REPORT

Unstable Areas Demonstration

Escalante Station Active Coal Combustion Residuals Landfill

Submitted to:

Tri-State Generation and Transmission Association, Inc.
1100 West 116th Avenue, Westminster, Colorado 80234

Submitted by:

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1783558

October 10, 2018

Table of Contents

1.0 INTRODUCTION

1.1 Background

Golder Associates Inc. (Golder) has prepared this report for Tri-State Generation and Transmission Association, Inc. (Tri-State) to summarize our assessment of the active coal combustion residuals (CCR) landfill (the Facility) at Tri-State's Escalante Generating Station (the site) with respect to factors that could cause an area to be considered an unstable area, and to provide supporting information demonstrating that the Facility is not located in an unstable area. This report includes written certification by a qualified professional engineer registered in New Mexico stating that the Facility is not located in an unstable area and is in compliance with 40 CFR 257.64.

1.2 Facility Information

The Facility is located less than a mile east of the power block at Tri-State's Escalante Generating Station, a 270-megawatt coal-fired electric generation plant located in McKinley County, New Mexico. It serves as the location for final deposition of CCRs generated at Escalante Generating Station and classifies as an existing CCR landfill under 40 CFR 257.

2.0 UNSTABLE AREA ASSESSMENT

2.1 Requirements

An unstable area is defined under 40 CFR 257.53 as follows:

> Unstable area means a location that is susceptible to natural or human-induced events or forces capable of impairing the integrity, including structural components of some or all of the CCR unit that are responsible for preventing releases from such unit. Unstable areas can include poor foundation conditions, areas susceptible to mass movements, and karst terrains.

Under 40 CFR 257.64(b), the following factors, at a minimum, must be considered as part of the assessment to determine whether the Facility is located in an unstable area:

- On-site or local soil conditions that may result in significant differential settling
- On-site or local geologic or geomorphologic features
- On-site or local human-made features or events (both surface and subsurface)

2.2 Review of Available Information

Golder reviewed the following information in the course of completing the unstable area assessment:

- Groundwater monitoring plan for the site (Metric Corporation 1983)
- Engineering design report for the Facility (Metric Corporation 2006)
- Quaternary faults and folds dataset for the United States (United States Geological Survey and New Mexico Bureau of Mines and Mineral Resources 2006)
- Karst dataset for the United States (Weary and Doctor 2014)
- 2015 annual inspection report for the Facility (Golder 2016a)
- Drilling and monitoring well installation summary for the Facility (Golder 2016b)

- 2016 annual inspection report for the Facility (Golder 2017)
- 2017 annual inspection report for the Facility (Golder 2018)

In addition to the review of available information, the professional engineer overseeing the unstable area assessment has visited and observed the Facility on several occasions, including the site visits associated with annual inspections conducted for compliance with 40 CFR 257.84(b)(1) in 2015, 2016, and 2017, and has visually assessed the factors that could cause the area within and in close proximity to the Facility to be considered an unstable area.

2.3 Geotechnical and Geologic Information

Near-surface geology at the site is generally characterized by Quaternary alluvium underlain by bedrock of the Triassic Chinle Formation, Petrified Forest Member. Within the Chinle Formation is the Correo sandstone bed, which is confined on the top and bottom by Chinle claystone, upper part.

The surficial Quaternary alluvium generally ranges from approximately 10 to 25 feet thick near the Facility, and the Chinle claystone overlying the Correo sandstone bed ranges from approximately 100 to 200 feet thick in the area (Golder 2016b). The Correo sandstone bed is approximately 50 feet thick beneath the Facility, and the Chinle claystone underlying the Correo sandstone bed is several hundred feet thick (Golder 2016b).

Quaternary alluvium in the vicinity of the Facility consists primarily of clayey sand, silty sand, or sandy clay (Golder 2016c). For purposes of accumulating soil resources for Facility construction and closure, Tri-State has excavated the surficial soils to a nominal depth of 5 feet and stockpiled the excavated material before expanding the Facility footprint into a given area.

2.4 Findings

Golder's review of available information and knowledge of the Facility indicate the following with respect to factors that could cause an area to be considered an unstable area:

- On-site or local soil conditions that may result in significant differential settling
  - The thickness of unconsolidated material (Quaternary alluvium) at the site prior to construction of the Facility is limited, generally ranging from 10 to 25 feet (Golder 2016b). Further reducing the thickness of unconsolidated material beneath the Facility, Tri-State has excavated the surficial soils to a nominal depth of 5 feet before constructing or expanding the Facility footprint into a given area.
  - Quaternary alluvium found at the site consists primarily of soils characterized as clayey sand, silty sand, or sandy clay (Golder 2016c). These soil types are not commonly prone to high compressibility.
  - No evidence of differential settlement has been observed at the Facility during annual inspections by a qualified professional engineer (Golder 2016a, Golder 2017, Golder 2018).
  - Given the limited thickness of unconsolidated material beneath the Facility, the characteristics of the unconsolidated material (i.e., not commonly prone to high compressibility), and site observations, Golder concludes that there are not on-site or local soil conditions that may result in significant differential settling.

- On-site or local geologic or geomorphologic features
  - The Facility is not located in an area with geological conditions that create the potential for karst terrain or features, as shown in Figure 1.
  - The Facility is not located in an area with known faults or folds that demonstrate geological evidence of coseismic surface deformation during the Quaternary Period, as shown in Figure 1.
  - Site topography is gentle, sloping at an average grade of 1 percent from west to east in the vicinity of the Facility. The Facility is higher in elevation than the surrounding topography around its east, south, and west sides. Along its north side, it abuts an inactive CCR landfill that shows no evidence of mass movement. As such, the Facility is not susceptible to instability related to mass movement (e.g., landslides, avalanches, debris flows, solifluction, block sliding, or rock fall) from adjacent areas.
  - No evidence of faulting, rock fall, landslides, or local soil conditions that are conducive to downslope movement of soil, rock, or debris have been observed at the Facility during annual inspections by a qualified professional engineer (Golder 2016a, Golder 2017, Golder 2018).
- On-site or local human-made features or events (both surface and subsurface)
  - There are no known historical mine workings at the site. Geotechnical investigations at the site have not identified coal seams or other subsurface resources that may have motivated mining at the site.
  - Slope stability analyses for the Facility indicate a factor of safety equal to 1.7 for static conditions and a factor of safety equal to 1.1 under design seismic loading. The slope stability analyses for the Facility are summarized in Appendix A.
  - No human-made features having the potential to create unstable conditions have been observed at the Facility during annual inspections by a qualified professional engineer (Golder 2016a, Golder 2017, Golder 2018).

3.0 CONCLUSION

Based upon the assessment described in this report, the undersigned professional engineer registered in New Mexico certifies that the active CCR landfill at Escalante Generating Station is not located in an unstable area and is in compliance with 40 CFR 257.64.

4.0 REFERENCES

Golder Associates Inc. (2016a). Coal Combustion Residuals Landfill Annual Inspection Report. Report prepared for Tri-State Generation and Transmission Association, Inc. Project number 1533418CCR. January 18, 2016.

Golder Associates Inc. (2016b). Drilling and Monitoring Well Installation Summary at the Escalante Generating Station in Prewitt, New Mexico. Technical memorandum prepared for Tri-State Generation and Transmission Association, Inc. Project number 1533418GW. August 19, 2016.

Golder Associates Inc. (2016c). Assessment of Final Cover Hydraulic Performance. Report prepared for Tri-State Generation and Transmission Association, Inc. Project number 1663066. October 2016.

Golder Associates Inc. (2017). Coal Combustion Residuals Landfill Annual Inspection Report. Report prepared for Tri-State Generation and Transmission Association, Inc. Project number 1663066. January 18, 2017.

Golder Associates Inc. (2018). Active Coal Combustion Residuals Landfill Annual Inspection Report. Report prepared for Tri-State Generation and Transmission Association, Inc. Project number 1783558. January 15, 2018.

Metric Corporation (1983). Ground-Water Monitoring Plan for the Plains Escalante Generating Station No. 1. Report prepared for Plains Electric Generation and Transmission Cooperative, Inc.

Metric Corporation (2006). Scrubber Sludge/Fly Ash Landfill Expansion Plan for the Tri-State Escalante Generating Station. Report prepared for Tri-State Generation and Transmission Association, Inc. August 14, 2006.

United States Geological Survey and New Mexico Bureau of Mines and Mineral Resources (2006). Quaternary Fault and Fold Database for the United States. Available online: http://earthquake.usgs.gov/hazards/qfaults. Accessed September 12, 2018.

Weary, D.J., and D.H. Doctor (2014). Karst in the United States: A Digital Map Compilation and Database. United States Geological Survey Open-File Report 2014-1156. Available online: https://pubs.usgs.gov/of/2014/1156/pdf/of2014-1156.pdf. Accessed September 12, 2018.

