Groundwater Monitoring System Certification

Big Stone Plant – Ash Disposal Area
Big Stone City, South Dakota

Prepared for
Otter Tail Power Company

Prepared by
Barr Engineering Co.

March 2025

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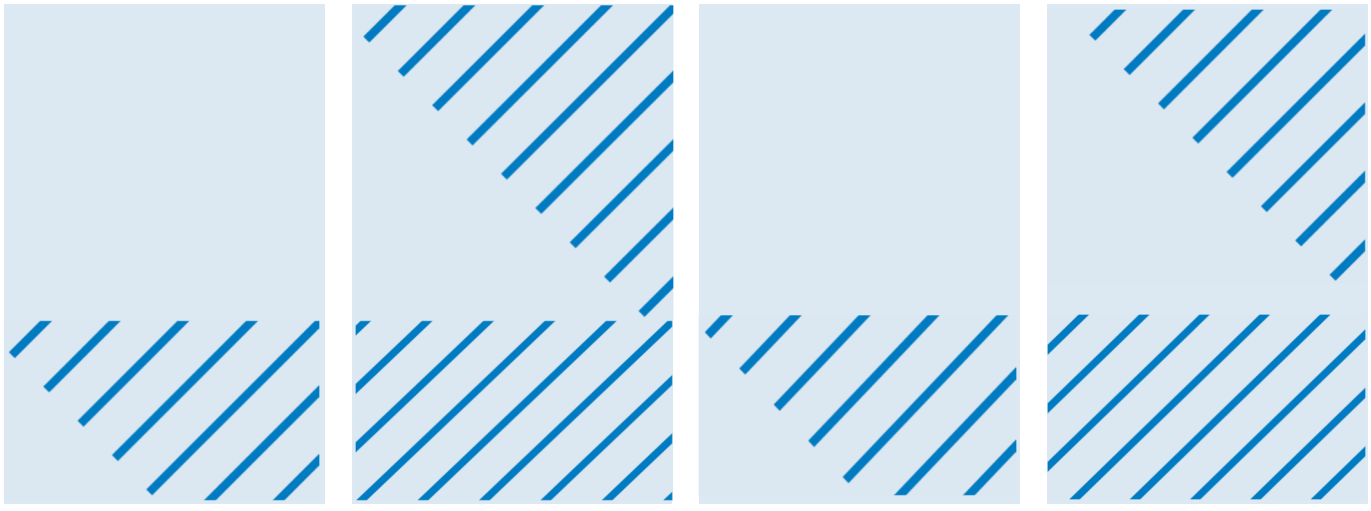
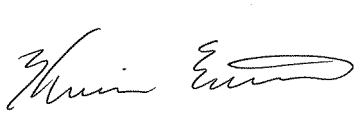
barr.com



Certification

I hereby certify that I have examined the facility and, being familiar with the provisions of 40 CFR 257 Subpart D, attest that the CCR Groundwater Monitoring System has been designed in accordance with good engineering practice, including consideration of applicable industry standards and the requirements of 40 CFR §257.91(f). I certify that the plan is adequate for this facility and that procedures for recordkeeping and reporting have been established. I further certify that I am a duly Licensed Professional Engineer under the laws of the state of South Dakota.



Kevin Eisen
Barr Engineering Co.
#: PE 27551

March 7, 2025
Date

Groundwater Monitoring System Certification

Big Stone Plant – Ash Disposal Area
Big Stone City, South Dakota

March 2025

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1 Introduction

This report was prepared by Barr Engineering Co. (Barr) for Otter Tail Power Company to certify the groundwater monitoring system for the Ash Disposal Area (ADA) coal combustion residuals (CCR) landfill (Site) at their Big Stone Plant (Facility) located in Big Stone City, South Dakota. The purpose of the groundwater monitoring system is to collect groundwater samples for water quality to comply with the federal CCR Rule (40 CFR Part 257), which went into effect on October 19, 2015.

Section 257.91 of the CCR Rule outlines the requirements of the groundwater monitoring system, including performance standards. This certification is intended to demonstrate that the groundwater monitoring system installed at the Site is in compliance with the Rule.

1.1 System Certification Requirement Summary

The table below is a detailed discussion of the system certification requirements outlined in §257.91 of the CCR Rule and this Site's compliance with the rule.

Table 1 CCR Rule Requirements and Compliance

CCR Rule Requirements (§257.91)	Compliance with CCR Rule
Performance Standard (a): 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: a. Hydrogeologic conditions do not allow the owner or operator of the CCR Unit to determine what wells are hydraulically upgradient; or b. Sampling at other wells will provide an indication of background groundwater quality that is 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 contamination must be monitored.	Yes, see Section 3.0 (Monitoring Wells) of this Certification.
Well Spacing and Site Specific Information (b): The number, spacing, and depths of monitoring systems shall be determined based upon site-specific technical information that must include thorough characterization of: (1) Aquifer thickness, groundwater flow rate, 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, thickness, stratigraphy, lithology, hydraulic conductivities, porosities, and effective porosities.	Yes, see Section 2.0 (Site Setting) and Section 3.0 (Monitoring Wells) of this Certification.

CCR Rule Requirements (§257.91)	Compliance with CCR Rule
Number of Monitoring Wells (c): The groundwater monitoring system must include the minimum number of monitoring wells necessary to meet the performance standards specified in paragraph (a) of this section, based on the site-specific information specified in paragraph (b) of this section. The groundwater monitoring system must contain: (1) A minimum of one upgradient and three downgradient monitoring wells; and (2) Additional monitoring wells are necessary to accurately represent the quality of background groundwater that has not been affected by leakage from the CCR unit and the quality of groundwater passing the waste boundary of the CCR unit.	Yes, see Section 3.0 (Monitoring Wells) of this Certification.
Multiunit Groundwater Systems (d): The owner or operator of multiple CCR units may install a multiunit groundwater monitoring system instead of separate groundwater monitoring systems for each CCR unit.	This Site does not contain multiple CCR units and therefore the system does not need to meet the requirements of this paragraph.
Monitoring Well Construction (e): Monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated and packed with gravel or sand, where necessary, to enable collection of groundwater samples. The annular space (i.e. the space between the borehole and well casing) above the sampling depth must be sealed to prevent contaminating of samples and the groundwater. (1) The owner or operator of the CCR unit must document and include in the operating record the design, installation, development, and decommissioning of any monitoring wells, piezometers, and other measurements, sampling, and analytical devices. The qualified professional engineer must be given access to this documentation when completing the groundwater monitoring system certification required under paragraph (f) of this section. (2) The monitoring wells, piezometers, and other measurements, sampling, and analytical devices must be operated and maintained so that they perform to the design specifications throughout the life of the monitoring program.	Yes, see Section 3.0 (Monitoring Wells) of this Certification. Supporting documentation in Appendix A.
Certification (f): The owner or operator must obtain a certification from a qualified professional engineer stating that the groundwater monitoring system has been designed and constructed to meet the requirements of this section. If the groundwater monitoring system includes the minimum number of monitoring wells specified in paragraph (c)(1) of this section, the certification must document the basis supporting this determination.	Yes, see Section 4.0 (System Certification) and Certifications page.

2 Site Setting

Big Stone Plant is a 474 megawatt coal-fired electric generating facility located in Big Stone City, South Dakota. The Facility is shown on Figure 1, which includes locations of ponds (Yard Pond, West Brine Pond, East Brine Pond, Reclaim Pond, Cooling Pond, Evaporation Pond, and Holding Pond), and the CCR landfill (Ash Disposal Area). The main coal ash products produced are boiler slag, economizer ash, and a flue gas desulfurization (FGD) product that contains a mixture of fly ash and spent desulfurization material.

2.1 Site Geology

The surficial geology is composed of Late Wisconsin Des Moines Lobe glacial till. The glacial till is clayey with generally low permeability, although locally higher permeability sand and silt seams are present within the clay. The seams are laterally discontinuous and dictate the horizontal hydraulic conductivity. The clay is generally more oxidized to brown hues and is more fractured near the water table as is typical of glacial till in the region. The brown oxidized zone transitions with increasing depth (varies by location) to a gray clay till of similar lithology but is unoxidized.

Underlying units consist of Cretaceous-aged sedimentary rocks deposited in terrestrial alluvial, tidal, and deeper marine shale environments. Precambrian granite outcrops to the south of Big Stone City and is likely present under the sedimentary rocks at the Facility. Because the Des Moines Lobe and earlier glacial tills eroded bedrock materials of similar provenance, the matrix of the glacial till carries many of the same geochemical characteristics of the bedrock source material. Chemical interaction of groundwater with the geologic matrix results in unique but spatially variable chemical signatures depending on flow characteristics and localized matrix composition.

2.2 Site Hydrogeology

Regional discharge is toward Big Stone Lake (of the Minnesota River), located east of the Facility, and the Whetstone River to the south. Regional groundwater flow at the Facility is generally from the northwest to the south or southeast toward these discharge areas, depending on location at the Facility. Local to the Site, groundwater appears to follow topography generally conforming to the drainage pattern that predated the construction of the ADA. The primary drainage feature is a ravine that starts due north of 143rd Street and drains surface water into a narrow drainage that runs between the Cooling and Evaporation / Holding Ponds into the reclaim pond north of the ADA. As shown on Figure 2, the large pond areas likely exhibit a significant influence on flow directions.

The flow conditions shown on Figure 2 are interpretive because the low permeability and differential saturation of the clay typically results in localized flow variations. However, the overall groundwater flow is assumed to flow from areas of higher hydraulic head (corresponding to the topographically higher area to the north and the ponds to the east and west) and to areas of lower hydraulic head (downgradient of ADA).

A subsurface drain located along the western edge of the Holding Pond and southwestern edge of the Evaporation Pond was identified during the summer of 2016. The drain is a designed safety feature for the Holding Pond and Evaporation Pond to reduce the phreatic head in the embankment. The drain slopes toward a pump located near the southern end of the Holding Pond, which discharges to the Holding Pond. This feature likely influences the resulting groundwater flow pattern to be towards the drain

because the drain reduces the surrounding water table which is pumped from the drain back into the Holding Pond. The locations of the drain and pump are shown on Figure 2.

Groundwater moves relatively slowly in the clay till and the overall potential for lateral migration is low. As shown on Figure 3, groundwater levels show very little correlation with total monthly rainfall indicating that most precipitation results in runoff and evaporation rather than infiltration.

Very slow downward vertical migration through the clay till is possible over millennia. However, based on the tritium analysis of the HX-series wells (Huntingdon, 1995), vertical migration rates are on the order of decades per foot. Monitoring of groundwater in these deeper zones was discontinued because release detection is ineffective in zones where there is virtually no groundwater movement.

Cross sections illustrating the lithology and relevant features are shown on Figure 4 (Cross Section Locations), Figure 5 (Section A-A'), Figure 6 (Section B-B') and Figure 7 (Section C-C').

3 Monitoring Wells

The CCR Rule requirements include a groundwater monitoring system that can monitor the upper-most aquifer, including at least three downgradient wells to provide for sampling of groundwater that passes the waste boundary, and at least one well that represents upgradient conditions. The initial monitoring system consisted of three upgradient wells and three downgradient wells. Due to identifying the drain located to the east of the ADA, one additional upgradient well and additional two downgradient wells were installed with screens in the uppermost aquifer. They were strategically placed to improve upon the already existing monitoring system as well as reduce the spacing between the wells to approximately 500 feet or less, which is established industry practice and suggested in the EPA CCR Rule preamble.

3.1 Monitoring System

The monitoring well system around the CCR unit consists of one upgradient well (H12) that is likely influenced by water quality of the Cooling Pond, and three upgradient wells (H2OX, H30X, and H40X) that represent historical (pre-pond CCR activity) upgradient groundwater quality along the ravine present between the Cooling Pond and Evaporation Pond. Five downgradient wells are present (H6, H8, H9, H10, and H11). The upgradient monitoring wells are hydraulically upgradient of the CCR unit and accurately represent groundwater quality upstream of the ADA, which may differ in water quality from areas less influenced by the Cooling Pond and/or Evaporation Pond. The downgradient monitoring wells are located hydraulically downgradient of the CCR unit and are along the waste boundary. All downgradient monitoring wells are spaced approximately 500 feet (or less) apart.

The number, spacing, and hydraulic positions of the monitoring wells comply with requirements outlined in §257.91 (a)-(c) of the CCR Rule.

