FINAL

Coal Combustion Residue Impoundment
Round 12 - Dam Assessment Report

Big Brown Steam Electric Station
Bottom Ash Pond
Fairfield, Texas
Luminant Generation Co., LLC

Prepared for:

United States Environmental Protection Agency
Office of Resource Conservation and Recovery

Prepared by:

Dewberry Consultants LLC
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INTRODUCTION, SUMMARY CONCLUSIONS AND RECOMMENDATIONS

The release of over five million cubic yards of coal combustion residue from the Tennessee Valley Authority's Kingston, Tennessee facility in December 2008, which flooded more than 300 acres of land and damaged homes and property, is a wake-up call for diligence on coal combustion residue disposal units. A first step toward this goal is to assess the stability and functionality of the ash impoundments and other units, then quickly take any needed corrective measures.

This assessment of the stability and functionality of the Big Brown Steam Electric Station Bottom Ash Pond impoundment dikes is based on a review of available documents and on the site assessment conducted by Dewberry personnel on September 26, 2012. We found the supporting technical documentation adequate (Section 1.1.3). Subsequent to the submittal of Dewberry's Draft report, Luminant provided the Ash Pond Slope Stability Investigation Report conducted by Golder Associates.
Based on the new information, the Big Brown Steam Electric Station Bottom Ash Pond management unit is **SATISFACTORY** for continued safe and reliable operation.

PURPOSE AND SCOPE

The U.S. Environmental Protection Agency (EPA) is investigating the potential for catastrophic failure of Coal Combustion Surface Impoundments (i.e., management unit) from occurring at electric utilities in an effort to protect lives and property from the consequences of a dam failure or the improper release of impounded slurry. The EPA initiative is intended to identify conditions that may adversely affect the structural stability and functionality of a management unit and its appurtenant structures (if present); to note the extent of deterioration (if present), status of maintenance and/or a need for immediate repair; to evaluate conformity with current design and construction practices; and to determine the hazard potential classification for units not currently classified by the management unit owner or by a state or federal agency. The initiative will address management units that are classified as having a Less-than-Low, Low, Significant, or High Hazard Potential ranking (for Classification, see pp. 3-8 of the 2004 Federal Guidelines for Dam Safety).

In early 2009, the EPA sent letters to coal-fired electric utilities seeking information on the safety of surface impoundments and similar facilities that receive liquid-borne material that store or dispose of coal combustion residue. This letter was issued under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 104(e), to assist the Agency in assessing the structural stability and functionality of such management units, including which facilities should be visited to perform a safety assessment of the berms, dikes, and dams used in the construction of these impoundments.

EPA requested that utility companies identify all management units including surface impoundments or similar diked or bermed management units or management units designated as landfills that receive liquid-borne material used for the storage or disposal of residuals or by-products from the combustion of coal, including, but not limited to, fly ash, bottom ash, boiler slag, or flue gas emission control residuals. Utility companies provided information on the size, design, age and the amount of material placed in the units.

The purpose of this report is **to evaluate the condition and potential of residue release from management units and to determine the hazard potential classification**. This evaluation included a site visit. Prior to conducting the site visit, a two-person team reviewed the information submitted to EPA, reviewed any relevant publicly available information from state or federal agencies regarding the unit hazard potential classification (if any) and accepted information provided via telephone communication with the management unit owner.

This report presents the opinion of the assessment team as to the potential of catastrophic failure and reports on the condition of the management unit(s).

Note: The terms "embankment", "berm", "dike" and "dam" are used interchangeably within this report, as are the terms "pond", "basin", and "impoundment".

LIMITATIONS

The assessment of dam safety reported herein is based on field observations and review of readily available information provided by the owner/operator of the subject coal combustion residue management unit(s). Qualified Dewberry engineering personnel performed the field observations and review and made the assessment in conformance with the required scope of work and in accordance with reasonable and acceptable engineering practices. No other warranty, either written or implied, is made with regard to our assessment of dam safety.

FINAL

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1.0 CONCLUSIONS AND RECOMMENDATIONS

1.1 CONCLUSIONS

Conclusions are based on visual observations from a one-day site visit, September 26, 2012, and review of technical documentation provided by the Luminant.

1.1.1 Conclusions Regarding the Structural Soundness of the Management Unit(s)

The dike embankments appear to be structurally sound based on Dewberry engineers' observations during the site visit. However, documentation of slope stability Factors of Safety under static and seismic conditions for the Bottom Ash Pond was not provided for review. Subsequent to Dewberry's Draft submittal Golder Associates completed the Ash Pond slope stability analyses (See Doc 08 in Appendix C). Based on the new documentation of slope stability factors of safety, the embankments are rated SATISFACTORY for structural soundness.

1.1.2 Conclusions Regarding the Hydrologic/Hydraulic Safety of the Management Unit

Documentation of the hydrologic and hydraulic safety was not provided to Dewberry for review. However, since the pond only receives ash sluice water at a controlled rate and direct rainfall, the safety of the pond can be determined without an extensive hydrologic analysis. The normal pool elevation of the Bottom Ash Pond is managed to a relatively constant +347 feet, providing a 3-ft. freeboard. Dewberry examined the 100-year rainfall event and compared the data with the available freeboard. The freeboard should be adequate to contain the one-percent probability, 24-hour precipitation event (10.6 inches) without overtopping the impoundment embankments.

Based on the information reviewed the management unit is rated SATISFACTORY for hydrologic and hydraulic safety.

1.1.3 Conclusions Regarding the Adequacy of Supporting Technical Documentation

The supporting technical documentation is adequate although no documentation for the hydrologic and hydraulic safety analyses was provided to Dewberry for review.

1.1.4 Conclusions Regarding the Description of the Management Unit(s)

The description of the management unit provided by the owner was an accurate representation of what Dewberry observed in the field.

1.1.5 Conclusions Regarding the Field Observations

Dewberry staff was provided access to all areas in the vicinity of the management unit required to conduct a thorough field observation. The visible parts of the embankments were observed to have no signs of overstress, significant settlement, shear failure, or other signs of instability. Embankments appear structurally sound. There are no apparent indications of unsafe conditions or conditions needing remedial action.

The Bottom Ash Pond does not have an outlet spillway. After the bottom ash is collected at the dewatering bins, the transport water is returned to the two-celled Bottom Ash Pond at the east end of the impoundment. Water, from sluice water and precipitation, is removed using a 42-in. diameter pipe through the west end of each cell. The discharge pipes lead to below grade control valves which are used to recycle water back through the plant.

1.1.6 Conclusions Regarding the Adequacy of Maintenance and Methods of Operation

The Bottom Ash Pond appears to be well maintained with no outstanding issues.

1.1.7 Conclusions Regarding the Adequacy of the Surveillance and Monitoring Program

The Bottom Ash Pond monitoring program consists of reading groundwater levels, and collecting samples for water quality testing from the piezometers installed near the toe of the embankments. Piezometer readings are taken on a semi-annual basis.

The surveillance program consists of weekly inspections with results recorded on site checklists, and formal annual inspections documented with formal written report.

1.1.8 Classification Regarding Suitability for Continued Safe and Reliable Operation

The Bottom Ash Pond Cell impoundment embankments are rated SATISFACTORY for continued safe and reliable operation.

1.2 RECOMMENDATIONS

1.2.1 Recommendations Regarding Structural Stability

Based on the new report (Ash Pond Slope Stability Investigation Report, See Doc 08 in Appendix C) no recommendations are warranted regarding structural stability.

1.2.2 Recommendations Regarding the Supporting Technical Documentation

Since Dewberry issuance of the Draft Report Luminant submitted additional documentation, see Doc 08 in Appendix C. The supporting technical documentation is adequate.

1.2.3 Recommendations Regarding Continued Safe and Reliable Operation

No recommendations for continued safe and reliable operation of the management unit are warranted at this time.

1.3 PARTICIPANTS AND ACKNOWLEDGEMENT

1.3.1 List of Participants

Eric Chavers, Big Brown Steam Electric Station
Joe Hubbert, Big Brown Steam Electric Station
Phillip Street, Big Brown Steam Electric Station
Jeffrey White, Big Brown Steam Electric Station
Gary Spicer, Luminant
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Mark Kelly, Luminant
Patrick Kelly, US EPA Washington, D.C.
Golam Mustafa, US EPA Regions 6
Joseph P. Klein, III, P.E., Dewberry
Michael McLaren, P.E., Dewberry

1.3.2 Acknowledgement and Signature

We acknowledge that the management unit referenced herein has been assessed on August 20, 2012.

Joseph P. Klein, III, P.E.

MICHAEL J. McLAREN
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Michael McLaren, P.E.

2.0 DESCRIPTION OF THE COAL COMBUSTION RESIDUE MANAGEMENT UNIT(S)

2.1 LOCATION AND GENERAL DESCRIPTION

The Big Brown Steam Electric Station (Big Brown SES) is located on Texas Farm to Market (FM) Route 2570 about 10 miles northeast of Fairfield, Freestone County, Texas. Fairfield is about 140 miles northwest of Houston, Texas. The coordinates of the plant site are 31.8218° N and 96.0610° W. The site abuts the northeast corner of Fairfield reservoir, which was constructed to provide cooling water for the plant.

The Bottom Ash Pond is a single diked impoundment divided into two cells by an interior divider dike. The impoundment is about 1,400 feet long by about 600 feet wide. The long axis is oriented in the east-west direction. The impoundment is divided into two approximately equal cells, designated the North and South Ash Ponds. The cells are separated by an engineered divider dike that was part of the original facility constructions. Figure 2.1a depicts a vicinity map around the Big Brown SES. Figure 2.1b depicts an aerial view of the Big Brown SES and the CCR impoundment. Table 2.1 presents size information about the active disposal areas.

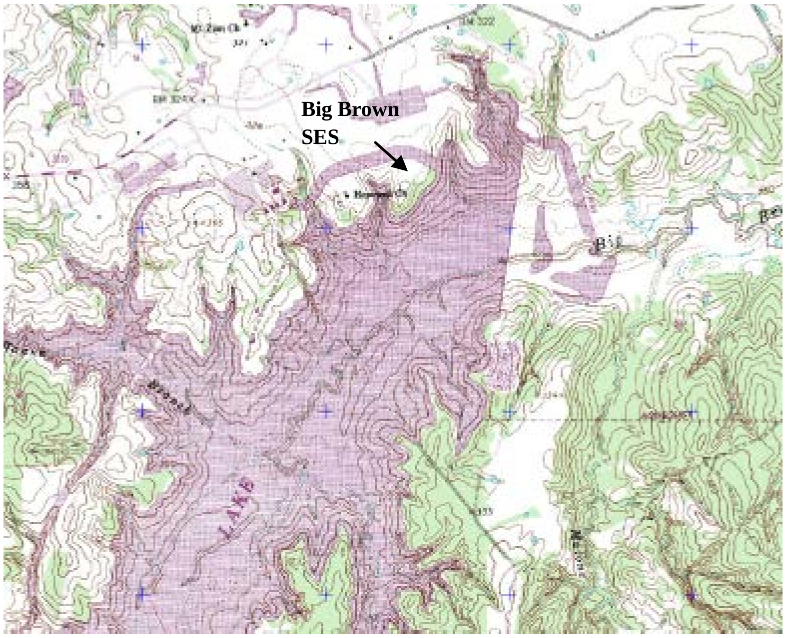

Figure 2.1 a: Big Brown SES Plant Vicinity Map

Figure 2.1 b: Big Brown SES and Bottom Ash Impoundment Locations

Table 2.1: Summary of Dam Dimensions and Size[1]	
	Bottom Ash Pond
Dam Height (ft)	25
Crest Width (ft)	25
Length (ft)	4,000
Side Slopes (upstream) H:V	2.5:1
Side Slopes (downstream) H:V	2.0:1 to 2.2:1 varies by location

[1] Dimensions based on design drawings prepared by Luminant (See Appendix A – Doc 01)

2.2 COAL COMBUSTION RESIDUE HANDLING

2.2.1 Fly Ash

Information provided by Luminant indicates that fly ash is handled dry for off-site beneficial reuse or land disposal.

2.2.2 Bottom Ash

Bottom ash is sluiced to bins and dewatered. After dewatering, bottom ash is transported offsite for beneficial re-use or land disposal as solid waste. (Photograph 2.2.2-1).

Photograph 2.2.2-1: Ash sluice water return pipes from dewatering bins to Bottom Ash Pond

2.2.3 Boiler Slag

Boiler slag is handled with the bottom ash.

2.2.4 Flue Gas Desulfurization Sludge

No scrubbers are used in this plant so there is no flue gas desulfurization (FGD) process or related waste products to be discharged.

2.3 SIZE AND HAZARD CLASSIFICATION

Based on the size of the Bottom Ash Pond embankment height and impoundment storage capacity, the impoundment would be classified as Small by US Army Corps of Engineers (USACE) criteria.

Table 2.2a: USACE ER 1110-2-106
Size Classification

Category	**Impoundment Storage (Ac-ft)**	**Height (ft)**
Small	50 and < 1,000	25 and < 40
Intermediate	1,000 and < 50,000	40 and < 100
Large	> 50,000	> 100

Federal guidelines for dam safety hazard classification use two criteria: potential loss of human life and economic, environmental and lifeline losses. Per the Federal Guidelines for Dam Safety dated April 2004, a Significant Hazard Potential classification applies to those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant Hazard Potential dams are often located in agricultural areas.

Luminant representatives reported that the company owns most of the property in the vicinity of the plant, including the lake and dam. Land near the south end of the lake operated as a State Park is owned by Luminant and leased to the State of Texas for a nominal amount. Failure or misoperation of the impoundment is not expected to result in a probable loss of human life, and the economic and environmental looses are expected to be contained on the owner's property. Therefore, a Federal Hazard Classification of **LOW** is appropriate for these facilities.

Table 2.2b: FEMA Federal Guidelines for Dam Safety Hazard Classification

Classification	**Loss of Human Life**	**Economic or Environmental Damage**
Low	None Expected	Low and generally limited to owner site
Significant	None Expected	Yes
High	Probable. One or more expected	Yes (but not necessary for classification)

2.4 AMOUNT AND TYPE OF RESIDUALS CURRENTLY CONTAINED IN THE UNIT(S) AND MAXIMUM CAPACITY

The Bottom Ash Pond generally only receives sluiced bottom ash and direct precipitation.

	Bottom Ash Pond
Surface Area (acre)	19.3
Current Storage Capacity (cubic yards)	110,352
Current Storage Capacity (acre-feet)	68.4
Total Storage Capacity (cubic yards)	367,840
Total Storage Capacity (acre-feet)	228
Crest Elevation (feet)	+350.0
Normal Pond Level (feet)	+347.0

2.5 PRINCIPAL PROJECT STRUCTURES

2.5.1 Earth Embankment

The embankments consist of compacted earth fill with a 3-ft. thick compacted clay liner on the inside slope. Geotextile erosion control fabric has been installed along the inside slope to mitigate the impacts of wind driven wave action.

The exterior slopes are vegetated with various grasses and small weeds. The slopes are free of trees, tall bushes, or other vegetation potentially deleterious to slope stability.

2.5.2 Outlet Structures

Sluice water in each Bottom Ash Pond cell drains to the west portion of the cell. A concrete pipe drop inlet riser allows decant water into a reinforced concrete discharge pipe that passes through the west embankment to a valve control pit. The discharge pipe diameters are 30-in. at the north cell and 42-in. at the south cell. The inlet elevation of the decant risers is +342.7 ft.

There are no other outlets from the Bottom Ash Pond.

2.6 CRITICAL INFRASTRUCTURE WITHIN FIVE MILES DOWN GRADIENT

The Big Brown SES is located near the northeast corner of Fairfield Lake, about 10 miles northeast of Fairfield Texas. Area topographic conditions are shown on Figure 2.6-1. Observations of the area around the plant site and nearby roads did not identify critical infrastructure within 5 miles of the plant other than the electric transmission lines from the plant.

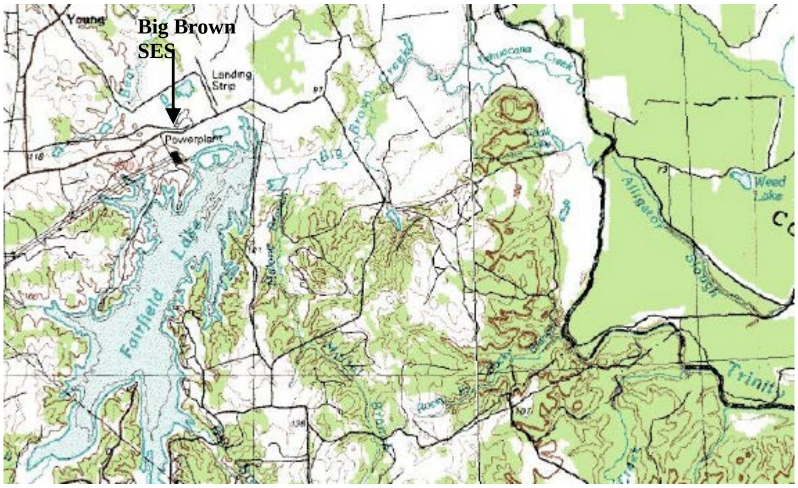

Figure 2.6-1: Bottom Ash Pond Area Topography

3.0 SUMMARY OF RELEVANT REPORTS, PERMITS, AND INCIDENTS

3.1 SUMMARY OF REPORTS ON THE SAFETY OF THE MANAGEMENT UNITS

Luminant provided representative 2012 weekly inspection reports prepared by plant personnel for the Bottom Ash Pond. The inspection reports focus on the Bottom Ash Pond pool elevation, and observations of the embankments. No issues were identified in the reports provided which covered inspections for September 6, 2012 and September 11, 2012 (See Appendix A – Doc 2).

Luminant also provided the 2011annual inspection report prepared by Luminant technical staff, and the 2012 annual inspection report prepared by HDR Engineering, Inc. Findings of the 2011 inspections were generally minor issues related to erosion from recent rains, vegetation maintenance, and animal scrapings disturbing areas of the embankment slopes (See Appendix A – Doc 3).

The 2012 annual inspection report indicates the inspection was conducted shortly after several day of rain of about 1.2 in. fell at the plant. Findings of the 2012 report were generally minor issues related to erosion rills, animal burrows, areas of standing water near the toe of the slope, tire ruts on the embankment crest, and vegetation maintenance (See Appendix A – Docs 3 and 4).

3.2 SUMMARY OF LOCAL, STATE, AND FEDERAL ENVIRONMENTAL PERMITS

The Texas Commission on Environmental Quality has issued a Texas Pollutant Discharge Elimination System Permit. Permit No. WQ0001309000 was issued April 18, 2007 (See Appendix A – Doc 05). The permit expired February 1, 2012. Luminant submitted an application for renewal which is still being reviewed by the State.

3.3 SUMMARY OF SPILL/RELEASE INCIDENTS

No recent documented spills or releases have been reported for the Bottom Ash Pond.

4.0 SUMMARY OF HISTORY OF CONSTRUCTION AND OPERATION

4.1 SUMMARY OF CONSTRUCTION HISTORY

4.1.1 Original Construction

Based on construction drawings provided to Dewberry for review, the Bottom Ash Pond was designed and constructed in 1989. Dimensions of the Bottom Ash Pond are about 1,600 feet at the base along the east-west axis, and 600 feet along the north-south axis (See Appendix A – Doc. 1). The pond is divided into north and south cells by an interior divided dike.

The dikes were constructed of compacted soil fill excavated from within the pond plan area.

Discharge from each of the two cells in the Bottom Ash Pond is through a pipe to a valve pit located near the toe of the west embankment. Valves in the pit control flow back to the plant for recycling. There are no other outlets from the Bottom Ash Pond (See Appendix A – Doc 01). In an emergency, portable pumps would be deployed to pump water from the impoundment into the nearby plant cooling water discharge canal.

Each cell receives sluiced bottom ash and boiler slag through dedicated pipes. In the event there is a need to transfer liquid between cells, a mobile pump connected to HDPE pipes is used. The HDPE pipes are located at the opposite end of the ponds from the incoming sluice pipes.

4.1.2 Significant Changes/Modifications in Design since Original Construction

Drawings provided to Dewberry during the site visit indicate the embankment design was modified in 1999 to include a 3-ft. thick compacted clay liner along the interior side of the embankments and the impoundment bottom. Drawing General Notes specify that the clay liners shall have a permeability of $1\text{x}10^{-7}$ cm/sec.

The 1999 design also modified the discharge pipe from the south cell by replacing the original 30-in. diameter concrete pipe with a 42-in. diameter concrete pipe. Other modifications included adjustments to the outfall access bridges, and sluice pipe support structures to accommodate the addition of the 3-ft. thick liner.

4.1.3 Significant Repairs/Rehabilitation since Original Construction

No significant repairs or rehabilitation have been made to the Bottom Ash Pond other than the 1999 design changes.

4.2 SUMMARY OF OPERATIONAL PROCEDURES

4.2.1 Original Operational Procedures

Bottom ash from coal combustion is sluiced to dewatering bins. Bottom ash sluice water flows to the Bottom Ash Pond. The bottom ash from the de-watering bins is transported off-site for beneficial re-use or land disposal as solid waste (See Appendix A – Doc. 06).

The Bottom Ash Pond may also receive metal-cleaning wastes, and waste water treatment wastes. However, fly ash is normally managed dry and transported off-site for beneficial reuse or land disposal as solid waste.

Big Brown SES does not have scrubbers.

4.2.2 Significant Changes in Operational Procedures and Original Startup

Based on information provided to Dewberry during the site visit, no significant change in operational procedures have been made since the 1999 design upgrades were completed.

4.2.3 Current Operational Procedures

Based on observations made during the Dewberry site visit current operations are substantively the same as described in the original operational procedures.

4.2.4 Other Notable Events since Original Startup

No notable events were reported to Dewberry during our site visit.

5.0 FIELD OBSERVATIONS

5.1 PROJECT OVERVIEW AND SIGNIFICANT FINDINGS

Dewberry personnel Michael McLaren, P.E., and Joseph P. Klein, III, P.E. conducted a site visit on September 26, 2012 in company with the participants.

The site visit began at 9:00 AM. The weather was sunny and warm. Photographs were taken of conditions observed. Please refer to the Dam Inspection Checklist in Appendix B for additional information. Selected photographs are included here for ease of visual reference. All pictures were taken by Dewberry personnel during the site visit. Copies of all photographs were provided to Luminant representatives.

The overall visual assessment of the dam slopes was that the dikes are in satisfactory condition and no significant findings were noted.

5.2 BOTTOM ASH POND

5.2.1 Crest

Overall, there were no signs of rutting, depressions, tension cracking, or other indications of settlement or shear failure and the crest appeared to be in satisfactory condition (see Figure 5.2.1-1).

Figure 5.2.1-1 North Dike Crest View West Along Bottom Ash Pond

5.2.2 Upstream/Inside Slope

No scarps, sloughs, depressions, bulging or other indications of slope instability were observed (see Figure 5.2.2-1). Vegetation along the interior slope generally consisted of various types of grass and weeds.

Figure 5.2.2-1 Interior Slope South Embankment

Isolated areas of erosion from wind generated waves were observed on the interior slopes of the east and west embankments. It appears that recent lack of rain has had an adverse impact on vegetation planted to mitigate wave erosion. (See Figure 5.2.2-2)

Figure 5.2.2-2 Area of Interior Slope Erosion – West Embankment

5.2.3 Downstream/Outside Slope and Toe

No scarps, sloughs, depressions, bulging or other indications of slope instability or signs of erosion were observed. Exterior slopes were vegetated with grass, and weeds (See Figure 5.2.3-1).

Figure 5.2.3-1 North Embankment Outside Slope and Toe

The plant cooling water discharge canal passes near the center of the north embankment on its path to the main lake (See Figure 5.2.3-2)

Figure 5.2.3-2 Plant Cooling Water Discharge Canal near Bottom Ash Pond North Embankment

No evidence of seepage was observed in the exterior slopes or along the toe of the embankments.

5.2.4 Abutments and Groin Areas

The Bottom Ash Pond is a fully diked impoundment with no abutments. Groins were found to be in satisfactory condition with no signs of distress (See Figure 5.2.4-1)

Figure 5.2.4-1: Bottom Ash Pond Northeast Groin

5.3 OUTLET STRUCTURES

5.3.1 Overflow Structure

The north and south cells of the Bottom Ash Pond each have an overflow structure. Each overflow structure consists of a concrete pipe riser connected to an outlet conduit. The overflow structure consists of a concrete riser pipe with an inlet elevation of +342.5. The riser diameters are 30-in. and 42-in. in the north and south cells respectively.

Access to the overflow structure is provided by a steel framed bridge (See Figure 5.3.1-1).

Figure 5.3.3-1: Access Bridge to Riser Structure; Bottom Ash Pond South Cell

The pipe along the top of the access bridge is the HDPE pipe that can be connected to a mobile pump for transferring water between pond cells.

5.3.2 Outlet Conduit

The north and south cells of the Bottom Ash Pond each have a concrete pipe through the embankment to a valve chamber near the exterior toe of the embankment. The valves direct the discharge back to the plant for recycling.

The HDPE pipe located in the outlet access bridge was installed to facilitate transferring water between the north and south cells. Temporary, mobile pumps can be connected to the pipes as operational conditions require. Dewberry was informed that transfer of water between cells is not done on a regular basis.

5.3.3 Emergency Spillway

The Bottom Ash Pond does not have an emergency spillway. In the event of an emergency, a temporary, mobile pump would be used to pump water from the impoundment to the plant cooling water discharge canal located to the south.

5.3.4 Low Level Outlet

The Bottom Ash Pond does not have a low level outlet.

6.0 HYDROLOGIC/HYDRAULIC SAFETY

6.1 SUPPORTING TECHNICAL DOCUMENTATION

6.1.1 Flood of Record

No documentation has been provided about the flood of record.

6.1.2 Inflow Design Flood

According to FEMA Federal Guidelines for Dam Safety, the current practice in the design of dams is to use the Inflow Design Flood (IDF) that is deemed appropriate for the hazard potential of the dam and reservoir, and to design spillways and outlet works that are capable of safely accommodating the flood flow without risking the loss of the dam or endangering areas downstream from the dam to flows greater than the inflow. The recommended IDF or spillway design flood for a low hazard, small-sized structure (See section 2.2) in accordance with the USACE Recommended Guidelines for Safety Inspection of Dams ER 1110-2-106 criteria is the 50 to100 year storm (See Table 6.1.2).

Table 6.1.2: USACE Hydrologic Evaluation Guidelines Recommended Spillway Design Floods

Hazard	Size	Spillway Design Flood
Low	Small	50- to 100-year frequency
	Intermediate	100-year to ½ PMF
	Large	½ PMF to PMF
Significant	Small	100-year to ½ PMF
	Intermediate	½ PMF to PMF
	Large	PMF
High	Small	½ PMF to PMF
	Intermediate	PMF
	Large	PMF

No hydrologic and hydraulic documentation was provided to Dewberry for review.

A brief internet search by Dewberry found data from indicating the one percent probability in any given year (100-year storm) 24- hour precipitation in Freestone County, Texas is 10.6 inches (www.onlinemanuals.txdot.gov/txdotmanuals/hyd/p24lkup.xls).

6.1.3 Spillway Rating

The Bottom Ash Pond does not have a spillway discharge. The method of discharge from the impoundment is recirculation pumping from risers and conduits through the embankment of each cell to recycle water to the plant.

6.1.4 Downstream Flood Analysis

No downstream flood analysis was provided.

6.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Supporting documentation from the utility and reviewed by Dewberry is inadequate since no hydrologic and hydraulic safety analyses were provided. However, national rainfall data available to Dewberry is sufficient to determine whether the impoundment is safe from floods and overflows.

6.3 ASSESSMENT OF HYDROLOGIC/HYDRAULIC SAFETY

The crest elevation of the Bottom Ash Pond is a minimum of 8 feet above the adjacent exterior grade. Stormwater into the impoundment is expected to be limited to direct rainfall.

The normal pool elevation of the Bottom Ash Pond is managed to a relatively constant +347 feet, providing a 3-ft. freeboard. The freeboard should be adequate to contain the one-percent probability, 24-hour precipitation event (10.6 inches) without overtopping the impoundment embankments.

7.0 STRUCTURAL STABILITY

7.1 SUPPORTING TECHNICAL DOCUMENTATION

7.1.1 Stability Analyses and Load Cases Analyzed

Subsequent to Dewberry's Draft report submittal, Luminant provided slope stability analyses for the Ash Pond (See Doc 08 in Appendix C).

Slope stability analyses were performed using the commercial slope stability software program, SLIDE Version 6.0. The typical containment dike section has an interior (wet side) slope of 2.5 horizontal to 1 vertical (2.5H:1V) and a minimum exterior (dry side) slope of 2H:1V. The crest elevation of the containment dike is at approximately 350 ft-msl. The ponds are lined with 3 feet of compacted clay. The top of liner elevation on the pond floors is approximately 328 ft-msl. The most critical slope geometry was identified along the west sideslope, consisting of an approximately 24-foot high, 1.7H:1V slope.

Stability analyses were performed for four (4) separate slope sections to assess the various soil conditions and slope geometries around the ponds. Stability analyses considered "empty pond" and "full pond" conditions.

A rapid drawdown scenario was analyzed for one full pond condition at each section. The analysis was completed on the drained or undrained section with the lower factor of safety in the full condition. The analysis was completed using the B-bar method to simulate the effects of rapid drawdown in a low permeability material such as the sandy clays and clayey sands encountered at Big Brown. The initial water level was modeled as the full condition and the final water level was modeled at the pond floor, representing a final condition after drawdown where the pond is empty.

The most critical slope geometry was identified along the east sideslope. The effect of pseudo-static[1] earthquake loading was also analyzed at this location. The plant is not located in a seismic zone (Reference: Figure 6 of EM 1110-2-1902, "Stability of Earth and Rock-Fill Dams", U.S. Army

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[1] The pseudostatic method is a simplified method for determining seismic slope stability that is based on the same approach (i.e., limit equilibrium) used in analyzing static slope stability. In current practice, the pseudostatic method of analysis is used primarily as a screening tool to help assess whether an embankment dam or slope requires a more detailed seismic slope analysis. The pseudostatic method ignores cyclic loading of the earthquake, but accounts for seismicity by applying an equivalent static force on the slope. In the limit equilibrium approach bearing capacity and stress-strain relationship of the soil is not considered, so the method should not be used for sensitive clays and other materials that lose shear strength during an earthquake or loose soils located below the groundwater table subject to liquefaction.

Corps of Engineers, 1970), so a nominal seismic coefficient of 0.01g was therefore used in the earthquake loading analysis.

7.1.2 Design Parameters and Dam Materials

The Golder Associates report, Ash Pond Slope Stability Investigation Report (See Appendix C – Doc 08) included design parameters and dam material information used for modeling structural stability. Table 7.1 presents parametric values for impoundment materials from the report that were used in the stability analyses

Table 7.1 Soil Material Properties

Soil Material	Moist Unit Weight (lb/ft^3)	Saturated Unit Weight (lb/ft^3)	Undrained Soil Properties		Drained Soil Properties	
			Undrained Shear Strength, s_u (lb/ft^2)	Friction Angle ø (^{o})	Cohesion, c’ (lb/ft^2)	Friction Angle ø (^{o})
Sandy Clay/ Clayey Sand	127	132	1500	0	1000	14
Clean Sand	127	132	0	29	0	29

7.1.3 Uplift and/or Phreatic Surface Assumptions

No documentation of uplift force or phreatic surface assumptions was provided to Dewberry for review.

7.1.4 Factors of Safety and Base Stresses

Slope stability analyses were performed for both short-term and long-term conditions using undrained and drained soil properties, respectively. The results of the analyses are provided in Table 7.2. A factor of safety of 1.5 is typically considered adequate for permanent slopes. The minimum calculated factor of safety from our analyses is 2.5 (Case 2) for normal loading conditions. The analyses indicate that the slopes are stable. Additionally, slope stability analyses for rapid drawdown and earthquake conditions have factors of safety greater than 1.5 as well.

TABLE 7.2 SLOPE STABILITY FACTORS OF SAFETY

Case	Description	Factor of Safety	Inside/outside slope
1	East sideslope; empty pond; short-term (undrained) conditions	2.6	Inside
2	East sideslope; empty pond; long-term (drained) conditions	2.5	Inside
3	East sideslope; full pond; short-term (undrained) conditions	5.7	Inside
4	East sideslope; full pond; long-term (drained) conditions	5.9	Inside
5	East sideslope; empty pond; long-term conditions; **seismic**, earthquake loading analysis	2.4	Inside
6	East sideslope; rapid drawdown	2.6	Inside
7	North sideslope; empty pond; short-term (undrained) conditions	3.3	Inside
8	North sideslope; empty pond; long-term (drained) conditions	3.2	Inside
9	North sideslope; full pond; short-term (undrained) conditions	6.3	Inside
10	North sideslope; full pond; long-term (drained) conditions	6.6	Inside
11	North sideslope; rapid drawdown	3.1	Inside
12	Northeast sideslope; empty pond; short-term (undrained) conditions	3.5	Outside
13	Northeast sideslope; empty pond; long-term (drained) conditions	3.6	Outside
14	Northeast sideslope; full pond; short-term (undrained) conditions	3.5	Outside
15	Northeast sideslope; full pond; long-term (drained) conditions	3.6	Outside
16	Northeast sideslope; rapid drawdown	3.6	Outside
17	West sideslope; empty pond; short-term (undrained) conditions	5.5	Outside
18	West sideslope; empty pond; long-term (drained) conditions	4.4	Outside
19	West sideslope; full pond; short-term (undrained) conditions	5.4	Outside
20	West sideslope; full pond; long-term (drained) conditions	4.4	Outside
21	West sideslope; rapid drawdown	4.4	Outside

7.1.5 Liquefaction Potential

The soils encountered in the borings are not susceptible to liquefaction.

The 2008 U.S.G.S. seismic risk map indicates the estimated peak ground acceleration for an earthquake having a two percent probability of exceedance in 50 years is 0.04g.

7.1.6 Critical Geological Conditions

Critical geologic conditions were determined from maps in the *Geologic Atlas of* Texas, accessed on the Texas Water Development Board website.[2] The sequence of geologic formations from the surface included the Calvert Bluff, Simsboro, and Hooper formations.

The Calvert Bluff formation includes sandy to silty clays between seams of lignite. The lignite is surface mined to provide fuel for the Big Brown SES. The thickness of the Calvert Formation is several hundred feet. The Calvert Bluff Formation is underlain by the Simsboro Formation consisting of well-sorted fine to coarse sand with lenses of mudstone. The Hooper formation which underlies the Simsboro Formation consists of mudstone and sandstone.

7.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Subsequent to Dewberry’s Draft report submittal, Luminant provided slope stability analyses for the Ash Pond (See Doc 08 in Appendix C). Based on the new information provide the structural stability documentation is adequate to support a quantitative analysis of the stability of the embankments impounding the Bottom Ash Pond.

7.3 ASSESSMENT OF STRUCTURAL STABILITY

Overall, the structural stability of the Bottom Ash Pond embankment appears to be **Satisfactory** based on the following observations:

- Safety factors for static stability and seismic stability meet the minimum required by the US Army Corp of Engineers guidance.

---

[2] Texas Water Development Board web site: www.txwb.state.tx.us/groundwater/acquifer/GAT/

8.0 ADEQUACY OF MAINTENANCE AND METHODS OF OPERATION

8.1 OPERATING PROCEDURES

Dehydrated bottom ash and boiler slag are collected in dewatering bins and transported off-site for beneficial re-use or land disposal as solid waste.. The Bottom Ash Pond also receives process water and precipitation runoff (See Appendix A –Doc 6). There are dedicated pipes feeding each the north and south cells of the impoundment. Sluiced ash is piped to the east end of each cell. Sluice water is recycled through a decant riser at the west end of each cell. The outlet pipes connect to a valve box near the exterior toe of the south cell. Standard operating procedures are for the valves to route water back to the plant for recycling. In the event of unexpected conditions, the valves are reset to send water to a Bottom Ash Treatment Pond, which is the TXPDES permitted outfall for the plant.

Water transfer between pond cells is not a frequent event, but when required it is accomplished using a temporary mobile pump and HDPE pipes attached to the top of the decant riser system access bridge.

Emergency drainage of the Bottom Ash Pond is conducted using mobile pumps and discharging water to the plant discharge canal near the south side of the impoundment.

8.2 MAINTENANCE OF THE DAM AND PROJECT FACILITIES

Maintenance of the impoundment generally consists of mowing the exterior slopes and toe areas, periodic grading of the crest, and repairing anomalies reported in weekly inspection reports.

8.3 ASSESSMENT OF MAINTENANCE AND METHODS OF OPERATIONS

8.3.1 Adequacy of Operating Procedures

Based on assessments from received documents and the site visit, operating procedures appear to be adequate.

8.3.2 Adequacy of Maintenance

Based on assessments from received documents and the site visit, maintenance procedures appear to be adequate.

9.0 ADEQUACY OF SURVEILLANCE AND MONITORING PROGRAM

9.1 SURVEILLANCE PROCEDURES

Normal plant surveillance procedures consist of weekly visual inspections of the Bottom Ash Pond. Results of the inspections are recorded on checklist reports and submitted to plant management.

Critical impoundment inspections are conducted annually, either by Luminant corporate technical staff, or outside technical consultants. Dewberry was provided copies of the February 2011 and April 2012 inspection reports prepared by engineers from the Luminant Fossil Engineering and Support group, and HDR Engineering, Inc. respectively (See Appendix A – Docs 3 and 4, respectively).

Although both reports included recommendations for relatively minor maintenance actions, no major concerns were identified. Findings in both reports were consistent with Dewberry's observations during our site visit.

9.2 INSTRUMENTATION MONITORING

Instrumentation of the embankment consists of groundwater piezometers located outside the toe of the perimeter embankment (See Figure 9.2-1). The piezometers are read semi-annually and results reported to plant management.

Figure 9.2-1: Piezometer near Embankment Toe – Northwest Groin

9.3 ASSESSMENT OF SURVEILLANCE AND MONITORING PROGRAM

9.3.1 Adequacy of Inspection Program

Based on the data reviewed by Dewberry, including observations during the site visit, the inspection program is adequate.

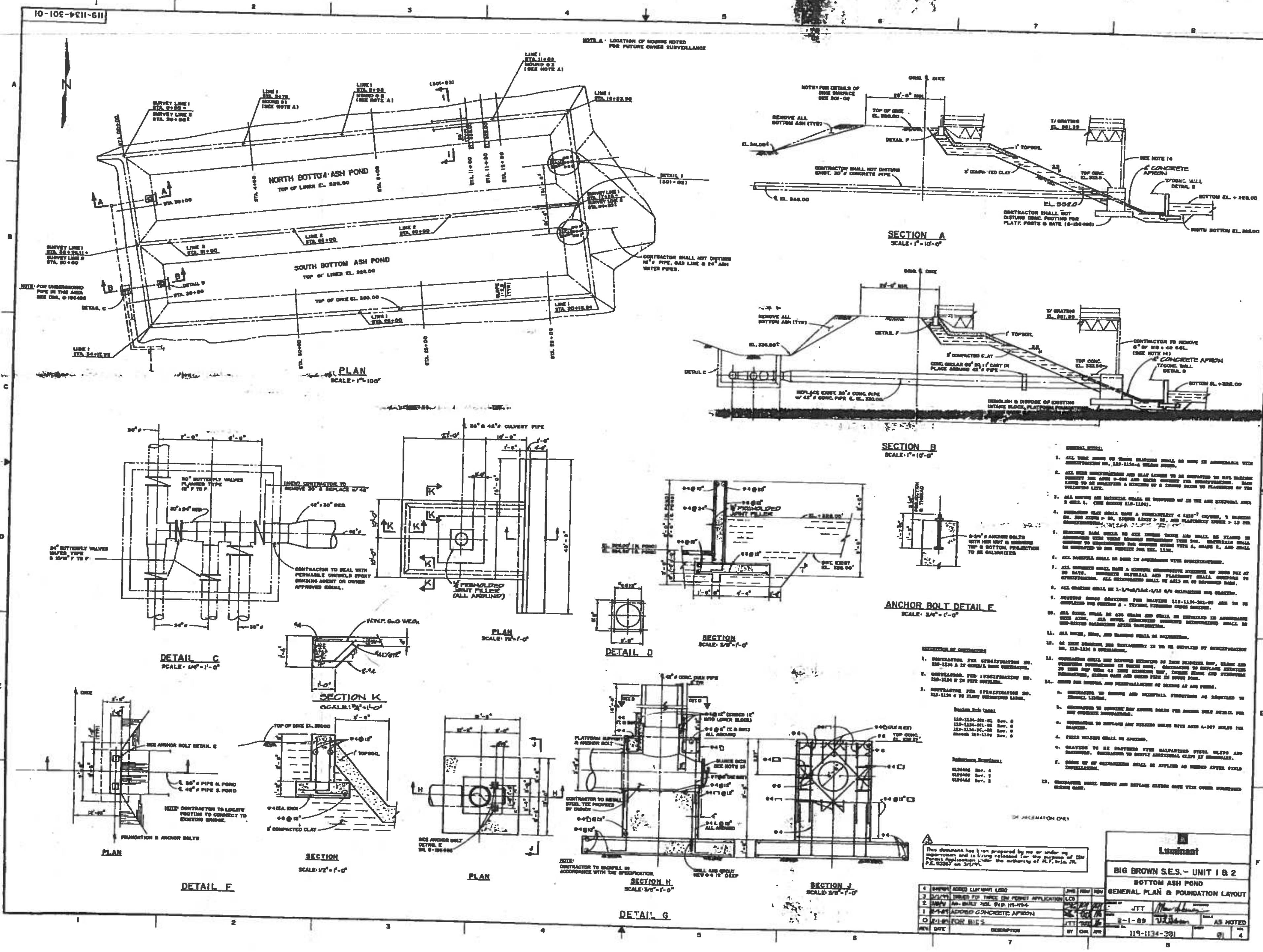
9.3.2 Adequacy of Instrumentation Monitoring Program

Based on the data reviewed by Dewberry, including observations during the site visit, the monitoring program is adequate.

