burns lignite coal to operate its 454-megawatt generating unit.

Boiler slag and economizer ash are sluiced into the Sluice Outfall (Figure 2). Some of the fines overflow with the sluice water to the Slag Pond. Boiler slag is removed from the Sluice Outfall and utilized beneficially in accordance with the CCR Rule or disposed of in the Blue Pit.

The Slag Pond fines are dredged once every two to three years. The dredged material is dewatered in Nelsen Pond. The water drains by gravity back into the Slag Pond system, while the solid portion remains in Nelsen Pond (Figure 2). After dewatering is complete, the solids are transported by mobile equipment and placed in the Blue Pit.

2.1.1 Slag Pond Area History and Construction

The Slag Pond, Sluice Outfall, and Nelsen Pond are CCR surface impoundments located at Coyote Station. The Slag Pond and Sluice Outfall were constructed shortly after the construction of the plant in 1981. Nelsen Pond was constructed in 1992.

2.2 Site Setting

The Site lies on a portion of the Missouri Plateau, which consists of rolling to hummocky terrain incised by the Knife River. The region has historically been mined for lignite coal. Because of past mining activities, most of the native soil and geologic materials within and adjacent to the Site have been exposed, mined, and/or reclaimed with mine soils and mixed overburden materials. The subsurface units around the Facility have remained largely intact. Information on the geology and hydrogeology surrounding the Site is summarized in the sections below.

2.2.1 Regional Geology

The surface geology underlying most of the Site is comprised of the Coleharbor and Sentinel Butte Formations. Mine spoils primarily consist of a mixture of these two units in varying quantities.

The uppermost and youngest deposits consist of late Pleistocene glacial till of the Coleharbor Formation. This formation was deposited over older formations and generally fills in pre-existing valleys and erosional channels. The Coleharbor Formation generally consists of an unbedded, unsorted mixture (till) of clay, silt, sand, pebbles, and a few cobbles and boulders, with a thickness up to 100 feet (Clayton, 1980). Sorted glaciofluvial sediments derived from meltwater are also part of the Coleharbor Formation.

The geological unit below the Coleharbor Formation is the Sentinel Butte Formation, which consists of brown to gray silt, sand, clay, sandstone, and lignite mixtures, along with river, lake, and swamp sediment with a thickness of up to 550 feet (Carlson, 1973). The Sentinel Butte Formation is subdivided into several intervals corresponding to associated lignite beds, which are separated by discontinuous low-permeability

silts, clays, and sand. The School House (upper-most lignite bed) and Beulah-Zap (B-Z) lignite bed are mined in the area. The Spaer and Hazen "B" lignite beds are lignite beds located below the B-Z lignite bed and are not mined in the area because they are too deep below the ground surface to mine economically.

2.2.2 Regional Hydrogeology

Groundwater results primarily from infiltration into the ground within topographically higher upland areas consisting of the geological strata described above. Regional groundwater flow is toward the Knife River located approximately one mile north of the Site.

2.2.3 Site Geology

Figure 3 shows the surface geology at the Site as mapped by the State of North Dakota 1:500,000 Geologic Map, (Clayton, 1980). Due to the scale of this map, the geologic contacts shown when enlarged to the Site scale are not accurate. However, the map does show the general geological context.

The Oahe Formation is shown to the northwest of the Site on Figure 3, but it is not believed to be in the vicinity of the Slag Pond Area and is not discussed further.

Coleharbor Formation

The Coleharbor Formation consists primarily of clay with a few laterally discontinuous lenses of silt, sand and gravel. A lens is defined in this report as a deposit that is thick in the middle and thins at the edges, but it may be truncated abruptly by erosion. In many cases, this formation has been stripped or partially removed as overburden above the mine deposits. The Coleharbor Formation is a continuous lithostratigraphic till unit, but it is divided into two separate hydrostratigraphic units for the purpose of this report as described below.

The Upper Coleharbor is the uppermost oxidized (weathered) clay till of the Coleharbor Formation.

The Lower Coleharbor is located below the Upper Coleharbor and is defined as typically less oxidized and grayer in color than the more oxidized Upper Coleharbor. The Lower Coleharbor is also less fractured and less permeable than the Upper Coleharbor, except where sand seams are present (Barr, 2013). The Lower Coleharbor may exhibit higher moisture content which may result in higher apparent plasticity (Barr, 2013).

Sentinel Butte Formation

As mentioned in Section 2.2.1, the Sentinel Butte Formation underlies the Coleharbor Formation. The Sentinel Butte Formation consists largely of gray consolidated clay (i.e. claystone) and some discontinuous low-permeability silts, clays, and sand. The formation is subdivided into several lignite intervals corresponding to associated lignite beds that are separated by claystone and discontinuous low-permeability silts, clays, and sand.

2.2.3.1 Slag Pond Area

Generally for the Slag Pond Area, the soil borings show that the shallow geology from 0 to approximately 30 feet below ground surface (bgs) consists of the Upper Coleharbor, followed by the Lower Coleharbor to a depth of up to 60 feet bgs, except near the southern end of the Slag Pond Area. The boring log for POND 16S shows the Lower Coleharbor is apparently not present near the southern end of the Slag Pond Area. Below these formations, generally greater than 60 feet bgs, lies the Sentinel Butte Formation.

Available soil boring logs and monitoring well completion logs for pre-existing monitoring wells shown on Figure 2 were provided by OTP. Appendix A includes the following information:

- Soil boring and monitoring well completion logs for monitoring system wells discussed in Section 4.0.
- Soil boring and well monitoring well completion log for POND 16S, which was installed in July 2016.
- Available soil logs and monitoring well completion logs used to create cross-sections presented in Section 3.0. There are no known soil boring or monitoring well completion logs for MW 1S/D, MW 2S/D, and MW 4S/D.

2.2.4 Site Hydrogeology

The movement of groundwater within the geologic formations mainly occurs within more permeable material (e.g., fractured lignite, sand or silty sand) within an otherwise fine-grained geologic media (e.g., claystone, clay till).

2.2.4.1 Slag Pond Area

The most conductive zones within the Upper Coleharbor underlying the Slag Pond Area are the saturated sand and silt seams. The groundwater is shallow and occurs at 10 to over 40 feet bgs in the Upper Coleharbor.

Groundwater Flow

Figure 4 shows the temporal groundwater elevations (hydrograph) for monitoring wells included in the monitoring well system, which is described in more detail in Section 4.0. There are currently limited groundwater elevation data for monitoring wells MW-2S and POND 16S because monitoring well MW-2S was not routinely monitored in the past and monitoring well POND 16S was installed recently (July 2016).

The site hydrogeology and upgradient vs. downgradient stratigraphic relationships are discussed in detail in the recent Hydrogeological Investigation Report (Barr, 2013).

Figure 5 shows the water table elevation contours on August 16, 2016. Based on the groundwater elevations, groundwater enters the CCR unit boundary north of Nelsen Pond, and flows radially southeast, toward the Slag Pond.

Hydraulic Conductivity and Laboratory Permeability

Table 1 summarizes the hydrogeological test results from the Slag Pond Area. Slug tests were performed at two monitoring wells (POND N3 and POND 16S) to provide estimates of horizontal hydraulic conductivity of the uppermost aquifer; values range from 1.6×10^{-4} to 2.8×10^{-5} cm/s based on single-well slug tests, with a geometric mean of 5.3×10^{-5} cm/s.

Table 1 Slag Pond Area Slug Test Values

| Well | Monitored Unit | Hydraulic Conductivity Slug-In (cm/s) | Hydraulic Conductivity Slug-Out (cm/s) |
|----------|---------------------------|---------------------------------------|--|
| POND N3 | Water Table, upgradient | 1.6×10^{-4} | 4.9×10^{-5} |
| POND 16S | Water Table, downgradient | 3.6×10^{-5} | 2.8×10^{-5} |

A slug test consists of monitoring the water-level recovery in a well following an “instantaneous” change in water level. For this work, displacement of the water level in the well was achieved by adding and removing a solid cylinder of PVC with a known volume. A slug test in which the displacement is initiated by rapidly lowering the slug below the water level is referred to as a slug-in or falling-head test; a slug-out or rising-head test is one in which the slug is rapidly removed. At least two slug tests—slug-in and slug-out—were performed sequentially at each well listed in Table 1. The resulting water-level recovery to static, pre-test conditions, was monitored using a data-logging pressure transducer (InSitu LevelTroll 700).

Hydraulic conductivity values were estimated using the AQTESOLV software package (Duffield, 2007) to match the Bouwer-Rice (1976) analytical solution against the water-level recovery data. Aquifer and well construction parameter values required for the analysis were obtained from the available boring logs and well-construction records.

Porosities of glacial outwash aquifers in the region range from 0.2 to 0.3 (Reppe et al, 2005). The assumed porosity of the Coleharbor Formation aquifer is 0.25.

The groundwater velocity is calculated using Darcy’s equation:

$$V_t = K * i/n = 0.01 \text{ ft/day or } 5 \text{ ft/year}$$

Where: V_t = average linear velocity

K = hydraulic conductivity (geometric mean = 5.3×10^{-5} cm/s)

i = gradient (N3 to POND 10 = 0.023; calculated from water levels)

n = effective porosity (0.25)

Confining Unit Characteristics

As mentioned above, the most conductive zones within the Upper Coleharbor underlying the Slag Pond Area are the saturated sand and silt seams. Below the Upper Coleharbor lies the Lower Coleharbor, as

mentioned in Section 2.2.3. A downward vertical gradient is apparent when comparing monitoring wells screened within the Upper Coleharbor and Lower Coleharbor. This phenomenon exists because the lower till is less weathered than the upper till, which limits the movement of water from the Upper Coleharbor to the Lower Coleharbor. Furthermore, the vertical hydraulic conductivity value for the Upper Coleharbor shown in Table 2 (Pond 16S), is also less than the values given in Table 1. Therefore, groundwater is expected to travel primarily in the horizontal direction within the Upper Coleharbor at an average velocity of 0.01 ft/day. Below the Upper and Lower Coleharbor is a confining layer consisting of the Sentinel Butte claystone. In the companion report for the Blue Pit Area, the hydraulic conductivity values for the Sentinel Butte claystone are on the order of 10^{-9} cm/s, which is much lower than the conductivity values for the Upper Coleharbor shown in Table 1 or Table 2.

Table 2 Slag Pond Area Laboratory Values (Coleharbor Formation)

| Boring/ Well | Depth (ft) | Sample Description | USCS | Test Type | Hydraulic Conductivity (cm/s) |
|--------------|------------|-----------------------|------|------------|-------------------------------|
| POND 16S | 35-40 | Silty Sand | SM | Grain Size | -- |
| POND 16S | 40-45 | Clayey Sand w/ Gravel | SC | Vertical | 3.4×10^{-6} |

Additional geotechnical laboratory data are available in Appendix B and additional details pertaining to the data analysis are included in Appendix C.

2.2.5 Potential Groundwater Flow Receptors

There are no known groundwater flow receptors (e.g., private water wells) within a 1-mile radius of the Slag Pond Area.

2.3 Well Development

Well development was completed to remove fines from the water column in the sand pack adjacent to the well screen and to improve formation permeability near the borehole that may have been influenced by drilling activities. Monitoring wells were surged several times initially by raising the pump up and down within the casing to settle the sand pack and collapse voids in the filter pack caused by bridging. Monitoring wells identified to be within the monitoring well system discussed in Section 4.0 were then developed by a combination of higher-rate pumping followed by lower-rate pumping without significant surging.

Volume of purge water removed, relative clarity and turbidity were measured at each well during development. Monitoring well development continued until the water from the well was relatively sediment free, appeared clear, and yielded consistent turbidity values. Table 3 provides the approximate lowest turbidity measurements, total volumes purged, and the approximate well recharge rates for each well developed.

Table 3 Slag Pond Area Turbidity, Purge, and Recharge Field Measurements

| Well ID | Lowest Obtained Turbidity Measurement (NTU) | Approx. Total Amount Volume Purged (gal) | Approx. Most Recent Recharge Rate (ft.) [date] |
|----------|---|--|--|
| POND N3 | 23 | 27 | 25 minutes to recharge 10 ft [7/13/16] |
| MW 2S | 13 | 7 | 25 minutes to recharge 4 ft [7/13/16] |
| POND 6 | 10 | 10 | 14 minutes to recharge 0.6 ft [7/14/16] |
| POND 10 | 77 | 4.0 | 30 minutes to recharge 2 ft [8/23/16] |
| POND 12 | 23 | 24.3 | 5 minutes to recharge 1 ft [7/14/16] |
| POND 16S | 5 | 33 | 5 minutes to recharge 1 ft [7/14/16] |

Table 3 also shows the approximate recharge rate measured by pumping the well dry and then measuring its recovery.

3.0 Conceptual Models

3.1 Slag Pond Area Site Conceptual Model

Cross section locations for the Slag Pond Area are shown on Figure 6 and include the location of cross section A-A', B-B', and C-C'. Cross section A-A' is shown on Figure 7; cross section B-B' is shown on Figure 8; and cross section C-C' is shown on Figure 9. The groundwater elevations shown on Figures 7 through 9 were collected on August 16, 2016. There are no soil boring or monitoring well completion logs for MW 1S/D, MW 2S/D, and MW 4S/D; therefore, the geological conditions shown around these wells on Figure 7, Figure 8, and Figure 9 were inferred from logs of other wells nearby.

In summary, Figure 7, Figure 8, and Figure 9 show the following features about the hydrogeology of the Slag Pond Area:

- Generally, the soil borings show that the shallow geology from 0 to approximately 30 feet below ground surface (bgs) consists of the Upper Coleharbor, followed by the Lower Coleharbor to a depth of up to 60 feet bgs, except near the southern end of the Slag Pond Area. The boring log for POND 16S shows the Lower Coleharbor is apparently not present near the southern end of the Slag Pond Area. Below these formations, generally greater than 60 feet bgs, lies the Sentinel Butte Formation.
- Several apparently discontinuous saturated sand and silt seams are present.
- Saturated conditions occur approximately 10 to 40 feet below the ground surface.
- Groundwater flow is from northwest to southeast.
- A downward vertical gradient is apparent when comparing monitoring wells screened within the Upper Coleharbor and Lower Coleharbor.

3.2 Release Conceptual Model

A release conceptual model uses the groundwater flow direction and geologic information of the site conceptual model to predict the likely pathway of a release from a CCR unit to groundwater would travel so that a monitoring system can be positioned properly to intercept it.

3.2.1 Release Conceptual Model for Slag Pond Area

A hypothetical release from Nelsen Pond, Sluice Outfall, or Slag Pond would likely be transported southeast, the downgradient direction of the water table shown on Figure 5. The downgradient wells discussed in the next section are positioned to ensure detection of any contaminants from such a release.

4.0 CCR Groundwater Monitoring System

Figure 10 shows and Table 4 describes the CCR groundwater monitoring system for the Slag Pond Area.

Table 4 Slag Pond Area Monitoring Well System Summary

| Well ID | Well Placement | Rationale |
|--|----------------|--|
| POND N3, *MW 2S | Upgradient | To account for geologic and hydrogeologic variability upgradient of the Slag Pond Area and to establish a sufficient number of upgradient monitoring wells at appropriate locations and depths to yield groundwater samples of the uppermost aquifer not impacted by the CCR unit (257.91(a) (1) and (2)). |
| POND 6, POND 10, POND 12, and POND 16S | Downgradient | To detect a release from the Slag Pond Area and to account for geologic and hydrogeologic variability and to establish sufficient number of downgradient monitoring wells at appropriate locations and depths to yield groundwater samples of the uppermost aquifer accurately representing the quality of groundwater passing through the waste boundary (257.91(a) (1) and (2)). |

*MW-2S is provisional.

As mentioned in Section 2.2.3.1, available soil boring logs and monitoring well completion logs for the monitoring well system are provided in Appendix A, except for monitoring well MW-2S. Monitoring well MW-2S has no known monitoring well log and is provisionally included in the monitoring well system until further water level data are available.

Based on our observations during sampling and well-development activities, the upgradient and downgradient monitoring wells included in the monitoring system will be able to provide representative groundwater samples. Based on the monitoring well completion logs available, each well has a casing that is screened; the annular space between the screen and borehole is filled with sand and the annular space above the sand pack is sealed. The downgradient wells listed in Table 4 are positioned to ensure detection of any contaminants from a hypothetical release in the Slag Pond Area.