Table 2 Monitoring System Summary

Well ID	Well Placement	Rationale
H12, H2OX, H3OX, and H4OX	Upgradient	To account for geologic and hydrogeologic variability upgradient of the Ash Disposal Area and to establish a sufficient number of upgradient monitoring wells at appropriate locations and depths to yield groundwater samples of the uppermost aquifer not impacted by the CCR unit (257.91(a) (1) and (2)).
H6, H8, H9, H10, and H11	Downgradient	To detect a release from the Ash Disposal Area and to account for geologic and hydrogeologic variability, establish sufficient number of downgradient monitoring wells at appropriate locations and depths to yield groundwater samples of the uppermost aquifer accurately representing the quality of groundwater passing through the waste boundary (257.91(a) (1) and (2)).

3.2 Monitoring Well Construction and Performance

Based on our understanding of the Site geology, all of the monitoring wells at the Site are screened within the uppermost aquifer. Construction details are included in Table 3. Monitoring wells were constructed in a manner which complies with CCR Rule §257.91 (e).

Table 3 CCR Well Construction

Well	Installation Date	TOR (ft. MSL)	Total Depth BMP (ft.)	Screen Length (ft.)/ Diameter (in)	Casing/ Screen/Slot
H2OX	5/9/1994	1103.86	32.57	5/2.0	PVC/PVC/#10
H3OX	5/11/1994	1095.26	22.45	5/2.0	PVC/PVC/#10
H4OX	5/12/1994	1108.25	27.13	5/2.0	PVC/PVC/#10
H6	11/10/2011	1097.76	17.69	10/2.0	PVC/PVC/#6
H8	7/29/2016	1081.23	22.05	10/2.0	PVC/PVC/#6
H9	7/30/2016	1086.21	30.20	10/2.0	PVC/PVC/#6
H10	10/12/2022	1090.83	38.55	15/2.0	PVC/PVC#6
H11	10/12/2022	1091.84	44.55	15/2.0	PVC/PVC#6
H12	9/14/2023	1127.40	24.80	10/2.0	PVC/PVC#6

All the monitoring wells at the Site were developed (new) to improve clarity of the water samples and reduce suspended solids prior to initial baseline sampling. Well development was completed to remove fines from the water column in the sand pack adjacent to the well screen and to ensure that an adequate hydraulic connection exists between the well screen and the filter pack. Monitoring wells were surged several times initially by moving the pump up and down within the casing to settle the sand pack and collapse voids in the filter pack caused by bridging.

Volumes of purge water removed and relative clarity were measured at each well during development. Well development continued until the water from the well was relatively sediment free, appeared clear, and had decreasing trends in turbidity measurements. Table 4 provides the approximate lowest obtained turbidity measurement, total amount purged, and the approximate well recharge rate field measurements.

Table 4 Well Development Summary

Well ID	Lowest Obtained Turbidity Measurement (NTU)	Approx. Total Amount Volume Purged (gal)	Approx. Most Recent Recharge Rate (ft.) [date]
H2OX	16.1	7	5 hours to recharge 8 ft. [7/28/16]
H3OX	4.2	12	7 minutes to recharge 14.5 ft. [7/27/16]
H4OX	6.3	5	12.5 minutes to recharge 2.5 ft. [7/27/16]
H6	6.2	6	9 minutes to recharge 1 ft. [7/28/16]
H8	6.2	25	16 minutes to recharge 10 ft. [8/8/16]
H9	6.9	52	10.5 minutes to recharge 24.5 ft. [8/8/16]
H10	NA	3	NA
H11	NA	15.5	NA
H12	NA	32	NA

NA – Not Available

4 System Certification

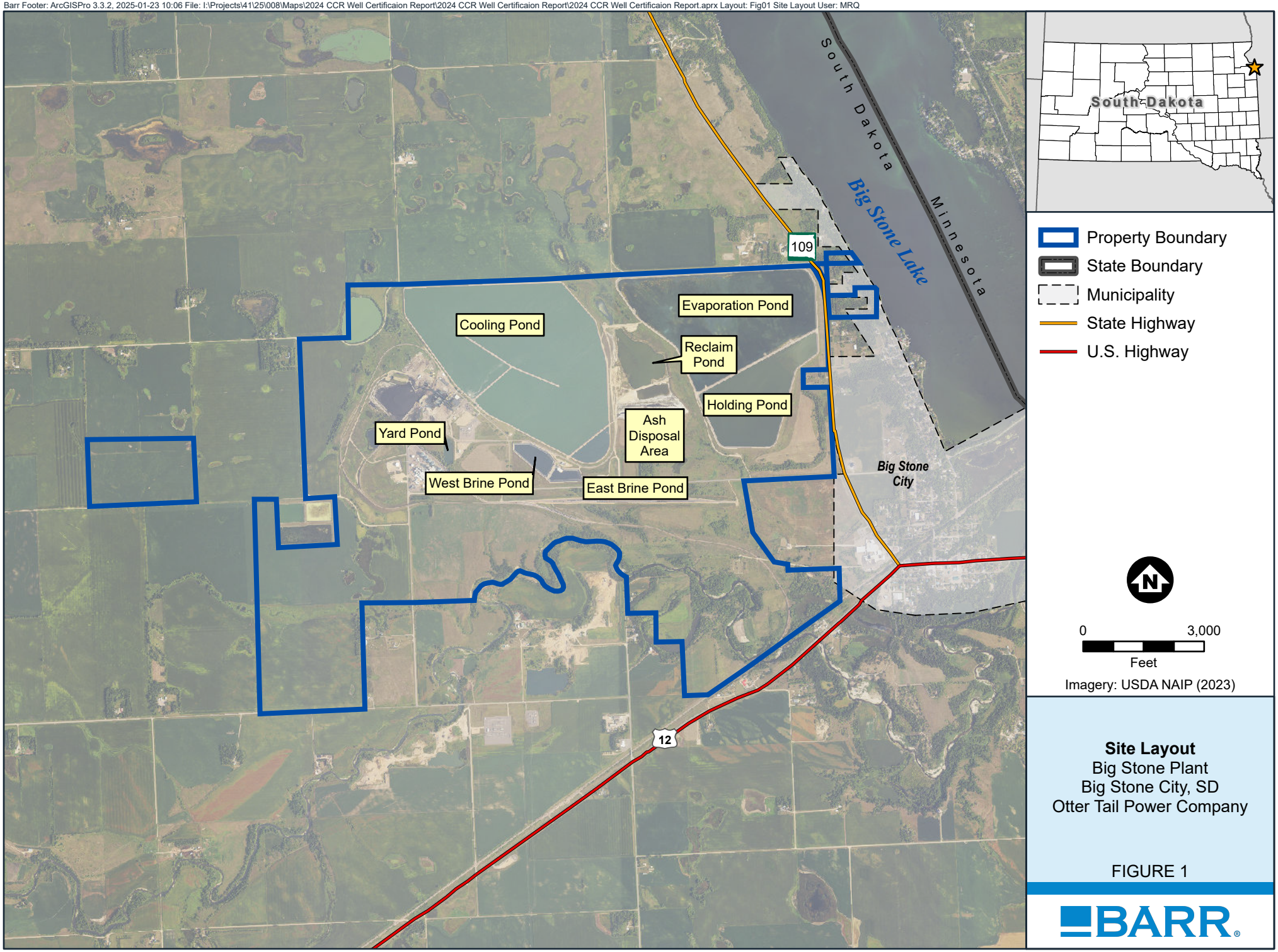
The modified monitoring system is adequate and conforms to the system certification requirements outlined in §257.91 of the CCR Rule. A professionally licensed engineer has certified this system (see Certification page).

5 References

Huntingdon, 1995, Transmittal of Tritium Analytical Results, Otter Tail Power Company Big Stone Plant. January 6, 199. Transmittal to Mr. Herschner.

Figures

Barr Footer: ArcGISPro 3.3.2, 2025-01-23 10:06 File: I:\Projects\41\25\008\Maps\2024 CCR Well Certificaion Report\2024 CCR Well Certificaion Report\2024 CCR Well Certificaion Report.aprx Layout: Fig01 Site Layout User: MRQ



Site Layout
Big Stone Plant
Big Stone City, SD
Otter Tail Power Company

FIGURE 1

BARR

- CCR Monitoring Well
- Groundwater Flow Direction
- Groundwater Contour (ft MSL, dashed where inferred)
- Drain
- Pump
- Property Boundary

Notes:
Ponds surveyed in March 2020.

* Groundwater elevation not contoured because well does not represent uppermost aquifer.

N

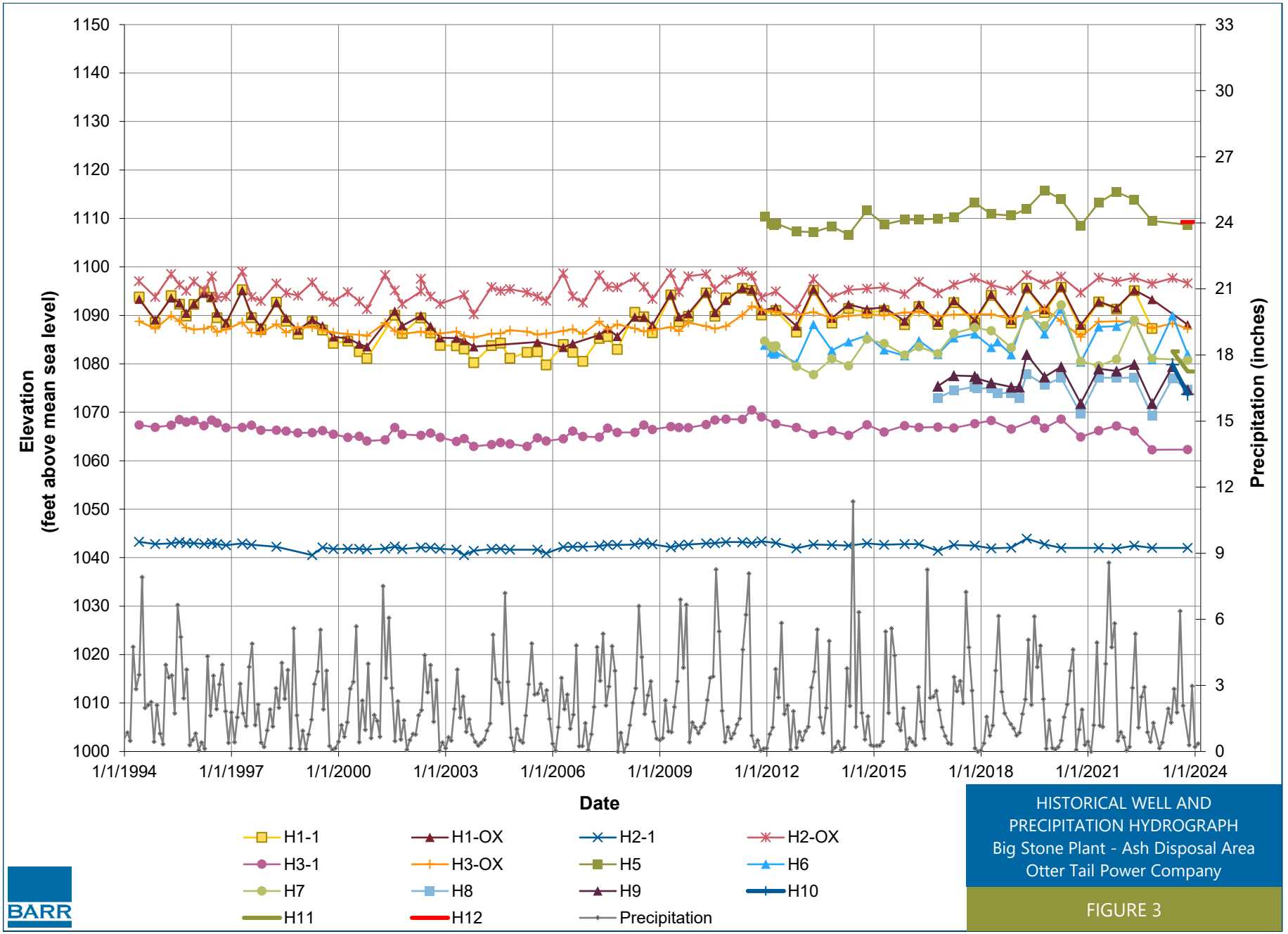
0 1,000
Feet

Imagery: USDA NAIP (2023)