APPENDIX A

Document 1

Bottom Ash Pond Design Drawing
119-1134-301 Sheets 1 - 3



GENERAL NOTES:

1. ALL WORK SHOWN ON THESE DRAWINGS SHALL BE DONE IN ACCORDANCE WITH SPECIFICATION NO. 119-1134-A UNLESS NOTED.
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]
6. ALL BACKFILL SHALL BE DONE IN ACCORDANCE WITH SPECIFICATIONS.
7. [illegible]
8. [illegible]
9. [illegible]
10. [illegible]
11. ALL BOLTS, NUTS, AND WASHERS SHALL BE GALVANIZED.
12. [illegible]
13. [illegible]
14. [illegible]
15. [illegible]

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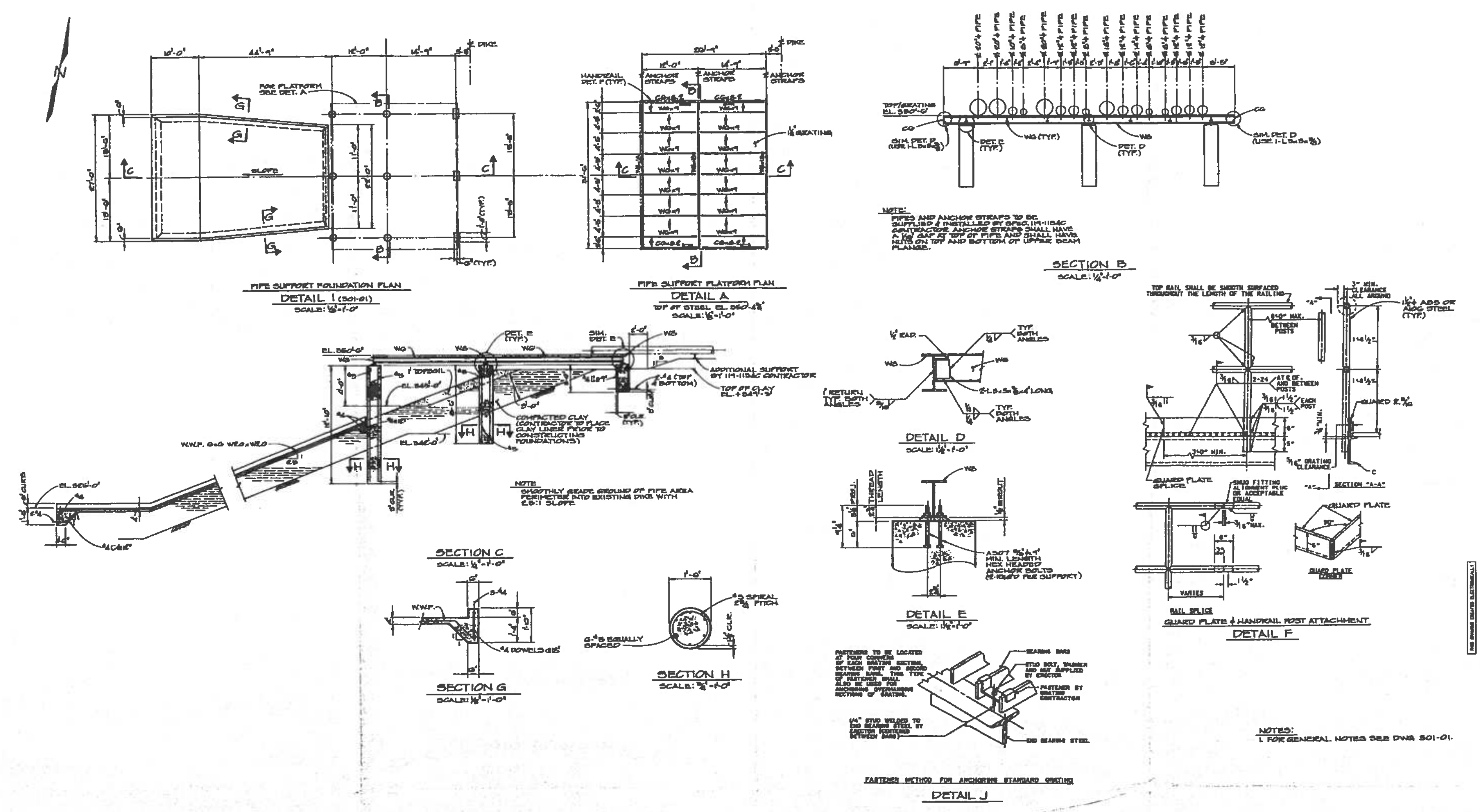
Luminant

BIG BROWN S.E.S. - UNIT 1 & 2
BOTTOM ASH POND
GENERAL PLAN & FOUNDATION LAYOUT

REV	DATE	DESCRIPTION	BY	CHK	APR
4	[illegible]	ADDED LUMINANT LOGO	JMS	[illegible]	[illegible]
3	3/1/99	ISSUED FOR THREE ISW PERMIT APPLICATION	LCO		
2	[illegible]	AS-BUILT PER. P.I.D. 119-1194	[illegible]	[illegible]	[illegible]
1	[illegible]	ADDED CONCRETE APRON	[illegible]	[illegible]	[illegible]
0	2-1-89	FOR BIDS	JTT	[illegible]	[illegible]

JTT
2-1-89
AS NOTED
119-1134-301
01
4

119-1134-301 02



NOTE:
PIPES AND ANCHOR STRAPS TO BE SUPPLIED & INSTALLED BY SPEC. 119-1134C CONTRACTOR. ANCHOR STRAPS SHALL HAVE A 1/4" GAP AT TOP OF PIPE AND SHALL HAVE NUTS ON TOP AND BOTTOM OF UPPER BEAM FLANGE.

NOTE
SMOOTHLY GRADE GROUND OF PIPE AREA PERIMETER INTO EXISTING DIKE WITH 2.5:1 SLOPE.

NOTES:
1. FOR GENERAL NOTES SEE DWG 301-01.

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OR INFORMATION ONLY

Luminant

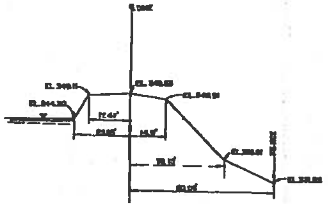
BIG BROWN S.E.S. UNITS 1&2

STRUCTURAL DETAILS

REV.	DATE	DESCRIPTION	BY	CHK.	APR.
3	3/18/09	ADDED LUMINANT LOGO	JHS	RDW	RDW
2	3/1/99	ISSUED FOR TNRCC ISW PERMIT APPLICATION	LCO		
1		AS-BUILT THIS DWG 119-1134			
0	2-1-89	FOR BIDS	JTT		

2-1-89
AS NOTED
119-1134-301 02 3

119-1134-301 | 03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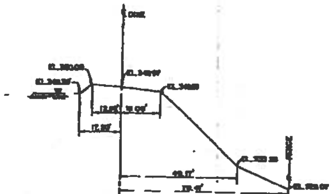
VERT. : 1" = 10'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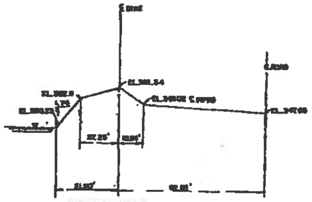
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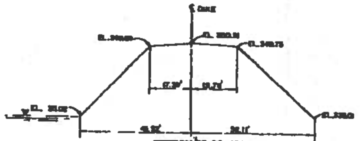
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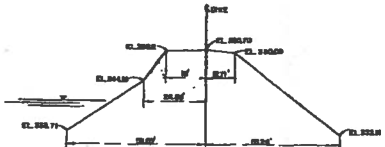
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STATION 35+00 (301-01)
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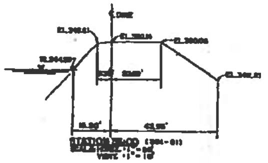
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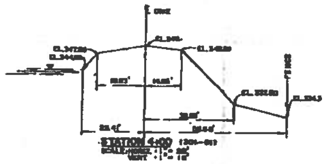
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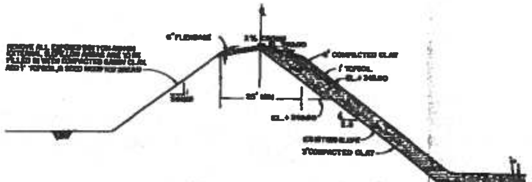

SECTION 1 (301-01)
TYPICAL FINISHED CROSS - SECTION
SCALE: NONE

THIS DRAWING CREATED ELECTRONICALLY

NOTES:
1. FOR GENERAL NOTES SEE DWG. 301-01

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FOR INFORMATION ONLY

FOR INFORMATION ONLY

Luminant

BIG BROWN S.E.S. UNITS 1, 2 & 3

BOTTOM ASH POND

3		ADDED LUMINANT LOGO	JHS		
2	3/1/99	ISSUED FOR TNRCC ISW PERMIT APPLICATION	LCD		
1					
0	2-1-89	FOR BIDS			
REV	DATE	DESCRIPTION	BY	CHK	APP

WLR
2-1-89
AS NOTED
119-1134-301 | 03 | 3

APPENDIX A

Document 2

Big Brown Bottom Ash Pond
Weekly Inspection Reports for
September 6 and 11, 2012

BIG BROWN STEAM ELECTRIC STATION

Bottom Ash Pond Inspection

Inspected by: McNew

Date of Inspection: 9-6-12

Permit #: SW-39099

Yes	No	Item	Deficiencies	Date Corrected
	✓	Visible leaks or corrosion associated with transfer piping for metal cleaning waste.		
✓		Freeboard is a minimum of 3 feet. Nth Pond Elevation --> 347 Sth Pond Elevation --> 347		
	✓	Evidence of overtopping of dikes.		
	✓	Depressions, potholes. Or Washouts in flexbase of truck ramp or on top of containment dike.		
	✓	Visible signs of erosion along external or internal slopes of containment dike.		
	✓	Bare spots in vegetative cover along external slope of dike.		
	✓	Trees, brush, or other plants with root systems capable of penetrating clay liner.		
✓	7 ✓	WMU signs prominently displayed.		
	✓	Evidence of tank truck or piping spills/leaks.		

Maintain completed form with the WMC Compliance Plan for a period of three (3) years.

FOR I [illegible] ON ONLY

BIG BROWN STEAM ELECTRIC STATION

Bottom Ash Pond Inspection

Inspected by: McNew

Date of Inspection: 9-11-12

Permit #. SW-39099

Yes	No	Item	Deficiencies	Date Corrected
	✓	Visible leaks or corrosion associated with transfer piping for metal cleaning waste.		
✓		Freeboard is a minimum of 3 feet. *Nth Pond Elevation -->* 346 8 *Sth Pond Elevation -->* 347		
	✓	Evidence of overtopping of dikes.		
	✓	Depressions, potholes. Or Washouts in flexbase of truck ramp or on top of containment dike.		
	✓	Visible signs of erosion along external or internal slopes of containment dike.		
	✓	Bare spots in vegetative cover along external slope of dike.		
	✓	Trees, brush, or other plants with root systems capable of penetrating clay liner.		
✓		WMU signs prominently displayed.		
	✓	Evidence of tank truck or piping spills/leaks.		

Maintain completed form with the WMC Compliance Plan for a period of three (3) years.

APPENDIX A

Document 3

Big Brown Critical Impoundment Inspection Report, Luminant Fossil Engineering Services, February 21, 2011

Critical Impoundment Inspection Report

For

Big Brown SES

The attached report is based on an on-site inspection conducted on January 17, 2011 at Luminant's Big Brown Steam Electric Station located in Freestone County, Texas.

Draft Report date:	February 3, 2011
Final report date:	February 20, 2011
Added PE Seal:	February 21, 2011

MARK W. KELLY
97279

FOR INFORMATION ONLY

Mark W. Kelly
February 21, 2011

Report prepared by: Mark W. Kelly, P.E.

Luminant
500 N. Akard St., Dallas, TX 75201
Office: 214-875-8259 <> Fax: 214-875-8284
Email: mark.kelly@luminant.com

Table of Contents:

Introduction:

The critical impoundments at Big Brown SES were inspected for dike structural stability on January 17, 2011. The inspection was performed by Mark W. Kelly of Luminant Fossil Engineering Services and Will Steen of Luminant Big Brown SES. As shown on Figure 1, the impoundments inspected were: North Bottom Ash Pond, South Bottom Ash Pond, Plant Operating Pond, Storm Drain Pond and the Inactive Waste Disposal Area.

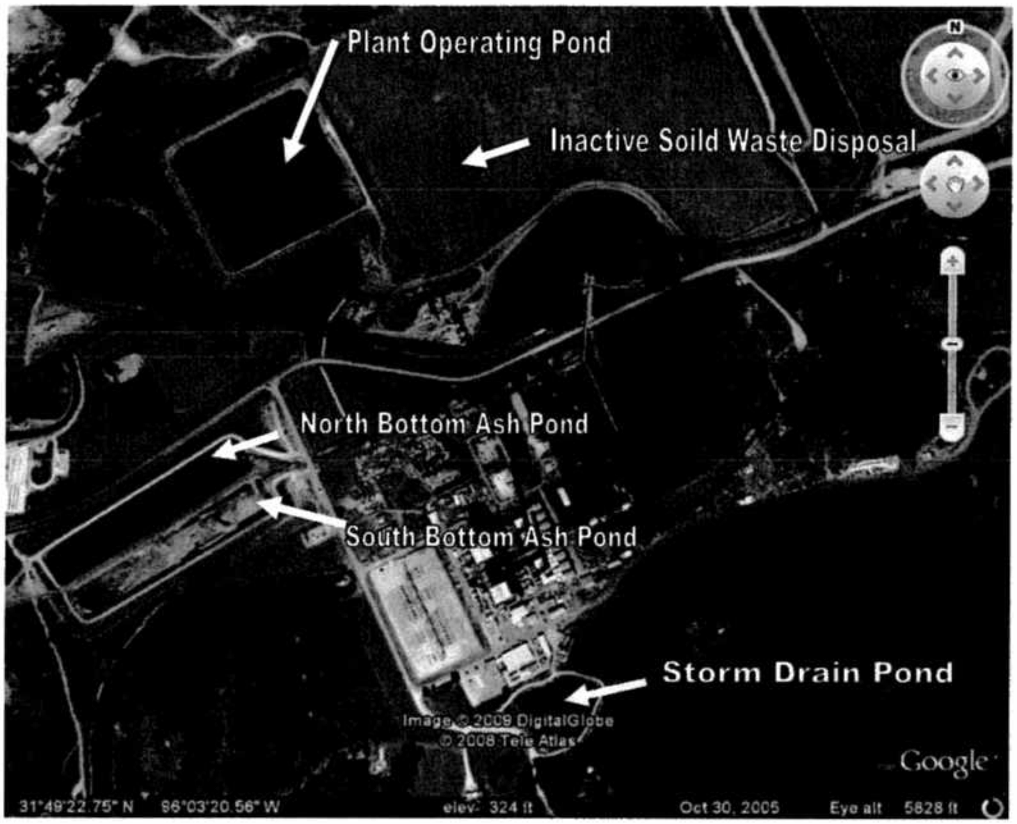


Figure 1: Big Brown Steam Electric Station Site Impoundments

The site had two days of rain fall prior to the inspection in the amounts of 1.15-in and 2.30-in on January 15th and 16th, 2011 respectively. At the time of inspection, the ground was moist with standing water in various locations.

Worksheets and photo location drawings for all impoundment inspections are included in Appendices A and B of this report.

The inspection of Big Brown's critical impoundments included a visual inspection of the inner and outer berms and crest for vegetative cover, erosion, misalignment, slides, settlement, damage and erosion, seeps, cracks, and lining condition.

North and South Bottom Ash Ponds:

The North and South Bottom Ash Ponds are adjacent to each other. They are clay-lined surface impoundments used to hold metal-cleaning wastes, waste water treatment wastes, and bottom ash contained in transporter sluice water. The rectangular impoundments measure approximately 1,400 feet by 264 feet at the crest. Each pond surface area is 9.6 acres. The slope of the dike is approximately 1:2.5, and the depth of the impoundments from the top of the dike to the top of the clay liner is 22 feet. Each pond will hold about 44 million gallons when the fluid level is at the top of the dike or about 38 million gallons (or 114 acre-feet) with 3 feet of freeboard.

Each impoundment is constructed with a compacted clay liner 3 feet thick underlying the bottom and interior dike slopes. The clay liner does not extend beyond the centerline of the crest.

The top of the dikes is approximately 14 to 21 feet above the surrounding grade. Surface runoff does not enter the impoundments.

On inspection day, the water elevations of South and North Bottom Ash Ponds were 347.0-feet. In 2010 both impoundments had their upstream slopes repaired and Recyclex erosion placed along the perimeter approximately 3-feet below and above the waterline. The Recyclex on the South Pond had been in place for 12 months at the time of the inspection and was found to be in good condition the vegetation is well established. The erosion protection at the North Pond had been in place approximately 4 months prior and was also performing well with the exception with one area. On the west side there was a gulley that has formed where the vegetation was not able to establish. This needs to be filled in and re-vegetated. The other major item noted is the extensive hog damage along the downstream slope on the south side of the South Pond. This should be smoothed out and reseeded to promote vegetation to take hold and prevent erosion. There are two minor action items identified including rutting at various locations on the crest and a few bean sprouts on the south side of the upstream embankment of the South Pond.

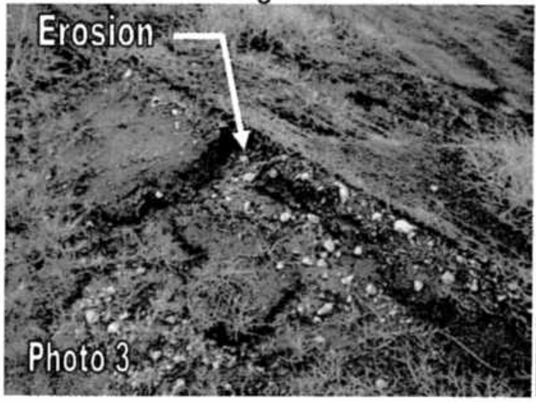
Photo locations in this report can be found in Appendix B on SK-1 “Bottom Ash Pond 2011 Inspection Photo Locator Plan.”

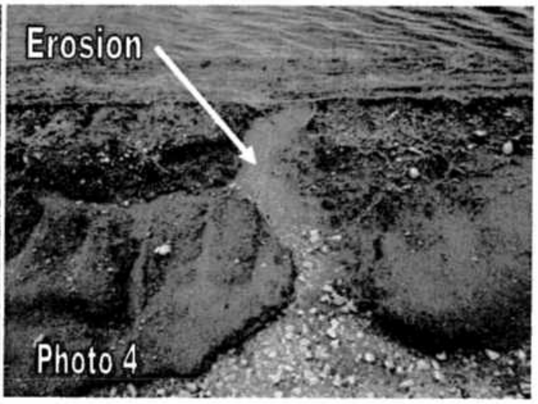
Photos 1 and 2 show the Recyclex along the upstream slopes. Photo 1 is representative of the South Pond where the vegetation has been established. The North Pond (Photo 2) depicts the Recyclex on the North Pond where the vegetation is not widely established. This should take hold once the spring growth season starts.

Photo 1

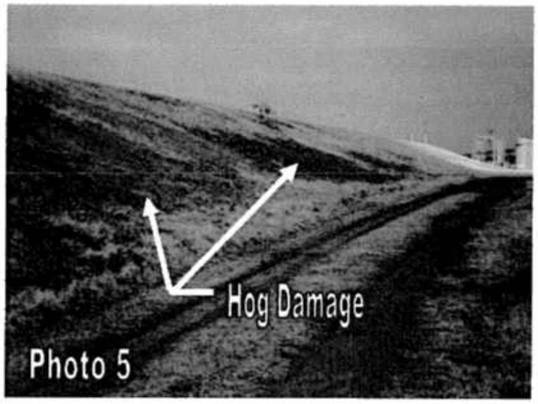
Photo 2

Photos 3 and 4 show the two locations on the north side of the North Pond where erosion has occurred under the Recyclex. It is recommended these areas be filled in and allowed to re-vegetate.





Photos 5 and 6 depict the hog damage that was prevalent along the downstream embankment of the South Pond. This needs to be re-vegetated to prevent erosion.



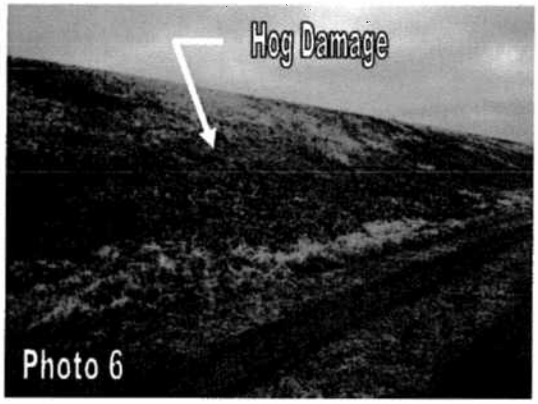
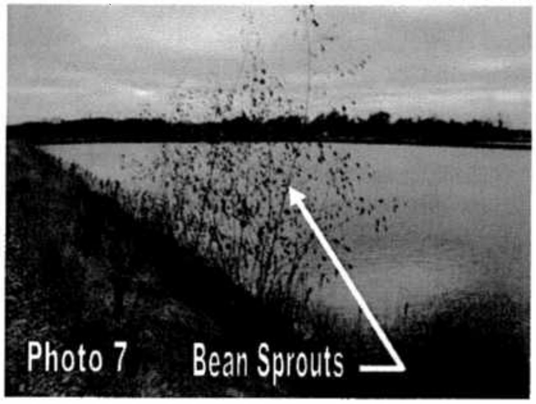


Photo 7 shows bean sprouts on the center of the upstream embankment of the South Pond. This needs to be removed at the next routine scheduled maintenance.



Photos 8 and 9 are rutting along the crest. The ruts allow rainwater to collect, penetrate and potentially weaken the embankment. These should be repaired and care should be taken to avoid driving on the crest when the embankment has been softened by wet conditions. See SK-1 for the locations of the ruts.


Photo 8


Photo 9

Plant Operating Pond:

The Plant Operating Pond is located north of the plant near the Boral facilities.

The square Plant Operating Pond measures approximately 800 feet by 800 feet at the crest and is 24 feet deep. Surface area is approximately 14.7 acres. The pond capacity is about 83 million gallons. On the day of the inspection the pond level was recorded at 322.4-feet.

The impoundment is constructed with a 3-foot thick compacted clay liner underlying the bottom and interior dike slopes. The clay liner does not extend beyond the centerline of the crest. Riprap has been placed at the upstream corners and along the east end of the pond.

The top of the dike is above the surrounding grade on all sides. Surface runoff does not enter the impoundments.

Photo locations in this report can be found in Appendix B on SK-2 “Plant Operating Pond 2010 Inspection Photo Locator Plan.”

Following are the observations with recommendations:

Rutting was absent from most of the crest except one location on the south east side where the rutting was deep and a large amount of water had collected. (Photo 1) This should be corrected as soon as possible as this water will penetrate and potentially weaken the embankment. Whenever possible, care should be taken to avoid driving on the embankment periods when the embankment is soft as a result of wet conditions.

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APPENDIX A

INSPECTION WORKSHEETS

CRITICAL IMPOUNDMENT INSPECTION CHECKLIST

Impoundment: North Bottom Ash Pond
Inspection Date: January 17, 2011
Weather: Cloudy and Cool
Inspected By: Mark Kelly
Last Inspection Date: February 1, 2010

Area	Item	Condition	Current Observations	Change From Last Inspection				Action		
				Similar	Improved	Deteriorated	unknown	OK	Monitor	Repair
CREST	1	SURFACE CRACKING	Non Observed	X				X		
	2	ANIMAL BURROWS	Non Observed	X				X		
	3	CREST SINKS	Non Observed	X				X		
	4	HORIZONTAL ALIGNMENT	Good	X				X		
	5	RUTS/PUDDLES	Some ruts on the west side		X					X
	6	VEGETATION	Grass on the edges and no vegetation on the driving surface.	X				X		
	7	TREES	Non Observed	X				X		
	8	CREST - OTHER	Non Observed	X				X		
	9									
	10									
UPSTREAM EMBANKMENT	11	TREES	Not Applicable	X				X		
	12	BERM SLIDE, SLOUGH	Repaired during the Fall of 2010.		X			X		
	13	SLOPE PROTECTION	Recyclex with Grass		X			X		
	14	BERM SINKS	Non Observed	X				X		
	15	ANIMAL BURROWS	Non Observed	X				X		
	16	ABUTMENT CONTACT	Good	X				X		
	17	EROSION	Two areas on the north side in the center. Improved from 2010.		X					X
	18	VEGETATION	Grass anchored by Recyclex		X			X		
	19	TREES	Non Observed		X			X		
	20	BERM BULGES	Non Observed	X				X		
	21	UPSTREAM - OTHER	Non Observed	X				X		
	22									
	23									
DOWNSTREAM EMBANKMENT	24	WET AREAS, SEEPAGE	Non Observed	X				X		
	25	EST. SEEPAGE RATE	Non Observed	X				X		
	26	SEEPAGE DESCRIPTION	Non Observed	X				X		
	27	BERM SLIDE, SLOUGH	Non Observed	X				X		
	28	ABUTMENT CONTACT	Good	X				X		
	29	ANIMAL BURROWS	Non Observed	X				X		
	30	EROSION	Some minor erosion on the NE side.		X			X		
	31	UNUSUAL MOVEMENT	Non Observed	X				X		
	32	VEGETATION	Grass	X				X		
	33	TREES	Non Observed							
	34	DOWNSTREAM - OTHER	Non Observed							
	35									
	36									
	37									

Comments and Photo Information:

CRITICAL IMPOUNDMENT INSPECTION CHECKLIST

Impoundment: South Bottom Ash Pond

Inspection Date: January 17, 2011

Weather: Cloudy and Cool

Inspected By: Mark Kelly

Last Inspection Date: February 1, 2010

Area	Item	Condition	Current Observations	Change From Last Inspection				Action		
				Similar	Improved	Deteriorated	unknown	OK	Monitor	Repair
CREST	1	SURFACE CRACKING	Non Observed	X				X		
	2	ANIMAL BURROWS	Non Observed	X				X		
	3	CREST SINKS	Non Observed	X				X		
	4	HORIZONTAL ALIGNMENT	Good	X				X		
	5	RUTS/PUDDLES	Some ruts on the west side		X					X
	6	VEGETATION	Grass on the edges and no vegetation on the driving surface.	X				X		
	7	TREES	Non Observed	X				X		
	8	CREST - OTHER	Non Observed	X				X		
	9									
	10									
UPSTREAM EMBANKMENT	11	TREES	Not Applicable	X				X		
	12	BERM SLIDE, SLOUGH	Repaired during the Fall of 2010.		X			X		
	13	SLOPE PROTECTION	Recyclex with Grass		X			X		
	14	BERM SINKS	Non Observed	X				X		
	15	ANIMAL BURROWS	Non Observed	X				X		
	16	ABUTMENT CONTACT	Good	X				X		
	17	EROSION	Non Observed	X				X		
	18	VEGETATION	Grass anchored by Recyclex		X			X		
	19	TREES	Non Observed		X			X		
	20	BERM BULGES	Non Observed	X				X		
	21	UPSTREAM - OTHER	Bean stalks to be remove don the south side near the center.			X				X
	22									
	23									
DOWNSTREAM EMBANKMENT	24	WET AREAS, SEEPAGE	Non Observed	X				X		
	25	EST. SEEPAGE RATE	Non Observed	X				X		
	26	SEEPAGE DESCRIPTION	Non Observed	X				X		
	27	BERM SLIDE, SLOUGH	Non Observed	X				X		
	28	ABUTMENT CONTACT	Good	X				X		
	29	ANIMAL BURROWS	Non Observed	X				X		
	30	EROSION	Some minor erosion on the NE side.	X				X		
	31	UNUSUAL MOVEMENT	Non Observed	X				X		
	32	VEGETATION	Grass	X				X		
	33	TREES	Non Observed	X				X		
	34	DOWNSTREAM - OTHER	Extensive hog damage on the south side. Revegetate.			X				X
	35									
	36									
	37									

Comments and Photo Information:

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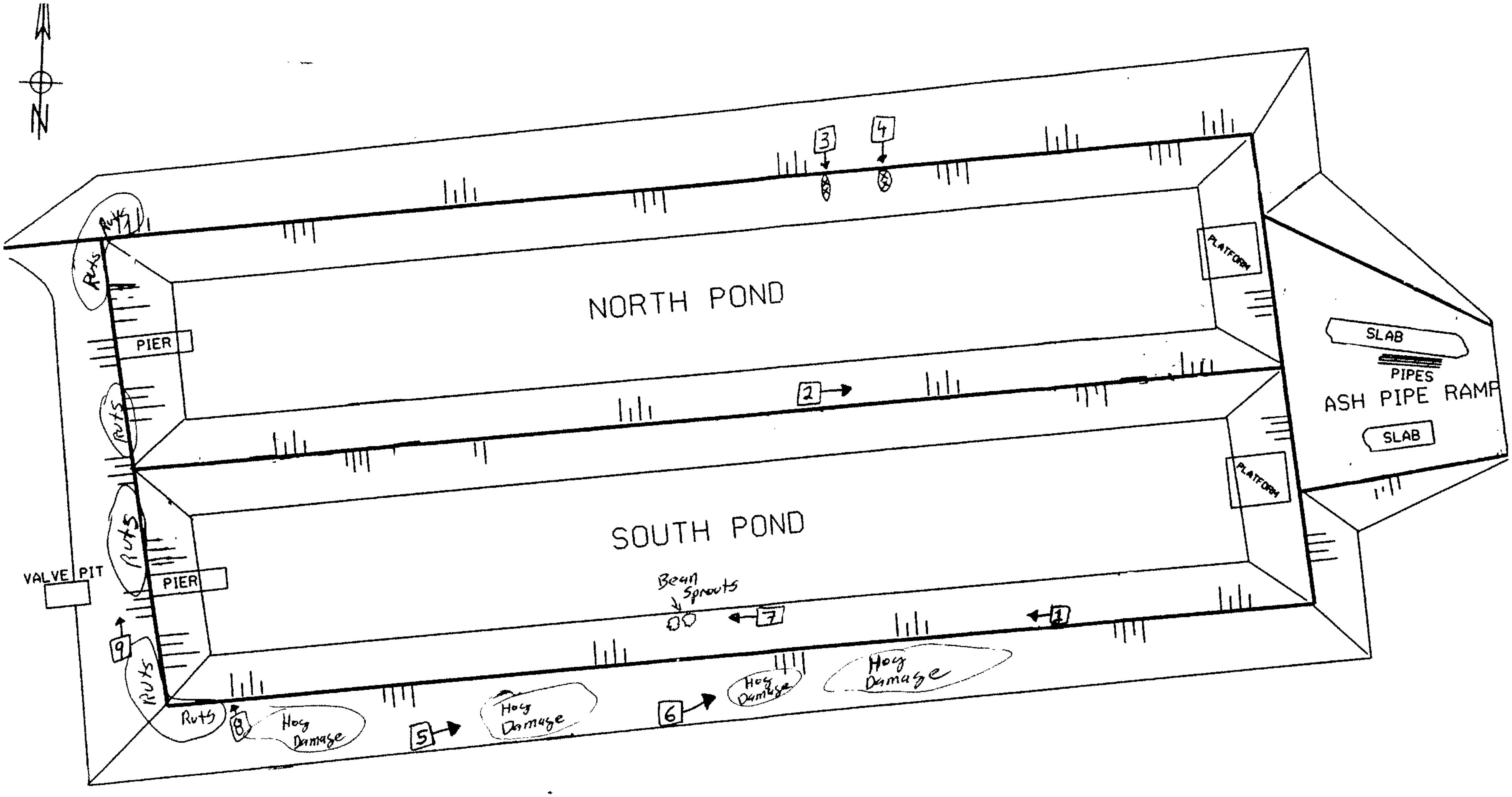
APPENDIX B

PHOTO LOCATOR PLANS



□→ DESIGNATES CAMERA VIEW LOCATION OF PHOTO. NUMBER IN BOX IS NUMBER OF PHOTO.

BIG BROWN SES
SK-1 "BOTTOM ASH POND"
INSPECTION DATE: JANUARY 17, 2011

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APPENDIX A

Document 4

Big Brown Critical Impoundment Inspection Report, HDR Engineering Inc., April 19, 2012

HDR

Luminant

FOR INFORMATION ONLY

Big Brown Steam Electric Station
Freestone County, Texas

Critical Impoundment Inspection Report

April 19, 2012

HDR Project No. 179596

Texas P.E. Firm Registration No. F-754

DAVID G. VOGT
93305

4/19/12

Contents

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The last recorded rainfall event occurred over a three day period. The plant recorded 0.55 inches of rain on February 2nd, 0.62 inches on February 3rd and 0.02 inches on February 4th, 2012. On the date of inspection, the ground was moist and there were areas of standing water present.

North and South Bottom Ash Pond:

The North and South Bottom Ash Ponds are adjacent to each other and can be found approximately 1,000 feet northwest of the plant. The clay-lined surface impoundments are used to hold metal-cleaning wastes, waste water treatment wastes, and bottom ash contained in transporter sluice water. The rectangular impoundments measure approximately 1,400 feet by 264 feet at the crest. Each pond surface area is 9.6 acres and is surrounded by an earth embankment that serves as a containment dike. The slope of the perimeter dike is approximately 2.5 Horizontal: 1 Vertical. The depth of the impoundments from the top of the dike to the top of the clay liner is approximately 22 feet. Each pond will hold about 44 million gallons when the fluid level is at the top of the dike or about 38 million gallons (or 114 acre-feet) with 3 feet of freeboard.

Each impoundment is constructed with a compacted clay liner 3 feet thick underlying the bottom and interior dike slopes. The clay liner does not extend beyond the centerline of the crest.

The top of the dike surrounding the ponds is approximately 14 to 21 feet above surrounding grade. Surface runoff does not enter the impoundments.

On the day of the inspection, the water elevation in the North Bottom Ash Pond was approximately 346.9 feet. The South Bottom Ash Pond had an elevation of 346.6 feet.

Crest

In general, the crest of the impoundment was in good condition (Figures 2 and 3).

Figure 2: Crest of North Impoundment

Figure 3: Crest of North Impoundment

MODERATE ITEM: The crest of the impoundment had areas with rutting from vehicular traffic (Figures 4 and 5) in localized areas around the entire pond.

Recommendation 1: Repair damaged areas and grade to drain.

Recommendation 2: Discourage vehicular traffic from driving on impoundment crests after storm events.

Figure 4: Crest Rutting North Pond

Figure 5: Crest Rutting South Pond

Upstream Embankment

MODERATE ITEM: Wave erosion was observed on the North Pond (Figure 6). Erosion matting was installed to mitigate the erosion along the upstream embankments of both ponds. The matting installed in the North Pond did not appear to be functioning as well as the matting installed on the South Pond (Figure 7). The North Pond was emptied in 2011 and repairs were made to the liner and protective cover. The South Pond was emptied and repaired in 2009.

Recommendation 1: Repair upstream embankment on North Pond using the same erosion matting installed on the South Pond.

Recommendation 2: Continue to monitor erosion to protective cover over liner and repair as needed with riprap.

Figure 6: North Pond Embankment (Note geotextile separation and erosion).

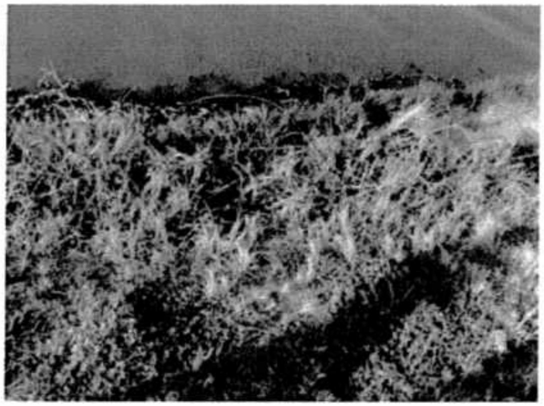

Figure 7: South Pond Upstream Embankment (Note geotextile well placed and functioning as intended)

MODERATE ITEM: The South Bottom Ash Pond had isolated areas of cattails and other vegetation growing on the upstream embankment (Figures: 8 and 9).

Recommendation 1: Remove cattails and undesirable vegetation (bushes) from upstream embankment. Repair surface areas disturbed by removal of large vegetation (bushes).

Figure 8: Cattails South Pond

Figure 9: Bush Growing South Pond Embankment

Downstream Embankment

In general, the downstream side of the impoundment embankment was in good condition (Figures 10 and 11).

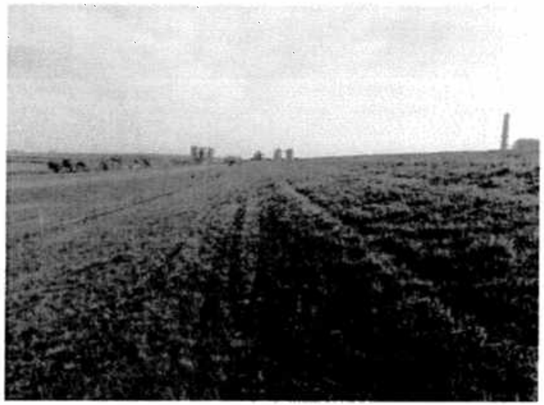
Figure 10: Downstream Embankment North Pond


Figure 11: Downstream Embankment South Pond

MODERATE ITEM: Animal burrows were found in the downstream embankment of both ponds (Figures 12 and 13).

Recommendation 1: Backfill burrows with compacted cohesive soil and reestablish vegetation.

Recommendation 2: Continue to monitor for burrow reestablishment or erosion to restored areas.

