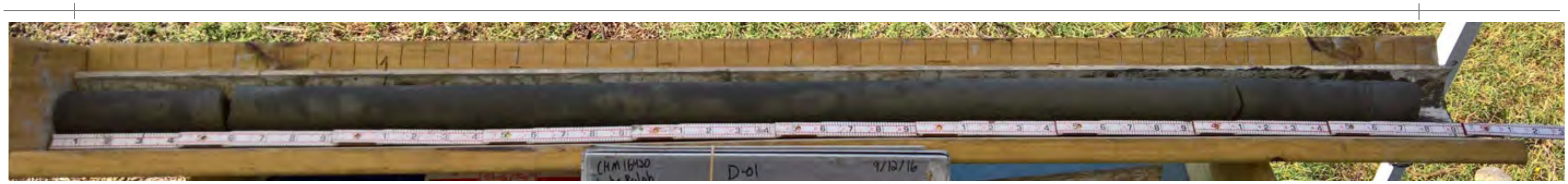
60’ 65’

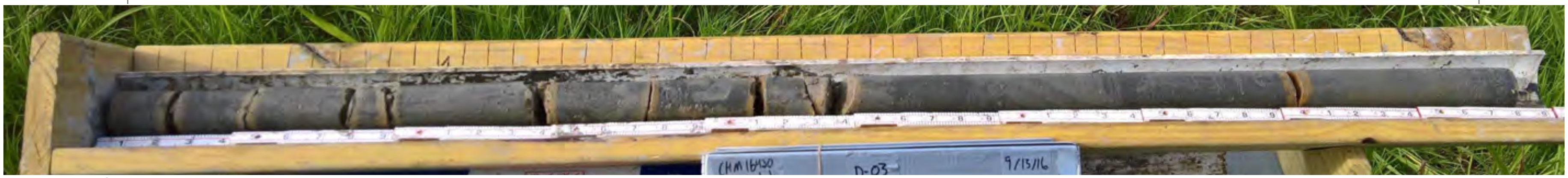
65’ 70’

70’ 75’



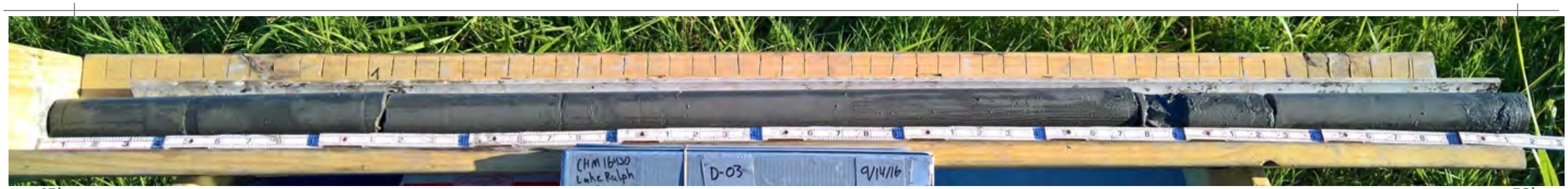
FNI PROJECT: CHM16420	FREESE AND NICHOLS	UTRWD Lake Ralph Hall	PLATE D-02-4
FILE: T:\STUDY\GEO\Rock Core Photos			
DATE: December 2016	4055 INTERNATIONAL PLAZA, STE 200 FORT WORTH, TX 76109	SAMPLE PHOTOGRAPHS **BORING D-02**	
PREPARED: MK			

30' 35'

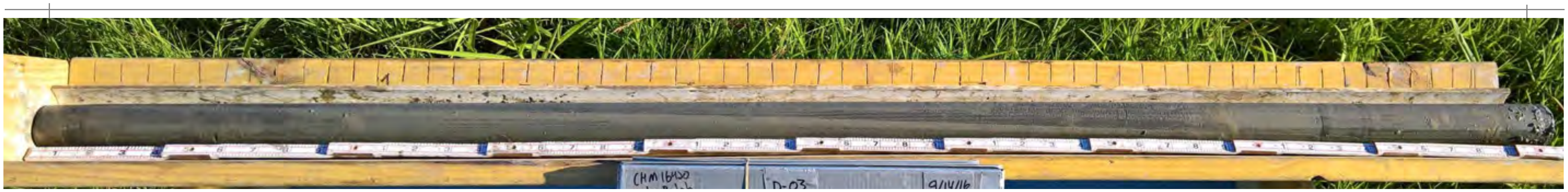


35' 40'

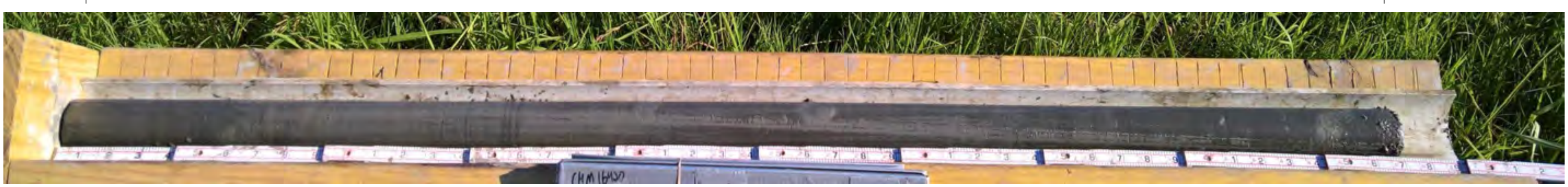
40' 45'



45' 50'



50' 55'



FNI PROJECT:	CHM16420
FILE:	T:\STUDY\GEO\Rock Core Photos
DATE:	December 2016
PREPARED:	MK

FREESE AND NICHOLS

4055 INTERNATIONAL PLAZA, STE 200
FORT WORTH, TX 76109

UTRWD Lake Ralph Hall

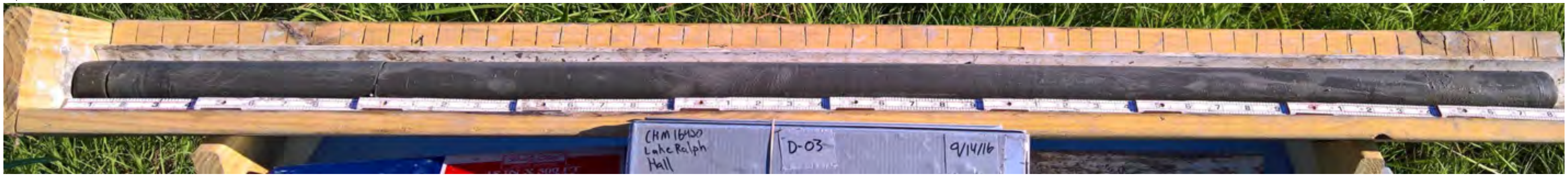
SAMPLE PHOTOGRAPHS

BORING D-03

PLATE D-03-1

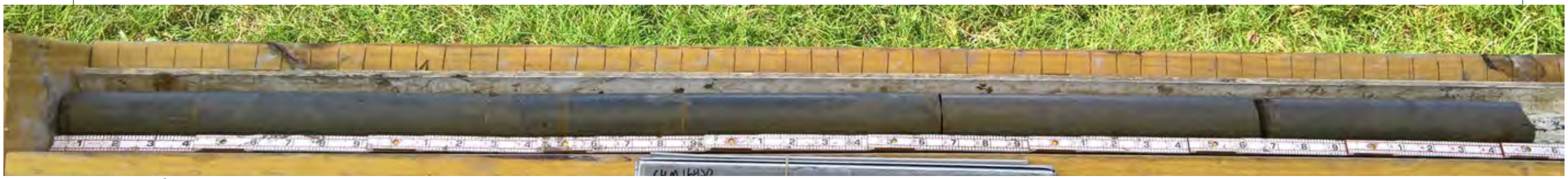
65'

70'



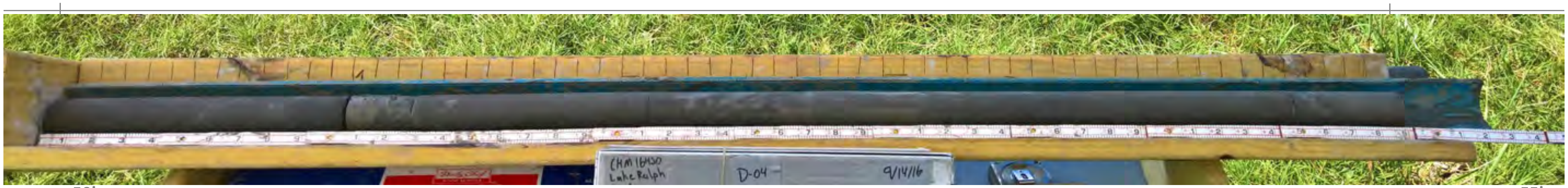
FNI PROJECT: CHM16420	FREESE AND NICHOLS	UTRWD Lake Ralph Hall		PLATE D-03-2
FILE: T:\STUDY\GEO\Rock Core Photos				
DATE: December 2016	4055 INTERNATIONAL PLAZA, STE 200 FORT WORTH, TX 76109	SAMPLE PHOTOGRAPHS **BORING D-03**		
PREPARED: MK				

35’ 40’



40’ 45’

45’ 50’



50’ 55’

55’ 60’

FNI PROJECT:	CHM16420
FILE:	T:\STUDY\GEO\Rock Core Photos
DATE:	December 2016
PREPARED:	MK

FREESE AND NICHOLS
4055 INTERNATIONAL PLAZA, STE 200
FORT WORTH, TX 76109

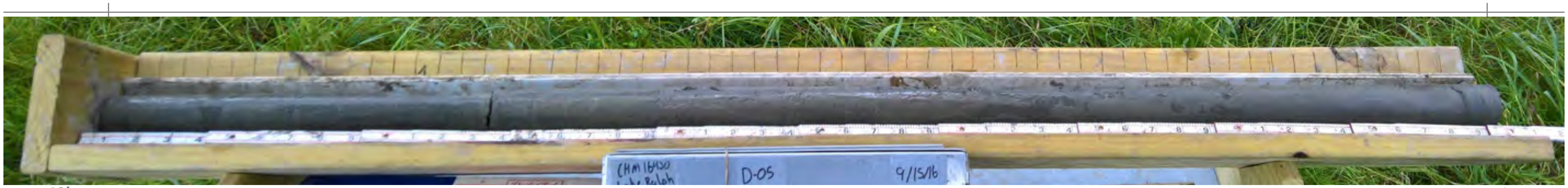
UTRWD Lake Ralph Hall

SAMPLE PHOTOGRAPHS

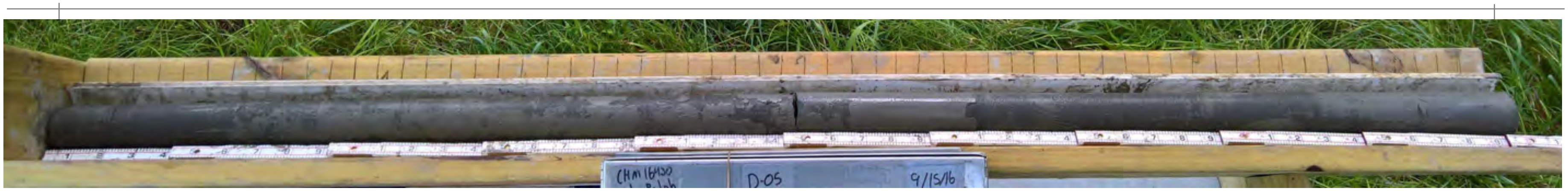
BORING D-04

PLATE
D-04-1

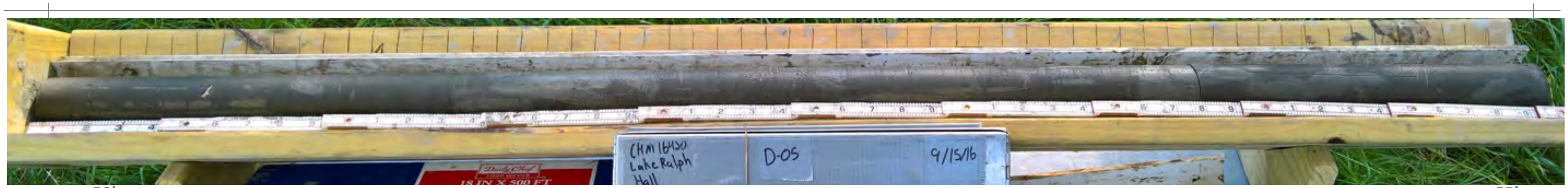
35’ 40’



40’ 45’



45’ 50’

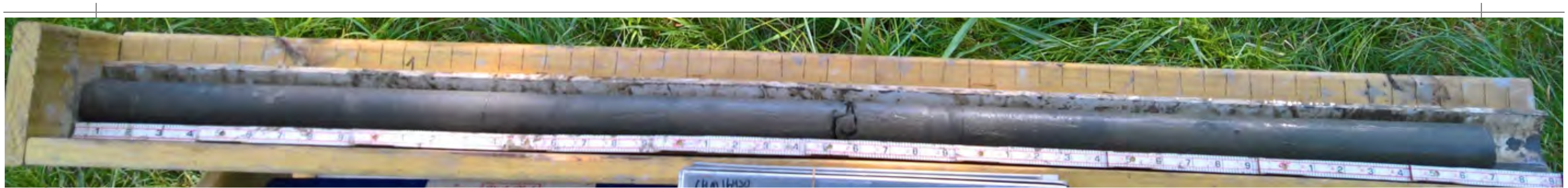


50’ 55’

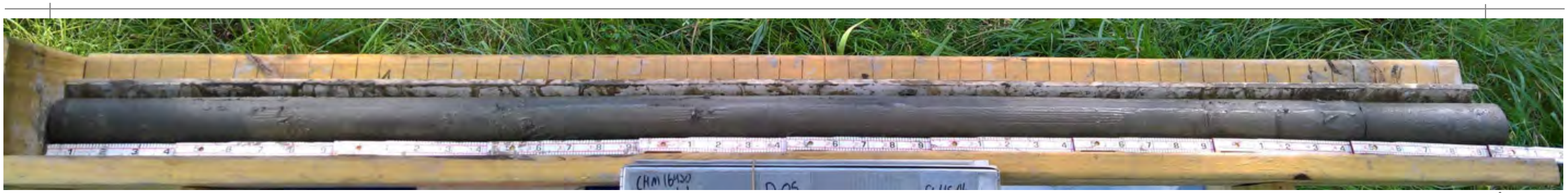
55’ 60’

FNI PROJECT: CHM16420	FREESE AND NICHOLS	UTRWD Lake Ralph Hall	PLATE D-05-1
FILE: T:\STUDY\GEO\Rock Core Photos	4055 INTERNATIONAL PLAZA, STE 200 FORT WORTH, TX 76109	SAMPLE PHOTOGRAPHS **BORING D-05**	
DATE: December 2016			
PREPARED: MK			

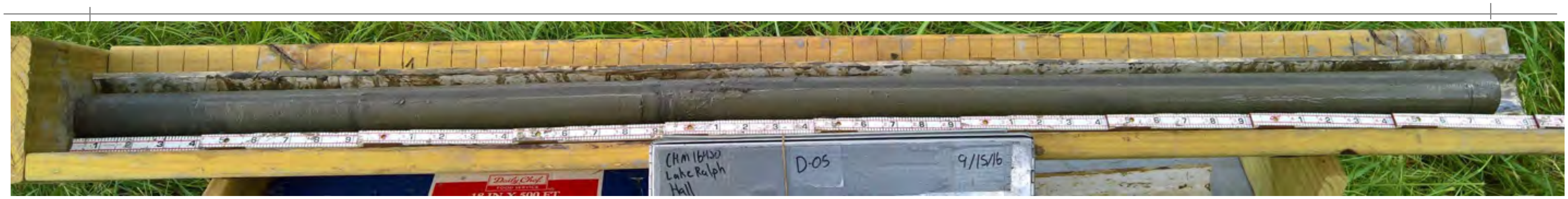
60’ 65’



65’ 70’



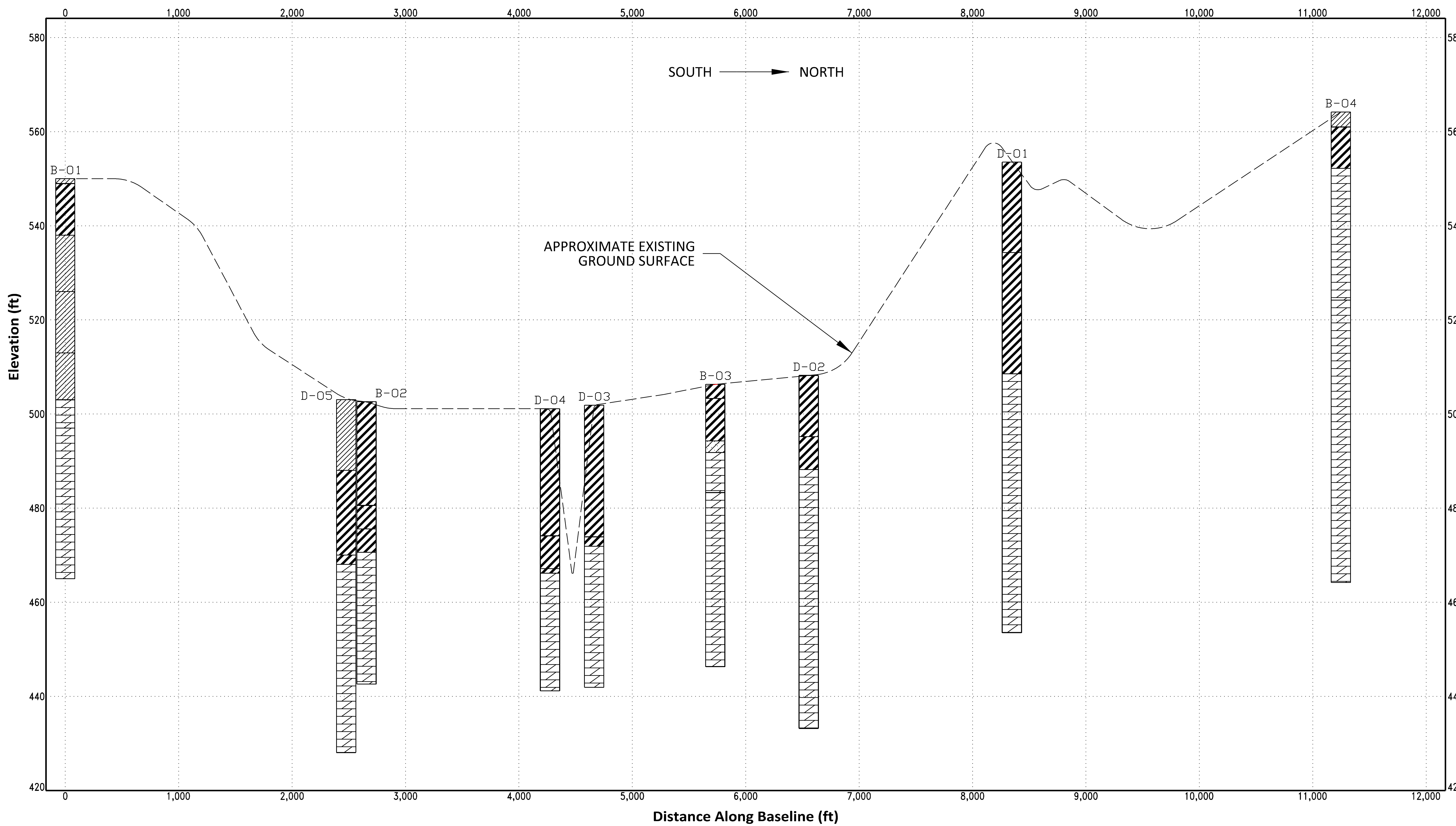
70’ 75’



FNI PROJECT: CHM16420	FREESE AND NICHOLS	UTRWD Lake Ralph Hall		PLATE D-05-2
FILE: T:\STUDY\GEO\Rock Core Photos				
DATE: December 2016	4055 INTERNATIONAL PLAZA, STE 200 FORT WORTH, TX 76109	SAMPLE PHOTOGRAPHS BORING D-05		
PREPARED: MK				

APPENDIX A-2

SOIL AND ROCK STRATIGRAPHY FIGURES



FREESE AND NICHOLS

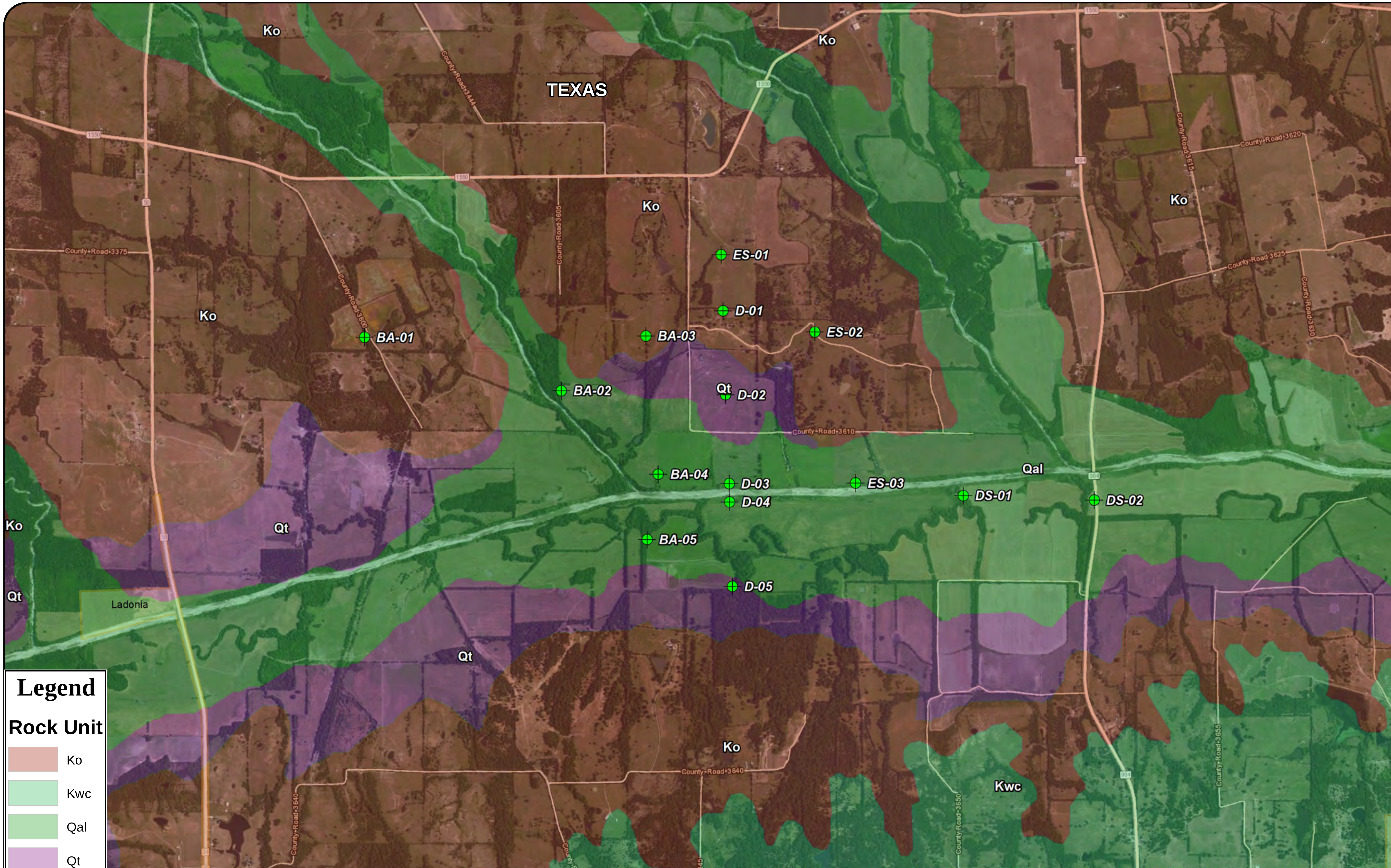
Legend

- USCS Low Plasticity Clay
- USCS High Plasticity Clay
- USCS Clayey Sand
- Marl

UTRWD Lake Ralph Hall

SUBSURFACE DIAGRAM

FNI JOB NO	DATE	FIGURE
CHM16420	05/26/2017	2
FILE	**DRAFTED**	
Fence Log.dgn	RGS	



Legend

Boring_Locations

0 — 1 Miles

SCALE = 1:24,000

N

FN PROJECT NO.	CHM16420
DATE CREATED	June 2017
DATUM & COORDINATE SYSTEM	NAD83 State Plane (feet) 4202 Texas North Central
FILE NAME	CHM16420-Geol.mxd
PREPARED BY	MPT

UTRWD

Lake Ralph Hall

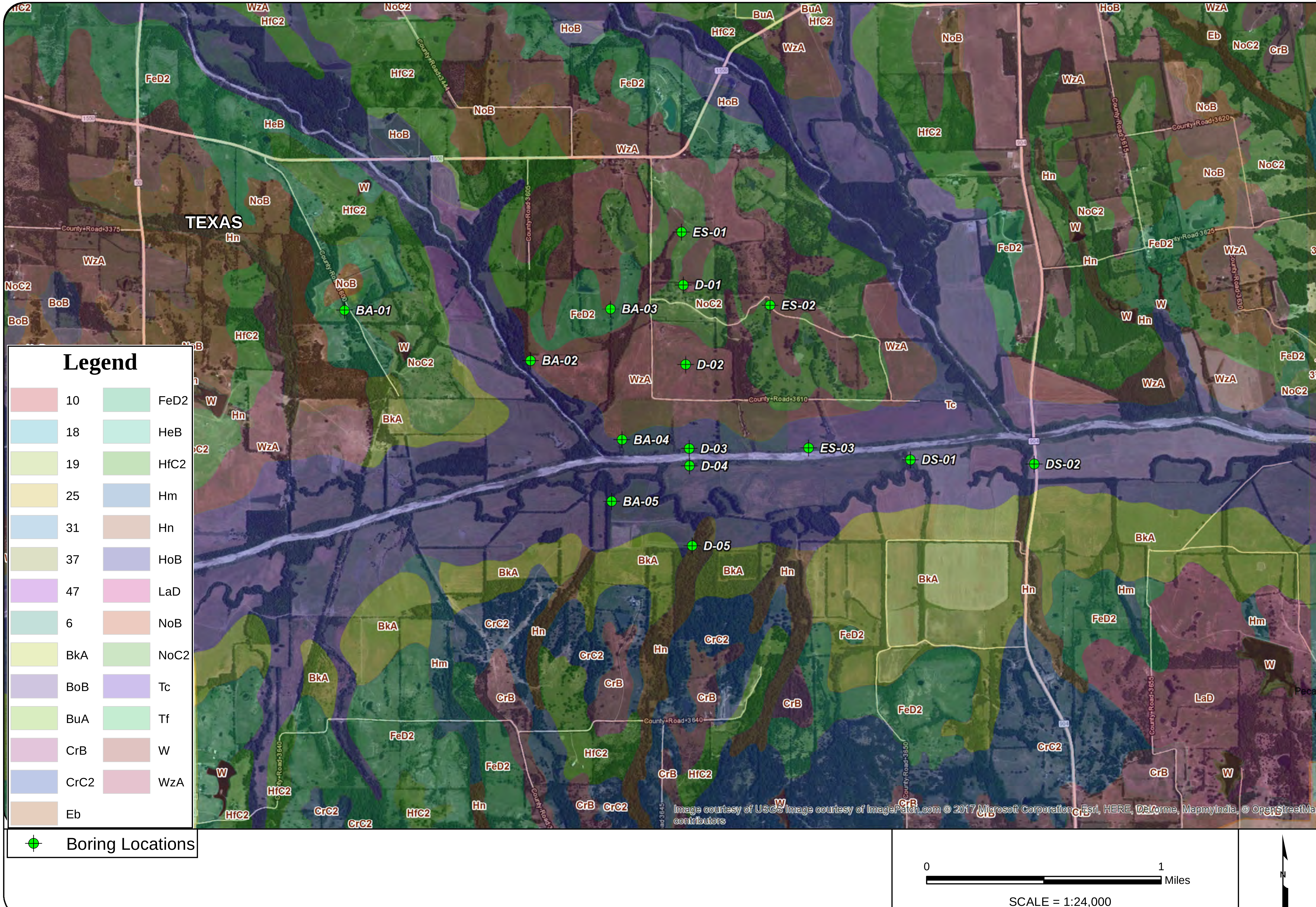
Boring Location/Geologic Map

FREESE AND NICHOLS, INC.
10814 JOLLYVILLE ROAD
BUILDING 4, SUITE 100
AUSTIN, TX 78759
PHONE: 512.617.3100

FIGURE

3

Updated: Monday, May 24, 2010



FN PROJECT NO.	CHM16420
DATE CREATED	June 2017
DATUM & COORDINATE SYSTEM	NAD83 State Plane (feet) 4202 Texas North Central
FILE NAME	CHM16420-Soils.mxd
PREPARED BY	MPT

UTRWD

Lake Ralph Hall

Boring Location/NRCS Soil Unit Map

FREESE AND NICHOLS, INC.
10814 JOLLYVILLE ROAD
BUILDING 4, SUITE 100
AUSTIN, TX 78759
PHONE: 512.617.3100

FIGURE

4

Updated: Monday, May 24, 2010

NRCS SOIL UNIT MAP DESCRIPTIONS

County	Map Unit Symbol	Map Unit Soil Name
Lamar and Delta	10	Crockett loam, 1 to 3 percent slopes
Lamar and Delta	18	Elbon silty clay loam, 0 to 1 percent slopes, frequently flooded
Lamar and Delta	19	Ferris clay, 5 to 12 percent slopes, eroded
Lamar and Delta	25	Heiden-Ferris complex, 3 to 5 percent slopes
Lamar and Delta	31	Lamar clay loam, 5 to 8 percent slopes
Lamar and Delta	37	Normangee clay loam, 2 to 5 percent slopes, eroded
Lamar and Delta	47	Trinity clay, 0 to 1 percent slopes, occasionally flooded
Lamar and Delta	6	Benklin silt loam, 0 to 1 percent slopes
Fannin	BkA	Benklin silt loam, 0 to 1 percent slopes
Fannin	BoB	Bonham silt loam, 1 to 3 percent slopes
Fannin	BuA	Burleson clay, 0 to 1 percent slopes
Fannin	CrB	Crockett loam, 1 to 3 percent slopes
Fannin	CrC2	Crockett loam, 2 to 5 percent slopes, eroded
Fannin	Eb	Elbon silty clay loam, frequently flooded
Fannin	FeD2	Ferris clay, 5 to 12 percent slopes, eroded
Fannin	HeB	Heiden clay, 1 to 3 percent slopes
Fannin	HfC2	Heiden-Ferris complex, 2 to 6 percent slopes, eroded
Fannin	Hm	Hopco silt loam, occasionally flooded
Fannin	Hn	Hopco silt loam, frequently flooded
Fannin	HoB	Houston Black clay, 1 to 3 percent slopes
Fannin	LaD	Lamar clay loam, 5 to 8 percent slopes
Fannin	NoB	Normangee clay loam, 1 to 3 percent slopes
Fannin	NoC2	Normangee clay loam, 2 to 5 percent slopes, eroded
Fannin	Tc	Tinn clay, 0 to 1 percent slopes, occasionally flooded
Fannin	Tf	Tinn clay, 0 to 1 percent slopes, frequently flooded
Fannin	W	Water
Fannin	WzA	Wilson silt loam, 0 to 1 percent slopes

FREESE AND NICHOLS

APPENDIX A-3

LABORATORY TEST DATA

FREESE AND NICHOLS, INC.
4055 INTERNATIONAL PLAZA, SUITE 200
FORT WORTH, TX 76109-4895
(817) 735-7300

GEOTECHNICAL LABORATORY TEST SUMMARY

PROJECT NAME: Lake Ralph Hall Conceptual Design Study
PROJECT NO.: CHM16420

Borehole	Depth	USCS	Water Content [%]	Dry Density [pcf]	Percent Passing No. 200 Sieve	Liquid Limit	Plastic Limit	Plasticity Index	Unconfined Compressive Strength [tsf]	Strain at Failure [percent]	
BA-01	2	CH	13	121							
BA-01	6	CH	19								
BA-02	4	CH	20	108							
BA-02	19	CH	26		87	71	28	43			
BA-03	1	CH	14								
BA-03	5	CH	19	107							
BA-04	9	CH	22	103							
BA-05	5	CH	20	101							
BA-05	8	CH	18	109							
BA-05	14	CL	22	105							
D-01	2	CH	17	108	98	73	24	49			
D-01	6	CH			96	61	21	40			
D-01	14	CH	15	114	95	52	17	35	9.2	2.9	
D-01	23	CH			98	67	21	46			
D-01	33	CH			96	70	27	43			
D-01	38	CH	19	108							
D-01	45	MARL	21	106	97	65	28	37	8.3	2.4	
D-02	2	CH	14	114							
D-02	6	CH	20	106	88	64	19	45	3	7.7	
D-02	9	CH	23	103	92	54	29	25			
D-02	13	CH			97	74	25	49			
D-02	20	CH	18	112	54	61	27	34	19.1	2.2	
D-02	35	MARL	20	107	70	60	29	31			

FREESE AND NICHOLS

FREESE AND NICHOLS, INC.
4055 INTERNATIONAL PLAZA, SUITE 200
FORT WORTH, TX 76109-4895
(817) 735-7300

GEOTECHNICAL LABORATORY TEST SUMMARY

PROJECT NAME: Lake Ralph Hall Conceptual Design Study
PROJECT NO.: CHM16420

Borehole	Depth	USCS	Water Content [%]	Dry Density [pcf]	Percent Passing No. 200 Sieve	Liquid Limit	Plastic Limit	Plasticity Index	Unconfined Compressive Strength [tsf]	Strain at Failure [percent]	
D-03	7	CH	24	100	93	56	29	27			
D-03	19	CH	23	105	96	77	20	57	2.8	15.6	
D-03	23	CH	23	100	91	56	23	33			
D-03	29	CH	20	107	85	72	24	48	4.3	4.3	
D-03	34	MARL	18		73	58	24	34			
D-03	50	MARL	18	114					15.2	1.9	
D-04	2	CH	22	97							
D-04	6	CH	26	96	100	66	31	35			
D-04	9	CH	24	103	98	70	23	47			
D-04	13	CH	23	104					1.8	5.3	
D-04	18	CH	23	102	96	54	24	30			
D-04	23	CH	22	106					2.1	15.2	
D-04	28	CH	24	103	78	55	19	36	1.1	2.5	
D-04	40	MARL	18	114	90	60	26	34	11.3	1.8	
D-05	3	CL			85	36	20	16			
D-05	8	CL	22								
D-05	19	CH	19	112	94	58	19	39	3.3	15.9	
D-05	24	CH	21	108					2.9	14.9	
D-05	29	CH	27	97	89	50	25	25	--	--	
D-05	35	MARL	17	116	67	50	23	27	13.6	2.4	
D-05	45	MARL	17	116							
DS-01	6	CH	26	101	90	82	28	54	2.6	15.7	
DS-01	13	CH	26	100							
DS-01	23	CH	24	102	91	56	22	34	1.6	15.4	
DS-01	35	MARL	20	112					13.8	2.3	
DS-02	2	CH	17		93	51	20	31			
DS-02	13	CH	27	111	95	80	27	53	2.1	3.3	
DS-02	33	CH	29	97	89	77	24	53	1.3	6.9	

FREESE AND NICHOLS, INC.
4055 INTERNATIONAL PLAZA, SUITE 200
FORT WORTH, TX 76109-4895
(817) 735-7300

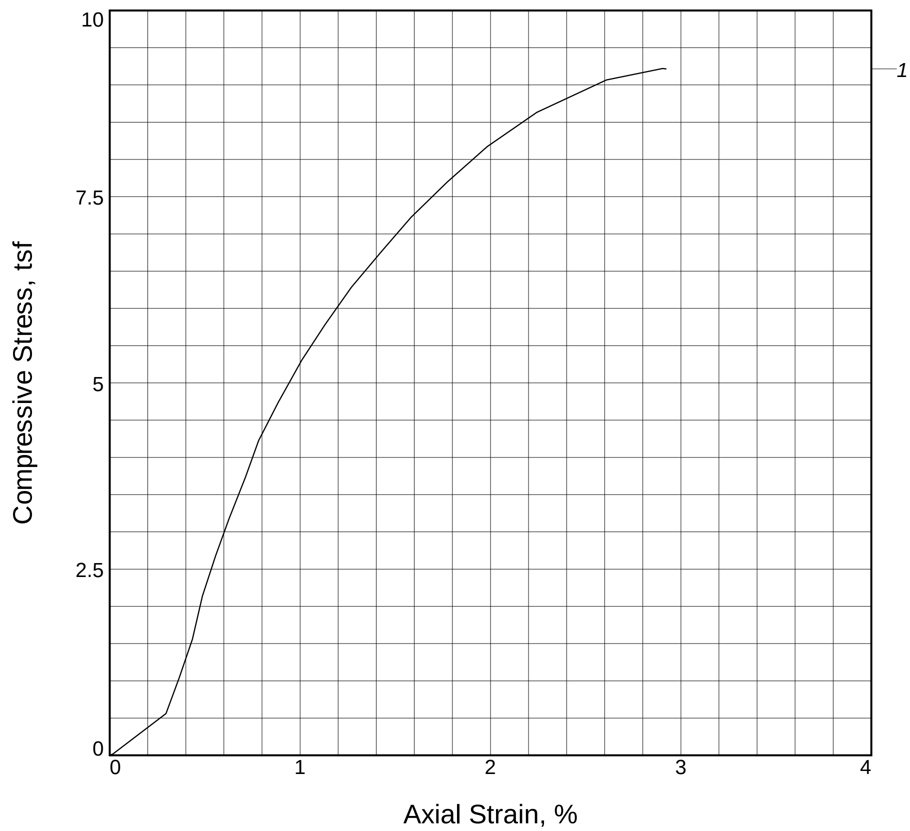
GEOTECHNICAL LABORATORY TEST SUMMARY

PROJECT NAME: Lake Ralph Hall Conceptual Design Study
PROJECT NO.: CHM16420

Borehole	Depth	USCS	Water Content [%]	Dry Density [pcf]	Percent Passing No. 200 Sieve	Liquid Limit	Plastic Limit	Plasticity Index	Unconfined Compressive Strength [tsf]	Strain at Failure [percent]	
ES-01	2	CH	16								
ES-01	5	CH	30	98							
ES-01	13	CH	22								
ES-02	7	CL	19								
ES-02	13	CL	16	101	85	46	20	26			
ES-03	18	CH	26								

FREESE AND NICHOLS

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	9.220			
Undrained shear strength, tsf	4.610			
Failure strain, %	2.9			
Strain rate, %/min.	1.00			
Water content, %	15.0			
Wet density, pcf	130.9			
Dry density, pcf	113.8			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.77			
Specimen height, in.	5.75			
Height/diameter ratio	2.08			

Description:

LL = 52	**PL =** 17	**PI =** 35	**Assumed GS=**	**Type:** Shelby Tube

Project No.: CHM16420
Date Sampled: 10/11/16
Remarks:
Shear Plane Failure

Figure ________

Client: Freese and Nichols, Inc.