Monitoring Well Locations and Groundwater Elevation Contours: October 14, 2024
Big Stone Plant
Big Stone City, SD
Otter Tail Power Company

FIGURE 2

BARR



HISTORICAL WELL AND PRECIPITATION HYDROGRAPH
Big Stone Plant - Ash Disposal Area
Otter Tail Power Company

FIGURE 3

BARR

4/18/2024

\\barr.com\projects\Mpls\41 SD\25\4125008 Big Stone Annual Monitoring & Reporting\WorkFiles\2023 Annual Report\Hydrographs\Ash Disposal Area Historical Hydrograph through 2023.xlsx

- CCR Monitoring Well
- Non-CCR Monitoring Well
- Cross Section Location
- Drain
- Ash Disposal Area
- Pump
- Property Boundary

N

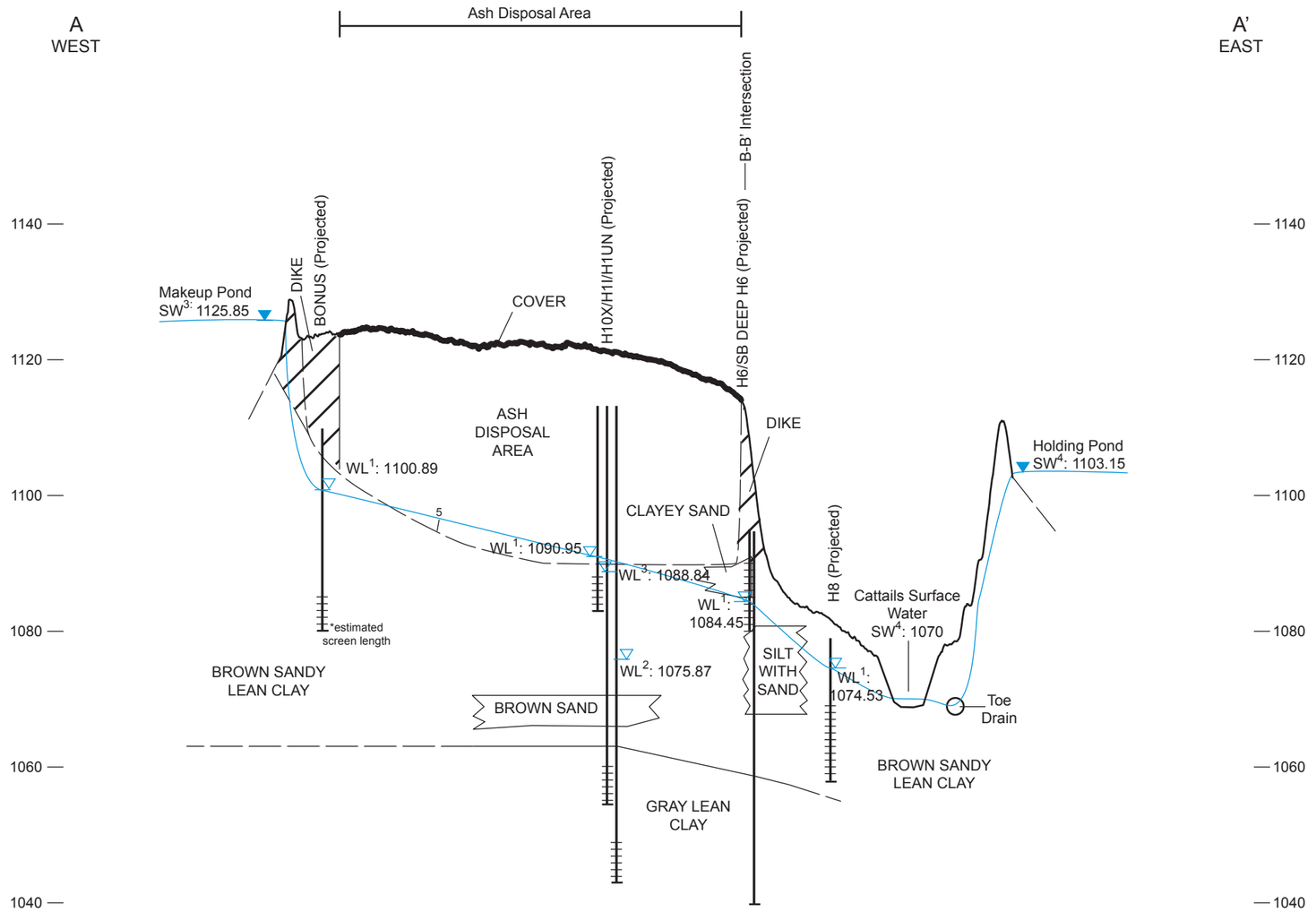
0 1,000
Feet

Imagery: USDA NAIP (2023)

Cross Section Locations
Big Stone Plant
Big Stone City, SD
Otter Tail Power Company

FIGURE 4

BARR



LEGEND

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

0 500

Approximate Horizontal Scale in Feet
25X Vertical Exaggeration

NOTES:
1. WL = Groundwater elevation on August 8, 2016.
2. WL = Groundwater elevation on August 12, 2016.
3. WL = Groundwater elevation on November 11, 2015
4. SW = Surface water elevation on July 25, 2016.
5. Assumed preconstruction elevation.1974 Big Stone Plant Topographic Map.

BARR

Figure 5

CROSS SECTION A-A'
Ash Disposal Area
Big Stone Plant
Otter Tail Power Company
Big Stone City, SD

B
NORTHWEST

B'
SOUTHEAST

Ash Disposal Area

North Reclaim Pond

1160
1140
1120
1100
1080
1060
1040
1020

H4OX/H4I/H4D (Projected)

H3OX/H3I/H3UN (Projected)

H6/SB DEPP H6 (Projected) -A-A' Intersection

COVER

ASH DISPOSAL AREA

DIKE

DIKE

North Reclaim Pond
SW[3]: 1090.22

WL[1]: 1089.88

WL[2]: 1089.08

WL[1]: 1090.20

SW[3]: 1085.04

4

CLAYEY SAND

WL[1]: 1084.45

BROWN SANDY LEAN CLAY

ASSUMED BOTTOM 1076'

WL[2]: 1067.22

BROWN SANDY LEAN CLAY

SILT WITH SAND

BROWN SILTY SAND

GRAY SANDY LEAN CLAY

GRAY SANDY LEAN CLAY

BROWN SAND

GRAY SILT

GRAY FAT CLAY

GRAY SANDY LEAN CLAY

BROWN SAND

BROWN CLAYEY SAND

GRAY SANDY LEAN CLAY

LEGEND

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

0 500

Approximate Horizontal Scale in Feet
25X Vertical Exaggeration

NOTES:
1. WL = Groundwater elevation on August 8, 2016.
2. WL = Groundwater elevation on November 11, 2015
3. SW = Surface water elevation on July 25, 2016.
4. Assumed preconstruction elevation from 1974 Big Stone Plant Topographic Map.

BARR

Figure 6

CROSS SECTION B-B'
Ash Disposal Area
Big Stone Plant
Otter Tail Power Company
Big Stone City, SD

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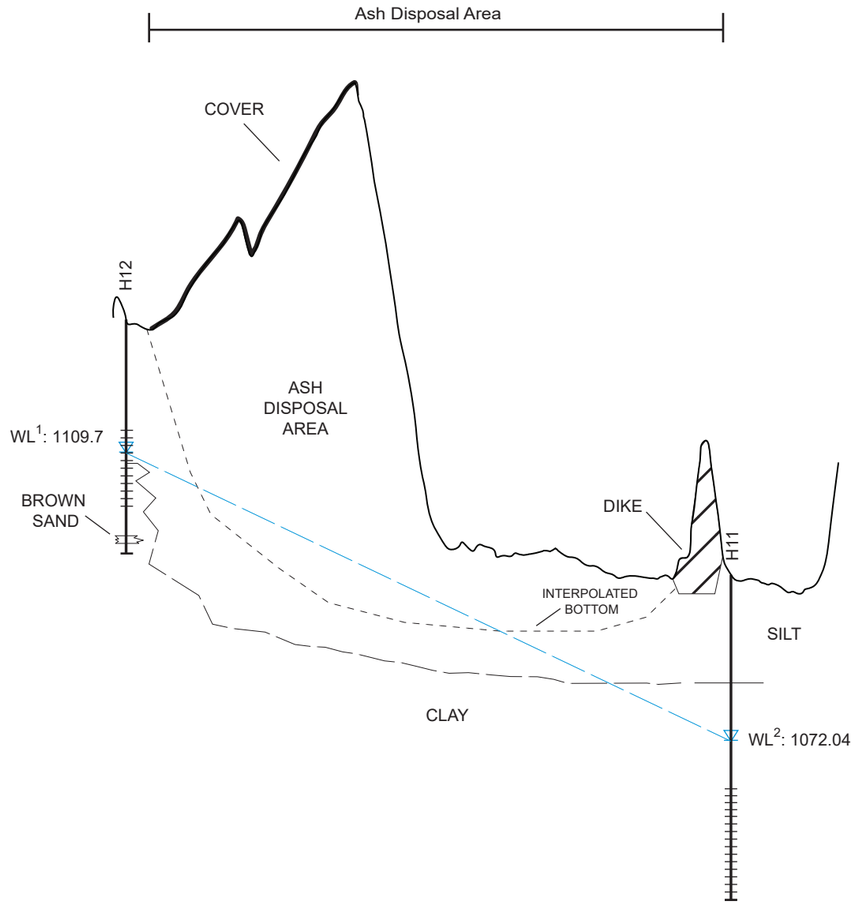
C
SOUTHWEST

C'
NORTHEAST



1160
1150
1140
1130
1120
1110
1100
1090
1080
1070
1060
1050
1040

LEGEND

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

0 300

Approximate Horizontal Scale in Feet
25X Vertical Exaggeration

NOTES:
1. WL = Groundwater elevation on November 14, 2023.
2. WL = Groundwater elevation on October 31, 2022.

BARR

Figure 7

CROSS SECTION C-C'
Ash Disposal Area
Big Stone Plant
Otter Tail Power Company
Big Stone City, SD

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Appendix A

Boring Logs

F.8.A.1.i

LOG OF TEST BORING

JOB NO. 6600 94-354 VERTICAL SCALE 1" = 6' BORING NO. H-1UN

PROJECT OTTER TAIL POWER COMPANY, BIG STONE CITY, SOUTH DAKOTA

DEPTH IN FEET	DESCRIPTION OF MATERIAL SURFACE ELEVATION 1113.1	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	TESTS W	TESTS D	ORGANIC VAPOR hNu (ppm)	ORGANIC VAPOR bkgd (ppm)
	FILL, mixture of SANDY LEAN CLAY and LEAN CLAY, with a little gravel, brown and dark brown	FILL			1	SB				
					2	SB				
					3	SB				
					4	SB				
19.0	**SANDY LEAN CLAY**, with a little gravel, brown, a 2" lens of waterbearing sand at 39' (CL)	TILL			5	SB				
					6	SB				
					7	3T*				
	* Shelby tube obtained from 25' to 27'.				8	SB				
					9	SB				
					10	SB				
				▽	11	SB				
42.5	**SAND**, medium to coarse grained, with gravel, brown, waterbearing (SP) BORING CONTINUED ON NEXT PAGE	COARSE ALLUVIUM			12	SB				

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
5-10	6:01	75'	75'	75'		50'
5-11	8:00	75'	75'	75'		41.5'

START 5-10-94 COMPLETE 5-10-94 @ 6:00

METHOD 3 1/4" HSA 0-75'

CREW CHIEF R. Hanson

twin city testing corporation

LOG OF TEST BORING

JOB NO. 6600 94-354 VERTICAL SCALE 1" = 6' BORING NO. H-1UN CONTINUED

PROJECT OTTER TAIL POWER COMPANY, BIG STONE CITY, SOUTH DAKOTA

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	TESTS W	TESTS D	ORGANIC VAPOR hNu (ppm)	ORGANIC VAPOR bkgd (ppm)
46										
47.0	SAME AS PREVIOUS PAGE	*			13	SB				
	SANDY LEAN CLAY, with a little gravel, brown (CL)	TILL			14	SB				
50.0	**LEAN CLAY**, with a little gravel, gray, a lens of waterbearing sand at 55' (CL)				15	SB				
					16	SB				
					17	SB				
					18	SB				
					19	3T				
					20	SB				
75.0	END OF BORING									