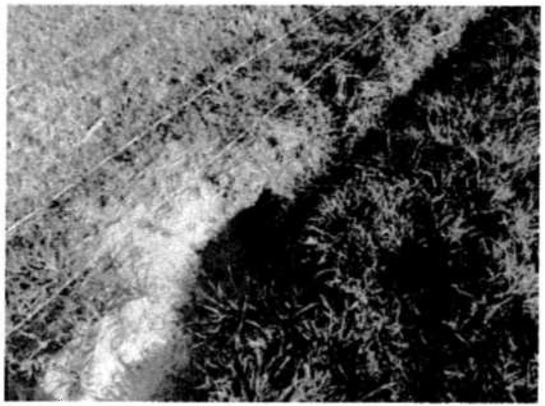
Figure 12: North Pond Animal Burrow

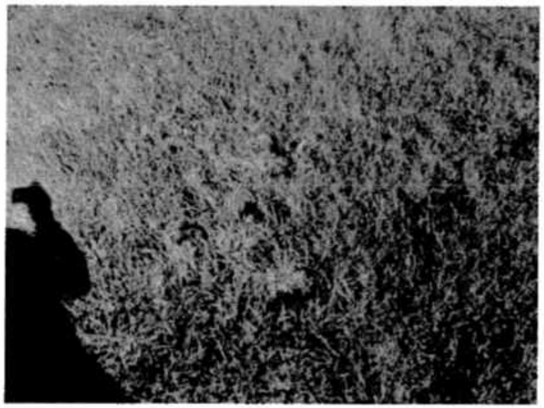
Figure 13: South Pond Animal Burrows

MODERATE ITEM: Bare areas were found at a couple of areas along the downstream face of the embankment around both ponds (Figures: 14 and 15).

Recommendation 1: Reseed and reestablish vegetation in these bare areas.

Recommendation 2: Continue to monitor for additional erosion after re-vegetation.

Figure 14: Bare Area North Pond

Figure 15: Bare Area South Pond

MODERATE ITEM: Water is ponding at the toe of both ponds in isolated areas (Figures 16 and 17). It is assumed the water was from recent storm activities, but this could also represent seepage from the impoundment.

Recommendation 1: Continue to monitor these low areas, especially during dry (i.e., rain free) periods to determine if this is storm water or water migrating from the ponds.

Recommendation 2: Provide compacted cohesive fill soil and grade to eliminate the ponding areas.

Figure 16: North Pond Standing Water at Toe

Figure 17: South Pond Standing Water at Toe

Other Observations

MODERATE ITEM: The North Bottom Ash Pond pipe rack has wave erosion at the foundation (Figures 18 and 19).

Recommendation 1: Backfill bare erosion gullies with compacted cohesive soil and reestablish vegetation.

Recommendation 2: Place riprap in areas of concentrated flow.

Recommendation 3: Continue to monitor areas after repairs for additional erosion.

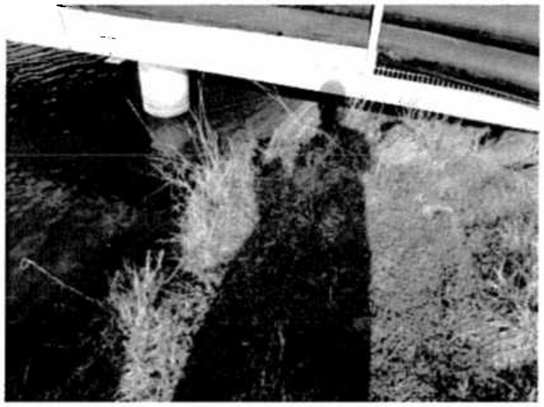

Figure 18: North Pond Pipe Rack Erosion

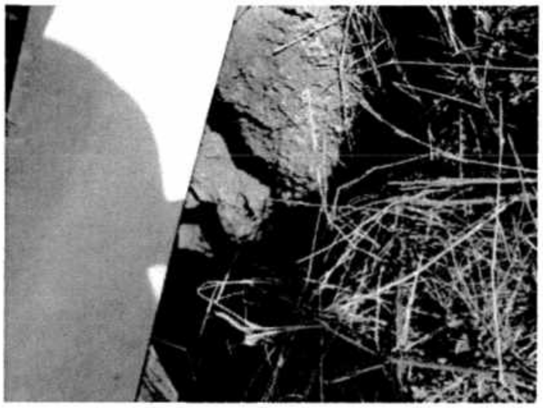

Figure 19: North Pond Pipe Rack Erosion

MODERATE ITEM: The pipe rack at the South Bottom Ash Pond has erosion gullies undercutting the slab foundation (Figures 20 and 21).

Recommendation 1: Backfill bare erosion gullies with compacted cohesive soil, grade and reestablish vegetation. Place and pack grave or grout in voids beneath concrete slab.

Recommendation 2: Place riprap or stone in areas of concentrated flow.

Recommendation 3: Continue to monitor areas after repairs for additional erosion.

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ATTACHMENT 1

Inspection Checklists

IMPOUNDMENT INSPECTION CHECKLIST

Impoundment: North and South Bottom Ash Ponds	Inspection Date:2/8/12	Weather: Sunny
Inspected By: Mark Kelly, Will Steen and Dave Vogt	Last Inspection Date: 1/7/11	

Element	Item	Component	Current Observations	Change From Last Inspection					Action				
				Similar	Improved	Deteriorated	Unknown		OK	Critical	Moderate	Minor	Monitor
Crest	1	Surface Cracking		X					X				
	2	Animal Burrows		X					X				
	3	Crest Sinks		X					X				
	4	Horizontal Alignment		X					X				
	5	Ruts/Puddles		X							X		
	6	Vegetation		X					X				
	7	Trees		X					X				
	8	Piezometer Readings					X						
	9	Piezometer Condition					X						
Upstream Embankment and Cap Area	10	Cap Erosion		X					X				
	11	Cap Vegetation/Trees		X					X				
	12	Berm Slide, Slough		X					X				
	13	Slope Protection		X					X				
	14	Berm Sinks		X					X				
	15	Animal Burrows		X					X				
	16	Abutment Contact		X					X				
	17	Erosion		X							X		
	18	Vegetation		X							X		
	19	Trees		X					X				
	20	Drains		X					X				
	21	Berm Bulges		X					X				
Downstream Embankment	22	Wet Areas/Seepage		X							X		
	23	Estimated Seepage Rate		X					X				
	24	Seepage Description		X					X				
	25	Toe Drain Status		X					X				
	26	Berm Slide/Slough		X					X				
	27	Abutment Contact		X					X				
	28	Animal Burrows		X							X		
	29	Erosion		X							X		
	30	Unusual Movement		X					X				
	31	Vegetation		X					X				
	32	Trees		X					X				
	33	Piezometer Reading					X						
	34	Piezometer Condition					X						

Comments and Photo Information:

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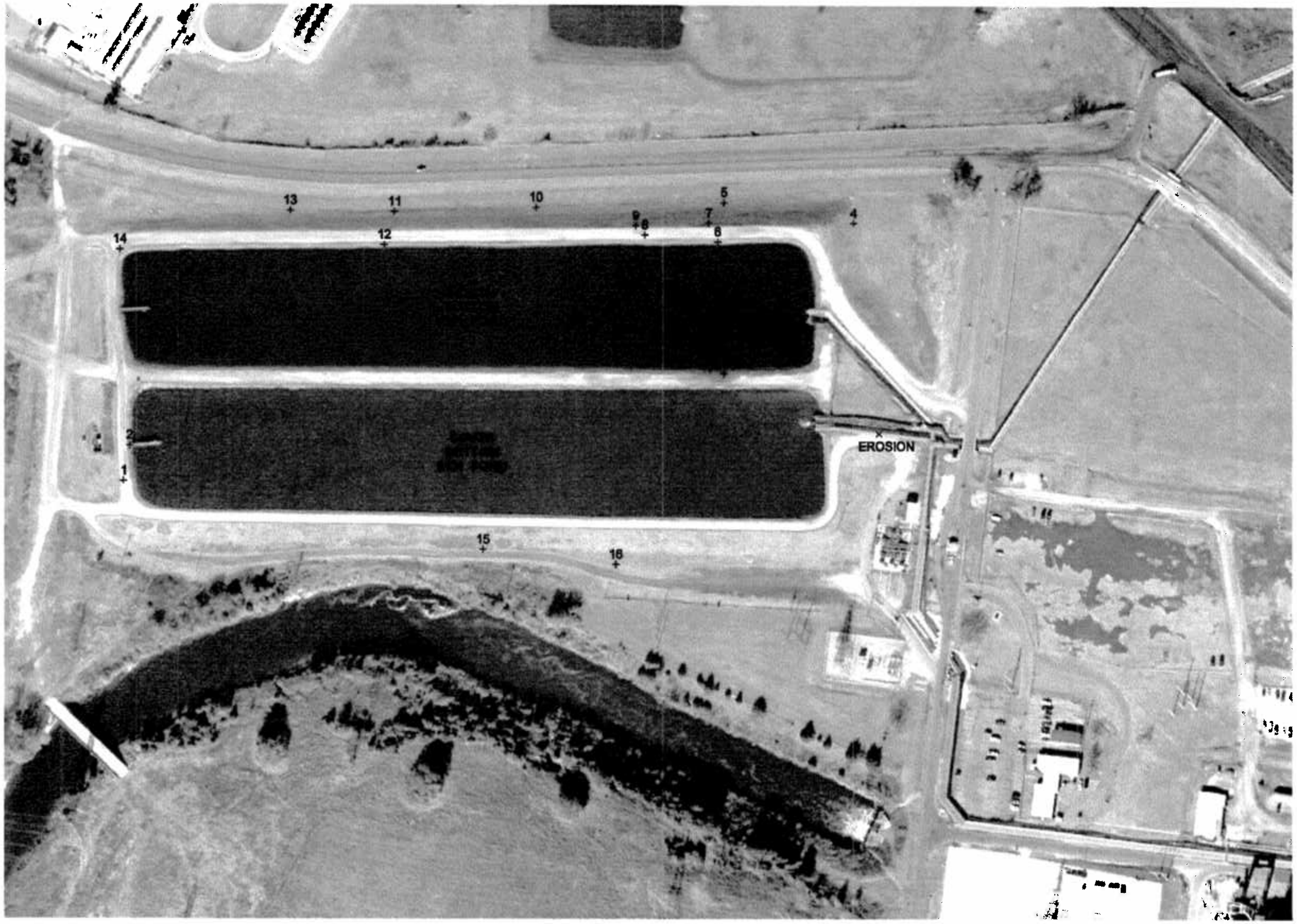
ATTACHMENT 2

Inspection Maps



N

0 100 200 300

LAYOUT SCALE IN FEET

LEGEND

13 + MARKED POINTS WITH COORDINATES

× **BUSH** MARKED POINTS WITHOUT COORDINATES

POINT NO.	NORTHING	EASTING	DESCRIPTION
1	[illegible]	[illegible]	RUT
2	[illegible]	[illegible]	EROSION
3	[illegible]	[illegible]	BANK EROSION
4	[illegible]	[illegible]	ANIMAL BURROW
5	[illegible]	[illegible]	ANIMAL BURROW
6	[illegible]	[illegible]	BANK EROSION
7	[illegible]	[illegible]	BURROW
8	[illegible]	[illegible]	RUT
9	[illegible]	[illegible]	BURROW
10	[illegible]	[illegible]	ANIMAL BURROW
11	[illegible]	[illegible]	ANIMAL BURROW
12	[illegible]	[illegible]	GEOGRID
13	[illegible]	[illegible]	ANIMAL BURROW
14	[illegible]	[illegible]	RUT NEEDS ROCK
15	[illegible]	[illegible]	ANIMAL BURROW
16	[illegible]	[illegible]	PONDING

DATE 4/19/2012
TIME 2:35:16 PM
USER rcox
FILE Luminant_Generation_Company_LLC\Impoundment_Inspections\13.00_CAD\Sheet Files

PLTDRVER 11X17LASER_BW_PDF.plt
PENTABLE 179596.tbl
FILENAME BB_SP01.dgn

Luminant

HDR

HDR ENGINEERING, INC.
17111 Preston Road
Suite 200
Dallas, Texas 75248

Texas P.E. Firm
Firm Registration No. F-754

ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	D.VOGT
CIVIL ENGINEER	D.VOGT
CHECKED BY	
DESIGNED	
DRAWN BY	B.COX
QA/QC	
PROJECT NUMBER	179596

PRELIMINARY

FOR INTERIM REVIEW ONLY. NOT FOR PERMITTING, BIDDING, OR CONSTRUCTION.
Prepared by or under the
Direct Supervision of
DAVID C. VOGT, P.E. 89806
4/19/2012

BIG BROWN STEAM ELECTRIC STATION
FREESTONE COUNTY, TEXAS

IMPOUNDMENT INSPECTIONS
SHEET 1 OF 4

FILENAME BB_SP01.dgn
SCALE

SHEET
BB1

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APPENDIX A

Document 5

NPDES Permit No. TN 85003-0-02

TPDES PERMIT NO. WQ0001309000
[For TCEQ office use only -
EPA I.D. No. TX0030180]

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
P. O. Box 13087
Austin, Texas 78711-3087

This is a renewal of TCEQ Permit No. WQ0001309000, issued on December 28, 2004.

PERMIT TO DISCHARGE WASTES
under provisions of
Section 402 of the Clean Water Act
and Chapter 26 of the Texas Water Code

TXU Big Brown Company LP (Owner) and TXU Generation Company LP (Operator)

whose mailing address is

c/o Water Programs Coordinator
Environmental Services
Energy Plaza
1601 Bryan Street
Dallas, Texas 75201-3411

is authorized to treat and discharge wastes from the Big Brown Steam Electric Station, a steam power generating facility (SIC 4911)

located on the north bank of Fairfield Lake on Farm-to-Market Road 2570, approximately 11 miles northeast of the City of Fairfield, Freestone County, Texas

to Fairfield Lake; thence to Big Brown Creek; thence to Tehuacana Creek; thence to the Trinity River Above Lake Livingston in Segment No. 0804 of the Trinity River Basin

only according to effluent limitations, monitoring requirements and other conditions set forth in this permit, as well as the rules of the Texas Commission on Environmental Quality (TCEQ), the laws of the State of Texas, and other orders of the TCEQ. The issuance of this permit does not grant to the permittee the right to use private or public property for conveyance of wastewater along the discharge route described in this permit. This includes, but is not limited to, property belonging to any individual, partnership, corporation or other entity. Neither does this permit authorize any invasion of personal rights nor any violation of federal, state, or local laws or regulations. It is the responsibility of the permittee to acquire property rights as may be necessary to use the discharge route.

This permit shall expire at midnight on February 1, 2012.

ISSUED DATE: APR 18 2007

For the Commission

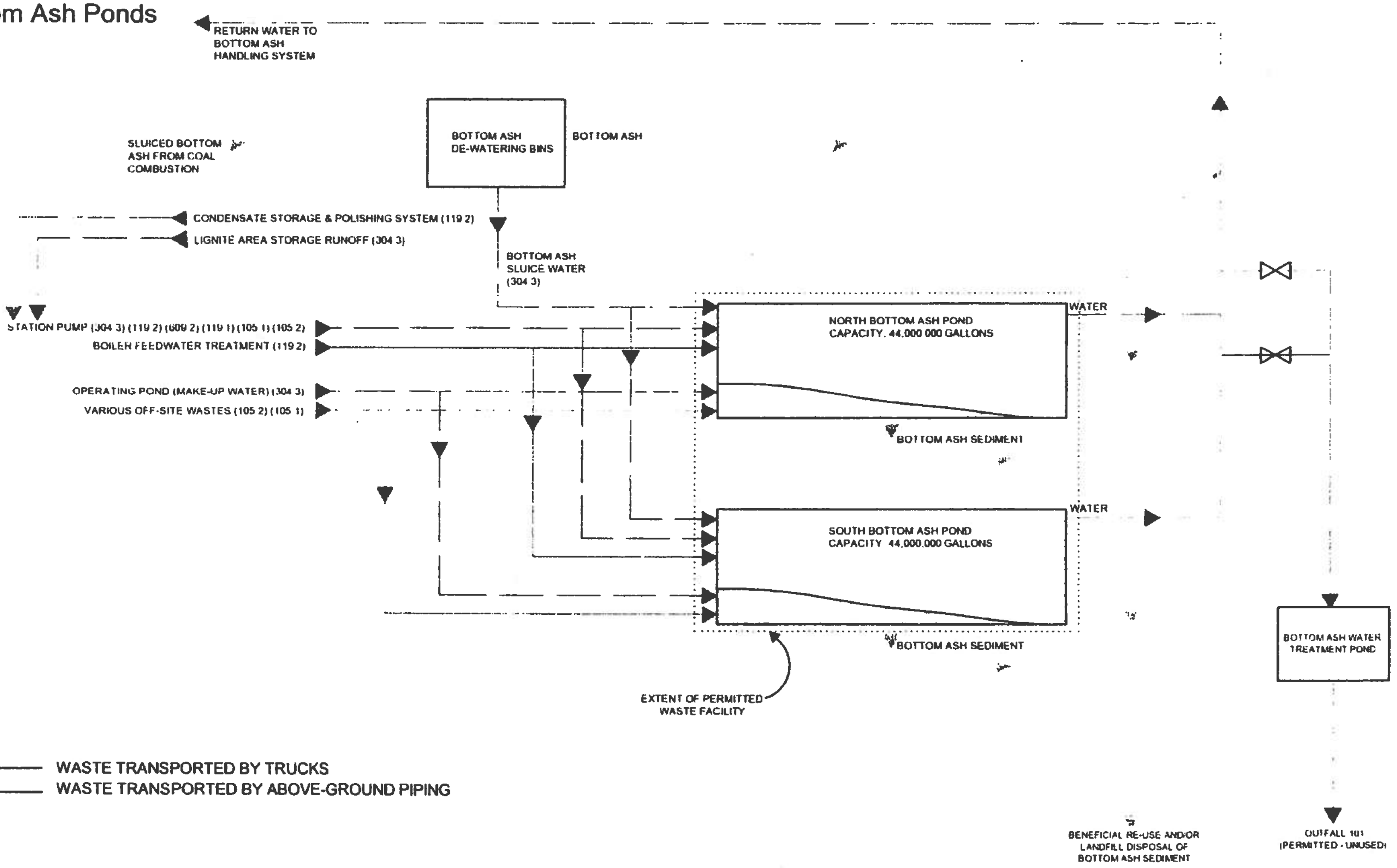
APPENDIX A

Document 6

FLOW CHART, Big Brown Steam Electric Station

FLOW CHART
Luminant Generation Company, LLC
Big Brown Steam Electric Station
Bottom Ash Ponds

FOR INFORMATION ONLY



APPENDIX B

Document 7

Dam Inspection Check List Lime and Ash Pond

Site Name:	**Big Brown Steam Electric Station**	**Date:**	**September 26, 2012**
Unit Name:	**Bottom Ash Pond**	**Operator's Name:**	**Luminant**
Unit I.D.:		**Hazard Potential Classification:**	**High** ☐ **Significant** ☐ **Low** ☒
	Inspector's Name:	Michael McLaren, P.E. and Joe Klein, P.E.	

Check the appropriate box below. Provide comments when appropriate. If not applicable or not available, record "N/A". Any unusual conditions or construction practices that should be noted in the comments section. For large diked embankments, separate checklists may be used for different embankment areas. If separate forms are used, identify approximate area that the form applies to in comments.

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	X		18. Sloughing or bulging on slopes?		X
2. Pool elevation (operator records)?	347 ft		19. Major erosion or slope deterioration?		X
3. Decant inlet elevation (operator records)?		N/A	20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?		N/A	Is water entering inlet, but not exiting outlet?		N/A
5. Lowest dam crest elevation (operator records)?	350 ft		Is water exiting outlet, but not entering inlet?		N/A
6. If instrumentation is present, are readings recorded (operator records)?	X		Is water exiting outlet flowing clear?		N/A
7. Is the embankment currently under construction?		X	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation, stumps, topsoil in area where embankment fill will be placed)?		INA	From underdrain?		X
9. Trees growing on embankment? (If so, indicate largest diameter below)		X	At isolated points on embankment slopes?		X
10. Cracks or scarps on crest?		X	At natural hillside in the embankment area?		X
11. Is there significant settlement along the crest?		X	Over widespread areas?		X
12. Are decant trashracks clear and in place?		N/A	From downstream foundation area?		X
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		X	"Boils" beneath stream or ponded water?		X
14. Clogged spillways, groin or diversion ditches?		N/A	Around the outside of the decant pipe?		X
15. Are spillway or ditch linings deteriorated?		N/A	22. Surface movements in valley bottom or on hillside?		X
16. Are outlets of decant or underdrains blocked?		N/A	23. Water against downstream toe?		X
17. Cracks or scarps on slopes?		X	24. Were Photos taken during the dam inspection?	X	

Major adverse changes in these items could cause instability and should be reported for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, volume, etc.) in the space below and on the back of this sheet.

Issue #	Comments
1	Formal inspections conducted annually. Daily inspections conducted by plant staff and documented using checklist reports.
3, 4, 12, 14, 15, 16, 20	Bottom Ash Pond consists of two cells. Each cell has a suction pipe inlet on the opposite end from the sluice outlet. The suction pipe flows to a valve box used to recycle water to the plant. In abnormal conditions, the pipe flow can be rerouted to the process water pond for discharge to Fairfield Lake.
6	Piezometers at toe of embankment. Piezometers read semi-annually.
8	INA: Information Not Available

Coal Combustion Waste (CCW)

Impoundment Inspection

Impoundment NPDES Permit WQ0001309000 **INSPECTOR** Mike McLaren
Joe Klein

Date September 26, 2012
Impoundment Name Bottom Ash Pond
Big Brown Steam Electric Station
Impoundment Company TXU Big Brown Company, LP
EPA Region 6

State Agency (Field Office) Address Texas Commission on Environmental Quality
P.O. Box 13087
Austin, TX 78711
Name of Impoundment Big Brown Steam Electric Station
Bottom Ash Pond

(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New ☐ **Update** ☒

	Yes	**No**
Is impoundment currently under construction?	☐	☒
Is water or ccw currently being pumped into the impoundment?	☒	☐

IMPOUNDMENT FUNCTION: Receive and store sluiced bottom ash

Nearest Downstream Town Name: There are no towns downstream of the plant location between it and the Trinity River. There are no towns along the Trinity River in the general area of the plant site.

Distance from the impoundment: Trinity River is about 4 miles east of Big Brown Steam Electric Station

Location:

Latitude	31	Degrees	49	Minutes	18.47	Seconds	**N**
Longitude	96	Degrees	03	Minutes	39.44	Seconds	**W**

State Texas **County** Freestone

	Yes	No
Does a state agency regulate this impoundment?	☒	☐

If So Which State Agency? Texas Commission on Environmental Quality

HAZARD POTENTIAL *(In the event the impoundment should fail, the following would occur):*

☐ **LESS THAN LOW HAZARD POTENTIAL:** Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.

☒ **LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

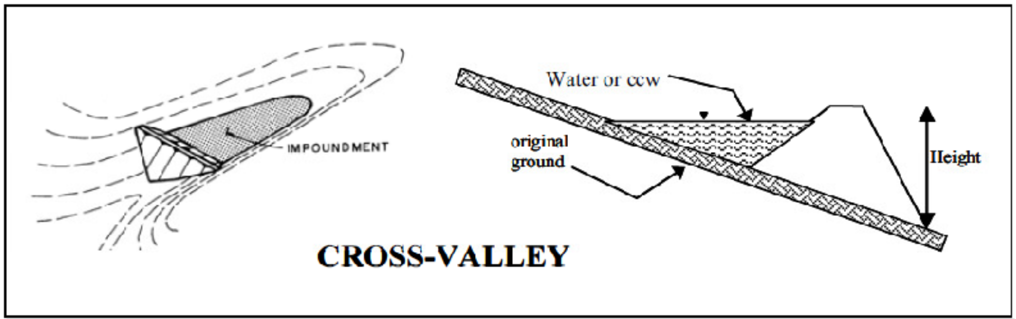
☐ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

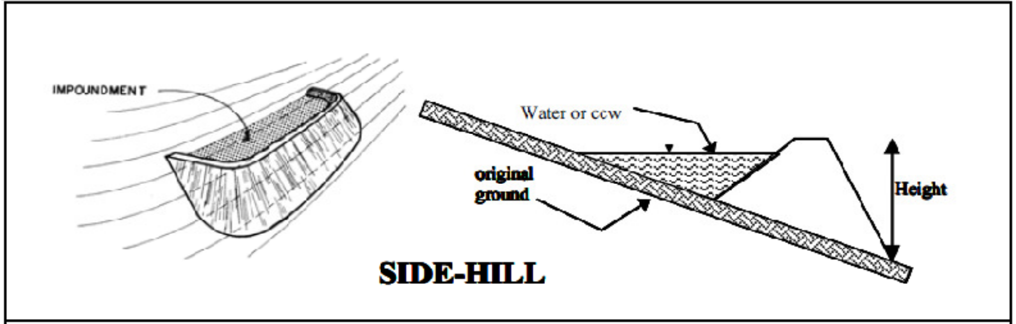
☐ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

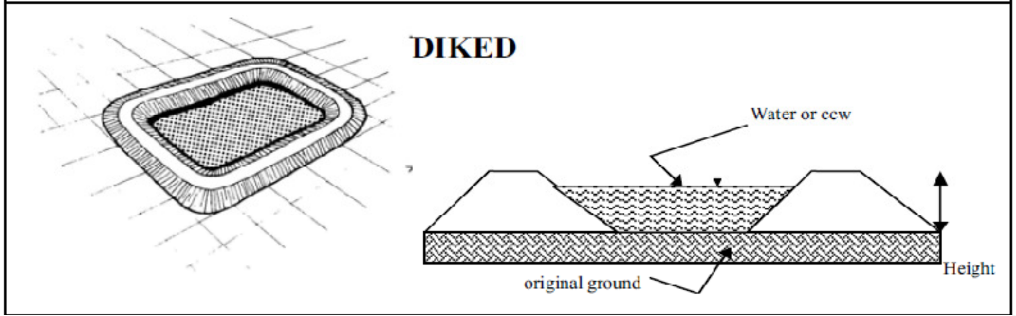
DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

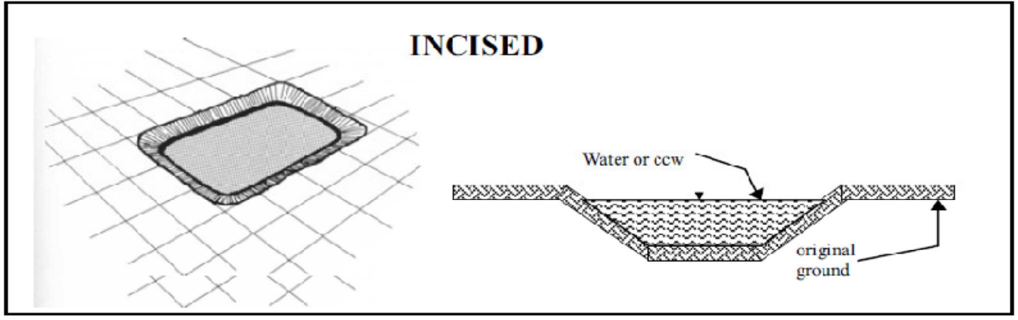
Based on the size and location of the Big Brown Steam Electric Station Bottom Ash Pond, there is no probable loss of life in the event of failure or misoperation. Economic and environmental losses are expected to be low and limited to the owner's property. The plant owner owns Fairfield Lake and most of the surrounding property. There is a State Park located on the upper end of Fairfield Lake. The park property is owned by Luminant and leased to the State for a nominal annual amount to provide public recreational access to the lake.

CONFIGURATION:









☐ Cross-Valley ☐ Side-Hill ☒ Diked

☐ Incised (form completion optional) ☐ Combination Incised/Diked

Embankment Height (ft)	25	**Embankment Material**	Soil Fill
Pool Area (ac)	19.3	**Liner**	Compacted Clay
Current Freeboard (ft)	3	**Liner Permeability**	10^{-7} cm/sec

TYPE OF OUTLET (Mark all that apply)

☐ **Open Channel Spillway**

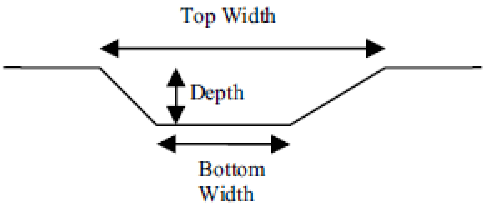
- ☐ Trapezoidal
- ☐ Triangular
- ☐ Rectangular
- ☐ Irregular

depth (ft)

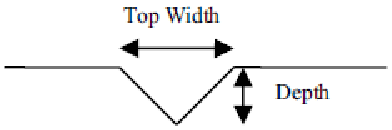
average bottom width (ft)

top width (ft)

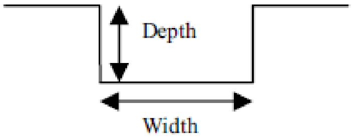
TRAPEZOIDAL



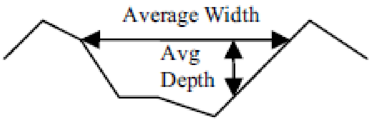
TRIANGULAR



RECTANGULAR

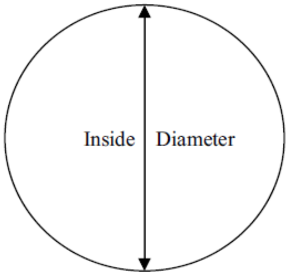


IRREGULAR



☐ **Outlet**

18” inside diameter
(SDR 17 – smooth lined – 19.5” OD)



Material

- ☐ corrugated metal
- ☐ welded steel
- ☐ concrete
- ☐ plastic (hdpe, pvc, etc.)
- ☐ other (specify):

	Yes	No
Is water flowing through the outlet?	☐	☐

☐ **No Outlet**

☒ **Other Type of Outlet** (specify):

Water from each of two cells is pumped from the bottom of the pond and recycled to the plant. In abnormal conditions, valves can direct pump discharge to plant discharge canal.

In emergency event, temporary pumps deployed to pump water into the plant discharge canal.

The Impoundment was Designed By Luminant

	Yes	No
Has there ever been a failure at this site?	☐	☒
If So When?		

If So Please Describe :

	Yes	No
Has there ever been significant seepages at this site?	☐	☒
If So When?		

If So Please Describe :

	Yes	No
Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site?	☐	☒
If so, which method (e.g., piezometers, gw pumping,...)?		

If So Please Describe :

ADDITIONAL INSPECTION QUESTIONS

Concerning the embankment foundation, was the embankment construction built over wet ash, slag, or other unsuitable materials? If there is no information just note that.

No formal documentation was available. However, it was reported that the Bottom Ash Pond was included in the original plant development. In the late 1980s and early 1990s both cells of the pond were upgraded. The upgrade included removal of stored ash, construction of a compacted clay liner and improvements at the suction line pipe inlets.

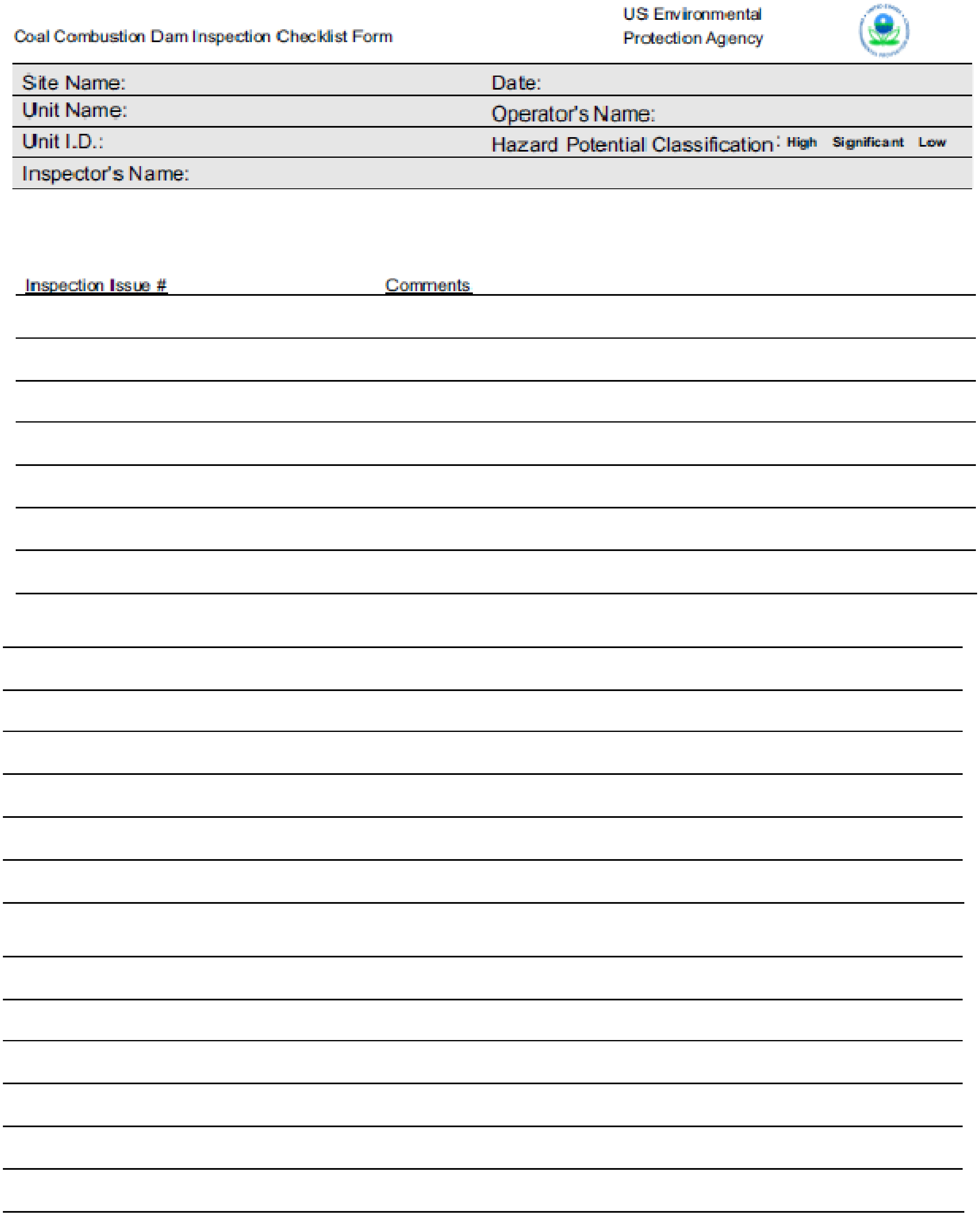
Observations during the site visit indicate the embankments were constructed on natural ground.

Did the dam assessor meet with, or have documentation from, the design Engineer-of-Record concerning the foundation preparation?

No documentation of original foundation preparation was provided.

From the site visit or from photographic documentation, was there evidence of prior releases, failures, or patchwork on the dikes?

Neither observations during the site visit, nor photographs in prior inspection reports provided to Dewberry indicate prior releases, failures or patchwork on the dikes.



Coal Combustion Dam Inspection Checklist Form

US Environmental
Protection Agency

Site Name:	Date:
Unit Name:	Operator's Name:
Unit I.D.:	Hazard Potential Classification: High Significant Low
Inspector's Name:	

Inspection Issue #	Comments

APPENDIX C

Document 8

Ash Pond Slope Stability Investigation Report, Golder Associates Inc., November 2012 (Revised December 2012)

REPORT

ASH POND SLOPE STABILITY INVESTIGATION REPORT

Big Brown Power Plant
Freestone County, Texas

Submitted To: Luminant – Systems Engineering
Energy Plaza, Floor 27
1601 Bryan Street
Dallas, Texas 75201

Submitted By: Golder Associates Inc.
500 Century Plaza Drive, Suite 190
Houston, TX 77073 USA
Texas Registration Number: F-2578

12/11/12
P. CHRIS MARSHALL
91893

P. Chris Marshall

November 2012 (Revised December 2012)

123-94128.001

A world of capabilities delivered locally

Golder Associates

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1.0 INTRODUCTION

This revised report supersedes original report submitted to Luminant on November 21, 2012.

1.1 Project Description

Luminant Power (Luminant) operates the Big Brown Power Plant, a lignite-fueled power plant near Fairfield, Freestone County, Texas. As part of regulatory compliance, the existing ash ponds are being characterized for slope stability. The ash ponds are located northwest of the power plant. The ash ponds consist of two adjacent ponds that share a dike that separates the two ponds. Each ash pond encompasses an area of approximately 8 acres.

Golder Associates Inc. (Golder) has been contracted by Luminant to perform a geotechnical site investigation at the facility and analyze the ash pond slope stability. This report presents the findings of the field investigation, boring logs, laboratory test results, a description of the subsurface soil conditions, and results of the slope stability analyses.

1.2 Scope of the Investigation

The scope of this investigation included:

- Drilling and sampling of six (6) geotechnical soil borings,
- Laboratory testing of representative soil samples,
- Characterization of subsurface conditions, and
- Slope stability analyses.

The subsurface investigation was performed on October 15, 16, and 17, 2012.

1.3 Coordinate System and Unit System

The soils boring locations and elevations were estimated by Golder using existing topographic maps and aerial imagery. We have reported coordinates with reference to latitude and longitude with WGS84 datum. All elevations are referenced to mean sea level (msl).

This report is presented using U.S. customary (or English) units.

2.0 SUBSURFACE INVESTIGATION

Golder performed a subsurface investigation that included six (6) soil borings. Two (2) borings were drilled to a depth of 30 feet below ground surface (bgs) and four (4) borings were drilled to a depth of 50 feet bgs. Table 1 provides the boring coordinates and elevations. The soils boring locations and elevations were estimated by Golder using existing topographic maps and aerial imagery. Boring locations are shown on Figure 1.

TABLE 1. BORING COORDINATES

Boring Number	Latitude	Longitude	Elevation (ft-msl)	Boring Depth (ft)
BH-1	31°49'21"N	96° 3'41"W	350	50
BH-2	31°49'18"N	96° 3'48"W	350	50
BH-3	31°49'14"N	96° 3'54"W	350	30
BH-4	31°49'10"N	96° 3'51"W	350	30
BH-5	31°49'13"N	96° 3'44"W	350	50
BH-6	31°49'17"N	96° 3'37"W	350	50

2.1 Soil Boring Procedures

The borings were drilled by Van and Sons Drilling Service, Inc. using an all terrain truck-mounted drilling rig and rotary drilling methods with solid stem augers. Soil samples were collected at 2.5-foot intervals within the top 10 feet of the boring and at 5-foot intervals below 10 feet. The boring logs from the site investigation are included as Appendix A.

Disturbed soil samples were obtained in sand using an ASTM standard split spoon sampler, i.e., 2-inch outer diameter and 1-3/8- inch inner diameter. Standard Penetration Tests (SPT) were conducted during sampling. Sampling and testing were carried out in general agreement with the guidelines in ASTM D1586.

SPTs involve counting the number of blows of a 140 lb hammer dropping 30 inches needed for the sampler to penetrate three successive 6-inch increments into the soil. The reported N value is the number of blows required to penetrate the second and third 6-inch intervals, with units of blows/12 inches. In some hard clays and very dense sands, 50 blows are insufficient to advance the sampler 6 inches and penetration “refusal” was encountered. In this case the N value is not obtained and the incomplete penetration is recorded. This is registered in the boring logs as, for example, 50/5 in., i.e. 50 blows with only 5 inches of penetration.

Select samples were obtained in clayey soils using steel Shelby tubes. Shelby tubes were 30-inch long and 3-inch outer diameter (OD). The inside diameter was 2.87 inch giving an area ratio of 9% (C_a = 100 x (OD^2 – ID^2)/ID^2). These Shelby tubes have a cutting edge diameter (D_e) of 2.85 in., thus an inside clearance ratio (C_i = 100 x (ID-D_e)/D_e) equal to 0.7%. The recovery ratio (length recovered/length pushed) is typically variable and dependent on the soil stiffness, with higher recovery values generally obtained in softer clays. The recovery ratio is reported in the individual boring logs.

All borings were sampled by a Golder field engineer and the soils were described using a modified version of the Unified Soil Classification System (ASTM D 2487). The soil description included a density or consistency qualifier, color, structural characteristics when evident, composition with major component in capital letters, and minor characteristics.

After visual classification, recovered samples from SPTs were placed in plastic bags to preserve the natural moisture content. After retrieval and visual soil identification of each Shelby tube sample, a pocket penetrometer test was performed at the bottom end of the sample. Shelby tubes pushed in stiff to hard clayey soils were extruded in the field and the recovered samples were placed in plastic storage tubes and plastic bags to preserve the moisture content. All samples were labeled and transported back to the Golder's Houston office for laboratory soils testing.

Boring logs were prepared from the field logs using the software package gINT v. 8.1.021. The boring logs are provided in Appendix A.

Following the completion of the ash pond soil borings, the boreholes were backfilled with bentonite grout and finished with cement to the surface.

