MEMORANDUM

SUBJECT: EPA Comments on "Assessment of Dam Safety of Coal Combustion Surface Impoundments: Luminant Generation Co., LLC – Oak Grove Steam Electric Station, Franklin, TX

DATE: April 7, 2014

No Comments

From:	Mustafa, Golam
To:	Englander, Jana; Vargo, Steve; wsamuels@tceq.state.tx.us
Cc:	Hoffman, Stephen; Dufficy, Craig; Kelly, PatrickM; Verhalen, Frances; Adidas, Eric
Subject:	RE: Comment Request on Coal Ash Site Assessment Round 12 Draft Reports – Luminant Generation Co., LLC – Monticello and Oak Grove Steam Electric Stations
Date:	Monday, March 10, 2014 9:30:25 AM

Hi Jana,

I have read the draft report for Oak Grove SES and I agree with the recommendations included in the draft report.

Regards,
Golam

Golam Mustafa, PhD
U.S. EPA Region 6
UST/Solid Waste Section
1445 Ross Avenue
Dallas, Texas 75202-2733
214-665-6576 – Office
469-693-0928 - Cell

From: Englander, Jana
Sent: Friday, March 07, 2014 9:28 AM
To: Mustafa, Golam; Vargo, Steve; wsamuels@tceq.state.tx.us
Cc: Hoffman, Stephen; Dufficy, Craig; Englander, Jana; Kelly, PatrickM
Subject: FW: Comment Request on Coal Ash Site Assessment Round 12 Draft Reports – Luminant Generation Co., LLC – Monticello and Oak Grove Steam Electric Stations

Dear All,

We would like to offer Texas and EPA Region 6 an opportunity to comment on the Draft Assessment Report on the Coal Combustion Residual Impoundment located at the facility below. Please let me know if you intend to comment or have any questions. Comments would be appreciated within 30 calendar days of receipt of this email. Thank you!
Regards,

Jana

Jana Englander
Office of Resource Conservation and Recovery,
Materials Recovery Waste Management Division
Energy Recovery and Waste Disposal Branch
U.S. Environmental Protection Agency
703-308-8711

From: Englander, Jana
Sent: Friday, March 07, 2014 10:19 AM
To: Mireles, Kimberly; Spicer, Gary
Cc: Hoffman, Stephen; Kelly, PatrickM; Dufficy, Craig; Englander, Jana
Subject: Comment Request on Coal Ash Site Assessment Round 12 Draft Reports – Luminant

Generation Co., LLC – Monticello and Oak Grove Steam Electric Stations

Dear Ms. Mireles,

The draft assessment reports for Luminant Generation Co., LLC – Monticello and Oak Grove Steam Electric Stations are ready for review. EPA would appreciate it if you would review and submit your comments on this report to us within 30 calendar days of receipt of this email. **Please confirm receipt of this email and send your comments to:**

Mr. Stephen Hoffman
US Environmental Protection Agency (5304P)
1200 Pennsylvania Avenue, NW
Washington, DC 20460

If you are using overnight of hand delivery mail, please use the following address:

Mr. Stephen Hoffman
US Environmental Protection Agency
Two Potomac Yard
2733 South Crystal Drive
5th Floor, N-5237
Arlington, VA 22202-2733

You may also provide your comments by e-mail to hoffman.stephen@epa.gov and englander.jana@epa.gov.

You may assert a business confidentiality claim covering all or part of the information requested, in the manner described by 40 C. F. R. Part 2, Subpart B. Information covered by such a claim will be disclosed by EPA only to the extent and only by means of the procedures set forth in 40 C.F.R. Part 2, Subpart B. If no such claim accompanies the information when EPA receives it, the information may be made available to the public by EPA without further notice to you. If you wish EPA to treat any of your response as "confidential" you must so advise EPA when you submit your response.

The draft report for Oak Grove is attached.

The draft report for Monticello can be accessed at the secured link below. **The secured link will expire on March 14, 2014**.

Here is the link for the report:
http://www.hightail.com/download/elNKVWR0NmN3NUw1SE1UQw

Please let me know if you have trouble accessing the report or have any questions/requests.

Respectfully,

Jana Englander

Jana Englander
Office of Resource Conservation and Recovery,
Materials Recovery Waste Management Division
Energy Recovery and Waste Disposal Branch
U.S. Environmental Protection Agency
703-308-8711

From:	Warren Samuelson
To:	Englander, Jana; Mustafa, Golam; Vargo, Steve
Cc:	Hoffman, Stephen; Dufficy, Craig; Kelly, PatrickM
Subject:	RE: Comment Request on Coal Ash Site Assessment Round 12 Draft Reports – Luminant Generation Co., LLC – Monticello and Oak Grove Steam Electric Stations
Date:	Monday, March 10, 2014 9:22:58 AM

The Texas Dam Safety Program has no comments as the structures are not covered by the dam safety regulations.

Warren D. Samuelson, P. E.
Manager, Dam Safety Section
TCEQ
512/239-5195

From: Englander, Jana [mailto:Englander.Jana@epa.gov]
Sent: Friday, March 07, 2014 9:28 AM
To: Mustafa, Golam; Vargo, Steve; Warren Samuelson
Cc: Hoffman, Stephen; Dufficy, Craig; Englander, Jana; Kelly, PatrickM
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Please let me know if you have trouble accessing the report or have any questions/requests.

Respectfully,

Jana Englander

Jana Englander
Office of Resource Conservation and Recovery,
Materials Recovery Waste Management Division
Energy Recovery and Waste Disposal Branch
U.S. Environmental Protection Agency
703-308-8711

DRAFT REPORT

Dam Safety Assessment of CCW Impoundments

Luminant ~~Generation Co., LLC~~/OAK GROVE STEAM ELECTRIC STATION

The site is actually owned and operated by Oak Grove Management Co., LLC, a subsidiary of Luminant Holding Company LLC. It is OK to refer to it as "Luminant", but not Luminant Generation Co., LLC.

I have tried to correct the name throughout the document, but I may a missed a few. See page 2 of the report.

United States Environmental Protection Agency
Washington, DC

February 10, 2014

O'BRIEN & GERE
www.obg.com

DRAFT REPORT

13498/46122

Dam Safety Assessment of CCW Impoundments

Luminant ~~Generation Co., LLC.~~/Oak Grove Steam Electric Station

Prepared for:
US Environmental Protection Agency
Washington, DC

ROBERT R. BOWERS, P.E. – VICE PRESIDENT
O'BRIEN & GERE ENGINEERS, INC.

ROBERT C. GANLEY, P.E. – VICE PRESIDENT
O'BRIEN & GERE ENGINEERS, INC.

The site is actually owned and operated by Oak Grove Management Co., LLC, a subsidiary of Luminant Holding Compay LLC. It is OK to refer to it as "Luminant", but not Luminant Generation Co., LLC

ELECTRIC misspelling in each header

Figures

Appendices

1. INTRODUCTION

1.1. GENERAL

In response to the coal combustion waste (CCW) impoundment failure at the TVA/Kingston coal-fired electric generating station in December of 2008, the Environmental Protection Agency has initiated a nationwide program of structural integrity and safety assessments of CCW impoundments or "management units". A CCW management unit is defined as a surface impoundment or similar diked or bermed management unit or management units designated as landfills that receive liquid-borne material and are 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. Management units also include inactive impoundments that have not been formally closed in compliance with applicable federal or state closure/reclamation regulations.

The U.S. EPA has authorized O'Brien & Gere to provide site specific impoundment assessments at selected facilities. This project is being conducted in accordance with the terms of BPA# EP10W000673, Order EP-B12S-00065, dated July 18, 2012.

1.2. PROJECT PURPOSE AND SCOPE

The purpose of this work is to provide Dam Safety Assessment of CCW management units, including the following:

- Identify conditions that may adversely affect the structural stability and functionality of a management unit and its appurtenant structures
- Note the extent of deterioration, status of maintenance, and/or need for immediate repair
- Evaluate conformity with current design and construction practices
- Determine the hazard potential classification for units not currently classified by the management unit owner or by state or federal agencies

O'Brien & Gere's scope of services for this project includes performing a site specific dam safety assessment of all CCW management units at the subject facility. Specifically, the scope includes the following tasks:

- Perform a review of pertinent records (prior inspections, engineering reports, drawings, etc.) made available at the time of the site visit (or shortly thereafter) to review previously documented conditions and safety issues and gain an understanding of the original design and modifications of the facility.
- Perform a site visit and visual inspection of each CCW management unit and complete the visual inspection checklist to document conditions observed.
- Perform an evaluation of the adequacy of the outlet works, structural stability, quality and adequacy of the management unit's inspection, maintenance, and operations procedures.
- Identify critical infrastructure within 5 miles down gradient of management units.
- Evaluate the risks and effects of potential overtopping and evaluate effects of flood loading on the management units.
- Immediate notification of conditions requiring emergency or urgent corrective action.
- Identify all environmental permits issued for the management units
- Identify all leaks, spills, or releases of any kind from the management units within the last 5 years.

- Prepare a report summarizing the findings of the assessment, conclusions regarding the safety and structural integrity, recommendations for maintenance and corrective action, and other action items as appropriate.

This report addresses the above issues for the FGD-A and FGD-B Ponds at the ~~Luminant Generation Co., LLC~~ Oak Grove Steam Electric Station near Franklin, TX. This power generation facility is owned and operated by ~~Luminant Generation Co., LLC~~ (Luminant). In the course of this assessment, O'Brien & Gere obtained information from Luminant representatives.

Oak Grove Management Co., LLC, a subsidiary of Luminant Holding Company LLC

Twin Oak, no "s"

in bag houses, then pneumatically conveyed to

2. PROJECT/FACILITY DESCRIPTION

The Oak Grove Steam Electric Station (SES) is located near Franklin, Robertson County, Texas (see Figure 1 for location plan). The generating facility has two operating units with a combined capacity of 1,600 MW. Construction of the Oak Grove facility began in 1979, the owner of the facility at that time was Texas Utilities (TXU) and the site was known as "Twin Oak~~s~~". Due to a significant drop in electricity demand, the plant was mothballed before construction could be completed. Construction re-commenced in 2007 and the facility became fully operational in 2010. The plant burns lignite mined at the Luminant~~-owned~~ Kosse Mine located approximately 15 miles from the Oak Grove SES.

All flyash generated at the facility is handled in a dry manner. It is collected ~~through electrostatic precipitators and pneumatically conveyed to bag houses, then~~ silos before it is ~~transported offsite~~. Bottom ash is also handled dry by drag chains to conveyor belts and ultimately transported off site via trucks. The CCW stored at the site is primarily wastewater from the facility's flue gas desulphurization (FGD) system wet scrubber blowdown, though the facility is permitted to also receive, metal cleaning waste, low volume wastewater, bottom ash contact water, and storm water runoff. Runoff from approximately 15 acres of the SES site can reportedly be pumped to the FGD-A Pond.

disposed of in an on-site landfill

2.1 MANAGEMENT UNIT IDENTIFICATION

The location of the CCW impoundments inspected during this safety assessment is identified on Figures 1 and 2. The impoundments are identified as FGD-A Pond and FGD-B Pond. The embankments for both impoundments were constructed with on-site borrow materials. FGD-A Pond was partially constructed during the initial construction phase but was not completed at that time. It was completed before the 2010 opening of the Oak Grove Steam Electric Station. Construction of FGD-B Pond was completed in 2012.

FGD-A Pond has a surface area of approximately 9.4 acres, it is used as the primary unit, while FGD-B Pond (11.3 acres) is used when there is maintenance on FGD-A Pond, or if FGD-A is otherwise out of service. The ponds are covered by a Texas State Pollutant Discharge Elimination System (TPDES) permit (Permit No. WQ0001986000). There is, however, no passive discharge structure from the ponds and site personnel indicate that due to evaporation and water management, the ponds have never discharged any of their contents. If necessary, FGD-A Pond contents can overflow/decant to FGD-B Pond through a 12-inch pipe. FGD-B Pond contents must be pumped to FGD-A Pond. Water can be recycled from FGD-A Pond back to the SES through a pumping station located near the northeast corner of the Pond.

2.2. HAZARD POTENTIAL CLASSIFICATION

The State of Texas classifies dams or embankments in accordance with Title 30 of the Texas Administrative Code (TAC), Chapter 299, Dams and Reservoirs. The regulations are administrated by the Texas Commission on Environmental Quality (TCEQ), Texas Dam Safety Program. The TCEQ Dam Safety program regulations apply to "*design, review, and approval of construction plans and specifications; and construction, operation and maintenance, inspection, repair, removal, emergency management, site security, and enforcement of dams that:*

1. *have a height greater than or equal to 25 feet and a maximum storage capacity greater than or equal to 15 acre-feet, as described in paragraph (2) of this subsection;*
2. *have a height greater than 6 feet and a maximum storage capacity greater than or equal to 50 acre-feet;*
3. *are a high- or significant-hazard dam as defined in §299.14 of this title (relating to Hazard Classification Criteria), regardless of height or maximum storage capacity; or*
4. *are used as a pumped storage or terminal storage facility.*

Dam and embankment hazard classifications are established by 30 TAC §299.14 and provide standards regarding impoundment facility structure classification:

> *The executive director shall classify dams for hazard based on either potential loss of human life or property damage, in the event of failure or malfunction of the dam or appurtenant structures, within affected developments, that are existing at the time of the classification. The hazard classification may include use of a breach analysis that addresses the incremental impact of the potential breach over and above the impact of the flood that may have caused the breach, as defined in §299.15(a)(4)(A)(i) of this title (relating to Hydrologic and Hydraulic Criteria for Dams). The classification must be according to the following.*
>
> *(1) Low. A dam in the low-hazard potential category has:*
> *(A) no loss of human life expected (no permanent habitable structures in the breach inundation area downstream of the dam); and*
> *(B) minimal economic loss (located primarily in rural areas where failure may damage occasional farm buildings, limited agricultural improvements, and minor highways as defined in §299.2(38) of this title (relating to Definitions)).*
> *(2) Significant. A dam in the significant-hazard potential category has:*
> *(A) loss of human life possible (one to six lives or one or two habitable structures in the breach inundation area downstream of the dam); or*
> *(B) appreciable economic loss, located primarily in rural areas where failure may cause:*
> *(i) damage to isolated homes;*
> *(ii) damage to secondary highways as defined in §299.2(58);*
> *(iii) damage to minor railroads; or*
> *(iv) interruption of service or use of public utilities, including the design purpose of the utility.*
> *(3) High. A dam in the high-hazard potential category has:*
> *(A) loss of life expected (seven or more lives or three or more habitable structures in the breach inundation area downstream of the dam); or*
> *(B) excessive economic loss, located primarily in or near urban areas where failure would be expected to cause extensive damage to:*
> *(i) public facilities;*
> *(ii) agricultural, industrial, or commercial facilities;*
> *(iii) public utilities, including the design purpose of the utility;*
> *(iv) main highways as defined in §299.2(33); or*
> *(v) railroads used as a major transportation system.*

The TCEQ Dam Safety Program currently does not regulate the FGD Scrubber Ponds and therefore Hazard Potentials have not been previously designated. In the absence of a state-assigned classification, the FEMA guidelines, *Hazard Potential Classification System for Dams* (2004) have been applied in this assessment to recommend a hazard potential classification for the following impoundment. The definitions for the four hazard potentials (Less than Low, Low, Significant and High) to be used in this assessment are included in the EPA CCW checklist found in Appendix A.

not used for recreation

Based on site evaluation, both units are considered **Low** Hazard Potential. This classification assumes that no probable loss of human life and low economic and/or environmental losses would occur in the event of a dam/embankment failure. The area that would potentially be inundated by a breach of any embankment of the FGD Scrubber Ponds is limited to property owned by Luminant. The potential exists for discharge to reach the Twin Oak Reservoir, which is also owned by Luminant. The Reservoir provides cooling water for the Oak Grove SES and is ~~used for recreation~~. It is not a water supply reservoir. The Twin Oak Reservoir has a reported storage capacity of 30,319 acre-feet. The volume of water and CCWs impounded in the FGD-A and FGD-B Ponds is approximately 240 acre-feet (78.5 million gallons). Thus the quantity of a release from an embankment breach would represent less than 1% of total available reservoir storage and the environmental damage would be limited to the adjacent area in the western reach of the reservoir.

2.3. IMPOUNDING STRUCTURE DETAILS

The following sections summarize the structural components and basic operations of the subject impoundments. The impoundments are located to the northwest of the Oak Grove SES, the impoundments abut each other. The location of the impoundments on the plant grounds is shown on Figures 1 and 2.

2.3.1. Embankment Configuration

FGD-A Pond

FGD-A Pond is approximately 9.4 acres in size. The impoundment is partially incised. The embankment's design crest elevation is EL. 449.5 and the designed bottom is at EL. 422.0. Embankment height varies, but is approximately 20 feet at the maximum section. The combined length of the impoundments embankments is approximately 2,400 feet. Construction of the impoundment began during the initial (1979) phase of construction of the Oak Grove SES and was completed prior to the SES being brought on-line in 2010. The designed slope of the inboard face is 2.5H:1V. A three-foot thick clay liner was installed on the embankment's inboard face. The clay liner and the embankment materials were excavated from on-site borrow areas. Portions of the inboard face are also coved by a high density polyethylene (HDPE) liner. A "dividing dike" extends approximately 300 feet westward from the eastern embankment approximately 200 feet south of the northern embankment. The dike provides separation from the inflow structure and pump station intake within the pond.

FGD-B Pond

FGD-B Pond is approximately 11.3 acres in size. The impoundment is partially incised. The embankment's design crest elevation is EL. 431.5 and the designed bottom varies from EL. 425.0 to EL. 416.0. Embankment height varies, but is approximately 10 feet at the maximum section. The designed inboard and outboard slopes are 3H:1V. The combined length of the impoundments embankments is approximately 3,000 feet. A two-foot thick clay liner is overlain by a 60-mil HDPE on the inboard slopes. The design also included one-foot of soil "protective cover" on top of the HDPE liner.

2.3.2. Type of Materials Impounded

FGD scrubber waste is the primary material that is impounded in the FGD-A and FGD-B Ponds. The Ponds, however, are permitted to receive FGD wet scrubber blowdown, metal cleaning waste, low volume wastewater, bottom ash contact water, and storm water runoff. Thus trace amounts of the other waste-products may be detected in the Ponds.

2.3.3. Outlet Works

FGD-A Pond is constructed with a 12-inch overflow/decant pipe that can discharge into FGD-B Pond. Flow through the pipe is controlled by a valve. The impoundment does not have a "passive" spillway system but water can be pumped from FGD-A Pond back to the Oak Grove SES through a pumping station located east of the impoundment. FGD-B Pond does not have a permanently installed outlet system. Portable pumps are used to pump wastewater from FGD-B into FGD-A when necessary.

3. RECORDS REVIEW

3.1. GENERAL

A review of the available records related to design, construction, operation and inspection of the FGD-A and FGD-B Ponds was performed as part of this assessment. The documents provided by Luminant are listed below:

Table 3.1 *Summary of Documents Reviewed*

the correct spelling is "Fluor"

Document	Dates	By	Description
FGD Scrubber Pond Cross Sections	Jun 24, 2008	~~Flour~~ Enterprises, Inc.	Design sections for FGD-A Pond
Figure 2-1: FGD Scrubber Pond Liner Verification Sampling Plan	August 5, 2008	~~Flour~~ Enterprises, Inc.	Soil sample locations for FGD-A Pond
Oak Grove SES. FGD Pond Soil Liner Evaluation Report. Robertson County, Texas.	November 17, 2008	Golder Associates, Inc.	Summary report of Golder's quality assurance services during subgrade prep and clay liner installation in FGD-A Pond
Oak Grove SES Groundwater. Water Level Data, 2-Yr. History	2009 - 2012	Luminant	Groundwater readings from 9 wells located near FGD-A and FGD-B Ponds
FGD-B Slope Stability Evaluation Report. Luminant Oak Grove SES	April 27, 2010	Golder Associates, Inc.	Summary report of slope stability analyses performed for the design of FGD-B Pond
FGD-A Slope Stability Evaluation Report. Luminant Oak Grove SES	March 2011	Golder Associates, Inc.	Summary report of slope stability analyses performed for FGD-A Pond
Luminant Oak Grove FGD-B Pond: Site Map with Monitoring Well Locations	March, 2011	Pastor, Behling & Wheeler, LLC.	Site plan showing FGD-A Pond, FGD-B Pond and monitoring well locations
Critical Impoundment Inspection Report for Oak Grove SES	March 4, 2011	Luminant	Summary report of annual inspection of the FGD-A Pond by Luminant
Oak Grove Steam Electric Station. FGD-B Pond Construction. Robertson County, Texas.	September, 2011	Golder Associates, Inc.	Design Drawings for FGD-B Pond
Liner Evaluation Report. Oak Grove SES. FGD-B Pond. Golder Robertson County, Texas.	January 2012	Golder Associates, Inc.	Summary report of Golder's Construction Quality Assurance (CQA) services during construction of the composite liner for the FGD-B Pond
Oak Grove Steam Electric Station. Robertson County, Texas. Critical Impoundment Inspection Report	April 25, 2012	HDR Engineering	Summary report of annual inspection of the FGD-A and FGD-B Ponds

3.2. DESIGN DOCUMENTS

3.2.1. General

Review of the available drawings and reports revealed the following:

- Construction of FGD-A Pond began during the initial construction phase of the Oak Grove SES but was not completed until 2008 during the second phase of plant construction.
- Golder Associates, Inc. provided third-party Construction Quality Assurance/Quality Control Plan (CQA/QCP) services during placement of the 3-foot thick clay liner on the inboard faces and floor of FGD-A Pond.

  - The subgrade to the liner was inspected and its condition approved by Golder prior to placement of the clay liner.
  - The liner was reported to have been placed in accordance with the project plans and specifications. The in-place hydraulic conductivity of the liner is reported to be no greater than $1.0x10^{-7}$ centimeters per second (cm/sec).
  - Data pertaining to foundation preparation or condition for construction of the Pond's embankments was not provided in the Golder report.
- Construction of FGD-B Pond began in 2011 and was completed in 2012.
- Golder Associates, Inc. provided third-party Construction Quality Assurance (CQA) monitoring and testing services during construction of the embankments and the composite liner for the FGD-B Pond.
  - Golder approved the subgrade (foundation) preparation prior to the placement of structural fill or liner material.
  - The composite liner was reported to have been placed in accordance with the project plans, specifications and Quality Control Plan (QCP). The in-place hydraulic conductivity of the composite liner is reported to be no greater than $1.0x10^{-7}$ centimeters per second (cm/sec).
  - The structural fill that form the embankments was reported to have been placed at, or above, 95% Maximum Dry Density.
- No breach or overtopping event of either impoundment has been reported.
- Formal "Critical Impoundment Inspections" are performed annually by a professional engineer licensed in Texas. Informal inspections are performed on a daily basis by Oak Grove personnel. Routine maintenance of the embankments is performed on an as-needed basis.
- Readings of the 9 monitoring wells are taken on a semi-annual basis.
- Annual inspections of FGD-A Pond indicate the impoundment has been found to be in good condition with minor rutting of the crest and localized erosion of the soil cover over the clay liner on the inboard face observed.
- Construction of the FGD-B Pond was completed shortly before the 2012 annual inspection and the vegetative cover had not had time to properly take root due to droughty conditions.
- The groundwater readings have remained relatively steady throughout the monitoring history.

3.2.2. Stormwater Inflows

No hydrologic & hydraulic analyses were available for review. According to Luminant personnel, stormwater inflow to the FGD-A and FGD-B Ponds has been evaluated and the Ponds were designed for a minimum design storm of the 24-hour, 25-year event. Because the embankments are raised on all sides of both ponds, direct runoff to the ponds is limited rainfall on the impoundments. However, runoff from approximately 15 acres of the SES facility can be pumped to FGD-A Pond. Based on charts presented in the National Weather Service's Technical Paper 40 (NWS TP-40), the 24-hour 25-year rainfall is approximately eight (8) inches and the regularly available freeboard exceeds seven (7) feet in FGD-A Pond and five (5) feet in FGD-B Pond, therefore the Ponds should be capable of containing the design event plus site runoff without overtopping their respective embankments. The Ponds should also be able to contain the 24-hour 100-year event which is approximately ten (10) inches of rainfall. While no formal hydrologic and hydraulic analyses have been performed, informal calculations indicate that the maximum possible volume of runoff from the 100-year event that could be pumped to the FGD-A Pond is approximately 544,500 ft^3. The pond has approximately 2,460,000 ft^3 of available storage. Thus the FGD-A Pond appears to have the capacity to store 4.5 times the maximum possible 24-hour, 100-year inflow. The ponds do not have a spillway or overflow structure, therefore the ponds will retain the precipitation and any stormwater pumped in until the precipitation evaporates or is pumped from the ponds.

3.2.3. Stability Analyses

O'Brien & Gere reviewed the April 2010 "FGD-B Slope Stability Investigation" and the March 2011 "FGD-A Slope Stability Evaluation" reports by Golder Associates, Inc. (Golder) as part of the investigation of the CCW impoundments at the Oak Grove SES. These reports document the stability analyses for the FGD Ponds. Two cross-sections through each impoundment were analyzed using the slope stability software program SLIDE. The load cases analyzed include long term and short term steady-state seepage under "full pond" conditions. Rapid drawdown and short term "empty pond" under seismic loading were not analyzed. Load cases analyzed were performed on the inboard and outboard slopes.

Soil shear strength parameters used in the slope stability analyses were based on a combination of information obtained during field (sampling) programs and laboratory soil testing. The field programs included sampling from the interior and embankment of FGD-A Pond and from the proposed location of FGD-B Pond. As-built samples of FGD-B Pond were not collected.

Disturbed samples were collected using a standard split spoon sampler and Standard Penetration Tests (SPT) were conducted as part of the sampling program. The disturbed samples were tested for grain-size analysis, Atterberg Limits, and natural moisture content. In addition, undisturbed samples of clayey soils were collected using steel Shelby tubes. Unconsolidated-undrained (UU) and consolidated-undrained (CU) triaxial compression tests were performed on the undisturbed samples. The soil properties utilized for the slope stability analyses are presented in Table 3.1.

Table 3.2 *Soil Material Properties*

Location	Stratum	Description	γ_{moist} (pcf)	$\gamma_{saturated}$ (pcf)	Undrained Shear Strength		Drained Shear Strength	
					C (psf)	ϕ (°)	C (psf)	ϕ (°)
FGD-A Pond Northwest	I	Sandy Clay	127	132	3000	-	270	26
	II	Sandy Clay / Silty Clay / Sandy Silt	127	132	2000	-	0	26
	III	Sand	127	132	0	-	0	36
FGD-A Pond Northeast	I	Sandy Clay	127	132	3000	-	270	26
	II	Sandy Clay / Clay	127	132	2000	-	0	26
	III	Clayey Sand	127	132	0	-	0	32
FGD-B Pond	I	Clay / Silty Clay / Sandy Clay	123	128	3200	0	278	26
	II	Sandy Clay / Clay	120	125	2000	0	0	26
	III	Clayey Sand	120	125	0	42	0	42
		Structural Fill	123	128	3200	0	278	26

The above soil parameters are based on laboratory and field tests on representative samples of the various soil strata encountered in the test borings. The soil parameters listed in Table 3.2 appear to be appropriate based on the review of available data.

Table 3.3 below provides a summary of the minimum computed factors of safety for slope stability of the two ponds:

Table 3.3 *Summary of Minimum Computed Factors of Safety for Slope Stability*

Location	Case	Description	Factor of Safety
FGD-A Pond	1	Northwest (interior) sideslope; full pond; short-term (undrained) conditions	5.8
	2	Northwest (interior) sideslope; full pond; long-term (drained) conditions	2.0
	3	Northeast (exterior) sideslope; full pond; short-term (undrained) conditions	6.2
	3a	Northeast (exterior) sideslope; full pond; long-term (drained) conditions	1.9
	4	Northeast (interior) sideslope; full pond; short-term (undrained) conditions	5.9
	5	Northeast (interior) sideslope; full pond; long-term (drained) conditions	2.0
FGD-B Pond	1	West sideslope; short-term (undrained) conditions	9.9
	2	West sideslope; long-term (drained) conditions	3.7
	3	East sideslope; short-term (undrained) conditions	5.2
	4	East sideslope; long-term (drained) conditions	2.5
	5	East sideslope (considering FGD pond); short-term (undrained) conditions	4.6
	6	East sideslope (considering FGD pond); long-term (drained) conditions	2.5

The results of the slope stability analyses indicated that the computed factors of safety exceed the minimum standard set by Golder (Factor of Safety = 1.5) for all load cases. The report stated that rapid drawdown analysis of the interior slope was not an applicable load case given the operational controls of the impoundment pool level.

It does not appear that a seismic stability analysis was performed for the embankment slopes of either pond. At a minimum, a pseudostatic slope stability analysis should be performed for the critical slope section of the Ponds to demonstrate that the slopes have a minimum factor of safety of 1.0 for the 2,500-year return period earthquake. However, based on the review of the static load case factors of safety, and given the low seismic coefficient for the site location, it is likely that the minimum Factor of Safety criteria will be met. In addition, the seismic stability analysis should include a liquefaction potential screening. While the majority of the soils encountered within borings conducted for the Golder slope stability analyses indicate predominantly fine-grained soils that are not typically susceptible to liquefaction, some saturated sand deposits were encountered within the deeper native soils, which could potentially be susceptible to liquefaction.

See Addendum Letter

3.3. PREVIOUS INSPECTIONS

Two previous inspection reports were provided by Luminant. The report dated March 4, 2011 was prepared by Luminant and the April 25, 2012 report was prepared by HDR Engineering, Inc. Similar issues related to the FGD-A Pond embankments were noted in the two reports. These include minor rutting on the crest and minor erosion gullies on the "upstream" (inboard) face of the embankment. The FGD-B Pond was not inspected in 2011 because it was not completed until after the 2012 inspection. Erosion gullies on the crest and inboard face of the embankment were noted in the 2012 inspection report. Additionally, it was noted that construction of the impoundment was not yet complete.

3.4. OPERATOR INTERVIEWS

Numerous plant personnel took part in the inspection proceedings along with a representative of the United States Environmental Protection Agency (USEPA). The following is a list of participants for the September 2012 assessment of the FGD - A and FGD - B Ponds:

Table 3.4 *Personnel Present at the Assessment of the Oak Grove SES CCW Impoundments*

Name	Affiliation
Jon King	Luminant
Marshall Shaw	Luminant
Julie Preyean	Luminant
Max Stephens	Luminant
Mark Kelly	Luminant
Jeff Jones	Luminant
Gary Spicer	Luminant
Bob Gentry	Luminant
Golam Mustafa	USEPA
Robert C. Ganley, PE	O'Brien & Gere
Johan Anestad, PE	O'Brien & Gere

Facility personnel provided a good working knowledge of the CCW impoundments, provided general plant operation background and provided requested historical documentation. These personnel also accompanied O'Brien & Gere and the USEPA representative throughout the visual assessment to answer questions and to provide additional information as needed in the field.

4. VISUAL ASSESSMENT

4.1. GENERAL

A visual assessment of the FGD-A and FGD-B Ponds was performed on September 19, 2012. The individuals listed in Table 3.4 were present during the assessment.

The weather on the date of the assessment was sunny and approximately 70 degrees. Field checklists were prepared by O'Brien & Gere to summarize the visual assessment and are included as Appendix A. Photographs were taken by both Luminant and O'Brien & Gere. Pertinent photos taken by O'Brien & Gere are included as Appendix B.

4.2. SUMMARY OF FINDINGS

Prior to the visual assessment, staff from Luminant provided an overview of the facility operation, including how fly ash and bottom ash are handled. Both materials are dry-handled and are not discharged into a CCW impoundment. Discharge to FGD-A Pond is primarily wastewater from the facility's flue gas desulphurization (FGD) system wet scrubber blowdown, though the Pond can receive runoff from approximately 15 acres of the SES facility as well as metal cleaning waste, low volume wastewater and bottom ash contact water. Discharge to FGD-B Pond is limited to overflow from the FGD-A Pond through a 12-inch HDPE cross-over pipe installed in the western embankment of FGD-A Pond. During the visual assessment of the FGD-A and FGD-B Ponds, the full length of the crests and outboard faces of the embankment were walked and representative features observed. The following observations were made during the assessment:

FGD-A Pond

- FGD wastewater enters the pond through pipes installed through the southern half of the Pond's eastern embankment.
- Minor erosion gullies in the clay liner cover material was observed in several locations on the eastern embankment and the "dividing dike".
- Minor erosion of the cover material was also observed along the water-line, primarily on the Pond's northern embankment.
- An HDPE liner is exposed at the southeast abutment of the "dividing dike" and the eastern embankment.
- An animal burrow was observed adjacent to one of the inflow pipes on the outboard face of the eastern embankment.
- Damage at the outboard toe and face of the Pond's western embankment was observed. Luminant personnel reported that the damage was caused by ~~wild boars~~. ← Feral hogs
- No evidence of prior releases, failures or patchwork of the impoundment was observed.

FGD-B Pond

- Inflow to the pond is limited to overflow from the FGD-A Pond through a 12-inch HDPE pipe in the western embankment of FGD-A Pond. No water was observed entering the Pond during the assessment.
- Minor erosion gullies were observed on the outboard face of the northern embankment. Heavy vegetative growth was also observed on portions of this embankment.
- The Twin Oaks Reservoir (owned by Luminant) is located north of the impoundment. The reservoir does not directly abut the Pond's embankment; it abuts the natural ground upon which the FGD-B Pond embankment is constructed.

- Erosion of the HDPE's cover material was observed along the water-line throughout the impoundment. A small section of liner was exposed near the northwest corner of the impoundment.
- The vegetative cover planted when construction of the impoundment was completed earlier in 2012 has not grown significantly due to drought conditions after planting.
- A deep erosion gully was observed on the eastern embankment. The liner's cover material was fully eroded and the liner was exposed at this location.
- No evidence of prior releases, failures or patchwork of the impoundment was observed.

5. CONCLUSIONS

Based on the ratings defined in the USEPA Task Order Performance Work Statement (Satisfactory, Fair, Poor and Unsatisfactory), the information reviewed and the visual assessment, the overall condition of FGD-A Pond and FGD-B Pond is considered to be **POOR**. While the visual condition of this management unit is good and recent engineering studies on the structural stability of the impounding dikes indicate acceptable performance under normal long-term loading conditions, this rating must be given since a seismic stability analysis has not been completed to assess the stability during the maximum credible earthquake (MCE). The MCE to be applied in the seismic analysis is equivalent to the 2,500-year return period or 2% probability of exceedence in 50 years earthquake. Acceptable performance is expected; however, some deficiencies exist that require repair and/or additional studies or investigations.

Major deficiencies include the following:

- Seismic stability analyses and liquefaction potential screenings were not performed for either FGD Pond.

Minor deficiencies include the following:

- Erosion of cover material down to the HDPE in one location of the eastern embankment of FGD-B Pond.
- The animal burrow observed adjacent to one of the inflow pipes on the outboard face of FGD-A Pond.
- Damage to outboard face of the western embankment of the FGD-A Pond from wild boars.
- Erosion of cover material at multiple locations along the waterline in both the FGD-A and FGD-B Ponds.

See addendum Letter

6. RECOMMENDATIONS

Based on the findings of our visual assessment and review of the available historical documents for the FGD-A Pond and the FGD-B Pond, O'Brien & Gere is recommending further evaluation of embankment stability under seismic loading and repairs to the erosion of the liner cover material and the animal burrow noted in the assessment.

6.1. URGENT ACTION ITEMS

None of the recommendations are considered to be urgent, since the issues noted above do not appear to threaten the structural integrity of the dam in the near term.

6.2. LONG TERM IMPROVEMENT/MAINTENANCE ITEMS

- Evaluate the seismic stability of the embankments and liquefaction potential of the embankments and underlying native soils given a 2,500 year earthquake.
- Repair eroded cover material.
- Fill the animal burrow.

All item have been addressed as part of routine maintenance, inspections, and the addendum letter.

6.3. MONITORING AND FUTURE INSPECTION

Daily visual inspections are reportedly performed and the results of annual detailed inspections have been recorded in inspection reports. Deficiencies noted during the annual inspections and in this CCW assessment report should be addressed in a timely manner to maintain dam integrity. Consideration should be given to development of an O&M Plan that would establish a firm schedule for operations, maintenance and inspection activities.

6.4. RECOMMENDED SCHEDULE FOR COMPLETION OF ACTION ITEMS

The facility should address any items noted during visual inspections in a timely manner, depending on the severity and location of the deficiency. The regular inspection schedule should be maintained.

6.5. CERTIFICATION STATEMENT

I acknowledge that the FGD-A Pond and FGD-B Pond management units referenced herein were personally assessed by me on September 19, 2012 and was found to be in ~~**POOR** condition due to the lack of a seismic slope stability and liquefaction potential evaluation for critical embankment sections~~.

see addendum letter

SATISFACTORY

FAIR

POOR

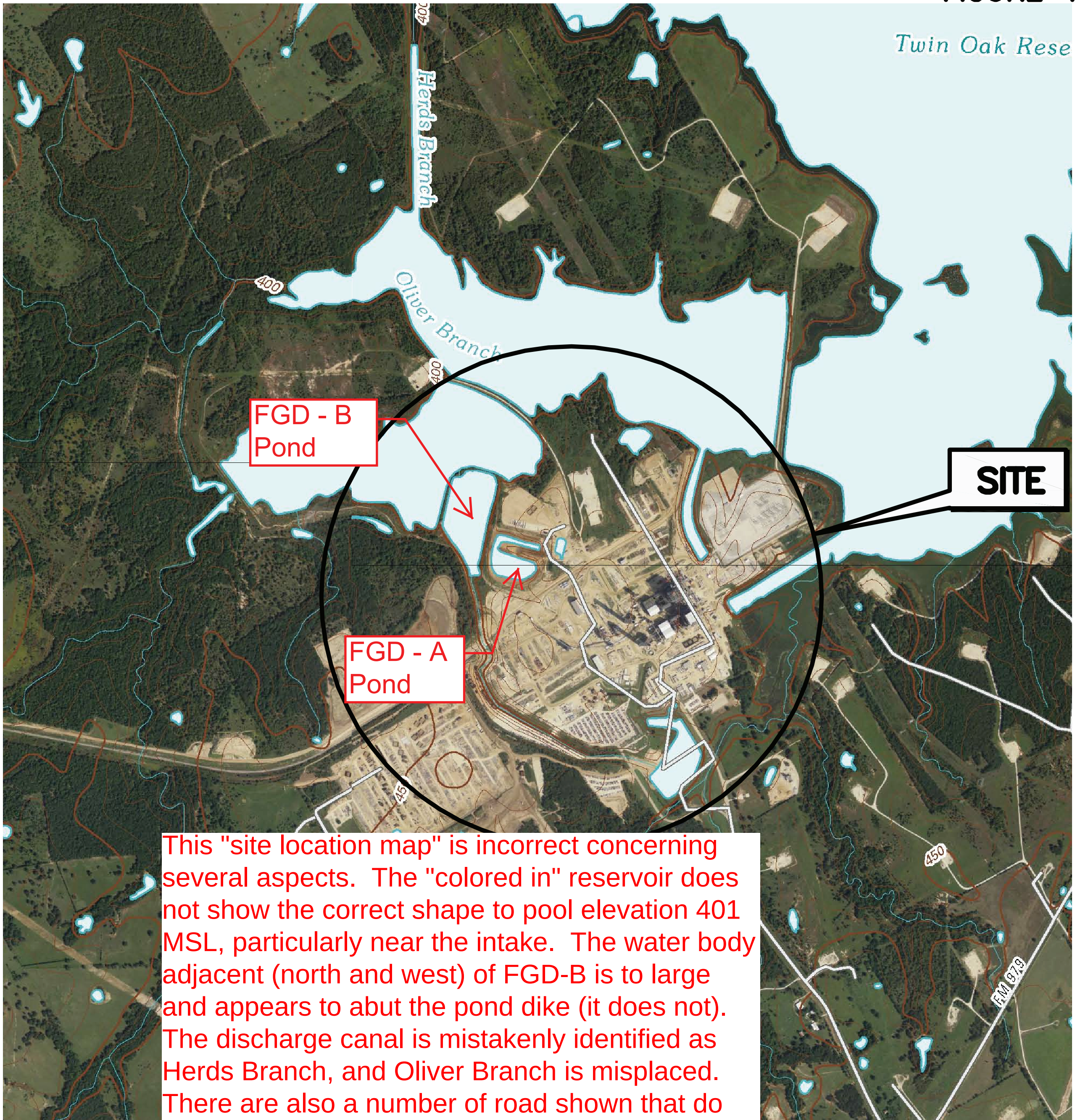
UNSATISFACTORY

Signature: ______________________________ Date: ______________________

Robert C. Ganley, PE
TX PE License #

FIGURES

FIGURE 1



This "site location map" is incorrect concerning several aspects. The "colored in" reservoir does not show the correct shape to pool elevation 401 MSL, particularly near the intake. The water body adjacent (north and west) of FGD-B is to large and appears to abut the pond dike (it does not). The discharge canal is mistakenly identified as Herds Branch, and Oliver Branch is misplaced. There are also a number of road shown that do not exist, and other minor errors. This should be updated with a more recent aerial.

ADAPTED FROM: PETTEWAY & BALD PRAIRIE QUADRANGLES, TEXAS U.S.G.S. 7.5 MIN. QUAD; 2010

QUADRANGLE LOCATION

US EPA
DAM SAFETY ASSESSMENT
OF CCW IMPOUNDMENTS

OAK GROVE STEAM ELECTRIC STATION
ROBERTSON COUNTY, TEXAS

SITE LOCATION MAP

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

SCALE: 1:24000

46122-OAK GROVE-F01
MAY 2013

O'BRIEN & GERE

March 19, 2014 Project Nos. 103-942563.002 & 113-94790

Mr. Gary L. Spicer
Luminant Power
1601 Bryan Street
Dallas, Texas 75201

RE: ADDENDUM TO SLOPE STABILITY INVESTIGATION REPORTS LUMINANT OAK GROVE SES, ROBERTSON COUNTY, TEXAS

Dear Mr. Spicer:

This letter report serves as an addendum to the following two reports issued by Golder Associates Inc. (Golder).