* COARSE ALLUVIUM

LOG OF TEST BORING

JOB NO. 6600 94-354 VERTICAL SCALE 1" = 6' BORING NO. H-3UN

PROJECT OTTER TAIL POWER COMPANY, BIG STONE CITY, SOUTH DAKOTA

DEPTH IN FEET	DESCRIPTION OF MATERIAL — SURFACE ELEVATION 1092.0	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	TESTS W	TESTS D	ORGANIC VAPOR hNu (ppm)	ORGANIC VAPOR bkgd (ppm)
	FILL, mixture of LEAN CLAY, SAND and CLAYEY SAND, with a little gravel, brown and black	FILL								
4.5	SANDY LEAN CLAY, with a little gravel, brown mottled, limonite staining in fractures from 5' to 10', fractures from 10' to 15', no fractures below 15' (CL)	TILL			1	SB				
					2	SB				
				▽	3	SB				
					4	SB				
					5	SB				
					6	SB				
35.0	SANDY LEAN CLAY, with a little gravel, gray mottled (CL)				7	SB				
					8	SB				
					9	SB				
45.0	BORING CONTINUED ON NEXT PAGE									

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
4-21	11:00	40'	35'	40'		17'

START 4-21-94 COMPLETE 4-21-94 @ 4:00

METHOD 4 1/4" HSA 0-60', 3 1/4" HSA 60'-68 1/2'

CREW CHIEF R. Hanson

Huntingdon

LOG OF TEST BORING

JOB NO. 6600 94-354 VERTICAL SCALE 1" = 6' BORING NO. H-3UN CONTINUED

PROJECT OTTER TAIL POWER COMPANY, BIG STONE CITY, SOUTH DAKOTA

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	TESTS W	TESTS D	ORGANIC VAPOR hNu (ppm)	ORGANIC VAPOR bkgd (ppm)
45	SAME AS PREVIOUS PAGE	COARSE ALLUVIUM			10	SB				
	SAND, fine to medium grained, with a little gravel, brown, waterbearing (SP)				11	SB				
53.5										
55.0	**CLAYEY SAND**, fine grained, with a little gravel, brown, waterbearing (SC)	MIXED ALLUVIUM			12	SB				
	SANDY LEAN CLAY, with a little gravel, gray, a 2' layer of reddish brown sandy lean clay at 60' (CL)	TILL			13	SB				
					14	SB				
					15	SB				
					16	3T				
					17	SB				
68.5	**OBSTRUCTION**									

LOG OF TEST BORING

JOB NO. 6600 94-354 VERTICAL SCALE 1" = 6' BORING NO. H-4D

PROJECT OTTER TAIL POWER COMPANY, BIG STONE CITY, SOUTH DAKOTA

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1105.9)	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	TESTS W	TESTS D	ORGANIC VAPOR hNu (ppm)	ORGANIC VAPOR bkgd (ppm)
	FILL, mostly SANDY LEAN CLAY, with a little gravel, black and brown	FILL			1	SB				
					2	SB				
7.5	SANDY LEAN CLAY, with a little gravel, brown mottled, lenses of waterbearing sand at 24', 25' and 39 1/2', limonite staining in fractures from 10' to 20', no fractures below 20' (CL)	TILL			3	SB				
					4	SB				
				▽	5	SB				
					6	SB				
					7	SB				
					8	SB				
					9	SB				
					10	SB				
41.7	SANDY LEAN CLAY, with a little gravel, gray (CL)				11	SB				
	BORING CONTINUED ON NEXT PAGE									

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
4-18	5:00	25'	3'	25'		24.6'
4-19	8:30	45'	45'	45'		14.8'

START 4-18-94 COMPLETE 4-19-94 @ 5:30

METHOD 6 1/4" HSA 0-4', 3 1/4" HSA 4'-91 1/2'

CREW CHIEF R. Hanson

Huntingdon

LOG OF TEST BORING

JOB NO. 6600 94-354 VERTICAL SCALE 1" = 6' BORING NO. H-4D CONTINUED

PROJECT OTTER TAIL POWER COMPANY, BIG STONE CITY, SOUTH DAKOTA

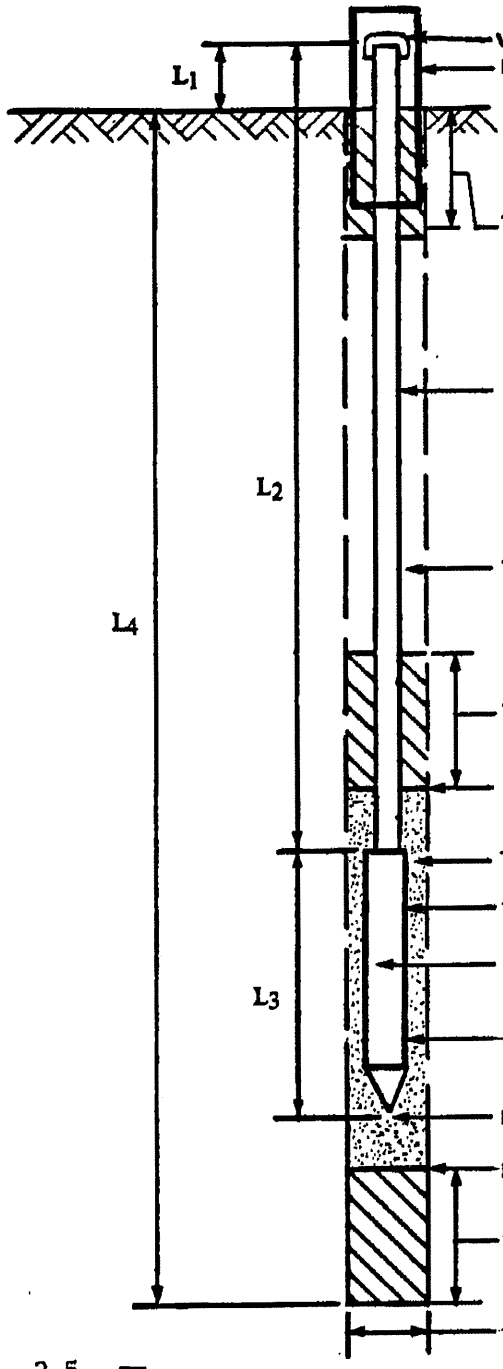
DEPTH IN FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	TESTS W	TESTS D	ORGANIC VAPOR hNu (ppm)	ORGANIC VAPOR bkgd (ppm)
45	SAME AS PREVIOUS PAGE	TILL			12	3T				
					13	SB				
49.0										
	SANDY LEAN CLAY, with a little gravel,				14	SB				
50.7	brown mottled (CL)				15	SB				
	SANDY LEAN CLAY, with a little gravel,				16	SB				
53.1	gray (CL)									
54.2	**SILTY SAND**, fine grained, brown,	*			17	SB				
	waterbearing (SM)	TILL			18	SB				
	SANDY LEAN CLAY, with a little gravel,				19	SB				
	gray, a cobble at 66' (CL)									
					20	SB				
					21	NSR				
68.0										
	FAT CLAY, gray (CH)	FINE ALLUVIUM			22	SB				
70.0										
	SILT, gray (ML)				23	SB				
74.0					24	SB				
	FAT CLAY, gray (CH)				25	SB				
78.0										
79.5	**SANDY LEAN CLAY**, with a little gravel,	TILL			26	SB				
	gray (CL)				27	SB				
	SAND, medium to coarse grained, with a little	COARSE ALLUVIUM								
	gravel, brown, waterbearing (SP)									
					28	SB				
	* MIXED ALLUVIUM									
					29	SB				
91.5										
	END OF BORING									

INSTALLATION OF MONITORING WELL

JOB NO. 6600 94-354 **MONITORING WELL NO.** H-lox

Otter Tail Power Company, Big Stone City, South Dakota

GROUND SURFACE ELEVATION 1113.07' **TOP OF RISER PIPE ELEVATION** (with cap removed) 1115.51'



VENTED CAP	
PROTECTIVE CASING	
Diameter and Type	4" steel tubing
Total Length	5'
Length Above Ground	3'
THICKNESS AND TYPE OF SEAL	3' cement
DIAMETER AND TYPE OF RISER PIPE	2" PVC
TYPE OF BACKFILL AROUND RISER	cement and bentonite grout
THICKNESS AND TYPE OF SEAL	2' bentonite
DEPTH TO TOP OF FILTER SAND	23'
TYPE OF FILTER AROUND SCREEN	silica sand
TYPE OF MONITORING WELL	PVC
SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.)	0.010"
DIAMETER AND LENGTH OF SCREEN	2" X 5'
DEPTH TO BOTTOM OF MONITORING WELL	30'
DEPTH TO BOTTOM OF FILTER SAND	30'
THICKNESS AND TYPE OF SEAL	—
DIAMETER OF BOREHOLE	7¼"

L_1= 2.5 FT

L_2= 27.5 FT

L_3= 5 FT

L_4= 30 FT

INSTALLATION COMPLETED:
Date 5/11/94 Time 4:30

MONITORING WELL WATER LEVEL MEASUREMENTS			
DATE	TIME	BAILED DEPTHS	WATER LEVEL *
			**

* DEPTH BELOW TOP OF RISER PIPE
** See report for water level information.

twin city testing corporation

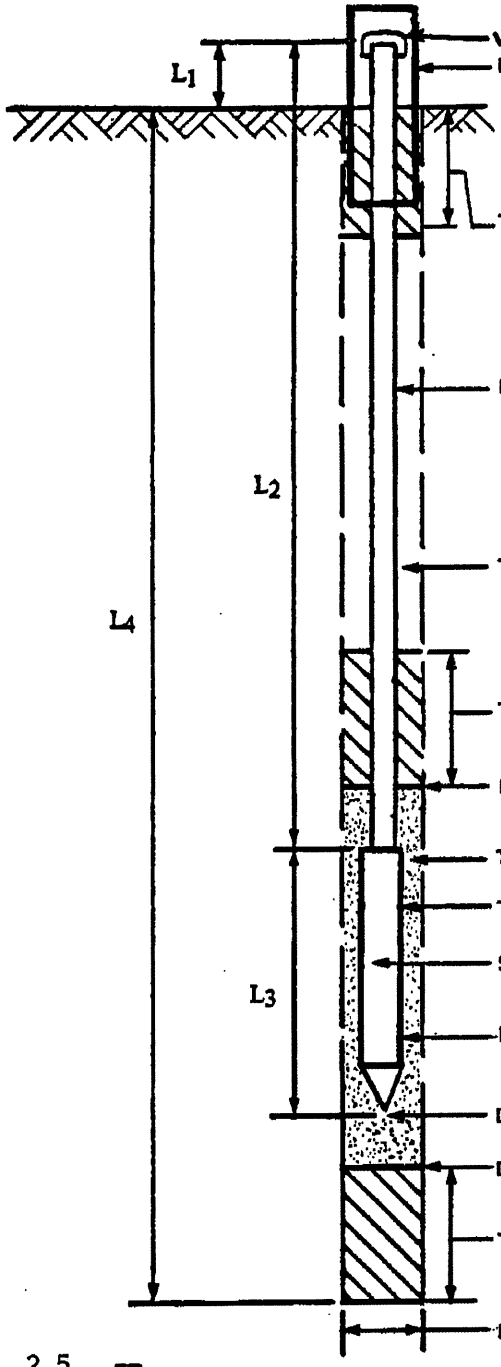
SE-29 (83-B)

INSTALLATION OF MONITORING WELL

JOB NO. 6600 94-354 **MONITORING WELL NO.** H-1i

Otter Tail Power Company, Big Stone City, South Dakota

GROUND SURFACE ELEVATION 1113.07' **TOP OF RISER PIPE ELEVATION** (with cap removed) 1115.48'