2.2 Laboratory Testing

Laboratory testing was performed on selected samples, in accordance with commonly accepted methods and practices. Undisturbed and disturbed soil samples were tested to determine water content, Atterberg limits, grain size distribution, and shear strength. Water content determination was performed in accordance with ASTM D2216; Atterberg limits were determined in accordance with ASTM D4318; and grain size distribution was performed in accordance with ASTM D422. Shear strength testing consisted of unconsolidated-undrained (UU) and consolidated-undrained (CU) triaxial compression tests in general accordance with ASTM D2850 and D4767, respectively. Laboratory data summary sheets are presented in Appendix B. Laboratory test result sheets are presented in Appendix C.

2.3 Subsurface Conditions

The soils encountered in the borings generally consist of very stiff to hard sandy clays and compact to very dense clayey sands. The subsurface stratigraphy generally consists of clayey or silty sand with interspersed layers of sandy clay and lean clay. The sandy clay and lean clay layers range in thickness from approximately 5 to 17 feet. A thin (less than 5 feet thick) layer of loose to compact clayey sand was encountered in BH-1, BH-2 and BH-5 at a depth of approximately 44 feet bgs. All of the borings except BH-3 and BH-6 were terminated in a stratum of compact to very dense silty sand. BH-3 and BH-6 were terminated in layers of dense to very dense sand.

Groundwater was encountered in 2 of the 6 borings. Groundwater elevations encountered during drilling ranged from 320 to 332 ft-msl. Our analyses were conducted assuming groundwater elevation at each cross section based on the boring closest to that cross section.

3.0 STABILITY ANALYSES

Slope stability analyses were performed using the commercial slope stability software program, SLIDE Version 6.0. The site topography and geometry used in the analyses were determined from site survey and design drawings provided by Luminant.

The typical containment dike section has an interior (wet side) slope of 2.5 horizontal to 1 vertical (2.5H:1V) and a minimum exterior (dry side) slope of 2H:1V. The crest elevation of the containment dike is at approximately 350 ft-msl. The ponds are lined with 3 feet of compacted clay. The top of liner elevation on the pond floors is approximately 328 ft-msl. The most critical slope geometry was identified along the west sideslope, consisting of an approximately 24-foot high, 1.7H:1V slope.

Stability analyses were performed for four (4) separate slope sections to assess the various soil conditions and slope geometries around the ponds; analysis locations are shown on Figure 2. Stability analyses considered “empty pond” and “full pond” conditions.

A rapid drawdown scenario was analyzed for one full pond condition at each section. The analysis was completed on the drained or undrained section with the lower factor of safety in the full condition. The analysis was completed using the B-bar method to simulate the effects of rapid drawdown in a low permeability material such as the sandy clays and clayey sands encountered at Big Brown. The initial water level was modeled as the full condition and the final water level was modeled at the pond floor, representing a final condition after drawdown where the pond is empty.

The most critical slope geometry was identified along the east sideslope. The effect of pseudo-static earthquake loading was also analyzed at this location. The plant is not located in a seismic zone (Reference: Figure 6 of EM 1110-2-1902, “Stability of Earth and Rock-Fill Dams”, U.S. Army Corps of Engineers, 1970), so a nominal seismic coefficient of 0.01g was therefore used in the earthquake loading analysis.

The soils encountered in the borings are not susceptible to liquefaction.

3.1 Soil Properties

For each slope section, a conservative, generalized subsurface stratigraphy was developed based on soil boring information and laboratory soil testing results from the borings conducted as part of this investigation. The soil properties assumed for the slope sections are provided in Table 2.

TABLE 2. SOIL MATERIAL PROPERTIES

Soil Material	Description	Moist Unit Weight (lb/ft^3)	Saturated Unit Weight (lb/ft^3)	Undrained Soil Properties		Drained Soil Properties	
				Undrained Shear Strength, s_u (lb/ft^2)	Friction Angle, φ (°)	Cohesion, c' (lb/ft^2)	Friction Angle, φ' (°)
I	Sandy Clay/ Clayey Sand	127	132	1500	0	1000	14
II	Clean Sand	127	132	0	29	0	29

3.2 Slope Stability Results

Slope stability analyses were performed for both short-term and long-term conditions using undrained and drained soil properties, respectively. The results of the analyses are provided in Table 3. SLIDE output files are included in Appendix D. A factor of safety of 1.5 is typically considered adequate for permanent slopes. The minimum calculated factor of safety from our analyses is 2.5 (Case 2) for normal loading conditions. Therefore, our analyses indicate that the slopes are stable. Additionally, slope stability analyses for rapid drawdown and earthquake conditions have factors of safety greater than 1.5 as well.

TABLE 3. SLOPE STABILITY FACTORS OF SAFETY

Case	Description	Factor of Safety
1	East sideslope; empty pond; short-term (undrained) conditions	2.6
2	East sideslope; empty pond; long-term (drained) conditions	2.5
3	East sideslope; full pond; short-term (undrained) conditions	5.7
4	East sideslope; full pond; long-term (drained) conditions	5.9
5	East sideslope; empty pond; long-term (drained) conditions; seismic	2.4
6	East sideslope; rapid drawdown	2.6
7	North sideslope; empty pond; short-term (undrained) conditions	3.3
8	North sideslope; empty pond; long-term (drained) conditions	3.2
9	North sideslope; full pond; short-term (undrained) conditions	6.3
10	North sideslope; full pond; long-term (drained) conditions	6.6
11	North sideslope; rapid drawdown	3.1
12	Northeast sideslope; empty pond; short-term (undrained) conditions	3.5
13	Northeast sideslope; empty pond; long-term (drained) conditions	3.6
14	Northeast sideslope; full pond; short-term (undrained) conditions	3.5
15	Northeast sideslope; full pond; long-term (drained) conditions	3.6
16	Northeast sideslope; rapid drawdown	3.6
17	West sideslope; empty pond; short-term (undrained) conditions	5.5
18	West sideslope; empty pond; long-term (drained) conditions	4.4
19	West sideslope; full pond; short-term (undrained) conditions	5.4
20	West sideslope; full pond; long-term (drained) conditions	4.4
21	West sideslope; rapid drawdown	4.4

4.0 IMPORTANT INFORMATION

Attention is drawn to the document - “Important Information About Your Geotechnical Engineering Report”, which is included in Appendix E of this report. This document has been prepared by the ASFE (Professional Firms Practicing in the Geosciences), of which Golder is a member. The statements presented in this document are intended to advise owners of what their realistic expectations of this report should be, and to present recommendations on how to minimize the risks associated with the groundworks for this project. The document is not intended to reduce the level of responsibility accepted by Golder, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

5.0 CLOSING

Golder appreciates the opportunity to assist Luminant with this project. If you have any questions, or require further assistance from Golder, please contact the undersigned at (281) 821-6868.

Very truly yours,

GOLDER ASSOCIATES INC.

P. Chris Marshall

P. Chris Marshall, P.E.
Senior Project Engineer

Charles F. Rickert, P.E.
Associate

J:_2012\123-94128 - Luminant_A - Ash Pond Slope Stability\12394128A001.dwg | Layout: ANSI_A_FIGURE_LANDSCAPE | Modified: HRolwing 11/21/2012 8:09 AM | Plotted: HRolwing 11/21/2012

LEGEND

● BH-1 BORING LOCATION

REFERENCES / SPECIFICATIONS

IMAGE SOURCE:
GOOGLE EARTH PRO. 2010

####	####	####	HPR	VJE	HPR	PCM
REV	DATE	REVISION DESCRIPTION	DES	CADD	CHK	RVW

PROJECT
LUMINANT - BIG BROWN
ASH POND SLOPE STABILITY INVESTIGATION REPORT
FREESTONE COUNTY, TEXAS

TITLE

BORING LOCATION PLAN

Golder Associates

PROJECT No.	123-94128	FILE No.	12394128A001
		SCALE	NTS

FIG-1

J:_2012\123-94128 - Luminant_A - Ash Pond Slope Stability\12394128A002.dwg | Layout: ANSI_A_FIGURE_LANDSCAPE | Modified: HRolwing 11/21/2012 8:11 AM | Plotted: HRolwing 11/21/2012

LEGEND

——— ANALYSIS LOCATION

REFERENCES / SPECIFICATIONS

IMAGE SOURCE:
GOOGLE EARTH PRO. 2010

####	####	####	HPR	VJE	HPR	PCM
REV	DATE	REVISION DESCRIPTION	DES	CADD	CHK	RVW

PROJECT

LUMINANT - BIG BROWN
ASH POND SLOPE STABILITY INVESTIGATION REPORT
FREESTONE COUNTY, TEXAS

TITLE

ANALYSIS LOCATIONS

Golder Associates

PROJECT No.	123-94128	FILE No.	12394128A002
		SCALE	NTS

FIG-2

APPENDIX A
BORING LOGS

Golder Associates
500 Century Plaza Drive, Suite 190
Houston, Texas 77073
Telephone: (281) 821-6868
Fax: (281) 821-6870

BORING NUMBER BH-1

PAGE 1 OF 2

CLIENT Luminant

PROJECT NAME Pond Slope Stability

PROJECT NUMBER 123-94128

PROJECT LOCATION Big Brown Plant

DATE STARTED 10/15/12 **COMPLETED** 10/15/12

GROUND ELEVATION **HOLE SIZE** inches

DRILLING CONTRACTOR Van & Sons Drilling Service

GROUND WATER LEVELS:

DRILLING METHOD Mud Rotary

AT TIME OF DRILLING ---

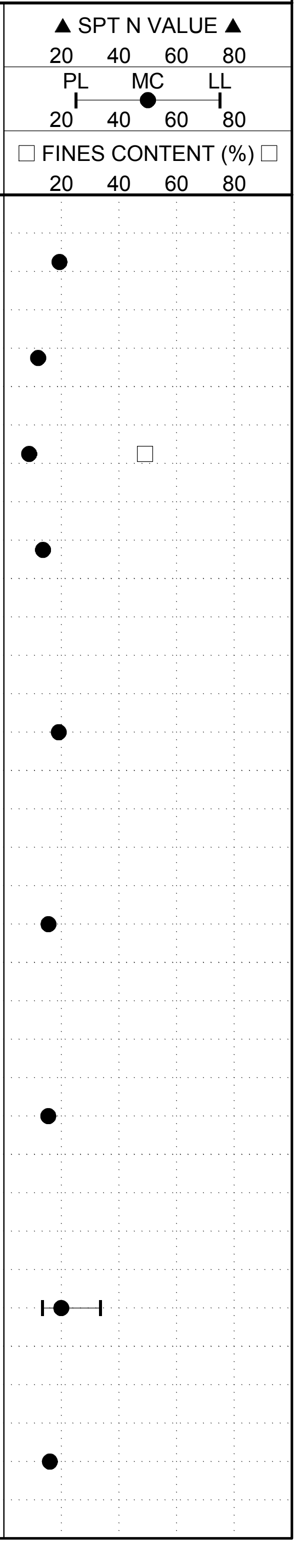
LOGGED BY HR **CHECKED BY** PCM

AT END OF DRILLING ---

NOTES

▽ **AFTER DRILLING** 20.00 ft

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0	(SC) CLAYEY SAND, medium to fine, well graded, light brown, and low plasticity clay, moist	SH 1	78		3.0	
5	sandy clay lenses, dry at 3.5'	SH 2			4.9	
	no clay lenses at 6.0'	SH 3	78		4.5	
10	(CL) LEAN CLAY, low plasticity, with sand, brown-orange, cohesive, dry	SH 4			4.5	
15	(SC) CLAYEY SAND, medium to fine, well graded, brown to orange, and low plasticity clay, moist	SH 5	65			
20	▽	SH 6	79		1.5	
25	gray at 23.0'	SH 7	83			
30	(CL) LEAN CLAY, low plasticity, some fine to medium sand, gray to brown, cohesive, moist	SH 8	79			
35		SH 9	83			



(Continued Next Page)

Golder Associates
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Houston, Texas 77073
Telephone: (281) 821-6868
Fax: (281) 821-6870

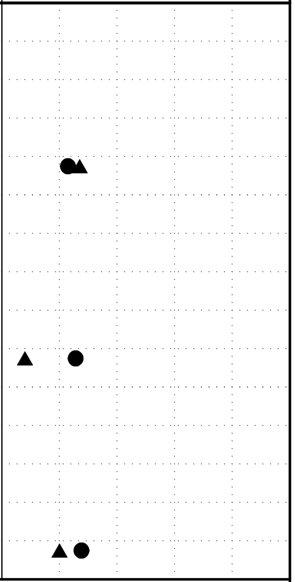
BORING NUMBER BH-1

CLIENT Luminant

PROJECT NAME Pond Slope Stability

PROJECT NUMBER 123-94128

PROJECT LOCATION Big Brown Plant

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 PL MC LL 20 40 60 80 ☐ FINES CONTENT (%) ☐ 20 40 60 80
35	▨	(CL) LEAN CLAY, low plasticity, some fine to medium sand, gray to brown, cohesive, moist *(continued)*						
40	▨	(SC) CLAYEY SAND, medium to fine, well graded, with low plasticity clay, brown, wet	SS 10	83	12-13-14 (27)			
45			SS 11	100	5-5-3 (8)			
50			SS 12	100	8-9-11 (20)			

Bottom of borehole at 50.0 feet.

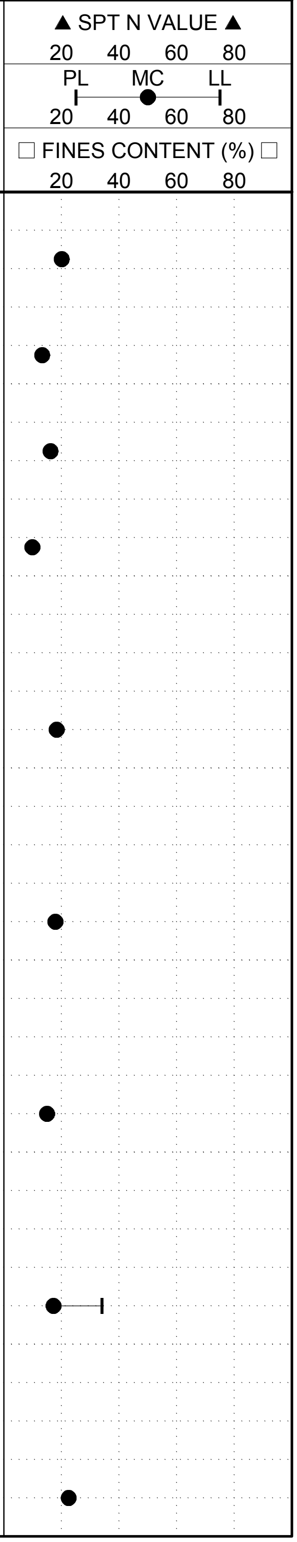
GEOTECH BH PLOTS - GINT STD US LAB.GDT - 11/20/12 15:09 - P:_2012 PROJECT FOLDERS\123-94128 LUMINANT POND SLOPE STABILITY\BIG BROWN FIELD INVESTIGATION\94128BIGBROWN.GPJ

Golder Associates
500 Century Plaza Drive, Suite 190
Houston, Texas 77073
Telephone: (281) 821-6868
Fax: (281) 821-6870

BORING NUMBER BH-2

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Big Brown Plant
DATE STARTED 10/16/12 **COMPLETED** 10/16/12
GROUND ELEVATION **HOLE SIZE** inches
DRILLING CONTRACTOR Van & Sons Drilling Service
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING ---
LOGGED BY HR **CHECKED BY** PCM
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0		(CL) LEAN CLAY, low plasticity, with sand and gravel, decreasing coarse content with depth, dry, gray and brown					
			SH 1	58		4.5	
5			SH 2	75		4.5	
		(SC) CLAYEY SAND, medium to fine, well graded, with low plasticity clay, brown, moist	SH 3	100		4.5	
10			SH 4	50		3.0	
15			SH 5	67		4.5	
20		decreasing clay with depth at 18.0'	SH 6	44		2.25	
25			SH 7	94		4.5	
30		gray and orange at 28.0'	SH 8	88		4.5	
35			SH 9	90		2.5	



(Continued Next Page)

Golder Associates
500 Century Plaza Drive, Suite 190
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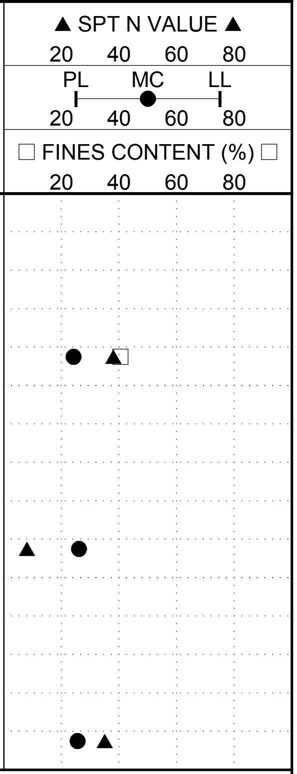
Telephone: (281) 821-6868
Fax: (281) 821-6870

BORING NUMBER BH-2

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Big Brown Plant

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
35		(SC) CLAYEY SAND, medium to fine, well graded, with low plasticity clay, brown, moist *(continued)*					
		wet at 38.5'	SS 10	56	15-18-20 (38)		
40							
			SS 11	100	3-3-5 (8)		
45							
50			SS 12	100	18-18-17 (35)		



Bottom of borehole at 50.0 feet.

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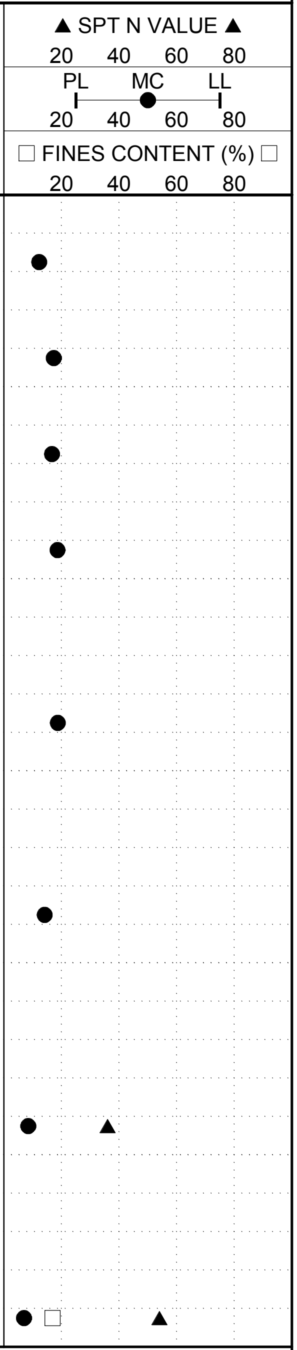
Houston, Texas 77073
Telephone: (281) 821-6868
Fax: (281) 821-6870

BORING NUMBER BH-3

PAGE 1 OF 1

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Big Brown Plant
DATE STARTED 10/15/12 **COMPLETED** 10/15/12
GROUND ELEVATION
HOLE SIZE inches
DRILLING CONTRACTOR Van & Sons Drilling Service
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING ---
LOGGED BY HR **CHECKED BY** PCM
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0	(SC) CLAYEY SAND, medium to fine, some gravel, brown, moist					
		SH 1	56		2.5	
5	increasing clay content and clay lenses at 3.5'	SH 2	67		4.5	
	(CL) LEAN CLAY, low plasticity, and well graded, medium to fine sand, light brown, moist	SH 3	72		4.5	
10		SH 4	89		4.5	
15		SH 5	81		4.5	
20	(SC) CLAYEY SAND, medium to fine, brown, moist	SH 6	75		4.0	
25	(SP) SAND, poorly graded, medium, tan, moist	SS 7	89	13-18-18 (36)		
30		SS 8	100	13-24-30 (54)		



Bottom of borehole at 30.0 feet.

Golder Associates
500 Century Plaza Drive, Suite 190
Houston, Texas 77073
Telephone: (281) 821-6868
Fax: (281) 821-6870

BORING NUMBER BH-4

PAGE 1 OF 1

CLIENT Luminant

PROJECT NAME Pond Slope Stability

PROJECT NUMBER 123-94128

PROJECT LOCATION Big Brown Plant

DATE STARTED 10/16/12 **COMPLETED** 10/16/12

GROUND ELEVATION **HOLE SIZE** inches

DRILLING CONTRACTOR Van & Sons Drilling Service

GROUND WATER LEVELS:

DRILLING METHOD Mud Rotary

AT TIME OF DRILLING ---

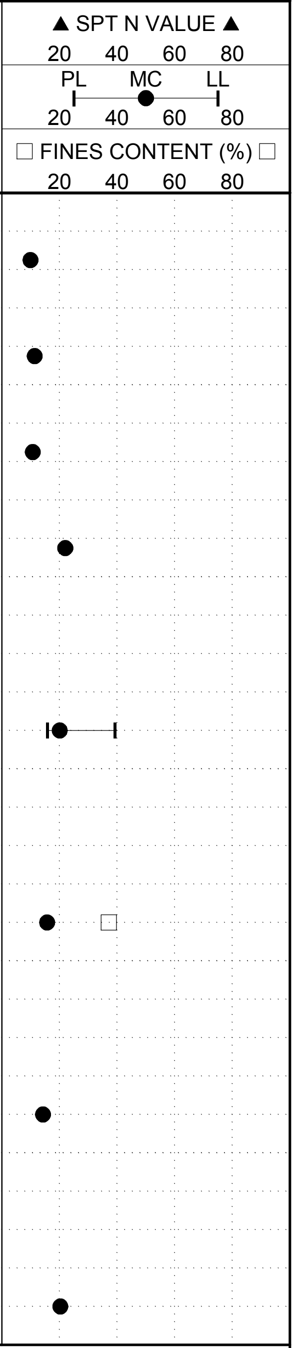
LOGGED BY HR **CHECKED BY** PCM

AT END OF DRILLING ---

NOTES

AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0		(SC) CLAYEY SAND, medium to fine, well graded, and low plasticity clay, moist					
			SH 1	56		4.5	
		dry at 3.5'	SH 2	67		4.5	
5							
		moist at 6.0'	SH 3	72		4.5	
			SH 4	100		4.0	
10							
		(CL) LEAN CLAY, low plasticity, with medium to fine sand, gray - brown, moist, cohesive	SH 5	83		1.5	
15							
		(SC) CLAYEY SAND, medium to fine, well graded, and low plasticity clay, moist	SH 6	54		1.5	
20							
			SH 7	58		2	
25							
			SH 8	92		1.0	
30							



Bottom of borehole at 30.0 feet.

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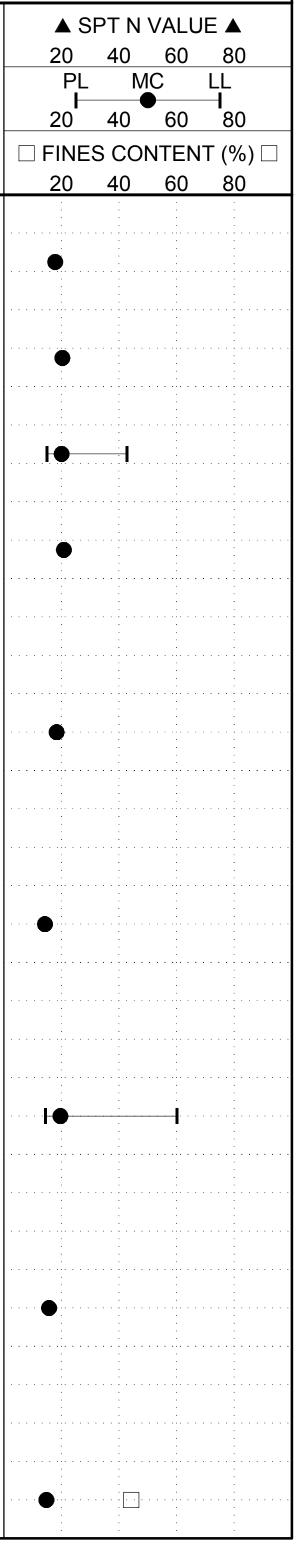
BORING NUMBER BH-5

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Big Brown Plant
DATE STARTED 10/16/12 **COMPLETED** 1/16/12
GROUND ELEVATION **HOLE SIZE** inches
DRILLING CONTRACTOR Van & Sons Drilling Service
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING ---
LOGGED BY HR **CHECKED BY** PCM
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0	(CL) SANDY LEAN CLAY, low plasticity, medium to fine, well graded, brown and orange, cohesive, moist					
		SH 1	78		4.5	
5	trace gravel, red and gray at 3.5'	SH 2	78		4.5	
		SH 3	100		2.25	
	(SC) CLAYEY SAND, medium to fine, well graded, some low plasticity clay, orange, cohesive, moist					
10	(CL) SANDY LEAN CLAY, low plasticity, medium to fine, well graded, brown and orange, cohesive, moist	SH 4	89		0.75	
	(SC) CLAYEY SAND, medium to fine, well graded, some low plasticity clay, gray to brown, non-cohesive, moist					
15	(CL) SANDY LEAN CLAY, low plasticity, medium to fine, well graded, gray and brown, cohesive, moist	SH 5	75		3.25	
20	(SW) WELL GRADED SAND, medium to fine, with low plasticity clay lenses, orange, non-cohesive, moist	SH 6	52		3.0	
25	(CH) SANDY FAT CLAY, high plasticity, medium to fine, well graded, gray, cohesive, moist	SH 7	83		2.75	
	(CL) SANDY LEAN CLAY, low plasticity, medium to fine, well graded, gray, cohesive, moist orange and gray at 28.0'					
30		SH 8	73		4.5	
35	(SC) CLAYEY SAND, medium to fine, well graded, some low plasticity clay, gray and orange, cohesive, moist	SH 9	67		4.25	



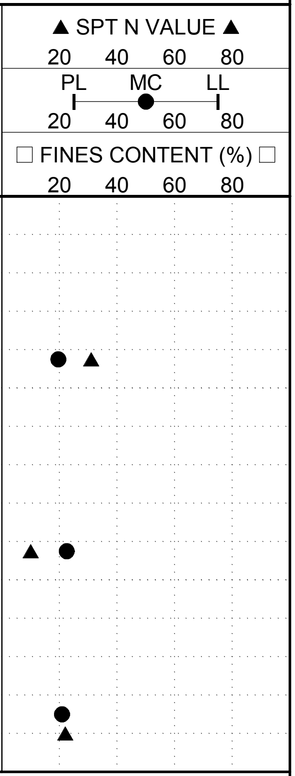
(Continued Next Page)

BORING NUMBER BH-5

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Big Brown Plant

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
35		(SC) CLAYEY SAND, medium to fine, well graded, some low plasticity clay, gray and orange, cohesive, moist *(continued)*					
40			SS 10	100	13-15-16 (31)		
		wet at 43.5'					
45			SS 11	100	4-5-5 (10)		
50			SS		10-10-12 (22)		

Bottom of borehole at 50.0 feet.



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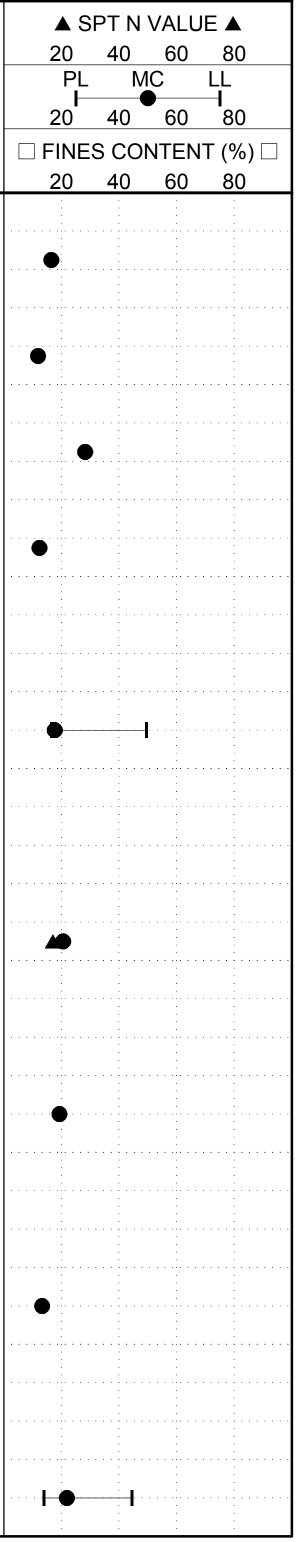
BORING NUMBER BH-6

PAGE 1 OF 2

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Big Brown Plant
DATE STARTED 10/16/12 **COMPLETED** 10/16/12
GROUND ELEVATION **HOLE SIZE** inches
DRILLING CONTRACTOR Van & Sons Drilling Service
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING ---
LOGGED BY HR **CHECKED BY** PCM
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft) 0	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
		(SC) CLAYEY SAND, medium to fine, well graded, some low plasticity clay, brown, cohesive, moist	SH 1	28			
5		and low plasticity clay at 3.5'	SH 2	67		4.5	
		(CL) SANDY LEAN CLAY, low plasticity, some medium to fine sand, orange, wet	SH 3	72		0.0	
		(SW) WELL GRADED SAND, medium to fine, gray, dry					
10		(SC) CLAYEY SAND, medium to fine, well graded, and low plasticity clay, orange, dry, cohesive	SH 4	61		4.5	
15		(CL) LEAN CLAY, low plasticity, some medium to fine sand, orange, moist, cohesive	SH 5	54		4.5	
20		(SC) CLAYEY SAND, medium to fine, well graded, and low plasticity clay, gray, moist, cohesive	SS 6	54	5-7-10 (17)		
25		(CL) SANDY LEAN CLAY, low plasticity, increasing sand with depth, gray, cohesive, moist	SH 7	100		2.0	
30		(SC) CLAYEY SAND, medium to fine, well graded, and low plasticity clay, gray and orange, possible some lignite (black), moist, cohesive	SH 8	88		3.5	
35		no lignite at 33.0'	SH 9	69		3.5	



(Continued Next Page)

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BORING NUMBER BH-6

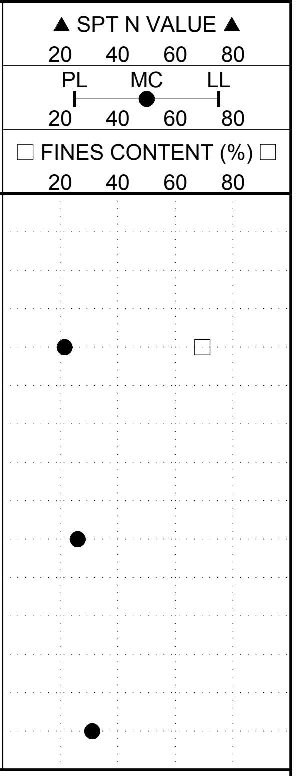
CLIENT Luminant

PROJECT NAME Pond Slope Stability

PROJECT NUMBER 123-94128

PROJECT LOCATION Big Brown Plant

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
35		(SC) CLAYEY SAND, medium to fine, well graded, and low plasticity clay, gray and orange, possible some lignite (black), moist, cohesive *(continued)*					
40		(SW) WELL GRADED SAND, medium to fine, trace low plasticity clay lenses, gray, non-cohesive, moist	SH 10	60		0.0	
45		orange, clay nodules at 43.0'	SH 11	50		0.0	
50		with stiff, gray, clay nodules and lenses at 48.0'	SH 12	46		0.0	



Bottom of borehole at 50.0 feet.

APPENDIX B
LABORATORY TEST SUMMARY SHEETS

SUMMARY OF LABORATORY RESULTS

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Big Brown Plant

Sample ID	Depth	Natural Moisture (%)	Atterberg Limits			%<#200 Sieve	Class-ification	Unit Weight		Permeability (cm/sec)	Additional Lab Testing
			Liquid Limit	Plastic Limit	Plasticity Index			Moisture Content (%)	Dry Density (psf)		
BH-1	1	19.3									
BH-1	4	11.9									
BH-1	6	8.8									
BH-1	9	13.6									
BH-1	13	19.1									
BH-1	18	15.5									
BH-1	23	15.4									
BH-1	28	19.9	33	13	20						
BH-1	33	16.0									
BH-1	39	22.9									
BH-1	44	25.6									
BH-1	49	27.6									
BH-2	1	20.1									
BH-2	4	13.3									
BH-2	6	16.2									
BH-2	9	9.9									
BH-2	13	18.3									
BH-2	18	17.9									
BH-2	23	15.0									
BH-2	28	17.2	34	17	17						
BH-2	33	22.5									
BH-2	39	24.2									
BH-2	44	26.1									
BH-2	49	25.6									
BH-3	1	12.2									
BH-3	4	17.3									
BH-3	6	16.7									
BH-3	9	18.6									
BH-3	13	18.7									
BH-3	18	14.1									
BH-3	24	8.5									
BH-3	29	7.0				17					
BH-4	1	9.9									
BH-4	4	11.4									
BH-4	6	10.7									
BH-4	9	22.0									
BH-4	13	20.1	39	16	23						
BH-4	18	15.7									
BH-4	23	14.3									
BH-4	28	20.3									
BH-5	1	17.8									

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SUMMARY OF LABORATORY RESULTS

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Big Brown Plant

Sample ID	Depth	Natural Moisture (%)	Atterberg Limits			%<#200 Sieve	Class-ification	Unit Weight		Permeability (cm/sec)	Additional Lab Testing
			Liquid Limit	Plastic Limit	Plasticity Index			Moisture Content (%)	Dry Density (psf)		
BH-5	4	20.3									
BH-5	6	20.0	43	15	28						
BH-5	9	20.8									
BH-5	13	18.3									
BH-5	18	14.2									
BH-5	23	19.6	60	14	46						
BH-5	28	15.7									
BH-5	33	14.8									
BH-5	39	19.6									
BH-5	44	22.5									
BH-5	49	20.9									
BH-6	1	16.5									
BH-6	4	11.9									
BH-6	6	28.2									
BH-6	9	12.3									
BH-6	13	17.7	49	16	33						
BH-6	19	20.6									
BH-6	23	19.3									
BH-6	28	13.3									
BH-6	33	21.9	44	14	30						
BH-6	38	21.5				69					
BH-6	43	26.0									
BH-6	48	31.1									

APPENDIX C
LABORATORY TEST RESULTS

ATTERBERG LIMIT RESULTS

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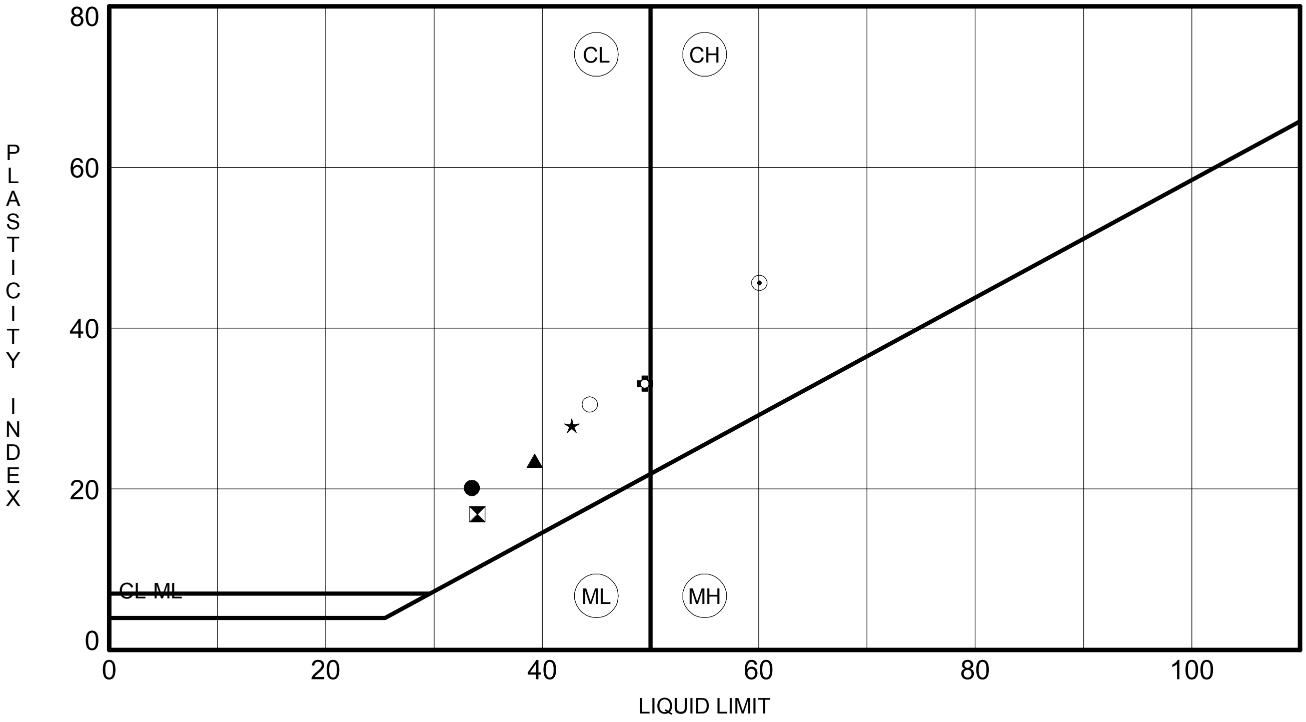
ATTERBERG LIMITS' RESULTS

CLIENT Luminant

PROJECT NAME Pond Slope Stability

PROJECT NUMBER 123-94128

PROJECT LOCATION Big Brown Plant



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**BH-1**	**28.0**	**33**	**13**	**20**		
⧗	**BH-2**	**28.0**	**34**	**17**	**17**		
▲	**BH-4**	**13.0**	**39**	**16**	**23**		
★	**BH-5**	**6.0**	**43**	**15**	**28**		
⊙	**BH-5**	**23.0**	**60**	**14**	**46**		
✪	**BH-6**	**13.0**	**49**	**16**	**33**		
○	**BH-6**	**33.0**	**44**	**14**	**30**		

GRAIN SIZE ANALYSIS

GRAIN SIZE - CQA - GINT STD US LAB.GDT - 11/16/12 13:59 - P:_2012 PROJECT FOLDERS\123-94128 LUMINANT POND SLOPE STABILITY\BIG BROWN FIELD INVESTIGATION\94128BIGBROWN.GPJ

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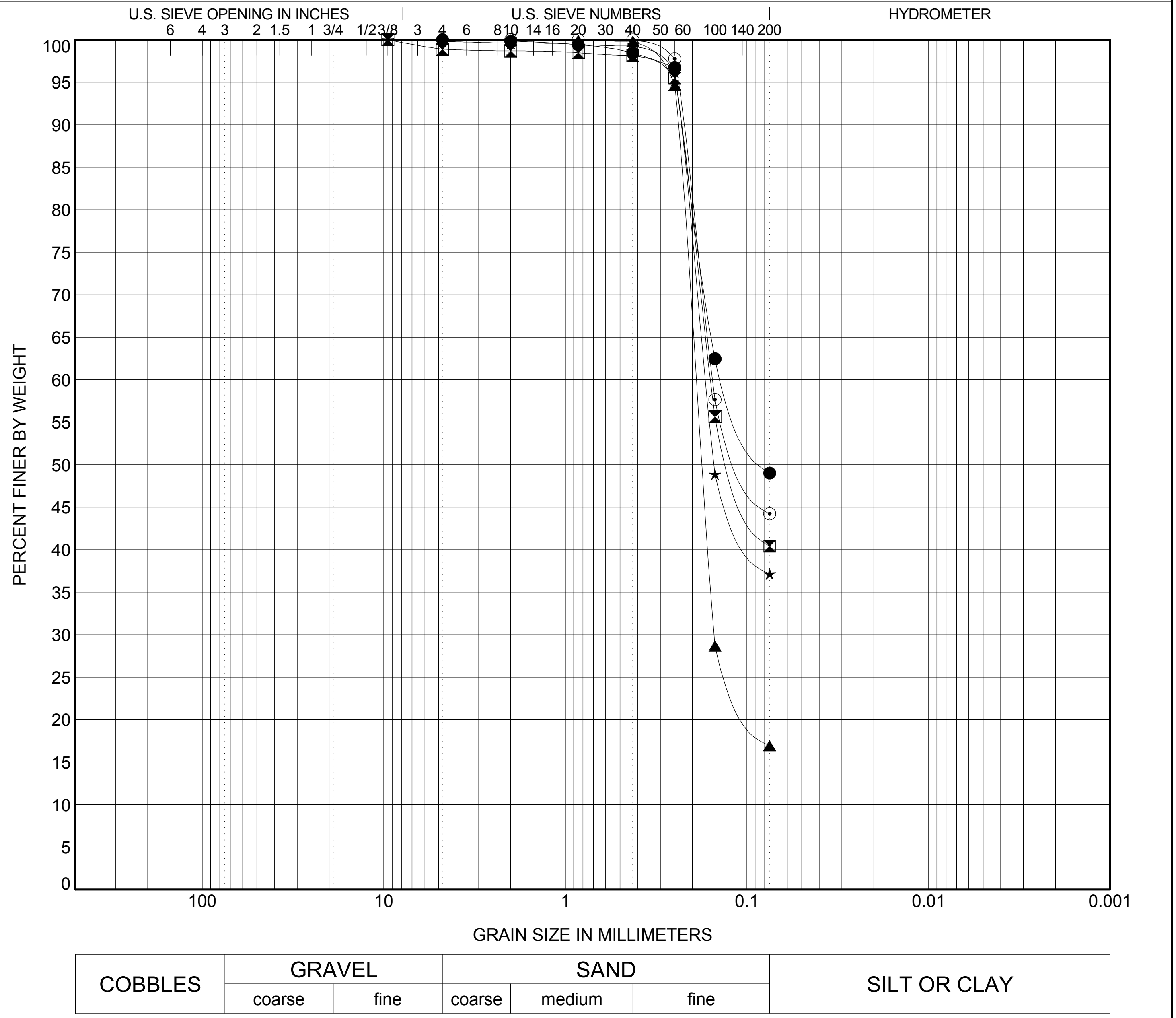
GRAIN SIZE DISTRIBUTION

