PETTIGREW & ASSOCIATES PA

ENGINEERING | SURVEYING | TESTING

DEFINING QUALITY SINCE 1965

Soils Investigation

Bank Stabilization Cuchillo Negro Arroyo
Sierra County, New Mexico

PREPARED FOR:

County of Sierra
Attn: Jocelyn Holguin
855 Van Patten
Truth or Consequences, NM

LAB No. 16 5364
PROJECT No. 2016.1125

DEBRA P. HICKS
NEW MEXICO
10871
REGISTERED PROFESSIONAL ENGINEER

Debra P. Hicks, PE/LSI
NM 10871

November 21, 2016

PREFACE

This report is generated specifically for the purpose of providing design criteria for the Bank Stabilization Cuchillo Negro Arroyo Project – Sierra County, New Mexico. Under no circumstances shall it be used for any other project on or off the site. This report is meant to provide information that will inform the County of Sierra of appropriate design criteria for the planned use. The conditions encountered in field exploration and reported herein are accurate for the test location(s), time and conditions. It is not meant to eliminate the uncertainty regarding the potential for variation or changes in subsurface conditions at the site. Subsurface descriptions contained herein are of a generalized nature to provide highlights of major strata and conditions revealed in the soil samples, however it represents only the conditions at the actual boring locations.

Debra P. Hicks, PE/LSI

NM 10871

Table of Contents

Soils Investigation

Introduction

County of Sierra proposes to stabilize the banks of the Cuchillo Negro Arroyo north of Highway 51 in Sierra County, New Mexico.

This report presents the results of the field and laboratory soils investigation. The proposed site is located in Pedro Armendariz Land Grant No. 33, Sierra County, New Mexico. This investigation was performed at the direction and authorization of Ms. Jocelyn Holguin with the County of Sierra.

The purpose of this investigation is to determine the characteristics of the subsoils and provide recommendations for bank stabilization. This report provides an overview of existing geotechnical/geologic conditions at the proposed site and geotechnical design parameters for the proposed facilities. The geotechnical site conditions presented herein are based on our field exploration as well as literature reviewed from available geotechnical/geologic reports in the project vicinity. This report does not include environmental site characterization, hazardous materials testing, or other environmental services.

Proposed Development

The proposed development includes the following:

- Installation of Bank Stabilization

Field Exploration

Six (6) test borings were drilled July 6 through July 7, 2016 at the locations listed in Table 1. The exploratory borings were drilled to approximate depths listed in Table 1 of this Report. Boring locations are shown on the Boring Location Map. Drilling was carried out using a truck-mounted drill rig contracted with Enviro-Drill, Inc. – Albuquerque, New Mexico.

TABLE – 1 Boring Dates, Elevations and Depths

Boring	Date Drilled	Latitude	Longitude	Depth
BH-1	7/7/16	33.1495	-107.2215	22′0″
BH-2	7/7/16	33.1501	-107.2227	22′0″
BH-3	7/7/16	33.1509	-107.2241	22′0″
BH-4	7/6/16	33.1519	-107.2257	22′0″
BH-5	7/6/16	33.1494	-107.2226	22′0″
BH-6	7/6/16	33.1502	-107.2241	22′0″

Subsurface materials were sampled at varying intervals by split spoon sampler and/or drill cuttings where applicable.

Air-rotary/auger drilling methods were employed to cut the test borings. During the drilling, the soils encountered were continuously examined, visually classified and, where applicable, sampled.

Standard penetration tests (SPT) were performed at varying depths. Penetration resistance was measured in accordance with ASTM D 1586 by driving a standard 2″ split tube sampler having a 30″ free fall drop hammer weighing 140 pounds. The penetration resistance value is a useful index in estimating the consistency, relative density or hardness of the materials encountered.

Laboratory Analysis

Representative samples were tested in the laboratory to determine certain engineering properties of the soils. Mechanical analysis and soil constant determinations were performed for classification and identification of each soil type encountered. Classifications are in accordance with the Unified Soil Classification System ASTM D 2487. The results of the laboratory tests are presented in the Summary of Tests.

The following tests were conducted on selected soil samples:

- Moisture Content
- Sieve Analysis
- Atterberg Limits
- Unit Weight
- Direct Shear

A summary of the test results are presented on the Logs and in the Appendix.

Site Conditions

As previously described, the project site is located in Pedro Armendariz Land Grant No. 33, Sierra County, New Mexico. The project site is the arroyo north of Highway 51 and approximately 0.25 miles west of Highway 179. Site vegetation includes large brush, mesquite, salt cedars, grasses and trees.

