# SAFETY FACTOR ASSESSMENT
# PERIODIC 5-YEAR REVIEW

**30 TAC 352.731 (40 CFR 257.73e)**

East Bottom Ash Pond

Pirkey Plant
Hallsville, Texas

October, 2021

Prepared for: Southwest Electric Power Company (SWEPCO) – Pirkey Plant

Hallsville, Texas

Prepared by: American Electric Power Service Corporation

1 Riverside Plaza

Columbus, OH 43215

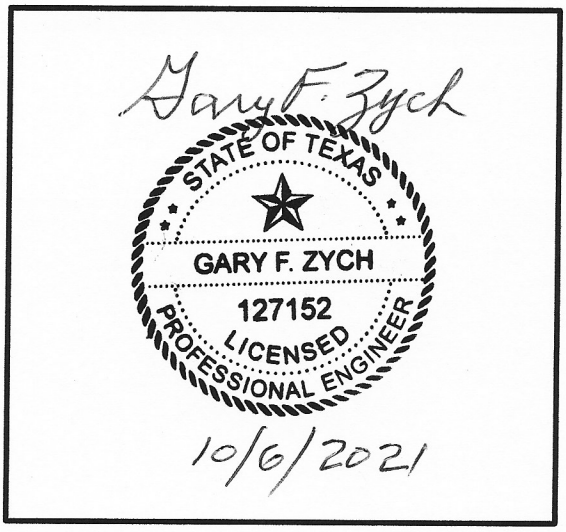

GERS-21-050

# SAFETY FACTOR ASSESSMENT
# PERIODIC 5-YEAR REVIEW
# CFR 257.73(e)
# PIRKEY PLANT
# EAST BOTTOM ASH POND

PREPARED BY Brett A. Dreger DATE 10/6/2021
Brett A. Dreger, P.E.

REVIEWED BY _____ DATE 10/6/2021
Mohammad A. Ajlouni, Ph.D., P.E.

APPROVED BY Gary F. Zych DATE 10/6/2021
Gary F. Zych, P.E.
Section Manager – AEP Geotechnical Engineering




I certify to the best of my knowledge, information, and belief that the information contained in this safety factor assessment meets the requirements of 40 CFR § 257.73(e)

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## 1.0 OBJECTIVE

This report was prepared by AEP- Geotechnical Engineering Services (GES) section to fulfill requirements of 30 TAC 352.731 (40 CFR 257.73(e)) for the safety factor assessment of CCR surface impoundments. This is the first periodic 5-year review of the safety factor assessment.

## 2.0 DESCRIPTION OF THE CCR UNIT

The Henry W. Pirkey Power Station is located at 2400 FM 3251 and south of Hallsville, Texas. It is owned and operated by Southwest Electric Power Company (SWEPCO). The facility operates two surface impoundments for storing CCR materials called the East Bottom Ash Pond (East BAP) and the West Bottom Ash Pond (West BAP). This report addresses the East Bottom Ash Pond.

The East BAP is located directly adjacent to and east of the West BAP. The East BAP receives sluiced bottom ash and has a surface area of 30.9 acres and a storage capacity of 188 acre-feet. The East BAP is almost entirely incised on three sides with a reported maximum embankment height of 4 feet and a splitter dike on the west side that is shared with the West BAP. Design documents indicate that the main upstream embankment slopes are 3 feet horizontal to 1 foot vertical (3:1 H:V); while the main downstream slopes are 2.5:1 H:V. The East BAP embankments have the same crest width and slopes and are constructed of the same materials with the same compaction and strength characteristics as the West BAP embankments. Since the soil characteristic and foundation conditions of the East BAP are similar to the soil characteristics and foundation conditions of the West BAP, it is concluded that the East BAP embankments would be covered under West BAP stability report titled Initial Safety Factor Assessment – West Bottom Ash Pond. A copy of the West BAP Safety Factor assessment report is attached.

## 3.0 SAFETY FACTOR ASSESSMENT 257.73(e)

As mentioned above, it was concluded that the safety factor assessment of the East BAP would be covered under the West BAP stability report titled Initial Safety Factor Assessment – West Bottom Ash Pond. Additionally, since the maximum embankment height of the East BAP is 4 feet while the maximum embankment height of the West BAP is 25 feet it is concluded that the factor of safety for the East BAP embankments would be equal to or better than the West BAP embankments. Therefore, the periodic 5-year review was conducted to evaluate if any physical changes have been made to the earthen dike and/or operating changes that could impact the loading on the structure. The assumptions, material properties and operating pools defined in the initial assessment were reviewed. The review concluded that there have been no changes that would impact the stability analyses that were previously conducted. Therefore, the previous report and analyses are still applicable to the current conditions of the facility. The results indicate that the calculated factors of safety meet or exceed the minimum values defined in Section 257.73(e).

**ATTACHMENT A**

# Initial Safety Factor Assessment – West Ash Pond

# Initial Safety Factor Assessment – West Ash Pond

**Pirkey Power Generating Station**
**Hallsville, Texas**

**Auckland Project No. 2015-008C (Revision No. 2)**
**January 14, 2016**

Prepared For:

American Electric Power Company
1 Riverside Plaza
Columbus, Ohio 43215

Prepared By:

Auckland Consulting, LLC
Jacksonville, Texas

TBPE Firm Registration No. F-16721
Expires 2/29/2016

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## Appendix

# 1.0 Introduction and Embankment Information

## 1.1 Introduction

The following report and evaluation provides the Initial Safety Factor Assessment of the West Ash Pond, an existing CCR impoundment (as defined by 40 CFR §257.2) located at the Pirkey Power Station near Hallsville, Texas. In accordance with 40 CFR §257.73(e)(1)(i) through (iv) this initial assessment provides field and laboratory data, model outputs (detailing multiple stability conditions) and summary of safety factors for the West Ash Pond. In accordance with 40 CFR §257.73(e)(2) this report provides the Initial Safety Factor Assessment certification for the West Ash Pond.

## 1.2 Referenced Information and Data

Soils data, comprised of field and laboratory testing, utilized in the preparation of this assessment were completed by ETTL Engineers and Consultants, Inc. and documented in the report *Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas* dated October 12, 2010. Based on a review of the provided field and laboratory data, it appears to be accurate and appropriate for use in the initial structural stability assessment of the West Ash Pond [40 CFR §257.73(e)(1)]. Furthermore, based on a recent site visit (October 2015), no modifications or elevation alterations have been made to the embankment since the referenced investigation. No additional field or laboratory activities were conducted. Soil data utilized in this evaluation is provided in the Appendix of this report.

To supplement existing data collected in the above reference report, an additional eight (8) Cone Penetrometer Test (CPT) soundings were advanced both along the crest and southern toe of the West Ash Pond. Sounding depths ranged between approximately 14 feet and 40 feet before encountering refusal. The data collected generally supports the findings from the 2010 study and confirms that embankment and foundation soils are relatively consistent. The location of and data from these CPT soundings are provided in the Appendix of this report.

The impoundment pool elevation data cited herein were provided in a separate hydrology and hydraulic (H&H) analysis report completed by Akron Consulting, LLC titled *Hydrology & Hydraulic Report, East & West Ash Ponds, H.W. Pirkey Power Plant – Hallsville, Texas,* dated December 15, 2015 (not included herein). The referenced report generally meets the demonstration requirements of 40 CFR §257.82(a).

Embankment profile dimensions and elevations were determined by using existing information provided by the client or representatives of the client. This information is also included in the Appendix of this report.

### 1.3 Embankment Evaluation Criteria

Based on information provided by the client, the existing embankment is constructed of lean clay (CL) and fat clay (CH) with existing side slopes (both up- and downstream) of approximately 3:1 (H:V), maximum embankment height of 20 feet and top of dam elevation of 358.0 feet (MSL). The upstream base elevation of the impoundment is approximately 347.0 feet (MSL). The crest width of the embankment is approximately 25 feet. Two (2) critical sections were evaluated for this initial safety factor assessment. Section No. 1 represents the northwest corner of the West Ash embankment and Section No. 2 represents the southern berm of the embankment.

It is our understanding that the maximum storage elevation of impounded CCR ash is 355.0 feet (MSL); however, the facility is managed to maintain an ash level less than this maximum level. The downstream toe of the West Ash Pond is not adjacent to other water bodies and therefore not subject to 40 CFR §257.73(d)(1)(A)(3)(vii).

In accordance with 40 CFR §257.73(e)(1)(i) and (ii), the maximum storage pool elevation for the West Ash Pond as determined by the 25-year, 24-hour storm event is 354.81 feet (MSL). For the purposes of this evaluation, the maximum storage pool elevation of 355.0 feet (MSL) was utilized. Likewise, the maximum (or flood) surcharge loading elevation as determined by the 100-year, 24-hour event is 355.01 feet (MSL), for this evaluation a maximum surcharge loading elevation of 355.0 feet (MSL) was utilized. Storage pool elevations were determined in accordance with 40 CFR §257.82(a).

## 2.0 Slope Stability Analyses

### 2.1 General

Soil parameters used for stability analyses of the existing embankment are based on findings of previous laboratory and field testing programs. The probable failure planes were analyzed using the analytical slope stability software, SLIDE by Rocscience, Inc. Methods of evaluation used in SLIDE are considered to be limited equilibrium methods of analysis, where each individual shear plane is evaluated to determine the resulting shear stress at the point of failure. For the purposes of this evaluation the Bishop Method of analysis, which analyzes circular failure planes through the slope was utilized.

Per 40 CFR §257.73(e)(1)(i) through (iii), three (3) modeled scenarios (presented below) were utilized to evaluate the stability of the existing embankment: steady state seepage (long term) condition under maximum storage pool, steady state seepage (long term) condition under maximum surcharge pool, and steady state seepage condition with seismic loading under maximum storage pool conditions. The following minimum factors of safety (FS) and soil stress parameters were utilized in modeling. Minimum factors of safety are based on demonstration requirements provided in 40 CFR §257.73(e)(1).

| Summary of Embankment Condition and Factor of Safety | | |
|---|---|---|
| **Embankment Condition** | **Soil Parameters** | **Minimum Factor of Safety** |
| Steady State Seepage – Maximum Pool | Effective Stress | 1.50 |
| Steady State Seepage – Surcharge Pool | Effective Stress | 1.40 |
| Steady State Seepage (Seismic) – Maximum Pool | Total Stress | 1.00 |
| **NOTE:** Minimum factors of safety based on demonstration requirements provided in 40 CFR §257.82 (e)(1). | | |

For evaluation of steady state seepage (long term) conditions with seismic, peak ground acceleration for this location was obtained from the USGS National Seismic Hazard Mapping Project (http://earthquake.usgs.gov/hazards). Based on the seismic survey data, the anticipated site specific peak ground acceleration (PGA) of 0.06g (acceleration at rock sites) for two (2) percent probability of exceedance in 50 years (40 CFR Part 257, Preamble page 21384). Correcting for acceleration at soft soil sites (Seismic Site Classification D) yields an estimated PGA of 0.13g. The seismic coefficient (k) used for pseudo static analysis is determined by reducing the estimated PGA by 50% yielding a seismic coefficient of 0.065g.

## 2.2 Liquefaction Assessment

Liquefaction of soils occurs when horizontal shearing stresses exceed the strength of existing loose, saturated sand. This sudden loss of shear strength and subsequent soil structure is typically associated with earthquake-induced horizontal movement. Recent engineering publications[1] provide criteria to assess liquefaction potential of sands (little to no fines) and clayey soils of low plasticity (e.g. clayey sands, silts). These criteria indicate that water content of fine-grained or cohesive soils needs to be high (≥ 0.85 *Liquid Limit [LL]), a clay fine content (defined as grains smaller than 0.002 mm) of less than 10 percent (< 10%), and relatively low soil density (assessed in terms of SPT blow counts). In addition, the accepted minimum seismic threshold acceleration to cause liquefaction in loose sands is 0.10g, the anticipated site specific PGA for this site is 0.06g.

Native fine grained (or cohesive) material underlying the West Ash Pond generally consist of medium dense to very dense clayey sand (SC), clayey gravel (GC) and silty clayey sand (SC-SM) Based on these soil characteristics and that the West Ash Pond is located in a zone of low peak ground acceleration (PGA), the risk of either embankment or underlying soils liquefying are negligible [40 CFR §257.73(e)(1)(iv)].

[1] Seed, R.B., et al, Recent Advances in Soil Liquefaction Engineering: A Unified and Consistent Framework, 26th Annual ASCE Los Angeles Spring Seminar, April 2003

## 2.3 Embankment and Foundation Stratigraphy

The models developed for this evaluation are based on the existing embankment geometry, results of field and laboratory testing and hydrologic site information provided by the client and recent field activities. Selection of critical slope sections (Section Nos. 1 and 2) was based on both height and subsurface sensitivity to loading. The following tables provide a summary of soil parameters used for these analyses. Specific soil parameters used for each model are presented in the Appendix.

**Summary of Long Term, Total Stress Soil Parameters, Section No. 1:**

| Material Type | Unit Weight (pcf) | Consolidated-Undrained Cohesion (psf) | Consolidated-Undrained Angle of Internal Friction (degrees) |
|---|---|---|---|
| Embankment Fill | 125 | 450 | 12 |
| Lean Clay/Fat Clay (CL/CH) | 125 | 530 | 13 |
| Silty Sand/Clayey Sand (SM/SC) | 125 | 0 | 28 |
| Ash | 100 | 0 | 30 |

**NOTE:** Properties used for Steady State Seepage with Seismic analysis.

**Summary of Long Term, Effective Stress Soil Parameters, Section No. 1**

| Material Type | Unit Weight (pcf) | Consolidated-Drained Cohesion (psf) | Consolidated-Drained Angle of Internal Friction (degrees) |
|---|---|---|---|
| Embankment Fill | 125 | 590 | 16 |
| Lean Clay/Fat Clay (CL/CH) | 125 | 320 | 17 |
| Silty Sand/Clayey Sand (SM/SC) | 125 | 430 | 28 |
| Ash | 100 | 0 | 30 |

**NOTE:** Properties used for Steady State Seepage analysis. Consolidated-drained conditions determined based on pore pressure measurements made during Consolidated-Undrained (CU) triaxial testing.

| Summary of Long Term, Total Stress Soil Parameters, Section No. 2 | | | |
|---|---|---|---|
| **Material Type** | **Unit Weight (pcf)** | **Consolidated-Undrained Cohesion (psf)** | **Consolidated-Undrained Angle of Internal Friction (degrees)** |
| Embankment Fill | 125 | 450 | 12 |
| Lean Clay/Fat Clay (CL/CH) | 125 | 530 | 13 |
| Clayey Sand/Silty Sand (SC/SM) | 125 | 0 | 28 |
| Lean Clay (CL) | 125 | 260 | 20 |
| Ash | 100 | 0 | 30 |
| **NOTE:** Properties used for Steady State Seepage with Seismic analysis. | | | |

| Summary of Long Term, Effective Stress Soil Parameters, Section No. 2 | | | |
|---|---|---|---|
| **Material Type** | **Unit Weight (pcf)** | **Consolidated-Drained Cohesion (psf)** | **Consolidated-Drained Angle of Internal Friction (degrees)** |
| Embankment Fill | 125 | 590 | 16 |
| Lean Clay/Fat Clay (CL/CH) | 125 | 320 | 17 |
| Clayey Sand/Silty Sand (SC/SM) | 125 | 0 | 28 |
| Lean Clay (CL) | 125 | 290 | 22 |
| Ash | 100 | 0 | 30 |
| **NOTE:** Properties used for Steady State Seepage analysis. Consolidated-drained conditions determined based on pore pressure measurements made during Consolidated-Undrained (CU) triaxial testing. | | | |

## 2.4 Seepage Analysis Parameters

The analysis of embankment seepage is based on laboratory results and estimated values for permeability for various embankment and native foundation soils. These soil parameters were utilized in the models to establish a long term steady state condition and corresponding phreatic surface in the embankment. Hydraulic conductivity test results are provided in the Appendix. Hydraulic conductivity properties utilized in the seepage analysis are provided in the below table.

| Hydraulic Conductivity of Embankment Soils, Section Nos. 1 and 2 | |
|---|---|
| **Material Type** | **Permeability (ft/sec)** |
| Embankment Fill | $1 \times 10^{-8}$ |
| Lean Clay/Fat Clay (CL/CH) | $1 \times 10^{-8}$ |
| Clayey Sand/Silty Sand (SC/SM) | $1 \times 10^{-5}$ |
| Lean Clay (CL) | $1 \times 10^{-8}$ |
| Ash | $1 \times 10^{-4}$ |

## 2.5 Stability Analysis Results

The following tables provides the results of the stability analysis for each of the conditions cited herein, as required by 40 CFR §257.73(e)(1)(i) through (iii). The graphical representations of each analysis are included in the Appendix.

| Summary of Stability Analyses – Safety Factors, Section No. 1 | | |
|---|---|---|
| **Modeled Condition** | **Factor of Safety** | |
| | **Actual** | **Minimum** |
| Steady State Seepage – Maximum Pool | 2.21 | 1.50 |
| Steady State Seepage – Surcharge Pool | 2.21 | 1.40 |
| Steady State Seepage with Seismic – Maximum Pool | 1.35 | 1.00 |

| Summary of Stability Analyses – Safety Factors, Section No. 2 | | |
|---|---|---|
| **Modeled Condition** | **Factor of Safety** | |
| | **Actual** | **Minimum** |
| Steady State Seepage – Maximum Pool | 1.83 | 1.50 |
| Steady State Seepage – Surcharge Pool | 1.83 | 1.40 |
| Steady State Seepage with Seismic – Maximum Pool | 1.50 | 1.00 |

Based on the findings of this analysis, the evaluated embankments appear to be stable under the modeled conditions and demonstrate the minimum safety factors, as required by 40 CFR §257.73(e)(1)(i) through (iii).

## 3.0 Report Limitations

This report has been prepared for the exclusive use of our client for the specific application to the project discussed and has been prepared in accordance with the generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. The analyses contained in the report are based on the data obtained from the referenced soil borings performed within the project site. This report does not reflect variations that may occur between borings or across the site. Soil borings do not necessarily reflect strata variations that may exist at other locations within the project site.

## 4.0 Initial Structural Stability Assessment Certification

By means of this certification, (i) I have reviewed the requirements of 40 CFR §257.73(e)(1) – *Periodic Safety Factor Assessments*, (ii) I or my agent has visited and examined the facility, (iii) the referenced data used in this evaluation to the best of my knowledge appears correct and appropriate for use, (iv) and this Initial Safety Factor Assessment for the West Ash Pond (Pirkey Power Station) has been prepared to the best of my knowledge in accordance with §257.73(e)(1).