- FGD-B Slope Stability Investigation Report (Revised), Luminant Oak Grove SES, Robertson County, Texas, dated June 2010
- FGD-A Slope Stability Evaluation Report, Luminant Oak Grove SES, Robertson County, Texas, dated March 2011

This addendum report includes the results of additional slope stability analyses for seismic considerations and a review of the liquefaction potential at the pond areas.

Details of the field investigations, subsurface conditions, and soil material properties used in the stability analyses are included in the above reports.

1.0 ADDITIONAL STABILITY ANALYSES

Additional stability analyses were performed to quantify the effect of pseudo-static earthquake loading. The slope stability analyses were performed using the commercial slope stability software program, SLIDE Version 6.026. Based on the “US Seismic Hazard 2008 Map” prepared by the United States Geologic Survey (USGS), the peak ground acceleration (PGA) for a 2% probability of exceedance in 50 years is about 4%g for the site location. A seismic load coefficient of 0.04 was therefore used in the earthquake loading analysis. The earthquake load was applied to all slope stability cases and profiles presented in the original reports. The results of the analyses are provided in Tables 1 and 2.

Golder Associates Inc.
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Houston, TX 77073 USA
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TABLE 1. FGD-A SLOPE STABILITY FACTORS OF SAFETY WITH AN EARTHQUAKE LOAD

Case	Description	Factor of Safety
1	Northwest (interior) sideslope; full pond; short-term (undrained) conditions	4.6
2	Northwest (interior) sideslope; full pond; long-term (drained) conditions	1.7
3	Northeast (exterior) sideslope; full pond; short-term (undrained) conditions	5.1
3a	Northeast (exterior) sideslope; full pond; long-term (drained) conditions	1.7
4	Northeast (interior) sideslope; full pond; short-term (undrained) conditions	4.6
5	Northeast (interior) sideslope; full pond; long-term (drained) conditions	1.7

TABLE 2. FGD-B SLOPE STABILITY FACTORS OF SAFETY WITH AN EARTHQUAKE LOAD

Case	Description	Factor of Safety
1	West sideslope; empty pond; short-term (undrained) conditions	7.9
2	West sideslope; empty pond; long-term (drained) conditions	3.1
3	West sideslope; full pond; short-term (undrained) conditions	10.2
4	West sideslope; full pond; long-term (drained) conditions	3.4
5	East sideslope; empty pond; short-term (undrained) conditions	3.1
6	East sideslope; empty pond; long-term (drained) conditions	2.0
7	East sideslope; full pond; short-term (undrained) conditions	3.0
8	East sideslope; full pond; long-term (drained) conditions; circular failure	1.7
8A	East sideslope; full pond; long-term (drained) conditions; block failure	1.6
9	North sideslope; empty pond; short-term (undrained) conditions	7.1
10	North sideslope; empty pond; long-term (drained) conditions	3.0
11	North sideslope; full pond; short-term (undrained) conditions	9.5
12	North sideslope; full pond; long-term (drained) conditions	3.2

In summary, our analyses indicate that the FGD-A and FGD-B proposed pond slopes are stable.

2.0 LIQUEFACTION POTENTIAL

Soil liquefaction describes a phenomenon whereby a saturated or partially saturated soil substantially loses strength and stiffness in response to an applied stress, usually earthquake shaking or other sudden change in stress condition, causing it to behave like a liquid. The phenomenon is most often observed in saturated, loose (low density or uncompacted), sandy soils.

A screening assessment of liquefaction potential has been undertaken based on the ground conditions encountered at the borehole locations, a surface acceleration of 0.04g, and with a 7.5 earthquake magnitude.

The assessment of liquefaction potential was carried out for predominantly granular soils based on SPT blow counts (N values) using the procedures outlined in Youd et al. (2001). This method is generally considered to be the standard of practice for liquefaction-screening using the SPT. The methodology tends to be conservative as it was developed mainly for clean sands and then modified to consider sands with increasing amounts of fines; thus, it is most accurate for sands with fines content less than 5%.

The method was implemented with the following key considerations:

- The methodology requires the fines content of the predominantly granular material. When particle size distribution testing was not available for the specific sample, a fines content was assumed based on field classification.
- Only SPT field (uncorrected) N-values lower or equal to 30 were considered, since greater values are generally accepted to indicate dense soils which are not susceptible to liquefaction.

Two scenarios were evaluated at the borehole locations meeting the above criteria. The first scenario was modelled with the ground surface and groundwater elevation measured at the time of drilling. The second scenario was modelled with the ground surface and groundwater at the pond base elevation.

Based on the procedures outlined in Youd et al. (2001) the minimum factor of safety exceeds 1.1, which indicates, the site soils are not susceptible to liquefaction.

3.0 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.
Texas Firm Registration Number: F-2578

STATE OF TEXAS
JEFFREY B. FASSETT
85675
LICENSED
PROFESSIONAL ENGINEER

Sarajane B. Kroupa
Project Geological Engineer

Jeffrey B. Fassett, P.E.
Associate

Golder Associates

REPORT

FGD-A SLOPE STABILITY EVALUATION REPORT

Luminant Oak Grove SES
Robertson County, Texas

Submitted To: Luminant Power
Oak Grove
P.O. Box 356
Franklin, Texas 77856

Submitted By: Golder Associates Inc.
500 Century Plaza Drive
Suite 190
Houston, TX 77073 USA
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STATE OF TEXAS
3/15/11
P. CHRIS MARSHALL
91893
LICENSED
PROFESSIONAL ENGINEER

March 2011 **113-94790**

A world of capabilities delivered locally

Golder Associates

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1.0 INTRODUCTION

1.1 Project Description

Luminant Power (Luminant) operates the Oak Grove Steam Electric Station (SES), a lignite-fueled power plant near Franklin, Robertson County, Texas. The location of the Oak Grove SES is presented on Figure 1. As part of the current site development, the existing FGD-A pond pool elevation may be raised to increase the pond's storage capacity. Luminant contracted Golder Associates Inc. (Golder) to evaluate the FGD-A pond berm slope stability considering a higher pond pool elevation.

The project scope includes conducting pond berm slope stability analyses based on available geotechnical information for the FGD-A and FGD-B pond areas.

The FGD-A pond is located on the northern portion of the facility (see Figure 2). The FGD-A pond was constructed in 2008 at the site of an existing pond. The pond has an area of approximately 9 acres and is located adjacent to the existing west railroad retention pond (location of proposed FGD-B pond). The pond bottom elevation is 422 feet-mean sea level (ft-msl) and the crest elevation is 450 ft-msl. The pond berms have interior and exterior slopes of 2.5 horizontal to 1 vertical (2H:1V) (Fluor, 2008).

1.2 Coordinate System and Unit System

The local plant grid coordinate system is used in this report. All elevations are referenced to mean sea level (msl).

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

2.0 SUBSURFACE CONDITIONS

Information from previous subsurface investigations was used to characterize the subsurface site conditions. Golder conducted a subsurface investigation for the FGD-A pond in July 2008, prior to pond construction. Golder completed nine borings within the pond footprint with boring depths ranging from 16 to 28 feet below ground surface (bgs) (Golder, 2008). Golder also conducted a subsurface investigation for the proposed FGD-B pond in March 2010 (Golder, 2010). Boring locations are shown on Figure 3. Appendix A includes select, representative boring logs.

The soils encountered under the pond consist of lean clays, sandy clays, silty clays, sands, silty sands, clayey sands, and sandy silts. The near surface soils under the pond generally consist of fine-grained soils extending to depths ranging from approximately 6 feet to more than 19 feet below the pond bottom. Coarse-grained soils (i.e., sands) were generally encountered at depths greater than 6 feet below the pond bottom. Sands were encountered at shallower depths in the northwest portion of the pond than in the southeast portion of the pond.

The pond berm is assumed to consist of sandy fat clay, based on the soils encountered in boring BH-FGD-105.

Water level measurements taken in December 2009 and June 2010 from monitoring wells near the FGD-A pond indicate that the groundwater level is between approximately 406 and 409 ft-msl. In our analyses, we have conservatively assumed that the water level in the soil units under the pond is equal to the pond pool elevation.

3.0 STABILITY ANALYSES

Slope stability analyses were performed using the commercial slope stability software program, SLIDE Version 5.044. Stability analyses were performed for two separate slope sections (northwest and northeast sideslopes) to assess the various soil conditions and slope geometries around the pond. Analysis locations are shown on Figure 3. Stability analyses considered "full pond" conditions, which is the most severe case for berm stability. For the "full pond" case, a pond pool elevation of 448 ft-msl was used. For the northwest berm, the phreatic surface in the berm was modeled to vary linearly between the FGD-A and FGD-B pond pool elevations. For the northeast berm, the phreatic surface was conservatively assumed to be at 448 ft-msl within the berm and at the ground surface on the exterior side of the berm.

Stability analyses for the external side of the northwest berm (considering the combined effects of the FGD-A and FGD-B ponds) were included in Golder's slope stability investigation for the FGD-B pond (Golder, 2010). The slope was determined to be stable with an adequate factor of safety.

Based on our discussions with Luminant, "rapid drawdown" is an unlikely loading scenario for the FGD-A pond and was not considered in our analyses.

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 for the existing borings. Tables 1 and 2 list the estimated soil properties for the slope sections.

Table 1: Soil Material Properties for Northwest Sideslope Section

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)	Cohesion, c' (lb/ft^2)	Friction Angle, φ' (°)
I	Sandy Clay	127	132	3000	270	26
II	Sandy Clay/ Silty Clay/ Sandy Silt	127	132	2000	0	26
III	Sand/ Silty Sand	127	132	N/A	0	36

Note: Soil properties based on interpretation of borings BH-FGD-105 and FGD-B-7.

Table 2: Soil Material Properties for Northeast Sideslope Section

Soil Material	Description	Moist Unit Weight (lb/ft³)	Saturated Unit Weight (lb/ft³)	Undrained Soil Properties	Drained Soil Properties	
				Undrained Shear Strength, s_u (lb/ft²)	Cohesion, c' (lb/ft²)	Friction Angle, φ' (°)
I	Sandy Clay	127	132	3000	270	26
II	Silty Clay/ Clay	127	132	2000	0	26
III	Clayey Sand	127	132	N/A	0	32

Notes: Soil properties based on interpretation of borings BH-FGD-105, FGD-B-8, and FGD-B-9.

3.2 Slope Stability Results

Slope stability analyses were performed for both short- and long-term conditions using undrained and drained soil properties for the clay and silt soils, respectively. Sands were considered drained for both conditions. The results of the analyses are provided in Table 3. SLIDE output files are included in Appendix B. A factor of safety of 1.5 is typically considered adequate for permanent slopes. The minimum calculated factor of safety from our analyses is 1.9. Therefore, our analyses indicate that the proposed slopes will be stable under the assumed conditions.

Table 3: Slope Stability Factors of Safety

Case	Description	Factor of Safety
1	Northwest (interior) sideslope; full pond; short-term (undrained) conditions	5.8
2	Northwest (interior) sideslope; full pond; long-term (drained) conditions	2.0
3	Northeast (exterior) sideslope; full pond; short-term (undrained) conditions	6.2
3a	Northeast (exterior) sideslope; full pond; long-term (drained) conditions	1.9
4	Northeast (interior) sideslope; full pond; short-term (undrained) conditions	5.9
5	Northeast (interior) sideslope; full pond; long-term (drained) conditions	2.0

The factors of safety are lower for long-term than short-term conditions.

"Rapid drawdown" is frequently a critical slope stability case in water retention structures. Rapid drawdown occurs where the water level in a pond or river is high for an extended period, and is then suddenly reduced resulting in an additional load from the water remaining within the berm soil. Slope stability analyses did not consider "rapid drawdown" loading conditions. If the FGD-A pond ever needs to be drained rapidly, additional analyses should be performed to analyze this particular loading condition.

Golder Associates

4.0 IMPORTANT INFORMATION

Attention is drawn to the document "Important Information About Your Geotechnical Engineering Report," which is included in Appendix C 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 REFERENCES

Fluor Enterprises, Inc. (2008). Oak Grove Electric Station, Grading and Drainage Plan; Drawings A2YF00-0-CV-0-GR.PL.-32-2; A2YF00-0-CV-0-GR.PL.-33-3; A2YF00-0-CV-0-GR.PL.-41-2; and A2YF00-0-CV-0-GR.PL.-42-4.

Golder Associates Inc. (2008). Data Report, Oak Grove SES, FGD Pond Subsurface Investigation, Robertson County, Texas, October 31, 2008.

Golder Associates Inc. (2010). FGD-B Slope Stability Investigation Report (Revised), Luminant Oak Grove SES, Robertson County, Texas, June 10, 2010.

6.0 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.

STATE OF TEXAS
3/15/11
P. CHRIS MARSHALL
91893
LICENSED
PROFESSIONAL ENGINEER

P. Chris Marshall, PE
Senior Project Engineer

Ken Been, PhD, PE
Principal

Golder Associates

FIGURES

Drawing File: J:\113-94790 - Oak Grove_A - FGD-A Pond\11394790A001.dwg | Layout: ---- | Modified: 3/11/2011 12:17:49 PM TLe | Plotted: Friday, March 11, 2011 12:26:04 PM TLe

REFERENCE: AERIAL PHOTOGRAPH BY GOOGLE EARTH PRO 2010

Luminant

Golder Associates
500 Century Plaza Drive, Suite 190
Houston, Texas USA 77073
Tel: (281) 821-6868
Texas Registration Number: F-2578

TITLE

SITE LOCATION PLAN

PROJECT

FGD-A-POND SLOPE STABILITY ANALYSIS
LUMINANT OAK GROVE SES
ROBERTSON COUNTY, TEXAS

DRAWN	TLE	DATE	MARCH 2011	FIGURE NUMBER
CHECKED	PCM	SCALE	AS SHOWN	1
REVIEWED	PCM	JOB NO.	113-94790	
FILE NO.		DWG NO.	11394790A001	

REFERENCE: AERIAL PHOTOGRAPH BY GOOGLE EARTH PRO 2010

Luminant

Golder Associates
500 Century Plaza Drive, Suite 190
Houston, Texas USA 77073
Tel: (281) 821-6868
Texas Registration Number: F-2578

TITLE

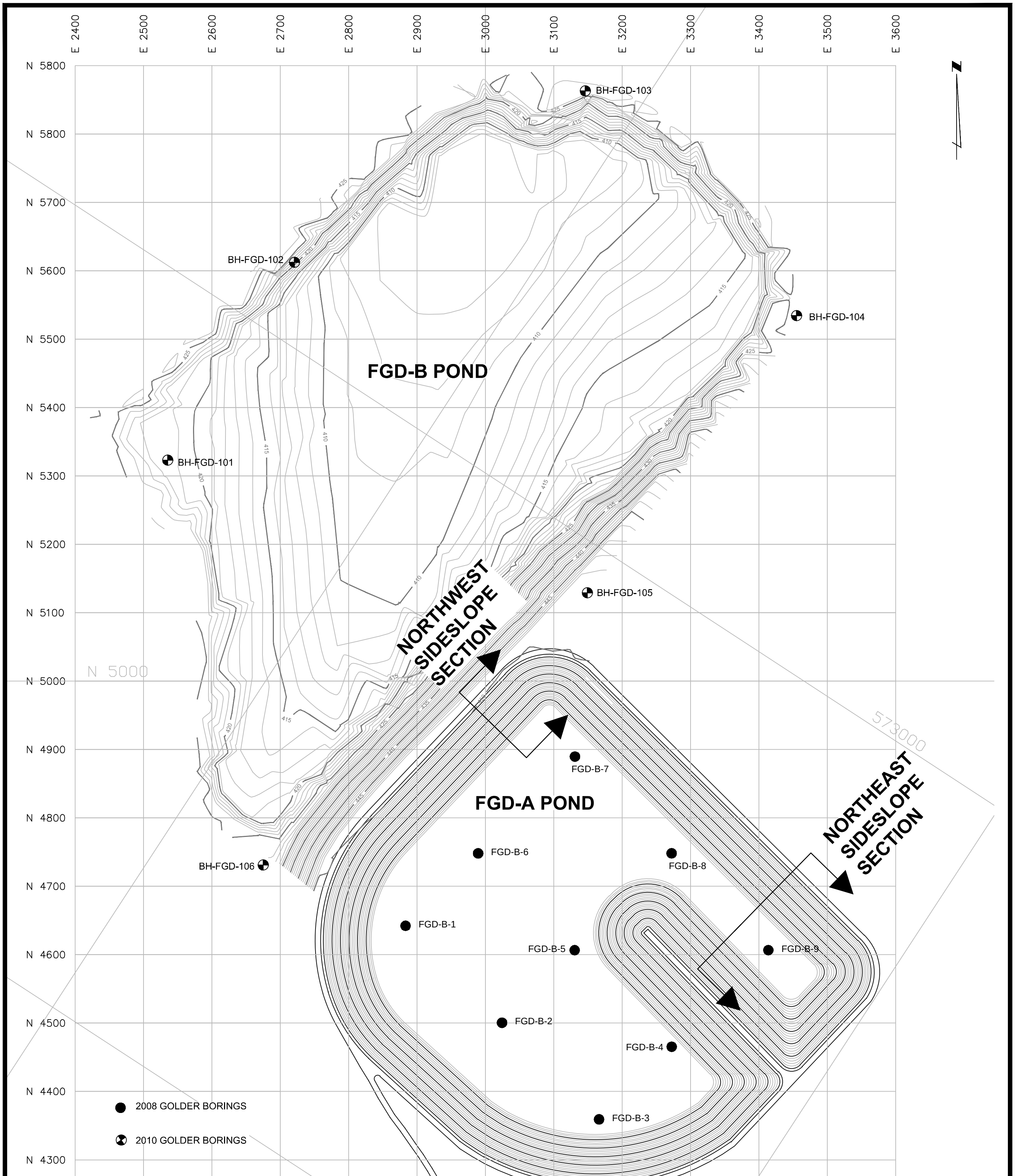
SITE VICINITY PLAN

PROJECT

FGD-A-POND SLOPE STABILITY ANALYSIS
LUMINANT OAK GROVE SES
ROBERTSON COUNTY, TEXAS

DRAWN	TLE	DATE	MARCH 2011	FIGURE NUMBER
CHECKED	PCM	SCALE	AS SHOWN	2
REVIEWED	PCM	JOB NO.	113-94790	
FILE NO.		DWG NO.	11394790A002	

Drawing File: J:\113-94790 - Oak Grove_A - FGD-A Pond\11394790A002.dwg I Layout: ---- I Modified: 3/11/2011 12:17:04 PM TLe I Plotted: Friday, March 11, 2011 12:23:31 PM TLe



Luminant

Golder Associates
500 Century Plaza Drive, Suite 190
Houston, Texas USA 77073
Tel: (281) 821-6868
Texas Registration Number: F-2578

TITLE

EXISTING BORING LOCATION PLAN

PROJECT

FGD-A-POND SLOPE STABILITY ANALYSIS
LUMINANT OAK GROVE SES
ROBERTSON COUNTY, TEXAS

DRAWN	TLE	DATE	MARCH 2011	FIGURE NUMBER
CHECKED	PCM	SCALE	AS SHOWN	**3**
REVIEWED	PCM	JOB NO.	113-94790	
FILE NO.		DWG NO.	11394790A003	

APPENDIX A
REPRESENTATIVE BORING LOGS

RECORD OF BOREHOLE FGD-B-7

SHEET 1 OF 2
DATUM: LOCAL

PROJECT: OAK GROVE SES
LOCATION: FRANKLIN, TEXAS

BORING STARTED: 17-Jul-2008
BORING FINISHED: 17-Jul-2008

DRILLING EQUIPMENT: MOBILE B-57 BUGGY
DRILLING OPERATOR: Lewis Environmental Drilling

NORTHING (ft): 4889.56
EASTING (ft): 3130.96
ELEVATION (ft): 422.24

Legend: UNDRAINED SHEAR STRENGTH Cu — CU - ● P.P. - ⊕ Field Vane Shear ■; UU - ✤ TORV. - ▲ UCS - ✱ (scale 400, 800, 1200, 1600). ROCK QUALITY DESIGNATION (RQD) % ★ (20, 40, 60, 80). WATER CONTENT PERCENT: PL ⊢—O^W—⊣ LL (20, 40, 60, 80).

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (ft)	SAMPLE NUMBER	TYPE	BLOWS/0.5 FT	ADDITIONAL LAB. TESTING	INSTALLATION NOTES AND GROUNDWATER OBSERVATIONS
0	Hollow Stem Auger	GROUND SURFACE	422.2					
		Stiff to very stiff, reddish brown, sandy CLAY, damp	0.0	1	SB	4 7 8 N15		
		dark brown at 1.5'						
2		Very stiff, reddish brown and yellowish brown, CLAY, trace sand, damp	2.0	2	SH		perm sieve	
4				3	SB	7 10 13 N23	sieve	
6		Dense, reddish brown to brown, SAND, with clay, damp	6.0	4	SB	12 22 24 N46		
8		light brown, sandy clay layer at 8.0'						
		reddish brown at 8.5'		5	SB	12 17 21 N38	sieve	
10		dense to very dense at 10.0'		6	SB	11 14 17 N31		
12		light brown at 12.0'		7	SB	17 30 28 N58		
14		clayey at 14'		8	SB	17 17 22 N39	sieve	
16		moist at 16.0'		9	SB	10 14 18 N32		▼ 16'
18		light gray at 19.0'		10	SB	12 24 26 N50		
20								

— CONTINUED NEXT PAGE —

DEPTH SCALE
1 inch to 2.5 feet

Golder Associates

REVISED October 21, 2008

LOGGED: CS
CHECKED: CFR

RECORD OF BOREHOLE FGD-B-7

SHEET 2 OF 2
DATUM: LOCAL

PROJECT: OAK GROVE SES
LOCATION: FRANKLIN, TEXAS

BORING STARTED: 17-Jul-2008
BORING FINISHED: 17-Jul-2008

DRILLING EQUIPMENT: MOBILE B-57 BUGGY
DRILLING OPERATOR: Lewis Environmental Drilling

NORTHING (ft): 4889.56
EASTING (ft): 3130.96
ELEVATION (ft): 422.24

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS/0.5 FT	UNDRAINED SHEAR STRENGTH Cu (CU - ● P.P. - ⊕ Field Vane Shear ■ UU - ✿ TORV - ▲ UCS - ✱) 400 800 1200 1600	ROCK QUALITY DESIGNATION (RQD) % ★ 20 40 60 80 / WATER CONTENT PERCENT PL ├──○W──┤ LL 20 40 60 80	ADDITIONAL LAB. TESTING	INSTALLATION NOTES AND GROUNDWATER OBSERVATIONS
		— CONTINUED FROM PREVIOUS PAGE —									
20	Hollow Stem Auger			20.0	11	SB	12 24 24 N48				
22		TOTAL DEPTH AT 22.0'		22.0							
24											
26											
28											
30											
32											
34											
36											
38											
40											

DEPTH SCALE
1 inch to 2.5 feet

Golder Associates

REVISED October 21, 2008

LOGGED: CS
CHECKED: CFR

RECORD OF BOREHOLE FGD-B-8

DATUM: LOCAL

PROJECT: OAK GROVE SES
LOCATION: FRANKLIN, TEXAS

BORING STARTED: 17-Jul-2008
BORING FINISHED: 17-Jul-2008

DRILLING EQUIPMENT: MOBILE B-57 BUGGY
DRILLING OPERATOR: Lewis Environmental Drilling

NORTHING (ft): 4748.26
EASTING (ft): 3272.19
ELEVATION (ft): 426.97

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (ft)	SAMPLE NUMBER	TYPE	BLOWS/0.5 FT	WATER CONTENT PERCENT (PL–W–LL)	ADDITIONAL LAB. TESTING	INSTALLATION NOTES AND GROUNDWATER OBSERVATIONS
0	Hollow Stem Auger	GROUND SURFACE		427.0						
		Stiff to very stiff, reddish brown, CLAY, wtih sand, damp		0.0						
					1	SB	3 4 6 N10			
		silty at 1.5'								
2					2	SB	11 10 10 N20			
4					3	SB	4 4 6 N10			
6		Stiff to very stiff, light brown and yellowish brown, silty CLAY, trace sand, damp		6.0	4	SB	4 7 8 N15			
8		very stiff, brown with mottled yellowish brown at 8'						PL–W–LL plotted		
					5	SH			perm sieve	
10		reddish brown at 10.0'			6	SB	3 4 6 N10			
12					7	SB	3 3 5 N8			
14		dark brown at 14.5'			8	SB	3 3 4 N7			
16								PL–W–LL plotted		
					9	SH			sieve	
18										
		Hard, reddish brown, sandy CLAY, damp		19.0	10	SB	8 17 19 N36			20' (water level symbol)
20										

Legend: UNDRAINED SHEAR STRENGTH Cu (400, 800, 1200, 1600): CU - ● P.P. - ⊕ Field Vane Shear ■ UU - ✣ TORV. - ▲ UCS - ✱; ROCK QUALITY DESIGNATION (RQD) % ★ (20, 40, 60, 80); WATER CONTENT PERCENT PL ⊢—O W—⊣ LL (20, 40, 60, 80)

— CONTINUED NEXT PAGE —

RECORD OF BOREHOLE FGD-B-8

SHEET 2 OF 2
DATUM: LOCAL

PROJECT: OAK GROVE SES
LOCATION: FRANKLIN, TEXAS

BORING STARTED: 17-Jul-2008
BORING FINISHED: 17-Jul-2008

DRILLING EQUIPMENT: MOBILE B-57 BUGGY
DRILLING OPERATOR: Lewis Environmental Drilling

NORTHING (ft): 4748.26
EASTING (ft): 3272.19
ELEVATION (ft): 426.97

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS/0.5 FT	UNDRAINED SHEAR STRENGTH Cu (CU - ● P.P. - ⊕ Field Vane Shear ■ UU - ✤ TORV. ▲ UCS - ✱) 400 800 1200 1600	ROCK QUALITY DESIGNATION (RQD) % ★ 20 40 60 80 / WATER CONTENT PERCENT PL ⊢—○W—⊣ LL 20 40 60 80	ADDITIONAL LAB. TESTING	INSTALLATION NOTES AND GROUNDWATER OBSERVATIONS
		--- CONTINUED FROM PREVIOUS PAGE ---									
20	Hollow Stem Auger	Compact to dense, brown, clayey SAND, moist		20.0							
					11	SB	7 17 24 N41			sieve	
		light brown at 21.5'									
22					12	SB	4 7 10 N17				
24									○ (approx. 38)		
					13	SB	14 19 24 N43			sieve	
		Firm, gray, CLAY		25.5							
26		TOTAL DEPTH 26'		26.0							
28											
30											
32											
34											
36											
38											
40											

OAK GROVE - FGD 94281GINT.GPJ GLDR_HOU.GDT 10/31/08

DEPTH SCALE
1 inch to 2.5 feet

Golder Associates

REVISED October 21, 2008

LOGGED: CS
CHECKED: CFR

RECORD OF BOREHOLE FGD-B-9

SHEET 1 OF 2
DATUM: LOCAL

PROJECT: OAK GROVE SES
LOCATION: FRANKLIN, TEXAS

BORING STARTED: 17-Jul-2008
BORING FINISHED: 17-Jul-2008

DRILLING EQUIPMENT: MOBILE B-57 BUGGY
DRILLING OPERATOR: Lewis Environmental Drilling

NORTHING (ft): 4606.63
EASTING (ft): 3413.66
ELEVATION (ft): 427.99

Boring method: Hollow Stem Auger

Undrained shear strength Cu: CU - ● P.P. - ⊕ Field Vane Shear ■ UU - ✤ TORV. - ▲ UCS - ✱ (scale 400, 800, 1200, 1600)

Rock Quality Designation (RQD) % ★ (scale 20, 40, 60, 80); Water content percent PL —O W— LL (scale 20, 40, 60, 80)

DEPTH SCALE FEET	SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (ft)	SAMPLE NUMBER	TYPE	BLOWS/0.5 FT	ADDITIONAL LAB. TESTING	INSTALLATION NOTES AND GROUNDWATER OBSERVATIONS
0	GROUND SURFACE	428.0					
	Firm to stiff, yellowish brown and brown, CLAY, with sand, damp	0.0	1	SB	2, 4, 4, N8		
2	mottled reddish brown and light gray at 3.0'		2	SB	3, 4, 4, N8		
4	Stiff to very stiff, brown with occasional yellow brown seams, silty CLAY, damp	4.0	3	SB	4, 4, 6, N10		
8			4	SB	4, 6, 6, N12		
8			5	SH		perm, sieve	
10	dark brown with occasional streaks of reddish brown at 10.0'		6	SB	3, 4, 5, N9		
12			7	SB	4, 10, 10, N20		
14			8	SH			
16	Hard, light gray with occasional yellowish brown and brown, CLAY, trace sand, moist	16.0	9	SB	11, 12, 19, N31		
18			10	SB	7, 17, 24, N41	sieve	▼ 18'
20							

— CONTINUED NEXT PAGE —

RECORD OF BOREHOLE FGD-B-9

DATUM: LOCAL

PROJECT: OAK GROVE SES
LOCATION: FRANKLIN, TEXAS
BORING STARTED: 17-Jul-2008
BORING FINISHED: 17-Jul-2008
DRILLING EQUIPMENT: MOBILE B-57 BUGGY
DRILLING OPERATOR: Lewis Environmental Drilling
NORTHING (ft): 4606.63
EASTING (ft): 3413.66
ELEVATION (ft): 427.99

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS/0.5 FT	UNDRAINED SHEAR STRENGTH Cu (CU - ● P.P. - ⊕ Field Vane Shear ■ UU - ✪ TORV. - ▲ UCS - ✱) 400 800 1200 1600	ROCK QUALITY DESIGNATION (RQD) % ★ 20 40 60 80 / WATER CONTENT PERCENT PL ⊢—O W—⊣ LL 20 40 60 80	ADDITIONAL LAB. TESTING	INSTALLATION NOTES AND GROUNDWATER OBSERVATIONS
		— CONTINUED FROM PREVIOUS PAGE —									
20	Hollow Stem Auger	Hard, dark brown with occasional reddish brown, sandy CLAY, moist		20.0	11	SB	5 18 28 N46			sieve	
22		gray with occasional reddish brown at 23'			12	SB	18 29 33 N62			sieve	
24		TOTAL DEPTH 24.0'		24.0							
26											
28											
30											
32											
34											
36											
38											
40											

DEPTH SCALE
1 inch to 2.5 feet

Golder Associates

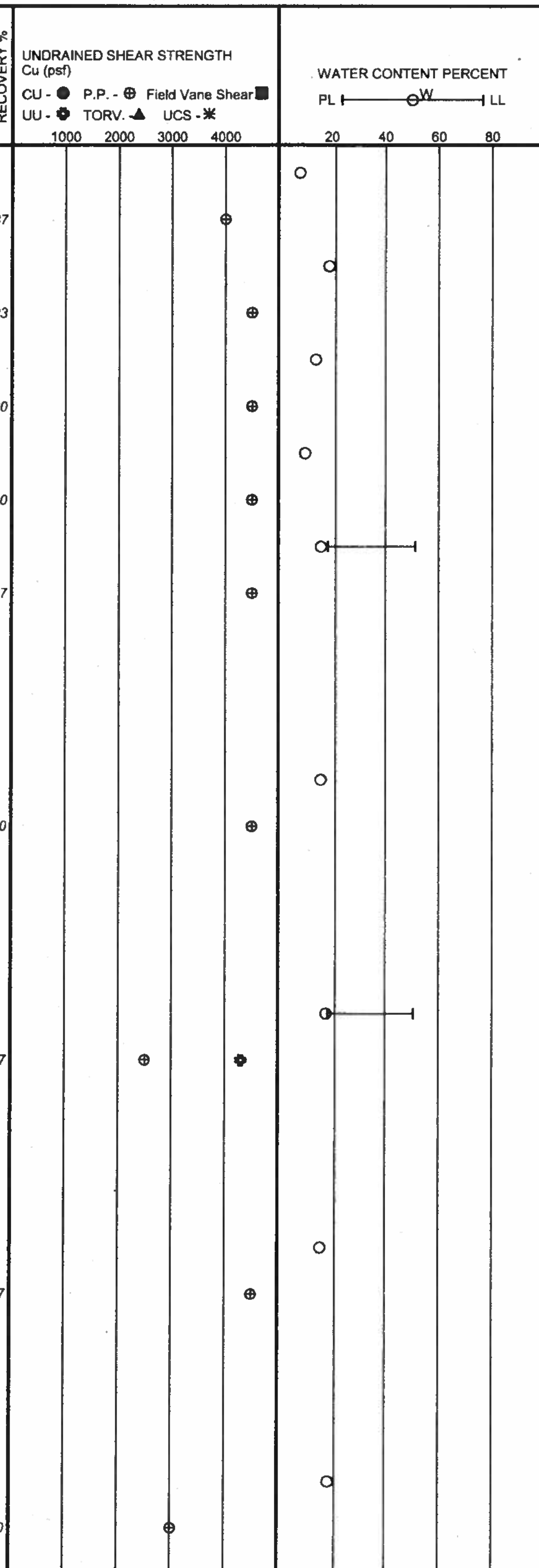
REVISED October 21, 2008
LOGGED: CS
CHECKED: CFR

RECORD OF BOREHOLE BH-FGD-105

SHEET 1 OF 2
DATUM: GEODETIC

PROJECT: Luminant Pond Stability Geotechnical Investigation
LOCATION: Oak Grove, Texas
BORING STARTED: 24-Mar-2010
BORING FINISHED: 24-Mar-2010
DRILLING EQUIPMENT: Buggy Mounted Rig
DRILLING OPERATOR: Van & Sons
NORTHING (ft): 5129
EASTING (ft): 3149
ELEVATION (ft): 449

DEPTH (ft)	SOIL PROFILE – DESCRIPTION	ELEV. / DEPTH (ft)	SAMPLE NUMBER	TYPE	BLOWS/0.5 FT	RECOVERY %	ADDITIONAL LAB. TESTING	INSTALLATION NOTES AND GROUNDWATER OBSERVATIONS
0	Grass	449.0						
	Very stiff, mottled dark brown, sandy fat CLAY (CH), trace organics, damp		44	SH		37		
2.0	hard, light brown at 2.0'		45	SH		33		
4.0	dark brown at 4.0'		46	SH		30		
6.0	light brown at 6.0'		47	SH		50		
			48	SH		67	(3) CU	c'=278 psf phi'=26 deg
13.0	mottled, trace lignite at 13.0'		49	SH		30		
18.0	very stiff, dark gray at 18.0'		50	SH		37		
23.0	hard, dark brown at 23.0'		51	SH		37		
28.0	Very stiff, mottled dark gray to brown, silty CLAY (CL-ML), few sand, moist	28.0	52	SH		50		



— CONTINUED NEXT PAGE —

DEPTH SCALE
1 inch to 3.8 feet

Golder Associates

LOGGED: DM
CHECKED: PCM

RECORD OF BOREHOLE BH-FGD-105

DATUM: GEODETIC

PROJECT: Luminant Pond Stability Geotechnical Investigation
LOCATION: Oak Grove, Texas

BORING STARTED: 24-Mar-2010
BORING FINISHED: 24-Mar-2010

DRILLING EQUIPMENT: Buggy Mounted Rig
DRILLING OPERATOR: Van & Sons

NORTHING (ft): 5129
EASTING (ft): 3149
ELEVATION (ft): 449

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (ft)	SAMPLE NUMBER	TYPE	BLOWS/0.5 FT	RECOVERY %	UNDRAINED SHEAR STRENGTH Cu (psf)	WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	INSTALLATION NOTES AND GROUNDWATER OBSERVATIONS
		— CONTINUED FROM PREVIOUS PAGE —									
30			30.0								
		Stiff, black, sandy SILT (ML), trace clay, some organics, some wood fragments, moist	33.0								
35		Stiff, dark brown, fat CLAY (CH), trace organics, trace sand, moist	33.8	53	SH		50				
		Very dense, light brown, fine, poorly-graded SAND (SP), trace clay, damp	38.0	54	SS	50/6" N>50	56				
40											
45		Very dense, light brown, fine, poorly-graded SAND (SP-SM), with silt, moist	43.0	55	SS	24 34 38 N72	67				
50		Very dense, grayish brown, silty SAND (SM), trace clay, moist	48.0	56	SS	22 26 50/5" N>50	83				
		BORING TERMINATED AT 50.0'	50.0								
55											
60											

Legend: CU - ● P.P. - ⊕ Field Vane Shear ■ UU - ✿ TORV. - ▲ UCS - ✱ ; Cu scale 1000 2000 3000 4000; PL —o W— LL; water content scale 20 40 60 80

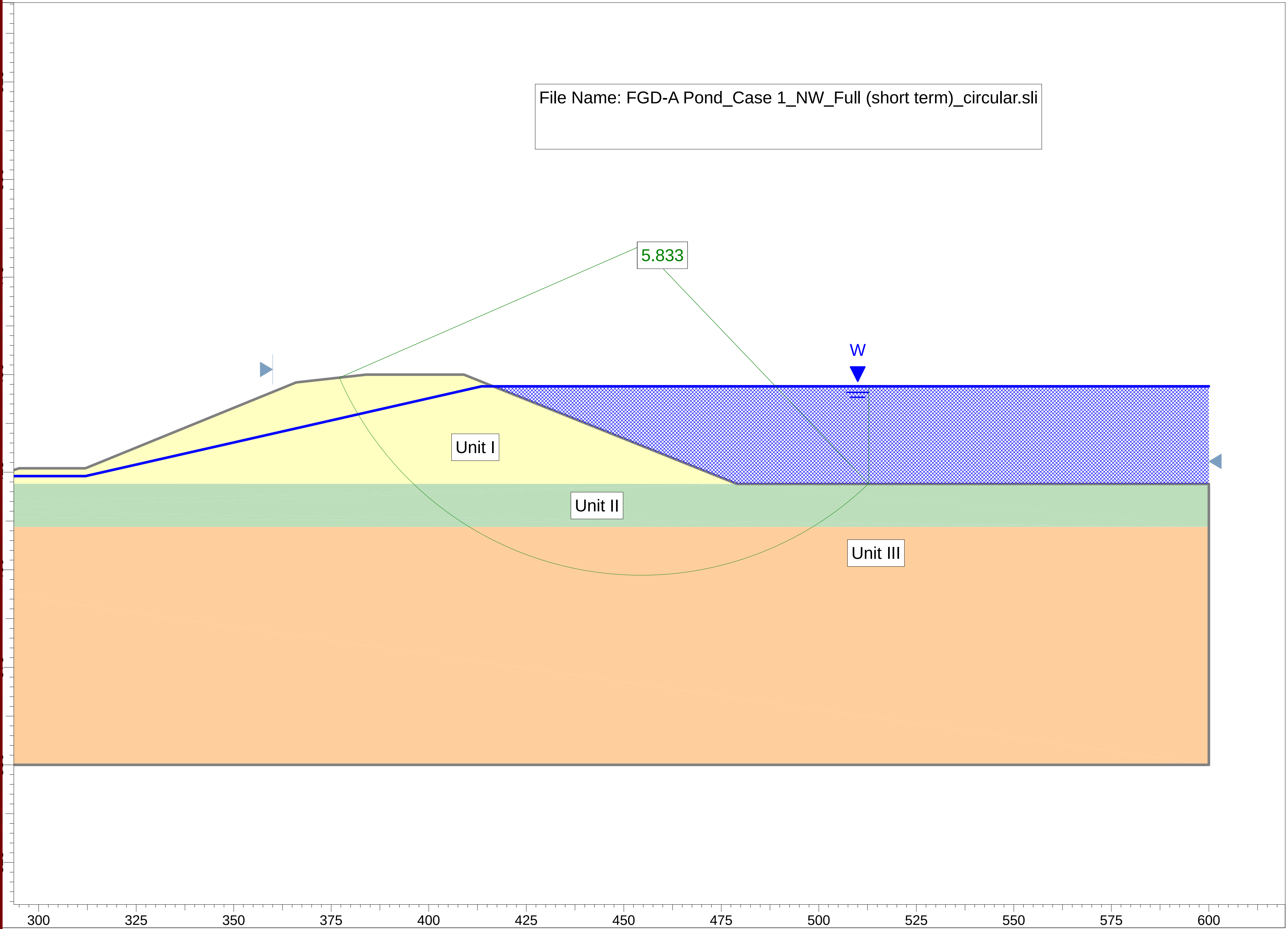
DEPTH SCALE
1 inch to 3.8 feet

Golder Associates

LOGGED: DM
CHECKED: PCM

APPENDIX B
SLOPE STABILITY ANALYSES

CASE 1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5.833
W
Unit I
Unit II
Unit III
300
325
350
375
400
425
450
475
500
525
550
575
600

Slide Analysis Information

Document Name

File Name: FGD-A Pond_Case 1_NW_Full (short term)_circular.sli

Project Settings

Project Title: FGD-A Pond - Case 1 - NW Slope - Full pond (short term)
Failure Direction: Left to Right
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified
GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 50
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

Surface Type: Circular
Search Method: Auto Refine Search
Divisions along slope: 15
Circles per division: 10
Number of iterations: 10
Divisions to use in next iteration: 50%
Composite Surfaces: Disabled
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Material: I - Sandy Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: II - Silty Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 2000 psf
Friction Angle: 0 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: III - Sand
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 36 degrees
Water Surface: Water Table
Custom Hu value: 1

