

Groundwater Monitoring System Report

Ash Landfill Hoot Lake Plant

Fergus Falls, Minnesota

Prepared for Otter Tail Power Company

November 2016

Groundwater Monitoring System Report Ash Landfill, Hoot Lake Plant

November 2016

Contents

1.0	Int	Introduction						
	21.15	roduction Purpose	1					
1.1		Purpose	د					
	1.1.1	Distance from Waste Boundary	2					
9	1.1.2	Lateral Spacing	2					
1.2		Report Contents	3					
2.0		e Background						
2.1		Hoot Lake Plant						
2.2		Delineation of the CCR Facility	4					
2.3		Site Setting	∠					
	2.3.1	Regional Geology						
	2.3.2	Regional Hydrogeology	5					
	2.3.3	Site Geology	6					
	2.3.4	Site Hydrogeology	6					
	2.3.5	Potential Groundwater Flow Receptors	<u>c</u>					
3.0		nceptual Models	10					
3.1		Site Conceptual Model	10					
3.2		Release Conceptual Model						
4.0		R Groundwater Monitoring System						
5.0		ferences						

List of Tables

Table 1	Otter Tail surficial aquifer characteristics	b
Table 2	Laboratory Values for Permeability	8
Table 3	Slug Test Values for Permeability	8
Table 4	CCR Monitoring Well Details	14
	List of Figures	
Figure 1	Site Location Map	
Figure 2	Site Map	
Figure 3	Site Surficial Geology Map	
Figure 4	Groundwater Contours	
Figure 5	Upgradient Groundwater Levels Over Time	
Figure 6	Downgradient Groundwater Levels Over Time	
Figure 7	Groundwater Levels Over Time in CCR Monitoring Wells	
Figure 8	Cross Section and Conceptual Site Model	
Figure 9	Conceptual Release Model	
Figure 10	Proposed CCR Groundwater Monitoring System	

List of Appendices

Appendix A Boring and Well Logs

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 Minnesota.

November 21, 2016

Date

James Berkas, P.E.

1.0 Introduction

Otter Tail Power Company owns and operates the Hoot Lake Plant, a coal-fired generation unit in Fergus Falls, Minnesota. Coal combustion residuals (CCR) from plant operations are placed in a landfill, referred to as the Hoot Lake Ash Landfill, on the plant property. The Site location is shown on Figure 1 and the layout is shown on Figure 2. The Ash Landfill is the CCR Unit at the Hoot Lake Plant that is required to comply with the provisions of the US EPA Coal Combustion Residuals (CCR) rule (40 CFR Parts 257 and 261 Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities). The Site includes the Ash Landfill itself and the area around the landfill in which the monitoring system is located.

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

- The Site hydrogeology
- The CCR groundwater monitoring system meeting the requirements of the CCR Rule (40 CFR Part 257, US EPA, 2015) at the Otter Tail Power Company (OTP) Hoot Lake Plant Ash Landfill (Site).

1.1 Purpose

This document has been prepared to describe the groundwater monitoring system for the Hoot Lake Plant Ash Landfill and how it has been designed to meet the requirements of the CCR rule. Specific requirements for the groundwater monitoring system 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 sitespecific 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.

The monitoring system has been designed based on the site conceptual model (SCM) as it is currently understood, which is also presented herein, with the intent of obtaining representative samples of groundwater so that a release from the CCR unit can be detected.

The CCR rule has three primary requirements addressing the locations of wells in the network. These include:

- The wells must be placed near enough to the waste boundary to provide timely detection of a release
- There must be a minimum of three downgradient wells and one upgradient well
- The wells must be spaced appropriately to provide a reasonable opportunity to intersect a plume resulting from a hypothetical release

Each of these requirements is discussed below.

1.1.1 Distance from Waste Boundary

The industry practice is to place the monitoring downgradient of the waste disposal area and within the property boundary (EPA, 2015, p. 21324). The Minnesota Rules require a compliance boundary no more than 200 feet from the waste, so existing monitoring wells were generally placed 200 feet or less from the waste to be compliant. This distance is also based on the presumed flow directions and the need to allow sufficient space between the waste boundary and the monitoring network to allow for hydrodynamic dispersion which increases the probability of detection.

1.1.2 Lateral Spacing

Monitoring well spacing satisfies part 257.91 (a)(2) of the Coal Combustion Rule.

1.2 Report Contents

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

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

2.0 Site Background

2.1 Hoot Lake Plant

The Hoot Lake Plant operates its 54 MW Unit 2, on line since 1959, and 75 MW Unit 3, on line since 1964. Coal ash is generated by combustion of subbituminous coal for the production of electricity. Coal ash is either utilized for a beneficial use or placed in an on-site ash landfill that has been in use since 1980. The ash landfill is located on approximately 43 acres within the Otter Tail Power Company Hoot Lake Plant property in the N 1/2 of the SE 1/4 of Section 36, Township 133N, Range 43W, within the city limits of Fergus Falls, Otter Tail County, Minnesota.

2.2 Delineation of the CCR Facility

The Minnesota Pollution Control Agency (MPCA) Permit SW-211 for the Site defines two waste activity areas:

- Closed Industrial Waste Disposal Area IL001
- Industrial Waste Disposal Area IL002

While not directly applicable to the CCR rules, the MPCA-defined areas align with the CCR rules in that the MPCA IL001 area ceased receiving CCR prior to October 19, 2015. 40 CFR Parts 257.50 (d) states "This subpart does not apply to CCR landfills that have ceased receiving CCR prior to October 19, 2015." Area IL001 was closed in 2011. Therefore, the CCR rules do not apply to IL001. The CCR rules do apply to the IL002 area as it is an existing CCR landfill. Figure 2 is a map showing these areas.

2.3 Site Setting

The Site is underlain by several hundred feet of glacial deposits. Figure 3 shows the surficial geology of the Site. The following sections provide a description of regional and Site geology and hydrogeology, as well as potential groundwater flow receptors.

2.3.1 Regional Geology

The surficial geology is composed of Late Wisconsin Des Moines Lobe glacial till. The surficial units are the upper Goose River Group. From Harris (1999):

Glacial sediment deposited in and adjacent to the Red River lowland by unnamed phases of the Des Moines (Red River) lobe. The sediment is derived from a northwestern-source area (Riding Mountain area of western Manitoba). Sand and gravel were deposited on older stratigraphic units by coalescing, anastomosing meltwater streams to form undulating outwash plains. The deposits are generally collapsed (pitted) due to melting of buried ice blocks.

The pitting from melted ice blocks is apparent in the many lakes and ponds. Generally, this area is described as being covered by a hummocky moraine (Ekman, 2002).

Per Harris (1999), the Site is in an area covered by glacial sediment deposited by glacial ice on ice-cored glaciated landscape that later collapsed due to the melting of the buried ice. These sediments are interspersed with glacial outwash deposits.

The upper Goose River Group is generally underlain by the lower Goose River Group and other older deposits from earlier glacial advances.

2.3.2 Regional Hydrogeology

Ekman and Berg (2002) describe the hydrogeology of the region just east of the site, which is underlain by the same deposits as are found at the site. They note that the surficial hydrogeology is generally characterized as a two-layer system, with the upper system recharged by spring and fall rains and interacting with surface water bodies, whereas the lower system has little interaction with surface water and is more regionally recharged.

In a USGS report, Reppe (2005) defines a roughly oval area approximately 50 miles north to south and 20 miles east to west around Fergus Falls as being underlain by the Otter Tail surficial aquifer:

"The Otter Tail surficial aquifer consists of ice-contact and outwash deposits, primarily well-sorted sand with varying gradations of fine- to coarse-grained sand and gravel and lenses of clay. Although bedrock is 200 ft below land surface near Perham, Minnesota, and Big Pine Lake, north and northwest of Little Pine Lake bedrock is more than 400 ft below land surface. The aquifer is predominantly unconfined although some parts may be confined locally by clay lenses. The depth to the aquifer's water table ranges from 0 to 70 ft below land surface depending on local topography. The aquifer has a saturated thickness of at least 20 ft across 95 mi² and varies up to 5 ft with fluctuations in the water table."

Reppe (2005) also notes:

"Ground-water flow in the aquifer is towards the Otter Tail River (and the lakes along the river) and south and west along the axis of the river. In the southern one-third of the aquifer, ground water flows north-northwest toward the Otter Tail and Leaf Rivers. The water table has a maximum slope of approximately 25 ft/mi and a mean slope of 9 ft/mi."

Table 1 summarizes the Otter Tail surficial aquifer characteristics.

Table 1 Offer Tail surficial aquifer characteristics

Parameter	Value
Thickness	Maximum – 100 feet Mean – 50 feet
Transmissivity	Maximum – 26,800 ft²/day (290 cm²/sec) Mean – 14,500 ft²/day (156 cm²/sec) Minimum – 6,700 ft²/day (72 cm²/sec)
nickness	Maximum – 410 ft/day (0.14 cm/sec) Minimum – 86 ft/day (0.03 cm/sec)

(extracted in part from Reppe, 2005)

On the basis of available water-quality data, the concentrations of selected constituents were generally relatively low in the Otter Tail surficial aquifer relative to the other surficial aquifers in the region (Reppe, 2005). On the basis of characteristics and hydraulic properties, estimated water budgets, theoretical well yields, groundwater storage and use, and water quality, the Otter Tail surficial aquifer has near the greatest potential for additional development of groundwater resources compared to the other surficial aquifers in the region (Reppe, 2005). The estimated travel times from the surface to the aquifer is characterized as moderate, years to decades, for the higher elevations and as high, weeks to years, for the low-lying area along the river (Ekman, 2002).

2.3.3 Site Geology

Figure 3 shows the surface geology at the Site as mapped by the Minnesota Geological Survey to be Quaternary undivided. Per Wenck (2010):

"...all borings have shown an interbedded profile of coarse and fine alluvium, as well as clay till strata (the upper 30-50 feet is dominated by till). These strata are largely intermittent with undulating surfaces and varying thicknesses. Below the till, fine and medium sands with gravel predominate. Many of the previous site borings showed an intermediate clay or silt strata at or near elevation 1250 ft MSL.

"Below the majority of the site a deep lean, gray clay strata is present at an elevation of 1190 ft and is 20 feet thick or greater. This was found in all site borings that went deep enough (9 borings spread across the site), with the sole exception of B-3. At historical boring B-3, from elevation 1207-1195 ft, dense layers of gray silts and clayey sands were encountered."

Subsequent borings (see boring and well logs in Appendix A) have found consistent conditions.

2.3.4 Site Hydrogeology

Groundwater recharge at the Site is likely from the higher regional water table to the south and precipitation and infiltration in the local area. As shown on Figure 4, groundwater flow is generally from southeast to northwest under the facility.

The multiple clay and silt till units interbedded with sand and gravel outwash units under the Site create multiple saturated zones. Some are intermittent, and some are above the lined landfill space. The pond west of the landfill appears to be perched above the aquifer on a low permeability unit.

Four persistent saturated sand and gravel outwash aquifer units separated by leaky confining clayey till units have been identified in the area under and around the Ash Landfill:

- Upper perched zone Well S-3 (upgradient of water table aquifer) water elevation 1260-1270 feet. This aquifer is very limited in lateral extent and above the lined landfill space (outside of the waste boundary), so is not relevant to CCR monitoring.
- Intermediate aquifer Wells S-4, S-50, and S-51 (upgradient of water table aquifer) water elevation 1238-1260 feet. This aquifer extends an unknown distance south of facility and extends partway under the facility and apparently "merges" with or drains away into the underlying water table aquifer. It is important for upgradient water quality monitoring but does not exist downgradient.
- Water table aquifer All other wells not identified in other aquifers water elevation 1196-1220 feet. This aquifer appears to be continuous under the Site and for an unknown extent off Site and is considered the upper aquifer at the Site. It may be confined south of the Site.
- Deep aquifer Wells M-1 and M-3 (upgradient of water table) water elevation 1215-1219 feet.
 This aquifer appears to be continuous under the Site and for an unknown extent off Site. As it is
 not downgradient of the facility and is separated from the water table aquifer by a relatively thick
 gray till, it is not part of the CCR monitoring.

The adjacent Otter Tail River varies from a high of Elevation 1202 feet MSL upstream to Elevation 1193 feet MSL downstream. Groundwater generally flows toward and discharges into the Otter Tail River north of the Site.

Table 2 and Table 3 summarize hydrogeological test results from the Site.

Laboratory Values for Permeability Table 2

Boring/ Well	Depth	Sample Description	USCS	Test Type	Hydraulic Conductivity, cm/sec
S-2A*	33-34.5	Clayey sand w/gravel	CL	Vertical	3.3x10 ⁻⁷
B-7*	21.5-23	Clayey sand with gravel	CL	Vertical	1.8x10 ⁻⁶
B-7*	46-50	Sand w/ silt and gravel	SP-SM	Recompacted	7.6x10 ⁻⁶
B-7*	50-55	Sand w/ silt and gravel	SP-SM	Recompacted	6.4×10 ⁻⁴
S-1*	72.5-77.5	Silty sand	SM	Recompacted	3.5x10 ⁻⁵
S-1*	80-87.5	Sand w/ silt and gravel	SP-SM	Recompacted	2.8x10 ⁻⁵
B-5**	11-12.5	Clayey sand w/ gravel	SC	Vertical	1.9x10 ⁻⁷
B-5**	26-28	Clayey sand w/ gravel	SC	Vertical	4.5x10 ⁻⁷
B-6**	21-22	Lean clay	CL	Vertical	1.4x10 ⁻⁷
B-3**	65-66 & 70-71	Sand w/silt and gravel	SP-SM	Recompacted	7.6x10 ⁻⁴

^{*}TKDA, 1989

Slug Test Values for Permeability Table 3

Well	Monitored Unit	Hydraulic Conductivity
S-1*	Water table, upgradient	1.0x10 ⁻⁴ cm/sec
S-4**	Water table, upgradient	8.0x10 ⁻⁴ cm/sec
S-5*	Water table, downgradient	8.0x10 ⁻⁶ cm/sec
S-10R***	Water table, downgradient	2.5x10 ⁻² cm/sec
S-14R***	Water table, downgradient	7.7x10 ⁻³ cm/sec
S-2014***	Water table, downgradient	2.5x10 ⁻² cm/sec
S-10	Water table, downgradient, abandoned 2015	1.2x10 ⁻¹ cm/sec

^{*}TKDA, 1989

The hydraulic conductivity of the uppermost aquifer ranges from 8.0x10⁻⁶ to 1.2x10⁻¹ cm/sec based on single-well slug tests, with a geometric mean of 2.3x10⁻³ cm/sec.

