SAFETY FACTOR ASSESSMENT
PERIODIC 5-YEAR REVIEW

30 TAC 352.731 (40 CFR 257.73e)

Primary Bottom Ash Pond

Welsh Plant
Pittsburg, Texas

October, 2021

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

Pittsburg, Texas

Prepared by: American Electric Power Service Corporation

1 Riverside Plaza

Columbus, OH 43215

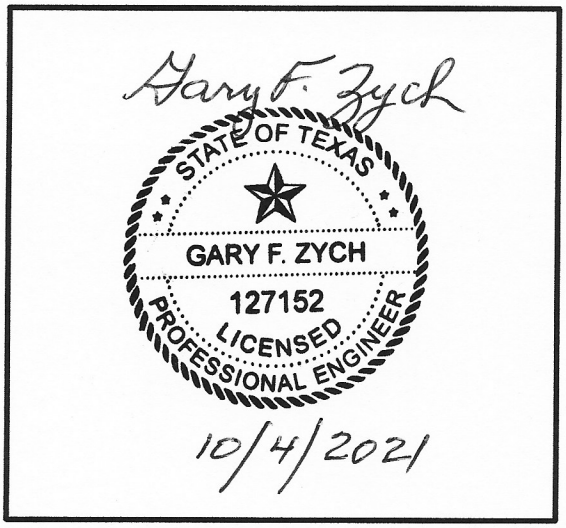
GERS-21-047

SAFETY FACTOR ASSESSMENT
PERIODIC 5-YEAR REVIEW
CFR 257.73(e)
WELSH PLANT
PRIMARY BOTTOM ASH POND

PREPARED BY Brett A. Dreger DATE 10/01/2021
Brett A. Dreger, P.E.

REVIEWED BY _____ DATE 10/01/2021
Mohammad A. Ajlouni, P.E.

APPROVED BY Gary F. Zych DATE 10/4/2021
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)

Table of CONTENTS

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 AEP J. Robert Welsh Plant is located in southern Titus County, approximately 8 miles northeast of Pittsburg, Texas, and approximately two miles northwest of Cason, Texas. The facility operates two surface impoundments for storing CCR materials called the Primary Bottom Ash Pond and the Bottom Ash Storage Pond. This report addresses the Primary Bottom Ash Pond. The Primary Bottom Ash Pond CCR unit is located southwest of the Plant and directly west of the Welsh Reservoir.

The Primary Bottom Ash pond is bounded by natural ground surface (topographically higher areas) to the north and west, and embankment dikes to the south and east. The elevation at the top of embankment along the crest area is approximately 340.0 feet above msl. Presently, economizer ash and bottom ash is sluiced to the Primary Bottom Ash Pond.

3.0 SAFETY FACTOR ASSESSMENT 257.73(e)

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 – Primary Ash Pond

Initial Safety Factor Assessment – Primary Ash Pond

Welsh Power Generating Station
Pittsburgh, Texas

Auckland Project No. 2015-008A (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

Table of Contents

Appendix

1.0 Introduction and Embankment Information

1.1 Introduction

The following report and evaluation provides the Initial Safety Factor Assessment of the Primary Ash Pond, an existing CCR impoundment (as defined by 40 CFR §257.2) located at the Welsh Power Station near Pittsburgh, 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 Primary Ash Pond. In accordance with 40 CFR §257.73(e)(2) this report provides the Initial Safety Factor Assessment certification for the Primary 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 *Welsh Power Station, Existing Ash Storage Pond Embankment Investigation, Pittsburg, Texas* dated June 21, 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 Primary 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.

The impoundment pool elevation data cited herein were provided in a separate hydrology and hydraulic (H&H) analysis report completed by Freese and Nichols titled *Hydraulic Analysis of Welsh Power Plant Ash Ponds* dated December 29, 2010 (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. 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 2.5:1 (H:V), maximum embankment height of 35 feet (downstream) and top of dam elevation of 340.0 feet MSL. The crest width of the embankment is approximately 50 feet. An embankment cutoff key (key trench) extends below the core structure approximately five (5) feet and has an approximate bottom width of 20 feet.

The downstream toe of the Primary Ash Pond extends below the impounded water level of the adjacent Welsh Reservoir. Based on information provided by the client, the normal pool elevation for the Welsh Reservoir is approximately 320.0 feet (MSL). Reservoir levels are monitored and adjusted as needed to maintain a constant pool elevation of approximately 320.0 feet (MSL). Based on the active management and control of the Welsh Reservoir pool elevation, the downstream toe of the Primary Ash Pond should not be subject to sudden or rapid drawdown conditions, notwithstanding a catastrophic failure of or uncontrolled release from the Welsh Reservoir. Regardless, the sudden drawdown of the Welsh Reservoir along the downstream slope of the Primary Ash Pond is modeled herein (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 Primary Ash Pond as determined by the 25-year, 24-hour storm event is 329.35 feet (MSL). For the purposes of this evaluation, the maximum storage pool elevation of 330.0 feet (MSL) was utilized. Likewise the maximum (or flood) surcharge loading elevation as determined by the 100-year, 24-hour event is 330.80 feet (MSL), for this evaluation a maximum surcharge loading elevation of 331.0 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), four (4) 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, steady state seepage condition with seismic loading under maximum storage pool conditions, and rapid drawdown (of the inundated downstream slope). 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) and guidance provided by the United States Army Corps of Engineers (USACE).

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
Rapid Drawdown – Downstream Slope	Effective and Total Stress	1.20
NOTE: Minimum factors of safety based on demonstration requirements provided in 40 CFR §257.82 (e)(1). Minimum factor of safety for Rapid Drawdown based on guidance provided by the United States Army Corps of Engineers (USACE).		

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 Primary Ash Pond generally consist of medium stiff to hard lean clay and fat clay (CL and CH) soils and coarse grained (or sandy) material consist of medium dense to very dense clayey sand (SC), silty sand (SM) and silty clayey sand (SC-SM) soils. Based on these soil characteristics and that the Primary Ash Pond is located in a zone of low peak ground acceleration (PGA), the risk of

[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

either embankment or underlying soils liquefying are negligible [40 CFR §257.73(e)(1)(iv)].

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. Selection of the critical slope section 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:			
Material Type	**Unit Weight (pcf)**	**Consolidated-Undrained Cohesion (psf)**	**Consolidated-Undrained Angle of Internal Friction (degrees)**
Embankment Fill	125	570	12
Clayey Sand (SC)	130	360	10
Silty Sand (SM)	125	0	30
Fat Clay (CH)	130	320	19
NOTE: Properties used for Steady State Seepage with Seismic and Rapid Drawdown analyses.			

Summary of Long Term, Effective Stress Soil Parameters			
Material Type	**Unit Weight (pcf)**	**Consolidated-Drained Cohesion (psf)**	**Consolidated-Drained Angle of Internal Friction (degrees)**
Embankment Fill	125	310	23
Clayey Sand (SC)	130	320	15
Silty Sand (SM)	125	0	30
Fat Clay (CH)	130	300	28
NOTE: Properties used for Steady State Seepage and Rapid Drawdown analyses. 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	
Material Type	**Permeability (ft/sec)**
Embankment Fill	1×10^{-9}
Clayey Sand (SC)	1×10^{-7}
Silty Sand (SM)	1×10^{-5}
Fat Clay (CH)	1×10^{-8}

2.5 Stability Analysis Results

The following table 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		
Modeled Condition	**Factor of Safety**	
	Actual	**Minimum**
Steady State Seepage – Maximum Pool	1.51	1.50
Steady State Seepage – Surcharge Pool	1.51	1.40
Steady State Seepage with Seismic – Maximum Pool	1.07	1.00
Rapid Drawdown – Downstream Slope	1.21	1.20

Based on the findings of this analysis, the evaluated embankment appears 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 Primary Ash Pond (Welsh Power Station) has been prepared to the best of my knowledge in accordance with §257.73(e)(1).

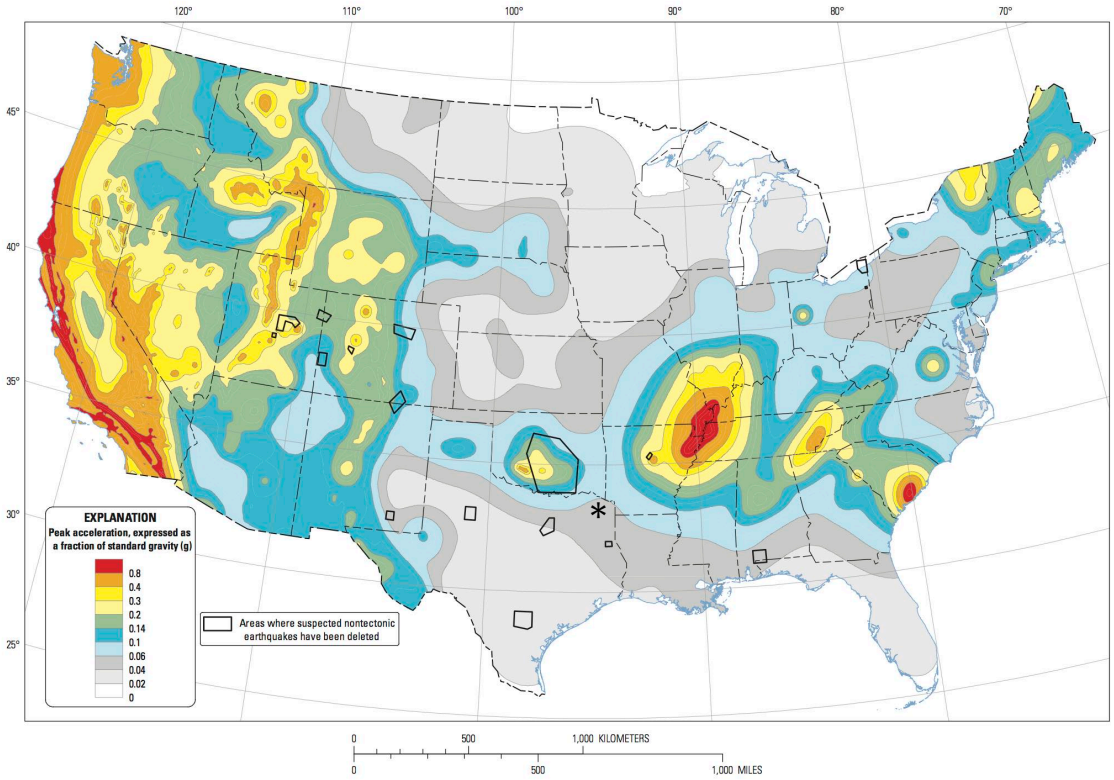
By: _____

Dated: January 14, 2016

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

Appendix

Stability Analyses
Reference Data

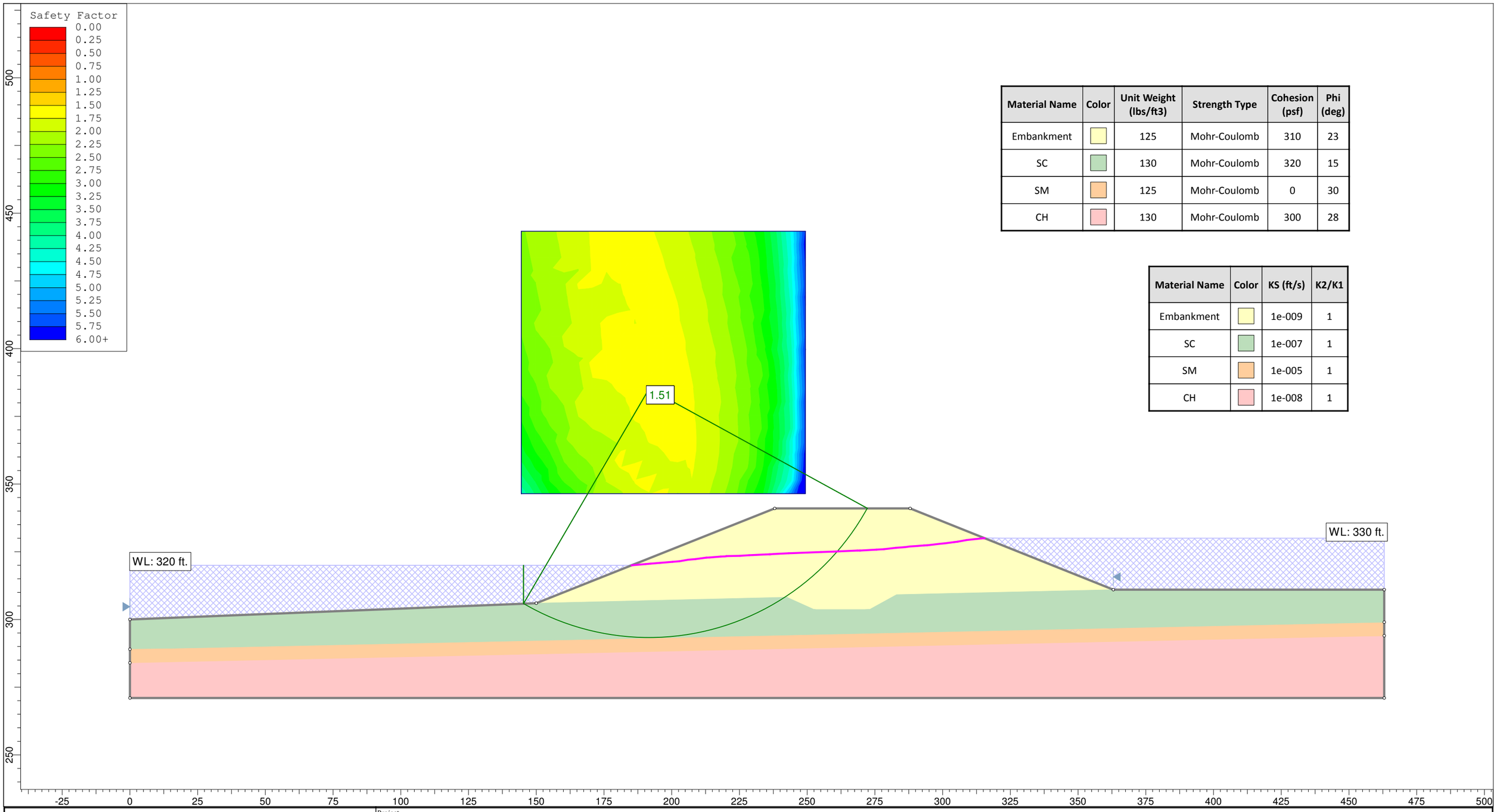


Two-percent probability of exceedance in 50 years map of peak ground acceleration

* Approximate location of Welsh Power Generating Station

Provided by USGS National Seismic Hazard Mapping Project.

Seismic Probability Map	
Scale: N/A	**Welsh Power Generating Station** **Initial Safety Factor Assessment - Primary Ash Pond** **Pittsburgh, Texas**
Auckland Project No. 2015-008A	



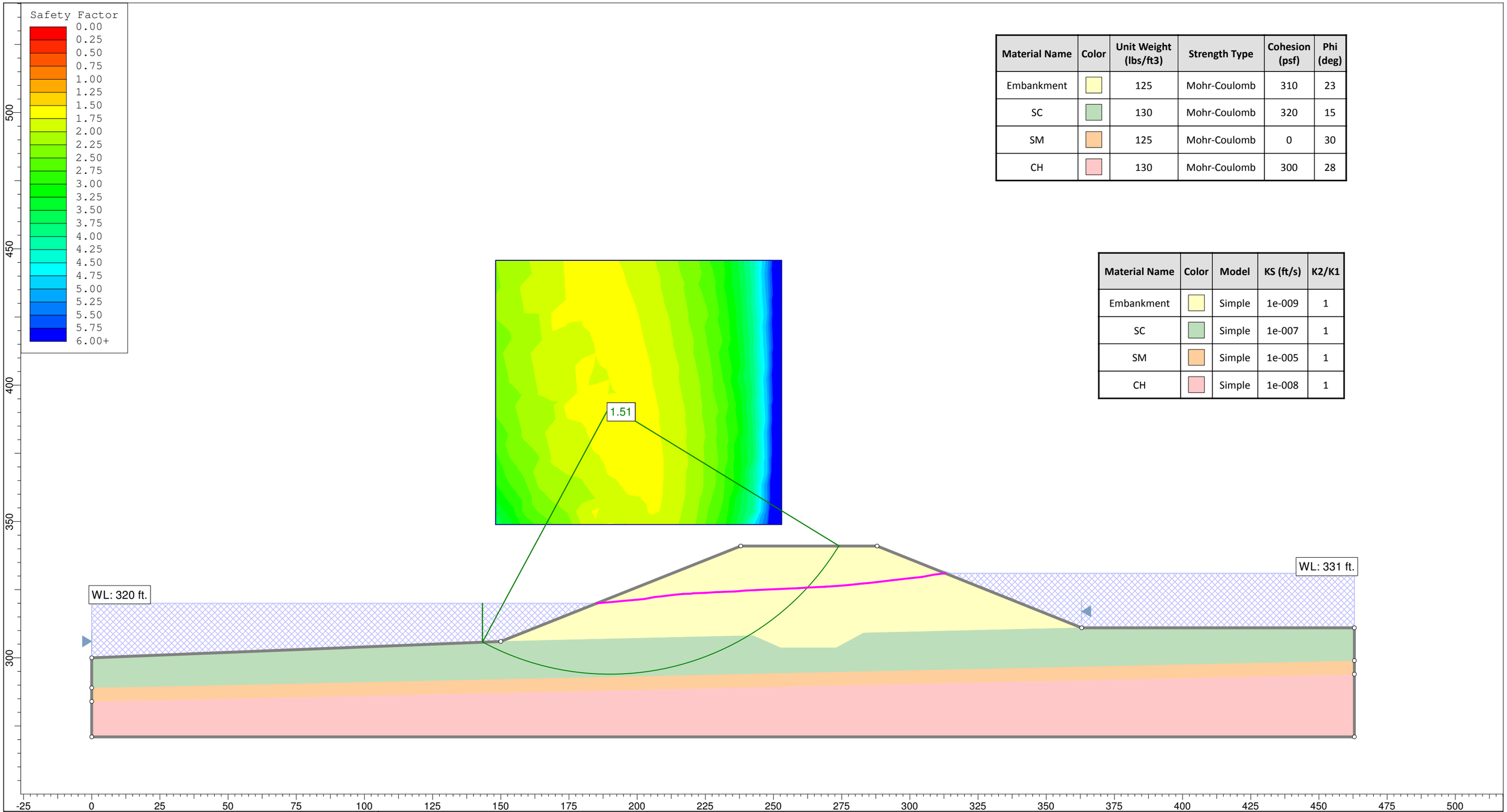
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment		125	Mohr-Coulomb	310	23
SC		130	Mohr-Coulomb	320	15
SM		125	Mohr-Coulomb	0	30
CH		130	Mohr-Coulomb	300	28

Material Name	Color	KS (ft/s)	K2/K1
Embankment		1e-009	1
SC		1e-007	1
SM		1e-005	1
CH		1e-008	1

Auckland Consulting LLC
PO Box 8155
Jacksonville, Texas 75766

SLIDEINTERPRET 6.036

Project	Welsh Power Station - Primary Ash Pond		
Analysis Description	Maximum Storage Pool at Normal Reservior Pool		
Drawn By	JJT	*Company*	
Date	12/2/2015	*File Name*	Primary_SSS_normal_25yr pool_Rev1.slim