Subsurface Soil Conditions

Stratigraphy – Southern Portion of East Bank (Borings 1-2)

Stratum 1 – Stratum 1 is silty sand with gravel (SM). These soils are loose to very dense in relative density. The thickness of this stratum is approximately 6' below ground surface. Soils are grayish tan, moist and non-plastic.

Stratum 2 – Stratum 2 is classified as silty sand (SM) and silty clay with sand (CL-ML). These soils are very loose to medium dense. The thickness of this stratum is approximately 6' to 12' below ground surface. Soils are brown, moist to wet and non-plastic to slightly plastic.

Stratum 3 – Stratum 3 is classified as silty sand with gravel (SM). These soils are very loose to medium dense. This stratum is present approximately 12' to 22' below ground surface. Soils are brown, moist to wet and non-plastic to slightly plastic.

TABLE – 2 Soil Parameters

Strata	Unified Soil Classification	Strata Depth (ft)	Total Unit Weight γ (pcf)	Cohesion C (ksf)	Friction Angle Φ (°)	Subgrade Modulus K (pci)	Equivalent Fluid Pressure At Rest ko	Equivalent Fluid Pressure Active ka	Equivalent Fluid Pressure Passive kp
S-1	SM	0	130.0	0.0	40.0	276.5	0.357	0.217	4.599
S-2	CL-ML	6	120.4	0.071	31.9	313.1	0.472	0.309	3.241
S-3	SM	10	119.4	0.0	35.2	79.4	0.424	0.269	3.722

Soil Parameters determined with Allpile.

Stratigraphy – Northern Portion of East Bank (Boring 3)

Water was encountered at 14' below ground surface.

Stratum 1 – Stratum 1 is silty sand (SM). These soils are medium dense to dense in relative density. This stratum is approximately 6' thick. Soils are brown, damp and non-plastic.

Stratum 2 – Stratum 2 is classified as silty clay with sand (CL-ML). These soils are very soft to soft in relative firmness. This stratum is present at a depth of 6' to 15' below ground surface. Soils are brown, moist and moderately plastic.

Stratum 3 – Stratum 3 is classified as silty sand with gravel (SM). These soils are loose to medium dense. This stratum is present from a depth of 15' to 22' below ground surface. Soils are light brown, moist and non-plastic.

TABLE – 3 Soil Parameters

Strata	Unified Soil Classification	Strata Depth (ft)	Total Unit Weight γ (pcf)	Cohesion C (ksf)	Friction Angle Φ (°)	Subgrade Modulus K (pci)	Equivalent Fluid Pressure At Rest ko	Equivalent Fluid Pressure Active ka	Equivalent Fluid Pressure Passive kp
S-1	SM	0	121.6	0.0	36.6	111.7	0.404	0.253	3.953
S-2	CL-ML	6	120.4	0.0	33.6	67.2[1]	0.447	0.288	3.478
S-3	SM	15	117.6	0.0	34.2	62.7	0.438	0.280	3.567

Soil Parameters determined with Allpile.
[1]Tested by Terracon

Stratigraphy – Northern Portion of East Bank (Boring 4)

Stratum 1 – Stratum 1 is silty sand with gravel (SM). These soils are medium dense to very dense in relative density. This stratum is approximately 6' thick. Soils are grayish tan, damp and non-plastic.

Stratum 2 – Stratum 2 is classified as silty sand (SM) with a 6" seam of silty clay with sand (CL-ML) at the base of the stratum. These soils are very loose to medium dense. This stratum is present approximately 6' to 15'6" below ground surface. Soils are brown, moist and non-plastic.

Stratum 3 – Stratum 3 is classified as silty sand with gravel (SM). These soils are medium dense. This stratum is present approximately 15'6" to 22' below ground surface. Soils are light brown, moist and non-plastic.

TABLE – 4 Soil Parameters

Strata	Unified Soil Classification	Strata Depth (ft)	Total Unit Weight γ (pcf)	Cohesion C (ksf)	Friction Angle Φ (°)	Subgrade Modulus K (pci)	Equivalent Fluid Pressure At Rest ko	Equivalent Fluid Pressure Active ka	Equivalent Fluid Pressure Passive kp
S-1	SM	0	123.0	0.00	38.0	158.0	0.384	0.238	4.204
S-2	SM	6	117.0	0.047[1]	33.6[1]	58.8	0.447	0.288	3.478
S-3	SM	15.5	120.0	0.00	35.5	86.3	0.419	0.265	3.770

Soil Parameters determined with Allpile.
[1]Tested by Terracon

Stratigraphy – West Bank (Boring 5)

Water was encountered at 15' below ground surface.