The water table aquifer is described as

- poorly graded sand to poorly graded sand with gravel (S-10R)
- poorly graded sand (S-10R)
- coarse sand and gravel (S-3AR)
- sand with a little gravel (S-13)
- sand with a little gravel (S-2A)

Porosity of sands range from 0.25 to 0.5 (Freeze and Cherry, 1979). Porosities of glacial outwash aquifers in the region range from 0.2 to 0.3 (Reppe, 2005). The assumed porosity of the Site aquifer is 0.25.

^{**}TKDA, 1988

^{**}TKDA, 1988

^{***}Barr, 2015

The groundwater velocity is calculated using Darcy's equation:

Vt = k * i/n = 0.3-0.5 ft/day or 100-200 ft/year

Where: Vt = true velocity

K = hydraulic conductivity (2.3x10⁻³ cm/sec)

i = gradient (S52-S2A - 0.20, S52-S13 - 0.12; calculated from water levels)

n = effective porosity (0.25)

Figure 4 shows the groundwater contours in the mid-level perched aquifer and the water table aquifer. These contours are consistent with historical measurements at the Site. Based on the groundwater elevations, groundwater enters the existing CCR landfill boundary in the southeast corner and flows radially to the north to west-northwest, toward the river.

Figure 5 shows a hydrograph of groundwater elevations over time in two of the wells upgradient of the IL001 unit and in the two wells upgradient of the existing CCR landfill. This graph indicates the groundwater elevations in the new wells are consistent with what had been anticipated. The water level in well S-51 is about 20 feet higher than the water level in well S-52, indicating that these wells are screened in two different hydrogeological units.

Figure 6 shows the groundwater elevations over time in the wells downgradient of the existing CCR landfill. Discounting a few outliers, the trends over time are reasonably consistent from well to well, indicating these wells are all in the same aquifer. For comparison, Figure 7 shows the groundwater elevations over time in all the existing CCR landfill wells.

2.3.5 Potential Groundwater Flow Receptors

Per the Minnesota County Well Index (accessed 6/29/16), the nearest domestic well is about 1,800 feet west (sidegradient) of the Site. There are no water supply wells downgradient of the Site. The primary discharge area for groundwater is the Otter Tail River.

3.0 Conceptual Models

In order to solve any hydrogeologic problem, it is necessary to assemble relevant field data and synthesize what is known about a site into a site hydrogeological conceptual model (Anderson et al., 2015).

3.1 Site Conceptual Model

Figure 4 shows the approximate orientation of conceptual cross section A-A' which is illustrated on Figure 8 illustrating the conceptual model at the Site. The Site is underlain by a complex mix of interlayered till and outwash deposits deposited in a stagnation moraine setting. The area around the Site has a hummocky and collapsed topography characteristic of stagnation moraines formed from differential melting of glacial ice blocks. Stagnation moraines have a complicated distribution of soil materials composed of glacial till, outwash, and water-laid sediments. Layers of different sediment types can form complex vertical and lateral sequences as outwash sediments are deposited in meltwater channels concurrently as till is deposited from melting ice blocks. Outwash deposits are generally sandy and till deposits are composed of clay to silt loam in the area. Gravel and boulders are also present in the deposits.

The surficial geology at the Site is generally composed of an upper outwash deposit consisting of sandy material with discontinuous layers of silty and clayey till material at various depths within approximately 100 to 110 feet of the ground surface. The discontinuous till layers within this upper deposit do not appear to extend laterally across the Site. A continuous layer of clayey till approximately 10 to 30 feet thick is present below the upper sequence of outwash and till at depths generally greater than 100 feet. A deeper layer of sandy outwash deposits is present below the continuous till layer. Cross section A-A', extending across the Site from well S-2A in the northwest to well S-50 in the southeast, shows the surficial geology of the interlayered upper deposits over the continuous clay layer.

The Otter Tail River has cut a surficial channel across the glacial sediments with a general east-west trend to the north of the Site. Post-glacial fluvial deposits are likely present in the river valley (Figure 4). The elevation of the river is approximately 70 to 95 feet below the surficial elevation of the Site. The river elevation ranges from approximately 1202 feet MSL to the east of the Site to 1193 feet MSL to the west of the Site.

The Site geology is consistent with the regional geology described in Section 2.3.1. In general the surficial geology of the Site consists of the following sequence:

- The uppermost layer across most of the Site consists of a unit of sandy outwash material which
 contains discrete layers of silty and/or clayey material to depths of approximately 100 to 110 feet.
 The base of this layer is at an elevation of approximately 1190 to 1200 feet MSL in the Site area.
- The surficial layer in the northwest corner of the Site in the vicinity of wells S-2, S-2A, S-3, S-3A-R, S-10-R, S-13, and S-14-R consists dominantly of till composed of clayey sand to sandy clay with discontinuous interlayered sand lenses to depths of approximately 37 to 60 feet. A layer of sandy

material is present below the surficial clay deposit which is consistent with the geology in other areas of the Site.

- Individual layers of fine-grained material within the upper outwash sand in the east-southeast
 portion of the Site do not extend laterally across the Site, range in length/width from
 approximately 100 to 1,500 feet, and are approximately 1 to 25 feet thick (see cross section A-A').
 The elevation of the base of this upper outwash unit (1190 to 1200) is generally below the
 elevation of the Otter Tail River.
- A consistent layer of clay and sandy clay material is present below the interlayered outwash material. This layer of clayey material ranges from approximately 10 to over 30 feet thick and appears to be laterally extensive across the Site. The top of this clay layer is the contact with the base of the upper outwash sand with interlayered clay and silt at an elevation of approximately 1190 to 1200 feet at the Site.
- A layer of sandy material is present below the extensive clay layer.

Details of the Site hydrology and hydrogeology are presented in Section 2.3.4. Monitoring wells are screened within multiple intervals of the geologic sequence described above. The general hydrogeology consists of the following:

• **Upper Perched Zones.** Zones of perched water are present on discrete fine-grained soil layers within the upper sandy outwash deposits. Perched water was encountered in several borings. The layers of fine-grained material that perch water in these zones are not laterally extensive, tend to terminate within the Site area, and do not extend completely below the lined facility (see cross section A-A'). Water will eventually drain from the discrete perched units to lower portions of the sandy deposit. Well S-3 is screened in one such zone but, because it is isolated from the existing CCR landfill, it is not included in the CCR monitoring.

The pond located to the west of the Site appears to be perched on the clayey surficial soil observed in borings on the western portion of the Site (S-10R and S-14R).

- Intermediate Aquifer Zone. Wells S-4, S-50, and S-51 are screened in a saturated zone that extends from approximately Elevation 1220 feet MSL to Elevation 1260 feet MSL. Laterally this zone extends off site to the south and west but does not extend as far west as well S-1 nor as for north as well S-6 (Figure 4). While this intermediate aquifer does not extend under the CCR facility, the groundwater in the intermediate aquifer drains down into the underlying water table aquifer, which then extends under the CCR facility. As such the intermediate aquifer is an important component of the upgradient water quality.
- Water Table Aquifer Zone. Groundwater is continuously present in the lower sandy outwash
 deposit underlying the Site. This unit is referred to as the water table aquifer, despite the fact that
 it appears to be confined south of the facility and despite the fact that the intermediate aquifer
 described above is the water table south of the Site. Head elevations in the lower sand unit are

higher than the elevation of the overlying clay indicating flow is upward from the lower sand toward the surficial unconfined aquifer.

The groundwater elevation ranges from approximately 1196 to 1220 feet MSL in the water table aquifer. This unconfined saturated zone is consistent across the Site. The flow direction of the water table aquifer is toward the Otter Tail River and the river is at a lower elevation than the water table. The lower boundary of the saturated outwash deposit is the surface of the underlying continuous clay layer at an elevation of approximately 1190 to 1200 feet.

Water infiltrating into the soil from the ground surface at the Site will migrate vertically downward until reaching the water table within the unconfined outwash deposits (water table elevation of approximately 1196 to 1200 feet), then flow laterally toward the Otter Tail River. Water may become perched on the discrete layers of fine-grained soil until sufficient water is present in the perched layer to drain to lower portions of the deposit. There do not appear to be other outlets for perched water other than eventually draining to the lower water table aquifer. Flow in the water table aquifer is expected to be toward the north-northwest from the Site to the Otter Tail River. Perched water does not appear to be present below the lined facility or potentially below only a portion of the lined facility. Therefore, the water table aquifer at elevations of approximately 1196 to 1200 feet will receive water infiltrating at the lined facility location. The lower confined aquifer is recharged at upgradient locations, and water from the Site will not flow to the lower confined aquifer as the hydraulic gradient is vertically upward from the deeper confined aquifer to the overlying unconfined aquifer.

3.2 Release Conceptual Model

A release conceptual model uses the flow and geologic information of the site conceptual model to predict the likely pathway that a release to groundwater would travel so that a monitoring network can be properly sited. In order for a hypothetical release from the facility to occur it would need to breach the compacted clay and geomembrane composite liner system at the base of the landfill and slowly seep through the base of lined footprint into the unsaturated zone under the landfill. The release would then drain with gravity primarily vertically downward. Some lateral dispersion would be anticipated as the release encounters layers of lesser or greater permeability. Eventually the release would reach the water table in the Monitoring Zone which consists of the lower saturated outwash.

Assuming predominantly horizontal flow, the release would then move toward the Otter Tail River which is the discharge area for groundwater. Long before the release would reach the river, the leading edge of the release would disperse laterally as the constituents of the release move into well screens within the monitoring well network (e.g., S-13 on Figure 9). Samples of groundwater from the network wells would then detect the concentrations of constituents in groundwater. If the concentrations exceed statistical thresholds as described in the Sampling and Analysis Plan for the Site, it would indicate that a release has occurred unless otherwise demonstrated to be unrelated to the landfill. This release conceptual model is illustrated on Figure 9.

4.0 CCR Groundwater Monitoring System

USEPA guidance (1991) is the basis for determining the adequacy of the wells. The CCR groundwater monitoring system for the Ash Landfill is shown on Figure 10. The CCR groundwater monitoring system well network consists of the following:

- upgradient water table aquifer wells:
 - S-51. This well was recently installed in the intermediate aquifer. It is adequately
 constructed and well placed for upgradient monitoring of the existing CCR landfill
 because, based on the conceptual model, groundwater from this area flows past the
 upgradient waste boundary and then to downgradient wells.
 - o S-52. This well was recently installed in the water table aquifer upgradient of the existing CCR landfill. It is adequately constructed and well placed for upgradient monitoring of the existing CCR landfill because, based on the conceptual model, this water is likely to move past the upgradient waste boundary to reach downgradient wells. The downgradient groundwater is a mixture of both the intermediate and lower upgradient groundwater.
- downgradient water table aquifer wells:
 - S-2A. This well is adequately constructed and screened within the Monitoring Zone downgradient of the existing CCR landfill.
 - S-3A-R. This well is adequately constructed and screened within the Monitoring Zone downgradient of the existing CCR landfill.
 - S-13. This well is adequately constructed and screened within the Monitoring Zone downgradient of the existing CCR landfill.
 - S-14-R. This well is adequately constructed and screened within the Monitoring Zone downgradient of the existing CCR landfill.
 - S-10R. This well is adequately constructed and screened within the Monitoring Zone downgradient of the existing CCR landfill.