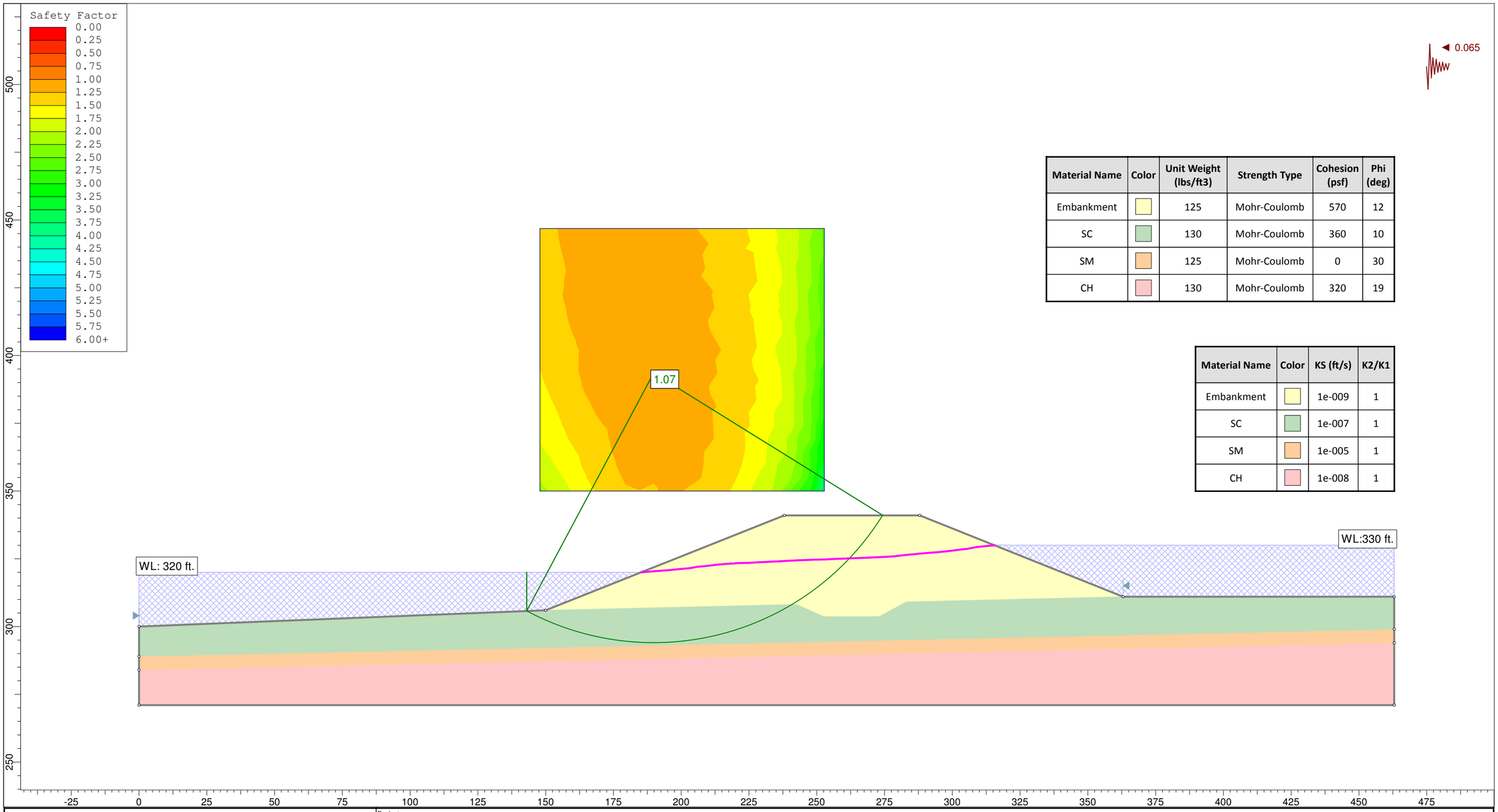


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment		125	Mohr-Coulomb	310	23
SC		130	Mohr-Coulomb	320	15
SM		125	Mohr-Coulomb	0	30
CH		130	Mohr-Coulomb	300	28

Material Name	Color	Model	KS (ft/s)	K2/K1
Embankment		Simple	1e-009	1
SC		Simple	1e-007	1
SM		Simple	1e-005	1
CH		Simple	1e-008	1

Auckland Consulting LLC
PO Box 8155
Jacksonville, Texas 75766

Project	Welsh Power Station - Primary Ash Pond		
Analysis Description	Maximum Surcharge Pool at Normal Reservior Pool		
Drawn By	JJT	*Company*	
Date	12/2/2015	*File Name*	Primary_SSS_normal_100 yr pool_Rev1.slim



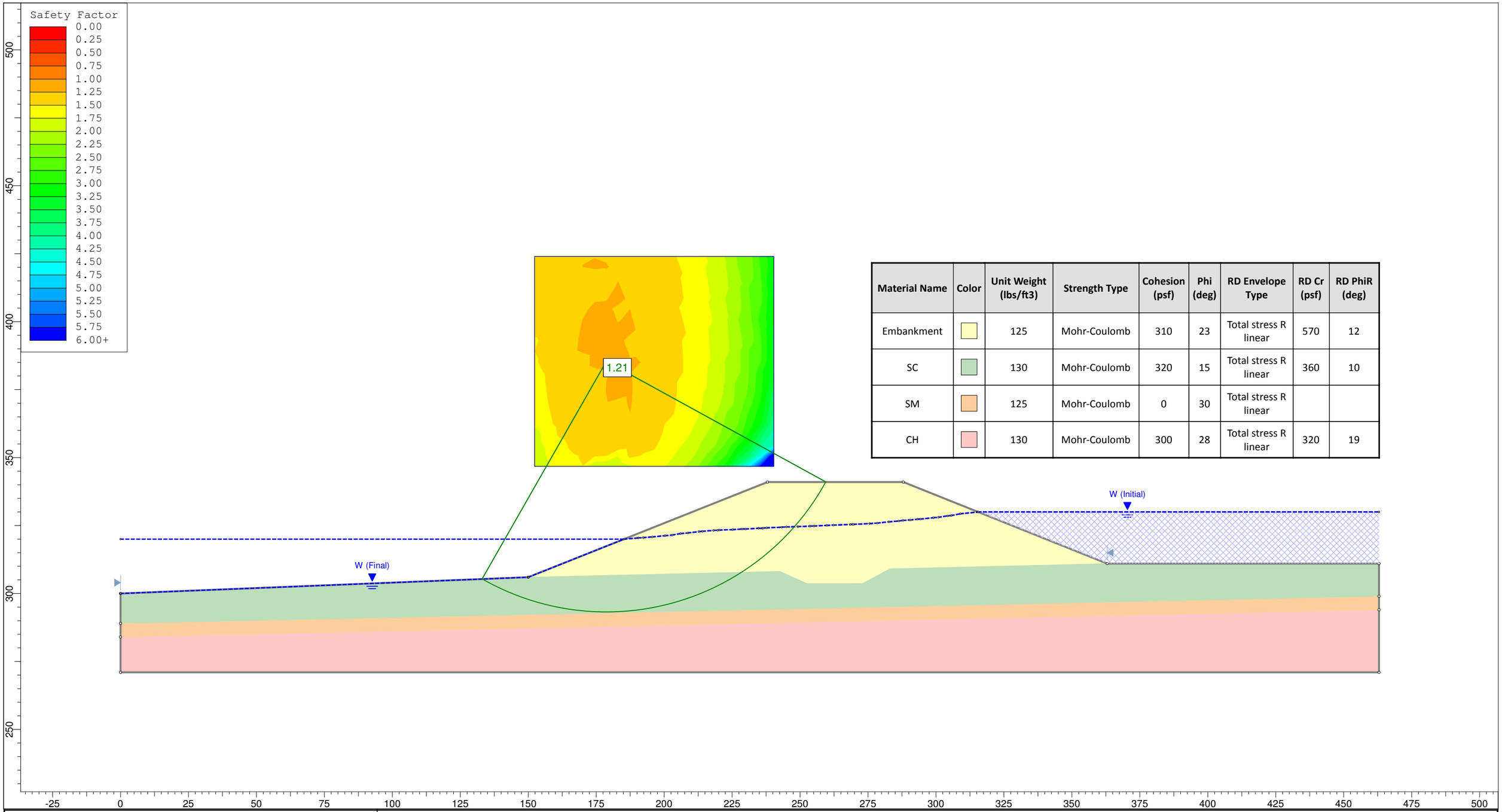
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment		125	Mohr-Coulomb	570	12
SC		130	Mohr-Coulomb	360	10
SM		125	Mohr-Coulomb	0	30
CH		130	Mohr-Coulomb	320	19

Material Name	Color	KS (ft/s)	K2/K1
Embankment		1e-009	1
SC		1e-007	1
SM		1e-005	1
CH		1e-008	1

Auckland Consulting LLC
PO Box 8155
Jacksonville, Texas 75766

SLIDEINTERPRET 6.036

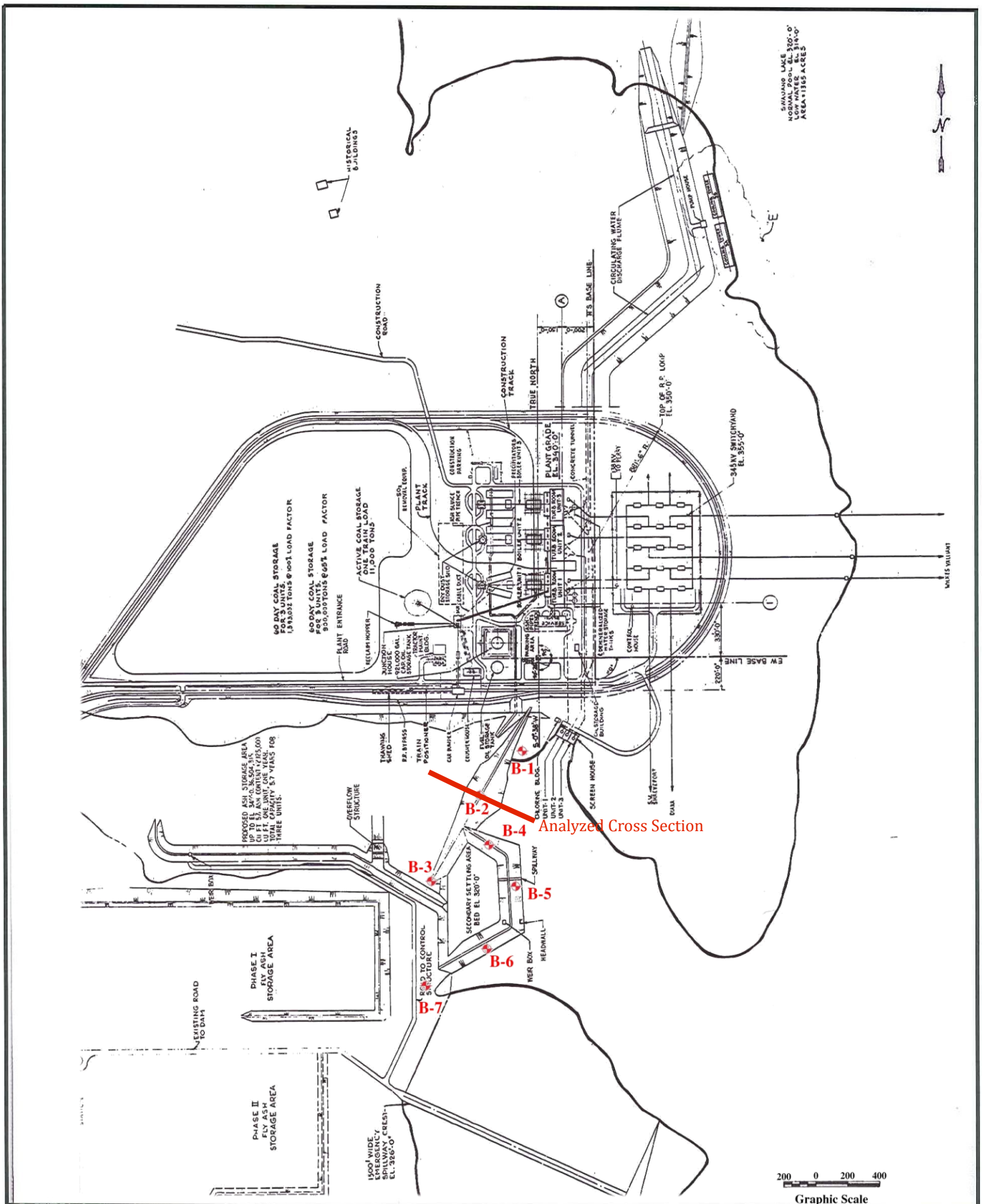
Project	Welsh Power Station - Primary Ash Pond		
Analysis Description	Maximum Storage Pool at Normal Reservior Pool, Seismic Analysis		
Drawn By	JJT	*Company*	
Date	12/23/2015	*File Name*	Primary_SSS_seismic_25yr pool.slim



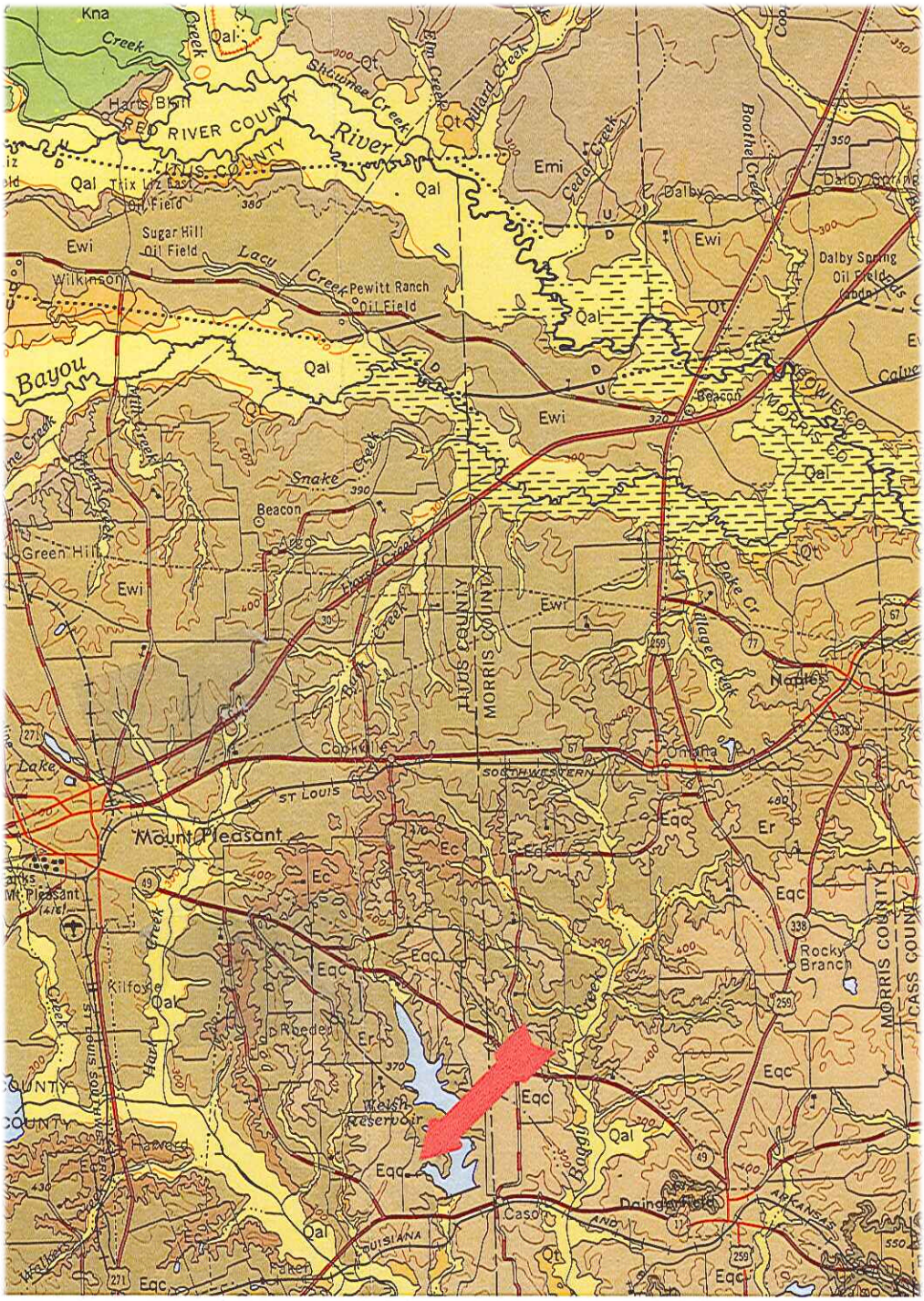
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	RD Envelope Type	RD Cr (psf)	RD PhiR (deg)
Embankment		125	Mohr-Coulomb	310	23	Total stress R linear	570	12
SC		130	Mohr-Coulomb	320	15	Total stress R linear	360	10
SM		125	Mohr-Coulomb	0	30	Total stress R linear		
CH		130	Mohr-Coulomb	300	28	Total stress R linear	320	19

Auckland Consulting LLC
PO Box 8155
Jacksonville, Texas 75766

Project	Welsh Power Station - Primary Ash Pond		
Analysis Description	Maximum Storage Pool with Rapid Drawdown of Reservior Pool		
Drawn By	JJT	*Company*	
Date	12/2/2015	*File Name*	Primary_RD Res_normal_25yr pool.slim



ETTL ENGINEERS & CONSULTANTS MAIN OFFICE 1717 East Erwin Tyler, Texas 75702 (903) 595-4421	**WELSH POWER PLANT** **PITTSBURGH, TEXAS**	**PLATE 1 - PLAN OF BORINGS**	APPROVED BY:
		JOB NO.: G3242-095	DRAWN BY: K.C.R.
		DATE: JAN. 2010	SCALE: AS SHOWN



EXPLANATION

SEDIMENTARY ROCKS

Qal — Alluvium
Flood-plain deposits

Qt — Fluviatile terrace deposits undivided

Etg / Es — Sparta Sand
Quartz sand, fine to medium grained, light gray to brownish gray, slightly cohesive from silt and clay matrix, massive, locally cross-bedded, interbeds of sandy clay more abundant upward, locally carbonaceous; weathers various shades of light gray, at base hard, brown, ferruginous sandstone; lower part 170± feet thick, upper part absent. Locally includes Tyler Green-sand Member, Etg, quartz-glauconite greensand, greenish green, massive, locally cross-bedded; weathers dark reddish brown, abundant ironstone concretions

Ew — Weches Formation
Glauconite and quartz sand, greenish green to greyish olive green, thin bedded, locally cross-bedded to laminated, clay interbeds light brown to moderate light gray, silty, muscovitic, thin bedded; weathers moderate to dark reddish brown, locally forms limonitic and siderotic iron ore and clay ironstone concretions; marine megafossils in southern part; 33± feet thick, range 0–70 feet

Eqc — Queen City Sand
Quartz sand, fine grained to locally medium grained, light gray to brownish gray, locally carbonaceous, and clay, gray to brown, silty, slightly lignitic, sand most abundant to west; weathers red and white mottled, ironstone concretions and ledges common; local beds of glauconite-quartz greensand, cross-bedded, weathers to ferruginous ledges and rubble; 150–400 feet thick, thins southeastward

Er — Reklaw Formation
Upper 100± feet, clay, brownish black to brownish gray, silty, muscovitic, carbonaceous, laminated, interbeds of moderate reddish-brown clay; weathers light brown, ironstone concretions common; a few marine fossils. Lower 125± feet, quartz sand, fine to very fine grained, greyish green, glauconitic, argillaceous, massive, locally cross-bedded; weathers moderate brown to dark yellowish orange with clay ironstone ledges and rubble; fossils, clay ironstone, and clay decrease northward

Ec — Carrizo Sand
Upper part, very fine sand, silt, clayey silt, silty clay, medium to dark gray, carbonaceous; weathers moderate yellowish brown to dark reddish brown, indurated ledges of dark brownish-gray ironstone common. Lower part, quartz sand, fine to medium grained, light brownish gray, weakly cohesive, massive, locally cross-bedded; weathers light gray to various shades of red. Thickness 50–100 feet

Ewi — Wilcox Group undivided
Mostly silty and sandy clay, various shades of gray, local beds of clay, lignite, silt, and quartz sand, in part carbonaceous, laminated to massive, locally cross-bedded, weathers to various shades of gray, brown, yellow, and red; calcareous siltstone and ironstone concretions common; abundant plant fossils, a few marine fossils in southeastern part; 500–1,000 feet thick.