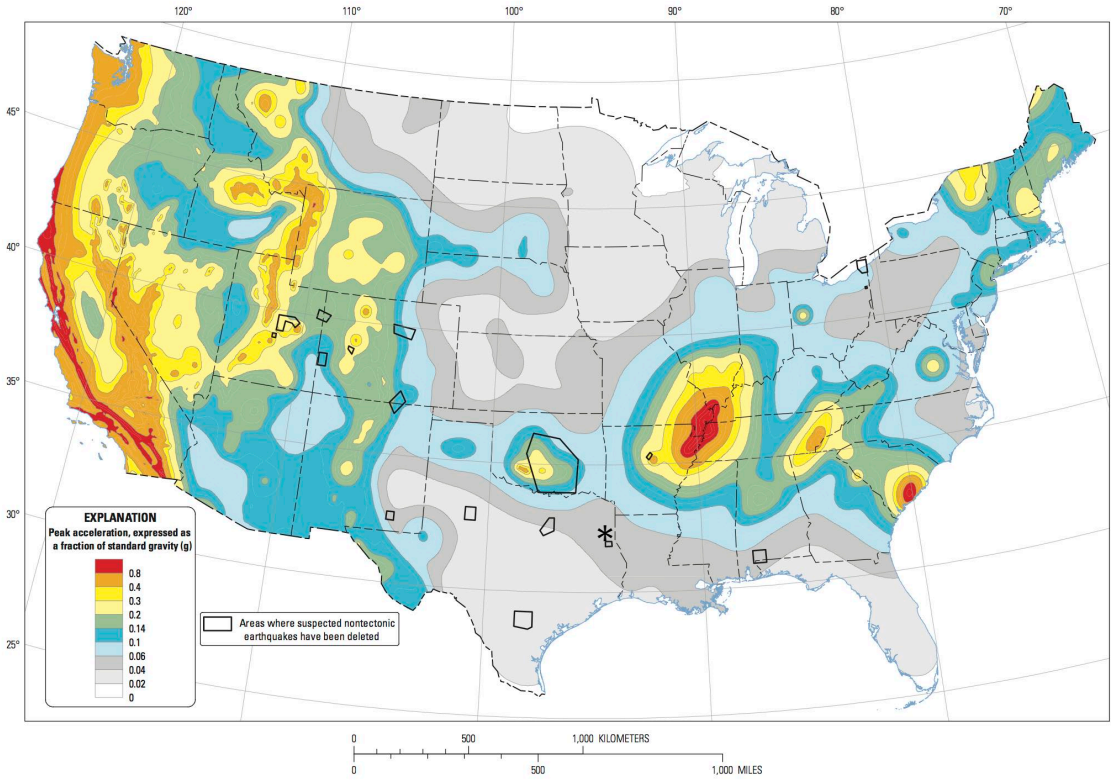
By: _____

Dated: January 14, 2016


TBPE Firm Registration No. F-16721
Expires 2/29/2016

# Appendix

## Stability Analyses
## Reference Data




**Two-percent probability of exceedance in 50 years map of peak ground acceleration**

* Approximate location of Pirkey Power Generating Station

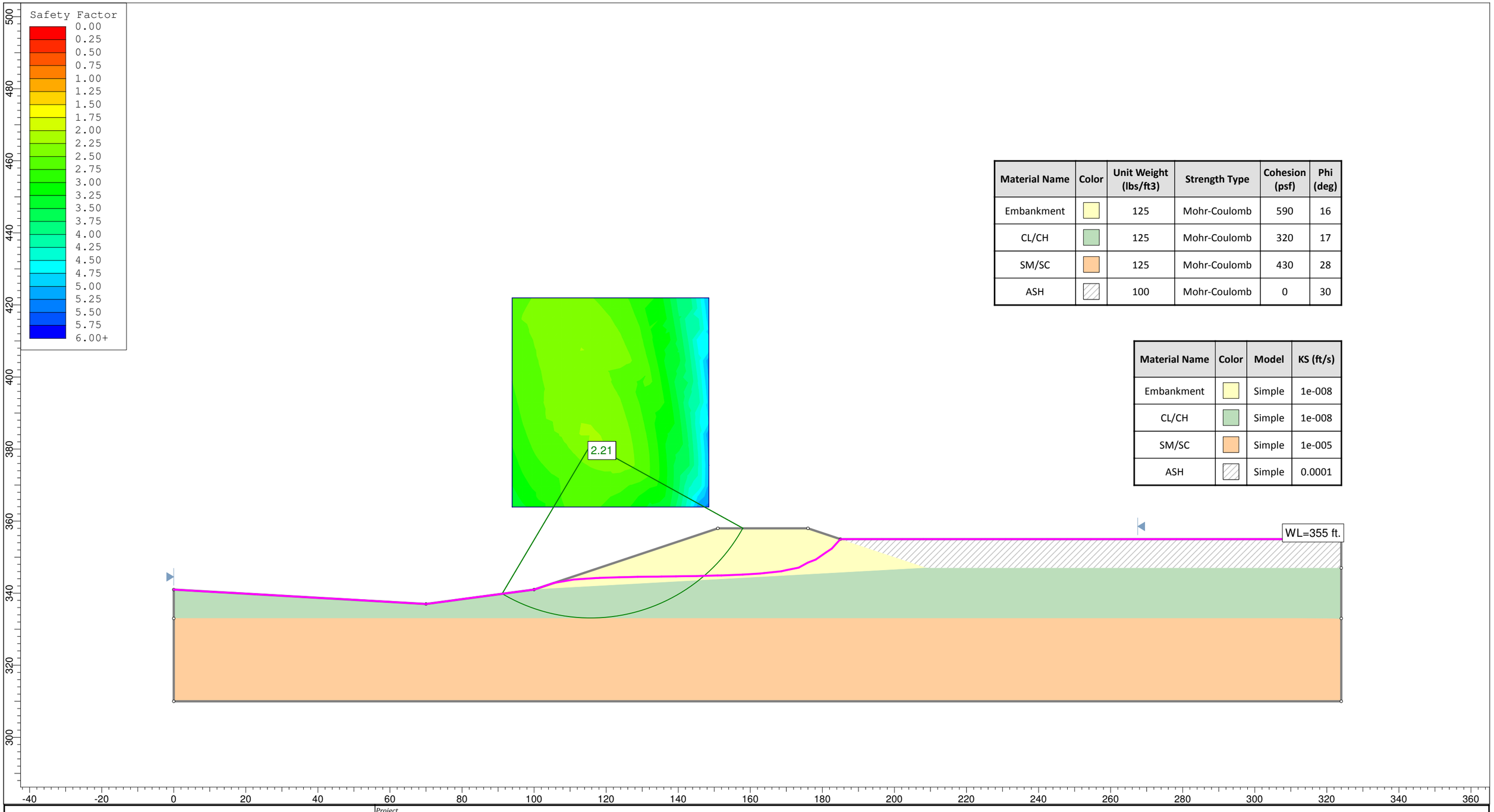
Provided by USGS National Seismic Hazard Mapping Project.

| **Seismic Probability Map** | |
|---|---|
| Scale: N/A | **Pirkey Power Generating Station**<br>**Initial Safety Factor Assessment - West Ash Pond**<br>**Hallsville, Texas** |
| Auckland Project No. 2015-008C | |


Provided by Google Earth.

**Cone Penetrometer Test (CPT) Location Map**

| | |
|---|---|
| Scale: N/A | **Pirkey Power Generating Station**<br>**Initial Safety Factor Assessment - West Ash Pond**<br>**Hallsville, Texas** |
| Auckland Project No. 2015-008C | |

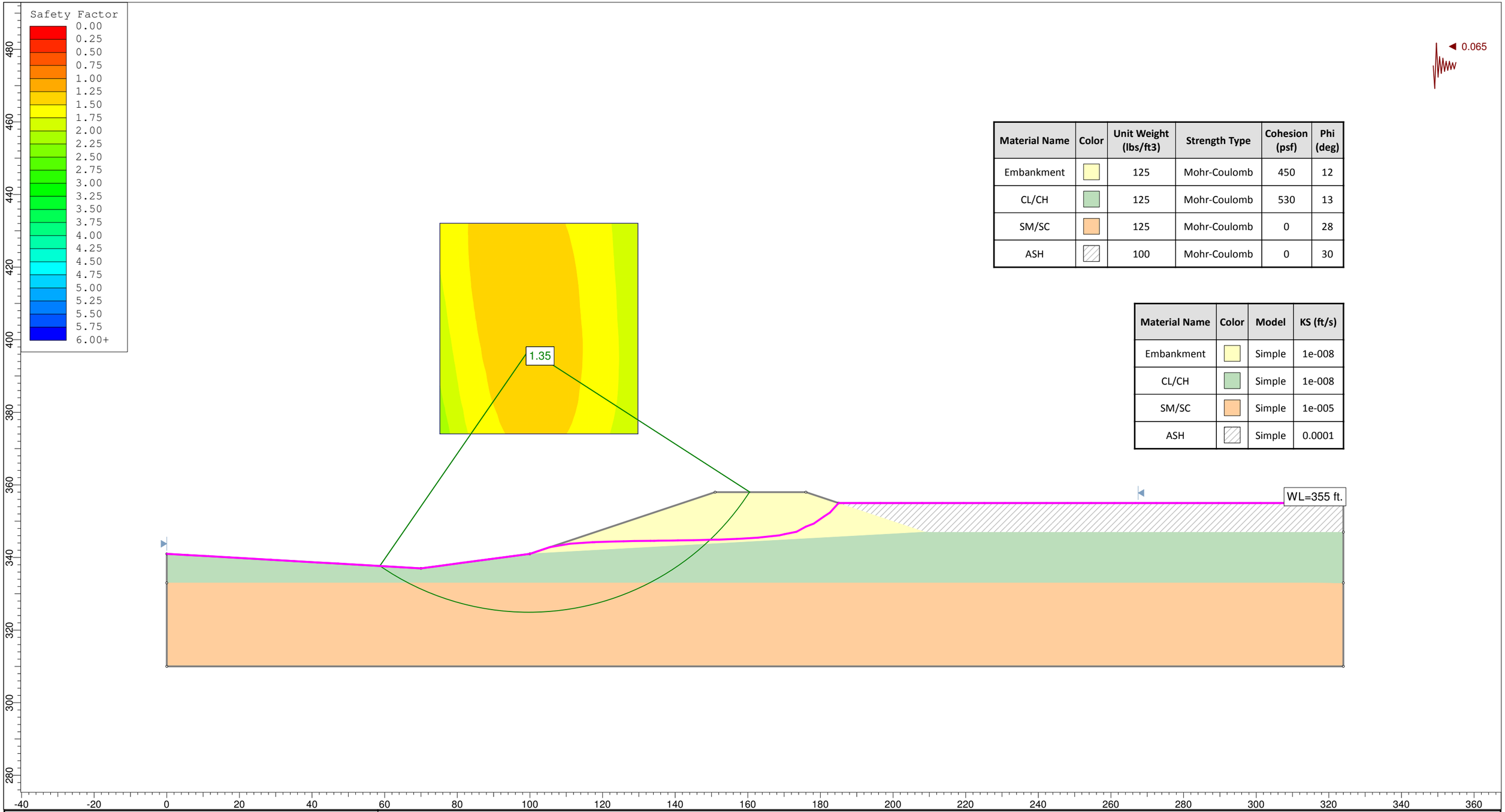



| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) |
|---|---|---|---|---|---|
| Embankment | | 125 | Mohr-Coulomb | 590 | 16 |
| CL/CH | | 125 | Mohr-Coulomb | 320 | 17 |
| SM/SC | | 125 | Mohr-Coulomb | 430 | 28 |
| ASH | | 100 | Mohr-Coulomb | 0 | 30 |

| Material Name | Color | Model | KS (ft/s) |
|---|---|---|---|
| Embankment | | Simple | 1e-008 |
| CL/CH | | Simple | 1e-008 |
| SM/SC | | Simple | 1e-005 |
| ASH | | Simple | 0.0001 |

**Auckland Consulting LLC**
**PO Box 8155**
**Jacksonville, Texas 75766**

| | | | |
|---|---|---|---|
| *Project* | Pirkey Power Station - West Ash Pond, Section No. 1 | | |
| *Analysis Description* | Steady State Seepage at Maximum and Surcharge Pool | | |
| *Drawn By* | JJT | *Company* | |
| *Date* | 12/15/2015 | *File Name* | WEST ASH_Section 1_SSS_25yr.slim |




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) |
|---|---|---|---|---|---|
| Embankment | | 125 | Mohr-Coulomb | 450 | 12 |
| CL/CH | | 125 | Mohr-Coulomb | 530 | 13 |
| SM/SC | | 125 | Mohr-Coulomb | 0 | 28 |
| ASH | | 100 | Mohr-Coulomb | 0 | 30 |

| Material Name | Color | Model | KS (ft/s) |
|---|---|---|---|
| Embankment | | Simple | 1e-008 |
| CL/CH | | Simple | 1e-008 |
| SM/SC | | Simple | 1e-005 |
| ASH | | Simple | 0.0001 |

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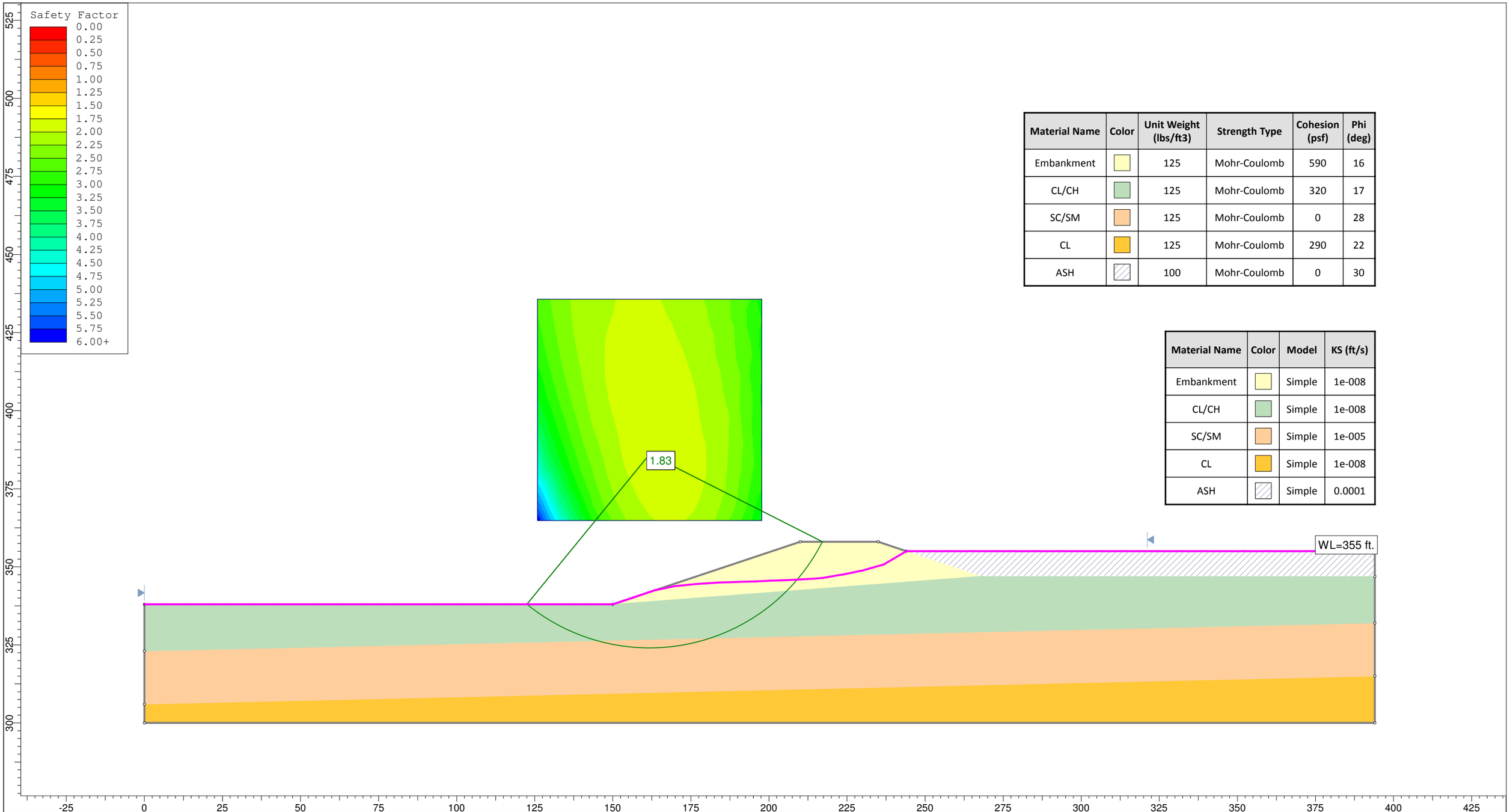
**Jacksonville, Texas 75766**

SLIDEINTERPRET 6.036

| | | | |
|---|---|---|---|
| *Project* | Pirkey Power Station - West Ash Pond, Section No. 1 | | |
| *Analysis Description* | Steady State Seepage at Maximum Pool, Seismic Analysis | | |
| *Drawn By* | JJT | *Company* | |
| *Date* | 12/23/2015 | *File Name* | WEST ASH_Section 1_SSS_25yr_seismic.slim |




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) |
|---|---|---|---|---|---|
| Embankment | | 125 | Mohr-Coulomb | 590 | 16 |
| CL/CH | | 125 | Mohr-Coulomb | 320 | 17 |
| SC/SM | | 125 | Mohr-Coulomb | 0 | 28 |
| CL | | 125 | Mohr-Coulomb | 290 | 22 |
| ASH | | 100 | Mohr-Coulomb | 0 | 30 |

| Material Name | Color | Model | KS (ft/s) |
|---|---|---|---|
| Embankment | | Simple | 1e-008 |
| CL/CH | | Simple | 1e-008 |
| SC/SM | | Simple | 1e-005 |
| CL | | Simple | 1e-008 |
| ASH | | Simple | 0.0001 |

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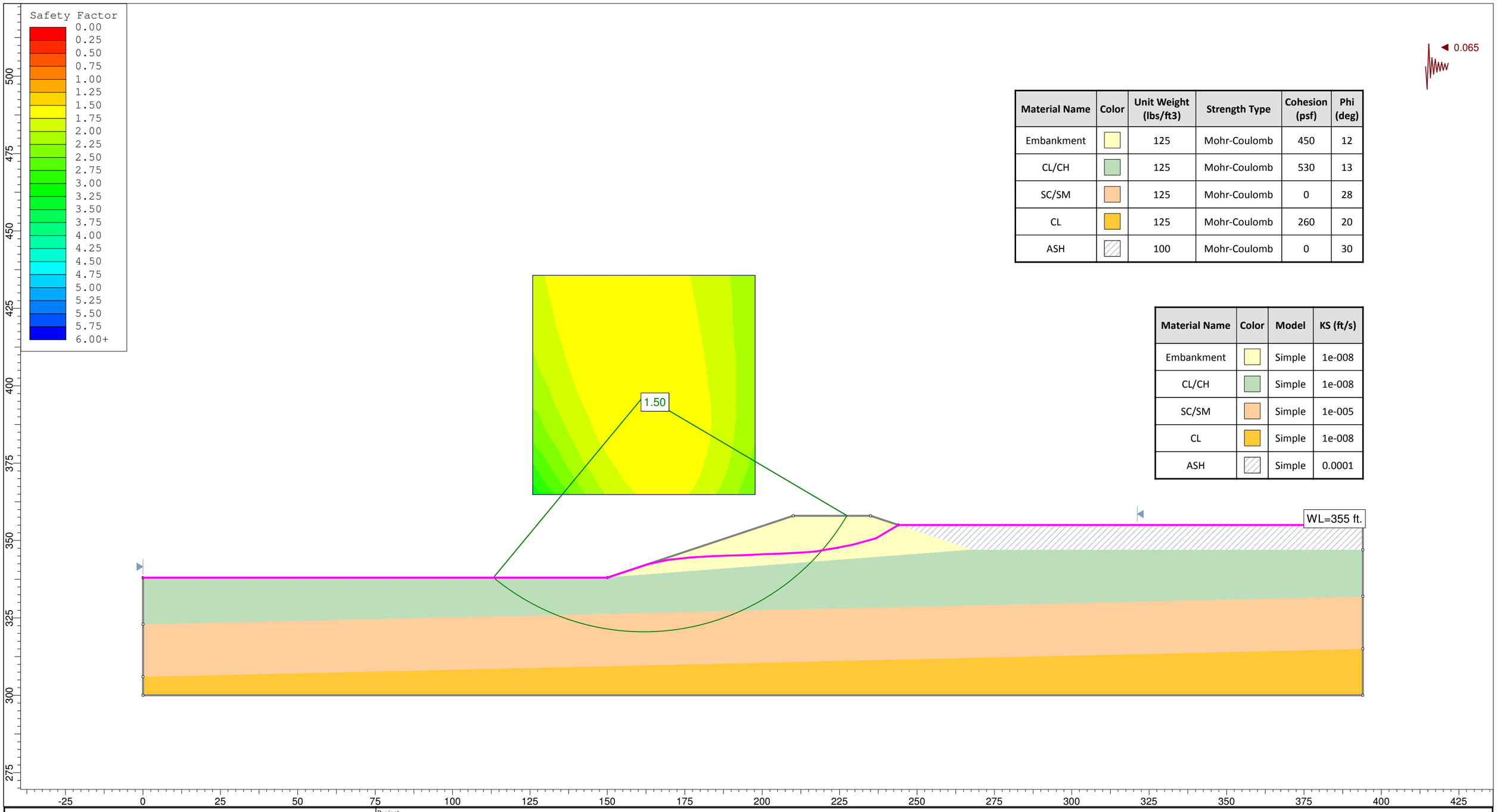
**Jacksonville, Texas 75766**

| | | | |
|---|---|---|---|
| *Project* | Pirkey Power Station - West Ash Pond, Section No. 2 | | |
| *Analysis Description* | Steady State Seepage at Maximum and Surcharge Pool | | |
| *Drawn By* | JJT | *Company* | |
| *Date* | 12/15/2015 | *File Name* | WEST ASH_Section 2_SSS_25yr.slim |




