STRUCTURAL STABILITY AND FACTOR OF SAFETY ASSESSMENT
METAL CLEANING BASIN
POWERTON STATION
JUNE 2021

This report has been prepared for the Metal Cleaning Basin (herein referred to as the Basin) at Powerton Station pursuant to Sections 845.450 Structural Stability Assessment and 845.460 Safety Factor Assessment of Title 35 Subtitle G Subchapter I Subchapter j Coal Combustion Waste Surface Impoundments. The purpose of this project is to perform the initial structural stability and factor of safety assessments for the Basin by a licensed professional engineer. Civil & Environmental Consultants, Inc. (CEC) completed this structural stability and factor of safety assessment as described in the following sections.

1.0 REGULATION REQUIREMENTS 845.450 AND 845.460

In accordance with Sections 845.450 and 845.460, owners or operator of a coal combustion residuals (CCR) impoundment are required to conduct initial and annual structural stability assessments to document whether the design, construction, operation, and maintenance of the CCR surface impoundment is consistent with recognized and generally accepted engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded; and to conduct an initial and annual safety factor assessment for each CCR surface impoundment and document whether the calculated factors of safety for each CCR surface impoundment achieve the minimum safety factors specified for the critical cross section of the embankment.

2.0 SITE CONDITIONS

The Basin is located at Powerton Station in Pekin, Illinois situated northeast of the main power building, south of the Wastewater Building and between the Ash Surge Basin and former Cooling Water Intake Canal, See Figure 1. Measuring 450 feet long and 225 feet wide, approximately 2.3 acres in size, the Basin is lined with a 60-mil high-density polyethylene (HDPE) liner. Gravel access roads are located along the north, east, and west sides.

Based on information provided by station personnel, the Basin was constructed in the late 1970s or early 1980s, and has not undergone significant changes in the geometry. The original operation was designed to receive bottom ash and, twice a year, boiler wash via sluicing with wastewater treated in the wastewater treatment plant. Operation of the basin has changed to also receive bottom ash and fly ash by end dumping into the basin. Wastewater is periodically pumped from the Basin, treated to remove elevated metal concentrations, and discharged into the Ash Surge Basin. The Basin is inspected weekly by the environmental specialist including checking water level in the Basin.

3.0 STRUCTURAL STABILITY ASSESSMENT - SECTION 845.540

The following sections describe the structural stability assessment.

3.1 Stable Foundation and Abutments - 845.450(a)(1)

This assessment indicates the soils forming the Basin foundation are stable. Soils data from within the vicinity of the Basin shows up to 28 feet of clay soils overlying approximately 35 to 40 feet of loose to very dense poorly graded sand and silty sand with some gravel. Soil data developed from soil borings completed for this assessment are consistent with the above soil descriptions.

Inspection of the Basin did not show signs of distress due to settlement of the underlying foundation soils. Furthermore both elastic settlement and primary consolidation settlement of the underlying soils would have occurred soon after construction of the basin in the late 1970s or early 1980s, and the secondary consolidation settlement, which would have been expected to be minimal considering the type of soils and associated loading, would also have occurred. Without significant changes in the operation of the Basin that would significantly increase loading on the foundation material, there should be no significant settlement of the foundation soils.

The Basin is partially incised and supported by earthen embankment on the west. This type of basin constructed with earthen berms does not require abutments, and therefore consideration of abutment design, construction, and operation is not required.

3.2 Adequate Slope Protection - 845.450(a)(2)

The Basin is constructed with a 60-mil HDPE liner that provides adequate protection of the interior slopes against surface erosion, wave action, and adverse effects of sudden drawdown.

3.3 Dike Compaction - 845.450(a)(3)

As-built construction documents for the Basin are unavailable. It would be standard practice for the dikes to be mechanically compacted to a density sufficient to withstand the range of loading conditions in the Basin. This is supported by the consideration that the Basin has been in operation since the 1980s, and that the station has no record of observed distress or repair. Furthermore, the initial inspection of the dike did not shows signs of distress that would be indicative of improperly placed and/or loosely compacted soils.

3.4 Downstream Slope Protection - 845.450(a)(4)

Consistent with Section 845.430, the Basin slope protection consists of vegetative cover over the downstream slopes and pertinent surrounding areas. Inspection shows the grassy vegetation is well maintained; protective against surface erosion, wave action, and adverse effect of rapid drawdown; easily observable and accessible; and free of woody vegetation. At the time of inspection, the vegetation did not exceed 12 inches in height.