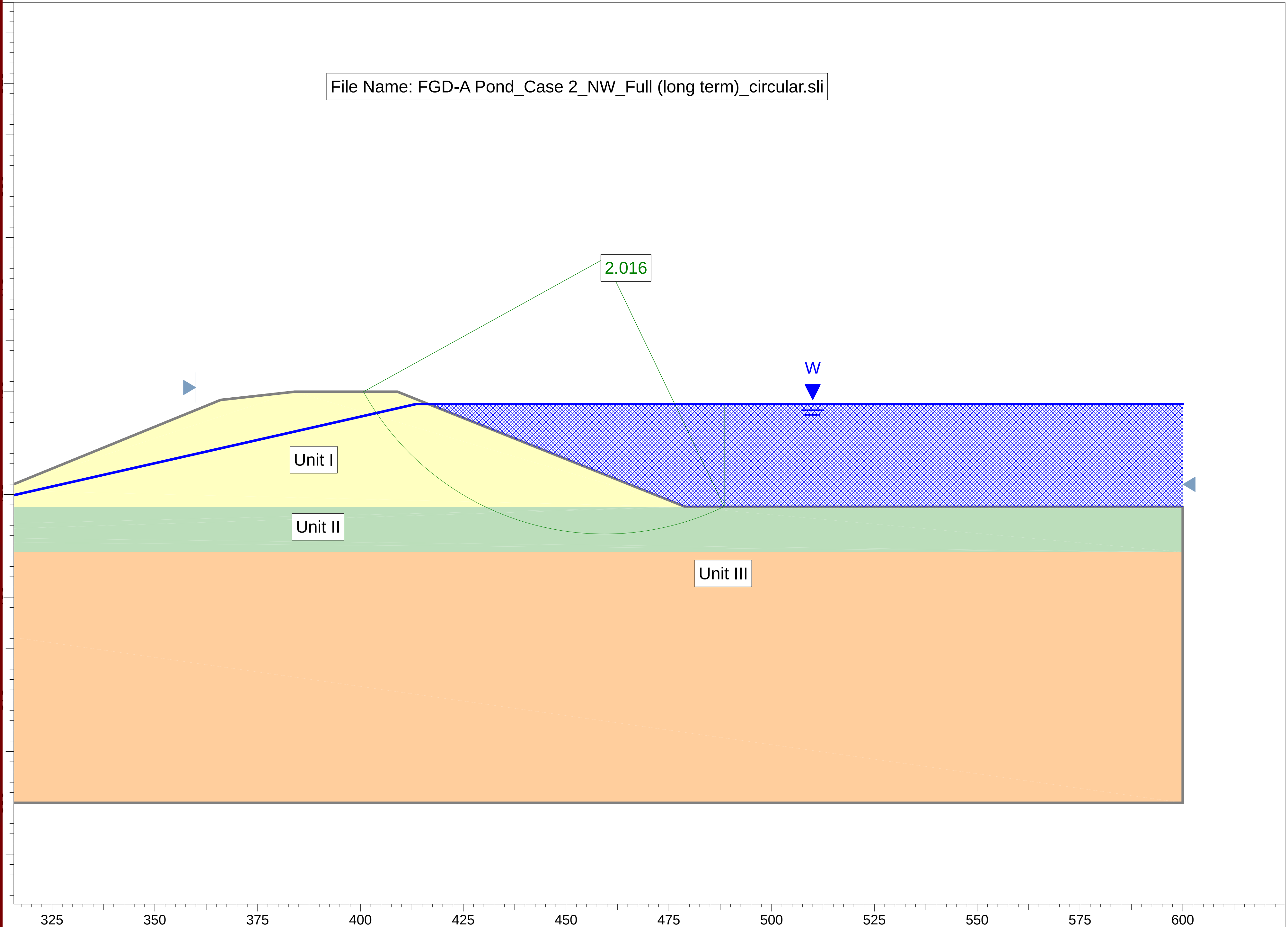
Global Minimums

Method: bishop simplified
FS: 5.836020
Center: 453.961, 482.815
Radius: 83.989
Left Slip Surface Endpoint: 376.984, 449.220
Right Slip Surface Endpoint: 511.889, 422.000
Left Slope Intercept: 376.984 449.220
Right Slope Intercept: 511.889 447.000
Resisting Moment=2.60578e+007 lb-ft
Driving Moment=4.465e+006 lb-ft

Method: spencer
FS: 5.832340
Center: 453.943, 482.843
Radius: 84.065
Left Slip Surface Endpoint: 376.899, 449.211
Right Slip Surface Endpoint: 511.953, 422.000
Left Slope Intercept: 376.899 449.211
Right Slope Intercept: 511.953 447.000
Resisting Moment=2.61026e+007 lb-ft
Driving Moment=4.4755e+006 lb-ft
Resisting Horizontal Force=246274 lb
Driving Horizontal Force=42225.6 lb

Method: gle/morgenstern-price
FS: 5.832870
Center: 454.455, 483.035
Radius: 84.448
Left Slip Surface Endpoint: 377.069, 449.230
Right Slip Surface Endpoint: 512.817, 422.000
Left Slope Intercept: 377.069 449.230
Right Slope Intercept: 512.817 447.000
Resisting Moment=2.63217e+007 lb-ft
Driving Moment=4.51265e+006 lb-ft
Resisting Horizontal Force=247226 lb
Driving Horizontal Force=42385.1 lb

CASE 2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Unit I
Unit II
Unit III
325
350
375
400
425
450
475
500
525
550
575
600

Slide Analysis Information

Document Name

File Name: FGD-A Pond_Case 2_NW_Full (long term)_circular.sli

Project Settings

Project Title: FGD-A Pond - Case 2 - NW Slope - Full pond (long term)
Failure Direction: Left to Right
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified
GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 50
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

Surface Type: Circular
Search Method: Auto Refine Search
Divisions along slope: 15
Circles per division: 10
Number of iterations: 10
Divisions to use in next iteration: 50%
Composite Surfaces: Disabled
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Material: I - Sandy Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: II - Silty Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 26 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: III - Sand
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 36 degrees
Water Surface: Water Table
Custom Hu value: 1

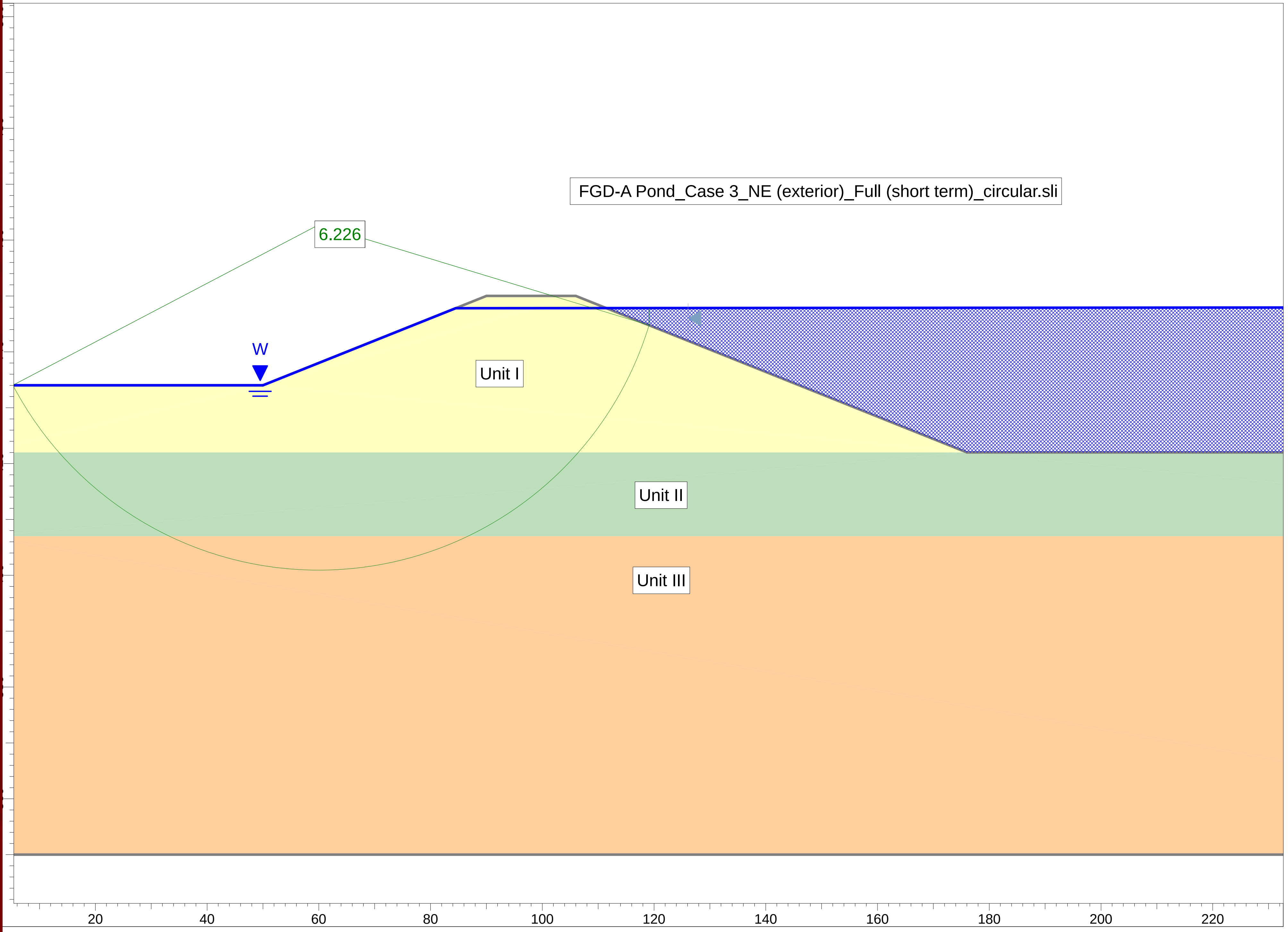
Global Minimums

Method: bishop simplified
FS: 2.015010
Center: 459.454, 482.205
Radius: 66.696
Left Slip Surface Endpoint: 401.048, 450.000
Right Slip Surface Endpoint: 488.155, 422.000
Left Slope Intercept: 401.048 450.000
Right Slope Intercept: 488.155 447.000
Resisting Moment=3.32924e+006 lb-ft
Driving Moment=1.65222e+006 lb-ft

Method: spencer
FS: 2.018110
Center: 459.469, 482.116
Radius: 66.555
Left Slip Surface Endpoint: 401.176, 450.000
Right Slip Surface Endpoint: 488.027, 422.000
Left Slope Intercept: 401.176 450.000
Right Slope Intercept: 488.027 447.000
Resisting Moment=3.31008e+006 lb-ft
Driving Moment=1.64019e+006 lb-ft
Resisting Horizontal Force=42750.9 lb
Driving Horizontal Force=21183.6 lb

Method: gle/morgenstern-price
FS: 2.015920
Center: 459.416, 482.426
Radius: 67.050
Left Slip Surface Endpoint: 400.728, 450.000
Right Slip Surface Endpoint: 488.475, 422.000
Left Slope Intercept: 400.728 450.000
Right Slope Intercept: 488.475 447.000
Resisting Moment=3.3917e+006 lb-ft
Driving Moment=1.68246e+006 lb-ft
Resisting Horizontal Force=43543.7 lb
Driving Horizontal Force=21599.9 lb

CASE 3



FGD-A Pond_Case 3_NE (exterior)_Full (short term)_circular.sli
6.226
W
Unit I
Unit II
Unit III
20
40
60
80
100
120
140
160
180
200
220

Slide Analysis Information

Document Name

File Name: FGD-A Pond_Case 3_NE (exterior)_Full (short term)_circular.sli

Project Settings

Project Title: FGD-A Pond - Case 3 - NE (exterior) Slope - Full (short term) - circular
Failure Direction: Right to Left
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified
GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 50
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

Surface Type: Circular
Search Method: Auto Refine Search
Divisions along slope: 15
Circles per division: 10
Number of iterations: 10
Divisions to use in next iteration: 50%
Composite Surfaces: Disabled
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Material: I - Sandy Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: II - Silty Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 2000 psf
Friction Angle: 0 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: III - Sand
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 32 degrees
Water Surface: Water Table
Custom Hu value: 1

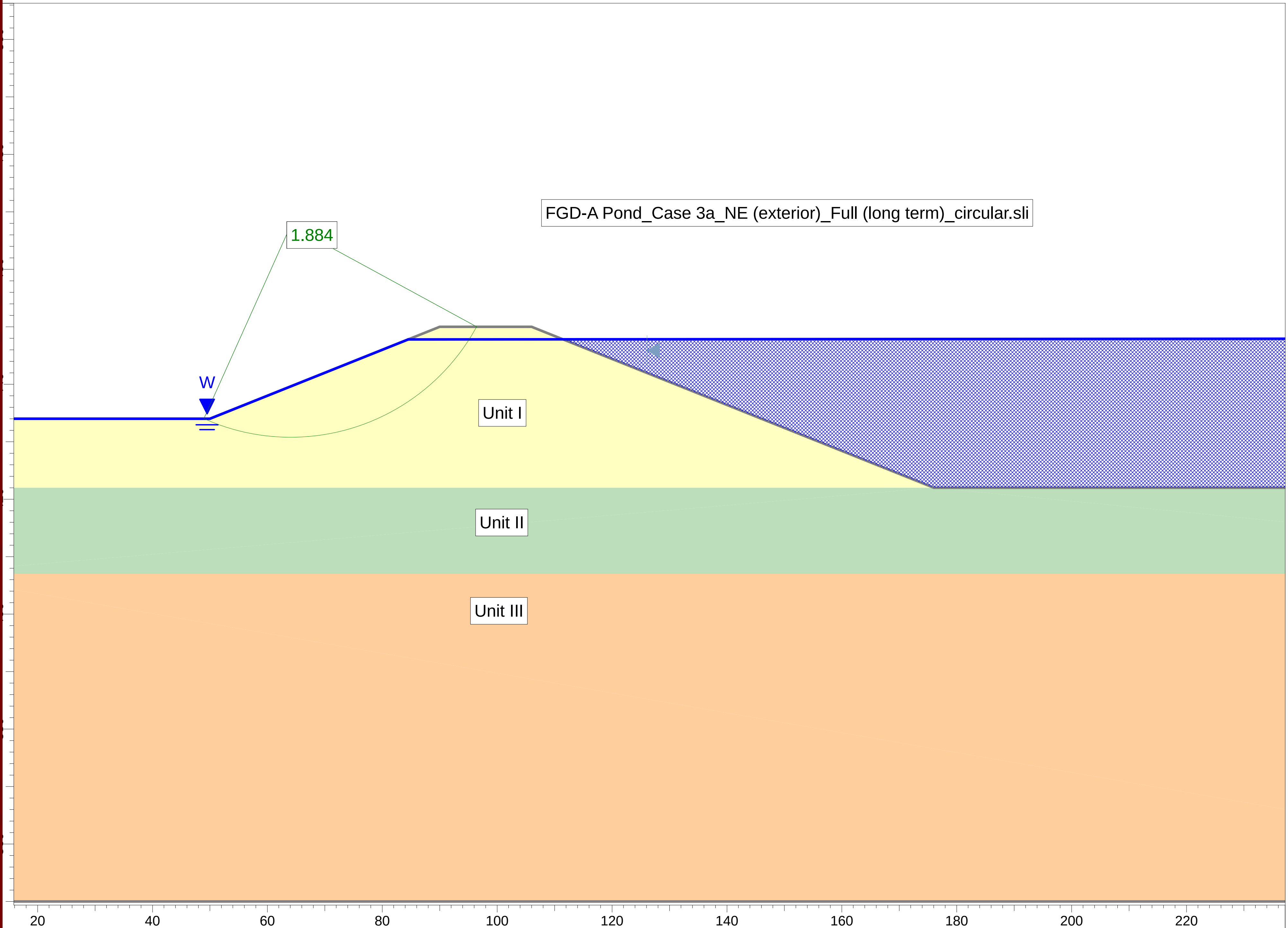
Global Minimums

Method: bishop simplified
FS: 6.226250
Center: 59.969, 462.747
Radius: 61.838
Left Slip Surface Endpoint: 5.219, 434.000
Right Slip Surface Endpoint: 119.130, 444.748
Left Slope Intercept: 5.219 434.000
Right Slope Intercept: 119.130 447.831
Resisting Moment=1.91087e+007 lb-ft
Driving Moment=3.06905e+006 lb-ft

Method: spencer
FS: 6.332610
Center: 60.693, 473.550
Radius: 71.532
Left Slip Surface Endpoint: 1.089, 434.000
Right Slip Surface Endpoint: 125.072, 442.371
Left Slope Intercept: 1.089 434.000
Right Slope Intercept: 125.072 447.835
Resisting Moment=2.27056e+007 lb-ft
Driving Moment=3.5855e+006 lb-ft
Resisting Horizontal Force=248781 lb
Driving Horizontal Force=39285.7 lb

Method: gle/morgenstern-price
FS: 6.335550
Center: 60.693, 473.550
Radius: 71.532
Left Slip Surface Endpoint: 1.089, 434.000
Right Slip Surface Endpoint: 125.072, 442.371
Left Slope Intercept: 1.089 434.000
Right Slope Intercept: 125.072 447.835
Resisting Moment=2.27161e+007 lb-ft
Driving Moment=3.5855e+006 lb-ft
Resisting Horizontal Force=248806 lb
Driving Horizontal Force=39271.4 lb

CASE 3A


FGD-A Pond_Case 3a_NE (exterior)_Full (long term)_circular.sli
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Unit I
Unit II
Unit III
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40
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100
120
140
160
180
200
220

Slide Analysis Information

Document Name

File Name: FGD-A Pond_Case 3a_NE (exterior)_Full (long term)_circular.sli

Project Settings

Project Title: FGD-A Pond - Case 3a - NE (exterior) Slope - Full (long term) - circular
Failure Direction: Right to Left
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified
GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 50
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

Surface Type: Circular
Search Method: Auto Refine Search
Divisions along slope: 15
Circles per division: 10
Number of iterations: 10
Divisions to use in next iteration: 50%
Composite Surfaces: Disabled
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Material: I - Sandy Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: II - Silty Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 26 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: III - Sand
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 32 degrees
Water Surface: Water Table
Custom Hu value: 1

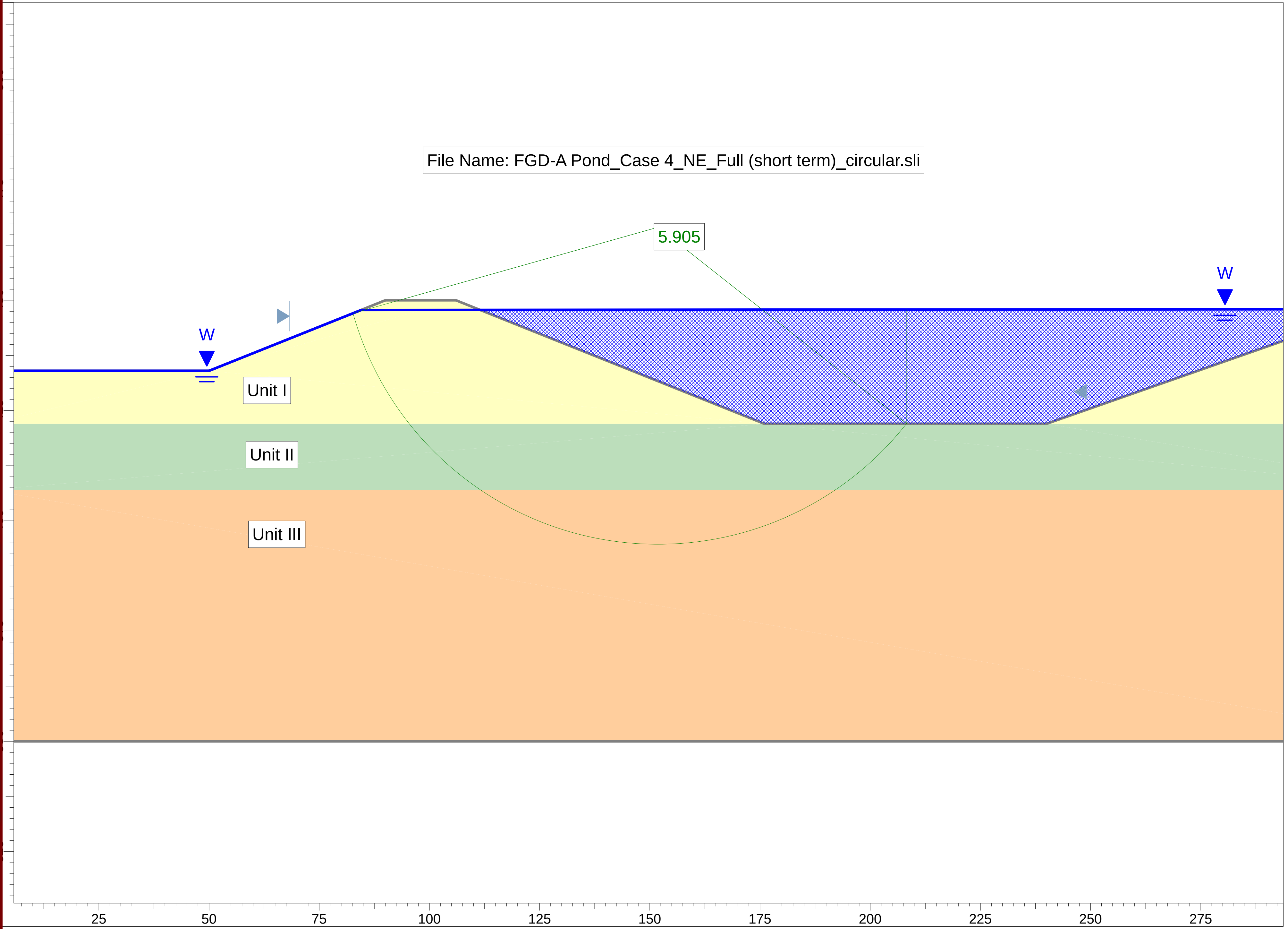
Global Minimums

Method: bishop simplified
FS: 1.883560
Center: 64.058, 467.621
Radius: 36.864
Left Slip Surface Endpoint: 48.937, 434.000
Right Slip Surface Endpoint: 96.439, 450.000
Resisting Moment=1.01407e+006 lb-ft
Driving Moment=538376 lb-ft

Method: spencer
FS: 1.885870
Center: 64.036, 467.566
Radius: 36.778
Left Slip Surface Endpoint: 49.005, 434.000
Right Slip Surface Endpoint: 96.348, 450.000
Resisting Moment=1.00771e+006 lb-ft
Driving Moment=534348 lb-ft
Resisting Horizontal Force=24341.4 lb
Driving Horizontal Force=12907.2 lb

Method: gle/morgenstern-price
FS: 1.879340
Center: 64.071, 467.539
Radius: 36.735
Left Slip Surface Endpoint: 49.085, 434.000
Right Slip Surface Endpoint: 96.348, 450.000
Resisting Moment=1.0015e+006 lb-ft
Driving Moment=532898 lb-ft
Resisting Horizontal Force=24287.8 lb
Driving Horizontal Force=12923.6 lb

CASE 4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Unit II
Unit III
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125
150
175
200
225
250
275

Slide Analysis Information

Document Name

File Name: FGD-A Pond_Case 4_NE_Full (short term)_circular.sli

Project Settings

Project Title: FGD-A Pond - Case 4 - NE Slope - Full (short term) - circular
Failure Direction: Left to Right
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified
GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 50
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

Surface Type: Circular
Search Method: Auto Refine Search
Divisions along slope: 15
Circles per division: 10
Number of iterations: 10
Divisions to use in next iteration: 50%
Composite Surfaces: Disabled
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Material: I - Sandy Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: II - Silty Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 2000 psf
Friction Angle: 0 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: III - Sand
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 32 degrees
Water Surface: Water Table
Custom Hu value: 1

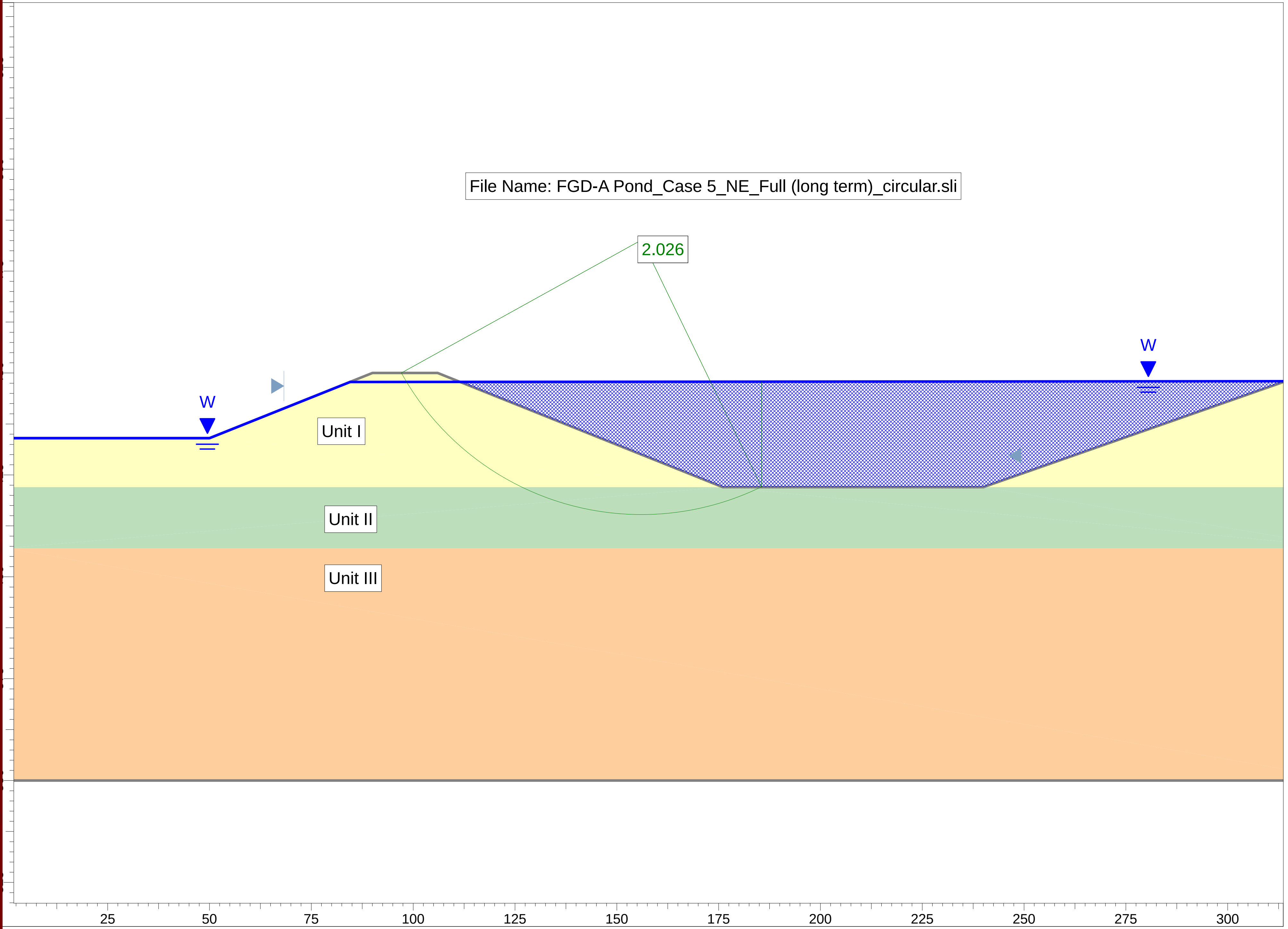
Global Minimums

Method: bishop simplified
FS: 5.904510
Center: 151.857, 466.570
Radius: 71.916
Left Slip Surface Endpoint: 82.639, 447.056
Right Slip Surface Endpoint: 208.297, 422.000
Left Slope Intercept: 82.639 447.056
Right Slope Intercept: 208.297 447.902
Resisting Moment=2.1364e+007 lb-ft
Driving Moment=3.61826e+006 lb-ft

Method: spencer
FS: 5.936720
Center: 156.014, 480.038
Radius: 84.355
Left Slip Surface Endpoint: 79.008, 445.603
Right Slip Surface Endpoint: 217.229, 422.000
Left Slope Intercept: 79.008 445.603
Right Slope Intercept: 217.229 447.909
Resisting Moment=2.56417e+007 lb-ft
Driving Moment=4.31916e+006 lb-ft
Resisting Horizontal Force=239310 lb
Driving Horizontal Force=40310.2 lb

Method: gle/morgenstern-price
FS: 5.935700
Center: 155.872, 479.669
Radius: 82.531
Left Slip Surface Endpoint: 80.442, 446.177
Right Slip Surface Endpoint: 214.912, 422.000
Left Slope Intercept: 80.442 446.177
Right Slope Intercept: 214.912 447.908
Resisting Moment=2.44026e+007 lb-ft
Driving Moment=4.11115e+006 lb-ft
Resisting Horizontal Force=232274 lb
Driving Horizontal Force=39131.7 lb

CASE 5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Unit II
Unit III
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150
175
200
225
250
275
300

Slide Analysis Information

Document Name

File Name: FGD-A Pond_Case 5_NE_Full (long term)_circular.sli

Project Settings

Project Title: FGD-A Pond - Case 5 - NE Slope - Full (long term) - circular
Failure Direction: Left to Right
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified
GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 50
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

Surface Type: Circular
Search Method: Auto Refine Search
Divisions along slope: 15
Circles per division: 10
Number of iterations: 10
Divisions to use in next iteration: 50%
Composite Surfaces: Disabled
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Material: I - Sandy Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: II - Silty Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 26 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: III - Sand
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 32 degrees
Water Surface: Water Table
Custom Hu value: 1

Global Minimums

Method: bishop simplified
FS: 2.025000
Center: 155.808, 482.619
Radius: 67.361
Left Slip Surface Endpoint: 96.872, 450.000
Right Slip Surface Endpoint: 185.181, 422.000
Left Slope Intercept: 96.872 450.000
Right Slope Intercept: 185.181 447.884
Resisting Moment=3.43279e+006 lb-ft
Driving Moment=1.69521e+006 lb-ft

Method: spencer
FS: 2.028540
Center: 155.820, 482.540
Radius: 67.234
Left Slip Surface Endpoint: 96.985, 450.000
Right Slip Surface Endpoint: 185.065, 422.000
Left Slope Intercept: 96.985 450.000
Right Slope Intercept: 185.065 447.884
Resisting Moment=3.41723e+006 lb-ft
Driving Moment=1.68458e+006 lb-ft
Resisting Horizontal Force=43934.9 lb
Driving Horizontal Force=21658.4 lb

Method: gle/morgenstern-price
FS: 2.025720
Center: 155.810, 482.546
Radius: 67.243
Left Slip Surface Endpoint: 96.968, 450.000
Right Slip Surface Endpoint: 185.065, 422.000
Left Slope Intercept: 96.968 450.000
Right Slope Intercept: 185.065 447.884
Resisting Moment=3.41475e+006 lb-ft
Driving Moment=1.68569e+006 lb-ft
Resisting Horizontal Force=43939.6 lb
Driving Horizontal Force=21690.8 lb

APPENDIX C
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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Telephone: 301-565-2733 Facsimile: 301-589-2017
email: info@asde.org www.asfe.org

REPORT

FGD-B SLOPE STABILITY INVESTIGATION REPORT (REVISED)

Luminant Oak Grove SES
Robertson County, Texas

Submitted To: Luminant Power
Lincoln Plaza, 9th Floor
500 N. Akard Street
Dallas, Texas 75201

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

STATE OF TEXAS
6/10/10
P. CHRIS MARSHALL
91893
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PROFESSIONAL ENGINEER

June 2010

103-94563.002

A world of capabilities delivered locally

Golder Associates

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1.0 INTRODUCTION

1.1 Project Description

Luminant Power (Luminant) operates the Oak Grove Power Plant, a lignite-fueled power plant near Franklin, Robertson County, Texas. The location of the Oak Grove Power Plant is presented on Figure 1. Unit 1 began operations in 2009 and Unit 2 is under development. As part of the current site development, the existing FGD-B pond is being redesigned. The FGD-B Pond is located on the northern portion of the facility (see Figure 2). The FGD-B pond will encompass an area of approximately 12.5 acres and will have a storage capacity of approximately 30 million gallons.

Golder Associates Inc. (Golder) has been contracted by Luminant to perform a geotechnical site investigation at the facility and analyze the FGD-B 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 March 24 and 25, 2010.

1.3 Coordinate System and Unit System

The soils borings were located by Golder with reference to latitude and longitude using handheld Global Positioning System (GPS) survey equipment. We have converted this information to the local plant grid coordinate system. 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. Four (4) borings were drilled to a depth of 30 feet below ground surface (bgs) and two (2) borings were drilled to a depth of 50 feet bgs. Table 1 provides the boring coordinates and elevations. Elevations were estimated based on topographic information provided by Burns & McDonnell. Boring locations are shown on Figure 3.

TABLE 1. BORING COORDINATES

Boring Number	Easting (ft)	Northing (ft)	Elevation (ft-msl)	Boring Depth (ft)
BH-FGD-101	E 2535	N 5323	421	30
BH-FGD-102	E 2721	N 5612	421	30
BH-FGD-103	E 3146	N 5863	426	50
BH-FGD-104	E 3455	N 5534	425	30
BH-FGD-105	E 3149	N 5129	449	50
BH-FGD-106	E 2675	N 4731	425	30

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 hollow stem augers. Soil samples were collected at 2-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 were 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 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 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 each soil boring in the FGD-B Pond, the boreholes were backfilled with bentonite pellets 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 consisted of very stiff to hard clays and compact to very dense sands. The surficial soils were generally classified as very stiff to hard sandy (lean and fat) clay and ranged in thickness from 8 to 27 feet. The surficial clay stratum was underlain by layers of compact to very dense sand, clayey sand, silty sand, and/or very stiff to hard silty clay or clay. All of the borings except BH-FGD-103 were terminated in a stratum of compact to very dense silty sand. BH-FGD-103 was terminated in a layer of very stiff to hard lean clay.

Groundwater was encountered in 3 of the 6 borings. Groundwater elevations encountered during drilling ranged from EL 394 to 403 ft. The FGD-B pond design assumes that the high groundwater elevation is EL 410 ft at the southwest end of the pond and EL 403 ft at the northeast end. The design high groundwater elevations were used in our analyses.

3.0 STABILITY ANALYSES

Slope stability analyses were performed using the commercial slope stability software program, SLIDE Version 3.047. The site topography and geometry used in the analyses were determined from site survey and design data provided by Burns and McDonnell, as shown in Figure 4. Stability analyses were performed for 3 separate slope sections (west, east, and north sideslopes) to assess the various soil conditions and slope geometries around the pond; analysis locations are shown on Figure 3. Stability analyses also considered “empty pond” and “full pond” conditions.

The most critical slope geometry was identified along the east sideslope, consisting of an approximately 34-foot high, 2.6H:1V slope. Stability analyses for the east sideslope also considered the effects of the existing FGD pond located adjacent to the east sideslope.

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 Tables 2, 3, and 4. The fill required to construct the FGD-B pond was assumed to have the same properties as the in situ clay soils.

TABLE 2. SOIL MATERIAL PROPERTIES FOR WEST SIDESLOPE SECTION

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	Clay/ Silty Clay/ Sandy Clay	127	132	3000	0	270	26
II	Sand/ Silty Sand	127	132	0	36	0	36
	Structural Fill	127	132	3000	0	270	26

TABLE 3. SOIL MATERIAL PROPERTIES FOR EAST SIDESLOPE SECTION

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	Clay/ Silty Clay/ Sandy Clay	127	132	3000	0	270	26
II	Sandy Silt	127	132	2000	0	0	26
III	Sand/ Silty Sand	127	132	0	36	0	36
	Structural Fill	127	132	3000	0	270	26

TABLE 4. SOIL MATERIAL PROPERTIES FOR NORTH SIDESLOPE SECTION

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	Clay/ Silty Clay/ Sandy Clay	127	132	3000	0	270	26
II	Sandy Silt/ Silty Sand	127	132	0	32	0	32
	Structural Fill	127	132	3000	0	270	26

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 5. 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 1.75. Therefore, our analyses indicate that the proposed slopes will be stable.

Rapid drawdown analyses were not performed because the planned pond operation does not include conditions that would cause a rapid drawdown.

TABLE 5. SLOPE STABILITY FACTORS OF SAFETY

Case	Description	Factor of Safety
1	West sideslope; empty pond; short-term (undrained) conditions	10.0
2	West sideslope; empty pond; long-term (drained) conditions	3.6
3	West sideslope; full pond; short-term (undrained) conditions	14.7
4	West sideslope; full pond; long-term (drained) conditions	4.3
5	East sideslope; empty pond; short-term (undrained) conditions	3.6
6	East sideslope; empty pond; long-term (drained) conditions	2.3
7	East sideslope; full pond; short-term (undrained) conditions	3.6
8	East sideslope; full pond; long-term (drained) conditions; circular failure	1.9
8A	East sideslope; full pond; long-term (drained) conditions; block failure	1.75
9	North sideslope; empty pond; short-term (undrained) conditions	8.6
10	North sideslope; empty pond; long-term (drained) conditions	3.4
11	North sideslope; full pond; short-term (undrained) conditions	13.0
12	North sideslope; full pond; long-term (drained) conditions	4.0

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.

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.

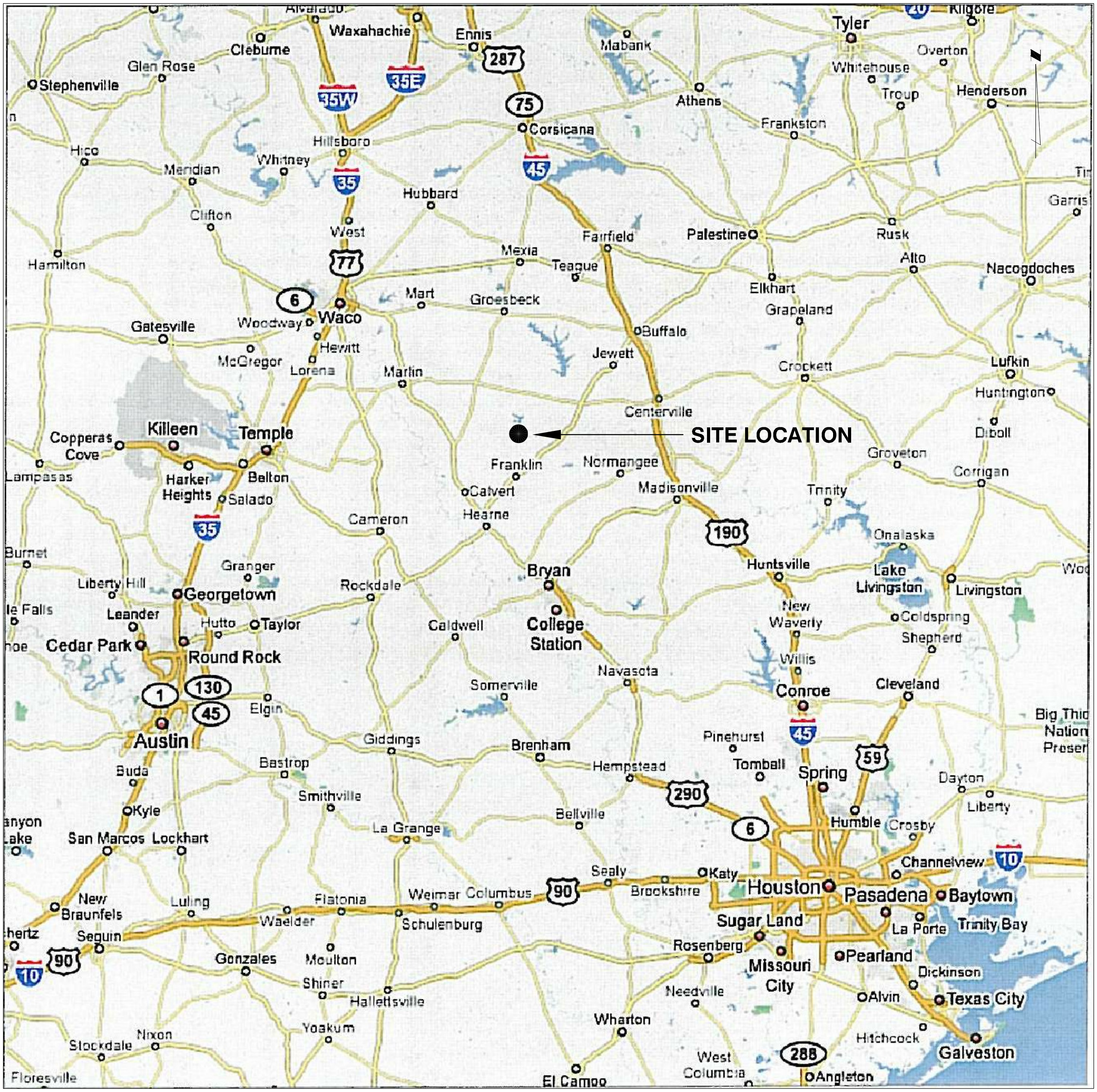
Very truly yours,

GOLDER ASSOCIATES INC.