VENTED CAP	
PROTECTIVE CASING	
Diameter and Type	4" steel tubing
Total Length	5'
Length Above Ground	
THICKNESS AND TYPE OF SEAL	3' cement
DIAMETER AND TYPE OF RISER PIPE	2" PVC
TYPE OF BACKFILL AROUND RISER	cement and bentonite grout
THICKNESS AND TYPE OF SEAL	2' bentonite
DEPTH TO TOP OF FILTER SAND	52'
TYPE OF FILTER AROUND SCREEN	silica sand
TYPE OF MONITORING WELL	PVC
SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.)	0.010"
DIAMETER AND LENGTH OF SCREEN	2" X 5'
DEPTH TO BOTTOM OF MONITORING WELL	58'
DEPTH TO BOTTOM OF FILTER SAND	58½'
THICKNESS AND TYPE OF SEAL	—
DIAMETER OF BOREHOLE	8¼"

L_1= 2.5 FT

L_2= 55.5 FT

L_3= 5 FT

L_4= 58.5 FT

INSTALLATION COMPLETED:
Date 6/02/94 Time 9:30

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	BAILED DEPTHS	WATER LEVEL *
			**

* DEPTH BELOW TOP OF RISER PIPE

** See report for water level information.

twin city testing corporation

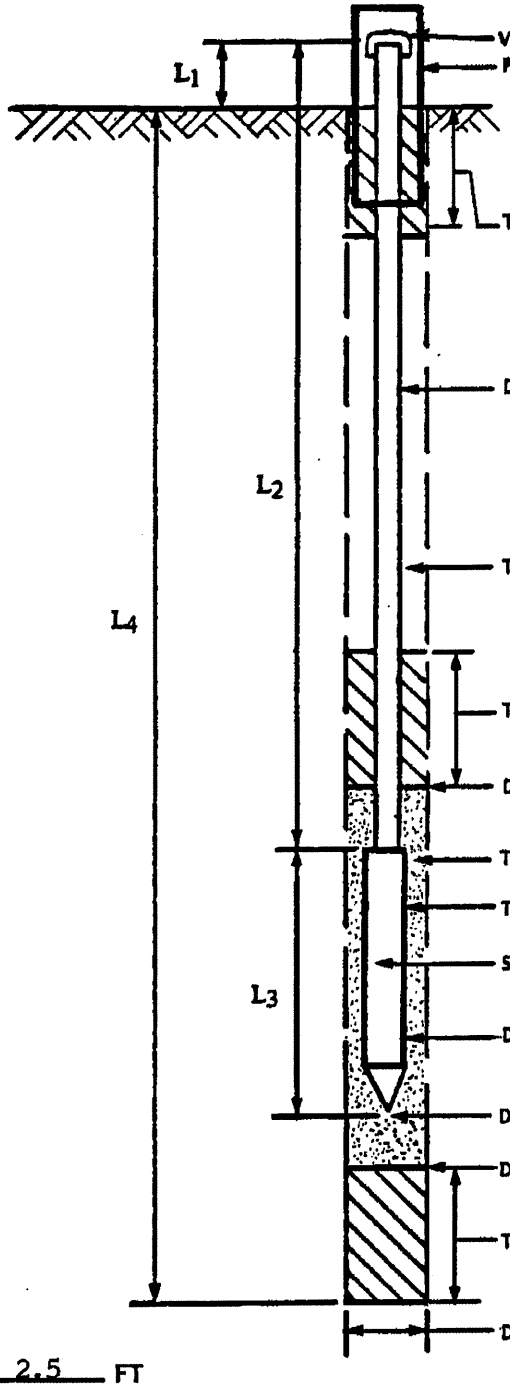
SE-29 (82-B)

INSTALLATION OF MONITORING WELL

JOB NO. 6600 94-354 **MONITORING WELL NO.** H-2ox

Otter Tail Power Company, Big Stone City, South Dakota

GROUND SURFACE ELEVATION 1100.55' TOP OF RISER PIPE ELEVATION (with cap removed) 1103.11'



VENTED CAP	
PROTECTIVE CASING	
Diameter and Type	4" steel tubing
Total Length	5'
Length Above Ground	2.8'
THICKNESS AND TYPE OF SEAL	3' cement
DIAMETER AND TYPE OF RISER PIPE	2' PVC
TYPE OF BACKFILL AROUND RISER	cement and bentonite grout
THICKNESS AND TYPE OF SEAL	2' bentonite
DEPTH TO TOP OF FILTER SAND	23'
TYPE OF FILTER AROUND SCREEN	silica sand
TYPE OF MONITORING WELL	PVC
SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.)	0.010"
DIAMETER AND LENGTH OF SCREEN	2" X 5'
DEPTH TO BOTTOM OF MONITORING WELL	30'
DEPTH TO BOTTOM OF FILTER SAND	30'
THICKNESS AND TYPE OF SEAL	—
DIAMETER OF BOREHOLE	8¼"

L_1= 2.5 FT

L_2= 27.5 FT

L_3= 5 FT

L_4= 30 FT

INSTALLATION COMPLETED:
Date 5/12/94 Time 12:00

MONITORING WELL WATER LEVEL MEASUREMENTS			
DATE	TIME	BAILED DEPTHS	WATER LEVEL *
			**

* DEPTH BELOW TOP OF RISER PIPE

** See report for water level information.

twin city testing corporation

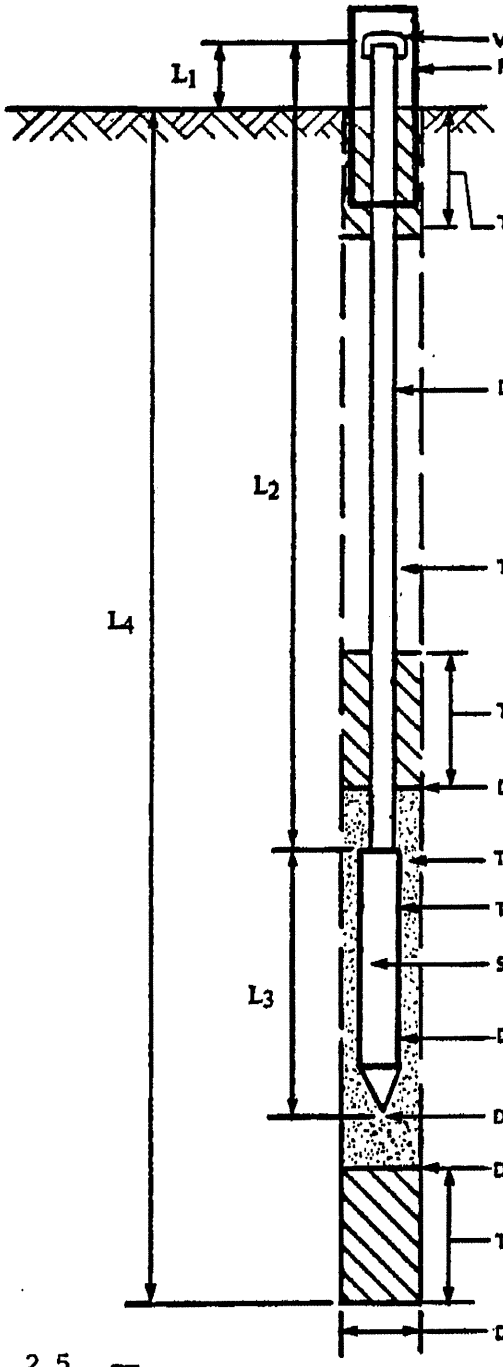
SE-28 (83-B)

INSTALLATION OF MONITORING WELL

JOB NO. 6600 94-354 **MONITORING WELL NO.** H-3ox

Otter Tail Power Company, Big Stone City, South Dakota

GROUND SURFACE ELEVATION 1092.19' **TOP OF RISER PIPE ELEVATION** (with cap removed) 1094.56'



VENTED CAP	
PROTECTIVE CASING	
Diameter and Type	4" steel tubing
Total Length	5'
Length Above Ground	2.8'
THICKNESS AND TYPE OF SEAL	3' cement
DIAMETER AND TYPE OF RISER PIPE	2" PVC
TYPE OF BACKFILL AROUND RISER	cement and bentonite grout
THICKNESS AND TYPE OF SEAL	2' bentonite
DEPTH TO TOP OF FILTER SAND	13'
TYPE OF FILTER AROUND SCREEN	silica sand
TYPE OF MONITORING WELL	PVC
SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.)	0.010"
DIAMETER AND LENGTH OF SCREEN	2" X 5'
DEPTH TO BOTTOM OF MONITORING WELL	20'
DEPTH TO BOTTOM OF FILTER SAND	20½'
THICKNESS AND TYPE OF SEAL	--
DIAMETER OF BOREHOLE	8¼"

L_1 = 2.5 FT

L_2 = 17.5 FT

L_3 = 5 FT

L_4 = 20.5 FT

INSTALLATION COMPLETED:
Date 5/11/94 Time 6:30

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	BAILED DEPTHS	WATER LEVEL *
			**

* DEPTH BELOW TOP OF RISER PIPE
** See report for water level information.

twin city testing corporation

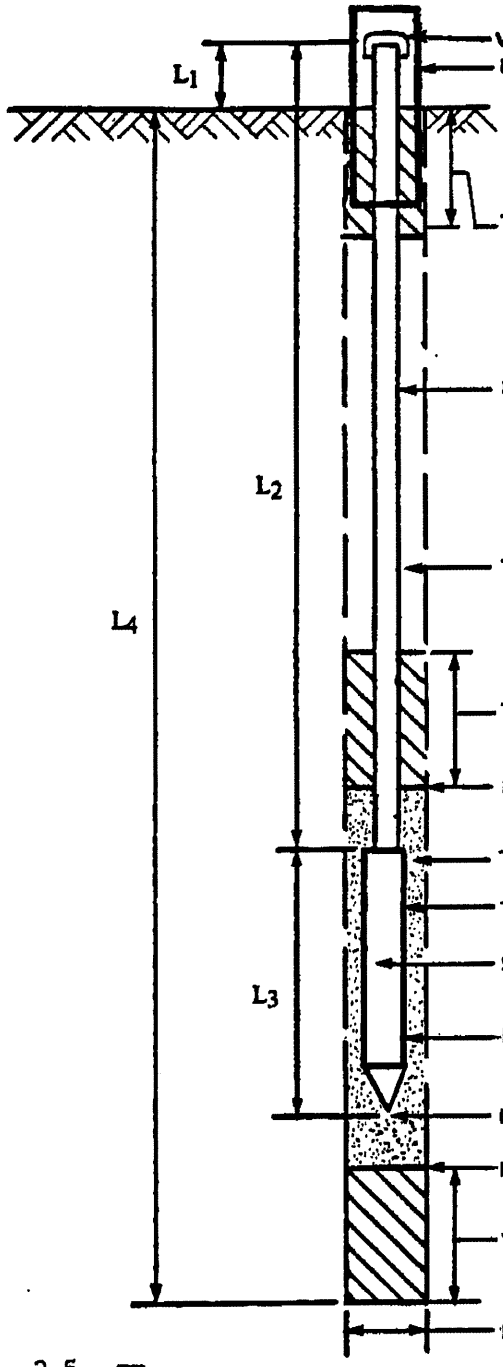
SE-29 (82-B)

INSTALLATION OF MONITORING WELL

JOB NO. 6600 94-354 **MONITORING WELL NO.** H-3i

Otter Tail Power Company, Big Stone City, South Dakota

GROUND SURFACE ELEVATION 1092.25' **TOP OF RISER PIPE ELEVATION** (with cap removed) 1094.69'



VENTED CAP	
PROTECTIVE CASING	
Diameter and Type	4" steel tubing
Total Length	5'
Length Above Ground	3.2'
THICKNESS AND TYPE OF SEAL	3' cement
DIAMETER AND TYPE OF RISER PIPE	2" PVC
TYPE OF BACKFILL AROUND RISER	cement and bentonite grout
THICKNESS AND TYPE OF SEAL	1' bentonite
DEPTH TO TOP OF FILTER SAND	44'
TYPE OF FILTER AROUND SCREEN	silica sand and natural sand
TYPE OF MONITORING WELL	PVC
SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.)	0.010"
DIAMETER AND LENGTH OF SCREEN	2" X 5'
DEPTH TO BOTTOM OF MONITORING WELL	52'
DEPTH TO BOTTOM OF FILTER SAND	52½'
THICKNESS AND TYPE OF SEAL	--
DIAMETER OF BOREHOLE	8¼"

L_1= 2.5 FT

L_2= 49.5 FT

L_3= 5 FT

L_4= 52.5 FT

INSTALLATION COMPLETED:
Date 5/25/94 Time 8:50

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	BAILED DEPTHS	WATER LEVEL *
			**