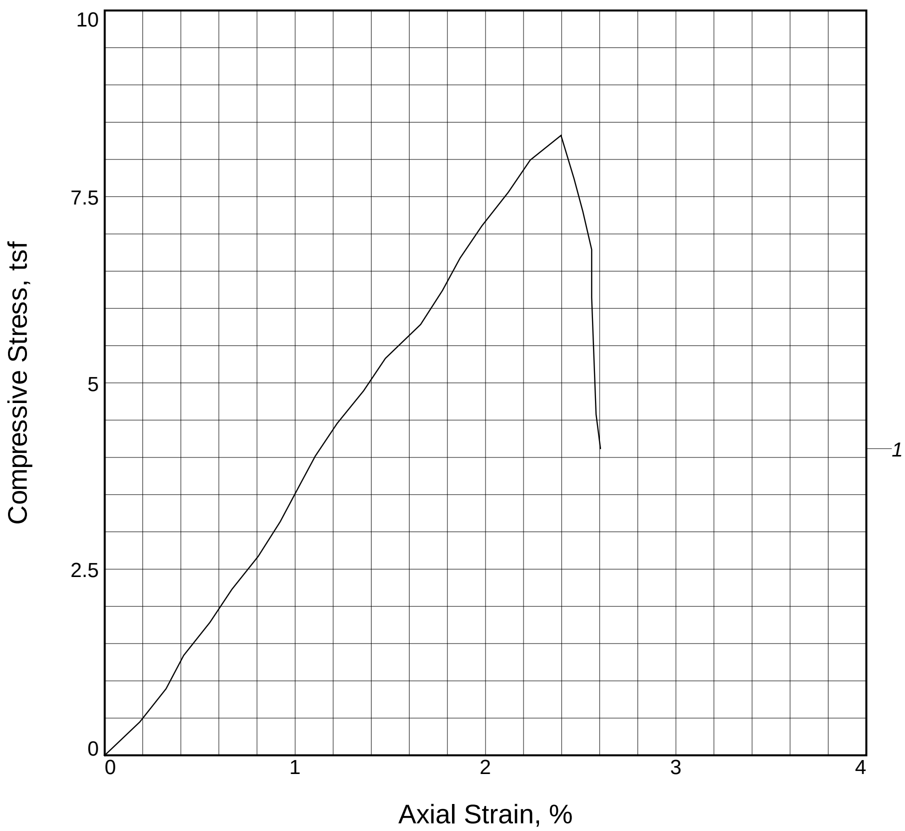
Project: UTRWD Lake Ralph Hall

Location: D-01
Sample Number: U11 **Depth:** (14.0-15.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

Tested By: Lupe **Checked By:** Sayak

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	8.323			
Undrained shear strength, tsf	4.162			
Failure strain, %	2.4			
Strain rate, %/min.	0.50			
Water content, %	20.5			
Wet density, pcf	128.2			
Dry density, pcf	106.4			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	1.97			
Specimen height, in.	4.34			
Height/diameter ratio	2.20			

Description:

LL = 65	**PL =** 28	**PI =** 37	**GS=**	**Type:** Rock Core

Project No.: CHM16420
Date Sampled: 10/13/16
Remarks:

Figure ________

Client: Freese and Nichols, Inc.

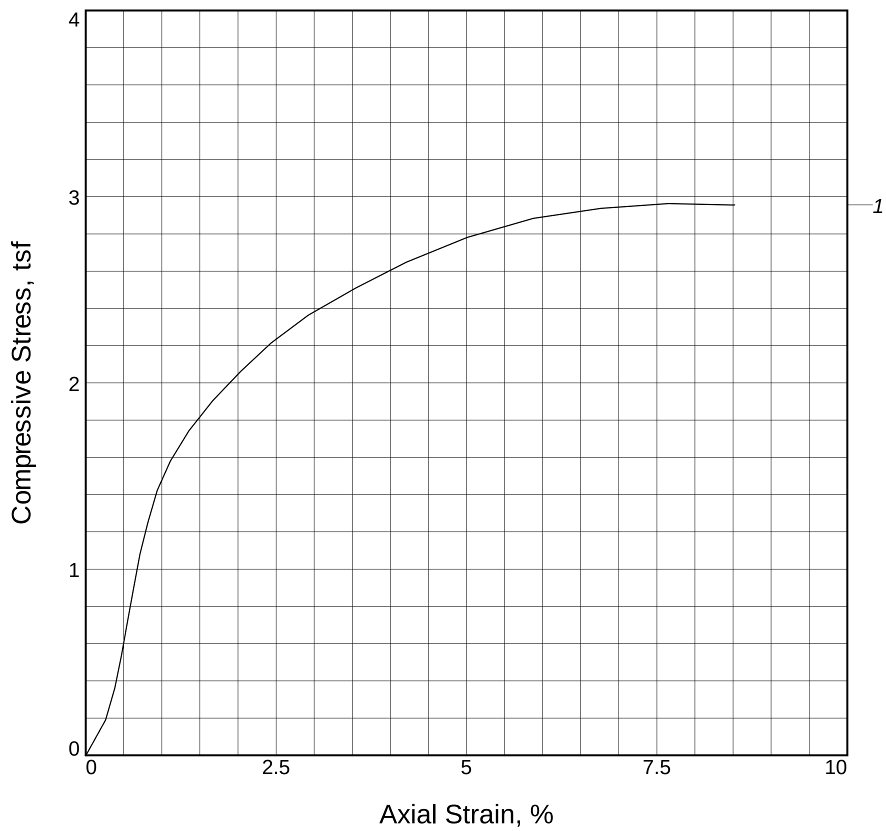
Project: UTRWD Lake Ralph Hall

Location: D-01
Sample Number: C18 **Depth:** (45.0-46.2) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

Tested By: Jack **Checked By:** Sayak

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.963			
Undrained shear strength, tsf	1.481			
Failure strain, %	7.7			
Strain rate, %/min.	1.00			
Water content, %	20.4			
Wet density, pcf	127.7			
Dry density, pcf	106.1			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.76			
Specimen height, in.	5.75			
Height/diameter ratio	2.08			

Description:

LL = 64	**PL =** 19	**PI =** 45	**GS=**	**Type:** Shelby Tube

Project No.: CHM16420
Date Sampled: 10/11/16
Remarks:
Shear Plane Failure

Figure _______

Client: Freese and Nichols, Inc.

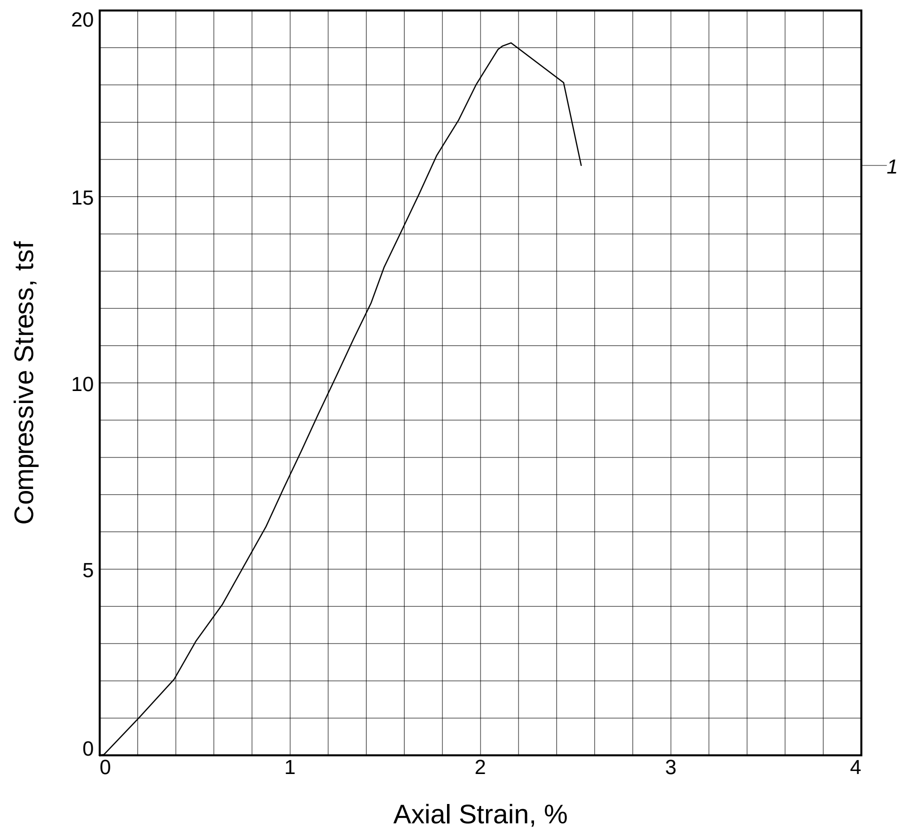
Project: UTRWD Lake Ralph Hall

Location: D-02
Sample Number: U6 **Depth:** (6.0-7.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

Tested By: Lupe **Checked By:** Sayak

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	19.130			
Undrained shear strength, tsf	9.565			
Failure strain, %	2.2			
Strain rate, %/min.	0.50			
Water content, %	18.1			
Wet density, pcf	132.3			
Dry density, pcf	112.0			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	1.95			
Specimen height, in.	4.35			
Height/diameter ratio	2.23			

Description:

LL = 61	**PL =** 27	**PI =** 34	**GS=**	**Type:** Rock Core

Project No.: CHM16420
Date Sampled: 10/11/16
Remarks:

Figure ________

Client: Freese and Nichols, Inc.

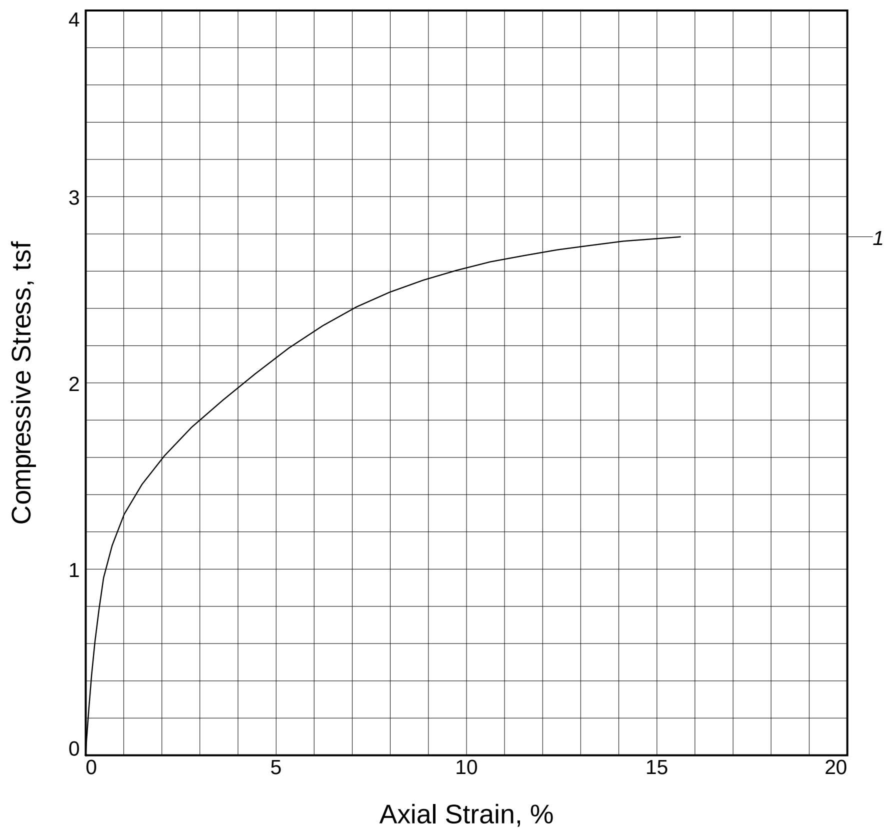
Project: UTRWD Lake Ralph Hall

Location: D-02
Sample Number: C1 **Depth:** (20.0-21.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

Tested By: Lupe **Checked By:** Sayak

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.785			
Undrained shear strength, tsf	1.392			
Failure strain, %	15.6			
Strain rate, %/min.	1.00			
Water content, %	23.4			
Wet density, pcf	128.9			
Dry density, pcf	104.5			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.73			
Specimen height, in.	5.75			
Height/diameter ratio	2.11			

Description:

LL = 77	**PL =** 20	**PI =** 57	**GS=**	**Type:** Shelby tube

Project No.: CHM16420

Date Sampled: 10/11/16

Remarks:
Bulge Failure

Figure ________

Client: Freese and Nichols, Inc.

Project: UTRWD Lake Ralph Hall

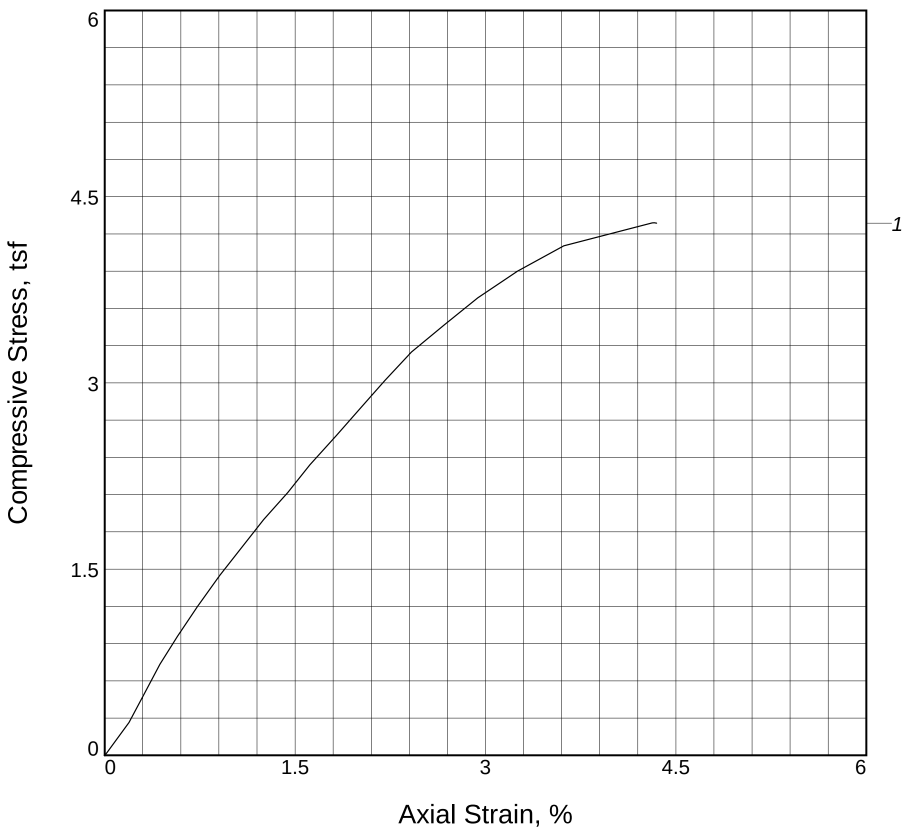
Location: D-03

Sample Number: U11 **Depth:** (19.0-20.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

Tested By: Lupe **Checked By:** Sayak

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	4.290			
Undrained shear strength, tsf	2.145			
Failure strain, %	4.3			
Strain rate, %/min.	1.00			
Water content, %	20.3			
Wet density, pcf	128.6			
Dry density, pcf	106.9			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.77			
Specimen height, in.	5.75			
Height/diameter ratio	2.08			

Description:

LL = 72	**PL =** 24	**PI =** 48	**GS=**	**Type:** Shelby tube

Project No.: CHM16420

Date Sampled: 10/11/16

Remarks:
Shear Plane Failure

Figure ________

Client: Freese and Nichols, Inc.

Project: UTRWD Lake Ralph Hall

Location: D-03

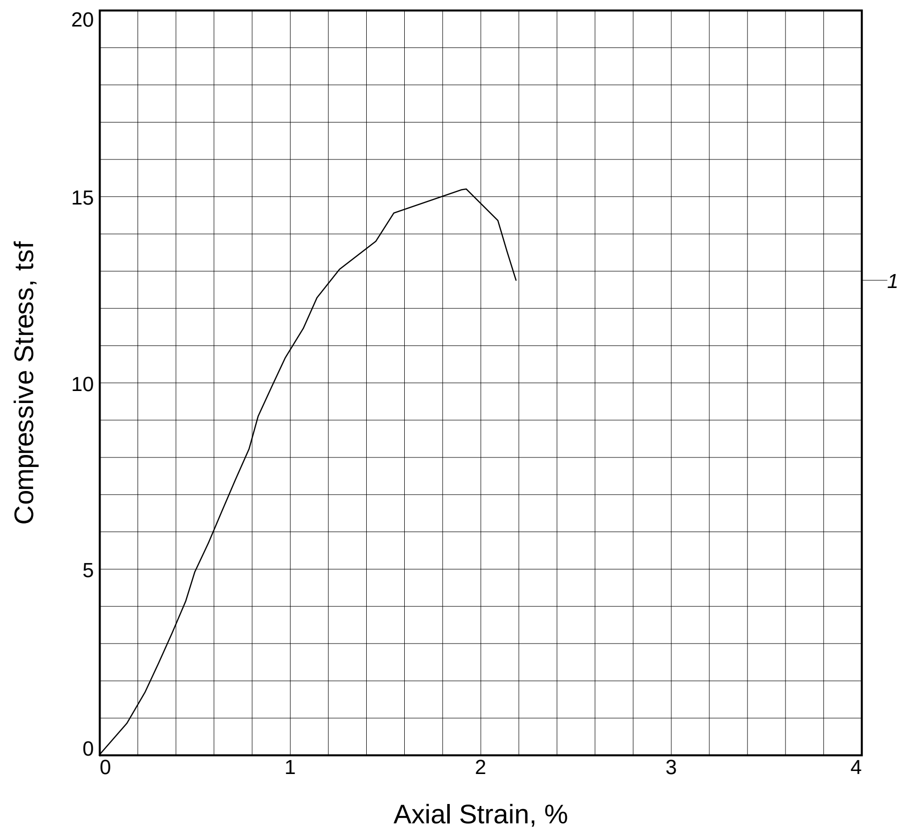
Depth: (29.0-31.0) ft.

UNCONFINED COMPRESSION TEST

Gorrondona & Associates, Inc.
Houston, Texas

Tested By: Lupe **Checked By:** Sayak

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	15.207			
Undrained shear strength, tsf	7.603			
Failure strain, %	1.9			
Strain rate, %/min.	0.50			
Water content, %	18.2			
Wet density, pcf	134.3			
Dry density, pcf	113.6			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	1.93			
Specimen height, in.	4.21			
Height/diameter ratio	2.18			

Description:

LL =	PL =	PI =	GS=	Type: Rock Core

Project No.: CHM16420
Date Sampled: 10/13/16
Remarks:

Figure ________

Client: Freese and Nichols, Inc.

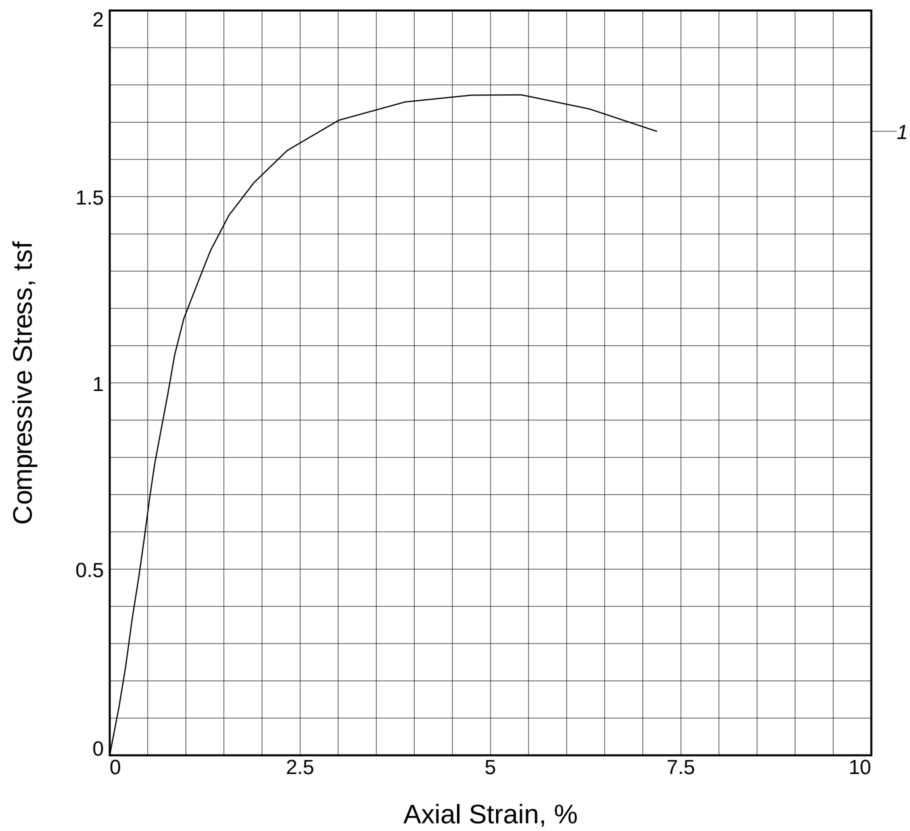
Project: UTRWD Lake Ralph Hall

Location: D-03
Sample Number: C5 **Depth:** (50.0-51.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

Tested By: Jack **Checked By:** Sayak

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.773			
Undrained shear strength, tsf	0.887			
Failure strain, %	5.3			
Strain rate, %/min.	1.00			
Water content, %	22.7			
Wet density, pcf	127.1			
Dry density, pcf	103.5			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.72			
Specimen height, in.	5.75			
Height/diameter ratio	2.11			

Description:

LL =	**PL =**	**PI =**	**GS=**	**Type:** Shelby tube

Project No.: CHM16420

Date Sampled: 10/11/16

Remarks:
Shear Plane Failure

Figure ________

Client: Freese and Nichols, Inc.

Project: UTRWD Lake Ralph Hall

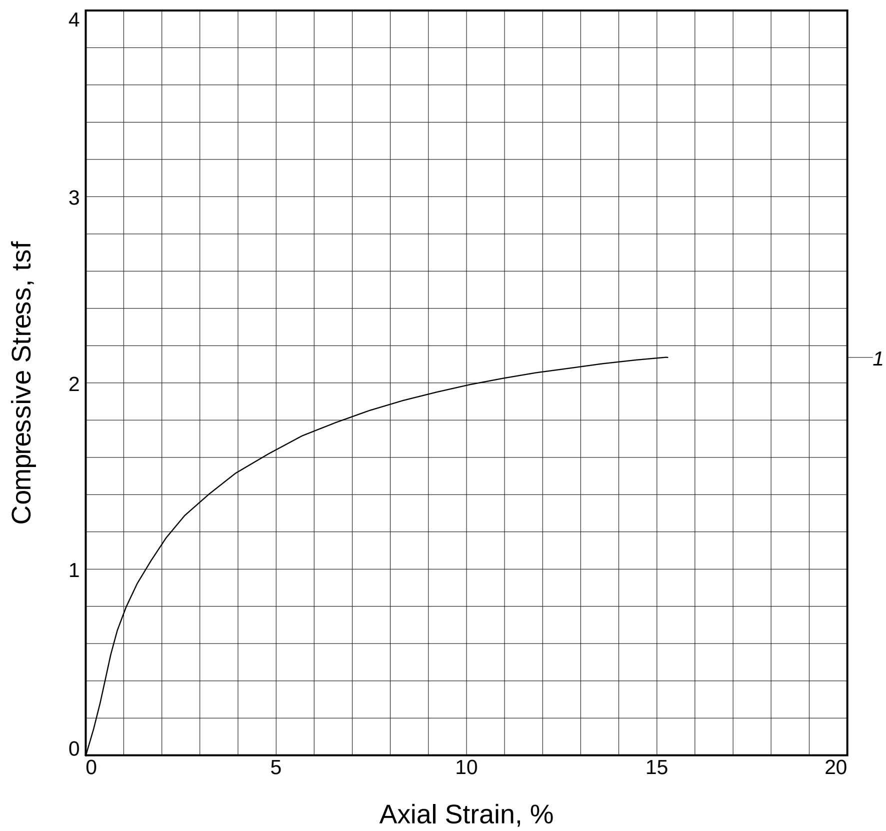
Location: D-04

Sample Number: U11 **Depth:** (13.0-15.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

Tested By: Lupe **Checked By:** Sayak

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.137			
Undrained shear strength, tsf	1.069			
Failure strain, %	15.2			
Strain rate, %/min.	1.00			
Water content, %	22.1			
Wet density, pcf	129.8			
Dry density, pcf	106.3			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.73			
Specimen height, in.	5.77			
Height/diameter ratio	2.11			

Description:

LL =	**PL =**	**PI =**	**GS=**	**Type:** Shelby tube

Project No.: CHM16420
Date Sampled: 10/11/16
Remarks:
Bulge failure

Figure ________

Client: Freese and Nichols, Inc.

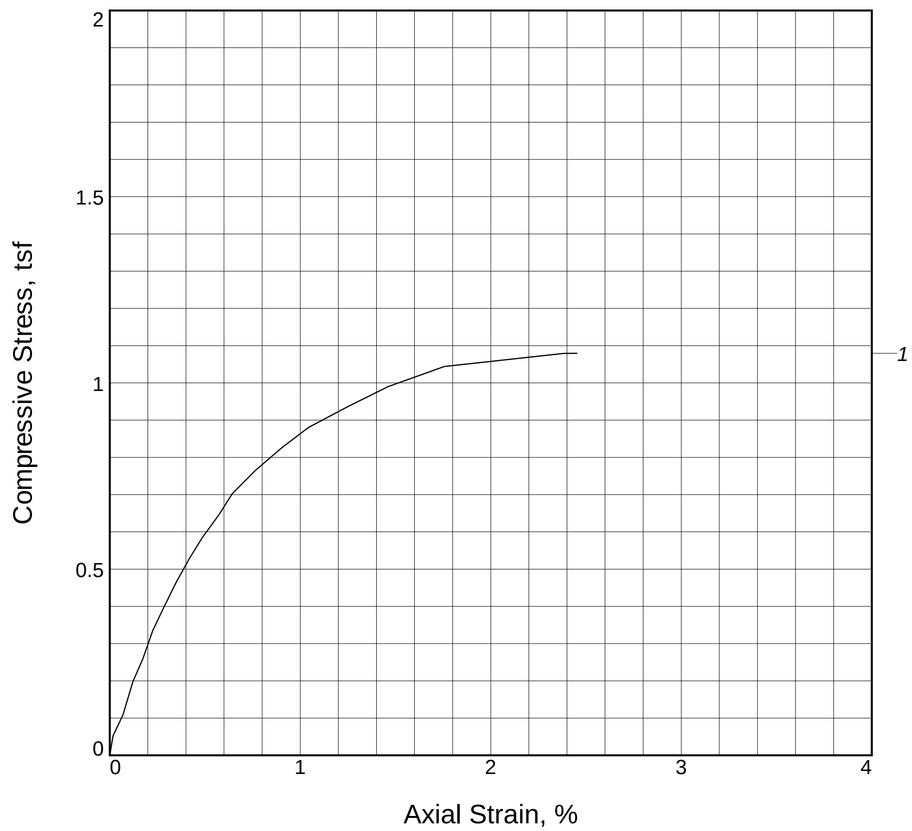
Project: UTRWD Lake Ralph Hall

Location: D-04
Sample Number: U13 **Depth:** (23.0-25.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

Tested By: Lupe **Checked By:** Sayak

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.080			
Undrained shear strength, tsf	0.540			
Failure strain, %	2.5			
Strain rate, %/min.	1.00			
Water content, %	24.2			
Wet density, pcf	127.6			
Dry density, pcf	102.7			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.78			
Specimen height, in.	5.75			
Height/diameter ratio	2.07			

Description:

LL = 55	**PL =** 19	**PI =** 36	**GS=**	**Type:** Shelby Tube

Project No.: CHM16420

Date Sampled: 10/11/16

Remarks:
Shear Plane Failure

Figure ________

Client: Freese and Nichols, Inc.

Project: UTRWD Lake Ralph Hall

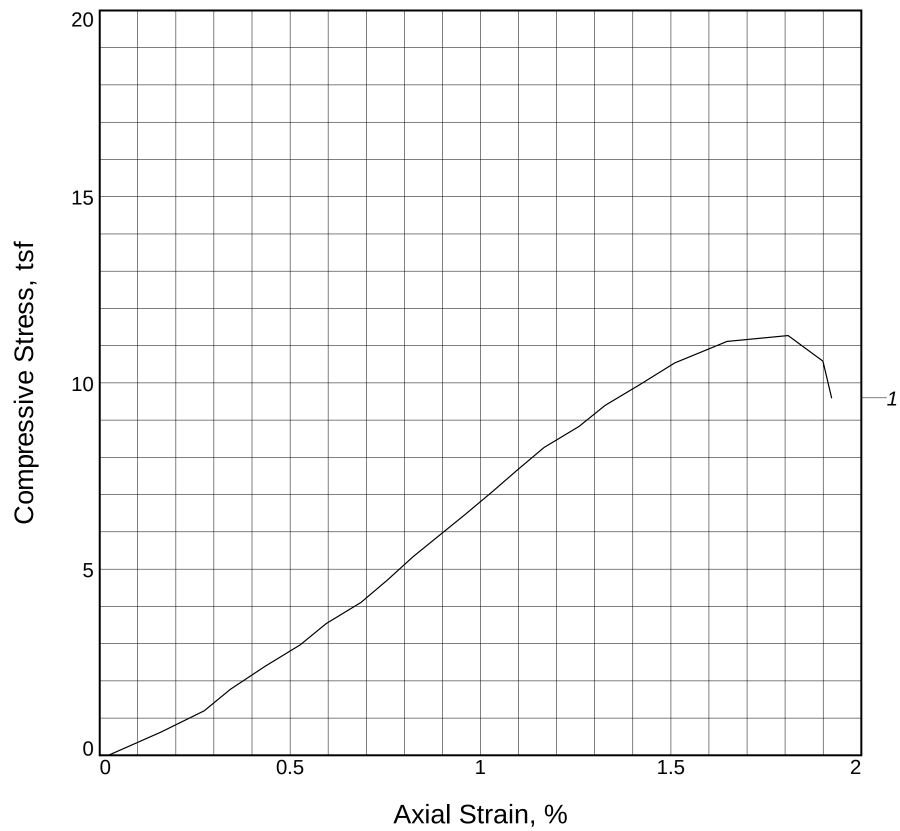
Location: D-04

Sample Number: U14 **Depth:** (28.0-30.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

Tested By: Lupe **Checked By:** Sayak

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	11.271			
Undrained shear strength, tsf	5.636			
Failure strain, %	1.8			
Strain rate, %/min.	0.50			
Water content, %	17.6			
Wet density, pcf	133.8			
Dry density, pcf	113.8			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.03			
Specimen height, in.	4.37			
Height/diameter ratio	2.15			

Description:

LL = 60	**PL =** 26	**PI =** 34	**GS=**	**Type:** Rock Core

Project No.: CHM16420
Date Sampled: 10/13/16
Remarks:

Figure ________

Client: Freese and Nichols, Inc.

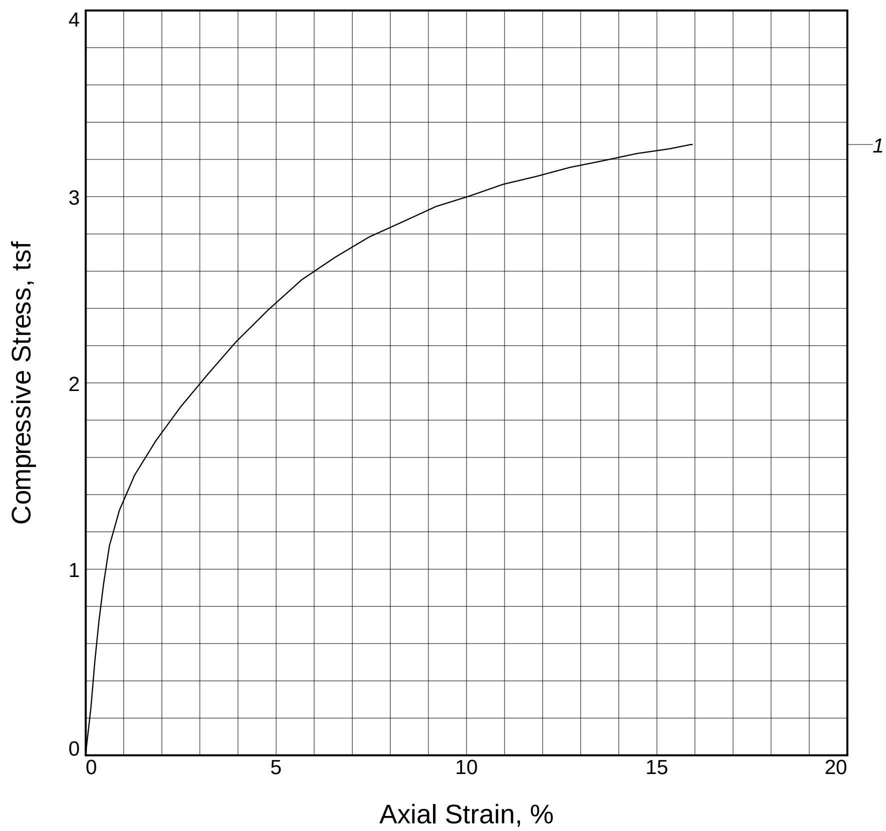
Project: UTRWD Lake Ralph Hall

Location: D-04
Sample Number: C2 **Depth:** (40.0-41.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

Tested By: Jack **Checked By:** Sayak

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	3.280			
Undrained shear strength, tsf	1.640			
Failure strain, %	15.9			
Strain rate, %/min.	1.00			
Water content, %	18.8			
Wet density, pcf	132.6			
Dry density, pcf	111.6			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.75			
Specimen height, in.	5.75			
Height/diameter ratio	2.09			

Description:

LL = 58	**PL =** 19	**PI =** 39	**GS=**	**Type:** Shelby tube

Project No.: CHM16420

Date Sampled: 10/11/16

Remarks:
Bulge Failure

Figure ________

Client: Freese and Nichols, Inc.