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

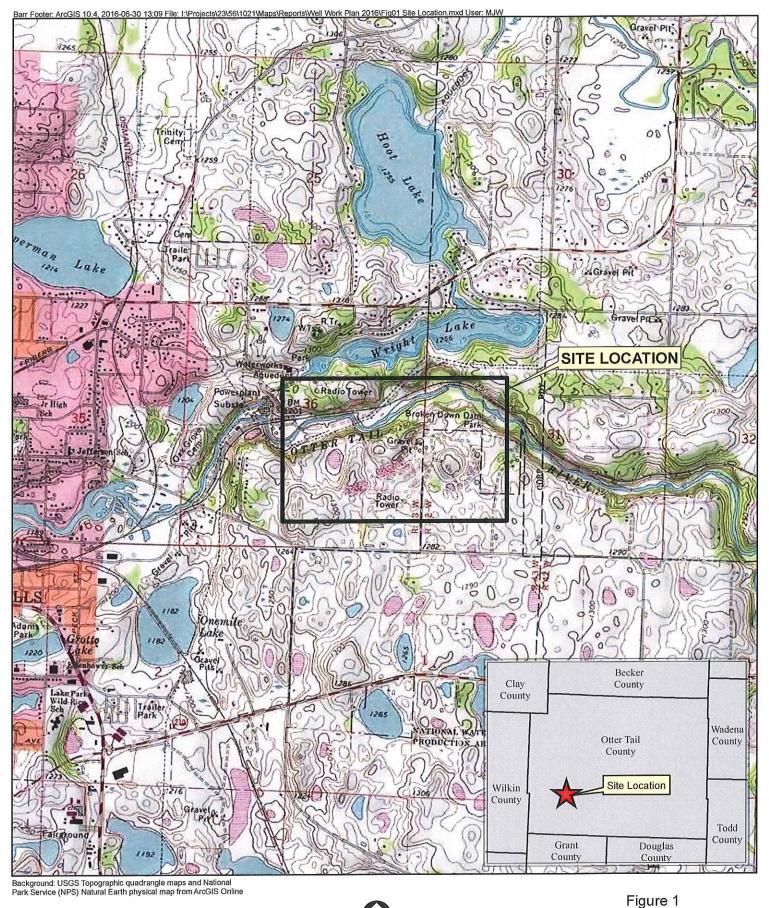
Table 4 CCR Monitoring Well Details

Well	Unique No.	Installation Date	TOR	Depth	Screen Length/ Diameter (ft/in)	Materials			
Upgradient Wells									
S-51	814830	6/3/2016	1286.90	53	10/2.0	black steel/SS/#10			
S-52	822155	7/6/2016	1286.62	100	10/2.0	black steel/SS/#10			
			Downgr	adient We	ells				
S-2A	444350	5/9/1989	1272.9	77	10/2.0	PVC/PVC/#10			
S-3AR	674671	9/27/2005	1271.56	77	10/2.0	PVC/PVC/#10			
S-10R	806341	4/23/2015	1281.47	78	10/2.0	black steel/SS/#10			
S-13	632810	4/9/2001	1296.42	96.5	10/2.0	SS/SS/#15			
S-14R	806342	4/21/2015	1280.61	84.5	10/2.0	black steel/SS/#10			

5.0 References

- Anderson, M.P., Woessner, WW, and Hunt, R.J., 2015 Applied Groundwater Monitoring Simulation of Flow and Advective Transport, Second Edition, Elsevier Inc. 564 pp.
- Barr, 2015. Monitoring Well Installation Report. Hoot Lake Plant Industrial Solid Waste Landfill Permit No. SW-211. Prepared for Otter Tail Power Company.
- 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.
- Ekman JC and JA Berg, 2002. Part B Plate 2 Geologic Sensitivity to Pollution of Near-surface Groundwater, Regional Hydrogeologic Assessments RHA-5. Minnesota Department of Natural Resources. http://www.dnr.state.mn.us/waters/programs/gw_section/mapping/platesum/rha_ot.html
- Ekman JC, 2002. Part B Plate 1 Surficial Hydrogeology, Regional Hydrogeologic Assessments RHA-5. Minnesota Department of Natural Resources. http://www.dnr.state.mn.us/waters/programs/gw_section/mapping/platesum/rha_ot.html
- Freeze, R. Allen and John A. Cherry, 1979. Groundwater. Prentice Hall.
- Harris, K.L., 1999. Quaternary geology-Otter Tail area, west-central Minnesota [Part A]. Minnesota Geological Survey. Regional Hydrogeologic Assessments RHA-5. Minnesota Geological Survey. Retrieved from the University of Minnesota Digital Conservancy, https://hdl.handle.net/11299/59783.
- Minnesota County Well Index (accessed 6/29/16).
- Reppe, Thomas H.C., 2005. Ground-Water Availability from Surficial Aquifers in the Red River of the North Basin, Minnesota. USGS Scientific Investigations Report 2005–5204. http://pubs.usgs.gov/sir/2005/5204/pdf/SIR20055204.pdf.
- TKDA, 1989. Phase II Geotechnical Investigation Report and Environmental Monitoring System Plan, Hoot Lake Ash Disposal Landfill, Otter Tail Power Company, Fergus Falls, Minnesota.
- TKDA, 1988. Geotechnical Investigation Report and Environmental Monitoring System Work Plan, Hoot Lake Ash Disposal Landfill, Otter Tail Power Company, Fergus Falls, Minnesota.
- 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.
- US EPA, 1991. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells. EPA 600/4-89/034 March 1991. 221 pp.
- Wenck, 2010. Supplemental Phase II/III Hydrogeologic Investigation Report, Hoot Lake Ash Disposal Facility, Otter Tail Power Company, Permit SW-211.

Figures



2,000 1,000 0 2,000 Feet

SITE LOCATION MAP Hoot Lake Ash Disposal Facility Otter Tail Power Company Fergus Falls, MN

Industrial Solid Waste Unit IL001

Existing CCR Landfill (IL002)

Existing Monitoring Well

Minnesota industrial solid waste unit IL001 was closed prior to the effective date of the CCR Rule and is therefore not subject to the rule.



Figure 2

SITE MAP
Hoot Lake Ash Disposal Facility
Otter Tail Power Company
Fergus Falls, MN



Industrial Solid Waste Unit IL001

Oha – Gravel, sand, silt, day and disseminated organic debris. Dark, obscurely bedder, associated in places with sand and gravel of older river-channel sediments; commonly more than 3 feet thick. In places eroded glacial sediment is exposed in channel.

Qus — loam to clay loam. Pebbly, unsorted, unbedded, abundant cobbles and boulders; more than 33 feet thick; 10 to 33 feet of overall relief on undulating to rolling surface.



250 125 0

Figure 3

SITE SURFICIAL GEOLOGY MAP Hoot Lake Ash Disposal Facility Otter Tail Power Company Fergus Falls, MN





Water Table Contours in Intermediate Aquifer

Water Table Contours in the Water Table Aquifer

* Spring 2016 Values

Figure 4

GROUNDWATER CONTOURS July 6, 2016 Hoot Lake Ash Disposal Facility Otter Tail Power Company Fergus Falls, MN

Troclery grozloris stocle16 →- S52 (CCR) 412212214 8120212013 **Upgradient Wells** 220217122 2202/2/4 S4 (non CCR) 112612017 0102/82/17 orozlerle 8002/62/07 1210 1215 1225 1220 1260 1255 1250 1265

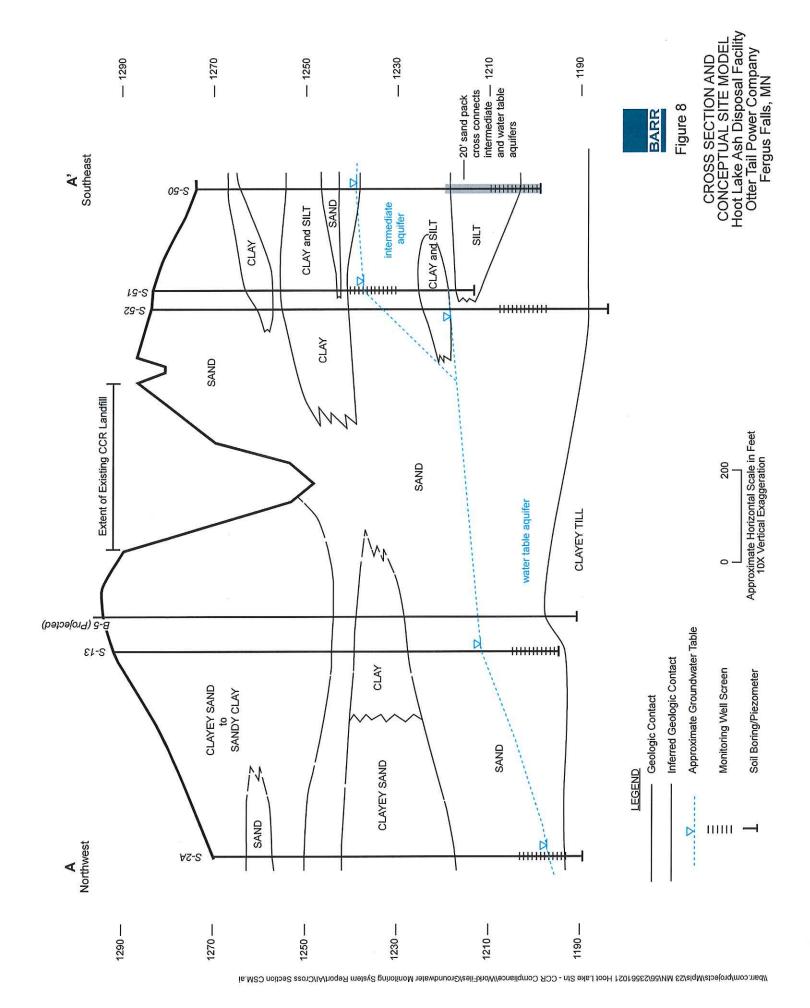
Figure 5 Upgradient Groundwater Levels Over Time

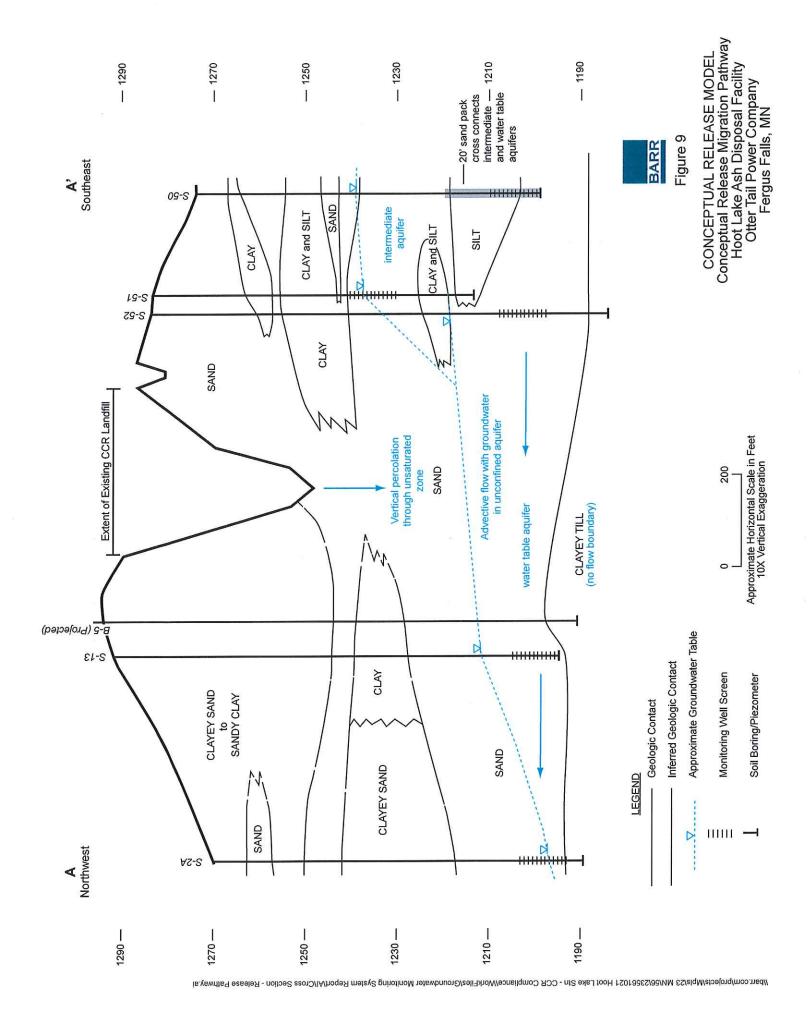
Troclery grozloris 5202/5/6 12/27/2014 Arozlizala ---S14R **Downgradient CCR Wells** 812412013 220217122 -S3AR -S10R 41212012 S2A Troclary 0202/82/22 orozlerle 41612009 8002/62/07 1216 1214 1212 1210 1206 1204 1200 1198 1196 1194 1208 1202 Elevation, Feet Above Mean Sea Level

Figure 6 Downgradient Groundwater Levels Over Time

Stocloris 31021516 S52 Arozizsia ---- S51 812412013 ---S14R 220217122 -S2A ----S3AR ----S10R ----S13 2202/2/4 112612017 0102/81/17 orozlerle 2002/52/07 1190 1215 1205 1200 1195 1225 1210 1235 1230 1240 Elevation, Feet Above Mean Sea Level

Figure 7 Groundwater Levels Over Time in Existing CCR Landfill Monitoring Wells









Industrial Solid Waste Unit IL001 Monitoring Program Well

Existing CCR Landfill (IL002)



9

Figure 10

CCR GROUNDWATER MONITORING SYSTEM Hoot Lake Ash Disposal Facility Otter Tail Power Company Fergus Falls, MN