STATE OF TEXAS
6/10/10
P. CHRIS MARSHALL
91893
LICENSED
PROFESSIONAL ENGINEER

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

Charles F. Rickert, P.E.
Associate



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Fax: (281) 821-6870

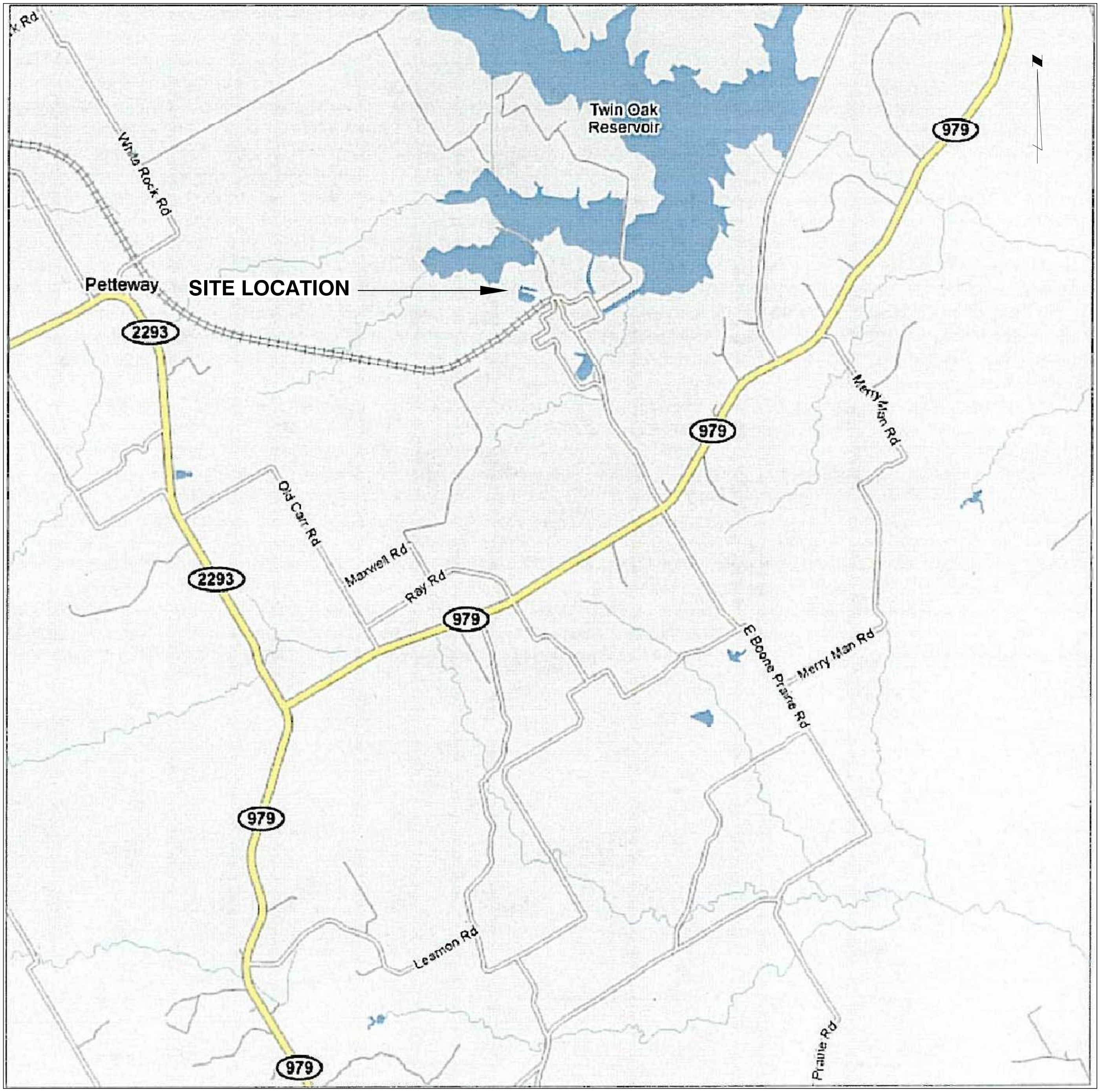
TITLE

SITE LOCATION PLAN

PROJECT

FGD-B SLOPE STABILITY INVESTIGATION
LUMINANT OAK GROVE SES
ROBERTSON COUNTY, TEXAS

DRAWN	DM	DATE	APRIL 2010	FIGURE NUMBER
CHECKED	PCM	SCALE	AS SHOWN	1
REVIEWED	PCM	JOB NO.	103-94563	
FILE NO.		DWG NO.	103-94563-101	



Luminant

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

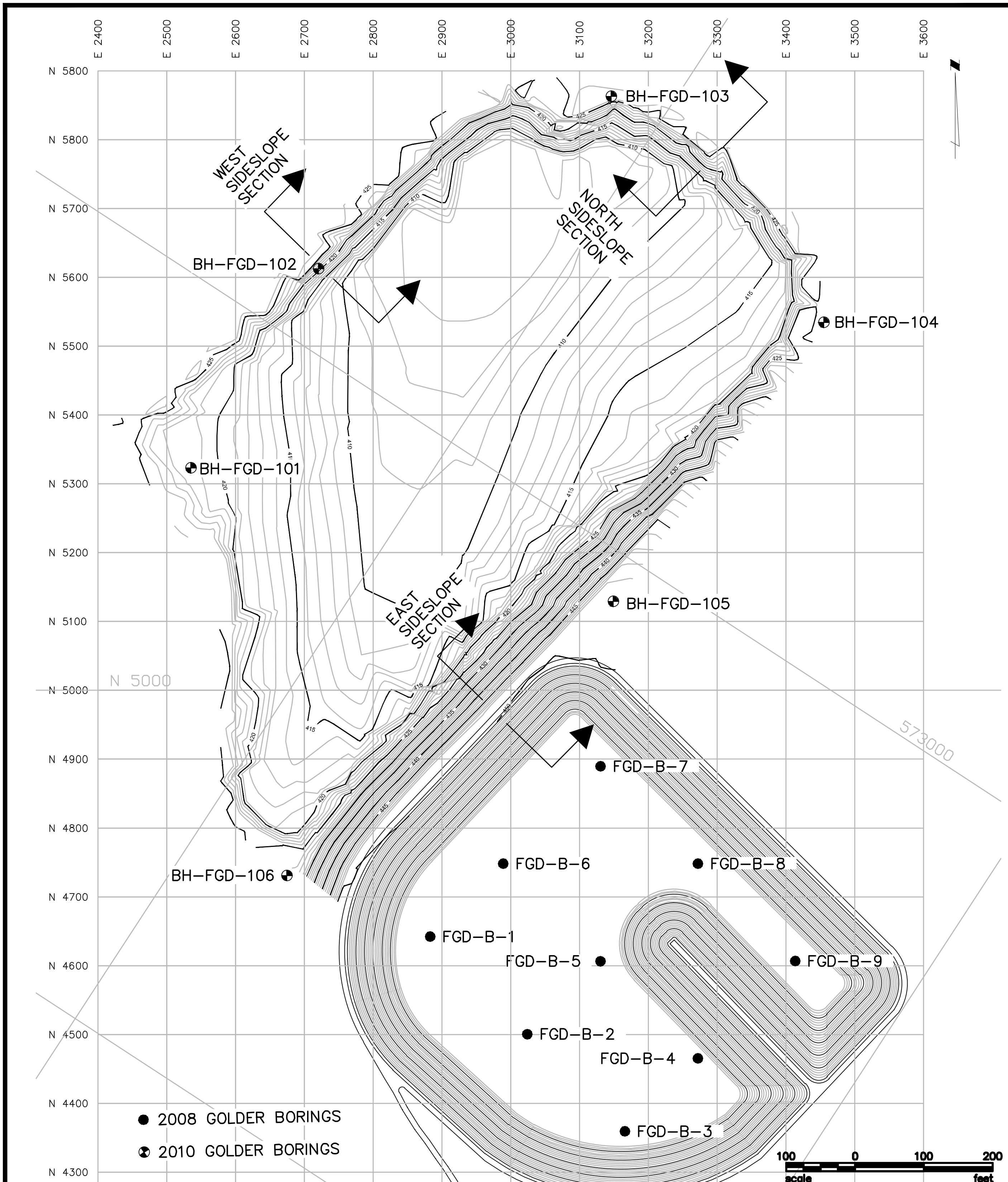
TITLE

SITE VICINITY PLAN

PROJECT

FGD-B SLOPE STABILITY INVESTIGATION
LUMINANT OAK GROVE SES
ROBERTSON COUNTY, TEXAS

DRAWN	DM	DATE	APRIL 2010	FIGURE NUMBER
CHECKED	PCM	SCALE	AS SHOWN	2
REVIEWED	PCM	JOB NO.	103-94563	
FILE NO.		DWG NO.	103-94563-102	



Luminant

Golder Associates
500 Century Plaza Drive, Suite 190
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Tel: (281) 821-6868
Texas Registration Number: F-2578

TITLE

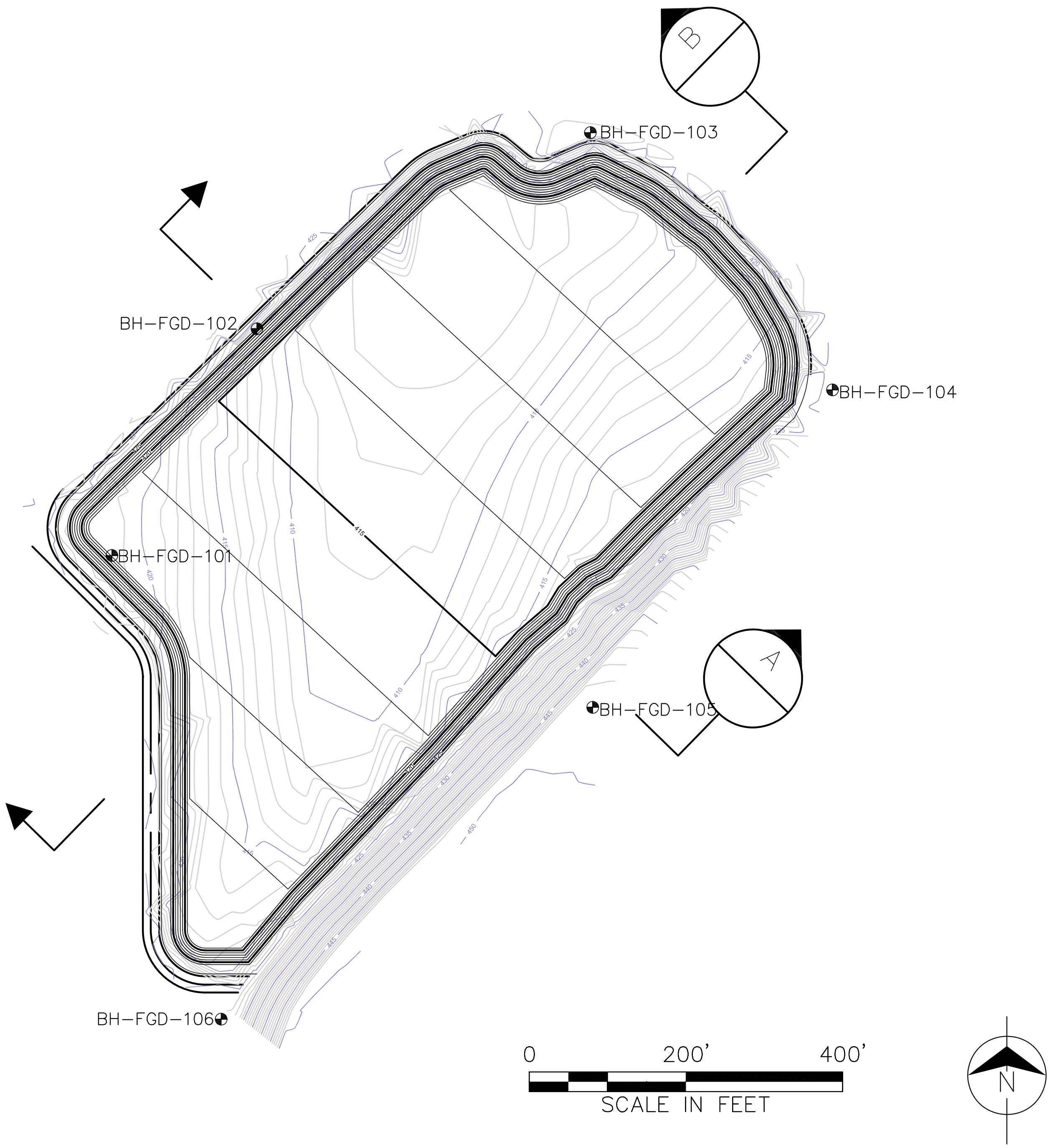
BORING LOCATION PLAN

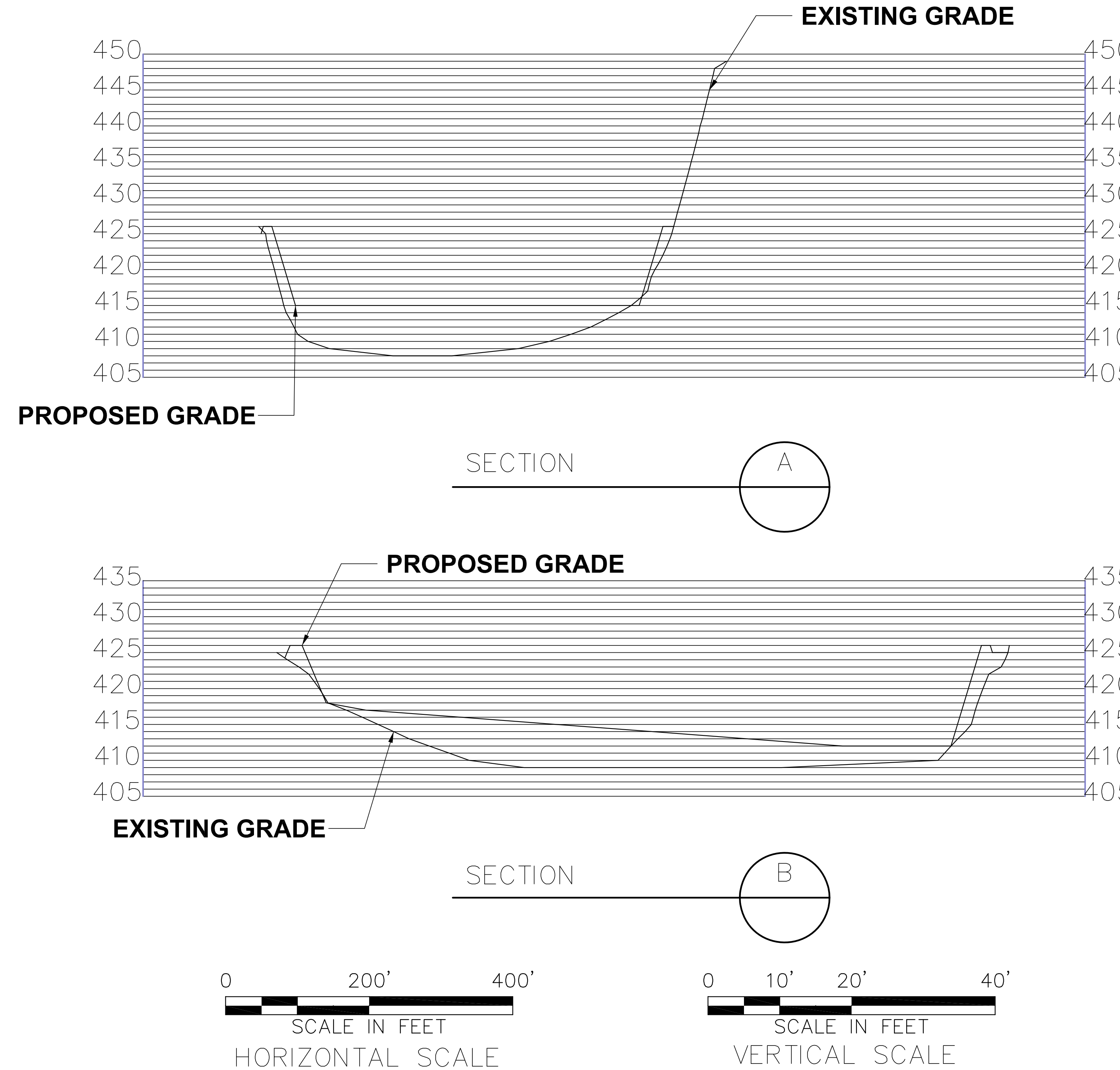
PROJECT

FGD-B SLOPE STABILITY INVESTIGATION
LUMINANT OAK GROVE SES
ROBERTSON COUNTY, TEXAS

DRAWN	DM	DATE	JUNE 2010	FIGURE NUMBER
CHECKED	PCM	SCALE	AS SHOWN	3
REVIEWED	PCM	JOB NO.	103-94563	
FILE NO.		DWG NO.	103-94563-103 – rev1	

P:\103-94563 Luminant Pond Stability\Drawings\Figures\FGD\103-94563-103 - rev1.dwg, 6/10/2010 4:09:43 PM, DWG To PDF.pc3





Note: Figure based on information provided to Golder by Burns & Mcdonnell.

Luminant

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TITLE

PROPOSED PLAN AND CROSS SECTIONS

PROJECT

FGD-B SLOPE STABILITY INVESTIGATION
LUMINANT OAK GROVE SES
ROBERTSON COUNTY, TEXAS

DRAWN	DM	DATE	APRIL 2010	FIGURE NUMBER
CHECKED	PCM	SCALE	AS SHOWN	4
REVIEWED	PCM	JOB NO.	103-94563	
FILE NO.		DWG NO.	103-94563-104	

APPENDIX A
BORING LOGS

RECORD OF BOREHOLE BH-FGD-101

DATUM: GEODETIC

PROJECT: Luminant Pond Stability Geotechnical Investigation
LOCATION: Oak Grove, Texas

BORING STARTED: 24-Mar-2010
BORING FINISHED: 25-Mar-2010

DRILLING EQUIPMENT: Buggy Mounted Rig
DRILLING OPERATOR: Van & Sons

NORTHING (ft): 5323
EASTING (ft): 2535
ELEVATION (ft): 421

DEPTH (ft)	DESCRIPTION	ELEV. / DEPTH (ft)	SAMPLE NUMBER	TYPE	BLOWS/0.5 FT	RECOVERY %	UNDRAINED SHEAR STRENGTH Cu (psf)	WATER CONTENT PERCENT	INSTALLATION NOTES AND GROUNDWATER OBSERVATIONS
0	Cleared ground	421.0							
0–2	Very stiff, mottled, sandy lean CLAY (CL), damp		88	SH		37			
2–4	hard, mottled reddish brown at 2.0'		89	SH		33			
4–6	trace silt at 4.0'		90	SH		30			
6–8	very stiff, reddish brown and light gray, some silt at 6.0'		91	SH		33			
8–13	Dense, grayish brown, SAND (SP-SM), with silt, damp	8.0	92	SH		23			
13–18	Very stiff, grayish brown, clayey fine SAND (SC), with some silt, layered gray and light brown at 13.5'	13.0	93	SH		40			
18–23	Very dense, light brown, fine, poorly-graded SAND (SP), damp	18.0	94	SS	35 50/6" N>50	50			
23–28	little clay at 23.0'		95	SS	40 50/4" N>50	83			27' 03/24/2010
28–30	dense, wet at 28.0'		96	SS	7 14 21 N35	83			
30	BORING TERMINATED AT 30.0'								

Legend: CU - ● P.P. - ⊕ Field Vane Shear ■ UU - ✪ TORV. - ▲ UCS - ✳; PL ⊢—○W—⊣ LL

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DEPTH SCALE
1 inch to 3.8 feet

Golder Associates

LOGGED: DM
CHECKED: PCM

HOU_SOIL_AUG2009 94563GINT.GPJ GLDR_HOU.GDT 4/27/10

RECORD OF BOREHOLE BH-FGD-101

DATUM: GEODETIC

PROJECT: Luminant Pond Stability Geotechnical Investigation
LOCATION: Oak Grove, Texas

BORING STARTED: 24-Mar-2010
BORING FINISHED: 25-Mar-2010

DRILLING EQUIPMENT: Buggy Mounted Rig
DRILLING OPERATOR: Van & Sons

NORTHING (ft): 5323
EASTING (ft): 2535
ELEVATION (ft): 421

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS/0.5 FT	RECOVERY %	UNDRAINED SHEAR STRENGTH Cu (psf) CU - ● P.P. - ⊕ Field Vane Shear ■ UU - ✿ TORV. - ▲ UCS - ✳ (1000 2000 3000 4000)	WATER CONTENT PERCENT PL ⊢—○W—⊣ LL (20 40 60 80)	ADDITIONAL LAB. TESTING	INSTALLATION NOTES AND GROUNDWATER OBSERVATIONS
		--- CONTINUED FROM PREVIOUS PAGE ---										
30				30.0								
35												
40												
45												
50												
55												
60												

DEPTH SCALE
1 inch to 3.8 feet

Golder Associates

LOGGED: DM
CHECKED: *PCM*

RECORD OF BOREHOLE BH-FGD-102

DATUM: GEODETIC

PROJECT: Luminant Pond Stability Geotechnical Investigation
LOCATION: Oak Grove, Texas
BORING STARTED: 24-Mar-2010
BORING FINISHED: 24-Mar-2010
DRILLING EQUIPMENT: Buggy Mounted Rig
DRILLING OPERATOR: Van & Sons
NORTHING (ft): 5612
EASTING (ft): 2721
ELEVATION (ft): 421

Depth (ft)	Soil Profile Description	Elev. / Depth (ft)	Sample Number	Type	Blows/0.5 ft	Recovery %	Undrained Shear Strength P.P. (psf, approx.)	Water Content
0	Grass	421.0						
0	Hard, mottled light brown, sandy lean CLAY (CL), damp							~20
1			79	SH		40	~4500	
2	very stiff, brown at 2.0'							~14
3			80	SH		37	~2500	
4	hard at 4.0'							~17
5			81	SH		27	~4500	
6	light gray, moist at 6.0'							~19
7			82	SH		40		
8	very stiff at 8.0'							~20
9			83	SH		48	~4000	
13	little silt at 13.0'							~20
14			84	SH		40	~3500	
18	Stiff, light to dark gray, silty fat CLAY (CH), trace sand, moist	18.0						PL ~22, W ~22, LL ~37
19			85	SH		53	~2000	
23	Stiff, gray, sandy lean CLAY (CL), trace silt, moist	23.0						~22
24			86	SH		43	~3000	
28	Very dense, light brown, fine, poorly-graded SAND (SP-SM), with clay, wet	28.0						~24
29	BORING TERMINATED AT 30.0'		87	SS	2 7 34 38 N72	67		

Legend — Undrained Shear Strength Cu (psf): CU - ● P.P. - ⊕ Field Vane Shear ■ UU - ✪ TORV. - ▲ UCS - ✳ (scale 1000, 2000, 3000, 4000)
Water Content Percent: PL ⊢—○W—⊣ LL (scale 20, 40, 60, 80)

Columns also shown: Boring Method, Strata Plot, Additional Lab. Testing, Installation Notes and Groundwater Observations.

--- CONTINUED NEXT PAGE ---

DEPTH SCALE
1 inch to 3.8 feet

Golder Associates

LOGGED: DM
CHECKED: PCM

RECORD OF BOREHOLE BH-FGD-102

DATUM: GEODETIC

PROJECT: Luminant Pond Stability Geotechnical Investigation
LOCATION: Oak Grove, Texas

BORING STARTED: 24-Mar-2010
BORING FINISHED: 24-Mar-2010

DRILLING EQUIPMENT: Buggy Mounted Rig
DRILLING OPERATOR: Van & Sons

NORTHING (ft): 5612
EASTING (ft): 2721
ELEVATION (ft): 421

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS/0.5 FT	RECOVERY %	UNDRAINED SHEAR STRENGTH Cu (psf) CU - ● P.P. - ⊕ Field Vane Shear ■ UU - ✪ TORV. - ▲ UCS - ✳ (1000 2000 3000 4000)	WATER CONTENT PERCENT PL ├─○W─┤ LL (20 40 60 80)	ADDITIONAL LAB. TESTING	INSTALLATION NOTES AND GROUNDWATER OBSERVATIONS
		--- *CONTINUED FROM PREVIOUS PAGE* ---										
30				30.0								
35												
40												
45												
50												
55												
60												

DEPTH SCALE
1 inch to 3.8 feet

Golder Associates

LOGGED: DM
CHECKED: *PCM*

RECORD OF BOREHOLE BH-FGD-103

DATUM: GEODETIC

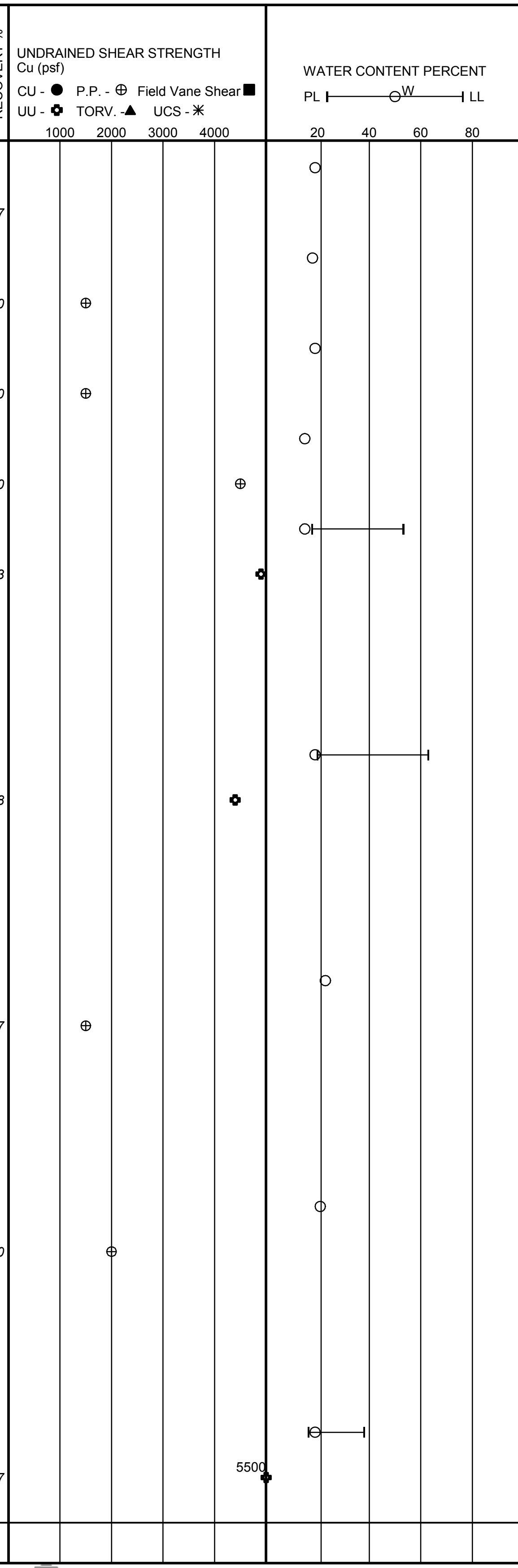
PROJECT: Luminant Pond Stability Geotechnical Investigation
LOCATION: Oak Grove, Texas

BORING STARTED: 24-Mar-2010
BORING FINISHED: 24-Mar-2010

DRILLING EQUIPMENT: Buggy Mounted Rig
DRILLING OPERATOR: Van & Sons

NORTHING (ft): 5863
EASTING (ft): 3146
ELEVATION (ft): 426

DEPTH SCALE FEET	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (ft)	SAMPLE NUMBER	TYPE	BLOWS/0.5 FT	RECOVERY %
0	Grass	426.0				
	Very soft to soft, light brown, sandy fat CLAY (CH), trace roots, damp		66	SH		27
	stiff at 2.0'		67	SH		30
5	light brown to dark grayish brown at 4.0'		68	SH		40
	hard at 6.0'		69	SH		40
	mottled at 8.0'		70	SH		23
10						
15			71	SH		38
	Stiff, brown, silty CLAY (CL-ML), with sand, trace lignite, moist	18.0	72	SH		47
20						
	stiff to very stiff, mottled, damp at 23.0'		73	SH		40
25						
	Stiff, mottled, sandy lean CLAY (CL), damp	28.0	74	SH		57
30						



ADDITIONAL LAB. TESTING

INSTALLATION NOTES AND GROUNDWATER OBSERVATIONS

--- CONTINUED NEXT PAGE ---

DEPTH SCALE
1 inch to 3.8 feet

Golder Associates

LOGGED: DM
CHECKED: *PCM*

RECORD OF BOREHOLE BH-FGD-103

DATUM: GEODETIC

PROJECT: Luminant Pond Stability Geotechnical Investigation
LOCATION: Oak Grove, Texas

BORING STARTED: 24-Mar-2010
BORING FINISHED: 24-Mar-2010

DRILLING EQUIPMENT: Buggy Mounted Rig
DRILLING OPERATOR: Van & Sons

NORTHING (ft): 5863
EASTING (ft): 3146
ELEVATION (ft): 426

--- CONTINUED FROM PREVIOUS PAGE ---

DEPTH SCALE FEET	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (ft)	SAMPLE NUMBER	TYPE	BLOWS/0.5 FT	RECOVERY %	UNDRAINED SHEAR STRENGTH Cu (psf)	WATER CONTENT PERCENT	INSTALLATION NOTES AND GROUNDWATER OBSERVATIONS
30		30.0							
									32' 03/24/2010 (water level)
	Compact, light gray, SILT (ML), with sand, wet	33.0						W ≈ 20	
	Firm, light gray and brown, silty SAND (SM), wet	33.7	75	SH	8, 7, 9, N16	67			
35									
	Very stiff, mottled light gray, lean CLAY (CL), trace lignite, trace sand, wet	38.0						PL ≈ 17, W ≈ 17, LL ≈ 27	
			76	SH		57	UU ≈ 3200; P.P. ≈ 3500		
40									
	hard at 43.0'							W ≈ 22	
			77	SH		27	P.P. ≈ 4500		
45									
	interbedded with sand layers at 48.0'							W ≈ 21	
			78	SH		37			
50	BORING TERMINATED AT 50.0'	50.0							
55									
60									

DEPTH SCALE
1 inch to 3.8 feet

Golder Associates

LOGGED: DM
CHECKED: *PCM*

RECORD OF BOREHOLE BH-FGD-104

DATUM: GEODETIC

PROJECT: Luminant Pond Stability Geotechnical Investigation
LOCATION: Oak Grove, Texas

BORING STARTED: 24-Mar-2010
BORING FINISHED: 24-Mar-2010

DRILLING EQUIPMENT: Buggy Mounted Rig
DRILLING OPERATOR: Van & Sons

NORTHING (ft): 5534
EASTING (ft): 3455
ELEVATION (ft): 425

DEPTH SCALE FEET	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (ft)	SAMPLE NUMBER	TYPE	BLOWS/0.5 FT	RECOVERY %	INSTALLATION NOTES AND GROUNDWATER OBSERVATIONS
0	Grass	425.0					
	Very stiff, light brown to dark brown, sandy lean CLAY (CL), damp		57	SH		40	
	hard, light brown at 2.0'		58	SH		35	
5	mottled to dark brown, trace silt at 4.0'		59	SH		30	
	grayish brown at 6.0'		60	SH		33	
			61	SH		37	
10							
	very stiff, moist at 13.0'		62	SH		53	
15							
	hard, damp at 18.0'						
	Very dense, grayish brown, medium to fine, silty clayey SAND (SC/SM), trace organic	18.5	63	SH		40	
20							22' 03/24/2010 (groundwater)
	Compact, light brown and gray, poorly-graded SAND (SP-SM), with silt, wet	23.0	64	SS	5 9 14 N23	67	
25							
	Dense, fine, silty SAND (SM), trace clay	28.0	65	SS	11 12 19 N31	67	
30							

Undrained shear strength Cu (psf) (CU - ●, P.P. - ⊕, Field Vane Shear ■, UU - ✪, TORV. - ▲, UCS - ✳; scale 1000, 2000, 3000, 4000): P.P. values plotted at samples 57, 58, 62, 63.

Water content percent (PL, W, LL; scale 20, 40, 60, 80): W values plotted between about 15 and 22 percent.

--- CONTINUED NEXT PAGE ---

DEPTH SCALE
1 inch to 3.8 feet

Golder Associates

LOGGED: DM
CHECKED: PCM

RECORD OF BOREHOLE BH-FGD-104

DATUM: GEODETIC

PROJECT: Luminant Pond Stability Geotechnical Investigation
LOCATION: Oak Grove, Texas

BORING STARTED: 24-Mar-2010
BORING FINISHED: 24-Mar-2010

DRILLING EQUIPMENT: Buggy Mounted Rig
DRILLING OPERATOR: Van & Sons

NORTHING (ft): 5534
EASTING (ft): 3455
ELEVATION (ft): 425

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE – DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (ft)	SAMPLES – NUMBER	TYPE	BLOWS/0.5 FT	RECOVERY %	UNDRAINED SHEAR STRENGTH Cu (psf) CU - ● P.P. - ⊕ Field Vane Shear ■ UU - ✪ TORV. - ▲ UCS - ✳ (1000 2000 3000 4000)	WATER CONTENT PERCENT PL ├──○W──┤ LL (20 40 60 80)	ADDITIONAL LAB. TESTING	INSTALLATION NOTES AND GROUNDWATER OBSERVATIONS
		--- *CONTINUED FROM PREVIOUS PAGE* ---										
30		BORING TERMINATED AT 30.0'		30.0								
35												
40												
45												
50												
55												
60												

DEPTH SCALE
1 inch to 3.8 feet

Golder Associates

LOGGED: DM
CHECKED: *PCM*

RECORD OF BOREHOLE BH-FGD-105

SHEET 1 OF 2
DATUM: GEODETIC

PROJECT: Luminant Pond Stability Geotechnical Investigation
LOCATION: Oak Grove, Texas

BORING STARTED: 24-Mar-2010
BORING FINISHED: 24-Mar-2010

DRILLING EQUIPMENT: Buggy Mounted Rig
DRILLING OPERATOR: Van & Sons

NORTHING (ft): 5129
EASTING (ft): 3149
ELEVATION (ft): 449

Legend — Undrained shear strength Cu (psf): CU - ●, P.P. - ⊕, Field Vane Shear ■, UU - ✿, TORV. - ▲, UCS - ✳ (scale 1000, 2000, 3000, 4000). Water content percent: PL ⊢—○W—⊣ LL (scale 20, 40, 60, 80).

DEPTH SCALE FEET	DESCRIPTION	ELEV. / DEPTH (ft)	SAMPLE NUMBER	TYPE	RECOVERY %	ADDITIONAL LAB. TESTING	INSTALLATION NOTES AND GROUNDWATER OBSERVATIONS
0	Grass	449.0					
	Very stiff, mottled dark brown, sandy fat CLAY (CH), trace organics, damp		44	SH	37		
	hard, light brown at 2.0'		45	SH	33		
5	dark brown at 4.0'		46	SH	30		
	light brown at 6.0'		47	SH	50		
			48	SH	67	(3) CU	c'=278 psf phi'=26 deg
10							
15	mottled, trace lignite at 13.0'		49	SH	30		
	very stiff, dark gray at 18.0'		50	SH	37		
20							
25	hard, dark brown at 23.0'		51	SH	37		
	Very stiff, mottled dark gray to brown, silty CLAY (CL-ML), few sand, moist	28.0	52	SH	50		
30							

--- CONTINUED NEXT PAGE ---

RECORD OF BOREHOLE BH-FGD-105

DATUM: GEODETIC

PROJECT: Luminant Pond Stability Geotechnical Investigation
LOCATION: Oak Grove, Texas

BORING STARTED: 24-Mar-2010
BORING FINISHED: 24-Mar-2010

DRILLING EQUIPMENT: Buggy Mounted Rig
DRILLING OPERATOR: Van & Sons

NORTHING (ft): 5129
EASTING (ft): 3149
ELEVATION (ft): 449

Legend: UNDRAINED SHEAR STRENGTH Cu (psf): CU - ●, P.P. - ⊕, Field Vane Shear ■, UU - ✪, TORV. - ▲, UCS - ✳ (scale 1000, 2000, 3000, 4000). WATER CONTENT PERCENT: PL ├─○W─┤ LL (scale 20, 40, 60, 80).

