

Periodic Safety Factor Assessment for Cell 3

Coal Combustion Residuals (CCR) Surface Impoundment



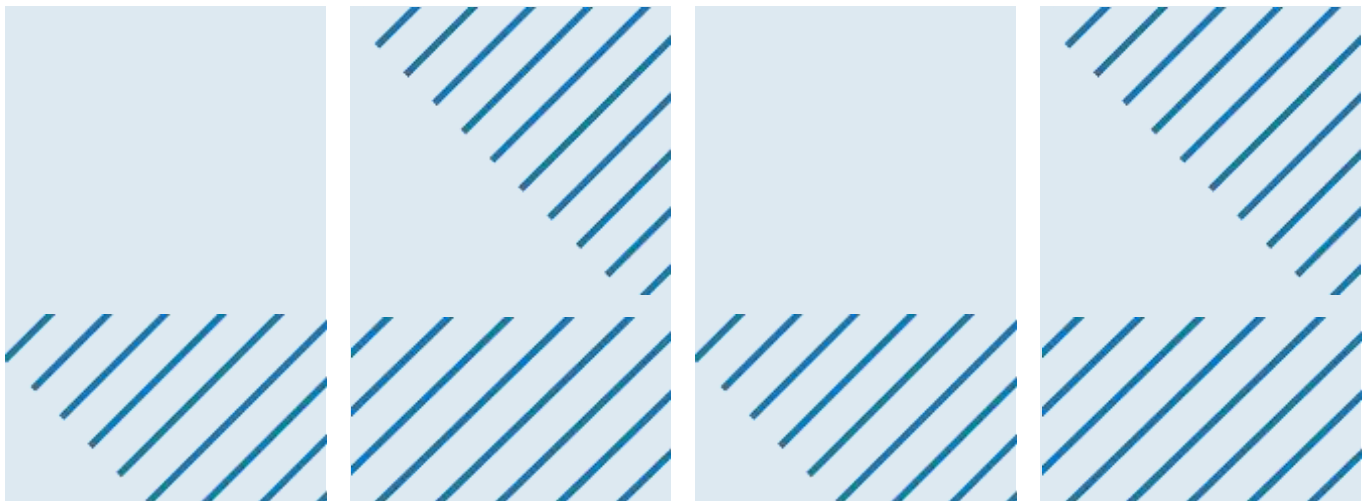
Prepared for
Minnkota Power Cooperative, Inc.
Milton R. Young Station

Prepared by
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September 2026

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Certification

I hereby certify that I have examined the facility and, being familiar with the provisions of NDAC 33.1-20, attest that this Coal Combustion Residuals (CCR) surface impoundment periodic safety factor assessment has been prepared in accordance with good engineering practice, including consideration of applicable industry standards and the requirements of NDAC 33.1-20-08-04.3.e. I certify that the assessment 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 North Dakota.



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ND Registration Number PE-10208

September 22, 2026
Date

Revision	Date	Summary of Revisions
0	October 13, 2016	Initial Safety Factor Assessment for Cell 3
1	September 24, 2021	Periodic Safety Factor Assessment for Cell 3
2	September 22, 2026	Periodic Safety Factor Assessment for Cell 3



Periodic Safety Factor Assessment for Cell 3

September 2026

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1 Periodic Safety Factor Assessment

1.1 Introduction

Minnkota Power Cooperative, Inc. (MPC) operates the Milton R. Young Station (MRYS), near Center, North Dakota. MRYS operates two lignite-fired cyclone boilers, resulting in production of coal combustion residuals (CCR). Cell 3 is a CCR surface impoundment permitted through the North Dakota Department of Environmental Quality (NDDEQ) per North Dakota Administrative Code (NDAC) 33.1-20-08, Permit No. 0159.

This periodic safety factor assessment for the MRYS surface impoundment Cell 3 has been developed to satisfy the requirements described in NDAC 33.1-20-08-04.3.e. To meet these requirements the following sections present facility information, stability analysis methods, and slope stability factor of safety results.

1.2 Historic and Cell 3 Construction Data

Subsurface and construction information can be found in the Cell 3 Embankment Design Report (Barr, 2012) and the Cell 3 History of Construction Report (Barr, 2016).

1.3 Critical Cross Section

1.3.1 Geometry

The western embankment of Cell 3 was determined to be the critical cross section (the embankment slope anticipated to yield the lowest stability factor of safety) for the exterior slope. A plan and profile view of the Cell 3 critical section, originating from work performed in 2016 and updated to reflect 2026 survey data, is provided in Figure 1a and Figure 1b. The top elevation of slurry deposited CCR solids utilized in slope stability analyses was based on this figure and assumes a recent CCR surface elevation at 2,093 feet. This is expected to be the maximum elevation of the slurry deposited CCR storage in Cell 3. Cell 3 stability was also modeled for the projected final fill contours, with final cover in place. A section view of the composite liner on the interior side slope is provided on Figure 2 and shows the liner as constructed to an elevation of 2,098 feet, and the top of embankment to an elevation of approximately 2,100 feet. The external slopes were constructed and modeled for stability at 4.5 horizontal-to-1 vertical (4.5H:1V) and the interior slopes at 2.5H:1V with a 20-foot-wide bench at an elevation of 2,065 feet and 15-foot wide bench at an elevation 2,085 feet.

1.3.2 Stratigraphy

A subsurface exploration was completed for Cell 3 design in August of 2009. Soil borings, logs of which are provided in Attachment A, were performed utilizing a combination of hollow stem auger (HSA) and coring to obtain samples of the native soils. The borings were in a grid arrangement with one boring located at each of the four corners and one boring located in the center of the proposed Cell 3 area. The borings were drilled to depths between 65 to 80 feet to extend below the proposed bottom of the Cell 3 liner elevation. Soil samples collected during this investigation were tested and were used to confirm previous material strength parameters and, if appropriate, select new strength parameters.

Borings 09-001 and 09-002 were primarily used to determine stratigraphy for the Cell 3 west embankment cross section as they contained the greatest level of detail, are the most recent borings performed in 2009, and have associated laboratory data which was used to develop modeling parameters. Logs from

other historical borings completed in Cell 3, included in Attachment A, were also examined and considered when developing the model stratigraphy. Although less detailed, the historical Cell 3 borings helped identify location of the Hagel formation and relatively consistent alternating layers of shale/mudstone and sandstone in the foundation. The critical cross section evaluated includes four native materials, two embankment materials, a geomembrane and the contained CCR and water. The interior bottom and sides of the cell are lined with a composite liner consisting of a 4- to 8-foot-thick clay liner overlain by a geomembrane liner. The geotechnical analysis contained the following units:

- Outwash Sand
- Hagel Formation
- Lower Shale
- Sandstone
- Embankment Fill
- Compacted Clay Liner
- Geomembrane
- CCR

The Cell 3 sidewall liner is composite-lined using a 6- to 8-foot thick clay liner overlain by a geomembrane liner. The Cell 3 floor is composite-lined using a 4-foot thick clay liner overlain by a geomembrane liner. All the materials listed above are shown in the seepage and stability model outputs provided in Attachment B for the western embankment of Cell 3. The embankment fill varies in thickness along the western embankment, therefore a sensitivity analysis was performed to determine the effect that depth of fill to native ground had on slope stability.

2 Modeling Methods

2.1 Analysis Software

A limit equilibrium slope stability modeling software called GeoStudio was used to analyze the Cell 3 embankment slopes. The 2025.2.1 version of the software, produced by Bentley Systems, Incorporated, was utilized to determine the factor of safety (FOS) values for the critical cross section described in Section 1.

Seepage analyses were conducted using the finite-element analysis technique within the SEEP/W program for estimation of flow, seepage forces, and pore water pressure distribution. The slope stability analyses were performed by determining factors of safety for the embankment slopes using the limit equilibrium method in SLOPE/W. Product integration between GeoStudio SLOPE/W and SEEP/W software modules allows the use of the seepage model results in the stability analyses.

Spencer's method was used for calculating the slope's FOS. Spencer's method is considered an adequate equilibrium solution because it provides a FOS based on both force and moment equilibrium. In SLOPE/W, the critical potential failure surface was modeled assuming a minimum slip surface depth of 2 feet below ground surface. Shallower slip surfaces are taken as being cosmetic, easily repaired, and not likely to place the integrity of the embankments at risk.

In SLOPE/W, the critical failure surface can be circular or block/wedge. Circular failure surfaces are curved, arc-shaped failures resulting from a rotational movement. To account for possible block failures/slides along the native materials below embankment fill, impenetrable strengths were applied to the native soils in a sensitivity analysis forcing the circular failure surface to truncate along the native and fill material interface creating a wedge or block-type failure. The failure surface resulting in the lowest FOS was reported in Section 3.

Potential failure surfaces were defined using the entry and exit method. This allows the location of the trial slip surfaces to be chosen manually, or where it is anticipated to enter and exit the ground surface, with a selected number of entry and exit points, and the computer program then searches for the slip surface yielding the lowest FOS.

2.2 Loading Conditions

2.2.1 Pond and CCR Fill Elevations

The maximum elevation of slurry deposited CCR for surface impoundment Cell 3 recorded in 2025 was 2,093 feet, which allows for a freeboard of seven feet, considering an approximate top of perimeter embankment elevation of 2,100 feet. Dry fill has begun to be placed to reach final closure grades. The elevation of dry fill recorded in 2025 varied from an elevation of approximately 2,090 feet to 2,140 feet.

The CCR elevation gradually decreases to the east. For the seepage and slope stability analysis, the 2026 CCR elevation was assumed to be the maximum elevation of slurry deposited CCR solids (2,093 feet).

Cell 3 dewatering was initiated in 2020 and is ongoing. Per NDAC 33.1-20-08 maximum potential surcharge pool must be considered and is the pool elevation where at no point will water be allowed above this level. For Cell 3, the maximum surcharge pool elevation is taken as elevation 2,098 feet,

allowing for two feet of freeboard. For this stability evaluation the existing CCR level was set at an approximate elevation of 2,093 feet, with water from the top of solids to an elevation of 2,098 feet.

Cell 3 embankment stability was also evaluated under a future fill condition, consisting of the projected final CCR fill and final cover system contours. Contours generally slope upward at a 5-percent slope, beginning at the inside crest of the perimeter embankment and progressing inward toward the center area of the impoundment to a top of permitted ash elevation of 2,145 feet. The CCR placed to achieve these contours will consist primarily of compacted bottom and fly ash fill.

The critical cross-section described in Section 1 was modeled for seepage and stability under various pond and CCR fill elevations, summarized in Table 1, considering the cell operations and surcharge conditions.

Table 1 Pond and CCR Fill Elevations

Description	Elevation [feet]		Freeboard [feet]	Remarks
	CCR	Pond		
Maximum storage pool	2,093	2,093	7	-
Maximum surcharge pool	2,093	2,098	2	-
Closure	2,145	2,093	-	CCR and final cover elevation at center of Cell 3

2.2.2 Drained and Undrained Conditions

If shear stress is applied to a soil at such a rate and/or the drainage conditions are such that excess pore water pressure within the embankment and embankment foundation soils is zero when failure occurs, failure is said to occur under drained conditions, or the effective stress shear strength of the soil has been mobilized. This case is referred to as the Effective Stress Stability Analysis (ESSA) condition, which is typically applied to long-term, steady-state seepage conditions, where any excess pore water pressures generated due to loading have dissipated. The drained condition also applies to free-draining granular materials for short-term conditions. When such materials have a high enough permeability, any excess pore water pressure is nearly immediately dissipated so that drained conditions exist.

If shear stress is applied to a soil quickly and/or if the drainage conditions are such that only a portion of shear-induced pore water pressure within the embankment and embankment foundation soils can dissipate when failure occurs, failure is said to occur in an undrained condition, or the undrained shear strength of the soil has been mobilized. This is referred to as the Undrained Strength Stability Analysis (USSA) condition and is typically applied to short-term conditions for saturated soils, for example during or immediately after construction when construction proceeds at a fast enough rate that excess pore water pressure develops.

2.2.2.1 Seismic Conditions (USGS Seismic Hazard Tool)

The occurrence of a seismic event could cause additional loading on the foundation soils. Seismic loads can be incorporated into the slope stability evaluation by performing a pseudo-static analysis where an additional seismic load is applied to all of the materials in the model. For the maximum fill capacity analysis, ESSA parameters were applied to the native foundation and embankment soils. For the

maximum surcharge pool, USSA parameters were applied to all materials including the embankment soils. NDAC 33.1-20-08 indicates this seismic load is to be determined using the peak ground acceleration (PGA) for a seismic event with a 2% probability of exceedance in 50 years, equivalent to a return period of approximately 2,475 years. Three different sources were analyzed to determine seismic conditions of the site.

The USGS provides a Unified Hazard Tool for the entire United States (www.usgs.gov). The USGS Unified Hazard Tool (USGS, 2024a) indicates a peak horizontal ground acceleration at the top of bedrock of 0.0233g with a probability of exceedance of 2% in 50 years, equivalent to a return period of approximately 2,475 years, for the project site based on the 2014 NSHM Conterminous model. An output of this is provided in Figure 3. The horizontal seismic coefficient, k , is half of the PGA, therefore a value of 0.012g will be incorporated into the seismic model conditions (Hynes-Griffin ME, 1984).

2.3 Seepage

2.3.1 Site Groundwater and Saturated Soil Conditions

Groundwater conditions at the Minnkota site were evaluated during the 1992 Feasibility Study (Barr, 1992) and the 1993 Facility Impacts Evaluation (Barr, 1993). Both reports indicated a groundwater surface elevation ranging from 1,900 to 1,920 feet, approximately 90 to 100 feet below the base of Cell 3. Review of the most recent groundwater monitoring collected in September of 2025 suggest groundwater elevations consistent with historical values and shows groundwater elevation dropping from an elevation of 1,920 feet on the west side of the site to an elevation of approximately 1,900 feet on the east side of Cell 3, as shown in Figure 4. The water surface in nearby Nelson Lake, approximately 3,000 feet east of Cell 3, is continuously held at 1,925 feet. A boundary condition of 1,920 feet was applied to the base of the seepage model to represent the highest-anticipated regional groundwater elevation.

As a sensitivity analysis, a boundary condition of 2,039 feet was applied to the seepage models to conservatively represent any elevated saturated soil conditions in the foundation that may be present.

Since the interior bottom and sides of Cell 3 are lined with a clay liner and nearly impermeable geomembrane, it was assumed that seepage from the Cell 3 impoundment would be precluded from entering the native soils and the Cell 3 embankment fill.

2.3.2 Steady-State Flow

A steady-state flow analysis assumes that the water level on the pond side of the embankment being evaluated for stability is at a specific elevation for an infinite amount of time, in which case the seepage flow through the embankment has sufficient time to reach its equilibrium condition. In the steady-state flow analysis, time is not a consideration. In many cases, steady-state flow analysis is considered to be conservative from an engineering perspective. The steady-state analyses will normally result in high phreatic surface, vertical gradient, uplift pressure, flows, and pore pressures, each of which can contribute to reductions in soil strength, and computed slope stability factor of safety values that are somewhat lower than what actually exist (hence conservative).

Boundary conditions applied in the model include the CCR pond elevation, groundwater conditions, and a potential seepage face. The CCR pond elevations were applied to Cell 3 and elevations are presented in Table 1 for maximum storage, maximum surcharge, and closure conditions. A potential seepage face boundary condition was applied to the exterior Cell 3 embankment slope to allow water to freely exit from

the subsurface (i.e. the model will allow a phreatic surface to exit a slope at ground surface instead of remaining below ground surface), a valid approach when steady-state conditions are evaluated.

2.3.3 Geomembrane

A layer of geomembrane was placed on the interior slope and bottom of Cell C. The geomembrane is underlain by clay liner. Due to extensive construction quality control, the geomembrane was installed with a low frequency of defects, and therefore little seepage will pass through the geomembrane into the Cell 3 clay liner and embankment. The geomembrane is assumed to be an effective hydraulic barrier and the geomembrane was modeled as a separate layer (interface) with very low permeability in the seepage analysis. With the intact geomembrane, steady-state flow was assumed for phreatic surface development.

2.3.4 Soil Seepage Parameters

Seepage parameters were applied to the seepage models within the SEEP/W program for estimation of flow, seepage forces, and pore water pressure distribution. The seepage parameters were mainly based on the 2012 Cell 3 Design Report (Barr, 2012). Embankment Fill hydraulic conductivity was updated based on the geomean of five laboratory testing results on undisturbed samples from the 2022 construction testing and subsurface investigation (Barr, 2023). The parameters are applicable to Cell 3 and are summarized in Table 2.

Table 2 Seepage Model Parameters

Material	Horizontal Permeability (cm/sec)	Horizontal Permeability (ft/sec)	k_y/k_x ratio ⁽¹⁾	Saturated Volumetric Water Content ⁽⁴⁾ (ft ³ /ft ³)	Residual Water Content ⁽¹¹⁾ (ft ³ /ft ³)	m_v ⁽⁵⁾ (1/psf)	D_{10} ⁽¹²⁾ [%]	D_{60} ⁽¹²⁾ [%]	Liquid Limit ⁽¹²⁾ [%]
Geomembrane ⁽²⁾	2.00E-13	6.56E-15	1.0	--	--	--	--	--	--
Clay Liner	4.83E-08 ⁽³⁾	1.58E-09	1.0	0.40	0.20	3.21E-05	0.002	0.0165	62.0
CCR	1.34E-05 ⁽¹⁾	4.40E-07	1.0	0.58 ⁽¹⁾	0.058	4.79E-07 ⁽⁹⁾	Clay Sample Function Material		
Embankment Fill	5.05E-06 ⁽⁶⁾	1.66E-07	1.0	0.40	0.20	2.56E-05	0.002	0.02	44.0
Shale	2.40E-08 ⁽³⁾	7.88E-10	1.0	0.40	0.20	1.17E-05	0.005	0.016	69.0
Sandstone	7.56E-06 ⁽⁷⁾	2.48E-07	0.08 ⁽⁸⁾	0.36	0.036	2.93E-06	Sand Sample Function Material		
Outwash Sand	1.00E-03 ⁽¹⁰⁾	3.28E-05	1.0	0.40 ⁽¹⁾	0.04	4.79E-07 ⁽⁹⁾	Sand Sample Function Material		
Hagel	1.00E-02	3.28E-04	1.0	0.60 ⁽¹⁾	0.06	4.79E-07 ⁽⁹⁾	Sand Sample Function Material		

[1] Assumed value, unless otherwise noted.