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) |
|---|---|---|---|---|---|
| Embankment | | 125 | Mohr-Coulomb | 450 | 12 |
| CL/CH | | 125 | Mohr-Coulomb | 530 | 13 |
| SC/SM | | 125 | Mohr-Coulomb | 0 | 28 |
| CL | | 125 | Mohr-Coulomb | 260 | 20 |
| ASH | | 100 | Mohr-Coulomb | 0 | 30 |

| Material Name | Color | Model | KS (ft/s) |
|---|---|---|---|
| Embankment | | Simple | 1e-008 |
| CL/CH | | Simple | 1e-008 |
| SC/SM | | Simple | 1e-005 |
| CL | | Simple | 1e-008 |
| ASH | | Simple | 0.0001 |

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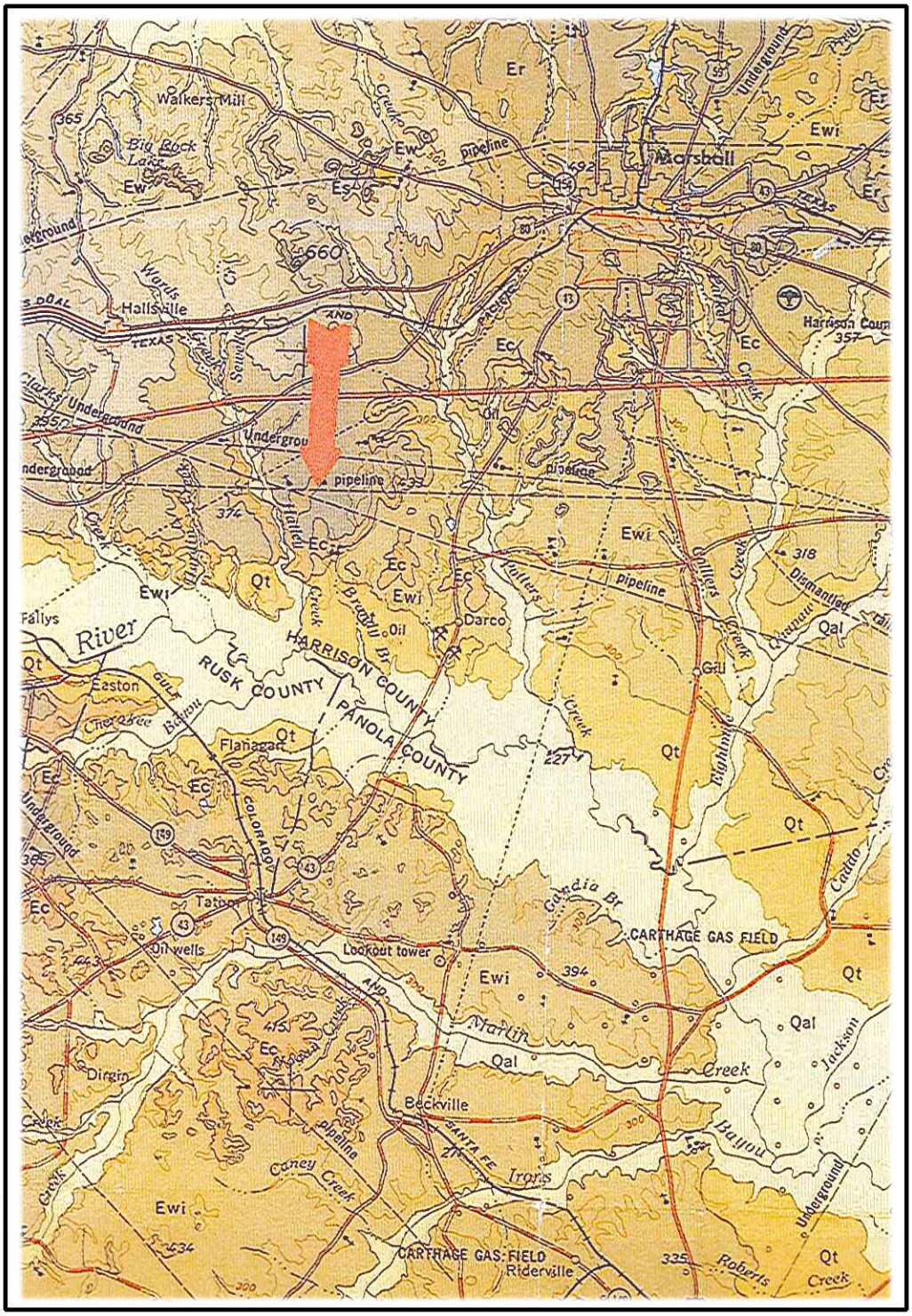
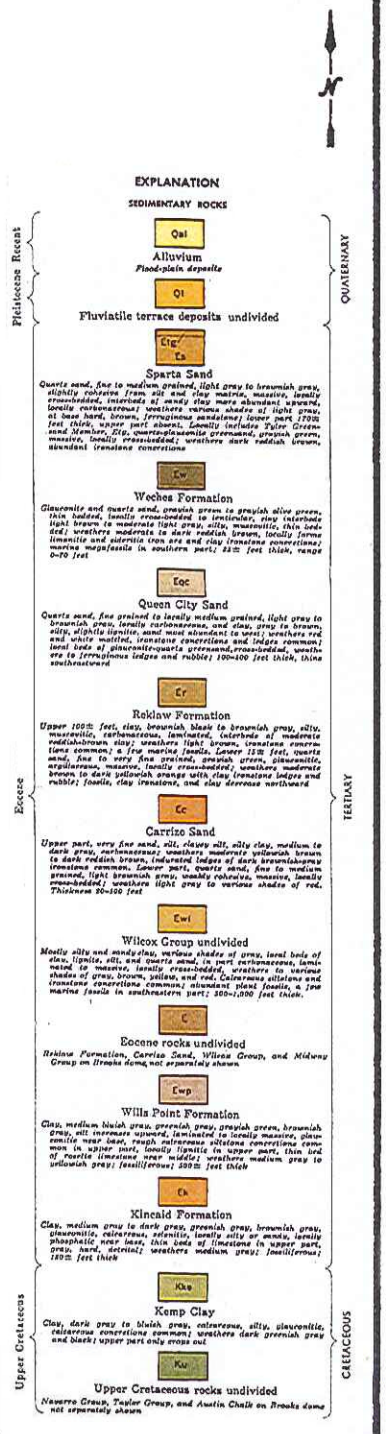
| | | | |
|---|---|---|---|
| *Project* | Pirkey Power Station - West Ash Pond, Section No. 2 | | |
| *Analysis Description* | Steady State Seepage at Maximum Pool, Seismic Analysis | | |
| *Drawn By* | JJT | *Company* | |
| *Date* | 12/23/2015 | *File Name* | WEST ASH_Section 2_SSS_25yr_seismic.slim |

SLIDEINTERPRET 6.036



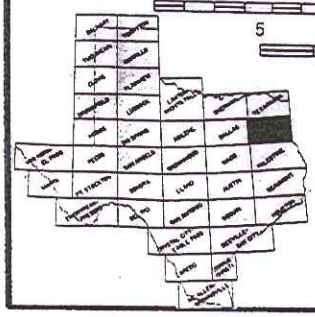

Scale 1:250,000

5 0 5 10 15 20 Statute Miles

5 0 5 10 15 20 25 30 Kilometers

5 0 5 10 Nautical Miles

CONTOUR INTERVAL 100 FEET
WITH SUPPLEMENTARY CONTOURS AT 50 FOOT INTERVALS



**ETTL ENGINEERS & CONSULTANTS**
MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

**PLATE 2**

# SITE SURFACE GEOLOGY

**JOB No.: G3241-095**

**DATE: DEC. 2009**

**SCALE: 1:250,000**

# LOG OF BORING W-1

**PROJECT:** Pirkey Power Plant
Hallsville. Texas

**PROJECT NO.:** G3241-095 **BORING TYPE:** Flight Auger

**DATE** 10/20/09

**SURFACE ELEVATION** 356.5


**ETTL ENGINEERS & CONSULTANTS**

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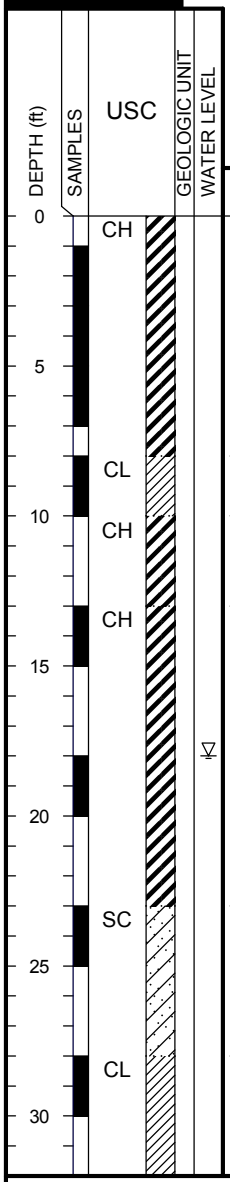
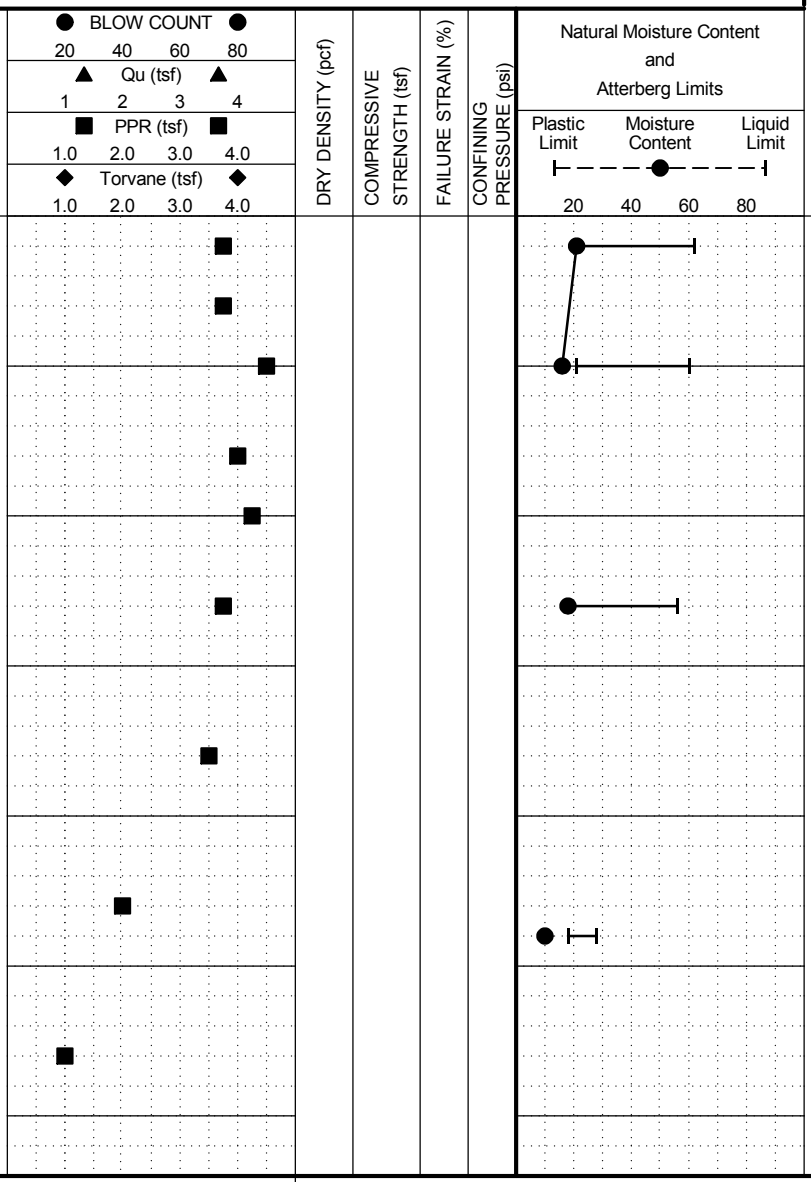
(903) 595-4421


| MATERIAL DESCRIPTION | FIELD STRENGTH DATA | DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | MOISTURE CONTENT (%) | ATTERBERG LIMITS(%) LL | PL | PI | MINUS #200 SIEVE (%) | OTHER TESTS PERFORMED (Page Ref. #) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CH FAT CLAY WITH SAND(CH) tan and red | P=3.75 | | | | | 21 | 62 | 21 | 41 | 79 | +40 Sieve=6%, +4 Sieve=0% |
| | P=3.75 | | | | | | | | | | |
| --red | P=4.5 | | | | | 16 | 60 | 21 | 39 | 75 | +40 Sieve=7%, +4 Sieve=1% |
| CL SANDY LEAN CLAY(CL) reddish yellow | P=4.0 | | | | | | | | | | |
| CH FAT CLAY(CH) red and tan | P=4.25 | | | | | | | | | | |
| CH FAT CLAY WITH SAND(CH) red and yellow | P=3.75 | | | | | 18 | 56 | 18 | 38 | 71 | +40 Sieve=5%, +4 Sieve=0% |
| --red | P=3.5 | | | | | | | | | | |
| SC CLAYEY SAND(SC) reddish brown | P=2.0 | | | | | 10 | 28 | 18 | 10 | 25 | +40Sieve=21%, +4 Sieve=11% |
| CL LEAN CLAY(CL) red; with sand seams | P=1.0 | | | | | | | | | | |




Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 18' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

# LOG OF BORING W-1


**ETTL ENGINEERS & CONSULTANTS**

MAIN OFFICE
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Tyler, Texas 75702
(903) 595-4421


**PROJECT:** Pirkey Power Plant
Hallsville. Texas

**PROJECT NO.:** G3241-095 **BORING TYPE:** Flight Auger

**DATE** 10/20/09

**SURFACE ELEVATION** 356.5

| DEPTH (ft) | SAMPLES | USC | GEOLOGIC UNIT | WATER LEVEL | MATERIAL DESCRIPTION | FIELD STRENGTH DATA | DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | Natural Moisture Content and Atterberg Limits | MOISTURE CONTENT (%) | ATTERBERG LIMITS(%) LIQUID LIMIT LL | PLASTIC LIMIT PL | PLASTICITY INDEX PI | MINUS #200 SIEVE (%) | OTHER TESTS PERFORMED (Page Ref. #) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | | SC | | | CLAYEY SAND(SC) grayish brown | N=32 | | | | | | | | | | | |
| | | | | | --tannish gray | P=4.15 | | | | | | | | | | | |
| 40 | | | | | | P=2.8 | | | | | | 17 | 29 | 19 | 10 | 25 | +40 Sieve=1%, +4 Sieve=0% |
| | | | | | --gray | N=47 | | | | | | | | | | | |
| 45 | | | | | | | | | | | | | | | | | |
| | | SM SC | | | SILTY CLAYEY SAND(SM-SC) gray | N=50/6" | | | | | | | | | | | |
| 50 | | | | | Bottom of Boring @ 50' | | | | | | | | | | | | |

FIELD STRENGTH DATA: BLOW COUNT (20 40 60 80); Qu (tsf) (1 2 3 4); PPR (tsf) (1.0 2.0 3.0 4.0); Torvane (tsf) (1.0 2.0 3.0 4.0)

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (20 40 60 80)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 18' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

# LOG OF BORING W-2

**ETTL ENGINEERS & CONSULTANTS**

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

**PROJECT:** Pirkey Power Plant
Hallsville. Texas

**PROJECT NO.:** G3241-095 **BORING TYPE:** Flight Auger

**DATE** 10/21/09

**SURFACE ELEVATION** 341.7

| DEPTH (ft) | USC | MATERIAL DESCRIPTION | FIELD STRENGTH DATA | DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | MOISTURE CONTENT (%) | ATTERBERG LIMITS(%) LL | PL | PI | MINUS #200 SIEVE (%) | OTHER TESTS PERFORMED (Page Ref. #) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | CL | SANDY LEAN CLAY(CL) stiff; red and gray | N=9 | | | | | | | | | | |
| | | --hard | P=4.5+ | | | | | 17 | 48 | 19 | 29 | 65 | +40 Sieve=6%, +4 Sieve=2% |
| 5 | | --gray, red, and tan | N=50 | | | | | | | | | | |
| | SC | CLAYEY SAND(SC) very dense; red and tan | N=50/5" | | | | | 16 | 28 | 18 | 10 | 27 | +40 Sieve=7%, +4 Sieve=2% |
| 10 | | | | | | | | | | | | | |
| | | --medium dense; tan and gray | P=1.5 | | | | | 19 | 32 | 17 | 15 | 31 | +40Sieve=13%, +4 Sieve=5% |
| 15 | | | | | | | | | | | | | |
| | | --very dense; gray and tan | N=62 | | | | | | | | | | |
| 20 | | | | | | | | | | | | | |
| | | --green | N=50/5" | | | | | 22 | 28 | 19 | 9 | 33 | +40 Sieve=6%, +4 Sieve=2% |
| 25 | | | | | | | | | | | | | |
| | | | N=56 | | | | | | | | | | |
| 30 | | Bottom of Boring @ 30' | | | | | | | | | | | |

FIELD STRENGTH DATA: BLOW COUNT (20 40 60 80); Qu (tsf) (1 2 3 4); PPR (tsf) (1.0 2.0 3.0 4.0); Torvane (tsf) (1.0 2.0 3.0 4.0)

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (20 40 60 80)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 13' while drilling. Water level @ 21' and open upon completion.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