--- CONTINUED FROM PREVIOUS PAGE ---

DEPTH SCALE FEET	BORING METHOD	DESCRIPTION	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS/0.5 FT	RECOVERY %	UNDRAINED SHEAR STRENGTH	WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	INSTALLATION NOTES AND GROUNDWATER OBSERVATIONS
30			30.0								
		Stiff, black, sandy SILT (ML), trace clay, some organics, some wood fragments, moist	33.0						W ≈ 22		
		Stiff, dark brown, fat CLAY (CH), trace organics, trace sand, moist	33.8	53	SH		50	P.P. ≈ 2000			
35											
		Very dense, light brown, fine, poorly-graded SAND (SP), trace clay, damp	38.0	54	SS	50/6" N>50	56		W ≈ 13		
40											
		Very dense, light brown, fine, poorly-graded SAND (SP-SM), with silt, moist	43.0	55	SS	24 34 38 N72	67		W ≈ 24		
45											
		Very dense, grayish brown, silty SAND (SM), trace clay, moist	48.0	56	SS	22 26 50/5" N>50	83		W ≈ 26		
50		BORING TERMINATED AT 50.0'	50.0								
55											
60											

DEPTH SCALE
1 inch to 3.8 feet

Golder Associates

LOGGED: DM
CHECKED: PCM

RECORD OF BOREHOLE BH-FGD-106

DATUM: GEODETIC

PROJECT: Luminant Pond Stability Geotechnical Investigation
LOCATION: Oak Grove, Texas

BORING STARTED: 23-Mar-2010
BORING FINISHED: 23-Mar-2010

DRILLING EQUIPMENT: Buggy Mounted Rig
DRILLING OPERATOR: Van & Sons

NORTHING (ft): 4731
EASTING (ft): 2675
ELEVATION (ft): 425

UNDRAINED SHEAR STRENGTH Cu (psf): CU - ● P.P. - ⊕ Field Vane Shear ■ UU - ✪ TORV. - ▲ UCS - ✳ (scale 1000, 2000, 3000, 4000)

WATER CONTENT PERCENT: PL ├—○W—┤ LL (scale 20, 40, 60, 80)

DEPTH SCALE FEET	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS/0.5 FT	RECOVERY %
0	Grass		425.0				
	Stiff, mottled dark gray, sandy lean CLAY (CL), trace silt, damp			97	SH		37
	light brown to dark brown at 2.0'			98	SH		37
	hard, brownish red, moist at 4.0'						
5				99	SH		40
	damp at 6.0'			100	SH		33
	mottled brownish red at 8.0'			101	SH		33
10							
	mottled gray, little silt at 13.0'			102	SH		40
15							
				103	SH		37
20							
	Compact, light gray, fine silty SAND (SM), moist		23.0	104	SH		43
25							
	wet at 28.0'			105	SS	7 10 17 N27	61
30							

--- CONTINUED NEXT PAGE ---

DEPTH SCALE
1 inch to 3.8 feet

Golder Associates

LOGGED: DM
CHECKED: *PCM*

RECORD OF BOREHOLE BH-FGD-106

DATUM: GEODETIC

PROJECT: Luminant Pond Stability Geotechnical Investigation
LOCATION: Oak Grove, Texas

BORING STARTED: 23-Mar-2010
BORING FINISHED: 23-Mar-2010

DRILLING EQUIPMENT: Buggy Mounted Rig
DRILLING OPERATOR: Van & Sons

NORTHING (ft): 4731
EASTING (ft): 2675
ELEVATION (ft): 425

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (ft)	SAMPLES NUMBER	TYPE	BLOWS/0.5 FT	RECOVERY %	UNDRAINED SHEAR STRENGTH Cu (psf) CU - ● P.P. - ⊕ Field Vane Shear ■ UU - ✪ TORV. - ▲ UCS - ✳ 1000 2000 3000 4000	WATER CONTENT PERCENT PL ⊢—○W—⊣ LL 20 40 60 80	ADDITIONAL LAB. TESTING	INSTALLATION NOTES AND GROUNDWATER OBSERVATIONS
		--- CONTINUED FROM PREVIOUS PAGE ---										
30		BORING TERMINATED AT 30.0'		30.0								
35												
40												
45												
50												
55												
60												

DEPTH SCALE
1 inch to 3.8 feet

Golder Associates

LOGGED: DM
CHECKED: *PCM*

APPENDIX B
LABORATORY TEST SUMMARY SHEETS

SUMMARY OF SOIL DATA AND LABORATORY TEST RESULTS

Sample								Atterberg Limits					Particle Size Analysis						CU Triaxial		UU Triaxial		Consolidation					
Borehole Number	Sample Number	Depth Interval (ft-bgs)	Elevation of Top (ft)	Sample Type	SPT N Value (blows/ 1 ft)	Moisture Content (%)	Soil Description	LL	PL	PI	LI	USCS	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Dry Unit wt (pcf)	Moist Unit wt (pcf)	c' (psf)	phi' (deg)	UU - c_u (psf)	Confining Pressure (psf)	Type	Cc_ε	Cr_ε	σ'_p (psf)	Gs	Organic Content (%)
BH-FGD-101	88	0.0-2.0		SH		18.2	Very stiff, mottled, sandy lean CLAY (CL), damp																					
BH-FGD-101	89	2.0-4.0		SH		11.9	hard, mottled reddish brown at 2.0'																					
BH-FGD-101	90	4.0-6.0		SH		18.4	trace silt at 4.0'																					
BH-FGD-101	91	6.0-8.0		SH		13.6	very stiff, reddish brown and light gray, some silt at 6.0'																					
BH-FGD-101	92	8.0-10.0		SH		18.4	Dense, grayish brown, SAND (SP-SM), with silt, damp																					
BH-FGD-101	93	13.0-15.5		SH		27.0	Very stiff, grayish brown, clayey fine SAND (SC), with some silt, layered																					
BH-FGD-101		-					gray and light brown at 13.5'																					
BH-FGD-101	94	18.0-20.0		SS	50	25.5	Very dense, light brown, fine, poorly-graded SAND (SP), damp																					
BH-FGD-101	95	23.0-25.0		SS	50	27.6	little clay at 23.0'																					
BH-FGD-101	96	28.0-30.0		SS	35	28.7	dense, wet at 28.0'																					
BH-FGD-101		-					BORING TERMINATED AT 30.0'																					

Golder Associates

Project: Luminant Pond Stability Geotechnical Investigation

Location: Oak Grove, Texas

SUMMARY OF SOIL DATA AND LABORATORY TEST RESULTS

Sample: Borehole Number	Sample: Sample Number	Sample: Depth Interval (ft-bgs)	Sample: Elevation of Top (ft)	Sample Type	SPT N Value (blows/ 1 ft)	Moisture Content (%)	Soil Description	Atterberg Limits: LL	Atterberg Limits: PL	Atterberg Limits: PI	Atterberg Limits: LI	Atterberg Limits: USCS	Particle Size Analysis: Gravel (%)	Particle Size Analysis: Sand (%)	Particle Size Analysis: Silt (%)	Particle Size Analysis: Clay (%)	Dry Unit wt (pcf)	Moist Unit wt (pcf)	CU Triaxial: c' (psf)	CU Triaxial: phi' (deg)	UU Triaxial: UU - c_u (psf)	UU Triaxial: Confining Pressure (psf)	Consolidation: Type	Consolidation: Cc_{ε}	Consolidation: Cr_{ε}	Consolidation: σ'_p (psf)	Gs	Organic Content (%)
BH-FGD-102	79	0.0-2.0		SH		20.1	Hard, mottled light brown, sandy lean CLAY (CL), damp																					
BH-FGD-102	80	2.0-4.0		SH		8.3	very stiff, brown at 2.0'																					
BH-FGD-102	81	4.0-6.0		SH		14.1	hard at 4.0'																					
BH-FGD-102	82	6.0-8.0		SH		17.9	light gray, moist at 6.0'																					
BH-FGD-102	83	8.0-10.0		SH		20.0	very stiff at 8.0'																					
BH-FGD-102	89	13.0-15.0		SH		20.7	little silt at 13.0'																					
BH-FGD-102	85	18.0-20.0		SH		25.1	Stiff, light to dark gray, silty fat CLAY (CH), trace sand, moist	54	22	32	0.08																	
BH-FGD-102	86	23.0-25.0		SH		23.3	Stiff, gray, sandy lean CLAY (CL), trace silt, moist																					
BH-FGD-102	87	28.0-30.0		SS	72	26.7	Very dense, light brown, fine, poorly-graded SAND (SP-SM), with clay, wet						0.0	75.2	24.8													
BH-FGD-102		-					BORING TERMINATED AT 30.0'																					

Golder Associates

Project: Luminant Pond Stability Geotechnical Investigation

Location: Oak Grove, Texas

SUMMARY OF SOIL DATA AND LABORATORY TEST RESULTS

Sample: Borehole Number	Sample: Sample Number	Sample: Depth Interval (ft-bgs)	Sample: Elevation of Top (ft)	Sample Type	SPT N Value (blows/ 1 ft)	Moisture Content (%)	Soil Description	Atterberg Limits: LL	Atterberg Limits: PL	Atterberg Limits: PI	Atterberg Limits: LI	Atterberg Limits: USCS	Particle Size Analysis: Gravel (%)	Particle Size Analysis: Sand (%)	Particle Size Analysis: Silt (%)	Particle Size Analysis: Clay (%)	Dry Unit wt (pcf)	Moist Unit wt (pcf)	CU Triaxial: c' (psf)	CU Triaxial: phi' (deg)	UU Triaxial: UU - c_u (psf)	UU Triaxial: Confining Pressure (psf)	Consolidation: Type	Consolidation: $Cc_ε$	Consolidation: $Cr_ε$	Consolidation: $σ'_p$ (psf)	Gs	Organic Content (%)
BH-FGD-103	66	0.0-2.0		SH		18.9	Very soft to soft, light brown, sandy fat CLAY (CH), trace roots, damp																					
BH-FGD-103	67	2.0-4.0		SH		18.3	stiff at 2.0'																					
BH-FGD-103	68	4.0-6.0		SH		18.8	light brown to dark grayish brown at 4.0'																					
BH-FGD-103	69	6.0-8.0		SH		14.9	hard at 6.0'																					
BH-FGD-103	70	8.0-10.0		SH		15.0	mottled at 8.0'	53	18	36	-0.08						109.6	126.0			4900	1123						
BH-FGD-103	71	13.0-15.0		SH		19.0		63	20	43	-0.02						105.0	125.0			4400	1541						
BH-FGD-103	72	18.0-20.0		SH		22.5	Stiff, brown, silty CLAY (CL-ML), with sand, trace lignite, moist																					
BH-FGD-103	73	23.0-25.0		SH		20.6	stiff to very stiff, mottled, damp at 23.0'																					
BH-FGD-103	74	28.0-30.0		SH		19.0	Stiff, mottled, sandy lean CLAY (CL), damp	38	16	22	0.12						111.6	132.8			5500	3571						
BH-FGD-103		-																										
BH-FGD-103	75	33.0-34.5		SH	16	21.3	Compact, light gray, SILT (ML), with sand, wet						0.0	39.7	60.3													
BH-FGD-103		-					Firm, light gray and brown, silty SAND (SM), wet																					
BH-FGD-103	76	38.0-40.0		SH		16.0	Very stiff, mottled light gray, lean CLAY (CL), trace lignite, trace sand, wet	35	16	20	0.02						111.8	129.7			3200	4435						
BH-FGD-103	77	43.0-45.0		SH		25.7	hard at 43.0'																					
BH-FGD-103	78	48.0-50.0		SH		23.6	interbedded with sand layers at 48.0'																					
BH-FGD-103		-					BORING TERMINATED AT 50.0'																					

Golder Associates

Project: Luminant Pond Stability Geotechnical Investigation

Location: Oak Grove, Texas

SUMMARY OF SOIL DATA AND LABORATORY TEST RESULTS

Sample				Sample Type	SPT N Value (blows/ 1 ft)	Moisture Content (%)	Soil Description	Atterberg Limits					Particle Size Analysis				Dry Unit wt (pcf)	Moist Unit wt (pcf)	CU Triaxial		UU Triaxial		Consolidation				Gs	Organic Content (%)
Borehole Number	Sample Number	Depth Interval (ft-bgs)	Elevation of Top (ft)					LL	PL	PI	LI	USCS	Gravel (%)	Sand (%)	Silt (%)	Clay (%)			c' (psf)	phi' (deg)	UU - c_u (psf)	Confining Pressure (psf)	Type	Cc_ε	Cr_ε	σ'_p (psf)		
BH-FGD-104	57	0.0-2.0		SH		14.7	Very stiff, light brown to dark brown, sandy lean CLAY (CL), damp																					
BH-FGD-104	58	2.0-4.0		SH		21.0	hard, light brown at 2.0'																					
BH-FGD-104	59	4.0-6.0		SH		17.6	mottled to dark brown, trace silt at 4.0'																					
BH-FGD-104	60	6.0-8.0		SH		13.3	grayish brown at 6.0'																					
BH-FGD-104	61	8.0-10.0		SH		15.6																						
BH-FGD-104	62	13.0-15.0		SH		18.6	very stiff, moist at 13.0'																					
BH-FGD-104	63	18.0-20.0		SH		15.2	hard, damp at 18.0'																					
BH-FGD-104		-					Very dense, grayish brown, medium to fine, silty clayey SAND (SC/SM), trace organic																					
BH-FGD-104	64	23.0-24.5		SS	23	23.4	Compact, light brown and gray, poorly-graded SAND (SP-SM), with silt, wet						0.0	83.8	16.2													
BH-FGD-104	65	28.0-30.0		SS	31	23.7	Fine, silty SAND (SM), trace clay																					
BH-FGD-104		-					BORING TERMINATED AT 30.0'																					

Golder Associates

Project: Luminant Pond Stability Geotechnical Investigation
Location: Oak Grove, Texas

SUMMARY OF SOIL DATA AND LABORATORY TEST RESULTS

Sample				Sample Type	SPT N Value (blows/ 1 ft)	Moisture Content (%)	Soil Description	Atterberg Limits					Particle Size Analysis				Dry Unit wt (pcf)	Moist Unit wt (pcf)	CU Triaxial		UU Triaxial		Consolidation				Gs	Organic Content (%)
Borehole Number	Sample Number	Depth Interval (ft-bgs)	Elevation of Top (ft)					LL	PL	PI	LI	USCS	Gravel (%)	Sand (%)	Silt (%)	Clay (%)			c' (psf)	phi' (deg)	UU - c_u (psf)	Confining Pressure (psf)	Type	Cc_ε	Cr_ε	σ'_p (psf)		
BH-FGD-105	44	0.0-2.0		SH		8.3	Very stiff, mottled dark brown, sandy fat CLAY (CH), trace organics, damp																					
BH-FGD-105	45	2.0-4.0		SH		19.3	hard, light brown at 2.0'																					
BH-FGD-105	46	4.0-6.0		SH		13.5	dark brown at 4.0'																					
BH-FGD-105	47	6.0-8.0		SH		10.3	light brown at 6.0'																					
BH-FGD-105	48	8.0-10.0		SH		16.3		51	19	33	-0.07	CH	0.0	12.3	87.7				278	26								
BH-FGD-105	49	13.0-15.0		SH		16.0	mottled, trace lignite at 13.0'																					
BH-FGD-105	50	18.0-20.0		SH		18.0	very stiff, dark gray at 18.0'	51	19	32	-0.02						107.9	127.3			4300	2434						
BH-FGD-105	51	23.0-25.0		SH		15.9	hard, dark brown at 23.0'																					
BH-FGD-105	52	28.0-30.0		SH		18.9	Very stiff, mottled dark gray to brown, silty CLAY (CL-ML), few sand, moist																					
BH-FGD-105		-																										
BH-FGD-105	53	33.0-35.0		SH		22.3	Stiff, black, sandy SILT (ML), trace clay, some organics, some wood fragments, moist																					
BH-FGD-105		-					Stiff, dark brown, fat CLAY (CH), trace organics, trace sand, moist																					
BH-FGD-105	54	38.0-39.5		SS	50	12.5	Very dense, light brown, fine, poorly-graded SAND (SP), trace clay, damp						1.2	62.0	36.8													
BH-FGD-105	55	43.0-45.0		SS	72	23.6	Very dense, light brown, fine, poorly-graded SAND (SP-SM), with silt, moist						0.0	78.8	21.2													
BH-FGD-105	56	48.0-50.0		SS	50	26.4	Very dense, grayish brown, silty SAND (SM), trace clay, moist						0.0	74.6	25.4													
BH-FGD-105		-					BORING TERMINATED AT 50.0'																					

Golder Associates

Project: Luminant Pond Stability Geotechnical Investigation

Location: Oak Grove, Texas

SUMMARY OF SOIL DATA AND LABORATORY TEST RESULTS

Sample				Sample Type	SPT N Value (blows/ 1 ft)	Moisture Content (%)	Soil Description	Atterberg Limits					Particle Size Analysis				Dry Unit wt (pcf)	Moist Unit wt (pcf)	CU Triaxial		UU Triaxial		Consolidation				Gs	Organic Content (%)
Borehole Number	Sample Number	Depth Interval (ft-bgs)	Elevation of Top (ft)					LL	PL	PI	LI	USCS	Gravel (%)	Sand (%)	Silt (%)	Clay (%)			c' (psf)	phi' (deg)	UU - c_u (psf)	Confining Pressure (psf)	Type	Cc_ε	Cr_ε	σ'_p (psf)		
BH-FGD-106	97	0.0-2.0		SH		21.3	Stiff, mottled dark gray, sandy lean CLAY (CL), trace silt, damp																					
BH-FGD-106	98	2.0-4.0		SH		23.8	light brown to dark brown at 2.0'																					
BH-FGD-106	99	4.0-6.0		SH		18.8	hard, brownish red, moist at 4.0'																					
BH-FGD-106	100	6.0-8.0		SH		13.1	damp at 6.0'																					
BH-FGD-106	101	8.0-10.0		SH		17.8	mottled brownish red at 8.0'																					
BH-FGD-106	102	13.0-15.0		SH		17.4	mottled gray, little silt at 13.0'																					
BH-FGD-106	103	18.0-20.0		SH		16.7																						
BH-FGD-106	104	23.0-25.0		SH		22.8	Compact, light gray, fine silty SAND (SM), moist						0.0	64.6	35.4													
BH-FGD-106	105	28.0-30.0		SS	27	28.0	wet at 28.0'																					
BH-FGD-106		-					BORING TERMINATED AT 30.0'																					

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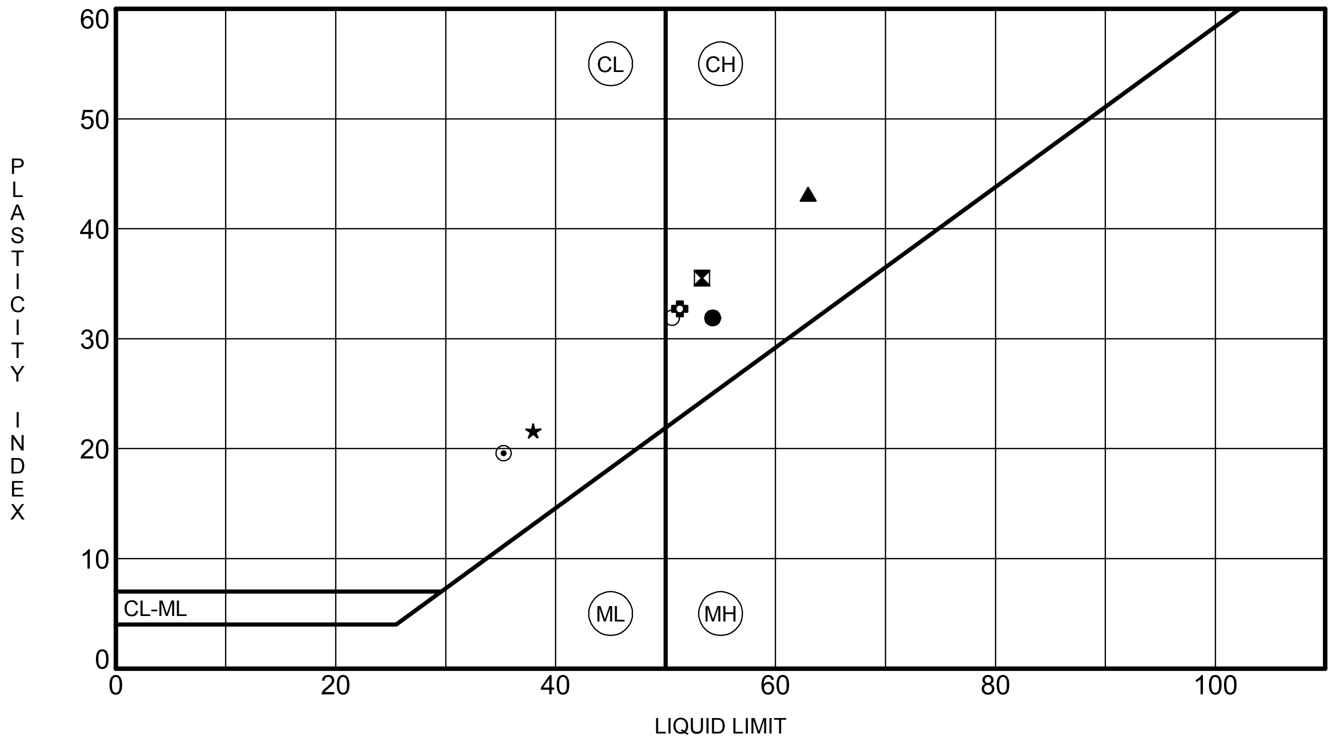
Project: Luminant Pond Stability Geotechnical Investigation

Location: Oak Grove, Texas

APPENDIX C
LABORATORY TEST RESULTS



	Specimen Identification		LL	PL	PI	Fines	Classification
●	**BH-FGD-102**	**18.00ft**	**54**	**22**	**32**		
⌧	**BH-FGD-103**	**8.00ft**	**53**	**18**	**35**		
▲	**BH-FGD-103**	**13.00ft**	**63**	**20**	**43**		
★	**BH-FGD-103**	**28.00ft**	**38**	**16**	**22**		
⊙	**BH-FGD-103**	**38.00ft**	**35**	**16**	**19**		
✿	**BH-FGD-105**	**8.00ft**	**51**	**19**	**32**	**88**	**FAT CLAY(CH)**
○	**BH-FGD-105**	**18.00ft**	**51**	**19**	**32**		

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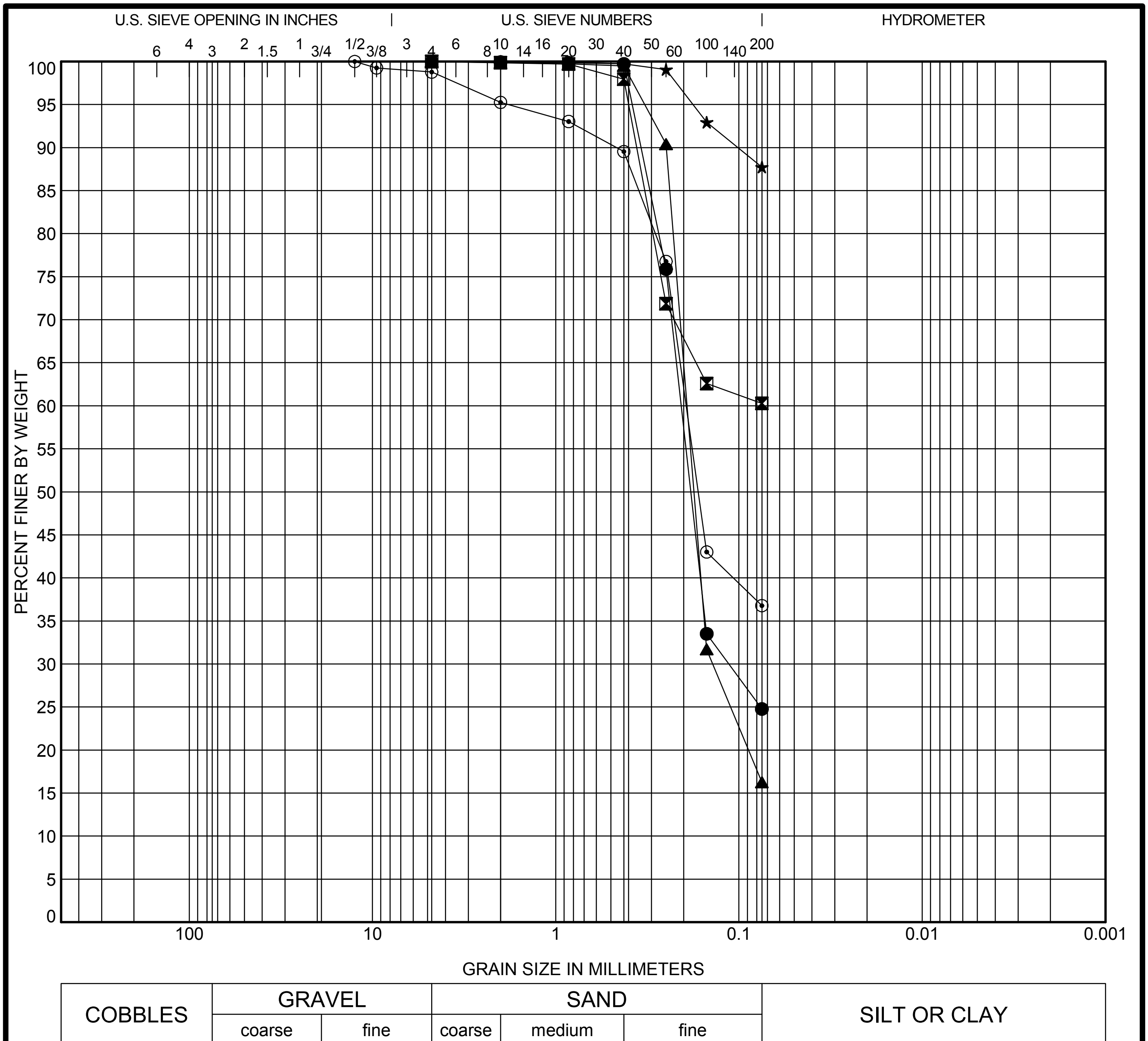
ATTERBERG LIMITS' RESULTS

Project: Luminant Pond Stability Geotechnical Investigation

Location: Oak Grove, Texas

CAN ATTERBERG LIMITS 94563GINT.GPJ GLDR LDN.GDT 4/23/10



Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**BH-FGD-102 28.00ft**						
⧗	**BH-FGD-103 33.00ft**						
▲	**BH-FGD-104 23.00ft**						
★	**BH-FGD-105 8.00ft**	**FAT CLAY(CH)**	**51**	**19**	**32**		
⊙	**BH-FGD-105 38.00ft**						

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH-FGD-102 28.00 ft**	**4.75**	**0.206**	**0.114**		**0.00**	**75.23**	**24.77**	
⧗	**BH-FGD-103 33.00 ft**	**4.75**				**0.00**	**39.73**	**60.27**	
▲	**BH-FGD-104 23.00 ft**	**4.75**	**0.192**	**0.139**		**0.00**	**83.76**	**16.24**	
★	**BH-FGD-105 8.00 ft**	**4.75**				**0.00**	**12.26**	**87.74**	
⊙	**BH-FGD-105 38.00 ft**	**12.5**	**0.194**			**1.23**	**62.00**	**36.77**	

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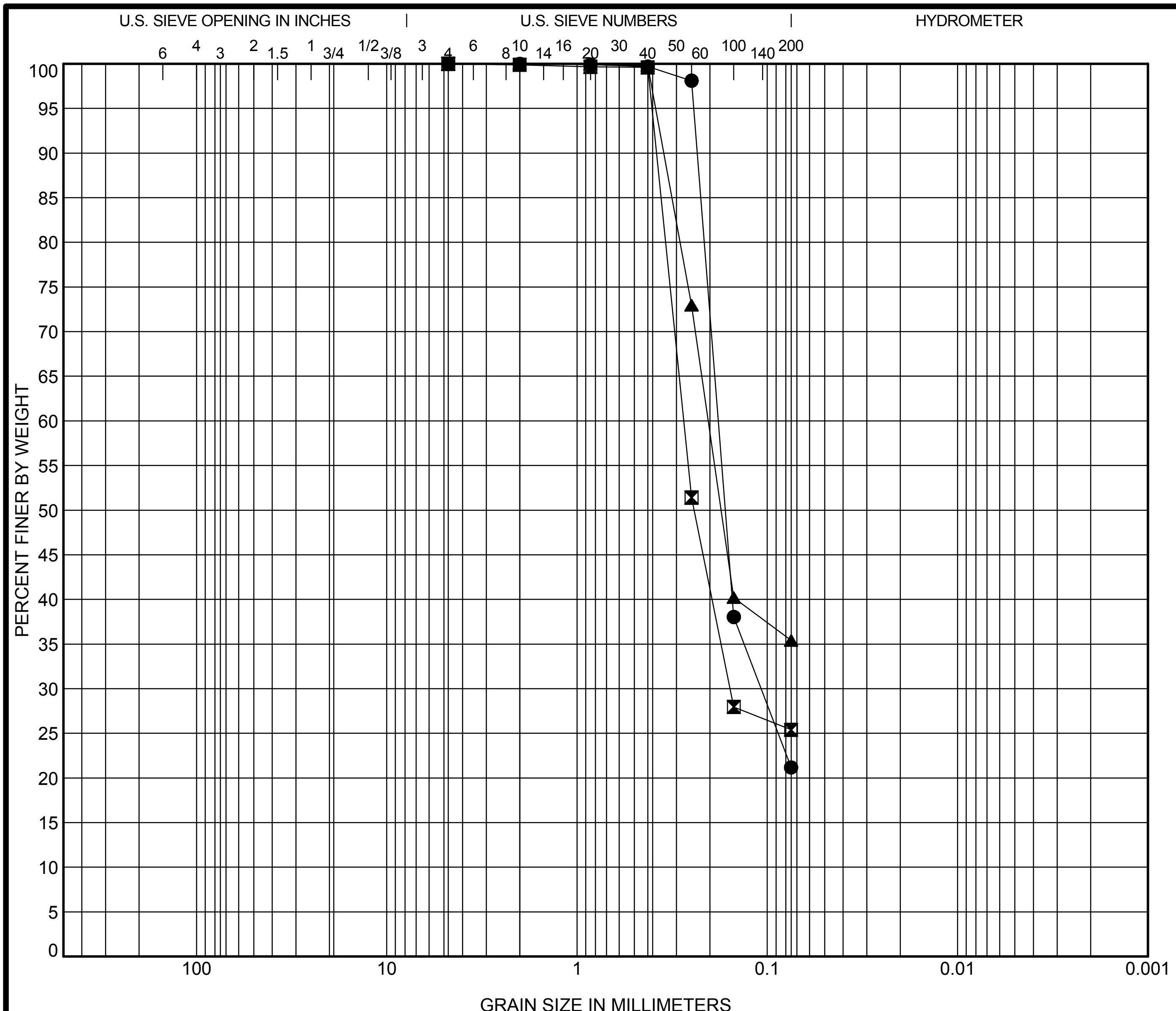
GRAIN SIZE DISTRIBUTION

Project: Luminant Pond Stability Geotechnical Investigation

Location: Oak Grove, Texas



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	**BH-FGD-105 43.00ft**						
⊠	**BH-FGD-105 48.00ft**						
▲	**BH-FGD-106 23.00ft**						

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH-FGD-105 43.00 ft**	**4.75**	**0.181**	**0.108**		**0.00**	**78.83**	**21.17**	
⊠	**BH-FGD-105 48.00 ft**	**4.75**	**0.275**	**0.157**		**0.00**	**74.61**	**25.39**	
▲	**BH-FGD-106 23.00 ft**	**2**	**0.204**			**0.00**	**64.60**	**35.40**	

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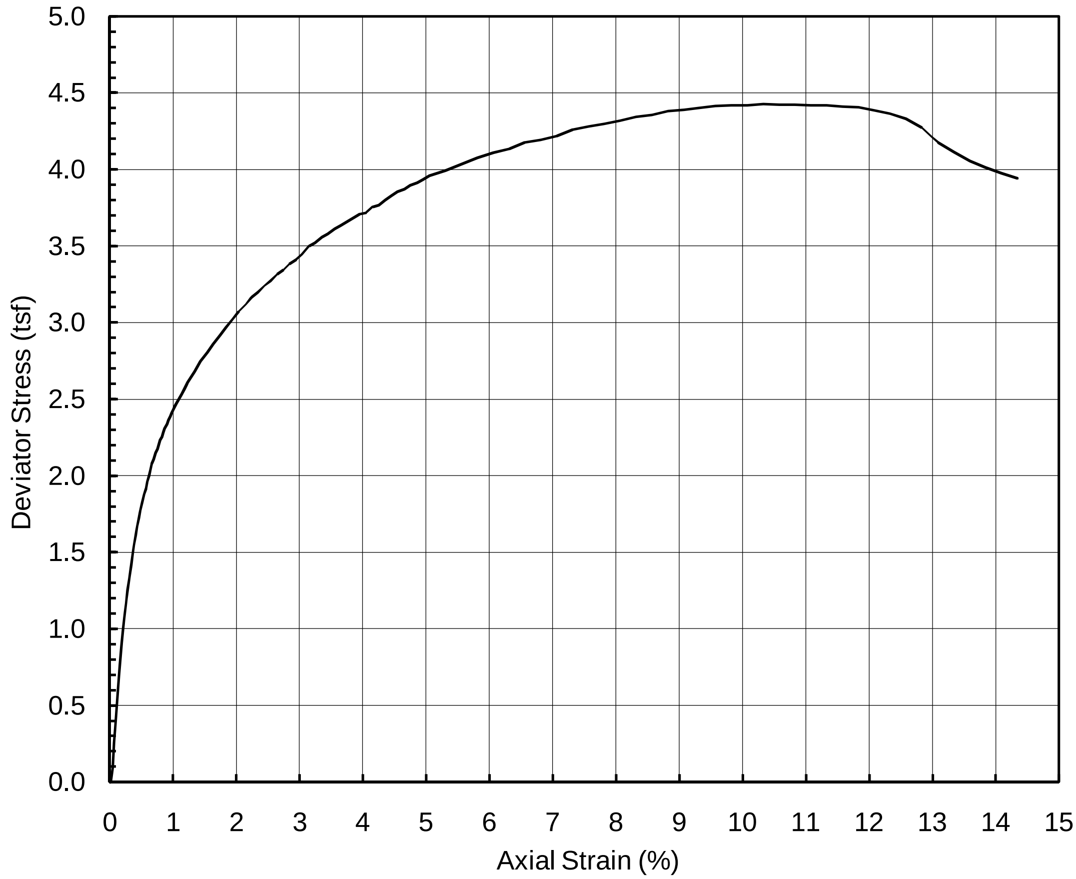
GRAIN SIZE DISTRIBUTION

Project: Luminant Pond Stability Geotechnical Investigation

Location: Oak Grove, Texas

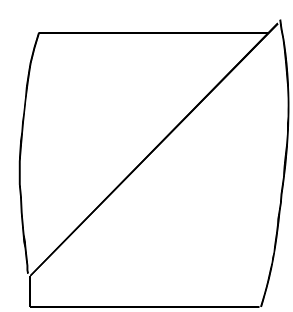
CAN GRAIN SIZE 94563GINT.GPJ GLDR LDN.GDT 4/27/10

UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Reddish Brown Sandy Clay						
LL	63	PI	43	LI	0.0	USCS	CH

Depth (ft)	13.0	Confining Pressure (psi)	10.7
Specimen Height (inch)	5.5	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (tsf)	4.4
Initial Specimen Weight (g)	1113.5	Axial Strain at Peak Stress (%)	10.3
Moist Unit Weight (pcf)	125.0		
Initial Water Content (%)	19		
Initial Dry Unit Weight (pcf)	104.8		



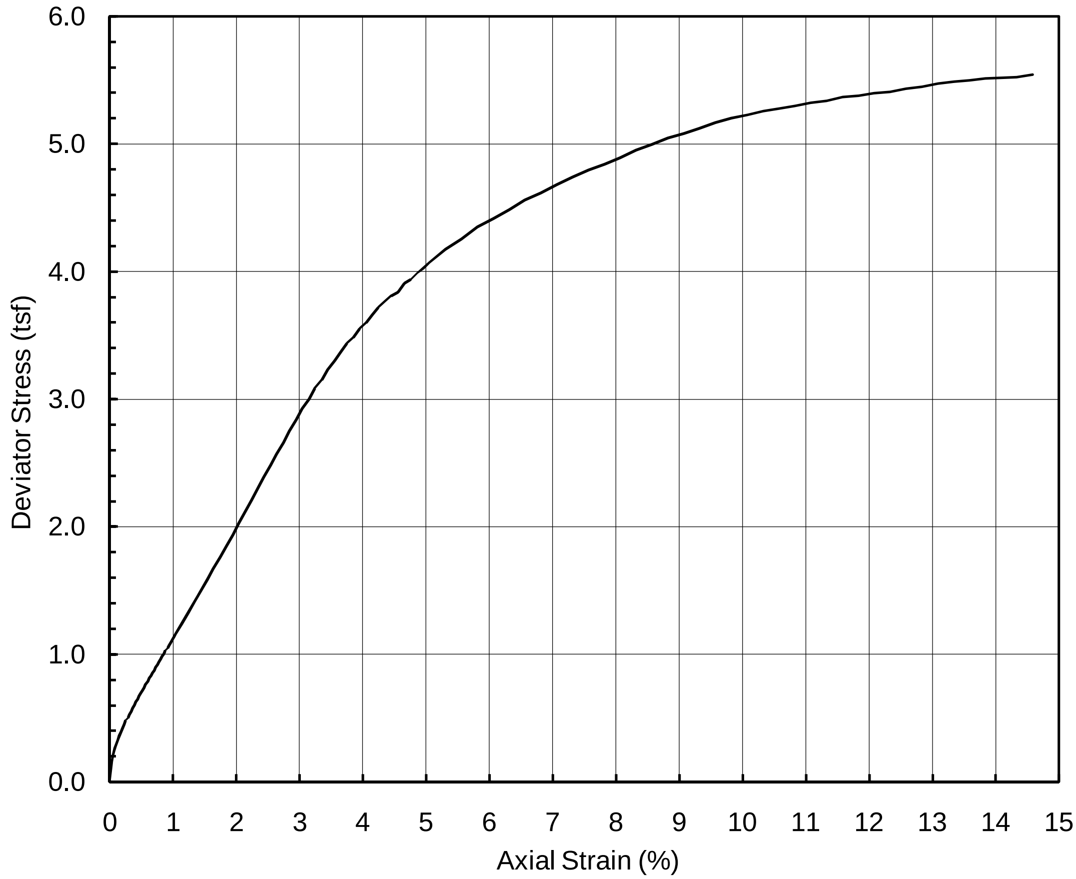
Failure Sketch

Project Title	Luminant Pond Stability
Project Number	103-94563
Sample Type	Shelby Tube
Sample ID	FGD-103 SA-71
Comments	

Golder Associates

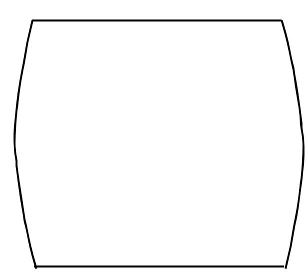
Performed by	**PN**
Date	**27-Mar-10**
Check	**DM**
Review	**PCM**

UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description		Light brown Sandy Clay					
LL	38	PI	22	LI	0.1	USCS	CL

Depth (ft)	28.0	Confining Pressure (psi)	24.8
Specimen Height (inch)	5.6	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (tsf)	5.5
Initial Specimen Weight (g)	1225.2	Axial Strain at Peak Stress (%)	14.8
Moist Unit Weight (pcf)	132.8		
Initial Water Content (%)	19		
Initial Dry Unit Weight (pcf)	111.8		



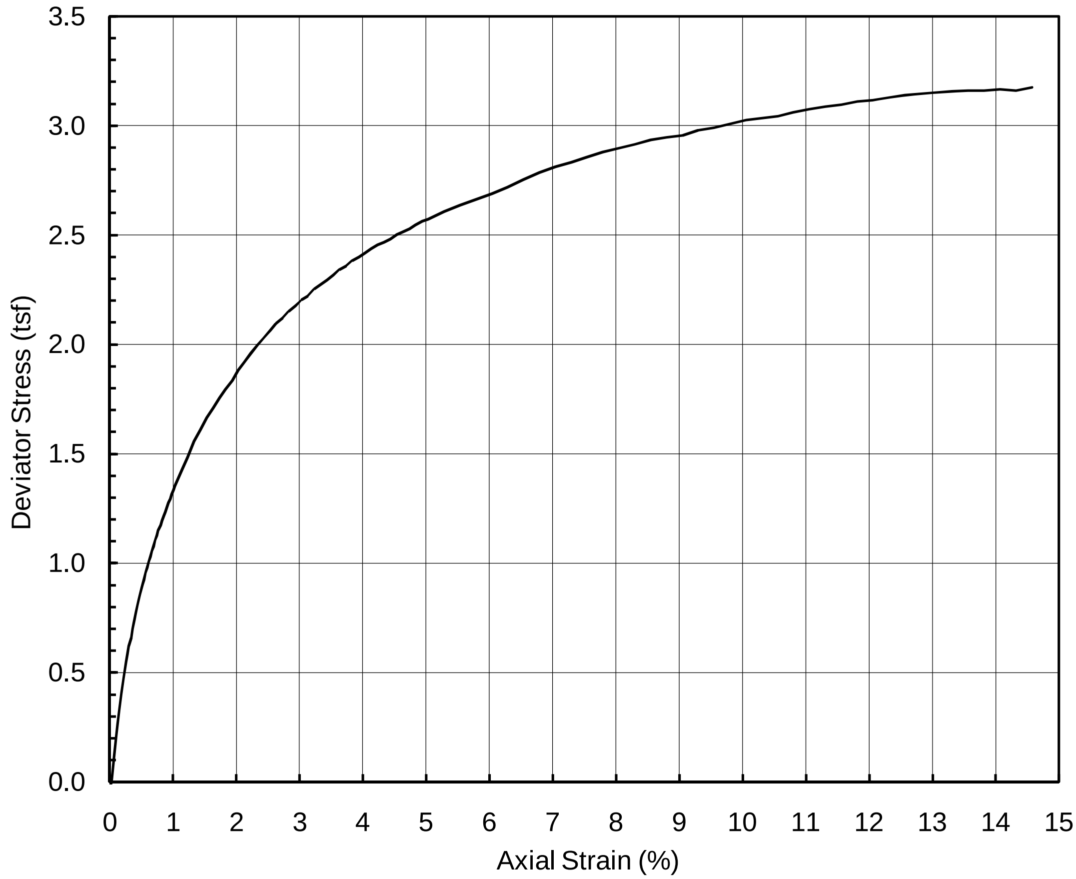
Failure Sketch

Project Title	Luminant Pond Stability
Project Number	103-94563
Sample Type	Shelby Tube
Sample ID	FGD-103 SA-74
Comments	

Golder Associates

Performed by	**PN**
Date	**29-Mar-10**
Check	**DM**
Review	**PCM**

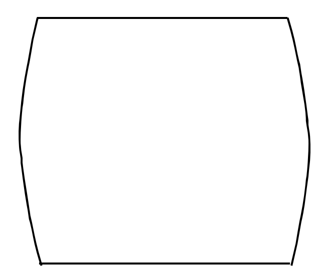
UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description		Light gray Sandy Clay					
LL	35	PI	19	LI	0.0	USCS	CL

Depth (ft)	38.0	Confining Pressure (psi)	30.8
Specimen Height (inch)	5.5	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (tsf)	3.2
Initial Specimen Weight (g)	1131.4	Axial Strain at Peak Stress (%)	15.0
Moist Unit Weight (pcf)	129.7		
Initial Water Content (%)	16		
Initial Dry Unit Weight (pcf)	111.8		

Project Title	Luminant Pond Stability
Project Number	103-94563
Sample Type	Shelby Tube
Sample ID	FGD-103 SA-76
Comments	

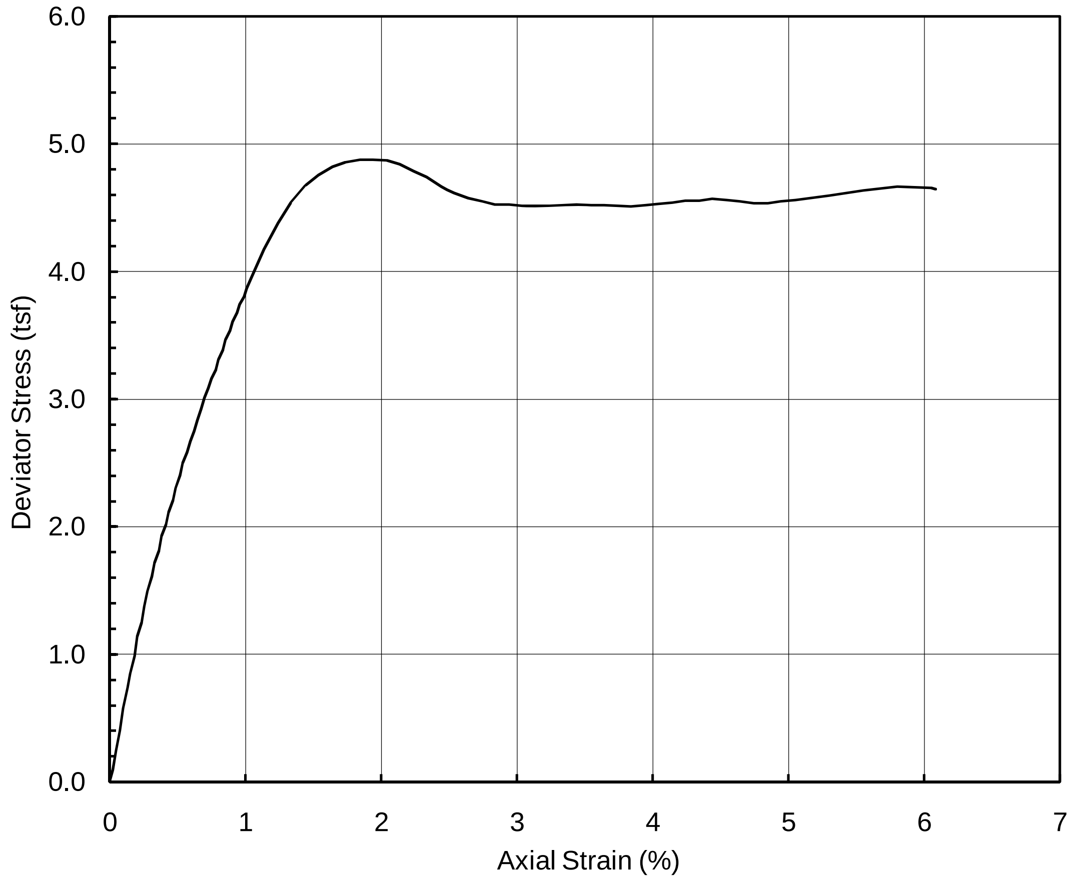


Failure Sketch

Golder Associates

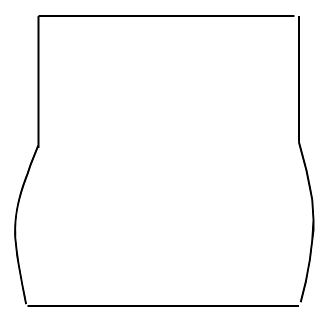
Performed by	**PN**
Date	**27-Mar-10**
Check	**DM**
Review	**PCM**

UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Yellowish Brown Sandy Clay						
LL	53	PI	35	LI	-0.1	USCS	CH