CLIENT Luminant

PROJECT NAME Pond Slope Stability

PROJECT NUMBER 123-94128

PROJECT LOCATION Big Brown Plant



	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**BH-1**	**6**						
⧗	**BH-2**	**39**						
▲	**BH-3**	**29**						
★	**BH-4**	**18**						
☉	**BH-5**	**33**						

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH-1**	**6**	**4.75**	**0.132**			**0.0**	**51.0**	**49.0**	
⧗	**BH-2**	**39**	**9.5**	**0.159**			**1.1**	**58.5**	**40.4**	
▲	**BH-3**	**29**	**4.75**	**0.191**	**0.152**		**0.0**	**83.1**	**16.9**	
★	**BH-4**	**18**	**9.5**	**0.169**			**0.2**	**62.7**	**37.2**	
☉	**BH-5**	**33**	**2**	**0.155**			**0.0**	**55.8**	**44.2**	

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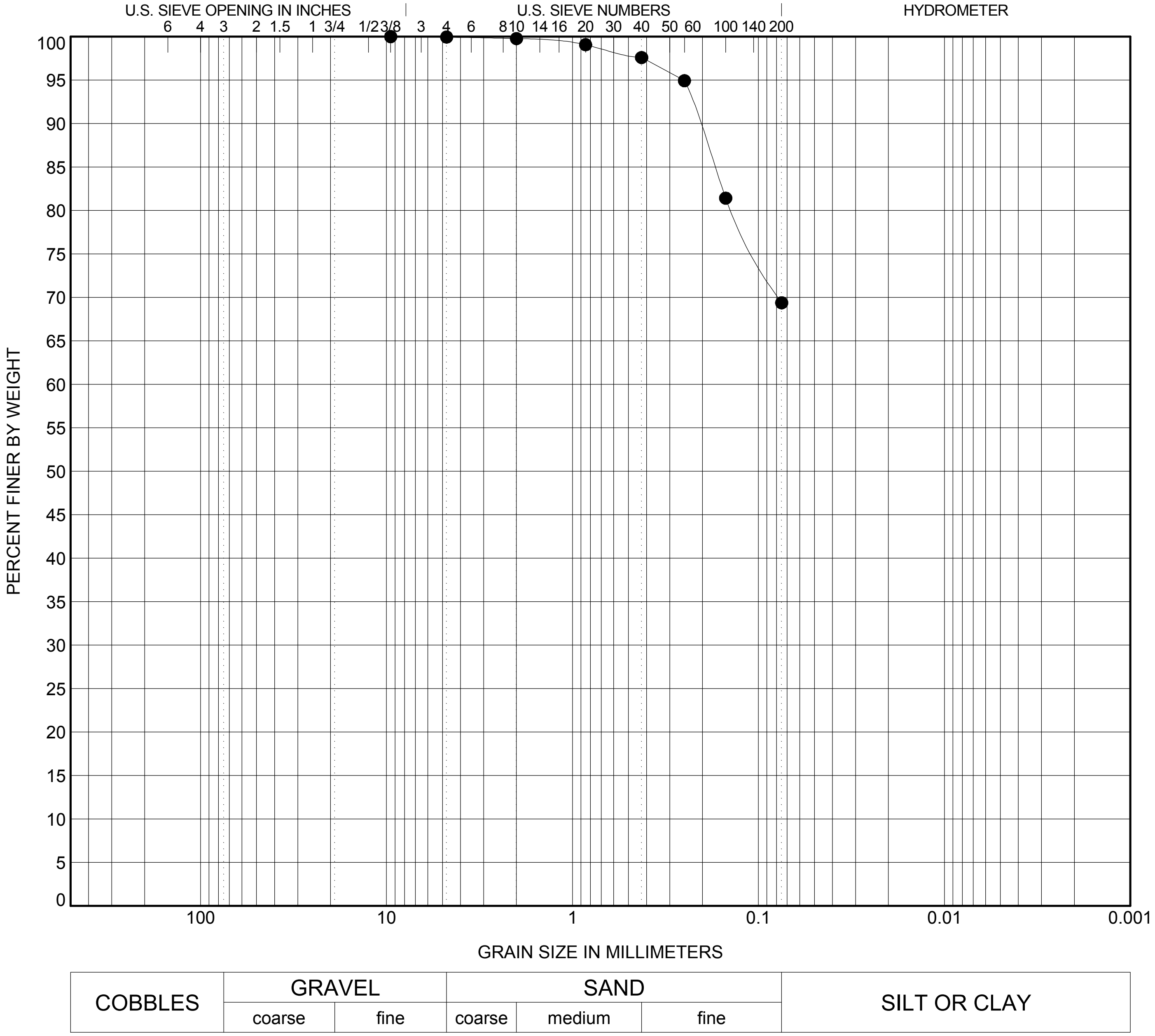
GRAIN SIZE DISTRIBUTION

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Big Brown Plant

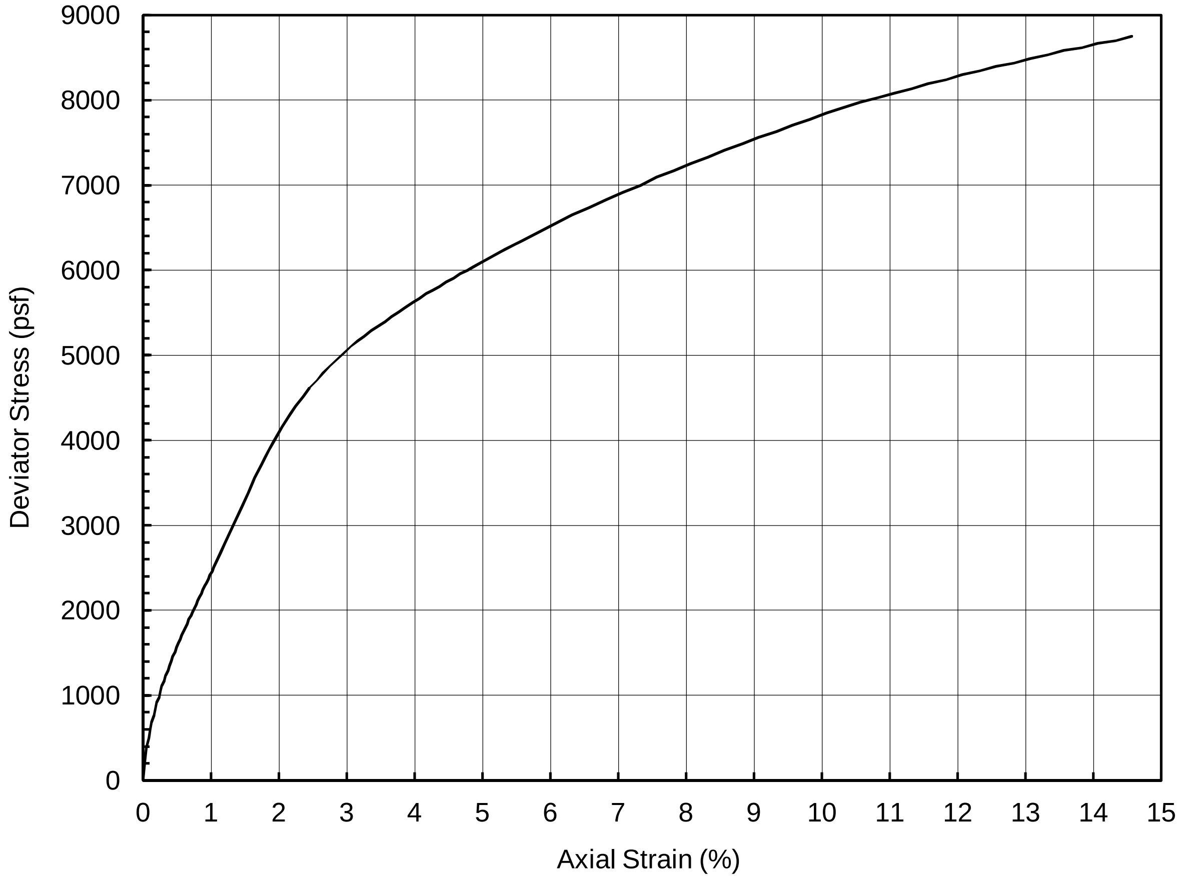


BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
● **BH-6**	**38**						

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **BH-6**	**38**	**9.5**				**0.1**	**30.6**	**69.4**	

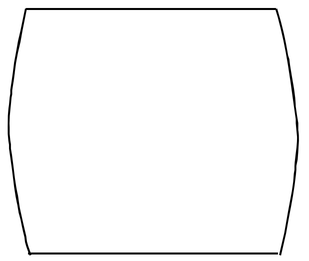
UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH (UU)

UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Light Tan and Gray Clayey Sand						
LL	33	PI	20	LI	0.2	USCS	CL

Depth (ft)	28.0	Confining Pressure (psf)	2879
Specimen Height (inch)	5.9	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	8784
Initial Specimen Weight (g)	1253.7	Axial Strain at Peak Stress (%)	15.0
Moist Unit Weight (pcf)	132.8		
Initial Water Content (%)	17		
Initial Dry Unit Weight (pcf)	113.3		



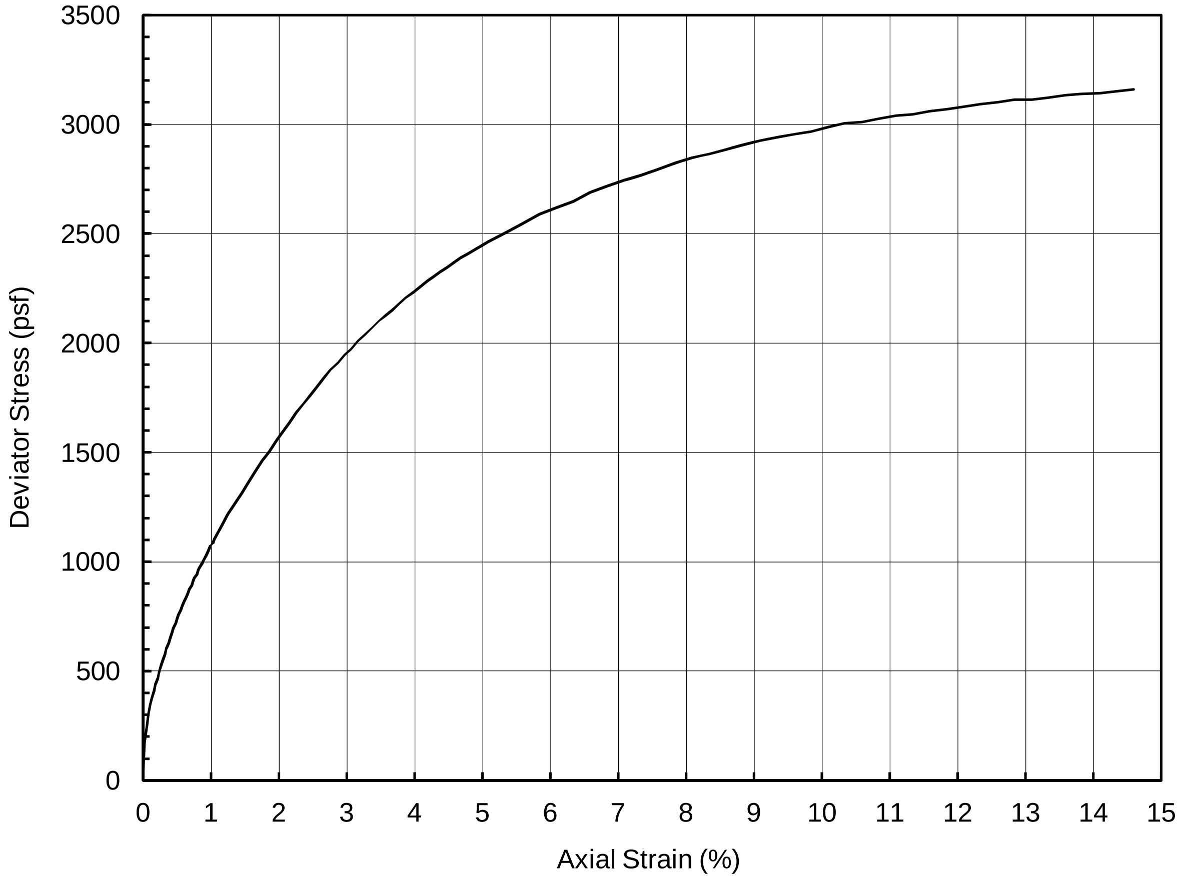
Failure Sketch

Project Title	Luminant - Big Brown Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-2 TO-8
Comments	

Golder Associates

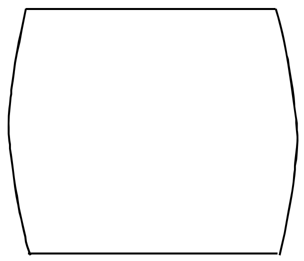
Performed by	**PN**
Date	**7-Nov-12**
Check	**HR**
Review	**PCM**

UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Light Tan and Gray Clayey Sand						
LL	39	PI	23	LI	0.2	USCS	CL

Depth (ft)	13.0	Confining Pressure (psf)	1754
Specimen Height (inch)	4.9	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	3164
Initial Specimen Weight (g)	950.5	Axial Strain at Peak Stress (%)	14.8
Moist Unit Weight (pcf)	121.4		
Initial Water Content (%)	20		
Initial Dry Unit Weight (pcf)	101.3		



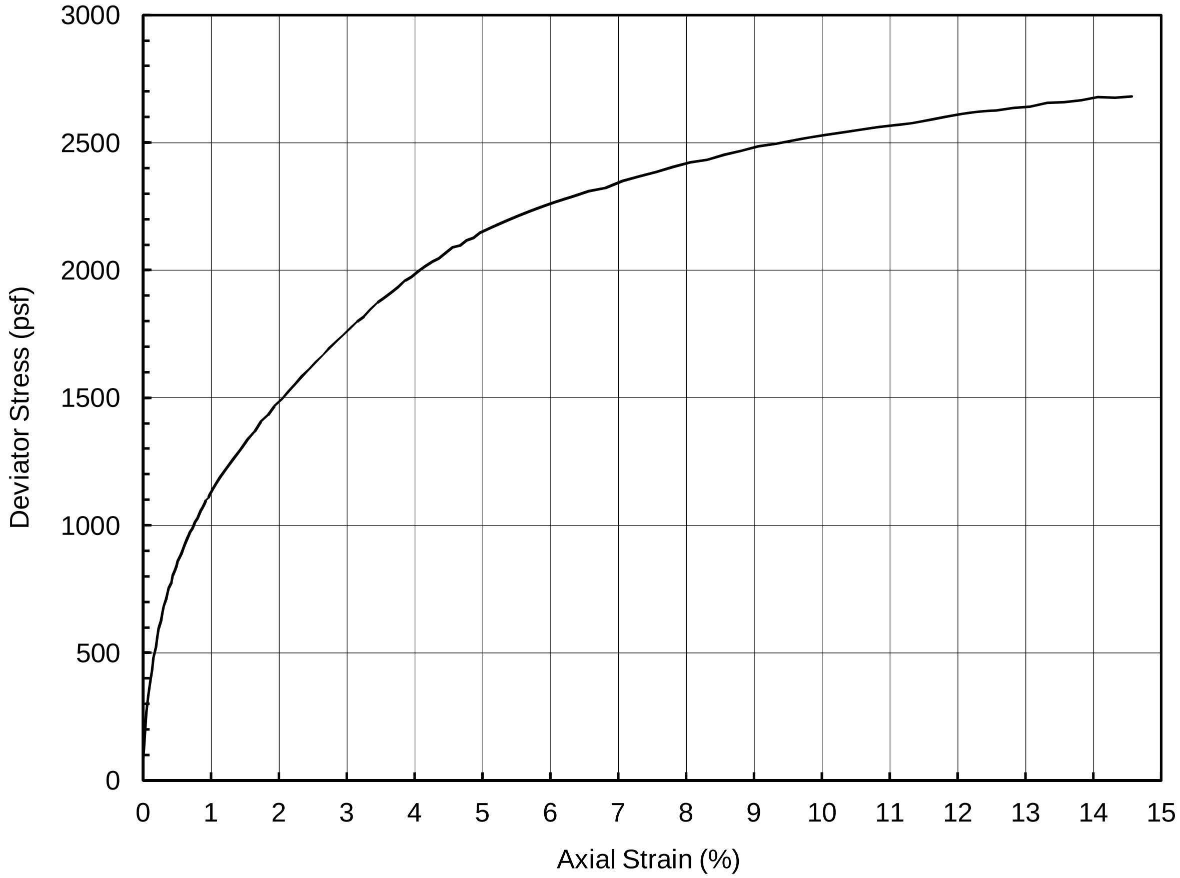
Failure Sketch

Project Title	Luminant - Big Brown Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-4 TO-5
Comments	Sample L/D ratio < 2

Golder Associates

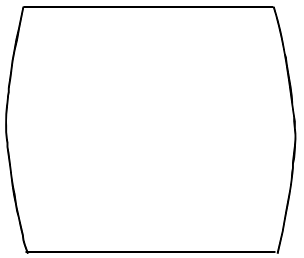
Performed by	**PN**
Date	**7-Nov-12**
Check	**HR**
Review	**PCM**

UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Reddish Gray Clayey Sand						
LL	43	PI	28	LI	0.2	USCS	CL

Depth (ft)	6.0	Confining Pressure (psf)	891
Specimen Height (inch)	4.6	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	2688
Initial Specimen Weight (g)	926.5	Axial Strain at Peak Stress (%)	14.8
Moist Unit Weight (pcf)	122.1		
Initial Water Content (%)	20		
Initial Dry Unit Weight (pcf)	101.5		



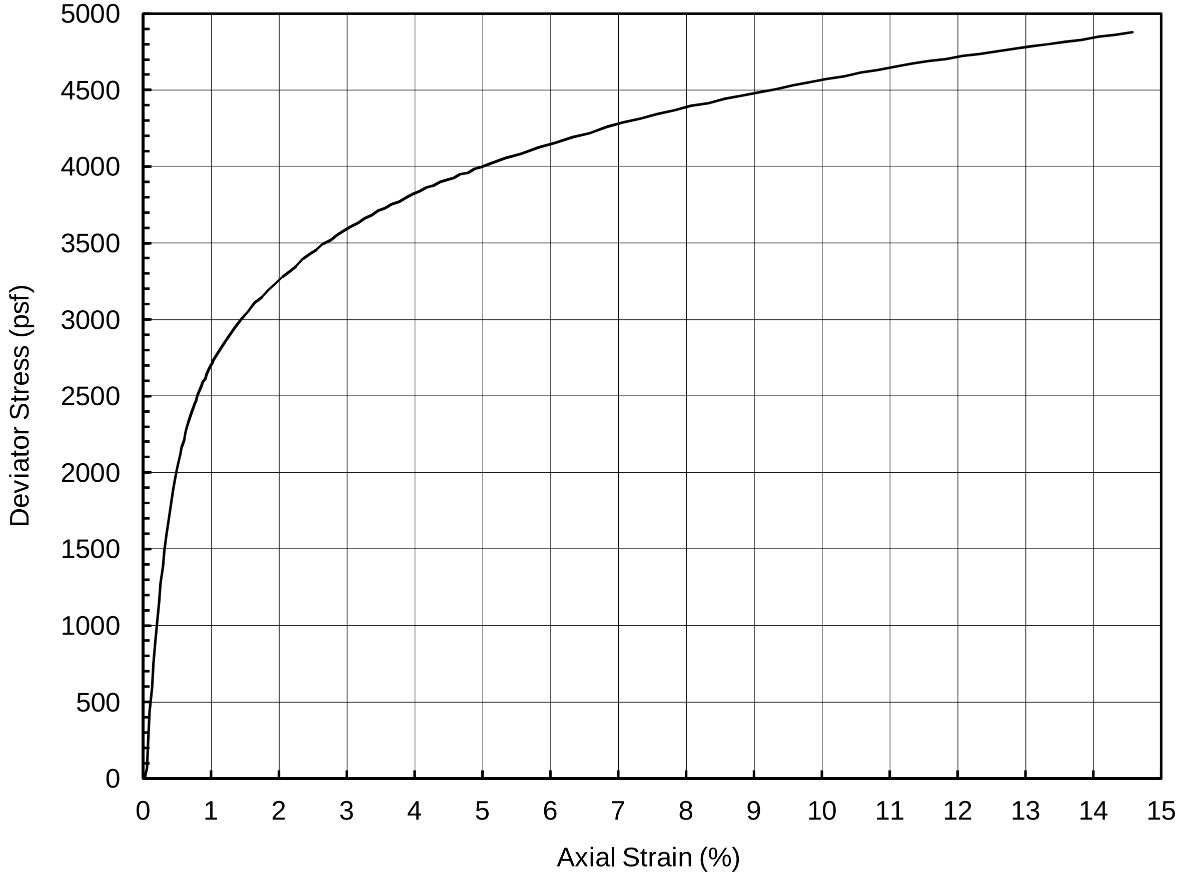
Failure Sketch

Project Title	Luminant - Big Brown Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-5 TO-3
Comments	Sample L/D ratio < 2

Golder Associates

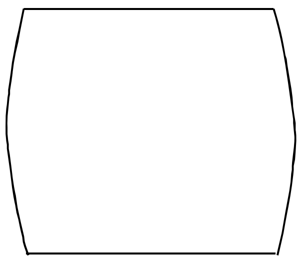
Performed by	**PN**
Date	**7-Nov-12**
Check	**HR**
Review	**PCM**

UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description		Reddish Gray Clay					
LL	60	PI	46	LI	0.1	USCS	CH

Depth (ft)	23.0	Confining Pressure (psf)	2879
Specimen Height (inch)	6.0	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	4887
Initial Specimen Weight (g)	1218.0	Axial Strain at Peak Stress (%)	15.0
Moist Unit Weight (pcf)	131.2		
Initial Water Content (%)	20		
Initial Dry Unit Weight (pcf)	109.1		

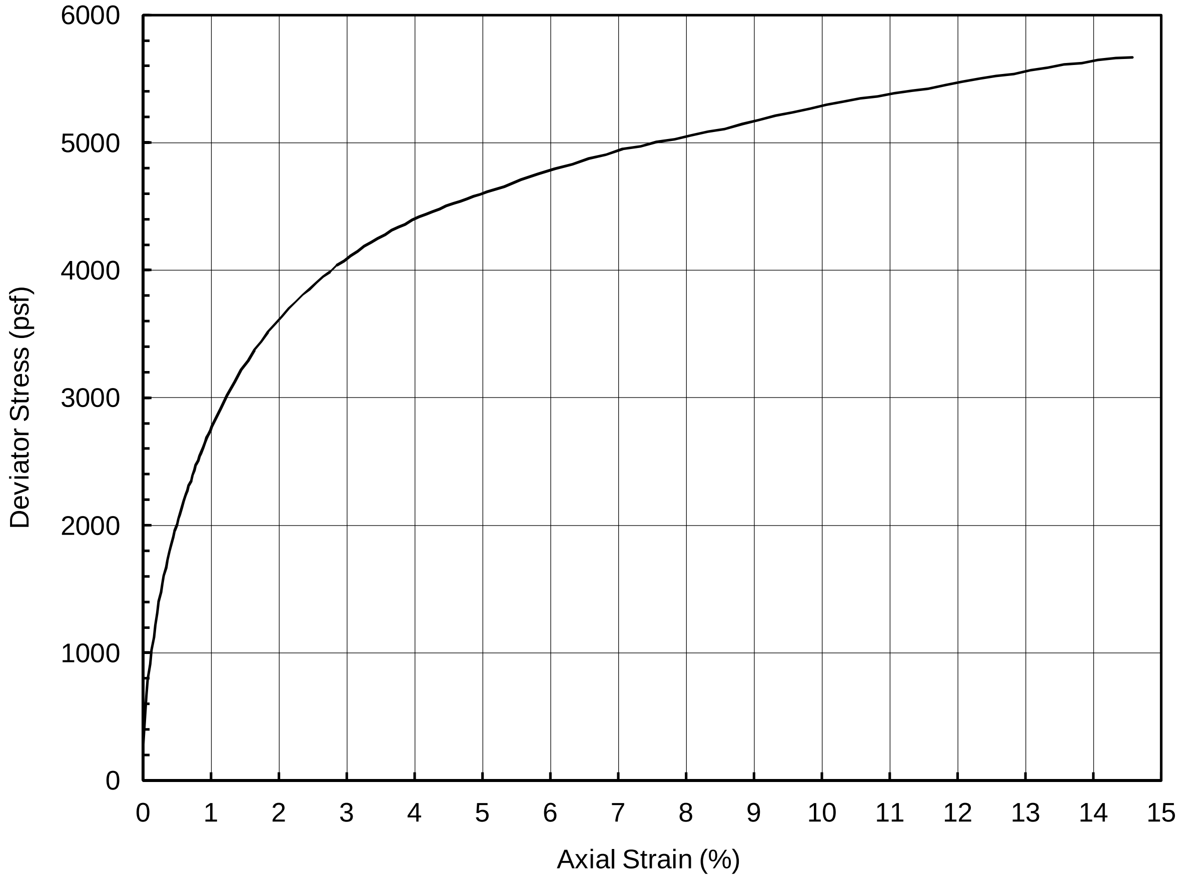

Failure Sketch

Project Title	Luminant - Big Brown Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-5 TO-7
Comments	

Golder Associates

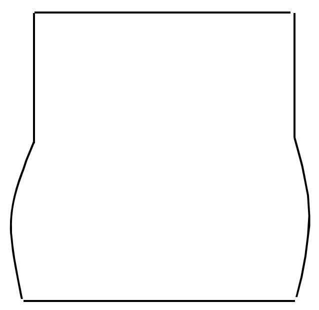
Performed by	**PN**
Date	**8-Nov-12**
Check	**HR**
Review	**PCM**

UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Light Red Sandy Clay						
LL	49	PI	33	LI	0.0	USCS	CL

Depth (ft)	13.0	Confining Pressure (psf)	1752
Specimen Height (inch)	5.7	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	5685
Initial Specimen Weight (g)	1150.2	Axial Strain at Peak Stress (%)	14.8
Moist Unit Weight (pcf)	125.3		
Initial Water Content (%)	17		
Initial Dry Unit Weight (pcf)	107.5		



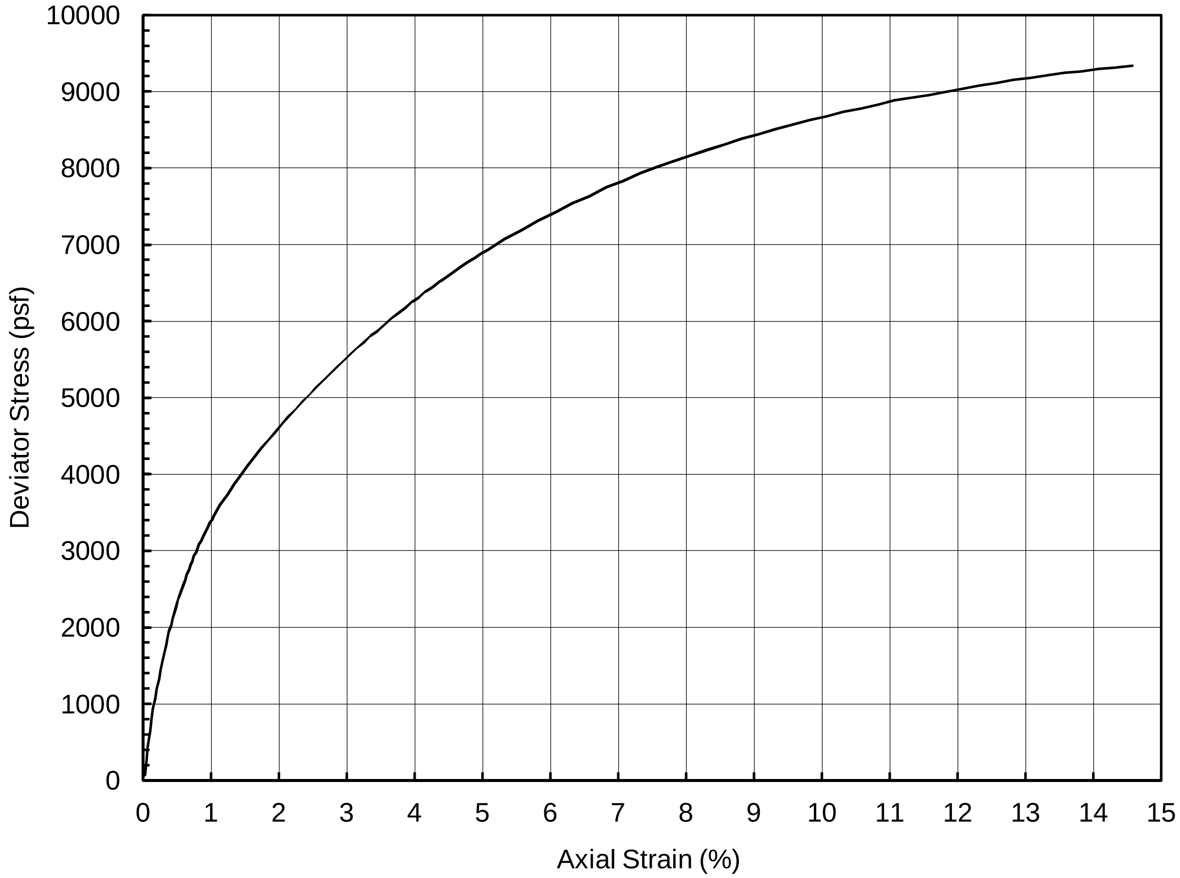
Failure Sketch

Project Title	Luminant - Big Brown Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-6 TO-5
Comments	

Golder Associates

Performed by	**PN**
Date	**8-Nov-12**
Check	**HR**
Review	**PCM**

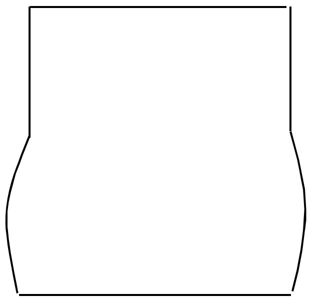
UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Light Gray Sandy Clay						
LL	44	PI	30	LI	0.1	USCS	CL

Depth (ft)	33.0	Confining Pressure (psf)	3304
Specimen Height (inch)	6.0	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.9	Peak Deviator Stress (psf)	9360
Initial Specimen Weight (g)	1270.9	Axial Strain at Peak Stress (%)	15.0
Moist Unit Weight (pcf)	127.4		
Initial Water Content (%)	18		
Initial Dry Unit Weight (pcf)	107.9		

Project Title	Luminant - Big Brown Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-6 TO-9
Comments	



Failure Sketch

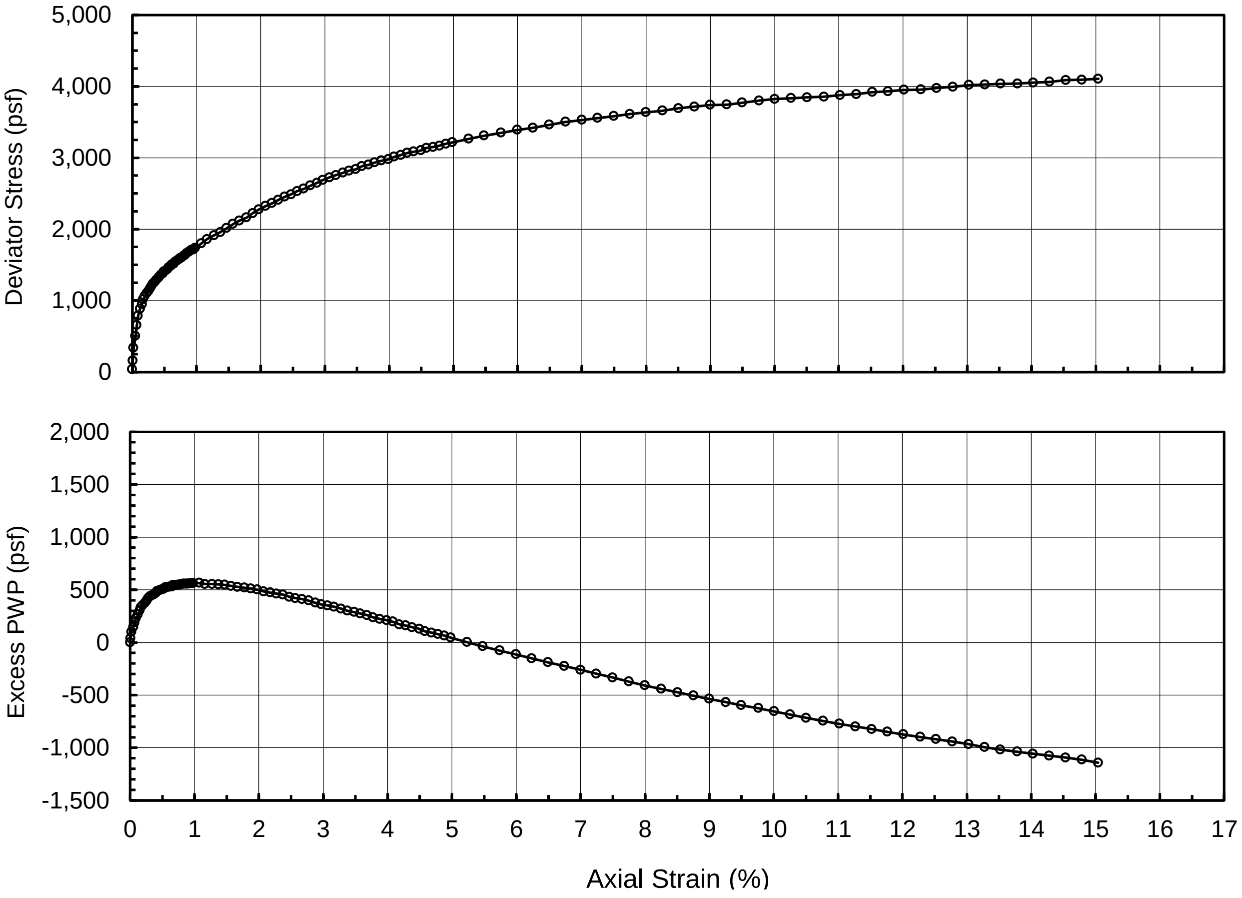
Golder Associates

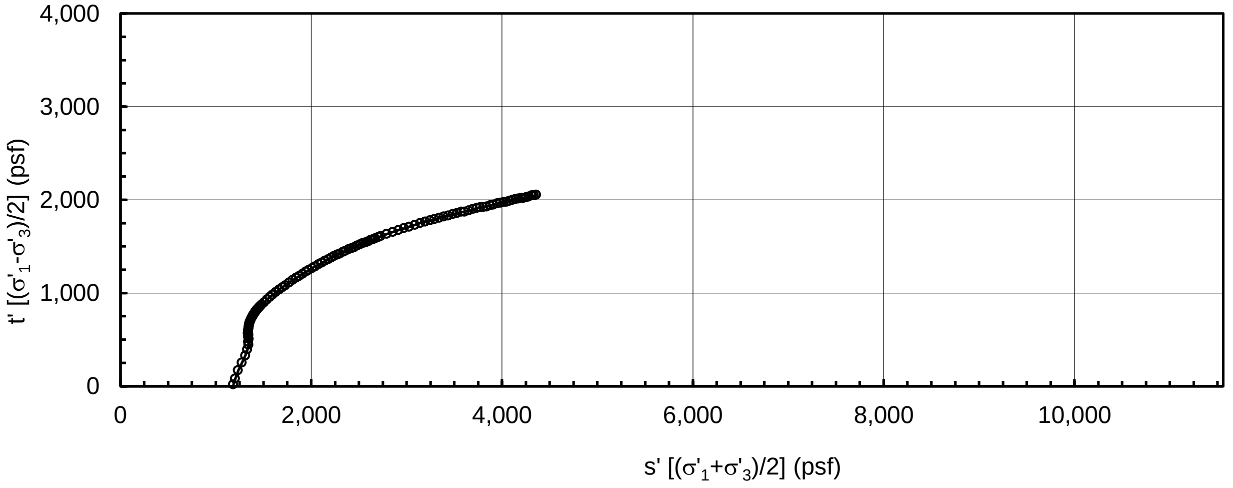
Performed by	**PN**
Date	**9-Nov-12**
Check	**HR**
Review	**PCM**

ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL TEST (ICU)

Isotropically Consolidated Undrained Triaxial Test (ICU)

Project Title: Big Brown Plant, Pond Stability
Project Number: 123-94128
Date: 11-Nov-12
Boring Number: BH-1
Specimen Name: TO-8
Depth (ft): 28.0





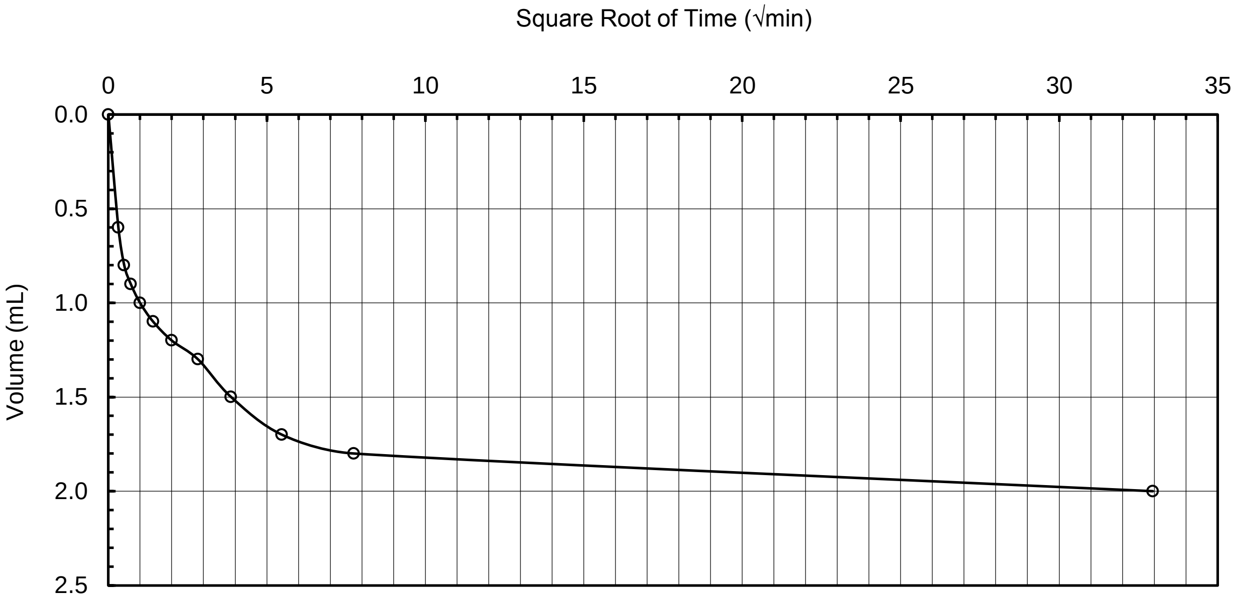
Specimen Description: Dark Gray Sandy CLAY