[2] A layer of geomembrane was placed on the interior slope and bottom of Cell 3. Due to extensive construction quality control and no indication of seepage, the geomembrane is assumed to be very low in defects and no seepage was assumed to pass through the geomembrane into the Cell 3 clay liner and embankment. The geomembrane is assumed to be a fully effective hydraulic barrier and the geomembrane was modeled as a separate layer (interface) with very low permeability in the seepage analysis.

[3] Geomean of laboratory vertical permeability testing on samples collected during construction for Cell 3.

[4] Average saturated volumetric water content calculated from assumed specific gravity, unit weight of water and average dry unit weight.

[5] Compressibility of soil, m_v , values are the average calculated from the void ratio and change in stress.

[6] Geomean of laboratory vertical permeability testing on samples collected during 2022 construction of Cell 5.

[7] Geomean of eight slug tests performed in 1992 in the sandstone unit.

[8] Anisotropy is based on horizontal permeability from field slug tests and lower vertical permeability from laboratory testing results.

[9] Estimated value based on GeoStudio guidance (GEO-SLOPE, 2012).

[10] Assumed value based on a lower-bound value for fine sand (Coduto, 2011); Table 7.1.

[11] Residual water content is assumed to be 50 percent of the saturated volumetric water content for fine-grained soils and 10 percent for granular soils.

[12] Average value from laboratory testing results.

2.4 Soil Strength Parameters

The soil strength parameters that were applied to the slope stability models in SLOPE/W were obtained from the Cell 3 Design Report (Barr 2012) and the Initial Safety Factor Assessment Compliance report for Cell 3 (Barr, 2016a). A summary of the strength parameters is provided in Table 3 and curvilinear properties are summarized in Table 4

Table 3 Material Strength Parameters

Material	Unit Weight Incf		Undrained Shear Strength ⁽³⁾		Drained Shear Strength ⁽³⁾
	Saturated ⁽²⁾	Moist ⁽¹⁾	Friction Angle ϕ_{cu} [deg.]	Cohesion c_u [psf]	
Clay Liner	123.2	117.1	19.4	100	Table 4 Curvilinear Envelope
CCR ⁽⁴⁾	122.0	--	26.0	0	Same as Undrained Shear Strength
Embankment Fill	124.4	117.1	17.5	100	Table 4 Curvilinear Envelope
Shale	125.2	122.6	27.7	1,800 ⁽⁶⁾	Table 4 Curvilinear Envelope ⁽⁵⁾
Sandstone	130.7	130.1	35.1 ⁽⁷⁾	0	Same as Undrained Shear Strength
Outwash Sand	125.0	120.0	32.0 ⁽⁸⁾	0	Same as Undrained Shear Strength
Hagel ⁽¹⁰⁾	82.0 ⁽⁹⁾	80.0 ⁽⁹⁾	30.0	2,000	Assume 30 degrees

- [1] Average moist unit weight value determined through laboratory testing of dry unit weight and moisture content (average moist unit weight of samples taken from above the phreatic surface), except where noted.
- [2] Average saturated unit weight based on dry unit weight and saturated moisture content from laboratory testing.
- [3] Shear strength envelopes, both drained and undrained, are based on triaxial laboratory testing results, unless otherwise noted.
- [4] All values for CCR are assumed.
- [5] Average fully softened shear strength envelope from Stark and Hussain, 2013.
- [6] Lower-bound envelope from laboratory consolidated undrained triaxial testing.
- [7] Lower-bound friction angle from direct shear laboratory testing.
- [8] Based on typical values for a medium dense rounded sand or loose angular sand (Das, 2006).
- [9] Typical assumed value based on literature review.
- [10] Hagel formation strength properties are taken from published values for coals in Western Canada (Gentzis, 2007). Cohesion value is significantly less than the published value.

Table 4 Curvilinear Envelope Summary

Embankment Fill		Clay Liner		Shale	
σ' [psf]	τ' [psf]	σ' [psf]	τ' [psf]	σ' [psf]	τ' [psf]
0	0	0	0	0	0
919	699	717	582	1,044	606
2,803	1,540	2,860	1,587	2,089	1,103
5,252	2,624	5,628	2,781	8,354	3,951
13,000	6,081	--	--	14,620	6,177

Note: σ' is effective normal stress, τ' is shear stress

Construction records (Barr, 2016) indicate that the embankment materials consist of silty sand and lean clay. Field moisture and density tests were performed, confirming that the embankment, including the clay liner, was compacted to 95% of the standard Proctor (ASTM D-698) maximum dry density and moisture content when placed was within the specifications. Due to the silty sand and clay embankment material

types and documentation that compaction of embankment materials was met during construction, the Cell 3 surface impoundment embankments are not considered susceptible to liquefaction (the embankment fill is dilative rather than contractive upon vibratory shear stress) and thus liquefaction analyses of the embankments is not applicable.

3 Safety Factor Results

This section of the report presents the results of the slope stability analyses performed for the Cell 3 western embankment.

NDAC 33.1-20-08-04.3.e(1) denotes four conditions under which the FOS for embankment stability during a periodic Safety Factor Assessment is to be reviewed;

- Static
 - Long-term maximum storage pool; factor of safety must equal or exceed 1.50
 - Maximum surcharge pool; factor of safety must equal or exceed 1.40
- Seismic
 - Seismic conditions; factor of safety must equal or exceed 1.00
 - Embankment liquefaction; factor of safety must equal or exceed 1.20

Factor of safety values from the analyses required by NDAC 33.1-20-08-04.3.e are summarized in Table 5 for the Cell 3 western embankment and seepage and stability model outputs are provided in Attachment B.

Table 5 Periodic Factor of Safety Assessment Outcomes for Cell 3 Western Embankment

Assessment Cases				Factor of Safety			
	Loading Conditions	Elevation [feet]		Static ^(1,2)		Seismic ⁽¹⁾	
		Pond	CCR	Required	Achieved	Required	Achieved
Potential CCR Level	Long-Term Maximum Storage Pool [ESSA]	2,093	2,093	≥ 1.50	2.73 ⁽⁶⁾	≥ 1.00	2.59 ⁽⁷⁾
	Maximum Surcharge Pool [USSA]	2,098	2,093	≥ 1.40	1.80 ⁽⁸⁾	≥ 1.00	1.71 ^(4,7)
	Liquefaction	2,093	2,093	≥ 1.20	NA ⁽³⁾	≥ 1.20	NA ⁽³⁾
Future CCR Closure	Closure [USSA]	2,093 ⁽⁵⁾	5% slope up to 2,145	≥ 1.40	1.80 ⁽⁸⁾	≥ 1.00	2.59 ⁽⁷⁾
	Long-Term Closure [ESSA]			≥ 1.50	2.73 ⁽⁶⁾		
	Liquefaction			≥ 1.20	NA ⁽³⁾		

- (1) Required minimum factor of safety per NDAC 33.1-20-08-04.3.e.
- (2) Static factor of safety under end-of-construction loading condition is only required for the initial safety factor assessment and is not required for subsequent assessment, per NDAC 33.1-20-08-04.3.e(1)(e).
- (3) Values are not reported because embankment soils are not contractive and were considered to not be susceptible to liquefaction.
- (4) Seismic analyses were performed using USSA material strength parameters.
- (5) The elevation of 2,093 feet is the maximum elevation of the pond and MPC will be dewatering Cell 3 so the actual water level will decrease over time; assuming a steady-state seepage analysis at this elevation is considered to be a conservative approach.
- (6) Sensitivity analysis for a block/wedge failure surface resulted in the lowest FOS of 2.52.
- (7) Reported value represents a circular failure surface applying a horizontal seismic coefficient value of 0.012g.
- (8) Sensitivity analysis for the possibility of deeper embankment fill resulted in the lowest FOS of 1.68.

Only the exterior slope was analyzed for the cross sections as the interior slope will continue to be buttressed by CCR and water during the loading conditions evaluated. The interior slopes would have experienced their critical condition during construction.

A sensitivity analysis evaluating failure surfaces incorporating a saturated subsurface condition below 2,039 feet indicated negligible differences between the originally assumed conditions. Since it was determined that elevated saturated soil conditions do not have a notable impact on slope stability of Cell 3 western slopes, these results are not reported.

All the resulting factor of safety values are satisfactory, i.e., exceeding the required minimum factor of safety for this facility.

4 Summary and Conclusion

The purpose of this report is to document and certify results of the periodic safety factor assessment for the Cell 3 CCR surface impoundment at MPC. Historic and available geotechnical data were reviewed and geotechnical models were developed based on the geometry and future operation of Cell 3. The critical cross section (i.e., western embankment of Cell 3) meets the minimum requirements for stability for CCR surface impoundments, satisfying NDAC 33.1-20-08.04.3.e. Future periodic safety factor assessments following this safety factor assessment will be conducted in accordance with the timeframes outlined in NDAC 33.1-20-08-04.3.

5 References

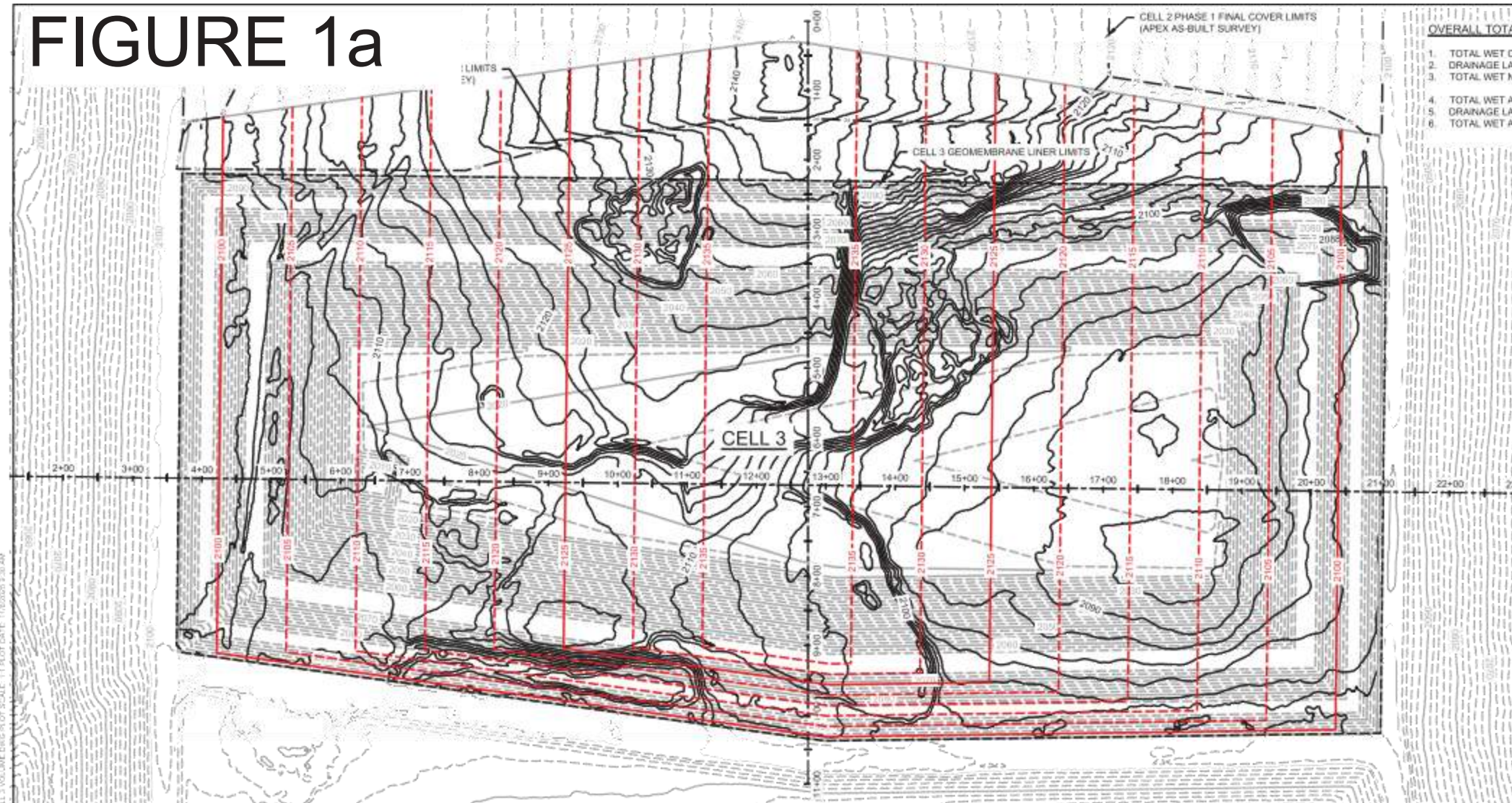
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Figures



FIGURE 1a



OVERALL TOTAL SOLIDS CAPACITY:

1. TOTAL WET CAPACITY TO EL. 2093:	2,057,400 CY
2. DRAINAGE LAYER VOLUME:	32,400 CY
3. TOTAL WET NET CAPACITY TO EL. 2093:	2,025,000 CY
4. TOTAL WET AND DRY CAPACITY:	3,432,400 CY
5. DRAINAGE LAYER VOLUME:	32,400 CY
6. TOTAL WET AND DRY NET CAPACITY:	3,400,000 CY

LEGEND

--- --	CELL 3 GEOMEMBRANE LINER LIMITS
--- --	TOP OF PERMITTED ASH TWENTY-FIVE FOOT CONTOURS
--- --	TOP OF PERMITTED ASH FIVE-FOOT CONTOURS
--- --	DESIGN TEN-FOOT CONTOURS (WITHIN CELL 3)
--- --	DESIGN TWO-FOOT CONTOURS (WITHIN CELL 3)
--- --	EXISTING SEP. 12, 2025 TEN-FOOT CONTOURS (OUTSIDE OF CELL 3)
--- --	EXISTING SEP. 12, 2025 TWO-FOOT CONTOURS (OUTSIDE OF CELL 3)
--- --	EXISTING SEP. 12, 2025 TEN-FOOT CONTOURS (WITHIN CELL 3)
--- --	EXISTING SEP. 12, 2025 TWO-FOOT CONTOURS (WITHIN CELL 3)
--- --	APPROXIMATE EDGE OF EXISTING FINAL COVER

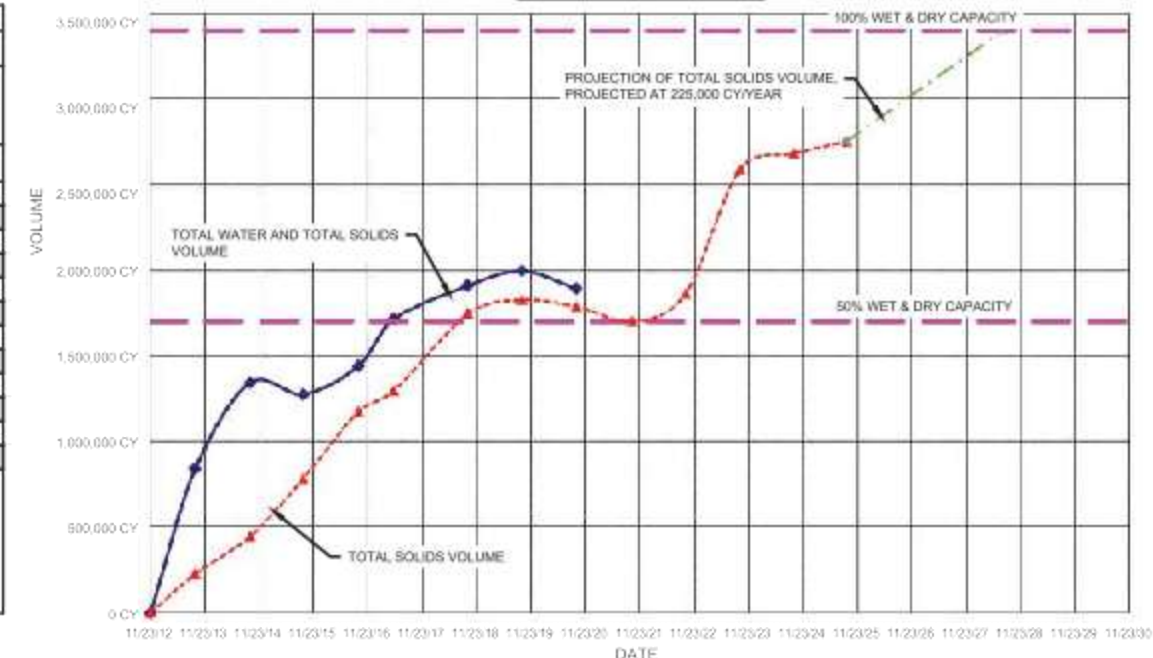
NOTES:

- CELL 3 TOPOGRAPHIC DATA PROVIDED FROM CRONE FLIGHT PERFORMED ON SEPTEMBER 12, 2025 BY BNI COAL, LTD.
- COORDINATE SYSTEM IS NORTH DAKOTA STATE PLANE SOUTH ZONE, NAD 27 - US SURVEY FEET (HORIZONTAL); NVGD 1929 (VERTICAL).
- CELL 3 TOTAL SOLIDS AND WATER VOLUMES ARE DETERMINED BY CALCULATING THE VOLUMETRIC DIFFERENCE BETWEEN 3-DIMENSIONAL SURFACES IN AUTOCAD CIVIL 3D SOFTWARE. WASTE CONSOLIDATION IS NOT CONSIDERED IN THE CALCULATIONS.
- THE TOTAL CAPACITY USED IN CALCULATING THE CONSUMED REMAINING CAPACITY UNDER TOTAL WATER AND TOTAL SOLIDS CAPACITY (FROM 2013 THROUGH 2015) IS 1,579,700 CY (CAPACITY TO ELEVATION 2093.0). CELL 3 TOTAL CAPACITY INCREASED TO 2,025,000 CY (CAPACITY TO ELEVATION 2093.0) WITH CELL 3 PHASE 3 CONSTRUCTION. CELL 3 TOTAL WET AND DRY CAPACITY IS 3,400,000 CY.
- WATER VOLUME ROUND-OFF ERRORS DUE TO ROUNDING OF CUBIC YARD VOLUMES.
- THE MAY 16, 2017 BATHYMETRIC SURVEY WAS PERFORMED VIA TWO DIFFERENT METHODS BY BARR ENGINEERING COMPANY: 1.) ROWBOAT AND HUMMINGBIRD DEPTH FINDER SIMILAR TO HOW SEPT. 17, 2013 AND SEPT. 22, 2014 BATHYMETRIC SURVEYS WERE PERFORMED, AND 2.) REMOTE CONTROLLED Z-BOAT SIMILAR TO HOW THE SEPT. 14, 2015 AND SEPT. 19, 2016 BATHYMETRIC SURVEYS WERE PERFORMED. THE TWO SURVEY METHODS PRODUCED VERY SIMILAR RESULTS WITH LESS THAN 2,600 CY DIFFERENCE BETWEEN THE BATHYMETRIC SURFACES CREATED FROM THE DIFFERENT DATA SETS. THE Z-BOAT COLLECTED MORE REFINED DATA AND IS WHAT WAS USED IN THIS ANALYSIS.
- TOTAL SOLIDS (FGD SLUDGE AND ASH) CONSOLIDATED APPROXIMATELY 0.9' ON AVERAGE FROM SEPT. 26, 2019 TO SEPT. 22, 2020.
- TOTAL SOLIDS (FGD SLUDGE AND ASH) CONSOLIDATED APPROXIMATELY 3.0' ON AVERAGE FROM SEPT. 22, 2020 TO OCT. 5, 2021.
- TOTAL SOLIDS (FGD SLUDGE AND ASH) CONSOLIDATED APPROXIMATELY 2.1' ON AVERAGE FROM OCT. 5, 2021 TO SEPT. 27, 2022.
- DRY DEPOSITION TOOK PLACE IN BOTH CELL 2 AND CELL 3 AND THE OVERALL DRY PLACEMENT WAS 365,600 CY BETWEEN OCT. 5, 2021 AND SEPT. 27, 2022. TOTAL PLACEMENT OF 365,600 CY CONSISTS OF 151,700 CY IN CELL 2 AND 213,900 CY IN CELL 3 (163,700 CY NET FILL AND 50,200 CY OF SETTLEMENT FROM EAST PORTION OF CELL 3).
- CELL 5 PHASE 1A CONSTRUCTION IN 2022 INCLUDED PLACING APPROXIMATELY 45,200 CY OF WASTE ROCK, WASTE COAL, AND EXCESS RANDOM FILL MATERIALS IN CELL 3. APPROXIMATELY 37,100 CY OF THIS MATERIAL WAS PLACED BETWEEN JUNE 20, 2022 AND SEPTEMBER 27, 2022 AND APPROXIMATELY 8,100 CY WAS PLACED BETWEEN SEPTEMBER 27, 2022 AND NOVEMBER 8, 2022. THAT AFFECT TO THE TOPOGRAPHIC DATA PROVIDED WAS NOT MANIPULATED IN CALCULATING THE CONSUMPTION VOLUMES.
- FROM THE SEPTEMBER 27, 2022 SURVEY TO THE SEPTEMBER 28, 2023 SURVEY, THE TOTAL CELL 3 CONSUMPTION WAS 721,500 CY THAT INCLUDED CELL 5 PHASE 1B WASTE ROCK, EXCESS RANDOM FILL, TEMPORARILY STOCKPILED BOTTOM ASH MATERIALS (TO BE SCREENED AND HAULED INTO CELL 5), AND CELL 2 PHASE 2 CLOSURE MATERIALS. THE TOTAL DRY SOLIDS GENERATION/CONSUMPTION FROM THE PLANT FOR 2023 IS UNKNOWN.

PLAN: CELL 3 2025 TOTAL SOLIDS CONTOURS



CELL 3 - FILL RATE



SURVEY DATE	TOTAL SOLIDS CAPACITY - SEE NOTE 3						TOTAL SOLIDS ACCUMULATION RATE						CELL 3 WATER LEVEL DATA				TOTAL WATER AND TOTAL SOLIDS CAPACITY - SEE NOTE 4			
	ZONE 1 (DELTA)	ZONE 2 (SUBMERGED)	TOTAL VOLUME	MAXIMUM CAPACITY	CONSUMED CAPACITY	REMAINING CAPACITY	COMPARISON SURVEY DATE	ACCUMULATED VOLUME	DATE RANGE	AVERAGE DAILY RATE	AVERAGE ANNUAL RATE (PROJECTED)	WATER ELEVATION (FT)	WATER VOLUME (CY)	CHANGE IN WATER VOLUME FROM PREVIOUS SURVEY (CY)	WATER VOLUME (GAL)	CHANGE IN WATER VOLUME FROM PREVIOUS SURVEY (GAL)	TOTAL WATER AND TOTAL SOLIDS VOLUME (CY)	MAXIMUM WET CAPACITY (CY)	CONSUMED CAPACITY (CY)	REMAINING CAPACITY (CY)
	(CY)	(CY)	(CY)	(CY)	(%)	(%)		(CY)	(DAYS)	(CY/DAY)	(CY/YEAR)		(CY)	(GAL)	(CY)	(GAL)	(CY)	(CY)	(CY)	(CY)
	(CY)	(CY)	(CY)	(CY)	(%)	(%)		(CY)	(DAYS)	(CY/DAY)	(CY/YEAR)		(CY)	(GAL)	(CY)	(GAL)	(CY)	(CY)	(CY)	(CY)
NOV. 23, 2012	-	-	-	-	-	-	NOV. 23, 2012	-	-	-	-	2062.15	611,100	123,434,000	611,100	123,434,000	638,800	1,579,700	83%	47%
SEP. 17, 2013	0	227,700	227,700	1,579,700	14%	66%	SEP. 17, 2013	227,700	298	765	278,900	2076.15	698,900	181,565,500	287,800	58,141,500	1,345,600	1,579,700	85%	15%
SEP. 22, 2014	2,000	444,700	446,700	1,579,700	28%	72%	SEP. 22, 2014	219,900	370	592	216,100	2076.08	490,000	98,367,000	-426,900	-82,588,000	1,276,000	1,579,700	81%	19%
SEP. 14, 2015	3,000	783,000	786,000	1,579,700	50%	50%	SEP. 14, 2015	336,300	367	865	330,300	2076.7	265,900	53,705,000	-224,100	-45,262,500	1,442,500	2,025,000	71%	29%
SEP. 19, 2016	100	1,178,500	1,178,600	2,025,000	57%	43%	SEP. 19, 2016	599,600	371	1,053	384,300	2086.3	475,800	83,341,000	149,700	30,236,000	1,715,000	2,025,000	85%	15%
MAY. 16, 2017	900	1,298,500	1,299,400	2,025,000	64%	36%	MAY. 16, 2017	122,800	239	514	187,800	2089.5	163,600	33,043,000	-252,000	-50,898,000	1,919,300	2,025,000	94%	6%
SEP. 26, 2018	16,800	1,729,900	1,746,700	2,025,000	86%	14%	SEP. 26, 2018	447,300	498	895	327,800	2091.8	168,300	33,588,000	2,700	545,000	1,994,900	2,025,000	99%	1%
DEC. 17, 2018	-	-	-	-	-	-	SEP. 26, 2019	81,900	320	256	93,400	2088.5	102,500	20,702,000	-63,800	-12,895,100	1,892,600	2,025,000	93%	7%
AUG. 12, 2019	-	-	-	-	-	-	NOV. 23, 2012	-	-	-	-	NO WATER	0	0	-182,500	-20,702,000	-	-	-	-
SEP. 26, 2019	3,300	1,825,300	1,828,600	2,025,000	90%	10%	SEP. 26, 2019	-38,300	362	-105	-38,700	NO WATER	0	0	-	-	-	-	-	-
SEP. 22, 2020	35,100	1,751,200	1,786,300	2,025,000	88%	12%	SEP. 22, 2020	-88,700	378	-235	-85,800	NO WATER	0	0	-	-	-	-	-	-
OCT. 05, 2021	-	-	-	-	-	-	OCT. 05, 2021	163,700	357	459	187,900	NO WATER	0	0	-	-	-	-	-	-
SEP. 27, 2022	-	-	-	-	-	-	SEP. 27, 2022	721,500	366	1,927	703,400	NO WATER	0	0	-	-	-	-	-	-
SEP. 28, 2023	-	-	-	-	-	-	SEP. 28, 2023	-	-	-	-	NO WATER	0	0	-	-	-	-	-	-
SEP. 20, 2024	-	-	-	-	-	-	SEP. 20, 2024	-	-	-	-	NO WATER	0	0	-	-	-	-	-	-
SEP. 12, 2025	-	-	-	-	-	-	SEP. 12, 2025	-	-	-	-	NO WATER	0	0	-	-	-	-	-	-
TOTAL	-	-	2,756,300	3,400,000	81%	19%	NOV. 23, 2012	2,756,300	4,876	569	216,000	NO WATER	0	0	-	-	-	-	-	-



4305 WARD DRIVE, SUITE 200
MINNEAPOLIS, MN 55412
PH: 1-800-430-2277
WWW.BARR.COM
MINNEAPOLIS ENGINEERING FIRM
NUMBER 1010411545

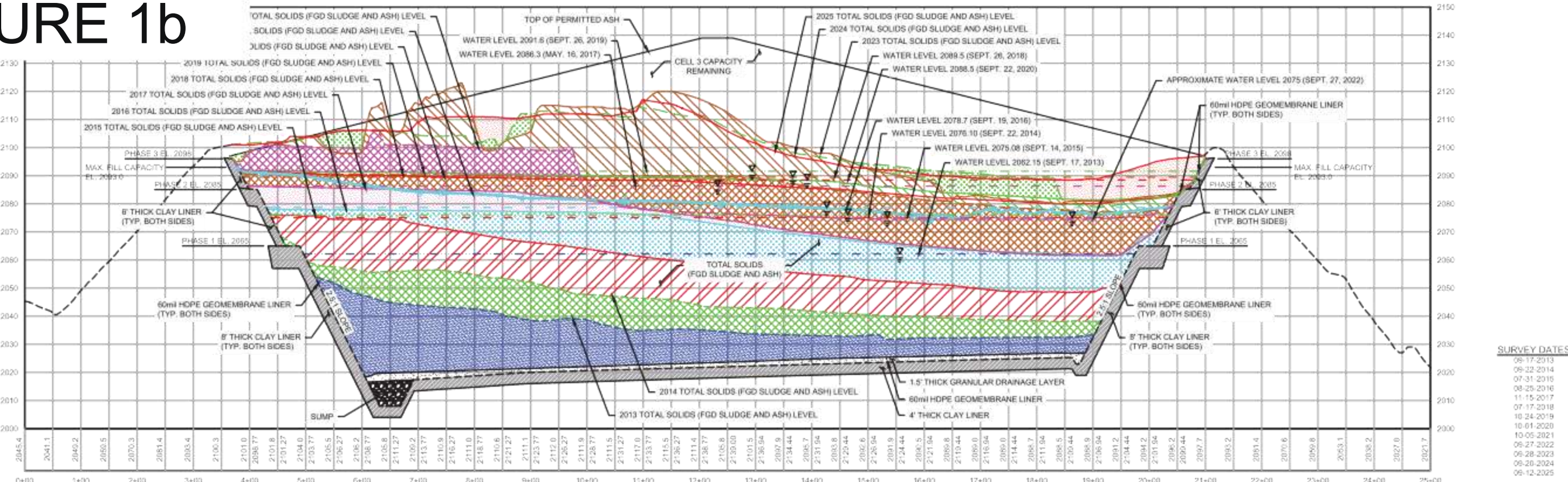
MILTON R. YOUNG STATION
MINNKOTA POWER COOPERATIVE

CELL 3
TOTAL SOLIDS ELEVATIONS
CONSTRUCTION THROUGH SEPTEMBER 2025
PLAN

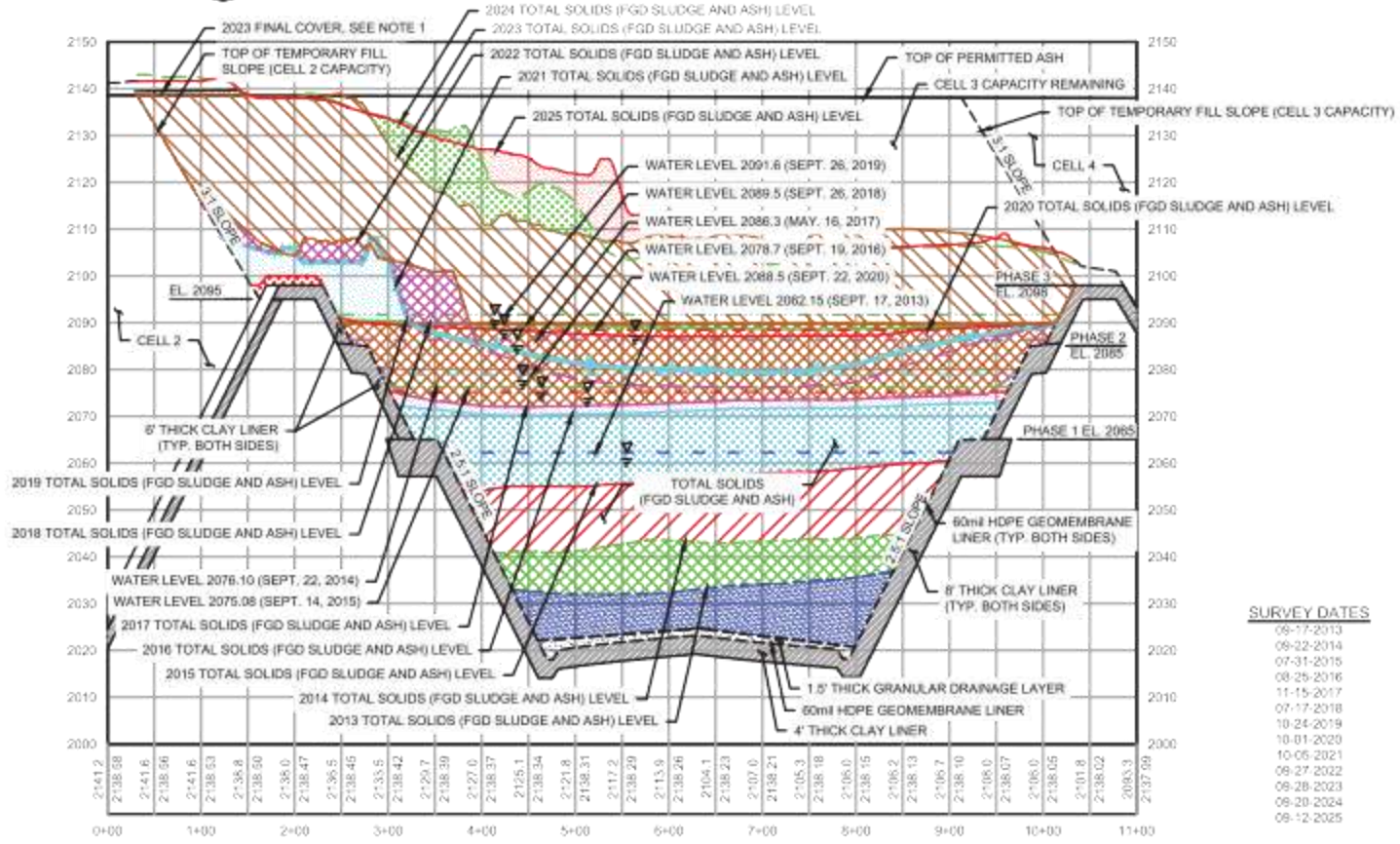
BARR PROJECT #
3433101469
DWG #
C001
REV #
A

CADD USER: ZACH J. NELSON FILE: C:\PROJECTS\2025\BARR\ENGINEERING\COMPAN\MINNKOTA\2025\CELL 3\TOTAL SOLIDS ELEVATIONS\FIGURE 1A.DWG DATE: 11/20/2025 3:30 AM

FIGURE 1b



SECTION: CELL 3 TOTAL SOLIDS (FGD SLUDGE AND ASH) CONTOURS - EAST-WEST
SCALE: AS SHOWN



SECTION: CELL 3 TOTAL SOLIDS (FGD SLUDGE AND ASH) CONTOURS - NORTH-SOUTH
SCALE: AS SHOWN

- LEGEND**
- 2013 TOTAL SOLIDS (FGD SLUDGE AND ASH)
 - 2014 TOTAL SOLIDS (FGD SLUDGE AND ASH)
 - 2015 TOTAL SOLIDS (FGD SLUDGE AND ASH)
 - 2016 TOTAL SOLIDS (FGD SLUDGE AND ASH)
 - 2017 TOTAL SOLIDS (FGD SLUDGE AND ASH)
 - 2018 TOTAL SOLIDS (FGD SLUDGE AND ASH)
 - 2019 TOTAL SOLIDS (FGD SLUDGE AND ASH)
 - 2020 TOTAL SOLIDS (FGD SLUDGE AND ASH)
 - 2021 TOTAL SOLIDS (FGD SLUDGE AND ASH)
 - 2022 TOTAL SOLIDS (FGD SLUDGE AND ASH)
 - 2023 TOTAL SOLIDS (FGD SLUDGE AND ASH)
 - 2024 TOTAL SOLIDS (FGD SLUDGE AND ASH)
 - 2025 TOTAL SOLIDS (FGD SLUDGE AND ASH)

TOP OF TOTAL SOLIDS (FGD SLUDGE AND ASH) OR FINAL COVER

TOP OF PERMITTED ASH

NOTES:

1. CELL 2 PHASE 2 CLOSURE WAS ONGOING AT THE TIME OF THE SEPTEMBER 28, 2023 SURVEY (18" SELECT CLAY LAYER WAS CONSTRUCTED, BUT THE 12" SPGM SUBSOIL AND 8" SPGM TOPSOIL LAYERS HAD YET TO BE PLACED).