Project: UTRWD Lake Ralph Hall

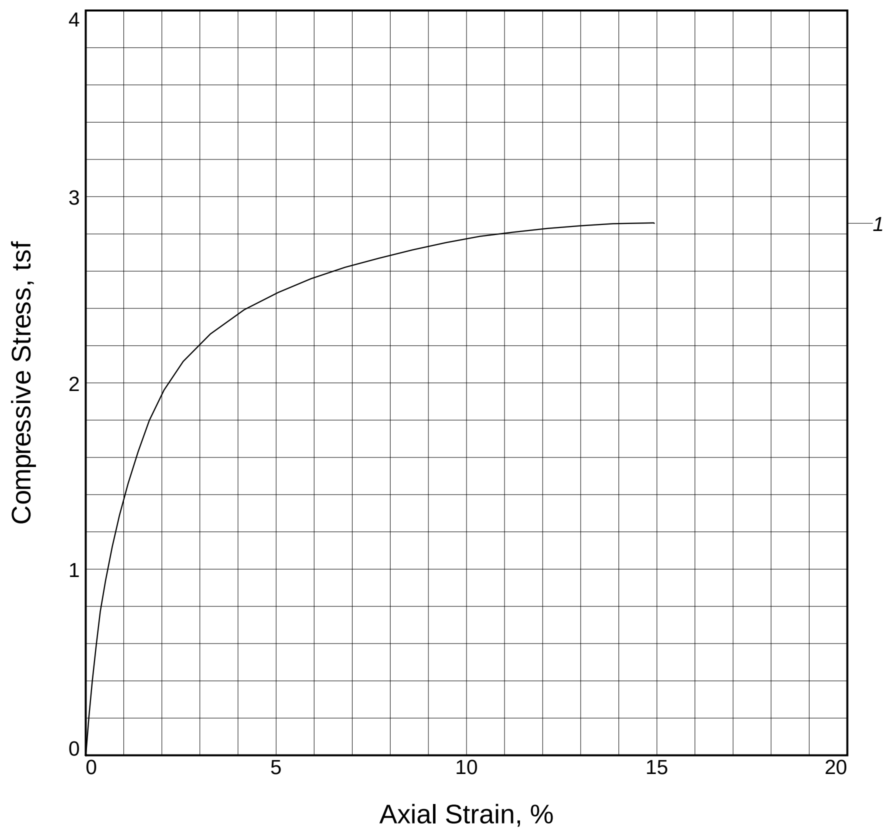
Location: D-05

Sample Number: U7 **Depth:** (19.0-20.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

Tested By: Lupe **Checked By:** Sayak

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.859			
Undrained shear strength, tsf	1.429			
Failure strain, %	14.9			
Strain rate, %/min.	1.00			
Water content, %	21.1			
Wet density, pcf	130.3			
Dry density, pcf	107.6			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.76			
Specimen height, in.	5.74			
Height/diameter ratio	2.08			

Description:

LL =	PL =	PI =	GS=	Type: Shelby Tube

Project No.: CHM16420

Date Sampled: 10/11/16

Remarks:
Bulge Failure

Figure ________

Client: Freese and Nichols, Inc.

Project: UTRWD Lake Ralph Hall

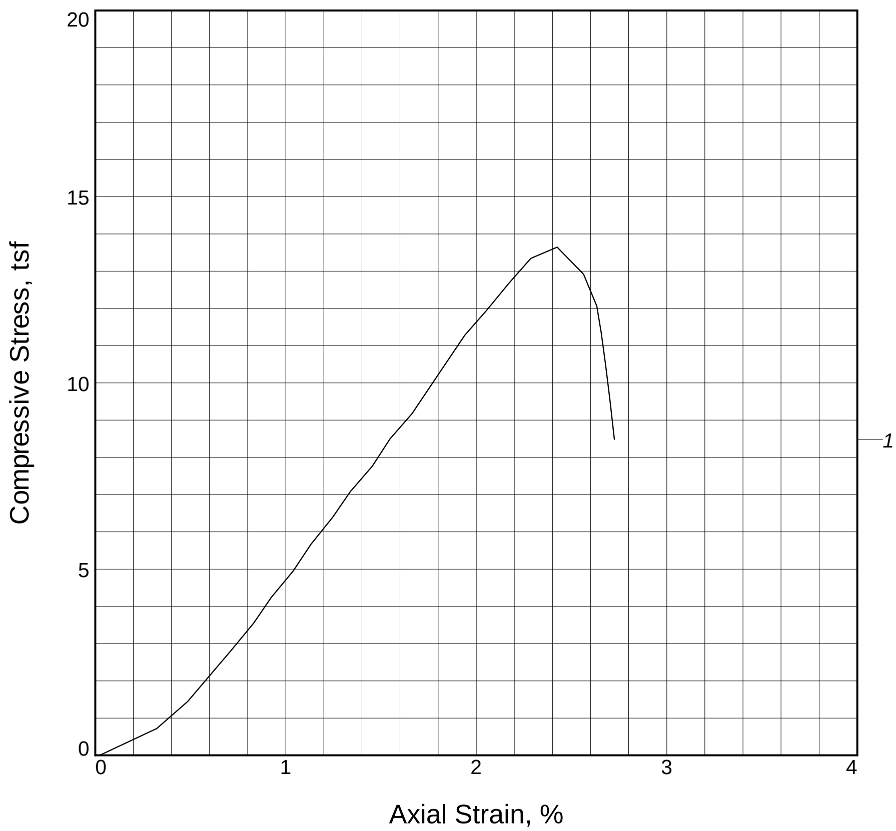
Location: D-05

Sample Number: U8 **Depth:** (24.0-25.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

Tested By: Lupe **Checked By:** Sayak

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	13.644			
Undrained shear strength, tsf	6.822			
Failure strain, %	2.4			
Strain rate, %/min.	0.50			
Water content, %	17.0			
Wet density, pcf	136.1			
Dry density, pcf	116.3			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	1.98			
Specimen height, in.	4.33			
Height/diameter ratio	2.19			

Description:

LL = 50	**PL =** 23	**PI =** 27	**GS=**	**Type:** Rock Core

Project No.: CHM16420
Date Sampled: 10/13/16
Remarks:

Figure ________

Client: Freese and Nichols, Inc.

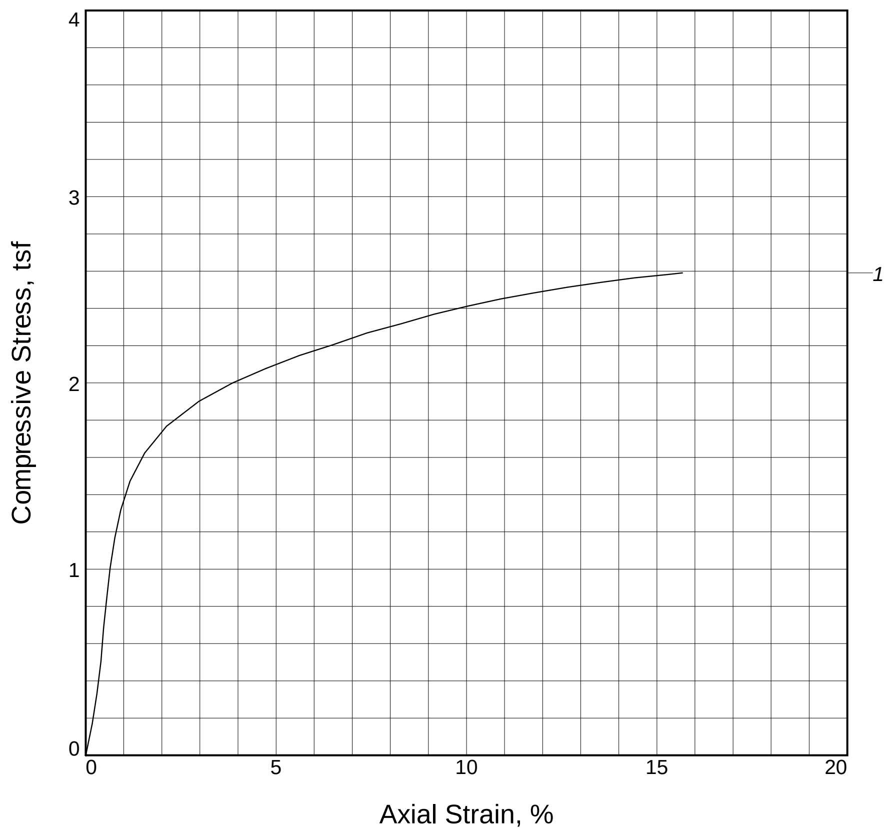
Project: UTRWD Lake Ralph Hall

Location: D-05
Sample Number: C1 **Depth:** (35.0-36.3) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

Tested By: Jack **Checked By:** Sayak

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.591			
Undrained shear strength, tsf	1.295			
Failure strain, %	15.7			
Strain rate, %/min.	1.00			
Water content, %	26.1			
Wet density, pcf	127.1			
Dry density, pcf	100.7			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.78			
Specimen height, in.	5.75			
Height/diameter ratio	2.07			

Description:

LL = 83	**PL =** 28	**PI =** 55	**GS=**	**Type:** Shelby Tube

Project No.: CHM16420

Date Sampled: 10/13/16

Remarks:
Bulge Failure

Figure ________

Client: Freese and Nichols, Inc.

Project: UTRWD Lake Ralph Hall

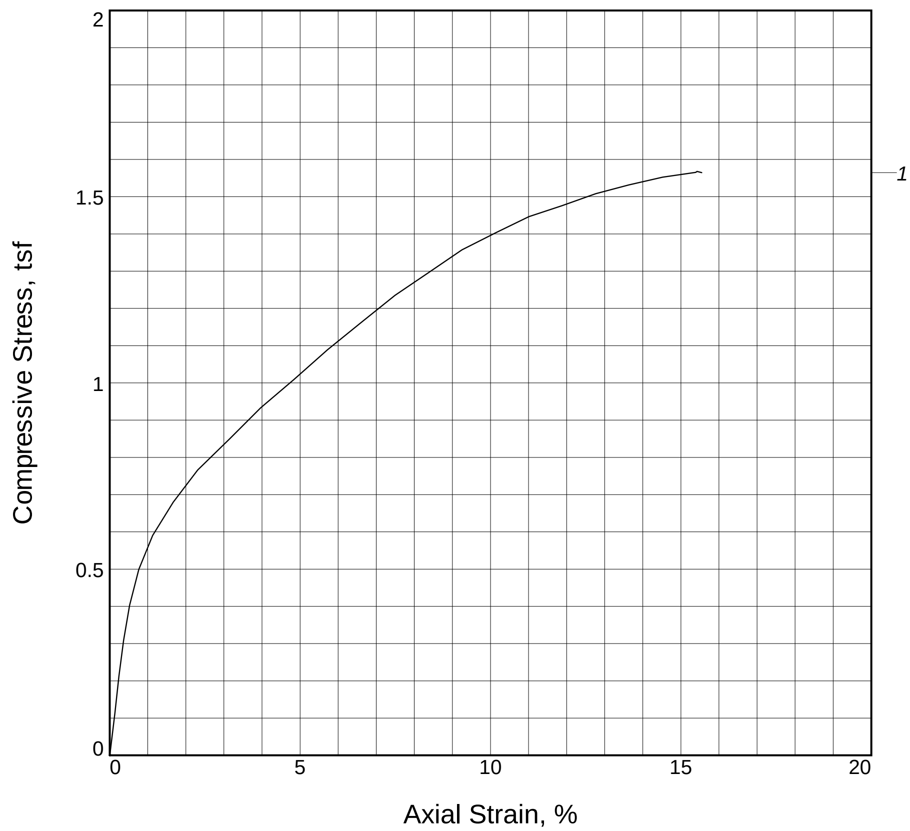
Location: DS-01

Sample Number: U7 **Depth:** (6.0-7.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

Tested By: Jack **Checked By:** Sayak

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.568			
Undrained shear strength, tsf	0.784			
Failure strain, %	15.4			
Strain rate, %/min.	1.00			
Water content, %	24.0			
Wet density, pcf	126.0			
Dry density, pcf	101.6			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.79			
Specimen height, in.	5.75			
Height/diameter ratio	2.06			

Description:

LL = 56	**PL =** 22	**PI =** 34	**GS=**	**Type:** Shelby Tube

Project No.: CHM16420

Date Sampled: 10/13/16

Remarks:
Bulge Failure

Figure ________

Client: Freese and Nichols, Inc.

Project: UTRWD Lake Ralph Hall

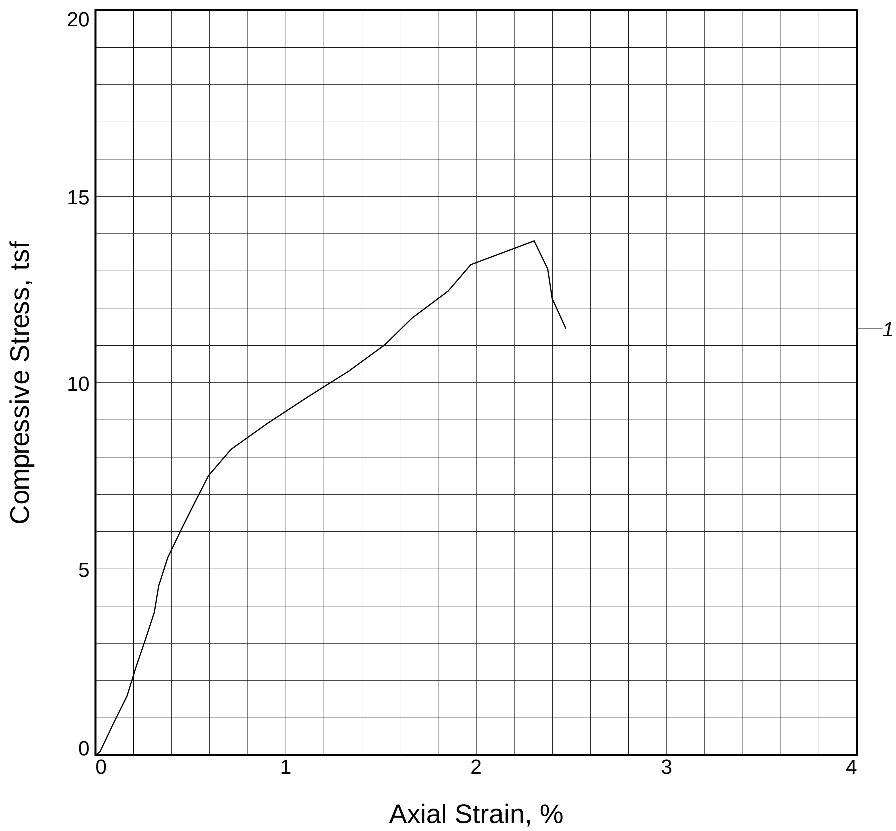
Location: DS-01

Sample Number: U13 **Depth:** (23.0-25.0) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

Tested By: Jack **Checked By:** Sayak

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	13.806			
Undrained shear strength, tsf	6.903			
Failure strain, %	2.3			
Strain rate, %/min.	0.50			
Water content, %	19.6			
Wet density, pcf	134.2			
Dry density, pcf	112.2			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.02			
Specimen height, in.	4.21			
Height/diameter ratio	2.08			

Description:

LL =	PL =	PI =	GS=	Type: Rock Core

Project No.: CHM16420
Date Sampled: 10/13/16
Remarks:

Figure ________

Client: Freese and Nichols, Inc.

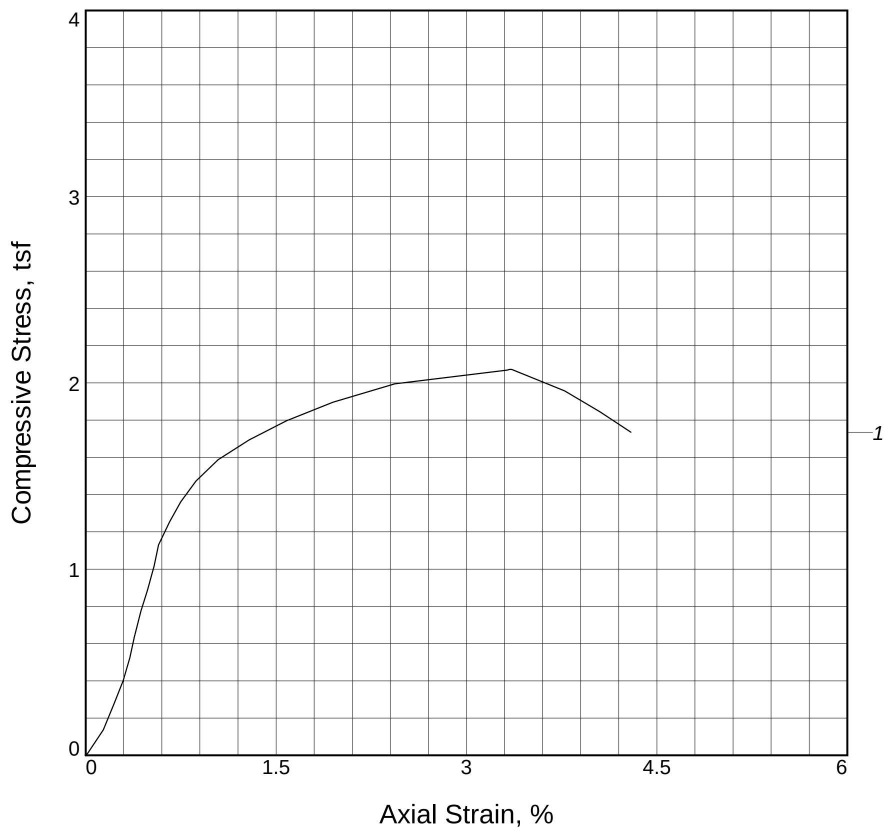
Project: UTRWD Lake Ralph Hall

Location: DS-01
Sample Number: C1 **Depth:** (35.0-36.7) ft.

UNCONFINED COMPRESSION TEST
Gorrondona & Associates, Inc.
Houston, Texas

Tested By: Jack **Checked By:** Sayak

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	2.072			
Undrained shear strength, tsf	1.036			
Failure strain, %	3.3			
Strain rate, %/min.	1.00			
Water content, %	27.1			
Wet density, pcf	140.7			
Dry density, pcf	110.7			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.60			
Specimen height, in.	5.75			
Height/diameter ratio	2.21			

Description:

LL = 80	**PL =** 27	**PI =** 53	**GS=**	**Type:** Shelby Tube

Project No.: CHM16420

Date Sampled: 10/13/16

Remarks:
Shear Plane Failure

Figure ________

Client: Freese and Nichols, Inc.

Project: UTRWD Lake Ralph Hall

Location: DS-02

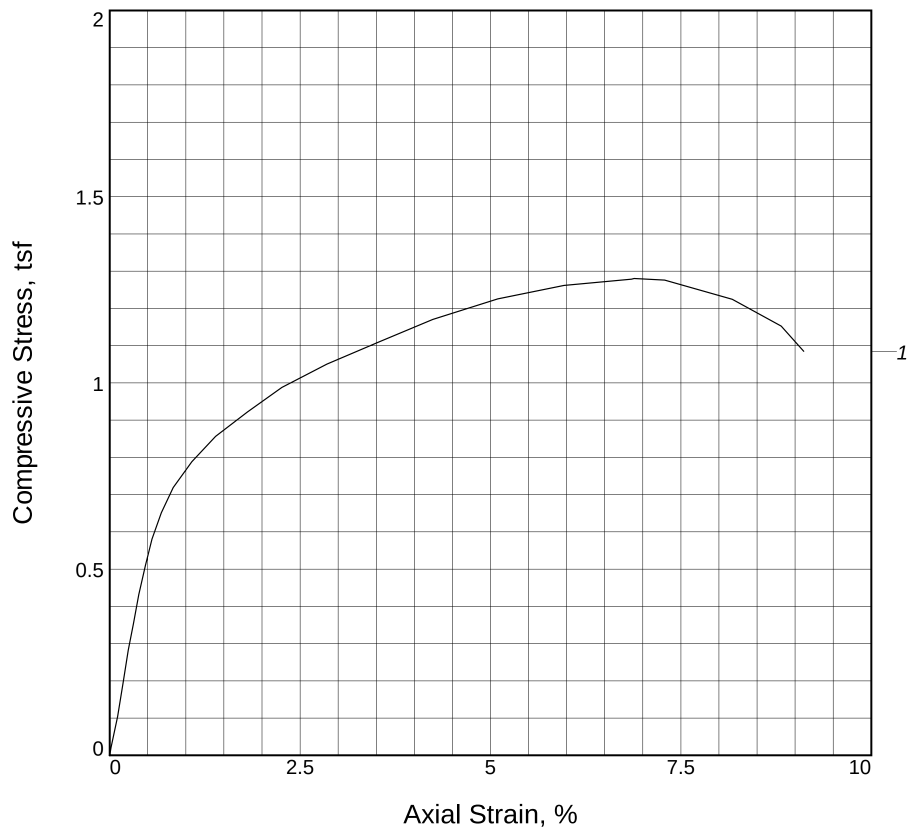
Sample Number: U11 **Depth:** (13.0-15.0) ft.

UNCONFINED COMPRESSION TEST

Gorrondona & Associates, Inc.
Houston, Texas

Tested By: Jack **Checked By:** Sayak

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.280			
Undrained shear strength, tsf	0.640			
Failure strain, %	6.9			
Strain rate, %/min.	1.00			
Water content, %	28.8			
Wet density, pcf	125.2			
Dry density, pcf	97.2			
Saturation, %	N/A			
Void ratio	N/A			
Specimen diameter, in.	2.77			
Specimen height, in.	5.75			
Height/diameter ratio	2.08			

Description:

LL = 77	**PL =** 24	**PI =** 53	**GS=**	**Type:** Shelby Tube

Project No.: CHM16420

Date Sampled: 10/13/16

Remarks:
Bulge Failure

Figure ________

Client: Freese and Nichols, Inc.

Project: UTRWD Lake Ralph Hall

Location: DS-02

Sample Number: U15 **Depth:** (33.0-35.0) ft.

UNCONFINED COMPRESSION TEST

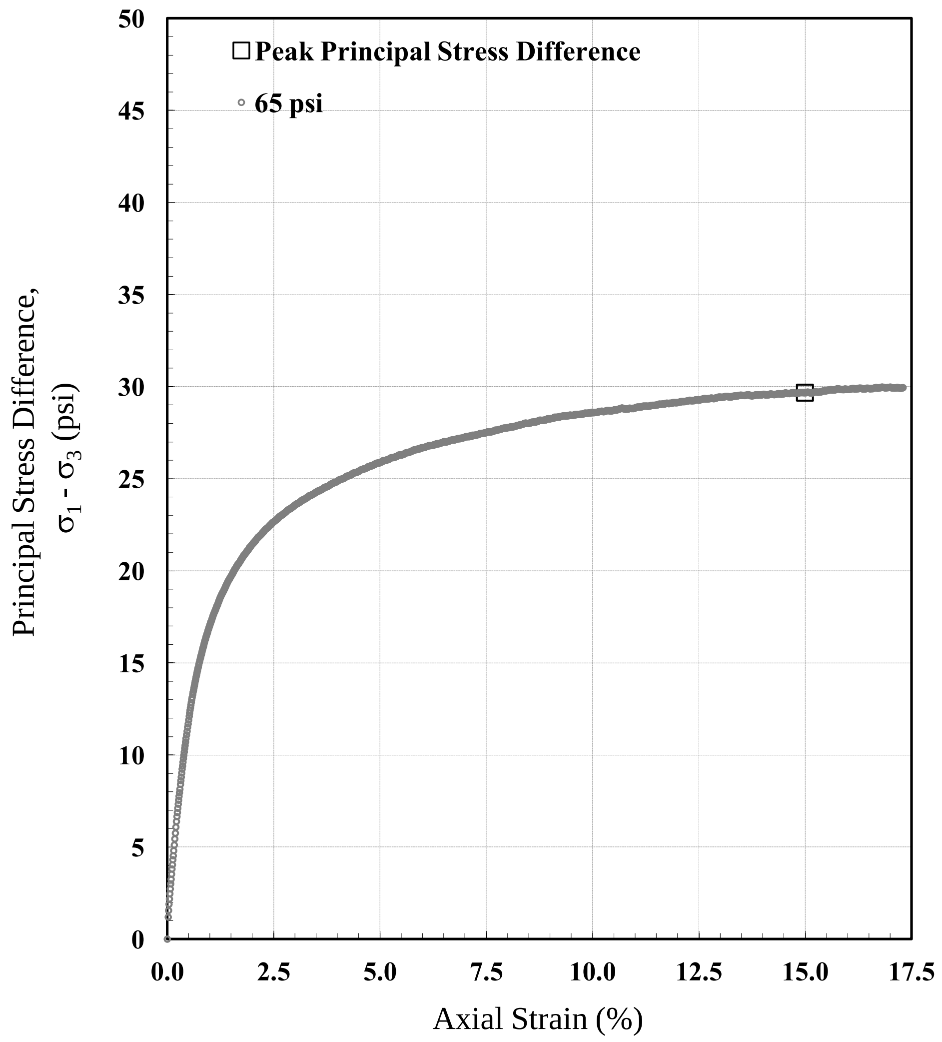
Gorrondona & Associates, Inc.
Houston, Texas

Tested By: Jack **Checked By:** Sayak

Unconsolidated-Undrained (Q) Triaxial Compression

Client: Gorrondona & Associates
Project: UTRWD Lake Ralph Hall
Sample: D-02 (9-10)

TRI Log #: 24670
Test Method: ASTM D2850



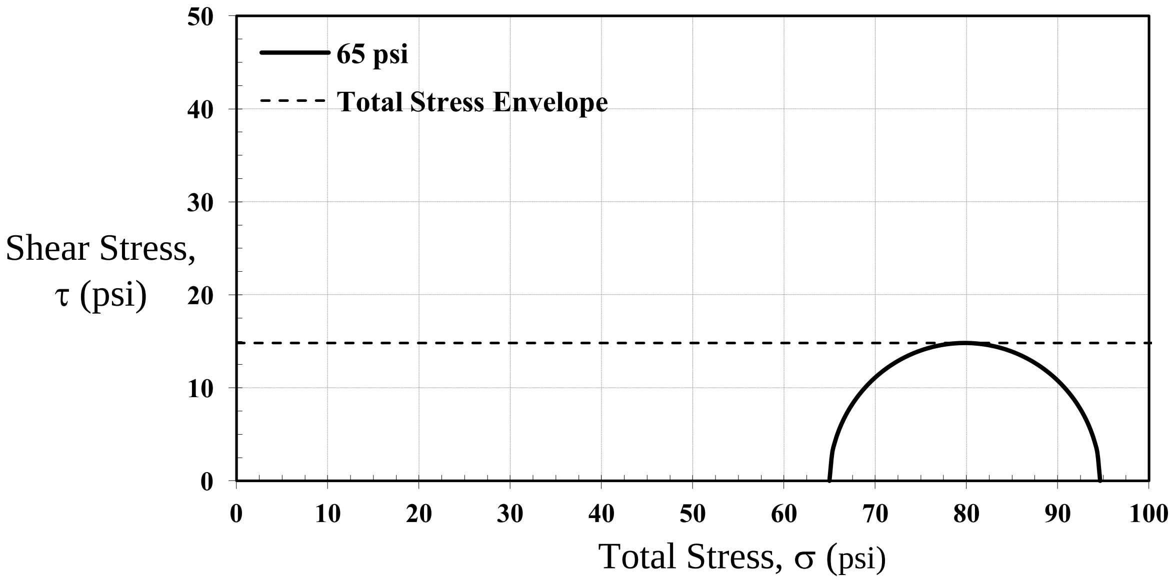
Test Parameters	
Minor Principal Stress (psi)	65.0
Rate of Strain (%/hr)	60

Initial Properties	
Avg. Diameter (in)	2.72
Avg. Height (in)	5.70
Avg. Water Content (%)	22.5
Bulk Density (pcf)	126.6
Dry Density (pcf)	103.4
Saturation (%)	99.2
Void Ratio	0.60
Specific Gravity (Assumed)	2.65

At Failure - Maximum Deviator Stress	
Axial Strain at Failure (%)	15.0
Minor Total Stress (psi)	65.0
Major Total Stress (psi)	94.7
Principal Stress Diff. (psi)	29.7

Total Stress Envelope	
Friction Angle (deg)	0
Undrained Shear Strength, S_u (psi)	14.8
S_u / σ_3	0.2

Note: The Mohr failure envelope was taken as a horizontal straight line. It should, however, be noted that the specimen was partially saturated.



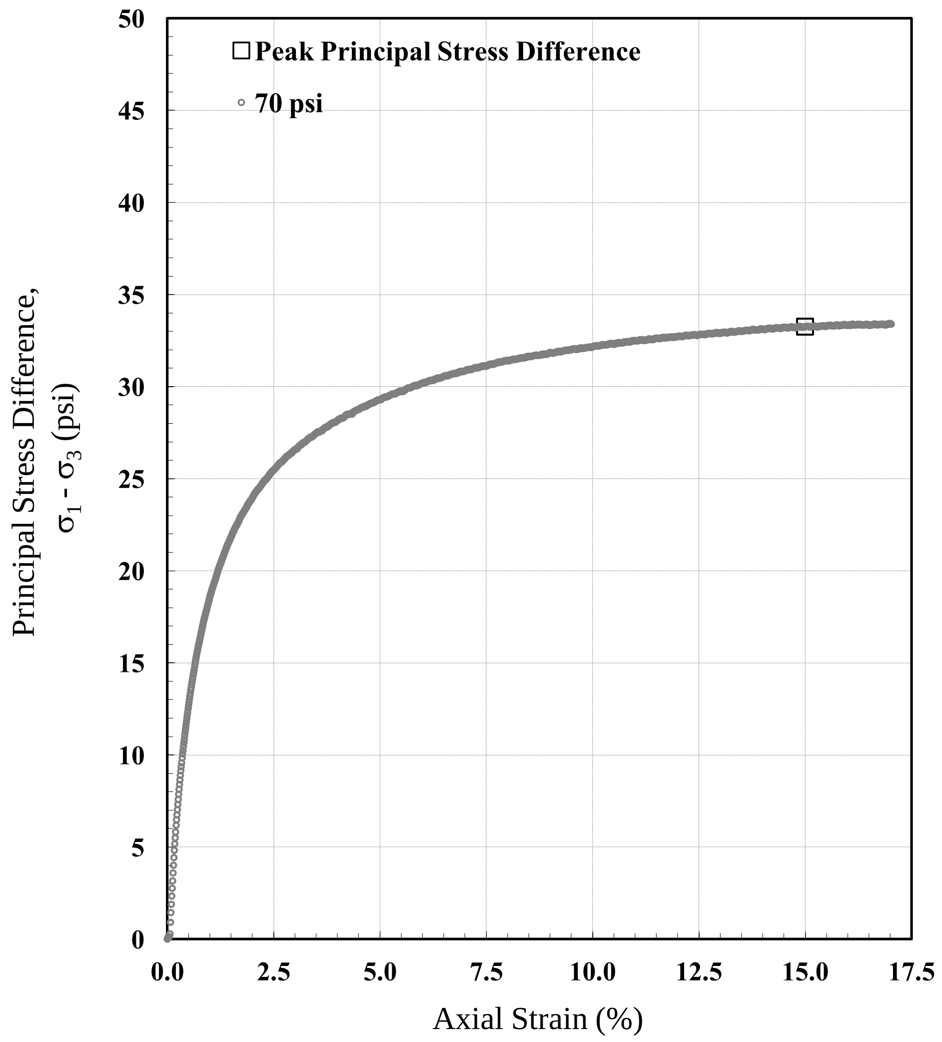
Jeffrey A. Kuhn , Ph.D., P.E., 11/16/2016
Analysis & Quality Review/Date
Laboratory Staff: LC

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

Unconsolidated-Undrained (Q) Triaxial Compression

Client: Gorrondona & Associates
Project: UTRWD Lake Ralph Hall
Sample: D-03 (7-8)

TRI Log #: 24670
Test Method: ASTM D2850



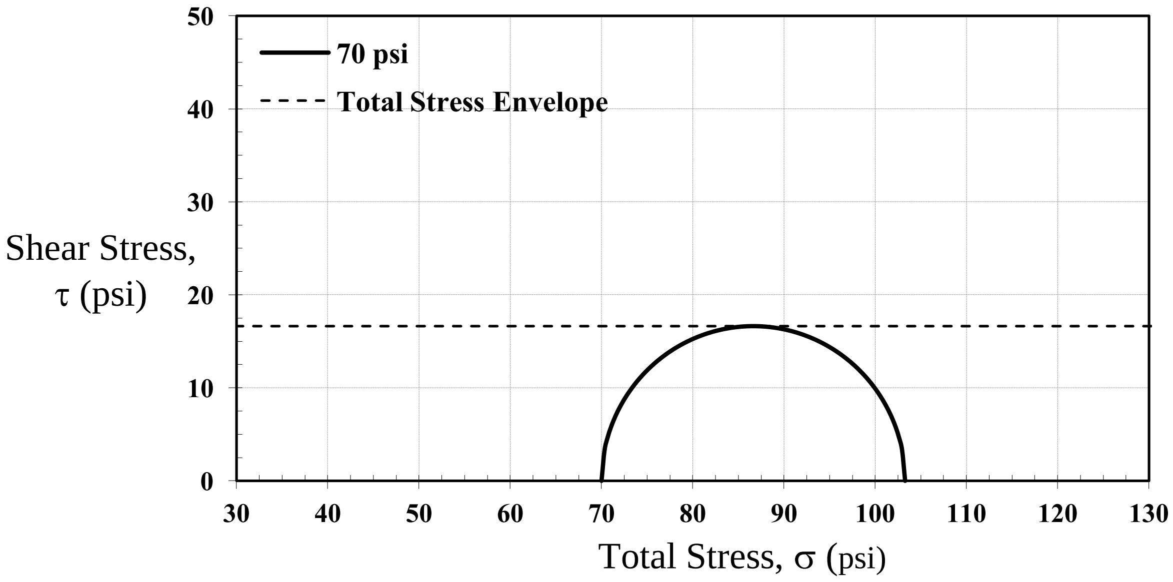
Test Parameters	
Minor Principal Stress (psi)	70.0
Rate of Strain (%/hr)	60

Initial Properties	
Avg. Diameter (in)	2.73
Avg. Height (in)	5.63
Avg. Water Content (%)	23.8
Bulk Density (pcf)	123.8
Dry Density (pcf)	100.0
Saturation (%)	96.4
Void Ratio	0.65
Specific Gravity (Assumed)	2.65

At Failure - Maximum Deviator Stress	
Axial Strain at Failure (%)	15.0
Minor Total Stress (psi)	70.0
Major Total Stress (psi)	103.3
Principal Stress Diff. (psi)	33.3

Total Stress Envelope	
Friction Angle (deg)	0
Undrained Shear Strength, S_u (psi)	16.6
S_u / σ_3	0.2

Note: The Mohr failure envelope was taken as a horizontal straight line. It should, however, be noted that the specimen was partially saturated.