Signature Page

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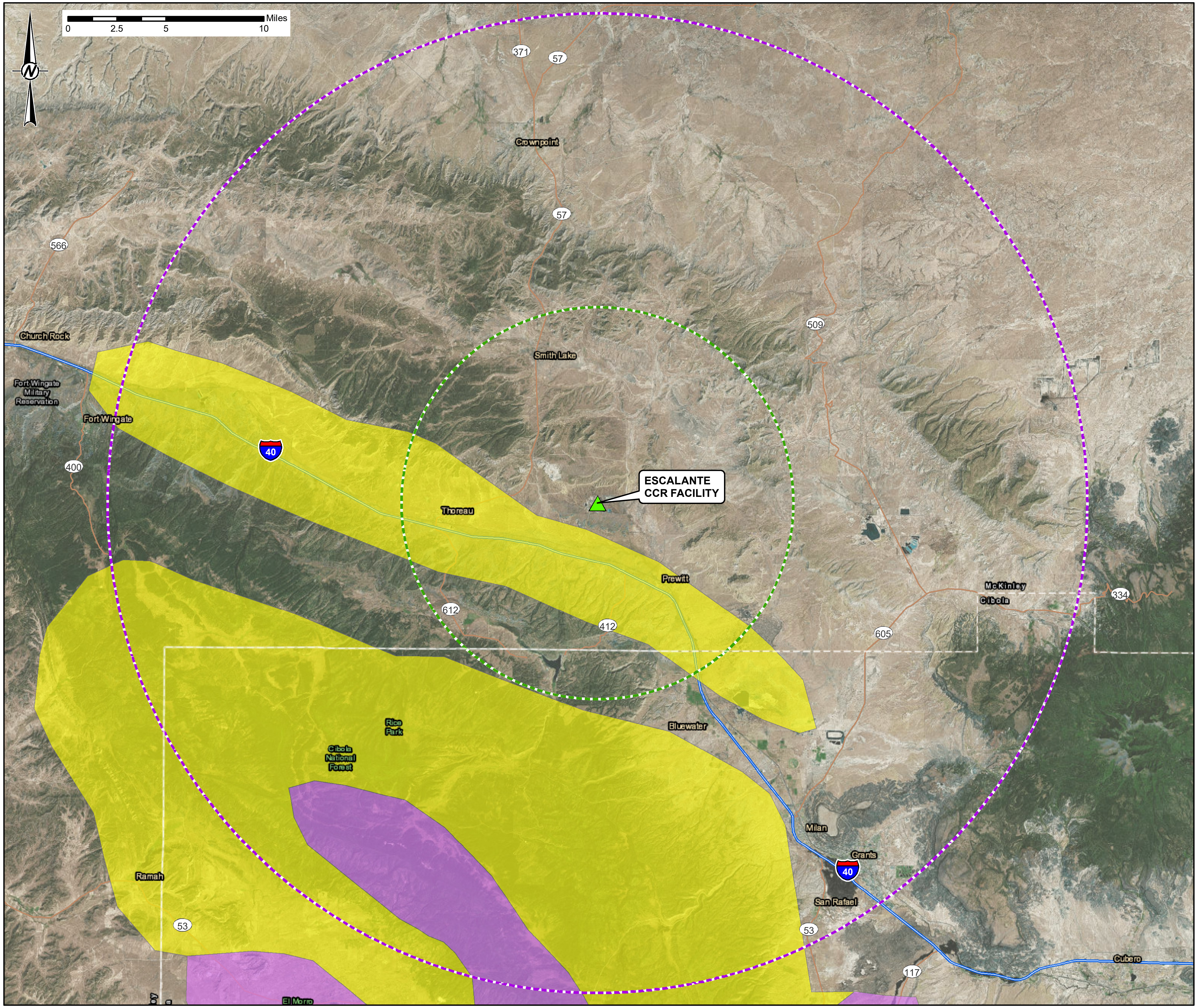
https://golderassociates.sharepoint.com/sites/15537g/deliverables/reports/escalante_unstable_areas_demonstration_fnl_10oct18/1783558-0008--2-r-0-escalante_ccr_unstable_areas_demonstration_10oct18.docx

Figure



LEGEND

- SITE LOCATION
- 10-MILE RADIUS FROM SITE
- 25-MILE RADIUS FROM SITE
- QUATERNARY FAULT (NONE WITHIN MAP EXTENTS)

KARST TYPE

- FISSURES, TUBES AND CAVES GENERALLY LESS THAN 1,000 FT (300 M) LONG; 50 FT (15 M) OR LESS VERTICAL EXTENT; IN GENTLY DIPPING TO FLAT-LYING BEDS OF CARBONATE ROCK
- FISSURES, TUBES, AND TUNNELS PRESENT TO A DEPTH OF 50 FT. (15 M) IN LAVA

KEY MAP

REFERENCES

1. DIGITAL ENGINEERING ASPECTS OF KARST MAP : A GIS VERSION OF DAVIES, W.E., SIMPSON, J.H., OHLMACHER, G.C., KIRK, W.S., AND NEWTON, E.G., 1984, ENGINEERING ASPECTS OF KARST:
U.S. GEOLOGICAL SURVEY, NATIONAL ATLAS OF THE UNITED STATES OF AMERICA, SCALE 1:7,500,000
BY BRET D. TOBIN AND DAVID J. WEARY
U.S. GEOLOGICAL SURVEY OPEN-FILE REPORT 2004-1352
2. QUATERNARY FAULTS DATASET: U.S. GEOLOGICAL SURVEY AND NEW MEXICO BUREAU OF MINES AND MINERAL RESOURCES, 2006, QUATERNARY FAULT AND FOLD DATABASE FOR THE UNITED STATES, ACCESSED SEPTEMBER 2018, FROM USGS WEB SITE: HTTP//EARTHQUAKE.USGS.GOV/HAZARDS/QFAULTS/.
3. BASEMAP: ESRI, DIGITAL GLOBE, VIVID, 2017.

CLIENT

TRI-STATE GENERATION AND TRANSMISSION ASSOCIATION, INC.

PROJECT

UNSTABLE AREAS DEMONSTRATION

TITLE

QUATERNARY FAULTS AND KARST FEATURES IN PROXIMITY TO ESCALANTE CCR FACILITY

CONSULTANT

GOLDER

YYYY-MM-DD	2018-10-09
DESIGNED	KJC
PREPARED	KJC
REVIEWED	JEO
APPROVED	TJS

PROJECT NO. 1783558

FIGURE 1

PATH: M:\TriState_Escalante\Mapping\11x17_1783558_EscalanteFaults&Karst.mxd PRINTED ON: 2018-10-09 AT: 3:30:05 PM

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APPENDIX A

Global Slope Stability Calculations

CALCULATIONS

DATE	October 9, 2018	**PREPARED BY**	JEO
DOCUMENT NO.	1783558	**CHECKED BY**	CCS
SITE NAME	Escalante Generating Station Active Coal Combustion Residuals Landfill	**REVIEWED BY**	TJS

GLOBAL SLOPE STABILITY ANALYSIS

1.0 OBJECTIVE

Evaluate the global slope stability of the active coal combustion residuals (CCR) landfill at the Escalante Generating Station (the landfill) at final closure. The analysis assesses the stability of the landfill using grades shown in the Closure Plan (Golder 2016).

2.0 METHODOLOGY

A typical cross section at the landfill's full design height (final closure grades) was developed for global slope stability analysis. Limit equilibrium slope stability analyses were performed using Spencer's method in Slide 8.0, a two-dimensional slope stability modeling software platform (Rocscience 2018). Spencer's method considers both moment and force equilibrium. It is common geotechnical practice to analyze the stability of embankment slopes using limit equilibrium methods.

The slope stability analyses focus on circular slip surfaces that pass into the CCRs contained in the landfill (minimum depth of 4 feet). Slope stability analyses were performed to evaluate the minimum factors of safety under static and seismic loading conditions.

2.1 Geometry

The cross section was taken through the longest existing embankment slope, which is also expected to be the longest embankment slope at final closure. A plan view showing the cross section location is included as Figure A-1.

2.2 Analysis

The slope stability analyses were predicated on the following assumptions:

- Factors of safety were computed using Spencer's method (Spencer 1967).
- The seismic hazard analysis reported by the United States Geological Survey (2014) indicates a 2% probability of exceeding a peak ground acceleration (PGA) of 0.10 g in 50 years at the site (see Attachment A-1). Pseudo-static analyses were conducted using a horizontal seismic coefficient of 0.05, corresponding to half of the PGA, in accordance with the recommendations of Hynes-Griffin and Franklin (1984).
- Strength properties for cover soil and foundation soil (i.e., site soil) were selected based on the results of consolidated-undrained triaxial testing performed on soil sampled from a stockpile that serves as a borrow source for final cover system construction (refer to Attachment A-2).

- Site soil was assumed to exhibit drained strengths under static loading and undrained strengths under seismic loading. A 20% reduction was applied to site soil undrained strengths in the seismic analyses, as recommended by Hynes-Griffin and Franklin (1984).
- Site soil density was selected based on the average initial density in the consolidated-undrained triaxial test.
- The bedrock underlying the CCRs was assumed to have infinite strength, constraining slip surfaces to the cover soil, CCRs, and foundation soil.
- The top of the bedrock layer was assumed to be at a depth of 30 feet below the pre-landfill ground surface, based on findings from subsurface investigations conducted in the vicinity of the landfill. The floor grades for the landfill were assumed to involve excavation to a depth of 5 feet below the pre-landfill ground surface, based on Golder's understanding and observation of typical construction practices for the landfill.
- Strength properties for CCRs were selected based on the results of consolidated-undrained triaxial testing performed on comingled ash sampled from the landfill (refer to Attachment A-3). CCRs were assumed to exhibit drained strengths under static and seismic loading conditions, and no strength reduction was applied for seismic analyses.
- Density of CCRs was selected based on the average initial density in the consolidated-undrained triaxial test.
- CCRs were assumed to be unsaturated based on site observation.