* DEPTH BELOW TOP OF RISER PIPE

** See report for water level information.

twin city testing corporation

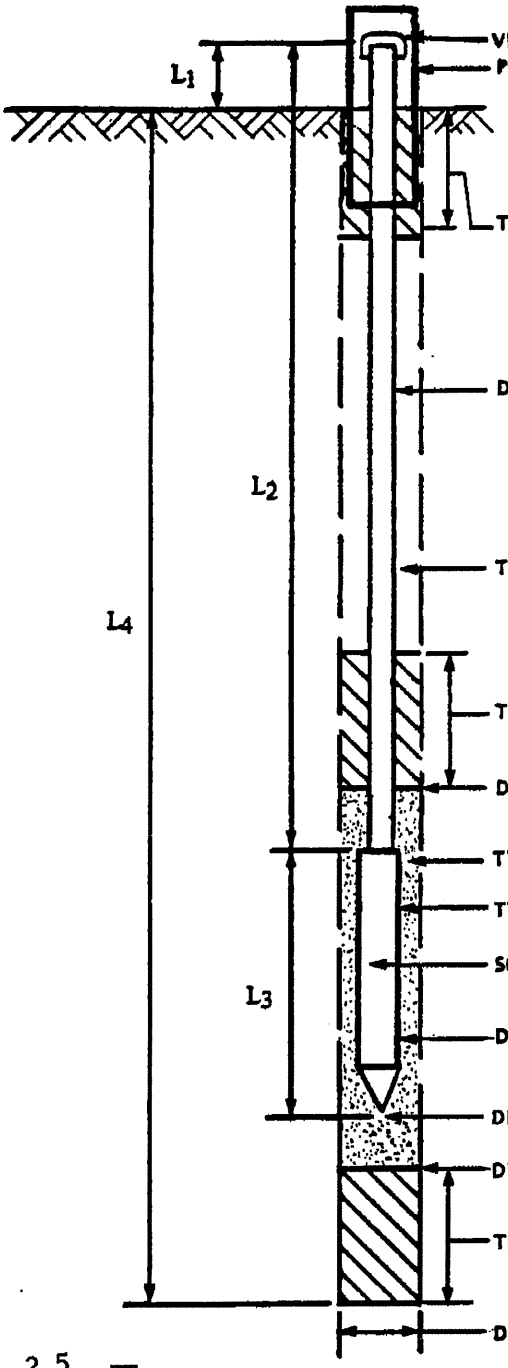
SE-29 (83-B)

INSTALLATION OF MONITORING WELL

JOB NO. 6600 94-354 **MONITORING WELL NO.** H-4ox

Otter Tail Power Company, Big Stone City, South Dakota

GROUND SURFACE ELEVATION 1105.69' **TOP OF RISER PIPE ELEVATION** (with cap removed) 1108.01'



VENTED CAP	
PROTECTIVE CASING	
Diameter and Type	4" steel tubing
Total Length	5'
Length Above Ground	2.8'
THICKNESS AND TYPE OF SEAL	3' cement
DIAMETER AND TYPE OF RISER PIPE	2" PVC
TYPE OF BACKFILL AROUND RISER	cement and bentonite grout
THICKNESS AND TYPE OF SEAL	2' bentonite
DEPTH TO TOP OF FILTER SAND	18'
TYPE OF FILTER AROUND SCREEN	silica sand
TYPE OF MONITORING WELL	PVC
SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.)	0.010"
DIAMETER AND LENGTH OF SCREEN	2" X 5'
DEPTH TO BOTTOM OF MONITORING WELL	25'
DEPTH TO BOTTOM OF FILTER SAND	25½'
THICKNESS AND TYPE OF SEAL	--
DIAMETER OF BOREHOLE	8¼"

L_1= 2.5 FT

L_2= 22.5 FT

L_3= 5 FT

L_4= 25.5 FT

INSTALLATION COMPLETED:
Date 5/12/94 Time 2:45

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	BAILED DEPTHS	WATER LEVEL *
			**

* DEPTH BELOW TOP OF RISER PIPE

** See report for water level information.

twin city testing corporation

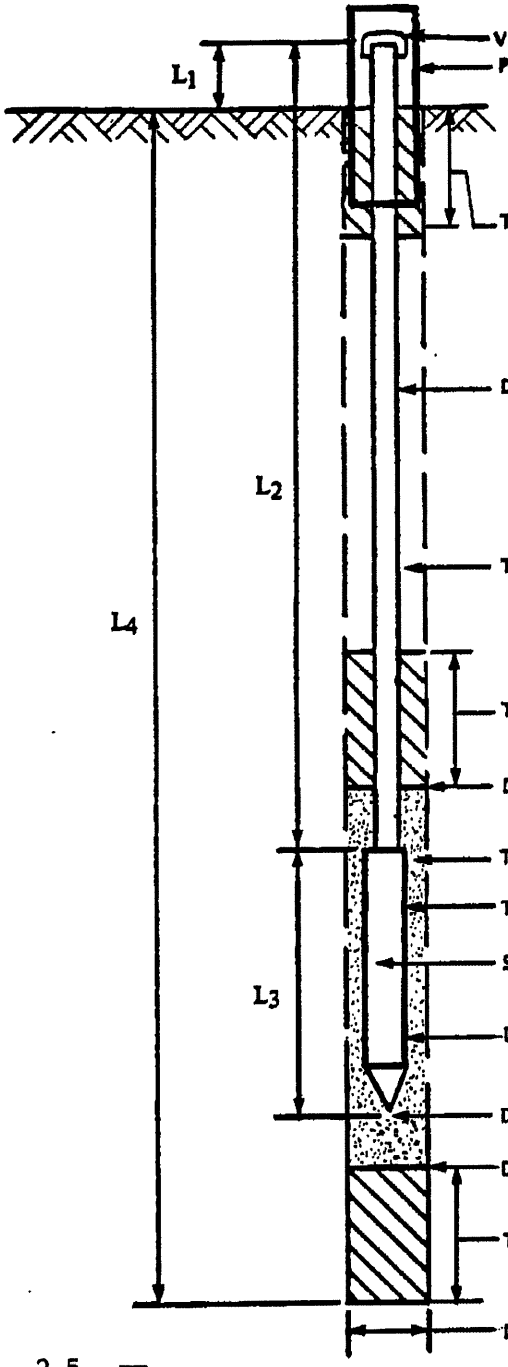
SE-29 (83-B)

INSTALLATION OF MONITORING WELL

JOB NO. 6600 94-354 **MONITORING WELL NO.** H-4i

Otter Tail Power Company, Big Stone City, South Dakota

GROUND SURFACE ELEVATION 1105.96' **TOP OF RISER PIPE ELEVATION** (with cap removed) 1108.36'



VENTED CAP	
PROTECTIVE CASING	
Diameter and Type	4" steel tubing
Total Length	5'
Length Above Ground	3'
THICKNESS AND TYPE OF SEAL	3' cement
DIAMETER AND TYPE OF RISER PIPE	2" PVC
TYPE OF BACKFILL AROUND RISER	cement and bentonite grout
THICKNESS AND TYPE OF SEAL	1.8' bentonite
DEPTH TO TOP OF FILTER SAND	51'
TYPE OF FILTER AROUND SCREEN	silica sand
TYPE OF MONITORING WELL	PVC
SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.)	0.010"
DIAMETER AND LENGTH OF SCREEN	2" X 5'
DEPTH TO BOTTOM OF MONITORING WELL	58'
DEPTH TO BOTTOM OF FILTER SAND	58½'
THICKNESS AND TYPE OF SEAL	--
DIAMETER OF BOREHOLE	8¼"

L_1= 2.5 FT

L_2= 55.5 FT

L_3= 5 FT

L_4= 58.5 FT

INSTALLATION COMPLETED:
Date 5/24/94 Time 10:00

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	BAILED DEPTHS	WATER LEVEL *
			**

* DEPTH BELOW TOP OF RISER PIPE

** See report for water level information.

twin city testing corporation

SE-29 (83-B)

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

LOG OF WELL H8

Project:Big Stone Station
Project No.:41251005
Location:Big Stone City, SD
Coordinates:N 554,702.0 ft E 2,872,096.6 ft
Datum:SD North State Plane NAD83

Surface Elevation:1078.9 ft
Drilling Method:HSA
Sampling Method:SS
Completion Depth:20.0 ft

Top of Casing Elev.: 1081.2 ft

Depth, feet	Sample Type & Recovery	Sample No.	Blows/6in.	USCS	Graphic Log	LITHOLOGIC DESCRIPTION	Elevation, feet
0				OL/OH		TOPSOIL (OL/OH): black (10YR 2/1); moist; 0% gravel, 10% sand, 90% fines.	
			2-2-1-1.			LEAN CLAY (CL): yellowish brown to dark yellowish brown (10YR 5/6 to 10YR 4/4); moist; 5% gravel, 5% sand, 90% fines, with very fine to medium grain sand, oxidized seams, light gray clumps of silt (ML) becoming sandier with depth.	
			2-2-3-1.				1075
5			4-4-5-4.			5.5': Trace gravel.	
			5-6-6-7.				
			3-3-4-3.	CL			1070
10			4-5-7-10.			11.5': SILTY SAND (SM) seam, very fine grain, oxidized.	
			5-11-11-15.				1065
15			4-7-9-10.			16': SILTY SAND (SM), dark yellowish brown (10YR 4/4), wet, medium to coarse grain, 20% gravel, 50% sand, 30% fines.	
			5-6-5-9.			18.7': SILTY SAND (SM) seam, dark yellowish brown (10YR 4/4), very fine grain.	1060
20						End of well 20.0 feet	
25							
30							

WELL OR PIEZOMETER CONSTRUCTION DETAIL

PRO. CASING
Diameter: **6"**
Type: **Steel**
Interval:

RISER CASING
Diameter: **2"**
Type: **PVC Sch 40**
Interval:

GROUT
Type: **Neat Cement**
Interval: **0-6' bgs**

SEAL
Type: **Bentonite**
Interval: **6-8' bgs**

SANDPACK
Type: **Silica #50-80**
Interval: **8-21' bgs**

SCREEN
Diameter:
Type: **#6 Sch 40**
Interval: **10-20' bgs**

Date Boring Started: 7/29/16 1:45 pm
Date Boring Completed: 7/29/16
Logged By: JWJ
Drilling Contractor: SDE
Drill Rig: Truck

Remarks:

Additional data may have been collected in the field which is not included on this log.

M:\GINT\PROJECTS\41251005 BIG STONE.GPJ BARRLIBRARY.GLB ENVIRO LOG BARR TEMPLATE.GDT

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

LOG OF WELL H9

Project:Big Stone Station
Project No.:41251005
Location:Big Stone City, SD
Coordinates:N 555,166.2 ft E 2,872,218.3 ft
Datum:SD North State Plane NAD83

Surface Elevation:1083.8 ft
Drilling Method:HSA
Sampling Method:SS
Completion Depth:30.0 ft

Top of Casing Elev.: 1086.2 ft

Depth, feet	Sample Type & Recovery	Sample No.	Blows/6in.	USCS	Graphic Log	LITHOLOGIC DESCRIPTION	Elevation, feet
0				OL/OH		TOPSOIL (OL/OH): dark brown (10YR 3/3); moist; 0% gravel, 15% sand, 85% fines.	
			1-2-1-1.	ML		SILT WITH SAND (ML): very fine to fine grained; dark yellowish brown (10YR 4/6); moist; 0% gravel, 30% sand, 70% fines, trace gravel.	
			3-2-3-3.				1080
5			3-3-5-6.	CL		LEAN CLAY (CL): yellowish brown to dark yellowish brown (10YR 5/6 to 10YR 4/4); moist; 0% gravel, 10% sand, 90% fines, with very fine to medium grain sand and trace gravel throughout, reddish orange oxidation throughout.	
			5-6-6-8.				
			5-7-7-9.				1075
10						9.4': CLAYSTONE, dark gray, 1.2" thick.	
			6-8-10-12.				
			6-6-7-9.				1070
15			5-6-6-11.				
			4-6-7-9.				
			7-9-9-11.				1065
20			4-5-6-6.				
			5-6-9-12.				1060
25			4-6-5-7.			24': SILTY SAND (SM), dark brown (10YR 3/3), wet, very fine to medium grain, 0% gravel, 90% sand, 10% fines, 1.3' thick.	
			5-6-6-8.			29': SILTY SAND (SM), dark yellowish brown (10YR 4/4), wet, very fine to medium grain, 0% gravel, 90% sand, 10% fines, 9.6" thick.	1055
30						End of well 30.0 feet	

WELL OR PIEZOMETER CONSTRUCTION DETAIL

PRO. CASING
Diameter: **6"**
Type: **Steel**
Interval:

RISER CASING
Diameter: **2"**
Type: **PVC Sch 40**
Interval:

GROUT
Type: **Neat Cement**
Interval: **0-13.5' bgs**

SEAL
Type: **Bentonite**
Interval: **13-15.5' bgs**

SANDPACK
Type: **Silica #50-80**
Interval: **15.5-30' bgs**

SCREEN
Diameter:
Type: **#6 Sch 40**
Interval: **18-28' bgs**

Date Boring Started: 7/30/16 8:50 am
Date Boring Completed: 7/30/16 8:45 pm
Logged By: NJS2
Drilling Contractor: SDE
Drill Rig: Truck

Remarks:

Additional data may have been collected in the field which is not included on this log.