E — Eocene rocks undivided
Reklaw Formation, Carrizo Sand, Wilcox Group, and Midway Group on Brooks dome, not separately shown

Ewp — Wills Point Formation
Clay, medium bluish gray, greenish gray, greyish green, brownish gray, silt increases upward, laminated to locally massive, glauconitic near base, rough calcareous siltstone concretions common in upper part, locally lignitic in upper part, thin bed of fossile limestone, near middle; weathers medium gray to yellowish gray; fossiliferous; 300± feet thick

Ek — Kincaid Formation
Clay, medium gray to dark gray, greenish gray, brownish gray, glauconitic, calcareous, selenitic, locally silty or sandy, locally phosphatic near base, thin beds of limestone in upper part, gray, hard, detrital; weathers medium gray; fossiliferous; 180± feet thick

Kke — Kemp Clay
Clay, dark gray to bluish gray, calcareous, silty, glauconitic, calcareous concretions common; weathers dark greenish gray and black; upper part only cross cut

Ku — Upper Cretaceous rocks undivided
Navarro Group, Taylor Group, and Austin Chalk on Brooks dome not separately shown

Pleistocene Recent — QUATERNARY
Eocene — TERTIARY
Upper Cretaceous — CRETACEOUS

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

SITE SURFACE GEOLOGY

JOB No.: G3242-09

DATE: 1975

SCALE: 1:250,000

LOG OF BORING B-1

ETTL ENGINEERS & CONSULTANTS

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

PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

BORING TYPE: Flight Auger

DATE 10/27/09

SURFACE ELEVATION 324.1

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) very stiff; brownish orange	P=4.0 SF						
	SM	SILTY SAND(SM) tannish orange							
	CH	SANDY FAT CLAY(CH) medium stiff; tannish orange	N=7	20	54	16	38	63	+40Sieve=10%, +4 Sieve=1%
5		--stiff	P=1.5						
	SC	CLAYEY SAND(SC) medium dense; tannish orange; with clay seams	P=1.75	19	34	17	17	32	+40 Sieve=7%, +4 Sieve=3%
10	CL	SANDY LEAN CLAY(CL) stiff; orange							
	SC	CLAYEY SAND(SC) medium dense; orange; saturated; with iron oxide cemented sandstone rock	N=15	22	24	15	9	19	+40Sieve=35%, +4 Sieve=22%
15									
	CL	LEAN CLAY WITH SAND(CL) hard; dark gray; with clay seams	N=35	21	41	21	20	75	+40 Sieve=2%, +4 Sieve=0%
20									
	CL	SANDY LEAN CLAY(CL) hard; dark brown	P=4.5+	15	33	17	16	52	+40 Sieve=1%, +4 Sieve=0%
25									
		--grayish brown; laminated with silt	P=4.5+						
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

DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)

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

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

Water Observations: Seepage @ 5' while drilling. Water level @ 4' and open to 30' upon completion.

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

Notes:
GPS Coordinates: N 33°03.090', W 94°50.417'

LOG OF BORING B-2

ETTL ENGINEERS & CONSULTANTS

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

PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

BORING TYPE: Flight Auger

DATE 10/28/09

SURFACE ELEVATION 339.7

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	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) hard; red and tan	P=4.5+	13	28	14	14	61	+40 Sieve=3%, +4 Sieve=0%
		--very stiff	P=3.5						
5		--stiff	N=14	14	40	16	24	65	+40 Sieve=0%, +4 Sieve=0%
		--very stiff; reddish brown	P=2.75	13	30	14	16	58	+40 Sieve=0%, +4 Sieve=0%
10									
	CL	SANDY LEAN CLAY(CL) hard; red and tan	P=4.5+						
15									
		--very stiff	P=3.5	14	34	15	19	54	+40 Sieve=0%, +4 Sieve=0%
20									
			P=4.0						
25									
	SC	CLAYEY SAND(SC) medium dense; tan, red, and gray	P=4.5	15	37	16	21	47	+40 Sieve=5%, +4 Sieve=3%
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)

DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)

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

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

Water Observations:
Water level @ 19' and open to 24' upon completion.

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

Notes:
GPS Coordinates: N 33°03.078', W 94°50.449'

LOG OF BORING B-2

ETTL ENGINEERS & CONSULTANTS

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

PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09 **BORING TYPE:** Flight Auger

DATE 10/28/09

SURFACE ELEVATION 339.7

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. #)
					--red and tan	P=2.5										
35																
		SM SC			SILTY CLAYEY SAND(SM-SC) red, tan, and gray; saturated	SF					12	22	15	7	48	+40 Sieve=0%, +4 Sieve=0%
40																
		CH			FAT CLAY(CH) hard; brown, tan, and gray; with ferric joints; with lignite and sand seams	P=4.5+										
45																
		SM			SILTY SAND(SM) black and gray	SF										
50					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:
Water level @ 19' and open to 24' upon completion.

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

Notes:
GPS Coordinates: N 33°03.078', W 94°50.449'

LOG OF BORING B-3

ETTL ENGINEERS & CONSULTANTS

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

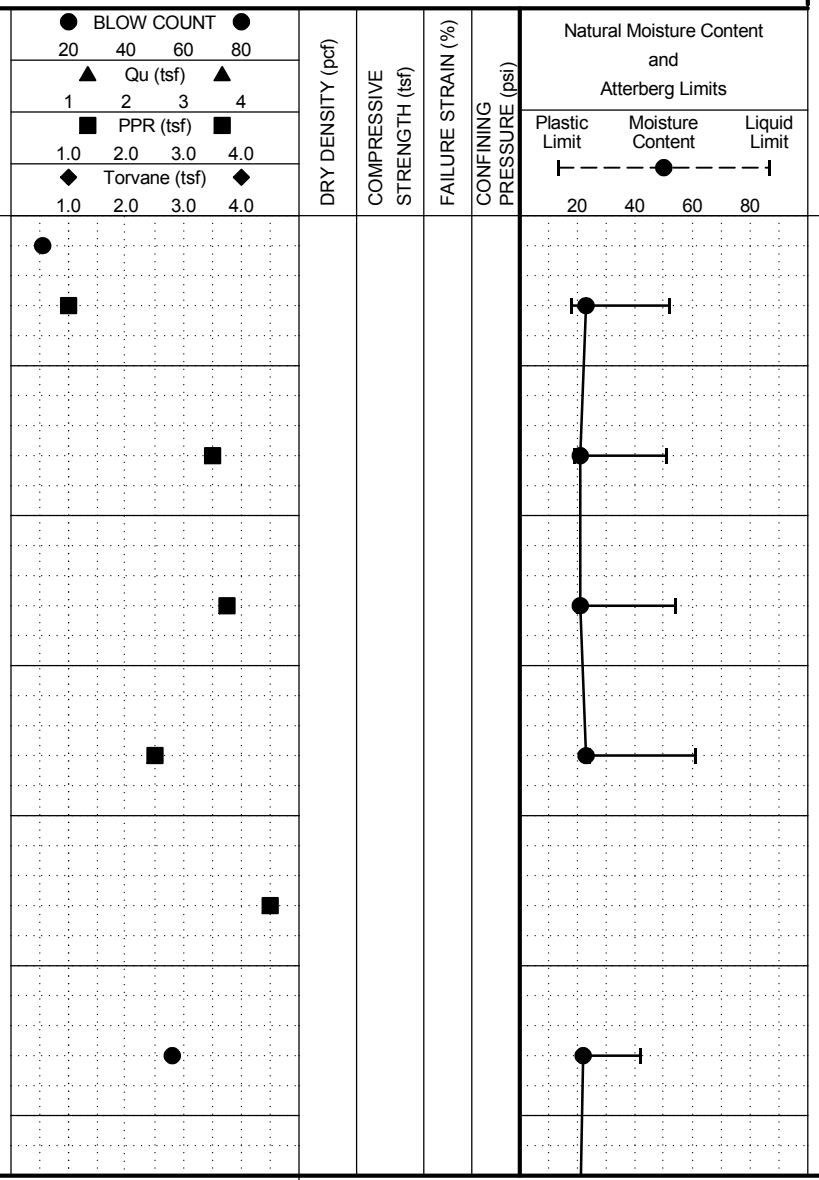
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09 **BORING TYPE:** Flight Auger

DATE 10/27/09

SURFACE ELEVATION 339.6

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	SC	CLAYEY SAND(SC) medium dense; gray and red	N=11						
	CH	FAT CLAY(CH) stiff; red and tan; with sand seams	P=1.0	23	52	18	34	87	+40 Sieve=3%, +4 Sieve=0%
5		--very stiff	P=3.5	21	51	19	32	86	+40 Sieve=3%, +4 Sieve=0%
10	CH	FAT CLAY WITH SAND(CH) very stiff; brown; with ferric joints	P=3.75	21	54	20	34	85	+40Sieve=10%, +4 Sieve=1%
15		--red and tan; layered; with ferric seams	P=2.5	23	61	24	37	81	+40Sieve=11%, +4 Sieve=0%
20	CH	FAT CLAY(CH) hard; gray; with sand seams	P=4.5+						
25	SC	CLAYEY SAND(SC) very dense; gray; with sand seams	N=56	22	42	22	20	35	+40 Sieve=1%, +4 Sieve=0%
30									



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

Water Observations: Seepage @ 13' while drilling. Water level @ 19' and open to 24' upon completion.

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

Notes:
GPS Coordinates: N 33°02.998', W 94°50.514'

LOG OF BORING B-3

ETTL ENGINEERS & CONSULTANTS

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

PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09 **BORING TYPE:** Flight Auger

DATE 10/27/09

SURFACE ELEVATION 339.6

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. #)
	CH	FAT CLAY(CH) hard; brown; layered and with sand seams	P=4.5+					21	60	24	36	95	+40 Sieve=1%, +4 Sieve=0%
35		--gray and green	P=4.5+										
40	CL	SANDY LEAN CLAY(CL) very stiff; gray and dark green; layered; with sand seams	P=3.5										
45	CH	FAT CLAY(CH) hard; gray and dark green; layered; with silt seams	P=4.5+										
50		Bottom of Boring @ 50'											

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 @ 19' and open to 24' upon completion.

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

Notes:
GPS Coordinates: N 33°02.998', W 94°50.514'

LOG OF BORING B-4

ETTL ENGINEERS & CONSULTANTS

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

PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09 **BORING TYPE:** Flight Auger

DATE 10/27/09

SURFACE ELEVATION 340.6

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	SM	SILTY SAND(SM) medium dense; tan; with gravel	N=19						
	CL	SANDY LEAN CLAY(CL) dark brown	SF	14	24	15	9	59	+40 Sieve=1%, +4 Sieve=0%
5		--tannish orange --hard; orangish tan	P=4.5						
			P=3.25	22	45	21	24	94	+40 Sieve=2%, +4 Sieve=0%
10		--very stiff; white							
	SC	CLAYEY SAND(SC) medium dense; tan	P=3.25	15	31	15	16	40	+40 Sieve=1%, +4 Sieve=0%
15		--orangish gray; with sand seams							
	CL	SANDY LEAN CLAY(CL) stiff; orangish tan	N=9						
20									
	CH	FAT CLAY(CH) very stiff; orangish tan; with ferric seams	P=4.0	25	59	24	35	88	+40 Sieve=4%, +4 Sieve=0%
25									
		--tannish brown; with iron ore seams	P=2.75						
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

DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)

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

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

Water Observations:
Water level @ 18' and open to 48' upon completion.

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

Notes:
GPS Coordinates: N 33°03.011', W 94°50.462'

LOG OF BORING B-4

ETTL ENGINEERS & CONSULTANTS

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

PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

BORING TYPE: Flight Auger

DATE 10/27/09

SURFACE ELEVATION 340.6

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. #)
35					--hard; light gray; layered and with silt seams	N=30										
40		CL			LEAN CLAY(CL) hard; light gray; layered and with silt seams	N=50/5.75"					21	44	25	19	93	+40 Sieve=1%, +4 Sieve=0%
45					--light gray	N=41										
50					--layered and with sand seams; with lignite	N=43										
					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: Water level @ 18' and open to 48' upon completion.

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

Notes:
GPS Coordinates: N 33°03.011', W 94°50.462'

LOG OF BORING B-5

ETTL ENGINEERS & CONSULTANTS

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

PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09 **BORING TYPE:** Flight Auger

DATE 10/27/09

SURFACE ELEVATION 340.0

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		CL			LEAN CLAY WITH SAND(CL) stiff; red and tan	P=2.0					22	47	19	28	81	+40 Sieve=9%, +4 Sieve=3%
		CL			LEAN CLAY(CL) hard; red and tan	P=4.5+										
5					--very stiff	P=4.0					21	46	18	28	94	+40 Sieve=3%, +4 Sieve=0%
		CH			FAT CLAY(CL) very stiff; brown and tan	P=3.0										
10																
		CH			FAT CLAY WITH SAND(CH) hard; red and tan	P=4.5+					22	52	24	28	88	+40 Sieve=3%, +4 Sieve=0%
15																
		CL			SANDY LEAN CLAY(CL) very stiff; red and gray; with sand seams	P=3.0										
20																
		SC			CLAYEY SAND(SC) very loose; tan, red, and gray	P=0.5					19	33	17	16	44	+40 Sieve=1%, +4 Sieve=0%
25																
		CH			FAT CLAY WITH SAND(CH) stiff; red and gray	P=2.0					25	61	19	42	83	+40 Sieve=5%, +4 Sieve=3%
30																

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

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

Water Observations: Seepage @ 35' while drilling. Water level @ 31' and open to 35' upon completion and after 30 minutes.

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

Notes:
GPS Coordinates: N 33°02.964', W 94°50.428'

LOG OF BORING B-5

ETTL ENGINEERS & CONSULTANTS

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

PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09 **BORING TYPE:** Flight Auger

DATE 10/27/09

SURFACE ELEVATION 340.0

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	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			SILTY CLAYEY SAND(SC) gray and red; saturated	SF											
40		CH			FAT CLAY(CH) hard; red and gray; with sand seams	P=4.5+						25	51	31	20	87	+40 Sieve=6%, +4 Sieve=0%
					--gray, tan, and red; with sand seams	P=4.5+											
45		SM SC			SILTY SAND(SM-SC) red and gray	SF											
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 @ 35' while drilling. Water level @ 31' and open to 35' upon completion and after 30 minutes.

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

Notes:
GPS Coordinates: N 33°02.964', W 94°50.428'

LOG OF BORING B-6

ETTL ENGINEERS & CONSULTANTS

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

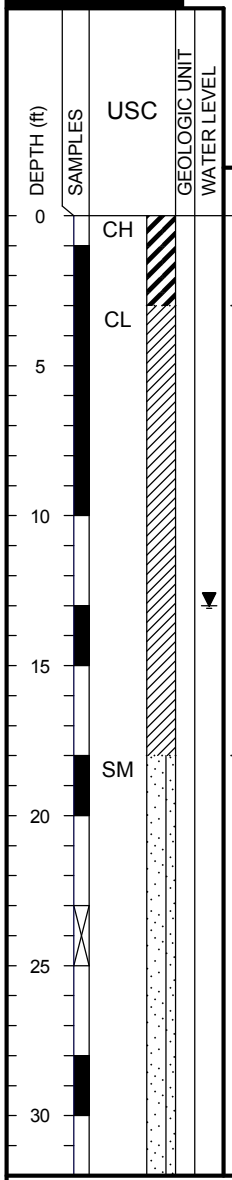
PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

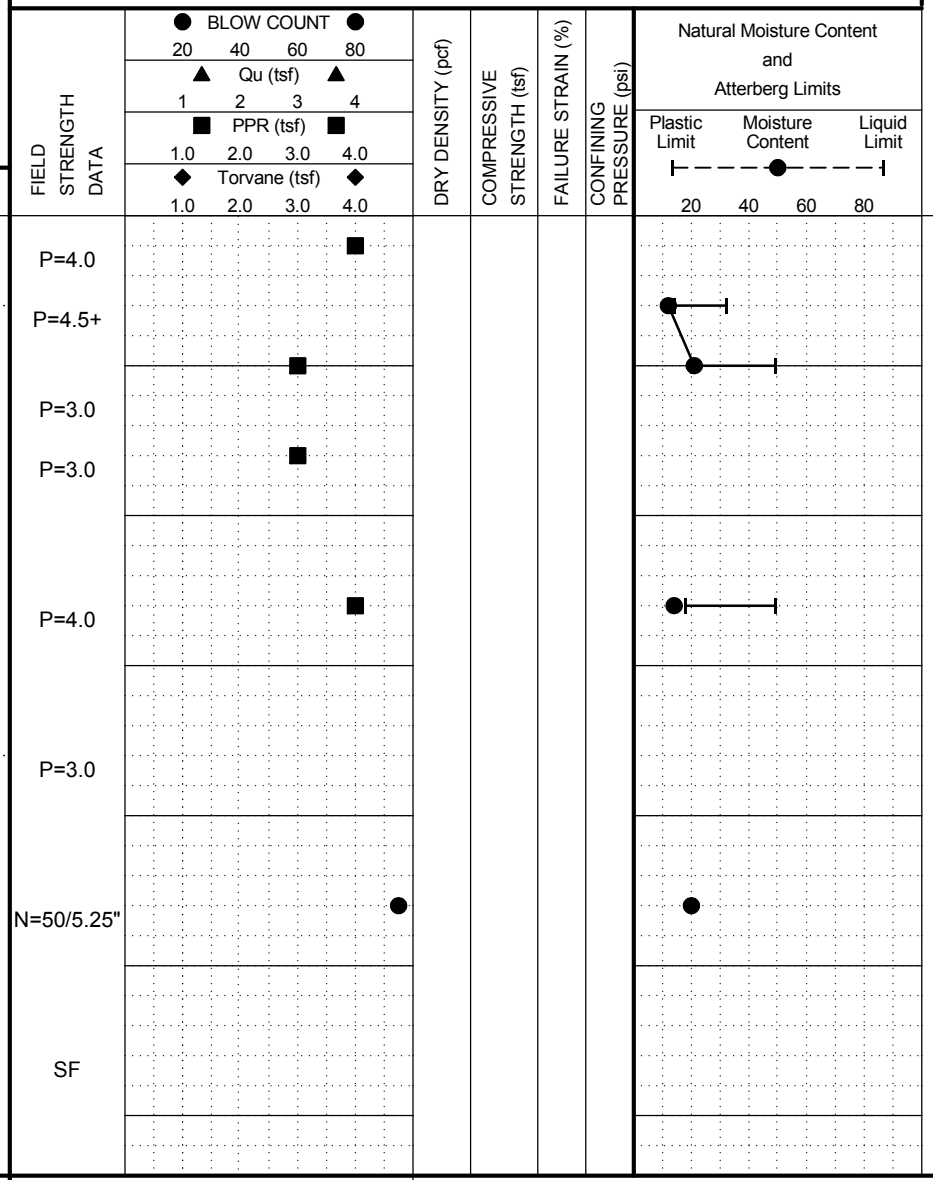
BORING TYPE: Flight Auger

DATE 10/27/09

SURFACE ELEVATION 340.1



MATERIAL DESCRIPTION



FAT CLAY(CH) very stiff; red and gray; with ferric seams	P=4.0									
SANDY LEAN CLAY(CL) hard; red and tan	P=4.5+					12	32	14	18	60	+40 Sieve=0%, +4 Sieve=0%
						21	49	20	29	93	+40 Sieve=2%, +4 Sieve=0%
	P=3.0										
--very stiff; red, gray, and brown; with gravel											
--with sand seams	P=3.0										
	P=4.0					14	49	18	31	65	+40 Sieve=0%, +4 Sieve=0%
SILTY SAND(SM) gray; saturated	P=3.0										
--very dense; gray and red	N=50/5.25"					20				18	+40 Sieve=0%, +4 Sieve=0%
	SF										

MOISTURE CONTENT (%) | ATTERBERG LIMITS(%): LIQUID LIMIT (LL) | PLASTIC LIMIT (PL) | PLASTICITY INDEX (PI) | MINUS #200 SIEVE (%) | OTHER TESTS PERFORMED (Page Ref. #)

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

Water Observations: Seepage @ 17' while drilling. Water level @ 13' and open to 15' upon completion and after 30 minutes.