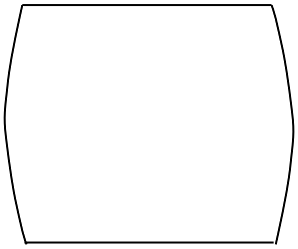
Initial Specimen Diameter (inch) =	2.84	Initial Specimen Height (inch) =	5.95
Initial Water Content (%) =	15.4	Water Content at End of Test (%) =	18.4
Initial Moist Unit Weight (pcf) =	127.6	B-value =	0.98
Back Pressure (BP, psf) =	4320.0	Consolidation Stress (σ'_3, psf) =	1165.6
Initial Lateral Stress (σ'_3, psf) =	1165.6	Consolidation t_{50} (min) =	10
Initial Deviator Stress (σ_1 - σ_3, psf) =	36.4	Rebound Stress (σ'_3, psf) =	NA
Test Strain Rate (%/hour) =	1.0	Rebound t_{50} (min) =	NA

LL =	33	PI =	20	USCS	CL	**Performed by**	SBK
Comments:						**Reviewed by**	PCM

Isotropically Consolidated Undrained Triaxial Test (ICU)

Project Title: Big Brown Plant, Pond Stability **Project Number:** 123-94128 **Date:** 11-Nov-12
Boring Number: BH-1 **Specimen Name:** TO-8 **Depth (ft):** 28.0





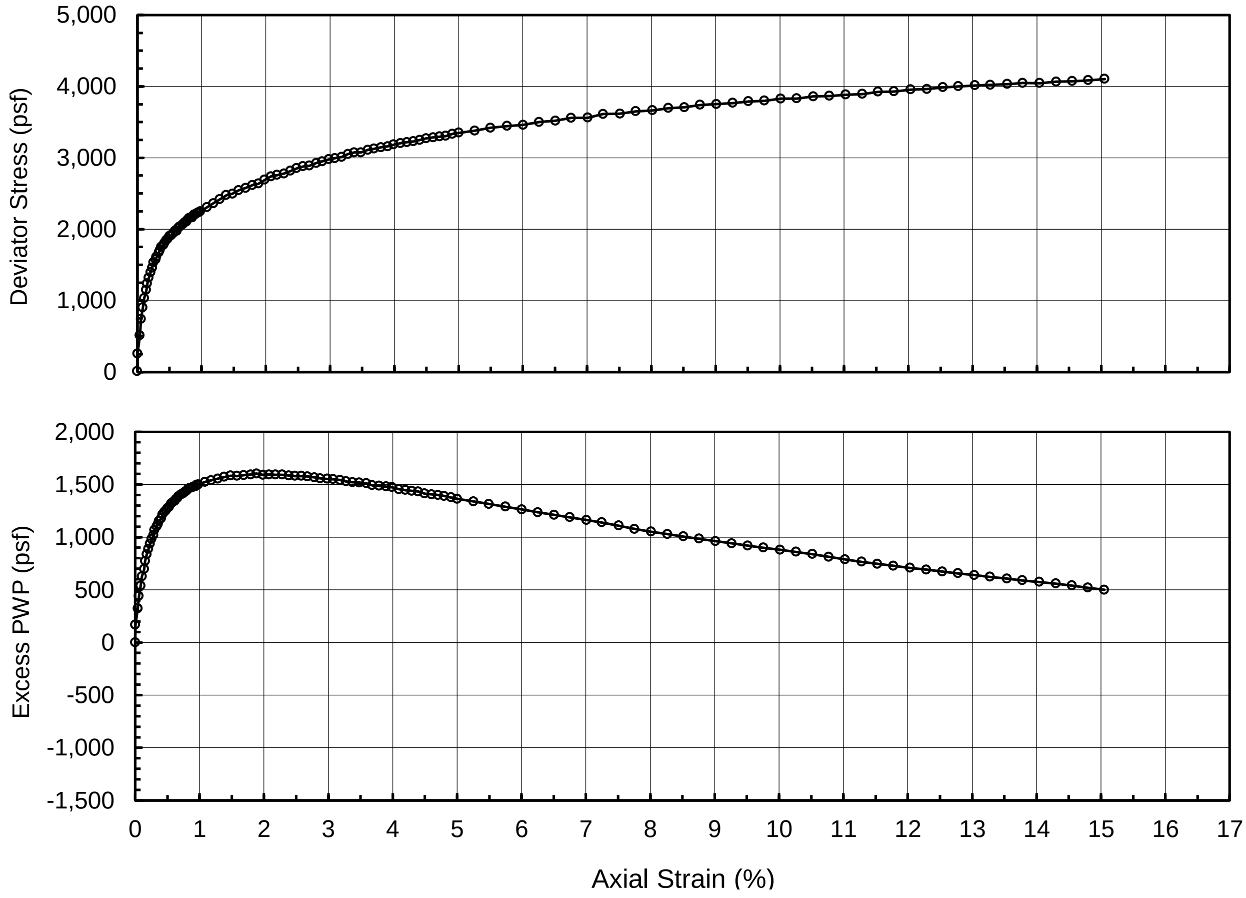
FAILURE SKETCH

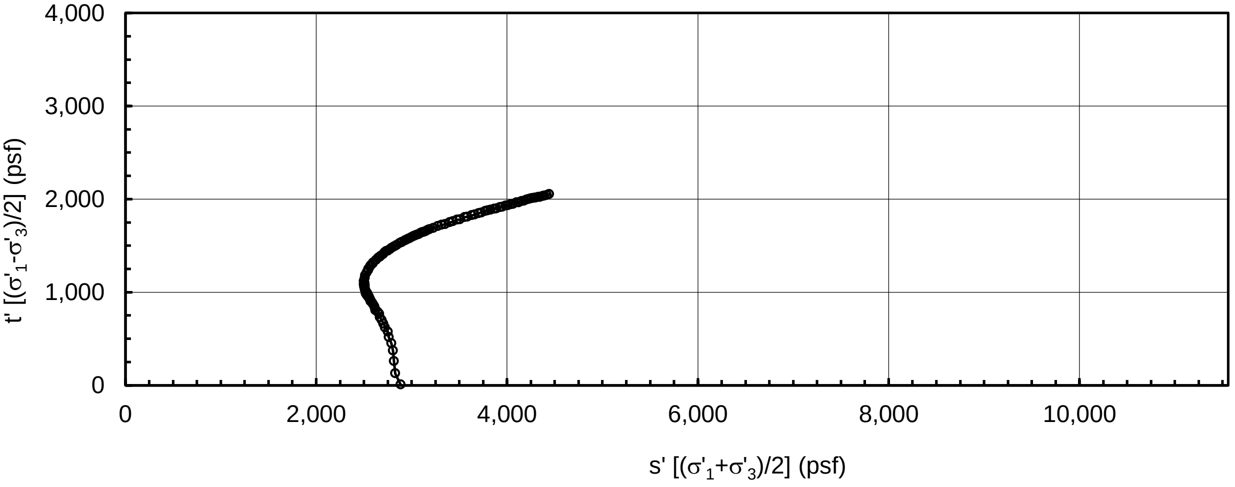
Consolidation Stress (σ'_3, psf) =			1165.6
Consolidation t_{50} (min) =			10
Consolidation Volume Change (mL) =			2.0
Unloading Stress (psf) =			NA
Unloading t_{50} (min) =			NA
Unloading Volume Change (mL) =			NA
LL =	33	PI =	20
USCS	CL		
Gs =	2.65	assumed	

Performed by SBK
Reviewed by PCM

Isotropically Consolidated Undrained Triaxial Test (ICU)

Project Title: Big Brown Plant, Pond Stability **Project Number:** 123-94128 **Date:** 12-Nov-12
Boring Number: BH-1 **Specimen Name:** TO-8 **Depth (ft):** 28.0





Specimen Description: Dark Gray Sandy CLAY

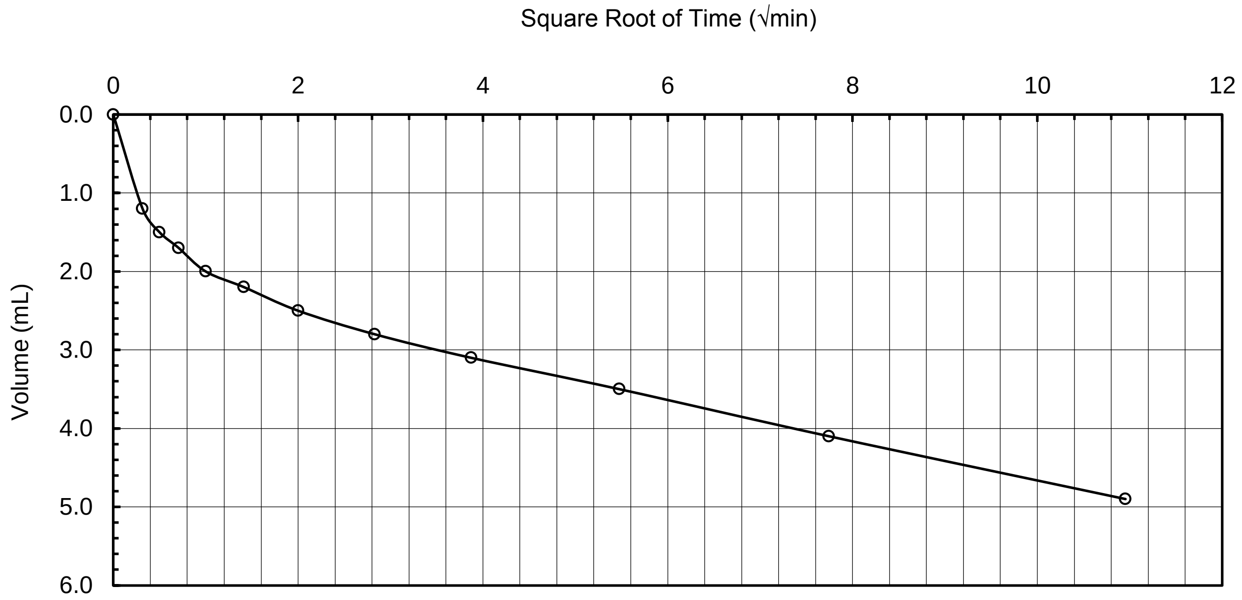
Initial Specimen Diameter (inch) =	2.83	Initial Specimen Height (inch) =	5.95
Initial Water Content (%) =	16.9	Water Content at End of Test (%) =	18.0
Initial Moist Unit Weight (pcf) =	128.7	B-value =	0.99
Back Pressure (BP, psf) =	3600.0	Consolidation Stress (σ'_3, psf) =	2879.8
Initial Lateral Stress (σ'_3, psf) =	2879.8	Consolidation t_{50} (min) =	3
Initial Deviator Stress ($\sigma_1 - \sigma_3$, psf) =	11.4	Rebound Stress (σ'_3, psf) =	NA
Test Strain Rate (%/hour) =	1.0	Rebound t_{50} (min) =	NA

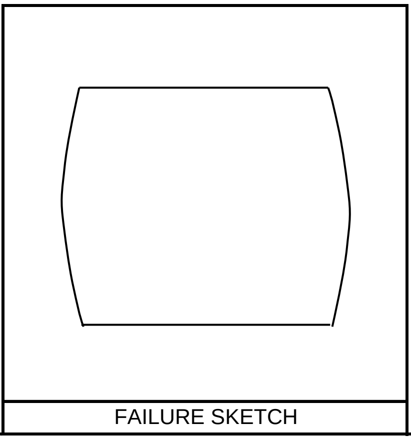
LL =	33	PI =	20	USCS	CL	**Performed by**	SBK
Comments:						**Reviewed by**	PCM

Golder Associates

Isotropically Consolidated Undrained Triaxial Test (ICU)

Project Title: Big Brown Plant, Pond Stability
Project Number: 123-94128
Date: 12-Nov-12
Boring Number: BH-1
Specimen Name: TO-8
Depth (ft): 28.0





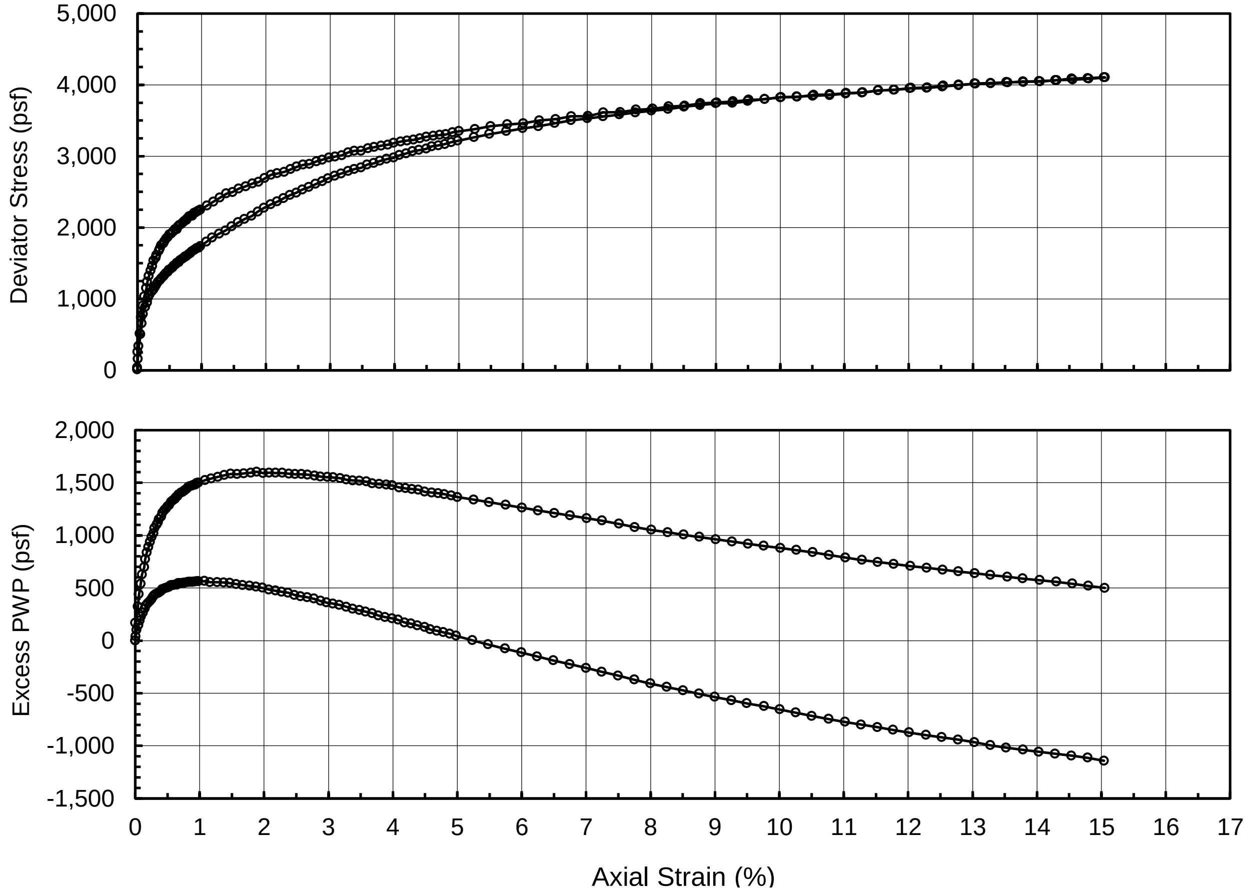
FAILURE SKETCH

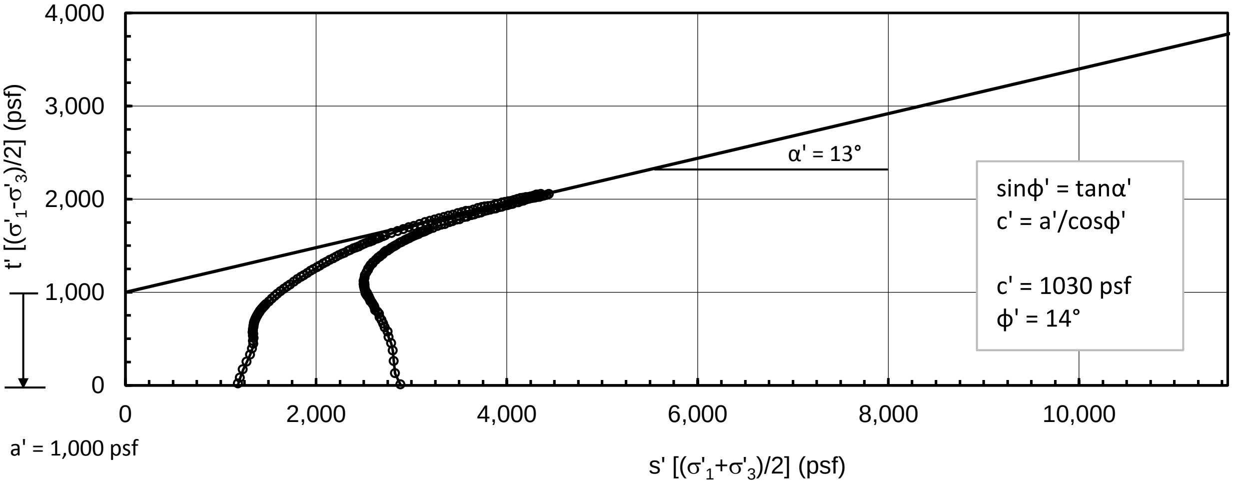
Consolidation Stress (σ'_3, psf) =			2879.8
Consolidation t_{50} (min) =			3
Consolidation Volume Change (mL) =			4.9
Unloading Stress (psf) =			NA
Unloading t_{50} (min) =			NA
Unloading Volume Change (mL) =			NA
LL =	33	PI =	20
USCS	CL		
Gs =	2.65	assumed	

Performed by SBK
Reviewed by PCM

Isotropically Consolidated Undrained Triaxial Test (ICU)

Project Title: Big Brown Plant, Pond Stability **Project Number:** 123-94128 **Date:** 12-Nov-12
Boring Number: BH-1 **Specimen Name:** TO-8 **Depth (ft):** 28.0





Specimen Description: Dark Gray Sandy CLAY

Initial Specimen Diameter (inch) =		Initial Specimen Height (inch) =	
Initial Water Content (%) =		Water Content at End of Test (%) =	
Initial Moist Unit Weight (pcf) =		B-value =	
Back Pressure (BP, psf) =		Consolidation Stress (σ'_3, psf) =	
Initial Lateral Stress (σ'_3, psf) =		Consolidation t_{50} (min) =	
Initial Deviator Stress (σ_1 - σ_3, psf) =		Rebound Stress (σ'_3, psf) =	
Test Strain Rate (%/hour) =		Rebound t_{50} (min) =	

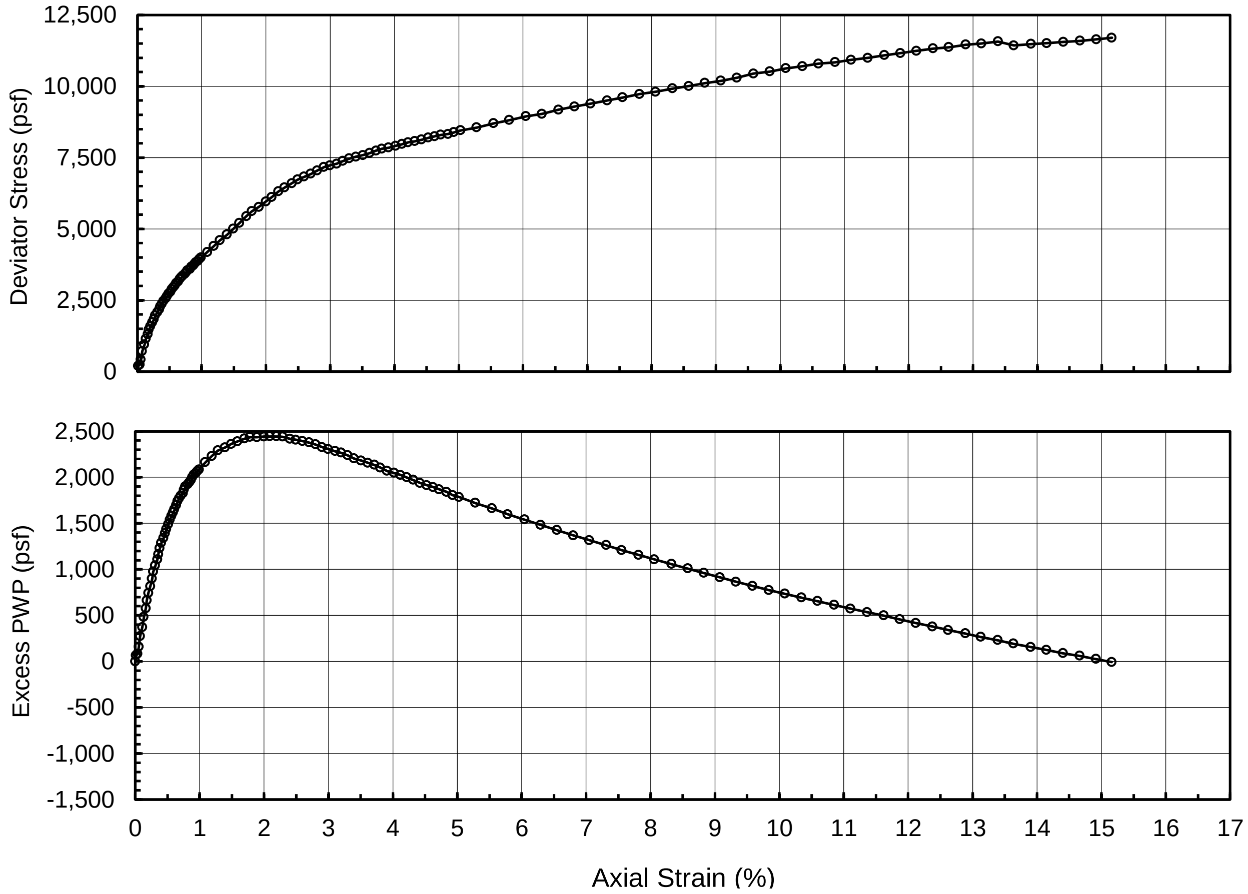
LL =	33	PI =	20	USCS	CL	**Performed by**	SBK
Comments:						**Reviewed by**	PCM

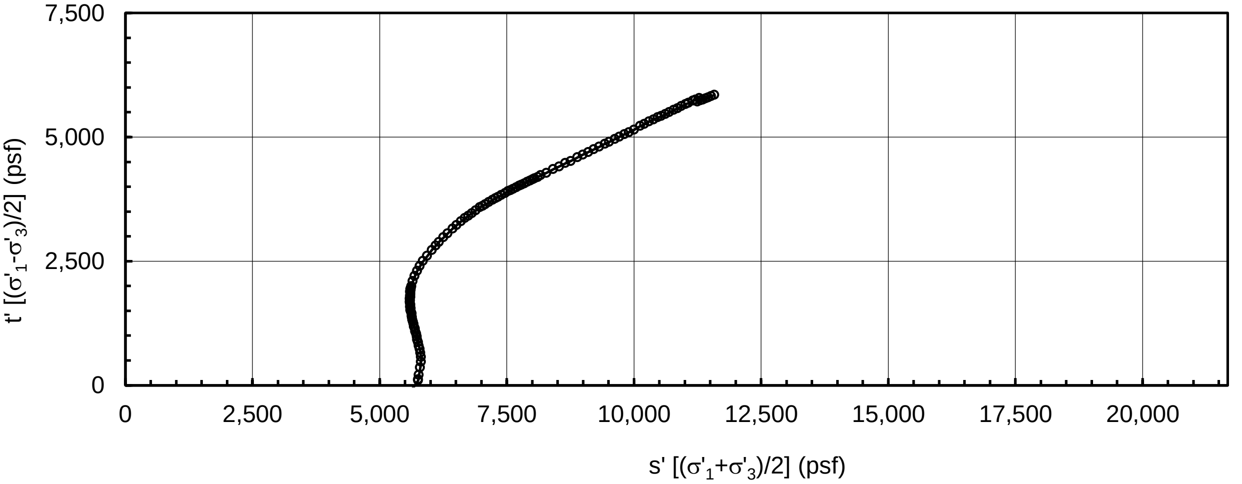
Golder Associates

Isotropically Consolidated Undrained Triaxial Test (ICU)

Project Title: Big Brown Plant, Pond Stability **Project Number:** 123-94128 **Date:** 13-Nov-12

Boring Number: BH-1 **Specimen Name:** TO-9 **Depth (ft):** 33.0





Specimen Description: Light Gray Sandy CLAY (visual classification)

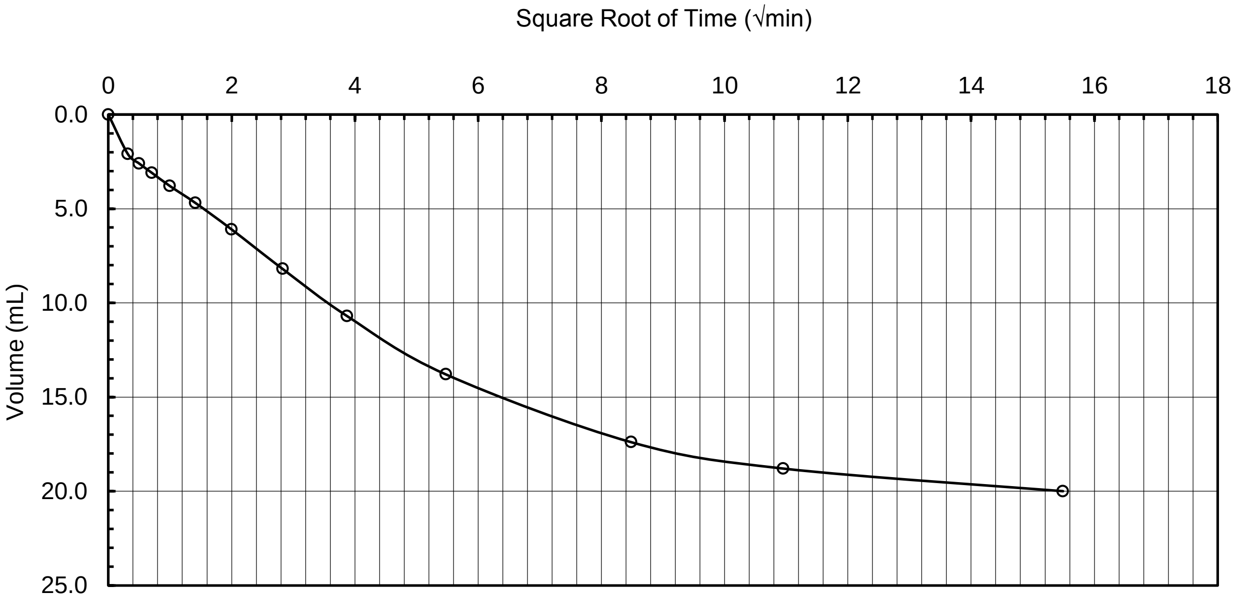
Initial Specimen Diameter (inch) =	2.83	Initial Specimen Height (inch) =	5.89
Initial Water Content (%) =	16.1	Water Content at End of Test (%) =	17.9
Initial Moist Unit Weight (pcf) =	127.4	B-value =	0.97
Back Pressure (BP, psf) =	5040.0	Consolidation Stress (σ'_3, psf) =	5717.7
Initial Lateral Stress (σ'_3, psf) =	5717.7	Consolidation t_{50} (min) =	11
Initial Deviator Stress (σ_1 - σ_3, psf) =	-164.7	Rebound Stress (σ'_3, psf) =	NA
Test Strain Rate (%/hour) =	1.0	Rebound t_{50} (min) =	NA

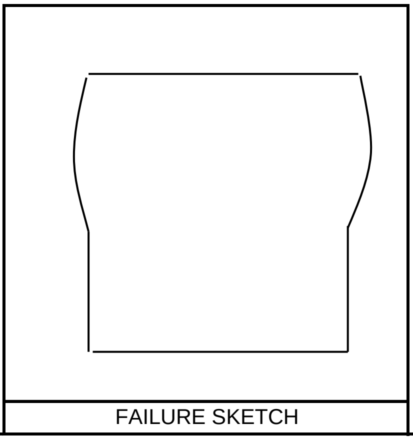
LL =		PI =		USCS	(CL)	**Performed by**	SBK
Comments:						**Reviewed by**	PCM

Golder Associates

Isotropically Consolidated Undrained Triaxial Test (ICU)

Project Title: Big Brown Plant, Pond Stability **Project Number:** 123-94128 **Date:** 13-Nov-12
Boring Number: BH-1 **Specimen Name:** TO-9 **Depth (ft):** 33.0




FAILURE SKETCH

Consolidation Stress (σ'_3, psf) =	5717.7
Consolidation t_{50} (min) =	11
Consolidation Volume Change (mL) =	20.0
Unloading Stress (psf) =	NA
Unloading t_{50} (min) =	NA
Unloading Volume Change (mL) =	NA

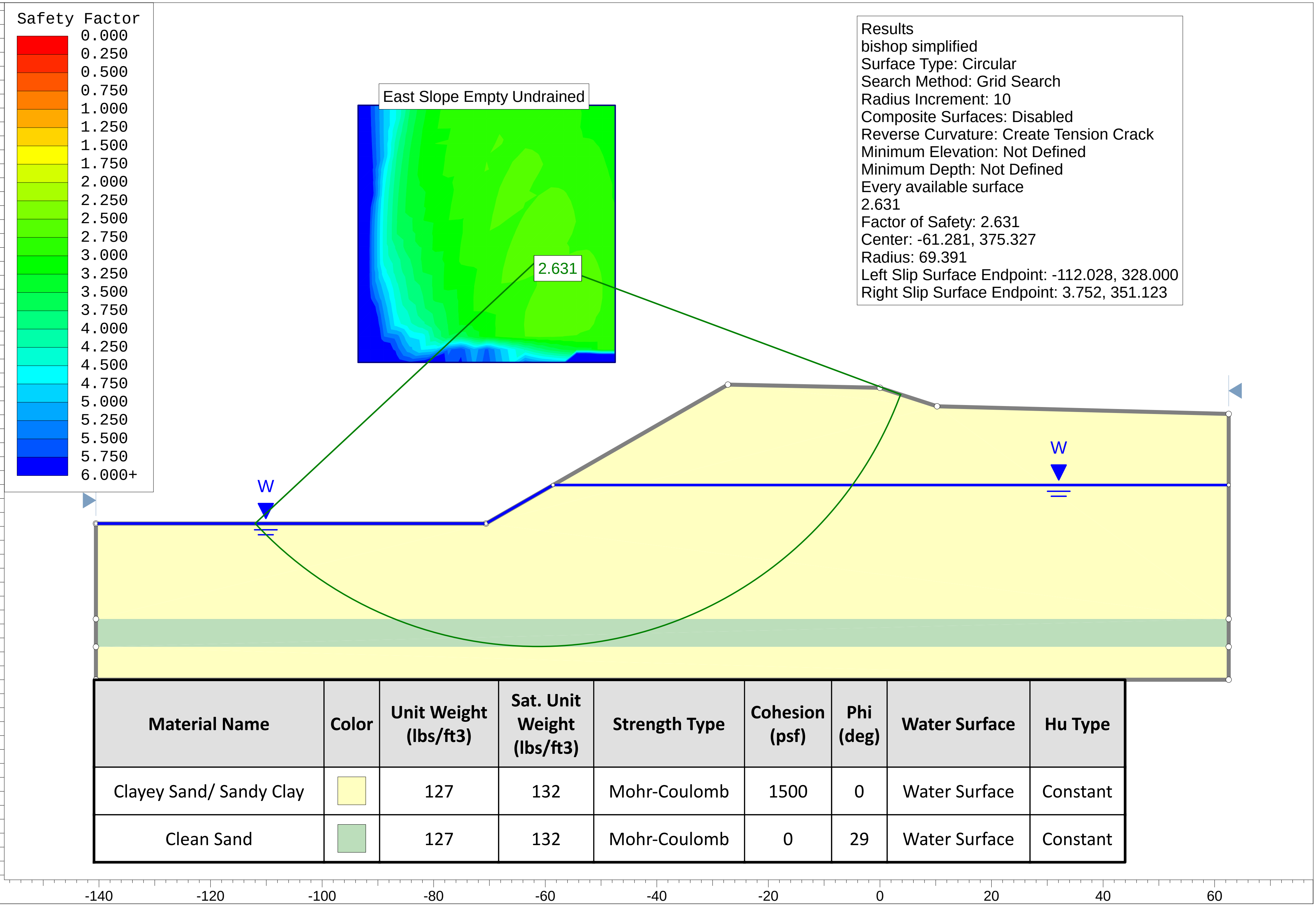
LL =		PI =	
USCS	(CL)		
Gs =	2.65	assumed	

Performed by	SBK
Reviewed by	PCM

Golder Associates

APPENDIX D
SLOPE STABILITY ANALYSES

Case 1

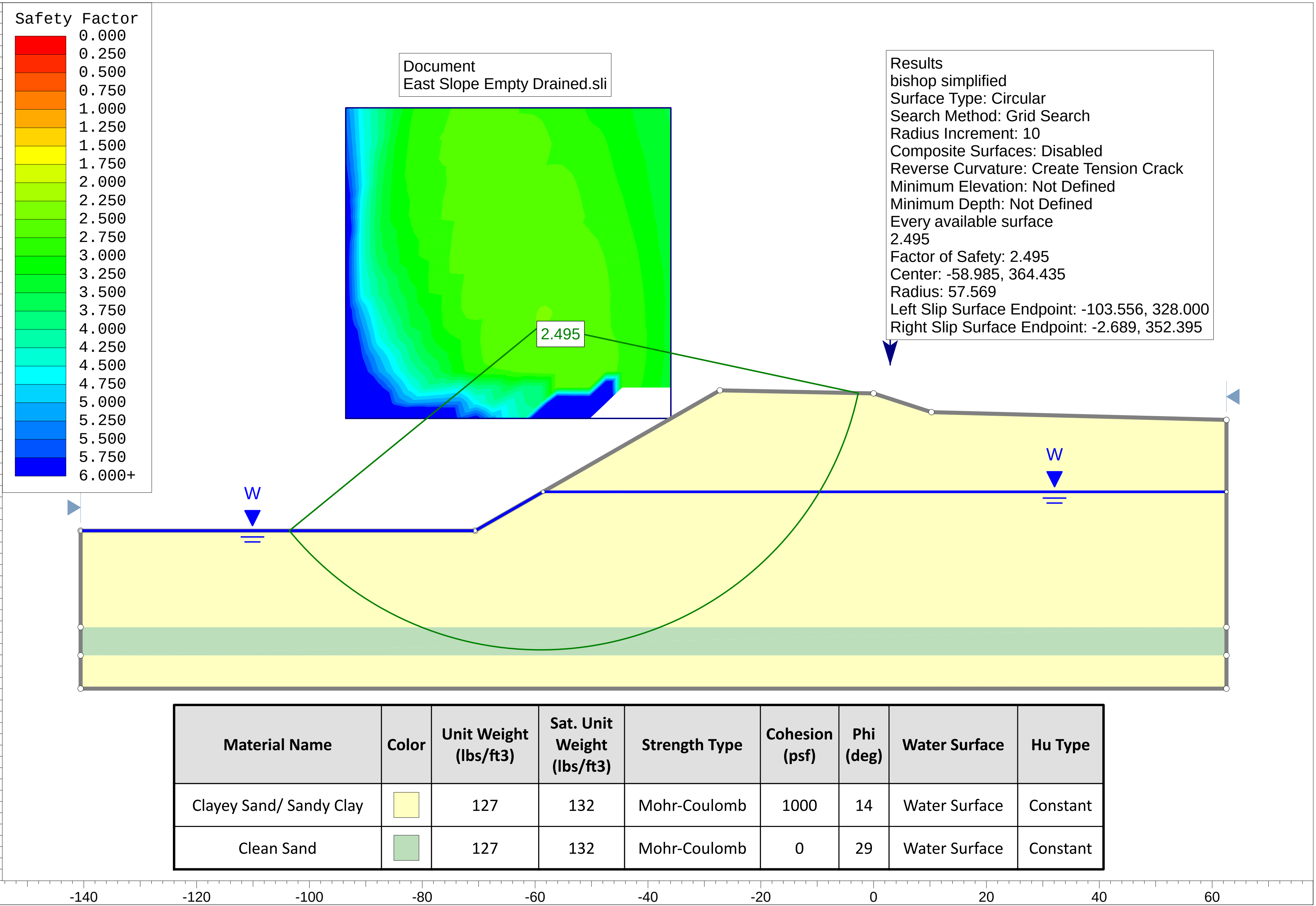


Results
bishop simplified
Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Every available surface
2.631
Factor of Safety: 2.631
Center: -61.281, 375.327
Radius: 69.391
Left Slip Surface Endpoint: -112.028, 328.000
Right Slip Surface Endpoint: 3.752, 351.123

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type
Clayey Sand/ Sandy Clay	🟨	127	132	Mohr-Coulomb	1500	0	Water Surface	Constant
Clean Sand	🟩	127	132	Mohr-Coulomb	0	29	Water Surface	Constant

SLIDEINTERPRET 6.019

Case 2

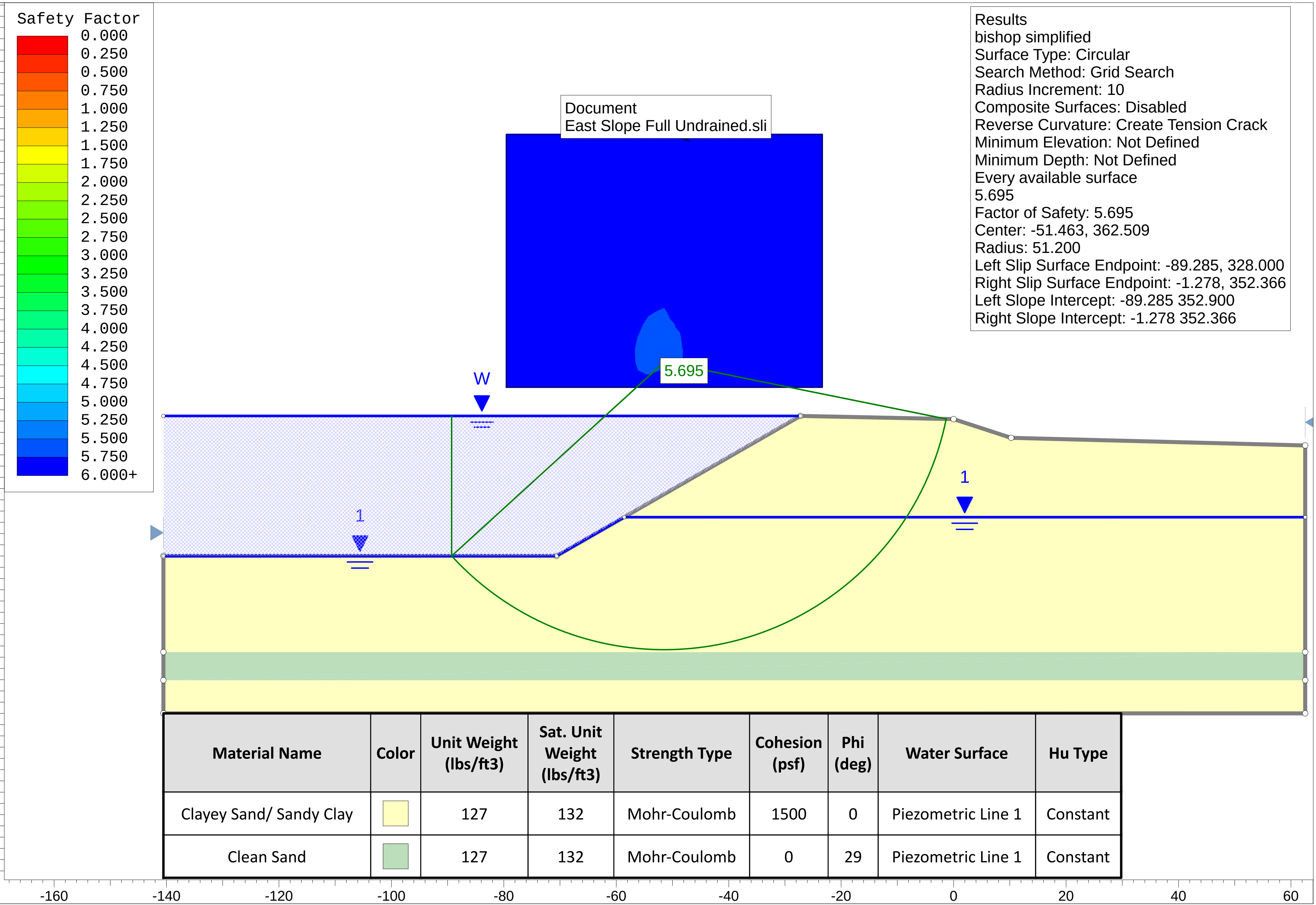


Document
East Slope Empty Drained.sli

Results
bishop simplified
Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Every available surface
2.495
Factor of Safety: 2.495
Center: -58.985, 364.435
Radius: 57.569
Left Slip Surface Endpoint: -103.556, 328.000
Right Slip Surface Endpoint: -2.689, 352.395