Stratum 1 – Stratum 1 is silty sand with gravel (SM). These soils are medium dense to dense in relative density. This stratum is approximately 6'6" thick. Soils are tannish brown, damp and non-plastic.

Stratum 2 – Stratum 2 is classified as sandy silt (ML). These soils are very loose to loose. This stratum is present from 6'6" to 8' below ground surface. Soils are tannish brown, moist and slightly plastic.

Stratum 3 – Stratum 3 is classified as lean clay (CL). These soils are medium stiff to stiff. This stratum is present from 8' to 16'6" below ground surface. Soils are brown, moist and plastic.

Stratum 4 – Stratum 4 is classified as silty sand with gravel (SM). These soils are medium dense to dense. This stratum is present from 16'6" to 22' below ground surface. A thin seam of silty clay is present at approximately 20' below ground surface. Soils are light brown, moist and non-plastic.

TABLE – 5 Soil Parameters

Strata	Unified Soil Classification	Strata Depth (ft)	Total Unit Weight γ (pcf)	Cohesion C (ksf)	Friction Angle Φ (°)	Subgrade Modulus K (pci)	Equivalent Fluid Pressure At Rest ko	Equivalent Fluid Pressure Active ka	Equivalent Fluid Pressure Passive kp
S-1	SM	0	122.1	0.00	37.0	123.8	0.398	0.249	4.023
S-2	ML	6.5	122.2	0.38	28.1	136.8	0.529	0.360	2.781
S-3	CL	8	120.4[1]	0.047[1]	33.6[1]	201.0	0.447	0.288	3.478
S-4	SM	16.5	120.0	0.00	36.9	120.0	0.400	0.250	4.005

Soil Parameters determined with Allpile.
[1]Tested by Terracon

Stratigraphy – West Bank (Boring 6)

Water was encountered at 15' below ground surface.

Stratum 1 – Stratum 1 is silty sand with gravel (SM). These soils are loose to dense in relative density. This stratum is approximately 6' thick. Soils are tannish brown, damp and non-plastic.

Stratum 2 – Stratum 2 is classified as sandy silt (ML). These soils are loose. This stratum is present from 6' to 8' below ground surface. Soils are tannish brown, moist and slightly plastic.

Stratum 3 – Stratum 3 is classified as lean clay (CL). These soils are soft to very stiff. This stratum is present from 8' to 12' below ground surface. Soils are brown, moist and plastic.

Stratum 4 – Stratum 4 is classified as poorly graded gravel with sand (GP). These soils are medium dense to very dense. This stratum is present from 12' to 22' below ground surface. Soils are tan to brown, moist and non-plastic.

TABLE – 6 Soil Parameters

Strata	Unified Soil Classification	Strata Depth (ft)	Total Unit Weight γ (pcf)	Cohesion C (ksf)	Friction Angle Φ (°)	Subgrade Modulus K (pci)	Equivalent Fluid Pressure At Rest ko	Equivalent Fluid Pressure Active ka	Equivalent Fluid Pressure Passive kp
S-1	SM	0	122.7	0.00	37.7	146.0	0.388	0.241	4.148
S-2	ML	6 1/2	125.1	0.45	28.7	188.0	0.520	0.351	2.848
S-3	CL	8	112.9[1]	0.047[1]	33.6[1]	201.0	0.447	0.288	3.478
S-4	SM	16 1/2	126.0	0.00	39.2	225.3	0.368	0.225	4.435

Soil Parameters determined with Allpile.
[1]Tested by Terracon

Groundwater

Groundwater was encountered in Borings 3, 5 and 6.

Expansive Soils

In accordance with the 2009 International Building Code - Section 1803.5.3 Soil Classification, onsite soils should be considered non-expansive.

Discussion and Recommendations

The following discussion and recommendations are based upon the results of field and laboratory testing, engineering analyses, experience with similar soil conditions, and our understanding of the proposed project.

Site Work

In general, field test results indicate that the silty, sandy, and clayey soils vary from very loose to very dense in relative density as indicated by measured SPT-N Values of 3 blows in 12" to 50 blows per 5". Very dense materials (N>30) were encountered at variable depths. Based on the results of the field investigation, excavations within the soil matrix and cemented zones are expected to be difficult.