In summary, the groundwater monitoring system identified in Table 4 and on Figure 10 is deemed to be adequate for groundwater monitoring under the CCR Rule requirements. Table 5 provides construction details of the CCR groundwater monitoring wells.

Table 5 Slag Pond Area CCR Monitoring Well Details

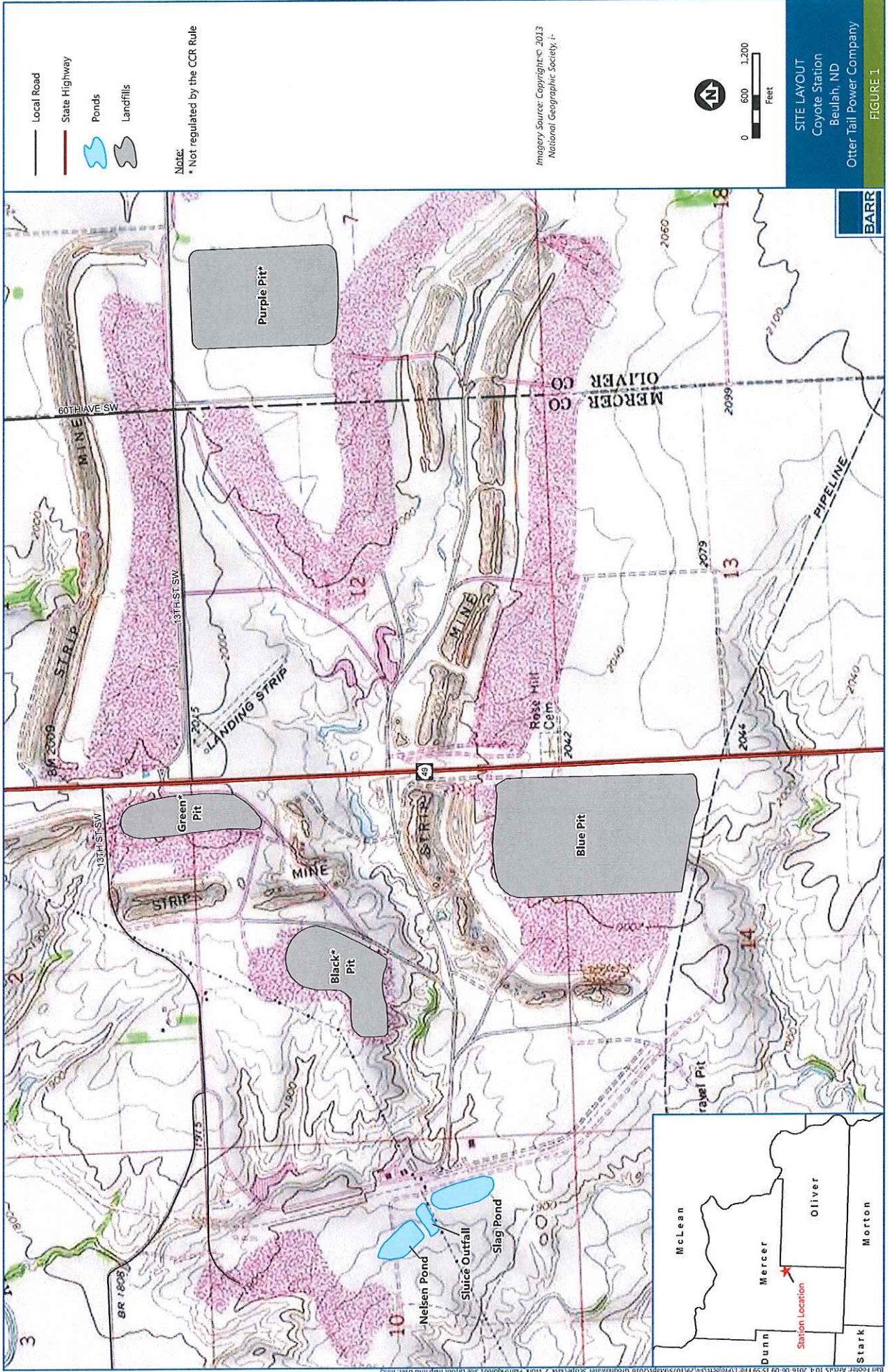
| Well | Installation Date | TOR (ft MSL) | Total Depth BMP (ft) | Screen Length (ft)/ Diameter (in) | Casing/Screen/Slot |
|----------|-------------------|--------------|----------------------|-----------------------------------|--------------------|
| POND N3 | 10/10/2001 | 1947.61 | 37.96 | 10/2.0 | PVC/PVC/#10 |
| MW-2S | NA | 1940.44 | 36.47 | NA/2.0 | PVC/PVC/NA |
| POND 6 | 2/24/1982 | 1911.11 | 23.81 | 10/2.0 | PVC/PVC/#10 |
| POND 10 | 11/17/2011 | 1911.33 | 23.3 | 10/2.0 | PVC/PVC/#10 |
| POND 12 | 5/14/2013 | 1921.57 | 39.1 | 10/2.0 | PVC/PVC/#10 |
| POND 16S | 7/8/2016 | 1924.95 | 48.64 | 10/2.0 | PVC/PVC/#8 |

NA = Not Available

5.0 References

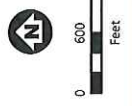
- Barr Engineering Co., 1983. Bottom Ash Pond Seepage Study. Coyote Station. Phase I Investigation. Prepared for Montana Dakota Utilities Company. July 1983.
- Barr Engineering Co., 2013. Hydrogeological Investigation Report Coyote Station Slag Pond Investigation. Prepared for Otter Tail Power, Submitted September 10, 2013.
- 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.
- Carlson, C.G., 1973. Geology of Mercer and Oliver Counties, North Dakota. North Dakota Geological Survey, Bulletin 56 – Part 1
- Clayton, 1980. North Dakota Geological Map
- Duffield, G.M., 2007. *AQTESOLV for Windows Version 4.5 User's Guide*, HydroSOLVE, Inc., Reston, VA.
- Freeze and Cherry, 1979. *Groundwater*. Englewood Cliffs, NJ, Prentice-Hall.
- EngTech. Inc, April 2009. Construction Drawings – Construction of Sequence No.7 and Partial Closure of Sequence Nos 4 & 5 Bismarck, ND.
- Rehm, B.W., G.H. Groenewold, and K.A. Morin, 1980. Hydraulic Properties of Coal and Related Materials, *Northern Great Plains, Ground Water*, vol. 18, no. 6, pp. 558-559.
- Reppe, T.H.C., Thompson, D.L., and Arntson, A.D., 2005. Ground-water availability assessment of surficial aquifers of the Red River of the North Basin, Minnesota; United States Geological Survey.
- US EPA, 2015. Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule, *Federal Register* vol. 80, no. 74

Figures



- Local Road
- State Highway
- Ponds
- Landfills

Note:
 * Not regulated by the CCR Rule

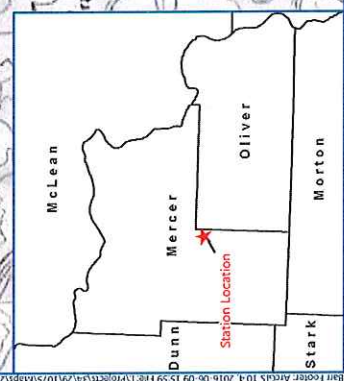


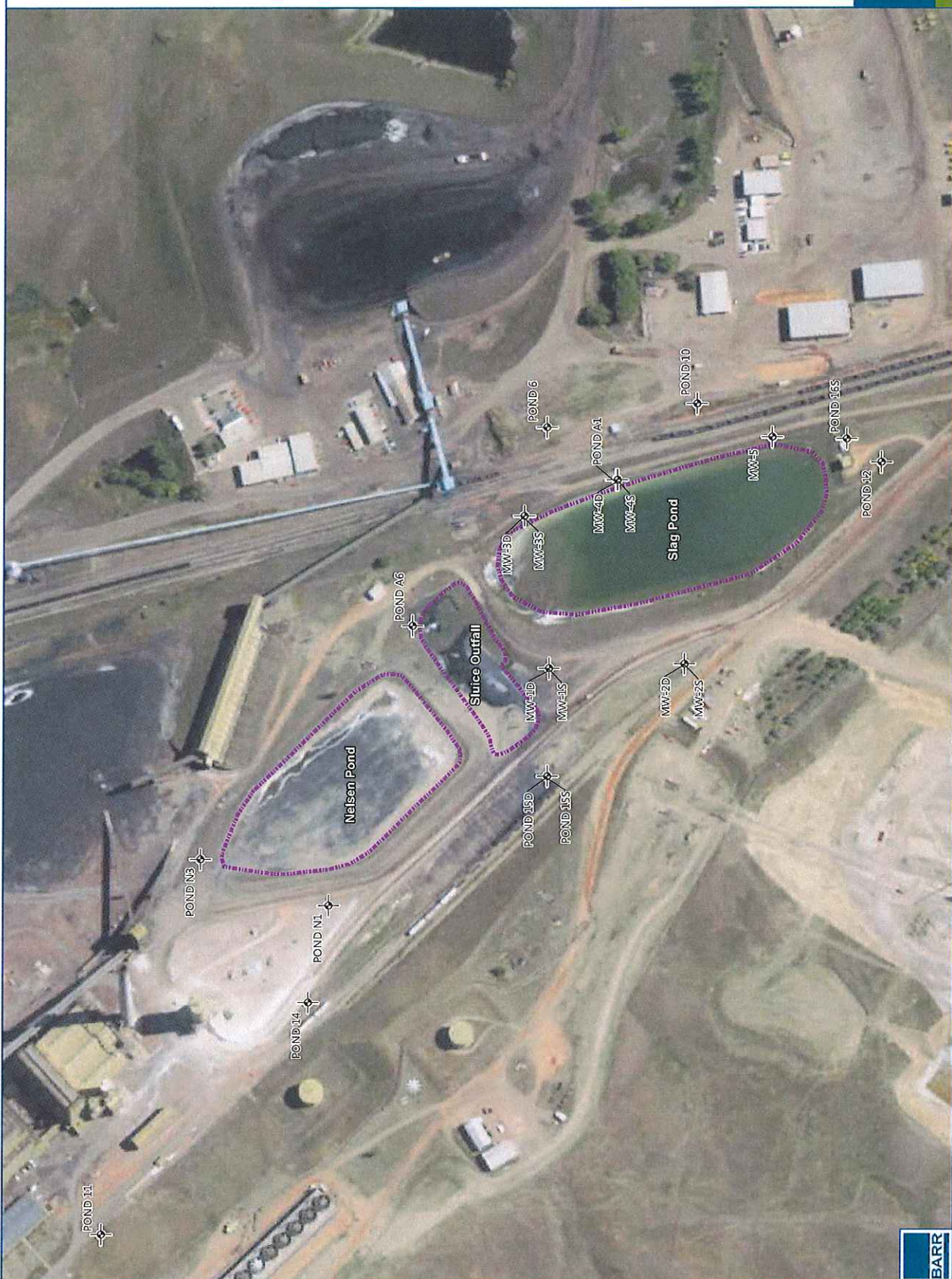
Imagery Source: Copyright © 2013
 National Geographic Society, Inc.