2.3 Material Properties

A summary of material properties used in the slope stability analyses is presented in Table A-1:

Table A-1: Material Properties

Condition	Material	Total Unit Weight (pcf)	Strength Type	Friction Angle (°)	Cohesion (psf)
Static Loading	Bedrock	120	Infinite Strength	--	--
Seismic Loading					
Static Loading	CCRs	94	Mohr-Coulomb	32	0
Seismic Loading					
Static Loading	Site Soil (Cover Soil and Foundation Soil)	115	Mohr-Coulomb	30	0
Seismic Loading			Shear-Normal Function[1]	--	--

Note:

1) The shear-normal function defining the undrained strength of site soil is based on the results of consolidated-undrained triaxial testing, with a 20% reduction for cyclic loading, as follows: shear strength of 80 psf under zero initial effective stress; shear strength of 179 psf under 864-psf initial effective stress; shear strength of 256 psf under 1,440-psf initial effective stress; shear strength of 2,213 psf under 7,200-psf initial effective stress.

3.0 RESULTS AND CONCLUSIONS

Results of the slope stability analyses are as follows:

- Minimum computed factor of safety = 1.7 under static loading
- Minimum computed factor of safety = 1.1 under seismic loading

The results are also illustrated graphically on the figures in Attachment A-4. The figures depict the critical slip surfaces and computed minimum factors of safety for the analyzed scenarios.

Based on the factors of safety computed using the methods and assumptions described herein, the landfill is expected to remain stable with an acceptable safety margin. A factor of safety greater than 1.5 was computed for critical slip surfaces passing into the CCRs under static loading. A factor of safety greater than 1.0 was computed for critical slip surfaces passing into the CCRs under seismic loading.

4.0 REFERENCES

Golder Associates Inc. 2016. Escalante Generating Station Active Ash Landfill Closure Plan. Report prepared for Tri-State Generation and Transmission Association, Inc. Project number 1663066. October 2016.

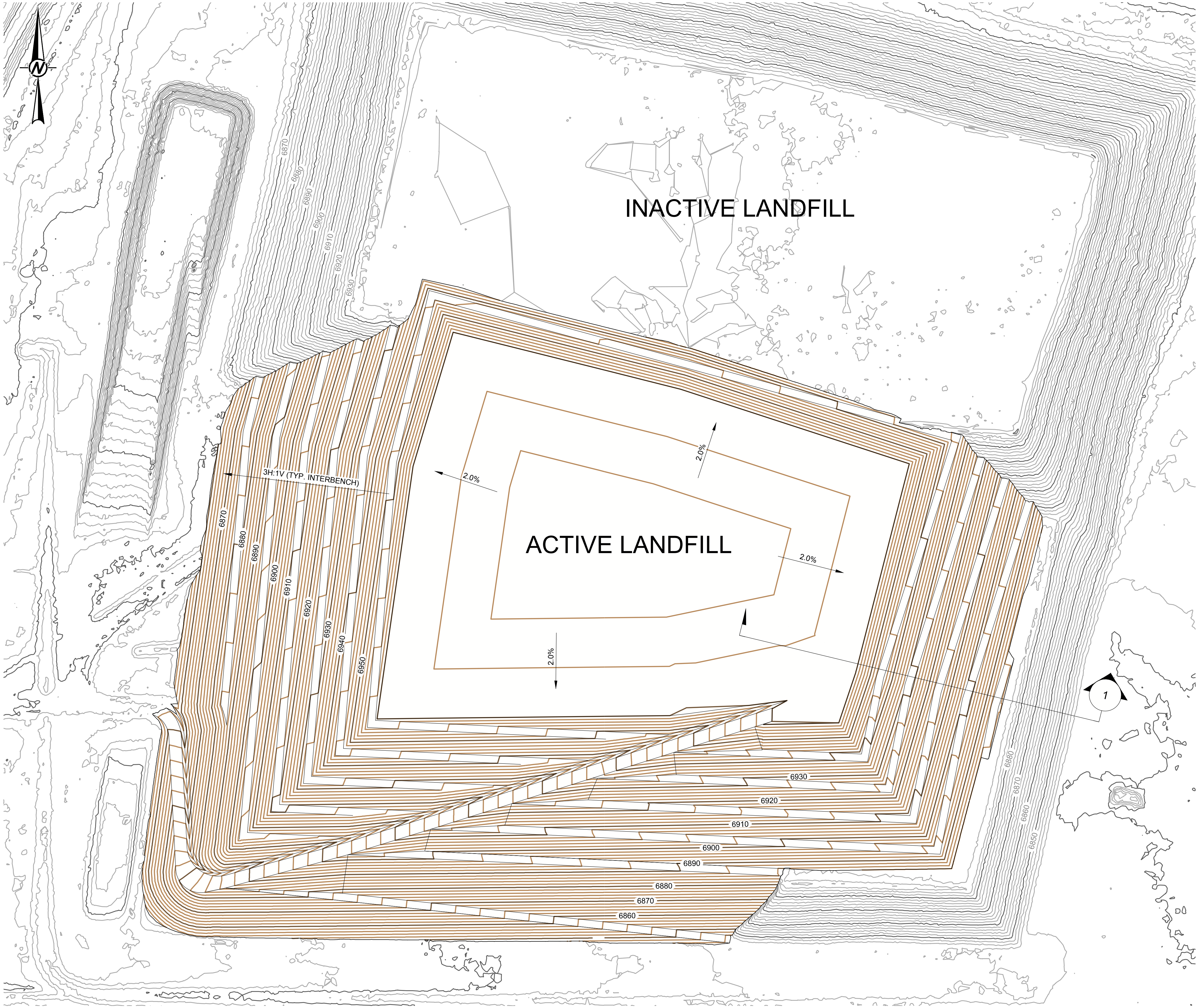
Hynes-Griffin, M. and A. Franklin. 1984. Rationalizing the Seismic Coefficient Method. Miscellaneous Paper GL-84-13. US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Rocscience Inc. 2018. Slide Version 8.016. Build date: July 23, 2018.

Spencer, E. 1967. A Method of Analysis of the Stability of Embankments Assuming Parallel Inter-Slice Forces. Geotechnique, Vol. XVII, No. 1, pp. 11–26.

United States Geological Survey. 2014. PGA with 2% probability of exceedance in 50 years, USGS map, 2014 rev. Available online: https://earthquake.usgs.gov/static/lfs/nshm/conterminous/2014/2014pga2pct.pdf. Accessed September 14, 2018.

FIGURE



LEGEND

EXISTING GROUND SURFACE CONTOURS

PROPOSED GROUND SURFACE CONTOURS

CLIENT
TRI-STATE GENERATION AND TRANSMISSION ASSOCIATION, INC.

PROJECT
ESCALANTE GENERATING STATION
ACTIVE COAL COMBUSTION RESIDUALS LANDFILL

TITLE
SLOPE STABILITY CROSS SECTION LOCATION

CONSULTANT

GOLDER

YYYY-MM-DD	2018-09-14
DESIGNED	JEO
PREPARED	JEO
REVIEWED	CCS
APPROVED	TJS

PROJECT NO.	PHASE	REV.	FIGURE
1783558	0008	A	A-1

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Path: \\DEN1-V-FS1.golder.gds\acad\16\1663066\PRODUCTION\A-SWControl-0001\ | File Name: Figure A-1.dwg

ATTACHMENT A-1

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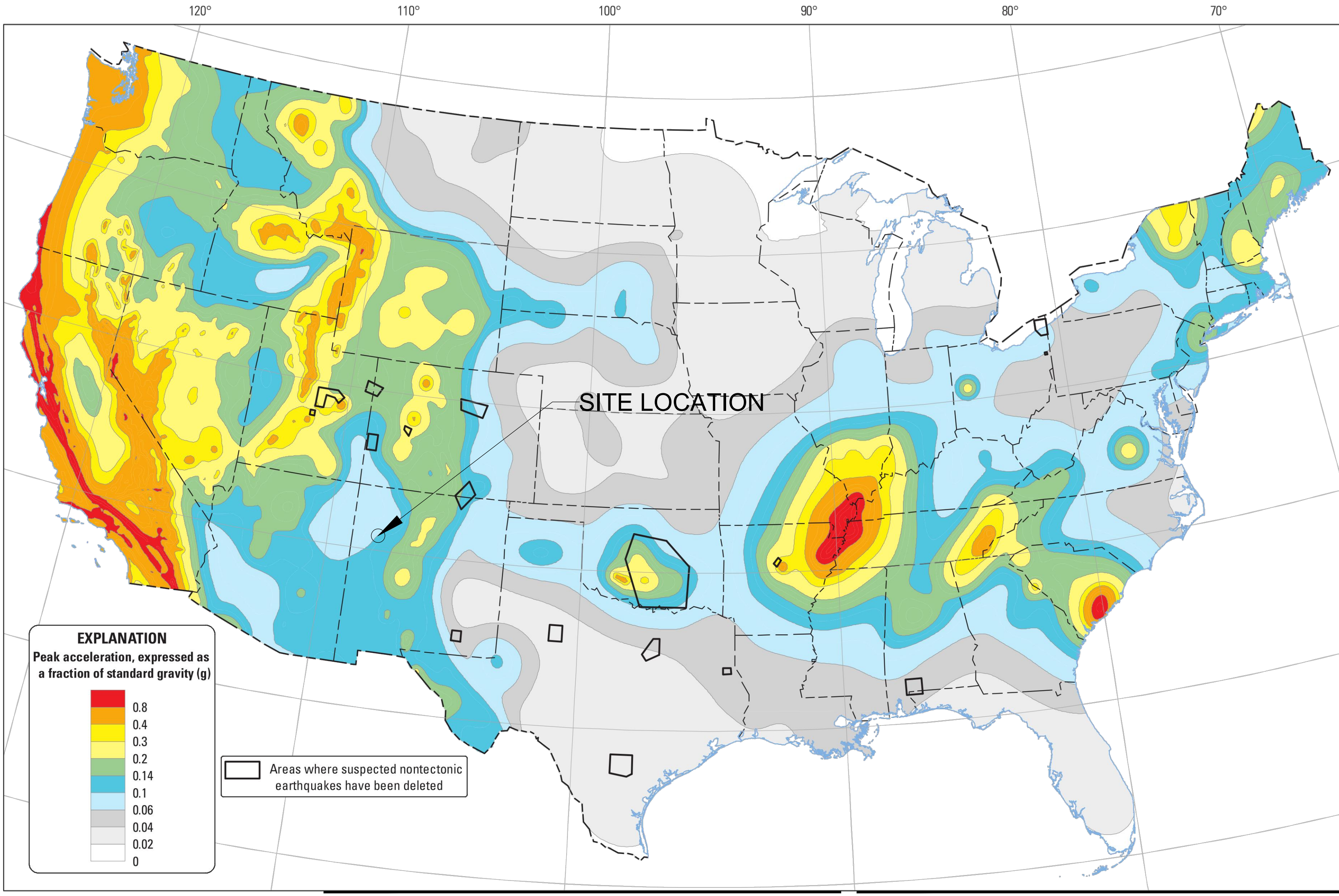