Frost Depth

Frost penetration approximates 15" to 18".

Seismic Design Parameters

In accordance with the 2012/2015 International Building Code®, Section 1613.3.1, Site Class D is applicable.

Liquefaction Potential

Soils to depths explored of up to 22'0" are dry to wet ranging from 2.0 to 42.5 percent in the samples tested. Subsurface soil and groundwater conditions indicate that there is potential for liquefaction to occur.

Recommendations

1) All vegetation and other deleterious materials should be removed from the site area prior to other construction activities. Stripped materials consisting of vegetation and organic materials (estimated depth of 8") should be wasted from the site, or used to re-vegetate landscaped areas or exposed slopes after completion of grading operations. Deleterious material should be removed from the site.

2) All soils that are to receive foundation elements should be scarified a minimum of 8" and compacted, at approximately optimum moisture (plus 1.5% to minus 1.5%), to not less than 95% of Laboratory Density as determined by ASTM D 698.

3) All fill and/or backfill be placed in lifts not to exceed 8" (loose), and compacted at approximately optimum moisture (plus 1.5% to minus 1.5%), to not less than 95% of Laboratory Density as determined by ASTM D 698.

4) **BACKFILL:** Materials for Backfill behind Gabions or Sheet Piles shall be classified as GP, GW, GM, GC, SW, SP, SM or SC as determined by the Unified Soil Classification System.

5) **ENGINEERED FILL:** Materials for Engineered Fill shall be composed of an appropriate combination of crushed stone, crushed or screened gravel, caliche, and/or sand to meet the specifications contained herein. Materials shall be free from vegetable matter and all other deleterious materials, including silt and clay balls.

Size	Cumulative % Passing
2″	100
½″	30-80
#4	20-60
#200	5-20

Liquid Limit	35 max
Plasticity Index	4 min to15 max

6) All imported fill material shall be from same source.

7) **PORTLAND CEMENT CONCRETE:** Portland Cement Concrete shall be proportioned in accordance with ACI 211.1-81; all portland cement shall be an approved American (USA) brand conforming to ASTM C150, Type II, or Type V with Class F flyash, where concrete is to be placed against high sulfate content soils, low alkali; and, all exposed Portland Cement Concrete or Portland Cement Concrete slabs on grade shall be air entrained.

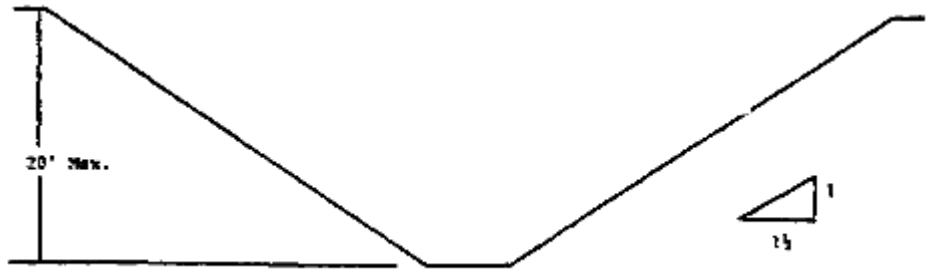
8) **OSHA EXCAVATIONS:** Temporary construction slopes should be designed and excavated in strict compliance with the rules and regulations of the Federal Register, Volume 54, No. 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA), 29 CFR, Part 1926. This document was prepared to better insure the safety of workers entering trenches or excavations, and requires that all excavations conform to the new OSHA guidelines.

   The contractor is solely responsible for protecting excavations by shoring, sloping, benching or other means as required to maintain stability of both the excavation sides and bottom. Pettigrew & Associates, P.A. does not assume any responsibility for construction site safety or the activities of the contractor.

   For this site, the overburden soil encountered in our exploratory borings consisted of mostly silty sands (OSHA Classification C) in Stratum 1. For stratum 2 soils, OSHA classification Type C is also recommended. OSHA recommends a maximum slope inclination of 1.5H:1V for Type C soils. Excavation requirements will vary depending on the actual soil conditions in some areas. Temporary construction slopes should be closely observed for signs of mass movement, such as tension cracks near the crest, bulging at the toe of the slope, etc.