SITE LAYOUT
 Coyote Station
 Beulah, ND
 Otter Tail Power Company



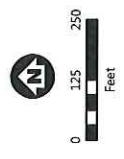
FIGURE 1





Monitoring Well Location
 Slag Pond Area

Imagery Source: USDA-FSA-AFPO
 NAIP 2015



SLAG POND AREA
 Coyote Station
 Beulah, ND
 Otter Tail Power Company

FIGURE 2

POND 11

POND N3

POND 14

POND N1

Nelsen Pond

POND A6

POND 15D

POND 15S

Sluice Outfall

MW-3D

MW-3S

POND 6

MW-4D

MW-4S

POND 10

MW-5

POND 16S

POND 12

MW-2D

MW-2S

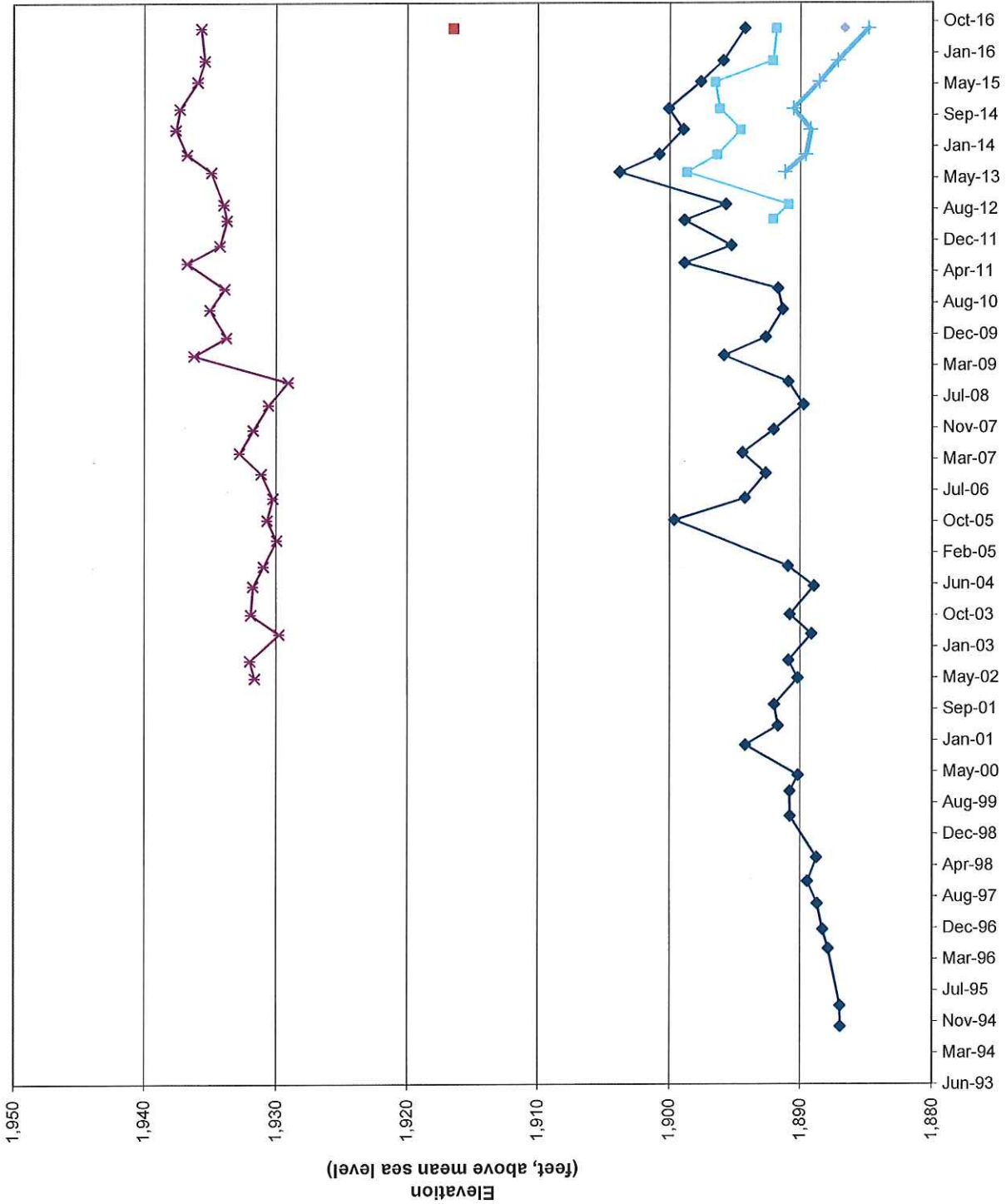




SURFACE GEOLOGY
 Coyote Station
 Beulah, ND
 Otter Tail Power Company

FIGURE 3



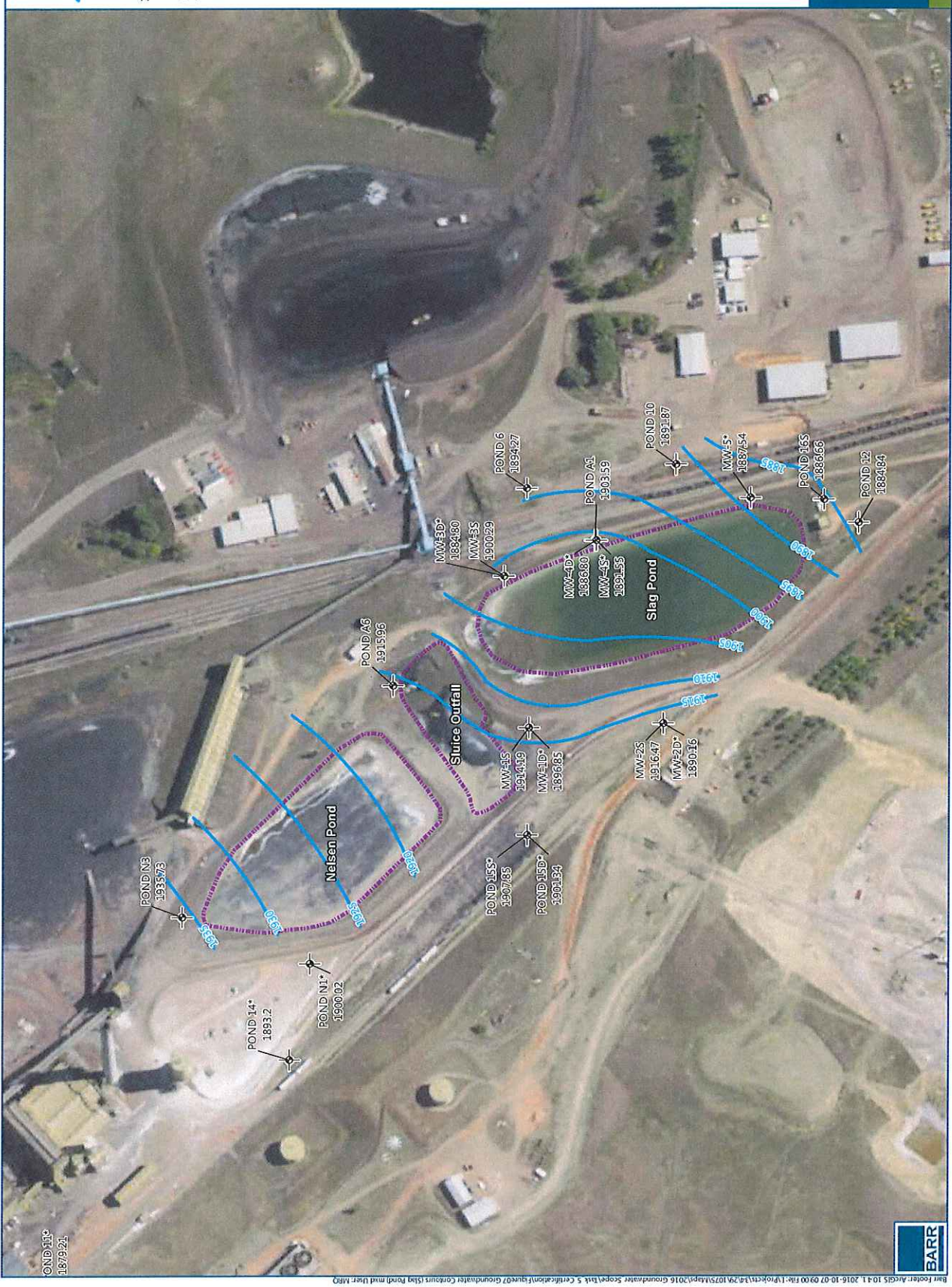


Note:
Monitoring Wells were resurveyed
in 2013. Water levels from June
2013 onward reflect this change.

- POND N3
- POND 6
- POND 10
- POND 12
- POND 16S
- MW-2S

WELL HYDROGRAPH (SLAG POND AREA)
Coyote Station
Beulah, ND
Otter Tail Power Company

FIGURE 4



- Monitoring Well Location
 - Groundwater Contour (ft MSL)
 - Slag Pond Area
 - Groundwater Elevation (ft. MSL)
 - 1105.12
- Note:
 * Monitoring wells not included in groundwater contouring

Imagery Source: USDA-FSA-AFPO
 NAIP 2015



GROUNDWATER CONTOURS
SLAG POND AREA
 August 16, 2016
 Coyote Station
 Beulah, ND
 Otter Tail Power Company
FIGURE 5

POND 11*
187921

POND 14*
18893.2

POND 11*
1900.02

POND 13*
183573

POND 15*
190735

POND 15B*
190134

POND 16*
191596

POND 6
189427

POND A1
190359

POND 10
189187

POND 16S
188665

POND 12
188484

MW 15D*
188430

MW 15S
190029

MW 10D*
188680

MW 10S*
189155

MW 15*
188754

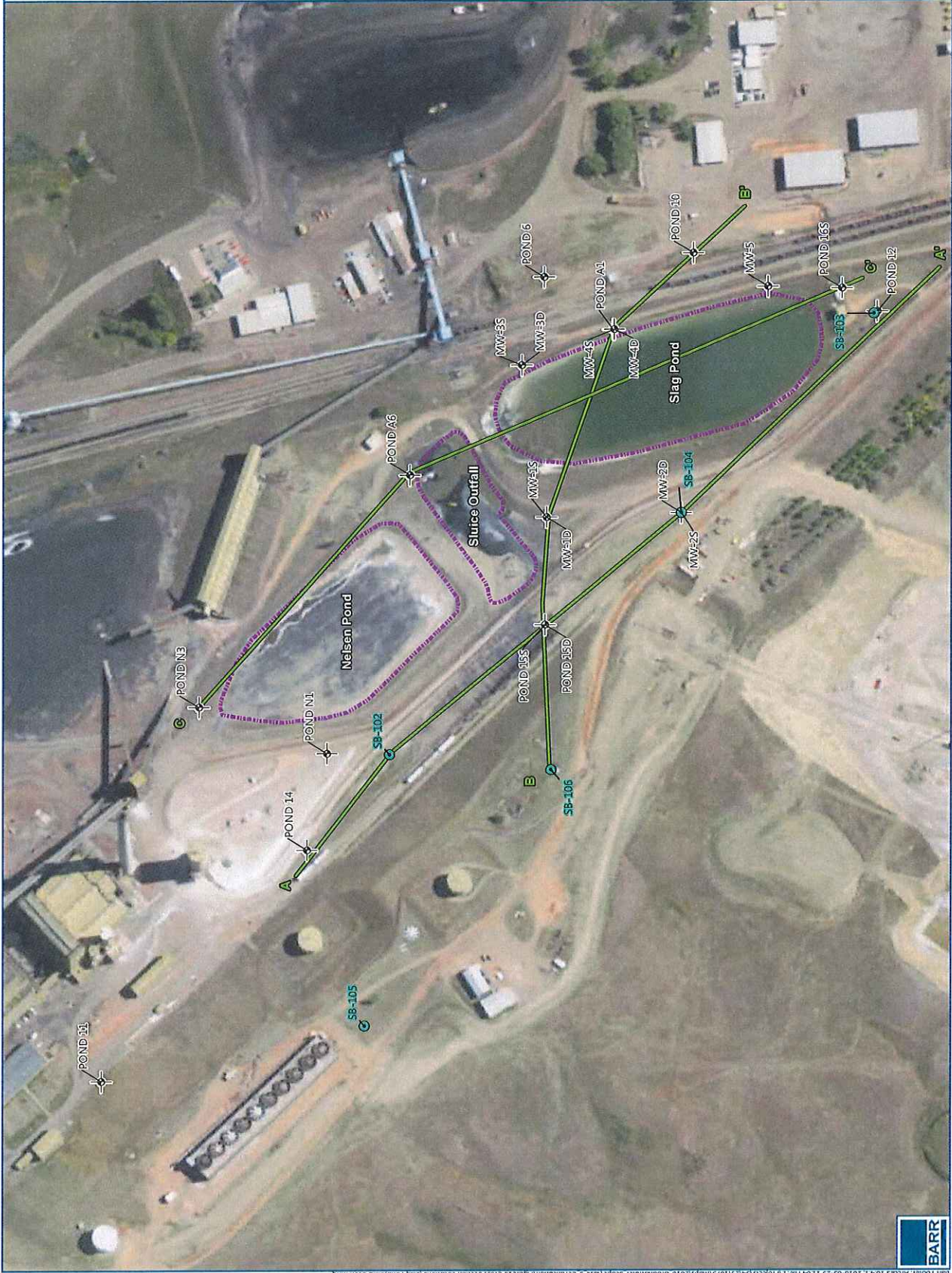
MW 15
191419

MW 10D*
189665

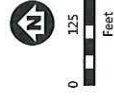
MW 2S
191647

MW 2D*
189016



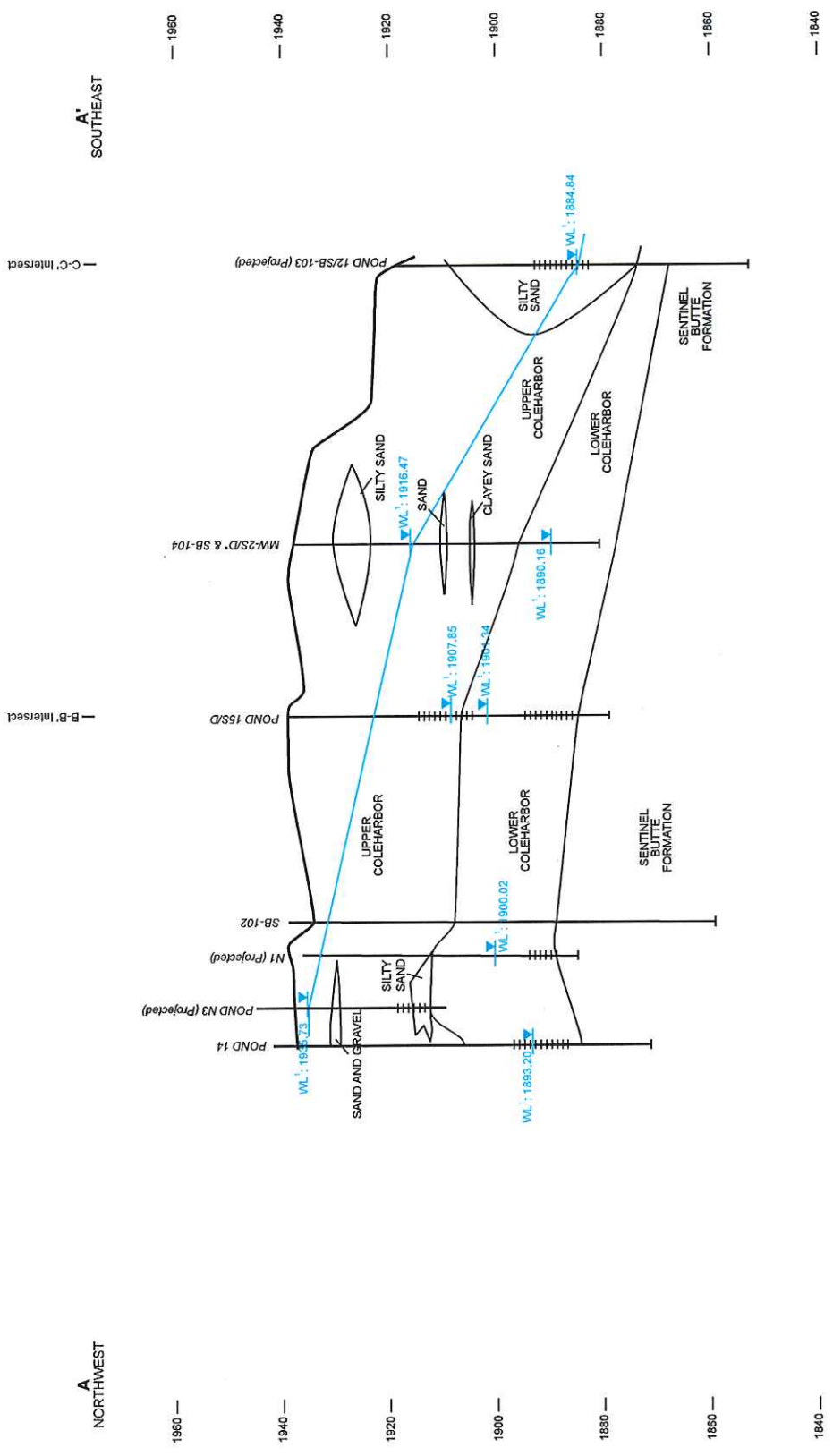


Imagery Source: USDA-FSA-AFPO
NAIP 2015



- Monitoring Well Location
- Soil Boring
- Cross Section Location
- Slag Pond Area

CROSS SECTION LOCATIONS
SLAG POND AREA
 Coyote Station
 Beulah, ND
 Otter Tail Power Company
FIGURE 6



- LEGEND**
- Geologic Contact
 - Inferred Geologic Contact
 - Approximate Water table
 - Monitoring Well Screen
 - Soil Boring/Piezometer

0 300
Approximate Horizontal Scale in Feet
15X Vertical Exaggeration

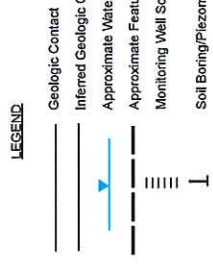
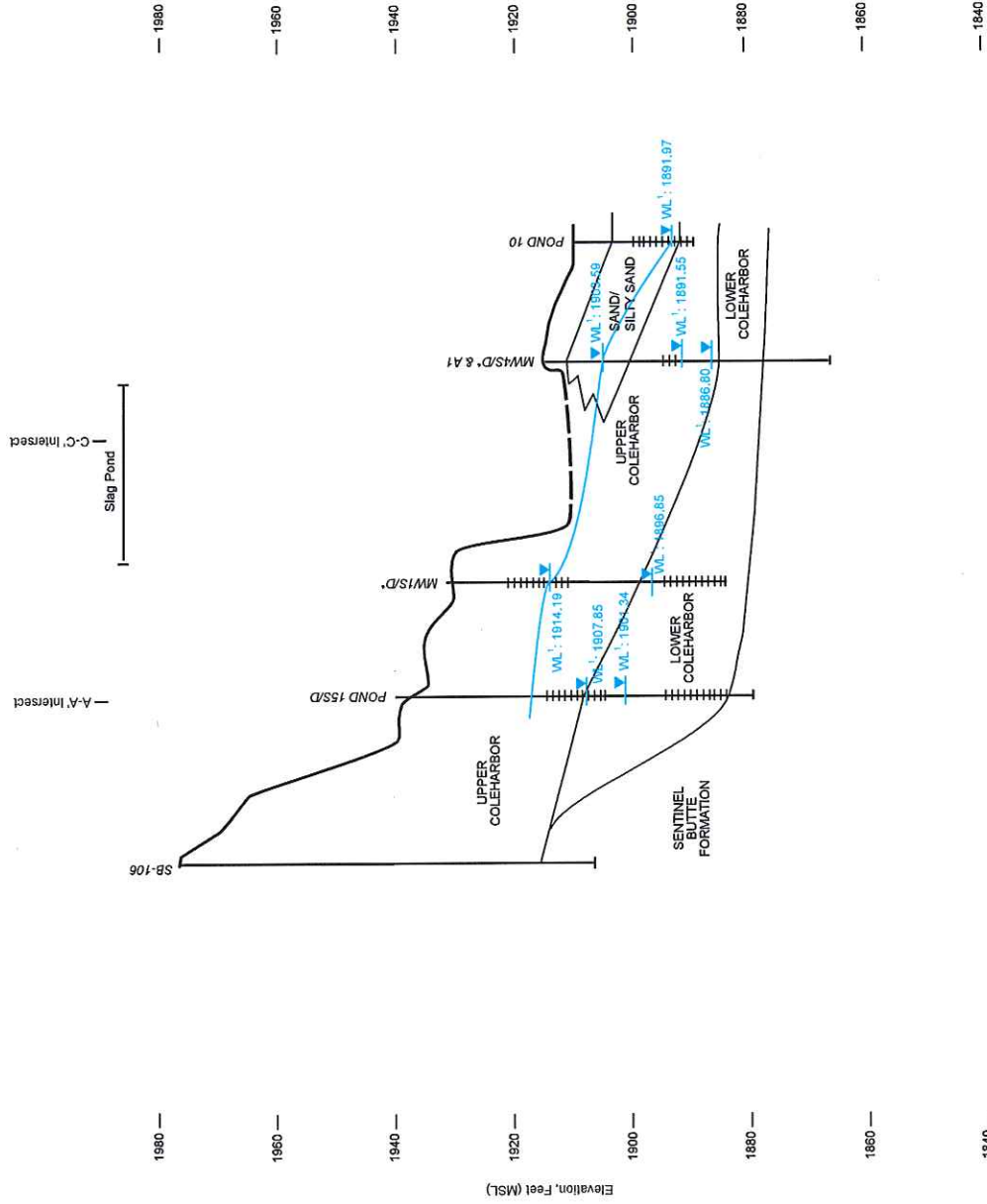
NOTES
1. WL = Groundwater elevation on August 16, 2016.
* no boring log and well construction data available for these locations