3.5 Spillway - 845.450(a)(5)

Section 845.450 specifies a single spillway or a combination of spillways configured as specified in subsection (a)(5)(A) and that the combined capacity of all spillways must be designed, constructed, operated, and maintained to adequately manage flow during and following the peak discharge from the event specified in subsection (a)(5)(B). Our inspection shows the Basin was designed and has been operated without an emergency spillway.

Although the Basin has been designed, constructed and operated for more than forty years without an emergency spillway, and the basin is inspected weekly by the environmental specialst with the intent to maintain the water level no higher than the weir elevation, not having an emergency spillway is considered a deficiency in accordance with the Section 845.450(a)(5).

3.6 Structural Integrity Of Hydraulic Structures - 845.450(a)(6)

A hydraulic structure, 24-inch pipe, passes through the dike between the north, incised end of the Basin and the Basin Discharge Sump. At the time of our inspection, the water level in the Basin was over the top of the pipe and a thorough inspection could not be conducted. Evidence showing the structural integrity of the pipe free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris could not be made. At the time of this report, inspection report for the pipe were unavailable.

3.7 Down Stream Slopes Adjacent To Water Bodies - 845.450(a)(7)

The former Cooling Water Intake is downstream of the Basin and a stability analysis was performed for both a low pool and rapid draw down condition. Stability analysis shows that the embankment is designed and constructed to maintain stability during both low pool and rapid draw down conditions.

3.8 Structural Stability Assessment Deficiencies

Structural deficiencies associated with the Basin were identified in the initial structural stability assessment, and the following corrective actions are required:

1) The Basin has been designed, constructed, and operated for more than forty years without an emergency spillway. Furthermore the basin is inspected weekly by the environmental specialist, who observes the water level in the pond with the intent to maintain the water level no higher than the weir elevation (approximately 658.0 mean sea level). Although the basin is out of compliance with Section 845.450, the probability of storm water over flowing the basin dike is low.

2) The 24-inch diameter pipe between Basin and the Discharge Sump could not be inspected for signs of distress at the time of inspection. Although our inspection did not identify distress that would suggest the existence of a structural deficiency, the 24-inch diameter pipe should be inspected in accordance with 845.450(a)(6).

3.9 Annual Inspection Requirement

In completing the structural stability assessment, the Basin was inspected for signs of distress that would have the potential to disrupt operation and safety. This inspection can suffice for the 2021 inspection.

4.0 SAFETY FACTOR ASSESSMENT - SECTION 845.460

In accordance with Section 845.460, the owner or operator of a CCR surface impoundment must conduct initial and annual safety factor assessments for each CCR surface impoundment and document whether the calculated factors of safety for each CCR surface impoundment achieve the minimum safety factors specified for the critical cross section of the embankment. The critical cross section is the cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments must be supported by appropriate engineering calculations.

4.1 Slope Stability Methodology

Slope stability software Slide2 was used to calculate the minimum factor of safety (FS) at Cross Section A-A. The program uses 2D limit equilibrium methods to determine the minimum FS against slope instability. The auto-refine, non-circular search method with optimization was used utilizing Spencer's method to calculate the FS for each design criteria scenario, as discussed below. For each section analyzed, the program searches for the sliding surface that procures the lowest FS which is defined as the ratio of the shear forces and moment resisting movement along the sliding surface to the forces and moments driving the instability.

Soil data obtained by CEC and supplemented with available soil information provided by the Station was used to develop soil properties for the slope stability analysis. The soil properties were confirmed and modified using the subsurface data obtained by CEC in 2021. The data shows the soil materials in the vicinity of the Basin consists of up to 28 feet of clay soils overlying approximately 35 to 40 feet of loose to very dense, poorly graded sand and silty sand with some gravel.

4.2 Slope Stability Analysis - 845.460

Four cases were analyzed to satisfy the safety factor assessment as per Section 845.460(a)(2) through (a)(4).

4.2.1 Static, Long-Term - 845.460(a)(2)

The static, long-term condition with the maximum surcharge loading on the embankment was evaluated. The static, long-term analysis included a pool elevation at 458 feet mean sea level and a groundwater elevation at 440 feet mean sea level.