- SURVEY DATES**
- 09-17-2013
 - 09-22-2014
 - 07-31-2015
 - 08-25-2016
 - 11-15-2017
 - 07-17-2018
 - 10-24-2019
 - 10-01-2020
 - 10-05-2021
 - 09-27-2022
 - 09-28-2023
 - 09-20-2024
 - 09-12-2025

A	ZJN	RDP	SWH	11/07/2025	ISSUED FOR REVIEW
#	BY	CHK	APP	DATE	RELEASE/REVISION DESCRIPTION



4305 WARREN DRIVE
SUITE 200
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MINNESOTA ENGINEERING FIRM
NUMBER 1010411545

MILTON R. YOUNG STATION
MINNKOTA POWER COOPERATIVE

CELL 3
TOTAL SOLIDS ELEVATIONS
CONSTRUCTION THROUGH SEPTEMBER 2025
SECTIONS

BAR# PROJECT #	3433101469
DWG#	C002
REV#	A

FIGURE 2

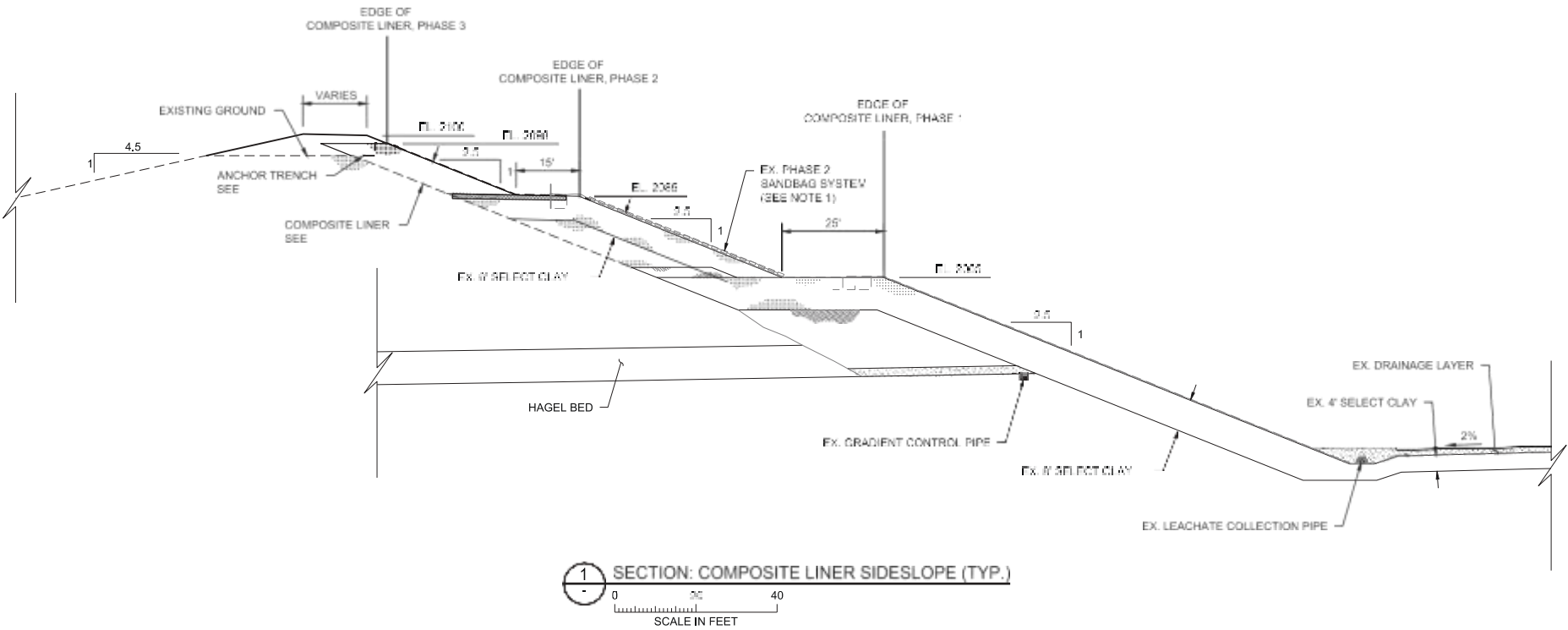
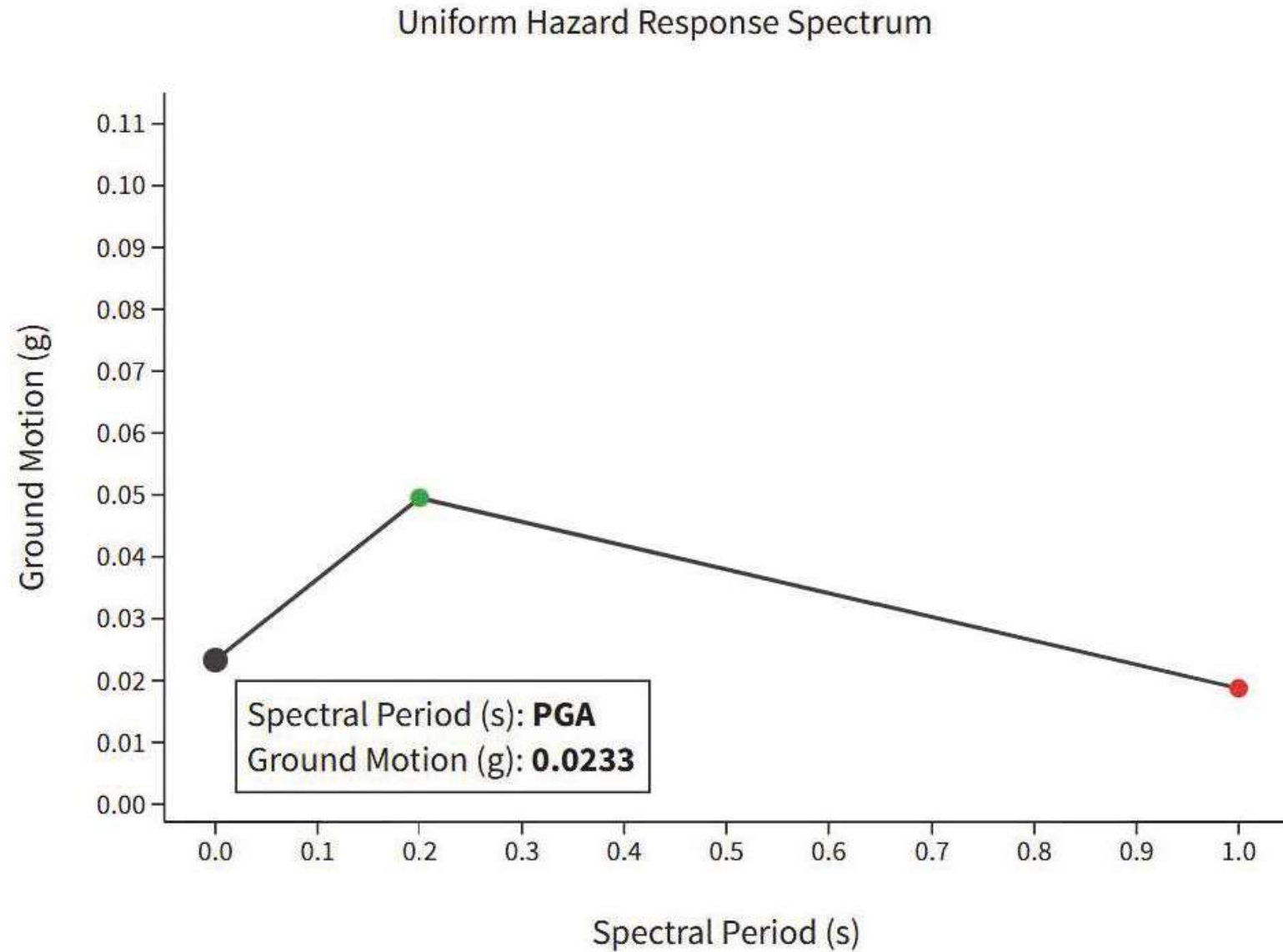
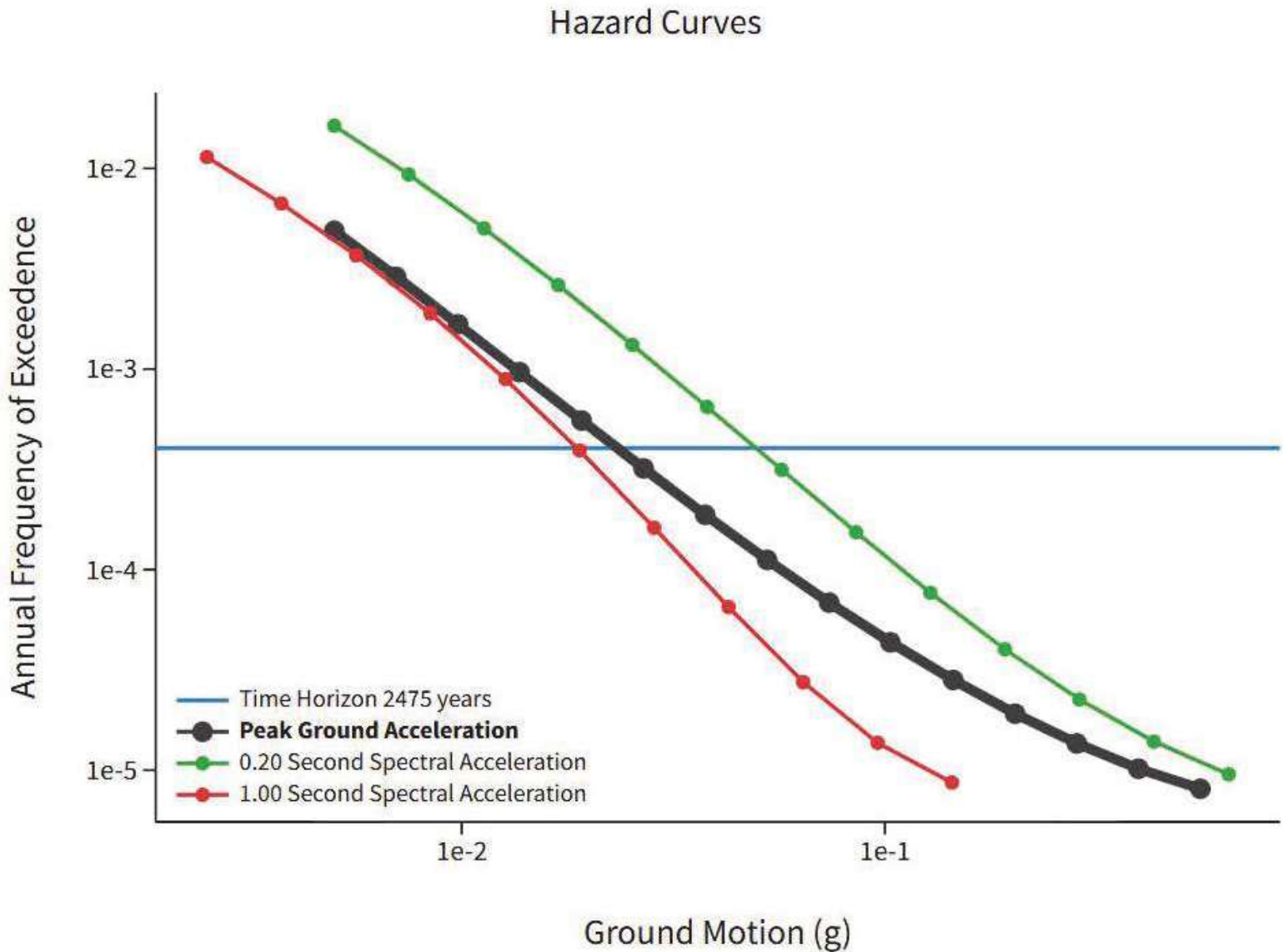
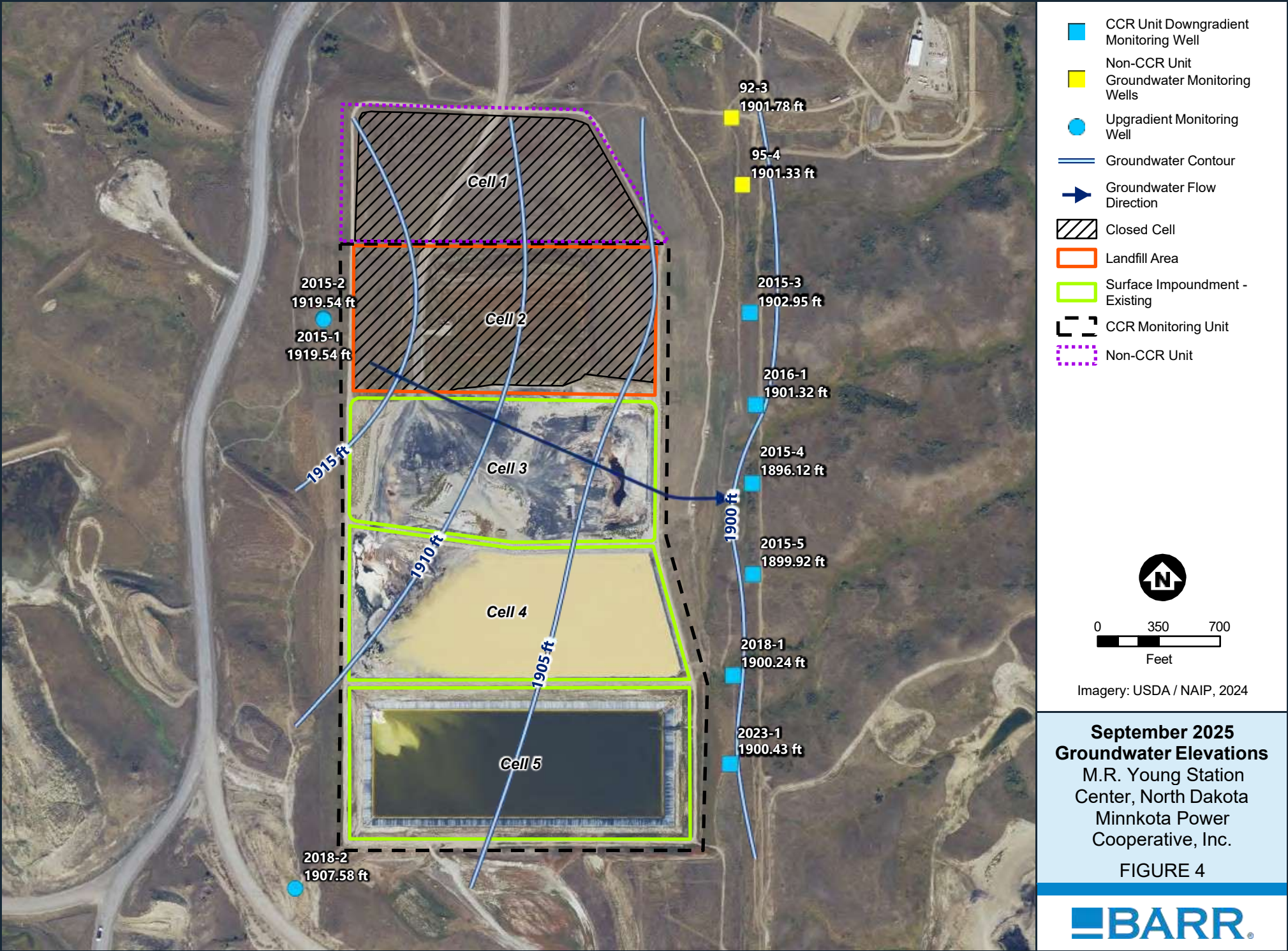


Figure 3 Peak Ground Acceleration







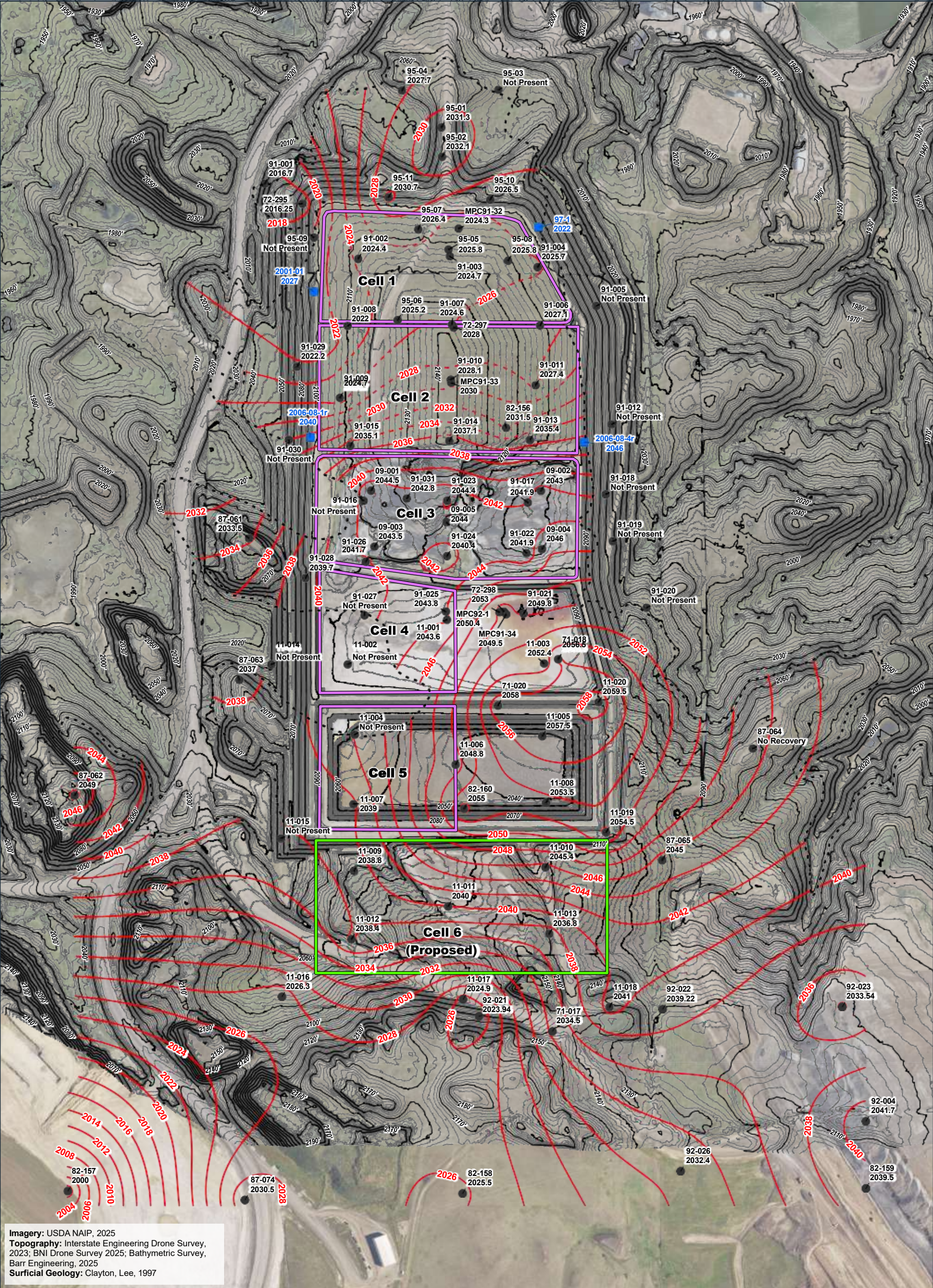
Attachments





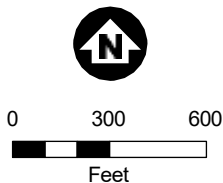
Attachment A

Cell 3 Boring Data



Imagery: USDA NAIP, 2025
Topography: Interstate Engineering Drone Survey, 2023; BNI Drone Survey 2025; Bathymetric Survey, Barr Engineering, 2025
Surficial Geology: Clayton, Lee, 1997