FIGURE 7
CROSS SECTION A-A'
(Slag Pond)
Coyote Station
Otter Tail Power Company
Beulah, North Dakota

B
WEST

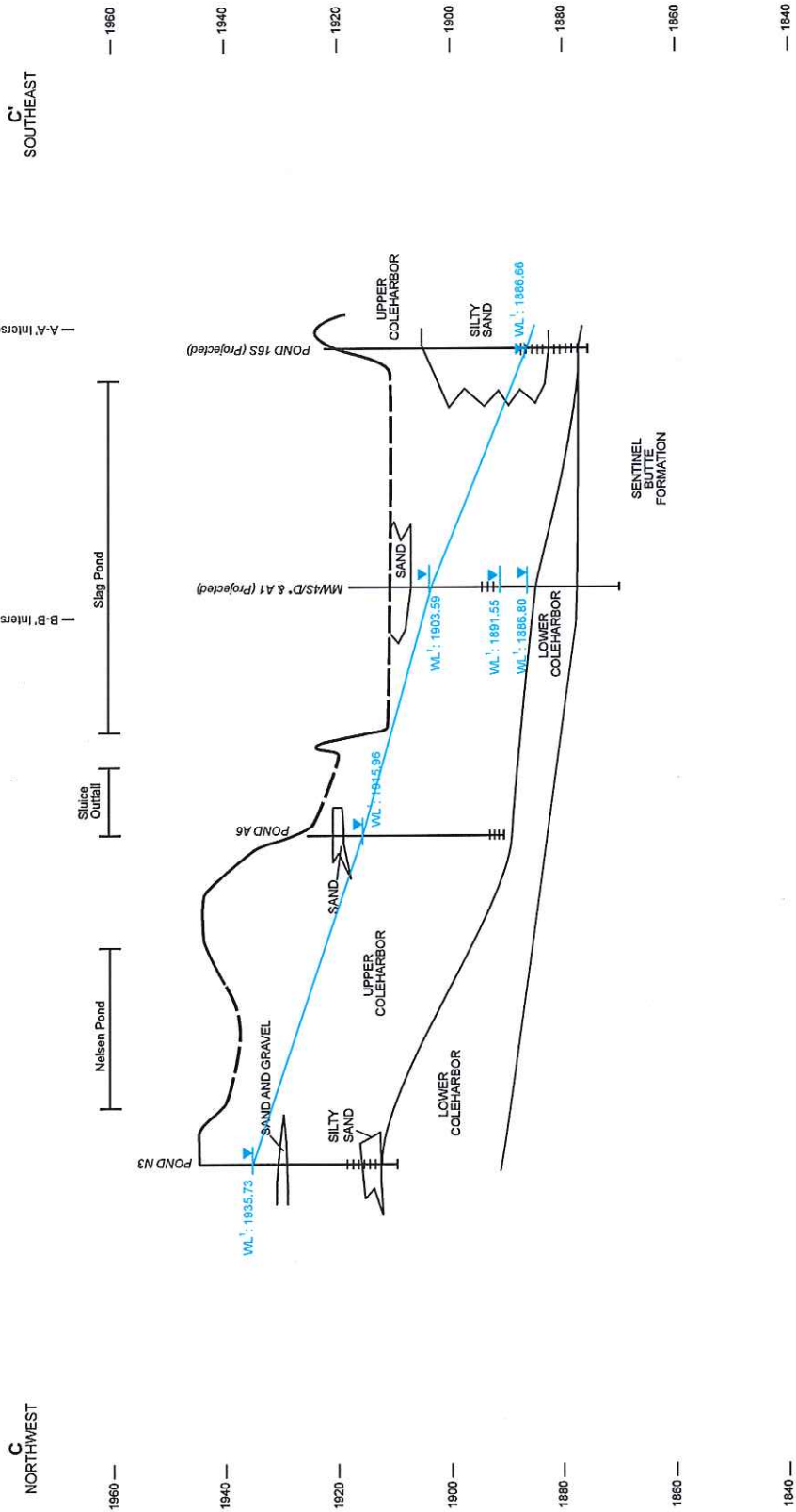
B'
EAST



NOTES

1. WL = Groundwater elevation on August 16, 2016.
2. Based on Coyote Station Topographic Survey conducted on 7/26/2016

² no boring log and well construction data available for these locations



LEGEND

- Geologic Contact
- Inferred Geologic Contact
- Approximate Water table
- Approximate Feature Surface²
- Monitoring Well Screen
- Soil Boring/Piezometer

0 300
 Approximate Horizontal Scales in Feet
 15X Vertical Exaggeration

NOTES

1. WL = Groundwater elevation on August 16, 2016.
2. Based on Coyote Station Topographic Survey conducted on 7/26/2016
 * no boring log and well construction data available for these locations

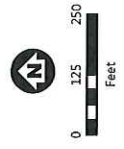


FIGURE 9
CROSS SECTION C-C'
 (Slag Pond)
 Coyote Station
 Otter Tail Power Company
 Beulah, North Dakota



Monitoring Well Location
 Slag Pond Area

Imagery Source: USDA-FSA-AFPO
 NAIP 2015



MONITORING WELL SYSTEM
 SLAG POND AREA
 Coyote Station
 Beulah, ND
 Otter Tail Power Company

FIGURE 10



Appendix A

Boring Logs (Slag Pond)

State of North Dakota
BOARD OF WATER WELL CONTRACTORS
 900 E. BOULEVARD * BISMARCK, NORTH DAKOTA 58505

MONITORING WELL REPORT

State law requires that this report be filed with the State Board of Water Well Contractors within 30 days after completion or abandonment of the well

1. WELL OWNER

Name Otter Tail Power, Coyote Sta.
 Address Box 496
Fergus Falls, MN 56538-0496

2. WELL LOCATION

Address (if in City) Nelsen's Pond, #N1
W of Pond at S end of loop road
143-088-10DBA

County Mercer

NE1/4 NW1/4 SE1/4 Sec. 10 Twp. 143N. Rge. 088W

Lat.: _____

Long.: _____

Altitude: MP=1937.74 & GL=1935.09

3. METHOD DRILLED

Auger Other at Direct Push TH

4. WELL CONSTRUCTION

Diameter of Hole 8 inches Depth 50 feet

Riser: PVC Other _____
 Threaded Solvent _____ Other _____

Riser rating SDR _____ Schedule 40

Diameter 2 inches
 From 2.65 ft. to 45 ft.

Was a well screen installed? Yes No

Material PVC Diameter 2 inches

Slot Size 10 set from 45 ft to 50 ft

Sand packed from 40 to 50

Depth grouted from 40 to Surface

Grouting material

Bentonite Grout & Chips Other _____

If other explain: _____

Well head completion:

24" above grade _____ Other _____

If other, specify 4" sq steel PC

Was protective casing installed? yes No

Was well disinfected upon completion? yes No

5. WATER LEVEL

Static water level 40.2 Feet below surface

if flowing: closed-in pressure _____ psi or

ft. above land surface _____

WSIKE/MWR04

6. WELL LOG

| Formation | Depth (Ft.) To |
|--|-------------------|
| Clay, silty to sandy w/pebbles & lignite chips, medium brown to gray, Till | 23.7 |
| Sand, silty, medium gray | 24 |
| Clay, silty w/pebbles, med gray | 45.8 |
| Sand, very fine, silty med gray | 47.1 |
| Sand, very fine, silty med gray w/dark laminations | 50 |

7. WAS THE HOLE PLUGGED OF ABANDONED?

Yes No

if so, how? _____

8. REMARKS 250# 20-40 silica sand pack to 40', 100# chips to 36', 200# high solids grout to 2', 180# concrete mix & 4" sq steel PC at surface

9. DATE COMPLETED 10/8/01

10. CONTRACTOR CERTIFICATION

This well was drilled under my jurisdiction and this report is true to the best of my knowledge

Water Supply, Inc. 96
 Monitoring Well Contractor Certificate No.
 Box 1191, Bismarck, ND 58501-1191
 Address

Signature _____ Date 10/10/01

LOG OF BORING SB-106

Client Otter Tail Power Company
 Project Name Coyote Slag Pond Investigation
 Project Number 34290018
 Location _____

Drill Contractor Braun
 Drill Method _____
 Drilling Started 5/16/13 Ended 5/16/13
 Logged By ARP2

SHEET 1 OF 2
 Surface Elevation 1976.0 ft
 Total Depth 72.0 ft

| DEPTH FEET | SAMP. LENGTH & RECOVERY | SAMP. NUMBER | Blows/6 in. | %GR/SA/ FINES | Color | Moisture | ASTM | LITHOLOGY | DESCRIPTION | ELEV. FEET |
|------------|-------------------------|--------------|-------------|---------------|----------|----------|------|--|-------------|------------|
| | | 1 | 3-7-7-7 | 0/60/40 | 10YR 3/3 | | | 0-0.5': TOPSOIL | | 1975 |
| | | 2 | 3-5-6-7 | | | | SM | 0.5-3.5': SILTY SAND with little CLAY: Dark brown, fine- to medium-grained sand. | | 1975 |
| 5 | | 3 | 3-4-5-5 | | | | | 3.5-50': SANDY CLAY with GRAVEL: Dark grayish brown. | | |
| | | 4 | 4-7-9-10 | 10/25/65 | 10YR 4/2 | | | White precipitate present | | 1970 |
| | | 5 | 4-7-8-11 | | | | | Rust discoloration | | |
| 10 | | 6 | 6-7-9-15 | | | | | Increasing lignite gravel (<10%) | | 1965 |
| | | 7 | 5-7-9-11 | | | | | | | |
| 15 | | 8 | 5-7-9-12 | | | | | | | |
| | | 9 | 4-6-7-8 | | | | | | | 1960 |
| | | 10 | 3-4-5-9 | | | | | | | |
| 20 | | 11 | 3-3-3-4 | 5/15/80 | 10YR 4/3 | | | Brown, decreasing sand and gravel | | 1955 |
| | | 12 | 4-5-7-10 | | | | SC | | | |
| 25 | | 13 | 4-7-9-10 | | | | | | | |
| | | 14 | 3-4-7-9 | | | | | | | 1950 |
| | | 15 | 4-6-8-10 | 10/15/75 | | | | Increasing gravel | | |
| 30 | | 16 | 4-4-5-5 | | | | | | | 1945 |
| | | 17 | 7-8-9-10 | | | | | | | |
| 35 | | | 6-7-11- | | | | | | | 1940 |

(continued)

ENVIRO LOG 5 (5/27/04) 34290018_COYOTE SLAG POND INVESTIGATION.GPJ BARR LIBR JAN06.GLB 9/12/13



Barr Engineering Co.
 4700 West 77th Street
 Minneapolis, MN 55435-4803
 Telephone: 952-832-2600
 Fax:

Remarks:

BGS = "below ground surface"
 Additional data may have been collected in the field which is not included on this log.

LOG OF BORING SB-106

Client Otter Tail Power Company
 Project Name Coyote Slag Pond Investigation
 Project Number 34290018
 Location _____

Drill Contractor Braun
 Drill Method _____
 Drilling Started 5/16/13 Ended 5/16/13
 Logged By ARP2

SHEET 2 OF 2
 Surface Elevation 1976.0 ft
 Total Depth 72.0 ft

| DEPTH FEET | SAMP. LENGTH & RECOVERY | SAMP. NUMBER | Blows/6 in. | %GR/SA/ FINES | Color | Moisture | ASTM | LITHOLOGY | DESCRIPTION | ELEV. FEET |
|------------|-------------------------|--------------|-------------|---------------|----------|----------|------|-----------|---|------------|
| 3.5-50' | | 18 | 14 | | | | | | SANDY CLAY with GRAVEL: Dark grayish brown. (continued) Large quartz clast at 40.5' bgs. | 1935 |
| 45 | | 19 | 4-7-11-13 | | | | SC | | | 1930 |
| 50 | | 20 | 4-7-8-17 | 0/0/100 | | | CL | | 50-51.5': CLAY | 1925 |
| | | | | 0/100/0 | | | SP | | 51.5-55': SAND: Fine- to medium-grained. | |
| 55 | | 21 | | 0/10/90 | 10YR 4/3 | | CL | | 55-61': CLAY with little SAND: Brown. | 1920 |
| 60 | | 22 | 8-18-33-47 | | | | CL | | Light gray/tan. | 1915 |
| | | | | | | | CL | | 61-65.5': CLAY/MUDSTONE: Dark gray. 0.5 inch lignite at 62' bgs. | |
| 65 | | 23 | 25-50/2"- | | | | CL | | 65.5-66': LIGNITE | 1910 |
| | | | | | | | CL | | 66-72': CLAY | |
| 70 | | 24 | 25-47-63- | | | | CL | | | 1905 |
| 75 | | | | | | | | | End of Boring - 72 feet | 1900 |

ENVIRO LOG 5 (5/27/04) 34290018_COYOTE SLAG POND INVESTIGATION.GPJ BARR LIBR JAN06.GLB 9/12/13

BARR Barr Engineering Co.
 4700 West 77th Street
 Minneapolis, MN 55435-4803
 Telephone: 952-832-2600
 Fax: _____

Remarks: _____

BGS = "below ground surface"
 Additional data may have been collected in the field which is not included on this log.

WATER SUPPLY, INC.

BOX 1191
BISMARCK, N.D. 58501

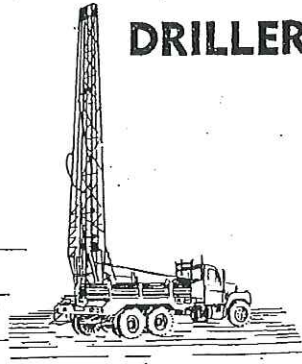
DRILLER'S LOG

State
Coordinates

| | | |
|--|--|--|
| | | |
| | | |
| | | |

sec. 10
Tp. 143
Rg. 88

N. _____
E. _____



Project: Coyote
State: North Dakota
County: Mercer

Hole No. A-1
Hole Elev. 1914.1

| Core Recovery (Thickness) | From | To | Sample Description | Comments |
|---------------------------|------|-----|---|----------|
| | 0 | 1.5 | Topsoil | |
| | 1.5 | 6 | Till, moderate yellowish brown, oxidized, clay thru pebbles | |
| | 6 | 12 | Sand, moderate yellowish brown, oxidized, fine to medium | |
| | 12 | 26 | Till, moderate yellowish brown, oxidized, clay thru pebbles | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

2" Well

| | | | | |
|-------------------------|----------------|-------------------|-----------|-------------|
| Footage Drilled w/Air | 503 Portadrill | Measuring Point | 1917.2 | (3.1 ALS) |
| Footage Drilled w/Water | 26 | Water Level | 1899.2 | (18.0 BMP) |
| Amount Water Used | | Screened Interval | 1888-1891 | (23-26 BLS) |

From _____ To _____ Hrs. _____ Date 24 Apr 83 Driller Knutson
Co. Rep. on Job _____ Title _____ Helpers: Reed & Schatz

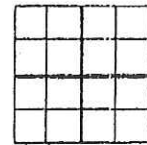
WATER SUPPLY, INC.