CLIENT
TRI-STATE GENERATION AND TRANSMISSION ASSOCIATION, INC.

PROJECT
ESCALANTE GENERATING STATION
ACTIVE COAL COMBUSTION RESIDUALS LANDFILL

CONSULTANT

GOLDER

YYYY-MM-DD	2018-09-14
PREPARED	JEO
DESIGN	JEO
REVIEW	CCS
APPROVED	TJS

TITLE
TWO PERCENT PROBABILITY OF EXCEEDANCE IN 50 YEARS MAP OF PEAK GROUND ACCELERATION

PROJECT No. 1783558
Rev. A
ATTACHMENT A-1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

0 1 in

ATTACHMENT A-2

	Point 1		Point 2		Point 3	
Boring or Test Pit:	--		--		--	
Sample:	Site Soil		Site Soil		Site Soil	
Depth:	1	ft	1	ft	1	ft
Point No.:	1		2		3	
Initial						
Length =	5.737	in	5.769	in	5.769	in
Diameter =	2.859	in	2.872	in	2.863	in
Wet Mass =	2.480	lb	2.480	lb	2.477	lb
Area =	6.420	in^2	6.478	in^2	6.438	in^2
Volume =	36.830	in^3	37.373	in^3	37.139	in^3
Specific Gravity =	2.68	(ASTM D854)	2.68	(ASTM D854)	2.68	(ASTM D854)
Dry Mass of Solids =	2.371	lb	2.373	lb	2.368	lb
Moisture Content =	4.6%		4.5%		4.6%	
Wet Unit Weight =	116.4	pcf	114.7	pcf	115.3	pcf
Dry Unit Weight =	111.2	pcf	109.7	pcf	110.2	pcf
Void Ratio =	0.50		0.52		0.52	
Percent Saturation =	25%		23%		24%	
After Consolidation						
Length =	5.786	in	5.674	in	5.632	in
Diameter =	2.854	in	2.881	in	2.782	in
Area =	6.399	in^2 (Method B)	6.519	in^2 (Method B)	6.077	in^2 (Method B)
Volume =	37.027	in^3	36.990	in^3	34.226	in^3
Moisture Content =	19.0%		18.9%		14.8%	
Wet Unit Weight =	131.7	pcf	131.8	pcf	137.3	pcf
Dry Unit Weight =	110.7	pcf	110.9	pcf	119.6	pcf
Void Ratio =	0.51		0.51		0.40	
Percent Saturation =	100%		100%		100%	
B Parameter =	0.95		0.95		0.80	
Shear Rate =	0.084%	/min.	0.083%	/min.	0.063%	/min.
t_{50} =	--	(not computed)	--	(not computed)	6.3	min.
Strain at Failure =	8.6%		6.6%		15.2%	
Cell Pressure =	106	psi	110	psi	150	psi
Back Pressure =	100	psi	100	psi	100	psi
Confining Pressure =	6	psi	10	psi	50	psi

Notes: USCS description (ASTM D 2487): Clayey sand, dry, red

Atterberg limits: LL = 22 PL = 13 PI = 9 (ASTM D4318)

Percent finer: 3/4 in. = 100% No. 4 = 99% No. 200 = 41% (ASTM D422, refer to separate report for gradation curve)

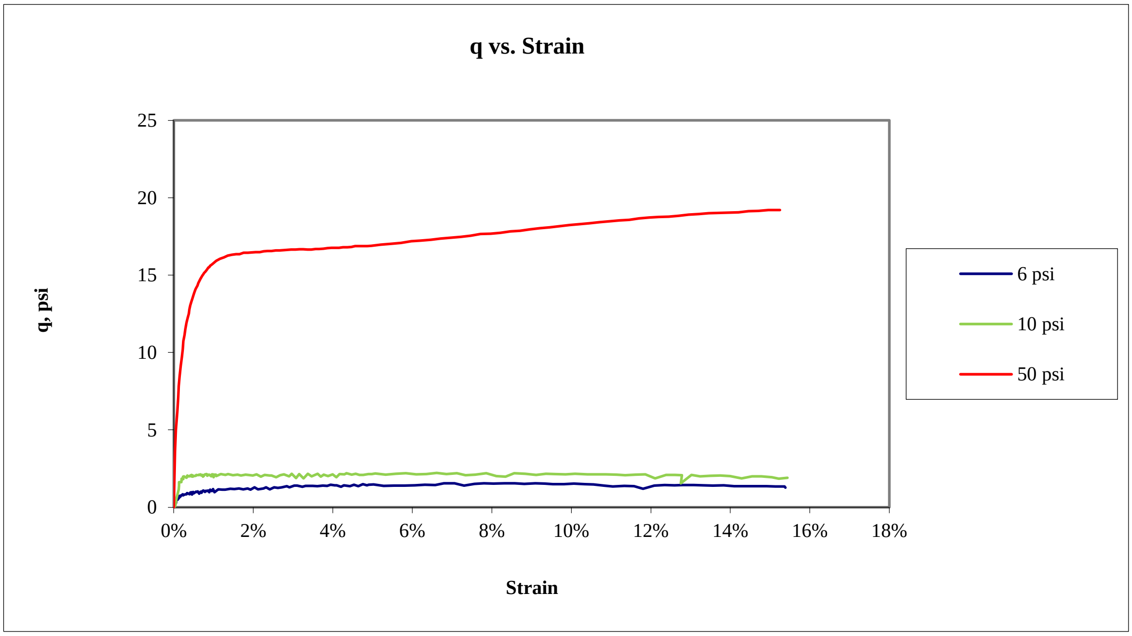
Specimen type:		Intact	X	Reconstituted	Remold targets: 110.4 pcf (dry) at 4.9% moisture	
Moisture from:		Cuttings	X	Entire specimen		
Saturation method:	X	Wet		Dry		
Failure criterion:		$(\sigma'_1/\sigma'_3)_{max}$	X	$(\sigma'_1-\sigma'_3)_{max}$		% strain
Membrane effect:	X	Corrected		Not Corrected		

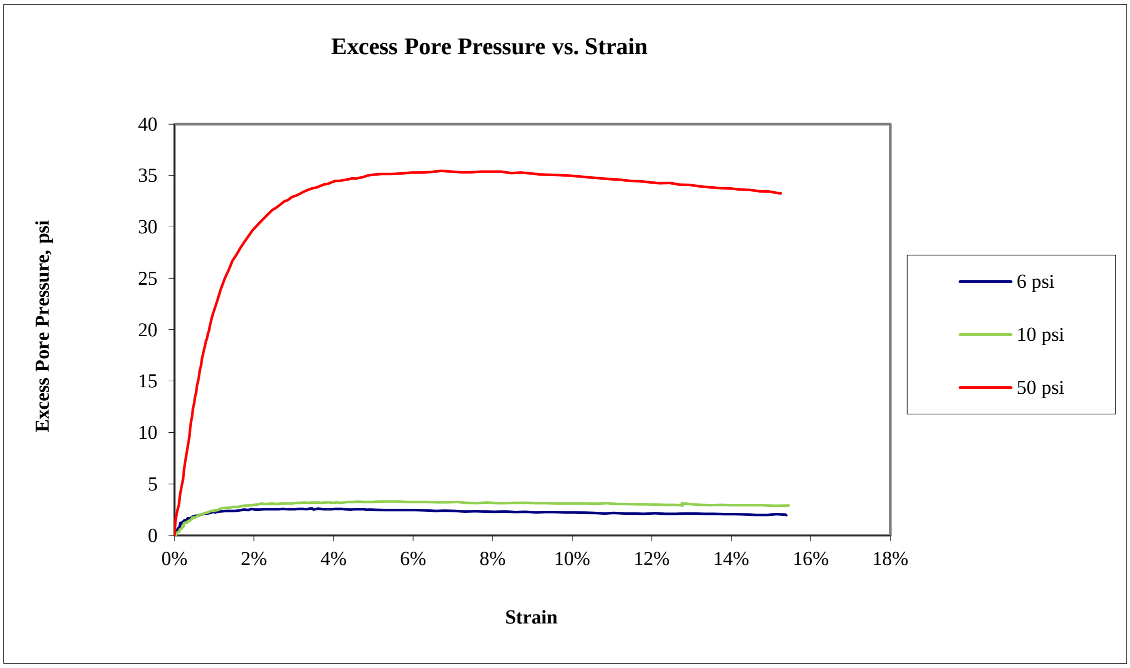
Golder Associates Inc.
Denver, Colorado

Title:
ASTM D4767
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT
SAMPLE AND TEST DATA