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

Notes:
GPS Coordinates: N 33°02.912', W 94°50.462'

LOG OF BORING B-6

ETTL ENGINEERS & CONSULTANTS

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

PROJECT: Welsh Power Plant
Pittsburgh, Texas

PROJECT NO.: G3242-09

BORING TYPE: Flight Auger

DATE 10/27/09

SURFACE ELEVATION 340.1

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		CH			FAT CLAY(CH) hard; brown; with sand seams	P=4.5+											
40						P=4.5+						22	68	24	44	95	+40 Sieve=0%, +4 Sieve=0%
45					--dark green	P=4.5+											
50		CL			LEAN CLAY(CL) hard; dark green; laminated with lignite	P=4.5+											
					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

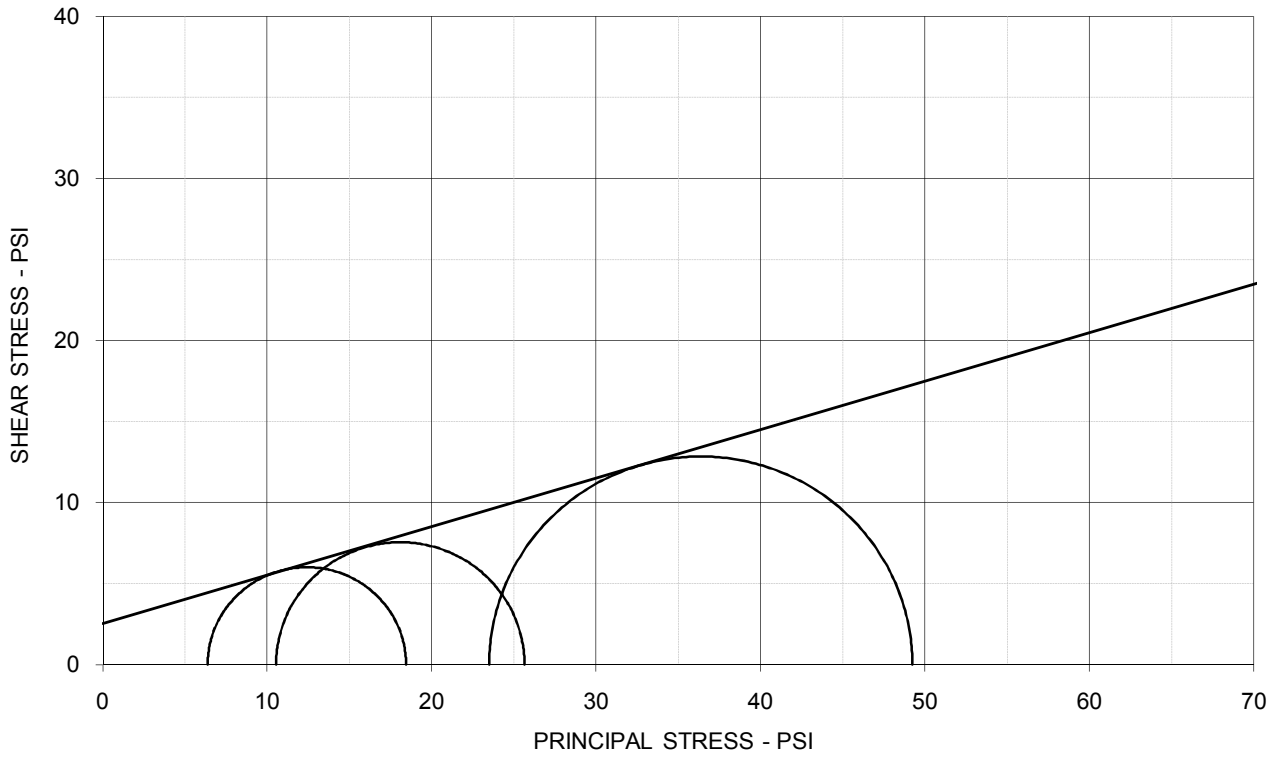
Water Level Est.: ▽ Measured: ▼ Perched: ⧩

Water Observations: Seepage @ 17' while drilling. Water level @ 13' and open to 15' upon completion and after 30 minutes.

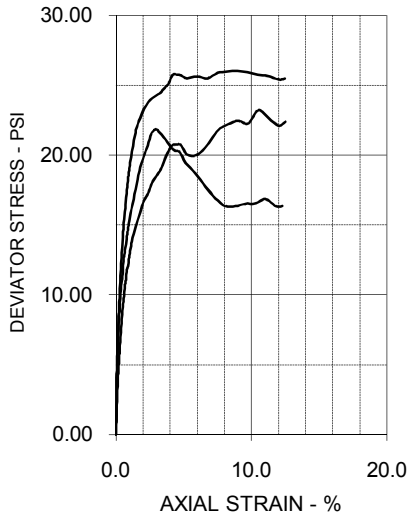
Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 33°02.912', W 94°50.462'

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	ϕ ' = 16.7 deg	c' = 2.5 psi		
SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	23.9	24.1	26.5	
Dry Density - pcf	102.5	100.6	99.0	
Diameter - inches	2.01	2.00	2.01	
Height - inches	4.00	3.92	3.98	
AT TEST				
Final Moisture - %	25.4	24.3	25.0	
Dry Density - pcf	102.7	102.4	101.9	
Calculated Diameter (in.)	2.01	1.98	1.99	
Height - inches	4.02	3.87	3.92	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	12.03	15.08	25.71	
Total Pore Pressure - psi	53.6	59.4	66.5	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	0.9	0.9	4.8	
σ_1' Failure - psi	18.43	25.64	49.23	
σ_3' Failure - psi	6.40	10.56	23.52	



TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Tan & Gray Clay & w/ some Ferric Joints
Sampled on Site, B-1 5' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

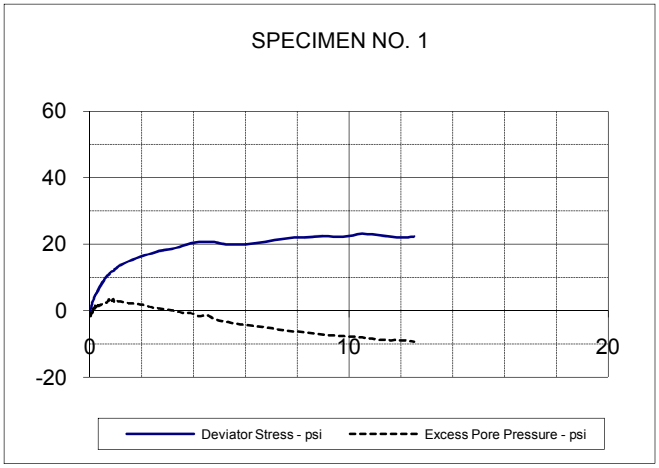
PROJECT INFORMATION

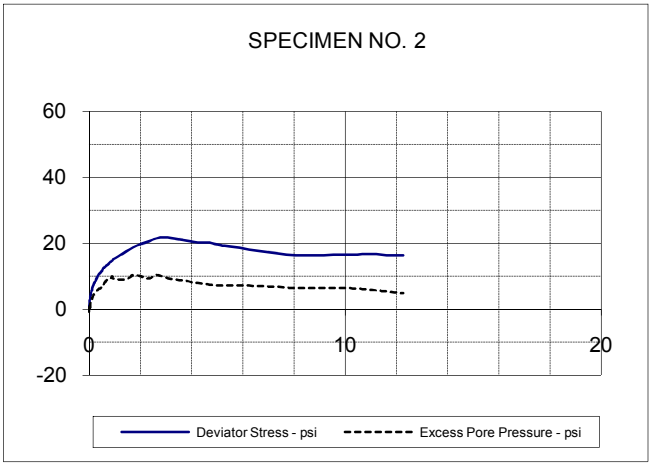
PROJECT: AEP Welsh Power Plant Bottom Ash Ponds
LOCATION: Pittsburg, Texas
PROJECT NO: G 3242 - 095
CLIENT:
December 2009

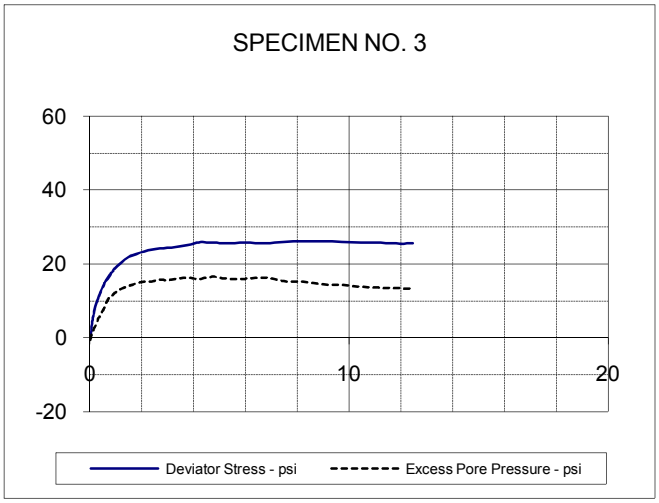
ETTL ENGINEERS & CONSULTANTS

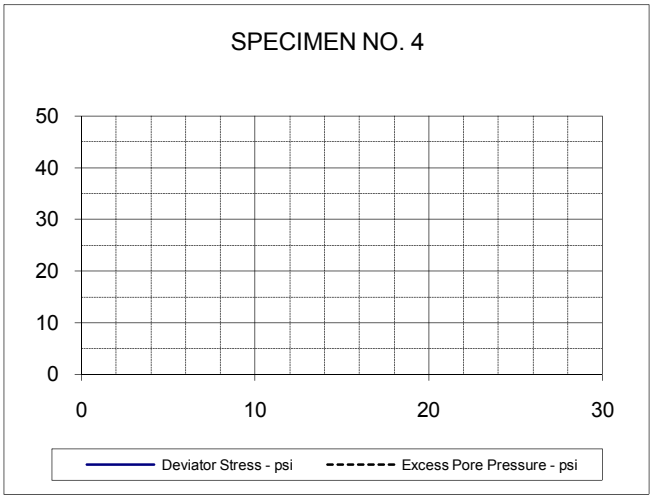
PLATE: B.1

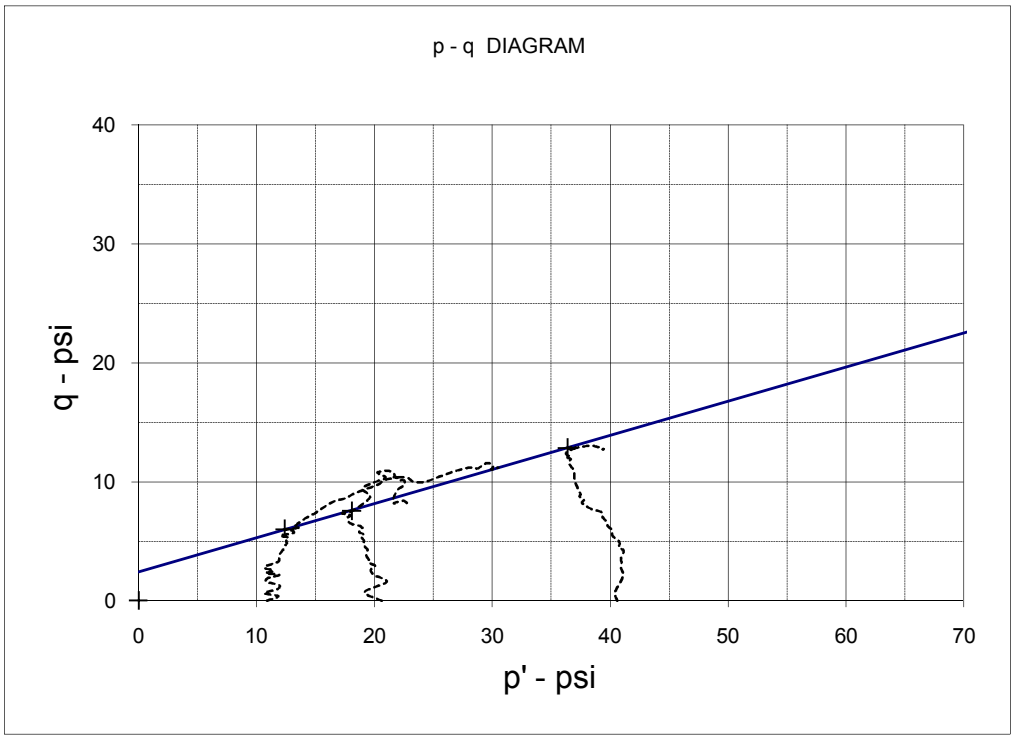
G 3242-095, B-1 5'-10' Welsh







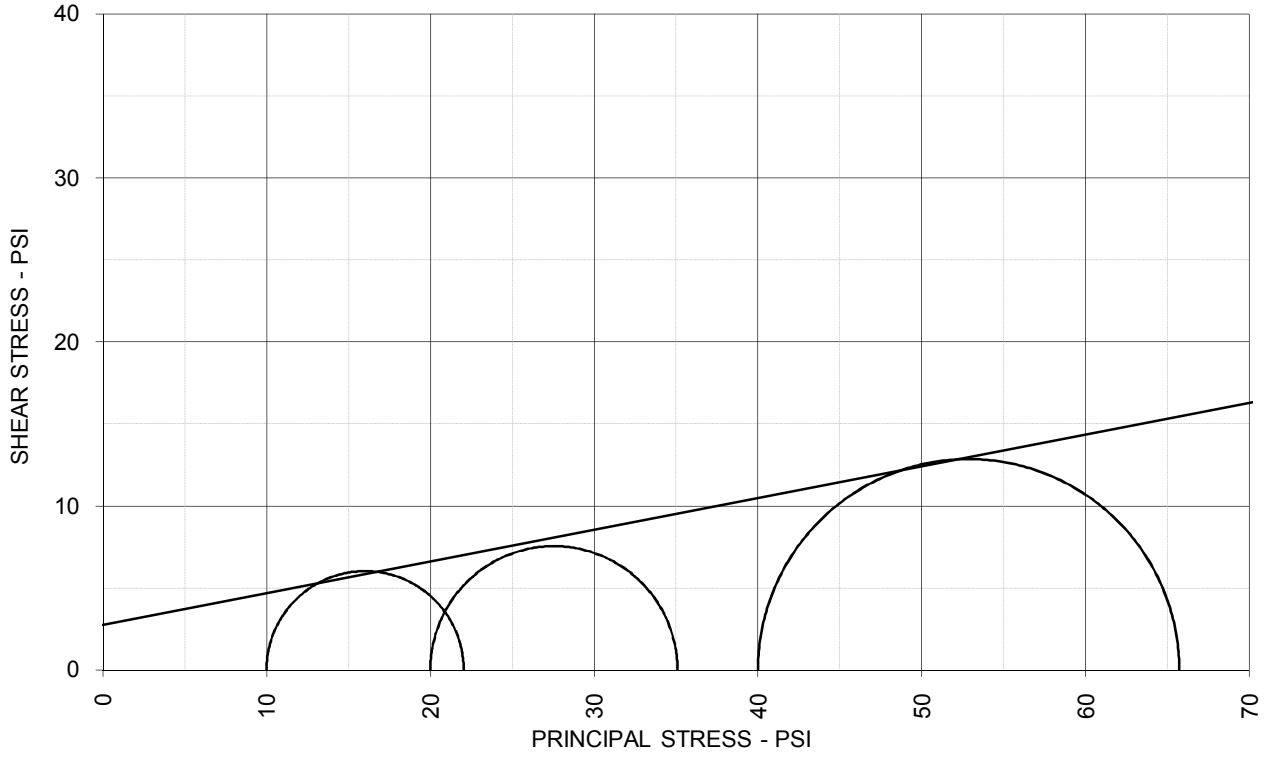




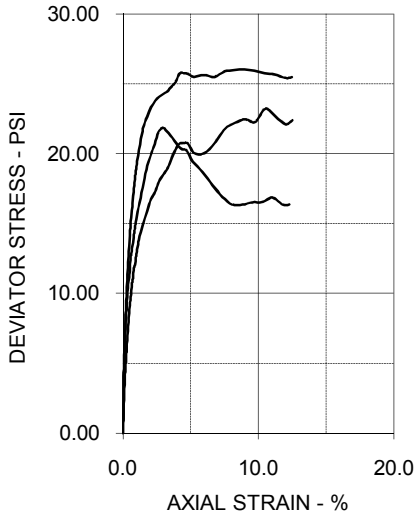
EFFECTIVE STRESS PARAMETERS	R^2 = 1.00	α (deg) = 16.0	a (psi) = 2.4
PROJECT: AEP Welsh Power Plant Bottom Ash Ponds		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 3242 - 095		**ETTL ENGINEERS & CONSULTANTS**	PLATE: B.2
DESCRIPTION: Tan & Gray Clay & w/ some Ferric Joints			

G 3242-095, B-1 5'-10' Welsh

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	ϕ = 10.9 deg	c = 2.8 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	23.9	24.1	26.5	
Dry Density - pcf	102.5	100.6	99.0	
Diameter - inches	2.01	2.00	2.01	
Height - inches	4.00	3.92	3.98	
AT TEST				
Final Moisture - %	25.4	24.3	25.0	
Dry Density - pcf	102.7	102.4	101.9	
Calculated Diameter (in.)	2.01	1.98	1.99	
Height - inches	4.02	3.87	3.92	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	12.03	15.08	25.71	
Total Pore Pressure - psi	53.6	59.4	66.5	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	0.9	0.9	4.8	
σ_1 Failure - psi	22.03	35.08	65.71	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Tan & Gray Clay & w/ some Ferric Joints
Sampled on Site, B-1 5' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