4.2.2 Static, Maximum Storage Pool - 845.460(a)(3)

The static, long-term, maximum storage pool condition with the maximum surcharge loading on the embankment was evaluated. The static, long-term analysis included a pool elevation set at the lowest points of the embankment crest, 466 feet mean sea level, and a groundwater elevation at 440 feet mean sea level.

4.2.3 Seismic - 845.460(a)(4)

Seismic analysis was performed by incorporating pseudo static seismic loading scenarios in the long-term global stability analysis calculations. A pseudo-static seismic horizontal load was applied to the long-term maximum storage pool loading condition model.

The seismic factor of safety is defined in the proposed CCR regulations as "the factor of safety (safety factor) determined using analysis under earthquake conditions 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 2,500 years, based on the U.S. Geological Survey (USGS) seismic hazard maps for seismic events with this return period for the region where the CCR surface impoundment is located".

4.2.4 Liquefaction - 845.460(a)(5)

For dikes constructed of soils susceptible to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20. Soils with potential for liquefaction typically consist of poorly drained fine-grained soils. Soil borings indicate that the embankment for the Basin was constructed with a well-graded, well-drained sand with silt and gravel material, which is not typically susceptible to liquefaction. Additionally, the geomembrane liner system makes it unlikely the embankment would become saturated or inundated. Because the likelihood of liquefaction and associated shear strength loss of the embankment soils is very low, the liquefaction condition is represented by the static factor of safety analysis and a separate analyses was not performed.

4.3 Factor of Safety Assessment Results

Results of the slope stability analysis for the critical cross section of the Basin are summarized in Table 1, below, and presented in Figures 2, 3, and 4. The results meet the factor of safety requirements presented in 845.460(a)(2) through (4).

Table 1: Safety Factor Results

Loading Condition	Required FS	Calculated FS
Static, Long Term - 845.460(a)(2)	1.50	1.50
Static, Maximum Storage Pool - 845.460(a)(3)	1.40	1.50
Seismic - 845.460(a)(4)	1.00	1.28
Liquefaction - 845.460(a)(5)	1.20	>1.20

5.0 LIMITATIONS AND CERTIFICATION

This Initial Structural Stability and Factor of Safety Assessment was prepared to meet the requirements of Parts 845.450 and 845.460 of draft Title 35 Subtitle G Subchapter I Subchapter j Coal Combustion Waste Surface Impoundments, and was prepared under the direction of Mr. M. Dean Jones, P.E.

By affixing my seal to this, I do hereby certify to the best of my knowledge, information, and belief that the information contained in this report is true and correct. I further certify I am licensed to practice in the State of Illinois and that it is within my professional expertise to verify the correctness of the information. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment.

Seal:

Signature: ______________________

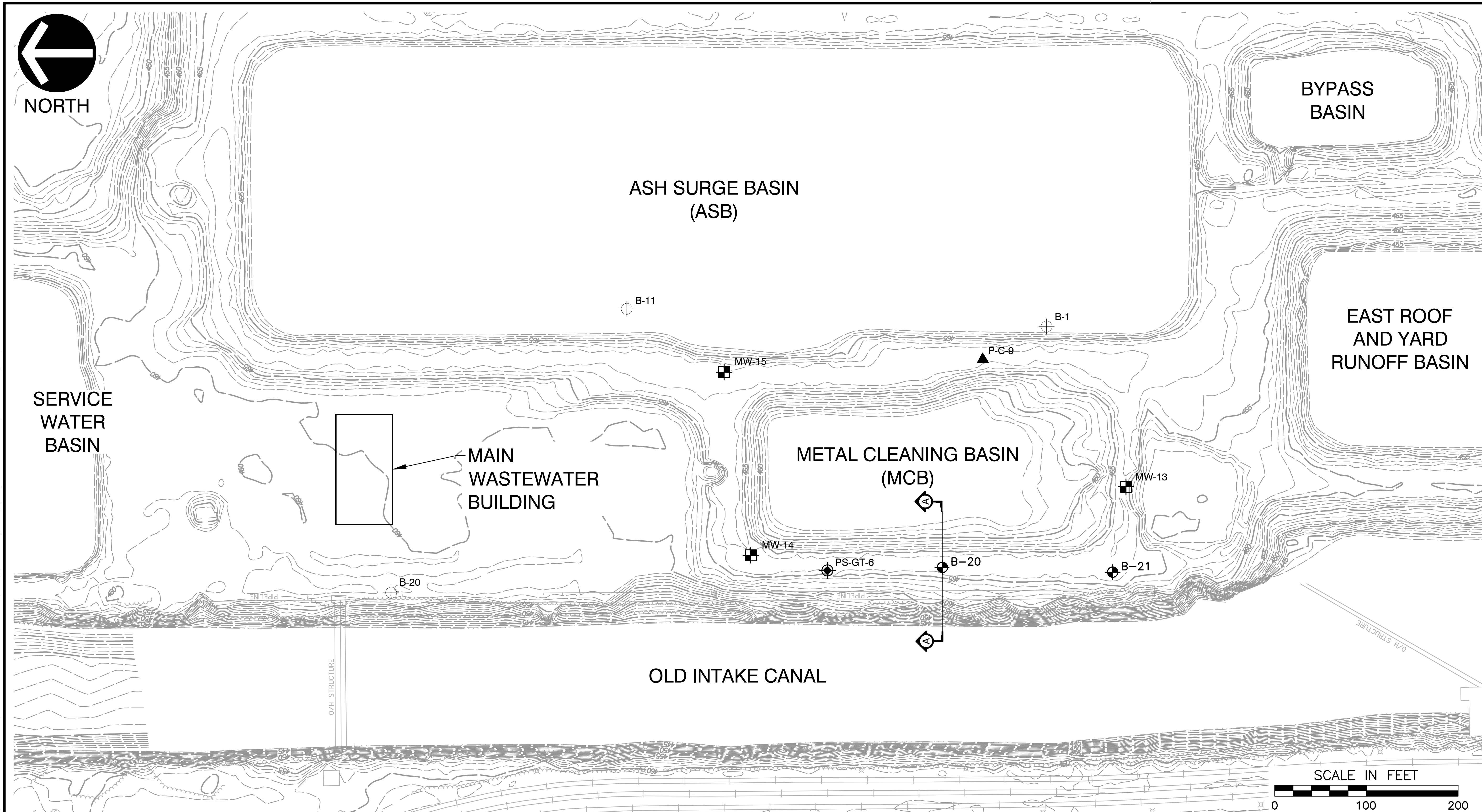
Name: M. Dean Jones, P.E.

Date of Certification: June 8, 2021

Illinois Professional Engineer No.: 062-051317

Expiration Date: November 30, 2021

FIGURES



REFERENCE

1. TOPOGRAPHIC INFORMATION SOUTH OF SECONDARY ASH SETTLING BASIN AND FAB IS BASED ON AERIAL SURVEY PERFORMED BY AEROMETRIC, INC. DATED JUNE 19, 2008. TOPOGRAPHIC INFORMATION NORTH OF ASH SURGE BASIN IS BASED ON SURVEY BY RIDGELINE CONSULTANTS, PERFORMED IN FEBRUARY AND MARCH, 2016.

LEGEND

- B-1 — APPROXIMATE SOIL BORING LOCATION (1978)
- P-C-9 — APPROXIMATE CPT SOUNDING LOCATION (GEOSYNTEC, 2016)
- B-21 — SOIL BORING LOCATION (2021)
- PS-GT-6 — APPROXIMATE SOIL BORING LOCATION (KPRG, 2005)
- MW-13 — APPROXIMATE EXISTING MONITORING WELL LOCATION (PATRICK, 2011)
- A — A — SLOPE STABILITY CROSS SECTION