Depth (ft)	8.0	Confining Pressure (psi)	7.8
Specimen Height (inch)	5.6	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (tsf)	4.9
Initial Specimen Weight (g)	1108.3	Axial Strain at Peak Stress (%)	1.9
Moist Unit Weight (pcf)	126.0		
Initial Water Content (%)	15		
Initial Dry Unit Weight (pcf)	109.2		



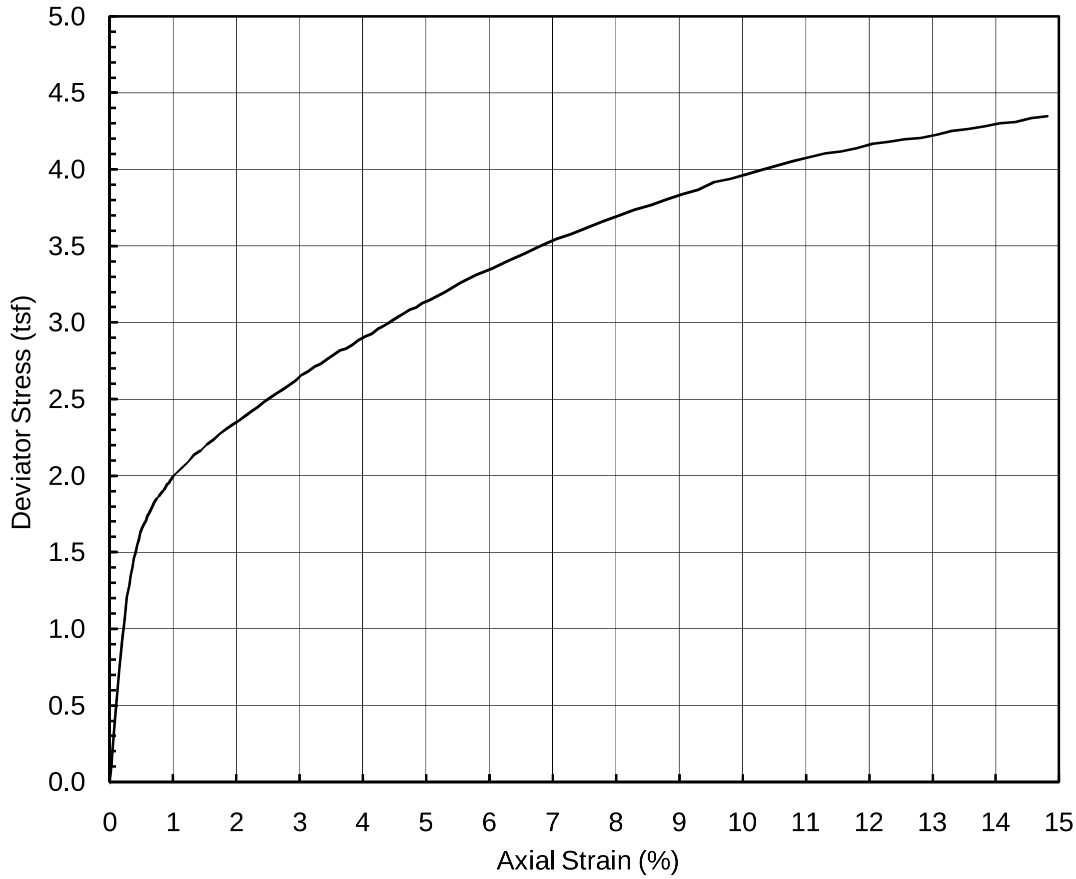
Failure Sketch

Project Title	Luminant Pond Stability
Project Number	103-94563
Sample Type	Shelby Tube
Sample ID	FGD-103 SA-70
Comments	

Golder Associates

Performed by	**PN**
Date	**27-Mar-10**
Check	**DM**
Review	**PCM**

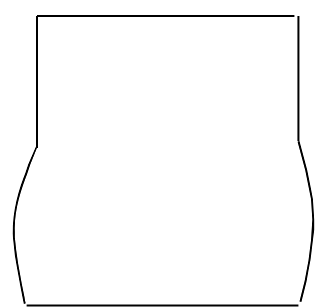
UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description		Brown Sandy Clay					
LL	51	PI	32	LI	0.0	USCS	CH

Depth (ft)	18.0	Confining Pressure (psi)	16.9
Specimen Height (inch)	5.0	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (tsf)	4.3
Initial Specimen Weight (g)	1035.2	Axial Strain at Peak Stress (%)	15.0
Moist Unit Weight (pcf)	127.3		
Initial Water Content (%)	18		
Initial Dry Unit Weight (pcf)	107.9		

Project Title	Luminant Pond Stability
Project Number	103-94563
Sample Type	Shelby Tube
Sample ID	FGD-105 SA-50
Comments	



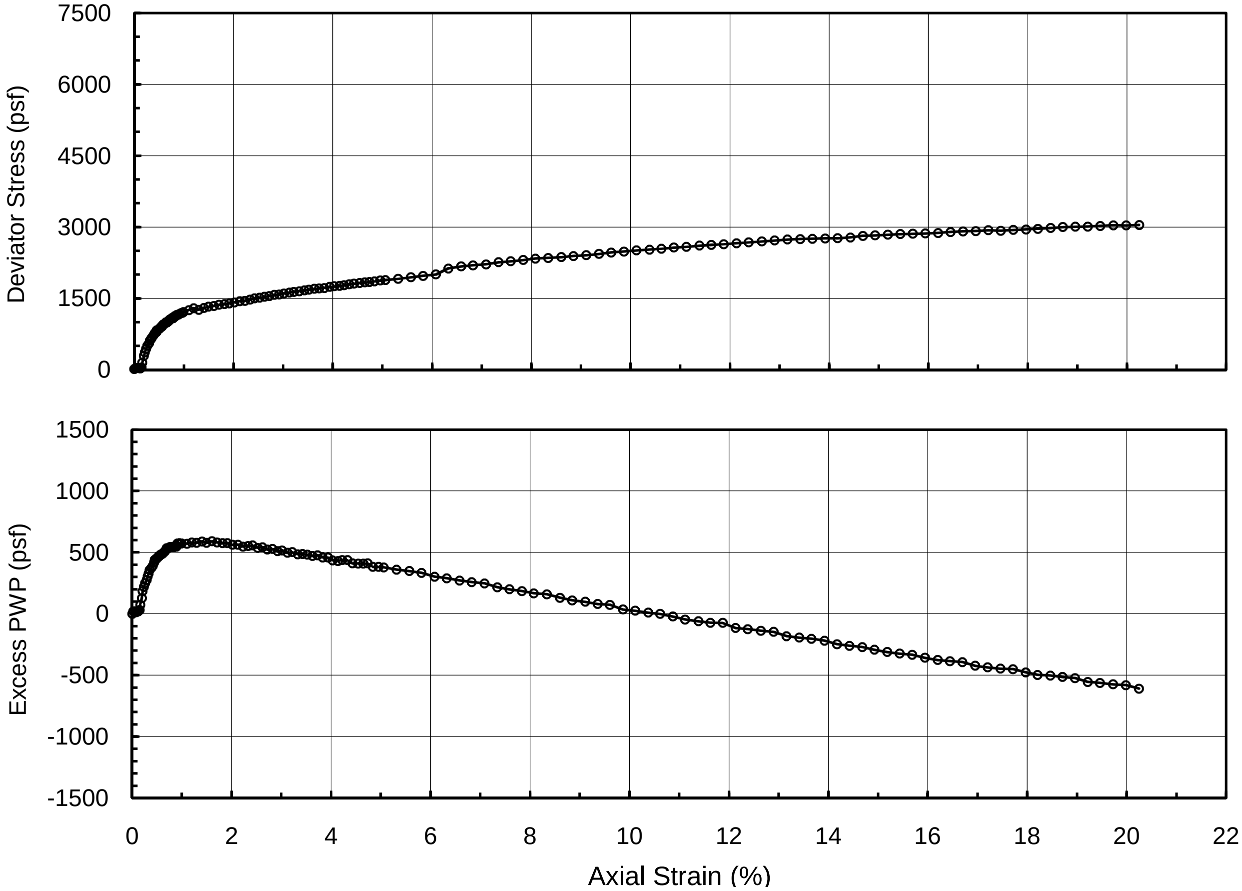
Failure Sketch

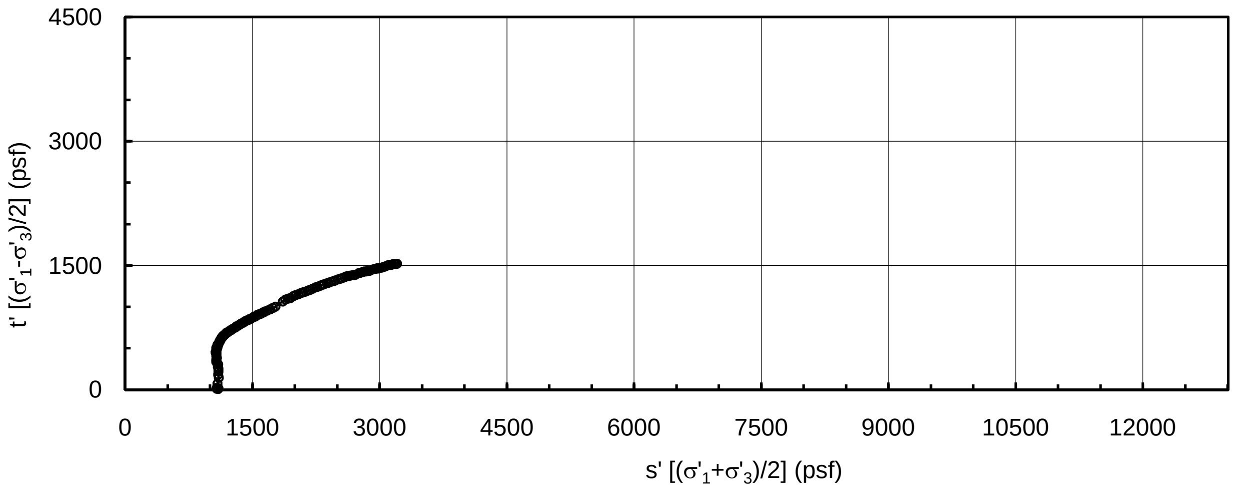
Performed by	**PN**
Date	**27-Mar-10**
Check	**DM**
Review	**SBK**

Golder Associates

Isotropically Consolidated Undrained Triaxial Test (ICU)

Project Title: Luminant Pond **Project Number:** 103-94563 **Date:** 08-Apr-10
Boring Number: FGD-105 **Specimen Name:** SA-48 **Depth (ft):** 8.9



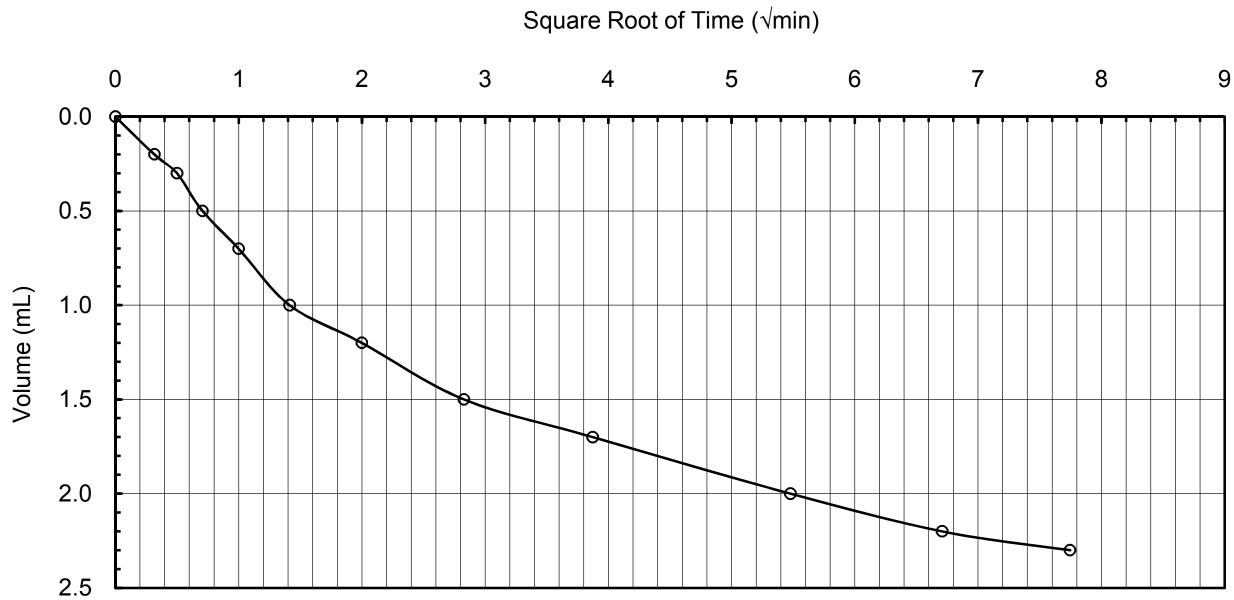


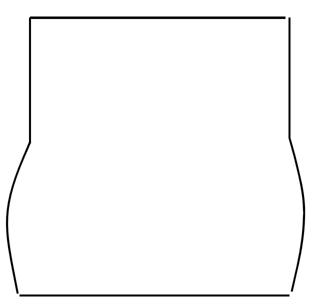
Specimen Description:	Light Brown Fat CLAY						
Initial Specimen Diameter (inch) =				2.94	Initial Specimen Height (inch) =		5.29
Initial Water Content (%) =				15.5	Water Content at End of Test (%) =		22.4
Initial Moist Unit Weight (pcf) =				121.8	B-value =		0.95
Back Pressure (BP, psf) =				10800	Consolidation Stress (σ'_3, psf) =		1088
Initial Lateral Stress (σ'_3, psf) =				1088	Consolidation t_{50} (min) =		3
Initial Deviator Stress (σ_1 - σ_3, psf) =				16	Rebound Stress (σ'_3, psf) =		NA
Test Strain Rate (%/hour) =				1.0	Rebound t_{50} (min) =		NA
LL =	51	PI =	32	USCS	CH	**Performed by**	DM
Comments:						**Reviewed by**	PCM

Golder Associates

Isotropically Consolidated Undrained Triaxial Test (ICU)

Project Title: Luminant Pond **Project Number:** 103-94563 **Date:** 08-Apr-10
Boring Number: FGD-105 **Specimen Name:** SA-48 **Depth (ft):** 8.9





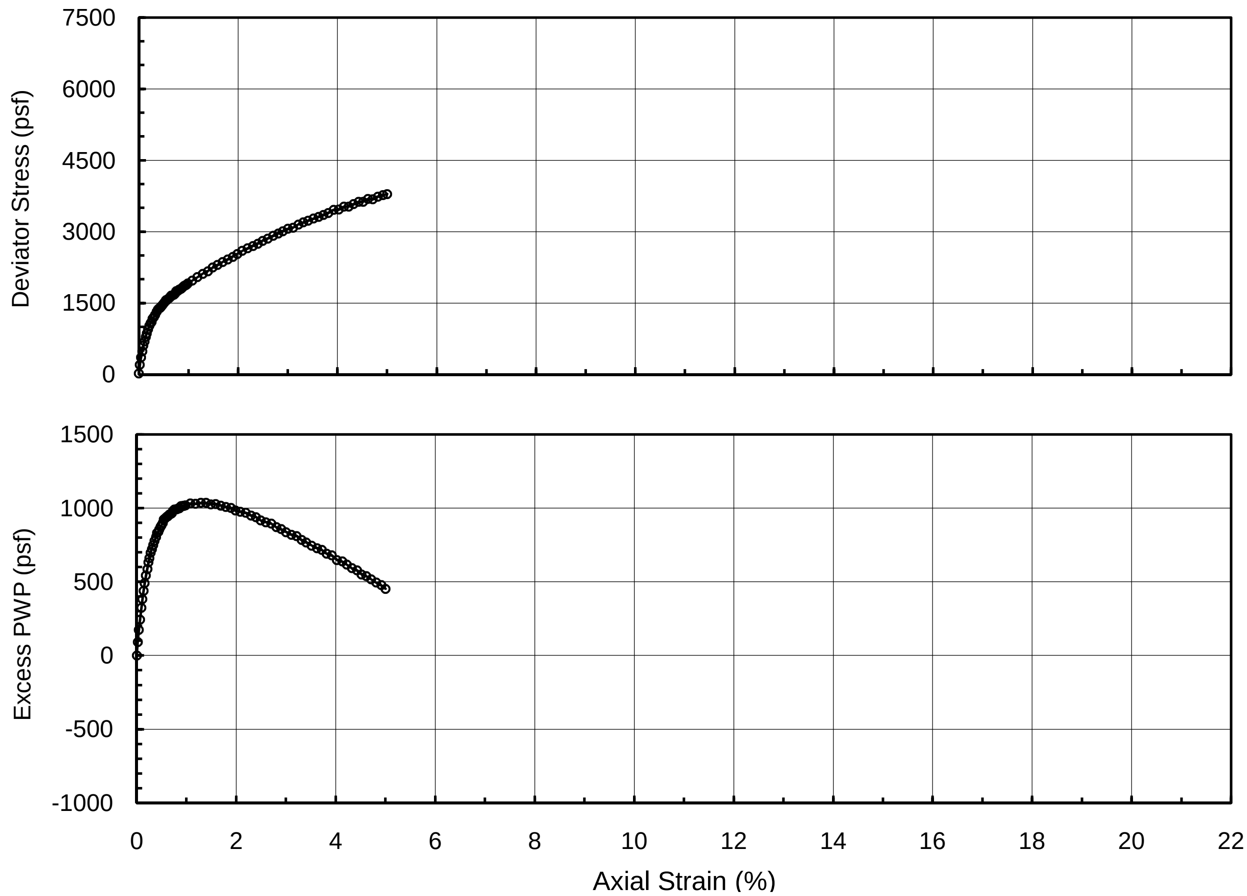
FAILURE SKETCH

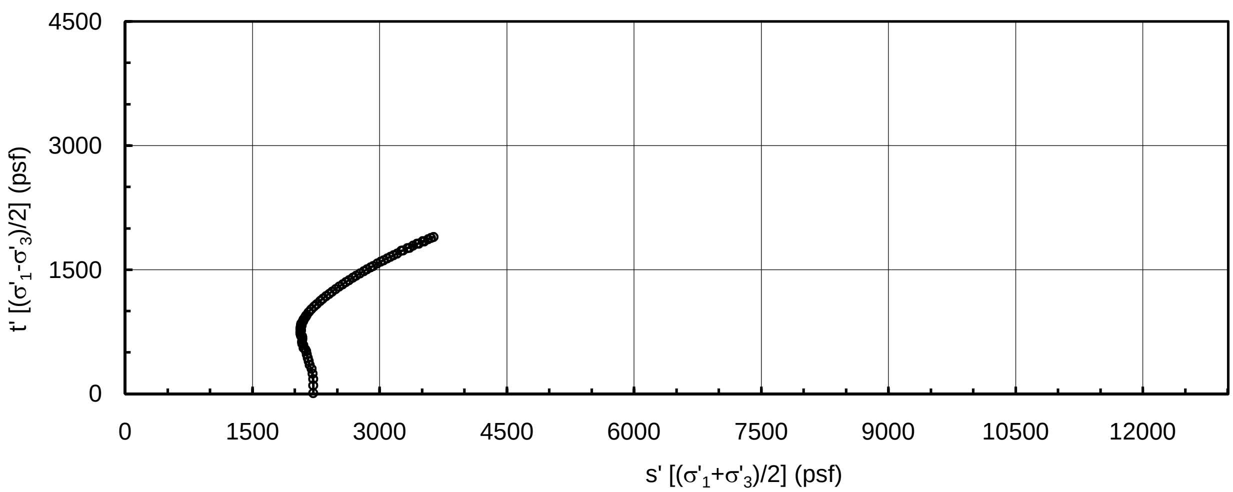
Consolidation Stress (σ'_3, psf) =			1088
Consolidation t_{50} (min) =			3
Consolidation Volume Change (mL) =			2.3
Unloading Stress (psf) =			NA
Unloading t_{50} (min) =			NA
Unloading Volume Change (mL) =			NA
LL =	51	PI =	32
USCS	CH		
Gs =	2.65	assumed	

Performed by	DM
Reviewed by	PCM

Isotropically Consolidated Undrained Triaxial Test (ICU)

Project Title: Luminant Pond **Project Number:** 103-94563 **Date:** 09-Apr-10
Boring Number: FGD-105 **Specimen Name:** SA-48 **Depth (ft):** 8.0



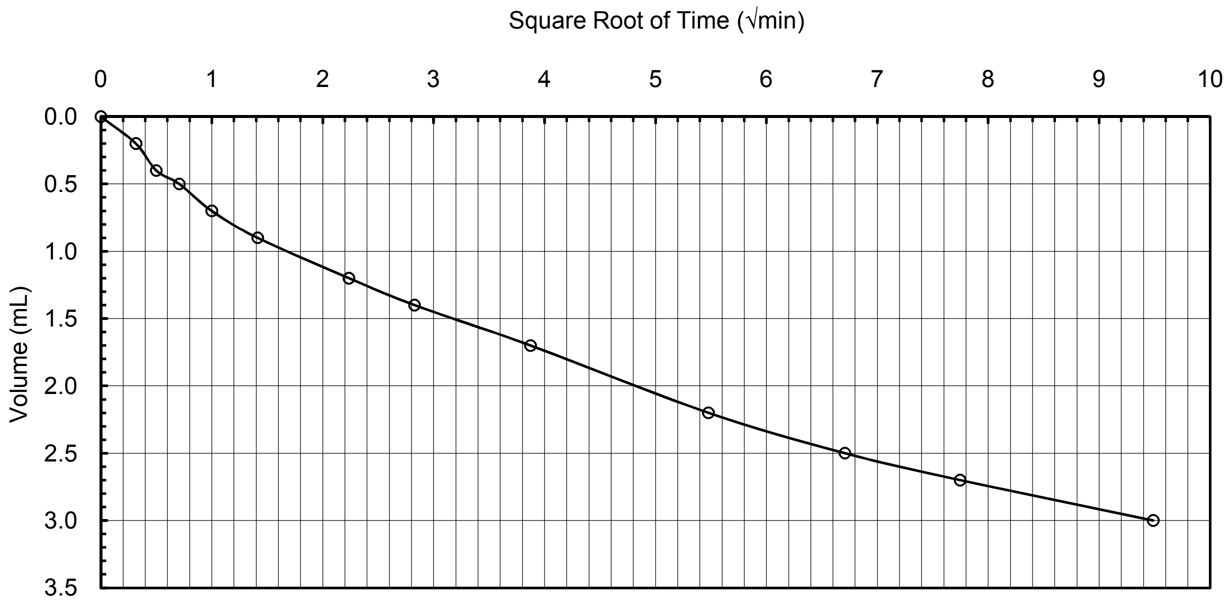


Specimen Description:	Light Brown Fat CLAY		
Initial Specimen Diameter (inch) =	2.94	Initial Specimen Height (inch) =	5.56
Initial Water Content (%) =	16.3	Water Content at End of Test (%) =	-
Initial Moist Unit Weight (pcf) =	123.6	B-value =	0.95
Back Pressure (BP, psf) =	9360	Consolidation Stress (σ'_3, psf) =	2209
Initial Lateral Stress (σ'_3, psf) =	2209	Consolidation t_{50} (min) =	17
Initial Deviator Stress (σ_1 - σ_3, psf) =	18	Rebound Stress (σ'_3, psf) =	NA
Test Strain Rate (%/hour) =	1.0	Rebound t_{50} (min) =	NA
LL = 51 PI = 32	USCS	CH **Performed by**	DM
Comments: Specimen #2 - Stage 1		**Reviewed by**	PCM

Golder Associates

Isotropically Consolidated Undrained Triaxial Test (ICU)

Project Title: Luminant Pond **Project Number:** 103-94563 **Date:** 09-Apr-10
Boring Number: FGD-105 **Specimen Name:** SA-48 **Depth (ft):** 8.0



Consolidation Stress (σ'_3, psf) =			2209
Consolidation t_{50} (min) =			17
Consolidation Volume Change (mL) =			3.0
Unloading Stress (psf) =			NA
Unloading t_{50} (min) =			NA
Unloading Volume Change (mL) =			NA
LL =	51	PI =	32
USCS	CH		
Gs =	2.65	assumed	

FAILURE SKETCH

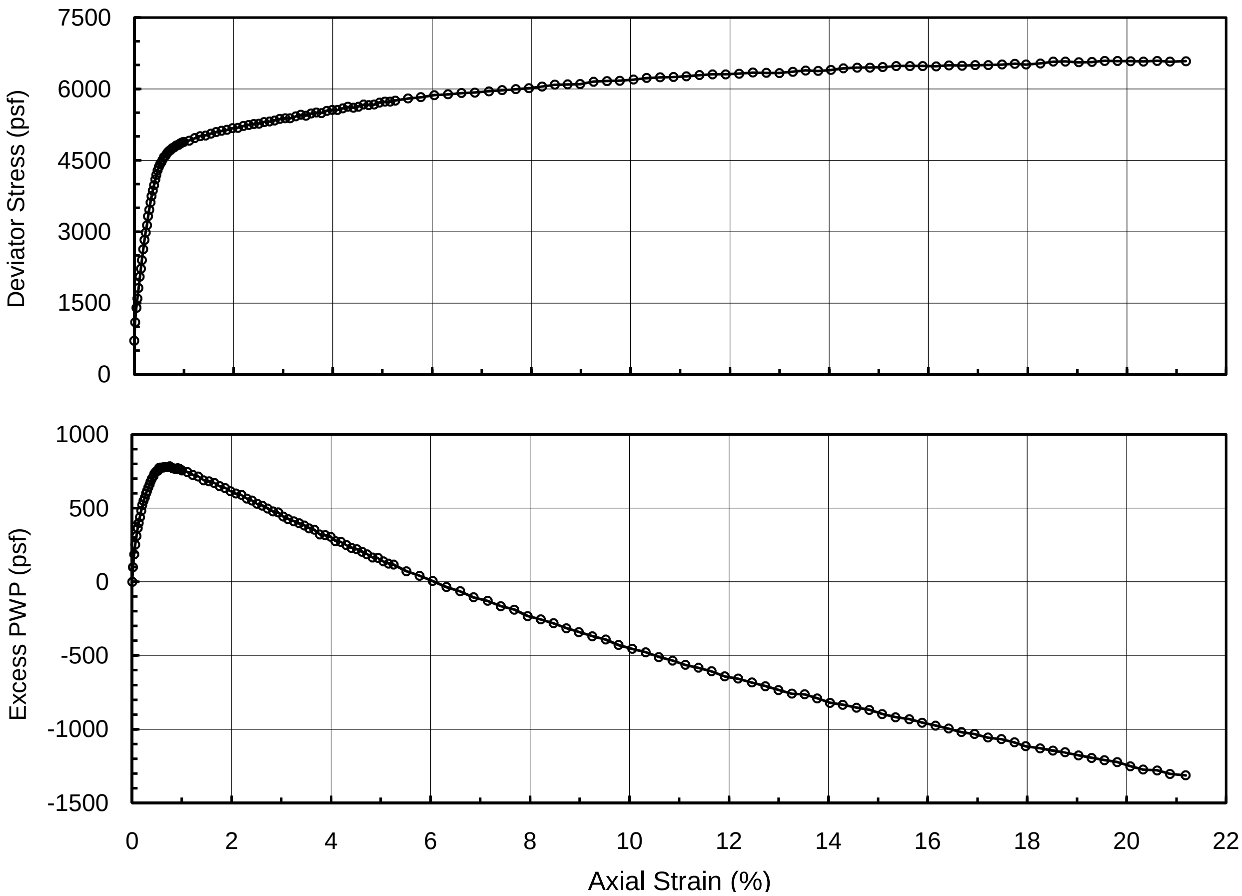
Performed by	DM
Reviewed by	PCM

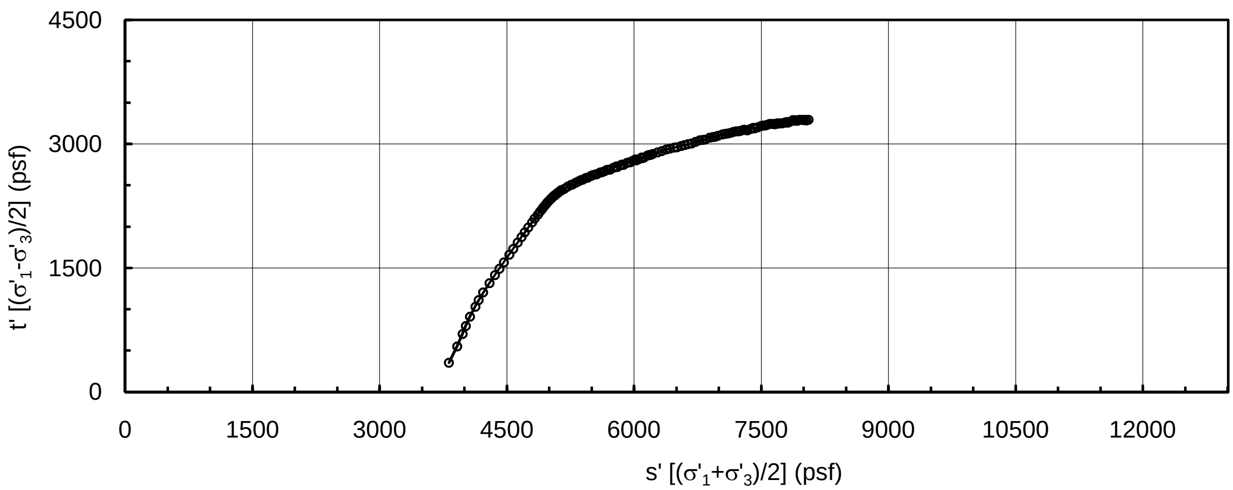
Golder Associates

Isotropically Consolidated Undrained Triaxial Test (ICU)

Project Title: Luminant Pond **Project Number:** 103-94563 **Date:** 10-Apr-10

Boring Number: FGD-105 **Specimen Name:** SA-48 **Depth (ft):** 8.0

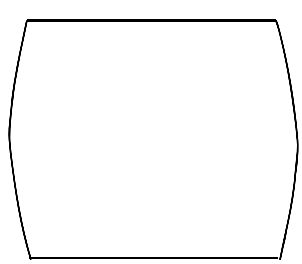




Specimen Description:	Light Brown Fat CLAY		
Initial Specimen Diameter (inch) =	3.00	Initial Specimen Height (inch) =	5.28
Initial Water Content (%) =	-	Water Content at End of Test (%) =	21.2
Initial Moist Unit Weight (pcf) =	-	B-value =	-
Back Pressure (BP, psf) =	9360	Consolidation Stress (σ'_3, psf) =	3463
Initial Lateral Stress (σ'_3, psf) =	3463	Consolidation t_{50} (min) =	6
Initial Deviator Stress (σ_1 - σ_3, psf) =	708	Rebound Stress (σ'_3, psf) =	NA
Test Strain Rate (%/hour) =	1.0	Rebound t_{50} (min) =	NA
LL = 51	PI = 32	USCS CH	**Performed by** DM
Comments: Specimen #2 - Stage 2			**Reviewed by** PCM

Isotropically Consolidated Undrained Triaxial Test (ICU)

Project Title: Luminant Pond **Project Number:** 103-94563 **Date:** 10-Apr-10
Boring Number: FGD-105 **Specimen Name:** SA-48 **Depth (ft):** 8.0



FAILURE SKETCH

Consolidation Stress (σ'_3, psf) =			3463
Consolidation t_{50} (min) =			6
Consolidation Volume Change (mL) =			5.4
Unloading Stress (psf) =			NA
Unloading t_{50} (min) =			NA
Unloading Volume Change (mL) =			NA
LL =	51	PI =	32
USCS	CH		
Gs =	2.65	assumed	

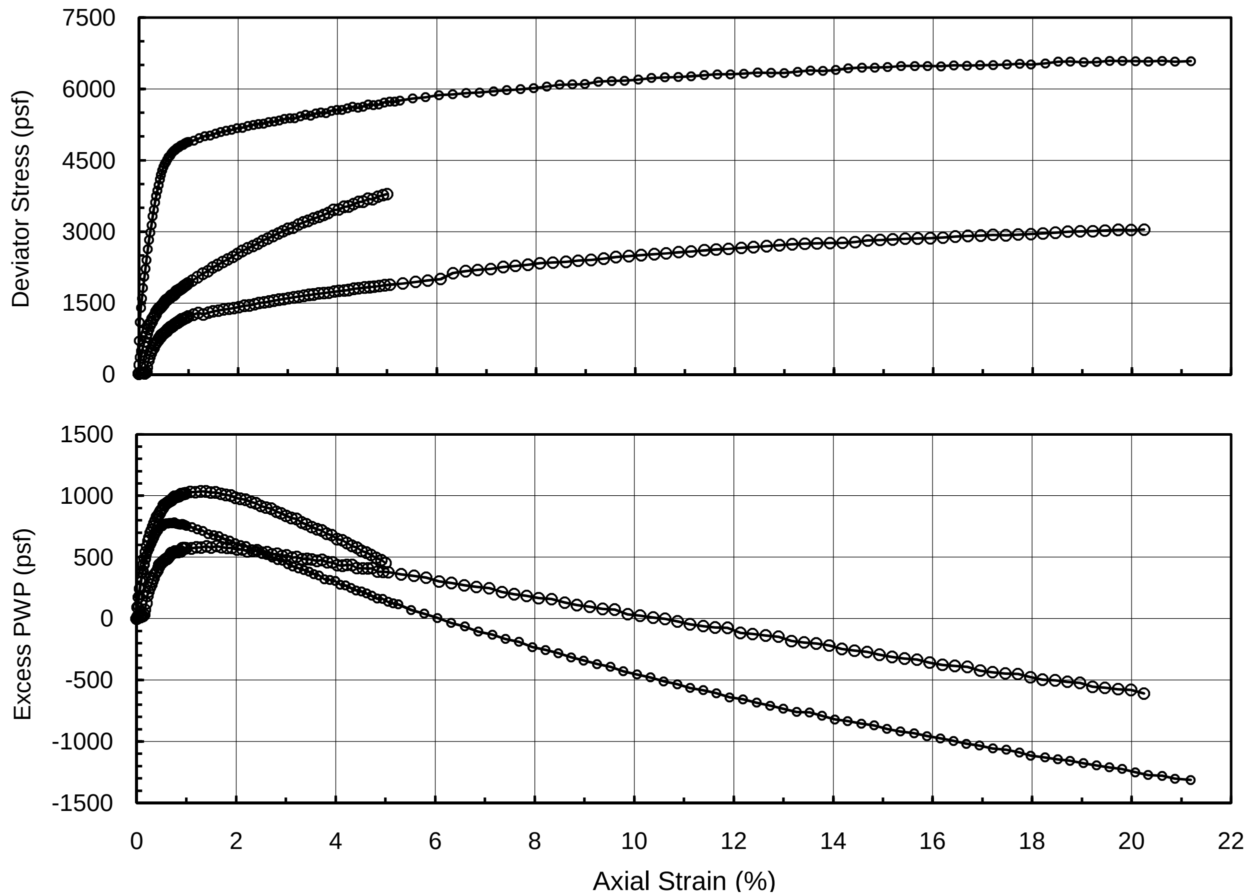
Performed by	DM
Reviewed by	PCM

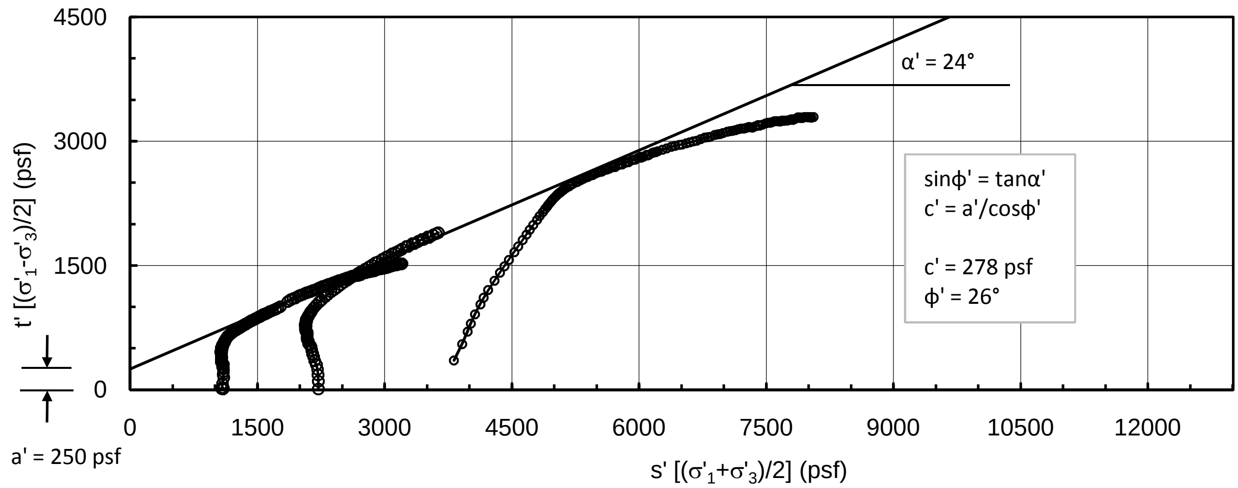
Golder Associates

Isotropically Consolidated Undrained Triaxial Test (ICU)

Project Title: Luminant Pond **Project Number:** 103-94563 **Date:** 10-Apr-10

Boring Number: FGD-105 **Specimen Name:** SA-48 **Depth (ft):**



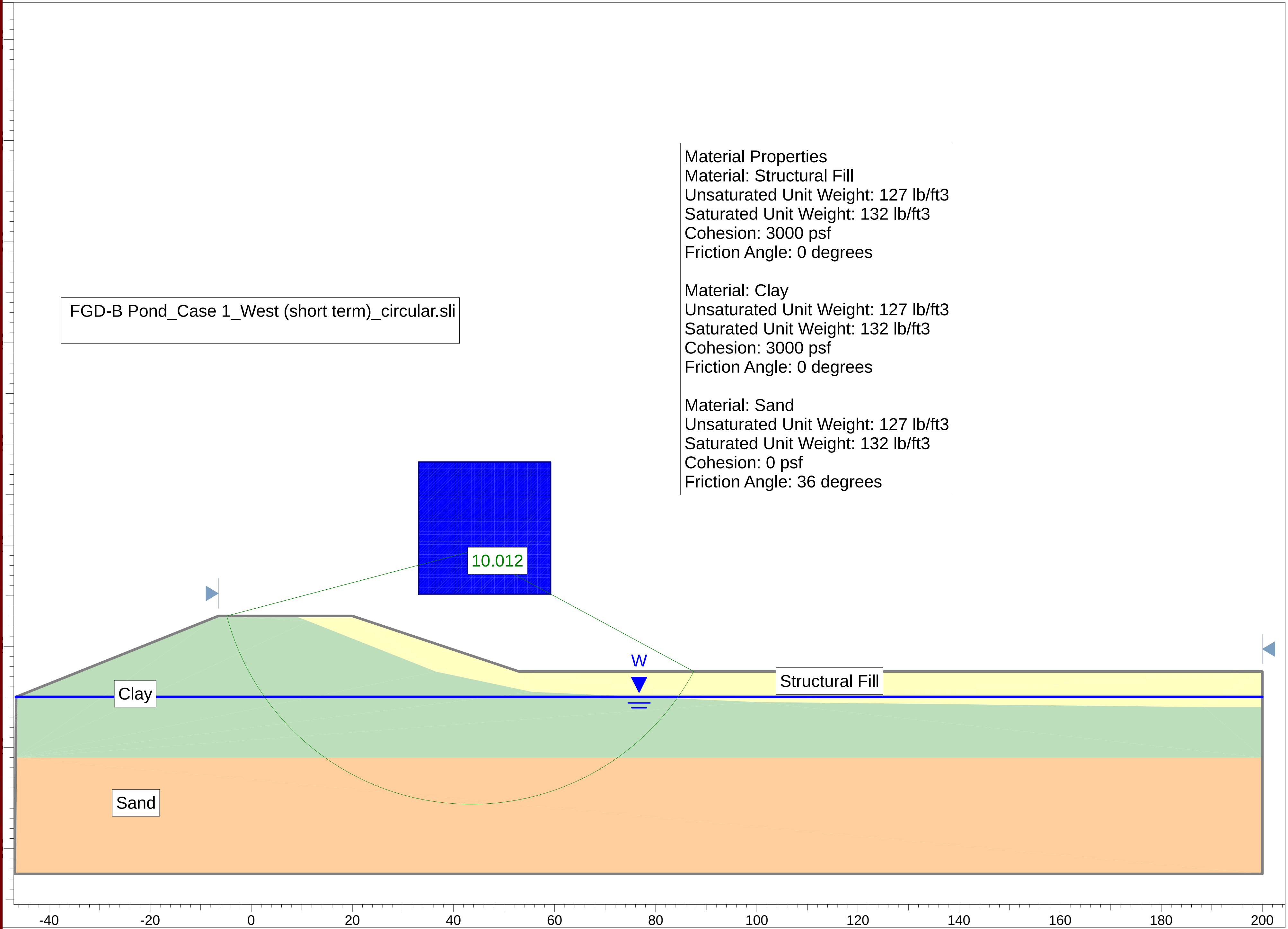


Specimen Description:	Light Brown Fat CLAY						
Initial Specimen Diameter (inch) =				Initial Specimen Height (inch) =			
Initial Water Content (%) =				Water Content at End of Test (%) =			
Initial Moist Unit Weight (pcf) =				B-value =			
Back Pressure (BP, psf) =				Consolidation Stress (σ'_3, psf) =			
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 =	51	PI =	32	USCS	CH	**Performed by**	DM
Comments:	3 Stages on 2 Specimens					**Reviewed by**	PCM