BOX 1191
BISMARCK, N.D. 58501

DRILLER'S LOG

State
Coordinates

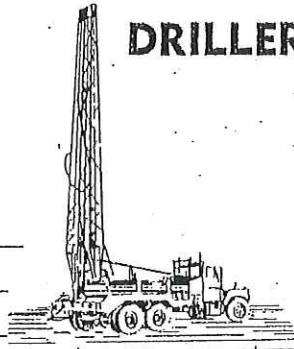
N. _____
E. _____



sec. 10
Tp. 143
Rg. 88

Project: Coyote
State: North Dakota
County: Mercer

Hole No. A-6
Hole Elev. 1924.2



| Core Recovery (Thickness) | From | To | Sample Description | Comments |
|---------------------------|------------|------------|--|---------------------------------------|
| <u>1</u> | <u>0</u> | <u>5</u> | <u>Fill</u> | |
| <u>1</u> | <u>5</u> | <u>7.5</u> | <u>Sand, oxidized, fine to medium, with organic material and roots</u> | |
| <u>10</u> | <u>7.5</u> | <u>35</u> | <u>Till, moderate yellowish brown, oxidized, clay thru pebbles</u> | |
| | | | | |
| | | | | |
| | | | | <u>Hole blown out at 28'</u> |
| | | | | <u>24.9' to water after 3 minutes</u> |
| | | | | <u>24.8 10</u> |
| | | | | <u>24.7 15</u> |
| | | | | <u>24.6 20</u> |
| | | | | <u>24.5 31</u> |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

2" Well

| | | |
|---------------------------------|--|--|
| <u>503 Portadrill</u> | | Measuring Point <u>1927.5</u> (3.3 ALS) |
| Footage Drilled w/Air <u>35</u> | | Water Level <u>1903.5</u> (24.0 BMP) |
| Footage Drilled w/Water _____ | | Screened Interval <u>1889.5-1892</u> (32.5-35 BLS) |
| Amount Water Used _____ | | |

| | |
|-----------------------------------|--|
| From _____ To _____ Hrs. _____ | Date <u>15 Apr 83</u> Driller <u>Knutson</u> |
| Co. Rep. on Job _____ Title _____ | Helpers: <u>Reed & Schatz</u> |

LOG OF BORING SB-102

Client Otter Tail Power Company

Drill Contractor Hansen

Project Name Coyote Slag Pond Investigation

Drill Method _____

SHEET 1 OF 2

Project Number 34290018

Drilling Started 11/15/11 Ended 11/16/11

Surface Elevation 1936.3 ft

Location _____

Logged By ARP2

Total Depth 77.0 ft

| DEPTH FEET | SAMP. LENGTH & RECOVERY | SAMP. NUMBER | %GR/SA/FINES | Color | Moisture | ASTM | LITHOLOGY | DESCRIPTION | ELEV. FEET |
|------------|-------------------------|--------------|--------------|----------------------|----------|------|-----------|---|------------|
| 0 | | 1 | 0/30/70 | 3/2 10YR | N | CL | | 0-1.5': SANDY CLAY, positive HCL reaction. | 1935 |
| 1.5 | | 2 | 15/20/65 | 4/3 10YR | N | | | 1.5-50': SANDY CLAY with GRAVEL, white/orange sub-rounded gravel, small black coal bits present. No HCL reaction. | 1930 |
| 5 | | 3 | 15/15/70 | 4/3 10YR | N | | | Less sand at 7' bgs. | 1925 |
| 10 | | 4 | | | | | | | 1920 |
| 15 | | 5 | 15/15/70 | 4/3 10YR | N | | | No HCL reaction at 14' bgs. | 1915 |
| 20 | | 6 | | | | | | | 1910 |
| 25 | | 7 | | 5/1 10YR | N | CL | | Gray mottled coloring present (30%) at 21' bgs, slight HCL reaction. | 1905 |
| 30 | | 9 | 15/15/70 | 4/3 10YR 5/1 10YR | N | | | Large gravel clast at 30' bgs. | 1900 |
| 35 | | 10 | 15/10/75 | 5/1 10YR | N | | | All gray and less sand at 35' bgs. | |

(continued)

ENVIRO LOG 5 (5/27/04) 34290018 COYOTE SLAG POND INVESTIGATION.GPJ BARR LIBR JAN06.GLB 9/12/13



Barr Engineering Co.
 4700 West 77th Street
 Minneapolis, MN 55435-4803
 Telephone: 952-832-2600
 Fax:

Remarks:

BGS = "below ground surface"
 Additional data may have been collected in the field which is not included on this log.

LOG OF BORING SB-102

Client Otter Tail Power Company
 Project Name Coyote Slag Pond Investigation
 Project Number 34290018
 Location _____

Drill Contractor Hansen
 Drill Method _____
 Drilling Started 11/15/11 Ended 11/16/11
 Logged By ARP2

SHEET 2 OF 2
 Surface Elevation 1936.3 ft
 Total Depth 77.0 ft

| DEPTH FEET | SAMP. LENGTH & RECOVERY | SAMP. NUMBER | %GR/SA/ FINES | Color | Moisture | ASTM | LITHOLOGY | DESCRIPTION | ELEV. FEET |
|------------|-------------------------|--------------|---------------|----------------------------------|----------|-------|-----------|---|------------|
| 45 | | 11 | 15/10/75 | 5/1 10YR | N | | | 1.5-50': SANDY CLAY with GRAVEL, white/orange sub-rounded gravel, small black coal bits present. No HCL reaction. <i>(continued)</i> Slight HCL reaction, larger gravel clasts (2-3 cm). | 1895 |
| 45 | | 12 | | | | CL | | 2-inch silty sand lens at 44.5' bgs. | 1890 |
| 50 | | 13 | 0/0/100 | | | | | 50-58.5': CLAY, no sand or gravel, stiff, gray. | 1885 |
| 55 | | 14 | | | | CL | | 2-inch silty sand lens at 56' bgs. | 1880 |
| 60 | | 15 | 0/0/100 | 7/3 10YR | N | | | 58.5-70': SILTY CLAY, same material, different colors, 10-20% silt, little cohesion, strong HCL reaction. | 1875 |
| 65 | | 16 | | 6/6 10YR 4/3 10YR 5/1 10YR | | CL-ML | | | 1870 |
| 70 | | 17 | 0/0/100 | 4/1 10YR | N | | | 70-77': SILTY CLAY, possibly bedrock/claystone, more cohesive, strong HCL reaction. | 1865 |
| 75 | | 18 | | | | CL-ML | | | 1860 |
| | | | | | | | | End of Boring - 77 feet | |

ENVIRO LOG 5 (5/27/04) 34290018_COYOTE SLAG POND INVESTIGATION.GPJ BARR LIBR JAN06.GLB 9/12/13



Barr Engineering Co.
 4700 West 77th Street
 Minneapolis, MN 55435-4803
 Telephone: 952-832-2600
 Fax:

Remarks:

BGS = "below ground surface"
 Additional data may have been collected in the field which is not included on this log.

LOG OF BORING SB-103

Client Otter Tail Power Company
 Project Name Coyote Slag Pond Investigation
 Project Number 34290018
 Location _____

Drill Contractor Hansen
 Drill Method _____
 Drilling Started 11/16/11 Ended 11/17/11
 Logged By ARP2

SHEET 1 OF 2
 Surface Elevation 1918.4 ft
 Total Depth 67.0 ft

| DEPTH FEET | SAMP. LENGTH & RECOVERY | SAMP. NUMBER | %GR/SA/ FINES | Color | Moisture | ASTM | LITHOLOGY | DESCRIPTION | ELEV. FEET |
|------------|-------------------------|--------------|---------------|-------------------------|----------|-------|---------------------|--|------------|
| 0 | | 1 | 0/35/65 | 3/2 10YR | N | CL-ML | [Diagonal Hatching] | 0-2.5': SANDY SILTY CLAY, little cohesion, fine- to medium-grained sand, no HCL reaction. | |
| 2.5 | | 2 | 10/10/80 | 6/4 10YR | N | CL | [Diagonal Hatching] | 2.5-3.5': SANDY CLAY with GRAVEL, white/tan sub-rounded gravel, no HCL reaction. | 1915 |
| 3.5 | | | 0/35/65 | 3/2 10YR | N | CL-ML | [Diagonal Hatching] | 3.5-5': SANDY SILTY CLAY, no HCL reaction. | |
| 5 | | | 10/10/80 | 6/4 10YR | N | CL | [Diagonal Hatching] | 5-6.5': SANDY CLAY with GRAVEL, no HCL reaction. | |
| 6.5 | | | 10/25/65 | 3/2 10YR | N | CL-ML | [Diagonal Hatching] | 6.5-10': SANDY SILTY CLAY with GRAVEL, white to tan sub-rounded small gravel, slight HCL reaction. | 1910 |
| 10 | | 4 | 0/85/15 | 6/4 10YR | N | | [Dotted Pattern] | 10-30': SILTY SAND. | |
| 15 | | 5 | | | | | | | 1905 |
| 20 | | 6 | 0/85/15 | 6/4 10YR (6/8 7.5YR) | N | SM | [Dotted Pattern] | Interbedded reddish coloration at 21' bgs, no HCL reaction. | 1900 |
| 25 | | 7 | | | | | | | 1895 |
| 30 | | 8 | | | | | | | 1890 |
| 30 | | 9 | 0/85/15 | | Y | | | 30-45': SILTY SAND, no HCL reaction, saturated. | |
| 35 | | 10 | | | | SM | [Dotted Pattern] | | 1885 |
| | | | | | | | | | 1880 |

(continued)

ENVIRO LOG 5 (5/27/04) 34290018 COYOTE SLAG POND INVESTIGATION.GPJ BARR LIBR JAN06.GLB 9/12/13



Barr Engineering Co.
 4700 West 77th Street
 Minneapolis, MN 55435-4803
 Telephone: 952-832-2600
 Fax:

Remarks:

BGS = "below ground surface"
 Additional data may have been collected in the field which is not included on this log.

LOG OF BORING SB-103

Client Otter Tail Power Company
 Project Name Coyote Slag Pond Investigation
 Project Number 34290018
 Location _____

Drill Contractor Hansen
 Drill Method _____
 Drilling Started 11/16/11 Ended 11/17/11
 Logged By ARP2

SHEET 2 OF 2
 Surface Elevation 1918.4 ft
 Total Depth 67.0 ft

| DEPTH FEET | SAMP. LENGTH & RECOVERY | SAMP. NUMBER | %GR/SA/ FINES | Color | Moisture | ASTM | LITHOLOGY | DESCRIPTION | ELEV. FEET |
|------------|-------------------------|--------------|---------------|----------|----------|------|-----------|---|------------|
| 45 | | 11 | 0/85/15 | 6/4 10YR | Y | SM | | 30-45': SILTY SAND, no HCL reaction, saturated. (continued) | 1875 |
| 45 | | 12 | | | | SM | | 45-51': SILTY SAND with GRAVEL, fine- to medium-grained sand, small sub-angular gravel. | 1870 |
| 50 | | 13 | 0/5/95 | 4/2 10YR | | CL | | 51-52': CLAY, little sand. | |
| 50 | | 14 | 0/60/40 | 4/2 10YR | Y | SC | | 52-54': CLAYEY SAND. | 1865 |
| 55 | | 15 | 0/0/100 | 4/2 10YR | | CL | | 54-62': CLAY, no visible sand or gravel, no HCL reaction. | 1860 |
| 60 | | 16 | 0/0/100 | 5/1 10YR | Y | SC | | 62-64': CLAYEY SAND, saturated. | 1855 |
| 65 | | 17 | 0/60/40 | 5/1 10YR | Y | CL | | 64-67': CLAY. | 1850 |
| 65 | | 18 | 0/0/100 | 5/1 10YR | Y | CL | | End of Boring - 67 feet | 1845 |
| 70 | | | | | | | | | 1840 |

ENVIRO LOG 5 (5/27/04) 34290018_COYOTE SLAG POND INVESTIGATION.GPJ BARR_LIBR JAN06.GLB 9/12/13

Barr Engineering Co.
 4700 West 77th Street
 Minneapolis, MN 55435-4803
 Telephone: 952-832-2600
 Fax:

Remarks:

BGS = "below ground surface"
 Additional data may have been collected in the field which is not included on this log.

LOG OF BORING SB-104

Client Otter Tail Power Company
 Project Name Coyote Slag Pond Investigation
 Project Number 34290018
 Location _____

Drill Contractor Hansen
 Drill Method _____
 Drilling Started 11/18/11 Ended 11/18/11
 Logged By ARP2

SHEET 1 OF 2
 Surface Elevation 1938.3 ft
 Total Depth 49.0 ft

| DEPTH FEET | SAMP. LENGTH & RECOVERY | SAMP. NUMBER | %GR/SA/ FINES | Color | Moisture | ASTM | LITHOLOGY | DESCRIPTION | ELEV. FEET |
|------------|-------------------------|--------------|---------------|----------|----------|-------|-----------|--|------------|
| 0 | | 1 | 10/20/70 | 4/2 10YR | N | CL-ML | | 0-7': SANDY SILTY CLAY with GRAVEL, small sub-rounded gravel, white to orange small bits of coal (0.5-1cm) visible from 0-2' bgs, positive HCL reaction. | 1935 |
| 5 | | 2 | | 5/4 10YR | | | | | |
| 6.5 | | 3 | 0/85/15 | 4/4 10YR | N | | | 2-inch medium-grained sand lens at 6.5' bgs. | |
| 7 | | 3 | | | | | | 7-16.5': SILTY SAND, fine- to medium-grained, no HCL reaction from 7-12' bgs. | 1930 |
| 10 | | 4 | | | | SM | | Positive HCL reaction from 12-14' bgs. | 1925 |
| 15 | | 5 | 0/80/20 | 4/4 10YR | N | | | 15.5-16.5': some clay (10%), positive HCL reaction. | |
| 16 | | 5 | 10/15/75 | 5/4 10YR | N | | | 16.5-28': SANDY CLAY with GRAVEL, small sub-angular white to orange gravel, slight HCL reaction, small bits of coal (<0.5 cm) present throughout. | 1920 |
| 20 | | 6 | | | | | | | |
| 21 | | 7 | 10/15/75 | 5/4 10YR | N | CL | | Small sub-angular orange and red gravel and gray mottling throughout 21-28' bgs, no HCL reaction. | 1915 |
| 25 | | 8 | | | | | | | |
| 28 | | 9 | 0/100/0 | 2/4 10YR | Y | SP | | 28-28.5': SAND, fine- to medium-grained, saturated. | 1910 |
| 28.5 | | 9 | 10/15/75 | 5/4 10YR | N | CL | | 28.5-30': SANDY CLAY with GRAVEL, Small sub-angular orange and red gravel and gray mottling throughout, no HCL reaction. | |
| 30 | | 9 | 0/80/20 | 6/4 10YR | Y | SC | | 30-31.5': CLAYEY SAND. | |
| 31.5 | | 10 | 20/10/70 | 5/4 10YR | NY | | | 31.5-49': SANDY CLAY with GRAVEL, more gravel, more/larger bits of coal, no gray present, no HCL reaction. | 1905 |
| 35 | | 10 | | | | | | | |
| 35 | | 11 | 20/10/70 | 5/4 10YR | NY | CL | | More gray mottling present (50%) and larger gravel (1-2cm) from 35-42' bgs, no HCL reaction. | 1900 |
| 35 | | 11 | | | | | | | |
| 35 | | 12 | | | | | | | |

(continued)

ENVIRO LOG 5 (5/27/04) 34290018_COYOTE SLAG POND INVESTIGATION.GPJ BARR LIBR JAN06.GLB 9/12/13

Barr Engineering Co.
 4700 West 77th Street
 Minneapolis, MN 55435-4803
 Telephone: 952-832-2600
 Fax:

Remarks:

BGS = "below ground surface"
 Additional data may have been collected in the field which is not included on this log.

LOG OF BORING SB-104

Client Otter Tail Power Company

Drill Contractor Hansen

Project Name Coyote Slag Pond Investigation

Drill Method _____

SHEET 2 OF 2

Project Number 34290018

Drilling Started 11/18/11 Ended 11/18/11

Surface Elevation 1938.3 ft

Location _____

Logged By ARP2

Total Depth 49.0 ft

| DEPTH FEET | SAMP. LENGTH & RECOVERY | SAMP. NUMBER | %GR/SA/FINES | Color | Moisture | ASTM | LITHOLOGY | DESCRIPTION | ELEV. FEET |
|------------|-------------------------|--------------|--------------|----------|----------|------|-----------|---|------------|
| 45 | | 13 | 15/15/70 | 4/1 10YR | N | CL | | 31.5-49': SANDY CLAY with GRAVEL, more gravel, more/larger bits of coal, no gray present, no HCL reaction.(continued) Whitish sub-angular small to medium sized gravel from 42-49' bgs, small bits of coal present throughout. | 1895 |
| 49 | | 14 | | | | | | End of Boring - 49 feet | 1890 |
| 50 | | | | | | | | | 1885 |
| 55 | | | | | | | | | 1880 |
| 60 | | | | | | | | | 1875 |
| 65 | | | | | | | | | 1870 |
| 70 | | | | | | | | | 1865 |
| 75 | | | | | | | | | 1860 |

ENVIRO LOG 5 (15/27/04) 34290018_COYOTE SLAG POND INVESTIGATION.GPJ BARR.LIBR.JAN06.GLB 9/12/13



Barr Engineering Co.
4700 West 77th Street
Minneapolis, MN 55435-4803
Telephone: 952-832-2600
Fax:

Remarks:

BGS = "below ground surface"
Additional data may have been collected in the field which is not included on this log.