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type
Clayey Sand/ Sandy Clay	🟨	127	132	Mohr-Coulomb	1000	14	Water Surface	Constant
Clean Sand	🟩	127	132	Mohr-Coulomb	0	29	Water Surface	Constant

Case 3

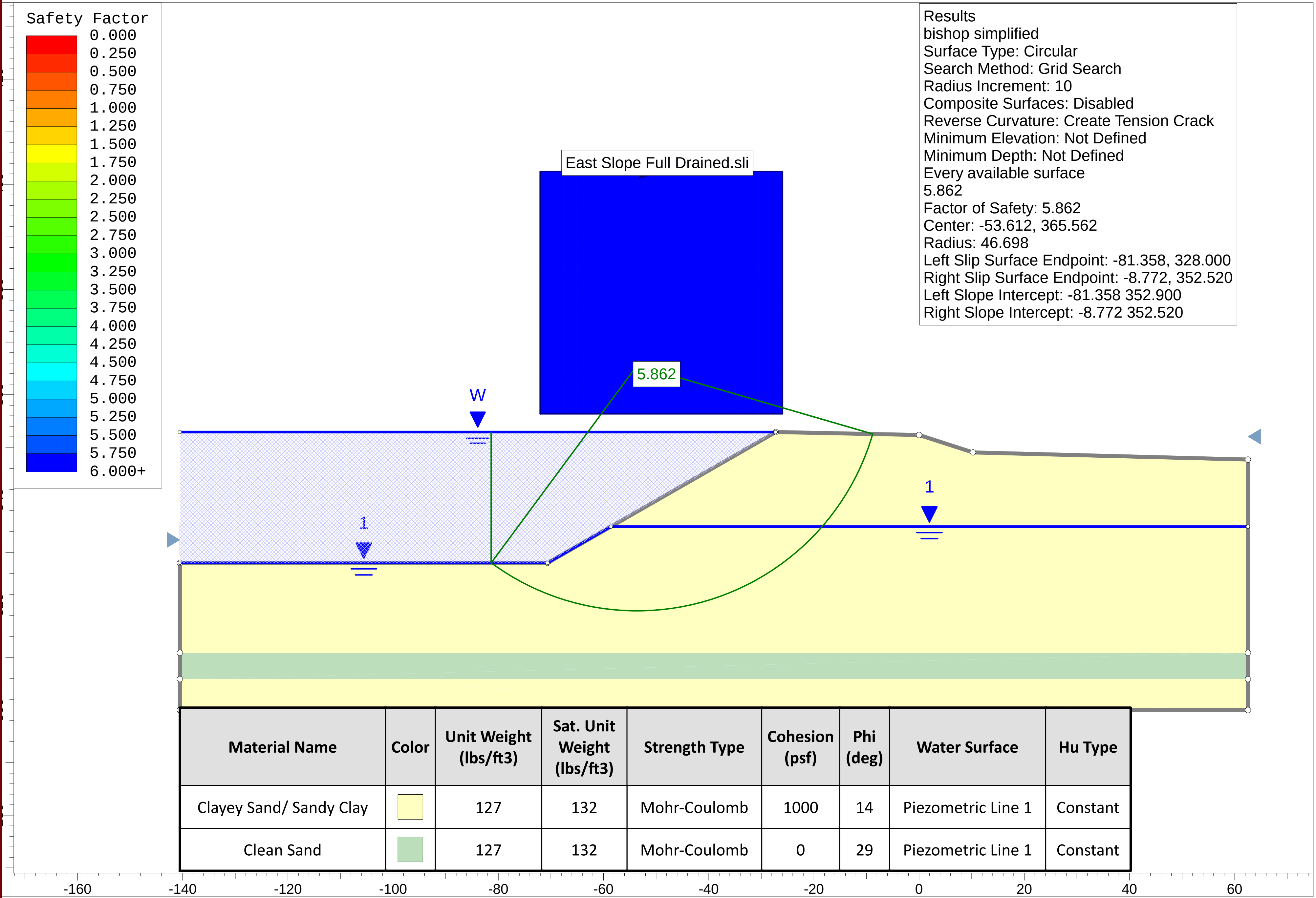


Results
bishop simplified
Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Every available surface
5.695
Factor of Safety: 5.695
Center: -51.463, 362.509
Radius: 51.200
Left Slip Surface Endpoint: -89.285, 328.000
Right Slip Surface Endpoint: -1.278, 352.366
Left Slope Intercept: -89.285 352.900
Right Slope Intercept: -1.278 352.366

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type
Clayey Sand/ Sandy Clay	🟨	127	132	Mohr-Coulomb	1500	0	Piezometric Line 1	Constant
Clean Sand	🟩	127	132	Mohr-Coulomb	0	29	Piezometric Line 1	Constant

SLIDEINTERPRET 6.019

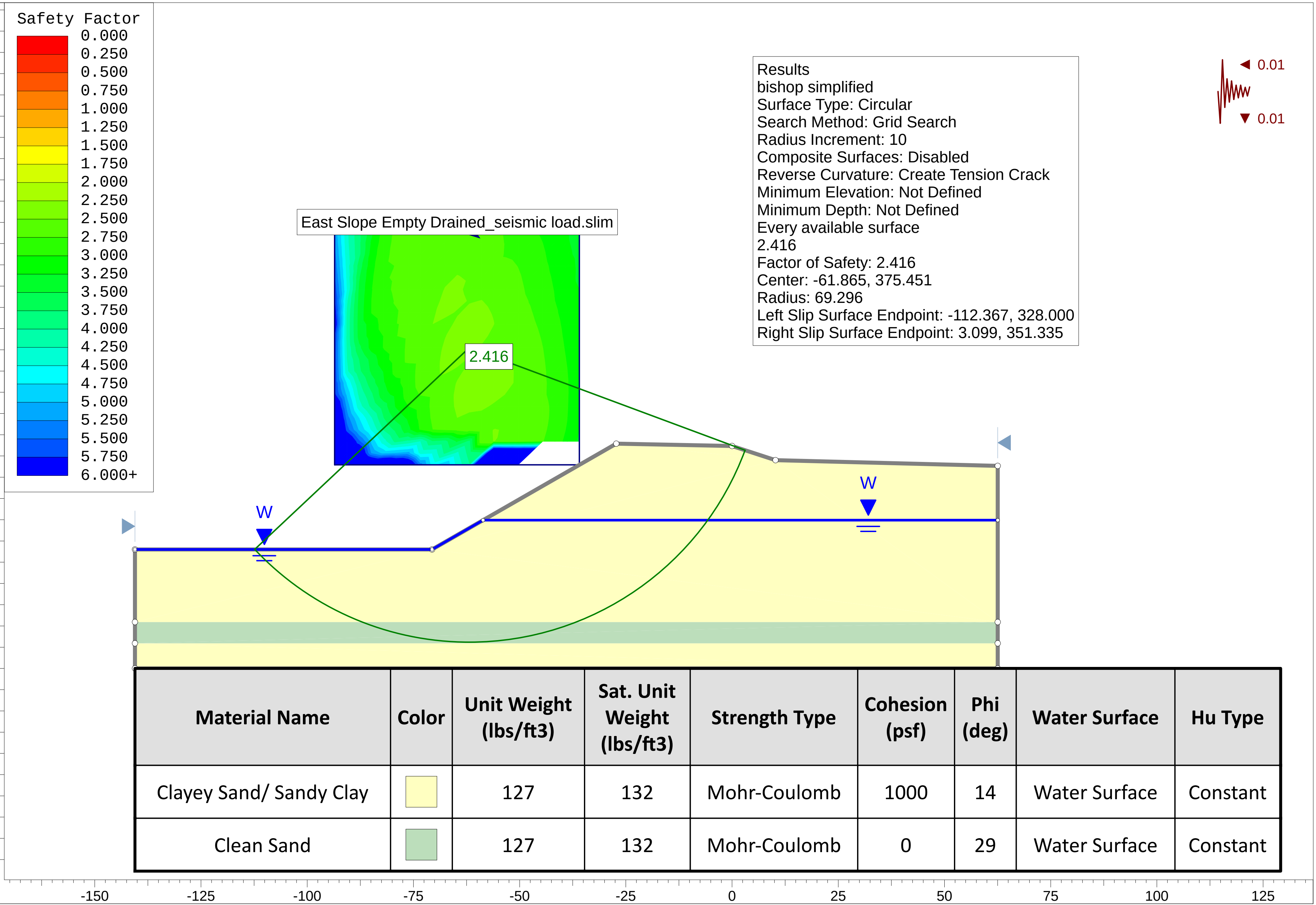
Case 4



Results
bishop simplified
Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Every available surface
5.862
Factor of Safety: 5.862
Center: -53.612, 365.562
Radius: 46.698
Left Slip Surface Endpoint: -81.358, 328.000
Right Slip Surface Endpoint: -8.772, 352.520
Left Slope Intercept: -81.358 352.900
Right Slope Intercept: -8.772 352.520

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type
Clayey Sand/ Sandy Clay	🟨	127	132	Mohr-Coulomb	1000	14	Piezometric Line 1	Constant
Clean Sand	🟩	127	132	Mohr-Coulomb	0	29	Piezometric Line 1	Constant

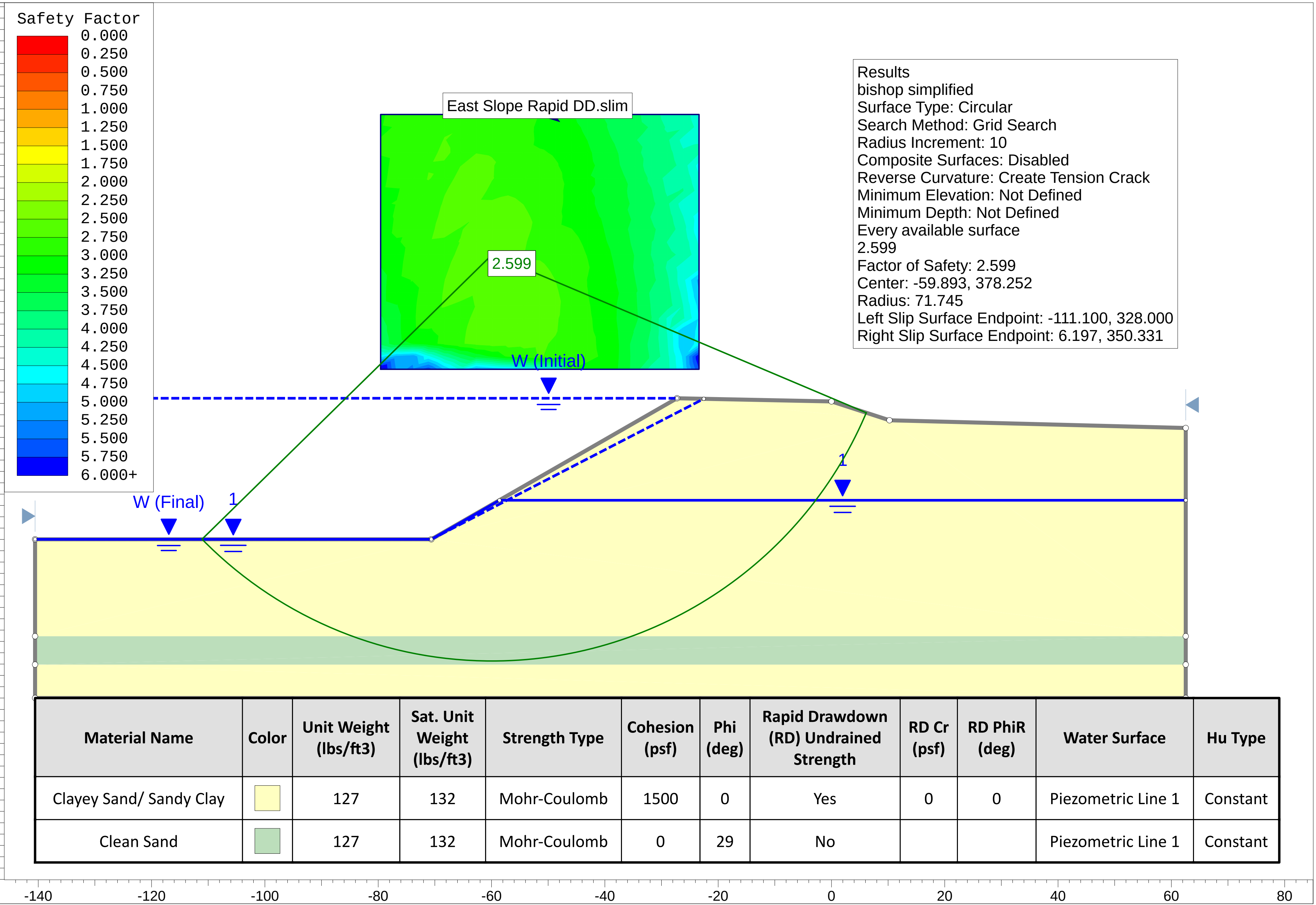
Case 5



Results
bishop simplified
Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Every available surface
2.416
Factor of Safety: 2.416
Center: -61.865, 375.451
Radius: 69.296
Left Slip Surface Endpoint: -112.367, 328.000
Right Slip Surface Endpoint: 3.099, 351.335

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type
Clayey Sand/ Sandy Clay	🟨	127	132	Mohr-Coulomb	1000	14	Water Surface	Constant
Clean Sand	🟩	127	132	Mohr-Coulomb	0	29	Water Surface	Constant

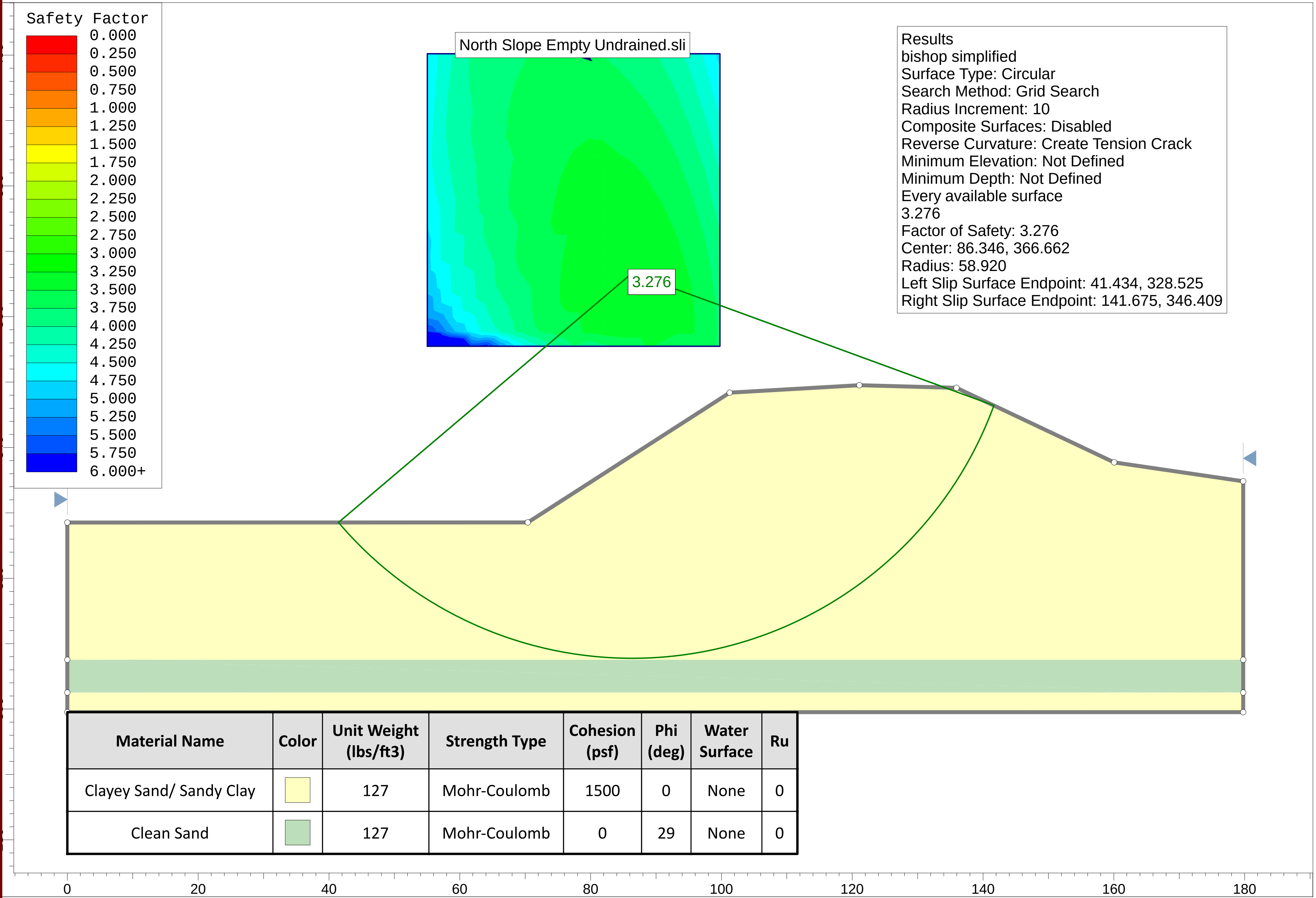
Case 6



Results
bishop simplified
Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Every available surface
2.599
Factor of Safety: 2.599
Center: -59.893, 378.252
Radius: 71.745
Left Slip Surface Endpoint: -111.100, 328.000
Right Slip Surface Endpoint: 6.197, 350.331

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Rapid Drawdown (RD) Undrained Strength	RD Cr (psf)	RD PhiR (deg)	Water Surface	Hu Type
Clayey Sand/ Sandy Clay	🟨	127	132	Mohr-Coulomb	1500	0	Yes	0	0	Piezometric Line 1	Constant
Clean Sand	🟩	127	132	Mohr-Coulomb	0	29	No			Piezometric Line 1	Constant

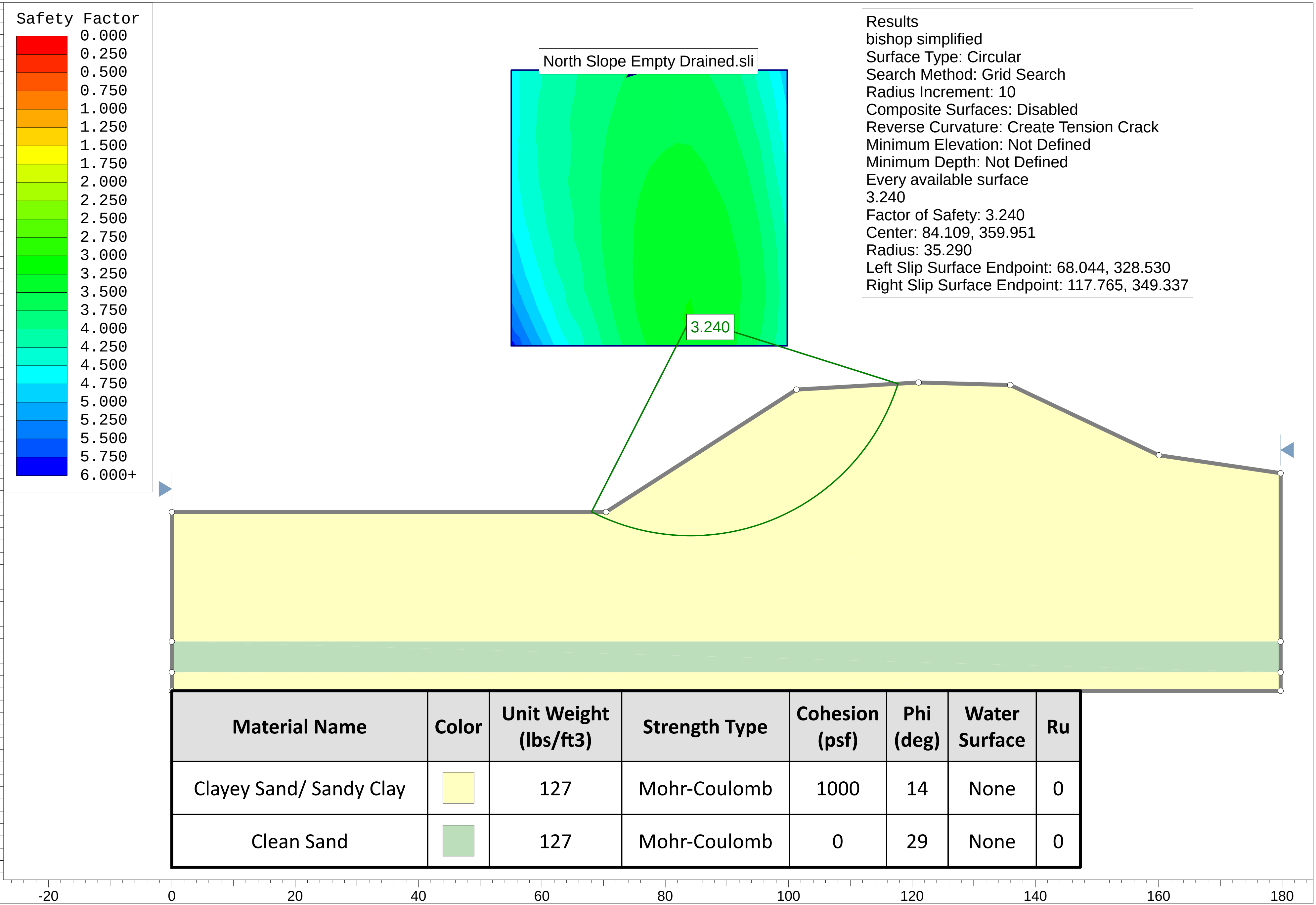
Case 7



Results
bishop simplified
Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Every available surface
3.276
Factor of Safety: 3.276
Center: 86.346, 366.662
Radius: 58.920
Left Slip Surface Endpoint: 41.434, 328.525
Right Slip Surface Endpoint: 141.675, 346.409

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Clayey Sand/ Sandy Clay	🟨	127	Mohr-Coulomb	1500	0	None	0
Clean Sand	🟩	127	Mohr-Coulomb	0	29	None	0

Case 8

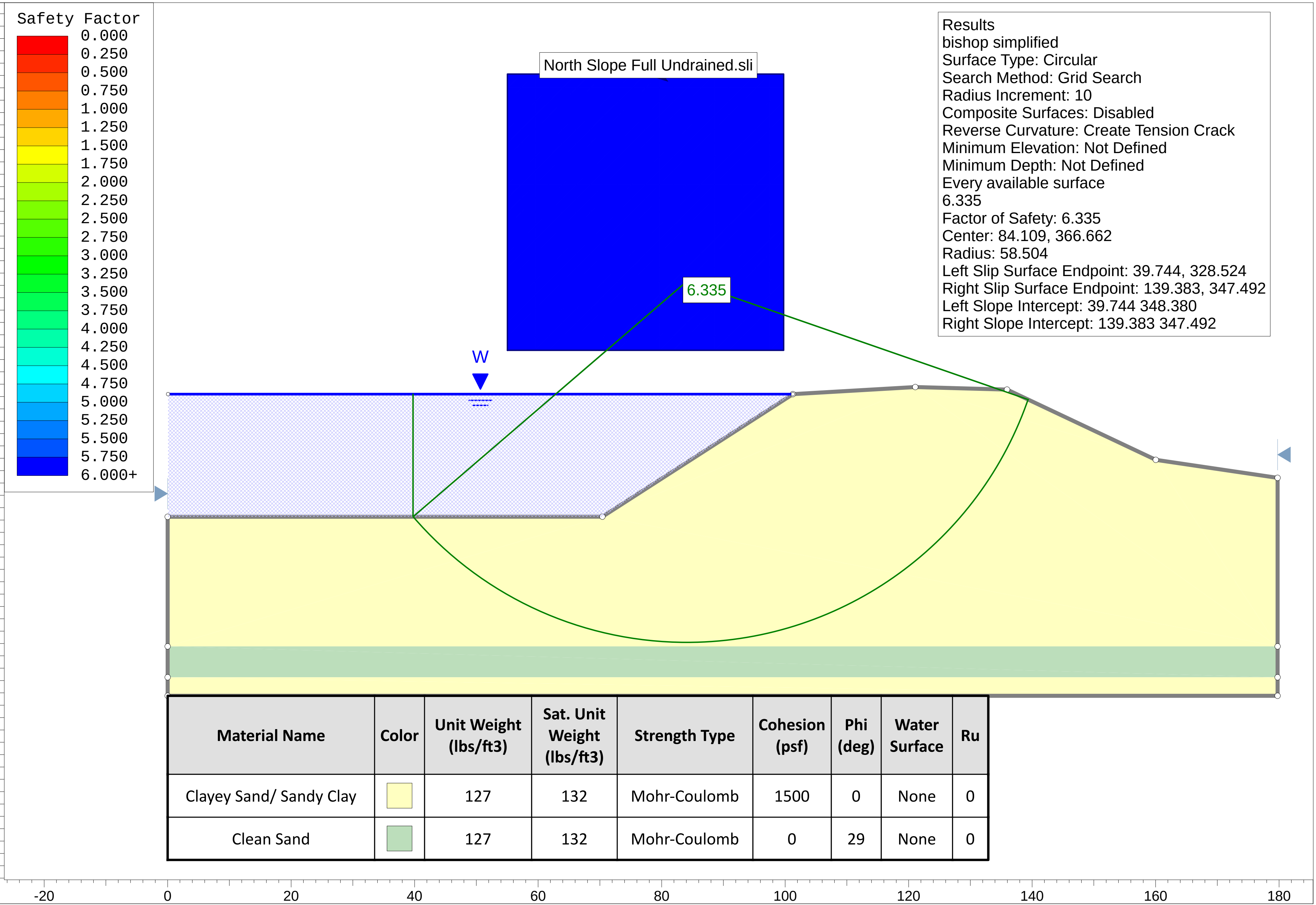


Results
bishop simplified
Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Every available surface
3.240
Factor of Safety: 3.240
Center: 84.109, 359.951
Radius: 35.290
Left Slip Surface Endpoint: 68.044, 328.530
Right Slip Surface Endpoint: 117.765, 349.337

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Clayey Sand/ Sandy Clay	🟨	127	Mohr-Coulomb	1000	14	None	0
Clean Sand	🟩	127	Mohr-Coulomb	0	29	None	0

SLIDEINTERPRET 6.019

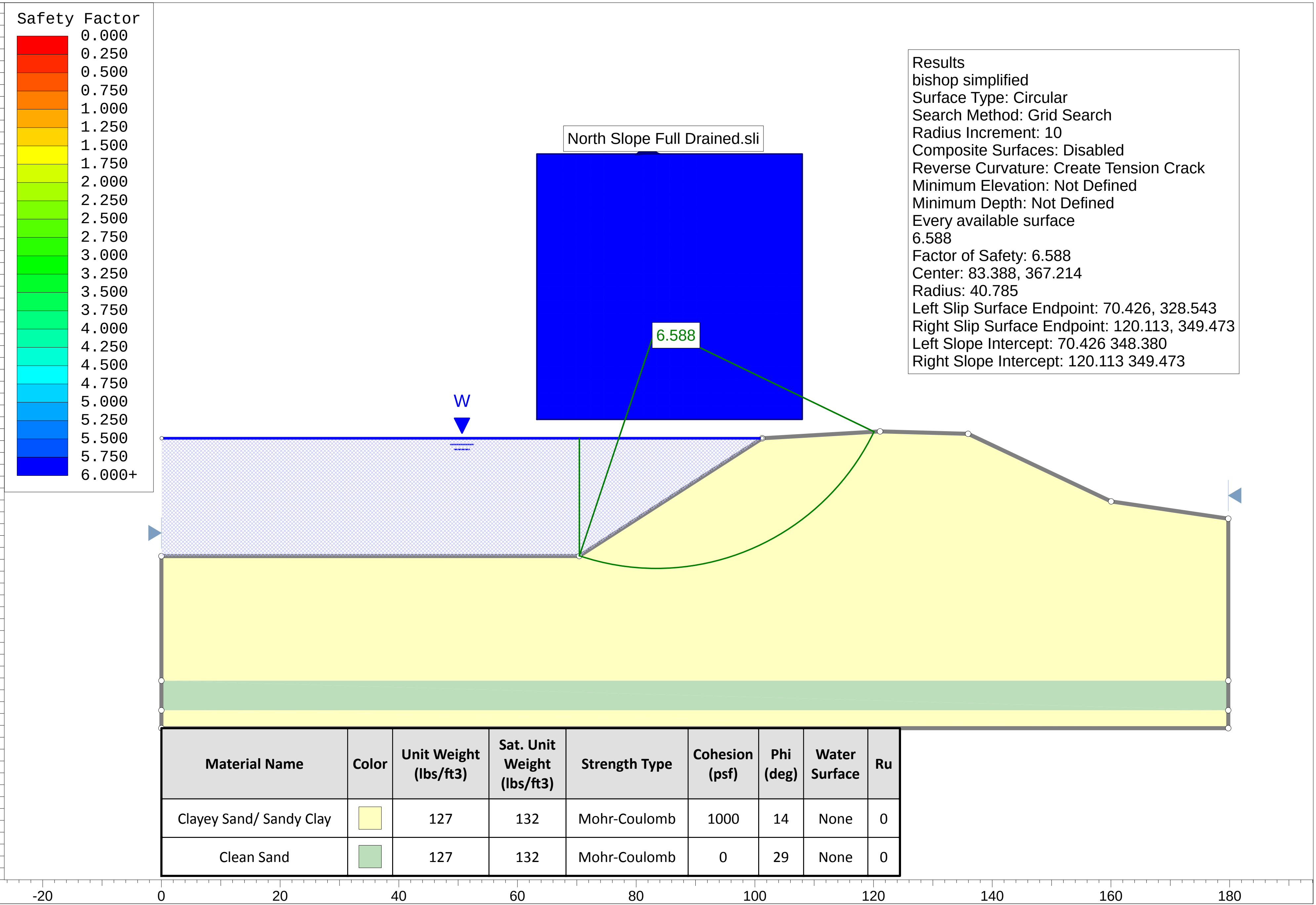
Case 9



Results
bishop simplified
Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Every available surface
6.335
Factor of Safety: 6.335
Center: 84.109, 366.662
Radius: 58.504
Left Slip Surface Endpoint: 39.744, 328.524
Right Slip Surface Endpoint: 139.383, 347.492
Left Slope Intercept: 39.744 348.380
Right Slope Intercept: 139.383 347.492

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Clayey Sand/ Sandy Clay	🟨	127	132	Mohr-Coulomb	1500	0	None	0
Clean Sand	🟩	127	132	Mohr-Coulomb	0	29	None	0

Case 10

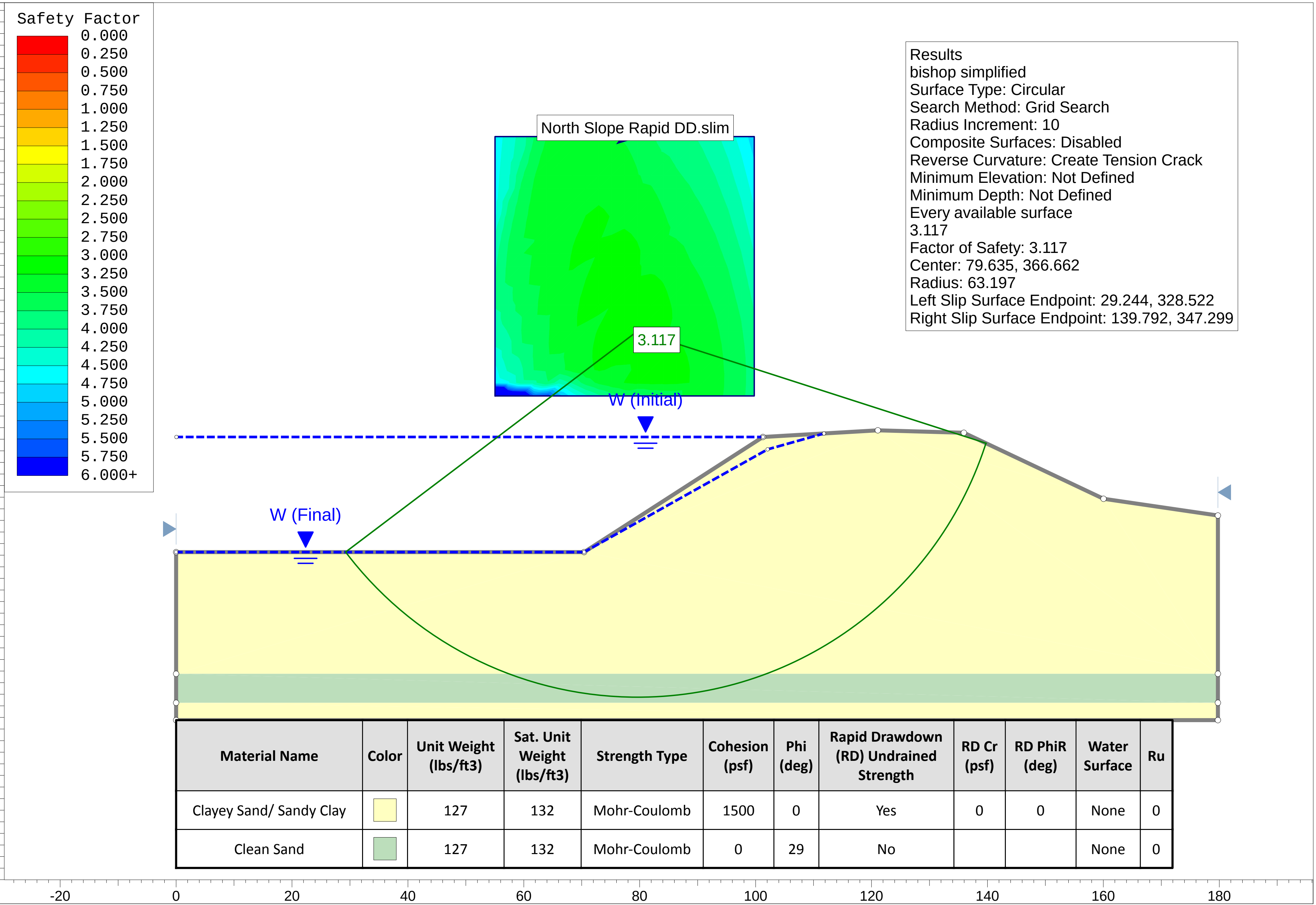


Results
bishop simplified
Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Every available surface
6.588
Factor of Safety: 6.588
Center: 83.388, 367.214
Radius: 40.785
Left Slip Surface Endpoint: 70.426, 328.543
Right Slip Surface Endpoint: 120.113, 349.473
Left Slope Intercept: 70.426 348.380
Right Slope Intercept: 120.113 349.473

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Clayey Sand/ Sandy Clay	🟨	127	132	Mohr-Coulomb	1000	14	None	0
Clean Sand	🟩	127	132	Mohr-Coulomb	0	29	None	0

SLIDEINTERPRET 6.019

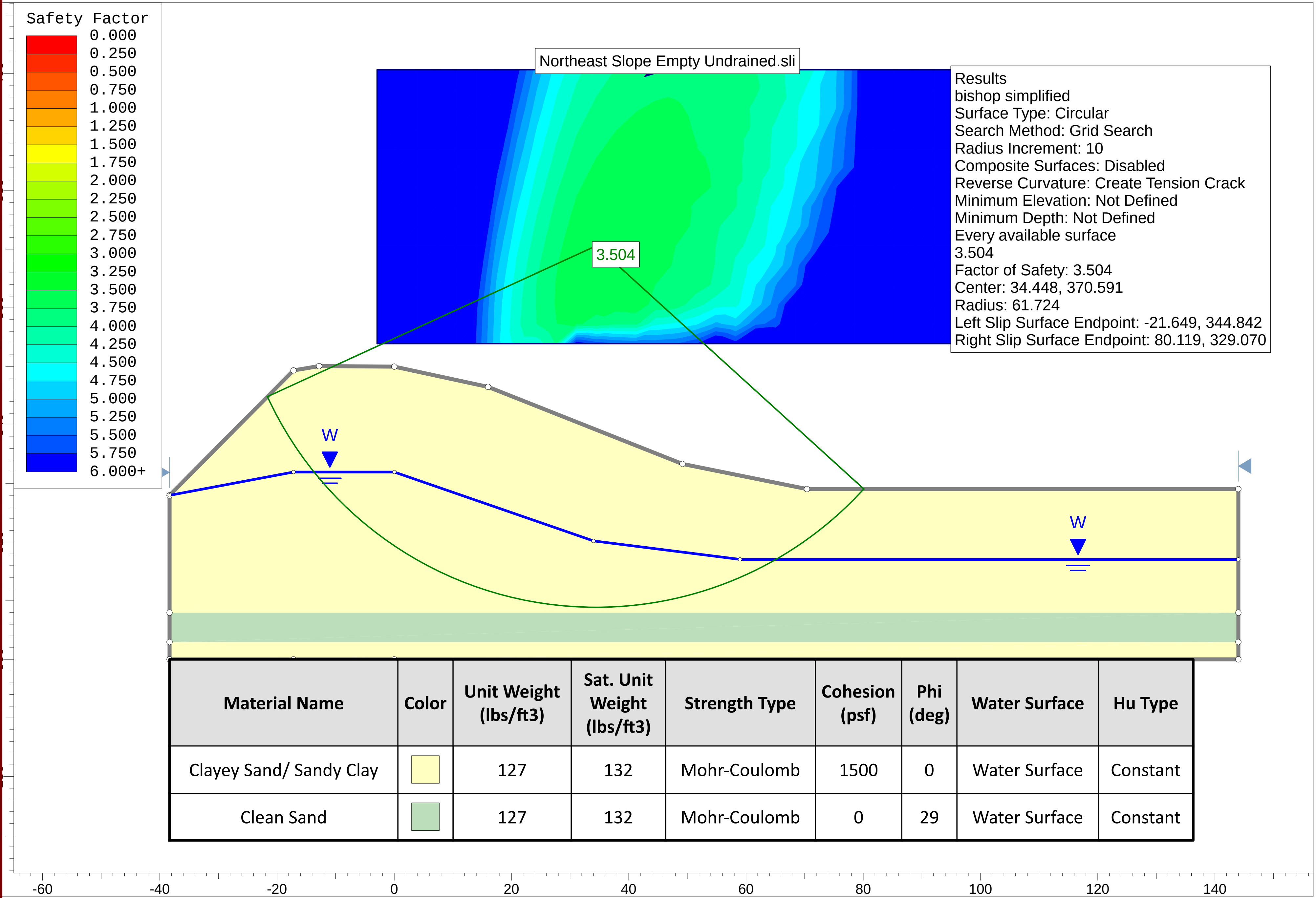
Case 11



Results
bishop simplified
Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Every available surface
3.117
Factor of Safety: 3.117
Center: 79.635, 366.662
Radius: 63.197
Left Slip Surface Endpoint: 29.244, 328.522
Right Slip Surface Endpoint: 139.792, 347.299

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Rapid Drawdown (RD) Undrained Strength	RD Cr (psf)	RD PhiR (deg)	Water Surface	Ru
Clayey Sand/ Sandy Clay	🟨	127	132	Mohr-Coulomb	1500	0	Yes	0	0	None	0
Clean Sand	🟩	127	132	Mohr-Coulomb	0	29	No			None	0