# LOG OF BORING W-3

**ETTL ENGINEERS & CONSULTANTS**

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

**PROJECT:** Pirkey Power Plant
Hallsville. Texas

**PROJECT NO.:** G3241-095 **BORING TYPE:** Flight Auger

**DATE** 10/20/09

**SURFACE ELEVATION** 356.3

| DEPTH (ft) | SAMPLES | USC | GEOLOGIC UNIT | WATER LEVEL | MATERIAL DESCRIPTION | FIELD STRENGTH DATA | DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | MOISTURE CONTENT (%) | ATTERBERG LIMITS(%) LIQUID LIMIT (LL) | PLASTIC LIMIT (PL) | PLASTICITY INDEX (PI) | MINUS #200 SIEVE (%) | OTHER TESTS PERFORMED (Page Ref. #) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | CL | | | SANDY LEAN CLAY(CL) stiff; white and tan | P=1.75 | | | | | 18 | 46 | 17 | 29 | 61 | +40 Sieve=7%, +4 Sieve=2% |
| | | CH | | | SANDY FAT CLAY(CH) very stiff; red, tan, and white | P=3.25 | | | | | | | | | | |
| 5 | | | | | --white, tan, and red | P=3.5 | | | | | 17 | 55 | 18 | 37 | 68 | +40 Sieve=5%, +4 Sieve=0% |
| | | CL | | | SANDY LEAN CLAY(CL) very stiff; red and yellow | P=2.25 P=4.0 | | | | | | | | | | |
| 10 | | | | | --hard; red and yellow | | | | | | | | | | | |
| | | CH | | | FAT CLAY WITH SAND(CH) very stiff; red and yellow | P=2.5 | | | | | 24 | 68 | 22 | 46 | 80 | +40 Sieve=6%, +4 Sieve=0% |
| 15 | | | | | --hard | P=4.5+ | | | | | | | | | | |
| 20 | | | | | --stiff | P=2.0 | | | | | 24 | 52 | 18 | 34 | 69 | +40 Sieve=4%, +4 Sieve=0% |
| 25 | | | | | | | | | | | | | | | | |
| | | SM | | | SILTY SAND(SM) very dense; yellow and red | N=88 | | | | | | | | | | |
| 30 | | | | | | | | | | | | | | | | |

FIELD STRENGTH DATA: BLOW COUNT 20 40 60 80; Qu (tsf) 1 2 3 4; PPR (tsf) 1.0 2.0 3.0 4.0; Torvane (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 34' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

# LOG OF BORING W-3

**ETTL ENGINEERS & CONSULTANTS**

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

**PROJECT:** Pirkey Power Plant
Hallsville. Texas

**PROJECT NO.:** G3241-095 **BORING TYPE:** Flight Auger

**DATE** 10/20/09

**SURFACE ELEVATION** 356.3

| DEPTH (ft) | SAMPLES | USC | GEOLOGIC UNIT | WATER LEVEL | MATERIAL DESCRIPTION | FIELD STRENGTH DATA | DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | Natural Moisture Content and Atterberg Limits | MOISTURE CONTENT (%) | ATTERBERG LIMITS(%) LIQUID LIMIT LL | PLASTIC LIMIT PL | PLASTICITY INDEX PI | MINUS #200 SIEVE (%) | OTHER TESTS PERFORMED (Page Ref. #) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | | CL | | ▽ | SANDY LEAN CLAY(CL) very stiff; gray; with iron oxide cemented sandstone gravel | P=3.25 | | | | | | | | | | | |
| 40 | | SC | | | CLAYEY SAND(SC) very dense; dark gray | P=4.5+ | | | | | | 17 | 33 | 17 | 16 | 38 | +40 Sieve=1%, +4 Sieve=0% |
| 45 | | SM SC | | | SILTY CLAYEY SAND(SM-SC) very dense; gray; saturated | N=59 | | | | | | | | | | | |
| 50 | | SC | | | CLAYEY SAND(SC) very dense; dark gray | N=50/4" | | | | | | | | | | | |
| | | | | | Bottom of Boring @ 50' | | | | | | | | | | | | |

BLOW COUNT 20 40 60 80
Qu (tsf) 1 2 3 4
PPR (tsf) 1.0 2.0 3.0 4.0
Torvane (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 34' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

# LOG OF BORING W-4

**ETTL ENGINEERS & CONSULTANTS**

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

**PROJECT:** Pirkey Power Plant
Hallsville. Texas

**PROJECT NO.:** G3241-095 **BORING TYPE:** Flight Auger

**DATE** 10/20/09

**SURFACE ELEVATION** 338.0

| DEPTH (ft) | SAMPLES | USC | GEOLOGIC UNIT | WATER LEVEL | MATERIAL DESCRIPTION | FIELD STRENGTH DATA | DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi) | MOISTURE CONTENT (%) | ATTERBERG LIMITS(%) LIQUID LIMIT LL | PLASTIC LIMIT PL | PLASTICITY INDEX PI | MINUS #200 SIEVE (%) | OTHER TESTS PERFORMED (Page Ref. #) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | SC | | | CLAYEY SAND(SC) stiff; brown, red, and yellow | N=13 | | | | | | | | | | |
| | | | | | --with gravel | N=22 | | | | | 12 | 31 | 17 | 14 | 35 | +40Sieve=31%, +4 Sieve=16% |
| 5 | | | | | --red and tan; with iron oxide cemented sandstone | N=28 | | | | | | | | | | |
| | | | | | --dense; red and white; with clay seams | N=36 | | | | | 15 | 60 | 16 | 44 | 39 | +40Sieve=11%, +4 Sieve=4% |
| 10 | | | | | | | | | | | | | | | | |
| | | | | | --medium dense; orangish gray; with gravel | N=12 | | | | | 17 | 30 | 14 | 16 | 22 | +40Sieve=28%, +4 Sieve=17% |
| 15 | | | | | | | | | | | | | | | | |
| | | GC | | ▽ | CLAYEY GRAVEL(GC) dense; dark gray | N=43 | | | | | 20 | 31 | 16 | 15 | 7 | +40Sieve=68%, +4 Sieve=52% |
| 20 | | | | | | | | | | | | | | | | |
| | | SM | | | SILTY SAND(SM) dense; dark gray | N=42 | | | | | | | | | | |
| 25 | | | | | | | | | | | | | | | | |
| | | CL | | | SANDY LEAN CLAY(CL) very dense; gray | N=84 | | | | | | | | | | |
| 30 | | | | | Bottom of Boring @ 30' | | | | | | | | | | | |

FIELD STRENGTH DATA: BLOW COUNT (20 40 60 80); Qu (tsf) (1 2 3 4); PPR (tsf) (1.0 2.0 3.0 4.0); Torvane (tsf) (1.0 2.0 3.0 4.0)

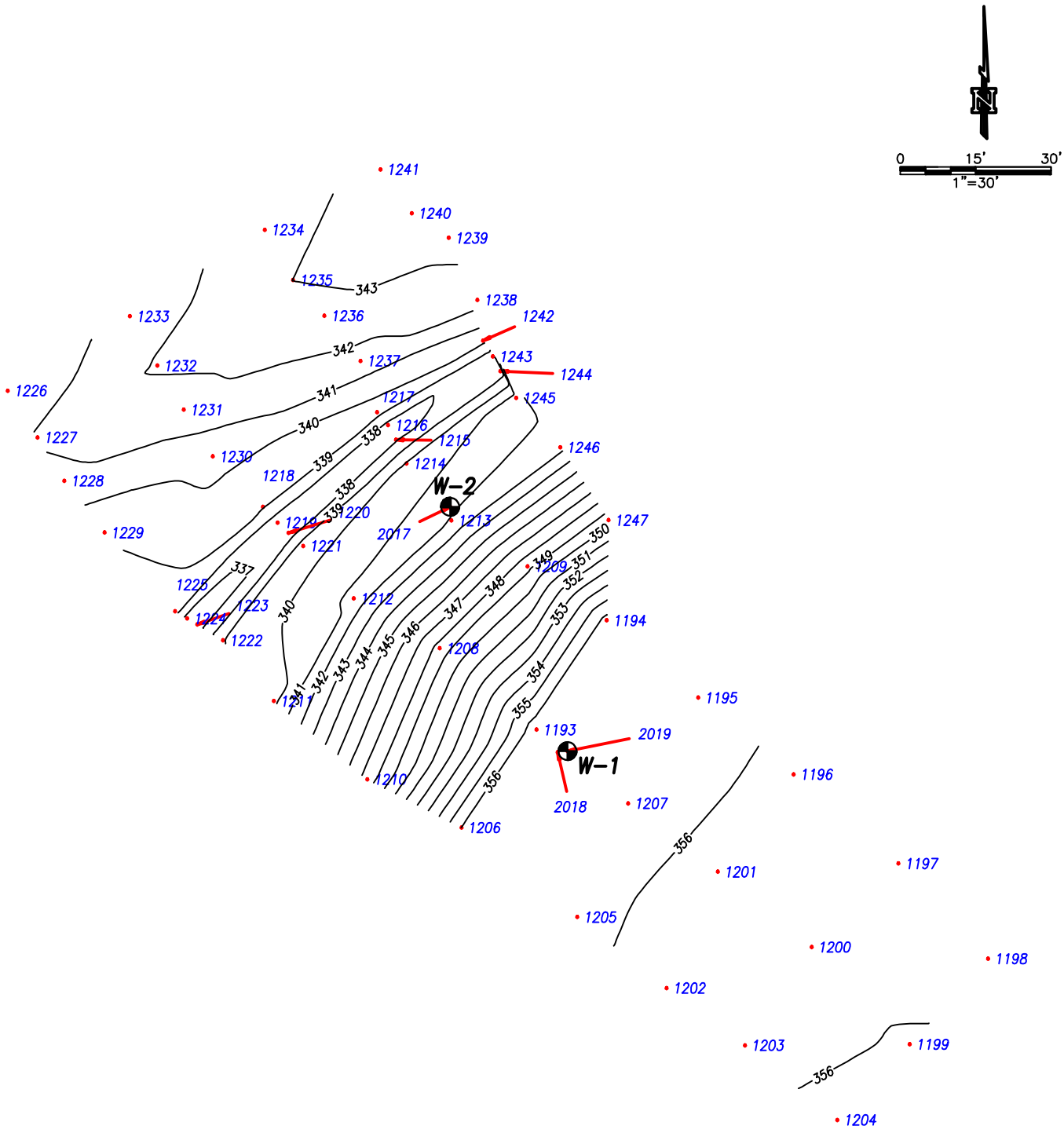
Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 19' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:





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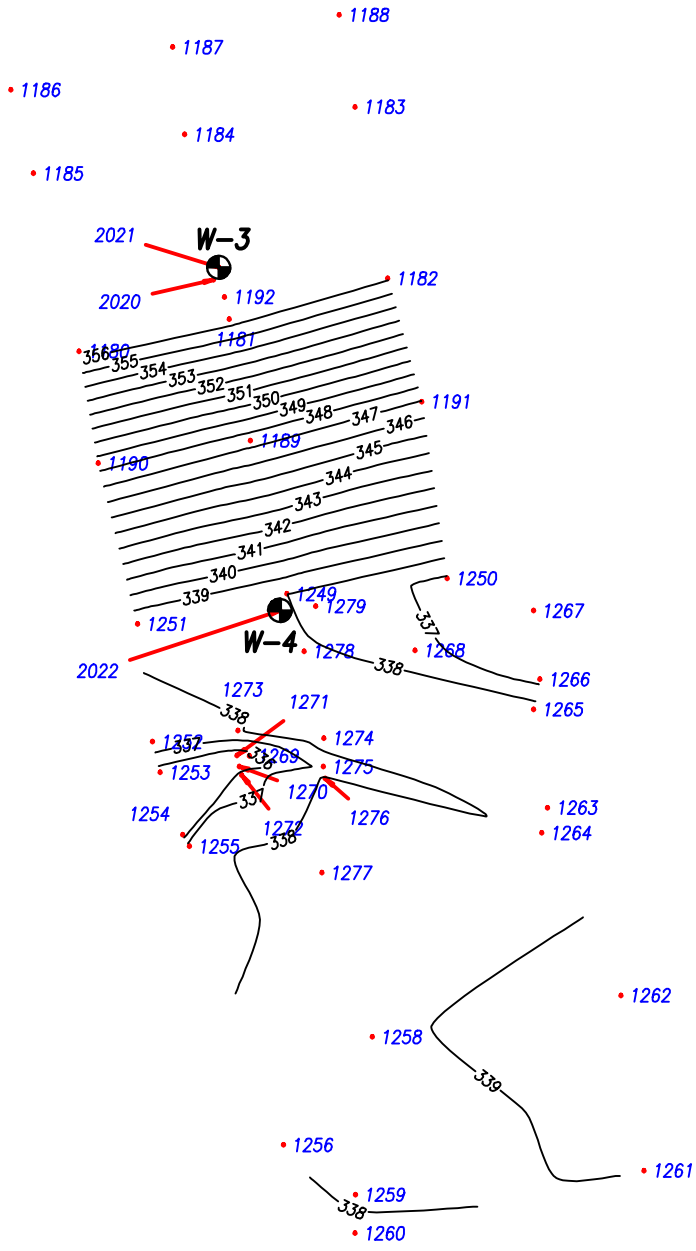
JOB NO: 2313-013 FIELD BOOK: XXX/XXX DATE: NOV. 2009

# EXHIBIT "1"

W-1 AND W-2 BOREHOLES
PIRKEY POWER PLANT
HALLSVILLE, TEXAS





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JOB NO: 2313-013 FIELD BOOK: XXX/XXX DATE: NOV. 2009

# EXHIBIT "J"

W-3 AND W-4 BOREHOLES
PIRKEY POWER PLANT
HALLSVILLE, TEXAS

# ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

## HYDRAULIC CONDUCTIVITY DETERMINATION
## FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
## (Mercury Permometer Test)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Project : | Pirkey Power Plants Embankments, Hallsville, Texas | | | | | | | |
| Date: | 11/3/2009 | Panel Number : | | P 2 ; ASTM D 5084 | | | | |
| Project No. : | G 3241-09 | Permometer Data | | | | | | |
| Boring No.: | W - 2 | ap = | 0.031416 | cm2 | Set Mercury to Pipet Rp at | Equilibrium | 1.8 | cm3 |
| Sample: | | aa = | 0.767120 | cm2 | | Pipet Rp | **6.7** | cm3 |
| Depth (ft): | 13' to 16' | M1 = | 0.030180 | C = 0.00043252 | | Annulus Ra | 1.5 | cm3 |
| Other Location: | | M2 = | 1.040953 | T = 0.203782344 | | | | |
| Material Description : | Tan & Gray Clayey Sand | | | | | | | |

### SAMPLE DATA

| | | | | | Before Test | | After Test | |
|---|---|---|---|---|---|---|---|---|
| Wet Wt. sample + ring or tare : | | | 571.51 | g | Tare No.: | T 13 | Tare No.: | T 16 |
| Tare or ring Wt. : | | | 0.0 | g | Wet Wt.+tare: | 660.71 | Wet Wt.+tare: | 733.72 |
| Wet Wt: of Sample : | | | 571.51 | g | Dry Wt.+tare: | 588.03 | Dry Wt.+tare: | 625.10 |
| Diameter : | 2.78 | in | 7.06 | cm2 | Tare Wt: | 219.71 | Tare Wt: | 151.95 |
| Length : | 2.78 | in | 7.06 | cm | Dry Wt.: | 368.32 | Dry Wt.: | 473.15 |
| Area: | 6.06 | in^2 | 39.10 | cm2 | Water Wt.: | 72.68 | Water Wt.: | 108.62 |
| Volume : | 16.85 | in^3 | 276.12 | cm3 | % moist.: | **19.7** | % moist.: | **23.0** |
| Unit Wt.(wet): | **129.15** | pcf | **2.07** | g/cm^3 | | | | |
| Unit Wt.(dry): | **107.87** | pcf | **1.73** | g/cm^3 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Specific Gravity: | **2.80** | Max Dry Density(pcf) = | 107.9147 | OMC = | 19.732841 |
| | | % of max = | 100.0 | +/- OMC = | 0.00 |
| Calculated % saturation: | 103.59 | Void ratio (e) = | **0.62** | Porosity (n)= | **0.38** |

### TEST READINGS

Z1(Mercury Height Difference @ t1): 5.1 cm  Hydraulic Gradient = 9.12

| Date | elapsed t (seconds) | Z (pipet @ t) | ΔZπ (cm ) | temp (deg C) | α (temp corr) | k (cm/sec) | k (ft./day) | Reset = * |
|---|---|---|---|---|---|---|---|---|
| 11/3/2009 | 76 | 4.5 | 2.1571965 | 24.5 | 0.899 | 2.96E-06 | 8.40E-03 | |
| 11/3/2009 | 106 | 4 | 2.6571965 | 24.5 | 0.899 | 2.86E-06 | 8.11E-03 | |
| 11/3/2009 | 140 | 3.5 | 3.1571965 | 24.5 | 0.899 | 2.87E-06 | 8.12E-03 | |
| 11/3/2009 | 182 | 3 | 3.6571965 | 24.5 | 0.899 | 2.92E-06 | 8.29E-03 | |

### SUMMARY

ka = 2.90E-06 cm/sec  Acceptance criteria = 25 %

| ki | | Vm | | |
|---|---|---|---|---|
| k1 = | 2.96E-06 cm/sec | 2.1 | % | Vm = \| ka-ki \| / ka x 100 |
| k2 = | 2.86E-06 cm/sec | 1.4 | % | |
| k3 = | 2.87E-06 cm/sec | 1.3 | % | |
| k4 = | 2.92E-06 cm/sec | 0.7 | % | |

| | | | | | |
|---|---|---|---|---|---|
| Hydraulic conductivity | k = | **2.90E-06** | cm/sec | **8.23E-03** | ft/day |
| Void Ratio | e = | **0.62** | | | |
| Porosity | n = | **0.38** | | | |
| Bulk Density | γ = | **2.07** | g/cm3 | **129.2** | pcf |
| Water Content | W = | **0.34** | cm3/cm3 | ( at 20 deg C) | |
| Intrinsic Permeability | kint = | **2.97E-11** | cm2 | ( at 20 deg C) | |

| | | |
|---|---|---|
| Liquid Limit LL | | |
| Plastic Limit PL | | |
| **Plasticity Index PI** | | |
| - 200 Sieve | | % |
| + No 40 Sieve | | % |
| + No 4 Sieve | | % |

Respectfully Submitted

Robert M. Duke, P.E.