Appendices

Appendix A Boring and Well Logs

Appendix A Boring and Well Logs

upgradient well S-52

WELL OR BORING LOCATION	-		MIN	INESOTA	DEPARTMENT OF HEALTH	MINNESOTA UNIQUE WELL AND BORING NO.
County Name	Nov This	WELLA	AND B	ORING	G CONSTRUCTION RECORD a Statutes, Chapter 1031	822155
Township Name Township	No. Range No.	Section No. Fra	action	7,70		WORK COMPLETED .
Favous Falls 132	N 43W	36 N	E SE	1/4	85' "	7-5-16
GPS LØCATION — decimal degrees (to	o four decimal places).				DRILLING METHOD Cable Tool Driven	
	ongitude				Auger Rotary	
House Number, Street Name, City, and	ZIP Code of Well Loc	ation	565	37	Other SONIC WELL!	HYDROFRACTURED? Yes No
Show exact location of well/boring in se	ection orid with "X"	Sketch map o	well/boring	location.	N/A From_	
Onlow exact localion of work sorting in st	Journ grid Way 74	Sketch map o SI roads, bu	howing prop ildings, and	erty lines, direction.	USE Domestic Monitoring	Heating/Cooling
	Cas	Man			Noncommunity PWS Environ. Bor	
	Jec	Map			☐ Community PWS ☐ Irrigation ☐ Elevator ☐ Dewatering	Remedial
W E-					CASING MATERIAL Drive Shoe?	THOU P DIAM
					Steel — Threaded	Welded
The state of the s	Mile				Plastic	
					Diameter Weight S	Specifications SIN 40 (a. in. To 85 ft.
1 Mile					in. To 75 ft. 3 65 lbs./ft.	in To the
PROPERTY OWNER'S NAME/COMPA	NY NAME	X 0	-51	0537	in. Tottlbs./ft.	in. Tot.
1018CMOTEN	PARKE	d Farqui	STATIS	MU	in. Toftlbs./ftSCREEN ★ € \	in. Toft.
Property owner's mailing address if diff	THE RESERVE OF THE PARTY OF THE	address indicated	above.	ر	Make Johnson From	m tt. To ft.
NO POX	196		Sat Mean		1) 0	Diam. O
Taxance To	US MA	1 905	343		Old Care	FITTINGS T + C
Fergus Fa	113,1-11				STATIC WATER LEVEL	Measured from Ground
						e Date measured 7-5-16
WELL OWNER'S NAME/COMPANY N	7	Carr	MI	1211	PUMPING LEVEL (below land surface)	
Well/boring owner's mailing address if	VONEY	owner's address in	dicaled abov	114	t, after	_hrs, pumpingg.p.m.
					Pitless/adapter manufacturer	Model
-Same	ac av	nve-			At-grade Well House Hand Pump	
- 20mc	v2 or	,010			GROUT INFORMATION (specify bentonite, cement-sand	
					Material V CAN CONTROL 65 TO D	ft
					Material From To Material From To	
GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	то	Driven casing seal From To	
			^	100	NEAREST KNOWN SOURCE OF CONTAMINATION	
Topsoil	25	7	0	10	Well disinfected upon completion? Yes No	directiontype
Clay	R-	5	10	25	PUMP	
	-7>	wa C	21-	10	Not installed Date installed	
SAND / SILT	6	(C)	25	60	Manufacturer's name	
With Is and	B	5	60	85	Applications of the Samuel Company of the Sa	PVolts
7111 / 15 miles	1					t. Capacity g.p.m.
					Type: Submersible L.S. Turbine Reciprocating	ng [] Jet []
					Does property have any not in use and not sealed well(s	s)? Yes No
					VARIANCE	Yes No TN#
					WELL CONTRACTOR CERTIFICATION	A A CONTRACTOR OF THE PARTY OF
					This well was drilled under my supervision and in accord The information contained in this report is true to the best	dance with Minnesota Rules, Chapter 4725. ist of my knowledge.
Use a sec REMARKS, ELEVATION, SOURCE OF	cond sheet, if needed. F DATA, etc.				A Division	22107
		7010	7		Caxage Drilling	260+
/	17-16	- 1817			Licensee Business Name	Lic. or Reg. No.
					Dato Mad	2856 7-29-16
14	tel 5:	57			Certified Representative Signature	Certified Rep. No. Date
					2 2 1 1	
IMPORTANT - FILE WITH PROPERT	Y PAPERS WELL OW	NER COPY Q	221	55	Roy Buckenbergen	<u> </u>
ID #52603		0		00	Traile of Dillier	HE-01205-15 (Rev. 8/13)

LOG OF BORING S-52 Barr Engineering Company 4300 MarketPointe Drive Suite 200 Minneapolis, MN 55435 BARR Telephone: 952-832-2600 SHEET 1 OF 2 Surface Elevation: 1284.1 ft Project:Hoot Lake CCR Compliance Project No.:23/56-1021 Drilling Method:Rotasonic Unique Well No.: Location: Hoot Lake, MN Sampling Method:Rotasonic core Coordinates:Lat: 46.28647° Long: -96.03146° Completion Depth: 100.0 ft feet Graphic Log Sample Type Sample No. WELL OR PIEZOMETER Elevation, SCS CONSTRUCTION Depth, LITHOLOGIC DESCRIPTION DETAIL CH/ TOPSOIL: FAT CLAY WITH SAND (CH): fine grained; dark yellowish brown; moist; roots; medium plasticity; weak HCl reaction; 5% gravel, 20% sand, 95% fines. WELL GRADED SAND WITH GRAVEL AND CLAY (SW-SC): dark yellowish brown; moist; PRO. CASING subrounded, fine to coarse sand, rounded gravel, loose; weak HCl reaction; 20% gravel, 70% sand, 1280 5 Type: Sch 40 Steel Interval: 3' ags-4' bgs SW-8 ft: 7.5YR 3/4 (more red). RISER CASING 1275 10 2" Type: Sch 10 304 s.s/ TEMPLATE.GDT Sch40 Steel Interval: 2.7' ags -1270 WELL GRADED SAND (SW): light olive brown; moist; subrounded to rounded, very fine grained; 75.5' bgs 15weak HCl reaction; 0% gravel, 95% sand, 5% fines. **GROUT** BARR Type: Neat Cement SW Interval: 0-67.5' bgs 1265 **ENVIRO LOG** 20-SFAL WELL GRADED SAND WITH CLAY AND GRAVEL (SW-SC): dark grayish brown; moist; rounded, Type: Bentonite SW fine to coarse grained, loose; 20% gravel, 70% sand, 10% fines. Interval: 67.5-71.5' qbs LAKE CCR.GPJ BARRLIBRARY.GLB 1260-SILT (ML): olive brown; moist to wet; black organic laminations (1 mm thick), somewhat cohesive, SANDPACK MI. trace orange oxidation laminations, very fine sand; low plasticity; slow dilatancy; weak HCl reaction; Type: #40 Red Flint 0% gravel, 10% sand, 90% fines. SW-WELL GRADED SAND WITH CLAY AND GRAVEL (SW-SC): dark grayish brown; moist to wet; counded, fine to coarse grained, loose; no HCl reaction; 20% gravel, 70% sand, 10% fines. Interval: 71.5-85.5' bgs SC ML SILT (ML): gray; moist; light gray laminations; low plasticity; rapid dilatancy; weak HCl reaction; 0% SCREEN 1255 SW gravel, 0% sand, 100% fines. 30-SC WELL GRADED SAND WITH CLAYEY GRAVEL (SW-SC): dark grayish brown; moist to wet; Diameter: CL counded, fine to coarse grained, loose; no HCl reaction. Type: Stainless Steel LEAN CLAY (CL): very dark gray; moist; medium plasticity. SW Interval: 75.5-85.5' bgs WELL GRADED SAND WITH CLAYEY GRAVEL (SW-SC): dark grayish brown; wet; rounded, fine to 3\23561021 HOOT LAKE CCR COMPLIANCE\23561021 HOOT 1250 coarse grained, loose; no HCl reaction. β2.5 to 33 ft: wet, very fine sandy silt, red brown. 35-SANDY LEAN CLAY WITH GRAVEL (CL): dark gray; moist; fine to very fine grained, lean, at times more clay and less sand; weak HCl reaction; 10% gravel, 30% sand, 60% fines CL 1245 40 WELL GRADED SAND WITH SILT (SW-SM): dark yellowish brown; moist to wet; trace rounded gravel, fine grained, rounded to subangular; weak HCl reaction. 43 ft: large cobble. 1240 45 SW-SM 1235 Date Boring Started: 7/5/16 4:05 pm Remarks: Date Boring Completed: 7/6/16 8:30 am AMK2 Logged By: **Drilling Contractor:** Cascade Additional data may have been collected in the field which is not included on this log. Weather: 82 F, 8mph NE winds, cloudy Drill Rig: Truck

						120					
		43	00 M	arket	ering Company Pointe Drive Suite 200		LOG	OF BORING S-	·52		
B	AR	R Te	innea elepho	polis, ne:	MN 55435 952-832-2600			SHEET 2 OF	2		
Proje	ect:Ho ect No ation:H rdinate ım:	:23/56 oot La	Unique W	/ell No.:							
Depth, feet	Sample Type & Recovery	Sample No.	U S C S	Graphic Log	LITH	LITHOLOGIC DESCRIPTION					
3	-		SW- SM		gravel, fine grained, rounded to subangul 51 to 54 ft: more gravel.	W W		PRO. CASING	1230		
55-	- 1				SILTY SAND (SM): dark greenish gray; n low plasticity; weak HCl reaction.	noist to wet; somewhat cohesive; medium to fast dilatancy;		Diameter: 6" Type: Sch 40 Steel Interval: 3' ags-4' bgs	-		
60-					57 ft: trace 1mm laminations; no HCl read			RISER CASING Diameter: 2"	1225		
PLATE.GDT	<u> </u>		SM		of to 64 it. lean day, no norreaction, ox	grave, 40% said, 60% inies.		Type: Sch 10 304 s.s/ Sch40 Steel Interval: 2,7' ags - 75.5' bgs	1220		
OG BARR TEM	-							GROUT Type: Neat Cement Interval: 0-67,5' bgs	1215		
BARRLIBRARY.GLB ENVIRO LOG BARR TEMPLATE.GDT -0.2 -0.2 -0.2 -0.2	-				subrounded, fine grained, loose, gravel, s			SEAL Type: Bentonite Interval: 67.5-71.5' gbs	1210		
PJ BARRLIBRAR 08	-				75 ft: color change to gray; no HCl reaction			SANDPACK Type: #40 Red Flint Interval: 71.5-85.5' bgs SCREEN	1205		
DOT LAKE CCR.G	-		SW- SC		83 ft: more clay; no HCl reaction. 85 ft: end of day 7/5/16; no HCl reaction.			Diameter: 2" Type: Stainless Steel Interval: 75,5-85,5' bgs	1200		
OXIGINTIPROJECTS/23561021 HOOT LAKE CCR COMPLIANCE/23561021 HOOT LAKE CCR.GPU OXIGINATION OF THE CCR.COMPLIANCE/23561021 HOOT LAKE CCR.CPU OXIGINATION OF THE CC	-					1195					
LAKE CCR COMP		S#			SANDY LEAN CLAY (CL): dark gray; mo gravel; no HCl reaction.	SANDY LEAN CLAY (CL): dark gray; moist to wet; lean, rounded fine to coarse sand, rounded small					
001 100 100			CL		End of boring 100.0 feet			1185			
Date	Boring	g Star	ted:		7/5/16 4:05 pm	Remarks:		1			
Date	Boring	g Com		d:	7/6/16 8:30 am	× =					
Logo	ged By		5121		AMK2						
	ng Cor	uracto	or:		Cascade	Additional data may have been collected in the field which is not included on t Weather: 82 F, 8mph NE winds, cloudy	his log.				
Ö Drill Rig:					Truck	vvediner. 621, onipitive winds, cloudy					

BAI	RF	43 Mi	00 Ma	arketl	oring Company Pointe Drive Suite 200 MN 55435 952-832-2600	LOG OF BORING S-5 DRAF SHEET 1 OF 3	
Project:	Hoo	t Lak	e CCI	R Cor	mpliance	Surface Elevation:	
Project	No.:	23/56	6-102	1		Drilling Method:Geoprobe	
Locatio Coordin			ke, N	1N		Sampling Method:	
Datum:	aice					Completion Depth:70.0 ft	
•		00		_			et
Depth, feet Sample Type	Recovery	Sample No.	U S C S	Graphic Log		LITHOLOGIC DESCRIPTION	Elevation, feet
-0-				—	(OL): ORGANIC SOIL; Black; moist; black	k topsoil with grass.	
-	3		OL		(SP): POORLY GRADED SAND; fine to n		
_	1				(SF). FOORET GIVADED SAND, line to h	neddin granta, ran, mosti	
		1					
						*	
5							
	8						
	3	2					
			SP				
			SP.				
10					More fine-grained from 10 ft.		
5 -							
	8						
Y -	0	3			¥		
9 _							
15	Ш						
						ii .	
NAKA -	ä			П	(SM): SILTY SAND; fine to medium grain	ed; tan/brown; moist to wet.	
	ř	4			A contract of the contracting contracts and contract of the co	Gestandarden authabendern. En	
7	h		SM		£		
- 1							
20					(CL): SANDY LEAN CLAY; brown; wet; lo	w plasticity, fine-grained sand.	
			CL				
	10	-					
3 -		5			(CL): LEAN CLAY; gray; moist; medium p	plasticity.	
- L	9		CL				
25	Ш		OL.				
2 20	Ü						
N			SP	0	(SP): POORLY GRADED SAND with GR		
(ML): SANDY SILT; brown; moist; trace gravel.							
98 102			s				
2 _30_J Date Bo	 orina	Star	ted:	HT.	6/2/16	Remarks:	
Date Bo	oring	Com		d:	6/2/16		
Logged					ECL		
Drilling		tracto	or:		Dakota	Additional data may have been collected in the field which is not included on this log. Weather:	
Drill Rig]:					TTOGETO.	-

D.		43 M	300 M innea	arket polis,	ering Company Pointe Drive Suite 200 MN 55435		LOG OF BORING S-51 DRAF								
Proje Proje Local	ect No. ition:H dinate	ot Lak :23/5	e CC 6-102	R Co	952-832-2600 mpliance	Surface Elevation: Drilling Method:Geoprobe Sampling Method: Completion Depth:70.0 ft									
	Sample Type & Recovery	Sample No.	U S C S	Graphic Log			Elevation, feet								
-30- -			CL		(CL): LEAN CLAY; gray; moist; low plasti	city.									
35-		7	ML		(ML): SILT; gray; moist; few gravel at 32	ft.									
		8	CL		(CL): SANDY LEAN CLAY; gray; moist to	(CL): SANDY LEAN CLAY; gray; moist to wet; low to medium plasticity, fine-grained sand.									
40-			SP- SM ML		(ML): SILT; brown; moist.	9 100									
CCR.GPJ BARKEIBRART.GPB ENVING		9				(SP): POORLY GRADED SAND with GRAVEL; fine to coarse grained; tan/brown; moist.									
50 – 50 – 50 – 50 – 50 – 50 – 50 – 50 –	-	11	SP		Gray from 52.5 ft. Silty sand lens (6) at 53 ft.										
55—		12	CL ML	000	Increasing fines content from 56 - 58 ft. (CL): SANDY LEAN CLAY; gray; moist to	Increasing fines content from 56 - 58 ft. (CL): SANDY LEAN CLAY; gray; moist to wet; low plasticity. (ML): SANDY SILT; gray; moist; fine-grained sand.									
Date Logge	Boring Boring ed By: ng Cor Rig:	g Con	nplete	d:	6/2/16 6/2/16 ECL Dakota	Remarks: Additional data may have been collected in the field which is not included on the Weather:	his log.								