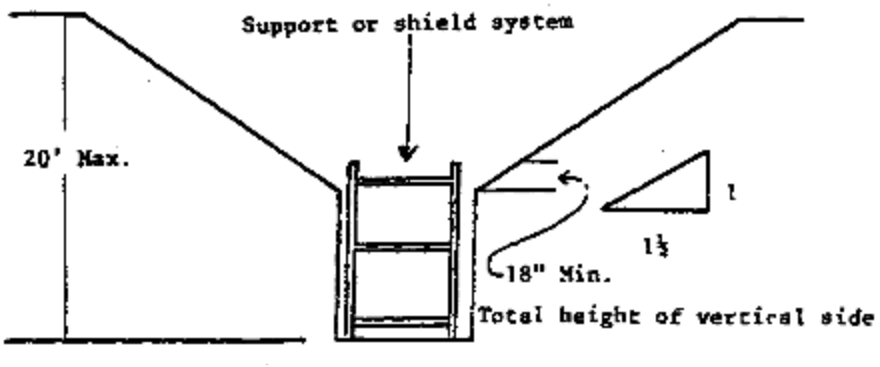
B-1.3 Excavations Made in Type C Soil

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1½:1.



SIMPLE SLOPE

2. All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1½:1.



VERTICAL SIDED LOWER PORTION

3. All other sloped excavations shall be in accordance with the other options permitted in § 1926.652(b).

OSHA Part 1926 Subpart P

Additional Services

The recommendations presented in this report are contingent on Pettigrew & Associates, P.A observing and/or monitoring:

- Proofrolling and fill Subgrade conditions;
- Backfilling and compaction of excavations;
- Suitability of borrow materials;
- Fill placement and compaction;
- Foundation subgrades; and
- Compliance with the geotechnical recommendations.

Closure

Our conclusions, recommendations and opinions presented herein are based upon our evaluation and interpretation of the findings of the field and laboratory investigation. **If during construction, conditions are found to be other than those presented in this report, this office should be consulted.** Pettigrew & Associates, P.A appreciates the opportunity to provide our services on this project and looks forward to working with you during construction and on future projects. Should you have any questions, please do not hesitate to contact us.

Boring Location Map

NM WebMap

Approximate Borehole Locations

Logs and Summaries

PETTIGREW & ASSOCIATES PA

ENGINEERING | SURVEYING | TESTING

DEFINING QUALITY SINCE 1965

BORING NO.: BH-1

CLIENT: County of Sierra
PROJECT NAME: Bank Stabilization Cuchillo Negro Arroyo
PROJECT NO.: 2016.1125
DATE DRILLED: 7/7/2016

COORDINATES: Lat.33.149450° Long. -107.221479°
SURFACE ELEVATION: 4257.32'
BOREHOLE DEPTH: 22'0"
DEPTH TO WATER: N/A

DEPTH (FT)	LITHOLOGIC SYMBOL	SAMPLE RECOVERED	BLOWS PER FOOT	DESCRIPTION	SOIL CLASSIFICATION	LABORATORY TEST DATA: % MOISTURE	% PASSING 3/4"	% PASSING #4	% PASSING #10	% PASSING #40	% PASSING #200	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	BEARING CAPACITY (psf)	qu (psf)	SHEAR STREGTH (tsf)
0			16	Grayish Tan Silty Sand with Gravel		3.0									2,730		
			68			3.0									>8,000		
			47			4.9									>8,000		
			36		SM	4.9	100	74	65	47	15.5	SNP	SNP	SNP	7,140		
			16			5.6									2,730		
5			9			5.6									1,190		
			4	Brown Silty Sand		23.5									90		
			4		SM	23.5	100	95	94	89	33.2	SNP	SNP	SNP	90		
				Brown Silty Clay with Sand Friction Angle = 31.9° Cohesion = 71psf	CL-ML	29.9	100	100	100	99	84.4	28	24	4			
10			5	Light Brown Silty Sand with Gravel		26.7									310		

SPLIT SPOON SAMPLE | AIR ROTARY | WATER | SHELBY SAMPLE

PETTIGREW & ASSOCIATES PA

ENGINEERING | SURVEYING | TESTING

DEFINING QUALITY SINCE 1965

BORING NO.: BH-1

CLIENT: County of Sierra
PROJECT NAME: Bank Stabilization Cuchillo Negro Arroyo
PROJECT NO.: 2016.1125
DATE DRILLED: 7/7/2016