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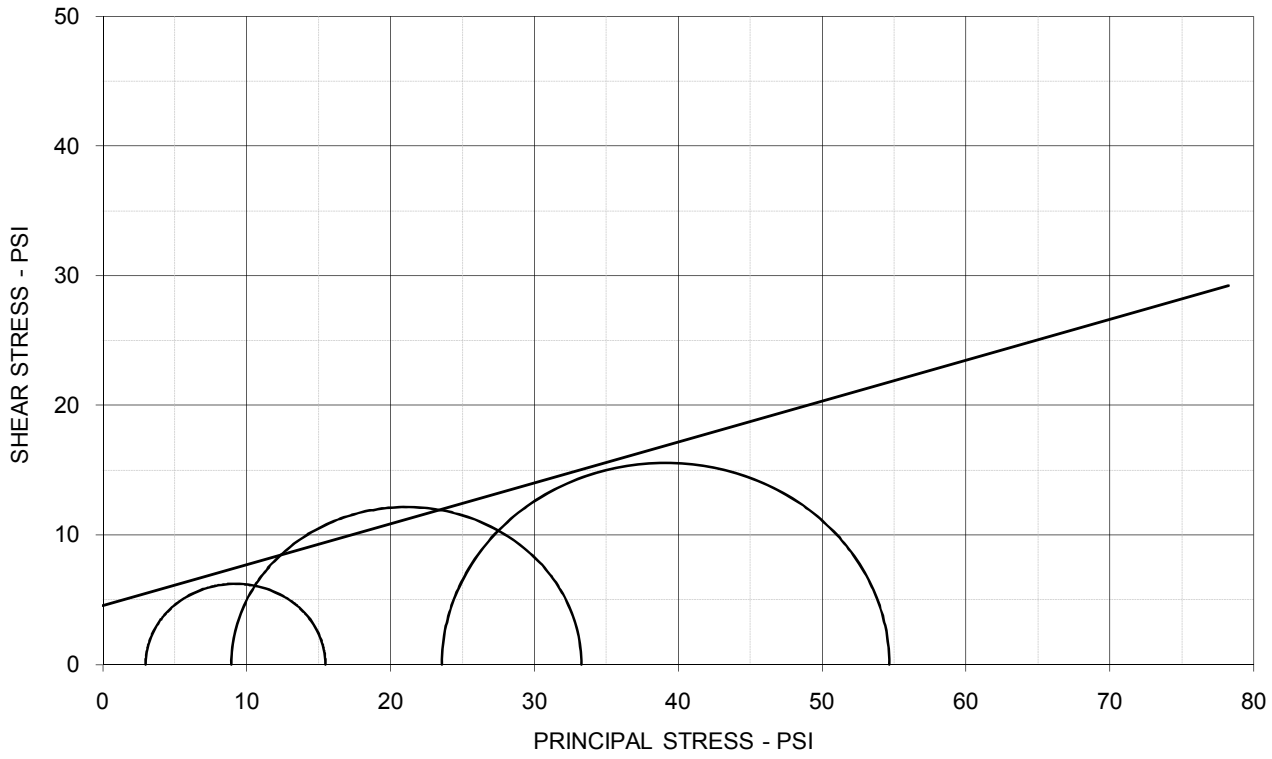
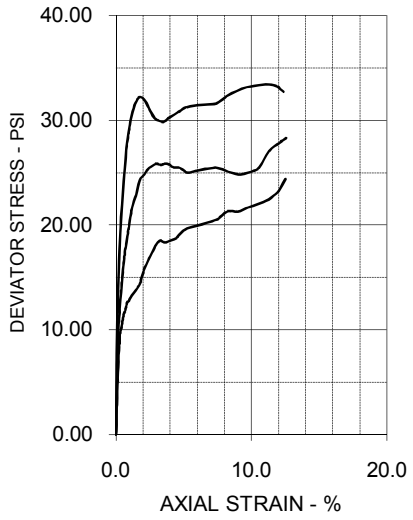
# TRIAXIAL SHEAR TEST REPORT




| EFFECTIVE STRESS PARAMETERS | $\phi$ ' = 17.5 deg | c' = 4.6 psi | | |
|---|---|---|---|---|
| SPECIMEN NO. | 1 | 2 | 3 | 4 |
| INITIAL | | | | |
| Moisture Content - % | 25.3 | 23.6 | 23.9 | |
| Dry Density - pcf | 96.5 | 100.5 | 101.1 | |
| Diameter - inches | 2.05 | 2.02 | 2.04 | |
| Height - inches | 3.98 | 4.00 | 3.95 | |
| AT TEST | | | | |
| Final Moisture - % | 28.8 | 28.1 | 24.5 | |
| Dry Density - pcf | 96.5 | 102.9 | 104.0 | |
| Calculated Diameter (in.) | 2.07 | 2.01 | 2.03 | |
| Height - inches | 4.02 | 3.98 | 3.91 | |
| Effect. Cell Pressure - psi | 10.0 | 20.0 | 40.0 | |
| Failure Stress - psi | 12.49 | 24.34 | 31.06 | |
| Total Pore Pressure - psi | 57.0 | 61.1 | 66.4 | |
| Strain Rate - inches/min. | 0.00050 | 0.00050 | 0.00050 | |
| Failure Strain - % | 1.0 | 2.1 | 1.5 | |
| $\sigma_1$' Failure - psi | 15.49 | 33.26 | 54.65 | |
| $\sigma_3$' Failure - psi | 3.00 | 8.92 | 23.59 | |




## TEST DESCRIPTION

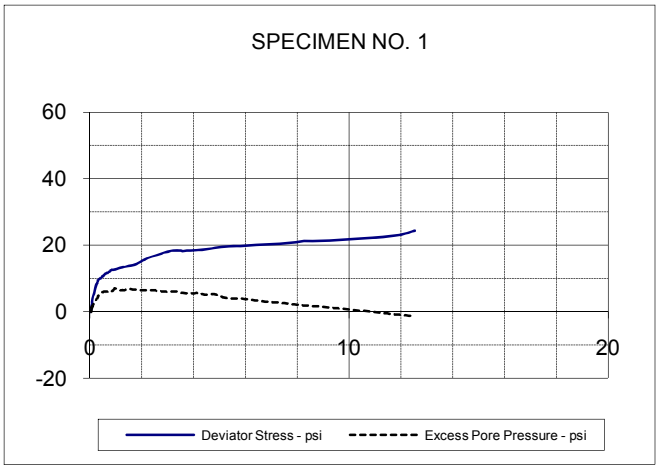
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand
Sampled on Site, W-1 13' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 5%
LL: 56 PL: 18 PI: 38 Percent -200: 71%
REMARKS: Both Ends and Diameter Trimmed + # 4 Sieve 0%

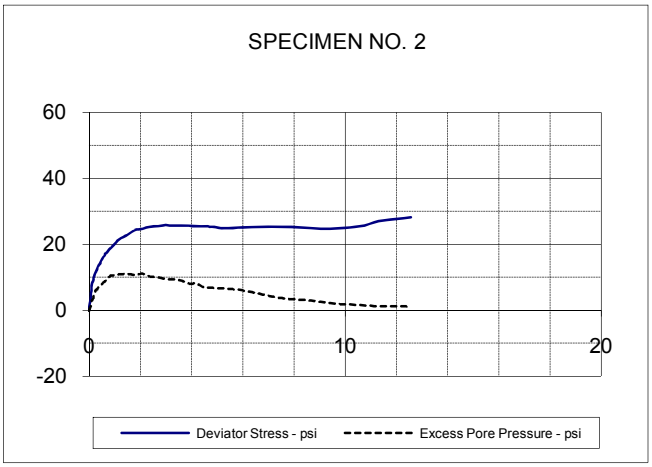
## PROJECT INFORMATION

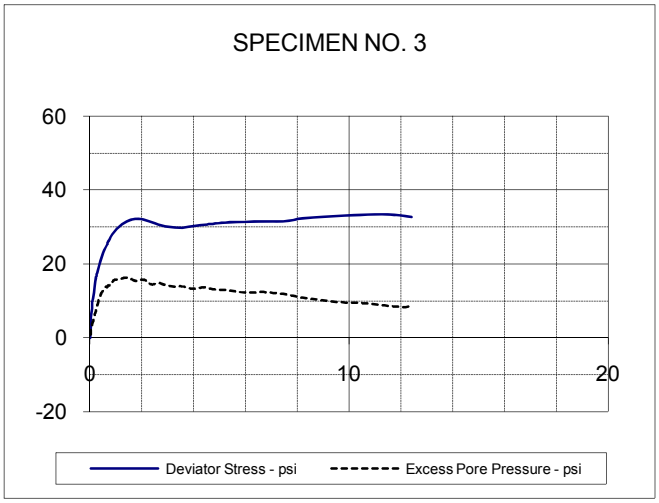
PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

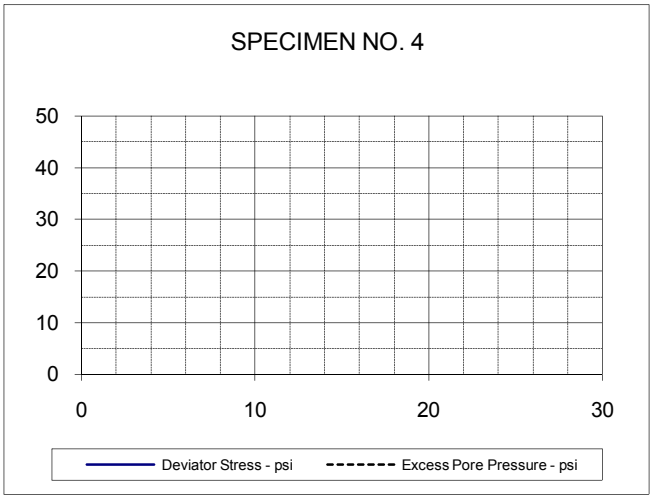
**ETTL ENGINEERS & CONSULTANTS**

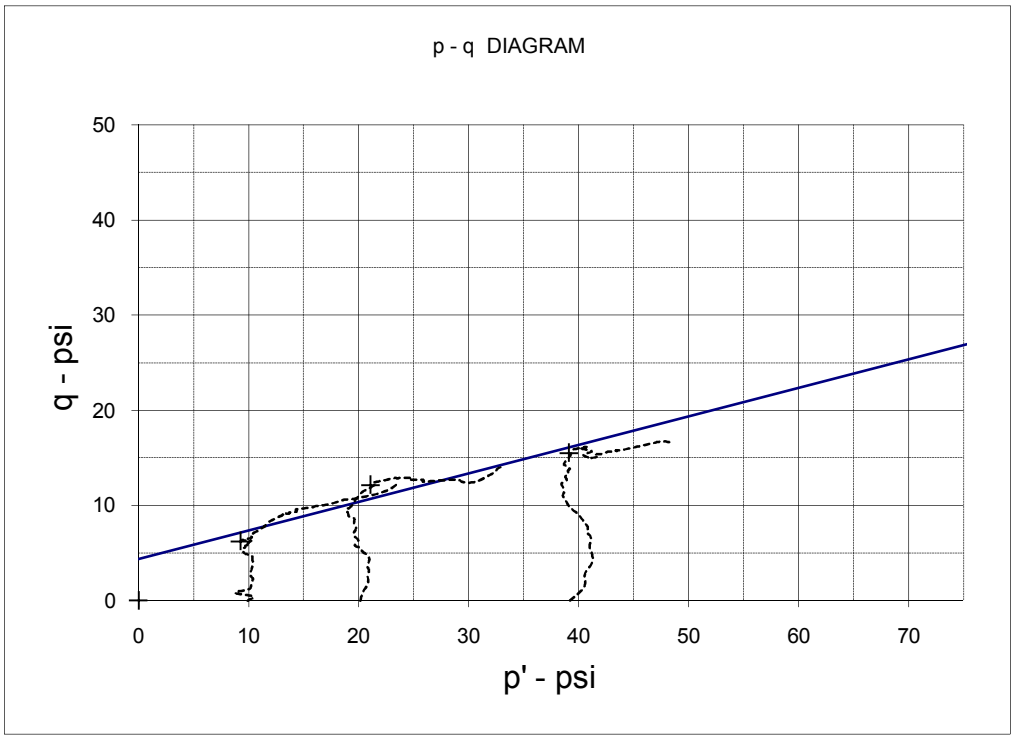
PLATE: B.1



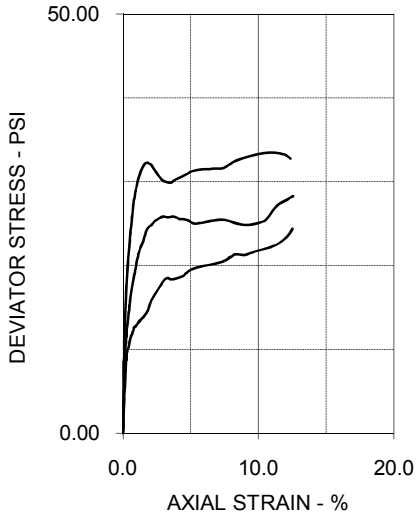




| | | | |
|---|---|---|---|
| EFFECTIVE STRESS PARAMETERS | $R^2$ = 0.93 | $\alpha$ (deg) = 16.7 | a (psi) = 4.4 |
| PROJECT: Pirkey Power Plant Embankments | | TYPE OF TEST & NO: CU with PP | |
| PROJECT NO: G 3241 - 095 | | **ETTL ENGINEERS & CONSULTANTS** | PLATE: B.2 |
| DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand | | | |

# TRIAXIAL SHEAR TEST REPORT


| TOTAL STRESS PARAMETERS | $\phi$ = 13.3 deg | c = 3.5 psi |
|---|---|---|




| SPECIMEN NO. | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| INITIAL | | | | |
| Moisture Content - % | 25.3 | 23.6 | 23.9 | |
| Dry Density - pcf | 96.5 | 100.5 | 101.1 | |
| Diameter - inches | 2.05 | 2.02 | 2.04 | |
| Height - inches | 3.98 | 4.00 | 3.95 | |
| AT TEST | | | | |
| Final Moisture - % | 28.8 | 28.1 | 24.5 | |
| Dry Density - pcf | 96.5 | 102.9 | 104.0 | |
| Calculated Diameter (in.) | 2.07 | 2.01 | 2.03 | |
| Height - inches | 4.02 | 3.98 | 3.91 | |
| Effect. Cell Pressure - psi | 10.0 | 20.0 | 40.0 | |
| Failure Stress - psi | 12.49 | 24.34 | 31.06 | |
| Total Pore Pressure - psi | 57.0 | 61.1 | 66.4 | |
| Strain Rate - inches/min. | 0.00050 | 0.00050 | 0.00050 | |
| Failure Strain - % | 1.0 | 2.1 | 1.5 | |
| $\sigma_1$ Failure - psi | 22.49 | 44.34 | 71.06 | |
| $\sigma_3$ Failure - psi | 10.00 | 20.00 | 40.00 | |

## TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand
Sampled on Site, W-1 13' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 5%
LL: 56 PL: 18 PI: 38 Percent -200: 71%
REMARKS: Both Ends and Diameter Trimmed + # 4 Sieve 0%

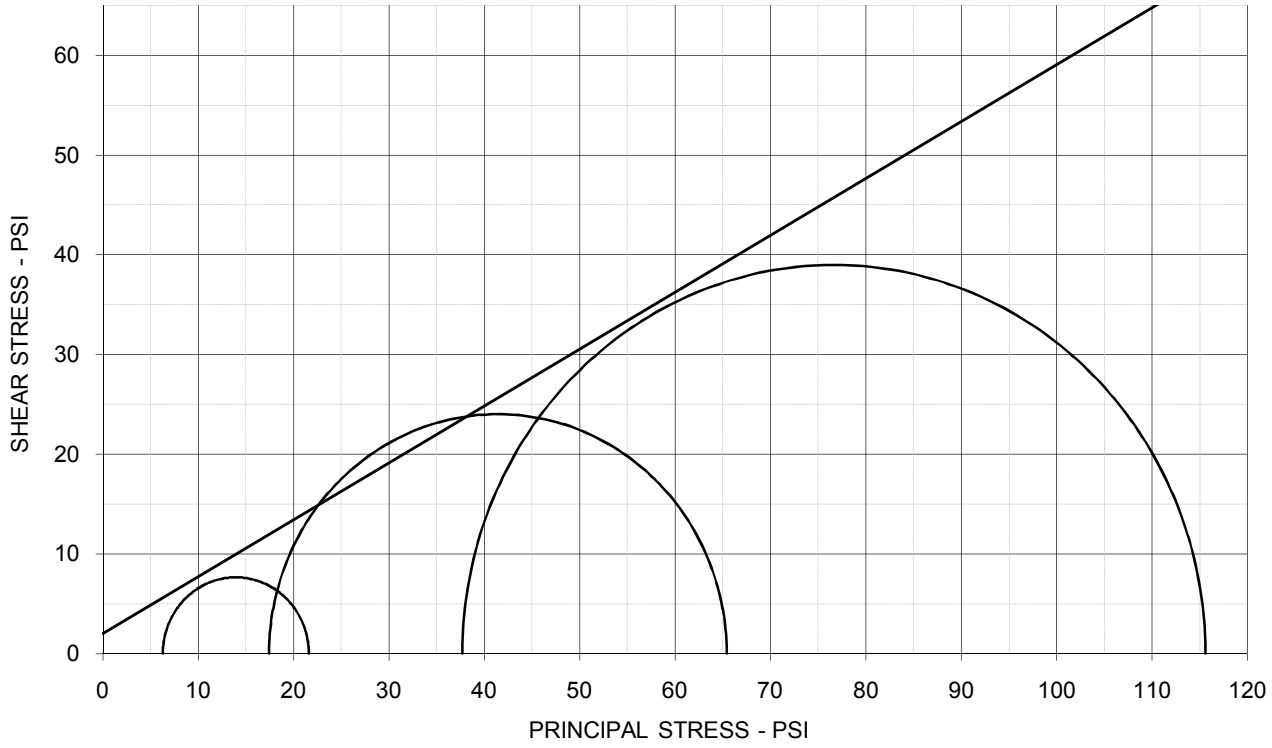
## PROJECT INFORMATION

PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

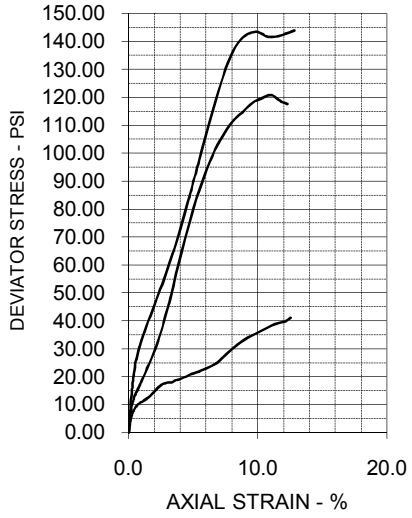
**ETTL ENGINEERS & CONSULTANTS**

PLATE: B.3

# TRIAXIAL SHEAR TEST REPORT




| EFFECTIVE STRESS PARAMETERS | $\phi$ ' = 29.7 deg | c' = 2.0 psi | | |
|---|---|---|---|---|
| SPECIMEN NO. | 1 | 2 | 3 | 4 |
| INITIAL | | | | |
| Moisture Content - % | 18.7 | 19.2 | 18.5 | |
| Dry Density - pcf | 108.5 | 105.5 | 104.8 | |
| Diameter - inches | 2.04 | 2.04 | 2.02 | |
| Height - inches | 4.25 | 4.18 | 4.37 | |
| AT TEST | | | | |
| Final Moisture - % | 21.3 | 21.7 | 20.7 | |
| Dry Density - pcf | 108.9 | 106.7 | 106.7 | |
| Calculated Diameter (in.) | 2.03 | 2.02 | 2.00 | |
| Height - inches | 4.21 | 4.13 | 4.31 | |
| Effect. Cell Pressure - psi | 10.0 | 20.0 | 40.0 | |
| Failure Stress - psi | 15.27 | 47.96 | 77.89 | |
| Total Pore Pressure - psi | 63.7 | 52.6 | 52.3 | |
| Strain Rate - inches/min. | 0.00050 | 0.00050 | 0.00050 | |
| Failure Strain - % | 2.1 | 3.2 | 4.3 | |
| $\sigma_1$' Failure - psi | 21.58 | 65.38 | 115.61 | |
| $\sigma_3$' Failure - psi | 6.31 | 17.42 | 37.72 | |




## TEST DESCRIPTION

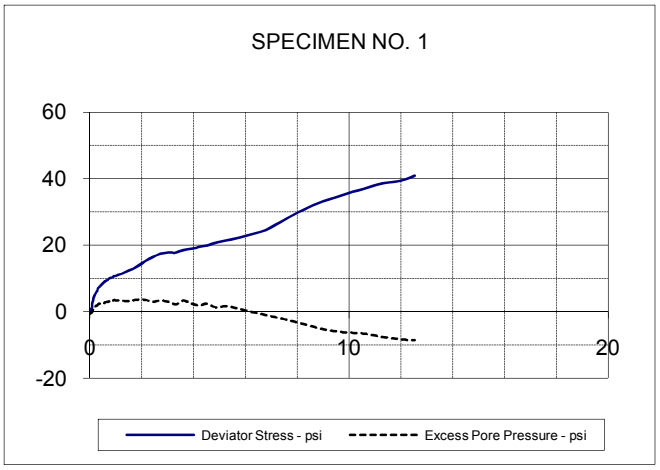
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Shelby Tube Sample
DESCRIPTION: Dark Gray Clayey Sand
Sampled on Site, W-1 38' to 41' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 1%
LL: 29 PL: 19 PI: 10 Percent -200: 25%
REMARKS: Diameter and Both Ends Trimmed. + # 4 Sieve 0%