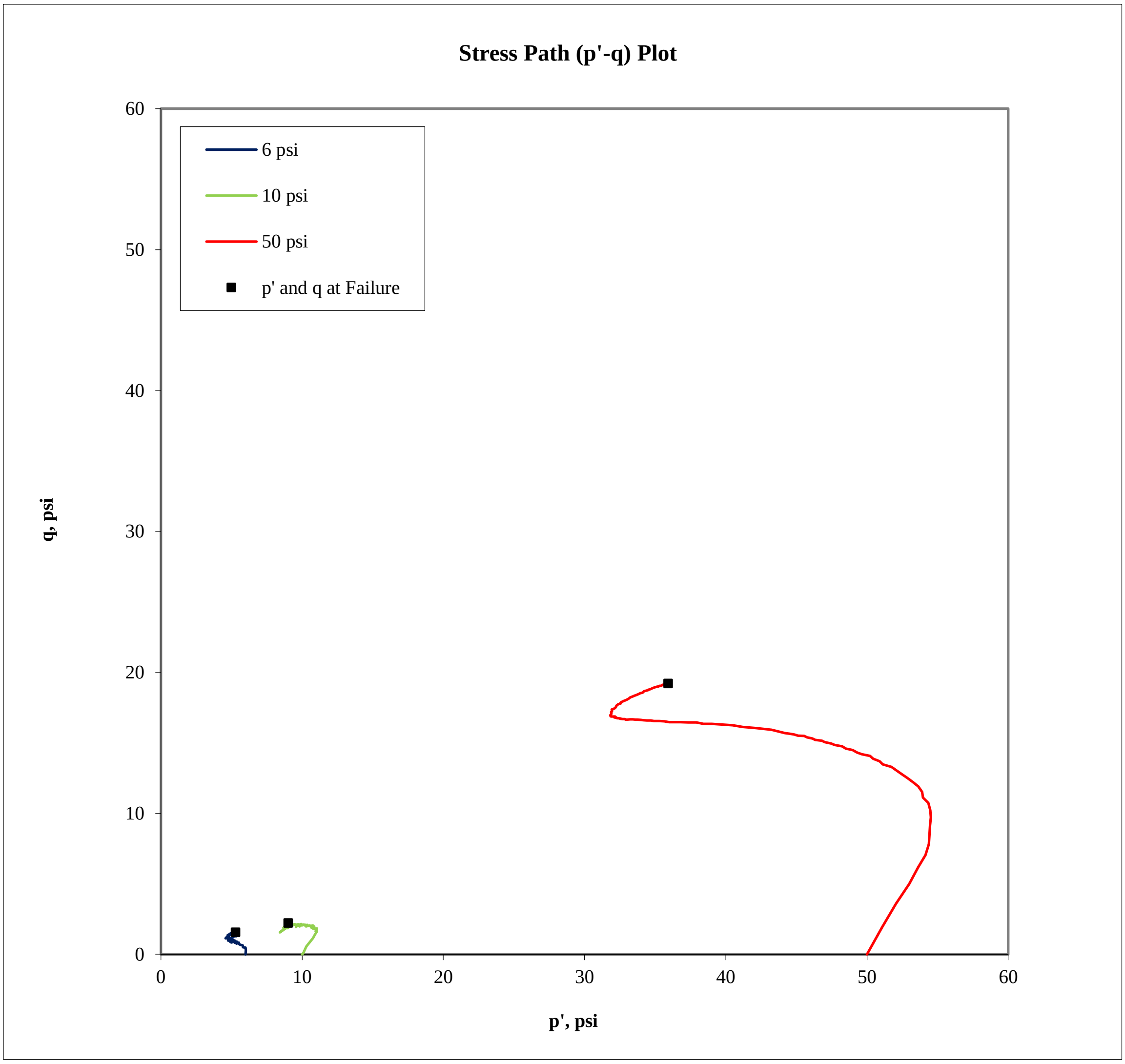
Job Short Title: **Tri-State/Escalante Station/CO**

Sample:	Technician:	Reviewed:	Date:	Job Number:	Figure:
Site Soil	BC	JO	1/21/2016	1533418CCR	1





Golder Associates Inc. Denver, Colorado	**Title:** **ASTM D4767** **CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT** **q AND EXCESS PORE PRESSURE PLOTS**				
Job Short Title: **Tri-State/Escalante Station/CO**					
Sample: **Site Soil**	**Technician:** **BC**	**Reviewed:** **JO**	**Date:** **1/21/2016**	**Job Number:** **1533418CCR**	**Figure:** **2**



Confining Pressure (psi)	p at failure (psi)	p' at failure (psi)	q at failure (psi)
6	7.6	5.3	1.6
10	12.2	9.0	2.2
50	69.2	35.9	19.2

Golder Associates Inc.
Denver, Colorado

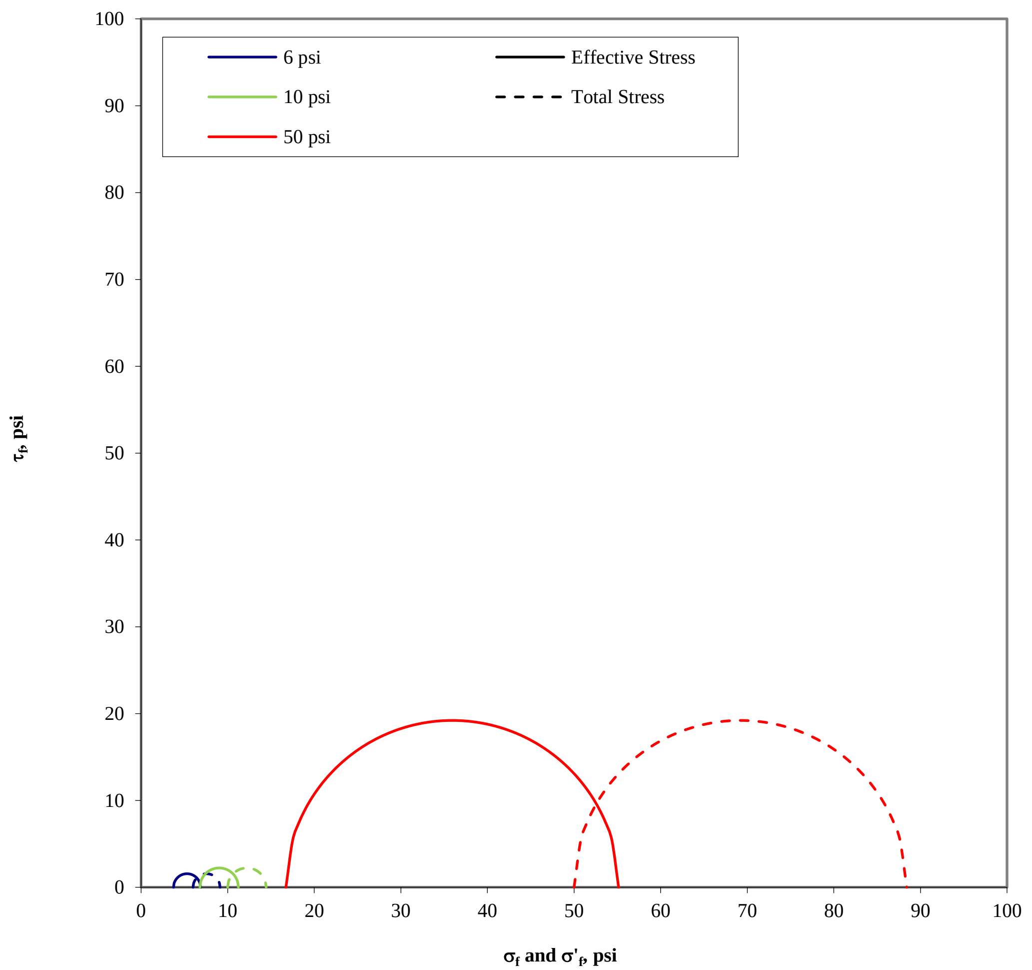
Title:

ASTM D4767
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT
STRESS PATH PLOT

Job Short Title: Tri-State/Escalante Station/CO

Sample:	Technician:	Reviewed:	Date:	Job Number:	Figure:
Site Soil	BC	JO	1/21/2016	1533418CCR	3

Mohr's Circle Diagram



Confining Pressure (psi)	σ'_1 at failure (psi)	σ'_3 at failure (psi)	σ_1 at failure (psi)	σ_3 at failure (psi)
6	6.9	3.7	9.1	6.0
10	11.2	6.8	14.4	10.0
50	55.1	16.7	88.4	50.0