LOG OF BORING Pond 14

Client Otter Tail Power Company
 Project Name Coyote Slag Pond Investigation
 Project Number 34290018
 Location _____

Drill Contractor Braun
 Drill Method _____
 Drilling Started 5/17/13 Ended 5/17/13
 Logged By ARP2

SHEET 1 OF 2
 Surface Elevation 1939.0 ft
 Total Depth 72.0 ft

| DEPTH FEET | SAMP. LENGTH & RECOVERY | SAMP. NUMBER | Blows/6 in. | %GR/SA/ FINES | Color | Moisture | ASTM | LITHOLOGY | DESCRIPTION | ELEV. FEET |
|------------|-------------------------|--------------|-------------|---------------|----------|----------|------|--|-------------|------------|
| 0 | | | 2-3-3-4 | 10/10/80 | 10YR 4/3 | | | 0-1': TOPSOIL | | |
| 1 | | 1 | 3-3-4-4 | | | | | 1-6': SANDY CLAY with GRAVEL: Brown, gravel is small, yellow/white, and sub-angular. | | 1935 |
| 2 | | 2 | 3-4-4-5 | | | N | SC | | | |
| 3 | | 3 | 1- | | | Y | | From 6 to 8 feet bgs, possible lens of fine- to medium-grained sand, moist, poor recovery. (Second run found no sand.) | | |
| 4 | | 4 | 2-5-7-1 | 20/70/10 | | Y | | | | |
| 5 | | 5 | 3-8-12-15 | 10/10/80 | 10YR 4/2 | | SP | 8-10': SAND and GRAVEL: Fine- to medium-grained sand and gravel, orange/white more rounded gravel. | | 1930 |
| 6 | | 6 | 4-7-9-10 | | | N | | 10-20': SANDY CLAY with GRAVEL: Dark grayish brown. More lignite at 11' bgs. | | |
| 7 | | 7 | 4-7-12-13 | | | | | 3 inch sand and gravel lens, very moist at 12.5' bgs. | | 1925 |
| 8 | | 8 | 4-8-12-15 | | | | | | | |
| 9 | | 9 | 6-10-12-15 | | | | | | | |
| 10 | | 10 | 8-16-21-22 | | | | | | | 1920 |
| 11 | | 11 | 5-8-12-21 | | | | | | | |
| 12 | | 12 | 5-11-15-19 | | | | | | | 1915 |
| 13 | | 13 | 4-7-12-15 | | | | SC | | | |
| 14 | | 14 | 8-11-16-20 | 15/10/75 | 10YR 4/3 | | | Increasing gravel. | | 1910 |
| 15 | | 15 | 7-11-15-18 | | | | | More lignite at 29' bgs. | | |
| 16 | | 16 | 3-7-9-11 | | 10YR 3/2 | | | More gray at 31' bgs. | | |
| 17 | | 17 | 5-10-13-15 | | | | | | | 1905 |
| 18 | | 18 | 8-10-13-16 | | | | | Large orange clast at 36' bgs. | | |
| 19 | | 19 | 5-11-13-19 | | | | | | | 1900 |
| 20 | | 20 | 5-11- | | | | | | | |

(continued)

ENVIRO LOG 5 (5/27/04) 34290018 COYOTE SLAG POND INVESTIGATION.GPJ BARR LIBR JAN06.GLB 9/12/13

BARR Barr Engineering Co.
 4700 West 77th Street
 Minneapolis, MN 55435-4803
 Telephone: 952-832-2600
 Fax: _____

Remarks:
 BGS = "below ground surface"
 Additional data may have been collected in the field which is not included on this log.

LOG OF BORING Pond 14

Client Otter Tail Power Company
 Project Name Coyote Slag Pond Investigation
 Project Number 34290018
 Location _____

Drill Contractor Braun
 Drill Method _____
 Drilling Started 5/17/13 Ended 5/17/13
 Logged By ARP2

SHEET 2 OF 2
 Surface Elevation 1939.0 ft
 Total Depth 72.0 ft

| DEPTH FEET | SAMP. LENGTH & RECOVERY | SAMP. NUMBER | Blows/6 in. | %GR/SA/ FINES | Color | Moisture | ASTM | LITHOLOGY | DESCRIPTION | ELEV. FEET | |
|------------|-------------------------|--------------|-------------|---------------|----------|----------|------|-----------|---|-----------------------------------|------|
| 45 | | 21 | 16-18 | 10/10/80 | 10YR 3/1 | | | | 10-20': SANDY CLAY with GRAVEL: Dark grayish brown.(continued) Very dark gray. | 1895 | |
| | | 22 | 4-5-11-13 | | | | | | | 1890 | |
| | | 23 | 5-9-11-13 | | | | | | | | |
| | | 24 | 5-8-11-14 | | | | | | | | |
| | | 25 | 4-7-11-12 | | | | SC | | | | |
| | | 26 | 7-12-17-20 | | | | | | | | |
| | | 27 | 3-7-11-15 | | | | | | | | |
| | | 28 | 8-10-15-17 | 5/10/85 | | | | | | | |
| | | 29 | 8-12-15-18 | | | | | | | | |
| | | 30 | 9-9-10-11 | 0/0/100 | 10YR 3/1 | | | | | 58-72': CLAY/MUDSTONE: Dark gray. | 1880 |
| | | 31 | 3-7-11-13 | 0/0/100 | 10YR 3/1 | | | | | | 1875 |
| | | 32 | 5-7-10-13 | | | | CL | | | | 1870 |
| 70 | | 33 | | | | | | | End of Boring - 72 feet | 1865 | |
| 75 | | | | | | | | | | 1860 | |

ENVIRO LOG 5 (5/27/04) 34290018_COYOTE SLAG POND INVESTIGATION.GPJ BARR LIBR JAN06.GLB 9/12/13



Barr Engineering Co.
 4700 West 77th Street
 Minneapolis, MN 55435-4803
 Telephone: 952-832-2600
 Fax: _____

Remarks:

BGS = "below ground surface"
 Additional data may have been collected in the field which is not included on this log.

LOG OF BORING Pond 10

Client Otter Tail Power Company
 Project Name Coyote Slag Pond Investigation
 Project Number 34290018
 Location _____

Drill Contractor Hansen
 Drill Method _____
 Drilling Started 11/17/11 Ended 11/17/11
 Logged By ARP2

SHEET 1 OF 1
 Surface Elevation 1909.0 ft
 Total Depth 21.0 ft

| DEPTH FEET | SAMP. LENGTH & RECOVERY | SAMP. NUMBER | %GR/SA/ FINES | Color | Moisture | ASTM | LITHOLOGY | DESCRIPTION | ELEV. FEET |
|------------|-------------------------|--------------|--------------------|----------------------|----------|------|-----------|---|------------|
| 0 | | | 10/0/90 | 4/1 10YR | N | CL | | 0-2': CLAY, little gravel and coal from 0-0.5' bgs, no HCL reaction. | 1909.0 |
| 2 | | 1 | 0/0/100 0/85/15 | 3/2 10YR 4/4 10YR | N N | ML | | 2-2.5': SILT, brown. 2.5-7': SILTY SAND, fine- to medium-grained sand, no gravel, no HCL reaction. | 1905 |
| 5 | | 2 | | | | SM | | | |
| 10 | | 3 | 0/95/5 | 4/4 10YR | N | | | 7-18': SAND, less silt, fine- to medium-grained. | 1900 |
| 15 | | 4 | | | | SP | | More medium-grained at 11' bgs. Saturated at 13' bgs. | 1895 |
| 20 | | 5 | 0/95/5 | 4/4 10YR | Y | | | | |
| | | 6 | 0/25/75 30/70/0 | 4/1 10YR 4/4 5YR | Y Y | CL | | 18-19': SANDY CLAY, no HCL reaction. | 1890 |
| | | | | | | SP | | 19-21': SAND with GRAVEL, medium- to coarse-grained sand, fine gravel, no HCL reaction. | |
| | | | | | | | | End of Boring - 21 feet | 1880 |

ENVIRO LOG 5 (5/27/04) 34290018_COYOTE SLAG POND INVESTIGATION.GPJ BARR LIBR JAN06.GLB 9/12/13

BARR Barr Engineering Co.
 4700 West 77th Street
 Minneapolis, MN 55435-4803
 Telephone: 952-832-2600
 Fax: _____

Remarks:
 BGS = "below ground surface"
 Additional data may have been collected in the field which is not included on this log.

LOG OF BORING Pond 12

Client Otter Tail Power Company
 Project Name Coyote Slag Pond Investigation
 Project Number 34290018
 Location _____

Drill Contractor Braun
 Drill Method _____
 Drilling Started 5/14/13 Ended 5/14/13
 Logged By ARP2

SHEET 1 OF 1
 Surface Elevation 1918.7 ft
 Total Depth 37.0 ft

| DEPTH FEET | SAMP. LENGTH & RECOVERY | SAMP. NUMBER | Blows/6 in. | %GR/SA/ FINES | Color | Moisture | ASTM | LITHOLOGY | DESCRIPTION | ELEV. FEET |
|------------|-------------------------|--------------|-------------|---------------|-------|----------|-------|---------------------|--|------------|
| 0-2.5' | | | | | | | CL-ML | [Diagonal Hatching] | 0-2.5': SANDY SILTY CLAY, little cohesion, fine- to medium-grained sand, no HCL reaction. | |
| 2.5-3.5' | | | | | | | CL | [Diagonal Hatching] | 2.5-3.5': SANDY CLAY with GRAVEL, white/tan sub-rounded gravel, no HCL reaction. | 1915 |
| 3.5-5' | | | | | | | CL-ML | [Diagonal Hatching] | 3.5-5': SANDY SILTY CLAY, no HCL reaction. | |
| 5-6.5' | | | | | | | CL | [Diagonal Hatching] | 5-6.5': SANDY CLAY with GRAVEL, no HCL reaction. | |
| 6.5-10' | | | | | | | CL-ML | [Diagonal Hatching] | 6.5-10': SANDY SILTY CLAY with GRAVEL, white to tan sub-rounded small gravel, slight HCL reaction. | 1910 |
| 10-30' | | | | | | | | [Dotted Pattern] | 10-30': SILTY SAND. | 1905 |
| 20-21' | | | | | | | SM | [Dotted Pattern] | Interbedded reddish coloration at 21' bgs, no HCL reaction. | 1900 |
| 25-27' | | | | | | | | [Dotted Pattern] | 25-27': SILTY SAND: Light yellowish brown, fine- to medium-grained. | 1895 |
| 27-37' | | | | | | | | [Dotted Pattern] | Saturated at 28' bgs. | 1890 |
| 35-37' | | | | | | | SM | [Dotted Pattern] | | 1885 |
| 37' | | | | | | | | | End of Boring - 37 feet | 1880 |

ENVIRO LOG 5 (5/27/04) 34290018_COYOTE SLAG POND INVESTIGATION.GPJ BARR LIBR JAN06.GLB 9/12/13

BARR Barr Engineering Co.
 4700 West 77th Street
 Minneapolis, MN 55435-4803
 Telephone: 952-832-2600
 Fax:

Remarks: Screen set at 27-37 ft bgs. *Boring log data from SB-103 used for 0-25'. Well borehole was direct drilled to 25'.
 BGS = "below ground surface"
 Additional data may have been collected in the field which is not included on this log.

LOG OF BORING Pond 15S/D

Client Otter Tail Power Company
 Project Name Coyote Slag Pond Investigation
 Project Number 34290018
 Location _____

Drill Contractor Braun
 Drill Method _____
 Drilling Started 5/22/13 Ended 5/22/13
 Logged By ARP2

SHEET 1 OF 2
 Surface Elevation 1939.4 ft
 Total Depth 61.0 ft

| DEPTH FEET | SAMP. LENGTH & RECOVERY | SAMP. NUMBER | Blows/6 in. | %GR/SA/ FINES | Color | Moisture | ASTM | LITHOLOGY | DESCRIPTION | ELEV. FEET | | | |
|------------|-------------------------|--------------|-------------|---------------|----------|----------|------|-----------|--|------------|---|------|------|
| | | 1 | 1-3-7-6 | 10/80/10 | 10YR 4/3 | N | SC | | 0-1.5': SANDY CLAY with GRAVEL: Brown. | | | | |
| | | | 2-4-4-6 | 20/50/30 | 5YR 5/6 | N | SP | | 1.5-2': SAND and GRAVEL with little CLAY: Yellowish red. | | | | |
| | | 2 | | 10/10/80 | 10YR 4/3 | N | | | 2-29': SANDY CLAY with GRAVEL: Brown, gravel is small, yellow/white, sub-angular, mild HCl reaction. | | | | |
| | 5 | | 3 | 2-4-6-11 | | | | | | | | 1935 | |
| | | | 4 | 2-5-9-12 | | | | | | | | | |
| | | | 5 | 4-5-9-11 | | | | | | | More lignite. | | 1930 |
| | 10 | | 6 | 3-5-7-11 | | | | | | | | | |
| | | | 7 | 3-6-11-14 | | | | | | | | | |
| | | | 8 | 4-6-11-12 | | | N | | | | Large gravel clast at 14' and 14.5' bgs. | | 1925 |
| | 15 | | 9 | 3-4-10-12 | | | | | SC | | | | |
| | | | 10 | 4-7-11-13 | | | | | | | | | |
| | 20 | | 11 | 4-7-11-14 | 10/10/80 | 10YR 4/2 | N | | | | More gray. | | 1920 |
| | | | 12 | 4-8-12-14 | | | | | | | | | |
| | 25 | | 13 | 3-6-12-15 | 10/20/70 | | | | | | More sand at 25' bgs. | | 1915 |
| | | | 14 | 4-8-12-14 | | | | | | | Large gravel clast at 27' and 29' bgs. | | |
| | | | 15 | 5-9-14-16 | 0/80/20 | 10YR 5/2 | Very | | | | | | |
| | 30 | | 16 | 4-6-10-13 | 0/0/100 | 10YR 5/2 | | | SP | | 29-30.5': SAND with CLAY: Grayish brown, fine- to medium-grained, very moist. | | 1910 |
| | | | 17 | 3-6-10-3 | 10/10/80 | 10YR 4/2 | | | CL | | 30.5-32': CLAY: Grayish brown. | | |
| | | | 18 | 6-9-13-15 | | | | | | | 32-55.5': SANDY CLAY with GRAVEL: Dark grayish brown. | | 1905 |
| | 35 | | 19 | 5-7-19-50 | | | | | SC | | Large lignite clast at 35.5' bgs. | | |
| | | 20 | 4-8-9-15 | | | | | | | | | | |
| | | | 2-4-9- | | | | | | | 1900 | | | |

(continued)

ENVIRO LOG 5 (5/27/04) 34290018 COYOTE SLAG POND INVESTIGATION.GPJ BARR LIBR JAN06.GLB 9/12/13

Barr Engineering Co.
 4700 West 77th Street
 Minneapolis, MN 55435-4803
 Telephone: 952-832-2600
 Fax: _____

Remarks:







BGS = "below ground surface"
 Additional data may have been collected in the field which is not included on this log.

LOG OF BORING Pond 15S/D

Client Otter Tail Power Company
 Project Name Coyote Slag Pond Investigation
 Project Number 34290018
 Location _____

Drill Contractor Braun
 Drill Method _____
 Drilling Started 5/22/13 Ended 5/22/13
 Logged By ARP2

SHEET 2 OF 2
 Surface Elevation 1939.4 ft
 Total Depth 61.0 ft

| DEPTH FEET | SAMP. LENGTH & RECOVERY | SAMP. NUMBER | Blows/6 in. | %GR/SA/ FINES | Color | Moisture | ASTM | LITHOLOGY | DESCRIPTION | ELEV. FEET |
|------------|---|--------------|-------------|---------------|----------|----------|------|-----------|--|------------|
| |  | 21 | 11 | 10/10/80 | 10YR 4/2 | | | SC | 32-55.5': SANDY CLAY with GRAVEL: Dark grayish brown. <i>(continued)</i> | 1895 |
| 45 |  | 22 | 4-8-13-14 | | | | | SC | | 1890 |
| 50 |  | 34 | 4-7-12-14 | | | | | SC | | 1885 |
| 55 |  | 24 | 3-5-8-10 | 0/0/100 | 10YR 4/2 | | | CL | 55.5-61': CLAY/MUDSTONE: Dark grayish brown. | 1880 |
| 60 |  | 25 | 4-7-13-15 | | | | | CL | | 1875 |
| |  | 26 | 4-8-14-15 | | | | | CL | | 1870 |
| | | | | | | | | | End of Boring - 61 feet | 1865 |
| | | | | | | | | | | 1860 |

ENVIRO LOG 5 (5/27/04) 34290018_COYOTE SLAG POND INVESTIGATION.GPJ BARR LIBR JAN06.GLB 9/12/13



Barr Engineering Co.
 4700 West 77th Street
 Minneapolis, MN 55435-4803
 Telephone: 952-832-2600
 Fax:

Remarks:

BGS = "below ground surface"
 Additional data may have been collected in the field which is not included on this log.