В	AR	43 M	300 M innea	arket polis.	ering Company Pointe Drive Suite 200 MN 55435 952-832-2600		LOG OF BORING S-51 DRAFT SHEET 3 OF 3
Pro Pro Loc Coo		ot Lak .:23/5/	e CC 6-102	R Co	mpliance	Surface Elevation: Drilling Method:Geoprobe Sampling Method: Completion Depth:70.0 ft	
Depth. feet	Sample Type & Recovery	Sample No.	USCS	Graphic Log		LITHOLOGIC DESCRIPTION	Elevation, feet
-60		13	ML		(ML); SANDY SILT; gray; moist; fine-gra	ined sand. (continued)	
65			SM		(SM): SILTY SAND; very fine to fine gra	ned; gray; wet.	
BARRLIBRARY.GLB ENVIRO LOG BARR TEMPLATE.GDT	-	14	ML		(ML): SANDY SILT; gray.		
BARR 70				1.1.1.	End of boring 70.0 feet		
ENVIRO LOG	-				·		2
RLIBRARY.GLB	- ;-				*		a a
21 HOOT LAKE CCR.GPJ BAR	- - -				er en		
CCR COMPLIANCE\235610	e Boringed Byling Col				v		
23561021 HOOT LAKE							
Dat Dat	e Borin e Borin	g Star g Con		d:	6/2/16 6/2/16	Remarks:	
Foo	ged By	:			ECL		
Dril Dril	ling Co l Rig:	ntracto	or:		Dakota	Additional data may have been collected in the field which is not included on the Weather:	his log.

upgradient well S-51

141.16

MINNESOTA UNIQUE WELL

WELL OR BORING LOCATION County Name	WELL		IND BORING CONSTRUCTION RECORD					
Ottertail Power Company				ta Statutes, Chapter 103I				
Township Name Falls Township No. Range No. 43W		raction SW NE		WELL/BORING DEPTH (completed) DATE WORK COMPLETED 6-3-16				
GPS LOCATION — decimal degrees (to four decimal place Latitude X Longitude				DRILLING METHOD Cable Tool Rotary				
House Number, Street Name, City, and ZIP Code of Well L	ocation us Falls :	56537		Other				
1012 Water Plant Rd Ferg Show exact location of well/boring in section grid with "X."			a location	144				
Show exact location of well/boring in section grid with "X."	Sketch map S roads, b	showing pro	perty lines,	From tt. To tt. USE Demestic X Monitoring Heating/Cooling				
133 - 133 -	10003, 0		/	Domestic X Monitoring Heating/Cooling Noncommunity PWS Environ. Bore Hole Industry/Commercial				
		-	1/	Community PWS Irrigation Remedial				
				Elevator Dewatering				
W F F				CASING MATERIAL Drive Shoe? Yes X No HOLE DIAM. X Steel Threaded Welded				
X ½ Mile		IN RO						
	> 11	8		CASING Diameter Weight Specifications				
S				Diameter Weight Specifications Sch 40 10 in. To 53 ft				
1 Mile				in. Toftin. Toft				
PROPERTY OWNER'S NAME/COMPANY NAME Ottertail Power Company				in. To ft. lbs./ft. in. To ft.				
				SCREEN OPEN HOLE				
Property owner's mailing address if different than well local	ion address indicated	above.		Make Johnson From - tt. To tt.				
215 South Cascade				Type stainless steel Diam. 2"				
Fergus Falls, MN 565	37			Slot/Gauze 10 slot Length 10 Set between 43 ft. and 53 ft. FITTINGS couplers				
•				STATIC WATER LEVEL 49 tt. XBelow Above land surface Above land surface				
WELL OWNER'S NAME/COMPANY NAME				PUMPING LEVEL (below land surface)				
Ottertail Power Comp	anv			NA ft. after hrs. pumping g.p.m				
Well/boring owner's mailing address if different than proper		dicated abo	ve.	WELLHEAD COMPLETION				
				Pitless/adapter manufacturer Model X Casing protection Pro top X 12 in. above grade				
215 South Cascade				At-grade Well House Hand Pump				
Fergus Falls, MN 565	37			GROUT INFORMATION (specify bentonite, cement-sand, neat-cement, concrete, cuttings, or other)				
				Material Bentonite-rom 0 To 40 ft. 4 Yds. X Bags				
				MaterialFromToIt Yds Bags				
GEOLOGICAL MATERIALS COLOR	HARDNESS OF	FROM	то	Material From To ft. Yds. Bags				
descende materials	MATERIAL	1200		Driven casing seal From ToBags				
Sandy clay BRN		0	26	NEAREST KNOWN SOURCE OF CONTAMINATION UNKNOWN				
Bandy Clay Birty				feettype				
San d BRN		26	27	Well disinfected upon completion? Yes No PUMP				
		-	-					
Sandy clay BRN		27	50	X Not installed Date installed				
	-		1	Manufacturer's name				
Sand BRN		50	70	Model Number HP Volls				
				Length of drop pipeft. Capacityg.p.m				
				Type: Submersible L.S. Turbine Reciprocating Jet				
				4				
				Does property have any not in use and not sealed well(s)? Yes X No VARIANCE				
				Was a variance granted from the MDH for this well? Yes X No TN#				
		1		WELL CONTRACTOR CERTIFICATION				
				This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.				
1		4						
Use a second sheet, if needed	d.			1 2 2				
	d.			Dakota Tech. 3553				
	d.			Dakota Tech. Licensee Business Name Lic. or Reg. No.				
	d.			Banota Italii				
	1.			Banota Italii				
	<i>1.</i>			Licensee Business Name Lic. or Reg. No. 2993 Certified Representative Signature Certified Rep. No. Date				
Use a second sheet, if needed				Licensee Business Name Lic. or Reg. No.				
		148	30	Licensee Business Name Lic. or Reg. No. 2993 Certified Representative Signature Certified Rep. No. Date				

		TE OF MINNES		r and total	VI VE IDAL I
WELL!	S-2A			ELL REC	MANUFOCA UNIQUE WELL NO.
OTTER TAIL				lules 156A.	0108
Name Township Nun	Range Number S	36 NU	NNE	"SE"	4. WELL DEPTH (completed) 7 It. 5/9/89
ance and Direction from Road Intersection or Stree	Address and City of We	Il Location Pe	ower P	LINT	5. DRILLING METHOD 1 Cable tool 4 Reverse 7 Driven 10 Dug
ASH DISPOSAL SITE					
Show exact location of well in section grid with "X."	ion Name	t Sect	map of wel	ii location.	20 Hollow rod GP 50 Air 92 80 Bored 110 -692 90 Power lauger HSA 0-692
	lon tvanie	E RO	AP		6. DRILLING FLUID
Block	Number	10	\frown		TUSE WYO-BEN EXTEN HIGH YIELD
│ ╙<u>├</u> 		<i>f</i>			1□ Domestic Monitoring 8□ Heat Pump
"mi. Lot	Number	Merc	Ì		2□ Irrigation 5□ Public 9□ Industry 3□ Test Well 6□ Municipal 10□ Commercial
<u> </u>			į		7 Air Conditioning 110
2. PROPERTY OWNER'S NAME					8. CASING ID Black HOLE DIAM. HOLE DI
OTTER TAIL POW 215 JOUTH CAS	ON COMPAN	14			20 Galv. 50 Welded Drive Shoe? Yes
Address					Drive Shoe? Yes No.S. Q (7
FEROUS FALLS	1 MN 26:				in to 61 ft. Weight lbs./ft. 7725ft.
3. FORMATION LOG	COLOR	FORMATION	FROM	то	
(50)	Brown	SOFT		1	in. toft, Weightlbs./ft. n. toft.
CLYGY SAND (SC)	GCWA	3071	10		Make TITAN INDUSTRIES from 11. to 11.
SAND W/SILT (SP-SM)	BROWN	DENSE	17	13	Type Pic Dis. Z'
			10	2	Stot/Gauze #10 Length 10'
CLYBY SAND (SC)	GRAY.	SNFF	13	20	Set between 67 ft. and 77 ft.
SAND WISH (SP-SM)	Brown	DENSE	20	23	10. STATIC WATER LEVEL 11. M below above Date Measured 5/16/89
3420 07 3101 (01 05 1)	1				ft. of below above Date Measured 5/16/8
JAND (SP)	GMY	DENSE	23	28	ft. afterhrs. pumping g.p.m.
	GRAY	SOFF	28	53	ft. afterhrs. pumping g.p.m.
CLYET SAND (SC)	GM	NEBA	20	23	12. HEAD WELL COMPLETION 1□ Pitless adapter. manufacturer model
SAUD WSILT (SP-SM)	Brown	DENSE	53	57	20 Basement offset 30 At least 12" above ground 30 Phastic casing protection. 4" DIA STEEL CUSING.
		VERY			13. WELL GROUTED?
3AND (SP)	Brown	DENSE	57	11	X Yes □ No
SANDY LEAN CLY (CL)	GRIY	STIFF	77	81	IN Neat Cement 20 Bentonite 30
CANOT GEAR COLL	0.5,1	0.11.1		01	Grout material Down Incompany to the Co. Yes
3.					14. NEAREST SOURCES OF POSSIBLE CONTAMINATION UNKnown test 5 F E direction ASH LANDFILL type
			-		Well disinfected upon completion?
					15. PÚMP
					Date installedNot installed
					Manufacturer's name
	ě.				Model number HP Volts.
		†	\vdash		Length of drop pipe
					Type: 1 Submersible 3 L.S. Turbine 5 Reciprocating
3E					2 Jet 4 Centrifugal 6 C
		 	+	-	16. EXISTING WELLS
He a seem	d sheet, if needed				Unused well on property?
17. REMARKS, ELEVATION, SOURCE OF DATA, etc.		- 0			Abandoned
TCT W.O. # 53	100 89-17	27			This well was drilled under my jurisdiction and this report is true to the best of my
PROJECT MUNAGER =	LOEL FET	TING			knowledge and belief.
WELL IL	5-71	🕶 🗷			TWIN CITY TESTING 0061 Licensee Business Name Address ZIOS 7TN AVE NOCTHY, FARCO, ND 5810Z
TET ID # : .	J LA				Address ZIOS 7TH AVE NECTHY FARCHO, ND 5810Z
GRUND ELEVATION =	= 1270. 3	36			Signed July Date 5/2489
					V Authorized Representative K. MILLER Date 5/26/89 Name of Driller
IMPORTANT:	0.000		1 /1 /1 /1	250	Name of Driller 5/74'30M
FILE WITH DEED - WELL OW	NER COPY	1/2	144	30U	77/16 30M 77/18 30M 18E-01205-02 (Rev. 10/85) 2/82 10M

Wenck Associates, Inc.
1800 Pioneer Creek Center
Maple Plain, MN 55359
Telephone: 783-479-4200
Fax: 763-479-4242

WELL NUMBER S-3A-R PAGE 1 OF 4

		i Andreas in Stranger	un, 10	0 110 1E	PROJECT NAME Environmental Monitoring System
PROJECT NUI					PROJECT NAME Environmental Monitoring System PROJECT LOCATION Fergus Falls, Minnesota
				COM	IPLETED 9/27/05 GROUND ELEVATION HOLE SIZE 8-Inch
					g Services GROUND WATER LEVELS:
DRILLING ME					AT TIME OF DRILLING
1					CKED BY Paul Turner AT END OF DRILLING
NOTES					AFTER DRILLING _—
O DEPTH (ft) SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	
ss 9	83	1-4-4-6 (8)	OH	77 3 6 3 8 ()	0.5 Black sandy clay topsoil Light brown and tan coarse sand and gravel Concrete surface installation
5			sw		
10					Brown to gray clayey sand with some gravel
ss 10	42	3-6-7-7 (13)			
15			sc		



WELL NUMBER S-3A-R PAGE 2 OF 4

					0-41 <i>0-</i> 42	PROJECT NAME Environmental Monitoring Sys	tem
			ower Comp 0909-50	any		PROJECT LOCATION Fergus Falls, Minnesota	tem
PROJ		DEK	0909-00				
DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
	SS 11	33	1-5-7-9 (12)			Brown to gray clayey sand with some gravel (continued)	
35	SS 12	100	2-6-8-11 (14)	SC		37.0 Gray sandy lean clay with discrete 1-inch saturated sand layers occuring in the bottom 10-feet	High solids bentonite grout 2-inch black steel riser pipe

Wenck Associates, Inc.
1800 Pioneer Creek Center
Maple Plain, MN 55359
Telephone: 763-479-4200
Fax: 763-479-4242

WELL NUMBER S-3A-R PAGE 3 OF 4

		- "-			341842	PROJECT NAME Environmental Monitoring Sys	stam
	JECT NUN		ower Comp 0909-50	oany		PROJECT LOCATION Fergus Falls, Minnesota	
DEPTH	E ~	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
	SS 14	100	3-9-11-15 (20)	CL		Gray sandy lean clay with discrete 1-inch saturated sand layers occurring in the bottom 10-feet (continued) 60.0 Tan fine to coarse sand	
NT FILES.GPJ WE	SS 15	75	22-58-34- 31 (92)	sw			
GENERAL BH / TP / WELL GINT FILES.GPJ WENCKGDT 10/3/05	-\ ss 16	92	7-10-13-21 (23)	CL- ML		63.0 Tan sandy silt and clay	2-inch stainless steel riser
GENERAL 65	X		-	GP	000	65.0 Tan with rust stained coarse sand and gravel	steel riser pipe