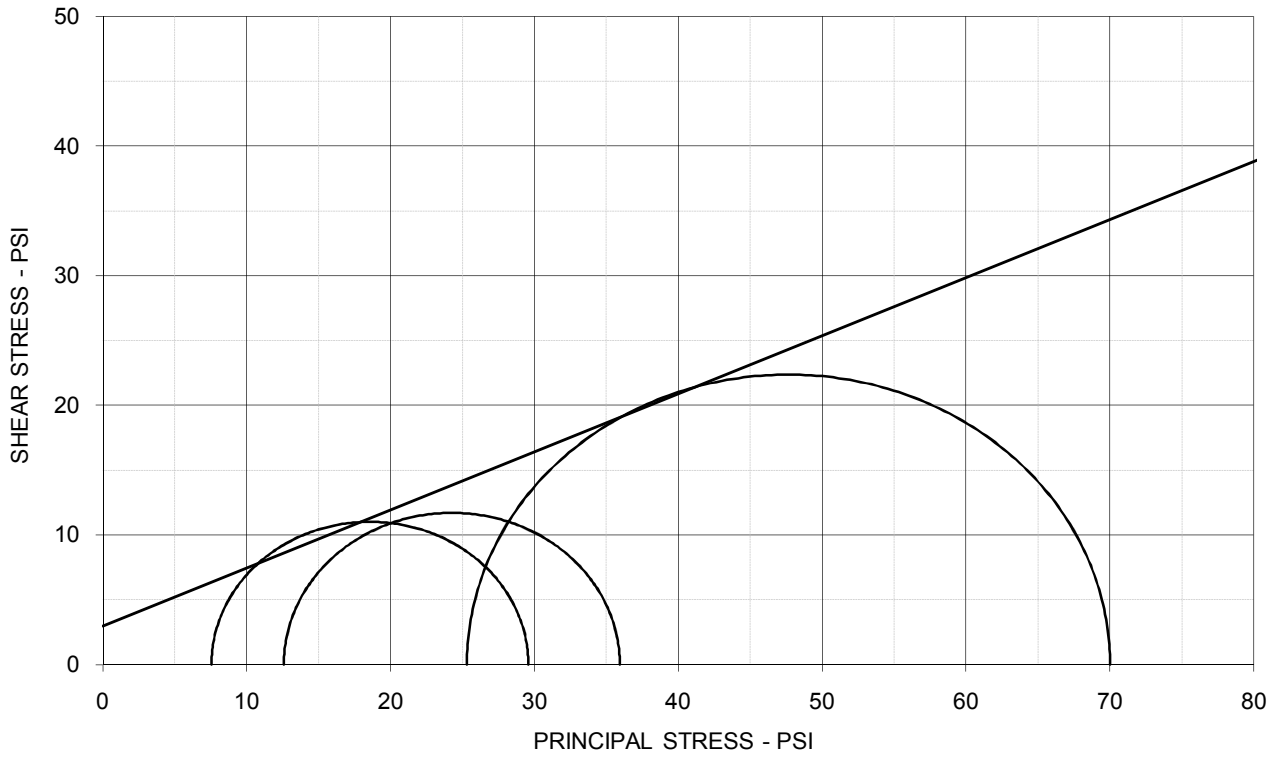
PROJECT INFORMATION

PROJECT: AEP Welsh Power Plant Bottom Ash Ponds
LOCATION: Pittsburg, Texas
PROJECT NO: G 3242 - 095
CLIENT:
December 2009

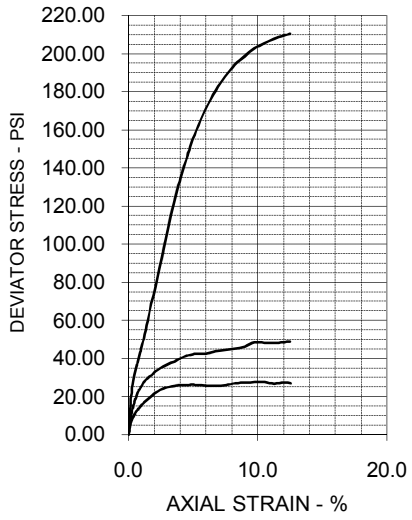
ETTL ENGINEERS & CONSULTANTS

PLATE: B.3

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	ϕ' = 24.1 deg	c' = 2.9 psi		
SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	14.4	23.6	13.0	
Dry Density - pcf	114.9	100.1	122.2	
Diameter - inches	2.01	2.02	2.00	
Height - inches	4.00	4.00	4.02	
AT TEST				
Final Moisture - %	18.7	24.4	13.2	
Dry Density - pcf	115.2	101.7	123.3	
Calculated Diameter (in.)	2.00	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	22.03	23.38	44.72	
Total Pore Pressure - psi	52.5	57.4	64.7	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	0.7	2.4	1.0	
σ_1' Failure - psi	29.58	35.95	70.02	
σ_3' Failure - psi	7.55	12.57	25.30	



TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Reddish Brown Sandy Lean Clay
Sampled on Site, B-2 8' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

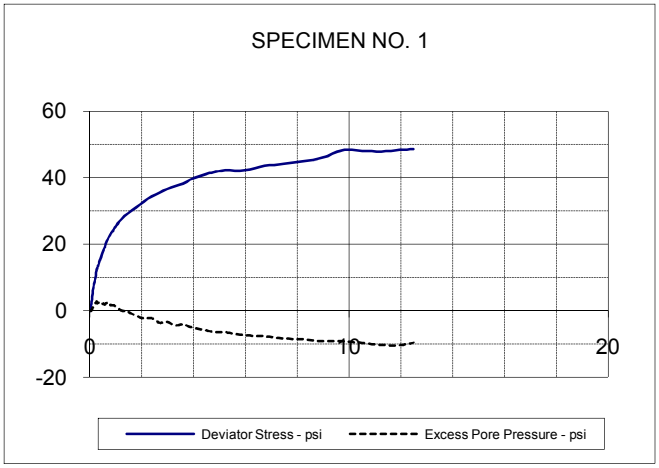
G 3242-095, B-2 8'-10' Welsh

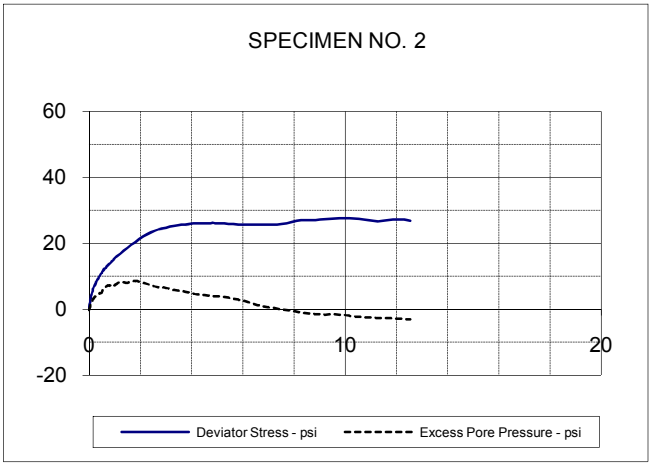
PROJECT INFORMATION

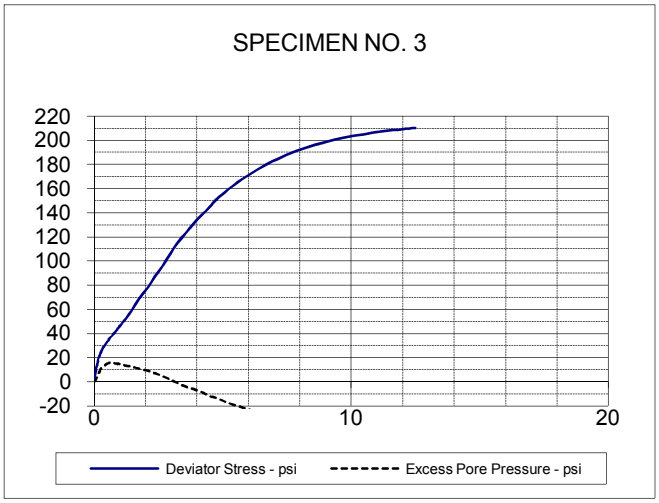
PROJECT: AEP Welsh Power Plant Bottom Ash Ponds
LOCATION: Pittsburg, Texas
PROJECT NO: G 3242 - 095
CLIENT:
December 2009

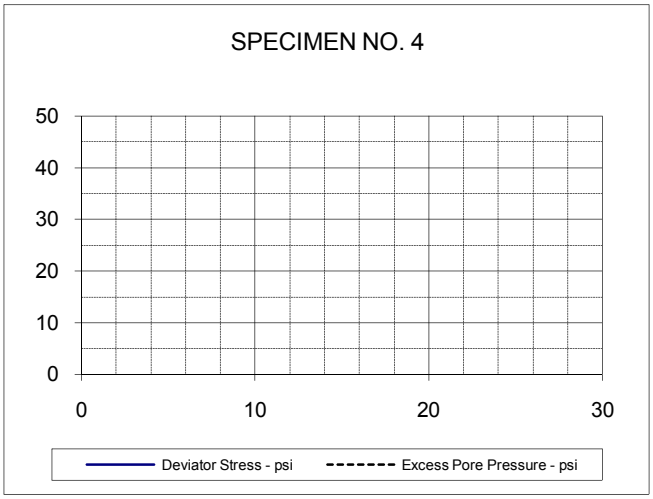
ETTL ENGINEERS & CONSULTANTS

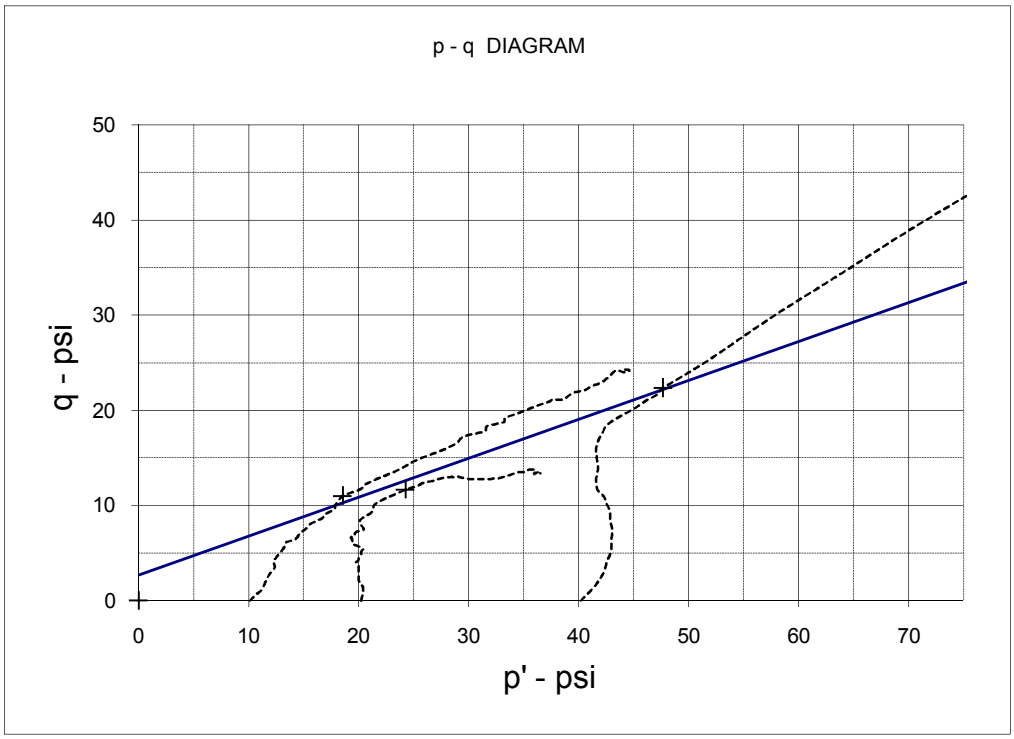
PLATE: B.1









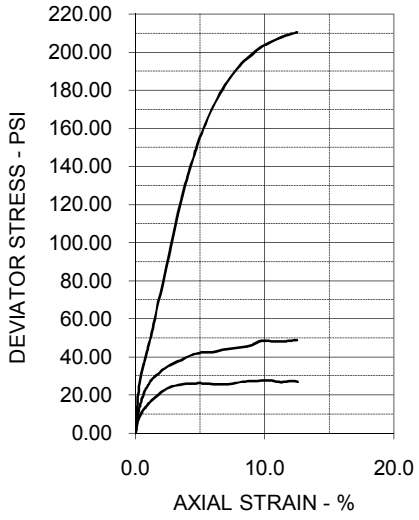


EFFECTIVE STRESS PARAMETERS	R^2 = 0.98	α (deg) = 22.3	a (psi) = 2.7
PROJECT: AEP Welsh Power Plant Bottom Ash Ponds		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 3242 - 095		**ETTL ENGINEERS & CONSULTANTS**	PLATE: B.2
DESCRIPTION: Reddish Brown Sandy Lean Clay			

G 3242-095, B-2 8'-10' Welsh

TRIAXIAL SHEAR TEST REPORT

TOTAL STRESS PARAMETERS	ϕ = 16.9 deg	c = 4.0 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	14.4	23.6	13.0	
Dry Density - pcf	114.9	100.1	122.2	
Diameter - inches	2.01	2.02	2.00	
Height - inches	4.00	4.00	4.02	
AT TEST				
Final Moisture - %	18.7	24.4	13.2	
Dry Density - pcf	115.2	101.7	123.3	
Calculated Diameter (in.)	2.00	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	22.03	23.38	44.72	
Total Pore Pressure - psi	52.5	57.4	64.7	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	0.7	2.4	1.0	
σ_1 Failure - psi	32.03	43.38	84.72	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Reddish Brown Sandy Lean Clay
Sampled on Site, B-2 8' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

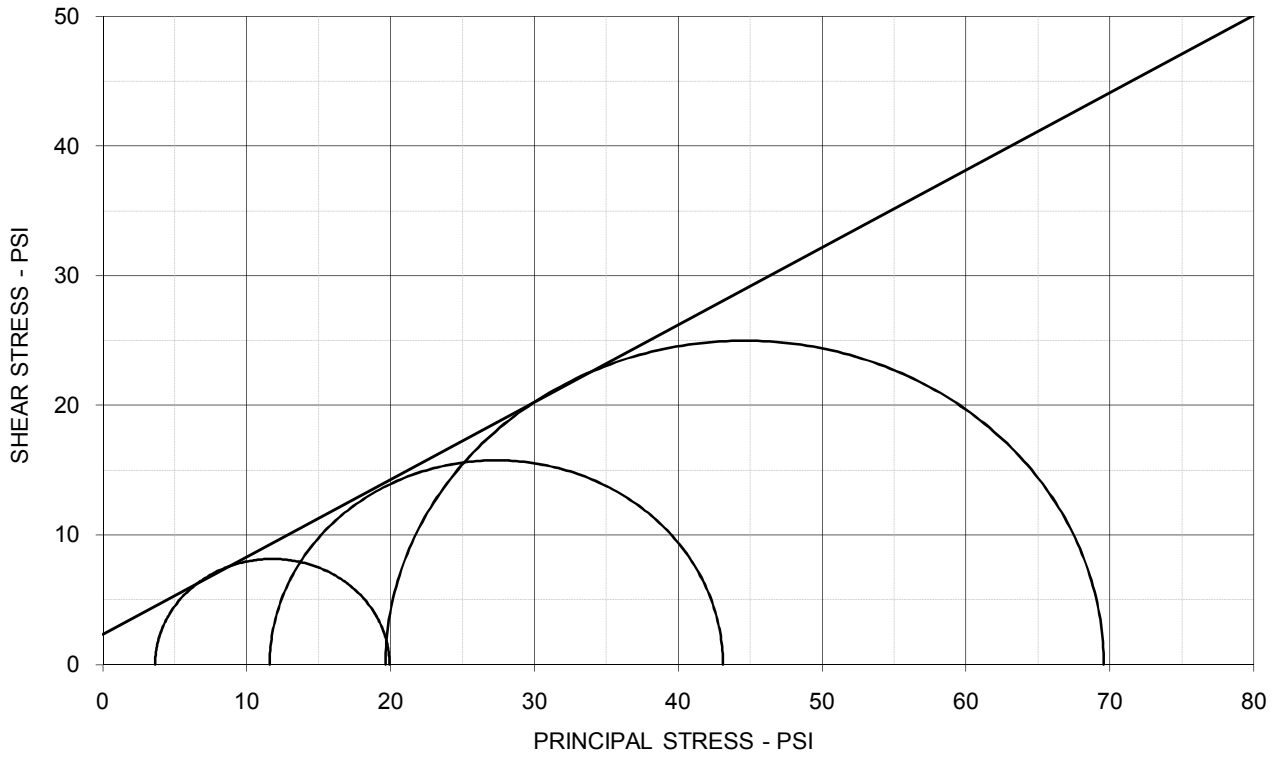
PROJECT INFORMATION

PROJECT: AEP Welsh Power Plant Bottom Ash Ponds
LOCATION: Pittsburg, Texas
PROJECT NO: G 3242 - 095
CLIENT:
December 2009

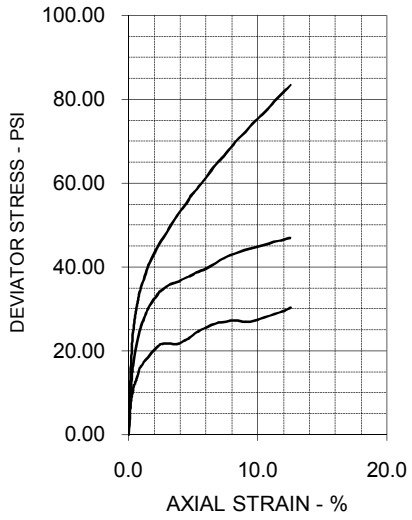
ETTL ENGINEERS & CONSULTANTS

PLATE: B.3

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	ϕ' = 30.8 deg	c' = 2.3 psi		
SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	20.5	17.7	16.0	
Dry Density - pcf	106.7	111.3	117.2	
Diameter - inches	2.00	1.99	1.98	
Height - inches	3.99	3.98	4.00	
AT TEST				
Final Moisture - %	27.8	18.6	16.3	
Dry Density - pcf	106.8	112.4	118.7	
Calculated Diameter (in.)	2.00	1.99	1.97	
Height - inches	3.98	3.97	3.96	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	16.30	31.51	49.94	
Total Pore Pressure - psi	56.4	58.4	70.4	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.0	1.8	3.3	
σ_1' Failure - psi	19.94	43.12	69.59	
σ_3' Failure - psi	3.64	11.61	19.65	



TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Tan, Brown, Gray & Red Clayey Sand
Sampled on Site, B-2 28' to 30' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

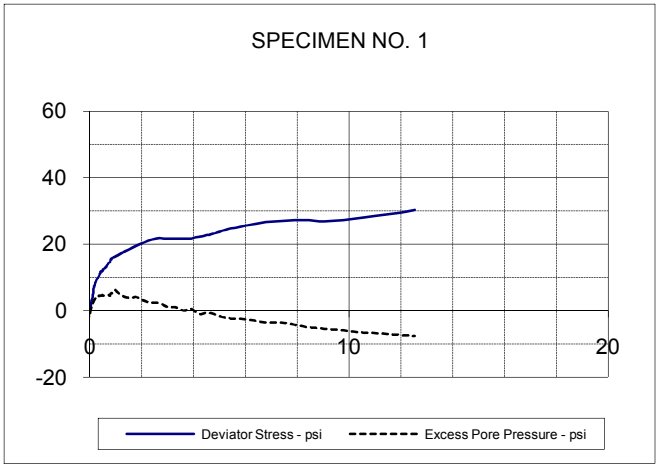
PROJECT INFORMATION

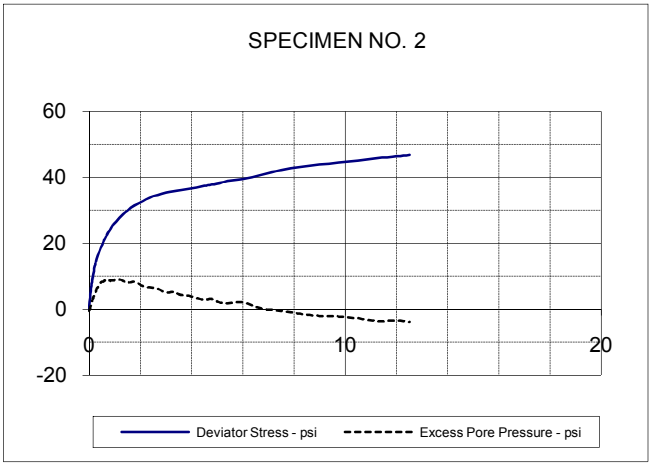
PROJECT: AEP Welsh Power Plant Bottom Ash Ponds
LOCATION: Pittsburg, Texas
PROJECT NO: G 3242 - 095
CLIENT:
December 2009