Barr Engineering Company
 234 West Century Avenue
 Bismarck, ND 58503
 Telephone: 701-255-5460

LOG OF BORING POND 16S

SHEET 1 OF 1

Project: Coyote Station CCR Rule
 Project No.: 34291075.01
 Location: Mercer County, North Dakota
 Coordinates: N 567,596.4 ft E 1,643,207.2 ft
 Datum: NAD83 ND State Plane South

Surface Elevation: 1922.1 ft
 Drilling Method: Rotasonic
 Sampling Method: Continuous
 Completion Depth: 47.0 ft

Unique Well No.: POND 16S

| Depth, feet | Sample Type & Recovery | Sample No. | USCS | Graphic Log | LITHOLOGIC DESCRIPTION | MAJOR UNIT | WELL OR PIEZOMETER CONSTRUCTION DETAIL | Elevation, feet | |
|-------------|------------------------|------------|------|-------------|--|----------------------|--|--|------|
| 0 | | | CH | | TOPSOIL: (FAT CLAY) (CH): very dark brown; moist; roots, very fine sand; high plasticity; no HCl reaction; 0% gravel, 20% sand, 80% fines. | FILL | PRO. CASING Diameter: 4" Type: Square Steel Interval: | 1920 | |
| 0 | | | GC | | GRAVEL WITH SAND (GC): yellowish red; moist; scoria, mud-fired clay, trace roots; weak HCl reaction; 50% gravel, 30% sand, 20% fines. | | | 1915 | |
| 5 | | | CH | | FAT CLAY WITH SAND (CH): very dark grayish brown; moist; very fine grained, trace scoria, trace oxidized stained granules, trace black organics, trace roots, firm; weak HCl reaction; 0% gravel, 30% sand, 70% fines. 5 to 6 ft: scoria; weak HCl reaction. | Coleharbor Formation | RISER CASING Diameter: 2" Type: PVC Sch 40 Interval: | 1910 | |
| 10 | | | CH | | 9 ft: no more trace scoria or roots; weak HCl reaction. 9 to 11 ft: soft; weak HCl reaction. 11 ft: very firm; weak HCl reaction. 12.5 ft: trace large rounded gravel; weak HCl reaction. 13 ft: 4" coal; weak HCl reaction. | | | 1905 | |
| 15 | | | CH | | 15 to 17 ft: scoria, grass, possible solugh; weak HCl reaction. | | | GROUT Type: Neat Cement Interval: 0-28' bgs | 1900 |
| 20 | | | SM | | SILTY SAND (SM): brown; moist; very fine grained, loose, soft; no HCl reaction; 0% gravel, 75% sand, 25% fines. 17 to 17.5 ft: black paleosol; no HCl reaction. 21 to 22 ft: slightly darker brown; no HCl reaction. | | | SEAL Type: Bentonite Interval: 28-33' bgs | 1895 |
| 25 | | | SM | | 25 32.5 ft: trace black manganese staining, some 2-4" layers of dampness; no HCl reaction. | Silty Sand | SANDPACK Type: Silica 30/50 Interval: 33-45' bgs | 1890 | |
| 30 | | | SM | | 32.5 to 33 ft: red oxidized staining; no HCl reaction. 33 ft: wet; no HCl reaction. | | | SCREEN Diameter: 2" (Slot Size 8) Type: PVC Sch 40 Interval: 35-45' bgs | 1885 |
| 35 | | | SM | | 35 to 40 ft: Sample taken for grain-size analysis. Lab analysis done by Terracon. Results: Silty Sand (SM). | | | | 1880 |
| 40 | | | SC | | CLAYEY SAND WITH GRAVEL (SC): dark yellowish brown; wet; fat, rounded small to large gravel, coarse sand; no HCl reaction; 0% gravel, 0% sand, 100% fines. 40 to 45 ft: Sample taken for grain-size analysis. Lab analysis done by Terracon. Results: Clayey Sand w/ Gravel (SC). | Sentinel Butte Fm | | | |
| 45 | | | CH | | FAT CLAY (CH): dark greensih gray; moist to wet; soft, fat; high plasticity; no HCl reaction. 45 to 45.5 ft: oxidized staining laminations; no HCl reaction. | | | | |
| 47.0 | | | | | End of boring 47.0 feet | | | | |

Date Boring Started: 7/7/16 3:25 pm
 Date Boring Completed: 7/7/16 4:45 pm
 Logged By: AMK2
 Drilling Contractor: Cascade
 Drill Rig: Truck

Remarks: Water level while drilling = 36'
 Additional data may have been collected in the field which is not included on this log.
 Weather: 70°F, partly cloudy, NW breeze, humid, soft ground

C:\GINT\PROJECTS\34291075\COYOTE BORING LOGS.GPJ_BARR\LIBRARY.GLB_ENVIRO LOG_BARR TEMPLATE.GDT

WATER SUPPLY, INC.

BOX 1191
BISMARCK, N.D. 58501

DRILLER'S LOG

State
Coordinates

| | | |
|--|--|--|
| | | |
| | | |
| | | |

sec. 10 dad

Tp. 143

Rg. 88

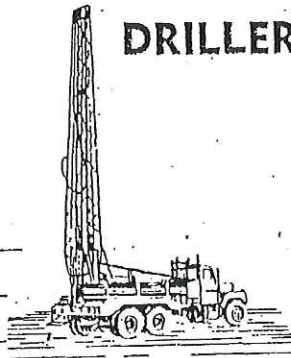
N. _____

E. _____

Project: Knife River at Beulah

State: North Dakota

County: Mercer



Hole No. #6 near shed

Hole Elev. 1907.3

| Core Recovery (Thickness) | From | To | Sample Description | Comments |
|---------------------------|------|----|------------------------------|----------|
| | 0 | 2 | Clay, silty, yellowish brown | |
| | 2 | 3 | Sand, fine | |
| | 3 | 5 | Clay, silty, yellowish brown | |
| | 5 | 7 | Sand, fine, medium to coarse | |
| | 7 | 8 | Clay, silty, yellowish brown | |
| | 8 | 17 | Sand, Fine, medium to coarse | |
| | 17 | 18 | Clay, silty, yellowish brown | |
| | 18 | 20 | Sand, fine, medium to coarse | |
| | 20 | 22 | Clay, silty, yellowish brown | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

2" PVC well silica sand packed to 14'

Footage Drilled w/Air _____
Footage Drilled w/Water 22
Amount Water Used _____

Measuring Point 1.9 ALS
Water Level 5.3 BLS
Screened Interval 15-20' BLS 0.01" slot

From _____ To _____ Hrs. _____
Co. Rep. on Job _____ Title _____

Date 2/24/82 Driller Knutson
Helpers: _____

Printed by _____

State of North Dakota
BOARD OF WATER WELL CONTRACTORS
 900 E. BOULEVARD * BISMARCK, NORTH DAKOTA 58505

MONITORING WELL REPORT

State law requires that this report be filed with the State Board of Water Well Contractors within 30 days after completion or abandonment of the well.

1. WELL OWNER

Name Otter Tail Power, Coyote Sta.
 Address Box 496
Fergus Falls, MN 56538-0496

2. WELL LOCATION

Address (if in City) Nelsen's Pond, #N3
N of Pond E of loop road
143-088-10ACD

County Mercer

SE1/4 SW1/4 NE1/4 Sec. 10 Twp. 143N. Rge. 088W

Lat.: _____

Long.: _____

Altitude: MP=1946.43 & GL=1943.65

3. METHOD DRILLED

Auger Other _____

4. WELL CONSTRUCTION

Diameter of Hole 8 inches Depth 34 feet

Riser: PVC Other _____
 Threaded Solvent Other _____

Riser rating SDR _____ Schedule 40

Diameter 2 inches

From 2.78 ft. to 29 ft.

Was a well screen installed? Yes No

Material PVC Diameter 2 inches

Slot Size 10 set from 29 ft to 34 ft

Sand packed from 18 to 30

Depth grouted from 18 to Surface

Grouting material

Bentonite Chips Other _____

If other explain: _____

Well head completion:

24" above grade _____ Other _____

If other, specify 4" sq steel PC

Was protective casing installed? Yes No

Was well disinfected upon completion? yes No

5. WATER LEVEL

Static water level 11.7 Feet below surface

if flowing: closed-in pressure _____ psi or

ft. above land surface _____

WSIKE/MWR04

6. WELL LOG

| Formation | Depth (Ft.) |
|---|-------------|
| | To |
| Silt, sand & lignite dark brown to black | 1 |
| Silt, sandy, w/ cobbles, medium brown | 4 |
| Clay, silty w/pebbles, dark brown | 4.5 |
| Clay, silty w/pebbles, medium brown, Till | 29 |
| Sand, fine, silty yellowish brown | 32.5 |
| Clay, silty w/pebbles, medium gray | 34 |

(use separate sheet if necessary)

7. WAS THE HOLE PLUGGED OR ABANDONED?

Yes No

if so, how? _____

8. REMARKS Natural pack to 30', 250# 20-40 silica sand pack to 30', 400# chips to 2', 180# concrete mix & 4" sq steel PC at surface

9. DATE COMPLETED 10/8/01

10. CONTRACTOR CERTIFICATION

This well was drilled under my jurisdiction and this report is true to the best of my knowledge

Water Supply, Inc. 96
 Monitoring Well Contractor Certificate No.
Box 1191, Bismarck, ND 58501-1191
 Address

Signature _____ Date 10/10/01

Appendix B

Geotechnical Laboratory Data



1805 Hancock Dr / PO Box 2084 / Bismarck, North Dakota 58502
Telephone (701) 258-2833 / Fax (701) 258-2857

REPORT OF: TESTS OF SOILS

PROJECT: Coyote Station Project
6240 13th St SW
Beulah, North Dakota

DATE: August 4, 2016

REPORTED TO: Otter Tail Power Company
Attn: Paul Vukonich
PO Box 496
Fergus Falls, MN 56538-0496

COPIES: Barr Engineering Company
Attn: Scott Korom

PROJECT NO: M2165099

SAMPLE IDENTIFICATION:

Pond 16S,
Depth 35-40',
Vertical

Pond 16S,
Depth 40-45',
Vertical

CLASSIFICATION:

SILTY SAND (SM)

CLAYEY SAND WITH
GRAVEL (SC)

COLOR:

Brown

Brown

PARTICLE DISTRIBUTION (see attached curves):

Gravel (%)

26.4

Sand (%)

57.7

33.3

Fines (%)

Silt (.074-.005 mm)

27.6

11.7

Clay (.005-.001 mm)

14.7

28.6

LABORATORY PERMEABILITY:

Not Tested

Method

US Army Corps of Engineers,
EM1110-2-1906, Appendix VII-
Permeability Tests (modified)

Initial Moisture Content (%)

31.7

Final Moisture Content (%)

39.2

Coefficient of Permeability (cm/sec)

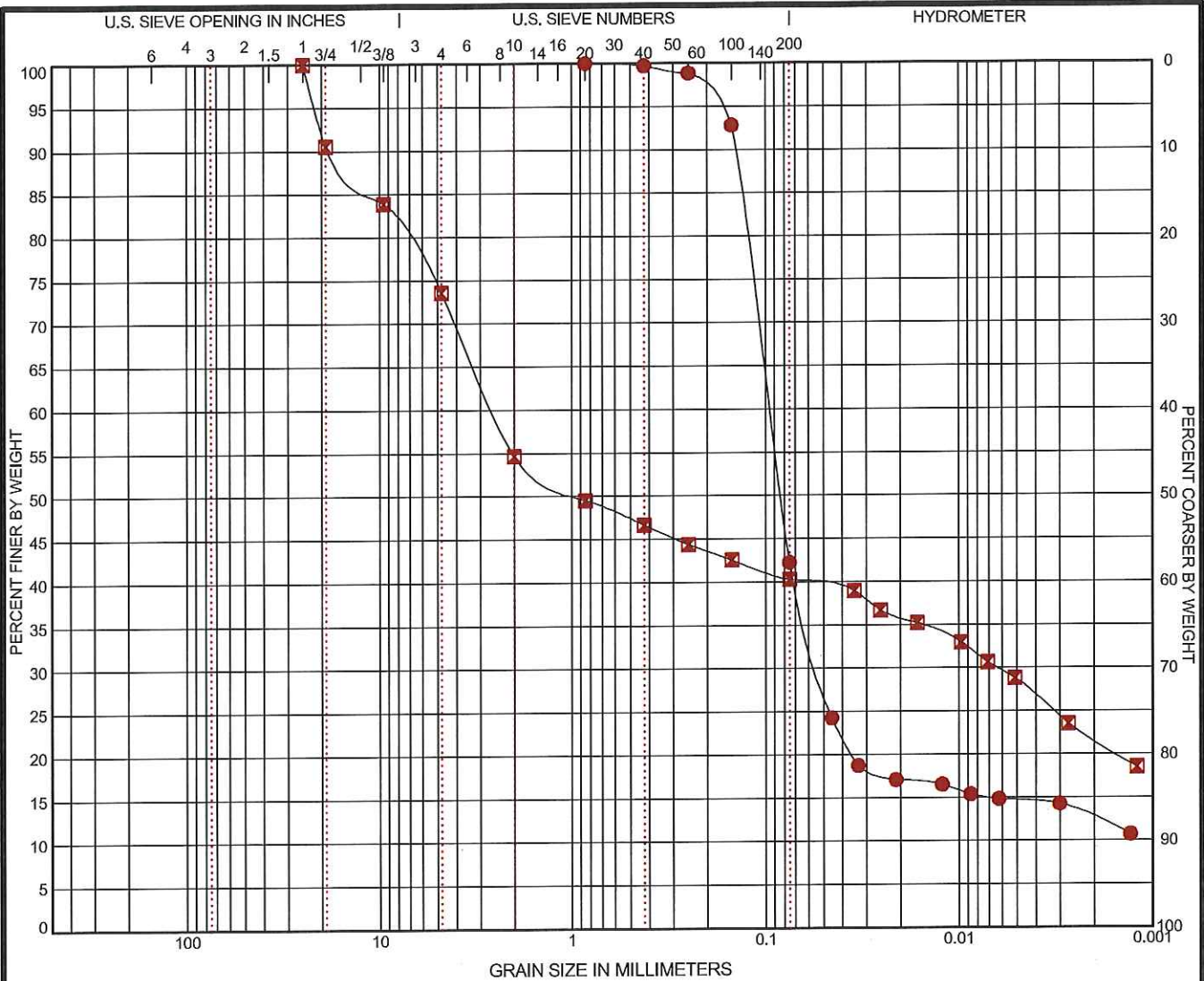
3.4×10^{-6}

REMARKS: Samples were submitted to and received here at the laboratory for test on July 25, 2016.

Signed: _____
Chad A. Cowley, P.E.