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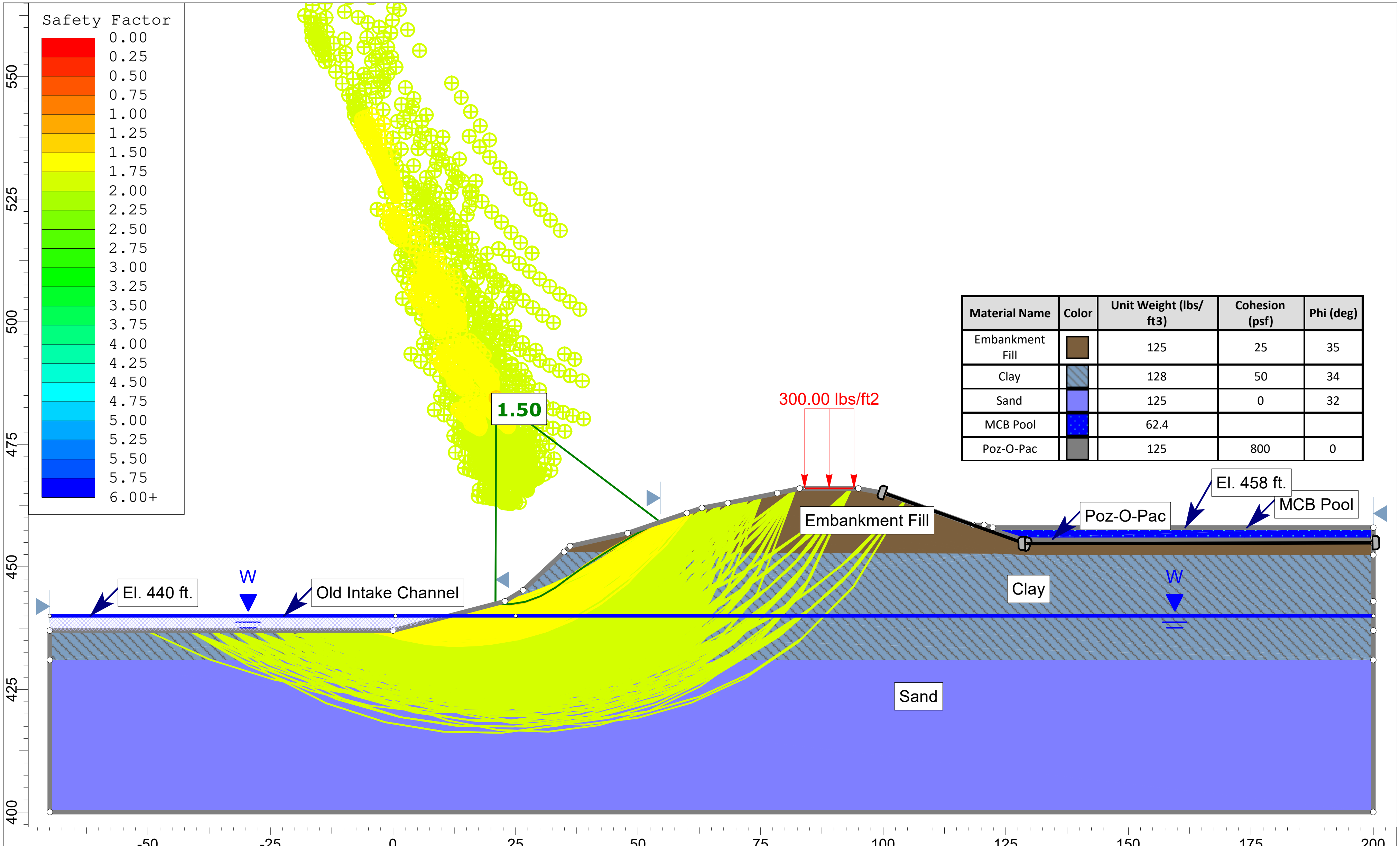
METAL CLEANING BASIN SLOPE STABILITY
PEKIN, TAZEWELL COUNTY, ILLINOIS

SITE PLAN WITH CROSS-SECTION

DRAWN BY: CAC	CHECKED BY: MDB	APPROVED BY: MDJ	FIGURE NO.:
DATE: 05/13/2021	DWG SCALE: 1"=60'	PROJECT NO: 310-533	1



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Embankment Fill		125	25	35
Clay		128	50	34
Sand		125	0	32
MCB Pool		62.4		
Poz-O-Pac		125	800	0