M:\GINT\PROJECTS\41251005 BIG STONE.GPJ BARRLIBRARY.GLB ENVIRO LOG BARR TEMPLATE.GDT

WCEC Job 8472

SOUTH DAKOTA WATER WELL COMPLETION REPORT 11-02

Location NW ¼ SW ¼ Sec 7 Twp 121N Rg 47W

County Grant

North

Please mark well location with an "X"

W X E

1 Mile

Well completion Date 11/2/11

Distance from nearest potential pollution source (Septic tank, abandoned well, feed lot, etc.)

? NA ft. from Unknown (identify source)

PROPOSED USE:
☐ Domestic/Stock ☐ Municipal ☐ Business ☐ Test Holes
☐ Irrigation ☐ Industrial ☐ Institutional ☒ Monitoring well

METHOD OF DRILLING: Augers Hollow Stem

CASING DATA: ☐ Steel ☒ Plastic ☐ Other

If other describe

PIPEWEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
LB/FT	2 IN	0 FT	5 FT	12 IN
LB/FT	IN	FT	FT	IN
LB/FT	IN	FT	FT	IN

GROUTING DATA:

Grout Type	No. of Sacks	Grout Weight	From	To
Env. Grout/Bentonite		Lb/gal	0 Ft	4 Ft
		Lb/gal	Ft	Ft

Describe grouting procedure

SCREEN: ☐ Perforated pipe ☒ Manufactured

Diameter 2 Inches Length 10 Feet

Material PVC

Slot Size 10 Set From 5 Feet to 15 Feet

Other information Sch 40

WAS A PACKER OR SEAL USED? ☐ Yes ☒ No

If so, what material?

Describe packer(s) and location

DISINFECTION: Was well disinfected upon completion?

☐ Yes, How?

☒ No, Why Not?

Lab sample sent to for water quality analysis

Well Owner: Otter Tail Power Company

Business Name: OTPC Big Stone Plant

Address1: 48450 124th St

Address2:

City, State, Zip: Big Stone City, SD 57216

WELL LOG:

FORMATION	DEPTH FROM	DEPTH TO
Top Soil	0	2
Sandy Clay	2	4
Clayey Sand	4	10
Sandy clay	10	15

STATIC WATER LEVEL 10.5 FEET

If flowing: closed in pressure PSI

GPM flow through Inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other

Reduced flow rate GPM

Can well be completely shut in?

WELL TEST DATA:

☐ Pumped Describe: NA

☐ Bailed

☐ Other

Pumping Level Below Land Surface

Ft. After Hrs. pumped GPM

Ft. After Hrs. pumped GPM

If pump installed, pump rate: GPM

REMARKS

MW2 Was Renamed H-6

This well was drilled under license # 769

And this report is true and accurate.

Drilling firm: WCEC

Signature of License Representative:

Signature of Well Owner or Equitable Property Holder (agent)

Date: 11/16/2011

Please return White Copy to DENR Water Rights **523 E. Capitol Ave., Pierre SD 57501**

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

LOG OF BORING SB DEEP H6

Project:Big Stone Station
Project No.:41251005
Location:Big Stone City, SD
Coordinates:N 554,399.9 ft E 2,871,848.1 ft
Datum:SD North State Plane NAD83

Surface Elevation:1094.7 ft
Drilling Method:HSA
Sampling Method:SS
Completion Depth:55.0 ft

Depth, feet	Sample Type & Recovery	Sample No.	Blows/6in.	USCS	Graphic Log	LITHOLOGIC DESCRIPTION	Elevation, feet
0			3-2-1-1.	OL/OH		TOPSOIL (OL/OH): black (10YR 2/1); moist; 0% gravel, 10% sand, 90% fines, trace roots.	
			3-3-3-5.			LEAN CLAY (CL): dark yellowish brown (10YR 3/6); moist; 0% gravel, 15% sand, 85% fines, with very fine to fine grain sand, little oxidization, some oxidized mottling, trace gravel througout, some cobbles, becomes sandier with depth.	
5			6-7-6-9.				1090
			4-7-7-8.	CL		6.7': SANDSTONE/SAND inclusion, whitish.	
			5-8-7-9.				
10			7-9-11-9.			10.5': Sand gravel mix, wet. 11.7': Sand gravel mix.	1085
15			5-8-11-12.			SILTY WITH SAND (ML): fine to medium grained; dark yellowish brown (10YR 3/6); moist to wet; 5% gravel, 20% sand, 75% fines, trace gravel, some heavy oxidization, becomes sandier with depth. 14.4' & 14.8': Sand lense.	1080
			7-8-10-12.				
			8-8-10-13.				
20				ML			1075
			11-18-23-28.				
25							1070
			8-9-11-14.			LEAN CLAY (CL): dark brown (10YR 3/3); moist; 0% gravel, 10% sand, 90% fines, some cobbles, oxidization and black inclusions.	
30			9-12-15-19.				1065
			15-21-22-28.			33.5': Black organic inclusion.	
35			6-9-13-16.				1060
			15-25-21-36.				
40				CL			1055
			4-6-8-5.				
45			5-4-6-7.				1050
50			6-5-7-8.				1045
55			12-15-18-17.			End of boring 55.0 feet	1040
60							

Date Boring Started: 7/31/16 8:22 am
Date Boring Completed: 7/31/16 3:45 pm
Logged By: NJS2
Drilling Contractor: SDE
Drill Rig: Truck

Remarks:

Additional data may have been collected in the field which is not included on this log.

O:\GINT\PROJECTS\41251005 BIG STONE.GPJ BARRLIBRARY.GLB ENVIRO LOG BARR TEMPLATE.GDT

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

LOG OF PIEZOMETER T-1

Project:Big Stone Station
Project No.:41251005
Location:Big Stone City, SD
Coordinates:N 554,209.8 ft E 2,870,671.0 ft
Datum:SD North State Plane NAD83

Surface Elevation:1107.5 ft
Drilling Method:HSA
Sampling Method:SS
Completion Depth:24.0 ft

Unique Well No.: T-1

Depth, feet	Sample Type & Recovery	Sample No.	Blows/6in.	USCS	Graphic Log	LITHOLOGIC DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	Elevation, feet
0			4-5-5-7.	OL/OH		TOPSOIL (OL/OH): very dark brown (10YR 2/2); moist; 5% gravel, 10% sand, 85% fines.	PRO. CASING Diameter: Type: Interval:	1105
			5-5-6-9.			SANDY CLAY (CL): yellowish borwn (10YR 5/4); moist; 10% gravel, 20% sand, 70% fines, with very fine grain to medium grain sand and coarse grain, subrounded gravel.		
5			4-5-5-7.				RISER CASING Diameter: **1"** Type: **PVC** Interval:	
			4-4-5-5.	CL				1100
			3-3-5-4.				GROUT Type: Interval:	
10			7-10-10-12.			11.5': CLAYEY SAND LENSE (SC), moist, 10% gravel, 60% sand, 30% fines, 1.2" thick.		
			4-7-7-8.			LEAN CLAY (CL): yellowish brown (10YR 5/4); moist; 5% gravel, 15% sand, 80% fines, with rusty cracks/seams,.	SEAL Type: Interval:	1095
						13.5': Small chunk of black organic material.		
15			6-6-8-8.				SANDPACK Type: **Silica #10** Interval:	
			5-5-7-8.	CL		17': Trace coarse grain gravel.	SCREEN Diameter: Type: **PVC #10 Slot** Interval: **13.7-23.7' bgs**	1090
20			7-10-11-13.			19': Coarse grain gravel, subangular.		
			6-8-10-14.					1085
25						End of piezometer 24.0 feet		
30								

Date Boring Started: 7/18/16 5:50 pm
Date Boring Completed: 7/19/16 9:30 am
Logged By: JWJ
Drilling Contractor: SDE
Drill Rig: Truck

Remarks:

Additional data may have been collected in the field which is not included on this log.

O:\GINT\PROJECTS\41251005 BIG STONE.GPJ BARRLIBRARY.GLB ENVIRO LOG BARR TEMPLATE.GDT

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

LOG OF PIEZOMETER T-2

Project:Big Stone Station
Project No.:41251005
Location:Big Stone City, SD
Coordinates:N 554,277.9 ft E 2,871,572.0 ft
Datum:SD North State Plane NAD83

Surface Elevation:1094.4 ft
Drilling Method:HSA
Sampling Method:SS
Completion Depth:28.0 ft

Unique Well No.: T-2

Depth, feet	Sample Type & Recovery	Sample No.	Blows/6in.	USCS	Graphic Log	LITHOLOGIC DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	Elevation, feet
0			2-1-1-1.	OL/OH		TOPSOIL (OL/OH): very dark brown (10YR 2/2); moist; 5% gravel, 10% sand, 85% fines.	PRO. CASING Diameter: Type: Interval:	
			2-1-2-2.			LEAN CLAY (CL): brown to dark brown (10YR 4/3 - 5YR 3/4); moist; 20% gravel, 10% sand, 70% fines, very fine grain to medium grain, subangular sand with fine to coarse grain gravel.		1090
5			2-3-5-9.				RISER CASING Diameter: **1"** Type: **PVC** Interval:	
			3-3-3-5.					
			10-8-5-5.				GROUT Type: Interval:	1085
10			2-4-7-11.	CL			SEAL Type: Interval:	
			2-4-4-7.					
			7-9-9-12.				SANDPACK Type: **Silica #10** Interval: **12-26' bgs**	1080
15			4-6-6-7.				SCREEN Diameter: Type: **PVC #10 Slot** Interval: **16-26' bgs**	
			6-8-8-10.					
				ML		SILT (ML): yellowish brown (10YR 5/4); wet; 20% gravel, 10% sand, 70% fines.		1075
20			5-6-8-11.			LEAN CLAY (CL): brown to dark brown (10YR 4/3 - 5YR 3/4); wet; 20% gravel, 10% sand, 70% fines, very fine grain to medium grain, subangular sand with fine to coarse grain gravel.		
			6-10-13-17.	CL				
25			5-6-8-11.			25.5': CLAYEY SAND LENSE (SC), yellowish brown (10YR 5/4), fine grain, subangular sand, wet, 3.6" thick.		1070
						End of piezometer 28.0 feet		
30								

Date Boring Started: 7/18/16 2:00 pm
Date Boring Completed: 7/18/16 5:35 pm
Logged By: JWJ
Drilling Contractor: SDE
Drill Rig: Truck

Remarks:

Additional data may have been collected in the field which is not included on this log.