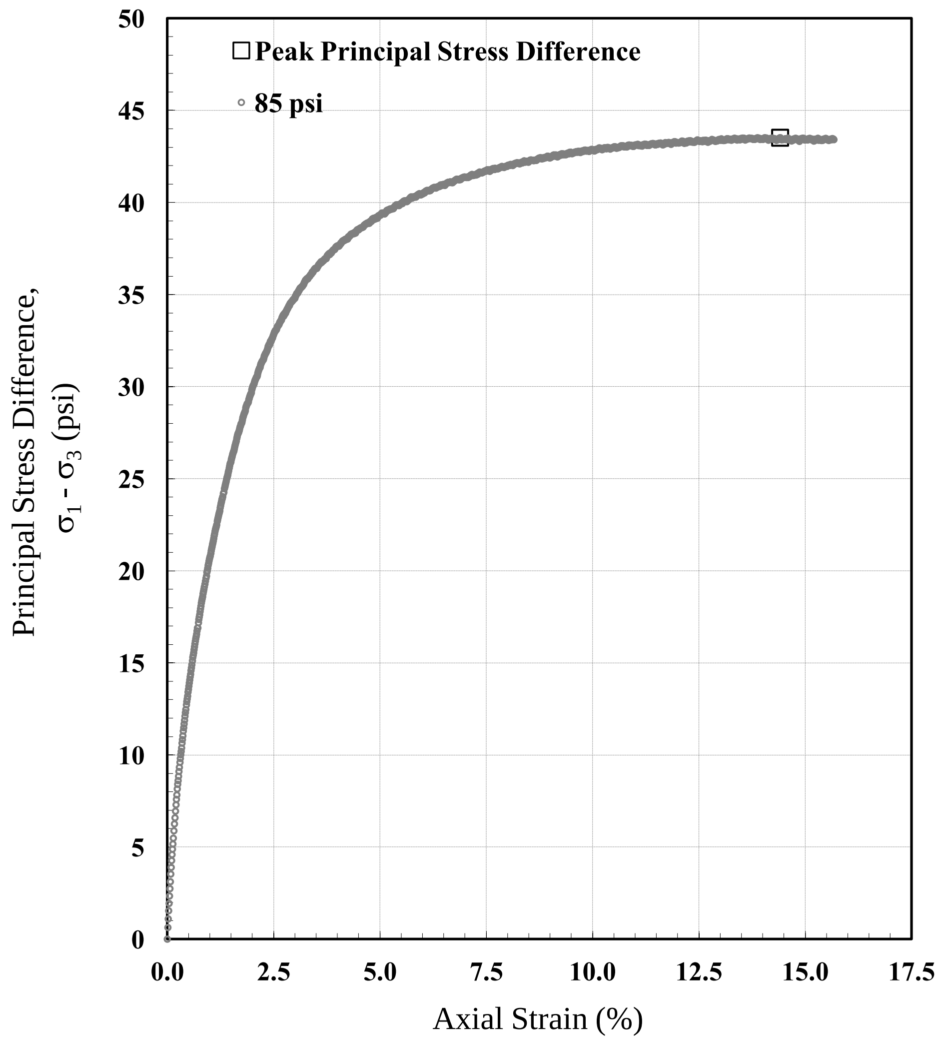


Jeffrey A. Kuhn , Ph.D., P.E., 11/16/2016
Analysis & Quality Review/Date
Laboratory Staff: LC

Unconsolidated-Undrained (Q) Triaxial Compression

Client: Gorrondona & Associates
Project: UTRWD Lake Ralph Hall
Sample: D-03 (23-25)

TRI Log #: 24670
Test Method: ASTM D2850



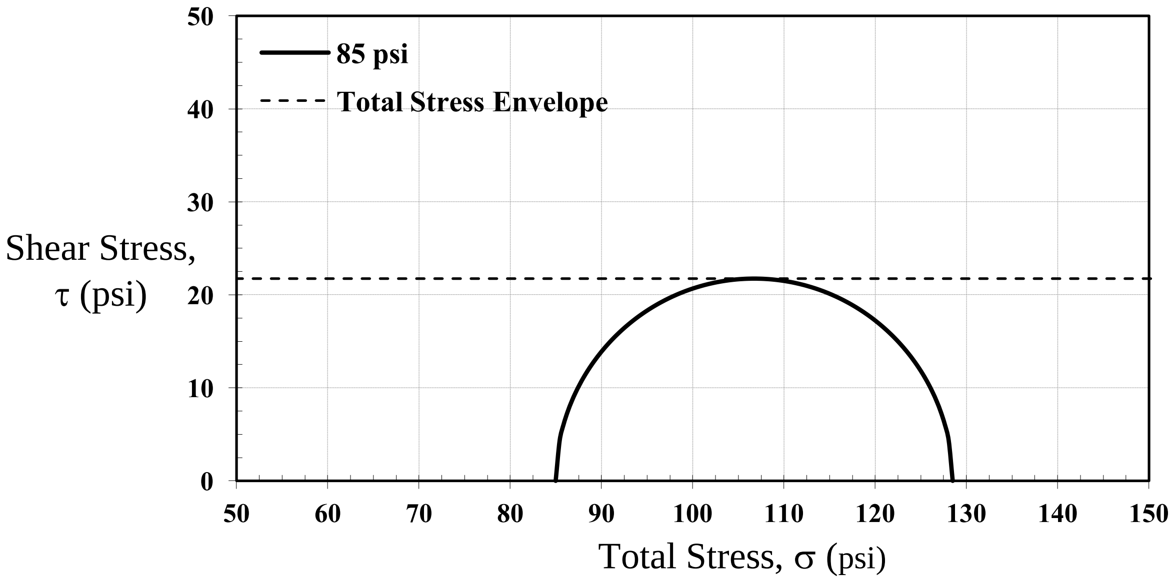
Test Parameters	
Minor Principal Stress (psi)	85.0
Rate of Strain (%/hr)	60

Initial Properties	
Avg. Diameter (in)	2.78
Avg. Height (in)	5.63
Avg. Water Content (%)	23.2
Bulk Density (pcf)	123.7
Dry Density (pcf)	100.4
Saturation (%)	94.9
Void Ratio	0.65
Specific Gravity (Assumed)	2.65

At Failure - Maximum Deviator Stress	
Axial Strain at Failure (%)	14.4
Minor Total Stress (psi)	85.0
Major Total Stress (psi)	128.5
Principal Stress Diff. (psi)	43.5

Total Stress Envelope	
Friction Angle (deg)	0
Undrained Shear Strength, S_u (psi)	21.8
S_u / σ_3	0.3

Note: The Mohr failure envelope was taken as a horizontal straight line. It should, however, be noted that the specimen was partially saturated.



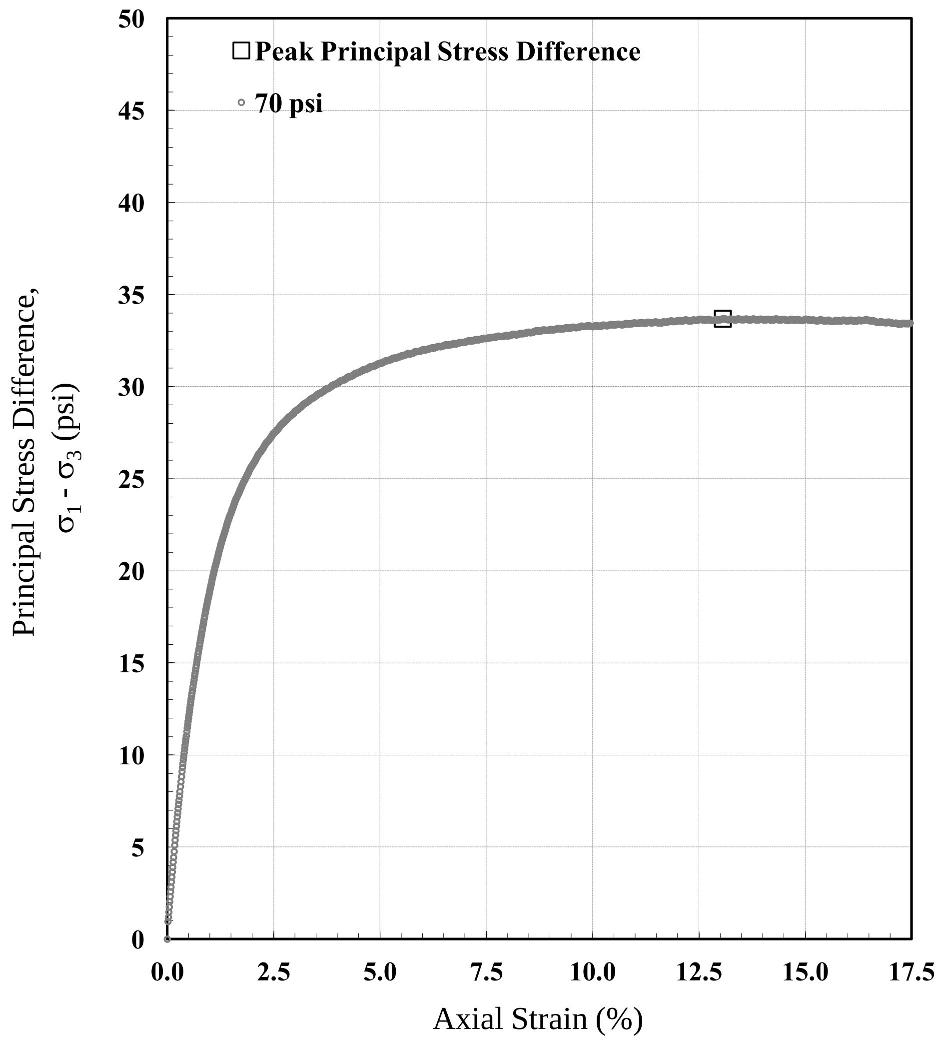
Jeffrey A. Kuhn , Ph.D., P.E., 11/16/2016
Analysis & Quality Review/Date
Laboratory Staff: LC

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

Unconsolidated-Undrained (Q) Triaxial Compression

Client:	Gorrondona & Associates
Project:	UTRWD Lake Ralph Hall
Sample:	D-04 (6-7)

TRI Log #:	24670
Test Method:	ASTM D2850



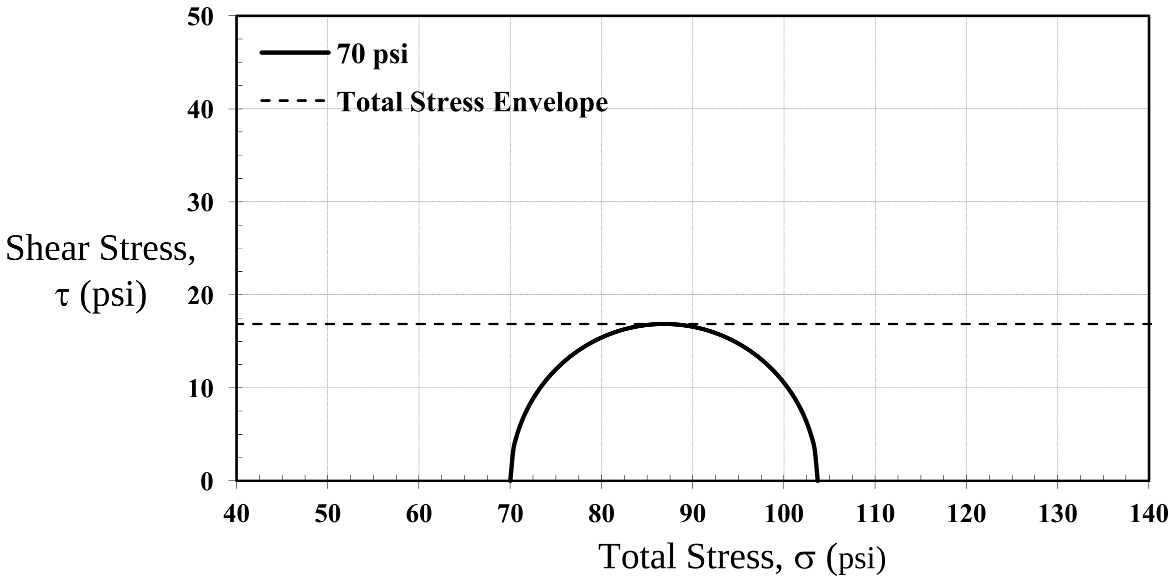
Test Parameters	
Minor Principal Stress (psi)	70.0
Rate of Strain (%/hr)	60

Initial Properties	
Avg. Diameter (in)	2.76
Avg. Height (in)	5.65
Avg. Water Content (%)	26.0
Bulk Density (pcf)	121.1
Dry Density (pcf)	96.2
Saturation (%)	95.5
Void Ratio	0.72
Specific Gravity (Assumed)	2.65

At Failure - Maximum Deviator Stress	
Axial Strain at Failure (%)	13.1
Minor Total Stress (psi)	70.0
Major Total Stress (psi)	103.7
Principal Stress Diff. (psi)	33.7

Total Stress Envelope	
Friction Angle (deg)	0
Undrained Shear Strength, S_u (psi)	16.8
S_u / σ_3	0.2

Note: The Mohr failure envelope was taken as a horizontal straight line. It should, however, be noted that the specimen was partially saturated.



Jeffrey A. Kuhn , Ph.D., P.E., 11/16/2016

Analysis & Quality Review/Date

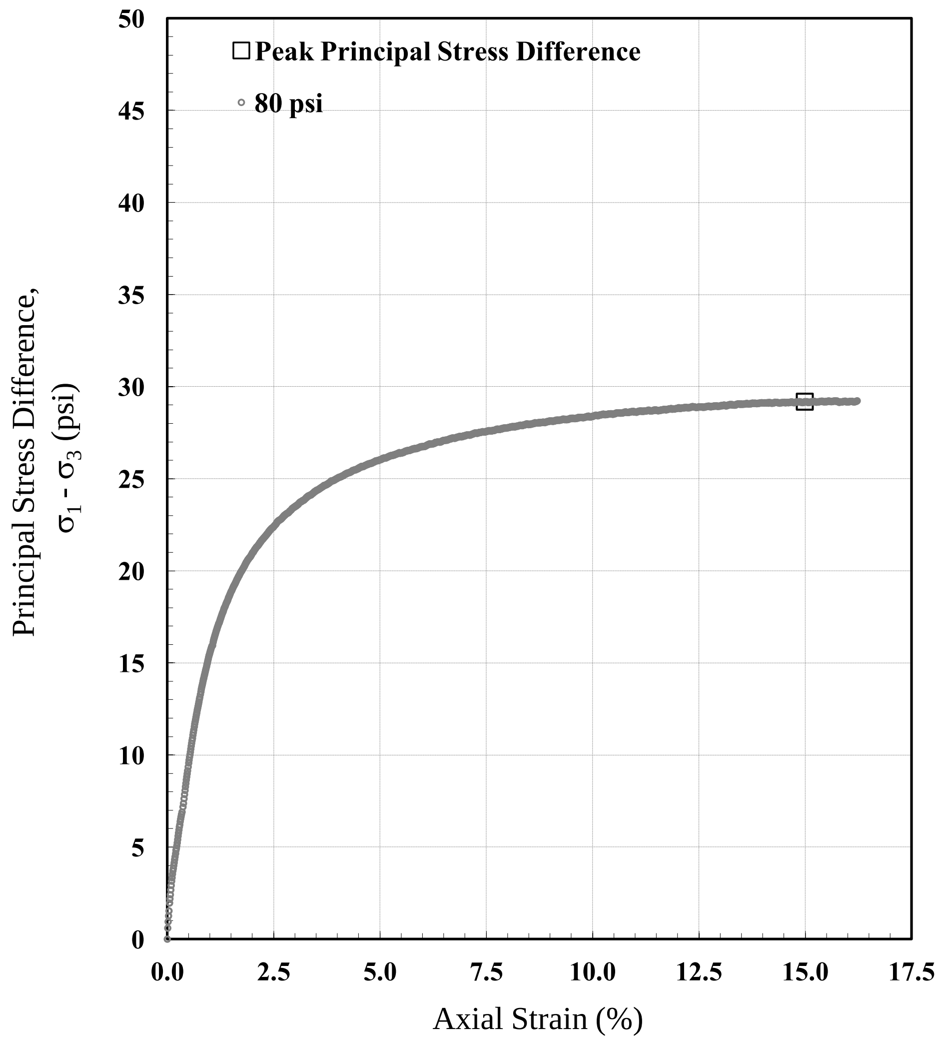
Laboratory Staff: LC

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

Unconsolidated-Undrained (Q) Triaxial Compression

Client: Gorrondona & Associates
Project: UTRWD Lake Ralph Hall
Sample: D-04 (18-20)

TRI Log #: 24670
Test Method: ASTM D2850



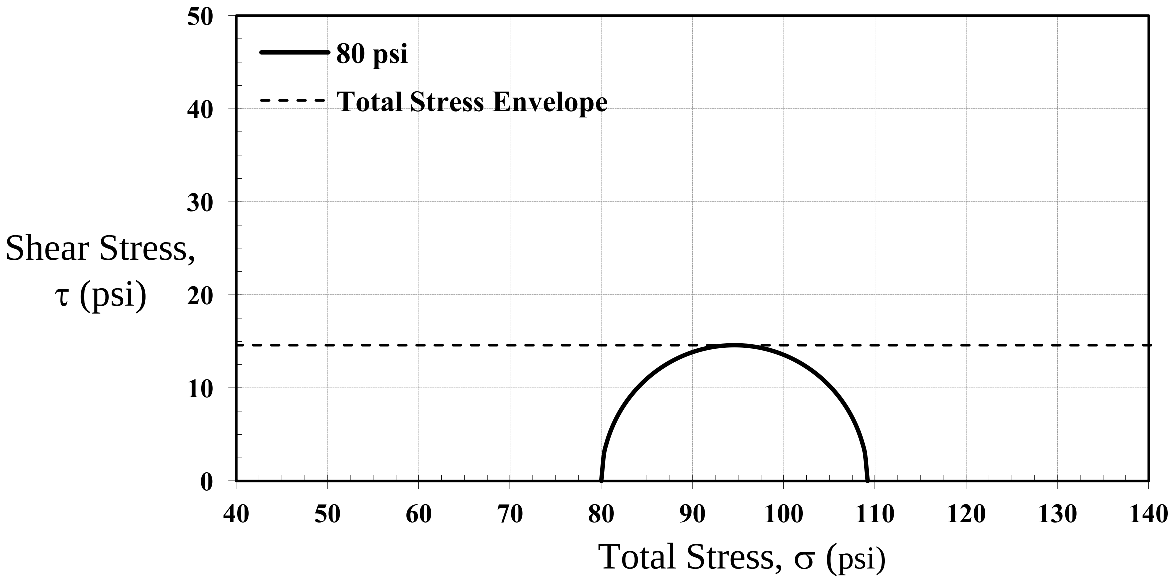
Test Parameters	
Minor Principal Stress (psi)	80.0
Rate of Strain (%/hr)	60

Initial Properties	
Avg. Diameter (in)	2.76
Avg. Height (in)	5.62
Avg. Water Content (%)	22.6
Bulk Density (pcf)	124.5
Dry Density (pcf)	101.5
Saturation (%)	95.2
Void Ratio	0.63
Specific Gravity (Assumed)	2.65

At Failure - Maximum Deviator Stress	
Axial Strain at Failure (%)	15.0
Minor Total Stress (psi)	80.0
Major Total Stress (psi)	109.2
Principal Stress Diff. (psi)	29.2

Total Stress Envelope	
Friction Angle (deg)	0
Undrained Shear Strength, S_u (psi)	14.6
S_u / σ_3	0.2

Note: The Mohr failure envelope was taken as a horizontal straight line. It should, however, be noted that the specimen was partially saturated.



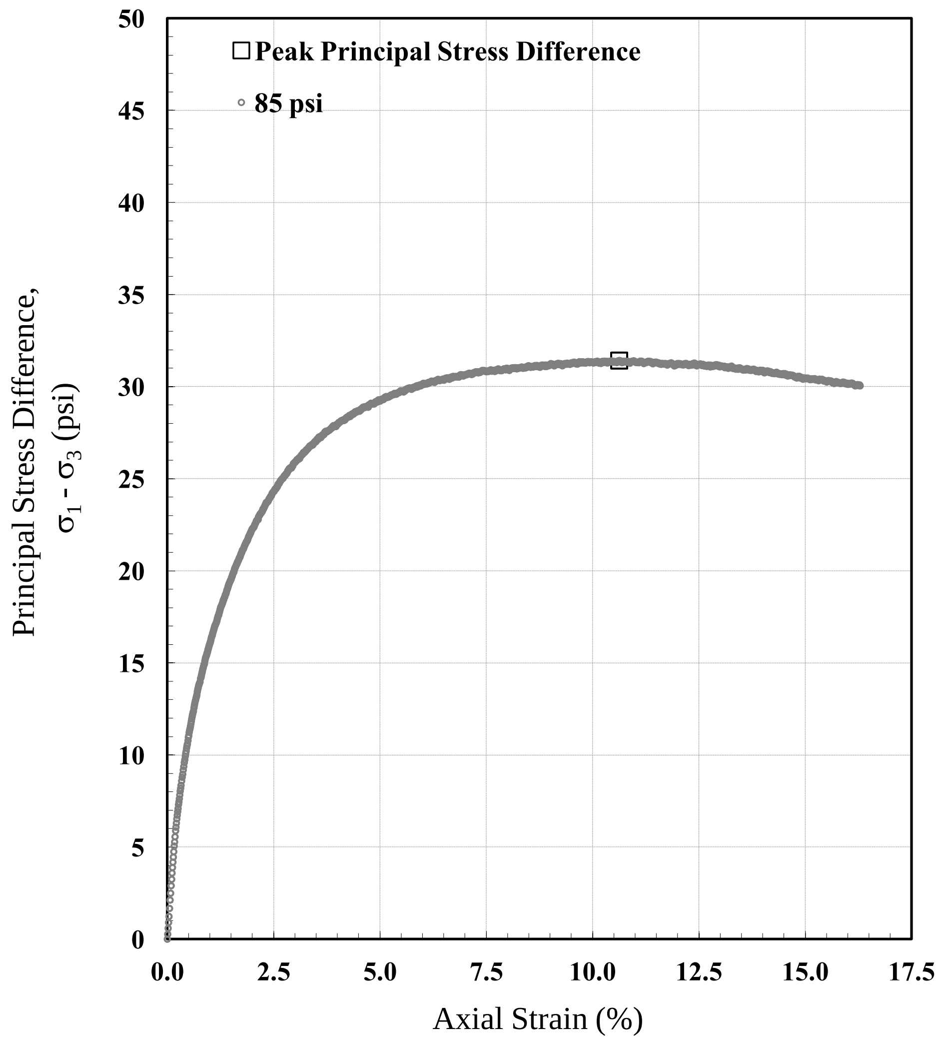
Jeffrey A. Kuhn , Ph.D., P.E., 11/16/2016
Analysis & Quality Review/Date
Laboratory Staff: LC

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

Unconsolidated-Undrained (Q) Triaxial Compression

Client: Gorrondona & Associates
Project: UTRWD Lake Ralph Hall
Sample: D-05 (29-30)

TRI Log #: 24670
Test Method: ASTM D2850



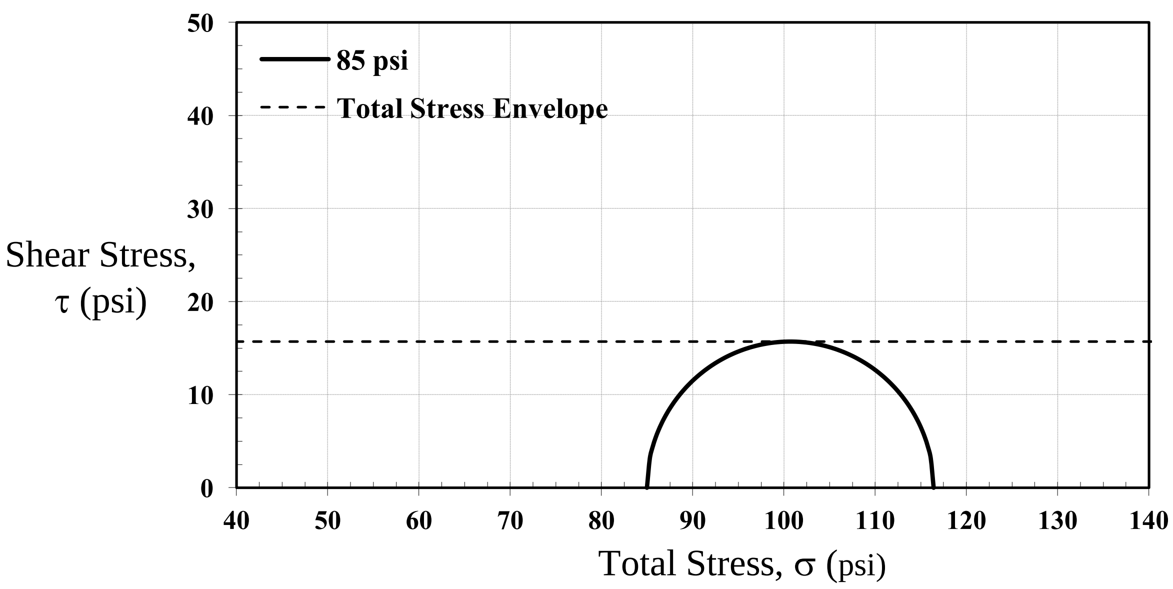
Test Parameters	
Minor Principal Stress (psi)	85.0
Rate of Strain (%/hr)	60

Initial Properties	
Avg. Diameter (in)	2.80
Avg. Height (in)	5.64
Avg. Water Content (%)	27.2
Bulk Density (pcf)	123.4
Dry Density (pcf)	97.0
Saturation (%)	100.0
Void Ratio	0.71
Specific Gravity (Assumed)	2.65

At Failure - Maximum Deviator Stress	
Axial Strain at Failure (%)	10.6
Minor Total Stress (psi)	85.0
Major Total Stress (psi)	116.4
Principal Stress Diff. (psi)	31.4

Total Stress Envelope	
Friction Angle (deg)	0
Undrained Shear Strength, S_u (psi)	15.7
S_u / σ_3	0.2

Note: The Mohr failure envelope was taken as a horizontal straight line.



Jeffrey A. Kuhn , Ph.D., P.E., 11/16/2016
Analysis & Quality Review/Date
Laboratory Staff: LC

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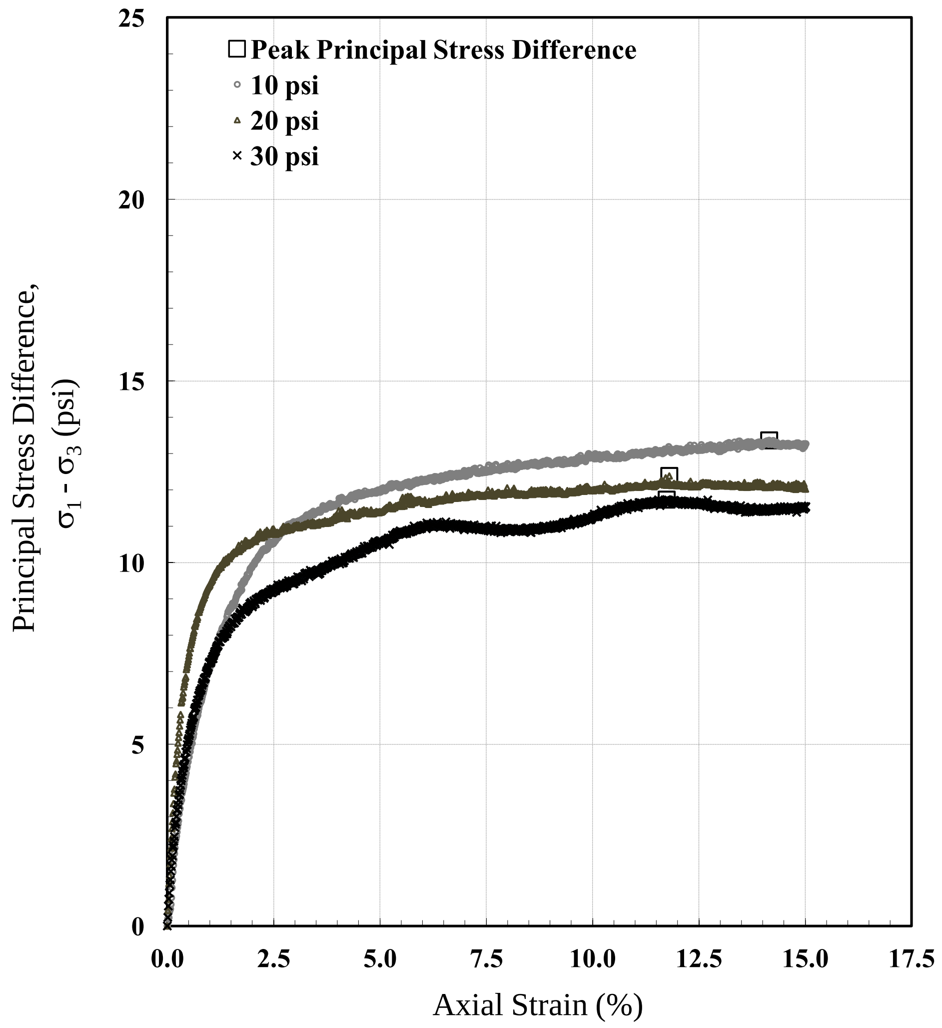
Unconsolidated-Undrained (Q) Triaxial Compression

Client: Gorrondona & Associates
Project: UTRWD Lake Ralph Hall
Sample: Composite BA-03 (4-20)

TRI Log #: 24670.37
Test Method: ASTM D2850

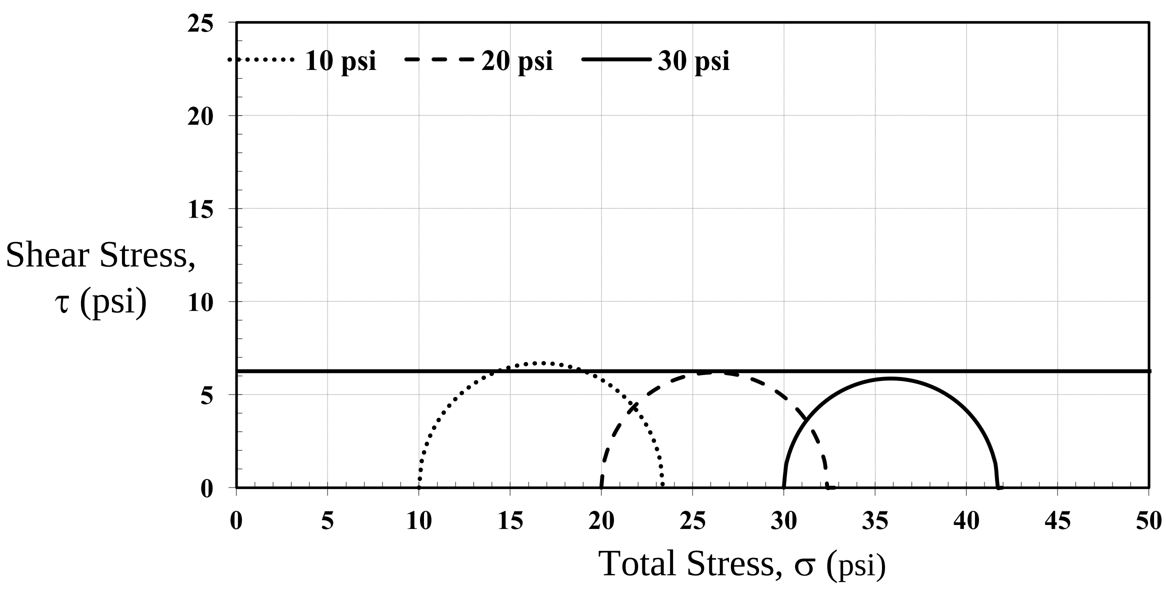


Samples			
Sample I.D.	Composite BA-03		
Depth/Elev. (ft)	4-20		
Minor Principal Stress (psi)	10.0	20.0	30.0
Initial Properties			
Avg. Diameter (in)	2.00	2.01	1.99
Avg. Height (in)	4.42	4.35	4.49
Avg. Water Content (%)	30.0	30.0	30.0
Bulk Density (pcf)	119.7	119.1	117.9
Dry Density (pcf)	92.1	91.6	90.7
Saturation (%)	99.8	98.6	96.4
Void Ratio	0.80	0.81	0.82
Specific Gravity (Assumed)	2.65	2.65	2.65

At Failure			
Failure Criterion	Maximum Deviator Stress		
Rate of Strain (%/hr)	30	30	30
Axial Strain at Failure (%)	14.2	11.8	11.7
Minor Total Stress (psi)	10.0	20.0	30.0
Major Total Stress (psi)	23.4	32.4	41.7
Principal Stress Diff. (psi)	13.4	12.4	11.7

Note: Remolded samples with target dry density of 90 pcf and moisture content of 30%.

Total Stress Envelope	
Friction Angle (deg)	0.0
Cohesion (psi)	6.2



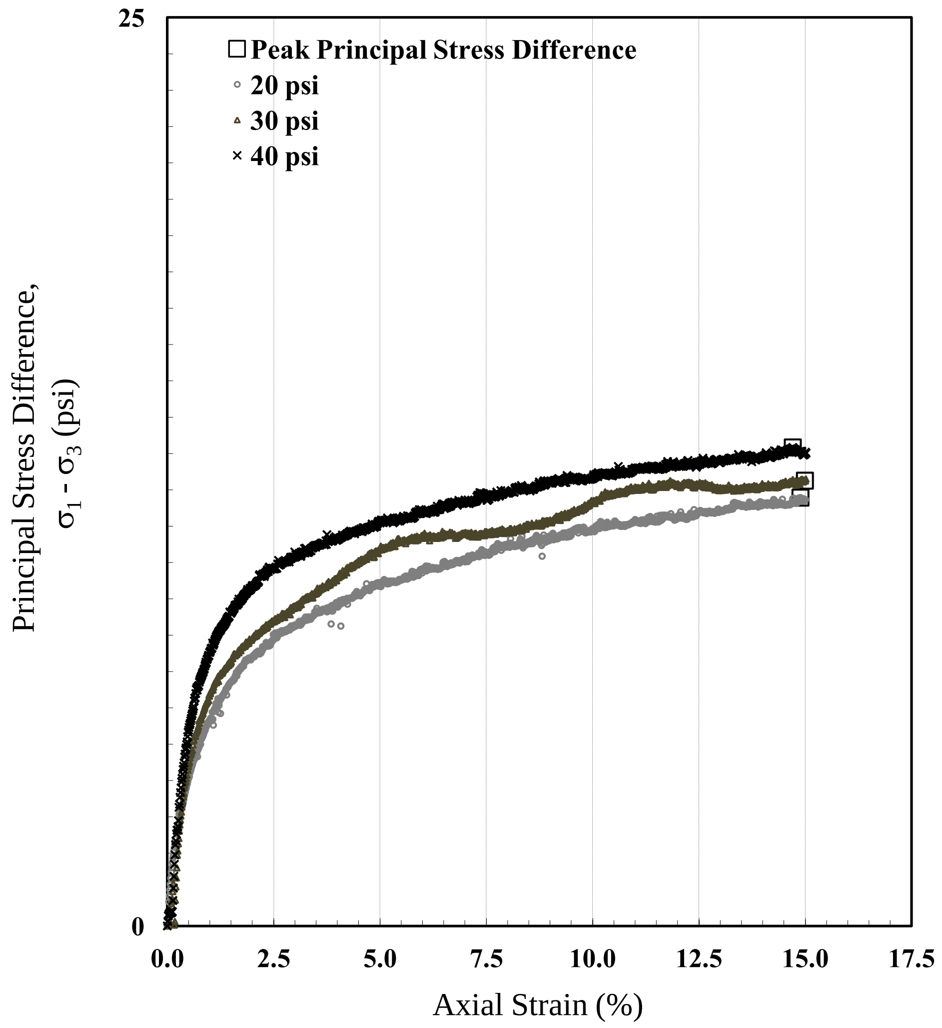
Note: A linear fit tangent to the Mohr circles results in a total stress envelope with a negative friction angle. The total stress envelope provide is the average of the undrained shear strengths of the three tests performed.

Shawn Hutcherson, P.E. 12/1/2016
Analysis & Quality Review/Date
Laboratory Staff: LC

Unconsolidated-Undrained (Q) Triaxial Compression

Client: Gorrondona & Associates
Project: UTRWD Lake Ralph Hall
Sample: Composite BA-04 (0-15)

TRI Log #: 24670.38
Test Method: ASTM D2850

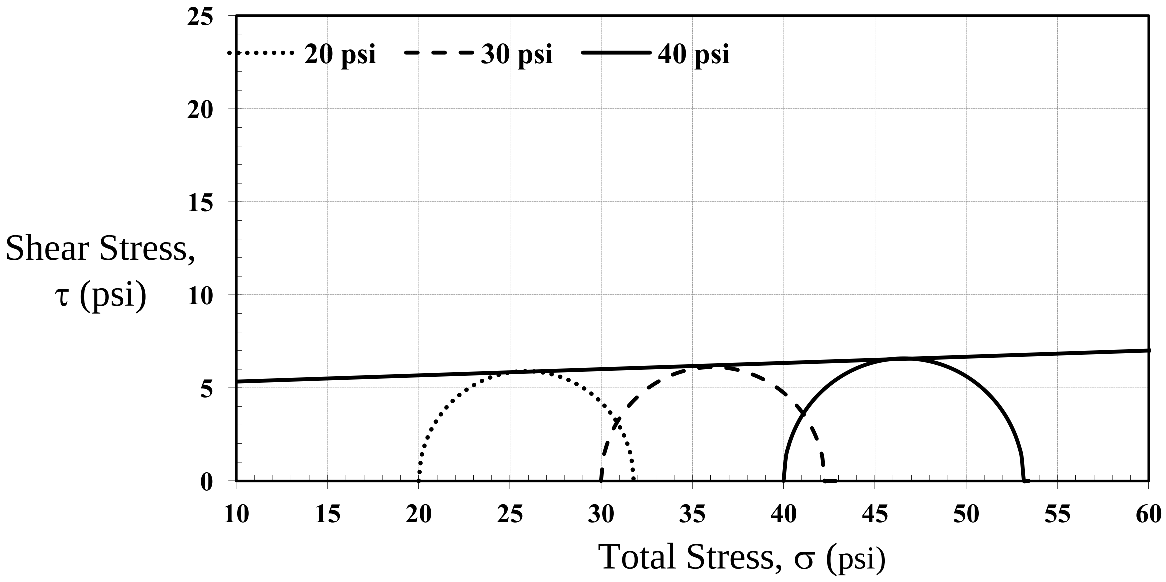


Samples			
Sample I.D.	Composite BA-04		
Depth/Elev. (ft)	0-15		
Minor Principal Stress (psi)	20.0	30.0	40.0
Initial Properties			
Avg. Diameter (in)	1.99	1.99	2.01
Avg. Height (in)	4.47	4.44	4.65
Avg. Water Content (%)	29.0	29.0	29.0
Bulk Density (pcf)	118.1	119.1	117.6
Dry Density (pcf)	91.6	92.3	91.2
Saturation (%)	95.3	97.0	94.3
Void Ratio	0.81	0.79	0.81
Specific Gravity (Assumed)	2.65	2.65	2.65

At Failure			
Failure Criterion	Maximum Deviator Stress		
Rate of Strain (%/hr)	30	30	30
Axial Strain at Failure (%)	14.9	15.0	14.7
Minor Total Stress (psi)	20.0	30.0	40.0
Major Total Stress (psi)	31.8	42.3	53.2
Principal Stress Diff. (psi)	11.8	12.3	13.2

Note: Remolded samples with target dry density of 90 pcf and moisture content of 29%.