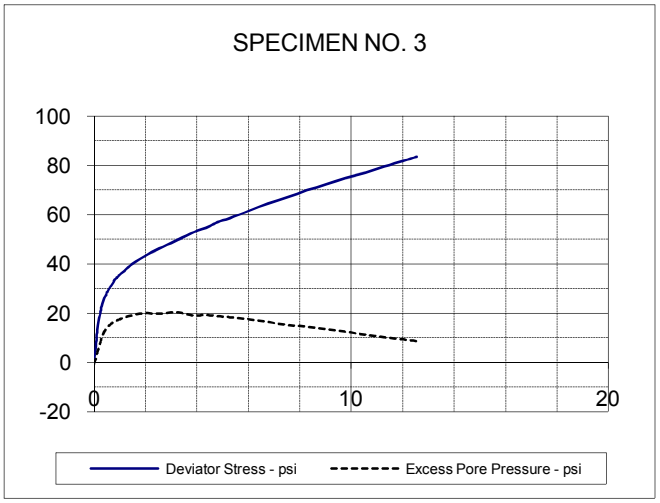
ETTL ENGINEERS & CONSULTANTS

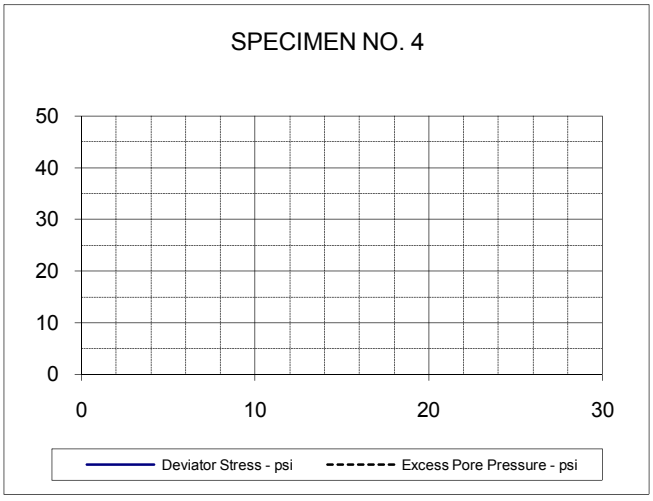
PLATE: B.1

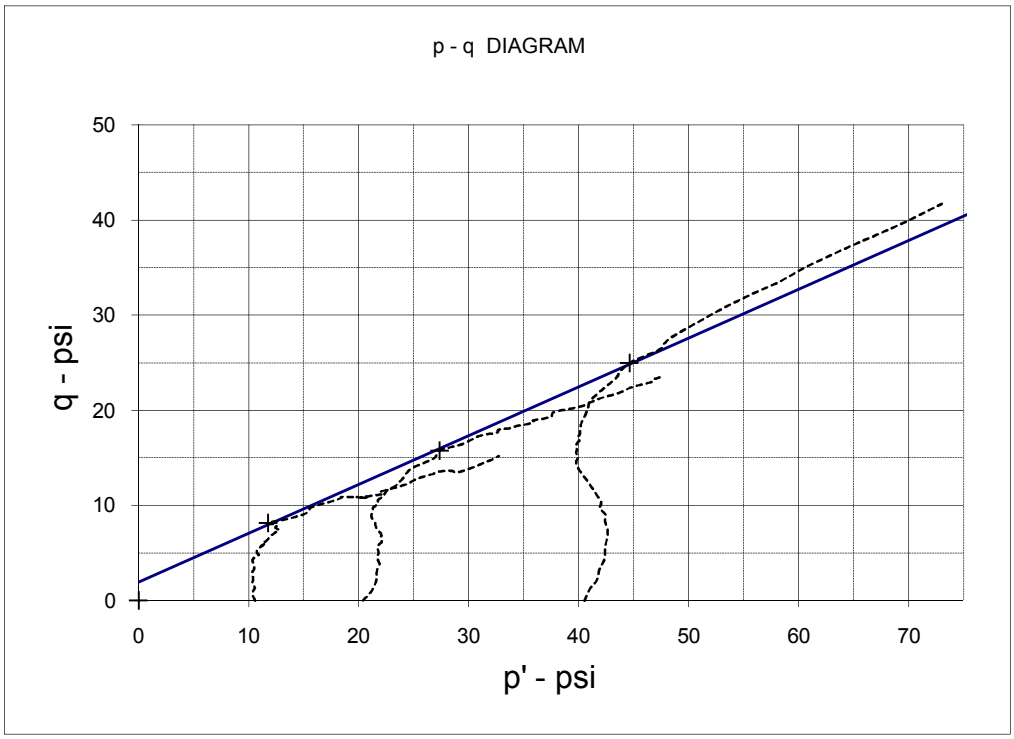
G 3242-095, B-2 28' 30' Welsh









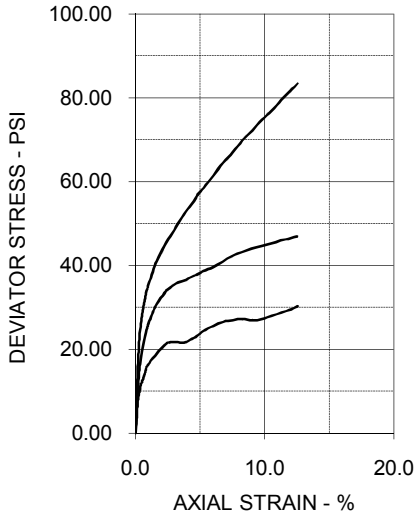


EFFECTIVE STRESS PARAMETERS	R^2 = 1.00	α (deg) = 27.1	a (psi) = 2.0
PROJECT: AEP Welsh Power Plant Bottom Ash Ponds		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 3242 - 095		**ETTL ENGINEERS & CONSULTANTS**	PLATE: B.2
DESCRIPTION: Tan, Brown, Gray & Red Clayey Sand			

G 3242-095, B-2 28'-30' Welsh

TRIAXIAL SHEAR TEST REPORT

TOTAL STRESS PARAMETERS	ϕ = 20.8 deg	c = 2.4 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	20.5	17.7	16.0	
Dry Density - pcf	106.7	111.3	117.2	
Diameter - inches	2.00	1.99	1.98	
Height - inches	3.99	3.98	4.00	
AT TEST				
Final Moisture - %	27.8	18.6	16.3	
Dry Density - pcf	106.8	112.4	118.7	
Calculated Diameter (in.)	2.00	1.99	1.97	
Height - inches	3.98	3.97	3.96	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	16.30	31.51	49.94	
Total Pore Pressure - psi	56.4	58.4	70.4	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.0	1.8	3.3	
σ_1 Failure - psi	26.30	51.51	89.94	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Tan, Brown, Gray & Red Clayey Sand
Sampled on Site, B-2 28' to 30' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

PROJECT INFORMATION

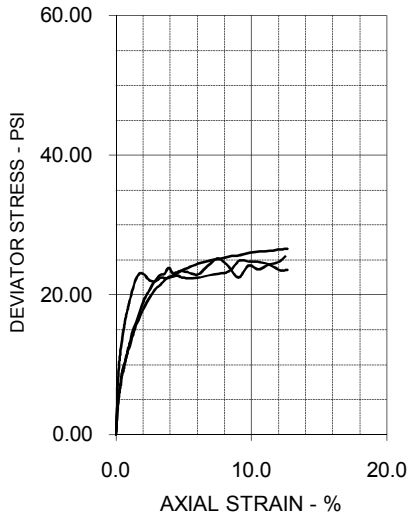
PROJECT: AEP Welsh Power Plant Bottom Ash Ponds
LOCATION: Pittsburg, Texas
PROJECT NO: G 3242 - 095
CLIENT:
December 2009

ETTL ENGINEERS & CONSULTANTS

PLATE: B.3

TRIAXIAL SHEAR TEST REPORT

EFFECTIVE STRESS PARAMETERS	ϕ ' = 26.9 deg	c' = 1.8 psi		
SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	24.0	23.2	20.1	
Dry Density - pcf	98.6	102.2	104.5	
Diameter - inches	2.01	2.02	2.00	
Height - inches	3.97	4.01	4.01	
AT TEST				
Final Moisture - %	26.5	24.8	24.2	
Dry Density - pcf	99.5	103.0	105.7	
Calculated Diameter (in.)	2.01	2.02	2.00	
Height - inches	3.99	4.01	4.03	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	12.64	23.13	24.50	
Total Pore Pressure - psi	55.7	58.4	79.8	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.0	1.8	6.1	
σ_1' Failure - psi	16.87	34.74	34.66	
σ_3' Failure - psi	4.23	11.61	10.16	



TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Gray, Brown & Tan Fat Clay w/ Ferric Seams
Sampled on Site, B-5 8' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

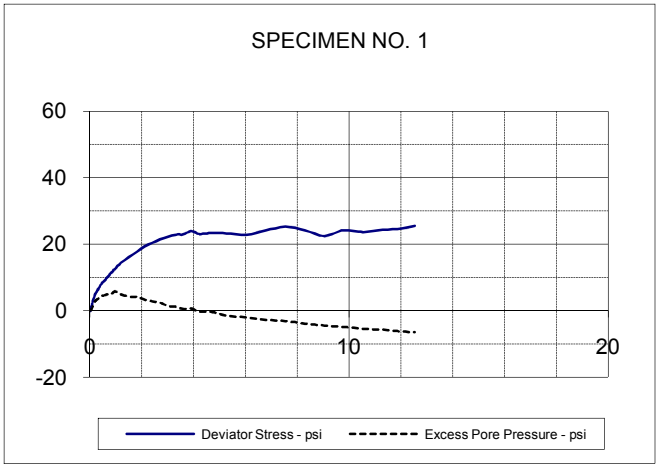
PROJECT INFORMATION

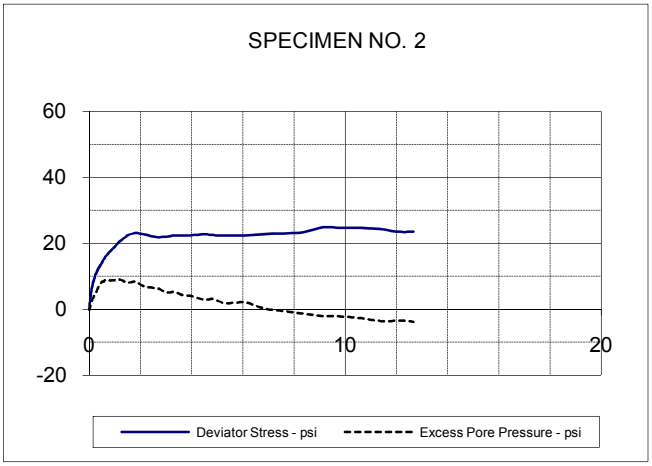
PROJECT: AEP Welsh Power Plant Bottom Ash Ponds
LOCATION: Pittsburg, Texas
PROJECT NO: G 3242 - 095
CLIENT:
December 2009

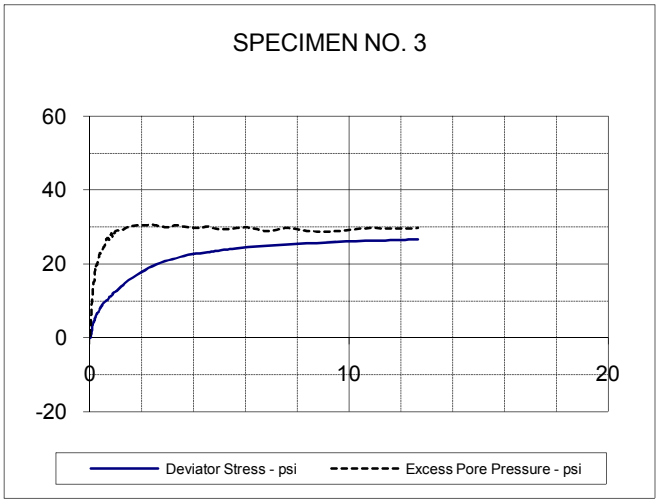
ETTL ENGINEERS & CONSULTANTS

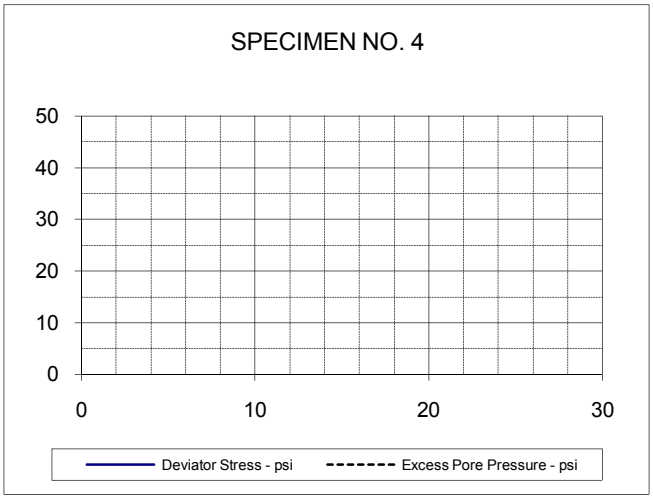
PLATE: B.1

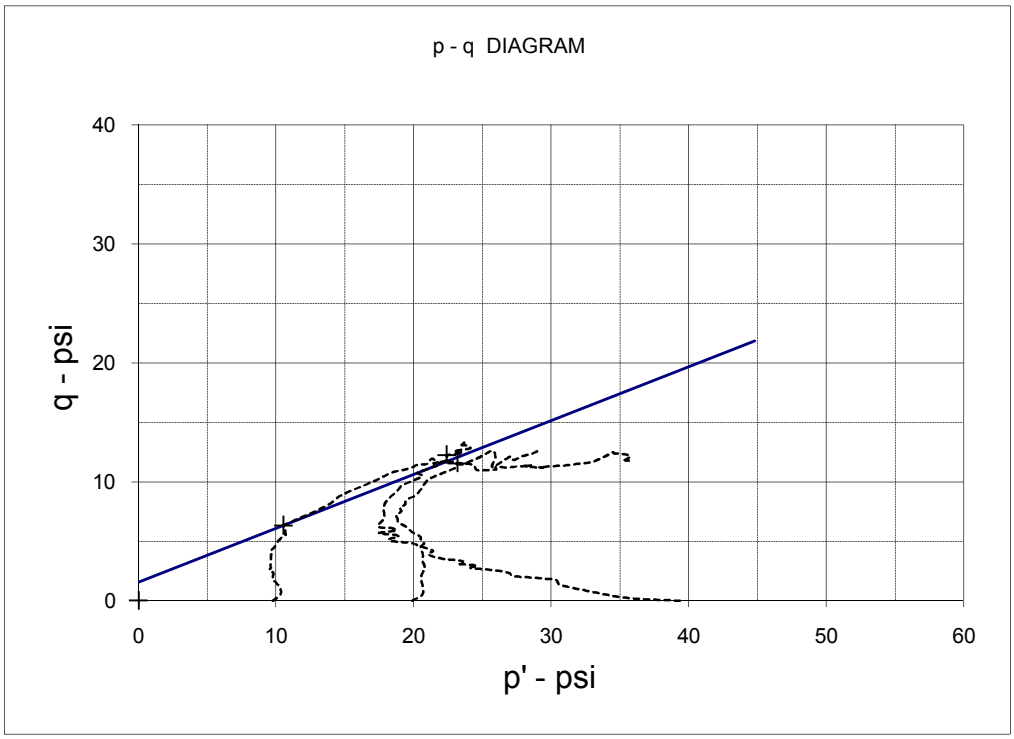
G 3242-095, B-5 8'-10' Welsh







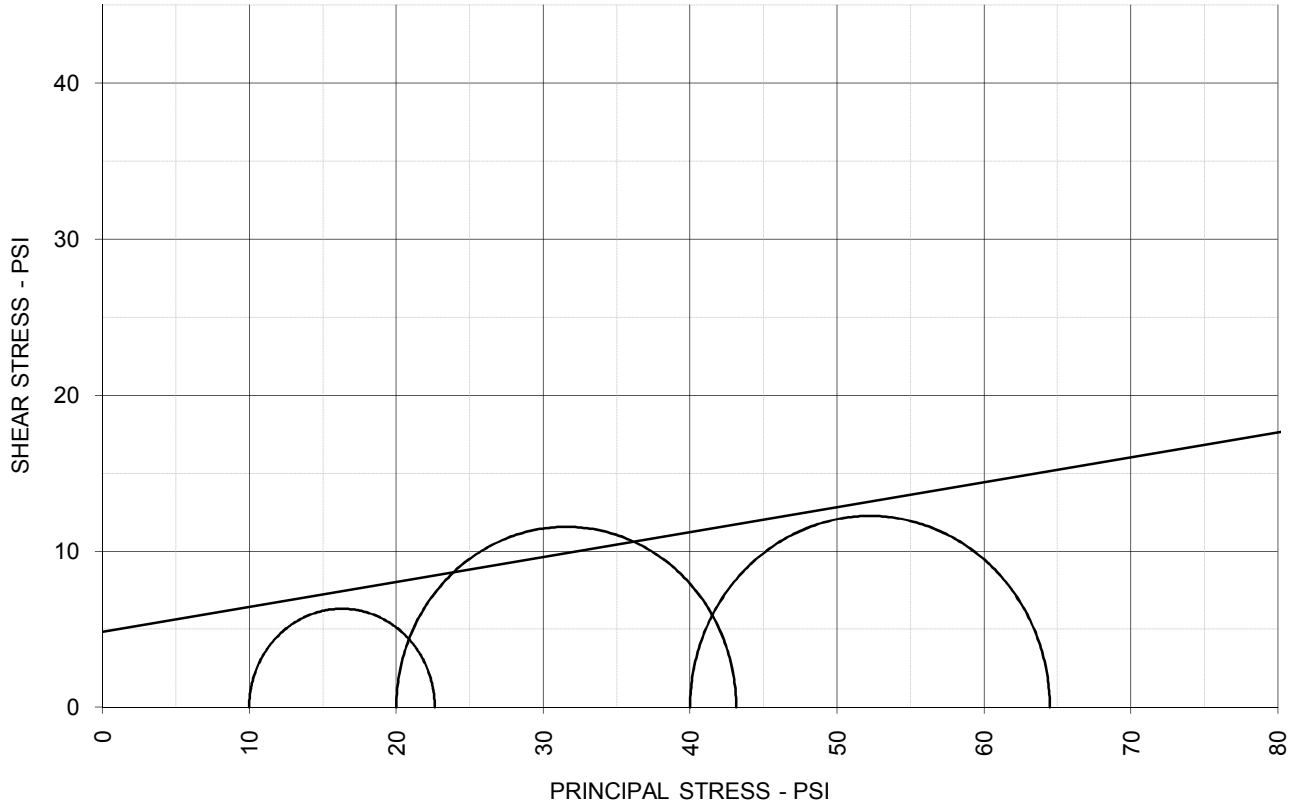




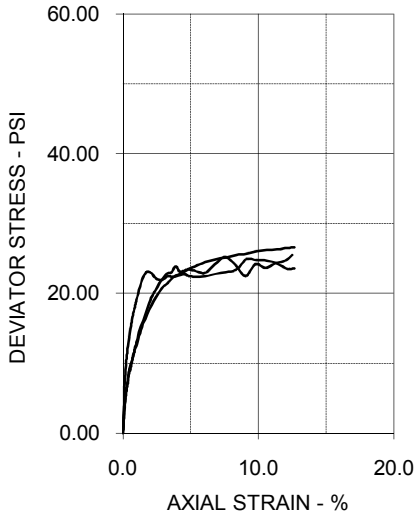
EFFECTIVE STRESS PARAMETERS	R^2 = 0.97	α (deg) = 24.3	a (psi) = 1.6
PROJECT: AEP Welsh Power Plant Bottom Ash Ponds		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 3242 - 095		**ETTL ENGINEERS & CONSULTANTS**	PLATE: B.2
DESCRIPTION: Gray, Brown & Tan Fat Clay w/ Ferric Seams			