Golder Associates

APPENDIX D
SLOPE STABILITY ANALYSES

CASE 1


Material Properties
Material: Structural Fill
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Material: Clay
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Material: Sand
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 36 degrees
FGD-B Pond_Case 1_West (short term)_circular.sli
10.012
W
Clay
Structural Fill
Sand
-40
-20
0
20
40
60
80
100
120
140
160
180
200

Slide Analysis Information

Document Name

File Name: FGD-B Pond_Case 1_West (short term)_circular.sli

Project Settings

Project Title: FGD-B Pond: Case 1 - West Sideslope (short term)
Failure Direction: Left to Right
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified
GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 50
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

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

Material Properties

Material: Structural Fill
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Sand
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 36 degrees
Water Surface: Water Table
Custom Hu value: 1

Global Minimums

Method: bishop simplified
FS: 10.011800
Center: 43.547, 438.818
Radius: 50.059
Left Slip Surface Endpoint: -4.844, 426.000
Right Slip Surface Endpoint: 87.577, 415.000
Resisting Moment=1.40967e+007 lb-ft
Driving Moment=1.40801e+006 lb-ft

Method: spencer
FS: 10.108200
Center: 46.159, 444.694
Radius: 54.385
Left Slip Surface Endpoint: -4.912, 426.000
Right Slip Surface Endpoint: 91.722, 415.000
Resisting Moment=1.5357e+007 lb-ft
Driving Moment=1.51926e+006 lb-ft
Resisting Horizontal Force=214960 lb
Driving Horizontal Force=21265.9 lb

Method: gle/morgenstern-price
FS: 10.109500
Center: 46.159, 444.694
Radius: 54.385
Left Slip Surface Endpoint: -4.912, 426.000
Right Slip Surface Endpoint: 91.722, 415.000
Resisting Moment=1.53589e+007 lb-ft
Driving Moment=1.51926e+006 lb-ft
Resisting Horizontal Force=214987 lb
Driving Horizontal Force=21265.9 lb

Valid / Invalid Surfaces

Method: bishop simplified
Number of Valid Surfaces: 17949

Number of Invalid Surfaces: 542
Error Codes:
Error Code -103 reported for 136 surfaces
Error Code -112 reported for 406 surfaces

Method: spencer
Number of Valid Surfaces: 14450
Number of Invalid Surfaces: 4041
Error Codes:
Error Code -103 reported for 136 surfaces
Error Code -108 reported for 2373 surfaces
Error Code -111 reported for 1126 surfaces
Error Code -112 reported for 406 surfaces

Method: gle/morgenstern-price
Number of Valid Surfaces: 14450
Number of Invalid Surfaces: 4041
Error Codes:
Error Code -103 reported for 136 surfaces
Error Code -108 reported for 2373 surfaces
Error Code -111 reported for 1126 surfaces
Error Code -112 reported for 406 surfaces

Error Codes

The following errors were encountered during the computation:

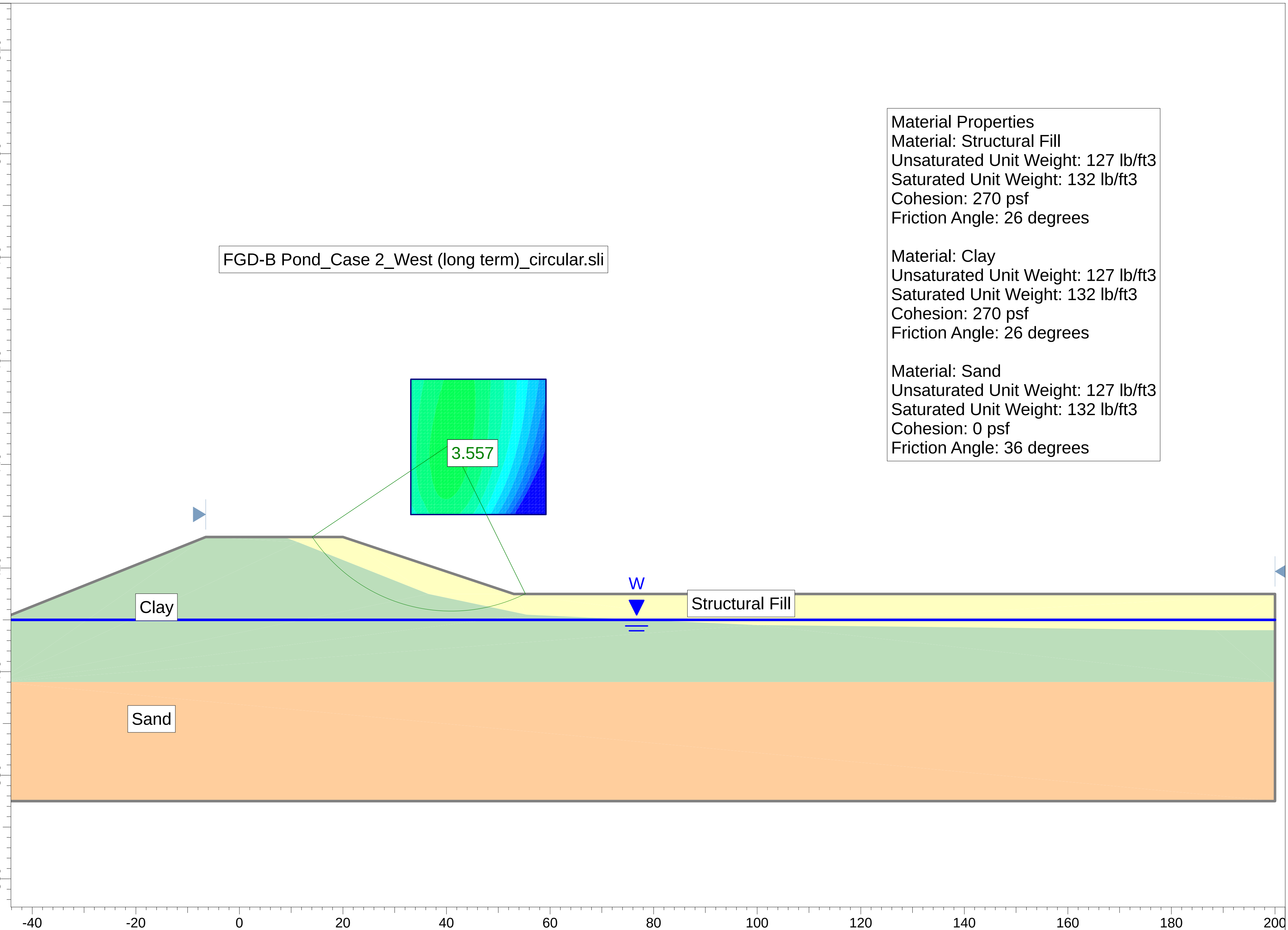
-103 = Two surface / slope intersections,
but one or more surface / nonslope external polygon
intersections lie between them. This usually occurs
when the slip surface extends past the bottom of the
soil region, but may also occur on a benched
slope model with two sets of Slope Limits.

-108 = Total driving moment
or total driving force < 0.1. This is to
limit the calculation of extremely high safety
factors if the driving force is very small
(0.1 is an arbitrary number).

-111 = safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F)
< 0.2 for the final iteration of the safety factor calculation. This screens out
some slip surfaces which may not be valid in the context of the analysis, in
particular, deep seated slip surfaces with many high negative base angle
slices in the passive zone.

CASE 2



FGD-B Pond_Case 2_West (long term)_circular.sli
3.557
W
Clay
Structural Fill
Sand
Material Properties
Material: Structural Fill
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Material: Clay
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Material: Sand
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 36 degrees
-40
-20
0
20
40
60
80
100
120
140
160
180
200

Slide Analysis Information

Document Name

File Name: FGD-B Pond_Case 2_West (long term)_circular.sli

Project Settings

Project Title: FGD-B Pond: Case 2 - West Sideslope (long term)
Failure Direction: Left to Right
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified
GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 50
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

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

Material Properties

Material: Structural Fill
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Sand
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 36 degrees
Water Surface: Water Table
Custom Hu value: 1

Global Minimums

Method: bishop simplified
FS: 3.557390
Center: 40.935, 444.041
Radius: 32.380
Left Slip Surface Endpoint: 14.046, 426.000
Right Slip Surface Endpoint: 55.256, 415.000
Resisting Moment=928269 lb-ft
Driving Moment=260941 lb-ft

Method: spencer
FS: 3.551800
Center: 40.935, 444.041
Radius: 32.380
Left Slip Surface Endpoint: 14.046, 426.000
Right Slip Surface Endpoint: 55.256, 415.000
Resisting Moment=926810 lb-ft
Driving Moment=260941 lb-ft
Resisting Horizontal Force=25989.4 lb
Driving Horizontal Force=7317.24 lb

Method: gle/morgenstern-price
FS: 3.551560
Center: 40.935, 444.041
Radius: 32.380
Left Slip Surface Endpoint: 14.046, 426.000
Right Slip Surface Endpoint: 55.256, 415.000
Resisting Moment=926746 lb-ft
Driving Moment=260941 lb-ft
Resisting Horizontal Force=25989.6 lb
Driving Horizontal Force=7317.81 lb

Valid / Invalid Surfaces

Method: bishop simplified
Number of Valid Surfaces: 18315

Number of Invalid Surfaces: 176
Error Codes:
Error Code -103 reported for 136 surfaces
Error Code -112 reported for 40 surfaces

Method: spencer
Number of Valid Surfaces: 18308
Number of Invalid Surfaces: 183
Error Codes:
Error Code -103 reported for 136 surfaces
Error Code -108 reported for 3 surfaces
Error Code -112 reported for 44 surfaces

Method: gle/morgenstern-price
Number of Valid Surfaces: 18312
Number of Invalid Surfaces: 179
Error Codes:
Error Code -103 reported for 136 surfaces
Error Code -108 reported for 3 surfaces
Error Code -112 reported for 40 surfaces

Error Codes

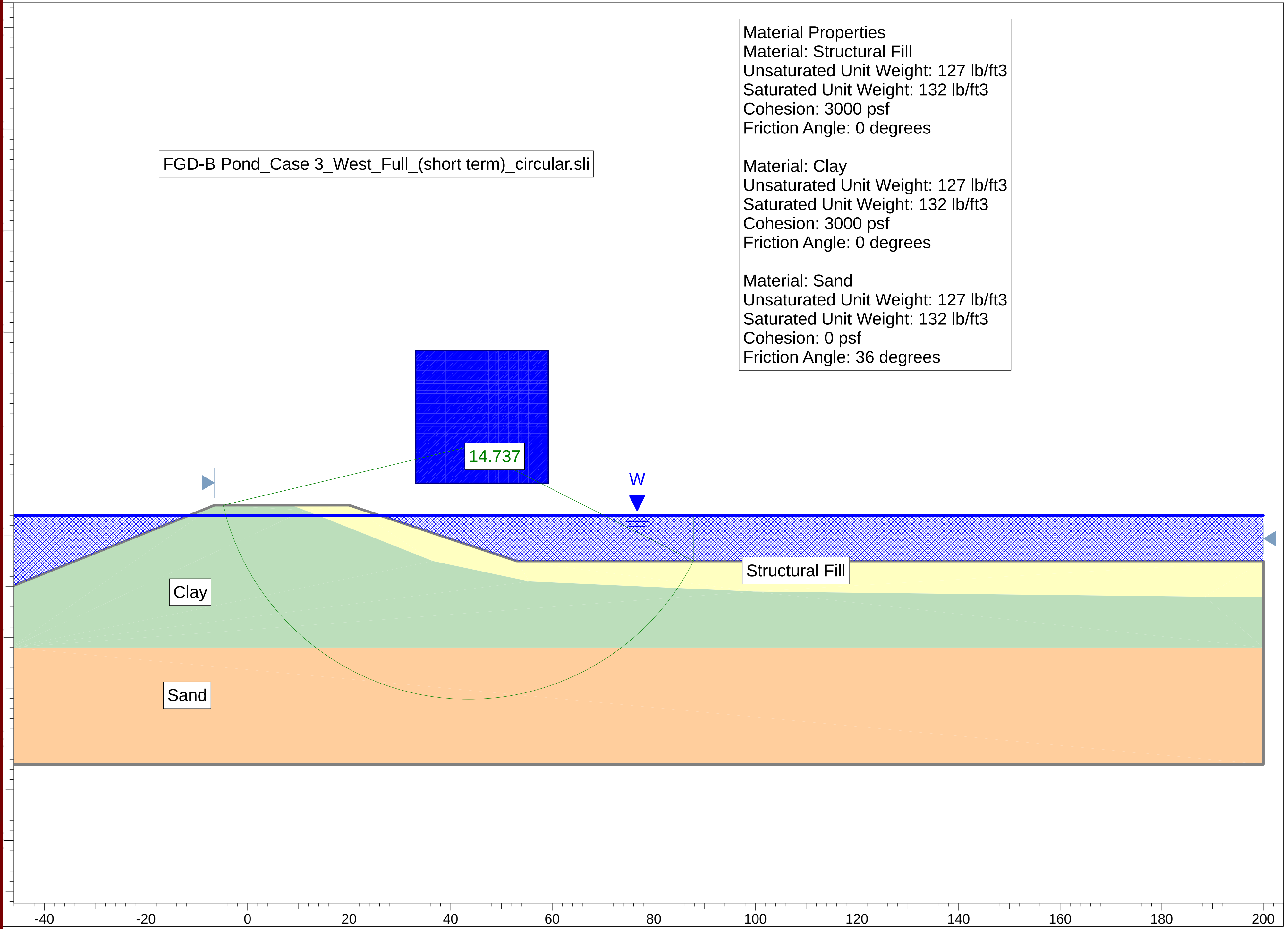
The following errors were encountered during the computation:

-103 = Two surface / slope intersections,
but one or more surface / nonslope external polygon
intersections lie between them. This usually occurs
when the slip surface extends past the bottom of the
soil region, but may also occur on a benched
slope model with two sets of Slope Limits.

-108 = Total driving moment
or total driving force < 0.1. This is to
limit the calculation of extremely high safety
factors if the driving force is very small
(0.1 is an arbitrary number).

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F)
< 0.2 for the final iteration of the safety factor calculation. This screens out
some slip surfaces which may not be valid in the context of the analysis, in
particular, deep seated slip surfaces with many high negative base angle
slices in the passive zone.

CASE 3



FGD-B Pond_Case 3_West_Full_(short term)_circular.sli
Material Properties
Material: Structural Fill
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Material: Clay
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Material: Sand
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 36 degrees
14.737
W
Structural Fill
Clay
Sand
-40
-20
0
20
40
60
80
100
120
140
160
180
200

Slide Analysis Information

Document Name

File Name: FGD-B Pond_Case 3_West_Full_(short term)_circular.sli

Project Settings

Project Title: FGD-B Pond: Case 3 - West Sideslope - Full Pond (short term)
Failure Direction: Left to Right
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified
GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 50
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

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

Material Properties

Material: Structural Fill
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Sand
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 36 degrees
Water Surface: Water Table
Custom Hu value: 1

Global Minimums

Method: bishop simplified
FS: 14.737400
Center: 43.547, 437.512
Radius: 49.704
Left Slip Surface Endpoint: -4.806, 426.000
Right Slip Surface Endpoint: 87.861, 415.000
Left Slope Intercept: -4.806 426.000
Right Slope Intercept: 87.861 424.000
Resisting Moment=1.29995e+007 lb-ft
Driving Moment=882073 lb-ft

Method: spencer
FS: 15.195600
Center: 48.770, 447.959
Radius: 57.996
Left Slip Surface Endpoint: -4.907, 426.000
Right Slip Surface Endpoint: 96.491, 415.000
Left Slope Intercept: -4.907 426.000
Right Slope Intercept: 96.491 424.000
Resisting Moment=1.55782e+007 lb-ft
Driving Moment=1.02518e+006 lb-ft
Resisting Horizontal Force=204005 lb
Driving Horizontal Force=13425.3 lb

Method: gle/morgenstern-price
FS: 15.194800
Center: 48.770, 447.959
Radius: 57.996
Left Slip Surface Endpoint: -4.907, 426.000
Right Slip Surface Endpoint: 96.491, 415.000
Left Slope Intercept: -4.907 426.000
Right Slope Intercept: 96.491 424.000
Resisting Moment=1.55775e+007 lb-ft
Driving Moment=1.02518e+006 lb-ft
Resisting Horizontal Force=204030 lb
Driving Horizontal Force=13427.6 lb

Valid / Invalid Surfaces

Method: bishop simplified
Number of Valid Surfaces: 17949
Number of Invalid Surfaces: 542
Error Codes:
Error Code -103 reported for 136 surfaces
Error Code -112 reported for 406 surfaces

Method: spencer
Number of Valid Surfaces: 14107
Number of Invalid Surfaces: 4384
Error Codes:
Error Code -103 reported for 136 surfaces
Error Code -108 reported for 2712 surfaces
Error Code -111 reported for 1130 surfaces
Error Code -112 reported for 406 surfaces

Method: gle/morgenstern-price
Number of Valid Surfaces: 14107
Number of Invalid Surfaces: 4384
Error Codes:
Error Code -103 reported for 136 surfaces
Error Code -108 reported for 2712 surfaces
Error Code -111 reported for 1130 surfaces
Error Code -112 reported for 406 surfaces

Error Codes

The following errors were encountered during the computation:

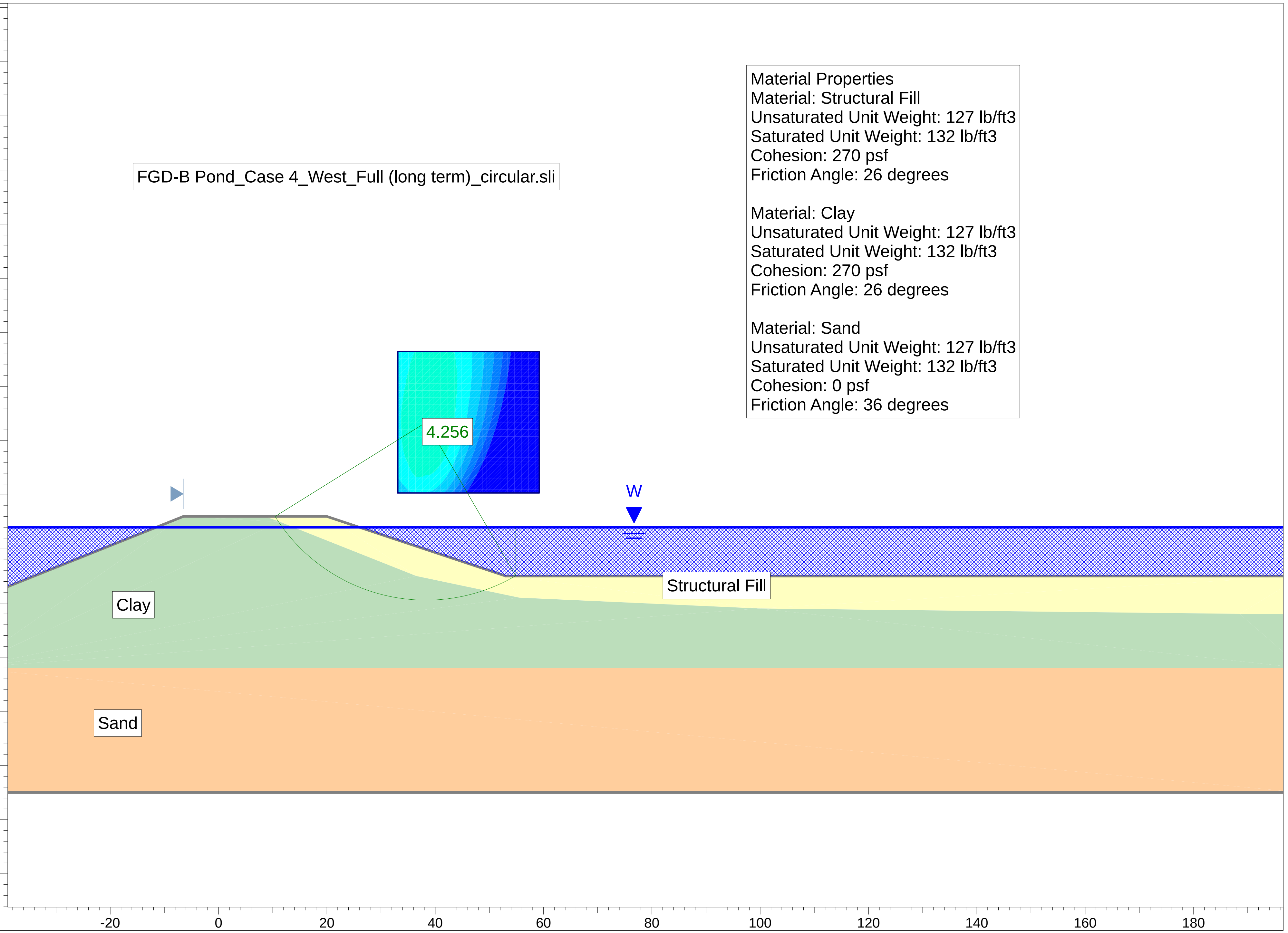
-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-111 = safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

CASE 4



FGD-B Pond_Case 4_West_Full (long term)_circular.sli
Material Properties
Material: Structural Fill
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Material: Clay
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Material: Sand
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 36 degrees
4.256
W
Structural Fill
Clay
Sand
-20
0
20
40
60
80
100
120
140
160
180

Slide Analysis Information

Document Name

File Name: FGD-B Pond_Case 4_West_Full (long term)_circular.sli

Project Settings

Project Title: FGD-B Pond: Case 4 - West Sideslope - Full Pond (long term)
Failure Direction: Left to Right
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified
GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 50
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

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

Material Properties

Material: Structural Fill
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Sand
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 36 degrees
Water Surface: Water Table
Custom Hu value: 1

Global Minimums

Method: bishop simplified
FS: 4.256160
Center: 38.323, 443.388
Radius: 32.863
Left Slip Surface Endpoint: 10.437, 426.000
Right Slip Surface Endpoint: 54.879, 415.000
Left Slope Intercept: 10.437 426.000
Right Slope Intercept: 54.879 424.000
Resisting Moment=858744 lb-ft
Driving Moment=201765 lb-ft

Method: spencer
FS: 4.252950
Center: 38.323, 443.388
Radius: 32.863
Left Slip Surface Endpoint: 10.437, 426.000
Right Slip Surface Endpoint: 54.879, 415.000
Left Slope Intercept: 10.437 426.000
Right Slope Intercept: 54.879 424.000
Resisting Moment=858097 lb-ft
Driving Moment=201765 lb-ft
Resisting Horizontal Force=23376.2 lb
Driving Horizontal Force=5496.47 lb

Method: gle/morgenstern-price
FS: 4.251050
Center: 38.323, 443.388
Radius: 32.863
Left Slip Surface Endpoint: 10.437, 426.000
Right Slip Surface Endpoint: 54.879, 415.000
Left Slope Intercept: 10.437 426.000
Right Slope Intercept: 54.879 424.000
Resisting Moment=857713 lb-ft
Driving Moment=201765 lb-ft
Resisting Horizontal Force=23375.5 lb
Driving Horizontal Force=5498.77 lb

Valid / Invalid Surfaces

Method: bishop simplified
Number of Valid Surfaces: 18302
Number of Invalid Surfaces: 189
Error Codes:
Error Code -103 reported for 136 surfaces
Error Code -112 reported for 53 surfaces

Method: spencer
Number of Valid Surfaces: 18298
Number of Invalid Surfaces: 193
Error Codes:
Error Code -103 reported for 136 surfaces
Error Code -108 reported for 2 surfaces
Error Code -112 reported for 55 surfaces

Method: gle/morgenstern-price
Number of Valid Surfaces: 18297
Number of Invalid Surfaces: 194
Error Codes:
Error Code -103 reported for 136 surfaces
Error Code -108 reported for 2 surfaces
Error Code -112 reported for 56 surfaces

Error Codes

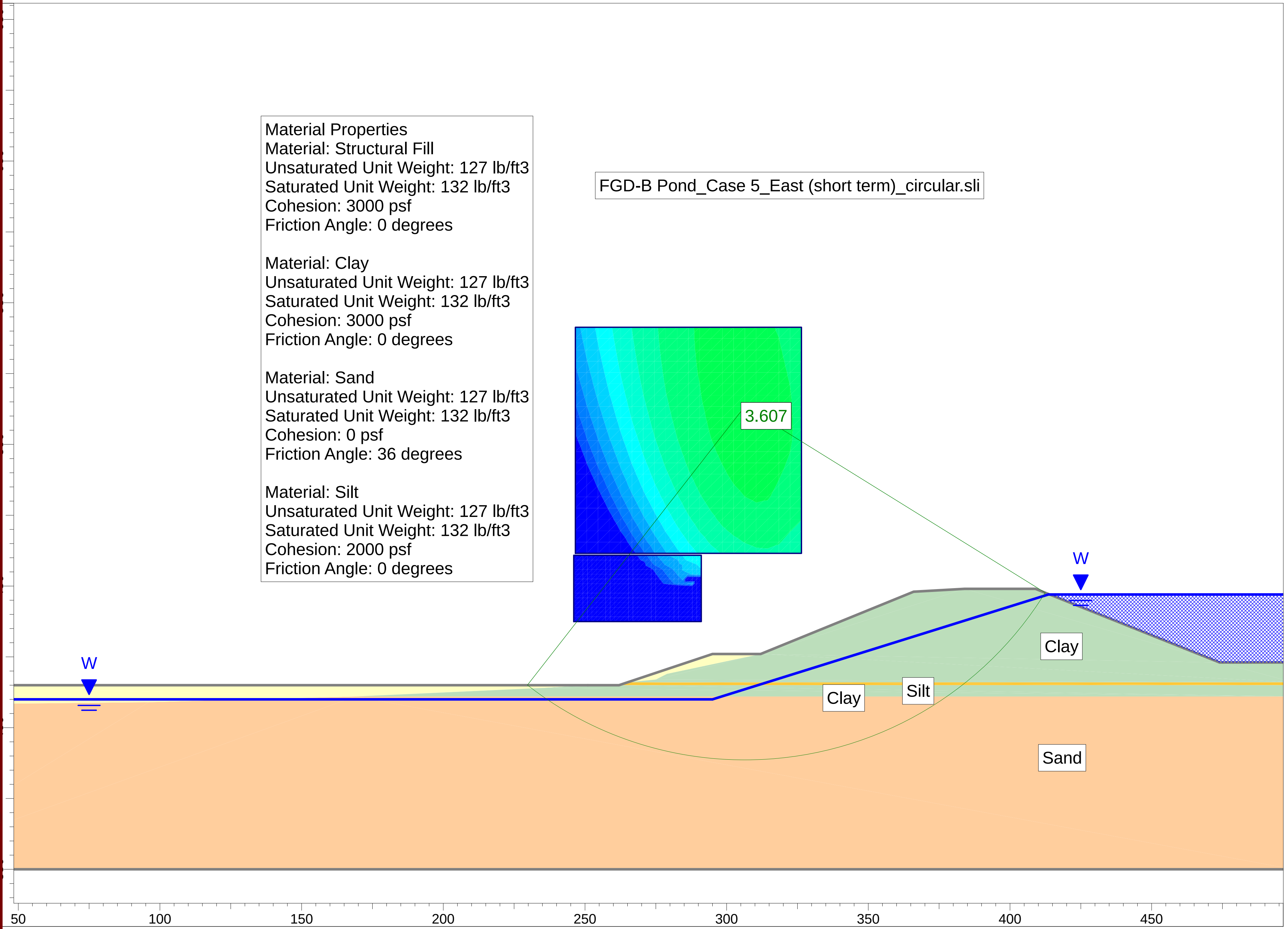
The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

CASE 5



Material Properties
Material: Structural Fill
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Material: Clay
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Material: Sand
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 36 degrees
Material: Silt
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 2000 psf
Friction Angle: 0 degrees
FGD-B Pond_Case 5_East (short term)_circular.sli
3.607
W
W
Clay
Clay
Silt
Sand
50
100
150
200
250
300
350
400
450

Slide Analysis Information

Document Name

File Name: FGD-B Pond_Case 5_East (short term)_circular.sli

Project Settings

Project Title: FGD-B Pond - Case 5 - East Slope (short term)
Failure Direction: Right to Left
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified
GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 50
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

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

Material Properties

Material: Structural Fill
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Sand
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 36 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Silt
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 2000 psf
Friction Angle: 0 degrees
Water Surface: Water Table
Custom Hu value: 1

Global Minimums

Method: bishop simplified
FS: 3.607490
Center: 306.458, 513.401
Radius: 124.818
Left Slip Surface Endpoint: 229.667, 415.000
Right Slip Surface Endpoint: 412.519, 447.593
Resisting Moment=6.0554e+007 lb-ft
Driving Moment=1.67857e+007 lb-ft

Method: spencer
FS: 3.624800
Center: 306.458, 513.401
Radius: 124.818
Left Slip Surface Endpoint: 229.667, 415.000
Right Slip Surface Endpoint: 412.519, 447.593
Resisting Moment=6.08446e+007 lb-ft
Driving Moment=1.67857e+007 lb-ft
Resisting Horizontal Force=419071 lb
Driving Horizontal Force=115612 lb

Method: gle/morgenstern-price
FS: 3.620870
Center: 306.458, 513.401
Radius: 124.818
Left Slip Surface Endpoint: 229.667, 415.000
Right Slip Surface Endpoint: 412.519, 447.593
Resisting Moment=6.07787e+007 lb-ft

Driving Moment=1.67857e+007 lb-ft
Resisting Horizontal Force=419064 lb
Driving Horizontal Force=115736 lb

Valid / Invalid Surfaces

Method: bishop simplified
Number of Valid Surfaces: 3685
Number of Invalid Surfaces: 5951
Error Codes:
Error Code -103 reported for 5552 surfaces
Error Code -112 reported for 399 surfaces

Method: spencer
Number of Valid Surfaces: 2797
Number of Invalid Surfaces: 6839
Error Codes:
Error Code -103 reported for 5552 surfaces
Error Code -108 reported for 479 surfaces
Error Code -111 reported for 409 surfaces
Error Code -112 reported for 399 surfaces

Method: gle/morgenstern-price
Number of Valid Surfaces: 2810
Number of Invalid Surfaces: 6826
Error Codes:
Error Code -103 reported for 5552 surfaces
Error Code -108 reported for 478 surfaces
Error Code -111 reported for 397 surfaces
Error Code -112 reported for 399 surfaces

Error Codes

The following errors were encountered during the computation:

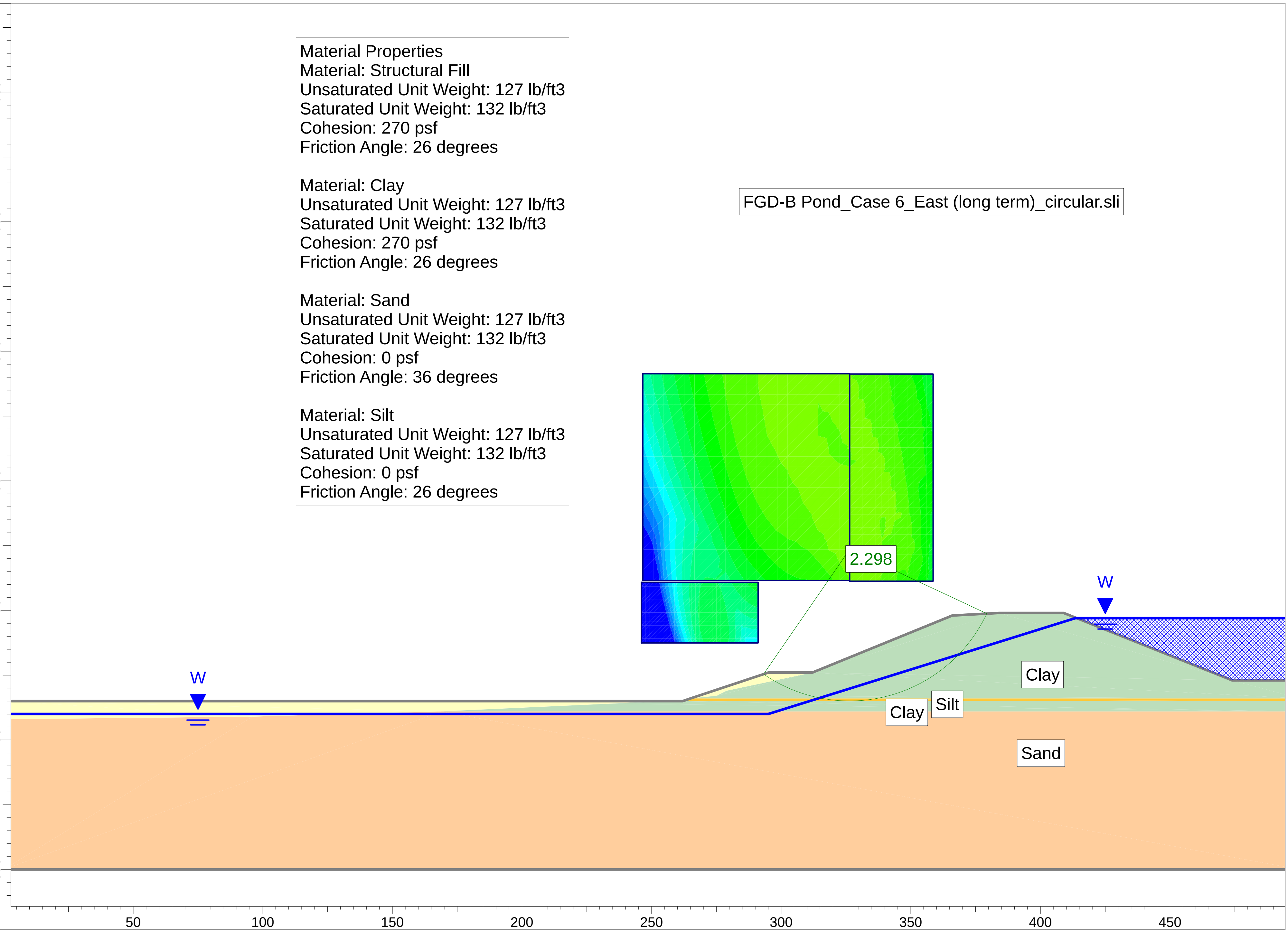
-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-111 = safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

CASE 6



Material Properties
Material: Structural Fill
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Material: Clay
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Material: Sand
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 36 degrees
Material: Silt
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 26 degrees
FGD-B Pond_Case 6_East (long term)_circular.sli
2.298
W
W
Clay
Silt
Clay
Sand
50
100
150
200
250
300
350
400
450

Slide Analysis Information

Document Name

File Name: FGD-B Pond_Case 6_East (long term)_circular.sli

Project Settings

Project Title: FGD-B Pond - Case 6 - East Slope (long term)
Failure Direction: Right to Left
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified
GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 50
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

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

Material Properties

Material: Structural Fill
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Sand
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 36 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Silt
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 26 degrees
Water Surface: Water Table
Custom Hu value: 1

Global Minimums

Method: bishop simplified
FS: 2.297790
Center: 326.403, 473.511
Radius: 58.478
Left Slip Surface Endpoint: 293.174, 425.391
Right Slip Surface Endpoint: 379.377, 448.743
Resisting Moment=5.40138e+006 lb-ft
Driving Moment=2.35069e+006 lb-ft

Method: spencer
FS: 2.301930
Center: 326.390, 474.187
Radius: 59.049
Left Slip Surface Endpoint: 293.150, 425.383
Right Slip Surface Endpoint: 379.684, 448.760
Resisting Moment=5.46925e+006 lb-ft
Driving Moment=2.37595e+006 lb-ft
Resisting Horizontal Force=81645.7 lb
Driving Horizontal Force=35468.4 lb

Method: gle/morgenstern-price
FS: 2.303490
Center: 326.403, 473.511
Radius: 58.478
Left Slip Surface Endpoint: 293.174, 425.391
Right Slip Surface Endpoint: 379.377, 448.743
Resisting Moment=5.41479e+006 lb-ft

Driving Moment=2.35069e+006 lb-ft
Resisting Horizontal Force=81249.3 lb
Driving Horizontal Force=35272.2 lb

Valid / Invalid Surfaces

Method: bishop simplified
Number of Valid Surfaces: 8002
Number of Invalid Surfaces: 6562
Error Codes:
Error Code -103 reported for 6560 surfaces
Error Code -112 reported for 2 surfaces

Method: spencer
Number of Valid Surfaces: 7968
Number of Invalid Surfaces: 6596
Error Codes:
Error Code -103 reported for 6560 surfaces
Error Code -111 reported for 6 surfaces
Error Code -112 reported for 30 surfaces

Method: gle/morgenstern-price
Number of Valid Surfaces: 7974
Number of Invalid Surfaces: 6590
Error Codes:
Error Code -103 reported for 6560 surfaces
Error Code -112 reported for 30 surfaces

Error Codes

The following errors were encountered during the computation:

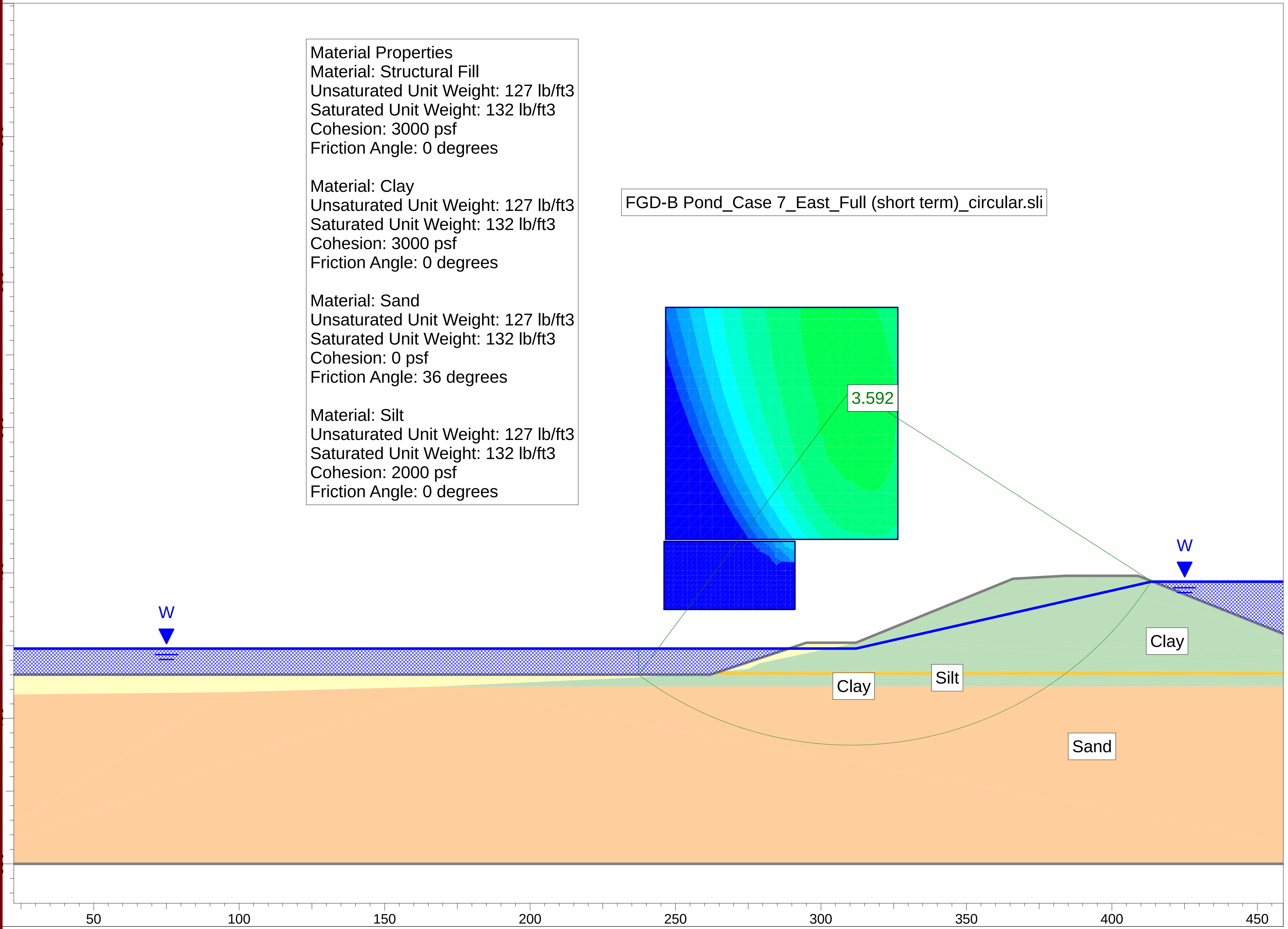
-103 = Two surface / slope intersections,
but one or more surface / nonslope external polygon
intersections lie between them. This usually occurs
when the slip surface extends past the bottom of the
soil region, but may also occur on a benched
slope model with two sets of Slope Limits.