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---------|--------|------|--------|--------|------|--------------|
| | coarse | fine | coarse | medium | fine | |

| BORING ID | DEPTH | % COBBLES | % GRAVEL | % SAND | % SILT | % FINES | % CLAY | USCS |
|------------|---------|-----------|----------|--------|--------|---------|--------|------|
| ● Pond 16S | 35 - 40 | 0.0 | 0.0 | 57.7 | 27.6 | | 14.7 | |
| ■ Pond 16S | 40 - 45 | 0.0 | 26.4 | 33.3 | 11.7 | | 28.6 | |

| | GRAIN SIZE | |
|-----------------|------------|-------|
| | ● | ■ |
| D ₆₀ | 0.096 | 2.554 |
| D ₃₀ | 0.053 | 0.006 |
| D ₁₀ | | |
| COEFFICIENTS | | |
| C _c | | |
| C _u | | |

| SIEVE (size) | PERCENT FINER | |
|--------------|---------------|-------|
| | ● | ■ |
| 1 1/2" | | |
| 1" | | 100.0 |
| 3/4" | | 90.52 |
| 1/2" | | |
| 3/8" | | 83.89 |
| #4 | | 73.61 |
| #10 | | 54.64 |
| #20 | 100.0 | 49.54 |
| #40 | 99.73 | 46.7 |
| #60 | 98.86 | 44.41 |
| #100 | 92.82 | 42.57 |
| #200 | 42.29 | 40.33 |

SOIL DESCRIPTION
 ● SILTY SAND (SM)
 ■ CLAYEY SAND with GRAVEL (SC)

REMARKS
 ●
 ■

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS 1 M2165099 LAB TESTING ONLY.GPJ 35159097 - ATTERBERG ISSUE.GPJ 8/3/16

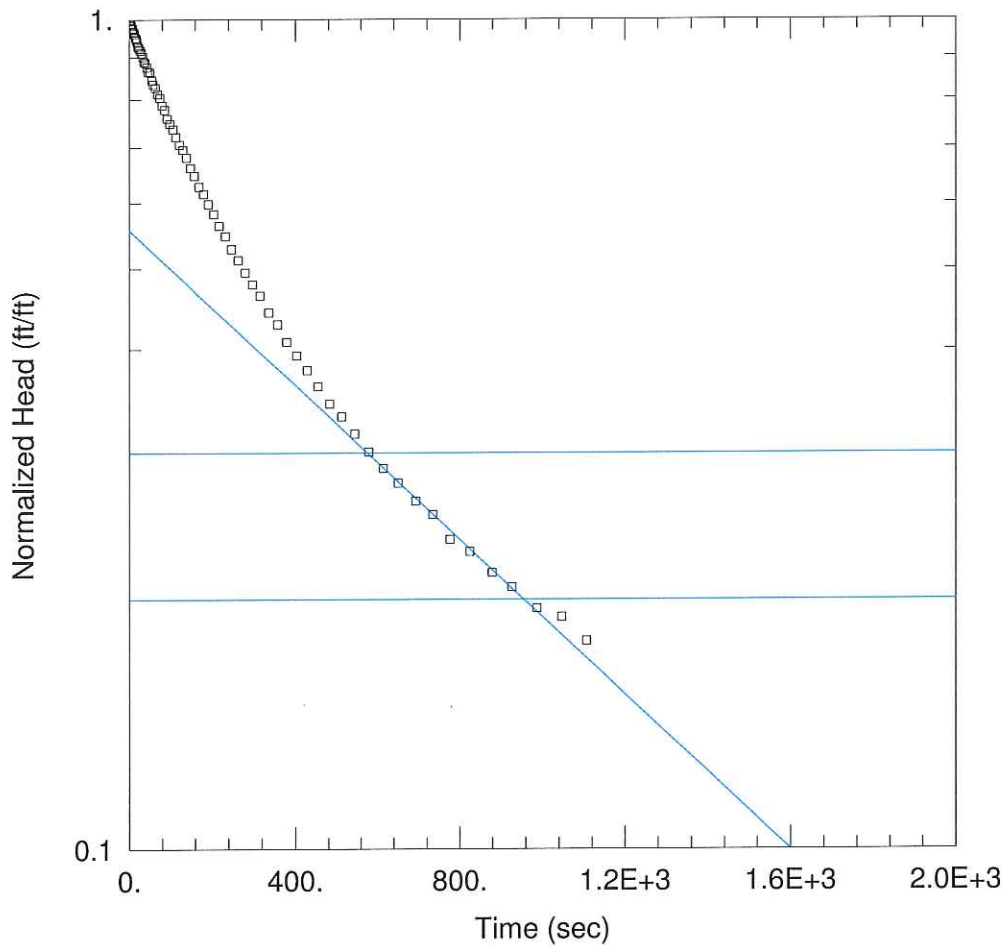
PROJECT: Coyote Station
 SITE: Mercer County, North Dakota



PROJECT NUMBER: M2165099
 CLIENT: Otter Tail Power Company

Appendix C

Slug Test Results



POND 16S FALLING HEAD SLUG TEST (SLUG-IN)

Data Set: \...\Pond 16S Slug In BR.aqt
 Date: 09/14/16

Time: 09:21:59

PROJECT INFORMATION

Company: Barr Engineering Co.
 Client: OtterTail Power Company
 Project: 34291075
 Location: Beulah, ND
 Test Well: Pond 16S
 Test Date: August 16, 2016

AQUIFER DATA

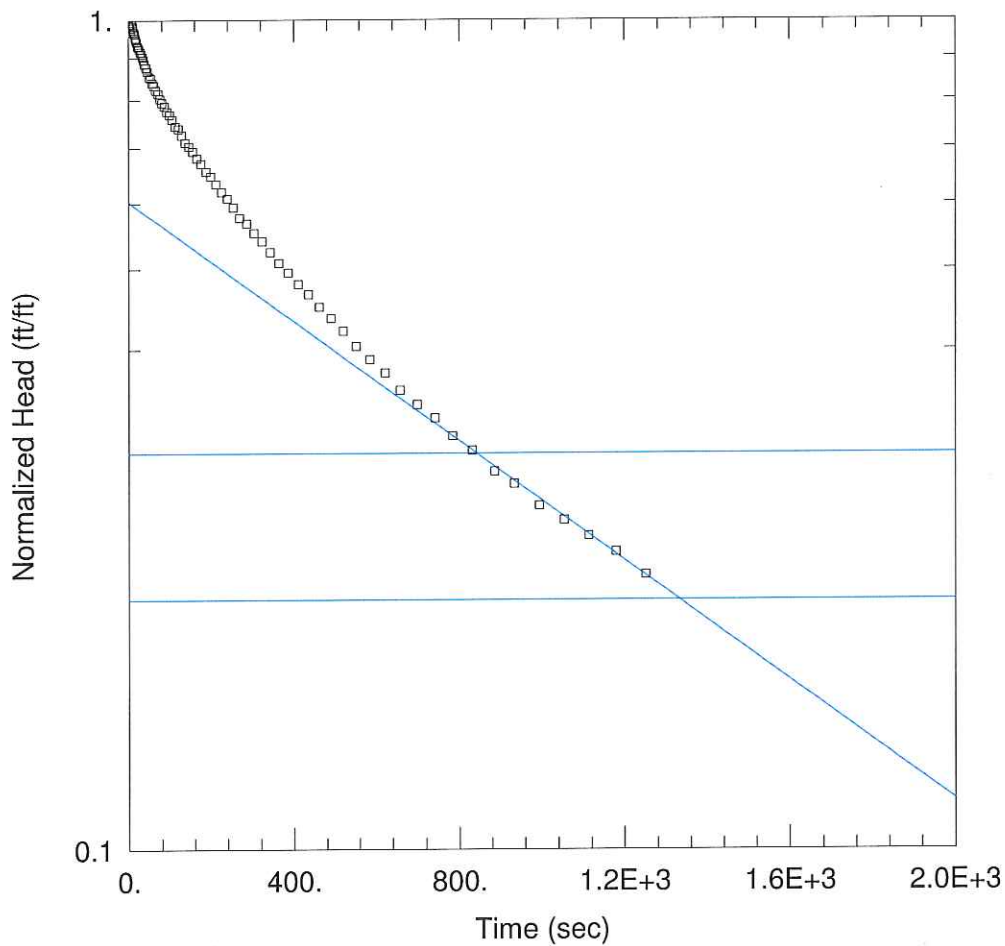
Saturated Thickness: 10.45 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (Pond 16S)

Initial Displacement: 1.258 ft Static Water Column Height: 10.45 ft
 Total Well Penetration Depth: 10.45 ft Screen Length: 10. ft
 Casing Radius: 0.083 ft Well Radius: 0.167 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice
 K = 3.567E-5 cm/sec y0 = 0.6997 ft



POND 16S RISING HEAD SLUG TEST (SLUG-OUT)

Data Set: \\...\Pond 16S Slug Out BR.aqt
 Date: 09/14/16

Time: 09:21:45

PROJECT INFORMATION

Company: Barr Engineering Co.
 Client: OtterTail Power Company
 Project: 34291075
 Location: Beulah, ND
 Test Well: Pond N3
 Test Date: August 16, 2016

AQUIFER DATA

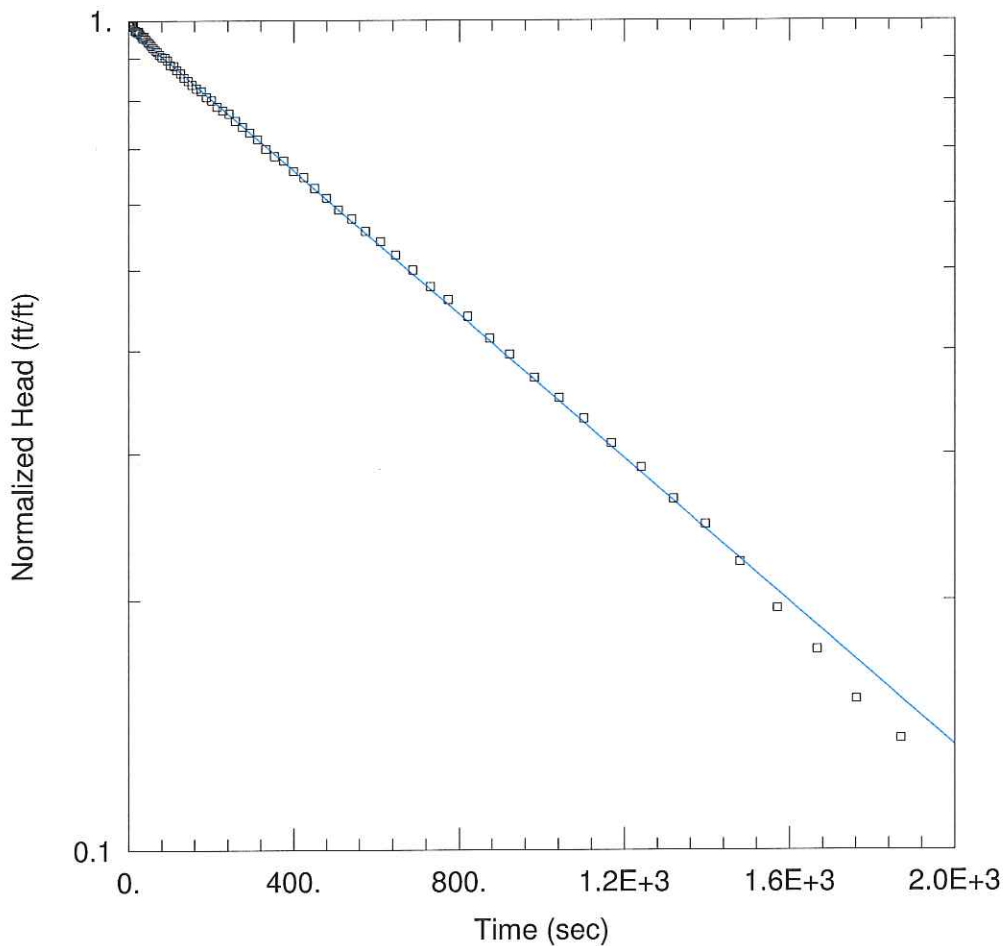
Saturated Thickness: 10.45 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (Pond 16S)

Initial Displacement: 1.192 ft Static Water Column Height: 10.45 ft
 Total Well Penetration Depth: 10.45 ft Screen Length: 10. ft
 Casing Radius: 0.083 ft Well Radius: 0.167 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bower-Rice
 K = 2.756E-5 cm/sec y0 = 0.7188 ft



POND N3 FALLING HEAD SLUG TEST (SLUG-IN)

Data Set: \...\Pond N3 Slug In BR.aqt
 Date: 09/14/16

Time: 09:47:42

PROJECT INFORMATION

Company: Barr Engineering Co.
 Client: OtterTail Power Company
 Project: 34291075
 Location: Beulah, ND
 Test Well: Pond N3
 Test Date: August 16, 2016

AQUIFER DATA

Saturated Thickness: 1.5 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (Pond N3)

Initial Displacement: 1.238 ft

Static Water Column Height: 25.07 ft

Total Well Penetration Depth: 25.07 ft

Screen Length: 1.5 ft

Casing Radius: 0.083 ft

Well Radius: 0.333 ft

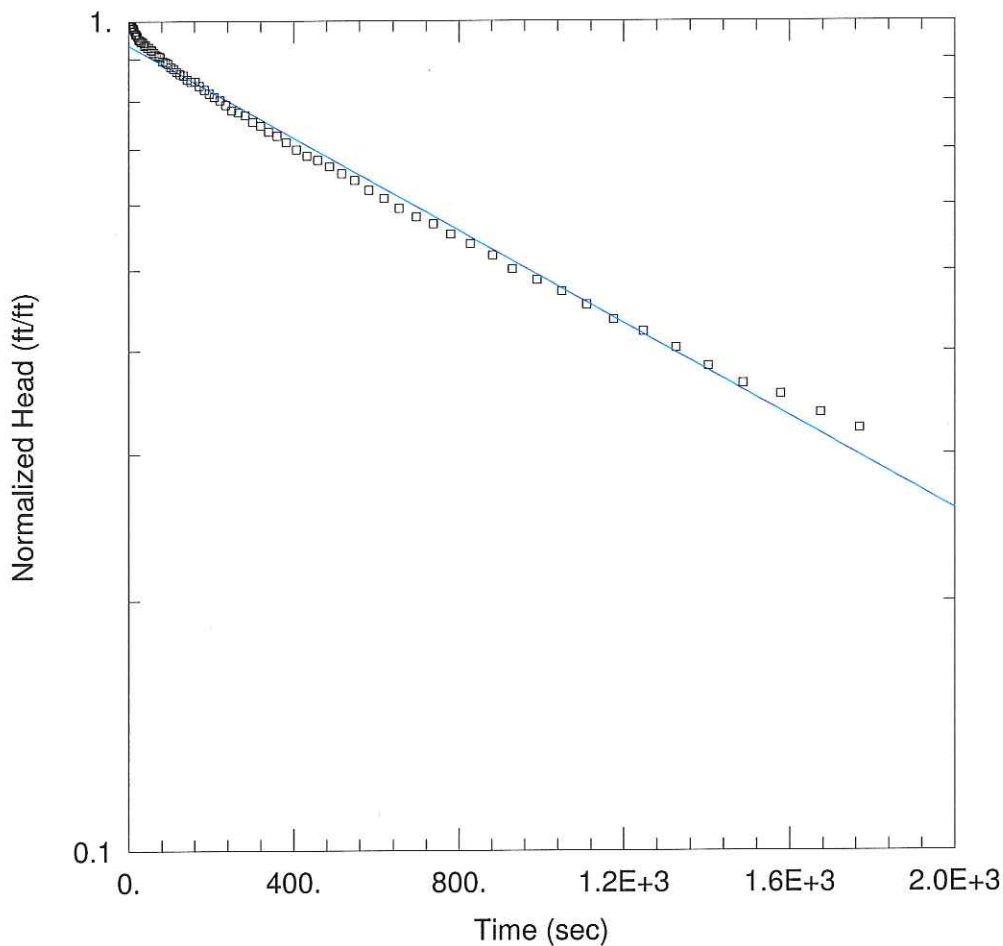
SOLUTION

Aquifer Model: Confined

Solution Method: Bower-Rice

K = 0.00016 cm/sec

y0 = 1.214 ft



POND N3 RISING HEAD SLUG TEST (SLUG-OUT)

Data Set: \\...\Pond N3 Slug Out BR.aqt
 Date: 09/14/16

Time: 09:47:30

PROJECT INFORMATION

Company: Barr Engineering Co.
 Client: OtterTail Power Company
 Project: 34291075
 Location: Beulah, ND
 Test Well: Pond N3
 Test Date: August 16, 2016

AQUIFER DATA

Saturated Thickness: 1.5 ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (Pond N3)

Initial Displacement: 1.224 ft
 Total Well Penetration Depth: 1.5 ft
 Casing Radius: 0.083 ft

Static Water Column Height: 24.66 ft
 Screen Length: 1.5 ft
 Well Radius: 0.333 ft

SOLUTION

Aquifer Model: Confined
 K = 4.937E-5 cm/sec

Solution Method: Bower-Rice
 y0 = 1.144 ft