Total Stress Envelope	
Friction Angle (deg)	1.9
Cohesion (psi)	5.0

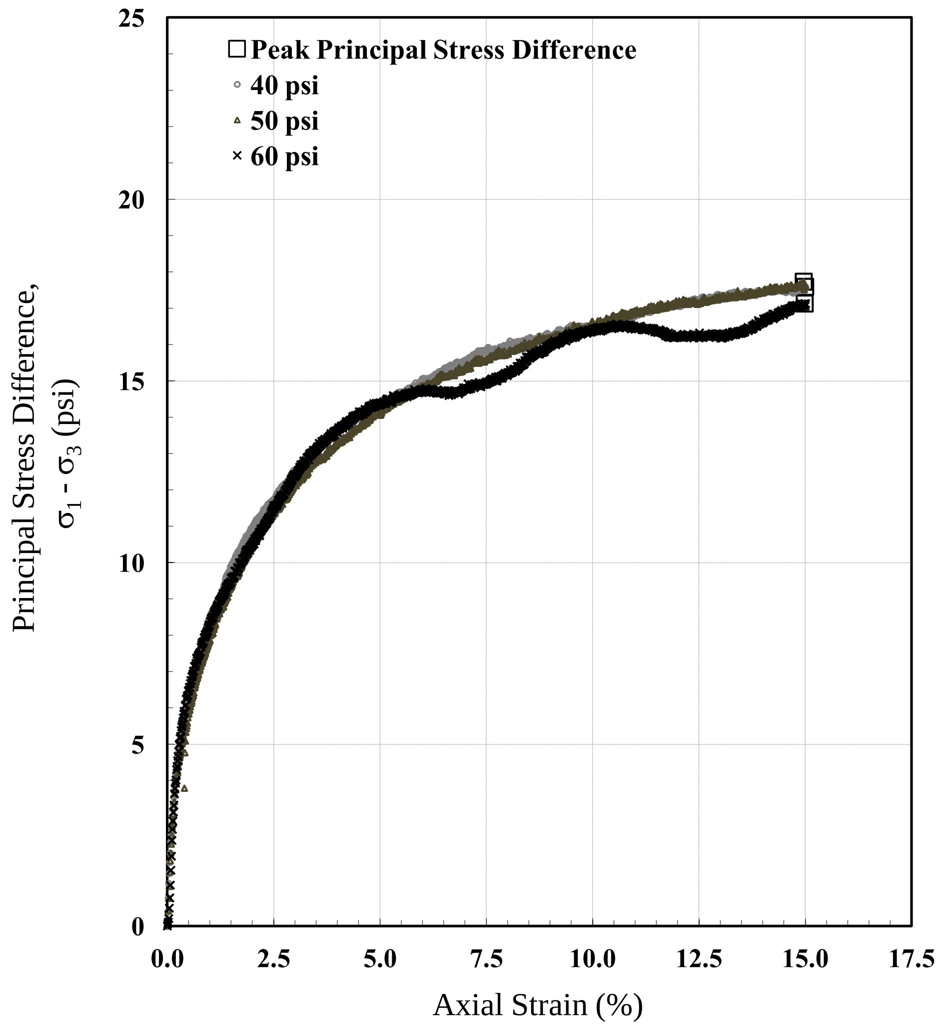


Shawn Hutcherson, P.E. 12/1/2016
Analysis & Quality Review/Date
Laboratory Staff: LC

Unconsolidated-Undrained (Q) Triaxial Compression

Client: Gorrondona & Associates
Project: UTRWD Lake Ralph Hall
Sample: Composite BA-05-1 (0-7)

TRI Log #: 24670.39
Test Method: ASTM D2850

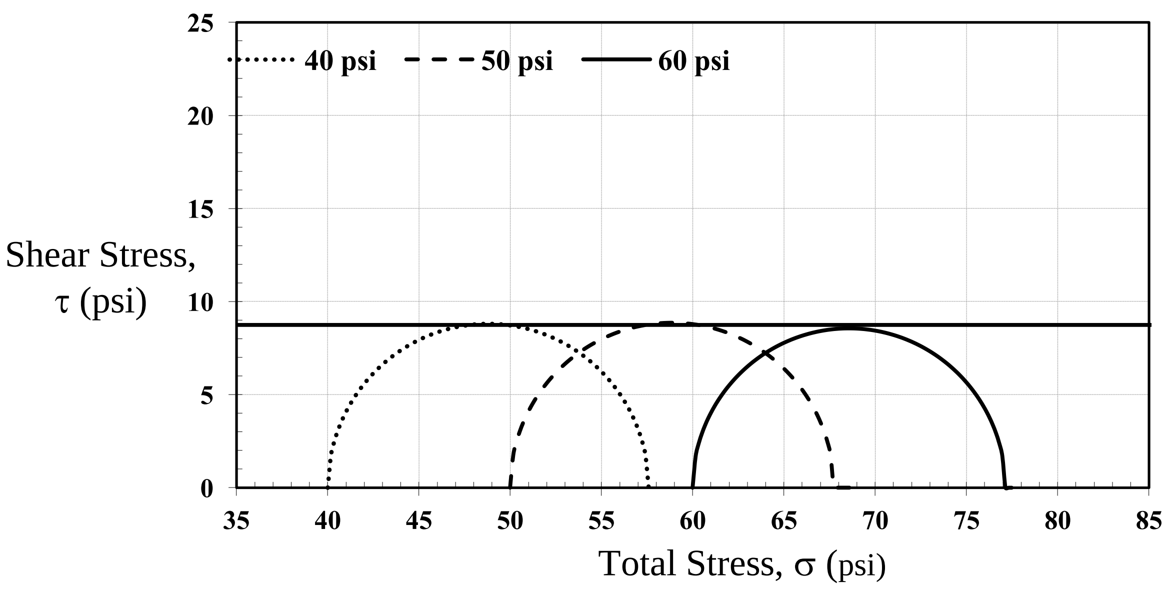


Samples			
Sample I.D.	Composite BA-05-1		
Depth/Elev. (ft)	0-7		
Minor Principal Stress (psi)	40.0	50.0	60.0
Initial Properties			
Avg. Diameter (in)	1.99	2.00	2.00
Avg. Height (in)	4.55	4.54	4.57
Avg. Water Content (%)	30.0	30.0	30.0
Bulk Density (pcf)	116.5	116.6	115.6
Dry Density (pcf)	89.6	89.7	88.9
Saturation (%)	93.9	94.1	92.4
Void Ratio	0.85	0.85	0.86
Specific Gravity (Assumed)	2.65	2.65	2.65

At Failure			
Failure Criterion	Maximum Deviator Stress		
Rate of Strain (%/hr)	30	30	30
Axial Strain at Failure (%)	15.0	15.0	15.0
Minor Total Stress (psi)	40.0	50.0	60.0
Major Total Stress (psi)	57.6	67.7	77.1
Principal Stress Diff. (psi)	17.6	17.7	17.1

Note: Remolded samples with target dry density of 90 pcf and moisture content of 30%.

Total Stress Envelope	
Friction Angle (deg)	0.0
Cohesion (psi)	8.7



Note: A linear fit tangent to the Mohr circles results in a total stress envelope with a negative friction angle. The total stress envelope provide is the average of the undrained shear strengths of the three tests performed.

Shawn Hutcherson, P.E. 12/1/2016
Analysis & Quality Review/Date
Laboratory Staff: LC

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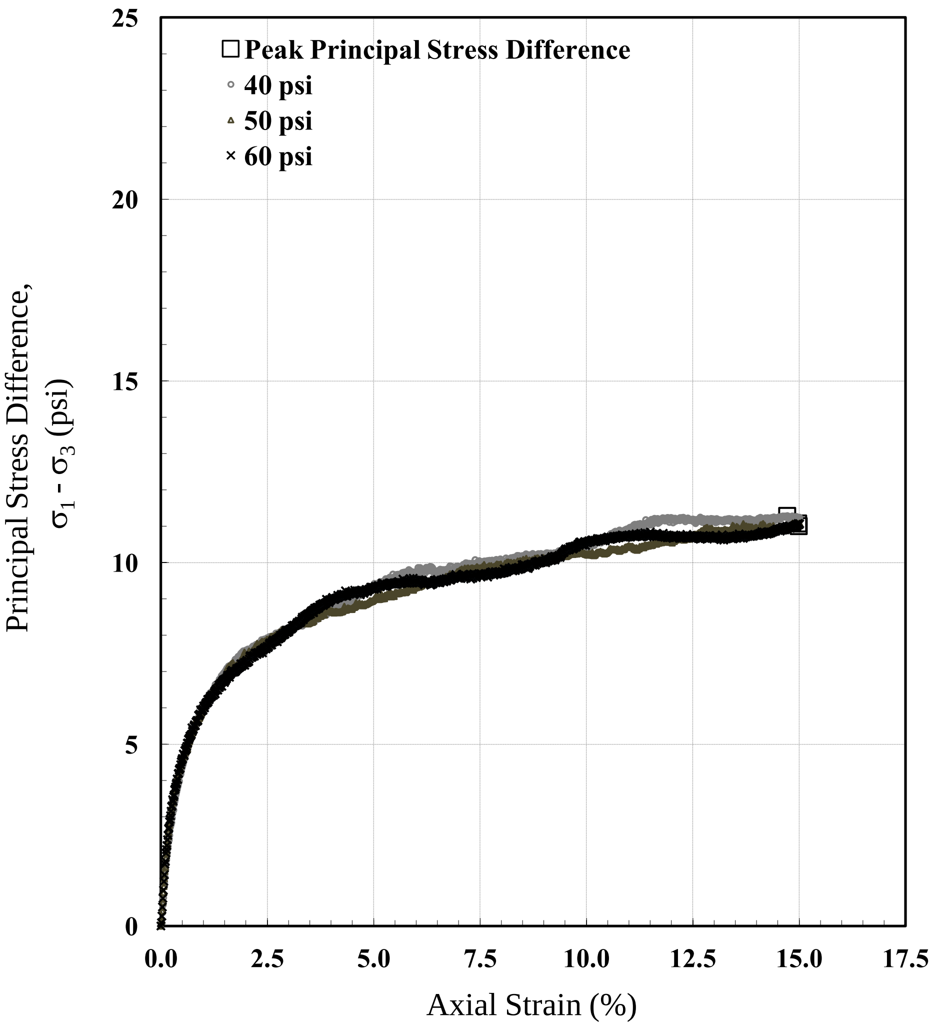
Unconsolidated-Undrained (Q) Triaxial Compression

Client: Gorrondona & Associates
Project: UTRWD Lake Ralph Hall
Sample: Composite BA-05-2 (7-14)

TRI Log #: 24670.40
Test Method: ASTM D2850

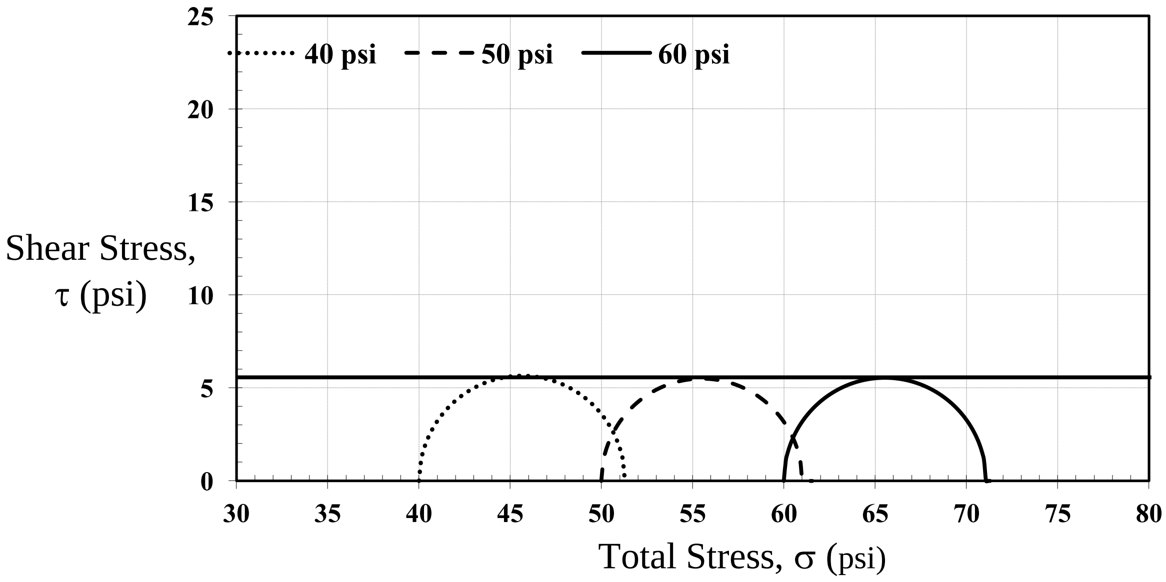


Samples			
Sample I.D.	Composite BA-05-2		
Depth/Elev. (ft)	7-14		
Minor Principal Stress (psi)	40.0	50.0	60.0
Initial Properties			
Avg. Diameter (in)	1.99	1.99	1.99
Avg. Height (in)	4.29	4.34	4.30
Avg. Water Content (%)	27.0	27.0	27.0
Bulk Density (pcf)	120.6	119.7	121.3
Dry Density (pcf)	95.0	94.3	95.5
Saturation (%)	96.4	94.8	97.7
Void Ratio	0.74	0.76	0.73
Specific Gravity (Assumed)	2.65	2.65	2.65

At Failure			
Failure Criterion	Maximum Deviator Stress		
Rate of Strain (%/hr)	30	30	30
Axial Strain at Failure (%)	14.7	15.0	15.0
Minor Total Stress (psi)	40.0	50.0	60.0
Major Total Stress (psi)	51.3	61.0	71.1
Principal Stress Diff. (psi)	11.3	11.0	11.1

Note: Remolded samples with target dry density of 90 pcf and moisture content of 27%.

Total Stress Envelope	
Friction Angle (deg)	0.0
Cohesion (psi)	5.6



Note: A linear fit tangent to the Mohr circles results in a total stress envelope with a negative friction angle. The total stress envelope provide is the average of the undrained shear strengths of the three tests performed.

Shawn Hutcherson, P.E. 12/1/2016
Analysis & Quality Review/Date
Laboratory Staff: LC

Crumb Test for Dispersibility of Clayey Soils

Client: Gorrondona & Associates
Project: UTRWD Lake Ralph Hall

TRI Log #: 24670
Test Method: ASTM D6572-B

Sample Identification	Moisture Content (%)		Temp. (°C)			Grade			Dispersive Classification (1 hr)
	Initial	Adjusted	2 min	1 hr	6 hr	2 min	1 hr	6 hr	
Composite BA-03 (4-20)	37.3	-	21.0	20.0	19.0	1	1	1	1
Composite BA-03 (4-20)	41.9	-	20.0	20.0	19.0	1	1	1	1
Composite BA-03 (4-20)	43.5	-	20.0	20.0	19.0	1	1	1	1
Composite BA-04 (0-15)	49.0	-	21.0	20.0	20.0	1	1	1	1
Composite BA-04 (0-15)	29.1	-	20.0	20.0	19.0	1	1	1	1
Composite BA-05-1 (0-7)	88.6	-	21.1	19.8	19.0	1	1	1	1
Composite BA-05-1 (0-7)	42.3	-	20.1	19.8	19.0	1	1	1	1
Composite BA-05-2 (7-14)	106.7	-	20.1	19.5	19.0	1	1	1	1
Composite BA-05-2 (7-14)	101.3	-	20.0	19.5	19.0	1	2	2	2

Grade 1, (Nondispersive): No Reaction; There is no turbid water created by colloids suspended in the water. All particles settle during the first hour.If the cloud is easily visible, assign Grade 3. If the cloud is faintly seen in only small area, assign Grade 1.
Grade 2, (Intermediate): Slight Reaction; A faint, barely visible colloidal suspension causes turbid water near or around the soil crumb surface.
Grade 3, (Dispersive): Moderate Reaction; an easily visible cloud of suspended clay colloids is seen around all of the soil crumb surface. The cloud may extend up to 10 mm (¾ in.) away from the soil crumb mass along the bottom of dish.
Grade 4, (Highly Dispersive): Strong Reaction; a dense, profuse cloud of suspended clay colloids is seen around the entire bottom of dish. The soil crumb dispersion is so extensive that it is difficult to determine the interface of the original soil crumb . Often, the colloidal suspension is easily visible on the sides of the dish.

Shawn Hutcherson, P.E. 12/1/2016
Quality Review/Date
Tested by: MF & PC

TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

Crumb Test for Dispersibility - ASTM (D6572)

Project Name UTRWD Lake Ralph Hall **Project No.** CHM16420 **Date** 10/19/2016

Boring No. BA-01 **Sample No.** Composite U3, U4 **Sample Depth (ft.)** 1.5-4.0
Sample Description Brown FAT CLAY (CH)

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type: Natural Cube	Grade	˚C	Grade	˚C	Grade	˚C	Grade	˚C
Time Started: / Initial Temp(˚C): 21.2	1	21.3	4	23.6	4	21.4	4	21.1

Boring No. BA-01 **Sample No.** Composite U5-U10 **Sample Depth (ft.)** 4.0-5.0
Sample Description Gray FAT CLAY (CH)

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type: Natural Cube	Grade	˚C	Grade	˚C	Grade	˚C	Grade	˚C
Time Started: / Initial Temp(˚C): 21.7	1	21.6	1	21.3	1	22.3	1	21.1

Boring No. BA-01 **Sample No.** Composite U5-U10 **Sample Depth (ft.)** 7.0-10.0
Sample Description Gray FAT CLAY (CH)

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type: Natural Cube	Grade	˚C	Grade	˚C	Grade	˚C	Grade	˚C
Time Started: / Initial Temp(˚C): 22.1	1	21.8	1	21.4	3	22.2	4	21.1

Boring No. BA-01 **Sample No.** Composite U11, U12 **Sample Depth (ft.)** 14.0-20.0
Sample Description Light Brown SANDY FAT CLAY (CH)

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type: Natural Cube	Grade	˚C	Grade	˚C	Grade	˚C	Grade	˚C
Time Started: / Initial Temp(˚C): 23.2	1	23.4	2	23.8	2	20.9	2	20.9

Boring No. BA-02 **Sample No.** Composite U2-U10 **Sample Depth (ft.)** 1.0-7.0
Sample Description Gray FAT CLAY (CH)

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type: Natural Cube	Grade	˚C	Grade	˚C	Grade	˚C	Grade	˚C
Time Started: / Initial Temp(˚C): 21.5	1	22.8	1	23.5	1	20.8	1	20.9

Crumb Test for Dispersibility - ASTM (D6572)

Project Name UTRWD Lake Ralph Hall **Project No.** CHM16420 **Date** 10/18/2016

Boring No. BA-02 **Sample No.** Composite U2-U10 **Sample Depth (ft.)** 7.0-10.0
Sample Description Gray FAT CLAY (CH)

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type	Grade	˚C	Grade	˚C	Grade	˚C	Grade	˚C
Natural Cube								
Time Started:	1	21.4	1	23	1	20.9	1	21
Initial Temp(˚C): 21.3								

Boring No. BA-03 **Sample No.** Composite U1-U4 **Sample Depth (ft.)** 0.0-4.0
Sample Description Gray FAT CLAY (CH)

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type	Grade	˚C	Grade	˚C	Grade	˚C	Grade	˚C
Natural Cube								
Time Started:	1	21.3	1	22.6	1	21.0	1	20.9
Initial Temp(˚C): 21.3								

Boring No. BA-05 **Sample No.** Composite U11, U12 **Sample Depth (ft.)** 14.0-20.0
Sample Description Brown LEAN CLAY (CL)

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type	Grade	˚C	Grade	˚C	Grade	˚C	Grade	˚C
Natural Cube								
Time Started:	1	22.5	1	21.9	1	21.2	1	21.1
Initial Temp(˚C): 22.5								

Boring No. ES-01 **Sample No.** Composite U1-U3 **Sample Depth (ft.)** 0.0-3.0
Sample Description Tan FAT CLAY (CH)

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type	Grade	˚C	Grade	˚C	Grade	˚C	Grade	˚C
Natural Cube								
Time Started:	1	23.1	1	21.3	1	21.0	1	20.1
Initial Temp(˚C): 21.9								

Boring No. ES-01 **Sample No.** Composite U4-U9 **Sample Depth (ft.)** 3.0-9.0
Sample Description Brown FAT CLAY (CH)

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type	Grade	˚C	Grade	˚C	Grade	˚C	Grade	˚C
Natural Cube								
Time Started:	1	21.5	1	21.5	1	22.1	1	21.2
Initial Temp(˚C): 21.6								

Crumb Test for Dispersibility - ASTM (D6572)

Project Name UTRWD Lake Ralph Hall **Project No.** CHM16420 **Date** 10/18/2016

Boring No. ES-01 **Sample No.** Composite U10-U12 **Sample Depth (ft.)** 10.0-20.0
Sample Description Brown FAT CLAY (CH)

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type: Natural Cube	Grade	˚C	Grade	˚C	Grade	˚C	Grade	˚C
Time Started: Initial Temp(˚C): 21.4	1	21.3	1	23.2	1	20.9	1	20.9

Boring No. ES-02 **Sample No.** Composite U2-U10 **Sample Depth (ft.)** 1.0-4.0
Sample Description Brown FAT CLAY (CH)

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type: Natural Cube	Grade	˚C	Grade	˚C	Grade	˚C	Grade	˚C
Time Started: Initial Temp(˚C): 21.2	1	21.1	1	22.4	1	21.1	1	21.0

Boring No. ES-02 **Sample No.** Composite U2-U10 **Sample Depth (ft.)** 4.0-7.0
Sample Description Brown FAT CLAY (CH)

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type: Natural Cube	Grade	˚C	Grade	˚C	Grade	˚C	Grade	˚C
Time Started: Initial Temp(˚C): 21.4	1	21.4	1	21.3	1	21.1	1	20.9

Boring No. ES-02 **Sample No.** Composite U2-U10 **Sample Depth (ft.)** 7.0-10.0
Sample Description Tan FAT CLAY (CH)

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type: Natural Cube	Grade	˚C	Grade	˚C	Grade	˚C	Grade	˚C
Time Started: Initial Temp(˚C): 22.4	1	23.9	1	23.7	1	20.9	1	21.0

Boring No. ES-02 **Sample No.** U-11 **Sample Depth (ft.)** 13.0-15.0
Sample Description Brown LEAN CLAY (CL)

Moisture Content	2 minutes		1 hour		6 hours		24 hours	
Specimen Type: Natural Cube	Grade	˚C	Grade	˚C	Grade	˚C	Grade	˚C
Time Started: Initial Temp(˚C): 21.4	1	21.3	1	22.3	1	21.2	1	20.9

Crumb Test for Dispersibility - ASTM (D6572)

Project Name UTRWD Lake Ralph Hall **Project No.** CHM16420 **Date** 10/18/2016

Boring No. ES-03 **Sample No.** Composite U3-U10 **Sample Depth (ft.)** 3.0-6.0

Sample Description Brown FAT CLAY (CH)

Moisture Content								
	2 minutes		1 hour		6 hours		24 hours	
Specimen Type	Grade	˚C	Grade	˚C	Grade	˚C	Grade	˚C
Natural Cube								
Time Started:	1	21.4	1	21.5	1	21.2	1	21.1
Initial Temp(˚C): 21.1								

Boring No. ES-03 **Sample No.** Composite U3-U10 **Sample Depth (ft.)** 6.0-10.0

Sample Description Brown FAT CLAY (CH)

Moisture Content								
	2 minutes		1 hour		6 hours		24 hours	
Specimen Type	Grade	˚C	Grade	˚C	Grade	˚C	Grade	˚C
Natural Cube								
Time Started:	1	22.9	1	21.6	1	21.1	1	21.1
Initial Temp(˚C): 22.8								

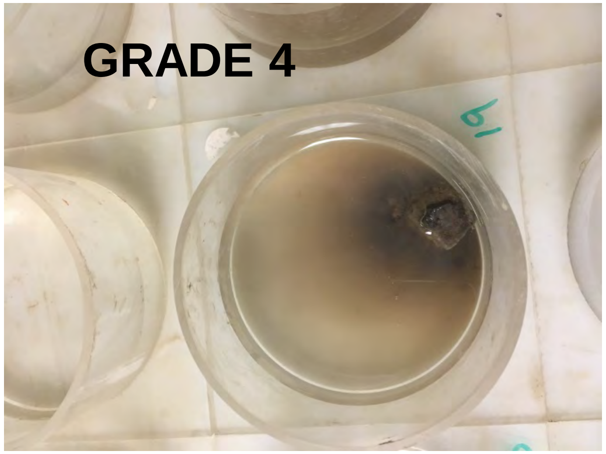
Boring No. ES-03 **Sample No.** Composite U11, U12 **Sample Depth (ft.)** 14.0-20.0

Sample Description Brown FAT CLAY (CH)

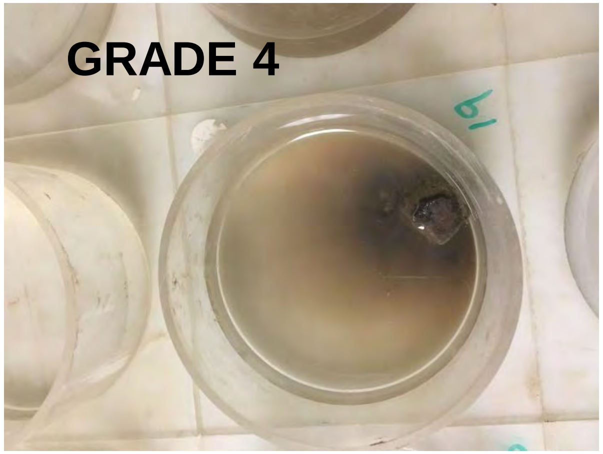
Moisture Content								
	2 minutes		1 hour		6 hours		24 hours	
Specimen Type	Grade	˚C	Grade	˚C	Grade	˚C	Grade	˚C
Natural Cube								
Time Started:	1	21.3	1	21.5	1	21.5	1	21.2
Initial Temp(˚C): 21.2								

CRUMB TEST PHOTOGRAPHS

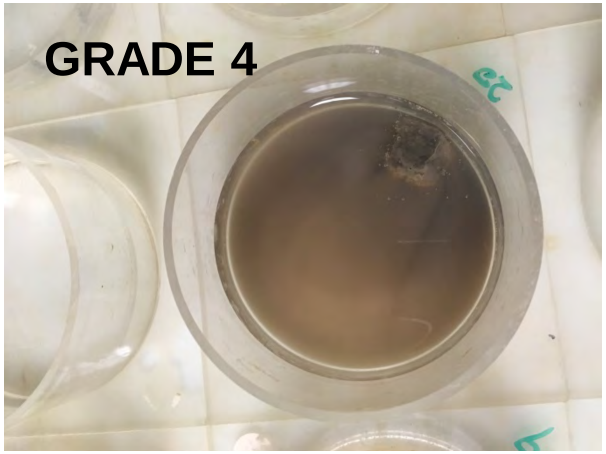
BA-01 (1.5-4.0 feet) – 2 Min.



BA-01 (1.5-4.0 feet)– 1 hour

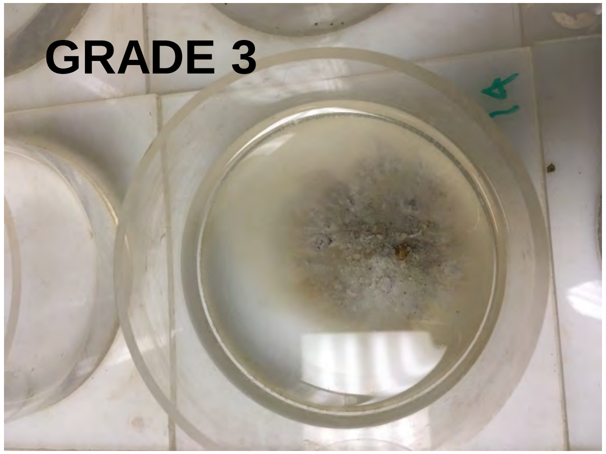


BA-01 (1.5-4.0 feet)– 6 hour



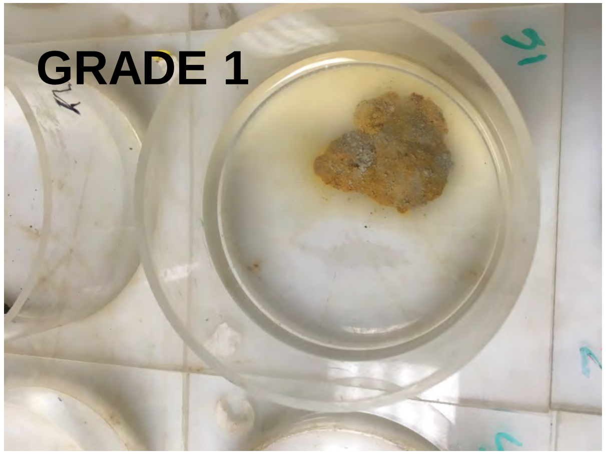
BA-01 (1.5-4.0 feet)– 24 hour

CRUMB TEST PHOTOGRAPHS



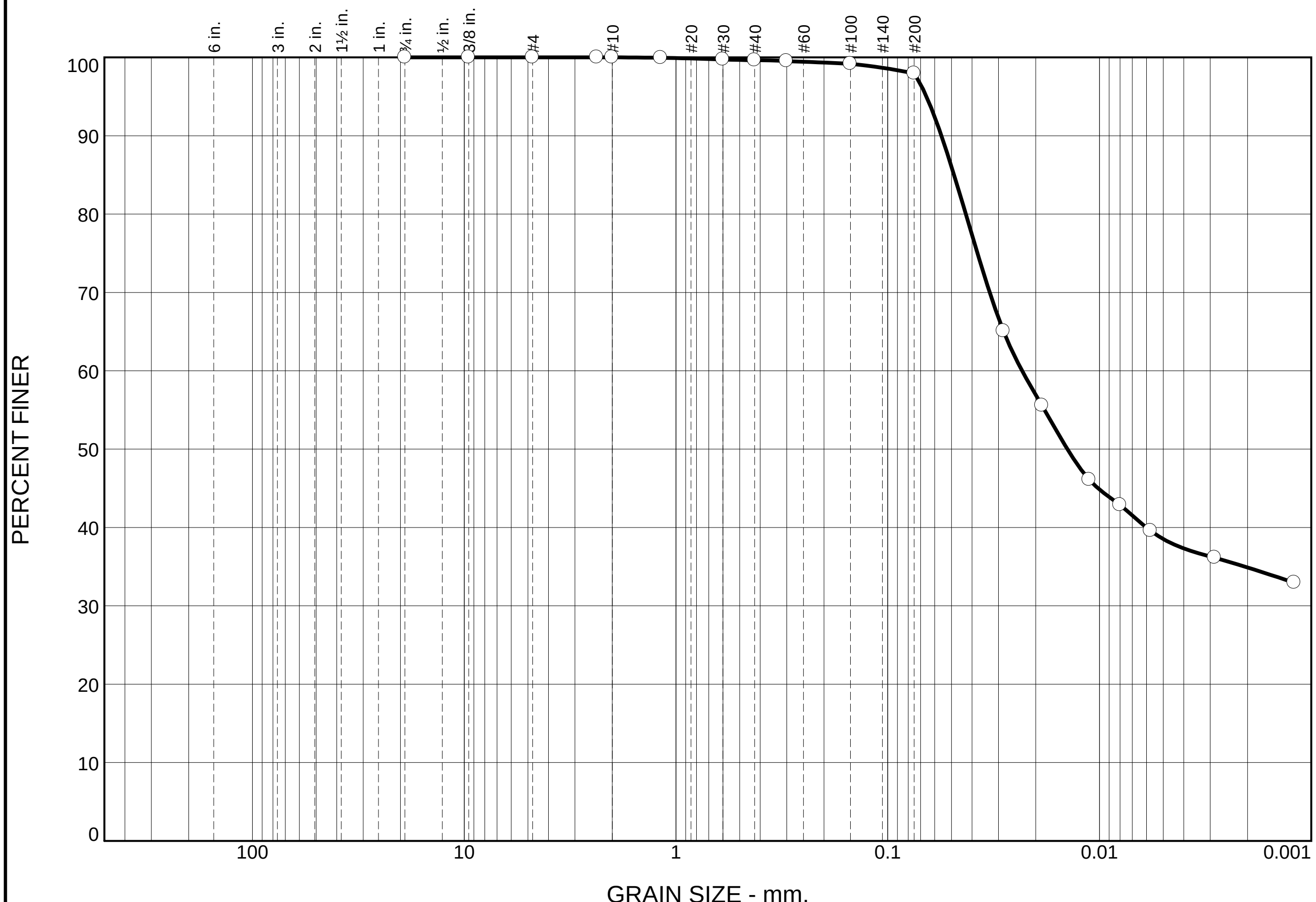
BA-01 (7-10 feet) – 6 hour

BA-05 (14-20 feet) – 24 hour



ES-02 (7-10 feet) – 6 hour

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.4	1.6	59.5	38.5

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	63	17	0.0486	0.0232	0.0142					

Material Description	USCS	AASHTO
○	CH	A-7-6(50)

Project No. CHM16420 **Client:** Freese and Nichols, Inc.

Project: UTRWD Lake Ralph Hall

○ **Loc.:** BA-01 **Depth:** (4.0-10.0) ft. **Sample No.:** Composite U5-U10

Remarks:

Gorrondona & Associates, Inc.