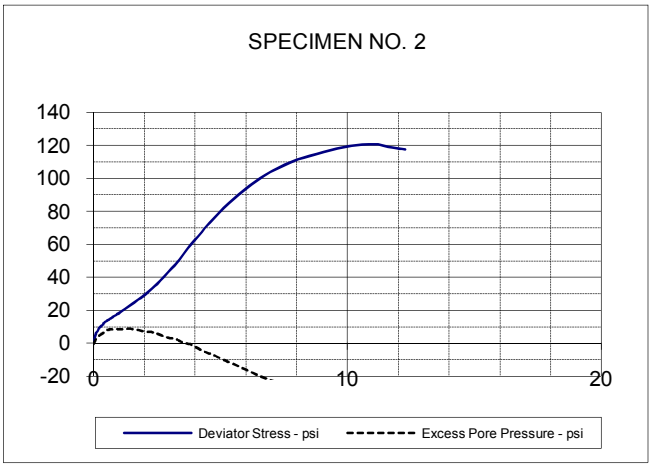
## PROJECT INFORMATION

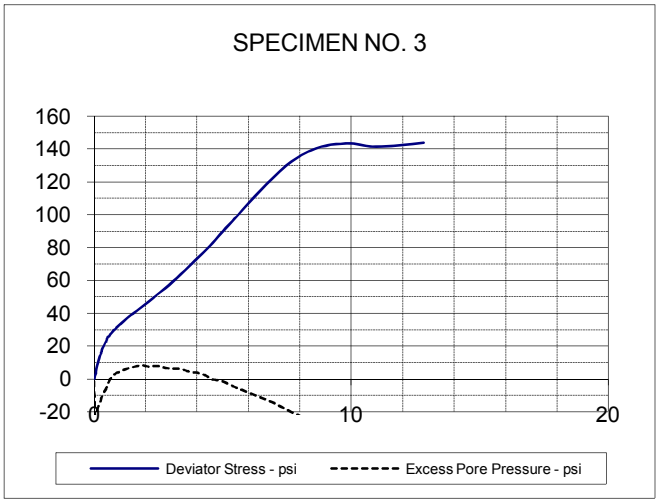
PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

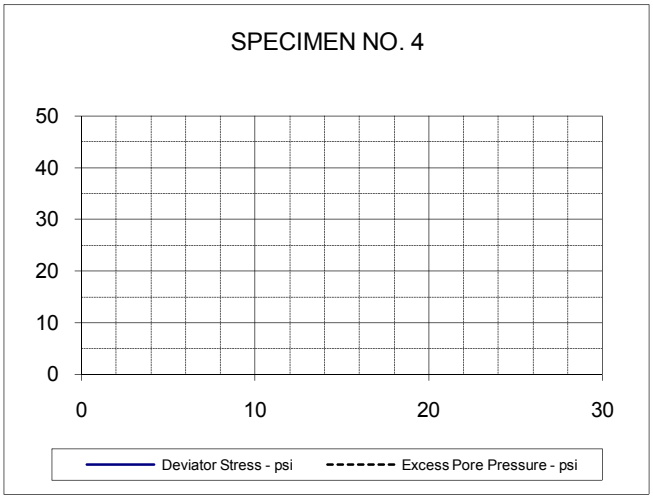
**ETTL ENGINEERS & CONSULTANTS**

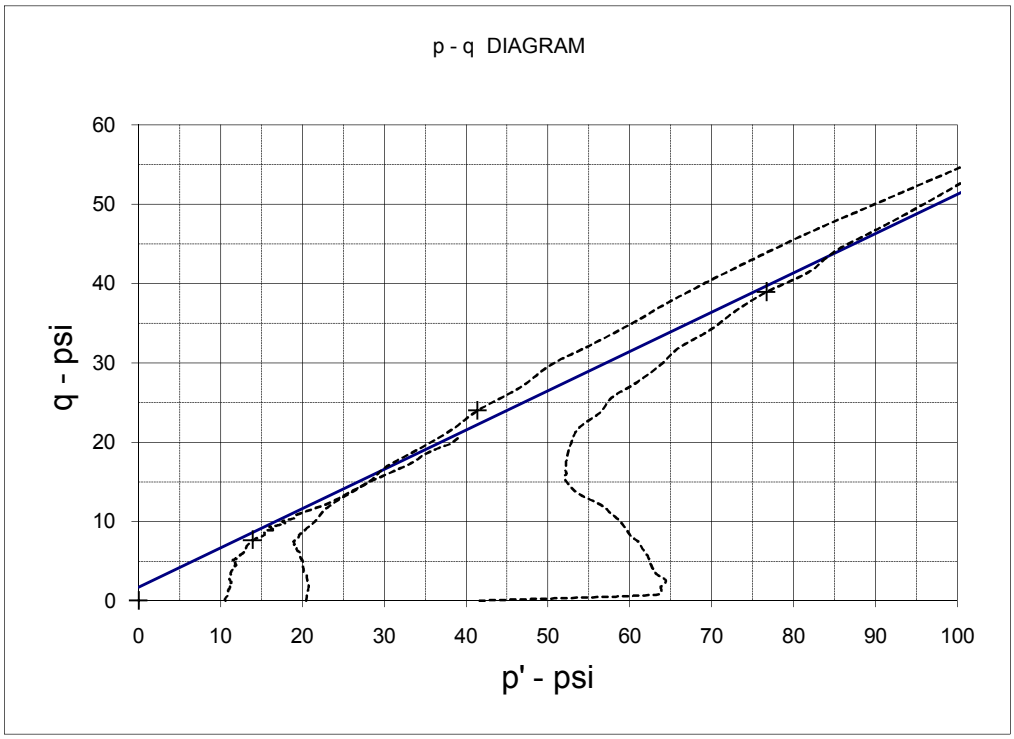
PLATE: B.1



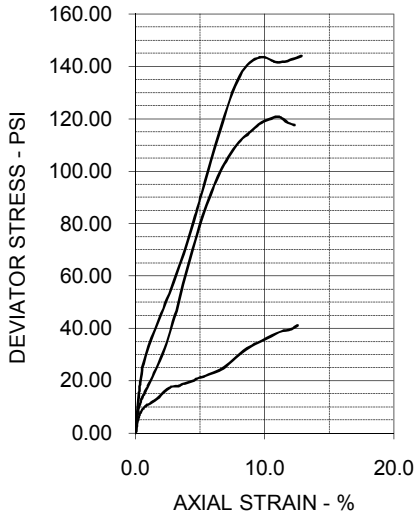




| | | | |
|---|---|---|---|
| EFFECTIVE STRESS PARAMETERS | $R^2$ = 0.99 | $\alpha$ (deg) = 26.4 | a (psi) = 1.7 |
| PROJECT: Pirkey Power Plant Embankments | | TYPE OF TEST & NO: CU with PP | |
| PROJECT NO: G 3241 - 095 | | **ETTL ENGINEERS & CONSULTANTS** | PLATE: B.2 |
| DESCRIPTION: Dark Gray Clayey Sand | | | |

# TRIAXIAL SHEAR TEST REPORT


| TOTAL STRESS PARAMETERS | $\phi$ = 30.4 deg | c = -0.2 psi |
|---|---|---|




| SPECIMEN NO. | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| INITIAL | | | | |
| Moisture Content - % | 18.7 | 19.2 | 18.5 | |
| Dry Density - pcf | 108.5 | 105.5 | 104.8 | |
| Diameter - inches | 2.04 | 2.04 | 2.02 | |
| Height - inches | 4.25 | 4.18 | 4.37 | |
| AT TEST | | | | |
| Final Moisture - % | 21.3 | 21.7 | 20.7 | |
| Dry Density - pcf | 108.9 | 106.7 | 106.7 | |
| Calculated Diameter (in.) | 2.03 | 2.02 | 2.00 | |
| Height - inches | 4.21 | 4.13 | 4.31 | |
| Effect. Cell Pressure - psi | 10.0 | 20.0 | 40.0 | |
| Failure Stress - psi | 15.27 | 47.96 | 77.89 | |
| Total Pore Pressure - psi | 63.7 | 52.6 | 52.3 | |
| Strain Rate - inches/min. | 0.00050 | 0.00050 | 0.00050 | |
| Failure Strain - % | 2.1 | 3.2 | 4.3 | |
| $\sigma_1$ Failure - psi | 25.27 | 67.96 | 117.89 | |
| $\sigma_3$ Failure - psi | 10.00 | 20.00 | 40.00 | |

## TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Shelby Tube Sample
DESCRIPTION: Dark Gray Clayey Sand
Sampled on Site, W-1 38' to 41' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 1%
LL: 29 PL: 19 PI: 10 Percent -200: 25%
REMARKS: Diameter and Both Ends Trimmed. + # 4 Sieve 0%

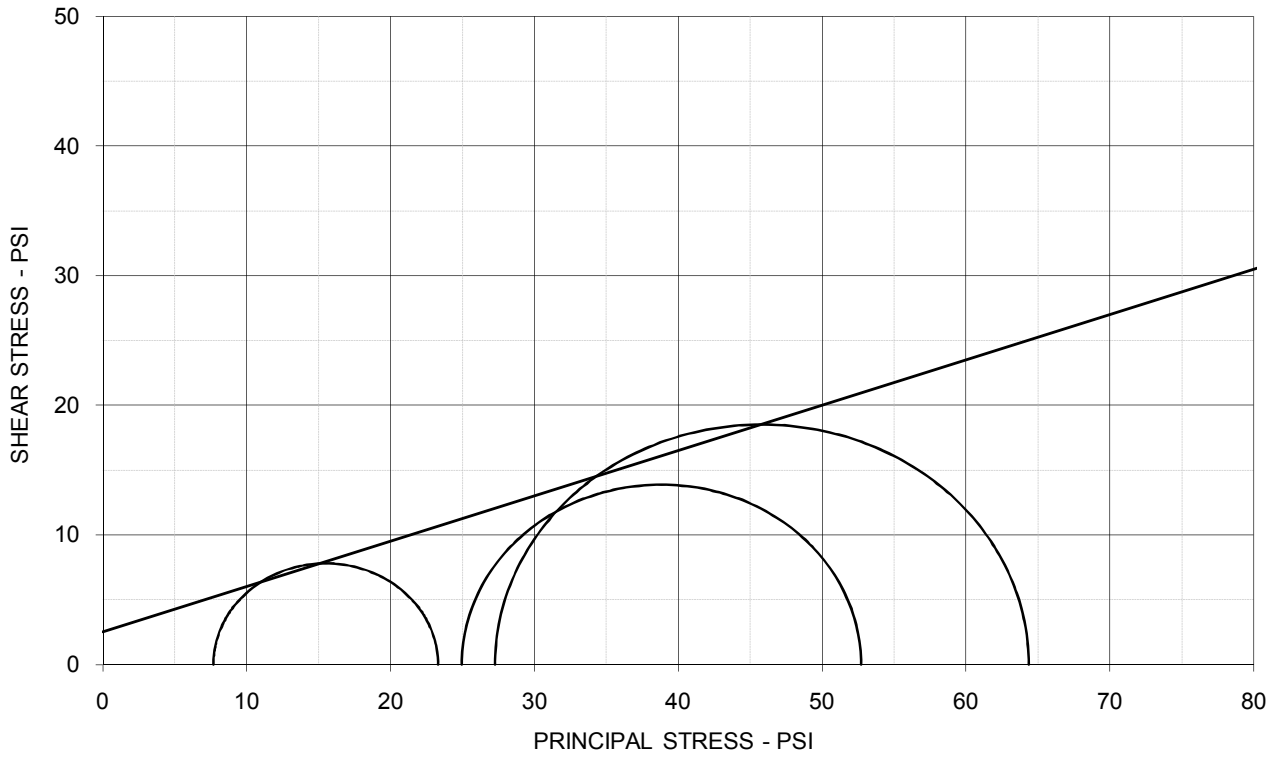
## PROJECT INFORMATION

PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

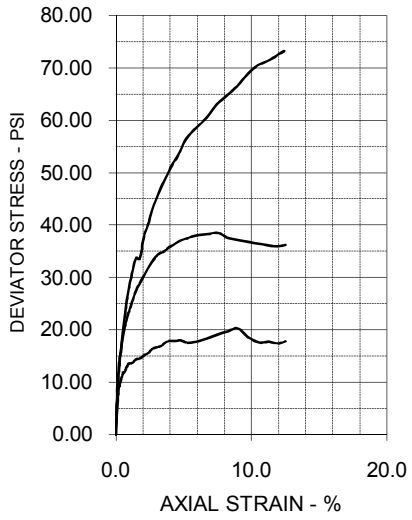
**ETTL ENGINEERS & CONSULTANTS**

PLATE: B.3

# TRIAXIAL SHEAR TEST REPORT




| EFFECTIVE STRESS PARAMETERS | $\phi$ ' = 19.3 deg | c' = 2.5 psi | | |
|---|---|---|---|---|
| SPECIMEN NO. | 1 | 2 | 3 | 4 |
| INITIAL | | | | |
| Moisture Content - % | 23.4 | 21.5 | 23.6 | |
| Dry Density - pcf | 99.0 | 104.7 | 98.6 | |
| Diameter - inches | 1.99 | 2.01 | 2.00 | |
| Height - inches | 4.01 | 3.99 | 4.01 | |
| AT TEST | | | | |
| Final Moisture - % | 27.8 | 20.6 | 27.1 | |
| Dry Density - pcf | 99.4 | 105.8 | 99.5 | |
| Calculated Diameter (in.) | 1.98 | 2.01 | 1.99 | |
| Height - inches | 3.99 | 3.97 | 3.98 | |
| Effect. Cell Pressure - psi | 10.0 | 20.0 | 40.0 | |
| Failure Stress - psi | 15.62 | 27.77 | 37.08 | |
| Total Pore Pressure - psi | 52.3 | 45.0 | 62.7 | |
| Strain Rate - inches/min. | 0.00050 | 0.00050 | 0.00050 | |
| Failure Strain - % | 2.4 | 1.0 | 4.8 | |
| $\sigma_1$' Failure - psi | 23.30 | 52.73 | 64.35 | |
| $\sigma_3$' Failure - psi | 7.68 | 24.96 | 27.27 | |




## TEST DESCRIPTION

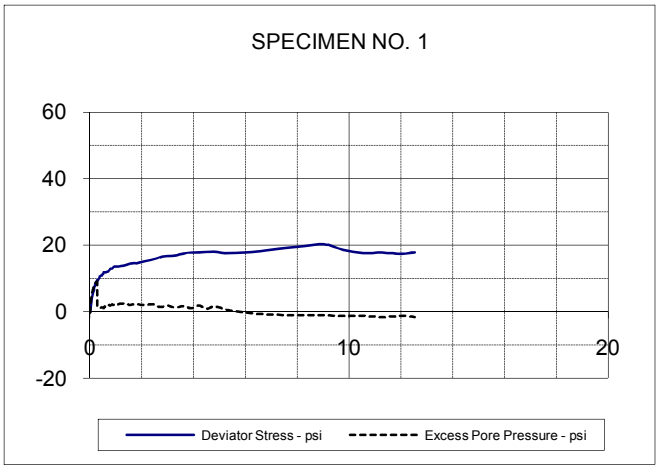
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand
Sampled on Site, W-3 10' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 6%
LL: 68 PL: 22 PI: 46 Percent -200: 80%
REMARKS: Both Ends and Diameter Trimmed + # 4 Sieve 0%

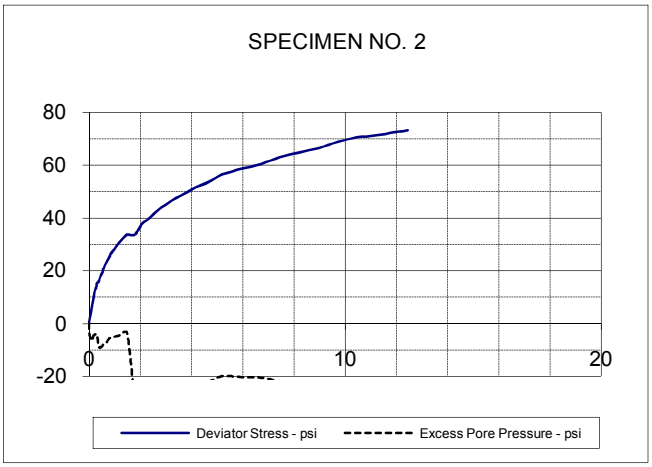
## PROJECT INFORMATION

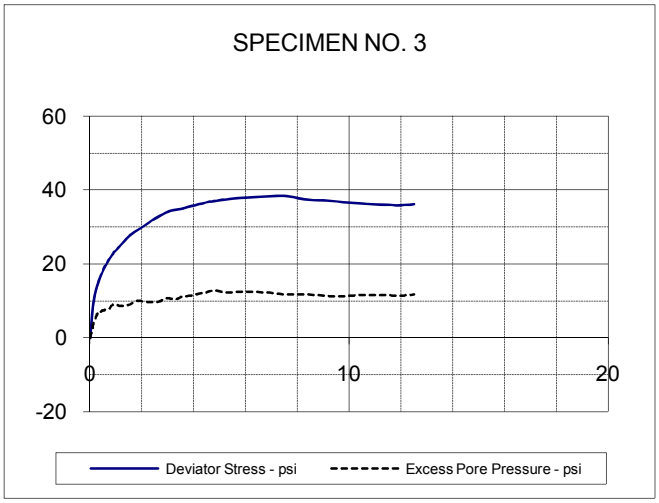
PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