- Boring
- Well
- Surface Elevation Contour (2-ft Contour)
- Current Base of Hagel Bed Elevation Contour (2 Ft Interval)
- Pre-Mining Base of Hagel Bed Elevation Contour - Now Removed (2 Ft Interval)
- Approximate Limit of Hagel Bed
- Hagel Bed Previously Mined from Cell
- Hagel Bed to be Mined from Cell 6



Map of Hagel Bed
(Updated 2026)
Hydrogeologic Evaluation
Minnkota Power Coop, Inc.
Center, North Dakota

FIGURE A-1



Client MinnkotaDrill Contractor Braun Intertec**LOG OF Boring 09-001**

SHEET 1 OF 1

DRAFTProject Name FGD Pond Cell 3 Phase 0Drill Method HSANumber 34330014Drilling Started 8/17/09 Ended 8/17/09Elevation 2055.0Location Cell 3Logged By JLS4Total Depth 63.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Blows/6 in.	Moisture	ASTM	LITHOLOGY	DESCRIPTION	ELEV. FEET
		1	3-6-6-5	Damp			0-6': Sandy Lean Clay, plastic, brown (10YR 5/3).	
		2	5-7-8-12	Damp	CL		2-4': Interbedded with several thin (0.01') fine sand layers.	
		3	4-8-7-8				5-7': Iron Staining, strong brown (10YR 5/8).	2050
		4	3-4-3-4	Damp	Rock	x x	6-7': Siltstone, with clay, little to some 5-30% fine sand, lignite coal fragments, friable, hard, poor recovery, gray (10 YR 6/1).	
10		5	3-3-2-2	Damp	Coal		7-10.5': Lignite Coal, carbonaceous, poor recovery, black (10YR 2/1).	
		6		Damp			10.5-54': Claystone, interbedded with Siltstone and Sandstone, hard, cemented, sand, silt, and clay content varies throughout section, sand content varies from little to some 1 to 30%, sand content appears to increase with silt content, grey (10 YR 5/1).	2040
20		7			Rock		13-22.5': Siltstone, with clay and little 5-12% fine sand, hard, friable, stratified, brown (10 YR 5/3) with grey (10YR 6/1).	
		8		Damp			~22.5' Color change from brown (10YR 5/3) to grey (10YR 6/1).	2030
				Damp			22.5-24.5' Stratified	
30		9			Rock		29.2-29.3': Siltstone, with clay and fine sand, light gray (10YR 7/1).	2020
40		10		Damp			41-42.5': Claystone, carbonaceous, hard, black (10YR 2/1).	
							42.4-42.5': Lignite Coal, carbonaceous, black (10YR 2/1).	2010
							43-49': Siltstone, with clay and little to some 5-30% fine sand, friable, hard, gray (10 YR 6/1).	
50		11		Damp			49-63': Sandstone, fine grained, with fines, stratified, hard, friable, thin lignite stringers, gray (10YR 6/1).	2000
							51-54': Siltstone, with clay and little to some 5-30% fine sand, crumbles, hard, friable, gray (10 YR 6/1).	
60		12		Moist	Rock			
							End of Boring - 63 feet	

ENVIRO LOG 5 (5/27/04) 34330014.GPJ BARR JAN06.GDT 11/12/09



Barr Engineering Co.
4700 W 77th St. Suite 200
Edina, MN 55435
Telephone: 952-832-2600
Fax: 952-862-2601

Remarks: Driller, Kyle Haag

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

Client Minnkota
 Project Name FGD Pond Cell 3 Phase 0
 Number 34330014
 Location Cell 3

Drill Contractor Braun Intertec
 Drill Method HSA
 Drilling Started 8/18/09 Ended 8/18/09
 Logged By JLS4

LOG OF Boring 09-002
DRAFT SHEET 1 OF 1
 Elevation 2072.0
 Total Depth 69.0

DEPTH FEET	SAMP. LENGTH & RECOVERY SAMP. NUMBER	Blows/6 in.	Moisture	ASTM	LITHOLOGY	DESCRIPTION	ELEV. FEET
	1	4-6-9-	Damp			0-7.5': Lean Clay, some silt and trace fine sand, grayish brown (10YR 5/2) with brown mottling (10YR 5/3). Lean Clay transitions to Silty Lean Clay with increasing depth, iron staining, dark yellowish brown (10YR 4/4). 6.5': Clayey Sand, thin layer (0.1' thick).	2070
	2	6-11-16-	Damp Damp	CL			
	3						
10			Damp	Rock		7-7.5': Sandstone, not fryable, well cemented, light gray (10YR 6/1).	
						7.5-21': Claystone, interbedded with Siltstone, hard, clay and silt content varies throughout section, sand content varies throughout section from little to some 1 to 30 %, sand content appears to increase with silt content, grey (10 YR 5/1).	2060
	4			Rock		7.5-10.5': Siltstone, with clay and little to some fine sand, hard, gray (10YR 5/1). 13.5': Thin lignite stringer	
20			Damp				
						21-29' Lignite Coal, carbonaceous, very dark brown (10YR 2/2)	2050
	5			Coal			
			Damp			29-69': Claystone, interbedded with Siltstone and Sandstone, hard, well cemented, sand, silt, and clay content varies throughout section, sand content varies from 1 to 30%, sand content appears to increase with silt content, color varies, grey (10 YR 5/1, 10 YR 6/1) and greenish grey (Gley 2, 5/1).	2040
30						30': Thin lignite stringers (0.02' thick).	
	6					31.5-34': Siltstone, with clay and trace fine sand, well cemented, friable, stratified, gray (10YR 5/1).	
			Damp			34.5-37.5': Siltstone, with clay, little 5-12% fine sand, friable, hard, gray (10 YR 6/1).	
40						34-34.5': Sandstone, with fines, hard, friable, gray (10YR 6/1).	2030
						36.5-37': Mudstone, low plasticity, wet.	
	7					42-43.5': Sand Stone, well cemented, not friable, very hard, dry, light gray (10YR 6/1).	
			Damp			44.5-48': Siltstone, with clay and little 5-12% fine sand, hard, friable, gray (10 YR 6/1).	
50				Rock		47.5-47.7': Limestone, well cemented, not friable, very pale brown (10YR 8/2).	
						48-56': Claystone, stratified.	2020
	8						
			Damp			56-57': Siltstone, with trace to little fine sand, friable, gray (10YR 6/1).	
60							
	9						2010
			Damp				
				Rock		64-65': Claystone, carbonaceous, hard, black (10YR 2/1).	
	10					65-69': Claystone, with silt and little to some fine sand, hard, greenish gray (Gley 2 10BG 5/1).	
						End of Boring - 69 feet	

ENV/RO LOG 5 (5/27/04) 34330014.GPJ BARR JAN06.GDT 11/12/09



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 Edina, MN 55435
 Telephone: 952-832-2600
 Fax: 952-862-2601

Remarks: Driller, Kyle Haag

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

Client Minnkota
 Project Name FGD Pond Cell 3 Phase 0
 Number 34330014
 Location Cell 3

Drill Contractor Braun Intertec
 Drill Method HSA
 Drilling Started 8/20/09 Ended 8/20/09
 Logged By JLS4

LOG OF Boring 09-004
DRAFT SHEET 1 OF 1
 Elevation 2083.0
 Total Depth 80.0

DEPTH FEET	SAMP. LENGTH & RECOVERY	SAMP. NUMBER	Blows/6 in.	Moisture	ASTM	LITHOLOGY	DESCRIPTION	ELEV. FEET
10		1	3-3-5-	Damp	CL		0-9': Sandy Lean Clay, fine grained sand, medium plasticity, brown (10YR 5/3). Interlayered with thin layers of Clayey Sand, from 0-2.5', 2.9-3.7', 4-5'), brown (10YR 4/3). Top 0-0.6' includes roots.	2080
		2	5-7-9-	Damp				
		3	5-7-9-	Damp				
		4	4-8-8-7	Damp				
		5		Damp	ML		9-13' Clayey Silt, with trace fine sand, iron staining, strong brown (7.5YR 5/6), from 9 to 10', brown (10YR 5/3).	
20		6		Damp	CL		13-16': Lean Clay, medium plasticity, color transitions with depth from grayish brown (10 YR 5/2) with strong brown mottling to gray (10YR 5/1) with dark brown brown mottling.	2070
					Rock		16-30': Claystone, interbedded with Siltstone, hard, clay and silt content varies throughout section, stratified, sand content ranges from 1-30%, sand content appears to increase with silt content, Color transitions in color from dark brown (10YR 3/3) to gray (10 YR 5/1).	2060
30		7			Coal		26.5-26.7': Concretion, well cemented, not friable, white (10 YR 8/1), thin bands of pyrite. 29-29.1': Scoria, hard, well cemented, not friable, reddish brown (5YR 4/4). 30-37': Lignite Coal, carbonaceous, black (10 YR 2/1)	2050
40		8		Moist Damp	Rock		37-42.5': Claystone, interbedded with Siltstone, hard, clay, silt, and sand content varies throughout section, stratified, sand content ranges from 1-30%, sand content appears to increase with silt content, Color transitions in color from brown (10YR 4/3) to gray (10 YR 5/1).	2040
				Moist	Rock		42.5-52': Sandstone, fine grained, with fines, hard, friable, sand and fine content varies throughout section, gray (10YR 6/1).	
50		9		Moist				
				Damp			52-80': Claystone, interbedded with Siltstone, hard, clay and silt content varies throughout section, sand content varies throughout section from 10 to 30%, sand content appears to increase with silt content, color varies, grey (10 YR 5/1, 10 YR 6/1) and greenish grey (Gley 2, 5/1). 52-54': Siltstone with clay and some 12-30% fine sand, hard, friable, stratified, gray (10 YR 6/1). 53.8': Claystone, with gravel, thin layer, coarse, angular gravel. 56.2-56.4': Limestone, well cemented, not friable, yellowish brown (10YR 5/8). 57.2-57.3': Limestone, well cemented, not friable, yellowish brown (10YR 5/8). 63-67': Siltstone, clay, little 5-12% fine sand, friable, stratified, hard, gray (10 YR 6/1).	2030
60		10		Moist	Rock			2020
70		11		Damp	Rock			2010
				Damp			72-73': Claystone, carbonaceous, hard, fractures, dark brown (10YR 3/3). 73-75': Claystone with silt and little fine sand, hard, greenish gray (Gley 2 10BG 5/1). 77-79': Siltstone, clay with some 12-30% fine sand, friable, hard, gray (10 YR 6/1). 79-79.5': Sandstone, fine grained, with fines, hard, gray (10YR 6/1). End of Boring - 80 feet	2000
80		12		Moist Damp				

BARR Engineering Co.
 4700 W 77th St. Suite 200
 Edina, MN 55435
 Telephone: 952-832-2600
 Fax: 952-862-2601

Remarks: Driller, Kyle Haag

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

JOB RE
PROJECT

- ENGINEERING COMPUTER SERVICES PTY. LTD. - AUSTRALIA -

PAGE 6
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Surface El: 2092.2

Coordinates: N 509,609 E 1,820,984

Borehole 91-003

ECS Database

Rock Type	Geological Description of Strata	Thickness	Depth
Sand brown		6.500	6.500
Sandstone		11.000	17.500
Sand brown		26.500	44.000
Sand blue		16.000	60.000
COAL medium hard, good		7.500	67.500 HA
Sand blue		58.500	126.000
Sandstone		2.500	128.500
Clay blue, sandy		8.500	137.000
COAL medium hard, good		0.500	137.500
Clay blue, sandy		7.500	145.000
Sand blue		16.000	161.000
Clay blue, sandy		11.000	172.000
COAL medium hard, good		1.000	173.000
Clay blue, sandy		7.000	180.000

to the
1100.000 m

Surface El: 2026.7

THEIRRETT AND THE OTHERS LTD. - 110 - 1100 - 1100.000 m

Coordinates: N 509,280 E 1,822,001

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11 000-91 001213

Geological

For Database

Bed Name

Geological Description of Strata

Thickness

Depth

Sand brown

8.000

8.000

Clay brown
sandy

7.000

15.000

Clay blue sandy

11.500

26.500

2000.7

Gravel

0.500

27.000

Clay blue sandy

8.500

35.500

Sandstone

1.500

37.000

FOR REF.
P100.0MCI01
Surface El: 2051.0

ENGINEERING COMPUTER SERVICES PTY. LTD. - NSW - AUSTRALIA -
Coordinates: N 507,997 E 1,820,431

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Borehole 91-016

ECS Database

Rock Type	Geological Description of Strata	Thickness	Depth
Sand brown		18.000	18.000
Clay brown sandy		13.000	31.000
Clay blue, sandy		6.500	37.500
Clay brown sandy		1.000	38.500
Clay blue, sandy		2.500	41.000
Sand blue		19.000	60.000

THE E.C.C.
PROGRAM

Surface El: 2086.9

ENGINEERING COMPUTER SERVICES PTY. LTD. - NSW - AUSTRALIA

Coordinates: N 507,970 E 1,821,524

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Borehole 91-017

ECS Database

Rock Type	Geological Description of Strata	Thickness	Depth
Sand brown		16.000	16.000
Clay brown, sandy		5.000	21.000
Clay blue, sandy		16.500	37.500
COAL medium hard, good		7.500	45.000 HA
Clay blue, sandy		35.000	80.000

SEE FILE
FROM GROUND

ENGINEERING COMPUTER SERVICES PTY. LTD. - NSW - AUSTRALIA -

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Surface El: 2037.5

Coordinates: N 508,021 E 1,822,049

Borehole 91 018

ECS Database

Rock Type	Geological Description of Strata	Thickness	Depth
Clay brown sandy		5.000	5.000
Sandstone		1.000	6.000
Clay brown sandy		8.000	14.000
Clay blue, sandy		10.000	24.000
Clay brown sandy		1.000	25.000
Clay blue, sandy		8.500	33.500
Sandstone	Wet.	3.000	36.500
Clay blue, sandy		23.500	60.000

Note: Driller's field log reported water in sandstone at 33.6 feet.

WSE REF:
PROB. DRILL

ENGINEERING COMPUTER SERVICES PTY. LTD. - NSW - AUSTRALIA

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Surface El: 2037.3
Borehole: 91-019

Coordinates: N 507,708 E 1,822,093

ECS Database

Rock Type	Geological Description of Strata	Thickness	Depth
Clay brown, sandy		16.000	16.000
Clay blue, sandy		9.000	25.000
Clay brown, sandy		1.000	26.000
Clay blue, sandy		11.500	37.500
Sandstone	Wet.	3.500	41.000
Clay blue, sandy		14.000	55.000
Clay brown, sandy		2.000	57.000
Clay blue, sandy		3.000	60.000

Note: Driller's field log reported water in sandstone at 37.5 feet.