Houston, Texas

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/27/2016

Client: Freese and Nichols, Inc.
Project: UTRWD Lake Ralph Hall
Project Number: CHM16420
Location: BA-01
Depth: (4.0-10.0) ft.
Sample Number: Composite U5-U10
Liquid Limit: 63
Plastic Limit: 17
USCS Classification: CH
AASHTO Classification: A-7-6(50)

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
203.17	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.00	100.0
			#8	0.00	100.0
			#10	0.00	100.0
			#16	0.11	99.9
			#30	0.53	99.7
			#40	0.74	99.6
			#50	0.98	99.5
			#100	1.67	99.2
			#200	4.16	98.0

Hydrometer Test Data

Hydrometer test uses material passing #40
Percent passing #40 based upon complete sample = 99.6
Weight of hydrometer sample =50
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -4
Meniscus correction only = 1.0
Specific gravity of solids = 2.69
Hydrometer type = 151H
Hydrometer effective depth equation: L = 16.294964 - 0.2645 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
2.00	23.6	1.0240	1.0205	0.0129	25.0	9.7	0.0284	65.1
5.00	23.6	1.0210	1.0175	0.0129	22.0	10.5	0.0187	55.6
15.00	23.7	1.0180	1.0145	0.0129	19.0	11.3	0.0112	46.1
30.00	23.6	1.0170	1.0135	0.0129	18.0	11.5	0.0080	42.9
60.00	23.4	1.0160	1.0125	0.0129	17.0	11.8	0.0057	39.6
250.00	22.9	1.0150	1.0114	0.0130	16.0	12.1	0.0029	36.1
1440.00	22.9	1.0140	1.0104	0.0130	15.0	12.3	0.0012	33.0

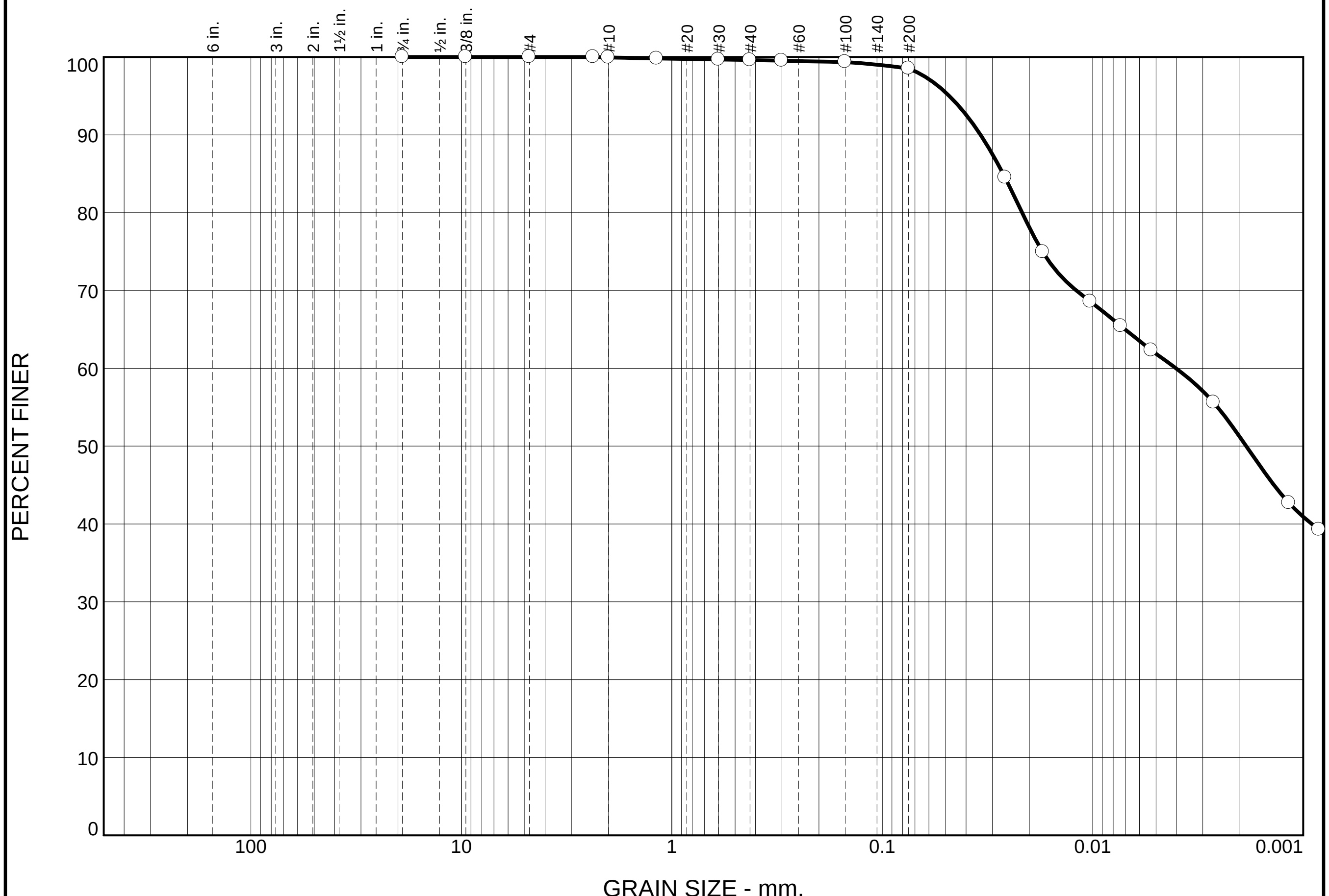
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.4	1.6	2.0	59.5	38.5	98.0

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
					0.0060	0.0142	0.0232	0.0428	0.0486	0.0558	0.0656

Fineness Modulus
0.02

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.1	0.3	1.1	36.6	61.9

╳	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	67	21	0.0267	0.0040	0.0019					

	Material Description	USCS	AASHTO
○		CH	A-7-6(51)

Project No. CHM16420 **Client:** Freese and Nichols, Inc.
Project: UTRWD Lake Ralph Hall

○ **Location:** D-01 **Depth:** (23.0-25.0) ft. **Sample Number:** U13

Remarks:

Gorrondona & Associates, Inc.

Houston, Texas

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/27/2016

Client: Freese and Nichols, Inc.
Project: UTRWD Lake Ralph Hall
Project Number: CHM16420
Location: D-01
Depth: (23.0-25.0) ft. **Sample Number:** U13
Liquid Limit: 67 **Plastic Limit:** 21
USCS Classification: CH **AASHTO Classification:** A-7-6(51)

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
178.38	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.00	100.0
			#8	0.00	100.0
			#10	0.09	99.9
			#16	0.33	99.8
			#30	0.58	99.7
			#40	0.70	99.6
			#50	0.86	99.5
			#100	1.16	99.3
			#200	2.65	98.5

Hydrometer Test Data

Hydrometer test uses material passing #40
Percent passing #40 based upon complete sample = 99.6
Weight of hydrometer sample =50
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -4
Meniscus correction only = 1.0
Specific gravity of solids = 2.67
Hydrometer type = 151H
Hydrometer effective depth equation: L = 16.294964 - 0.2645 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
2.00	23.7	1.0300	1.0265	0.0130	31.0	8.1	0.0261	84.5
5.00	23.7	1.0270	1.0235	0.0130	28.0	8.9	0.0173	75.0
15.00	23.7	1.0250	1.0215	0.0130	26.0	9.4	0.0103	68.6
30.00	23.8	1.0240	1.0206	0.0130	25.0	9.7	0.0074	65.5
60.00	23.9	1.0230	1.0196	0.0129	24.0	9.9	0.0053	62.3
250.00	23.3	1.0210	1.0175	0.0130	22.0	10.5	0.0027	55.6
1440.00	23.0	1.0170	1.0134	0.0131	18.0	11.5	0.0012	42.7
2880.00	22.5	1.0160	1.0123	0.0132	17.0	11.8	0.0008	39.3

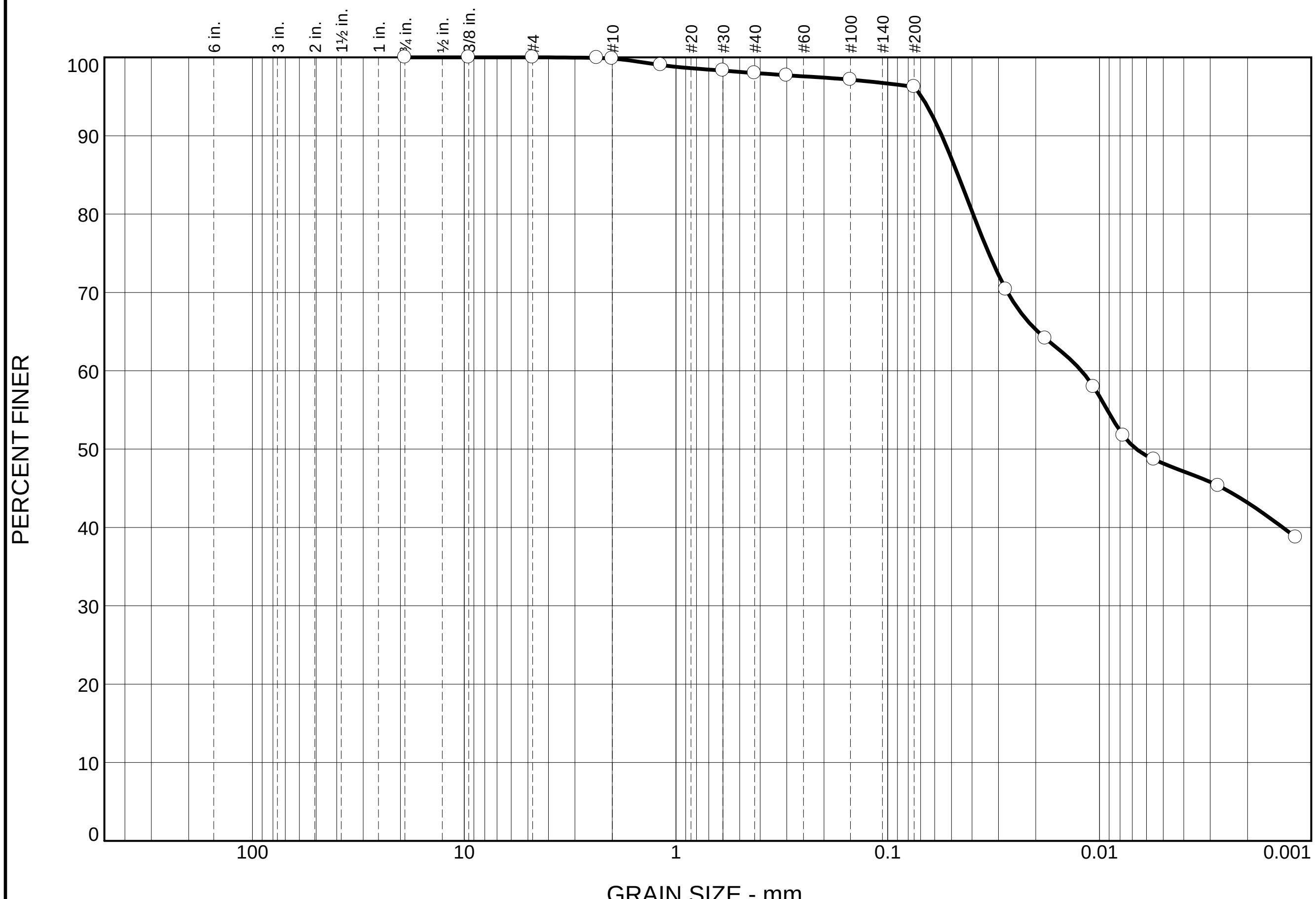
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.1	0.3	1.1	1.5	36.6	61.9	98.5

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
					0.0009	0.0019	0.0040	0.0217	0.0267	0.0341	0.0480

Fineness Modulus
0.02

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.2	1.8	1.8	48.0	48.2

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	70	23	0.0466	0.0122	0.0067					

	Material Description	USCS	AASHTO
○		CH	A-7-6(51)

Project No. CHM16420 **Client:** Freese and Nichols, Inc.

Project: UTRWD Lake Ralph Hall

○ **Location:** D-04 **Depth:** (9.0-10.0) ft. **Sample Number:** U10

Remarks:

Gorrondona & Associates, Inc.

Houston, Texas

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/27/2016

Client: Freese and Nichols, Inc.
Project: UTRWD Lake Ralph Hall
Project Number: CHM16420
Location: D-04
Depth: (9.0-10.0) ft.
Sample Number: U10
Liquid Limit: 70
Plastic Limit: 23
USCS Classification: CH
AASHTO Classification: A-7-6(51)

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
178.07	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.00	100.0
			#8	0.14	99.9
			#10	0.28	99.8
			#16	1.73	99.0
			#30	3.01	98.3
			#40	3.57	98.0
			#50	4.12	97.7
			#100	5.07	97.2
			#200	6.70	96.2

Hydrometer Test Data

Hydrometer test uses material passing #40
Percent passing #40 based upon complete sample = 98.0
Weight of hydrometer sample =50.0
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -4
Meniscus correction only = 1.0
Specific gravity of solids = 2.68
Hydrometer type = 151H
Hydrometer effective depth equation: L = 16.294964 - 0.2645 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
2.00	23.6	1.0260	1.0225	0.0129	27.0	9.2	0.0277	70.4
5.00	23.6	1.0240	1.0205	0.0129	25.0	9.7	0.0180	64.1
15.00	23.7	1.0220	1.0185	0.0129	23.0	10.2	0.0107	57.9
30.00	23.8	1.0200	1.0166	0.0129	21.0	10.7	0.0077	51.7
60.00	23.9	1.0190	1.0156	0.0129	20.0	11.0	0.0055	48.7
250.00	23.5	1.0180	1.0145	0.0130	19.0	11.3	0.0028	45.3
1440.00	22.9	1.0160	1.0124	0.0131	17.0	11.8	0.0012	38.7

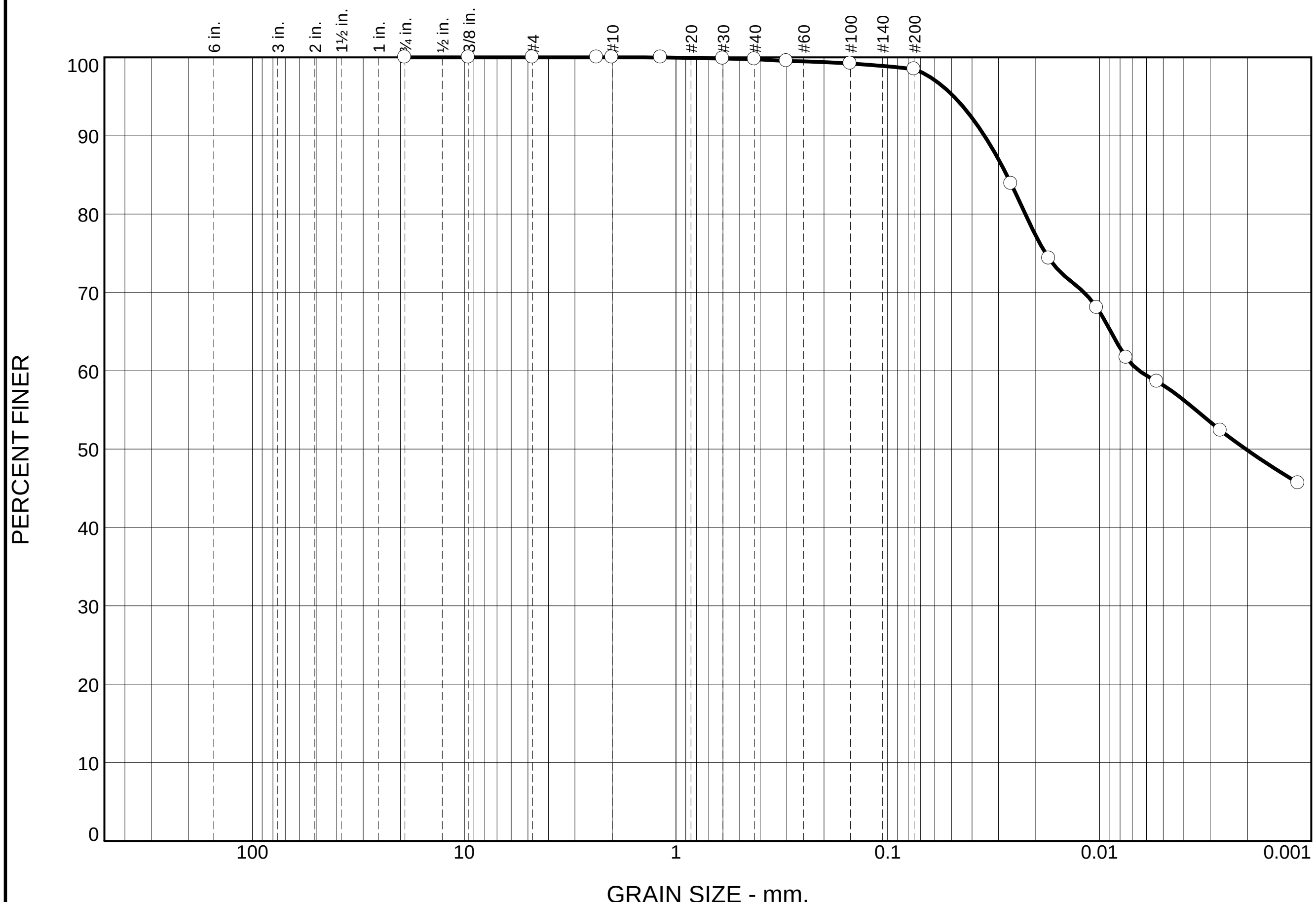
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.2	1.8	1.8	3.8	48.0	48.2	96.2

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
					0.0014	0.0067	0.0122	0.0395	0.0466	0.0555	0.0693

Fineness Modulus
0.08

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.2	1.3	40.3	58.2

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	75	27	0.0274	0.0065	0.0020					

	Material Description	USCS	AASHTO
○		CH	A-7-6(55)

Project No. CHM16420 **Client:** Freese and Nichols, Inc.
Project: UTRWD Lake Ralph Hall

○ **Loc.:** ES-01 **Depth:** (10.0-20.0) ft. **Sample No.:** Composite U10-U12

Gorrondona & Associates, Inc.

Houston, Texas

Remarks:

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/27/2016

Client: Freese and Nichols, Inc.
Project: UTRWD Lake Ralph Hall
Project Number: CHM16420
Location: ES-01
Depth: (10.0-20.0) ft.
Sample Number: Composite U10-U12
Liquid Limit: 75
Plastic Limit: 27
USCS Classification: CH
AASHTO Classification: A-7-6(55)

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
175.33	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.00	100.0
			#8	0.00	100.0
			#10	0.00	100.0
			#16	0.02	100.0
			#30	0.26	99.9
			#40	0.43	99.8
			#50	0.82	99.5
			#100	1.38	99.2
			#200	2.62	98.5

Hydrometer Test Data

Hydrometer test uses material passing #40
Percent passing #40 based upon complete sample = 99.8
Weight of hydrometer sample =50.0
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -4
Meniscus correction only = 1.0
Specific gravity of solids = 2.69
Hydrometer type = 151H
Hydrometer effective depth equation: L = 16.294964 - 0.2645 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
2.00	23.0	1.0300	1.0264	0.0130	31.0	8.1	0.0261	83.9
5.00	23.0	1.0270	1.0234	0.0130	28.0	8.9	0.0173	74.3
15.00	23.1	1.0250	1.0214	0.0130	26.0	9.4	0.0103	68.0
30.00	23.1	1.0230	1.0194	0.0130	24.0	9.9	0.0075	61.7
60.00	23.3	1.0220	1.0185	0.0130	23.0	10.2	0.0053	58.6
250.00	23.5	1.0200	1.0165	0.0129	21.0	10.7	0.0027	52.4
1440.00	22.8	1.0180	1.0144	0.0130	19.0	11.3	0.0012	45.7

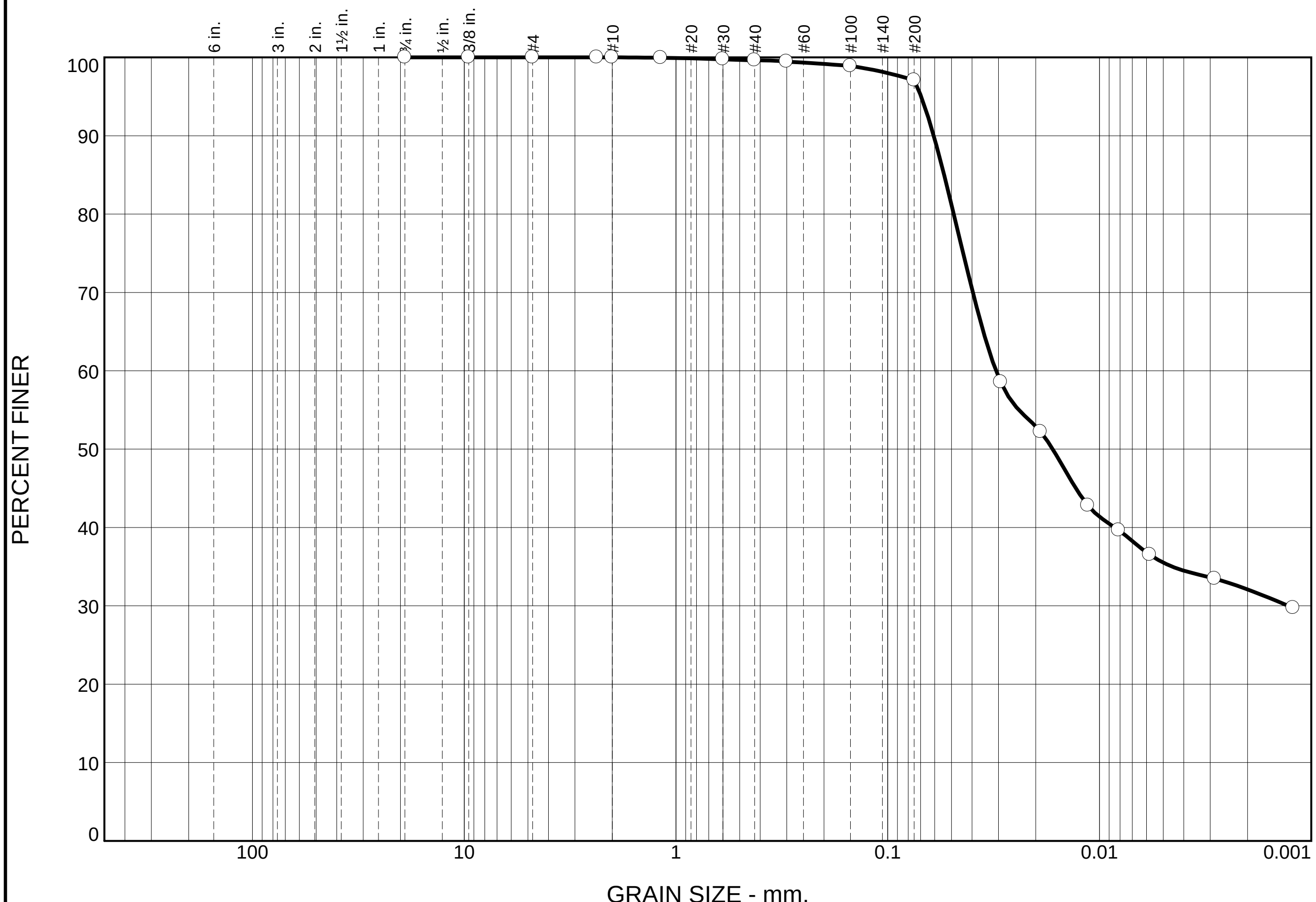
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.2	1.3	1.5	40.3	58.2	98.5

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
						0.0020	0.0065	0.0224	0.0274	0.0349	0.0487

Fineness Modulus
0.01

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.4	2.5	61.6	35.5

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	63	21	0.0542	0.0308	0.0166	0.0013				

	Material Description	USCS	AASHTO
○		CH	A-7-6(46)

Project No. CHM16420 **Client:** Freese and Nichols, Inc.
Project: UTRWD Lake Ralph Hall

○ **Loc.:** ES-02 **Depth:** (1.0-13.0) ft. **Sample No.:** Composite U2-U10

Remarks:

Gorrondona & Associates, Inc.

Houston, Texas

Figure

GRAIN SIZE DISTRIBUTION TEST DATA

10/27/2016

Client: Freese and Nichols, Inc.
Project: UTRWD Lake Ralph Hall
Project Number: CHM16420
Location: ES-02
Depth: (1.0-13.0) ft.
Sample Number: Composite U2-U10
Liquid Limit: 63
Plastic Limit: 21
USCS Classification: CH
AASHTO Classification: A-7-6(46)

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
354.61	0.00	0.00	0.75"	0.00	100.0
			3/8"	0.00	100.0
			#4	0.00	100.0
			#8	0.00	100.0
			#10	0.00	100.0
			#16	0.18	99.9
			#30	0.87	99.8
			#40	1.33	99.6
			#50	1.94	99.5
			#100	3.88	98.9
			#200	10.33	97.1

Hydrometer Test Data

Hydrometer test uses material passing #40
Percent passing #40 based upon complete sample = 99.6
Weight of hydrometer sample =50.0
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -4
Meniscus correction only = 1.0
Specific gravity of solids = 2.69
Hydrometer type = 151H
Hydrometer effective depth equation: L = 16.294964 - 0.2645 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer
2.00	23.3	1.0220	1.0185	0.0130	23.0	10.2	0.0293	58.6
5.00	23.3	1.0200	1.0165	0.0130	21.0	10.7	0.0190	52.2
15.00	23.5	1.0170	1.0135	0.0129	18.0	11.5	0.0113	42.8
30.00	23.5	1.0160	1.0125	0.0129	17.0	11.8	0.0081	39.6
60.00	23.6	1.0150	1.0115	0.0129	16.0	12.1	0.0058	36.5
250.00	23.8	1.0140	1.0106	0.0129	15.0	12.3	0.0029	33.5
1440.00	22.8	1.0130	1.0094	0.0130	14.0	12.6	0.0012	29.7

Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.4	2.5	2.9	61.6	35.5	97.1

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
				0.0013	0.0085	0.0166	0.0308	0.0488	0.0542	0.0607	0.0696

Fineness Modulus
0.02

APPENDIX A-4

EXISTING DATA

PRELIMINARY
SUBSURFACE EXPLORATION

Ralph Hall Dam
Fannin County, Texas

Project 53882
June 21, 2005

KLEINFELDER
An employee owned company

June 21, 2005
Project 53882

Mr. John Levitt, P.E.
Chiang, Patel & Yerby, Inc.
1820 Regal Row, Suite 200
Dallas, Texas 75235

Subject: Preliminary Subsurface Exploration
Ralph Hall Dam
Fannin County, Texas

Dear Mr. Levitt:

Attached are results of field exploration and laboratory testing performed at the proposed site of the Ralph Hall Dam in Fannin County, Texas. This report actually constitutes a data report regarding initial site subsurface exploration. The site appears to be consistent with anticipated materials and an initial Geological Characteristics report written by Chiang, Patel & Yerby in February 2004. The primary foundation materials are suitable for construction of the dam, according to the preliminary core borings.

As the design planning proceeds, we shall be available to assist you.

Sincerely,

KLEINFELDER

Michael M. Shiflett, P.E.

Copies Submitted: 5

Preliminary Subsurface Exploration

Ralph Hall Dam
Fannin County, Texas

Prepared for

Chiang, Patel & Yerby, Inc.

June 21, 2005

Michael M. Shiflett, P.E.

Donald D. James, P.G.

Kleinfelder
Fort Worth, Texas

An employee owned company

Project 53882

Photograph No. 1

Viewing easterly at Boring 1. Electrical restivity log equipment shown.

April 7, 2005

Photograph No. 2

Viewing easterly at Boring 3. Electrical restivity log equipment shown.

April 9, 2005

KLEINFELDER

SITE PHOTOGRAPHS
Ralph Hall Dam Preliminary
Fannin County, Texas
Project 53882 June 2005

Photograph No. 3

Arcuate parallel jointing in unweathered Ozan, south of channel at Merrill Creek.

April 9, 2005

Photograph No. 4

Orthogonal limonitic stained joints in Ozan at Merrill Creek.

April 9, 2005

Photograph No. 5

Slaked, unweathered Ozan at Merrill Creek.

April 9, 2005

KLEINFELDER

SITE PHOTOGRAPHS
Ralph Hall Dam Preliminary
Fannin County, Texas
Project 53882 June 2005

Important Information About Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

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

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

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

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

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

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

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

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

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

Subsurface Conditions Can Change

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

Most Geotechnical Findings Are Professional Opinions

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

A Report's Recommendations Are *Not* Final

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

A Geotechnical Engineering Report Is Subject to Misinterpretation

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

Do Not Redraw the Engineer's Logs

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

Give Contractors a Complete Report and Guidance

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

Read Responsibility Provisions Closely

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

Geoenvironmental Concerns Are Not Covered

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

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@asfe.org www.asfe.org

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1. INTRODUCTION

The Upper Trinity Regional Water District is in the preliminary stages of planning for Lake Ralph Hall. The proposed site of the dam and reservoir is on the North Sulphur River near Ladonia, Texas in southeastern Fannin County. Chiang, Patel & Yerby, Inc. is under contract with the District to provide initial planning and engineering for the dam and reservoir. A portion of the initial phases has been to provide preliminary subsurface, exploratory borings along the dam alignment to observe the subsurface conditions. Chiang, Patel & Yerby contracted with Kleinfelder to perform the subsurface borings and laboratory testing, which are being reported in this document.

In February 2004, CP&Y submitted a report, Geological Characteristics, to the District. This preliminary report presented general information regarding Regional Geologic Setting, Site Geology, Foundation Considerations, Surface and Groundwater discussions, and Natural Resources. While this current preliminary subsurface investigation has been limited to drilling four exploratory borings along the proposed dam centerline alignment and has therefore provided limited information and data, the subsurface information developed at the site is consistent with anticipated materials and the CP&Y report.

The Geologic Characteristics report states that for planning purposes, the dam will be a zoned earth-fill embankment, with a principal spillway, an emergency overflow spillway outlet, and a gated low-flow outlet structure. An embankment at this site with a crest elevation of 560 feet will be approximately 12,000 feet in length.

This preliminary report presents information regarding site exploration and methods, as well as results of laboratory tests performed on samples recovered from the borings. As the subsurface information is developed, design information and data will evolve regarding abutment slopes and core or slurry trench in the valley section.

2. FIELD EXPLORATION

Subsurface materials at the project site were explored by four borings drilled to depths of 60 to 100 feet along the proposed alignment of the dam. The borings were drilled on April 6, 7, 8, and 9, 2005 at the approximate locations shown on the Plan of Borings in the Appendix, Plate 2. The boring logs are also included in the Appendix on Plates 4 through 7, and a key to terms and descriptions on the logs is provided on Plate 3.

The four borings drilled along the proposed embankment alignment were located on property that had provided permission for access and also provided boring coverage near both the north and south abutments, as well as two borings within the valley section.

Table 1. Boring Locations

Boring No.	Ground Surface Elevation, feet	State Plane Coordinates		Station along Centerline
		Northing	Easting	
1	550	7221152.2556	2760734.7425	25+00 ±
2	502.6	7223918.0356	2760674.3652	53+00 ±
3	506.3	7226935.2921	2760645.3818	82+70 ±
4	564.2	7232423.3545	2760451.3557	North end

The borings locations were surveyed after the field operations were completed. The field survey was provided by The Wallace Group, Inc.

The borings were drilled using rotary drilling procedures and water as the drilling fluid. The drilling rig was mounted upon an articulating all-terrain vehicle (ATV) for access across the undeveloped property. The drilling operations were overseen by Mr. Donald James, P.G. Samples were logged and preserved in the field by Mr. James. Samples were logged for material type, color, and consistency; sealed in sheet plastic for moisture preservation; and transferred to the geotechnical laboratory.

Relatively undisturbed samples of cohesive soils encountered in the borings were taken by rapidly pushing a 3-inch OD thin-wall Shelby tube sampler (ASTM D 1587) a distance of approximately 1 foot into the soil using hydraulic pressure from the drill rig. Depths at which these samples were taken are designated "U" in the "Samples" column of the boring logs. After a Shelby tube was recovered from a boring, the sample was extruded in the field, examined visually and logged. A representative portion was selected, wrapped and sealed to prevent loss of moisture and to protect the sample during transportation. Estimates of the consistency of the cohesive soil samples were obtained in the field using a hand penetrometer. The result of a hand penetrometer reading is recorded at a corresponding depth in the "Hand Penetrometer, tsf" column of the boring logs. When the capacity of the hand penetrometer is exceeded, the value of 4.5+ is recorded.

The primary materials of the formation at the site are marl and were sampled using an NX-size double-tube core barrel fitted with a carbide bit. The lengths of marl cored by each “core run” are indicated within the “Samples” column, and the percents of core recovery are recorded on the boring logs in the appropriately marked columns. Rock Quality Designations (RQD) were measured for each core run, calculated and recorded in the field. The percent recovery is defined as the total length of material recovered in a specific core run divided by the total length of the core run. The RQD is a modified core recovery percentage in which all pieces of sound core over 4 inches long are summed and divided by the length of the core run. Core breaks caused by the drilling process were fitted together and counted as one piece. Where it was difficult to discern natural breaks from drilling breaks, the break was considered a natural break. The RQD designation is a method of quantifying the integrity or competency of the material being cored, being based upon the weathered or fractured condition of the material. The RQD values are presented on the Logs of Borings for each core run interval. The core run intervals for the project were typically 5 feet in length and are delineated on the boring logs.

Table 2. Classification of Rock by RQD Value

RQD	Rock Quality
Less than 25	Very Poor
25 – 50	Poor
50 – 75	Fair
75 – 90	Good
90 - 100	Excellent

All samples were extruded in the field, visually classified, sealed and packaged for transportation.

During coring of the marl in Boring 4, the catcher that secures the rock core within the core barrel became damaged and prevented core recovery below 60 feet. Therefore, in-place penetrometer tests were performed within the marl as the boring was advanced as a method of measuring marl consistency within the explored depth. The Texas Department of Transportation (TxDOT) cone penetrometer test utilizes a 3-inch steel cone driven by a 170-pound hammer dropped 24 inches. Either the number of blows required to produce 12 inches of penetration, or the inches of penetration due to 100 blows of the hammer are noted on the boring logs designated "T" in the "Penetration Resistance" column.

The general drilling procedures for these 4 preliminary borings included using a single flight auger to advance the boring between the undisturbed soil samples in the upper 15 feet, and then introducing water as drilling fluid to assist drilling advancement below the 15-foot depth.

After drilling and sampling, each borehole was electric logged for spontaneous potential, natural gamma, and resistivity. The electric logging was accomplished using a Century Geophysics 9060 logging tool. Although the electric logs were run for the entire length of each boring, the encoder value resulted in the lower halves of the borings, within the primary marl, being logged and recorded. The results of the Electrical Resistivity Readings are presented on a series of Logs of Borings presented in the Appendix on Plates 8 through 11.

Each boring was backfilled with soil cuttings, incorporating bentonite chips for a surface seal.

3. LABORATORY TESTING

Selected laboratory soil tests were performed on representative samples recovered from the borings. In addition to the classification tests (liquid limits, plastic limits, and percent passing #200 sieve), selected samples were tested for unconfined compressive strength, unit dry weight, and moisture content. Results of the laboratory tests are provided on each boring log, a summary table and on individual Plates presented in the Appendix.

Soil and rock descriptions used on the boring logs result from field data as well as from laboratory test data.

4. ANALYSIS AND RECOMMENDATIONS

4.1 SITE GEOLOGY

The regional geology was presented by Chiang, Patel & Yerby in the Geological Characteristics Report. A brief discussion of the geology across the proposed alignment of the earthen dam is now being presented as observed within the four coring borings. The proposed site is situated across a mature stream valley, the North Sulphur River Basin. The North Sulphur River trends west to east with gently rolling grade breaks bounding the northern and southern banks. The original North Sulphur River was bypassed with rechannelization during the 1920s resulting in rejuvenation of the river hydraulics and incisement of the current river channel.

The primary material beneath this river valley is documented as Cretaceous age Taylor Group, particularly the Ozan Formation. Younger sediments of Quarternary age line and fill the scour zone within the Ozan made by the original North Sulphur River.

The Ozan Formation is the lowest member of the Taylor Group and forms most of the "primary " bedrock beneath the study area. The Ozan consists of up to 425 feet of bluish-gray, calcareous clays (marl) and mudstones with occasional thin, sandy layers. The basal portion contains phosphate nodules. Unweathered Ozan is indurated, rock-like material. The Ozan weathers into light gray shale and light yellow-brown shaly clay and judging from exposures in the creek bottoms, ravels rather quickly once exposed to weathering.

Joints observed in the Ozan occur in several modes as observed during our site visits including: orthogonal joints that intersected at relatively high angles (see photograph no. 4) and were often weathered with limonite staining and gypsum infills; platy joints more or less emulating shaly cleavage upon weathering; and arcuate jointing observed in sub-parallel sets with low angle dip (see photograph no. 3). A joint and fracture trace analysis was beyond the scope of this study. These observations were made upstream from the proposed dam within the Merrill Creek channel crossing at FM 1550. The channel erosion had exposed Ozan marl within the bottom of the tributary and it was within this channel that photographs were taken and the above observations made.

4.2 STRATIGRAPHY

Boring 1 (located at the southern end of the site) encountered a thick sequence of colluvial and alluvial sandy clay and clay to a depth of approximately 47 feet. From 47 feet to approximately 53 feet the boring encountered weathered Ozan formation material, which consists of a yellow-brown and light gray indurated calcareous clay (marl) exhibiting high angle joints and stained with limonite. Fossil Inoceramus clam imprints were observed in this weathered zone material. From 53 feet to the total depth of 85 feet the boring encountered unweathered marl that is gray to dark gray, massive, and very indurated.