COORDINATES: Lat.33.149450° Long. -107.221479°
SURFACE ELEVATION: 4257.32'
BOREHOLE DEPTH: 22'0"
DEPTH TO WATER: N/A

DEPTH (FT)	LITHOLOGIC SYMBOL	SAMPLE RECOVERED	BLOWS PER FOOT	DESCRIPTION	SOIL CLASSIFICATION	LABORATORY TEST DATA									BEARING CAPACITY (psf)	qu (psf)	SHEAR STREGTH (tsf)
						% MOISTURE	% PASSING 3/4"	% PASSING #4	% PASSING #10	% PASSING #40	% PASSING #200	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)			
			10			26.7									1,410		
15			7		SM	24.4	98	74	64	50	17.6	SNP	SNP	SNP	750		
			10			24.4									1,410		
20			24			9.5									4,500		
			33			9.5									6,480		

SPLIT SPOON SAMPLE AIR ROTARY WATER SHELBY SAMPLE

PETTIGREW & ASSOCIATES PA

ENGINEERING | SURVEYING | TESTING

DEFINING QUALITY SINCE 1965

BORING NO.: BH-2

CLIENT: County of Sierra
PROJECT NAME: Bank Stabilization Cuchillo Negro Arroyo
PROJECT NO.: 2016.1125
DATE DRILLED: 7/7/16

COORDINATES: Lat.33.150111° Long. -107.222703°
SURFACE ELEVATION: 4258.19'
BOREHOLE DEPTH: 17'0"
DEPTH TO WATER: N/A

DEPTH (FT)	LITHOLOGIC SYMBOL	SAMPLE RECOVERED	BLOWS PER FOOT	DESCRIPTION	SOIL CLASSIFICATION	LABORATORY TEST DATA: % MOISTURE	% PASSING 3/4"	% PASSING #4	% PASSING #10	% PASSING #40	% PASSING #200	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	BEARING CAPACITY (psf)	qu (psf)	SHEAR STREGTH (tsf)
0			44	Grayish Tan Silty Sand with Gravel		2.8									>8,000		
			92			2.8									>8,000		
			72			4.8									>8,000		
			50/5"		SM	4.8	100	74	65	47	15.5	SNP	SNP	SNP	>8,000		
			50			5.1									>8,000		
5			46			5.1									>8,000		
			15	Brown Silty Sand		10.2									2,510		
			20		SM	10.2	100	95	94	89	33.2	SNP	SNP	SNP	3,620		
			14			14.0									2,290		
			12	Brown Silty Clay with Sand		28.5									2,470		
10			4		CL-ML	34.1	100	100	100	99	84.4	28	24	4	120		

SPLIT SPOON SAMPLE AIR ROTARY WATER SHELBY SAMPLE

PETTIGREW & ASSOCIATES PA

ENGINEERING | SURVEYING | TESTING

DEFINING QUALITY SINCE 1965

BORING NO.: BH-2

CLIENT: County of Sierra
PROJECT NAME: Bank Stabilization Cuchillo Negro Arroyo
PROJECT NO.: 2016.1125
DATE DRILLED: 7/7/16

COORDINATES: Lat.33.150111° Long. -107.222703°
SURFACE ELEVATION: 4258.19'
BOREHOLE DEPTH: 17'0"
DEPTH TO WATER: N/A

DEPTH (FT)	LITHOLOGIC SYMBOL	SAMPLE RECOVERED	BLOWS PER FOOT	DESCRIPTION	SOIL CLASSIFICATION	LABORATORY TEST DATA									BEARING CAPACITY (psf)	qu (psf)	SHEAR STREGTH (tsf)
						% MOISTURE	% PASSING 3/4"	% PASSING #4	% PASSING #10	% PASSING #40	% PASSING #200	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)			
			13	Unit Weight = 120.4 pcf		42.5									2,760		
				Light Brown Silty Sand with Gravel		8.8											
15			11			12.2									1,630		
			12		SM	12.2	98	74	64	50	17.6	SNP	SNP	SNP	1,850		
20			22			11.1									4,060		
			19			11.1									3,400		

SPLIT SPOON SAMPLE AIR ROTARY WATER SHELBY SAMPLE

PETTIGREW & ASSOCIATES PA

ENGINEERING | SURVEYING | TESTING

DEFINING QUALITY SINCE 1965

BORING NO.: BH-3

CLIENT: County of Sierra
PROJECT NAME: Bank Stabilization Cuchillo Negro Arroyo
PROJECT NO.: 2016.1125
DATE DRILLED: 7/7/16