WELL NUMBER S-3A-R

PAGE 4 OF 4

CLIENT Otter Tall Power Company		PROJECT NAME Environmental Monitoring System			
PROJECT NUMBER _0909-50	PROJECT LOCATION Fergus Falls, Minnesota				
	MATERIAL DESCRIPTION	WELL DIAGRAM			
SS 17 83 3-18-26-23 5 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	Tan with rust stained coarse sand and gravel (continued)	Natural collapse of sand and			
SS 50 4-14-18-20 50 60 70 70	56 20 20 20 20 20 20	gravel			
SS 19 50 1-16-22-30 (38)	. 6 20 20 20 20 20 20 20 20 20 20 20 20 20	2-inch stainless steel #10-slot			
SS 50 1-7-14-18 GP 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	26 26 26 26 26	screen			
AU 21 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	C C C C C C C C C C	Natural collapse of sand and gravel			

S-3AR

· -- • - 155

MINNESOTA DEPARTMENT OF HEALTH WELL AND BORING RECORD

WELL LOCATION			J MII	NNESOTA	A DEPARTMENT OF HEALTH MINNESOTA UNIQUE WELL NO.
County Name		-			D BORING RECORD
Otter Tail				Minnes	ota Statutes Chapter 1031 674671
Township Name. Tow	nship No. Range No.		Fraction	ec.	WELL DEPTH (completed) 77 n. Date Work Completed 9-27-05
Fergus Falls 1 House Number, Street Name, City	and the state of t		NW "NE		
Hoot Lake Plant, 10			or Fire Num		DRILLING METHOD ☐ Cable Tool ☐ Driven ☐ Dug
Show exact location of well in sec			h map of we		Auger HSA Rotary Jetted
Grow exact recursor of their in sec	ion grid min 'A'.	S	Showing prop roads and	erty lines, buildings.	DRILLING FLUID WELL HYDROFRACTURED? [] YES X) NO
				3	NA FROMft. toft.
┃ ┣╬┪ ┪╫	DI CACC	CCE ATTAC	WED M	AD	USE Monitoring Heating/Cooling
	PLEASE	SEE ATTAC	אכט ויו.	AP	☐ Domestic ☐ Community PWS ☐ Industry/Commercial
w	Т				☐ Roncommunity PWS ☐ Remedial ☐ Dewatering ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
	Yatrio				CASING Drive Shoe? Yes X No HOLE DIAM.
 ├ ┼┼┽╅╅	1				X) Steel
S 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1					2000000
	reministration of the second				CASING DIAMETER WEIGHT
PROPERTY OWNER'S NAM					62 in to 67 ft.304 Stainless Steel tos./ft. 8 in to 77 ft.
Otter Tail Pow Property owner's mailing address			- I ab and		0 in to 62 ft. Sch. 40 lbs/ft. in to ft.
215 Cascade St		ion address indicate	ed above.		SCREEN Stainless Steel OPEN HOLE
Fergus Falls,					Make Johnson fromft.toft.
(orgon (aman)					Type Flush Thread Diam. 28
					Slot/Gauze
					STATIC WATER LEVEL
WELL OWNER'S NAME					NAtt. □ below □ above land surface Date measured
Otter Tail Pow	er Company				PUMPING LEVEL (below land surface)
Well owner's mailing address if diff	erent than property own	er's address indicate	d above.	*	NAft. afterhrs. pumpingg.p.m.
-					WELL HEAD COMPLETION
					Pilless adapter manufacturer Model X1 Casing Protein 4" Protop/30" StickUp above grade
					☐ At-grade (Environmental Wells and Borings ONLY)
· ·					GROUTING INFORMATION Well grouted? X Yes 🗆 No
GEOLOGICAL MATERIALS	COLOR	HARDNESS O MATERIAL	FFROM	то	Grout Material ☐ Neat coment ☐ Bentonite ☐ Concrete X High Solids Bentonite
SANDY CLAY, topsoil					Concrete from 0 to 5 ft. 5 gyds.X1 bags Quick Grout from 5 to 58 ft. gyds. Q bags
(OH)	Black	Soft	0	0.5	fromtotL yds. □ bags
COARSE SAND & GRAVE	L Lt. Brown	Mad	0.5	8.0	NEAREST KNOWN SOURCE OF CONTAMINATION
(SW)	& Tan	Med. ·	0.5	0.0	
CLAYEY SAND, w/some	The second secon	Med. to	8	37	AND THE RESERVE TO TH
gravel (SC)	Gray	Hard	+		PUMP
SANDY LEAN CLAY, W/d		Hard	37	60	XXNot installed Date installed
1" saturated sand la occurring in bottom			-		Manufacturer's name HP Volts
CCCCTTE OF THE POSSESSION	10 (0.)				Length of drop pipe It. Capacityg.p.m.
FINE TO COARSE SAND	T	Morre Hand	60	63	Type: Submersible L.S. Turbine Reciprocating Jet
(SW)	Tan	Very Hard	00	03	ABANDONED WELLS
SANDY SILT & CLAY	Tan	Hard	63	65	Does property have any not in use and not sealed well(s)? ☐ Yes XI No
(CL-ML)	101	IMAG			VARIANCE
TAN WAUST-STAINED	. (GP) ^{Tan}	Very Hard	65	75	Was a variance granted from the MDH for this well? ☐ Yes 💢 No TN#
COARSE SAND & GRAVEL	. (GP)	72	-		WELL CONTRACTOR CERTIFICATION
Uso a sec	ond sheet, if needed				This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725.
REMARKS, ELEVATION, SOL	JRCE OF DATA, etc.				The information contained in this report is true to the best of my knowledge.
Well ID No.:	G_AF_P				Interstate Drilling Services, LLP M0148
IDS Project No					Lic. or Reg. No.
TOO LIGHTON	· · CONTET				White Sw 10-6-05
					Authorized Representative Signature Date
				Michael Zak 10-6-05	
IMPORTANT - FILE W	TH PROPERTY	PAPERS			Name of Driller Date
	VNER COPY	6	746	11	HE-01205-07 (Rev. 2/99)

LOG OF BORING S-10-R Barr Engineering Company 4700 West 77th St. Suite 200 Minneapolis, MN 55435 SHEET 1 OF 3 BARR Telephone: 952-832-2600 Top of Casing Elev.:1281.5 ft Surface Elevation: 1279.0 ft Project:Otter Tail Power Company Project No.:23/56-0038.03 Unique Well No.:806341 Drilling Method:Rotasonic Location: Fergus Falls, MN Sampling Method:Rotasonic core Coordinates:Lat: 46° 17' 14.20554"° Long: 96° 02' 07.14990"° Completion Depth:85.0 ft Sample Type Sample No. feet WELL OR PIEZOMETER Recovery USCS Elevation, **ENVIRONMENTAL** Graphic CONSTRUCTION Depth, LITHOLOGIC DESCRIPTION DATA DETAIL CLAYEY SAND (SC): fine to coarse grained; dark yellowish brown (10YR 4/4); moist; subangular to subrounded; with ~5% fine to coarse SC gravel; ~40% clayey fines, abundant carbonates with granitic and mafic lithology, soft, cohesive. PRO. CASING SANDY LEAN CLAY (CL): brown (10YR 5/3); moist; subangular to meter: 6" subrounded; medium plasticity; no dilatancy; medium toughness; No odors noted/ massive; soft to firm; 30-35% fine to medium-grained sand; 5-10% Type: sch 40 steel BARR TEMPLATE.GD mostly fine gravel with few-some coarse fraction; mostly carbonates Interval: 3' ags-4' bgs 1275 with granitic and mafic lithology. RISER CASING From 5-8.5' bgs, brown (10YR 5/3). 5' sch10 304 s.s/ Type: sch40 steel **ENVIRO LOG** Interval: 62-68' bgs 2.5 ags-62' bgs CI From 8.5-10' bgs, mottled with dark gray (2.5Y 4/1) and strong brown 1270-**GROUT** (7.5YR 5/6). Type: neat BARRLIBRARY.GLB 2 10 From 10-14.9' bgs, dark gray (2.5Y 4/1). cement/concrete No odors noted/ nterval: At 10.2' bgs, fine-grained gray sand lens (2.5Y 5/1). 0-59.5' bgs SEAL Type: bentonite Interval: 59.5-64.5' bgs At 12.8' bgs, fine-grained gray sand lens (2.5Y 5/1). POWER COMPANY.GPJ 1265 SANDPACK Type: #40 red flint SANDY LEAN CLAY (CL): yellowish brown (10YR 5/6); moist; medium plasticity; no dilatancy; medium toughness; ~40% fine to medium-grained sand; trace coarse sand; trace to 5% gravel, 15 CL Interval: 64.5-78' bgs subangular to subrounded. **SCREEN** GM SILTY GRAVEL WITH SAND (GM): dark yellowish brown (10YR 4/4); saturated; subangular to subrounded; fine to coarse gravel, trace cobble; subangular to subrounded; mostly carbonates/granitic material; 15-25% fine to coarse-grained sand; 15% fines. OTTER TAIL liameter stainless steel Type: 1260-Interval: 10 slot SANDY LEAN CLAY (CL): dark grayish brown (10YR 4/2); moist; low to medium plasticity; no dilatancy; low toughness; firm to hard; ~40% fine to medium-grained sand with ~10% coarse-grained total sand; trace to 68-78' bgs COMPANY\23560038.03 3 CL No odors noted/ 5% fine gravel; subangular to subrounded grains/clasts mottled dark grayish brown (10YR 4/2) and yellowish brown (10YR 5/4). POORLY GRADED SAND (SP): fine grained; light olive brown (2.5Y 5/3); moist; mostly quartz; no gravel; with ~15% medium-grained and SP trace coarse-grained sand; trace fines. 1255-SANDY LEAN CLAY (CL): dark grayish brown (10YR 4/2); moist; low to 25 medium plasticity; no dilatancy; low toughness; firm to hard; ~40% fine to medium-grained sand with ~10% coarse-grained total sand; trace 5% fine gravel; subangular to subrounded grains/clasts mottled dark gray CL brown (10YR 4/2) and yellow-brown (10YR 5/4). LEAN CLAY WITH SAND (CL): dark gray (5Y 4/1); moist; medium plasticity; no dilatancy; medium toughness; strong HCl reaction; CL massive; 30% fine to coarse-grained sand; 5% mostly fine gravel, trace coarse gravel, subangular to subrounded. 1250 4/22/15 Date Boring Started: Remarks: Samples collected with a 4" core barrel, 6" overide casing. 4/23/15 Date Boring Completed: Logged By: KAM PID = Headspace; D/O/S = Discoloration/Odor/Sheen; FID/MC = FID/Methane Corrected Cascade Drilling L.P. Drilling Contractor: Additional data may have been collected in the field which is not included on this log. Weather: Drill Rig:

LOG OF BORING S-10-R Barr Engineering Company 4700 West 77th St. Suite 200 Minneapolis, MN 55435 **BARR** Telephone: 952-832-2600 SHEET 2 OF 3 Surface Elevation: 1279.0 ft Top of Casing Elev.:1281.5 ft Project:Otter Tail Power Company Project No.:23/56-0038.03 Drilling Method:Rotasonic Unique Well No.:806341 Location: Fergus Falls, MN Sampling Method:Rotasonic core Coordinates:Lat: 46° 17' 14.20554"° Long: 96° 02' 07.14990"° Completion Depth:85.0 ft feet Sample Type Sample No. WELL OR PIEZOMETER Recovery USCS Elevation, **ENVIRONMENTAL** Graphic CONSTRUCTION LITHOLOGIC DESCRIPTION DATA **DETAIL** LEAN CLAY WITH SAND (CL): dark gray (5Y 4/1); moist; medium plasticity; no dilatancy; medium toughness; strong HCl reaction; massive; 30% fine to coarse-grained sand; 5% mostly fine gravel, trace No odors noted/ coarse gravel, subangular to subrounded. (continued) PRO. CASING From 30-33' bgs, firm to soft. CL eter 6" Type: sch 40 steel Interval: 3' ags-4' bgs 1245 35 CLAYEY SAND (SC): fine to medium grained; yellowish brown (10YR RISER CASING 5/4); moist; trace coarse and fine gravel, subangular to subrounded; BARR 7 SC ~30% clayey fines, cohesive; mottled with yellow-brown (10YR 5/4). 5' sch10 304 s.s/ SILTY SAND (SM): fine grained; brown (10YR 5/3); moist; ~10% Type: sch40 steel Log medium to coarse-grained sand; trace fine gravel, subangular to subrounded; 15% fines. 62-68' bgs interval: SM ENVIRO 2.5 ags-62' bgs Moist. 1240 CL **GROUT** LEAN CLAY WITH SAND (CL): dark gray (5Y 4/1); moist; mostly carbonates with some mafic and granitic grains/clasts. Type: neat GLB. 5 SP POORLY GRADED SAND (SP): fine to medium grained; light olive No odors noted/ Interval: cement/concrete brown (2.5Y 5/3); with 10% coarse-grained sand, ; trace to 5% fines; BARRLIBRARY 0-59,5' bgs subangular to subrounded. From 39-40' bgs, 20% fine to coarse gravel. SFAL From 40-41' bgs, no gravel. GP-Type: bentonite POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM): grayish brown (2.5Y 5/2); moist; fine to coarse gravel, angular to subangular; mostly granitic with some mafic with some carbonates; 15% fines; GM Interval: 59,5-64,5' bgs GPJ 1235 -35% fine to coarse-grained sand. POWER COMPANY. SANDPACK POORLY GRADED SAND WITH GRAVEL (SP): fine to coarse grained; Type: #40 red flint dark grayish brown (2.5Y 4/2); moist; ~30% fine to coarse gravel, 45 subangular to subrounded; 5% fines. Interval: 64.5-78' bgs SP SCREEN Diameter: Type: stainless steel No odors noted/ 1230 Interval: 10 slot SILT WITH VERY FINE SAND (ML): brown (10YR 5/3); moist; 68-78' bgs non-plastic; rapid dilatancy; noncohesive; ~15% very fine-grained sand. COMPANY\23560038.03 ML At 53' bgs. 1225 POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM): yellowish brown (10YR 5/4); moist; fine to coarse gravel, angular to subangular, % gravel and fines decrease to 20% and 5% respectively with depth; 30% fine to coarse-grained sand, 10% fines. 55 GP-7 No odors noted/ GM 1220-SP _60_____ Date Boring Started: 4/22/15 Remarks: Samples collected with a 4" core barrel, 6" overide casing. 4/23/15 Date Boring Completed: KAM Logged By: PID = Headspace; D/O/S = Discoloration/Odor/Sheen; FID/MC = FID/Methane Corrected Cascade Drilling L.P. Drilling Contractor: Additional data may have been collected in the field which is not included on this log, Weather: Drill Rig:

LOG OF BORING S-10-R Barr Engineering Company 4700 West 77th St. Suite 200 Minneapolis, MN 55435 BARR Telephone: 952-832-2600 SHEET 3 OF 3 Top of Casing Elev.: 1281.5 ft Project:Otter Tail Power Company Surface Elevation: 1279.0 ft Project No.:23/56-0038.03 Unique Well No.:806341 Drilling Method:Rotasonic Location: Fergus Falls, MN Sampling Method:Rotasonic core Coordinates:Lat: 46° 17' 14.20554"° Long: 96° 02' 07.14990"° Completion Depth:85.0 ft Datum: Elevation, feet Sample Type Sample No. WELL OR PIEZOMETER **ENVIRONMENTAL** SCS Graphic Depth, LITHOLOGIC DESCRIPTION CONSTRUCTION DATA DETAIL POORLY GRADED SAND (SP): fine to medium grained; olive brown (2.5Y 4/3); moist; 15-20% coarse-grained sand; trace to 5% fine gravel, subangular to subrounded; mostly quartz sand with carbonates and granitic minerals, some mafics; trace fines. (continued)
From 61-65' bgs, gravel is absent. PRO. CASING Diameter: 6" Type: sch 40 steel BARR TEMPLATE.GD Interval: 3' ags-4' bgs 1215 65 8 Below 65' bgs, gravel increases to ~15% and 5% fines (poorly graded No odors noted/ RISER CASING sand with gravel); moist. SP 5' sch10 304 s.s./ **ENVIRO LOG** sch40 steel 62-68' bas 2.5 ags-62' bgs ¥1210-GROUT Appears saturated below 69' bgs. BARRLIBRARY.GLB Type: neat 70 cement/concrete 0-59.5' bgs SEAL GP POORLY GRADED GRAVEL WITH SAND (GP): fine to coarse grained; Type: bentonite olive brown (2.5Y 4/3); saturated; subrounded; fine to coarse gravel; No odors noted/ Interval: 59.5-64.5' bgs 30% fine to coarse-grained sand; trace fines; mostly granitic lithology COMPANY/23560038.03_OTTER TAIL POWER COMPANY.GPJ and carbonates. 1205 POORLY GRADED SAND WITH GRAVEL (SP): gray (5Y 5/1); SANDPACK SP saturated; ~15% fine to coarse gravel, subangular to subrounded; trace Type: #40 red flint 75 fines; carbonates, mafics, granitic minerals. 64.5-78' bgs Interval: At 76.5' bgs, one 4-inch cobble present; saturated. **SCREEN** SANDY LEAN CLAY (CL): very dark gray (5Y 3/1); moist; medium 10 plasticity; medium toughness; strong HCl reaction; firm to soft, 30% fine to coarse-grained sand; 5% fine to coarse gravel, subangular to ameter: No odors noted/ stainless steel Type: subrounded; cohesive; mostly carbonates with some granitic lithology 1200 10 slot Interval: and mafics. From 79-80' bgs, firm. 68-78' bgs 80 CL 11 No odors noted/ 1195 POWER End of Boring 85' bgs. OTTER TAIL \$\23560038.03 Date Boring Started: 4/22/15 Remarks: Samples collected with a 4" core barrel, 6" overide casing. Date Boring Completed: 4/23/15 Logged By: KAM PID = Headspace; D/O/S = Discoloration/Odor/Sheen; FID/MC = FID/Methane Corrected Cascade Drilling L.P. **Drilling Contractor:** Additional data may have been collected in the field which is not included on this log. Weather: Drill Rig:

S-10R

MINNESOTA UNIQUE WELL AND BORING NO.

WELL OR BORING LOCATION					A DEPARTMENT OF HEALTH AND BORING NO.		
County Name			VVE	D BORING RECORD to a Statutes, Chapter 103I 8 0 6 3 4 1			
Offer lail				wiiniesc			
Township Name Township	117	Section No.	NW N	E SE	WELL/BORING DEPTH (completed) 78 n. DATE WORK COMPLETED 4-22-15		
Forgus Falls 133	42M	150	4 1	4 1/4	DRILLING METHOD	_	
LOCATION: Latitude			seconds		Cable Tool Driven		
Longitude House Number, Street Name, City, and			seconds		Auger Rotary		
		(1	CE	527	DRILLING FLUID WELL HYDROFRACTURED? Yes X No		
Show exact location of well/boring in se		rgus Faul Sketch map	of well/borin	ng location.	Vine From It. To	fi	
Chow chact location of recooning in co	out, grant min	S	Showing pro- uildings, an	perty lines.	USE Domestic Monitoring Heating/Cooling		
					Noncommunity PWS Environ. Bore Hole Industry/Commercial		
					Community PWS Irrigation Remedial		
				i	☐ Elevator ☐ Dewatering ☐		
W E T	>€	ee M	ap	9	CASING MATERIAL Drive Shoe? Yes No HOLE DIAM.		
1	Mile		/		Steel Threaded Welded		
					CASING		
S S					Diameter Weight Specifications A in To 68 ft. lbs:/ft. 6 in To 7	8	
1 Mile					A in. To 88 ft.	Uf	
PROPERTY OWNER'S NAME/COMPA	NY NAME				in, To ftlbs://t in, To	f	
Atter Tail Down	er Com	MICHA			in. To ftlos/ftin. To	f	
	erent than well location				SCREEN Y 25 OPEN HOLE		
215 South	· Casage	LA Chie	A		Make ft. To	ft	
712 Join	n caxac	NC SINC	-07		Type 5.3. Diam. A Stot/Gauze . UIU Length /U	_	
Fergus	FAUS. M	IN 56	00 t		Sel between 68 It. and 78 It. FITTINGS T+C		
1 Organs	10000				STATIC WATER LEVEL Measured from Grand		
					7/ ft. K Below Above land surface Date measured 4 - 27-/3	5	
WELL OWNER'S NAME/COMPANY NA	AME		-		PUMPING LEVEL (below land surface)		
Otter Tail Di	MEN C	mDax	NU		THE VIA tt. after hrs. pumping g.	p.m.	
Well/boring owner's mailing address if d		owner's address inc	dicated above	ve.	WELLHEAD COMPLETION		
					Pitless/adapter manufacturer Model		
- Same	α s α s α	DVC-			At-grade Well House Hand Pump		
- min	000				GROUTING INFORMATION (specify bentonite, cement-sand, neat-cement, concrete, cuttings, or ot	ner)	
					Malerial Cerut From 0 To 59 ft. 6 Yds. X Ba	533	
	_				Material From To ft. Yds. Ba	30	
GEOLOGICAL MATERIALS	COLOR	HARDNESS OF	FROM	то	Material From To ft. Yds. Ba	gs	
GEOLOGICAL WATERIALS	COLON	MATERIAL	THOM		Driven casing seal From To Bags		
I'	60.	1	Λ	40	NEAREST KNOWN SOURCE OF CONTAMINATION	3	
Fine Sand	01000	_ つ	0	10		type	
Sand + Gravel	60	M	40	78	Well disinfected upon completion? Yes No	-	
Java Graves	Dron		10	, 5			
					Not installed Date installed		
			-	-	Manufacturer's name	-	
	1				Model Number HP Volts		
					Length of drop pipeft. Capacityg.p.m.		
					Type: Submersible L.S. Turbine Reciprocating Jet		
					ABANDONED WELLS		
					Does property have any not in use and not sealed well(s)?	-	
					Was a variance granted from the MDH for this well? ☐ Yes ✓ No TN#		
					WELL CONTRACTOR CERTIFICATION	-	
					This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.		
Use a seco REMARKS, ELEVATION, SOURCE OF	nd sheet, if needed.				Λ		
TEMATINO, ELEVATION, SOURCE OF	LINIA, BIC.				Cascade Dvilliva L.Y. 22107		
	^				Licensee Business Name Licensee Business Name Lic. or Reg. No.	-	
5-	10 R					ار	
	10 1				Pale Dural 285b 5-15-15 Certified Representative Signature Certified Rep. No. Date		
					Certified Representative Signature Certified Rep. No. Date		
					10 01 01 -		
MINN. DEPT OF H	EALTH CORY	81	063	41	I' (of K D, opmarer	-	
MINN. DEPT OF H	LALTH COPY	00		T .J.	Name of Driller HE-01205-14 (Rev. 5)	12)	

MINNESOTA DEPARTMENT OF HEALTH

WELL LOCATION

E8. B.1.;

MINNESOTA UNIQUE WELL NO.

MINNESOTA DEPARTMENT OF HEALTH

11日本学/201111日

Otter Tail			ja k	WEL		ta Statutes Chapter 1031 632810		
	ownship No. 1.33N	Range No. 43W	Section No.	Fraction SW NE	SE "	WELL DEPTH (completed) 97 (I. Date Work Completed 4-9-01		
House Number, Street Name, C Hoot Lake Plant, Show exact location of well in s	1012 Wa	iter Plant	: Ad., Ferg	or Fire Number 1985 Fall	s 56537	DRILLING METHOD Cable Tool Rotary Diven Jetted		
N N N N N N N N N N N N N N N N N N N]		<	ch map of wel Showing prop roads and	erty lines, buildings.	None WELL HYDROFRACTURED? CIYES MINO FROM		
w	E T		SEE ATTACHEI MAP) .		USE		
- - - - - - - - - -	1.	s	s					
PROPERTY OWNER'S NA Otter Tail Po Property owner's malling address	wer Co		an addraca ladical	ted above		2 In. to 81.5 ft. Sch. 40 Ibs./ft. 8 In. to 97 ft. 2 In. to 87 ft. Flush Thread Ibs./ft. In. to In. to It. Ibs./ft. In. to It.		
215 S. Cascas Fergus Falls,	e St.		on address mucan	led above.	8	SCREEN 304 Stainless Make Steel From ft.to ft. Type Stainless Steel Diam. 2" SloV/Gauze 015 Length 10*		
WELL OWNER'S NAME	:	*	290	1 2	. 11	Set between 87 ft. and 97 ft. FITTINGS: Flush STATIC WATER LEVEL 5 ft. 25 below above land surface Date measured 3-21-01		
Otter Tail Por Well owner's mailing address if			r's address indicat	ed above.		PUMPING LEVEL (below land surface) (t. alter hrs. pumping g.p.m.		
				a d		WELL HEAD COMPLETION ☐ Pilless adapter manufacturer ☐ Casing Protection 4 Steel 30 XX n. above grade ☐ At-grade (Environmental Wells and Borings ONLY)		
a di sa			IUADDNIEGO C)el	· ·	GROUTING INFORMATION Well grouted? M Yes CI No		
GEOLOGICAL MATERIA	0	color erk	MATERIAL	THOM	то	Grout Material X Neat cement Bentonite Concrete High Solids Bentonite 15 yds. X bags fromto		
SANDY LEAN CLAY		Brown	Soft Medium	7	7 29	fromtoft.		
SANDY LEAN CLA		Gray	Medium	29	72	Well disinfected upon completion? ☐ Yes 💢 No		
SAND, Medium-grain		ROWN	Dense	72	97	X1 Not installed Date installed		
a little gravel						Model number HP Volts Length of drop pipe ft. Capacity g.p,m.		
						Type: Submersible L.S. Turbine Reclprocating Jet		
***************************************						Does property have any not in use and not sealed well(s)? Yes No VARIANCE NA		
				-		Was a variance granted from the MDH for this well? Yes No TN# WELL CONTRACTOR CERTIFICATION		
Use a	second shee	et, if needed				This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725.		
REMARKS, ELEVATION, S	OURCE O	F DATA, etc.				The Information contained in this report is true to the best of my knowledge.		
Well ID #S-13 IDS Project #2	0 102 5			ħ		Interstate Drilling Services, LLP M0148 Lic. or Reg. No. 5-3-01		
			ń	L		Authorized Representative Signature Michael Zak 5-3-01		
IMPORTANT - FILE W	VITH PRO		PERS 6	328	10	Name of Driller Date HE-01205-06 (Rev. 7/98)		