HRB REF.
PROG.GMCINH

ENGINEERING COMPUTER SERVICES PTY. LTD. - NSW - AUSTRALIA

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Surface El: 2090.9

Coordinates: N 507,632 E 1,821,519

Borehole 91-022

ECS Database

Rock Type	Geological Description of Strata	Thickness	Depth
Sand brown		19.000	19.000
COAL soft, poor		0.500	19.500
Clay brown, sandy		4.000	23.500
Clay blue, sandy		18.000	41.500
COAL medium hard, good		7.500	49.000 HA
Clay blue, sandy		5.000	54.000
Sand blue		10.000	64.000
Clay blue, sandy		16.000	80.000

BOE RLF.
KOG.GMCINI

ENGINEERING COMPUTER SERVICES PTY. LTD. - NSW - AUSTRALIA -

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Surface El: 2090.4
Borehole 91-023

Coordinates: N 507,976 E 1,820,985

ECS Database

Rock Type	Geological Description of Strata	Thickness	Depth
Clay brown, sandy		13.500	13.500
Sand brown		10.500	24.000
Clay brown, sandy		14.000	38.000
COAL medium hard, good		8.000	46.000 HA
Clay blue, sandy		6.000	52.000
Sand blue		3.000	55.000
Sandstone		1.500	56.500
Sand blue		1.500	58.000
Clay blue, sandy		22.000	80.000

NO. REF.
PR06.600181

ENGINEERING COMPUTER SERVICES PTY. LTD. - NSW - AUSTRALIA -

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Surface El: 2090.9

Coordinates: N 507,606 E 1,020,993

Corehole 91-024

ECS Database

Rock Type	Geological Description of Strata	Thickness	Depth
Clay brown, sandy		10.000	10.000
Sand brown		13.000	23.000
Clay brown, sandy		2.500	25.500
Sandstone		0.500	26.000
Clay brown, sandy		9.000	35.000
Clay blue, sandy		7.500	42.500
COAL medium hard, good		8.000	50.500 HA
Clay blue, sandy		3.500	54.000
Sand blue		10.000	64.000
Clay blue, sandy		16.000	80.000

000: 111.
PR06:0nC101

ENGINEERING COMPUTER SERVICES PTY. LTD. - NSW - AUSTRALIA -

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Surface El: 2057.8

Coordinates: N 508,410 E 1,819,936

Borehole 91-030

ECS Database

Rock Type	Geological Description of Strata	Thickness	Depth
Clay brown, sandy		14.000	14.000
Sand brown		11.000	25.000
Sand and gravel		2.000	27.000
Clay brown, sandy		3.000	30.000
Clay blue, sandy		1.000	31.000
Sand blue		2.000	33.000
Clay blue, sandy		17.500	50.500
Clay brown, sandy		1.000	51.500
Sand blue		10.500	62.000
Clay blue, sandy		2.500	64.500
Sandstone		4.000	68.500
Sand blue		14.500	83.000
Clay blue, sandy		2.500	85.500
COAL medium hard, good		1.000	86.500
Clay blue, sandy		13.500	100.000

LOT FILE,
1806.000101

Surface El: 2067.3

Corehole 91-031

ENGINEERING COMPUTER SERVICES PTY. LTD. - NSW - AUSTRALIA -

Coordinates: N 507,988 E 1,820,715

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ECS Database

Rock Type	Geological Description of Strata	Thickness	Depth
Sand brown		3.000	3.000
Clay brown, sandy		14.500	17.500
COAL medium, soft		6.000	23.500 HA
COAL medium, fair		-22.500	1.000
Clay blue, sandy		32.000	33.000
Sandstone		1.000	34.000
Clay blue, sandy		22.000	56.000
COAL medium, fair		0.500	56.500
Clay blue, sandy		3.500	60.000

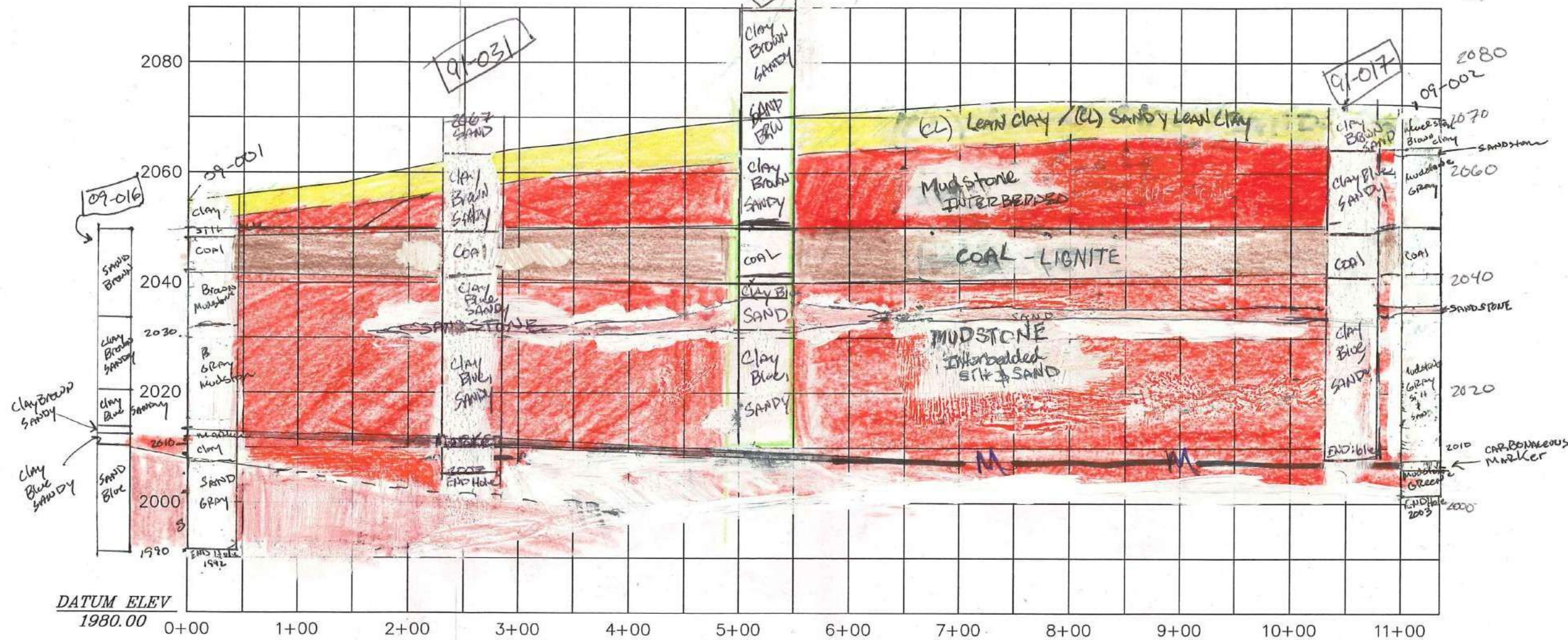
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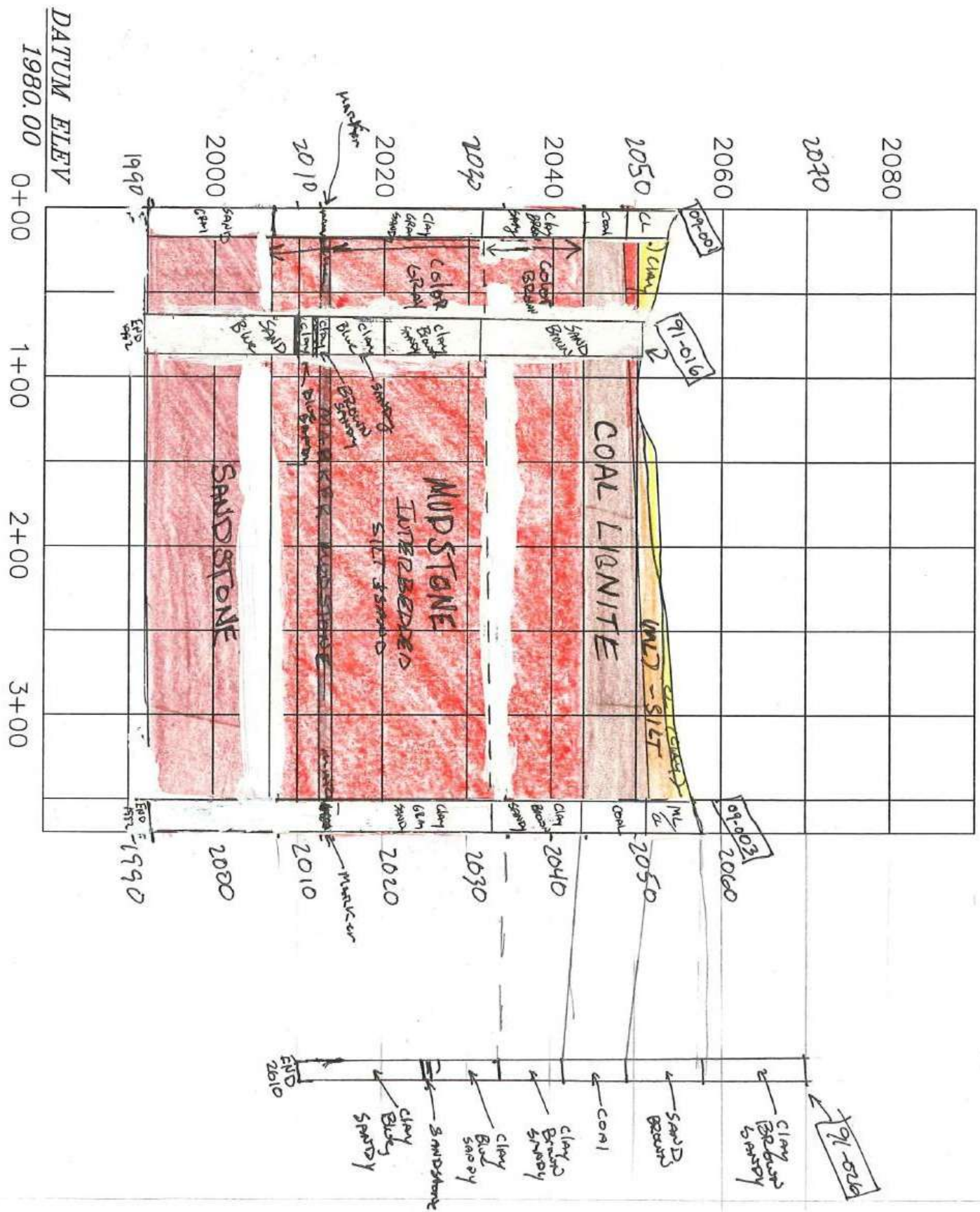
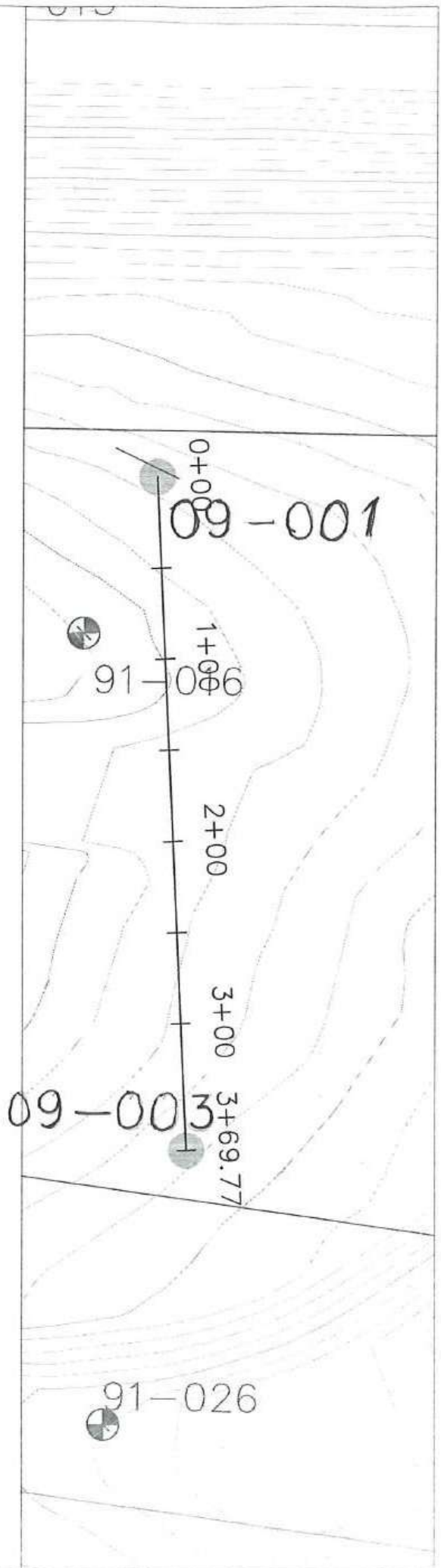
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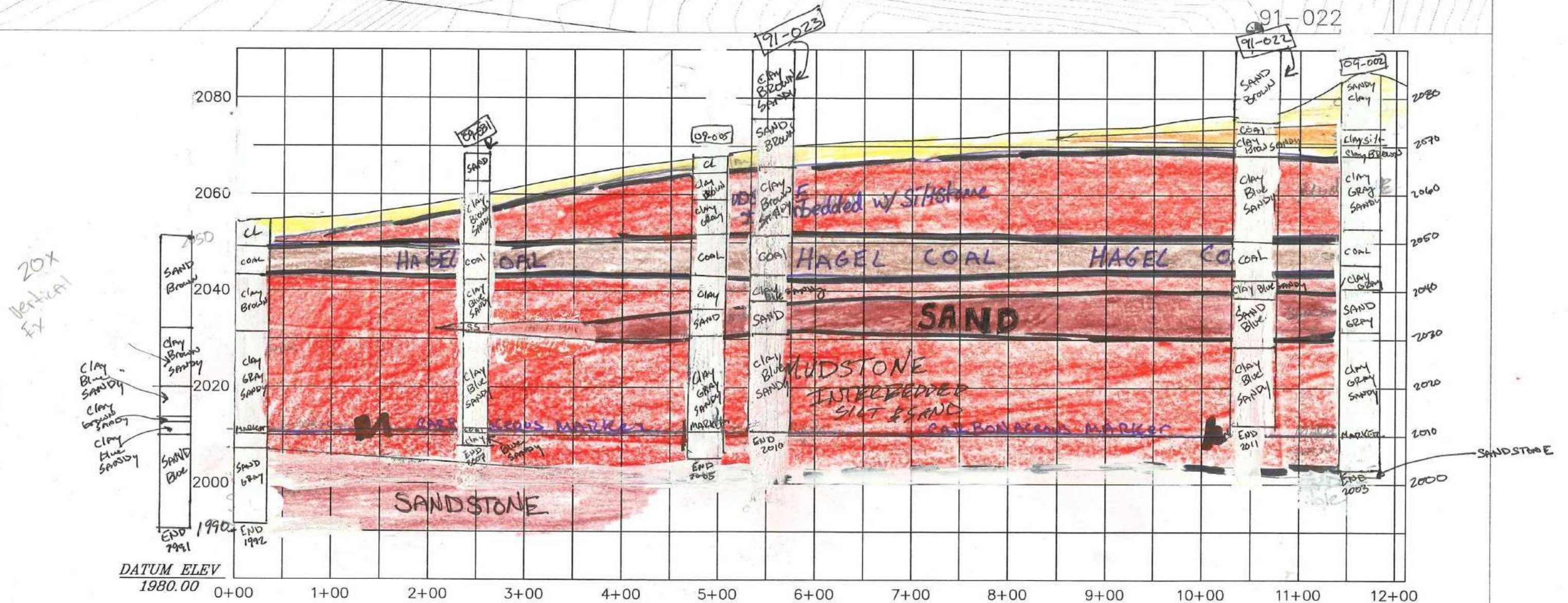
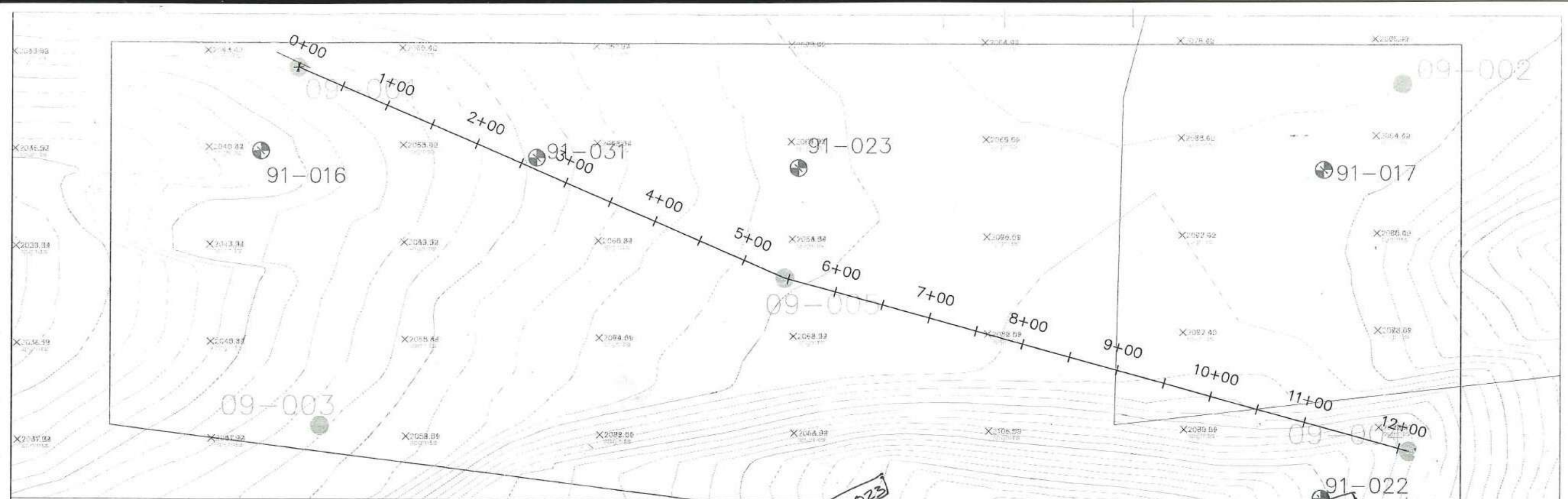
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91-023