COORDINATES: Lat.33.150939° Long. -107.224129°
SURFACE ELEVATION: 4261.81'
BOREHOLE DEPTH: 22'0"
DEPTH TO WATER: N/A

DEPTH (FT)	LITHOLOGIC SYMBOL	SAMPLE RECOVERED	BLOWS PER FOOT	DESCRIPTION	SOIL CLASSIFICATION	LABORATORY TEST DATA: % MOISTURE	% PASSING 3/4"	% PASSING #4	% PASSING #10	% PASSING #40	% PASSING #200	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	BEARING CAPACITY (psf)	qu (psf)	SHEAR STREGTH (tsf)
0			12	Brown Silty Sand		3.2									1,850		
			17		SM	3.2	97	95	94	92	38.5	SNP	SNP	SNP	2,950		
			16			3.2									2,730		
			34	Brown Silty Sand with Gravel		2.6									6,700		
			27		SM	4.3	100	76	63	46	13.5	SNP	SNP	SNP	5,160		
5			22			4.3									4,060		
			3	Brown Silty Clay with Sand		24.7									0		
			4			27.5									120		
				Friction Angle = 33.6° Cohesion = 0 psf													
10			4		CL-ML	26.2	100	100	100	99	84.4	28	24	4	120		

SPLIT SPOON SAMPLE | AIR ROTARY | WATER | SHELBY SAMPLE

PETTIGREW & ASSOCIATES PA

ENGINEERING | SURVEYING | TESTING

DEFINING QUALITY SINCE 1965

BORING NO.: BH-3

CLIENT: County of Sierra
PROJECT NAME: Bank Stabilization Cuchillo Negro Arroyo
PROJECT NO.: 2016.1125
DATE DRILLED: 7/7/16

COORDINATES: Lat.33.150939° Long. -107.224129°
SURFACE ELEVATION: 4261.81'
BOREHOLE DEPTH: 22'0"
DEPTH TO WATER: N/A

DEPTH (FT)	LITHOLOGIC SYMBOL	SAMPLE RECOVERED	BLOWS PER FOOT	DESCRIPTION	SOIL CLASSIFICATION	LABORATORY TEST DATA: % MOISTURE	% PASSING 3/4"	% PASSING #4	% PASSING #10	% PASSING #40	% PASSING #200	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	BEARING CAPACITY (psf)	qu (psf)	SHEAR STREGTH (tsf)
			6			26.2									710		
				Water @14' bgs													
15			7	Light Brown Silty Sand with Gravel		14.2									750		
			8												970		
					SM		98	74	64	50	17.6	SNP	SNP	SNP			
20			20			11.2									3,620		
			18			22.3									3,180		

SPLIT SPOON SAMPLE | AIR ROTARY | WATER | SHELBY SAMPLE

PETTIGREW & ASSOCIATES PA

ENGINEERING | SURVEYING | TESTING

DEFINING QUALITY SINCE 1965

BORING NO.: BH-4

CLIENT: County of Sierra
PROJECT NAME: Bank Stabilization Cuchillo Negro Arroyo
PROJECT NO.: 2016.1125
DATE DRILLED: 7/6/2016

COORDINATES: Lat.33.151889° Long. -107.225660°
SURFACE ELEVATION: 4266.34'
BOREHOLE DEPTH: 22'0"
DEPTH TO WATER: N/A

DEPTH (FT)	LITHOLOGIC SYMBOL	SAMPLE RECOVERED	BLOWS PER FOOT	DESCRIPTION	SOIL CLASSIFICATION	LABORATORY TEST DATA: % MOISTURE	% PASSING 3/4"	% PASSING #4	% PASSING #10	% PASSING #40	% PASSING #200	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	BEARING CAPACITY (psf)	qu (psf)	SHEAR STREGTH (tsf)
0			33	Grayish Tan Silty Sand with Gravel		3.0									5,820		
			75			3.0									>8,000		
			22			4.0									4,060		
			16		SM	4.0	100	74	65	47	15.5	SNP	SNP	SNP	2,730		
			18			3.9									3,180		
5			14			3.9									2,290		
			3	Brown Silty Sand		14.5									0		
			3			14.5									0		
				Friction Angle = 26.9° Cohesion = 590 psf	SM		100	95	94	89	33.2	SNP	SNP	SNP			
10			11			6.2									1,630		