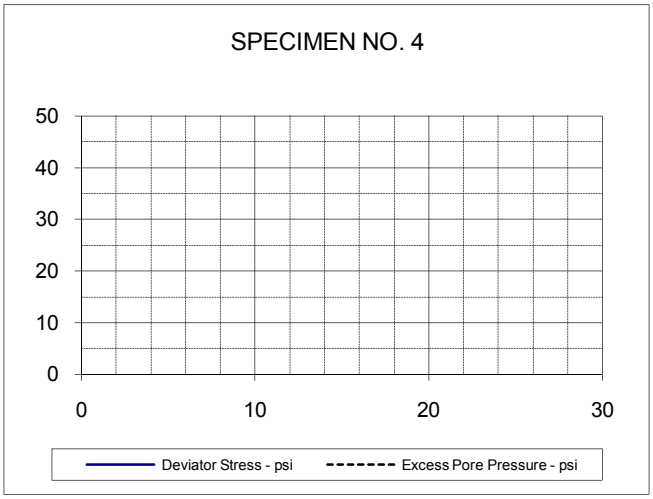
**ETTL ENGINEERS & CONSULTANTS**

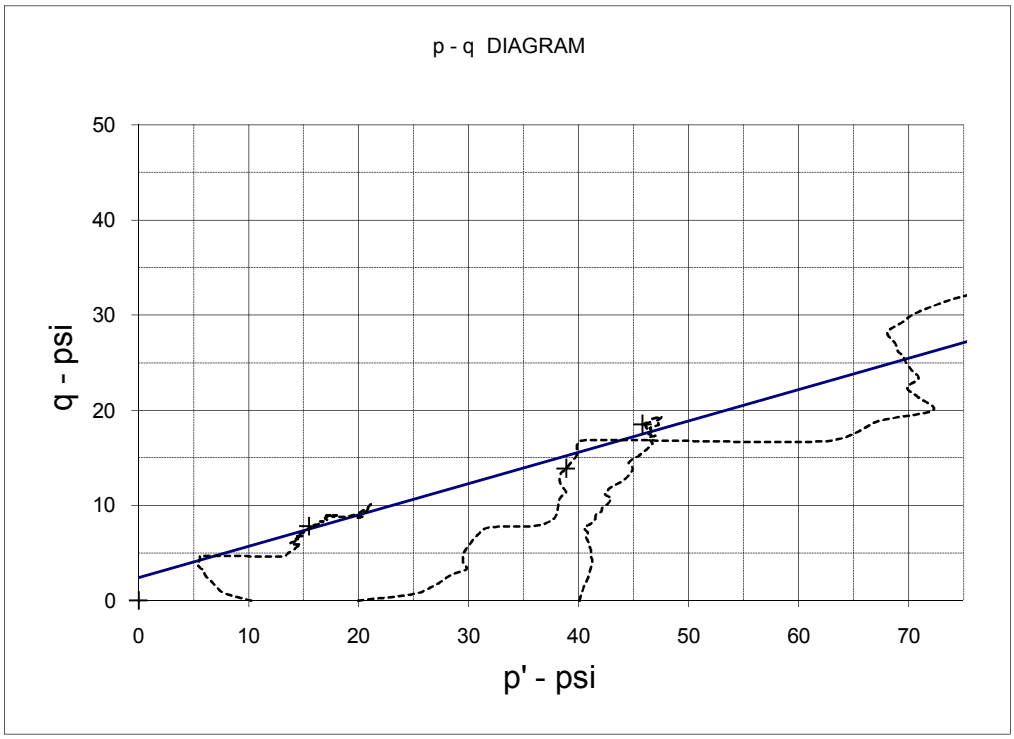
PLATE: B.1



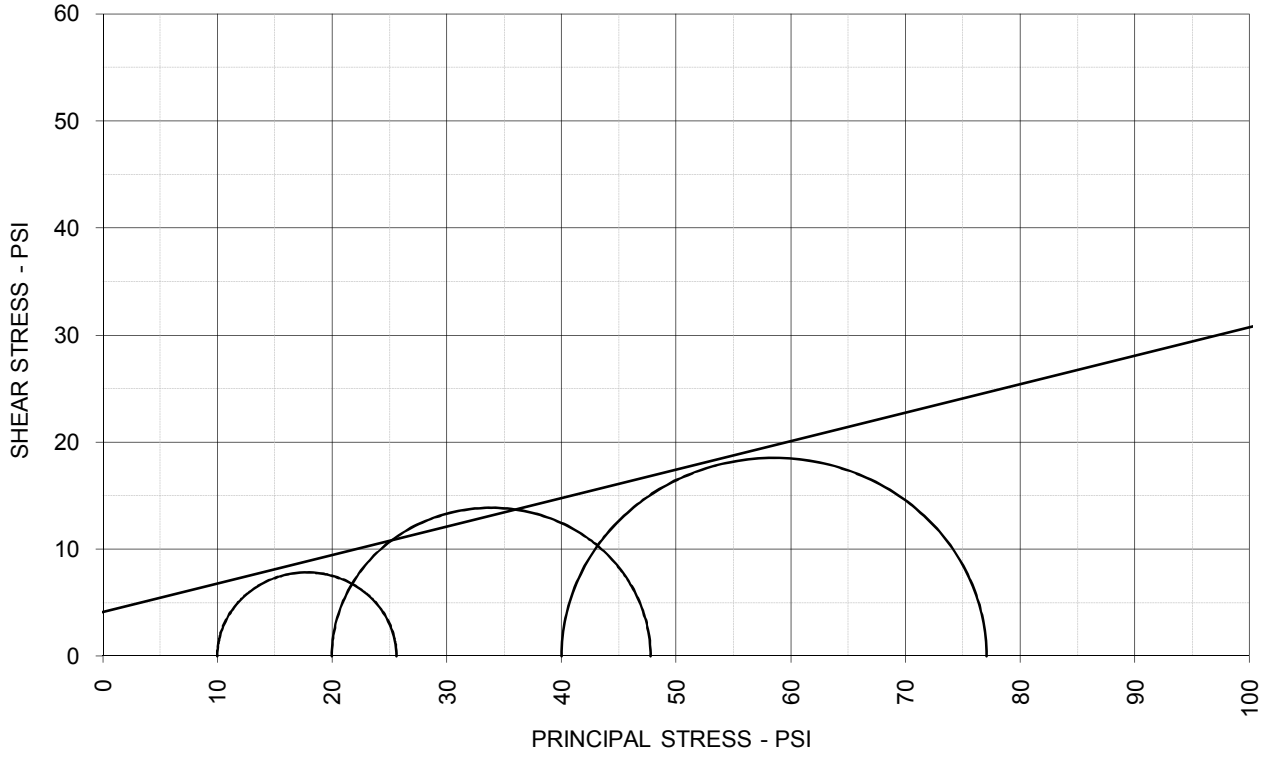



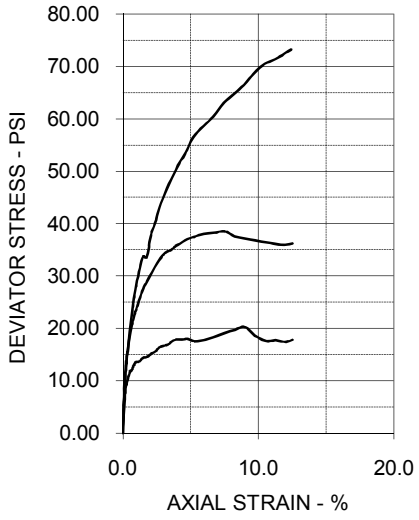

| | | | |
|---|---|---|---|
| EFFECTIVE STRESS PARAMETERS | $R^2$ = 0.95 | $\alpha$ (deg) = 18.3 | a (psi) = 2.4 |
| PROJECT: Pirkey Power Plant Embankments | | TYPE OF TEST & NO: CU with PP | |
| PROJECT NO: G 3241 - 095 | | **ETTL ENGINEERS & CONSULTANTS** | PLATE: B.2 |
| DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand | | | |

G 3241-095, W-3 10'-20'.xls

# TRIAXIAL SHEAR TEST REPORT




| TOTAL STRESS PARAMETERS | $\phi$ = 14.9 deg | c = 4.1 psi |
|---|---|---|




| SPECIMEN NO. | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| INITIAL | | | | |
| Moisture Content - % | 23.4 | 21.5 | 23.6 | |
| Dry Density - pcf | 99.0 | 104.7 | 98.6 | |
| Diameter - inches | 1.99 | 2.01 | 2.00 | |
| Height - inches | 4.01 | 3.99 | 4.01 | |
| AT TEST | | | | |
| Final Moisture - % | 27.8 | 20.6 | 27.1 | |
| Dry Density - pcf | 99.4 | 105.8 | 99.5 | |
| Calculated Diameter (in.) | 1.98 | 2.01 | 1.99 | |
| Height - inches | 3.99 | 3.97 | 3.98 | |
| Effect. Cell Pressure - psi | 10.0 | 20.0 | 40.0 | |
| Failure Stress - psi | 15.62 | 27.77 | 37.08 | |
| Total Pore Pressure - psi | 52.3 | 45.0 | 62.7 | |
| Strain Rate - inches/min. | 0.00050 | 0.00050 | 0.00050 | |
| Failure Strain - % | 2.4 | 1.0 | 4.8 | |
| $\sigma_1$ Failure - psi | 25.62 | 47.77 | 77.08 | |
| $\sigma_3$ Failure - psi | 10.00 | 20.00 | 40.00 | |

## TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand
Sampled on Site, W-3 10' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 6%
LL: 68 PL: 22 PI: 46 Percent -200: 80%
REMARKS: Both Ends and Diameter Trimmed + # 4 Sieve 0%

## PROJECT INFORMATION

PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

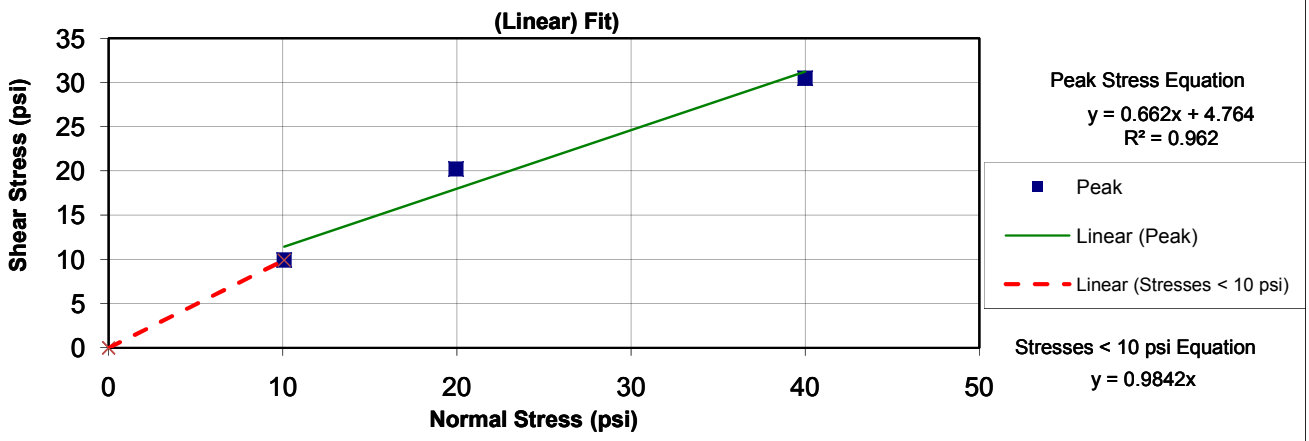
**ETTL ENGINEERS & CONSULTANTS**

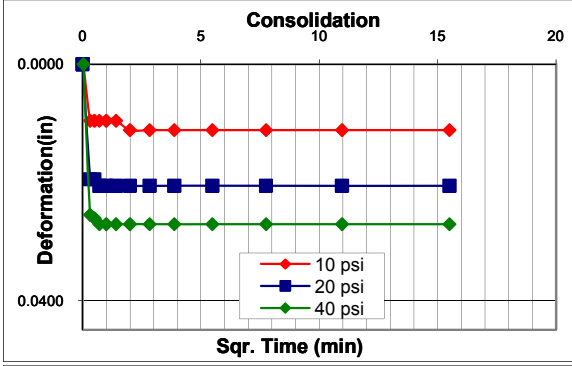
PLATE: B.3

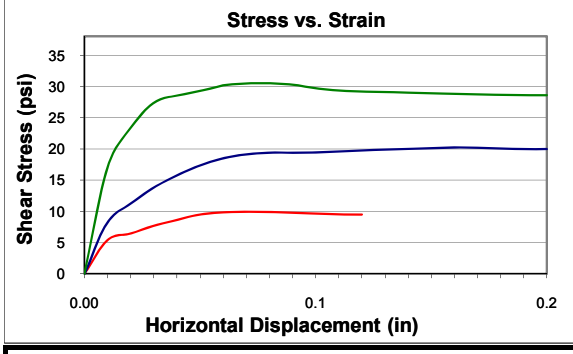
# ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS


## ASTM 3080 Direct Shear Test Report




## Peak Strength Parameters

| | Peak | | Residual | |
|---|---|---|---|---|
| Friction Angle | 33.5 (deg) | | - (deg) | |
| Cohesion | 4.76 (psi) | 686.0 (psf) | - (psi) | - (psf) |
| Friction Angle Stresses < 10psi | | | 44.5 (deg) | |
| Specimen Number | | 1 | 2 | 3 |
| **Initial** | | | | |
| Moisture Content - % | | 18.5% | 18.8% | 21.4% |
| Dry Density- lb/ft$^3$ | | 103.6 | 105.7 | 104.5 |
| Height-inches | | 1.008 | 1.008 | 1.008 |
| Diameter- inches | | 2.50 | 2.50 | 2.50 |
| **Final** | | | | |
| Moisture Content - % | | 24.4% | 22.1% | 24.1% |
| Dry Density- lb/ft$^3$ | | 105.6 | 172.8 | 108.2 |
| Height after shear-(inches) | | 0.997 | 0.620 | 0.978 |
| Height after consolidation (inches) | | 0.997 | 0.987 | 0.981 |
| Normal Stress-(psi) | | 10 | 20 | 40 |
| Peak Failure Stress-(psi) | | 9.92 | 20.23 | 30.49 |
| Residual Failure Stress-(psi) | | - | - | - |
| Strain Rate - (inches/min) | | 0.0029 | 0.0027 | 0.0029 |

## Project Information

| | | | | LL | PL | PI |
|---|---|---|---|---|---|---|
| **Project :** | Pirkey Power Plant Embankments | | | 32 | 17 | 15 |
| **Client:** | AEP | | | | | |
| **Material Origin:** | Hallsville, Tx | | | | | |
| **Material Description:** | Tan & Brown Clayey Sand with ferric seams | | | -200% | 31 | |
| **Job No:** | G 3241-095 | **Technician:** | Owen Sanderson | **Remarks** | | |
| **Boring No:** | W-2 | **Sample Type:** | Shelby Tube | When Calculating stresses < 10 psi: use appropriate Equation above (assuming no Cohesion) | | |
| **Depth:** | 13'-16' | **Sampling method:** | Shelby Tube | | | |
| **Date:** | October 31, 2009 | **Testing Device:** | Soiltest B-124BY 2.5 in. round | | | |