Boring 2 (located just south of the original river channel) encountered dark brown alluvial clay with occasional sand partings and clay infilled burrows (probably from crayfish). Calcareous accretions (caliche) were observed from approximately 4 to 8 feet depth. Below 22 feet the soil became sandier with sand partings and seams, and soil color turned to light yellow-brown and light brown. From 32 feet to the total depth the boring encountered unweathered marl that is gray to dark gray, massive, and indurated.

Boring 3 (located north of the realigned river channel and on the raised, earthen county road) encountered approximately 3 feet of hard road fill clay. Below 3 feet the boring encountered light brownish-gray and light yellow-brown firm to stiff alluvial clay to approximately 12 feet. From 12 to 14½ feet the boring encountered medium dense alluvial clayey sand. From 14½ to approximately 23 feet the boring encountered weathered Ozan formation material that consists of hard yellow-brown and gray indurated calcareous clay (marl) that was fissile and contained root-invaded joints and gypsum infills. Hard dark gray unweathered Ozan marl was encountered from 23 feet to the total depth of 60 feet. Below 57 feet the marl exhibited weak cementation, contained a high angle joint and some coarse phosphatic sand grains.

Boring 4 was drilled approximately 30 feet west of the dam centerline to avoid a possible phone utility. The surficial 3 feet encountered sandy clay that had been reworked as probable fill material. From 3¼ feet to approximately 12 feet depth the boring encountered colluvial and alluvial brown to light brown-gray hard clay. Calcareous accretions (caliche) were observed in the soil samples from approximately 4 to 8 feet depth. From 12 feet to approximately 40 feet the boring encountered weathered Ozan formation material that consists of hard yellow-brown and gray indurated calcareous clay (marl) that was fissile. Gypsum infills were observed in the weathered Ozan samples below 24 feet depth. Below 40 feet the boring encountered hard dark gray unweathered Ozan marl.

The surficial soils vary between clay of low plasticity, CL, to clay of high plasticity, CH, according to the Unified Soil Classification System. As is expected within alluvial soils, the material types vary, and thus the plasticity of the recovered soil samples was observed to vary.

Boring 1 near the southern abutment encountered a thin layer of coarse subrounded gravel overlying the weathered marl. Boring 3 revealed a layer of clayey sand atop the weathered marl, while Borings 2 and 4 did not encounter a distinct, identifiable layer of coarse material above the marl. Boring 2 drilled near the original river channel encountered 32 feet of CH clay over dark gray marl, indicating that at some previous time, the river channel had cut through the weathered marl exposing the unweathered gray marl. These preliminary borings have not exposed well-defined, coarse-grained strata deposits above the primary marl, as is commonly found within alluvial soils.

4.3 TESTING OF STRATA

Field electrical resistivity tests were performed within the core borings in an attempt to identify geologic marker beds within the subsurface materials across the river valley and to determine if subsurface anomalies, including faulting, occur within the valley that would influence design of the dam.

The downhole electrical testing performed in the widely spaced borings did not identify discernable discontinuities or anomalies with sufficient signature definition to correlate the strata across the valley. However, electrical surveys obtained from the preliminary borings will be useful in comparing to electric log data obtained from future, more closely spaced borings along the centerline. This information will be helpful in determining geologic structure at the project site.

The readings as presented upon the logs of borings are fairly consistent for the depths tested. The Gamma log is generally useful for defining shale beds when the SP curve is rounded. The Gamma log reflects the proportion of shale and can occasionally be used as an indicator of shale content. The Spontaneous-Potential (SP) curve is useful to detect permeable beds and to give qualitative indications of bed shalyness. The Resistivity log can identify differing beds of material and thickness. Since the electrical resistivity readings were basically taken within one material type, discontinuities or material differences would be expected to be slight and difficult to discern. The fluctuations recorded from these electrical resistivity readings are considered to be slight and within the normal variance ranges for the marl.

Recovered samples from the marl were tested in the laboratory for unit weight, moisture content, and unconfined compression. The variance within the unconfined compressive strength is commonly observed and is attributed to joints within the material that provide preferential shearing paths during compression loads when the sample is unconfined in this particular test. The higher values are indicative of the competent marl that does not include a joint set, while the lower strength values indicate failure of the test specimen along a fracture, joint surface. Of interest and probably more indicative of the marl condition is the unit dry weight values as measured in the laboratory test. Although not drastically different, the unit weights of the weathered marl are slightly less than the unit weights of the unweathered marl. The weathered marl is yellow-brown and light gray while the unweathered marl is gray. The unit weights are indicators of the higher strength and consistency of the unweathered portion of the formation.

4.4 GROUNDWATER OBSERVATIONS

A detailed groundwater study has not been performed as a portion of this preliminary subsurface exploration. However, a few observations and comments are provided. Observation wells and piezometers will be installed during the design phase subsurface exploration program that will allow measurements of groundwater. Specific remarks regarding drilling and groundwater observations are presented at the bottoms of the logs of borings.

Each of the borings introduced water used as drilling fluid into the core borings.

- Boring 1 lost drilling fluid at the 26-foot depth, indicating a sand layer or fracture zone through which the drilling fluid was lost.

- Boring 2 was bailed of drilling fluid to the 21-foot depth upon completion of the drilling and sampling; after 20 hours, water was measured near 8 feet. As noted by the hand penetrometer readings, the soils between 25 and 32 feet (marl), are moist and probably indicative of groundwater within the valley section perched upon the less permeable underlying marl. Also note some sandy zones directly above the marl.

- Boring 3 encountered seepage at 14 feet prior to the introduction of water as drilling fluid. A layer of light gray-brown clayey sand occurs between 12 and 14½ feet and it is within this permeable layer, atop the less permeable marl that groundwater seepage was noted.

- Boring 4 was bailed to 44 feet and after 20 hours, the boring contained water up to the 39-foot depth. This water was likely drill water seeping from the clay mass. There was no distinct permeable sand or gravel layer encountered by Boring 4.

Within the lower valley section, we would expect to be able to measure a distinct groundwater zone atop the less permeable marl, which will serve as an underlying aquitard or boundary upon which shallow groundwater will be perched. A definite groundwater study will provide information on the presence of groundwater, depth, pressure, and fluctuations during seasonal moisture cycles.

5. CONCLUSIONS

While the main purpose of this preliminary geotechnical data report has been to develop preliminary subsurface data, there are several items that have been observed and can be stated as conclusions.

The referenced Geological Characteristics of Proposed Lake Ralph Hall by Chiang, Patel & Yerby (February 6, 2004) presents general overview information of the area. This data report has confirmed the types of information that was presented in the CP&Y report.

The soil types revealed by the four preliminary borings are predominantly CL and CH clays. Boring 3 revealed a clayey sand layer that was 2½ feet thick, and this was the only clayey sand encountered by these preliminary borings. Only minimal amounts of coarse sand and subrounded gravel were found deposited upon the primary marl.

Therefore, based upon the completion of the four preliminary core borings, the site appears to be consistent with anticipated materials and the mentioned report. The subsurface materials are suitable for construction of the earth-fill dam and appurtenant structures, according to the preliminary core borings. There also appears to be soils within the proposed reservoir area that are low permeability. The alluvial soils and the primary materials of the Ozan Formation appear to be suitably tight and of low permeability to retain water.

6. RECOMMENDATIONS

Four exploratory borings have been drilled to provide preliminary subsurface conditions across the river valley. Detailed design memorandum drilling and laboratory testing will be required to provide detailed subsurface conditions necessary for design.

Numerous detailed design issues regarding subsurface conditions will be addressed during design of the dam. As the design details are considered, it is recommended that a joint and fracture trace analysis be performed. The discussion regarding the visual observations of the exposed marl in the bottom of a tributary explains the recommendation for performing the joint and fracture trace analysis.

Suitable borrow areas for clay core and various material zones within the earthen dam will need to be located and classified during the detailed design stages. Normally it is attempted to locate these soil borrow areas within the lake area. From the preliminary borings, and from site observations and published geologic maps, it appears that sufficient suitable materials to construct the earthen dam are present on site, but this must be confirmed with additional exploratory borings and testing.

The geotechnical design issues for the dam will be similar to other sites. This preliminary data report has not revealed unusual conditions that would require specialized services not normally performed for projects of this magnitude. As additional geologic and geotechnical information develops, there may arise specific issues that require particular tests and analysis. At this time, such specific items have not been identified.

7. REPORT CLOSURE

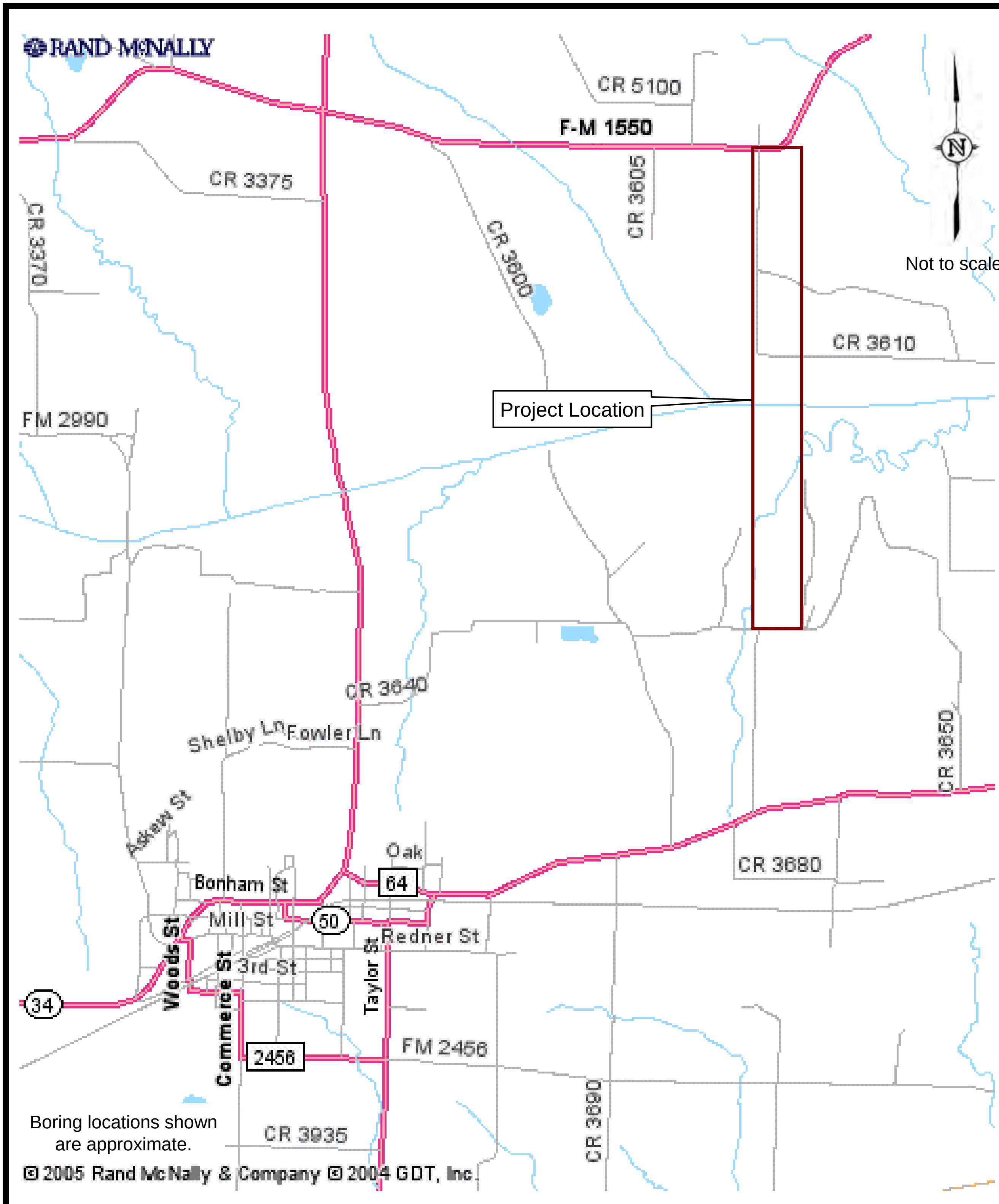
Recommendations contained in this report are based on our field observations and subsurface explorations, limited laboratory tests, and our present knowledge of the proposed construction. It is possible that soil conditions could vary between or beyond the points explored. If soil conditions are encountered during construction, which differ from those described herein, we should be notified immediately in order that a review may be made and any supplemental recommendations provided. If the scope of the proposed construction, including the proposed loads or structural locations, changes from that described in this report, our recommendations should also be reviewed.

We have prepared this report in substantial accordance with the generally accepted geotechnical engineering practice, as it exists in the site area at the time of our study. No warranty is expressed or implied. The recommendations provided in this report are based on the assumption that an adequate program of tests and observations will be conducted by Kleinfelder during the construction phase in order to evaluate compliance with our recommendations.

This report may be used only by the client and only for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both on-site and off-site) or other factors may change over time, and additional work may be required. Based on the intended use of the report, Kleinfelder may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else, unless specifically agreed to in advance by Kleinfelder in writing, will release Kleinfelder from any liability resulting from the use of this report by any unauthorized party.

Other standards or documents referenced in any given standard cited in this report, or otherwise relied upon by the authors of this report, are only mentioned in the given standard; they are not incorporated into it or "included by reference," as that latter term is used relative to contracts or other matters of law.

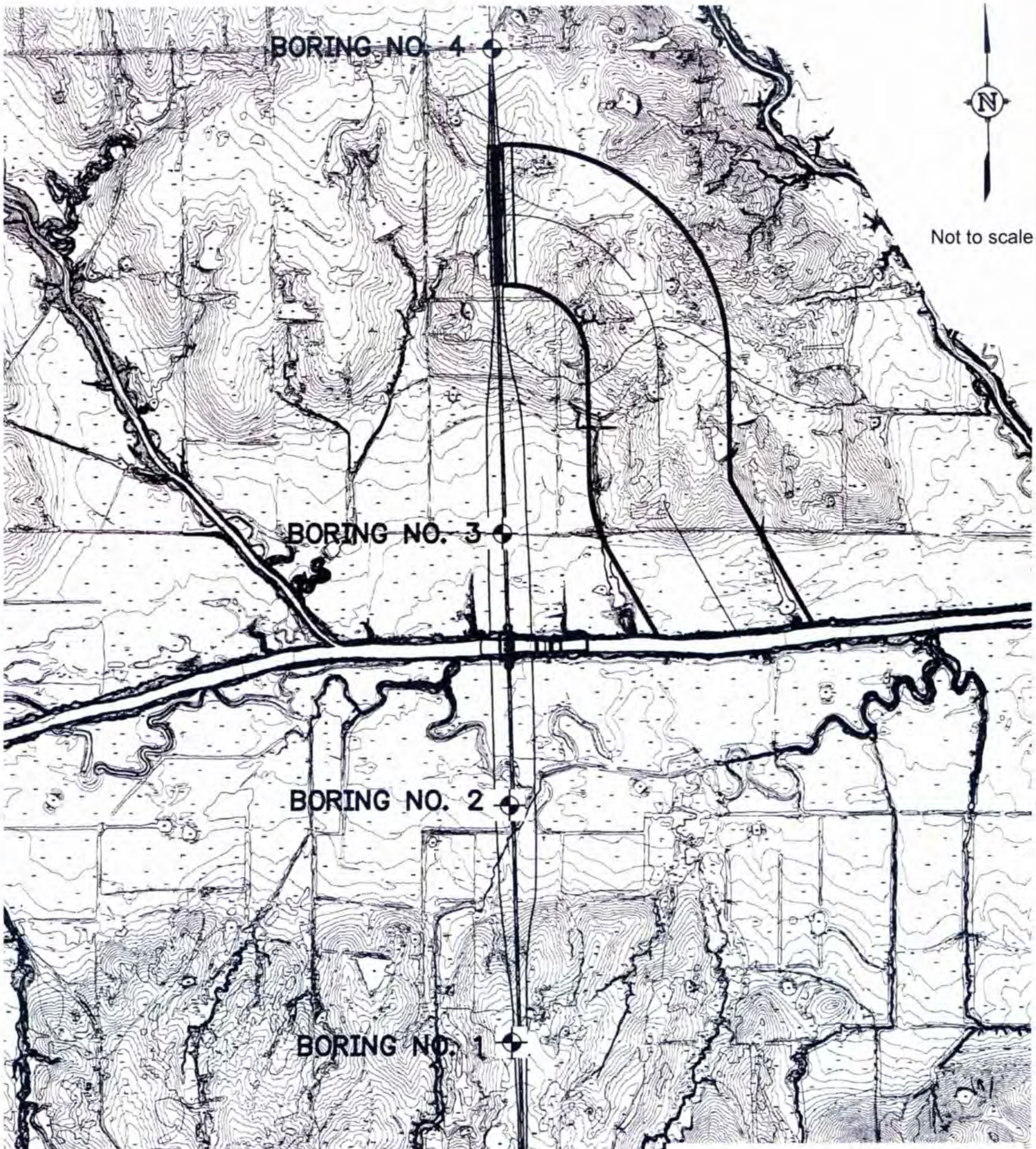
APPENDIX



KLEINFELDER

VICINITY MAP
Ralph Hall Dam Preliminary
Ladonia, Texas
Project 53882 June 2005

Plate 1



KLEINFELDER

PLAN OF BORINGS
Ralph Hall Dam Preliminary
Ladonia, Texas
Project 53882 June 2005

GENERAL NOTES

DRILLING AND SAMPLING SYMBOLS:

U / UD	Thin-Walled Tube - 3" O.D., Unless otherwise noted
A	Auger Sample
S	Split Spoon - 2" O.D., Unless otherwise noted
W	Wash Sample
C	Continuous Core Sample
P	Push Sample
T	THD Cone penetrometer
D	Denison Sample
B	Bag Sample

▽ Water Level Initial Measurement

▼ Water Level Subsequent Measurement

RELATIVE DENSITY OF COARSE-GRAINED SOILS:		**CONSISTENCY OF FINE-GRAINED SOILS:**	
Penetration Resistance Blows/foot	**Relative Density**	**Hand Penetrometer Readings, tsf**	**Consistency**
0-4	Very Loose	<1	Soft
4-10	Loose	1-2	Firm
10-30	Medium Dense	2-3	Stiff
30-50	Dense	3-4	Very Stiff
over 50	Very Dense	4.5+	Hard

TERMS CHARACTERIZING SOIL STRUCTURE:

Slickensided	:	Having inclined planes of weakness that are slick and glossy in appearance.
Fissured	:	Containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical
Laminated	:	Composed of thin layers of varying color and texture.
Interbedded	:	Composed of alternate layers of different soil types.
Calcareous	:	Containing appreciable quantities of calcium carbonate.
Well graded	:	Having wide range in grain sizes and substantial amounts of all intermediate particle sizes.
Poorly graded	:	Predominantly of one grain size, or having a range of sizes with some intermediate size missing.

NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths because of planes of weakness or cracks in the soil. The consistency rating of such soils are based on penetrometer readings.

DEGREE OF WEATHERING:

Unweathered	:	Rock in its natural state before being exposed to atmospheric agents.
Slightly weathered	:	Noted predominantly by color change with no disintegrated zones.
Weathered	:	Complete color change with zones of slightly decomposed rock.
Severely weathered	:	Complete color change with consistency, texture, and general appearance approaching soil.

SUBSURFACE CONDITIONS:

Soil and rock descriptions on the boring logs are a compilation of field data as well as from laboratory testing of samples. The stratification lines represent the approximate boundary between materials and the transition can be gradual.

Water level observations have been made in the borings at the times indicated. It must be noted that fluctuations in the groundwater level may occur due to variations in rainfall, hydraulic conductivity of soil strata, construction activity, and other factors.

LOG OF BORING NO. B-01

Project Description: **Ralph Hall Dam Preliminary - Ladonia, Texas**
Location: Station 25+00 +/-
Surface El.: 550.0'

Depth	Samples	Symbol/USCS	MATERIAL DESCRIPTION	Hand Penetrometer, TSF	Penetration Blows / Foot	Core Drilled, ft.	Core Recovered, %	Core RQD	Liquid Limit	Plasticity Index	% Passing No. 200 Sieve	Moisture Content, %	Unit Dry Weight, lb / cu ft	Unc. Compressive Strength, tsf	Strain at Failure, %
0	U-1		SANDY CLAY, dark yellow-brown, soft, with root filaments (El. 549.0; 1.0')	0.6											
	U-2		CLAY, light brown and dark brown, with yellow-brown, hard, with iron oxide stains with root filaments, with occasional sand	1.5											
	U-3			4.5+											
	U-4			4.5+											
5	U-5		- with limonitic stains below 4.5 feet	4.5+											
	U-6			4.5+								15	112	7.8	1.7
10	U-7		(El. 538.0; 12.0')	4.5+					52	35	89	17			
15	U-8		SANDY CLAY, silty, light brown, light yellow-brown and light brown-gray, medium dense, mottled with limonite	4.5+					40	21	63	13			
20	U-9		- laminated cross-bedded, less mottled below 20 feet (El. 526.0; 24.0')	4.5+								17	110		
25	U-10		CLAY with sand, yellow-brown and light gray-brown, stiff to very stiff, with calcareous webbing and infills, with iron oxide infills	4.1					35	14	86	18	96		
30	U-11			2.9								18	113	4.3	7.8
35	U-12		(El. 513.0; 37.0')	4.2								19	109		
40	U-13		SANDY CLAY, light gray-brown, gray and yellow-brown, firm to hard, mottled with limonite, with iron oxide infills, with root filament holes, faint blocky structure	1.9					31	9	67	21	107	0.9	3.9
45	U-14		- with silty fine sand partings, infilled burrows - with coarse subrounded gravel (El. 503.0; 47.0')	4.5+											
50	U-15		MARL, yellow-brown and gray, hard, jointed, stained with limonite, weathered	4.5+					60	37	98	23	104	4.4	4.1

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Completion Depth: 85 ft.
Date Boring Started: 4/7/05
Date Boring Completed: 4/7/05
Engineer / Geologist: D. James
Project No.: 53882

Remarks: Boring lost 350 gallons of drilling water at 26 feet during drilling. Groundwater at 25 feet 16 hours after completion. Boring not bailed at completion of drilling. Boring backfilled upon completion. Bentonite plug placed 1 to 2 feet below ground surface.

KLEINFELDER

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual.

LOG OF BORING NO. B-01 (cont'd)

Project Description: **Ralph Hall Dam Preliminary - Ladonia, Texas**
Location: Station 25+00 +/-
Surface El.: 550.0'

Depth	Samples	Symbol/USCS	MATERIAL DESCRIPTION	Hand Penetrometer, TSF	Penetration Blows / Foot	Core Drilled, ft.	Core Recovered, %	Core RQD	Liquid Limit	Plasticity Index	% Passing No. 200 Sieve	Moisture Content, %	Unit Dry Weight, lb / cu ft	Unc. Compressive Strength, tsf	Strain at Failure, %
			El. 497.0; 53.0'												
			MARL, gray to dark gray, hard, unweathered												
55	T-16				86/ 11¼"										
	C-17					5.0	32	16				18	113		
60	C-18					1.0	90	90							
	C-19					4.0	100	93							
												16	114	19.6	3.4
65	C-20					5.0	42	42							
70	C-21					5.0	98	76							
			- with moderate to high angle slickenside												
75	C-22					5.0	100	34							
80	C-23					5.0	0	-							
85			El. 465.0; 85.0'												

Completion Depth: 85 ft.
Date Boring Started: 4/7/05
Date Boring Completed: 4/7/05
Engineer / Geologist: D. James
Project No.: 53882

Remarks: Boring lost 350 gallons of drilling water at 26 feet during drilling. Groundwater at 25 feet 16 hours after completion. Boring not bailed at completion of drilling. Boring backfilled upon completion. Bentonite plug placed 1 to 2 feet below ground surface.

KLEINFELDER

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual.

LOG OF BORING NO. B-02

Project Description: **Ralph Hall Dam Preliminary - Ladonia, Texas**
Location: Station 53+00 +/-
Surface El.: 502.6'

Depth	Samples	MATERIAL DESCRIPTION	Hand Penetrometer, TSF	Penetration Blows / Foot	Core Drilled, ft.	Core Recovered, %	Core RQD	Liquid Limit	Plasticity Index	% Passing No. 200 Sieve	Moisture Content, %	Unit Dry Weight, lb / cu ft	Unc. Compressive Strength, tsf	Strain at Failure, %
0	U-1	CLAY, dark brown, brown, yellow-brown and gray, soft to very stiff	0.5											
	U-2		0.5											
	U-3		1.25											
	U-4		3.0											
5	U-5	- with occasional calcareous accretions	2.6											
	U-6	- with root filaments, with occasional silty sand pockets, with limonitic stains	2.75					61	43	96	22			
10	U-7	- with sand infilled burrows	3.8											
15	U-8		3.0											
		- occasionally jointed below 19 feet												
20	U-9	- with manganese dioxide stains	3.4											
		El. 480.6; 22.0'												
		CLAY, yellow-brown, gray and light brown, firm, intercalated with fine to coarse subrounded sand partings and seams												
25	U-10		1.9					59	40	92	24			
		El. 475.6; 27.0'												
		CLAY with sand, yellow-brown, gray and light brown, firm, intercalated with fine to coarse subrounded sand partings and seams												
30	U-11		1.0					57	35	75	25	102	0.9	3.4
		El. 470.6; 32.0'												
		MARL, dark gray, hard, jointed, occassionally fissile, unweathered												
35	U-12		4.5+											
	C-13				5.0	66	98							
								57	36	95	12	127	22.3	2.4
40	C-14				5.0	88	88							
											17	115		
45	C-15				5.0	66	-							
50	C-16				5.0	66	66							

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Completion Depth: 60 ft.
Date Boring Started: 4/6/05
Date Boring Completed: 4/6/05
Engineer / Geologist: D. James
Project No.: 53882

Remarks: Boring bailed to 21 feet. Groundwater measured after 20 hours at 8.1 feet. Boring backfilled upon completion. Bentonite plug placed 1 to 2 feet below ground surface.

KLEINFELDER

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual.

LOG OF BORING NO. B-02 (cont'd)

Project Description: **Ralph Hall Dam Preliminary - Ladonia, Texas**
Location: Station 53+00 +/-
Surface El.: 502.6'

Depth	Samples	Symbol/USCS	MATERIAL DESCRIPTION	Hand Penetrometer, TSF	Penetration Blows / Foot	Core Drilled, ft.	Core Recovered, %	Core RQD	Liquid Limit	Plasticity Index	% Passing No. 200 Sieve	Moisture Content, %	Unit Dry Weight, lb / cu ft	Unc. Compressive Strength, tsf	Strain at Failure, %
			MARL, dark gray, hard, jointed, occassionally fissile, unweathered									16	115		
55	C-17					5.0	70	60							
												16	117		
60			El. 442.6; 60.0'												

Completion Depth: 60 ft.
Date Boring Started: 4/6/05
Date Boring Completed: 4/6/05
Engineer / Geologist: D. James
Project No.: 53882

Remarks: Boring bailed to 21 feet. Groundwater measured after 20 hours at 8.1 feet. Boring backfilled upon completion. Bentonite plug placed 1 to 2 feet below ground surface.

KLEINFELDER

The stratification lines represent approximate strata boundaries.
In situ, the transition may be gradual.

LOG OF BORING NO. B-03

Project Description: **Ralph Hall Dam Preliminary - Ladonia, Texas**
Location: Station 82+70 +/-
Surface El.: 506.3'

Depth	Samples	Symbol/USCS	MATERIAL DESCRIPTION	Hand Penetrometer, TSF	Penetration Blows / Foot	Core Drilled, ft.	Core Recovered, %	Core RQD	Liquid Limit	Plasticity Index	% Passing No. 200 Sieve	Moisture Content, %	Unit Dry Weight, lb / cu ft	Unc. Compressive Strength, tsf	Strain at Failure, %
0	U-1		CLAY with sand, brown and dark brown, very stiff to hard, fill	4.5+											
	U-2			4.5+											
	U-3		El. 503.3; 3.0'	4.5+											
	U-4		CLAY, light brown-gray with yellow-brown, firm to stiff, mottled with limonite, with weathered ironstone sand	2.6					54	37	92	20			
5	U-5														
	U-6			1.5											
10	U-7		El. 494.3; 12.0'	2.0											
			CLAYEY SAND, light gray-brown and variegated, medium dense (▽) El. 491.8; 14.5'												
15	U-8		MARL, yellow-brown and gray, hard, jointed, fissile, with root invaded joints, with gypsum infills, weathered	4.5+								25	100	1.6	6.9
20	U-9		El. 483.3; 23.0'	4.5+								22	96	4.8	7.1
25	T-10		MARL, dark gray, hard, jointed, occasionally fissile, unweathered		100/ 2½"										
	C-11					5.0	98	98							
												18	112	14.2	3.0
30	C-12					5.0	68	66							
												18	112	22.1	2.3
35	C-13					5.0	96	94							
												25	105		
40	C-14					5.0	94	92							
												18	118		
45	C-15					5.0	96	94							
												18	112		
50	C-16					5.0	100	86							

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Completion Depth: 60 ft.
Date Boring Started: 4/9/05
Date Boring Completed: 4/9/05
Engineer / Geologist: D. James
Project No.: 53882

Remarks: Boring not bailed at completion of drilling. Groundwater seepage measured at 14 feet during. Boring backfilled upon completion. Bentonite plug placed 1 to 2 feet below ground surface.

KLEINFELDER

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual.

LOG OF BORING NO. B-03 (cont'd)

Project Description: **Ralph Hall Dam Preliminary - Ladonia, Texas**
Location: Station 82+70 +/-
Surface El.: 506.3'

Depth	Samples	Symbol/USCS	MATERIAL DESCRIPTION	Hand Penetrometer, TSF	Penetration Blows / Foot	Core Drilled, ft.	Core Recovered, %	Core RQD	Liquid Limit	Plasticity Index	% Passing No. 200 Sieve	Moisture Content, %	Unit Dry Weight, lb / cu ft	Unc. Compressive Strength, tsf	Strain at Failure, %
			MARL, dark gray, hard, jointed, occasionally fissile, unweathered												
55	C-17					5.0	86	78				19	111	9.5	2.8
			- with high angle joint or slickensides - with phosphatic sand, well indurated, slightly weakly cemented												
60			El. 446.3; 60.0'												

Completion Depth: 60 ft.
Date Boring Started: 4/9/05
Date Boring Completed: 4/9/05
Engineer / Geologist: D. James
Project No.: 53882

Remarks: Boring not bailed at completion of drilling. Groundwater seepage measured at 14 feet during. Boring backfilled upon completion. Bentonite plug placed 1 to 2 feet below ground surface.

KLEINFELDER

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual.

LOG OF BORING NO. B-04

Project Description: **Ralph Hall Dam Preliminary - Ladonia, Texas**
Location: Northend
Surface El.: 564.2'

Depth	Samples	Symbol/USCS	MATERIAL DESCRIPTION	Hand Penetrometer, TSF	Penetration Blows / Foot	Core Drilled, ft.	Core Recovered, %	Core RQD	Liquid Limit	Plasticity Index	% Passing No. 200 Sieve	Moisture Content, %	Unit Dry Weight, lb / cu ft	Unc. Compressive Strength, tsf	Strain at Failure, %
0	U-1		SANDY CLAY, brown and light brown, firm to very stiff, with silty fine sand, infilled joints	1.9											
	U-2			1.2											
	U-3		El. 561.0; 3.2'	1.2											
	U-4		CLAY, brown, yellow-brown and light brown-gray, hard, with iron oxide accretions, limonitic stains	4.5+											
5	U-5		- with calcareous accretions (caliche) below 4.5 feet	4.5+											
	U-6		- transition to light brown-gray and yellow-brown, with sand clasts below 7 feet	4.5+											
10	U-7		El. 552.2; 12.0'	4.5+					64	44	91	19			
15	U-8		MARL, yellow-brown and light gray, hard, jointed, occasionally fissile, limonitic stained, weathered	4.5+								27	97		
20	U-9			4.5+								21	107		
25	U-10		- with gypsum accretion and infilled joints	4.5+								22	104		
30	U-11			4.5+								22	102		
35	U-12		- with dark gray unweathered seams below 37 feet	4.5+								22	109		
40	U-13		El. 524.2; 40.0'	4.5+								21	105		
			MARL, dark gray, hard, jointed, indurated, occasionally fissile, unweathered												
45	U-14			4.5+								22	100		
	C-15					5.0	30	30				21	107		
50	C-16					5.0	50	-							

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Completion Depth: 100 ft.
Date Boring Started: 4/8/05
Date Boring Completed: 4/8/05
Engineer / Geologist: D. James
Project No.: 53882

Remarks: Boring bailed to 44 feet. Groundwater measured at 39 feet after 20 hours. Boring backfilled upon completion. Bentonite plug placed 1 to 2 feet below ground surface.

KLEINFELDER

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual.

LOG OF BORING NO. B-04 (cont'd)

Project Description: **Ralph Hall Dam Preliminary - Ladonia, Texas**
Location: Northend
Surface El.: 564.2'

Depth	Samples	Symbol/USCS	MATERIAL DESCRIPTION	Hand Penetrometer, TSF	Penetration Blows / Foot	Core Drilled, ft.	Core Recovered, %	Core RQD	Liquid Limit	Plasticity Index	% Passing No. 200 Sieve	Moisture Content, %	Unit Dry Weight, lb / cu ft	Unc. Compressive Strength, tsf	Strain at Failure, %
			MARL, dark gray, hard, jointed, indurated, occasionally fissile, unweathered												
55	C-17					5.0	54	34				22	105		
60	T-18				100/ 3"										
65	T-19				100/ 1"										
70	T-20				100/ 2¼"										
75	T-21				100/ 2"										
80	T-22				100/ 1½"										
85	T-23				100/ 1¾"										
90	T-24				100/ 1¾"										
95	T-25				100/ 1½"										
	C-26					5.0	0	-							
100			El. 464.2; 100.0'												

Completion Depth: 100 ft.
Date Boring Started: 4/8/05
Date Boring Completed: 4/8/05
Engineer / Geologist: D. James
Project No.: 53882

Remarks: Boring bailed to 44 feet. Groundwater measured at 39 feet after 20 hours. Boring backfilled upon completion. Bentonite plug placed 1 to 2 feet below ground surface.

KLEINFELDER

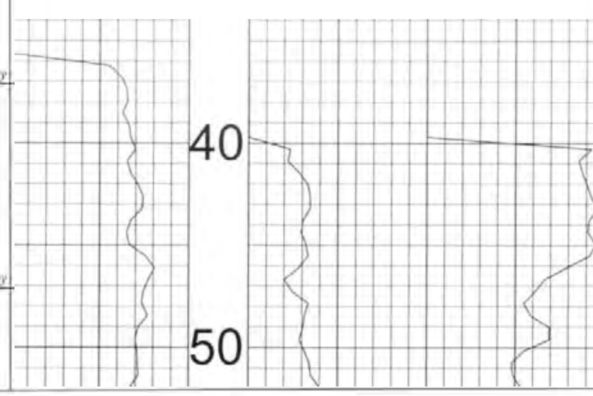
The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual.

LOG OF BORING NO. B-01

Project Description: **Ralph Hall Dam Preliminary - Ladonia, Texas**
Location: Station 25+00 +/-
Surface El.: 550.0'

Electrical Resistivity Readings

GAMMA	FEET	SP	RES
0 CPS 50		0 MV 50	0 OHM 100



Depth | Samples | Symbol/USCS

MATERIAL DESCRIPTION

Depth	Samples	Material Description
0	U-1	SANDY CLAY, dark yellow-brown, soft, with root filaments — El 549.0, 1.0'
	U-2, U-3, U-4, U-5	CLAY, light brown and dark brown, with yellow-brown, hard, with iron oxide stains with root filaments, with occasional sand
5		- with limonitic stains below 4.5 feet
	U-6, U-7	
10		El 538.0, 12.0'
	U-8	SANDY CLAY, silty, light brown, light yellow-brown and light brown-gray, medium dense, mottled with limonite
20	U-9	- laminated cross-bedded, less mottled below 20 feet — El 526.0, 24.0'
25	U-10	CLAY with sand, yellow-brown and light gray-brown, stiff to very stiff, with calcareous webbing and infills, with iron oxide infills
30	U-11	
35	U-12	El 513.0, 37.0'
40	U-13	SANDY CLAY, light gray-brown, gray and yellow-brown, firm to hard, mottled with limonite, with iron oxide infills, with root filament holes, faint blocky structure
45	U-14	- with silty fine sand partings, infilled burrows - with coarse subrounded gravel — El 503.0, 47.0'
50	U-15	MARL, yellow-brown and gray, hard, jointed, stained with limonite, weathered

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Completion Depth: 85 ft
Date Boring Started: 4/7/05
Date Boring Completed: 4/7/05
Engineer / Geologist: D. James
Project No.: 53882

Remarks: Boring lost 350 gallons of drilling water at 26 feet during drilling. Groundwater at 25 feet 16 hours after completion. Boring not bailed at completion of drilling. Boring backfilled upon completion. Bentonite plug placed 1 to 2 feet below ground surface.