LOG OF BORING S-14R Barr Engineering Company 4700 West 77th St. Suite 200 Minneapolis, MN 55435 BARR Telephone: 952-832-2600 SHEET 1 OF 3 Surface Elevation: 1278.1 ft Top of Casing Elev.:1280.6 ft Project: Otter Tail Power Company Project No.:23/56-0038.03 Unique Well No.:806342 Drilling Method:Rotasonic Location: Fergus Falls, MN Sampling Method:Rotasonic core Coordinates:Lat: 46° 17' 18.33531"° Long: 96° 2' 06.94320"° Completion Depth:90.0 ft Elevation, feet Sample Type & Recovery Sample No. feet WELL OR PIEZOMETER USCS **ENVIRONMENTAL** Graphic CONSTRUCTION LITHOLOGIC DESCRIPTION DATA DETAIL ORGANIC SOIL (OL/OH): black (10YR 2/1); moist; clayey; abundant DL/OI roots. POORLY GRADED SAND WITH SILT (SP-SM): fine to medium SP-PRO, CASING grained; very dark grayish brown (10YR 3/2); moist; 10% SM coarse-grained sand; trace to 5% fine gravel, subangular to neter: 6" No odors noted/ subrounded; 10% fines. 1275 Type: sch 40 steel POORLY GRADED SAND (SP): fine to medium grained; brown (10YR 5/3); 40-45% fine to medium-grained sand; 10% gravel-mostly fine with few coarse, subangular to subrounded; a little bit of lean clay at bottom; trace to 5% fines. Interval: 3' ags-4' bgs SP 5 SANDY LEAN CLAY TO CLAYEY SAND (CL): yellowish brown (10YR 5/4); moist; low plasticity; low toughness; massive; 40-45% fine to medium-grained sand with some coarse-grained sand; ~5 to 10% fine RISER CASING Diameter: 2" gravel, trace coarse gravel, subangular to subrounded; predominately sch10 304 s.s/ Type: carbonate, few to some granitic/mafics. sch40 steel **ENVIRO LOG** Interval: 69.5-74.5' bgs 1270 2.5 ags-69.5' bgs **GROUT** CL Type: neat cement 2 No odors noted/ Interval: 0-65' bgs SEAL Type: bentonite 1265 Interval: 65-70' bgs GPJ SANDPACK SANDY LEAN CLAY (CL): brown (10YR 5/2); moist; medium plasticity; medium dry strength; massive; soft to firm; 30-35% fine to Type: #40 red flint medium-grained sand with some coarse-grained sand interbedded; ~5-10% fine gravel with some coarse; abundant carbonate Interval: 70.5-84.5' bgs grains/clasts; with some granitic/mafics; grades to brown (10YR 4/3). SCREEN 1260 CL stainless steel 10 slot Interval: 3 74.5-84.5' bas No odors noted/ COMPANY\23560038.03 LEAN CLAY WITH SAND (CL): dark gray (5Y 4/1); moist; medium plasticity; high dry strength; medium toughness; strong HCl reaction; massive; 30% fine to coarse-grained sand; 5% fine gravel, trace coarse gravel; mostly carbonate grains/clasts with some granitic and mafics. 1255 25 From 25-27' bgs, very soft and very moist. CL 1250 30 No odors noted/ 4/21/15 Remarks: Samples collected with 4" core barrel, 6" overide casing. Date Boring Started: Date Boring Completed: 4/22/15 Logged By: KAM PID = Headspace; D/O/S = Discoloration/Odor/Sheen; FID/MC = FID/Methane Corrected Cascade Drilling L.P. Drilling Contractor: Additional data may have been collected in the field which is not included on this log. Weather: Drill Rig:

LOG OF BORING S-14R Barr Engineering Company 4700 West 77th St. Suite 200 Minneapolis, MN 55435 SHEET 2 OF 3 **BARR** Telephone: 952-832-2600 Top of Casing Elev.:1280.6 ft Surface Elevation: 1278.1 ft Project:Otter Tail Power Company Unique Well No.:806342 Project No.:23/56-0038.03 Drilling Method:Rotasonic Location: Fergus Falls, MN Sampling Method:Rotasonic core Coordinates:Lat: 46° 17' 18.33531"° Long: 96° 2' 06.94320"° Completion Depth:90.0 ft Sample Type Sample No. feet WELL OR PIEZOMETER Recovery USCS Elevation, **ENVIRONMENTAL** Graphic CONSTRUCTION Depth, 1 LITHOLOGIC DESCRIPTION DATA **DETAIL** LEAN CLAY WITH SAND (CL): dark gray (5Y 4/1); moist; medium plasticity; high dry strength; medium toughness; strong HCl reaction; massive; 30% fine to coarse-grained sand; 5% fine gravel, trace coarse gravel; mostly carbonate grains/clasts with some granitic and mafics. PRO. CASING 1245 neter 6" Type: sch 40 steel At 34' bgs, possible perched water; fine-grained 0.5 cm sand lens. BARR TEMPLATE.GD Interval: 3' ags-4' bgs 35 RISER CASING Type: sch10 304 s.s/ sch40 steel 1240-**ENVIRO LOG** Interval: 69.5-74.5' bgs 2.5 ags-69.5' bgs 40 5 **GROUT** No odors noted/ Type: neat cement BARRLIBRARY.GLB Interval: 0-65' bgs CL SEAL 1235 Below 43' bgs, very moist; soft; facets of gravel clasts in broken core Type: bentonite were wet. Interval: 65-70' bgs COMPANY/23560038.03_OTTER TAIL POWER COMPANY.GPJ 45-SANDPACK Type: #40 red flint Interval: 70.5-84.5' bgs 1230 **SCREEN** stainless steel Type: 50-6 No odors noted/ Interval: 10 slot 74.5-84.5' bgs 1225 POORLY GRADED GRAVEL WITH SAND (GP): light olive brown (2.5Y GP 5/3); moist; fine to coarse gravel, subangular to subrounded; 5% fines, 45% fine to coarse-grained sand; about 1/2 carbonate, 1/2 55granitic/mafic. POWER POORLY GRADED SAND WITH GRAVEL (SP): light clive brown (2.5Y 5/3); moist; fine to coarse gravel, subangular to subrounded, 15-20% fine gravel; trace coarse gravel, subangular to subrounded; about 1/2 OTTER TAIL carbonate, 1/2 granitic/mafic; 5% fines. 1220 SP Moist; From 55-61.5' bgs, moist; slighty fines with depth to ~15% gravel. At 56' bgs, 4" cobble. 60 5\23560038.03 No odors noted/ At 61' bgs, 3.5" cobble. SP Remarks: Samples collected with 4" core barrel, 6" overide casing. Date Boring Started: 4/21/15 4/22/15 Date Boring Completed: KAM Logged By: PID = Headspace; D/O/S = Discoloration/Odor/Sheen; FID/MC = FID/Methane Corrected Cascade Drilling L.P. **Drilling Contractor:** Additional data may have been collected in the field which is not included on this log. Weather: Drill Rig:

LOG OF BORING S-14R Barr Engineering Company 4700 West 77th St. Suite 200 Minneapolis, MN 55435 BARR Telephone: 952-832-2600 SHEET 3 OF 3 Surface Elevation:1278.1 ft Top of Casing Elev.:1280.6 ft Project:Otter Tail Power Company Project No.:23/56-0038.03 Unique Well No.:806342 Drilling Method:Rotasonic Location: Fergus Falls, MN Sampling Method:Rotasonic core Coordinates:Lat: 46° 17' 18.33531"° Long: 96° 2' 06.94320"° Completion Depth:90.0 ft feet Sample Type & Recovery Graphic Log Sample No. Depth, feet WELL OR PIEZOMETER USCS Elevation, ENVIRONMENTAL CONSTRUCTION LITHOLOGIC DESCRIPTION DATA DETAIL POORLY GRADED SAND (SP): fine grained; grayish brown (2.5Y 5/2); trace medium to coarse-grained sand; no gravel; mostly quartz sand; SP 1215 trace to 5% fines. (continued) PRO. CASING meter: 6" POORLY GRADED SAND WITH GRAVEL (SP-SM): fine to coarse grained; dark gray brown (2.5Y 4/2); moist; subangular to subrounded; 5-10% fines; 15-20% fine to coarse-grained sand. 65 Type: sch 40 steel BARR TEMPLATE.GDT Interval: 3' ags-4' bgs RISER CASING 1210 sch10 304 s.s/ Type: **ENVIRO LOG** sch40 steel SP-Interval: 69.5-74.5' bgs SM At 70' bgs, a few cobbles up to 3.5". No odors noted/ 2.5 ags-69.5' bgs GROUT Type: neat cement BARRLIBRARY.GLB Interval: 0-65' bgs 1205 From 73-74' bgs, 5-10% fines, 5% fine gravel. SEAL From 74-75.5' bgs, a fine to medium-grained sand lens; strong brown (7.5YR 5/6); oxidation; hard and slightly cemented. Type: bentonite Interval: 65-70' bgs SM SILTY SAND WITH GRAVEL (SM): fine to coarse grained; brown POWER COMPANY.GPJ 1 (10YR 5/3); moist; ~15% fine gravel; firm; 15% fines. SANDPACK POORLY GRADED SAND (SP): fine to medium grained; dark gray (2.5 4/1); moist; subangular to subrounded; with 20% coarse-grained sand; Type: #40 red flint 5-10% fine gravel, abundant carbonates, mafic and granitic material; Interval: 70,5-84,5' bgs 1200 At 76.5' bgs, fine-gravel lens; saturated below. **SCREEN** 80 OTTER TAIL No odors noted/ Diameter: stainless steel Type: 10 slot Interval: 74.5-84.5' bgs COMPANY\23560038.03 1195 SP From 83-84' bgs, coarse-grained sand decreases to ~10% of total sand. From 84-85' bgs, coarse-grained sand increases to ~20% of total sand. 85 POWER 10 No odors noted/ 1190 OTTER TAIL From 88.7-89.2' bgs, coarse-grained sand and gravel lens; gravel is mostly fine with a few coarse gravel; subangular to subrounded grains/clasts; carbonates, mafics, granitic materials. End of Boring 90' bgs. Date Boring Started: 4/21/15 Remarks: Samples collected with 4" core barrel, 6" overide casing. Date Boring Completed: 4/22/15 Logged By: KAM **Drilling Contractor:** Cascade Drilling L.P. PID = Headspace; D/O/S = Discoloration/Odor/Sheen; FID/MC = FID/Methane Corrected Additional data may have been collected in the field which is not included on this log. Weather: Drill Rig:

S-14R

WELL OR BORING LOCATION

MINNESOTA DEPARTMENT OF HEALTH WELL AND BORING RECORD

MINNESOTA UNIQUE WELL AND BORING NO.

County Name					VVE		ota Statutes, Chapter 103I	806342
Township Name	Township N	o. Rang	ge No.	Section No.	Fraction NW N		WELL/BORING DEPTH (completed) 8 4.5	VORK COMPLETED 15
GPS LOCATION: Latitude		grees		nutes	seconds _	74 74	DRILLING METHOD Cable Tool Driven	1 011 1
Longitude _ House Number, Street Name,		grees IP Code of V		utes	seconds _		Auger Some Rotary	
Show exact location of well/bo	Plan	t Road		Y QUS FA		653	1 1 ma	YDROFRACTURED? Yes No
N	ang in sect	on grid with		roads, i	Showing probuildings, a	operty lines nd direction	USE Domestic Monitoring	ft. Toft. Heating/Cooling
							☐ Noncommunity PWS ☐ Environ. Bore ☐ Community PWS ☐ Irrigation	Hole Industry/Commercial
							☐ Elevator ☐ Dewatering	
" - - - - - -			Sé	e M	-af		CASING MATERIAL Drive Shoe?	Yes No HOLE DIAM. Welded
	½ Mile	Å			/		CASING	
S 1 Mile							Diameter Weight Spe	b in. To 84.5
PROPERTY OWNER'S NAME			^				in. Toft,lbs./ft	in. Toft.
Property owner's mailing addre	Po	NON	CO	Mpm	NU		in. To tt. lbs./ft. OPEN	in. Toft.
							Make johnson From	11 ft. To ft.
512 201	UZM	Cas	cuu	ve on.	27		Slot/Gauze 2010 Ler	im. 10
215 Soi Fergus	ra	us, i	NIN	1000	10 4		STATIC WATER LEVEL	TINGS 7 FG Measured from Grand
WELL OWNER'S NAME/COMP	DANIV NIAM						ft. Below Above land surface I	
After Ta	U P	MEN	r ()	Damo	hu		PUMPING LEVEL (below land surface)	rs, pumping g.p.m.
Well/boring owner's mailing add	ress if diffe	rent than pro	operty ow	vner's address in	dicated abo	е.	WELLHEAD COMPLETION Pitless/adapter manufacturer	Model
-Sam	a 0	15 0	101	MA-			At-grade Well House Hand Pump	12 in. above grade
-2001	K U	WU		34 C			GROUTING INFORMATION (specify bentonite, cement-sand	/
							Material From To 6.5 Material From To 5	
GEOLOGICAL MATERIAL	s	COLOR	ŀ	HARDNESS OF MATERIAL	FROM	то		ft Yds. Bags
P2 0		^		MATERIAL		٠.١	Driven casing seal From To NEAREST KNOWN SOURCE OF CONTAMINATION	Bags
Fire Sand	1	Brow	_		0	54		type
Sand +Grav.	el	Brown	_	M	54	84.5	Well disinfected upon completion? Yes X No	
							Not installed Date installed	
Parameters -			_				Manufacturer's nameHP	Volts
mical and a second seco			-				WOOD CONTRACTOR OF THE CONTRAC	apacity g.p.m.
							Type: Submersible L.S. Turbine Reciprocating [] Jet []
							Does property have any not in use and not sealed well(s)?	☐ Yes M No
· · · · · · · · · · · · · · · · · · ·							VARIANCE	
er ractor and a contract and			_				Was a variance granted from the MDH for this well? Yes WELL CONTRACTOR CERTIFICATION	7
		sheet, if need	ded.				This well was drilled under my supervision and in accordance The information contained in this report is true to the best of n	with Minnesota Rules, Chapter 4725. ny knowledge.
EMARKS, ELEVATION, SOURC			Λ				Cascade Dvilling, L.	P. 33 67 Lic. or Reg. No.
5	_	14	K				Dale Dunt &	Lic. or Reg. No. 2856 5-15-15 ritlied Rep. No. Date
· · · · · · · · · · · · · · · · · · ·					200	4.0	Mich Riania	
MINN. DEPT	OF HEA	LTH CO	OPY	8(063	42	Name of Driller	