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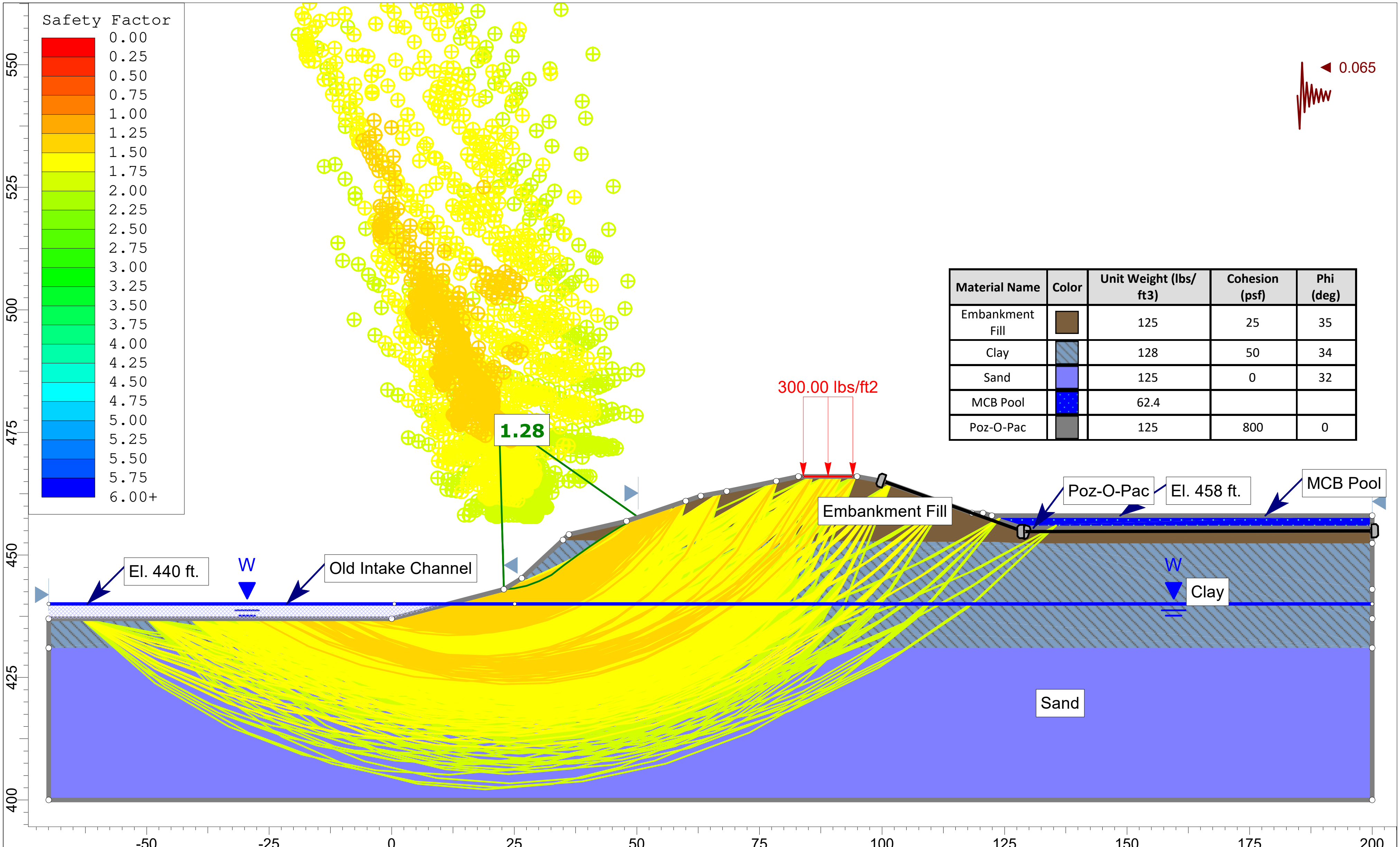
Project	**Metal Cleaning Basin Slope Stability Analysis**				
Analysis Spencer		*Scale:* 1:325		*Scenario* Figure 2: Long-Term; Maximum Storage - Static	
Drawn By CAC	*Checked By:* MDJ		*Approved By:* MDJ	*Company* Civil & Environmental Consultants, Inc.	
Date 05/06/2021	*Date:* 05/19/2021		*Date:* 05/19/2021	*File Name* 310-533 MCB Slope Stability-long term.slmd	



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Embankment Fill		125	25	35
Clay		128	50	34
Sand		125	0	32
MCB Pool		62.4		
Poz-O-Pac		125	800	0