KLEINFELDER

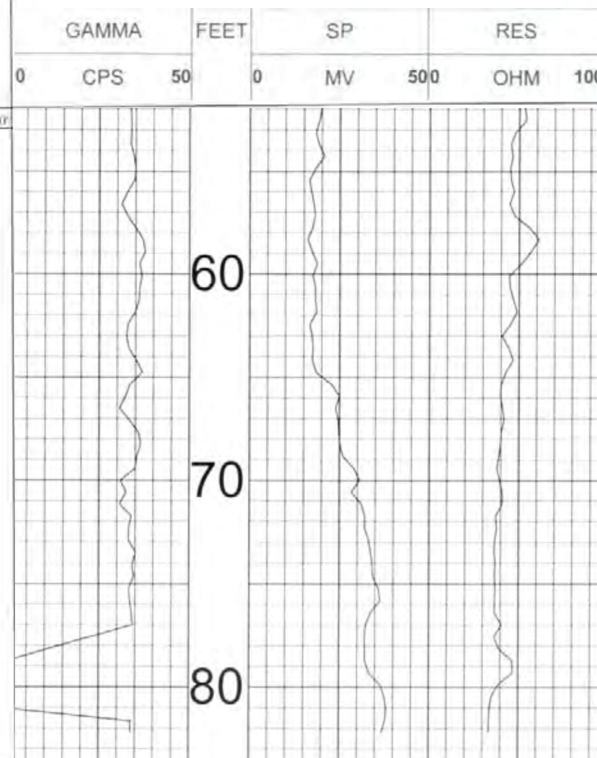
The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual.

LOG OF BORING NO. B-01 (cont'd)

Project Description: **Ralph Hall Dam Preliminary - Ladonia, Texas**
Location: Station 25+00 +/-
Surface El.: 550.0'

Depth	Samples	Symbol/USCS	MATERIAL DESCRIPTION
			El. 497.0, 53.0'
			MARL, gray to dark gray, hard, unweathered
55	T-16		
	C-17		
60	C-18		
	C-19		
65	C-20		
70	C-21		
			- with moderate to high angle slickenside
75	C-22		
80	C-23		
85			El. 465.0, 85.0'

Electrical Resistivity Readings



Completion Depth: 85 ft.
Date Boring Started: 4/7/05
Date Boring Completed: 4/7/05
Engineer / Geologist: D. James
Project No.: 53882

Remarks: Boring lost 350 gallons of drilling water at 26 feet during drilling. Groundwater at 25 feet 16 hours after completion. Boring not bailed at completion of drilling. Boring backfilled upon completion. Bentonite plug placed 1 to 2 feet below ground surface.

KLEINFELDER

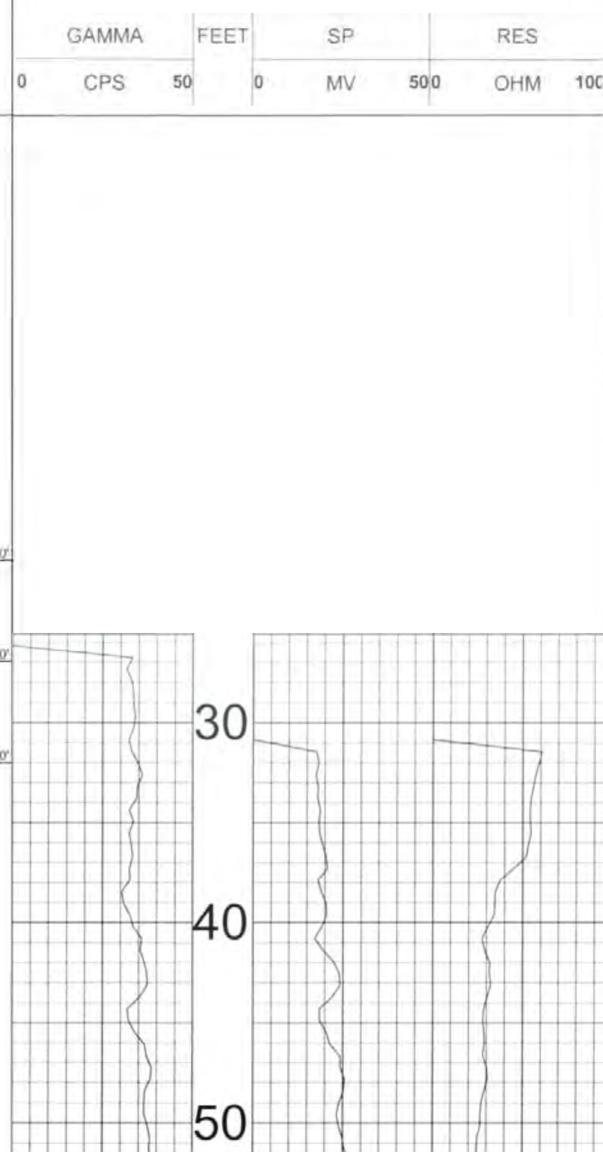
The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual.

LOG OF BORING NO. B-02

Project Description: **Ralph Hall Dam Preliminary - Ladonia, Texas**
Location: Station 53+00 +/-
Surface El.: 502.6'

Depth	Samples	Symbol/USCS	MATERIAL DESCRIPTION
0	U-1, U-2, U-3, U-4		CLAY, dark brown, brown, yellow-brown and gray, soft to very stiff
5	U-5		- with occasional calcareous accretions
	U-6		- with root filaments, with occasional silty sand pockets, with limonitic stains
10	U-7		- with sand infilled burrows
15	U-8		
20	U-9		- occasionally jointed below 19 feet - with manganese dioxide stains El. 480.6; 22.0'
25	U-10		CLAY, yellow-brown, gray and light brown, firm, intercalated with fine to coarse subrounded sand partings and seams El. 475.6; 27.0'
30	U-11		CLAY with sand, yellow-brown, gray and light brown, firm, intercalated with fine to coarse subrounded sand partings and seams El. 470.6; 32.0'
35	U-12, C-13		MARL, dark gray, hard, jointed, occassionally fissile, unweathered
40	C-14		
45	C-15		
50	C-16		

Electrical Resistivity Readings



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Completion Depth: 60 ft.
Date Boring Started: 4/6/05
Date Boring Completed: 4/6/05
Engineer / Geologist: D. James
Project No.: 53882

Remarks: Boring bailed to 21 feet. Groundwater measured after 20 hours at 8.1 feet. Boring backfilled upon completion. Bentonite plug placed 1 to 2 feet below ground surface.

KLEINFELDER

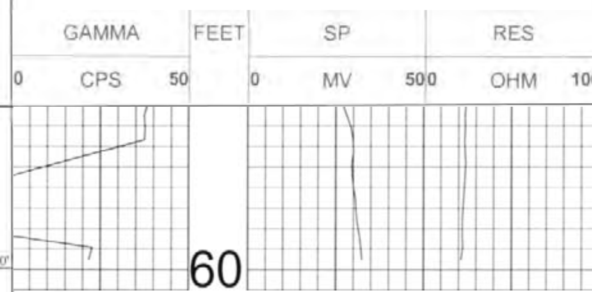
The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual.

LOG OF BORING NO. B-02 (cont'd)

Project Description: **Ralph Hall Dam Preliminary - Ladonia, Texas**
Location: Station 53+00 +/-
Surface El.: 502.6'

Depth	Samples	Symbol/USCS	MATERIAL DESCRIPTION
55	C-17		MARL, dark gray, hard, jointed, occassionally fissile, unweathered
60			El. 442.6, 60.0'

Electrical Resistivity Readings



Completion Depth: 60 ft.
Date Boring Started: 4/6/05
Date Boring Completed: 4/6/05
Engineer / Geologist: D. James
Project No.: 53882

Remarks: Boring bailed to 21 feet. Groundwater measured after 20 hours at 8.1 feet. Boring backfilled upon completion. Bentonite plug placed 1 to 2 feet below ground surface.

KLEINFELDER

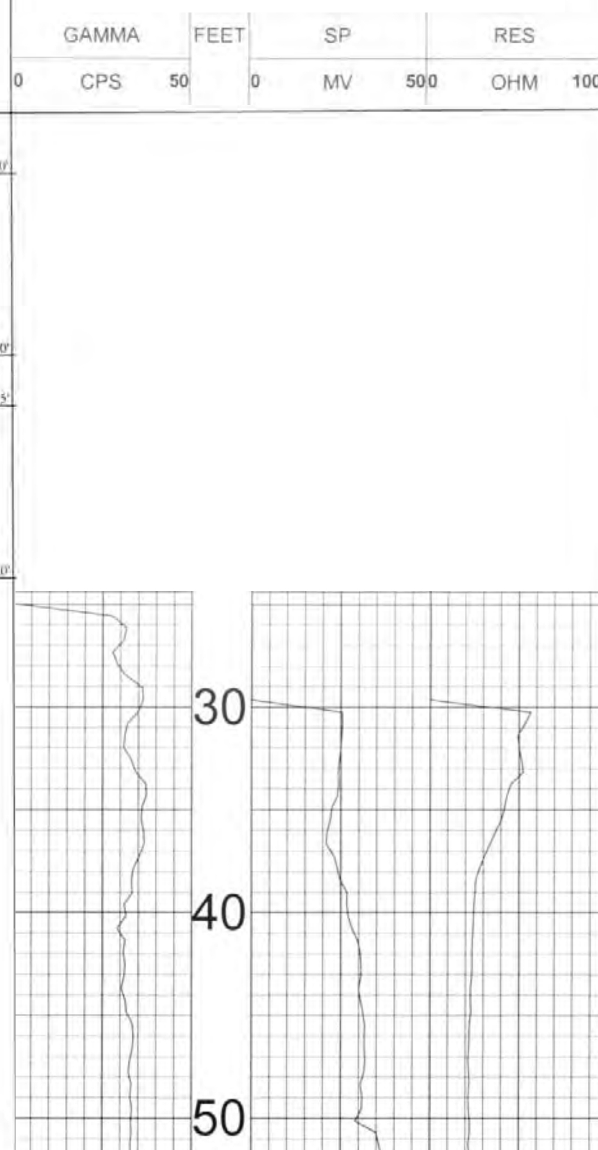
The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual.

LOG OF BORING NO. B-03

Project Description: **Ralph Hall Dam Preliminary - Ladonia, Texas**
Location: Station 82+70 +/-
Surface El.: 506.3'

Depth	Samples	Symbol/USCS	MATERIAL DESCRIPTION
0	U-1, U-2, U-3		CLAY with sand, brown and dark brown, very stiff to hard, fill (El 503.3, 3.0')
5	U-4, U-5, U-6		CLAY, light brown-gray with yellow-brown, firm to stiff, mottled with limonite, with weathered ironstone sand
10	U-7		(El 494.3, 12.0')
			CLAYEY SAND, light gray-brown and ▽variegated, medium dense (El 491.8, 14.5')
15	U-8		MARL, yellow-brown and gray, hard, jointed, fissile, with root invaded joints, with gypsum infills, weathered
20	U-9		(El 483.3, 23.0')
25	T-10, C-11		MARL, dark gray, hard, jointed, occasionally fissile, unweathered
30	C-12		
35	C-13		
40	C-14		
45	C-15		
50	C-16		

Electrical Resistivity Readings



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Completion Depth: 60 ft.
Date Boring Started: 4/9/05
Date Boring Completed: 4/9/05
Engineer / Geologist: D. James
Project No.: 53882

Remarks: Boring not bailed at completion of drilling. Groundwater seepage measured at 14 feet during. Boring backfilled upon completion. Bentonite plug placed 1 to 2 feet below ground surface.

KLEINFELDER

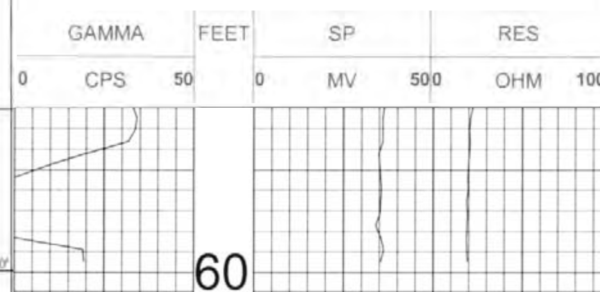
The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual.

LOG OF BORING NO. B-03 (cont'd)

Project Description: **Ralph Hall Dam Preliminary - Ladonia, Texas**
Location: Station 82+70 +/-
Surface El.: 506.3'

Depth	Samples	Symbol/USCS	MATERIAL DESCRIPTION
			MARL, dark gray, hard, jointed, occasionally fissile, unweathered
55	C-17		
			- with high angle joint or slickensides - with phosphatic sand, well indurated, slightly weakly cemented
60			El. 446.3, 60.0'

Electrical Resistivity Readings



Completion Depth: 60 ft.
Date Boring Started: 4/9/05
Date Boring Completed: 4/9/05
Engineer / Geologist: D. James
Project No.: 53882

Remarks: Boring not bailed at completion of drilling. Groundwater seepage measured at 14 feet during. Boring backfilled upon completion. Bentonite plug placed 1 to 2 feet below ground surface.

KLEINFELDER

The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual.

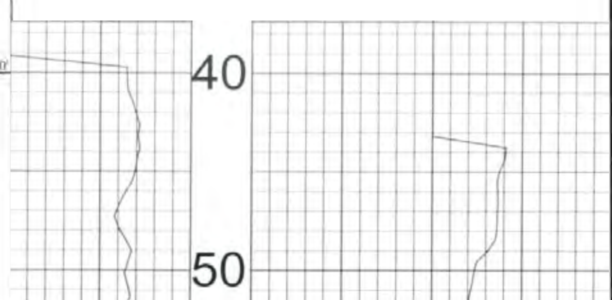
LOG OF BORING NO. B-04

Project Description: **Ralph Hall Dam Preliminary - Ladonia, Texas**
Location: Northend
Surface El.: 564.2'

Electrical Resistivity Readings

Depth	Samples	Symbol/USCS	MATERIAL DESCRIPTION
0	U-1, U-2, U-3		SANDY CLAY, brown and light brown, firm to very stiff, with silty fine sand, infilled joints — El 561.0, 3.2'
5	U-4, U-5, U-6, U-7		CLAY, brown, yellow-brown and light brown-gray, hard, with iron oxide accretions, limonitic stains - with calcareous accretions (caliche) below 4.5 feet - transition to light brown-gray and yellow-brown, with sand clasts below 7 feet — El 552.2, 12.0'
10–40	U-8, U-9, U-10, U-11, U-12, U-13		MARL, yellow-brown and light gray, hard, jointed, occasionally fissile, limonitic stained, weathered - with gypsum accretion and infilled joints - with dark gray unweathered seams below 37 feet — El 524.2, 40.0'
40–50	U-14, C-15, C-16		MARL, dark gray, hard, jointed, indurated, occasionally fissile, unweathered

GAMMA	FEET	SP	RES
0 CPS 50		0 MV 50	0 OHM 100



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Completion Depth: 100 ft.
Date Boring Started: 4/8/05
Date Boring Completed: 4/8/05
Engineer / Geologist: D. James
Project No.: 53882

Remarks: Boring bailed to 44 feet. Groundwater measured at 39 feet after 20 hours. Boring backfilled upon completion. Bentonite plug placed 1 to 2 feet below ground surface.

KLEINFELDER

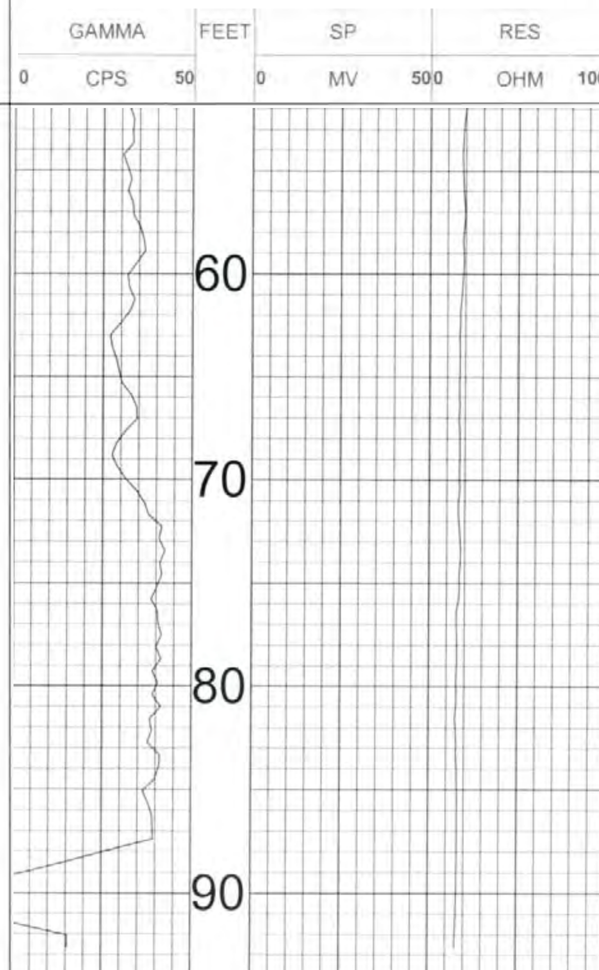
The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual.

LOG OF BORING NO. B-04 (cont'd)

Project Description: **Ralph Hall Dam Preliminary - Ladonia, Texas**
Location: Northend
Surface El.: 564.2'

Depth	Samples	Symbol/USCS	MATERIAL DESCRIPTION
			MARL, dark gray, hard, jointed, indurated, occasionally fissile, unweathered
55	C-17		
60	T-18		
65	T-19		
70	T-20		
75	T-21		
80	T-22		
85	T-23		
90	T-24		
95	T-25 C-26		
100			El. 464.2, 100.0'

Electrical Resistivity Readings



Completion Depth: 100 ft
Date Boring Started: 4/8/05
Date Boring Completed: 4/8/05
Engineer / Geologist: D. James
Project No.: 53882

Remarks: Boring bailed to 44 feet. Groundwater measured at 39 feet after 20 hours. Boring backfilled upon completion. Bentonite plug placed 1 to 2 feet below ground surface.

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The stratification lines represent approximate strata boundaries. In situ, the transition may be gradual.

Boring No.	Sample Depth (ft.)	Liquid Limit	Plastic Limit	Plasticity Index	Percent Passing No. 200 Sieve	Moisture Content (%)	Unit Dry Weight (pcf)	Unconfined Compressive Strength (tsf)	Strain at Failure (%)
B-01	7.0 - 8.0					15	112	7.8	1.7
B-01	9.0 - 10.0	52	17	35	89	17			
B-01	14.0 - 15.0	40	19	21	63	13			
B-01	19.0 - 20.0					17	110		
B-01	24.0 - 25.0	35	21	14	86	18	96		
B-01	29.0 - 30.0					18	113	4.3	7.8
B-01	34.0 - 35.0					19	109		
B-01	39.0 - 40.0	31	22	9	67	21	107	0.9	3.9
B-01	49.0 - 50.0	60	23	37	98	23	104	4.4	4.1
B-01	55.0 - 60.0					18	113		
B-01	62.1 - 62.5					16	114	19.6	3.4
B-02	7.0 - 8.0	61	18	43	96	22			
B-02	24.0 - 25.0	59	19	40	92	24			
B-02	29.0 - 30.0	57	22	35	75	25	102	0.9	3.4
B-02	36.0 - 36.5	57	21	36	95	12	127	22.3	2.4
B-02	43.0 - 43.5					17	115		
B-02	52.0 - 52.5					16	115		
B-02	57.0 - 57.5					16	117		
B-03	3.0 - 4.0	54	17	37	92	20			
B-03	14.0 - 15.0					25	100	1.6	6.9
B-03	19.0 - 20.0					22	96	4.8	7.1
B-03	27.0 - 27.5					18	112	14.2	3.0
B-03	33.0 - 33.5					18	112	22.1	2.3
B-03	38.0 - 38.5					25	105		
B-03	43.0 - 43.5					18	118		
B-03	48.0 - 48.5					18	112		
B-03	56.0 - 56.5					19	111	9.5	2.8
B-04	9.0 - 10.0	64	20	44	91	19			
B-04	14.0 - 15.0					27	97		
B-04	19.0 - 20.0					21	107		
B-04	24.0 - 25.0					22	104		
B-04	29.0 - 30.0					22	102		
B-04	34.0 - 35.0					22	109		
B-04	39.0 - 40.0					21	105		
B-04	44.0 - 45.0					22	100		
B-04	45.0 - 50.0					21	107		
B-04	55.0 - 60.0					22	105		

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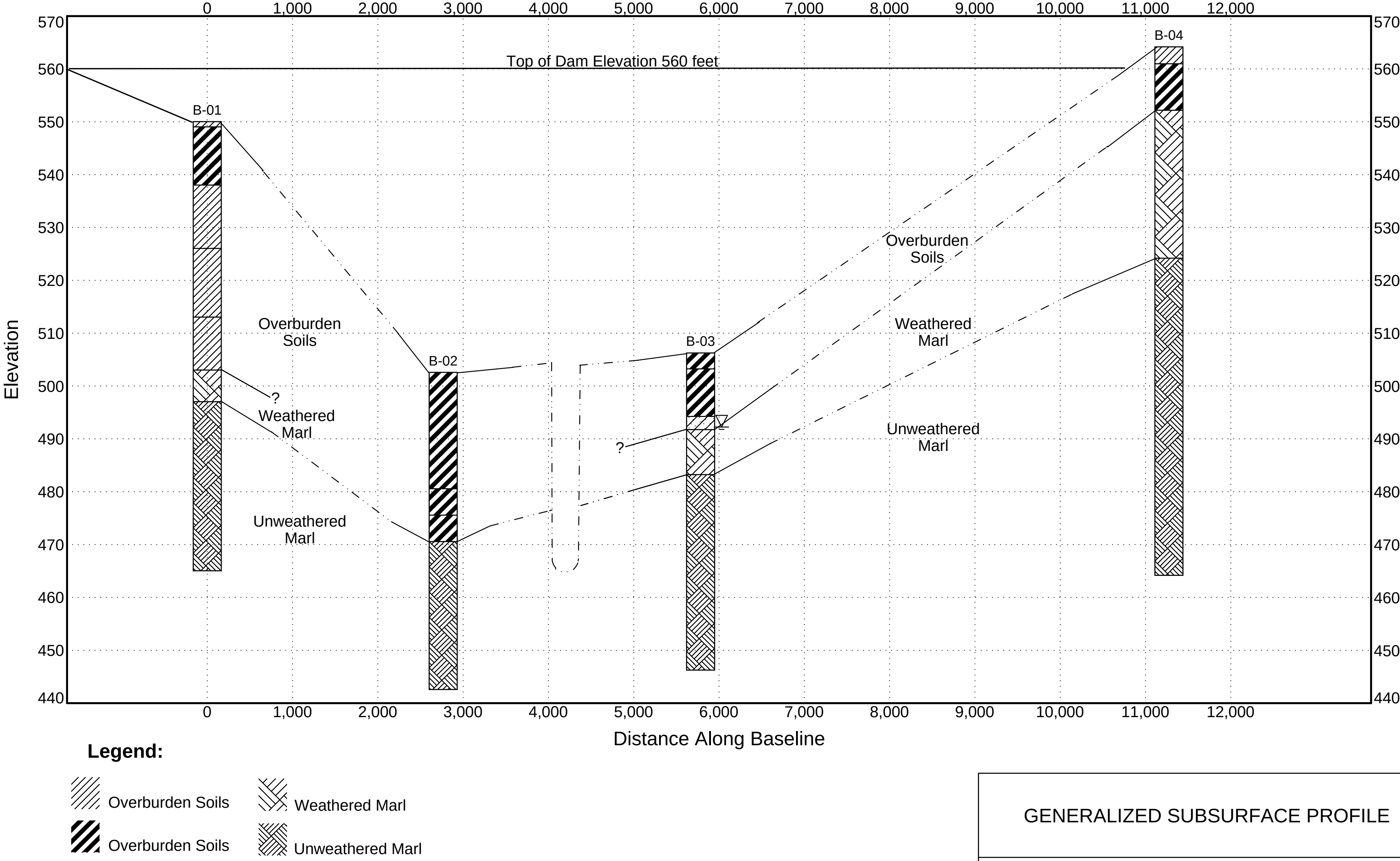
Summary of Laboratory Results

Project: Ralph Hall Dam Preliminary - Ladonia, Texas

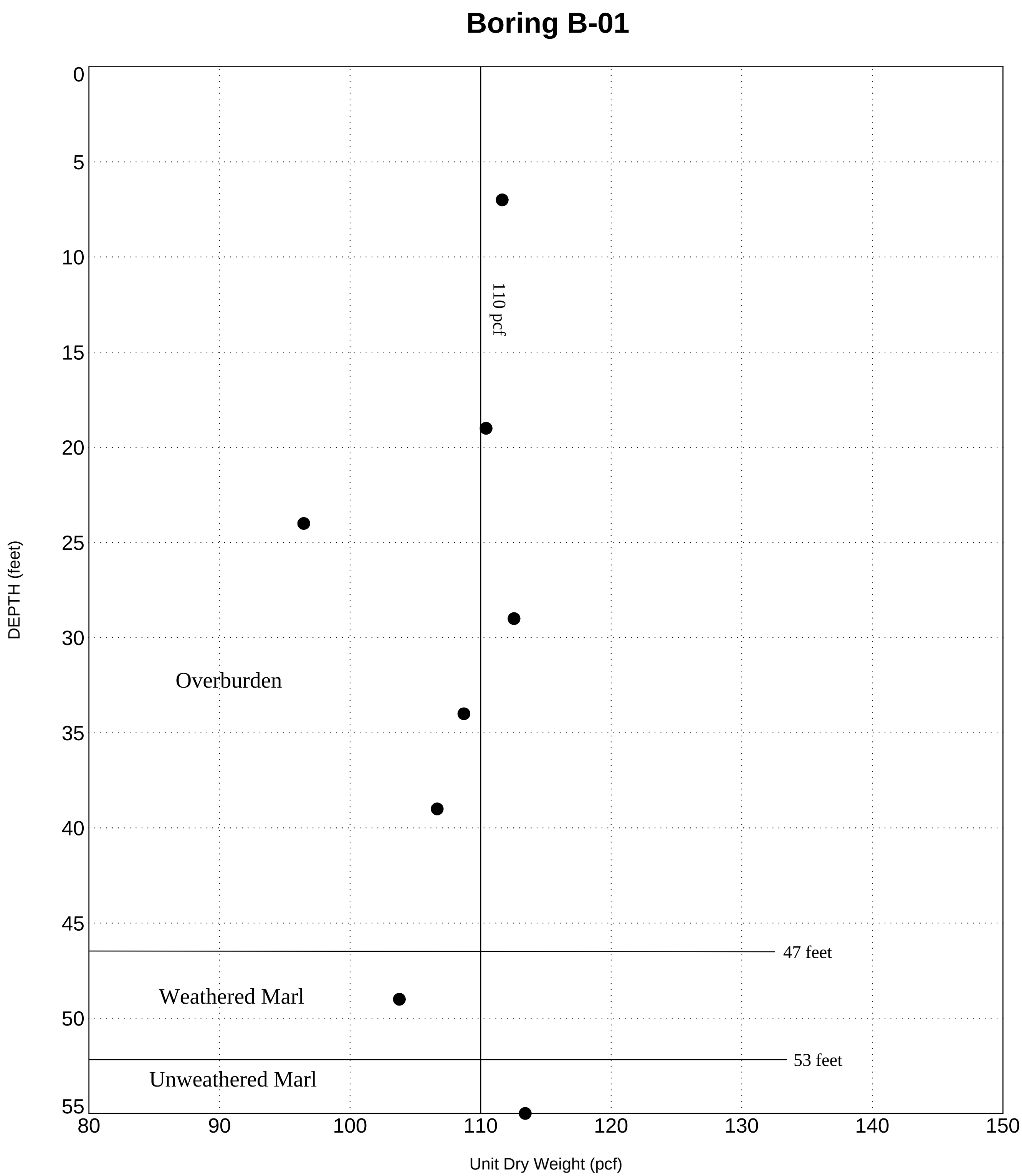
Project Number: 53882



GENERALIZED SUBSURFACE PROFILE		
Ralph Hall Dam Preliminary - Ladonia, Texas		
PROJECT # 53882	DATE Jun 05	PLATE 13

Note 1: The strata lines are based upon interpolation between borings, and may not represent actual subsurface conditions.

Note 2: See Logs of borings and report text for detailed material descriptions.



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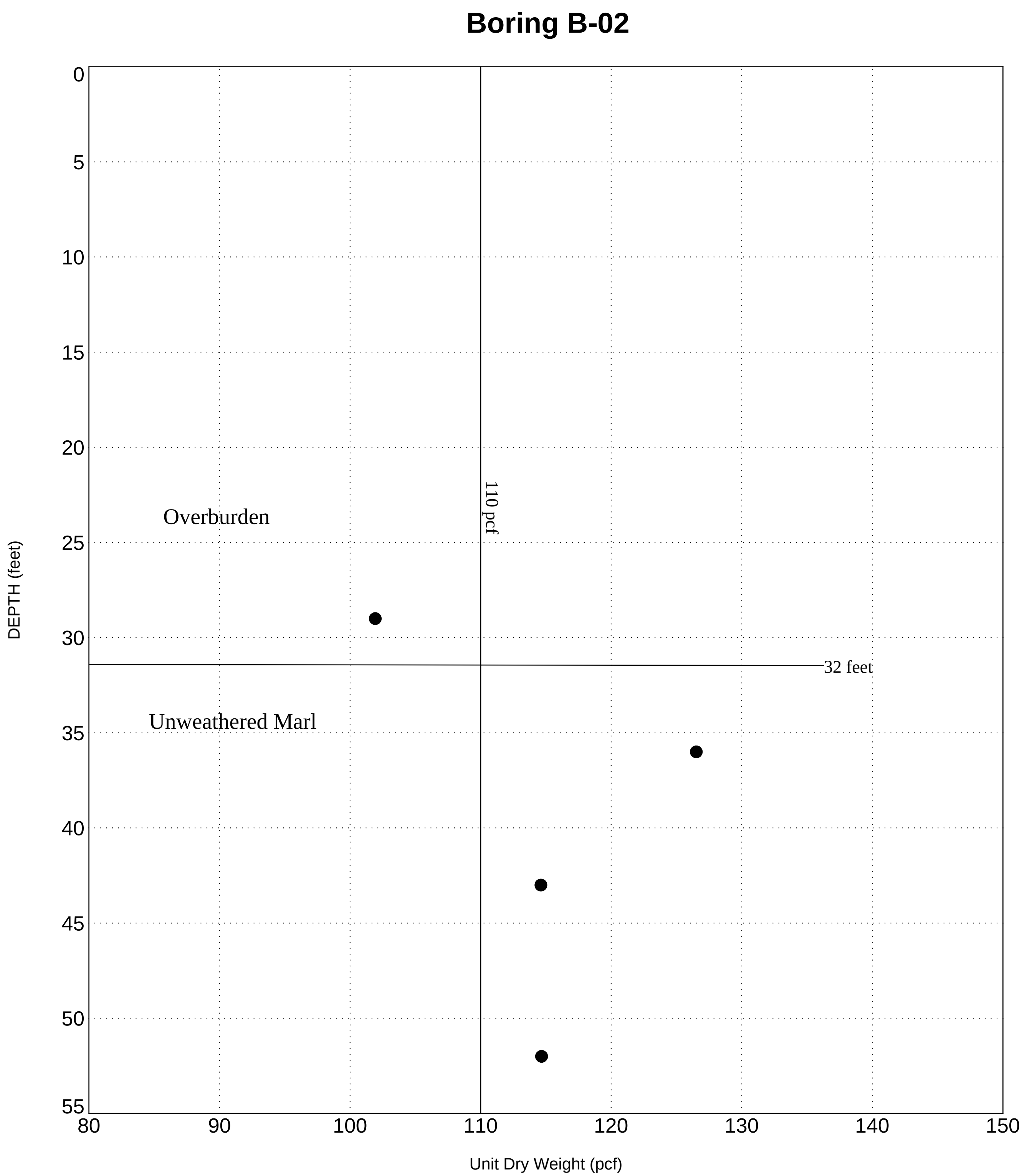
UNIT DRY WEIGHT VERSUS DEPTH

Project: Ralph Hall Dam Preliminary - Ladonia, Texas

Number: 53882



UNIT DRY WEIGHT VERSUS DEPTH

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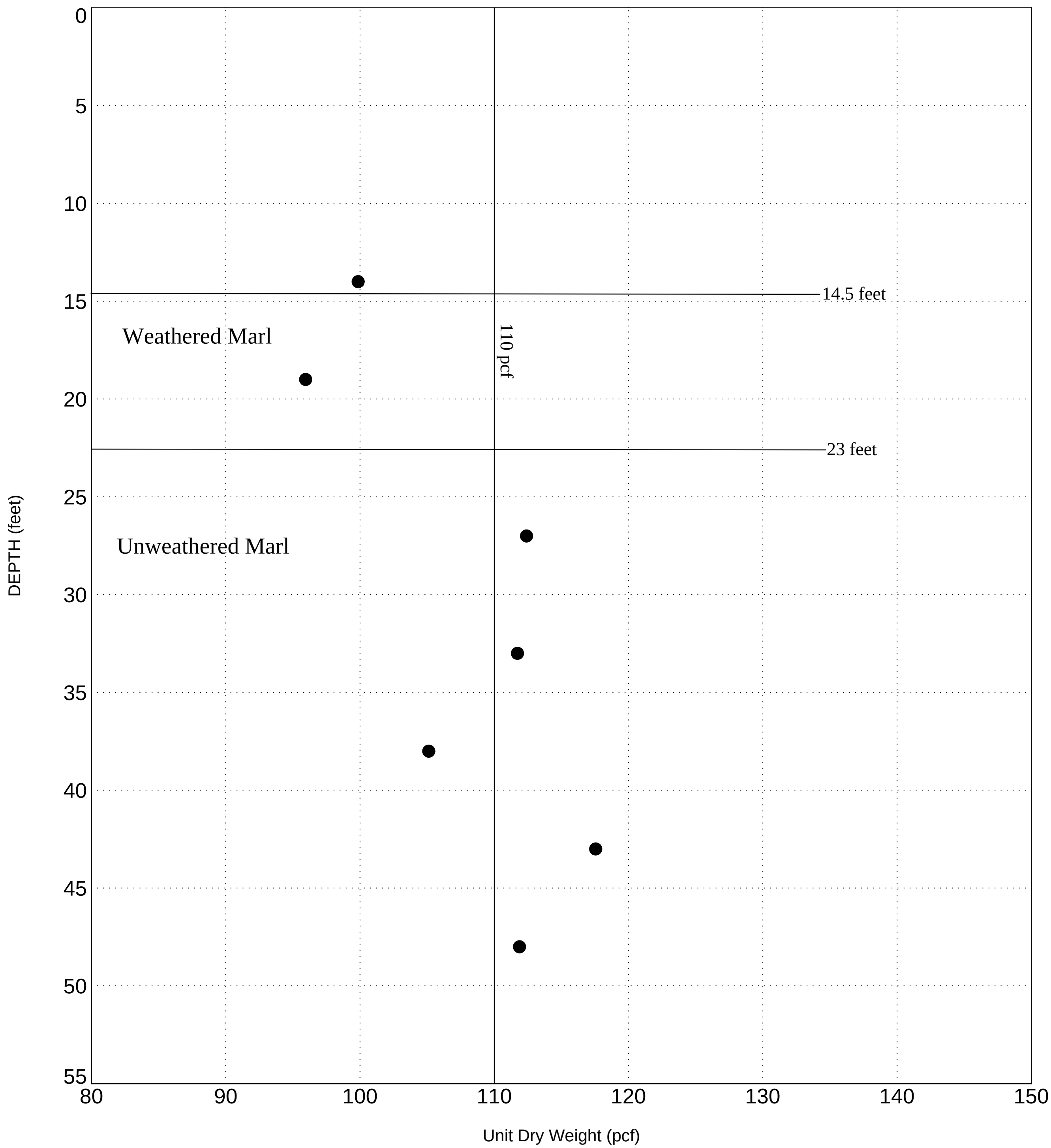
Project: Ralph Hall Dam Preliminary - Ladonia, Texas

Number: 53882

Boring B-03



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UNIT DRY WEIGHT VERSUS DEPTH

Project: Ralph Hall Dam Preliminary - Ladonia, Texas

Number: 53882