91-017





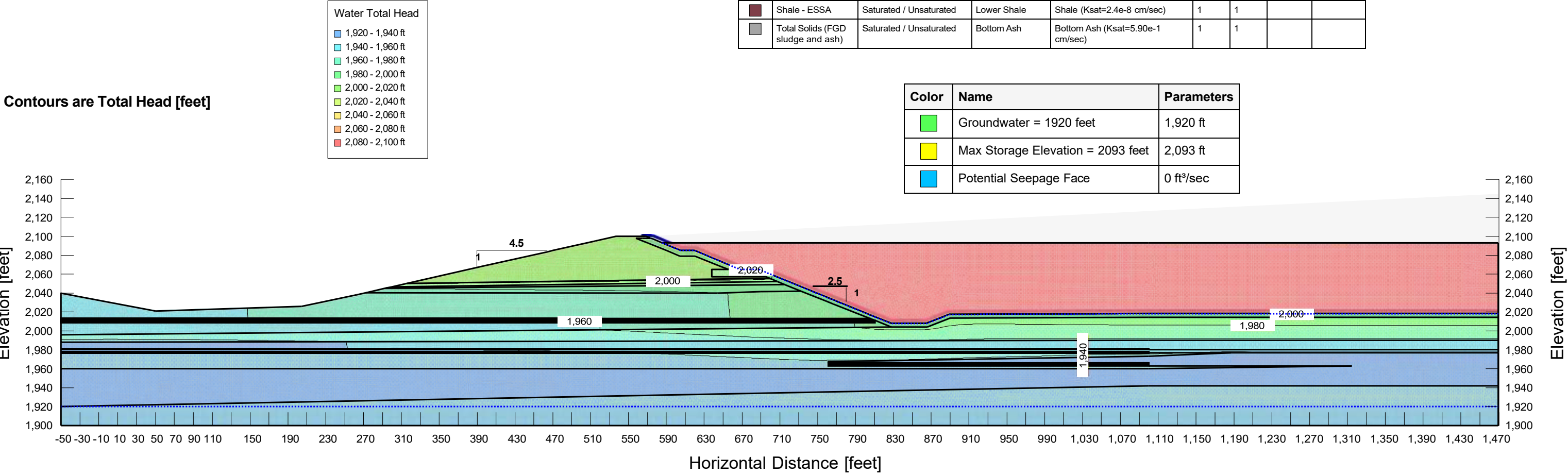




Attachment B

Seepage and Slope Stability Model Outputs

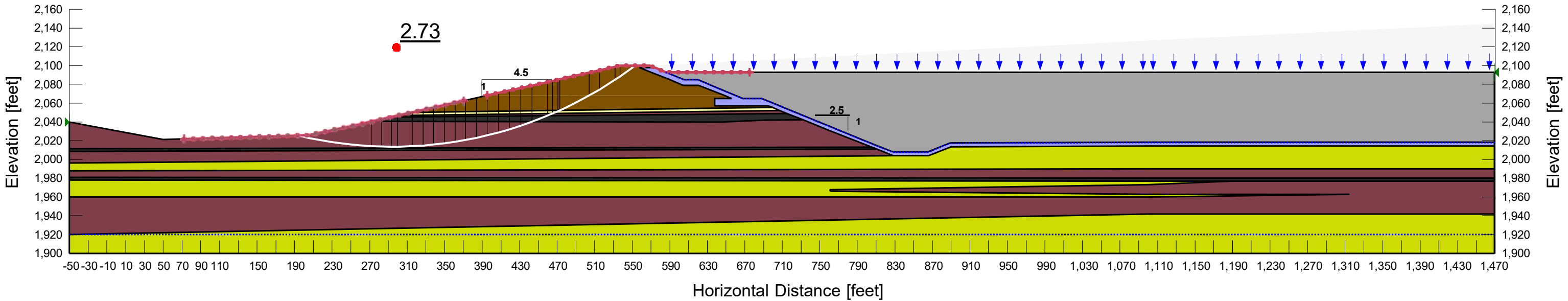
**Minnkota Power Cooperative Ash Pond
Cell 3 Seepage & Slope Stability Analysis
Current Solids Elevation at 2093 feet
1.0 Long-term maximum storage pool
Steady-State Seepage, Water to Elev. 2093 feet
Date: 09/02/2026**



Minnkota Power Cooperative Ash Pond
Cell 3 Seepage & Slope Stability Analysis
Current Solids Elevation at 2093 feet
1.1 Exterior SLOPE/W (ESSA), Pond Elev = 2093 ft
Circular Failure
Date: 09/17/2026

Factor of Safety: 2.73

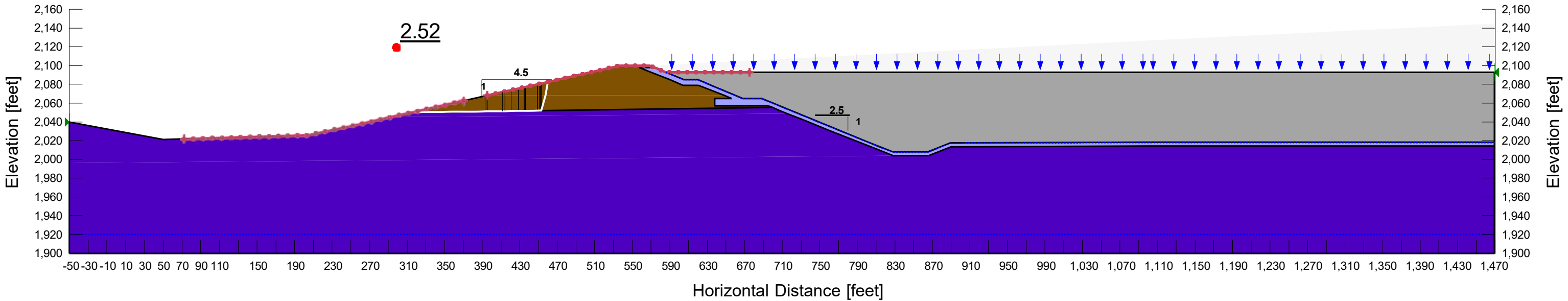
Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Shear/Normal Strength Fn.	Constant Unit Wt. Above Piezometric Surface (pcf)
	Embankment Fill - ESSA	Shear/Normal Fn.	124.4			Embankment Fill - Drained	117.1
	Hagel Formation (Lignite)	Mohr-Coulomb	82	2,000	30		80
	Outwash Sand	Mohr-Coulomb	125	0	32		120
	Sandstone	Mohr-Coulomb	130.7	0	35.1		130.1
	Select Clay Liner - ESSA	Shear/Normal Fn.	123.2			Select Clay Liner - Drained	117.1
	Shale - ESSA	Shear/Normal Fn.	125.2			Lower Shale	122.6
	Total Solids (FGD sludge and ash)	Mohr-Coulomb	122	0	26		



Minnkota Power Cooperative Ash Pond
Cell 3 Seepage & Slope Stability Analysis
Current Solids Elevation at 2093 feet
1.1b Exterior SLOPE/W (ESSA), Pond Elev = 2093 ft_block
Block Failure
Date: 09/03/2026

Factor of Safety: 2.52

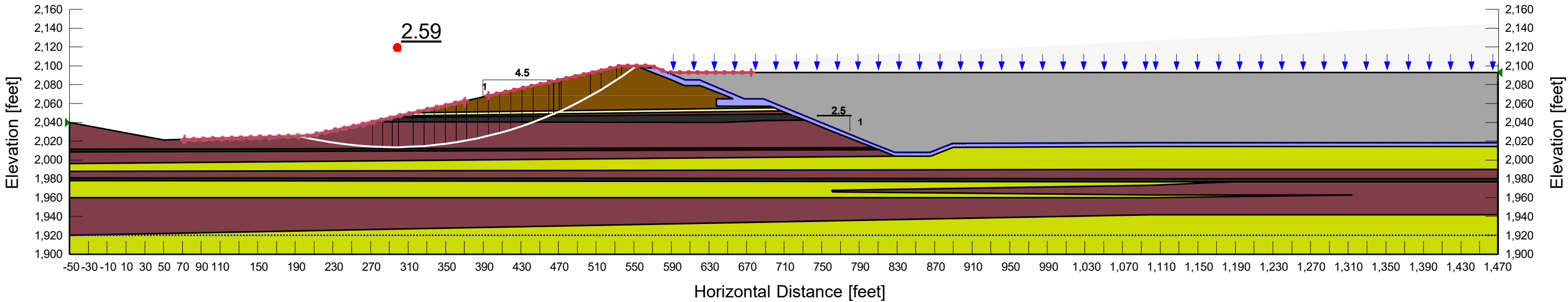
Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Shear/Normal Strength Fn.	Constant Unit Wt. Above Piezometric Surface (pcf)
	Embankment Fill - ESSA	Shear/Normal Fn.	124.4			Embankment Fill - Drained	117.1
	Impenetrable Surface	Bedrock (Impenetrable)					
	Select Clay Liner - ESSA	Shear/Normal Fn.	123.2			Select Clay Liner - Drained	117.1
	Total Solids (FGD sludge and ash)	Mohr-Coulomb	122	0	26		



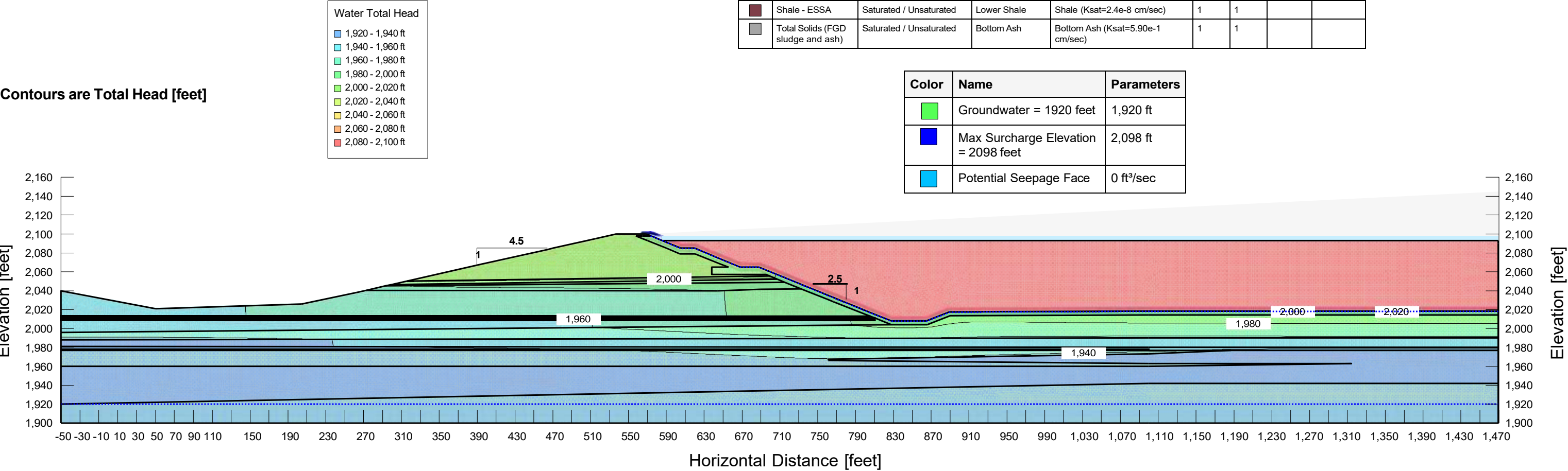
Minnkota Power Cooperative Ash Pond
Cell 3 Seepage & Slope Stability Analysis
Current Solids Elevation at 2093 feet
1.3b Exterior SLOPE/W (seismic_ESS), Pond Elev = 2093 ft all ESSA
horizontal seismic coefficient, kh = 0.012
Date: 09/02/2026

Factor of Safety: 2.59

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Shear/Normal Strength Fn.	Constant Unit Wt. Above Piezometric Surface (pcf)
	Embankment Fill - ESSA	Shear/Normal Fn.	124.4			Embankment Fill - Drained	117.1
	Hagel Formation (Lignite)	Mohr-Coulomb	82	2,000	30		80
	Outwash Sand	Mohr-Coulomb	125	0	32		120
	Sandstone	Mohr-Coulomb	130.7	0	35.1		130.1
	Select Clay Liner - ESSA	Shear/Normal Fn.	123.2			Select Clay Liner - Drained	117.1
	Shale - ESSA	Shear/Normal Fn.	125.2			Lower Shale	122.6
	Total Solids (FGD sludge and ash)	Mohr-Coulomb	122	0	26		



**Minnkota Power Cooperative Ash Pond
Cell 3 Seepage & Slope Stability Analysis
Current Solids Elevation at 2093 feet
2.0 Maximum surcharge loading condition
Steady-State Seepage, Water to Elev. 2098 feet
Date: 09/02/2026**

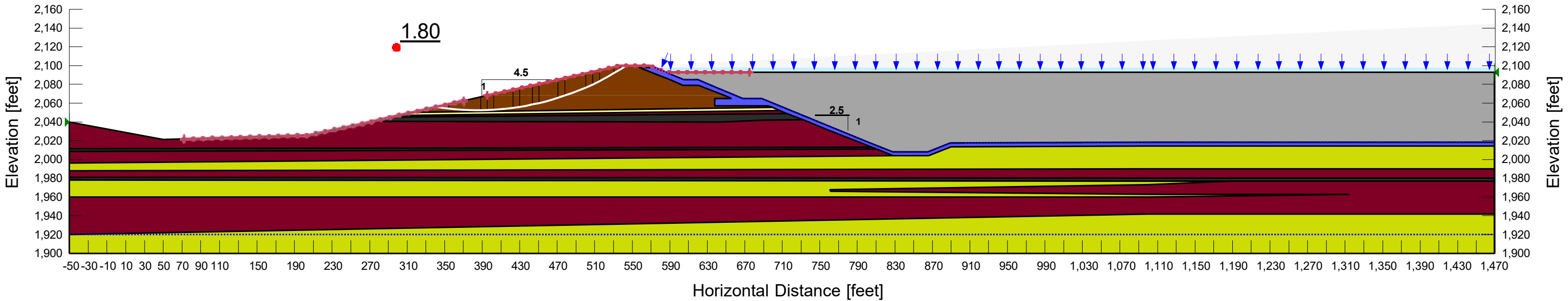


Color	Name	Hydraulic Material Model	Vol. WC. Function	K-Function	Ky'/Kx' Ratio	Kz'/Kx' Ratio	Sat Kx (ft/sec)	Volumetric Water Content
	Embankment Fill - ESSA	Saturated / Unsaturated	Embankment Fill	Embankment Fill (Ksat=5.05e-6 cm/sec)	1	1		
	Geomembrane	Saturated Only			1	1	6.56e-15	0
	Hagel Formation (Lignite)	Saturated / Unsaturated	Hagel Formation Lignite	Hagel Formation Lignite (Ksat=1.0e-2 cm/sec)	1	1		
	Outwash Sand	Saturated / Unsaturated	Outwash Sand	Outwash Sand (Ksat=1.0e-3 cm/sec)	1	1		
	Sandstone	Saturated / Unsaturated	Sentinel Butte Sandstone	Sentinel Butte Sandstone (Ksat=7.56e-6 cm/sec)	0.08	1		
	Select Clay Liner - ESSA	Saturated / Unsaturated	Select Clay Liner	Select Clay Liner (Ksat=4.83e-8 cm/sec)	1	1		
	Shale - ESSA	Saturated / Unsaturated	Lower Shale	Shale (Ksat=2.4e-8 cm/sec)	1	1		
	Total Solids (FGD sludge and ash)	Saturated / Unsaturated	Bottom Ash	Bottom Ash (Ksat=5.90e-1 cm/sec)	1	1		

Minnkota Power Cooperative Ash Pond
Cell 3 Seepage & Slope Stability Analysis
Current Solids Elevation at 2093 feet
2.2c Exterior SLOPE/W (USSA), Pond Elev = 2098 ft
Circular Failure
Date: 09/17/2026

Factor of Safety: 1.80

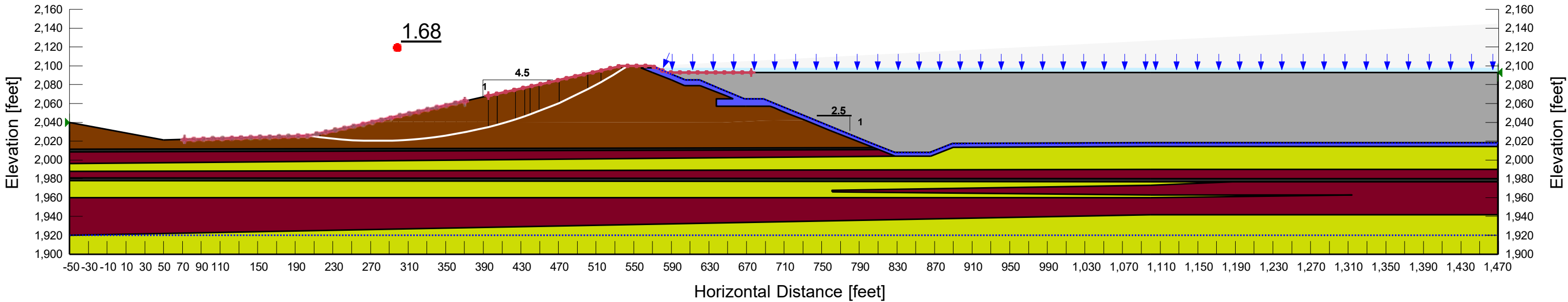
Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Constant Unit Wt. Above Piezometric Surface (pcf)
	Embankment Fill - USSA (2023)	Mohr-Coulomb	124.4	100	17.5	117.1
	Hagel Formation (Lignite)	Mohr-Coulomb	82	2,000	30	80
	Outwash Sand	Mohr-Coulomb	125	0	32	120
	Sandstone	Mohr-Coulomb	130.7	0	35.1	130.1
	Select Clay Liner - USSA	Mohr-Coulomb	123.2	100	19.4	117.1
	Shale - USSA	Mohr-Coulomb	125.2	1,800	27.7	123.2
	Total Solids (FGD sludge and ash)	Mohr-Coulomb	122	0	26	



Minnkota Power Cooperative Ash Pond
Cell 3 Seepage & Slope Stability Analysis
Current Solids Elevation at 2093 feet
2.2d Exterior SLOPE/W (USSA), Pond Elev = 2098 ft_more emb
Circular Failure
Date: 09/17/2026

Factor of Safety: 1.68

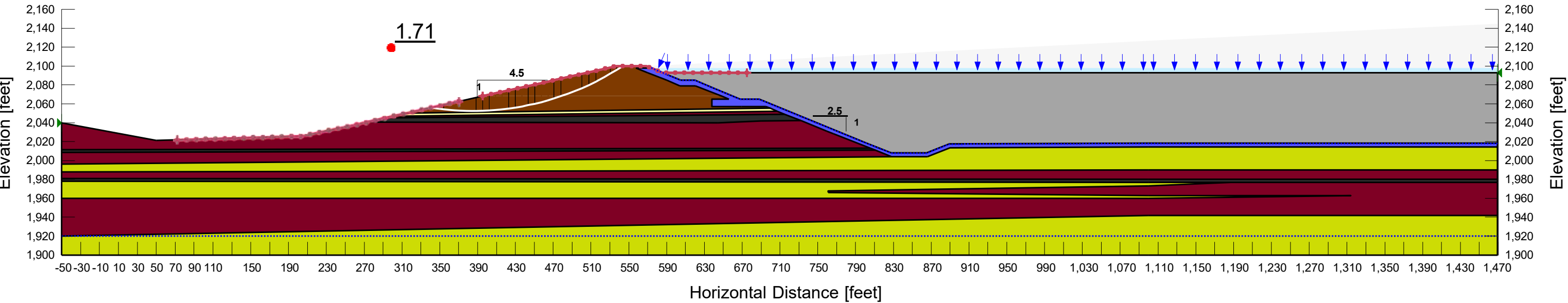
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	Embankment Fill - USSA (2023)	Mohr-Coulomb	124.4	100	17.5	117.1
	Hagel Formation (Lignite)	Mohr-Coulomb	82	2,000	30	80
	Sandstone	Mohr-Coulomb	130.7	0	35.1	130.1
	Select Clay Liner - USSA	Mohr-Coulomb	123.2	100	19.4	117.1
	Shale - USSA	Mohr-Coulomb	125.2	1,800	27.7	123.2
	Total Solids (FGD sludge and ash)	Mohr-Coulomb	122	0	26	