-111 = safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F)
< 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

US EPA ARCHIVE DOCUMENT

CASE 7


Material Properties
Material: Structural Fill
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Material: Clay
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Material: Sand
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 36 degrees
Material: Silt
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 2000 psf
Friction Angle: 0 degrees
FGD-B Pond_Case 7_East_Full (short term)_circular.sli
3.592
W
W
Clay
Clay
Silt
Sand
50
100
150
200
250
300
350
400
450

Slide Analysis Information

Document Name

File Name: FGD-B Pond_Case 7_East_Full (short term)_circular.sli

Project Settings

Project Title: FGD-B Pond - Case 7 - East Slope - Full pond (short term)
Failure Direction: Right to Left
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified
GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 50
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

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

Material Properties

Material: Structural Fill
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Sand
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 36 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Silt
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 2000 psf
Friction Angle: 0 degrees
Water Surface: Water Table
Custom Hu value: 1

Global Minimums

Method: bishop simplified
FS: 3.591930
Center: 310.447, 513.401
Radius: 122.640
Left Slip Surface Endpoint: 237.249, 415.000
Right Slip Surface Endpoint: 413.647, 447.141
Left Slope Intercept: 237.249 424.000
Right Slope Intercept: 413.647 447.141
Resisting Moment=5.16886e+007 lb-ft
Driving Moment=1.43902e+007 lb-ft

Method: spencer
FS: 3.604030
Center: 310.447, 513.401
Radius: 122.640
Left Slip Surface Endpoint: 237.249, 415.000
Right Slip Surface Endpoint: 413.647, 447.141
Left Slope Intercept: 237.249 424.000
Right Slope Intercept: 413.647 447.141
Resisting Moment=5.18626e+007 lb-ft
Driving Moment=1.43902e+007 lb-ft
Resisting Horizontal Force=360700 lb
Driving Horizontal Force=100082 lb

Method: gle/morgenstern-price
FS: 3.605250
Center: 310.447, 513.401

Radius: 122.640
Left Slip Surface Endpoint: 237.249, 415.000
Right Slip Surface Endpoint: 413.647, 447.141
Left Slope Intercept: 237.249 424.000
Right Slope Intercept: 413.647 447.141
Resisting Moment=5.18802e+007 lb-ft
Driving Moment=1.43902e+007 lb-ft
Resisting Horizontal Force=360971 lb
Driving Horizontal Force=100124 lb

Valid / Invalid Surfaces

Method: bishop simplified
Number of Valid Surfaces: 3685
Number of Invalid Surfaces: 5951
Error Codes:
Error Code -103 reported for 5552 surfaces
Error Code -112 reported for 399 surfaces

Method: spencer
Number of Valid Surfaces: 2684
Number of Invalid Surfaces: 6952
Error Codes:
Error Code -103 reported for 5552 surfaces
Error Code -108 reported for 644 surfaces
Error Code -111 reported for 357 surfaces
Error Code -112 reported for 399 surfaces

Method: gle/morgenstern-price
Number of Valid Surfaces: 2684
Number of Invalid Surfaces: 6952
Error Codes:
Error Code -103 reported for 5552 surfaces
Error Code -108 reported for 643 surfaces
Error Code -111 reported for 358 surfaces
Error Code -112 reported for 399 surfaces

Error Codes

The following errors were encountered during the computation:

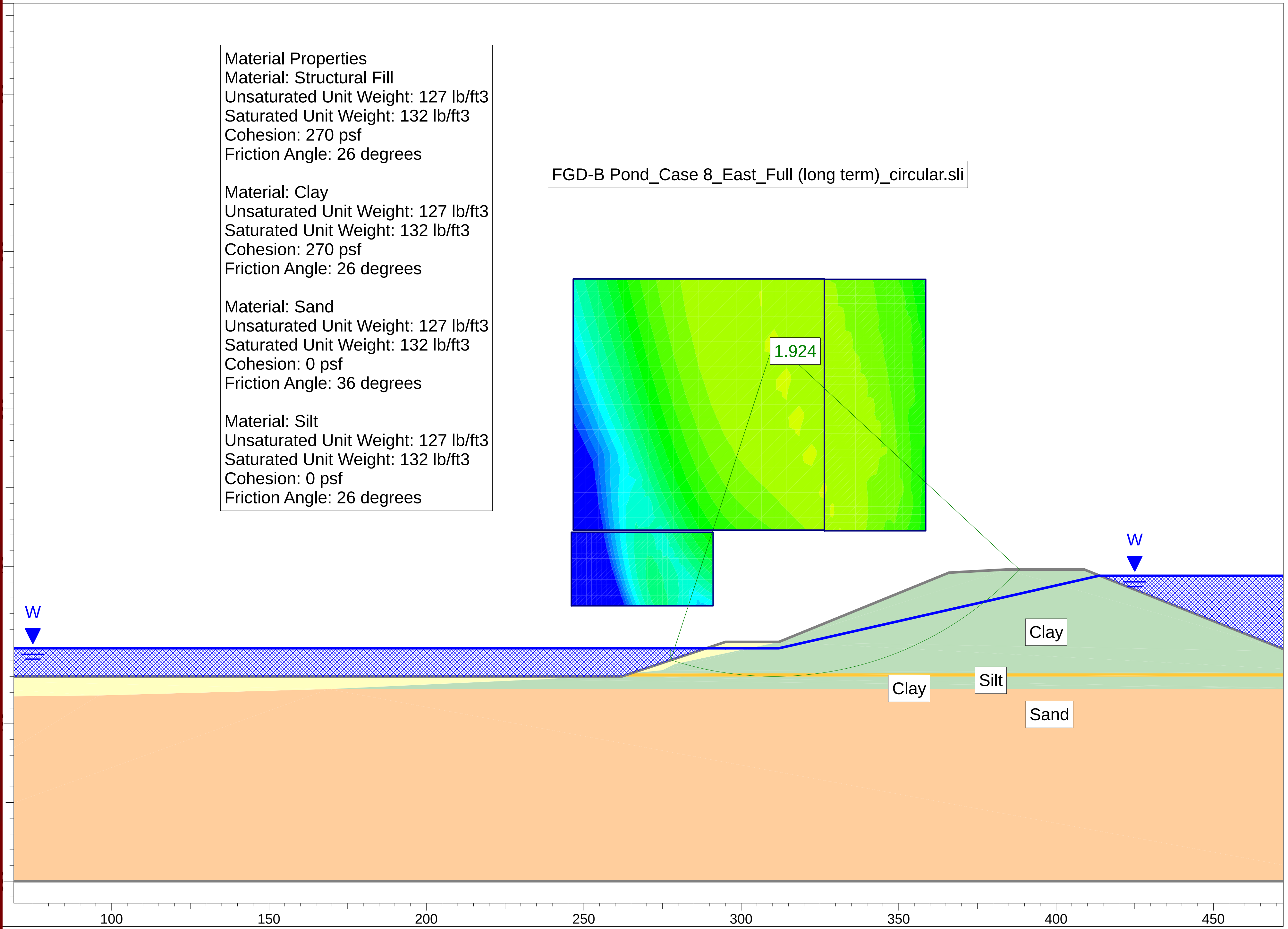
-103 = Two surface / slope intersections,
but one or more surface / nonslope external polygon
intersections lie between them. This usually occurs
when the slip surface extends past the bottom of the
soil region, but may also occur on a benched
slope model with two sets of Slope Limits.

-108 = Total driving moment
or total driving force < 0.1. This is to
limit the calculation of extremely high safety
factors if the driving force is very small
(0.1 is an arbitrary number).

-111 = safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

CASE 8



Material Properties
Material: Structural Fill
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Material: Clay
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Material: Sand
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 36 degrees
Material: Silt
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 26 degrees
FGD-B Pond_Case 8_East_Full (long term)_circular.sli
1.924
W
W
Clay
Clay
Silt
Sand
100
150
200
250
300
350
400
450

Slide Analysis Information

Document Name

File Name: FGD-B Pond_Case 8_East_Full (long term)_circular.sli

Project Settings

Project Title: FGD-B Pond - Case 8 - East Slope - Full Pond (long term)
Failure Direction: Right to Left
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified
GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 50
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

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

Material Properties

Material: Structural Fill
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Sand
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 36 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Silt
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 26 degrees
Water Surface: Water Table
Custom Hu value: 1

Global Minimums

Method: bishop simplified
FS: 1.923800
Center: 310.447, 521.379
Radius: 106.366
Left Slip Surface Endpoint: 277.617, 420.206
Right Slip Surface Endpoint: 388.389, 449.000
Left Slope Intercept: 277.617 424.000
Right Slope Intercept: 388.389 449.000
Resisting Moment=9.24549e+006 lb-ft
Driving Moment=4.80585e+006 lb-ft

Method: spencer
FS: 1.925810
Center: 310.447, 521.379
Radius: 106.366
Left Slip Surface Endpoint: 277.617, 420.206
Right Slip Surface Endpoint: 388.389, 449.000
Left Slope Intercept: 277.617 424.000
Right Slope Intercept: 388.389 449.000
Resisting Moment=9.25516e+006 lb-ft
Driving Moment=4.80585e+006 lb-ft
Resisting Horizontal Force=79844.9 lb
Driving Horizontal Force=41460.4 lb

Method: gle/morgenstern-price
FS: 1.925320
Center: 310.447, 521.379

Radius: 106.366
Left Slip Surface Endpoint: 277.617, 420.206
Right Slip Surface Endpoint: 388.389, 449.000
Left Slope Intercept: 277.617 424.000
Right Slope Intercept: 388.389 449.000
Resisting Moment=9.25279e+006 lb-ft
Driving Moment=4.80585e+006 lb-ft
Resisting Horizontal Force=79844.5 lb
Driving Horizontal Force=41470.8 lb

Valid / Invalid Surfaces

Method: bishop simplified
Number of Valid Surfaces: 7997
Number of Invalid Surfaces: 6567
Error Codes:
Error Code -103 reported for 6560 surfaces
Error Code -112 reported for 7 surfaces

Method: spencer
Number of Valid Surfaces: 7971
Number of Invalid Surfaces: 6593
Error Codes:
Error Code -103 reported for 6560 surfaces
Error Code -111 reported for 2 surfaces
Error Code -112 reported for 31 surfaces

Method: gle/morgenstern-price
Number of Valid Surfaces: 7973
Number of Invalid Surfaces: 6591
Error Codes:
Error Code -103 reported for 6560 surfaces
Error Code -112 reported for 31 surfaces

Error Codes

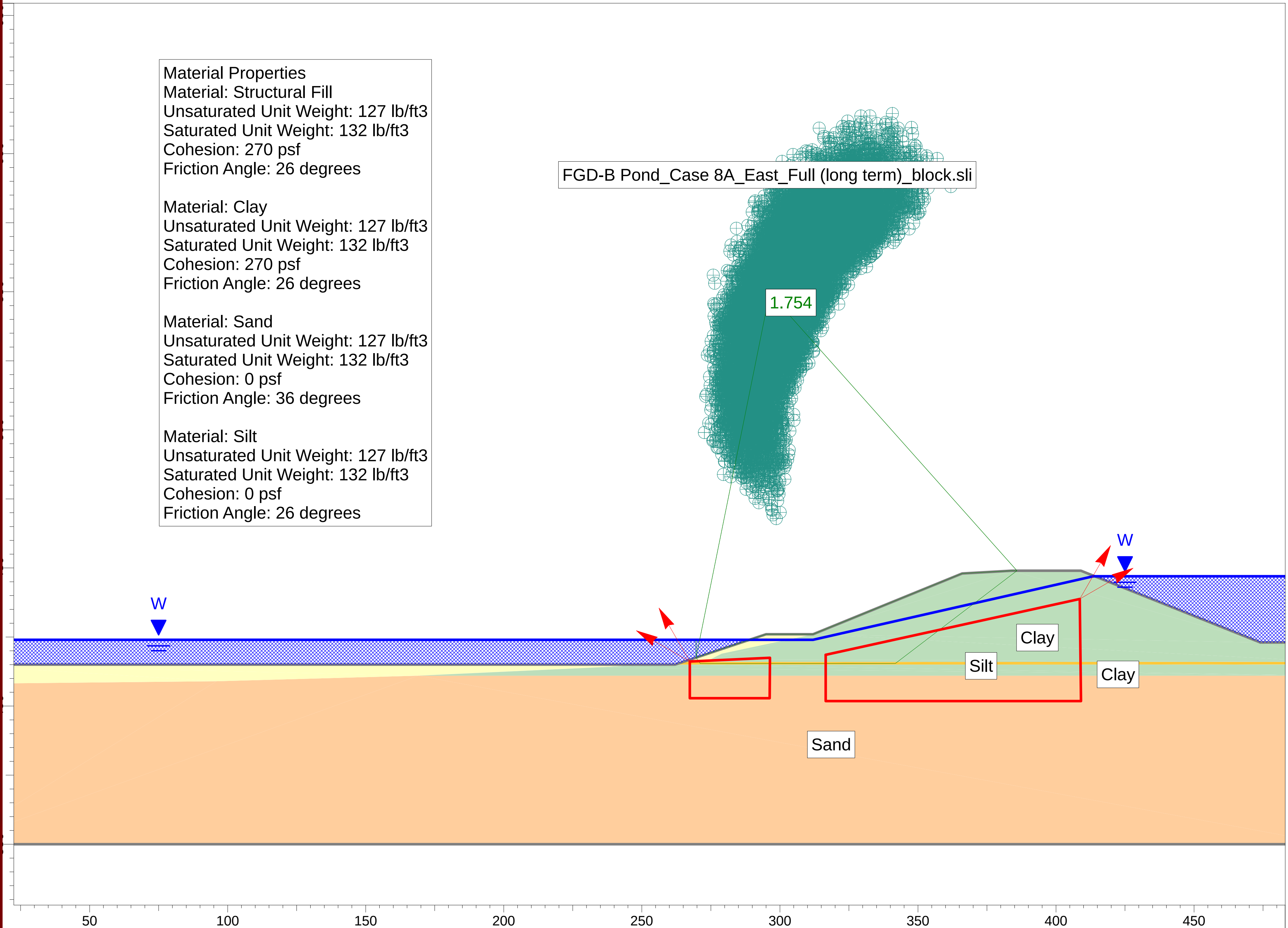
The following errors were encountered during the computation:

-103 = Two surface / slope intersections,
but one or more surface / nonslope external polygon
intersections lie between them. This usually occurs
when the slip surface extends past the bottom of the
soil region, but may also occur on a benched
slope model with two sets of Slope Limits.

-111 = safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F)
< 0.2 for the final iteration of the safety factor calculation. This screens out
some slip surfaces which may not be valid in the context of the analysis, in
particular, deep seated slip surfaces with many high negative base angle
slices in the passive zone.

CASE 8A


Material Properties
Material: Structural Fill
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Material: Clay
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Material: Sand
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 36 degrees
Material: Silt
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 26 degrees
FGD-B Pond_Case 8A_East_Full (long term)_block.sli
1.754
W
W
Clay
Silt
Clay
Sand
50
100
150
200
250
300
350
400
450

Slide Analysis Information

Document Name

File Name: FGD-B Pond_Case 8A_East_Full (long term)_block.sli

Project Settings

Project Title: FGD-B Pond - Case 8A - East Slope - Full Pond (long term)
Failure Direction: Right to Left
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 50
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

Surface Type: Non-Circular Block Search
Number of Surfaces: 15000
Pseudo-Random Surfaces: Enabled
Convex Surfaces Only: Disabled
Left Projection Angle (Start Angle): 120
Left Projection Angle (End Angle): 150
Right Projection Angle (Start Angle): 30
Right Projection Angle (End Angle): 60
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Material: Structural Fill
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Sand
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 36 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Silt
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 26 degrees
Water Surface: Water Table
Custom Hu value: 1

Global Minimums

Method: spencer
FS: 1.824880
Axis Location: 295.564, 556.395
Left Slip Surface Endpoint: 266.293, 416.431
Right Slip Surface Endpoint: 389.973, 449.000
Left Slope Intercept: 266.293 424.000
Right Slope Intercept: 389.973 449.000
Resisting Moment=1.28434e+007 lb-ft
Driving Moment=7.03794e+006 lb-ft
Resisting Horizontal Force=81380.1 lb
Driving Horizontal Force=44594.9 lb

Method: gle/morgenstern-price
FS: 1.753770
Axis Location: 296.291, 549.512
Left Slip Surface Endpoint: 269.628, 417.543
Right Slip Surface Endpoint: 385.868, 449.000
Left Slope Intercept: 269.628 424.000
Right Slope Intercept: 385.868 449.000
Resisting Moment=1.04154e+007 lb-ft
Driving Moment=5.93885e+006 lb-ft
Resisting Horizontal Force=69063.9 lb
Driving Horizontal Force=39380.3 lb

Valid / Invalid Surfaces

Method: spencer
Number of Valid Surfaces: 13449
Number of Invalid Surfaces: 1551
Error Codes:
Error Code -108 reported for 1443 surfaces
Error Code -111 reported for 105 surfaces
Error Code -112 reported for 3 surfaces

Method: gle/morgenstern-price
Number of Valid Surfaces: 14245
Number of Invalid Surfaces: 755
Error Codes:
Error Code -108 reported for 712 surfaces
Error Code -111 reported for 40 surfaces
Error Code -112 reported for 3 surfaces

Error Codes

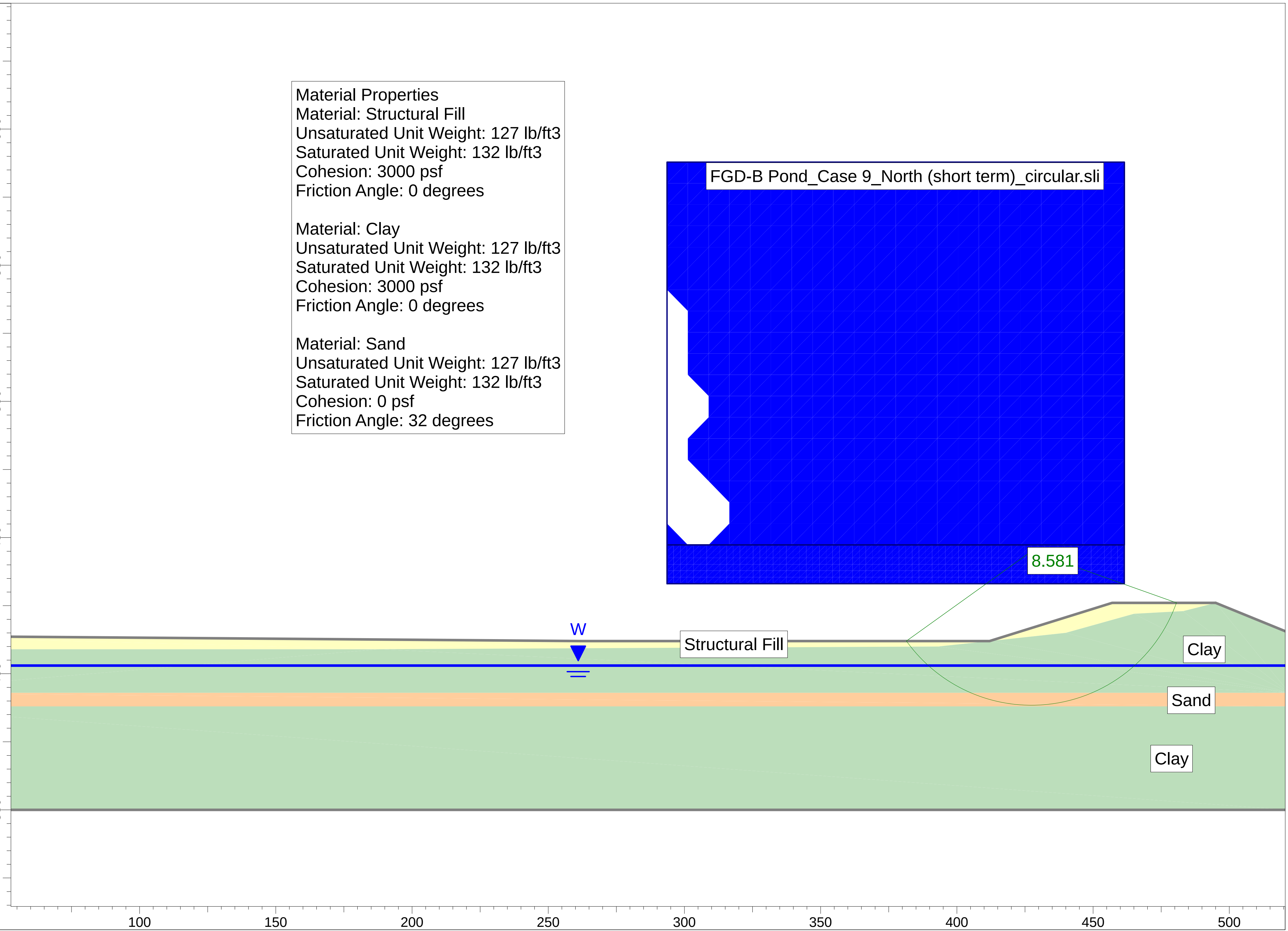
The following errors were encountered during the computation:

-108 = Total driving moment
or total driving force < 0.1. This is to
limit the calculation of extremely high safety
factors if the driving force is very small
(0.1 is an arbitrary number).

-111 = safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F)
< 0.2 for the final iteration of the safety factor calculation. This screens out
some slip surfaces which may not be valid in the context of the analysis, in
particular, deep seated slip surfaces with many high negative base angle
slices in the passive zone.

CASE 9


Material Properties
Material: Structural Fill
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Material: Clay
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Material: Sand
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 32 degrees
FGD-B Pond_Case 9_North (short term)_circular.sli
8.581
W
Structural Fill
Clay
Sand
Clay
100
150
200
250
300
350
400
450
500

Slide Analysis Information

Document Name

File Name: FGD-B Pond_Case 9_North (short term)_circular.sli

Project Settings

Project Title: FGD-B Pond: Case 9 North Slope (short term)
Failure Direction: Right to Left
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified
GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 50
Tolerance: 0.005
Maximum number of iterations: 50

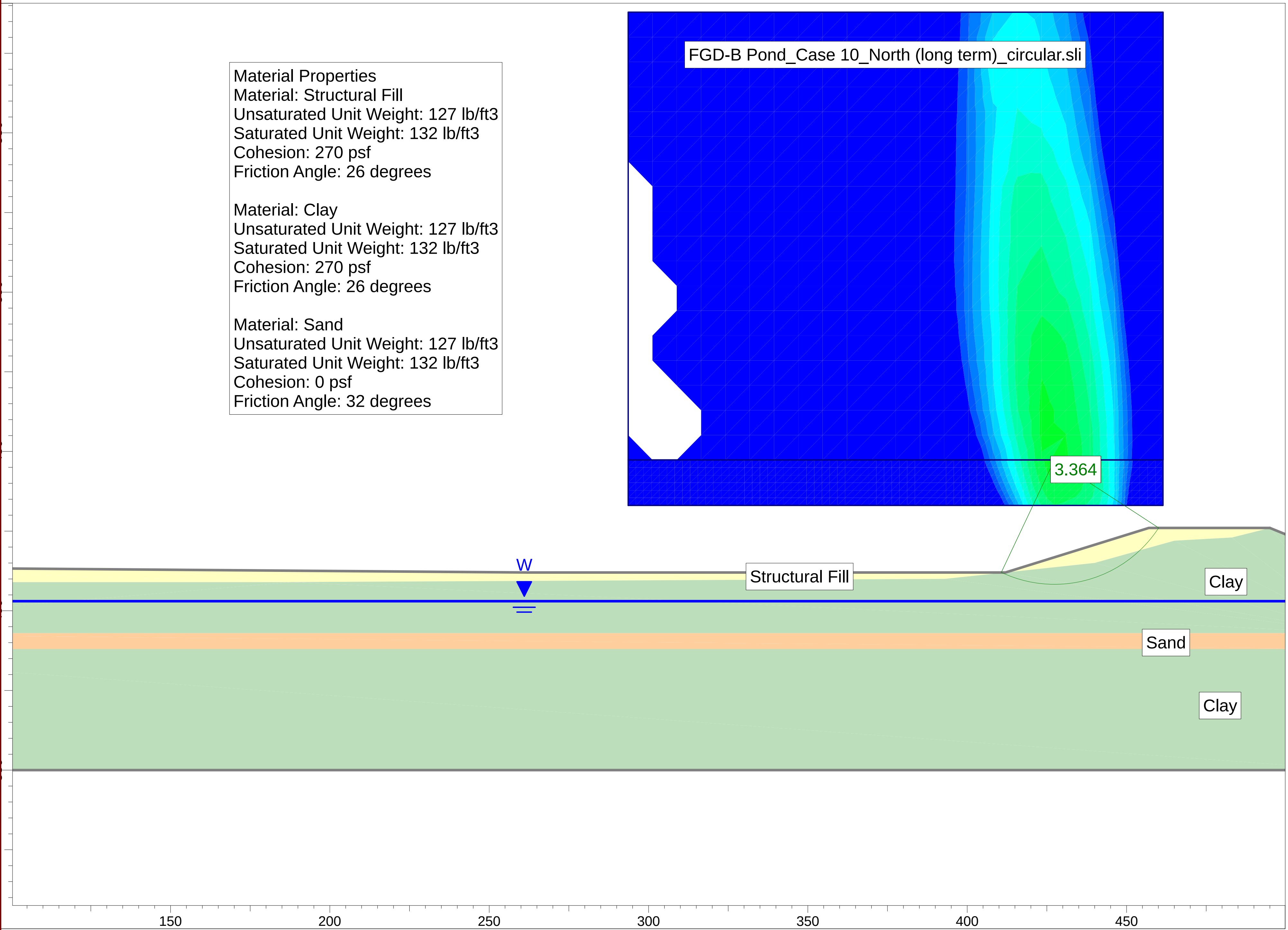
Surface Options

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

Material Properties

Material: Structural Fill
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Water Surface: Water Table
Custom Hu value: 1

CASE 10



FGD-B Pond_Case 10_North (long term)_circular.sli
Material Properties
Material: Structural Fill
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Material: Clay
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Material: Sand
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 32 degrees
3.364
W
Structural Fill
Clay
Sand
Clay
150
200
250
300
350
400
450

Slide Analysis Information

Document Name

File Name: FGD-B Pond_Case 10_North (long term)_circular.sli

Project Settings

Project Title: FGD-B Pond: Case 10 North Slope (long term)
Failure Direction: Right to Left
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified
GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 50
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

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

Material Properties

Material: Structural Fill
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Sand
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 32 degrees
Water Surface: Water Table
Custom Hu value: 1

Global Minimums

Method: bishop simplified
FS: 3.363860
Center: 427.394, 447.323
Radius: 39.070
Left Slip Surface Endpoint: 410.698, 412.000
Right Slip Surface Endpoint: 460.133, 426.000
Resisting Moment=1.46046e+006 lb-ft
Driving Moment=434162 lb-ft

Method: spencer
FS: 3.356090
Center: 427.394, 447.323
Radius: 39.070
Left Slip Surface Endpoint: 410.698, 412.000
Right Slip Surface Endpoint: 460.133, 426.000
Resisting Moment=1.45709e+006 lb-ft
Driving Moment=434162 lb-ft
Resisting Horizontal Force=33869.7 lb
Driving Horizontal Force=10092 lb

Method: gle/morgenstern-price
FS: 3.360740
Center: 427.394, 447.323
Radius: 39.070
Left Slip Surface Endpoint: 410.698, 412.000
Right Slip Surface Endpoint: 460.133, 426.000
Resisting Moment=1.45911e+006 lb-ft
Driving Moment=434162 lb-ft
Resisting Horizontal Force=33872.6 lb
Driving Horizontal Force=10078.9 lb

Valid / Invalid Surfaces

Method: bishop simplified
Number of Valid Surfaces: 6042

Number of Invalid Surfaces: 4155
Error Codes:
Error Code -103 reported for 3207 surfaces
Error Code -107 reported for 838 surfaces
Error Code -108 reported for 75 surfaces
Error Code -112 reported for 35 surfaces

Method: spencer
Number of Valid Surfaces: 5364
Number of Invalid Surfaces: 4833
Error Codes:
Error Code -103 reported for 3207 surfaces
Error Code -107 reported for 838 surfaces
Error Code -108 reported for 739 surfaces
Error Code -112 reported for 49 surfaces

Method: gle/morgenstern-price
Number of Valid Surfaces: 5359
Number of Invalid Surfaces: 4838
Error Codes:
Error Code -103 reported for 3207 surfaces
Error Code -107 reported for 838 surfaces
Error Code -108 reported for 743 surfaces
Error Code -112 reported for 50 surfaces

Error Codes

The following errors were encountered during the computation:

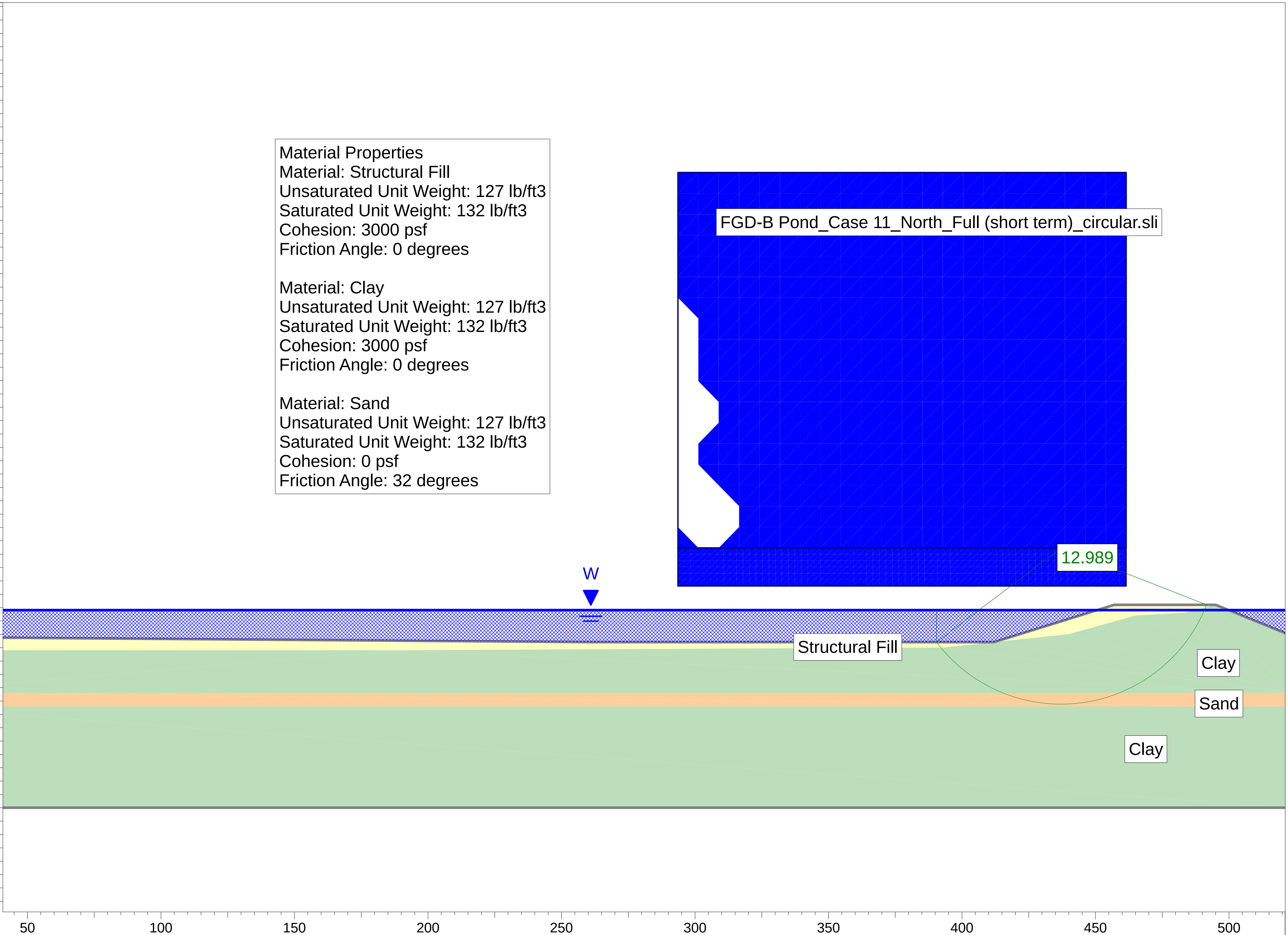
-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.

-107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

CASE 11


Material Properties
Material: Structural Fill
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Material: Clay
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Material: Sand
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 32 degrees
FGD-B Pond_Case 11_North_Full (short term)_circular.sli
12.989
W
Structural Fill
Clay
Sand
Clay
50
100
150
200
250
300
350
400
450
500

Slide Analysis Information

Document Name

File Name: FGD-B Pond_Case 11_North_Full (short term)_circular.sli

Project Settings

Project Title: FGD-B Pond: Case 11 North Slope - Full (short term)
Failure Direction: Right to Left
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified
GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 50
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

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

Material Properties

Material: Structural Fill
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 3000 psf
Friction Angle: 0 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Sand
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 32 degrees
Water Surface: Water Table
Custom Hu value: 1

Global Minimums

Method: bishop simplified
FS: 12.988600
Center: 437.124, 447.323
Radius: 58.544
Left Slip Surface Endpoint: 390.437, 412.000
Right Slip Surface Endpoint: 491.646, 426.000
Left Slope Intercept: 390.437 424.000
Right Slope Intercept: 491.646 426.000
Resisting Moment=1.73407e+007 lb-ft
Driving Moment=1.33507e+006 lb-ft

Method: spencer
FS: 12.987800
Center: 437.124, 447.323
Radius: 58.544
Left Slip Surface Endpoint: 390.437, 412.000
Right Slip Surface Endpoint: 491.646, 426.000
Left Slope Intercept: 390.437 424.000
Right Slope Intercept: 491.646 426.000
Resisting Moment=1.73397e+007 lb-ft
Driving Moment=1.33507e+006 lb-ft
Resisting Horizontal Force=229223 lb
Driving Horizontal Force=17649.1 lb

Method: gle/morgenstern-price
FS: 12.989900
Center: 437.124, 447.323
Radius: 58.544
Left Slip Surface Endpoint: 390.437, 412.000
Right Slip Surface Endpoint: 491.646, 426.000
Left Slope Intercept: 390.437 424.000
Right Slope Intercept: 491.646 426.000
Resisting Moment=1.73425e+007 lb-ft
Driving Moment=1.33507e+006 lb-ft
Resisting Horizontal Force=229264 lb
Driving Horizontal Force=17649.4 lb

Valid / Invalid Surfaces

Method: bishop simplified
Number of Valid Surfaces: 5876
Number of Invalid Surfaces: 4321
Error Codes:
Error Code -103 reported for 3207 surfaces
Error Code -107 reported for 835 surfaces
Error Code -108 reported for 74 surfaces
Error Code -112 reported for 205 surfaces

Method: spencer
Number of Valid Surfaces: 4166
Number of Invalid Surfaces: 6031
Error Codes:
Error Code -103 reported for 3207 surfaces
Error Code -107 reported for 835 surfaces
Error Code -108 reported for 1299 surfaces
Error Code -111 reported for 485 surfaces
Error Code -112 reported for 205 surfaces

Method: gle/morgenstern-price
Number of Valid Surfaces: 4166
Number of Invalid Surfaces: 6031
Error Codes:
Error Code -103 reported for 3207 surfaces
Error Code -107 reported for 835 surfaces
Error Code -108 reported for 1299 surfaces
Error Code -111 reported for 485 surfaces
Error Code -112 reported for 205 surfaces

Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.

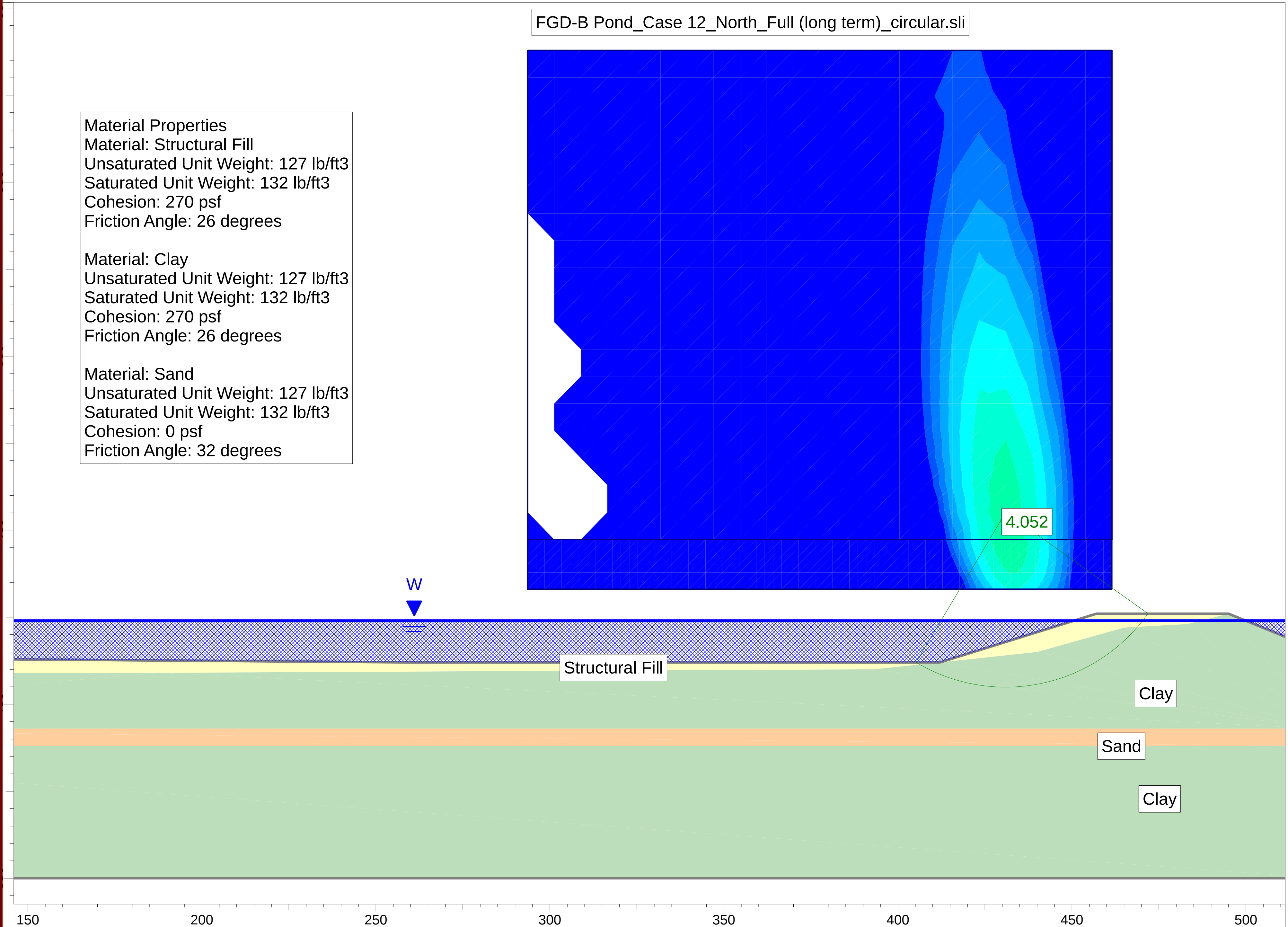
-107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-111 = safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

CASE 12


FGD-B Pond_Case 12_North_Full (long term)_circular.sli
Material Properties
Material: Structural Fill
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Material: Clay
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Material: Sand
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 32 degrees
4.052
W
Structural Fill
Clay
Sand
Clay
150
200
250
300
350
400
450
500

Slide Analysis Information

Document Name

File Name: FGD-B Pond_Case 12_North_Full (long term)_circular.sli

Project Settings

Project Title: FGD-B Pond: Case 12 North Slope - Full (long term)
Failure Direction: Right to Left
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified
GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 50
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

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

Material Properties

Material: Structural Fill
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clay
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 270 psf
Friction Angle: 26 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Sand
Strength Type: Mohr-Coulomb
Unsaturated Unit Weight: 127 lb/ft3
Saturated Unit Weight: 132 lb/ft3
Cohesion: 0 psf
Friction Angle: 32 degrees
Water Surface: Water Table
Custom Hu value: 1

Global Minimums

Method: bishop simplified
FS: 4.051780
Center: 430.962, 455.131
Radius: 50.257
Left Slip Surface Endpoint: 405.164, 412.000
Right Slip Surface Endpoint: 471.915, 426.000
Left Slope Intercept: 405.164 424.000
Right Slope Intercept: 471.915 426.000
Resisting Moment=2.27128e+006 lb-ft
Driving Moment=560563 lb-ft

Method: spencer
FS: 4.048490
Center: 430.962, 455.131
Radius: 50.257
Left Slip Surface Endpoint: 405.164, 412.000
Right Slip Surface Endpoint: 471.915, 426.000
Left Slope Intercept: 405.164 424.000
Right Slope Intercept: 471.915 426.000
Resisting Moment=2.26943e+006 lb-ft
Driving Moment=560563 lb-ft
Resisting Horizontal Force=41061.6 lb
Driving Horizontal Force=10142.5 lb

Method: gle/morgenstern-price
FS: 4.047140
Center: 430.962, 455.131
Radius: 50.257
Left Slip Surface Endpoint: 405.164, 412.000
Right Slip Surface Endpoint: 471.915, 426.000
Left Slope Intercept: 405.164 424.000
Right Slope Intercept: 471.915 426.000
Resisting Moment=2.26868e+006 lb-ft
Driving Moment=560563 lb-ft
Resisting Horizontal Force=41060 lb
Driving Horizontal Force=10145.4 lb

Valid / Invalid Surfaces

Method: bishop simplified
Number of Valid Surfaces: 6009
Number of Invalid Surfaces: 4188
Error Codes:
Error Code -103 reported for 3207 surfaces
Error Code -107 reported for 835 surfaces
Error Code -108 reported for 74 surfaces
Error Code -112 reported for 72 surfaces

Method: spencer
Number of Valid Surfaces: 5250
Number of Invalid Surfaces: 4947
Error Codes:
Error Code -103 reported for 3207 surfaces
Error Code -107 reported for 835 surfaces
Error Code -108 reported for 826 surfaces
Error Code -112 reported for 79 surfaces

Method: gle/morgenstern-price
Number of Valid Surfaces: 5288
Number of Invalid Surfaces: 4909
Error Codes:
Error Code -103 reported for 3207 surfaces
Error Code -107 reported for 835 surfaces
Error Code -108 reported for 787 surfaces
Error Code -112 reported for 80 surfaces

Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.

-107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

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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