G 3242-095, B-5 8'-10' Welsh

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	ϕ = 9.1 deg	c = 4.9 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	24.0	23.2	20.1	
Dry Density - pcf	98.6	102.2	104.5	
Diameter - inches	2.01	2.02	2.00	
Height - inches	3.97	4.01	4.01	
AT TEST				
Final Moisture - %	26.5	24.8	24.2	
Dry Density - pcf	99.5	103.0	105.7	
Calculated Diameter (in.)	2.01	2.02	2.00	
Height - inches	3.99	4.01	4.03	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	12.64	23.13	24.50	
Total Pore Pressure - psi	55.7	58.4	79.8	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.0	1.8	6.1	
σ_1 Failure - psi	22.64	43.13	64.50	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Gray, Brown & Tan Fat Clay w/ Ferric Seams
Sampled on Site, B-5 8' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

PROJECT INFORMATION

PROJECT: AEP Welsh Power Plant Bottom Ash Ponds
LOCATION: Pittsburg, Texas
PROJECT NO: G 3242 - 095
CLIENT:
December 2009

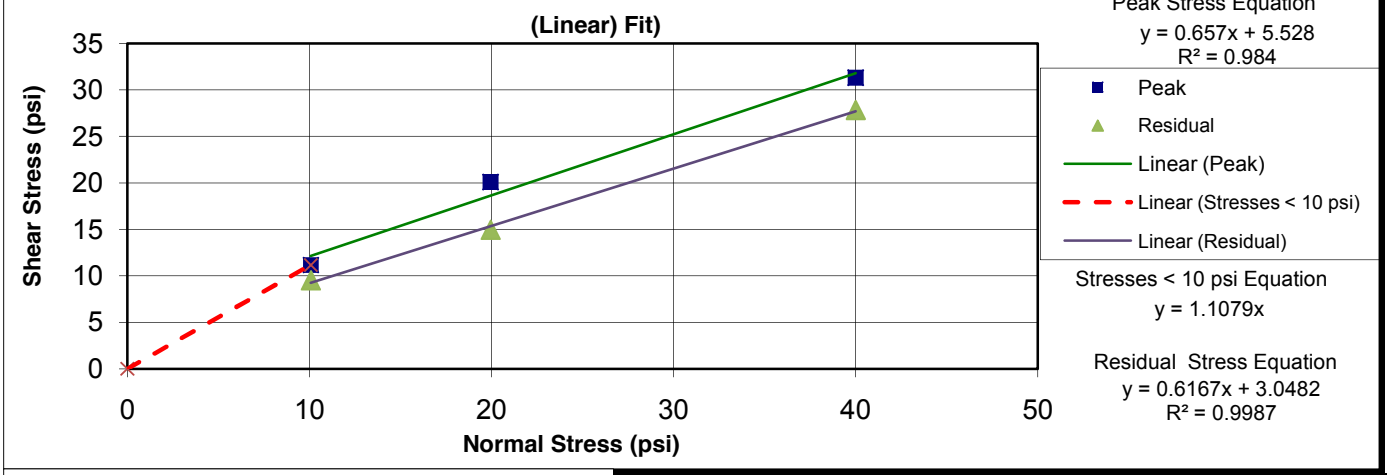
ETTL ENGINEERS & CONSULTANTS

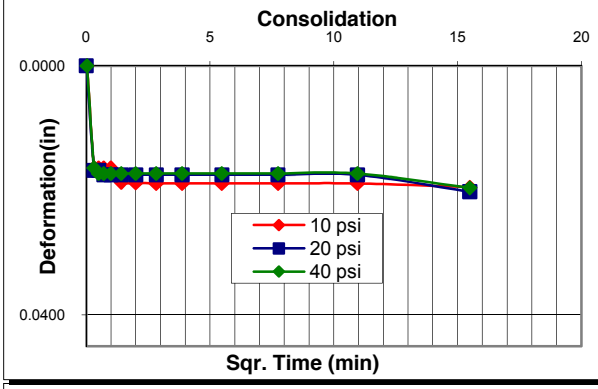
PLATE: B.3

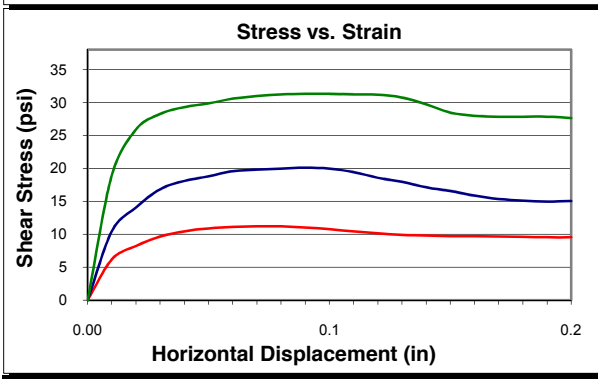
ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

ASTM 3080 Direct Shear Test Report







Peak Strength Parameters

	Peak		Residual	
Friction Angle	33.3 (deg)		31.63 (deg)	
Cohesion	5.53 (psi)	796.0 (psf)	3.05 (psi)	438.9 (psf)
Friction Angle Stresses < 10psi			47.91	(deg)
Specimen Number		1	2	3
Initial				
Moisture Content - %		22.5%	23.5%	23.2%
Dry Density- lb/ft^3		103.8	100.3	101.8
Height-inches		1.008	1.008	1.008
Diameter- inches		2.50	2.50	2.50
Final				
Moisture Content - %		23.1%	25.4%	23.5%
Dry Density- lb/ft^3		103.8	100.9	102.0
Height after shear-(inches)		1.009	1.006	1.006
Height after consolidation (inches)		0.989	0.988	0.988
Normal Stress-(psi)		10	20	40
Peak Failure Stress-(psi)		11.17	20.09	31.31
Residual Failure Stress-(psi)		9.52	14.96	27.84
Strain Rate - (inches/min)		0.0033	0.0033	0.0033

Project Information

Project :	Welsh power Plant Embankments
Client:	AEP
Material Origin:	, TX
Material Description:	Dark Red Silty Sand

LL	PL	PI
-	-	NP
-200%	18	

Job No:	G 3241-095	**Technician:**	Owen Sanderson
Boring No:	B-6	**Sample Type:**	Shelby Tube
Depth:	28'-31'	**Sampling method:**	Shelby Tube
Date:	November 24, 2009	**Testing Device:**	Soiltest B-124BY 2.5 in. round

Remarks

When Calculating stresses < 10 psi: use appropriate Equation above (assuming no Cohesion)

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

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

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

Project :	AEP Welsh Power Plant Bottom Ash Ponds: Pittsburg, Texas							
Date:	12/28/2009	Panel Number : P-3 ; ASTM D 5084						
Project No. :	G 3242-095	Permometer Data						
Boring No.:	B-2	a_p =	0.031416	cm^2	Set Mercury to Pipet Rp at beginning	Equilibrium	1.7	cm^3
Sample:		a_a =	0.767120	cm^2		Pipet **Rp**	**6.7**	cm^3
Depth (ft):	13'-15'	M_1 =	0.030180	C = 0.000444308		Annulus **Ra**	1.5	cm^3
Other Location:		M_2 =	1.040953	T = 0.201660671				
Material Description :	Red & Tan Sandy Lean Clay							

SAMPLE DATA

					Before Test		After Test	
Wet Wt. sample + ring or tare :			602.32	g				
Tare or ring Wt. :			0.0	g	Tare No.:	T-16	Tare No.:	T-1
Wet Wt: of Sample :			602.32	g	Wet Wt.+tare:	292.51	Wet Wt.+tare:	746.56
Diameter :	2.73	in	6.94	cm^2	Dry Wt.+tare:	276.22	Dry Wt.+tare:	683.49
Length :	2.76	in	7.02	cm	Tare Wt:	151.95	Tare Wt:	217.27
Area:	5.87	in^2	37.85	cm^2	Dry Wt.:	124.27	Dry Wt.:	466.22
Volume :	16.21	in^3	265.71	cm^3	Water Wt.:	16.29	Water Wt.:	63.07
Unit Wt.(wet):	**141.45**	pcf	**2.27**	$g/cm^{\wedge 3}$	% moist.:	**13.1**	% moist.:	**13.5**
Unit Wt.(dry):	**125.06**	pcf	**2.00**	$g/cm^{\wedge 3}$				

Assumed Specific Gravity: **2.65** Max Dry Density(pcf) = 125.1105 OMC = 13.108554

% of max = 100.0 +/- OMC = 0.00

Calculated % saturation: 111.02 Void ratio (e) = **0.32** Porosity (n)= **0.24**

TEST READINGS

Z_1(Mercury Height Difference @ t_1): 5.2 cm Hydraulic Gradient = 9.26

Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
12/28/2009	1680	6	0.6588251	23.5	0.920	3.47E-08	9.84E-05	
12/28/2009	2280	5.9	0.7588251	23.5	0.920	2.98E-08	8.44E-05	
12/28/2009	3180	5.7	0.9588251	23.5	0.920	2.76E-08	7.83E-05	
12/28/2009	4140	5.55	1.1088251	23.5	0.920	2.50E-08	7.09E-05	

SUMMARY

k_a = 2.93E-08 cm/sec Acceptance criteria = 25 %

ki		Vm	
k1 =	3.47E-08 cm/sec	18.5	%
k2 =	2.98E-08 cm/sec	1.7	%
k3 =	2.76E-08 cm/sec	5.6	%
k4 =	2.50E-08 cm/sec	14.6	%

$Vm = \frac{|ka-ki|}{ka} \times 100$

Hydraulic conductivity	k =	**2.93E-08**	cm/sec	**8.30E-05**	ft/day
Void Ratio	e =	**0.32**			
Porosity	n =	**0.24**			
Bulk Density	γ =	**2.27**	g/cm^3	**141.5**	pcf
Water Content	W =	**0.26**	cm^3/cm^3	(at 20 deg C)	
Intrinsic Permeability	k_{int} =	**3.00E-13**	cm^2	(at 20 deg C)	

Robert Duke, 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

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

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

Project : AEP Welsh Power Plant Bottom Ash Ponds: Pittsburg, Texas
Date: 12/28/2009 Panel Number : P-3 ; ASTM D 5084
Project No. : G 3242-095 Permometer Data
Boring No.: B-2 a_p = 0.031416 cm^2 **Set Mercury to Pipet Rp at beginning** Equilibrium 1.7 cm^3
Sample: a_a = 0.767120 cm^2 Pipet **Rp** **6.7** cm^3
Depth (ft): 33'-35' M_1 = 0.030180 C = 0.000433922 Annulus **Ra** 1.5 cm^3
Other Location: M_2 = 1.040953 T = 0.201660671
Material Description : Red & Tan Clayey Sand

SAMPLE DATA

					Before Test		After Test	
Wet Wt. sample + ring or tare :			553.04	g				
Tare or ring Wt. :			0.0	g	Tare No.:	T-21	Tare No.:	T-13
Wet Wt: of Sample :			553.04	g	Wet Wt.+tare:	553.04	Wet Wt.+tare:	784.01
Diameter :	2.76	in	7.01	cm^2	Dry Wt.+tare:	464.50	Dry Wt.+tare:	684.19
Length :	2.75	in	6.98	cm	Tare Wt:	0.00	Tare Wt:	219.69
Area:	5.97	in^2	38.54	cm^2	Dry Wt.:	464.5	Dry Wt.:	464.5
Volume :	16.42	in^3	269.13	cm^3	Water Wt.:	88.54	Water Wt.:	99.82
Unit Wt.(wet):	**128.23**	pcf	**2.05**	$g/cm^{\wedge 3}$	% moist.:	**19.1**	% moist.:	**21.5**
Unit Wt.(dry):	**107.70**	pcf	**1.73**	$g/cm^{\wedge 3}$				

Assumed Specific Gravity: **2.73** Max Dry Density(pcf) = 107.7462 OMC = 19.0613563
% of max = 100.0 +/- OMC = 0.00
Calculated % saturation: 100.72 Void ratio (e) = **0.58** Porosity (n)= **0.37**

TEST READINGS

Z_1(Mercury Height Difference @ t_1): 5.2 cm Hydraulic Gradient = 9.31

Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
12/28/2009	1580	5.4	1.2588251	23.5	0.920	7.40E-08	2.10E-04	
12/28/2009	2310	5	1.6588251	23.5	0.920	7.04E-08	2.00E-04	
12/28/2009	2535	4.9	1.7588251	23.5	0.920	6.90E-08	1.96E-04	
12/28/2009	2775	4.8	1.8588251	23.5	0.920	6.76E-08	1.92E-04	

SUMMARY

k_a =	7.03E-08	cm/sec		Acceptance criteria =	25	%
ki			Vm			
k1 =	7.40E-08	cm/sec	5.3	%	Vm = $\frac{\lvert ka-ki \rvert}{ka} \times 100$	
k2 =	7.04E-08	cm/sec	0.2	%		
k3 =	6.90E-08	cm/sec	1.8	%		
k4 =	6.76E-08	cm/sec	3.8	%		

Hydraulic conductivity	k =	**7.03E-08**	cm/sec	**1.99E-04**	ft/day
Void Ratio	e =	**0.58**			
Porosity	n =	**0.37**			
Bulk Density	γ =	**2.05**	g/cm^3	**128.2**	pcf
Water Content	W =	**0.33**	cm^3/cm^3	(at 20 deg C)	
Intrinsic Permeability	k_{int} =	**7.20E-13**	cm^2	(at 20 deg C)	

Robert Duke, 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

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

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

Project : AEP Welsh Power Plant Bottom Ash Ponds: Pittsburg, Texas
Date: 12/28/2009 Panel Number : P-3 ; ASTM D 5084
Project No. : G 3242-095 Permometer Data

Boring No.:	B-3	a_p =	0.031416	cm^2	Set Mercury to Pipet Rp at beginning	Equilibrium	1.7	cm^3
Sample:		a_a =	0.767120	cm^2		Pipet **Rp**	**6.7**	cm^3
Depth (ft):	8'-10'	M_1 =	0.030180	C = 0.000431052		Annulus **Ra**	1.5	cm^3
Other Location:		M_2 =	1.040953	T = 0.201660671				

Material Description : Red & Tan Fat Clay

SAMPLE DATA

					Before Test		After Test	
Wet Wt. sample + ring or tare :			559.11	g				
Tare or ring Wt. :			0.0	g	Tare No.:	T-23	Tare No.:	T-3
Wet Wt: of Sample :			559.11	g	Wet Wt.+tare:	166.09	Wet Wt.+tare:	783.53
Diameter :	2.75	in	6.99	cm^2	Dry Wt.+tare:	162.69	Dry Wt.+tare:	700.67
Length :	2.72	in	6.90	cm	Tare Wt:	140.30	Tare Wt:	220.71
Area:	5.94	in^2	38.32	cm^2	Dry Wt.:	22.39	Dry Wt.:	479.96
Volume :	16.13	in^3	264.26	cm^3	Water Wt.:	3.4	Water Wt.:	82.86
Unit Wt.(wet):	**132.02**	pcf	**2.12**	$g/cm^{\wedge 3}$	% moist.:	**15.2**	% moist.:	**17.3**
Unit Wt.(dry):	**114.62**	pcf	**1.84**	$g/cm^{\wedge 3}$				

Assumed Specific Gravity: **2.68** Max Dry Density(pcf) = 114.6685 OMC = 15.1853506
% of max = 100.0 +/- OMC = 0.00
Calculated % saturation: 100.64 Void ratio (e) = **0.46** Porosity (n)= **0.31**

TEST READINGS

Z_1(Mercury Height Difference @ t_1): 5.2 cm Hydraulic Gradient = 9.43

Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
12/28/2009	1476	5.4	1.258825	23.5	0.920	7.87E-08	2.23E-04	
12/28/2009	2205	5	1.658825	23.5	0.920	7.33E-08	2.08E-04	
12/28/2009	2370	4.9	1.758825	23.5	0.920	7.33E-08	2.08E-04	
12/28/2009	2580	4.8	1.858825	23.5	0.920	7.22E-08	2.05E-04	

SUMMARY

k_a =	7.44E-08	cm/sec		Acceptance criteria =	25 %
ki			Vm		
k1 =	7.87E-08	cm/sec	5.8	%	Vm = $\frac{\lvert ka-ki \rvert}{ka} \times 100$
k2 =	7.33E-08	cm/sec	1.5	%	
k3 =	7.33E-08	cm/sec	1.4	%	
k4 =	7.22E-08	cm/sec	2.9	%	

Hydraulic conductivity	k =	**7.44E-08**	cm/sec	**2.11E-04**	ft/day
Void Ratio	e =	**0.46**			
Porosity	n =	**0.31**			
Bulk Density	γ =	**2.12**	g/cm^3	**132.0**	pcf
Water Content	W =	**0.28**	cm^3/cm^3	(at 20 deg C)	
Intrinsic Permeability	k_{int} =	**7.62E-13**	cm^2	(at 20 deg C)	

Robert Duke, 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

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

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

Project : AEP Welsh Power Plant Bottom Ash Ponds: Pittsburg, Texas
Date: 12/28/2009 Panel Number : P-3 ; ASTM D 5084
Project No. : G 3242-095 Permometer Data
Boring No.: B-4 a_p = 0.031416 cm^2 Set Mercury to Pipet Rp at beginning Equilibrium 1.7 cm^3
Sample: a_a = 0.767120 cm^2 Pipet **Rp** **6.7** cm^3
Depth (ft): 8'-10' M_1 = 0.030180 C = 0.000429664 Annulus **Ra** 1.5 cm^3
Other Location: M_2 = 1.040953 T = 0.201660671
Material Description : Dark Brown Sandy Lean Clay

SAMPLE DATA

					Before Test		After Test	
Wet Wt. sample + ring or tare :			531.96	g	Tare No.:	T-24	Tare No.:	T-6
Tare or ring Wt. :			0.0	g	Wet Wt.+tare:	230.01	Wet Wt.+tare:	759.40
Wet Wt: of Sample :			531.96	g	Dry Wt.+tare:	207.52	Dry Wt.+tare:	648.84
Diameter :	2.76	in	7.01	cm^2	Tare Wt:	112.35	Tare Wt:	217.34
Length :	2.72	in	6.92	cm	Dry Wt.:	95.17	Dry Wt.:	431.5
Area:	5.98	in^2	38.57	cm^2	Water Wt.:	22.49	Water Wt.:	110.56
Volume :	16.29	in^3	266.87	cm^3	% moist.:	**23.6**	% moist.:	**25.6**
Unit Wt.(wet):	**124.38**	pcf	**1.99**	g/cm^3				
Unit Wt.(dry):	**100.61**	pcf	**1.61**	g/cm^3				