C. Brandon Quinn, P.E.


210 Beech Street
Texarkana, AR 71854
870-772-0013 Phone
870-216-2413 Fax

**1717 East Erwin**
**Tyler, Texas 75702**
**903-595-4421 Phone**
**903-595-6113 Fax**
**www.ettlinc.com**

707 West Cotton Street
Longview, Texas 75604-5505
903-758-0915 Phone
903-758-8245 Fax

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

# Cone Penetration Test

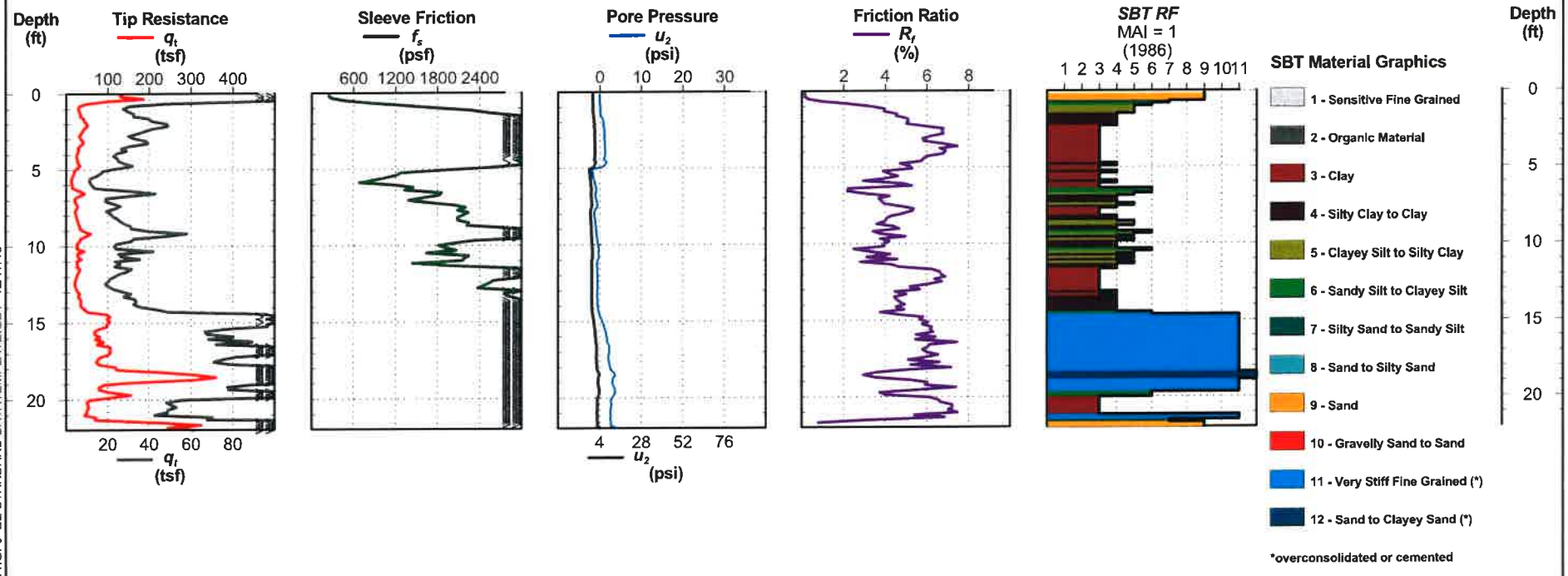
## CPT-1

**Latitude:** 32.46619
**Longitude:** -94.48989

**CPT ID/Net Area Ratio:** DSG0709 / 0.8

**Date:** 12/8/15
**Operator:** P. Thurmond

**Water Depth:** See Text
**Total Depth:** 22.0 ft




Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

# Cone Penetration Test

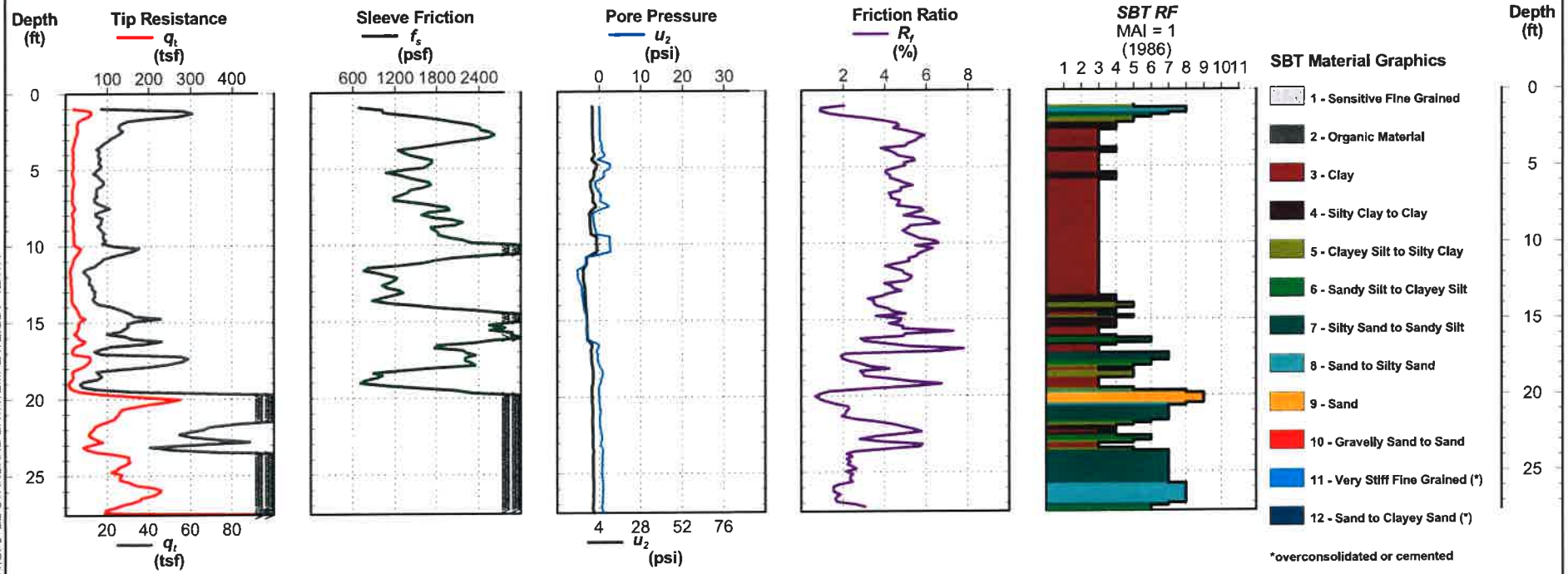
# CPT-2

**CPT ID/Net Area Ratio:** DSG0709 / 0.8

**Date:** 12/8/15
**Operator:** P. Thurmond

**Latitude:** 32.46613
**Longitude:** -94.49157

**Water Depth:** See Text
**Total Depth:** 27.6 ft




Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

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# Cone Penetration Test

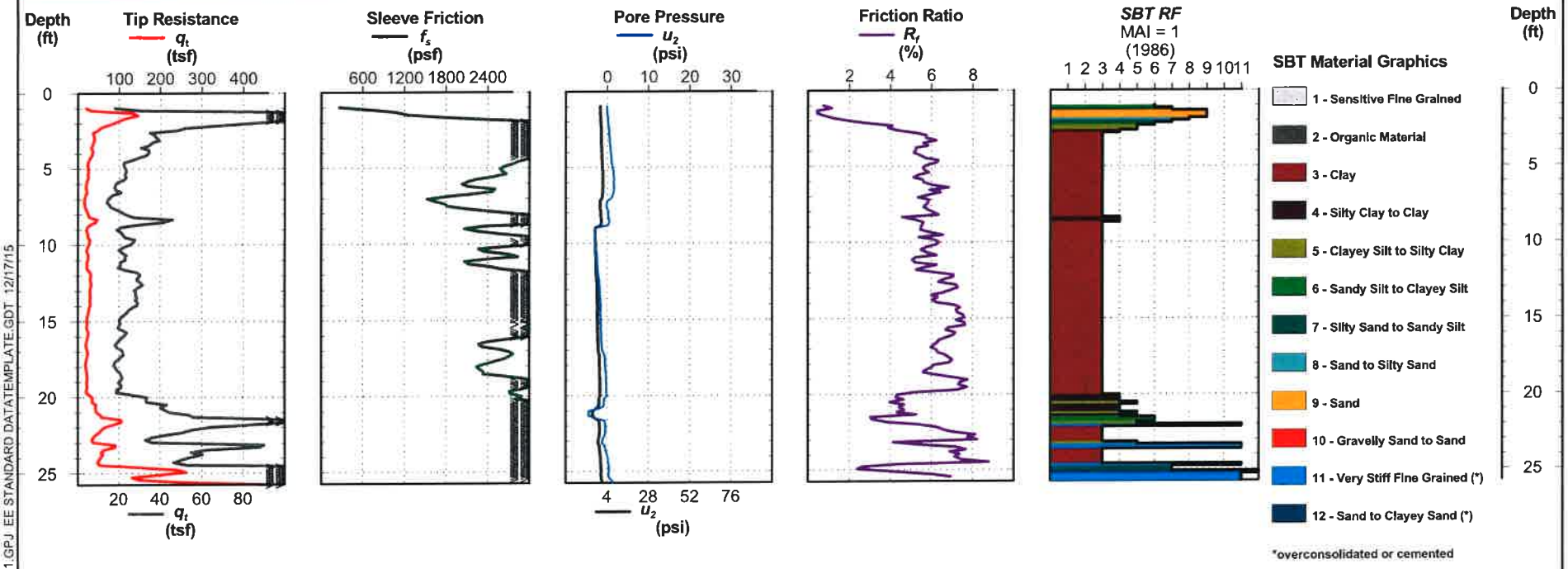
# CPT-3

**CPT ID/Net Area Ratio:** DSG0709 / 0.8

**Latitude:** 32.46587
**Longitude:** -94.49313

**Date:** 12/8/15
**Operator:** P. Thurmond

**Water Depth:** See Text
**Total Depth:** 25.8 ft




Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

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# Cone Penetration Test

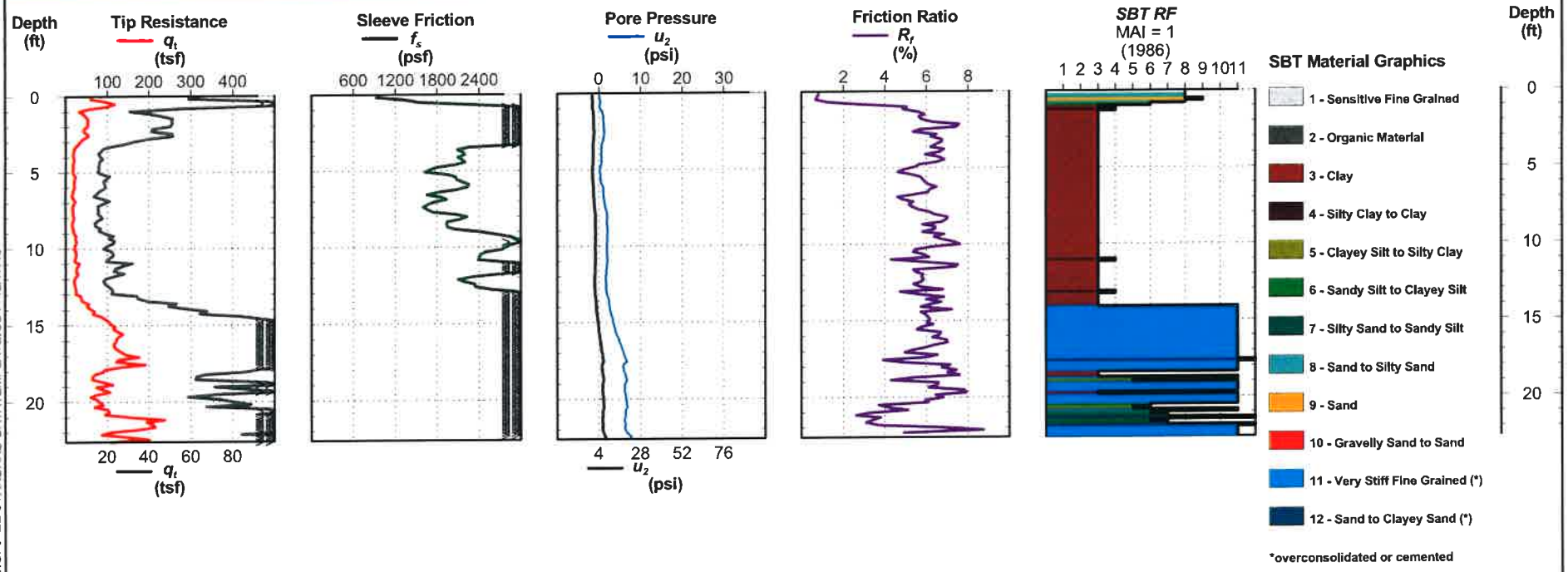
# CPT-4

**CPT ID/Net Area Ratio:** DSG0709 / 0.8

**Date:** 12/8/15
**Operator:** P. Thurmond

**Latitude:** 32.46672
**Longitude:** -94.49400

**Water Depth:** See Text
**Total Depth:** 22.6 ft




Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

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# Cone Penetration Test

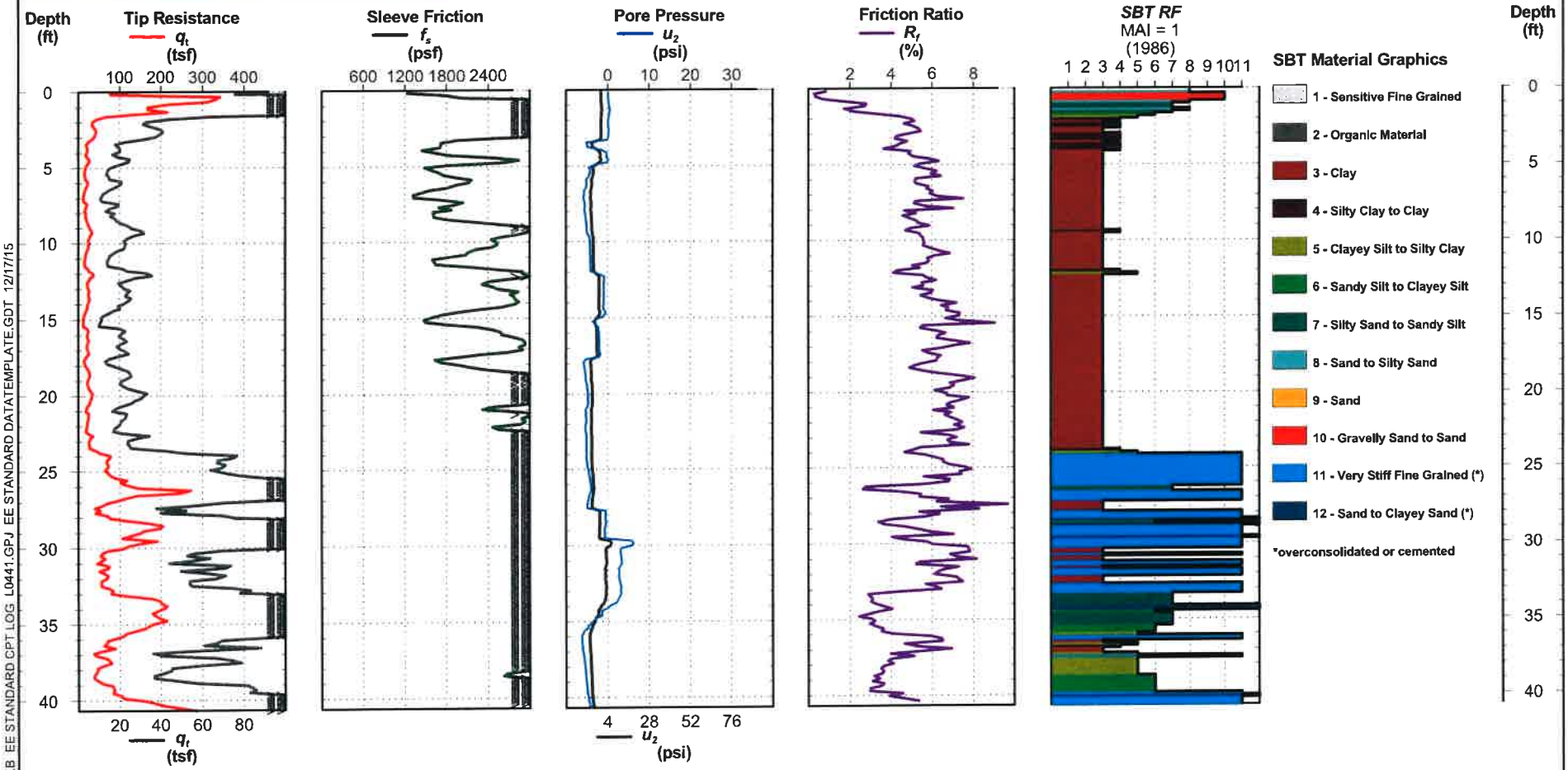
# CPT-5

**CPT ID/Net Area Ratio:** DSG0709 / 0.8

**Latitude:** 32.46803
**Longitude:** -94.49390

**Date:** 12/9/15
**Operator:** P. Thurmond

**Water Depth:** See Text
**Total Depth:** 40.7 ft




Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

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# Cone Penetration Test

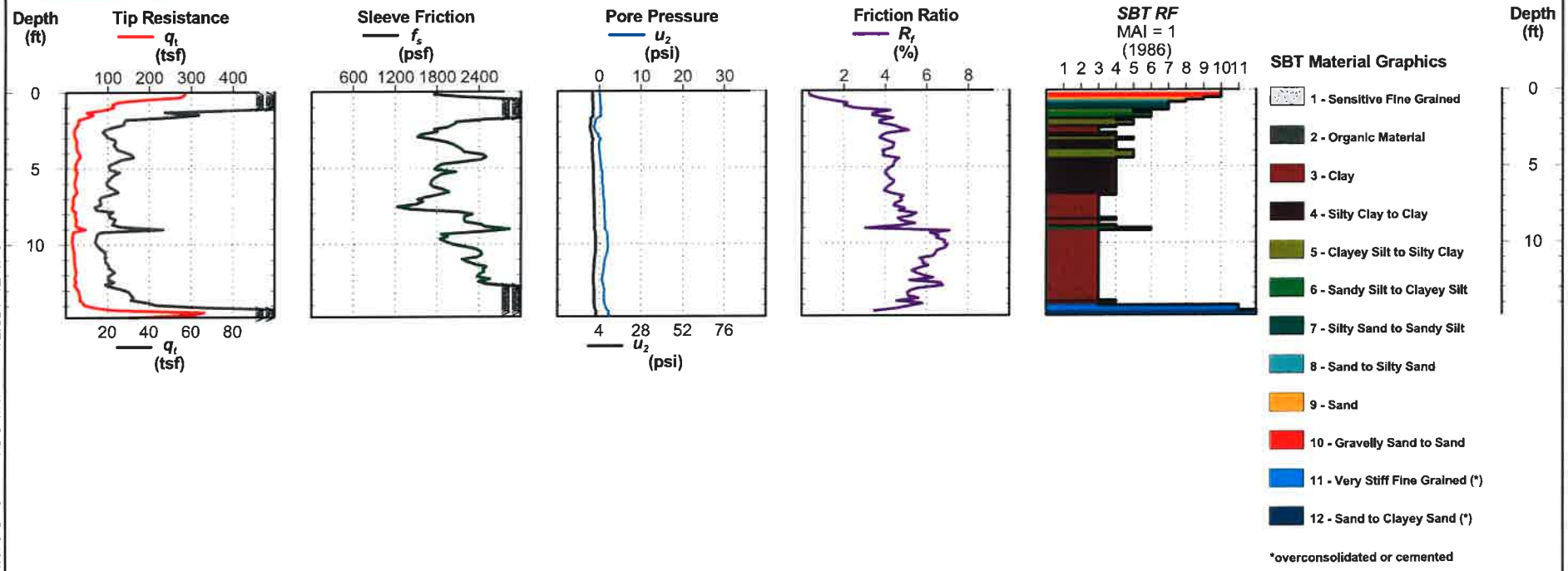
# CPT-6

**Latitude:** 32.46887
**Longitude:** -94.49243

**CPT ID/Net Area Ratio:** DSG0709 / 0.8

**Date:** 12/9/15
**Operator:** P. Thurmond

**Water Depth:** See Text
**Total Depth:** 14.8 ft




Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

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# Cone Penetration Test

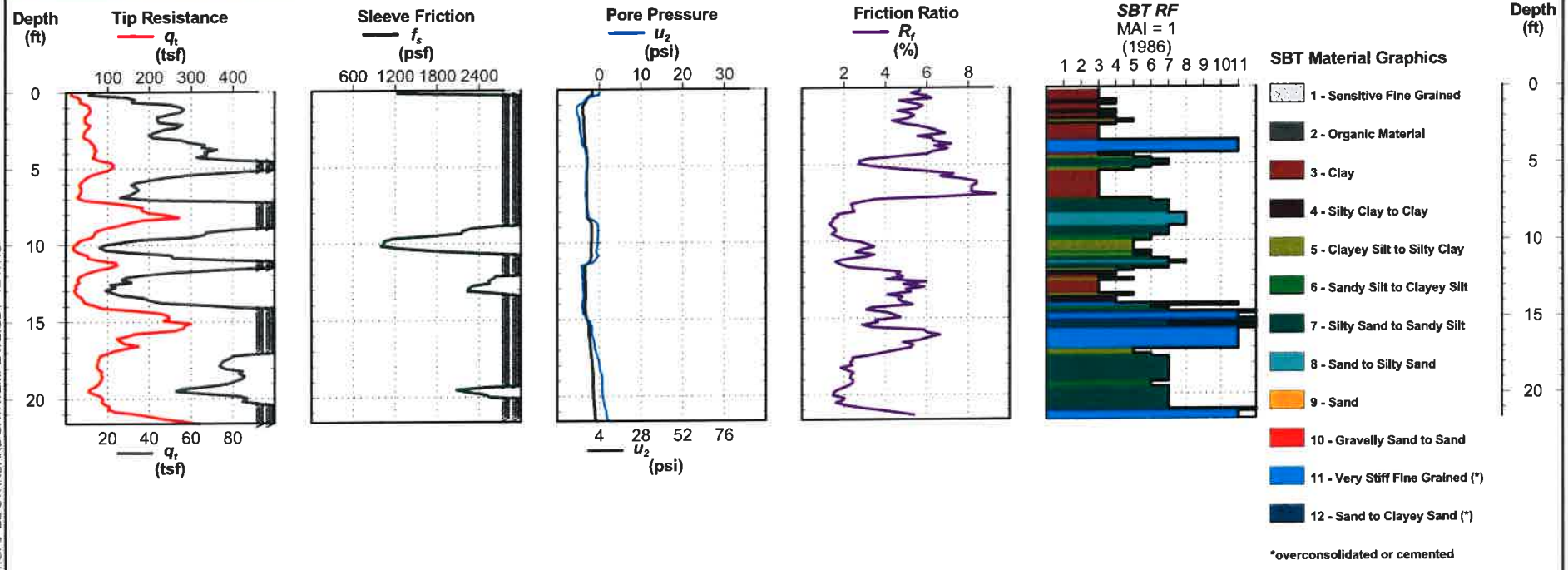
# CPT-7

**CPT ID/Net Area Ratio:** DSG0709 / 0.8

**Latitude:** 32.46572
**Longitude:** -94.49256

**Date:** 12/9/15
**Operator:** P. Thurmond

**Water Depth:** See Text
**Total Depth:** 21.7 ft




Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

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# Cone Penetration Test

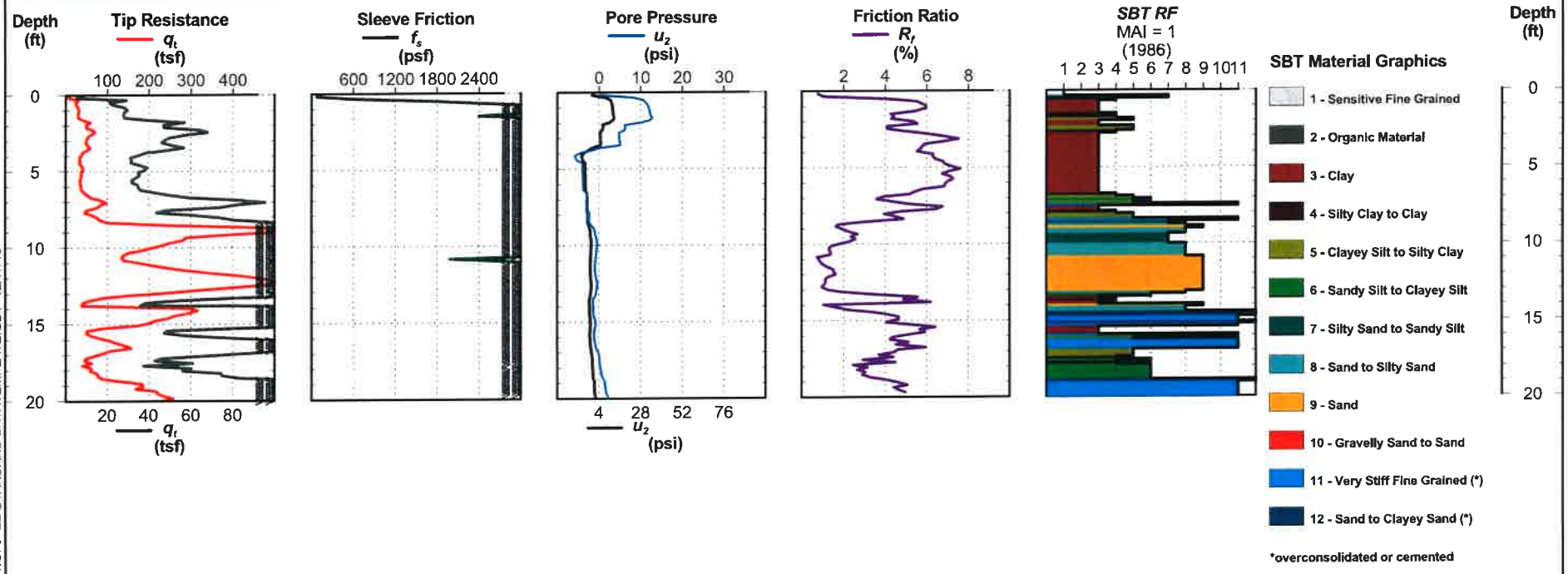
# CPT-8

**CPT ID/Net Area Ratio:** DSG0709 / 0.8

**Latitude:** 32.46603
**Longitude:** -94.49087

**Date:** 12/9/15
**Operator:** P. Thurmond

**Water Depth:** See Text
**Total Depth:** 20.0 ft




Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.