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

LOG OF PIEZOMETER T-3

Project:Big Stone Station
Project No.:41251005
Location:Big Stone City, SD
Coordinates:N 554,728.9 ft E 2,872,107.4 ft
Datum:SD North State Plane NAD83

Surface Elevation:1076.9 ft
Drilling Method:HSA
Sampling Method:SS
Completion Depth:16.0 ft

Unique Well No.: T-3

Depth, feet	Sample Type & Recovery	Sample No.	Blows/6in.	USCS	Graphic Log	LITHOLOGIC DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	Elevation, feet
0			1-1-1-1.	CL		LEAN CLAY (CL): brown (10YR 4/3); moist; 5% gravel, 5% sand, 90% fines, trace fine grain sand.	PRO. CASING Diameter: Type: Interval:	1075
			2-2-3-5.					
5			5-6-7-10.	SM		SILTY SAND (SM): brown (10YR 4/3); wet; 5% gravel, 75% sand, 20% fines, trace gravel and clay clumps.	RISER CASING Diameter: **1"** Type: **PVC** Interval:	1070
			7-8-8-10.	CL		SANDY CLAY (CL): brown (10YR 4/3); wet; 15% gravel, 40% sand, 55% fines, very fine grain to medium grain, subrounded to subangular sand, oxidized stains, light brownish gray clumps, sand clay becomes sandy lean clay with depth.	GROUT Type: Interval: SEAL Type: Interval:	
10			4-2-2-7.					1065
			7-4-9-9.				SANDPACK Type: **Silica #10** Interval: **2-16' bgs**	
15			4-5-6-6.			End of piezometer 16.0 feet	SCREEN Diameter: Type: **PVC #10 Slot** Interval: **6-16' bgs**	
20								
25								
30								

Date Boring Started: 7/19/16 10:50 am
Date Boring Completed: 7/16/16 12:45 pm
Logged By: JWJ
Drilling Contractor: SDE
Drill Rig: Truck

Remarks:

Additional data may have been collected in the field which is not included on this log.

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WCEC
ENVIRONMENTAL CONSULTANTS

14 Green River Road
P.O. Box 594
Morris, MN 56267

MONITORING WELL LOG

South Dakota Unique Well Number:
Well # : H10
Date Completed: 10/12/2022
Total Depth Installed (ft bsg): 35.49
Measured Depth Post-Installation (ft bsg): 35.49
Surface Elevation (ft): 1088.53 ft amsl
Top of Casing Elevation (ft): 1090.83 ft amsl
Start: 12:30 10/12/2022 Stop: 14:15 10/12/2022

WELL DEVELOPMENT

Post Installation Fluid Levels (below surface grade)

Date/Time	Water Level (ft)	Product Level (ft)
10/31/22 12:40	25.75	-

Development Date/Method: Surge block
Total Gallons Pumped: ~3

Post Development Fluid Levels (below surface grade)

Date/Time	Water Level (ft)	Product Level (ft)
10/31/22 13:05	36.15	-

Measured Bottom of Well Depths (ft. below surface)

PROJECT INFORMATION

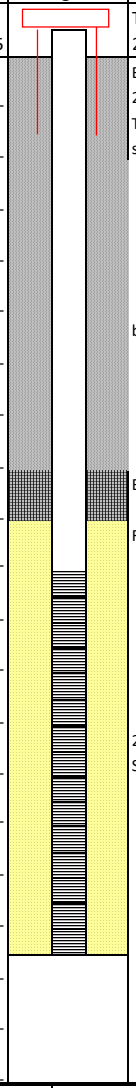
Project Name: **Otter Tail Power Company**
Project Location: **Big Stone City, SD**
Project Number: **14643**

DRILLING INFORMATION

Overseer: **Jesse Frank**
Geologist: **Jesse Frank**

Drilling Co.: **Dakota Technologies Co.**
Method of Drilling: **HSA**
Operator: **Cody Eystad**

Sample Core Interval	Depth (feet)	Material Description	Geologic Origin	ASTM	Sample Analysis/	PID (ppm)	amsl (ft.)
	0	Grass					1088.5
DT		0-1 ft: Top soil, silty, dry.		SM			
		1-5 ft: Silt loam, unsorted, matrix dominated, non-plastic moderate yellowish brown, dry to moist.	Till	SM			
DT		5-15ft: Silt loam, unsorted, matrix dominated, pebble clasts, non plastic, stiff at 9-10 ft, moderate yellowish brown, moist.	Till	SM			
	10						1078.5
DT		15-35 ft: Clay loam, unsorted, matrix dominated, pebble clasts, slightly plastic, stiff, dark yellowish brown, moist.	Till	CL			
DT							
	20						1068.5
DT							
DT							
	30						1058.5
DT		32-35 ft: Color change to olive gray					
	40						1048.5



Notes:
Surface elevation provided by OTP.
Well went dry during development. High sediments content were observed prior to going dry.

Well Construction Materials:
Casing: 2" ID, 2PVC
Screen: 2" ID, PVC, 6 slot
Granular Benseal
Grout
Bentonite Chips
Sand Pack/Natural Sand Pack

Sampling Methods:
SS= Split Spoon
LB = Large Bore
MS = Macro
DT = Dual Tube
HA = Hand Auger
R = Rotosonic

Hollow Stem Auger Measurements: Cutting Bit = 10" OD, Augers w/ Flights = 7 3/4" OD, Hollow Stem = 4 1/4" ID
Sample Analysis Key: LS = Lab Soil Sample, LW = Lab Water Sample, WL = Water Level

WCEC
ENVIRONMENTAL CONSULTANTS
14 Green River Road
P.O. Box 594
Morris, MN 56267

MONITORING WELL LOG

South Dakota Unique Well Number:
Well # : H11
Date Completed: 10/12/2022
Total Depth Installed (ft bsg): 42.15
Measured Depth Post-Installation (ft bsg): 42.15
Surface Elevation (ft): 1091.84 ft amsl
Top of Casing Elevation (ft): 1093.24 ft amsl
Start: 10:00 10/12/2022 Stop: 12:00 10/12/2022

WELL DEVELOPMENT

Post Installation Fluid Levels (below surface grade)

Date/Time	Water Level (ft)(TOC)	Product Level (ft)
10/31/2022 11:10PM	22.16	-

Development Date/Method: Surge block
Total Gallons Pumped: ~15.5

Post Development Fluid Levels (below surface grade)

Date/Time	Water Level (ft)(TOC)	Product Level (ft)
10/31/22 13:00	42.38	-

Measured Bottom of Well Depths (ft. below surface)

PROJECT INFORMATION

Project Name: **Otter Tail Power Company**
Project Location: **Big Stone City, SD**
Project Number: **14643**

DRILLING INFORMATION

Overseer: **Jesse Frank**
Geologist: **Jesse Frank**
Drilling Co.: **Dakota Technologies Co.**
Method of Drilling: **HSA**
Operator: **Cody Eystad**

Sample Core Interval	Depth (feet)	Material Description	Geologic Origin	ASTM	Sample Analysis/	PID (ppm)	amsl (ft.)	Well Diagram	Well Details
	0	Grass					1091.8		TOC 2.4 ft stickup
DT		0-2 ft: Top soil, silty, dry.	Fill	ML					Borehole Diameter: 10-inch 2-inch PVC casing
		2-5 ft: Silt with fine sand, unsorted, matrix dominated, non plastic, moderate yellowish brown, pale gray mottles, moist.	Till	SM					Total length of casing and screen 44.55 ft
DT		5-10 ft: Silt with fine sand, unsorted, small pebble clast, matrix dominated, non plastic, moderate yellowish brown, pale gray mottles, moist.	Till	SM					
	10						1081.8		
DT		12-15 ft: Silt loam, unsorted, small pebble clast, matrix dominated, non plastic, dark yellowish brown,	Till	SM					benseal 0-23 ft
		15-30 ft: Clay sandy loam, unsorted, matrix dominated, pebble clast, non plastic to slightly plastic, stiff, dark yellowish brown, moist. Wet at 20-25 ft	Till	CL					
DT									
	20						1071.8		
DT									Bentonite chips 23-25ft
DT									Flint sand 25-42 feet
									2-inch PVC 6 Slot Screen 27-42 ft
	30						1061.8		
DT		30-42 ft: Clay loam, unsorted, matrix dominated, pebble clast, plastic, very stiff, dark yellowish brown, moist. 32-42 ft: Color change to olive gray	Till	CL					
DT									
	40						1051.8		
DT									

Notes:
Surface elevation provided by OTP.
Well went dry during development. Low sediments were observed during the last ~2 gallons of purging prior to going dry.

Well Construction Materials:
Casing: 2" ID,PVC
Screen: 2" ID, PVC 6 Slot
Granular Benseal
Grout
Bentonite Chips
Sand Pack/Natural Sand Pack

Sampling Methods:
SS= Split Spoon
HA = Hand Auger
LB = Large Bore
R = Rotosonic
MS = Macro
DT = Dual Tube

Hollow Stem Auger Measurements: Cutting Bit = 10" OD, Augers w/ Flights = 7 3/4" OD, Hollow Stem = 4 1/4" ID
Sample Analysis Key: LS = Lab Soil Sample, LW = Lab Water Sample, WL = Water Level

Barr Engineering Co.
4300 MarketPointe Drive Suite 200
Minneapolis, MN 55435
Telephone: 952-832-2600

LOG OF WELL H12

Project:	CCR Monitoring Well Network	Surface Elevation:	1124.6 ft	Top of Casing Elev.: 1127.4 ft
Project No.:	41251005	Drilling Method:	Hollow Stem Auger	
Location:	Big Stone Plant	Sampling Method:	Dual tube	
Coordinates:		Completion Depth:	30.0 ft	
Datum:	NAD83			

Depth, feet	Sample Type & Recovery	Sample No.	USCS	Graphic Log	LITHOLOGIC DESCRIPTION	Elevation, feet
0			ML		SILT WITH SAND (ML): fine to medium sand; trace coarse sand; abundant roots; Very dark grayish brown (10YR 3/2); moist; non-plastic plasticity; 0% gravel, 25% sand, 75% fines, [top soil].	
		1	CL		SANDY LEAN CLAY (CL): fine to medium sand; trace coarse sand; trace coarse gravel; gray and orange mottling; increasing silt with depth; Light olive brown (2.5Y 5/3); moist; stiff; low plasticity; 0% gravel, 30% sand, 70% fines. 1.5-1.6: Strong brown oxidation; sand increased to 40%.	
5		2				1120
10		3	SP-SM		POORLY GRADED SAND WITH SILT (SP-SM): fine to medium sand; 10% of sand fraction coarse); trace fine gravel; grain size coarsens downward; trace strong brown oxidation; Yellowish brown (10YR 5/6); moist; non-plastic plasticity; 90% sand, 10% fines.	1115
15					15: Wet.	1110
		4	CL		SANDY LEAN CLAY (CL): fine to medium sand; trace fine to coarse gravel; orange mottling; Yellowish brown (10YR 5/4); moist; stiff; low plasticity; 0% gravel, 35% sand, 65% fines.	
20					19: 1 mm organic lamination. 20-23.5: soft; gray and orange mottling; sand decreased to 20%; siltier fines.	1105
		5			23: 1 " granitic gravel. 23.3-23.5: clayey sand (SC) lens; 60% coarse sand; 5-10% fine to medium sand; 35% clayey fines; red oxidation. 23.5: 0.1' poorly graded sand (SP) lens; very fine sand; trace fines.	
25						1100
		6	SP		POORLY GRADED SAND (SP): medium to coarse sand; fine to coarse gravel; Yellowish brown (10YR 5/6); wet; angular to subangular; 5% gravel, 90% sand, 5% fines.	
			CL		LEAN CLAY WITH SAND (CL): fine to coarse sand; fine gravel; strong brown mottling; black organics; Yellowish brown (10YR 5/4); moist; stiff; low plasticity; 5% gravel, 20% sand, 75% fines.	
30					End of well 30.0 feet	1095

WELL OR PIEZOMETER CONSTRUCTION DETAIL

PRO. CASING
- Diameter: **6"**
- Type: **Steel**
- Interval: **2.75' ags-4.25' bgs**

RISER CASING
- Diameter: **2"**
- Type: **PVC SCH 40**
- Interval: **2.5' ags-12' bgs**

GROUT
- Type: **Bentonite**
- Interval: **2-10' bgs**

SEAL
- Type: **Bentonite chips**
- Interval: **2-20' bgs**

SANDPACK
- Type: **Red Flint Sand**
- Interval: **#40**
- **10-22' bgs**

SCREEN
- Diameter: **2"**
- Type: **PVC SCH 40**
- Interval: **12-22' bgs**

Date Boring Started:	9/14/23 10:00 am
Date Boring Completed:	9/14/23 12:00 pm
Logged By:	KJN3
Drilling Contractor:	Dakota Technologies
Drill Rig:	7720DT

Remarks: Survey data provided by Otter Tail Power on October 18, 2023.

Additional data may have been collected in the field which is not included on this log.