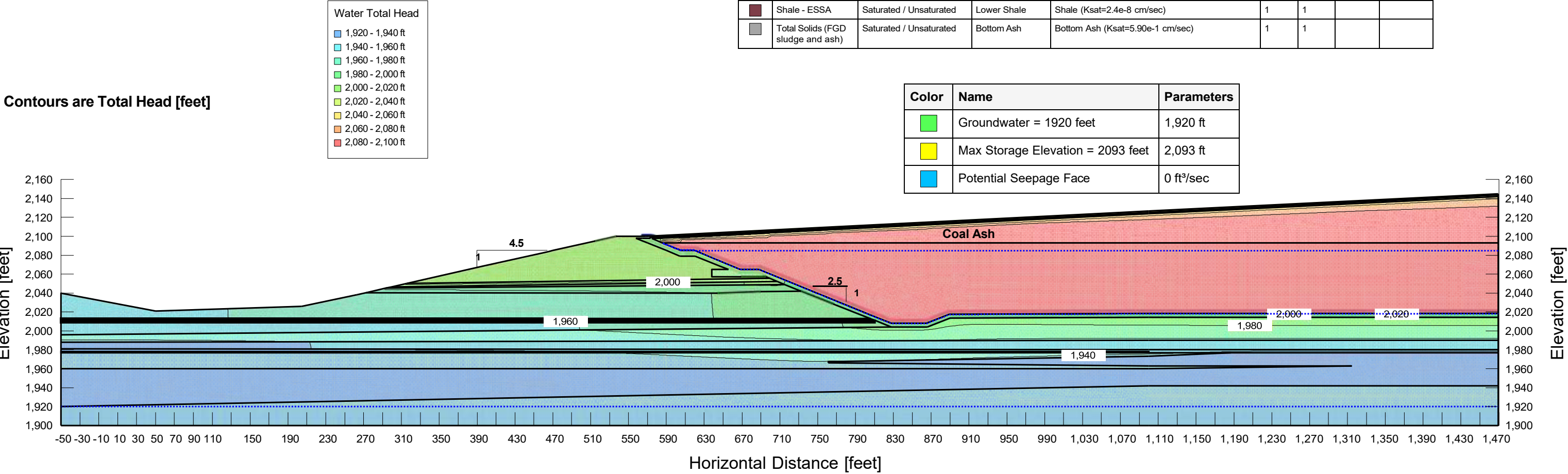
Minnkota Power Cooperative Ash Pond
Cell 3 Seepage & Slope Stability Analysis
Current Solids Elevation at 2093 feet
2.3 Exterior SLOPE/W (seismic_ESS), Pond Elev = 2098 ft
horizontal seismic coefficient, kh = 0.012
Date: 09/02/2026

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Constant Unit Wt. Above Piezometric Surface (pcf)
	Embankment Fill - USSA (2023)	Mohr-Coulomb	124.4	100	17.5	117.1
	Hagel Formation (Lignite)	Mohr-Coulomb	82	2,000	30	80
	Outwash Sand	Mohr-Coulomb	125	0	32	120
	Sandstone	Mohr-Coulomb	130.7	0	35.1	130.1
	Select Clay Liner - USSA	Mohr-Coulomb	123.2	100	19.4	117.1
	Shale - USSA	Mohr-Coulomb	125.2	1,800	27.7	123.2
	Total Solids (FGD sludge and ash)	Mohr-Coulomb	122	0	26	

Factor of Safety: 1.71



**Minnkota Power Cooperative Ash Pond
Cell 3 Seepage & Slope Stability Analysis
Current Solids Elevation at 2093 feet
3.0 Future Fill Condition
Steady-State Seepage, Water to Elev. 2093 feet
Date: 09/02/2026**

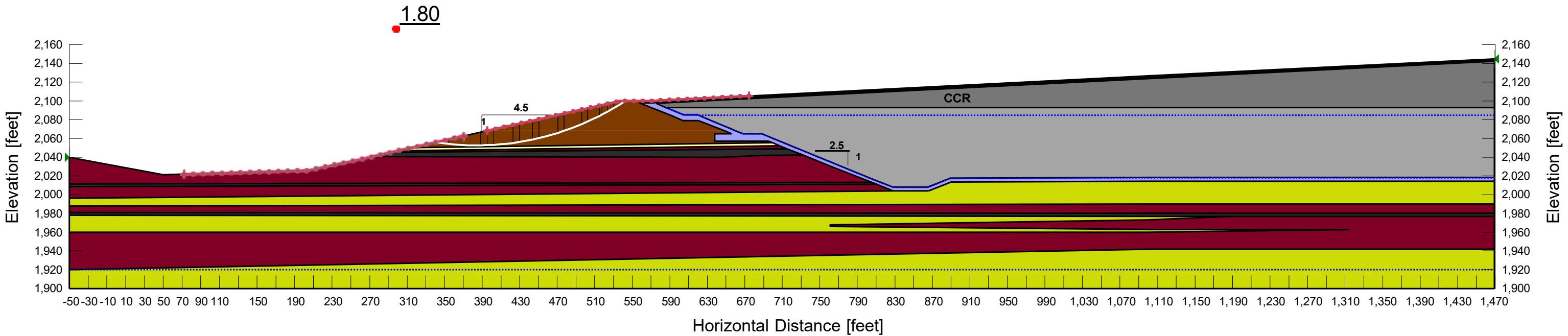


Color	Name	Hydraulic Material Model	Vol. WC. Function	K-Function	Ky'/Kx' Ratio	Kz'/Kx' Ratio	Sat Kx (ft/sec)	Volumetric Water Content
	Coal Ash	Saturated / Unsaturated	Outwash Sand	Outwash Sand (Ksat=1.0e-3 cm/sec)	1	1		
	Embankment Fill - ESSA	Saturated / Unsaturated	Embankment Fill	Embankment Fill (Ksat=5.05e-6 cm/sec)	1	1		
	Geomembrane	Saturated Only			1	1	6.56e-15	0
	Hagel Formation (Lignite)	Saturated / Unsaturated	Hagel Formation Lignite	Hagel Formation Lignite (Ksat=1.0e-2 cm/sec)	1	1		
	Outwash Sand	Saturated / Unsaturated	Outwash Sand	Outwash Sand (Ksat=1.0e-3 cm/sec)	1	1		
	Sandstone	Saturated / Unsaturated	Sentinel Butte Sandstone	Sentinel Butte Sandstone (Ksat=7.56e-6 cm/sec)	0.08	1		
	Select Clay Liner - ESSA	Saturated / Unsaturated	Select Clay Liner	Select Clay Liner (Ksat=4.83e-8 cm/sec)	1	1		
	Shale - ESSA	Saturated / Unsaturated	Lower Shale	Shale (Ksat=2.4e-8 cm/sec)	1	1		
	Total Solids (FGD sludge and ash)	Saturated / Unsaturated	Bottom Ash	Bottom Ash (Ksat=5.90e-1 cm/sec)	1	1		

Minnkota Power Cooperative Ash Pond
Cell 3 Seepage & Slope Stability Analysis
Current Solids Elevation at 2093 feet
3.2 Exterior SLOPE/W (USSA), Pond Elev = 2093 ft
Circular Failure
Date: 09/17/2026

Factor of Safety: 1.80

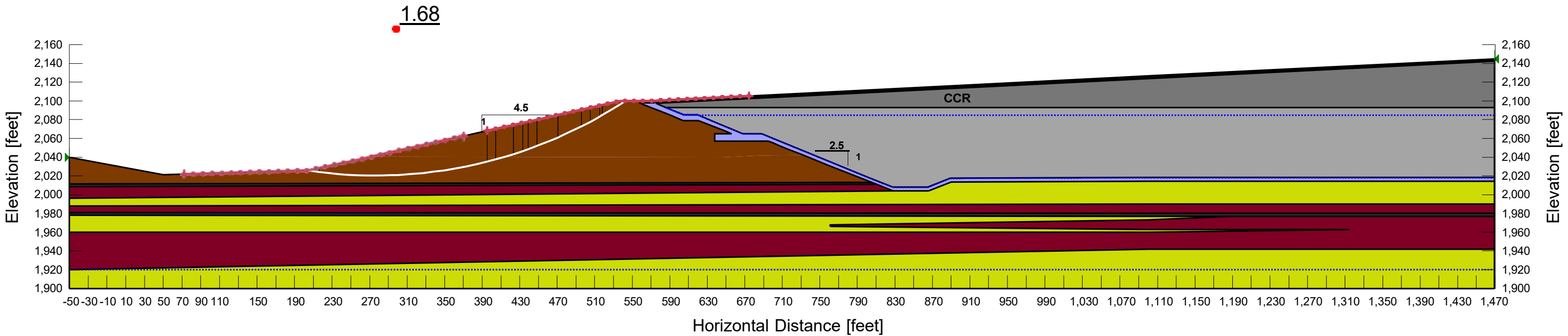
Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Shear/Normal Strength Fn.	Effective Cohesion (psf)	Effective Friction Angle (°)	Constant Unit Wt. Above Piezometric Surface (pcf)
	CCR	Mohr-Coulomb	122		0	26	
	Embankment Fill - USSA (2023)	Mohr-Coulomb	124.4		100	17.5	117.1
	Hagel Formation (Lignite)	Mohr-Coulomb	82		2,000	30	80
	Outwash Sand	Mohr-Coulomb	125		0	32	120
	Sandstone	Mohr-Coulomb	130.7		0	35.1	130.1
	Select Clay Liner - ESSA	Shear/Normal Fn.	123.2	Select Clay Liner - Drained			117.1
	Shale - USSA	Mohr-Coulomb	125.2		1,800	27.7	123.2
	Total Solids (FGD sludge and ash)	Mohr-Coulomb	122		0	26	



Minnkota Power Cooperative Ash Pond
Cell 3 Seepage & Slope Stability Analysis
Current Solids Elevation at 2093 feet
3.2a Exterior SLOPE/W (USSA), Pond Elev = 2093 ft_more emb
Circular Failure
Date: 09/17/2026

Factor of Safety: 1.68

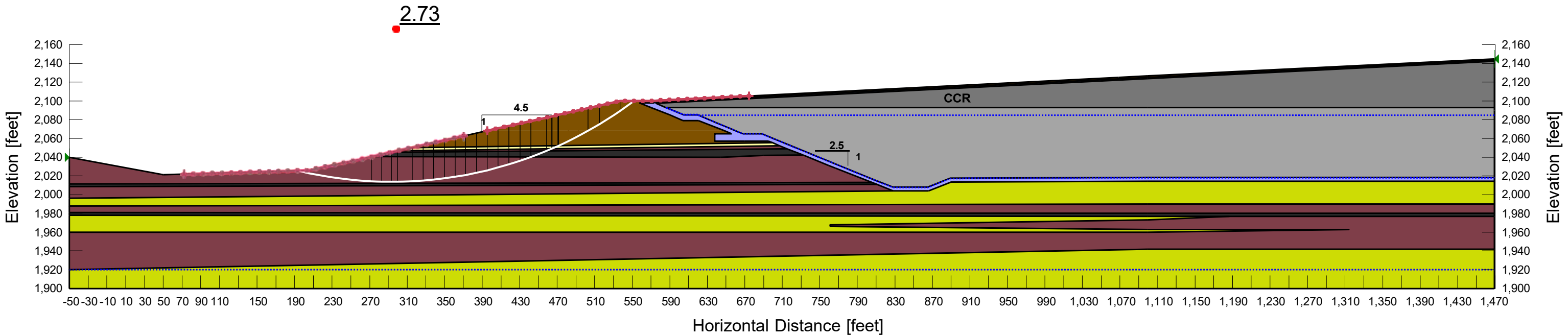
Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Shear/Normal Strength Fn.	Effective Cohesion (psf)	Effective Friction Angle (°)	Constant Unit Wt. Above Piezometric Surface (pcf)
	CCR	Mohr-Coulomb	122		0	26	
	Embankment Fill - USSA (2023)	Mohr-Coulomb	124.4		100	17.5	117.1
	Hagel Formation (Lignite)	Mohr-Coulomb	82		2,000	30	80
	Sandstone	Mohr-Coulomb	130.7		0	35.1	130.1
	Select Clay Liner - ESSA	Shear/Normal Fn.	123.2	Select Clay Liner - Drained			117.1
	Shale - USSA	Mohr-Coulomb	125.2		1,800	27.7	123.2
	Total Solids (FGD sludge and ash)	Mohr-Coulomb	122		0	26	



Minnkota Power Cooperative Ash Pond
Cell 3 Seepage & Slope Stability Analysis
Current Solids Elevation at 2093 feet
3.1 Exterior SLOPE/W (ESSA), Pond Elev = 2093 ft
Circular Failure
Date: 09/17/2026

Factor of Safety: 2.73

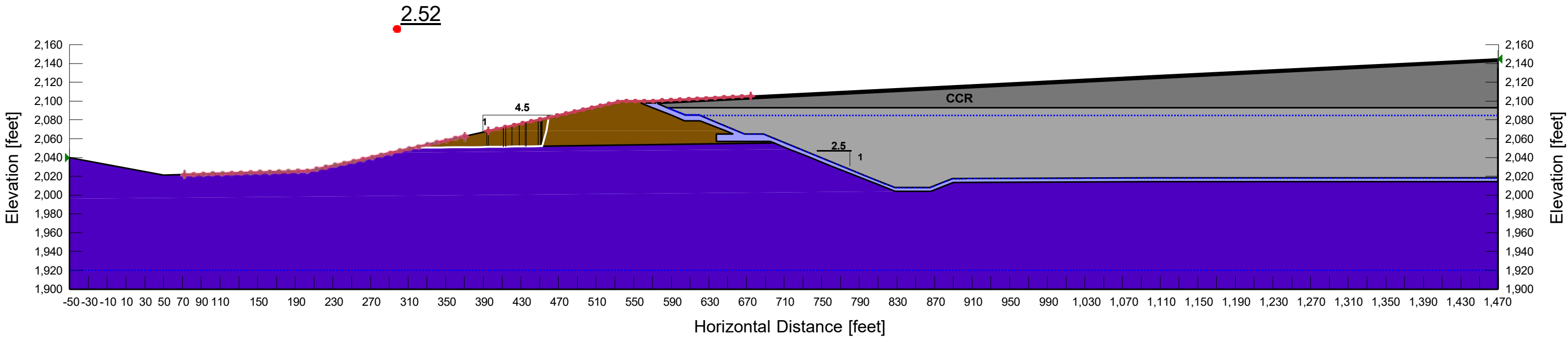
Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Shear/Normal Strength Fn.	Constant Unit Wt. Above Piezometric Surface (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	CCR	Mohr-Coulomb	122			0	26
	Embankment Fill - ESSA	Shear/Normal Fn.	124.4	Embankment Fill - Drained	117.1		
	Hagel Formation (Lignite)	Mohr-Coulomb	82		80	2,000	30
	Outwash Sand	Mohr-Coulomb	125		120	0	32
	Sandstone	Mohr-Coulomb	130.7		130.1	0	35.1
	Select Clay Liner - ESSA	Shear/Normal Fn.	123.2	Select Clay Liner - Drained	117.1		
	Shale - ESSA	Shear/Normal Fn.	125.2	Lower Shale	122.6		
	Total Solids (FGD sludge and ash)	Mohr-Coulomb	122			0	26



Minnkota Power Cooperative Ash Pond
Cell 3 Seepage & Slope Stability Analysis
Current Solids Elevation at 2093 feet
3.1b Exterior SLOPE/W (ESSA), Pond Elev = 2093 ft_block
Block Failure
Date: 09/03/2026

Factor of Safety: 2.52

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Shear/Normal Strength Fn.	Constant Unit Wt. Above Piezometric Surface (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	CCR	Mohr-Coulomb	122			0	26
	Embankment Fill - ESSA	Shear/Normal Fn.	124.4	Embankment Fill - Drained	117.1		
	Impenetrable Surface	Bedrock (Impenetrable)					
	Select Clay Liner - ESSA	Shear/Normal Fn.	123.2	Select Clay Liner - Drained	117.1		
	Total Solids (FGD sludge and ash)	Mohr-Coulomb	122			0	26



**Minnkota Power Cooperative Ash Pond
Cell 3 Seepage & Slope Stability Analysis
Current Solids Elevation at 2093 feet
3.3b Exterior SLOPE/W (seismic_ESS), Pond Elev = 2093 ft all ESSA
horizontal seismic coefficient, kh = 0.012
Date: 09/02/2026**

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Shear/Normal Strength Fn.	Constant Unit Wt. Above Piezometric Surface (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	CCR	Mohr-Coulomb	122			0	26
	Embankment Fill - ESSA	Shear/Normal Fn.	124.4	Embankment Fill - Drained	117.1		
	Hagel Formation (Lignite)	Mohr-Coulomb	82		80	2,000	30
	Outwash Sand	Mohr-Coulomb	125		120	0	32
	Sandstone	Mohr-Coulomb	130.7		130.1	0	35.1
	Select Clay Liner - ESSA	Shear/Normal Fn.	123.2	Select Clay Liner - Drained	117.1		
	Shale - ESSA	Shear/Normal Fn.	125.2	Lower Shale	122.6		
	Total Solids (FGD sludge and ash)	Mohr-Coulomb	122			0	26

Factor of Safety: 2.59