Golder Associates Inc. Denver, Colorado	**Title:** **ASTM D4767** **CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT** **MOHR'S CIRCLE DIAGRAM**
Job Short Title: **Tri-State/Escalante Station/CO**	

Sample:	**Technician:**	**Reviewed:**	**Date:**	**Job Number:**	**Figure:**
Site Soil	**BC**	**JO**	**1/21/2016**	**1533418CCR**	**4**

Golder Associates Inc. **Denver, Colorado**	**Title:** **ASTM D4767** **CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT** **SPECIMEN PHOTOGRAPH - 6 psi**
Job Short Title: **Tri-State/Escalante Station/CO**	

Sample:	**Technician:**	**Reviewed:**	**Date:**	**Job Number:**	**Figure:**
Site Soil	**BC**	**JO**	**1/21/2016**	**1533418CCR**	**5**

Golder Associates Inc. **Denver, Colorado**	**Title:** **ASTM D4767** **CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT** **SPECIMEN PHOTOGRAPH - 10 psi**				
Job Short Title: **Tri-State/Escalante Station/CO**					
Sample: **Site Soil**	**Technician:** **BC**	**Reviewed:** **JO**	**Date:** **1/21/2016**	**Job Number:** **1533418CCR**	**Figure:** **6**

Golder Associates Inc. Denver, Colorado	Title: ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT SPECIMEN PHOTOGRAPH - 50 psi				
Job Short Title: Tri-State/Escalante Station/CO					
Sample: Site Soil	Technician: BC	Reviewed: JO	Date: 1/21/2016	Job Number: 1533418CCR	Figure: 7

ATTACHMENT A-3

	Point 1	Point 2	Point 3	
Boring or Test Pit:	--	--	--	
Sample:	LF Ash	LF Ash	LF Ash	
Depth:	3	3	3	ft
Point No.:	1	2	3	
Initial				
Length =	5.705	5.737	5.713	in
Diameter =	2.879	2.877	2.876	in
Wet Mass =	2.016	2.024	2.019	lb
Area =	6.510	6.501	6.496	in^2
Volume =	37.139	37.295	37.113	in^3
Specific Gravity =	2.28	2.28	2.28	(ASTM D854)
Dry Mass of Solids =	1.676	1.699	1.691	lb
Moisture Content =	20.3%	19.1%	19.4%	
Wet Unit Weight =	93.8	93.8	94.0	pcf
Dry Unit Weight =	78.0	78.7	78.7	pcf
Void Ratio =	0.82	0.80	0.80	
Percent Saturation =	56%	54%	55%	
After Consolidation				
Length =	5.670	5.669	5.636	in
Diameter =	2.828	2.792	2.789	in
Area =	6.283	6.123	6.111	in^2 (Method B)
Volume =	35.627	34.712	34.441	in^3
Moisture Content =	32.8%	29.8%	29.6%	
Wet Unit Weight =	108.0	109.8	109.9	pcf
Dry Unit Weight =	81.3	84.6	84.8	pcf
Void Ratio =	0.75	0.68	0.67	
Percent Saturation =	100%	100%	100%	
B Parameter =	0.96	0.96	0.97	
Shear Rate =	0.033%	0.033%	0.034%	/min.
t_{50} =	--	--	--	(not computed)
Strain at Failure =	1.1%	3.1%	7.6%	
Cell Pressure =	125	150	199	psi
Back Pressure =	100	100	100	psi
Confining Pressure =	25	50	99	psi

Notes:

USCS description (ASTM D2487): Silt with sand, gray, moist

Atterberg limits: LL = NP PL = NP PI = NP (ASTM D4318)

Percent finer: 3/4 in. = 100% No. 4 = 100% No. 200 = 70% (ASTM D422, refer to separate report for gradation curve)

Specimen type:		Intact	X	Reconstituted	Remold targets: 78.4 pcf (dry) at 20.0% moisture	
Moisture from:		Cuttings	X	Entire specimen		
Saturation method:	X	Wet		Dry		
Failure criterion:		$(\sigma'_1/\sigma'_3)_{max}$	X	$(\sigma'_1-\sigma'_3)_{max}$		% strain
Membrane effect:	X	Corrected		Not Corrected		

Golder Associates Inc.

Title:

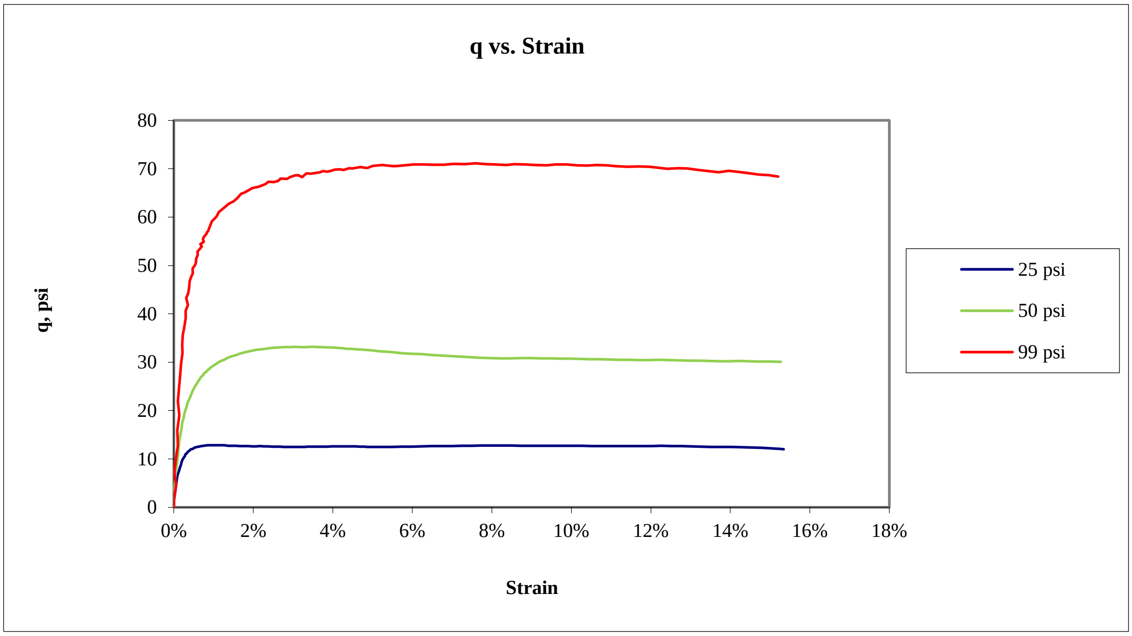
ASTM D4767

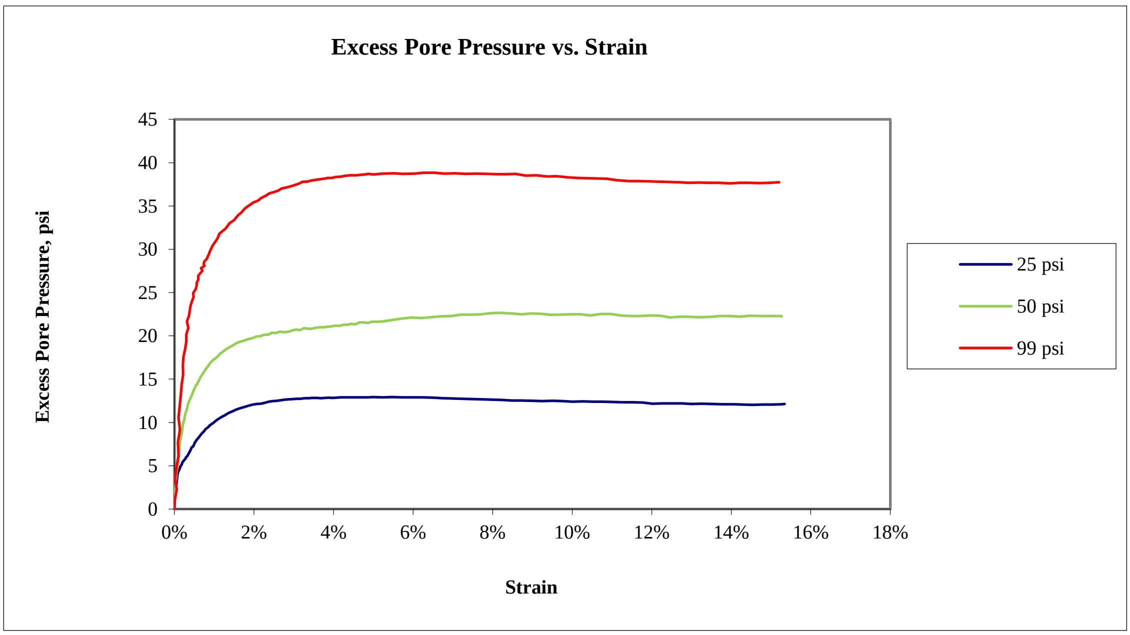
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT

SAMPLE AND TEST DATA

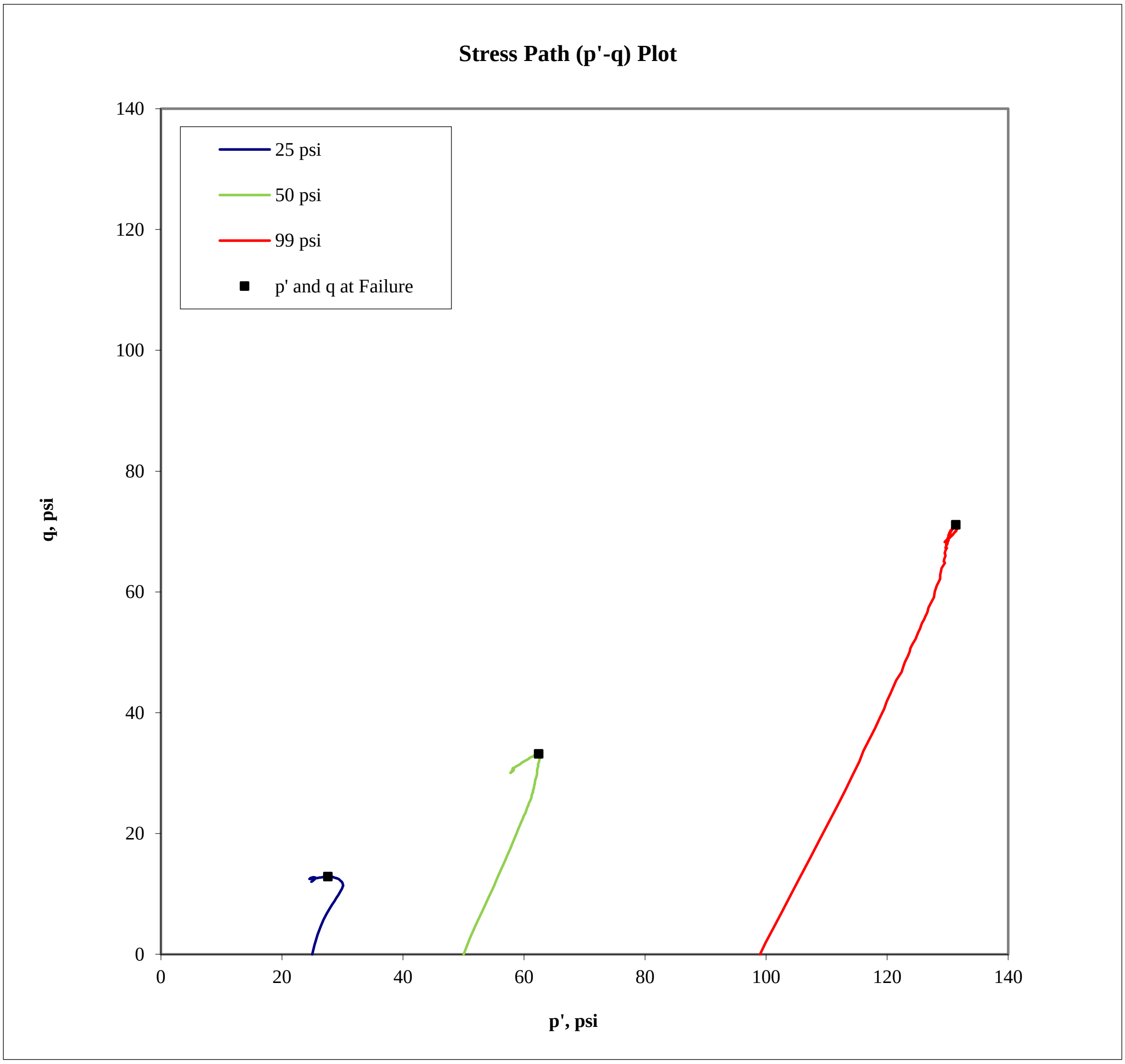
Job Short Title: Tri-State/Escalante Station/CO

Sample:	Technician:	Reviewed:	Date:	Job Number:	Figure:
LF Ash	BC	JO	12/22/2015	1533418CCR	1





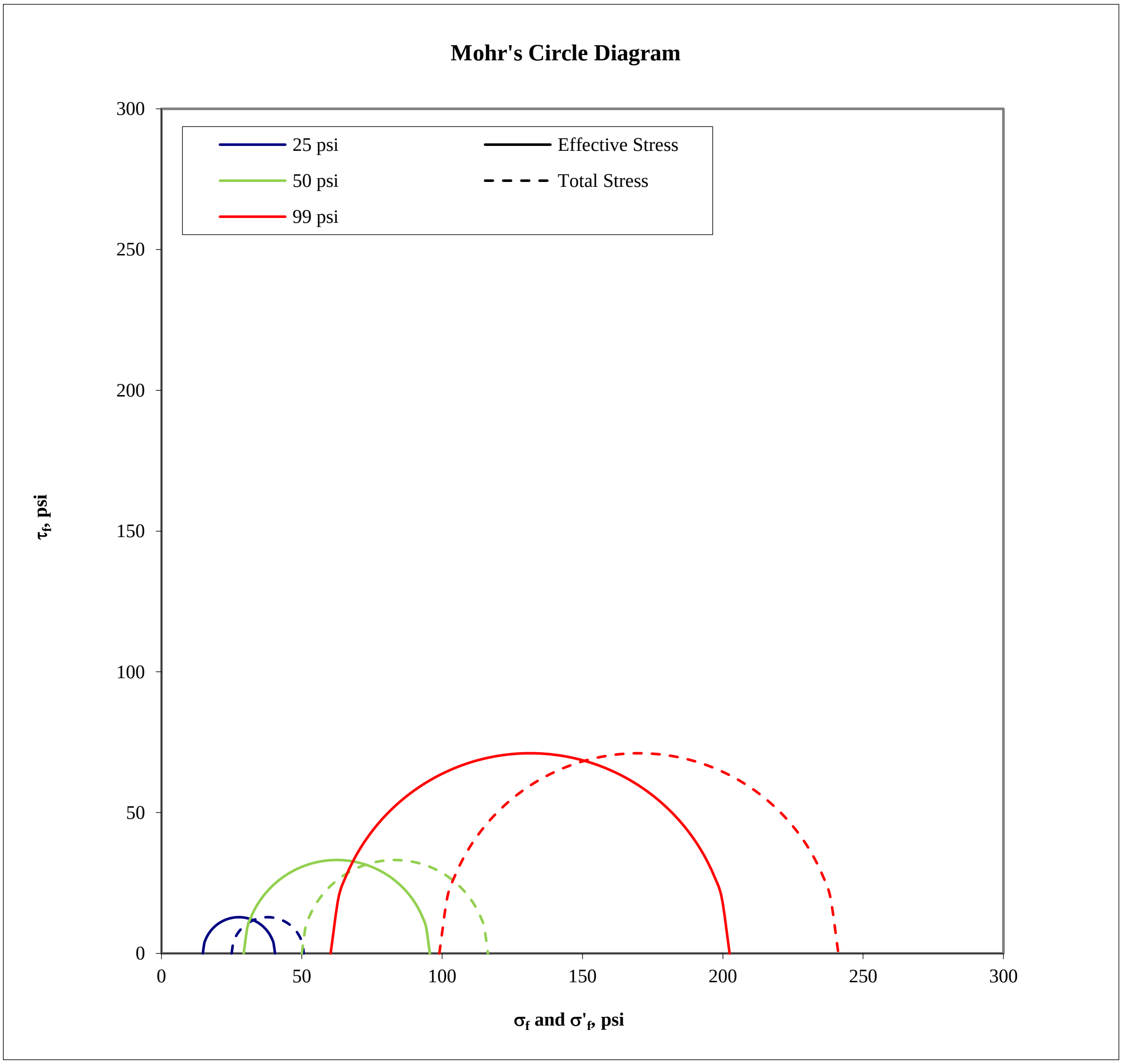
Golder Associates Inc.	**Title:** ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT q AND EXCESS PORE PRESSURE PLOTS				
Job Short Title: Tri-State/Escalante Station/CO					
Sample: LF Ash	**Technician:** BC	**Reviewed:** JO	**Date:** 12/22/2015	**Job Number:** 1533418CCR	**Figure:** 2



Confining Pressure (psi)	p at failure (psi)	p' at failure (psi)	q at failure (psi)
25	37.9	27.6	12.9
50	83.2	62.4	33.2
99	170.1	131.3	71.1

Golder Associates Inc.	Title: ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT STRESS PATH PLOT
Job Short Title: Tri-State/Escalante Station/CO	

Sample:	Technician:	Reviewed:	Date:	Job Number:	Figure:
LF Ash	BC	JO	12/22/2015	1533418CCR	3



Confining Pressure (psi)	σ'_1 at failure (psi)	σ'_3 at failure (psi)	σ_1 at failure (psi)	σ_3 at failure (psi)
25	40.4	14.7	50.7	25.0
50	95.6	29.3	116.3	50.0
99	202.4	60.3	241.2	99.0

Golder Associates Inc.	**Title:** **ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT MOHR'S CIRCLE DIAGRAM**
Job Short Title: **Tri-State/Escalante Station/CO**	

Sample:	**Technician:**	**Reviewed:**	**Date:**	**Job Number:**	**Figure:**
LF Ash	**BC**	**JO**	**12/22/2015**	**1533418CCR**	**4**

Golder Associates Inc.	**Title:** ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT SPECIMEN PHOTOGRAPH - 25 psi
Job Short Title: Tri-State/Escalante Station/CO	