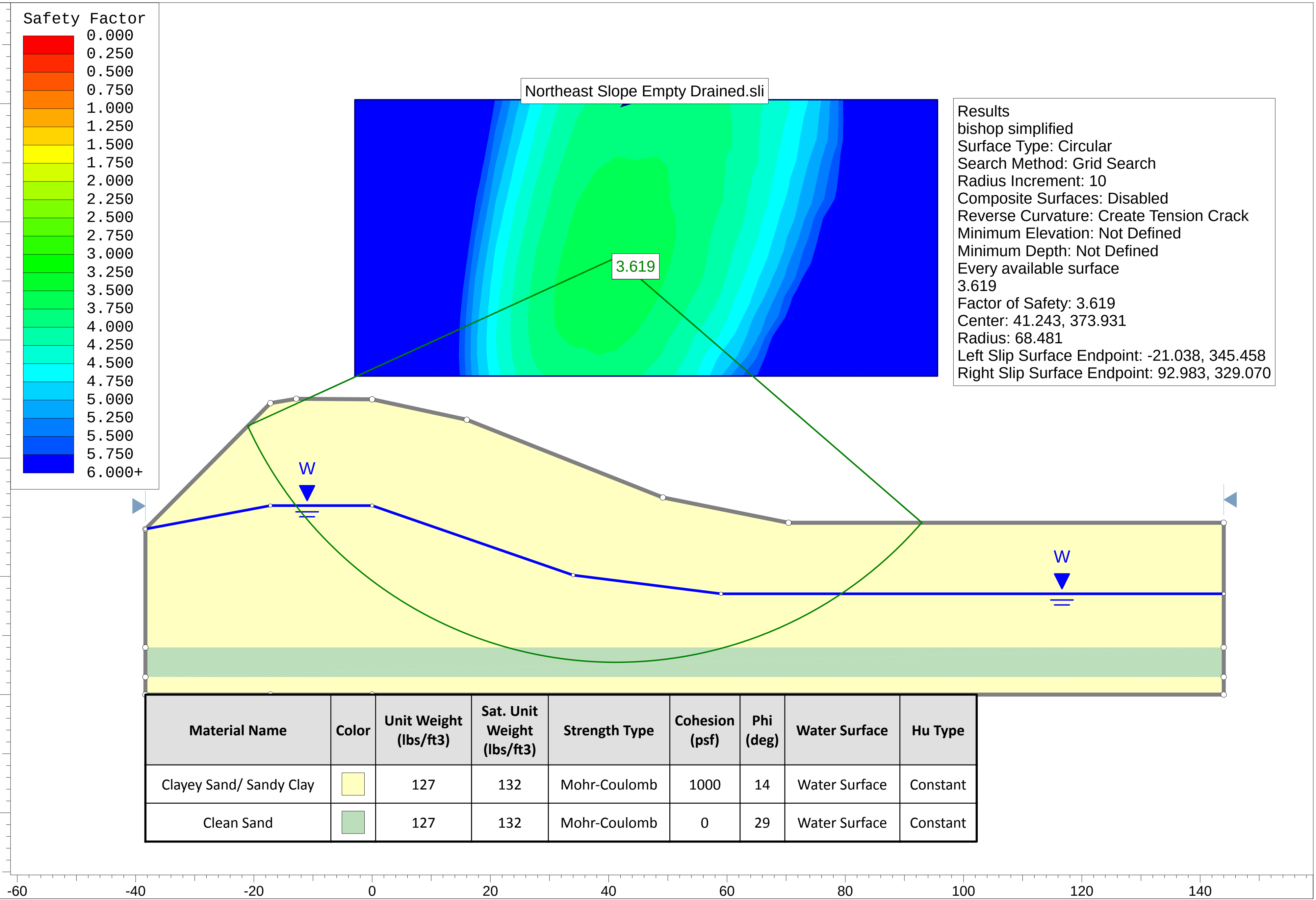
Case 12



```
Results
bishop simplified
Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Every available surface
3.504
Factor of Safety: 3.504
Center: 34.448, 370.591
Radius: 61.724
Left Slip Surface Endpoint: -21.649, 344.842
Right Slip Surface Endpoint: 80.119, 329.070
```

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type
Clayey Sand/ Sandy Clay	🟨	127	132	Mohr-Coulomb	1500	0	Water Surface	Constant
Clean Sand	🟩	127	132	Mohr-Coulomb	0	29	Water Surface	Constant

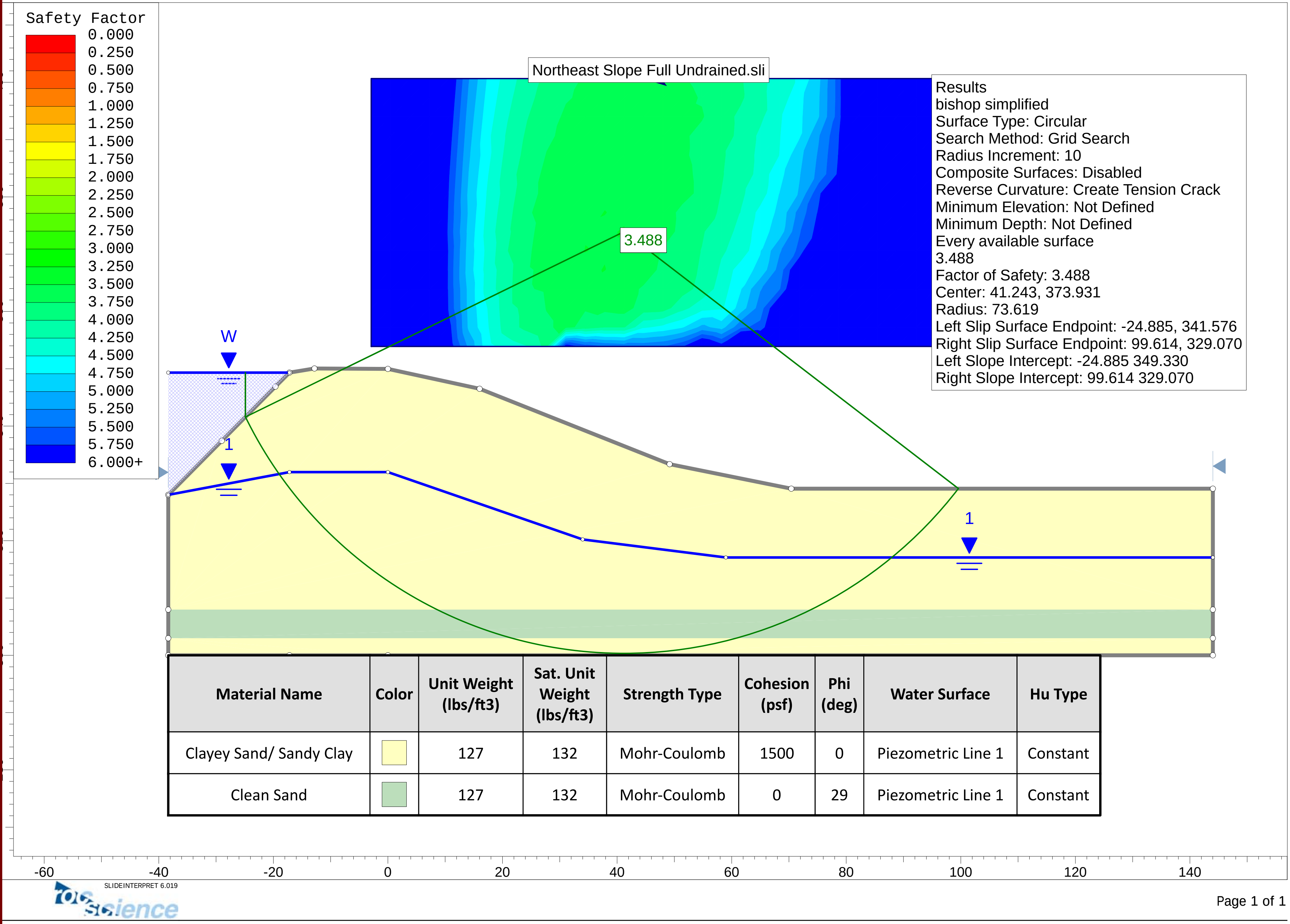
Case 13



Results
bishop simplified
Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Every available surface
3.619
Factor of Safety: 3.619
Center: 41.243, 373.931
Radius: 68.481
Left Slip Surface Endpoint: -21.038, 345.458
Right Slip Surface Endpoint: 92.983, 329.070

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type
Clayey Sand/ Sandy Clay	🟨	127	132	Mohr-Coulomb	1000	14	Water Surface	Constant
Clean Sand	🟩	127	132	Mohr-Coulomb	0	29	Water Surface	Constant

Case 14



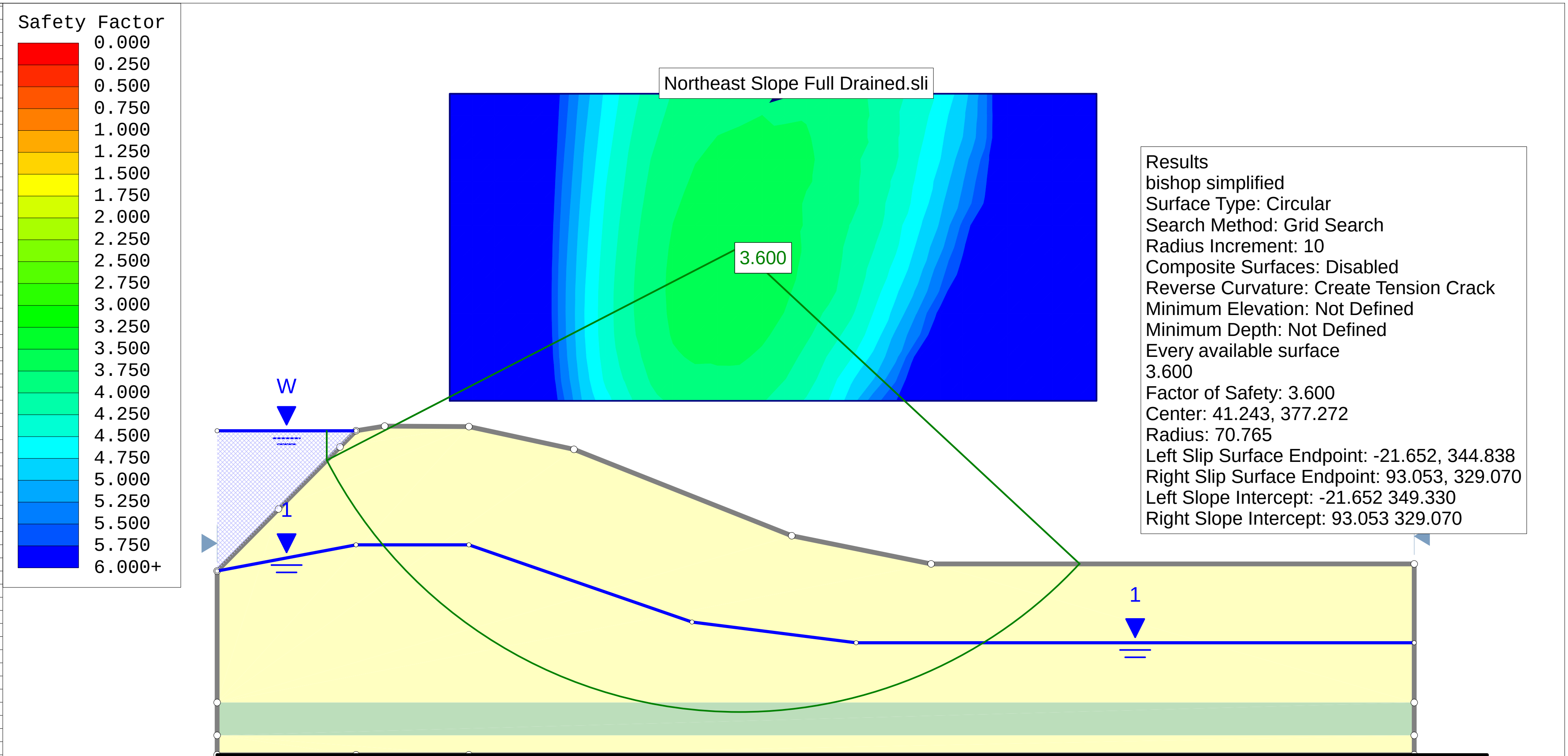
Northeast Slope Full Undrained.sli

Results
bishop simplified
Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Every available surface
3.488
Factor of Safety: 3.488
Center: 41.243, 373.931
Radius: 73.619
Left Slip Surface Endpoint: -24.885, 341.576
Right Slip Surface Endpoint: 99.614, 329.070
Left Slope Intercept: -24.885 349.330
Right Slope Intercept: 99.614 329.070

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type
Clayey Sand/ Sandy Clay	🟨	127	132	Mohr-Coulomb	1500	0	Piezometric Line 1	Constant
Clean Sand	🟩	127	132	Mohr-Coulomb	0	29	Piezometric Line 1	Constant

SLIDEINTERPRET 6.019

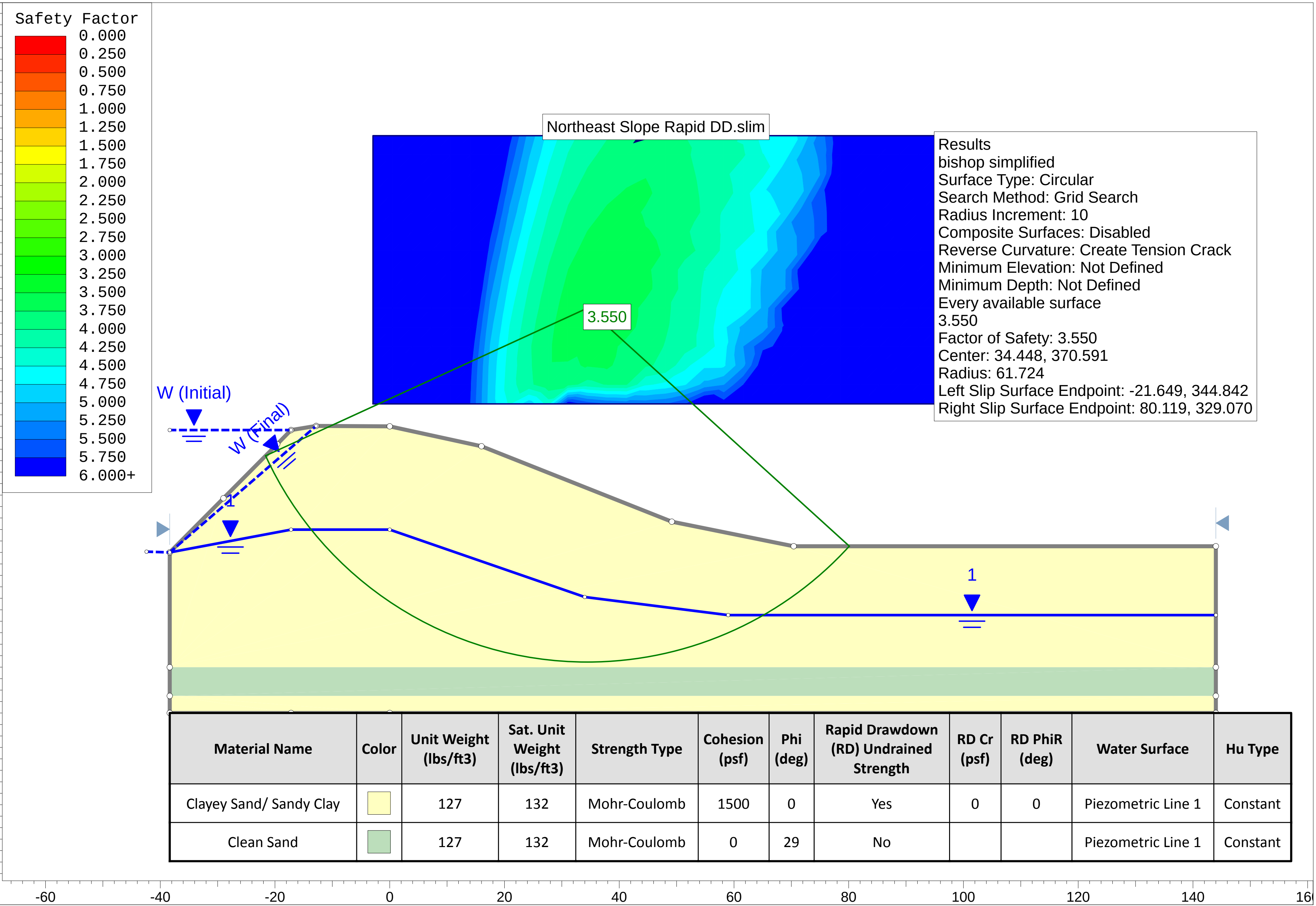
Case 15



Results
bishop simplified
Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Every available surface
3.600
Factor of Safety: 3.600
Center: 41.243, 377.272
Radius: 70.765
Left Slip Surface Endpoint: -21.652, 344.838
Right Slip Surface Endpoint: 93.053, 329.070
Left Slope Intercept: -21.652 349.330
Right Slope Intercept: 93.053 329.070

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type
Clayey Sand/ Sandy Clay	🟨	127	132	Mohr-Coulomb	1000	14	Piezometric Line 1	Constant
Clean Sand	🟩	127	132	Mohr-Coulomb	0	29	Piezometric Line 1	Constant

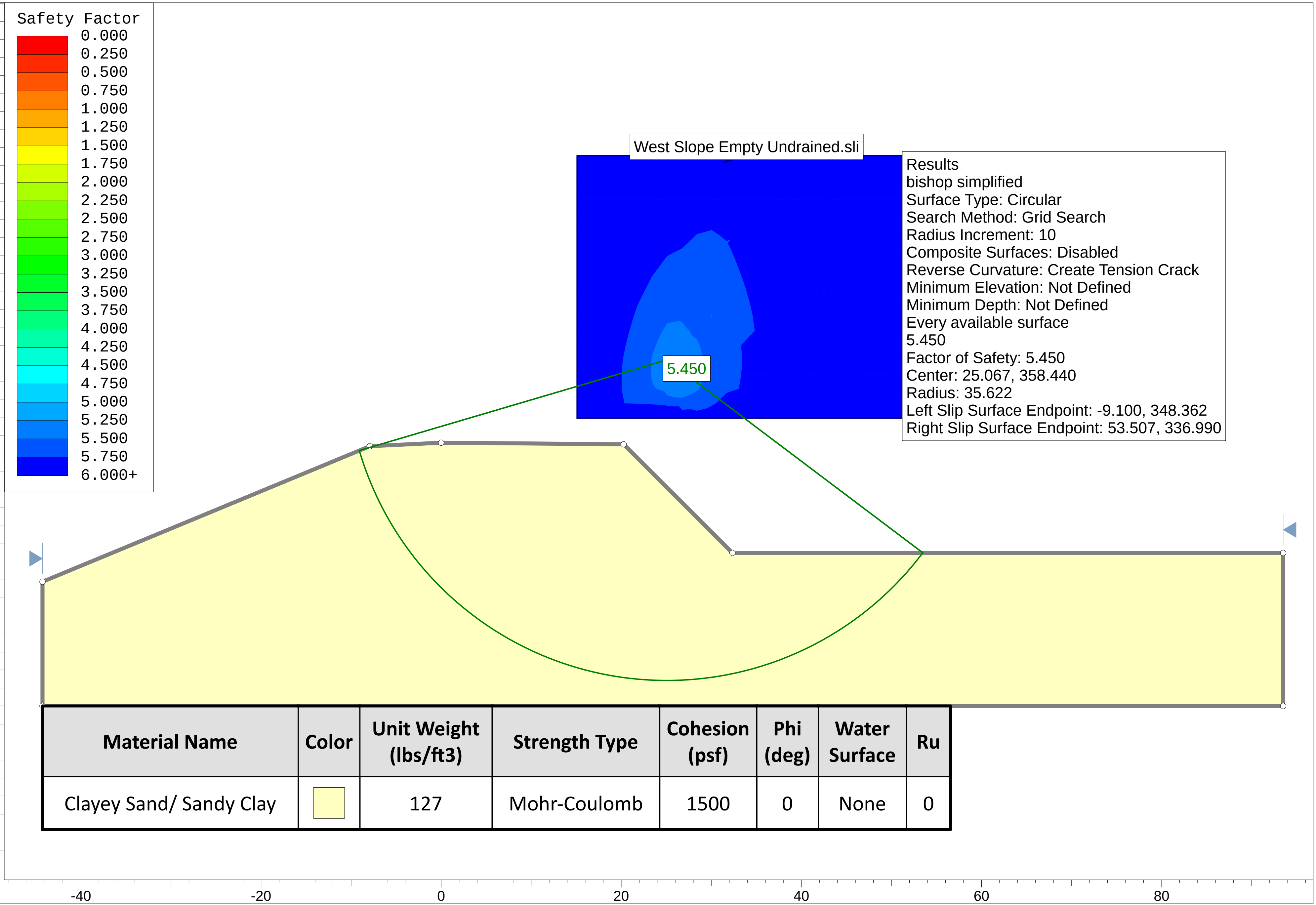
Case 16



Results
bishop simplified
Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Every available surface
3.550
Factor of Safety: 3.550
Center: 34.448, 370.591
Radius: 61.724
Left Slip Surface Endpoint: -21.649, 344.842
Right Slip Surface Endpoint: 80.119, 329.070

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Rapid Drawdown (RD) Undrained Strength	RD Cr (psf)	RD PhiR (deg)	Water Surface	Hu Type
Clayey Sand/ Sandy Clay	🟨	127	132	Mohr-Coulomb	1500	0	Yes	0	0	Piezometric Line 1	Constant
Clean Sand	🟩	127	132	Mohr-Coulomb	0	29	No			Piezometric Line 1	Constant

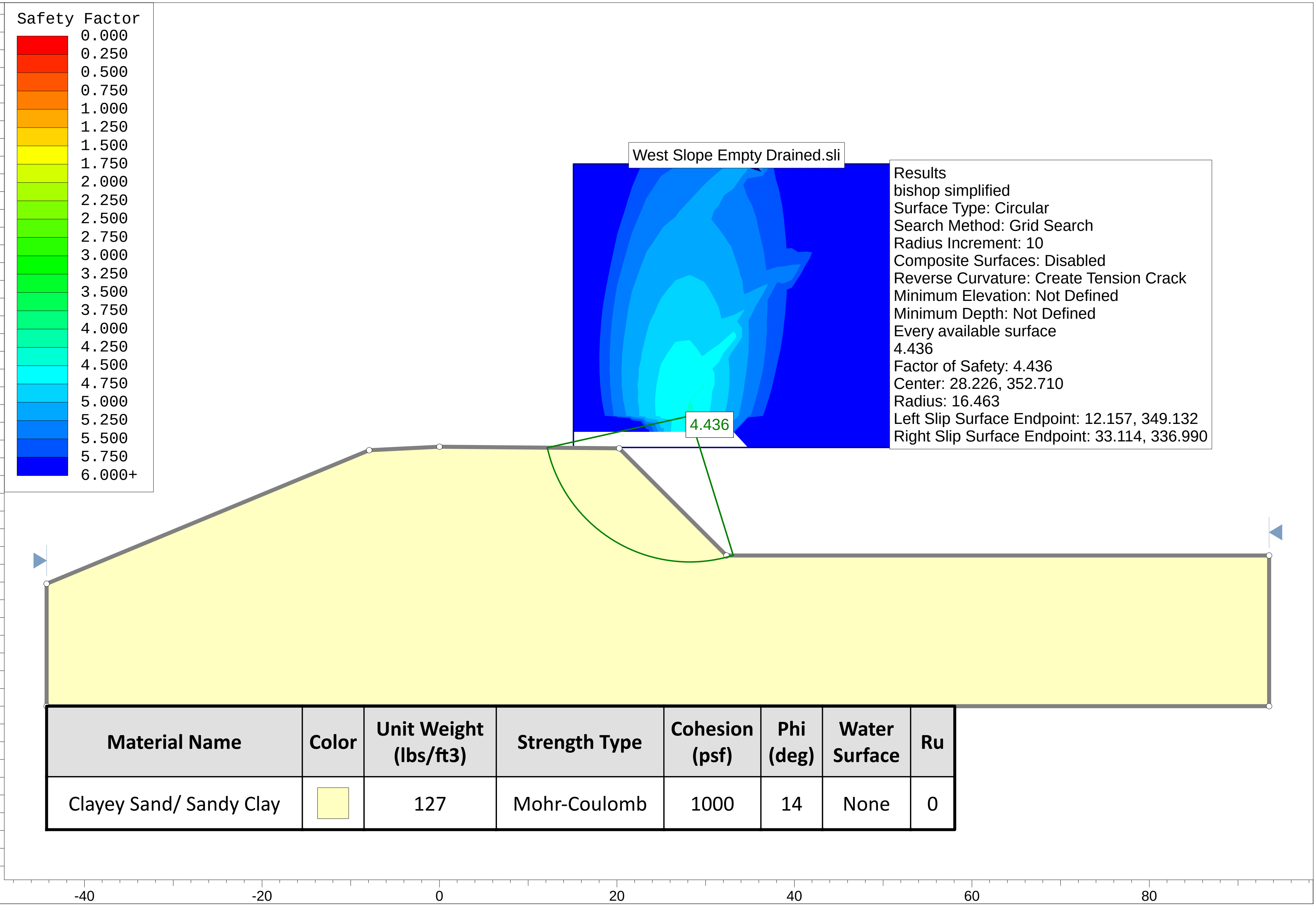
CASE 17



Results
bishop simplified
Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Every available surface
5.450
Factor of Safety: 5.450
Center: 25.067, 358.440
Radius: 35.622
Left Slip Surface Endpoint: -9.100, 348.362
Right Slip Surface Endpoint: 53.507, 336.990

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Clayey Sand/ Sandy Clay	🟨	127	Mohr-Coulomb	1500	0	None	0

CASE 18

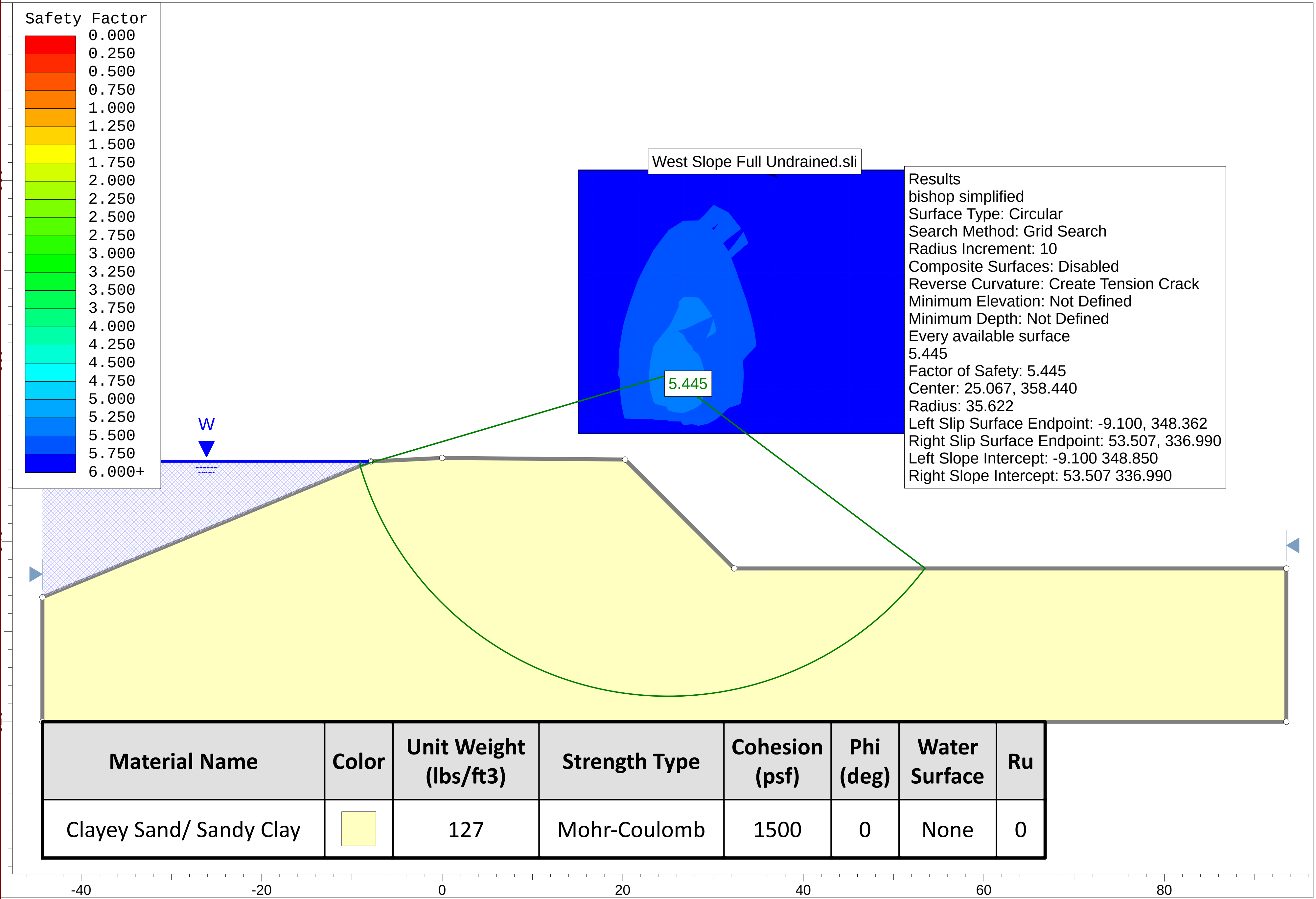


Results
bishop simplified
Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Every available surface
4.436
Factor of Safety: 4.436
Center: 28.226, 352.710
Radius: 16.463
Left Slip Surface Endpoint: 12.157, 349.132
Right Slip Surface Endpoint: 33.114, 336.990

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Clayey Sand/ Sandy Clay	🟨	127	Mohr-Coulomb	1000	14	None	0

SLIDEINTERPRET 6.019

CASE 19

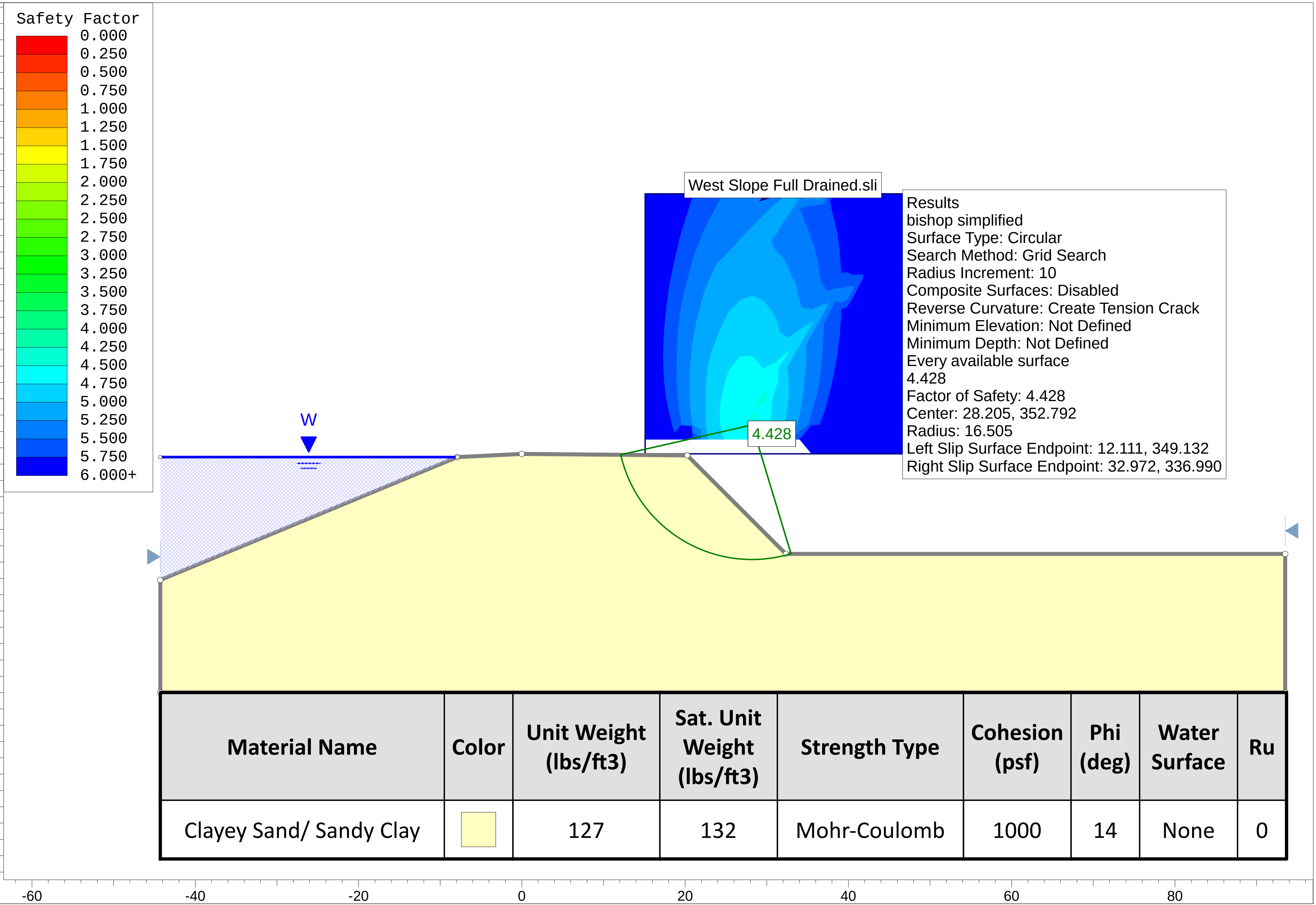


Results
bishop simplified
Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Every available surface
5.445
Factor of Safety: 5.445
Center: 25.067, 358.440
Radius: 35.622
Left Slip Surface Endpoint: -9.100, 348.362
Right Slip Surface Endpoint: 53.507, 336.990
Left Slope Intercept: -9.100 348.850
Right Slope Intercept: 53.507 336.990

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Clayey Sand/ Sandy Clay	🟨	127	Mohr-Coulomb	1500	0	None	0

SLIDEINTERPRET 6.019

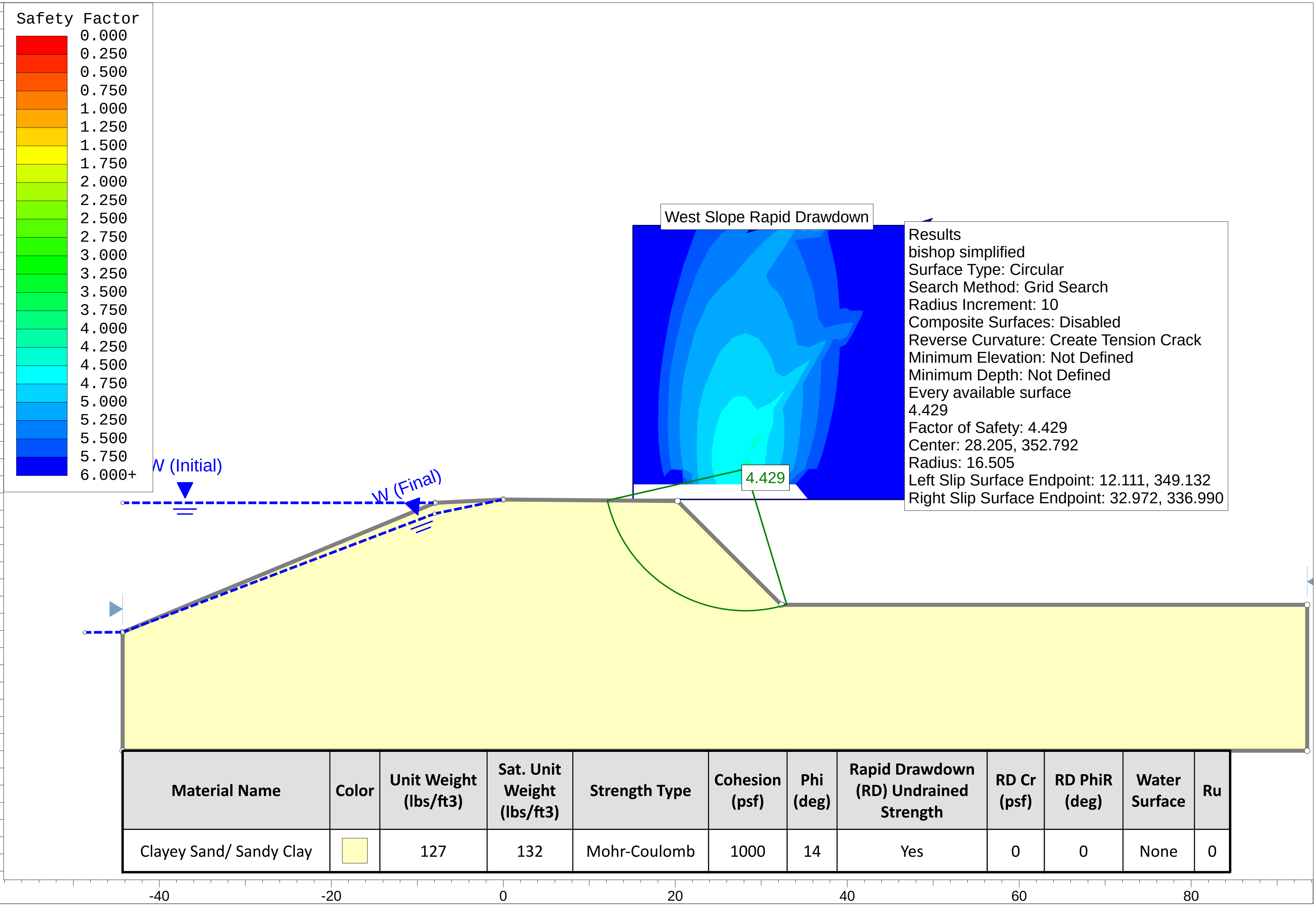
CASE 20



Results
bishop simplified
Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Every available surface
4.428
Factor of Safety: 4.428
Center: 28.205, 352.792
Radius: 16.505
Left Slip Surface Endpoint: 12.111, 349.132
Right Slip Surface Endpoint: 32.972, 336.990

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Clayey Sand/ Sandy Clay	🟨	127	132	Mohr-Coulomb	1000	14	None	0

CASE 21



West Slope Rapid Drawdown

Results
bishop simplified
Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Every available surface
4.429
Factor of Safety: 4.429
Center: 28.205, 352.792
Radius: 16.505
Left Slip Surface Endpoint: 12.111, 349.132
Right Slip Surface Endpoint: 32.972, 336.990

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Rapid Drawdown (RD) Undrained Strength	RD Cr (psf)	RD PhiR (deg)	Water Surface	Ru
Clayey Sand/ Sandy Clay	🟨	127	132	Mohr-Coulomb	1000	14	Yes	0	0	None	0

APPENDIX E
IMPORTANT INFORMATION ABOUT THIS GEOTECHNICAL REPORT

Important Information About Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.
The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared solely for the client. *No one except you* should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one - not even you -* should apply the report for any purpose or project except the one originally contemplated.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, Project-specific factors when establishing the scope of a study. Typical factors include the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, *do not rely on a geotechnical engineering report that was:*

- not prepared for you,
- not prepared for your project.
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, always inform your geotechnical engineer of project changes-even minor ones-and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations*.* *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an *opinion* about subsurface conditions throughout the site. Actual sub-surface conditions may differ - sometimes significantly - from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions

A Report's Recommendations Are *Not* Final

Do not over-rely on the construction recommendations included in your report. Those *recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability* for the report's recommendations if that engineer does not perform construction observation.

A Geotechnical Engineering Report Is Subject To Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should never be redrawn for inclusion in architectural or other design drawings. Only photo graphic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A brand conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce such risks, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations", many of these provisions indicate where geotechnical engineers responsibilities begin and end, to help others recognize their own responsibilities and risks. Read these provisions closely. Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a geoenvironmental study differ significantly from those used to perform a geotechnical study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations: e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures*. If you have not yet obtained your own geoenviromental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Rely on Your Geotechnical Engineer for Additional Assistance

Membership in ASFE exposes geotechnical engineers to a wide army of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

ASFE

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At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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