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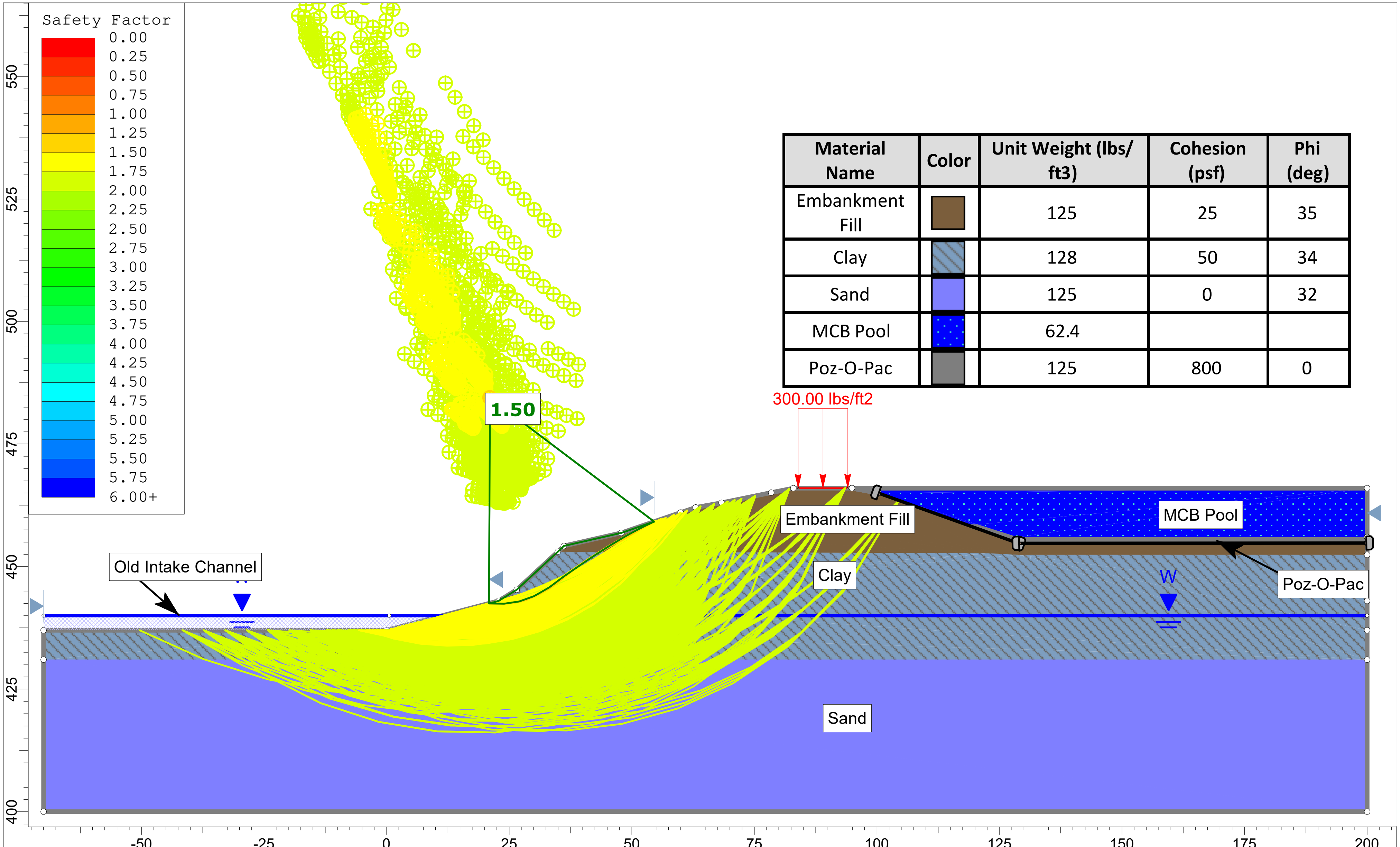
Civil & Environmental Consultants, Inc.

SLIDEINTERPRET 9.009

Project	**Metal Cleaning Basin Slope Stability Analysis**				
Analysis	Spencer	*Scale:*	1:325	*Scenario*	Figure 3: Long-Term; Maximum Storage - Seismic
Drawn By	CAC	*Checked By:* MDJ	*Approved By:* MDJ	*Company*	Civil & Environmental Consultants, Inc.
Date	05/06/2021	*Date:* 05/19/2021	*Date:* 05/19/2021	*File Name*	310-533 MCB Slope Stability-long term.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Embankment Fill		125	25	35
Clay		128	50	34
Sand		125	0	32
MCB Pool		62.4		
Poz-O-Pac		125	800	0