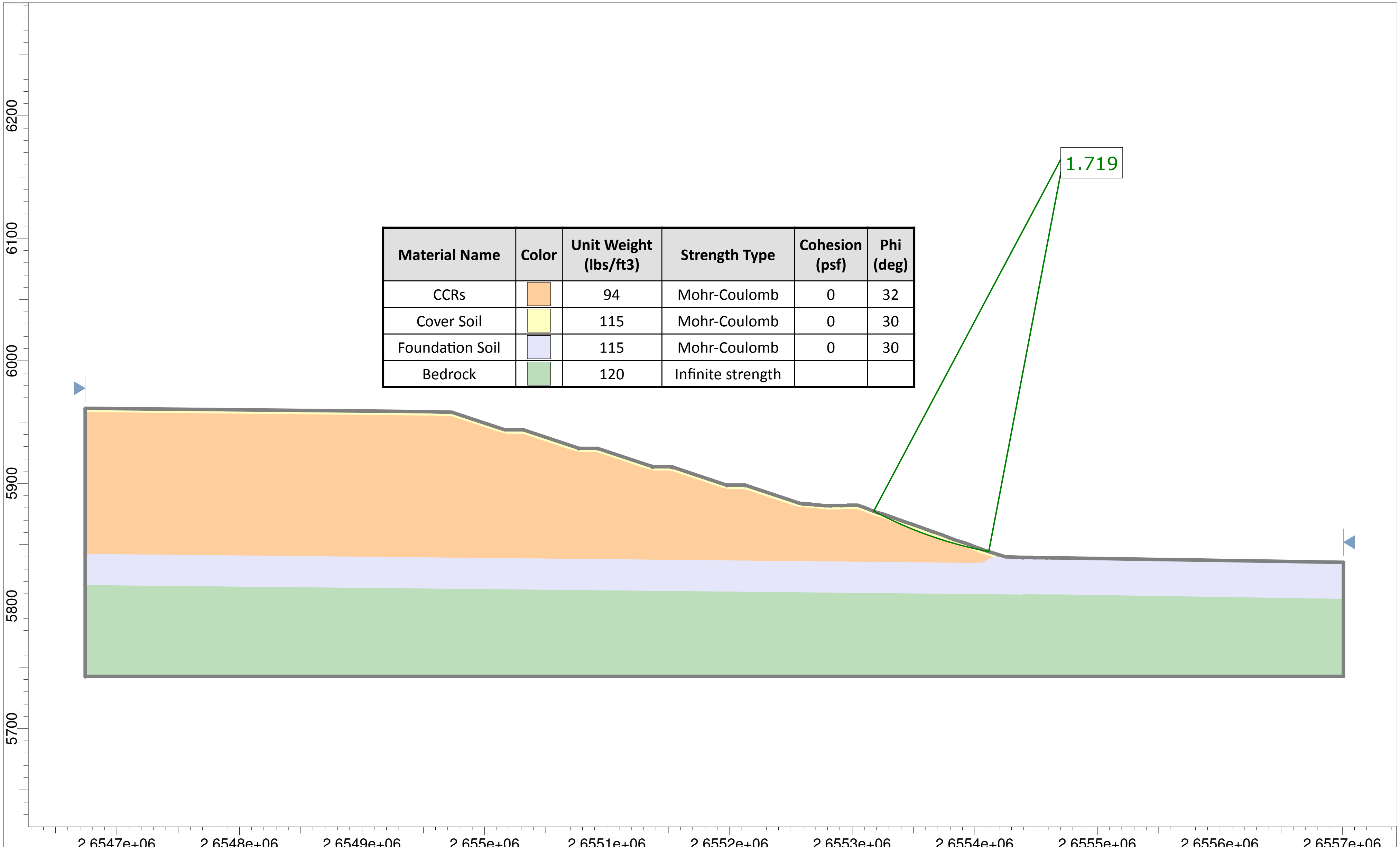
Sample:	Technician:	Reviewed:	Date:	Job Number:	Figure:
LF Ash	BC	JO	12/22/2015	1533418CCR	5

Golder Associates Inc.	Title: ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT SPECIMEN PHOTOGRAPH - 50 psi				
Job Short Title: Tri-State/Escalante Station/CO					
Sample: LF Ash	Technician: BC	Reviewed: JO	Date: 12/22/2015	Job Number: 1533418CCR	Figure: 6

Golder Associates Inc.	Title: ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT SPECIMEN PHOTOGRAPH - 99 psi
Job Short Title: Tri-State/Escalante Station/CO	

Sample:	Technician:	Reviewed:	Date:	Job Number:	Figure:
LF Ash	BC	JO	12/22/2015	1533418CCR	7

ATTACHMENT A-4

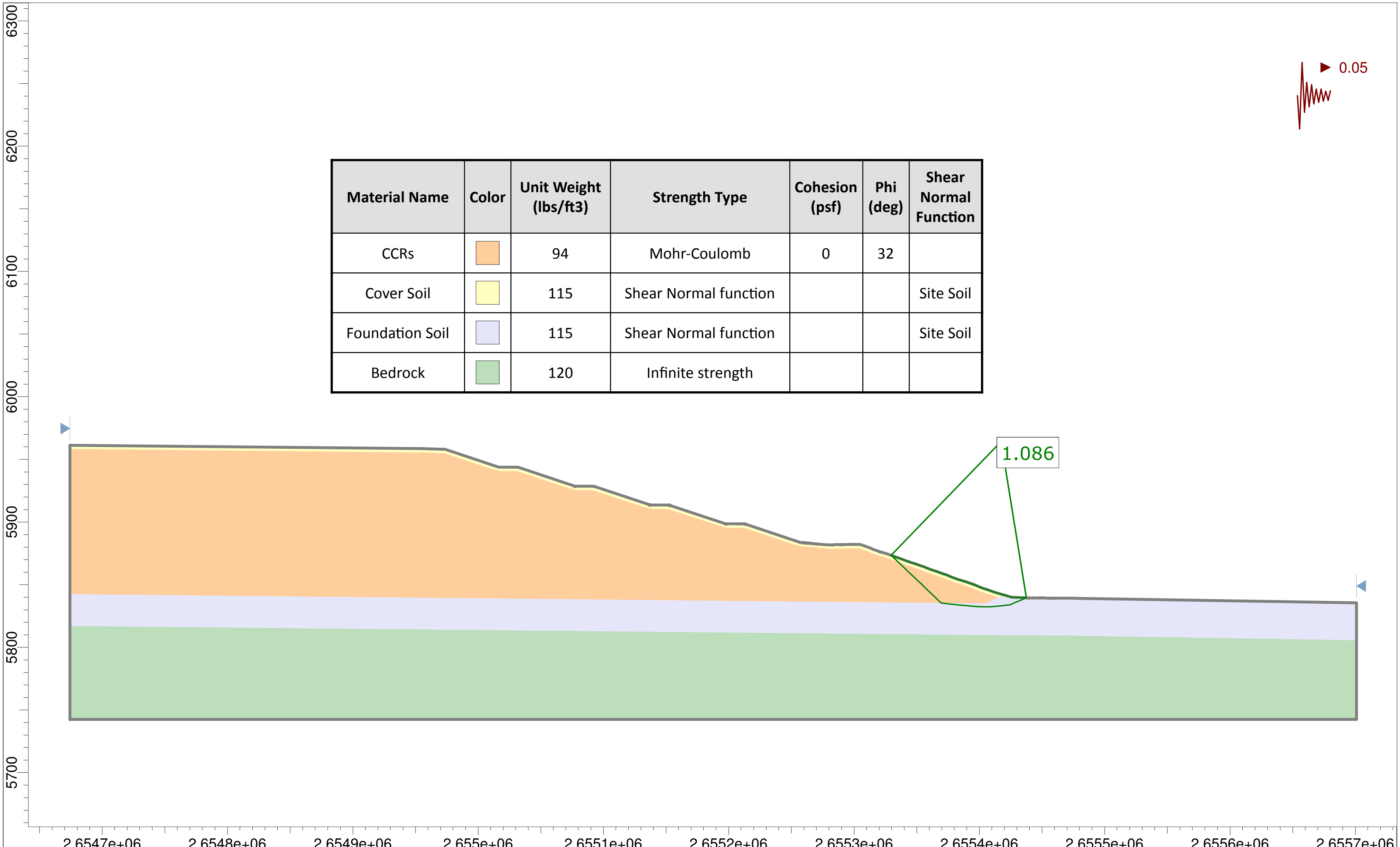


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
CCRs		94	Mohr-Coulomb	0	32
Cover Soil		115	Mohr-Coulomb	0	30
Foundation Soil		115	Mohr-Coulomb	0	30
Bedrock		120	Infinite strength		

rocscience

SLIDEINTERPRET 8.016

Project	Escalante Generating Station Active Coal Combustion Residuals Landfill		
Analysis Description	Static Loading		
Drawn By	Jason Obermeyer	*Company*	Golder Associates Inc.
Date	9/14/2018, 8:35:18 AM	*File Name*	Static.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Shear Normal Function
CCRs		94	Mohr-Coulomb	0	32	
Cover Soil		115	Shear Normal function			Site Soil
Foundation Soil		115	Shear Normal function			Site Soil
Bedrock		120	Infinite strength			

rocscience

SLIDEINTERPRET 8.016

Project	Escalante Generating Station Active Coal Combustion Residuals Landfill
Analysis Description	Seismic Loading
Drawn By	Jason Obermeyer
Company	Golder Associates Inc.
Date	9/14/2018, 8:35:18 AM
File Name	Pseudostatic2.slim

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