Assumed Specific Gravity: **2.72** Max Dry Density(pcf) = 100.6512 OMC = 23.6313964
% of max = 100.0 +/- OMC = 0.00
Calculated % saturation: 101.32 Void ratio (e) = **0.69** Porosity (n)= **0.41**

TEST READINGS

Z_1(Mercury Height Difference @ t_1): 5.2 cm Hydraulic Gradient = 9.40

Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
12/28/2009	2280	6.1	0.558825	23.5	0.920	2.07E-08	5.88E-05	
12/28/2009	2940	6	0.658825	23.5	0.920	1.92E-08	5.44E-05	
12/28/2009	3660	5.9	0.758825	23.5	0.920	1.79E-08	5.09E-05	
12/28/2009	4200	5.84	0.818825	23.5	0.920	1.70E-08	4.82E-05	

SUMMARY

k_a = 1.87E-08 cm/sec Acceptance criteria = 25 %

ki		Vm	
k1 =	2.07E-08 cm/sec	10.8	%
k2 =	1.92E-08 cm/sec	2.5	%
k3 =	1.79E-08 cm/sec	4.1	%
k4 =	1.70E-08 cm/sec	9.2	%

$Vm = \frac{|ka-ki|}{ka} \times 100$

Hydraulic conductivity	k =	**1.87E-08**	cm/sec	**5.30E-05**	ft/day
Void Ratio	e =	**0.69**			
Porosity	n =	**0.41**			
Bulk Density	γ =	**1.99**	g/cm^3	**124.4**	pcf
Water Content	W =	**0.38**	cm^3/cm^3	(at 20 deg C)	
Intrinsic Permeability	k_{int} =	**1.92E-13**	cm^2	(at 20 deg C)	

Robert Duke, 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

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

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

Project : AEP Welsh Power Plant Bottom Ash Ponds: Pittsburg, Texas
Date: 12/28/2009 Panel Number : P-3 ; ASTM D 5084
Project No. : G 3242-095 Permometer Data
Boring No.: B-5 a_p = 0.031416 cm^2 **Set Mercury to Pipet Rp at beginning** Equilibrium 1.7 cm^3
Sample: a_a = 0.767120 cm^2 Pipet **Rp** **6.7** cm^3
Depth (ft): 23'-25' M_1 = 0.030180 C = 0.00043565 Annulus **Ra** 1.5 cm^3
Other Location: M_2 = 1.040953 T = 0.201660671
Material Description : Orangish Tan Fat Clay

SAMPLE DATA

					Before Test		After Test	
Wet Wt. sample + ring or tare :			532.37	g				
Tare or ring Wt. :			0.0	g	Tare No.:	T-25	Tare No.:	T-9
Wet Wt: of Sample :			532.37	g	Wet Wt.+tare:	532.37	Wet Wt.+tare:	765.78
Diameter :	2.74	in	6.97	cm^2	Dry Wt.+tare:	441.00	Dry Wt.+tare:	661.51
Length :	2.73	in	6.94	cm	Tare Wt:	0.00	Tare Wt:	220.51
Area:	5.91	in^2	38.15	cm^2	Dry Wt.:	441	Dry Wt.:	441
Volume :	16.16	in^3	264.75	cm^3	Water Wt.:	91.37	Water Wt.:	104.27
Unit Wt.(wet):	**125.48**	pcf	**2.01**	g/cm^3	% moist.:	**20.7**	% moist.:	**23.6**
Unit Wt.(dry):	**103.94**	pcf	**1.67**	g/cm^3				

Assumed Specific Gravity: **2.72** Max Dry Density(pcf) = 103.9846 OMC = 20.7188209
% of max = 100.0 +/- OMC = 0.00
Calculated % saturation: 101.48 Void ratio (e) = **0.63** Porosity (n)= **0.39**

TEST READINGS

Z_1(Mercury Height Difference @ t_1): 5.2 cm Hydraulic Gradient = 9.37

Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
12/28/2009	212	5.5	1.158825	23.5	0.920	5.03E-07	1.43E-03	
12/28/2009	237	5.4	1.258825	23.5	0.920	4.95E-07	1.40E-03	
12/28/2009	259	5.3	1.358825	23.5	0.920	4.96E-07	1.41E-03	
12/28/2009	289	5.2	1.458825	23.5	0.920	4.83E-07	1.37E-03	

SUMMARY

k_a = 4.95E-07 cm/sec Acceptance criteria = 25 %

ki		Vm
k1 =	5.03E-07 cm/sec	1.8 %
k2 =	4.95E-07 cm/sec	0.2 %
k3 =	4.96E-07 cm/sec	0.3 %
k4 =	4.83E-07 cm/sec	2.2 %

$$Vm = \frac{|ka - ki|}{ka} \times 100$$

Hydraulic conductivity	k =	**4.95E-07**	cm/sec	**1.40E-03**	ft/day
Void Ratio	e =	**0.63**			
Porosity	n =	**0.39**			
Bulk Density	γ =	**2.01**	g/cm^3	**125.5**	pcf
Water Content	W =	**0.35**	cm^3/cm^3	(at 20 deg C)	
Intrinsic Permeability	k_{int} =	**5.07E-12**	cm^2	(at 20 deg C)	

Robert Duke, 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

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

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

Project : AEP Welsh Power Plant Bottom Ash Ponds: Pittsburg, Texas
Date: 12/28/2009 Panel Number : P-3 ; ASTM D 5084
Project No. : G 3242-095 Permometer Data

Boring No.:	B-6	a_p =	0.031416	cm^2	Set Mercury to Pipet Rp at beginning	Equilibrium	1.7	cm^3
Sample:		a_a =	0.767120	cm^2		Pipet **Rp**	**6.7**	cm^3
Depth (ft):	28'-30'	M_1 =	0.030180	C = 0.000408156		Annulus **Ra**	1.5	cm^3
Other Location:		M_2 =	1.040953	T = 0.201660671				

Material Description : Gray Silty Sand

SAMPLE DATA

					Before Test		After Test	
Wet Wt. sample + ring or tare :			457.40	g	Tare No.:	T-5	Tare No.:	T-10
Tare or ring Wt. :			0.0	g	Wet Wt.+tare:	355.86	Wet Wt.+tare:	661.49
Wet Wt: of Sample :			457.40	g	Dry Wt.+tare:	328.36	Dry Wt.+tare:	581.76
Diameter :	2.69	in	6.83	cm^2	Tare Wt:	218.80	Tare Wt:	221.13
Length :	2.46	in	6.24	cm	Dry Wt.:	109.56	Dry Wt.:	360.63
Area:	5.68	in^2	36.64	cm^2	Water Wt.:	27.5	Water Wt.:	79.73
Volume :	13.96	in^3	228.75	cm^3	% moist.:	**25.1**	% moist.:	**22.1**
Unit Wt.(wet):	**124.77**	pcf	**2.00**	$g/cm^{\wedge 3}$				
Unit Wt.(dry):	**99.74**	pcf	**1.60**	$g/cm^{\wedge 3}$				

Assumed Specific Gravity: **2.55** Max Dry Density(pcf) = 99.78226 OMC = 25.1004016
% of max = 100.0 +/- OMC = 0.00
Calculated % saturation: 94.57 Void ratio (e) = **0.60** Porosity (n)= **0.37**

TEST READINGS

Z_1(Mercury Height Difference @ t_1): 5.2 cm Hydraulic Gradient = 10.42

Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
12/28/2009	7	4	2.658825	23.5	0.920	4.12E-05	1.17E-01	
12/28/2009	9	3.5	3.158825	23.5	0.920	4.23E-05	1.20E-01	
12/28/2009	11	3	3.658825	23.5	0.920	4.57E-05	1.30E-01	
12/28/2009	16	2.5	4.158825	23.5	0.920	4.28E-05	1.21E-01	

SUMMARY

ka = 4.30E-05 cm/sec Acceptance criteria = 25 %

ki		Vm
k1 =	4.12E-05 cm/sec	4.2 %
k2 =	4.23E-05 cm/sec	1.7 %
k3 =	4.57E-05 cm/sec	6.3 %
k4 =	4.28E-05 cm/sec	0.4 %

$Vm = \frac{|ka-ki|}{ka} \times 100$

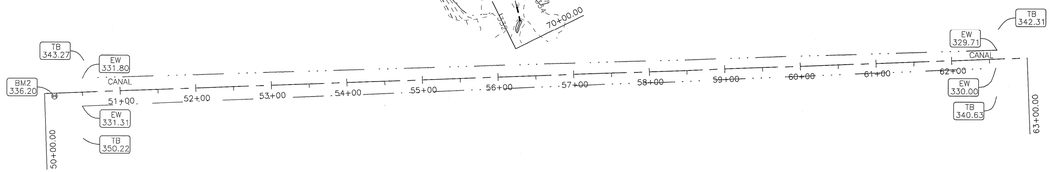
Hydraulic conductivity	k =	**4.30E-05**	cm/sec	**1.22E-01**	ft/day
Void Ratio	e =	**0.60**			
Porosity	n =	**0.37**			
Bulk Density	γ =	**2.00**	g/cm^3	**124.8**	pcf
Water Content	W =	**0.40**	cm^3/cm^3	(at 20 deg C)	
Intrinsic Permeability	k_{int} =	**4.41E-10**	cm^2	(at 20 deg C)	

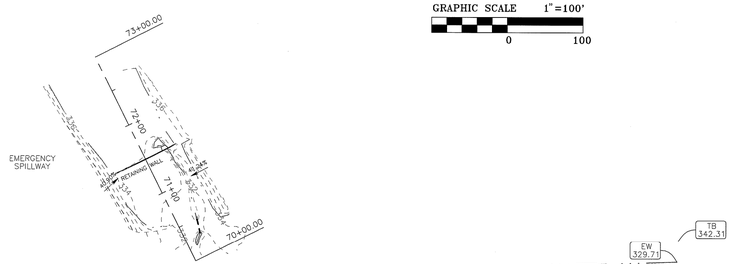
Robert Duke, P.E.

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

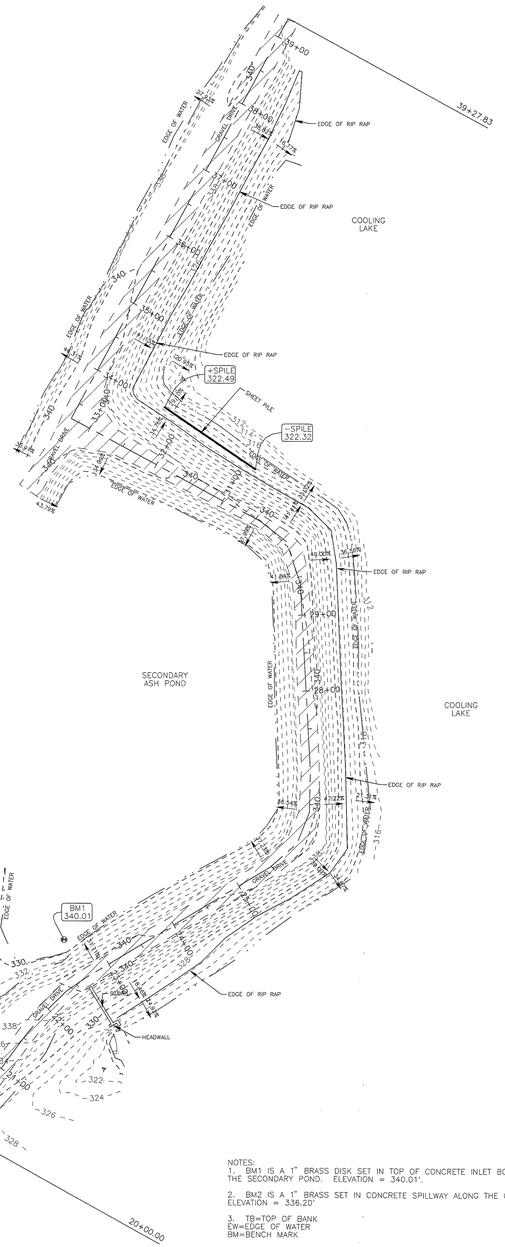
1717 East Erwin
Tyler, Texas 75702
903-595-4421 Phone
903-595-6113 Fax
www.ettlinc.com

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





GRAPHIC SCALE 1"=100'
0 100



NOTES:
1. BM1 IS A 1" BRASS DISK SET IN TOP OF CONCRETE INLET BOX FOR THE SECONDARY POND. ELEVATION = 340.01'.

2. BM2 IS A 1" BRASS SET IN CONCRETE SPILLWAY ALONG THE CANAL. ELEVATION = 336.20'

3. TB=TOP OF BANK
EW=EDGE OF WATER
BM=BENCH MARK

4. CONTOURS ARE ARE 2.0' APART.

5. LAKE ELEVATION PER WELSH POWER PLANT ON NOVEMBER 18, 2010 WAS 317.57 FEET MSL.

SURVEYOR CERTIFICATE:

I HEREBY CERTIFY THAT THIS TOPOGRAPHICAL SURVEY WAS MADE ON THE GROUND UNDER MY SUPERVISION ON NOVEMBER 18, 2010, THAT THIS PLAT (MAP OR DRAWING) REPRESENTS THE FACTS FOUND AT THE TIME.

MIKE GARDNER
REGISTERED PROFESSIONAL LAND SURVEYOR
NO. 5760, STATE OF TEXAS
FIRM CERTIFICATE NO. 101011-00
DATE: NOVEMBER 23, 2010
REVISED: DECEMBER 6, 2010

STATE OF TEXAS
MIKE GARDNER
#5760
PROFESSIONAL LAND SURVEYOR

TOPOGRAPHIC SURVEY

DIKE'S AT WELSH POWER PLANT
FOR: GREG CARTER

Date	Revision/Description
12/8/10	ADDED LAKE LEVEL NOTE
12/6/10	ADDED CROSS SECTION SHEETS

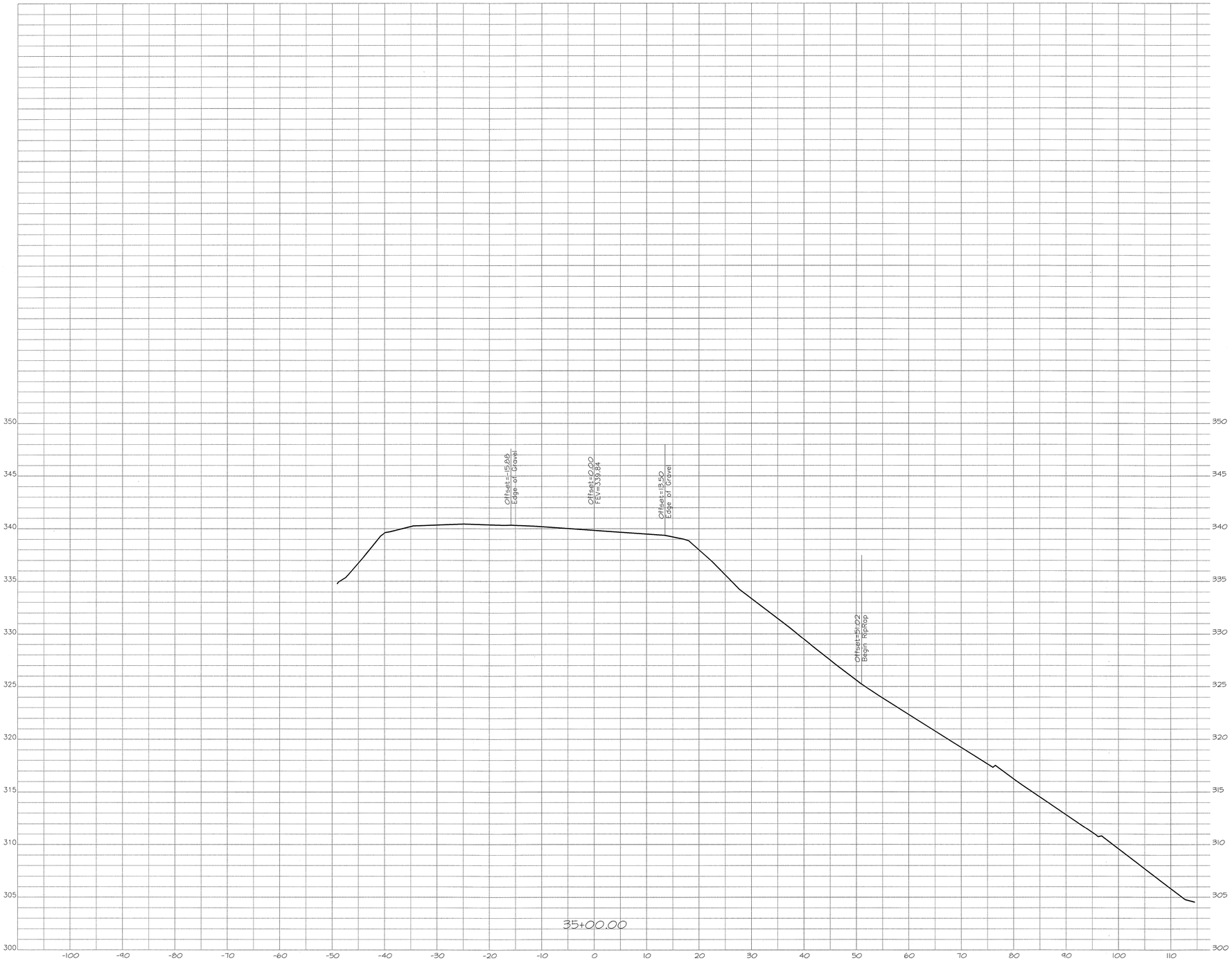
Drawn By	Checked By	Project No.	Dwg. Date
MG	DW	104021	11/19/10

File No. | Sheet No. 1

MTG engineers & surveyors
5930 SUMMERHILL RD. | P.O. BOX 3786
TEXARKANA TEXAS 75501
P 903.838.8533 | F 903.832.4700
www.mtgengineers.com

 TBPE NO. 354

HORIZONTAL SCALE - 1"=10'
VERTICAL SCALE - 1"=5'



SURVEYOR CERTIFICATE:

I HEREBY CERTIFY THAT THIS TOPOGRAPHICAL SURVEY WAS MADE ON THE GROUND UNDER MY SUPERVISION ON NOVEMBER 18, 2010, THAT THIS PLAT (MAP OR DRAWING) REPRESENTS THE FACTS FOUND AT THE TIME.

MIKE GARDNER
REGISTERED PROFESSIONAL LAND SURVEYOR
NO. 5760, STATE OF TEXAS
FIRM CERTIFICATE NO. 101011-00
DATE: NOVEMBER 23, 2010
REVISED: DECEMBER 6, 2010

STATE OF TEXAS
MIKE GARDNER
#5760
PROFESSIONAL LAND SURVEYOR

CROSS SECTIONS ASH POND BERM

DIKE'S AT WELSH POWER PLANT
FOR: GREG CARTER

Date	Revision/Description

Drawn By	Checked By	Project No.	Dwg. Date
J.B.D.	M.G.	104021	12/6/2010

MTG engineers & surveyors
5430 SUMMERHILL RD. | P.O. BOX 3786
TEXARKANA, TEXAS 75501
P 903.838.8533 | F 903.832.4700
www.mtgengineers.com

 TBPE NO. 354

File No. | Sheet No. 5

X:\2010 Projects\104021 TOPO AT WELSH POWER PLANT DAMS\104021 REVISED 12-3-10 G.pro
Mon Dec 06 2010 11:24AM