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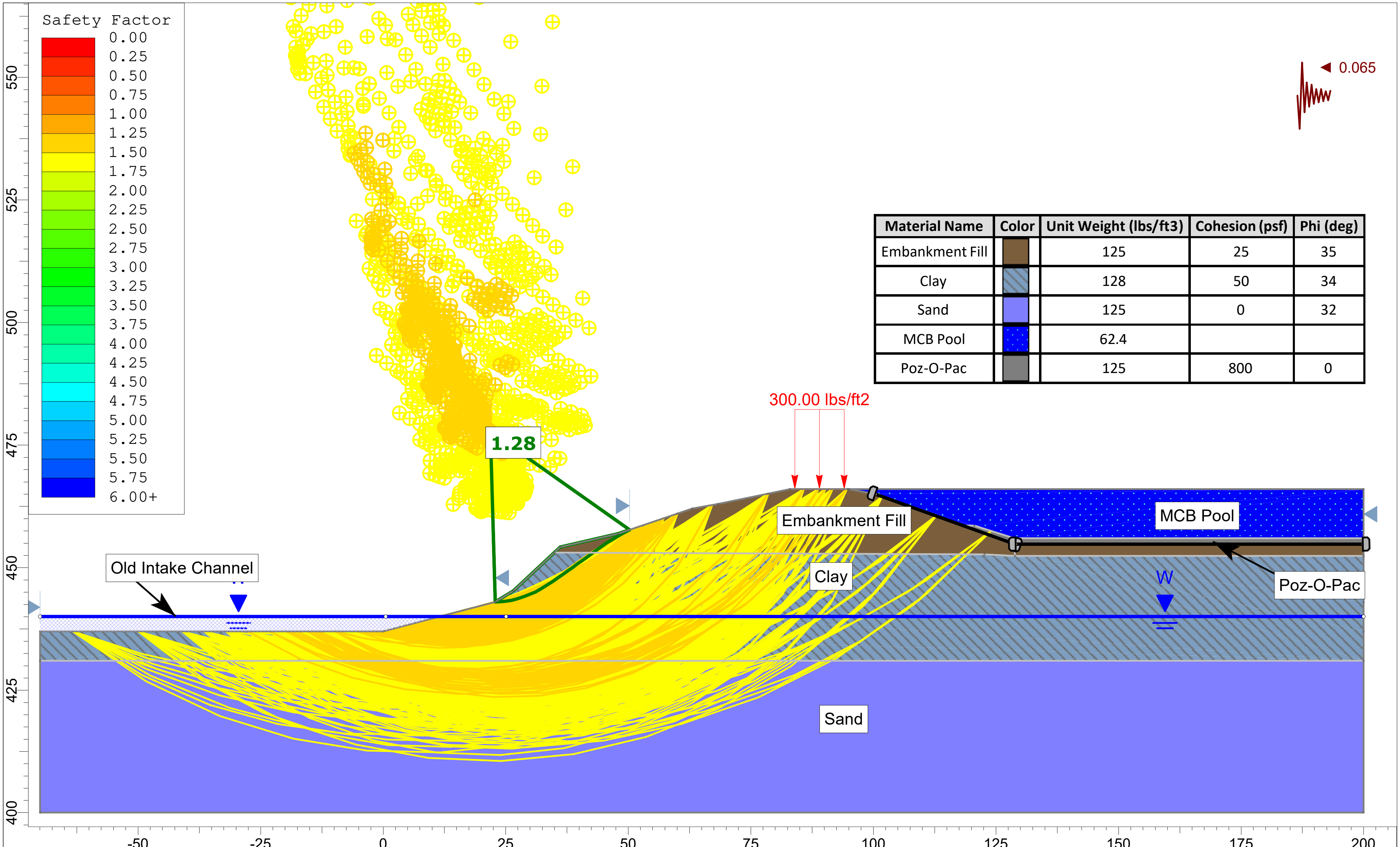
Project

Metal Cleaning Basin Slope Stability Analysis

Analysis Spencer	*Scale:* 1:325		*Scenario* Figure 4: Long-Term; Maximum Surcharge Pool - Static
Drawn By CAC	*Checked By:* MDJ	*Approved By:* MDJ	*Company* Civil & Environmental Consultants, Inc.
Date 05/06/2021	*Date:* 05/19/2021	*Date:* 05/19/2021	*File Name* 310-533 MCB Slope Stability-long term.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Embankment Fill		125	25	35
Clay		128	50	34
Sand		125	0	32
MCB Pool		62.4		
Poz-O-Pac		125	800	0

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Project
Metal Cleaning Basin Slope Stability Analysis

Analysis Spencer		*Scale:* 1:325		*Scenario* Figure 5: Long-Term; Maximum Surcharge Pool - Seismic	
Drawn By CAC	*Checked By:* MDJ		*Approved By:* MDJ	*Company* Civil & Environmental Consultants, Inc.	
Date 05/06/2021	*Date:* 05/19/2021		*Date:* 05/19/2021	*File Name* 310-533 MCB Slope Stability-long term.slmd	