SPLIT SPOON SAMPLE AIR ROTARY WATER SHELBY SAMPLE

PETTIGREW & ASSOCIATES PA

ENGINEERING | SURVEYING | TESTING

DEFINING QUALITY SINCE 1965

BORING NO.: BH-4

CLIENT: County of Sierra
PROJECT NAME: Bank Stabilization Cuchillo Negro Arroyo
PROJECT NO.: 2016.1125
DATE DRILLED: 7/6/2016

COORDINATES: Lat.33.151889° Long. -107.225660°
SURFACE ELEVATION: 4266.34'
BOREHOLE DEPTH: 22'0"
DEPTH TO WATER: N/A

DEPTH (FT)	LITHOLOGIC SYMBOL	SAMPLE RECOVERED	BLOWS PER FOOT	DESCRIPTION	SOIL CLASSIFICATION	LABORATORY TEST DATA									BEARING CAPACITY (psf)	qu (psf)	SHEAR STREGTH (tsf)
						% MOISTURE	% PASSING 3/4"	% PASSING #4	% PASSING #10	% PASSING #40	% PASSING #200	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)			
			15/6"	Brown Silty Sand with Gravel	SM	3.2	100	76	63	46	13.5	SNP	SNP	SNP	5,820		
15			20	Brown Silty Clay with Sand	CL-ML	10.5	100	100	100	99	84.4	28	24	4	3,620		
			10	Light Brown Silty Sand with Gravel	SM	11.5	98	74	64	50	17.6	SNP	SNP	SNP	1,410		
20			17			22.2									2,950		
			18			11.2									3,180		

SPLIT SPOON SAMPLE AIR ROTARY WATER SHELBY SAMPLE

PETTIGREW & ASSOCIATES PA

ENGINEERING | SURVEYING | TESTING

DEFINING QUALITY SINCE 1965

BORING NO.: BH-5

CLIENT: County of Sierra
PROJECT NAME: Bank Stabilization Cuchillo Negro Arroyo
PROJECT NO.: 2016.1125
DATE DRILLED: 7/6/2016

COORDINATES: Lat.33.149358° Long. -107.222620°
SURFACE ELEVATION: 4260.47'
BOREHOLE DEPTH: 22'0"
DEPTH TO WATER: 15'0"

DEPTH (FT)	LITHOLOGIC SYMBOL	SAMPLE RECOVERED	BLOWS PER FOOT	DESCRIPTION	SOIL CLASSIFICATION	LABORATORY TEST DATA: % MOISTURE	% PASSING 3/4"	% PASSING #4	% PASSING #10	% PASSING #40	% PASSING #200	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	BEARING CAPACITY (psf)	qu (psf)	SHEAR STREGTH (tsf)
0			22	Tannish Brown Silty Sand with Gravel		2.0									4,060		
			14			2.0									2,290		
			12			2.0									1,850		
			14		SM	2.0	100	59	51	38	14.2	SNP	SNP	SNP	2,290		
			35			2.8									6,920		
5			39			2.8									7,800		
			8			4.3									970		
			3	Brown Sandy Silt	ML	15.3 / 15.3	100	98	97	93	55.1	22	20	2	0		
			9	Brown Lean Clay Unit Weight = 120.4 pcf		22.9									1,590		
			6			27.4									710		
10				Friction Angle = 33.6° Cohesion = 47 psf													

SPLIT SPOON SAMPLE | AIR ROTARY | WATER | SHELBY SAMPLE

PETTIGREW & ASSOCIATES PA

ENGINEERING | SURVEYING | TESTING

DEFINING QUALITY SINCE 1965

BORING NO.: BH-5

CLIENT: County of Sierra
PROJECT NAME: Bank Stabilization Cuchillo Negro Arroyo
PROJECT NO.: 2016.1125
DATE DRILLED: 7/6/2016

COORDINATES: Lat.33.149358° Long. -107.222620°
SURFACE ELEVATION: 4260.47'
BOREHOLE DEPTH: 22'0"
DEPTH TO WATER: 15'0"

DEPTH (FT)	LITHOLOGIC SYMBOL	SAMPLE RECOVERED	BLOWS PER FOOT	DESCRIPTION	SOIL CLASSIFICATION	LABORATORY TEST DATA									BEARING CAPACITY (psf)	qu (psf)	SHEAR STREGTH (tsf)
						% MOISTURE	% PASSING 3/4"	% PASSING #4	% PASSING #10	% PASSING #40	% PASSING #200	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)			
					CL		100	100	100	99	87.1	27	19	8			
15			9	Water @ 15' bgs		31.2									1,590		
			19			31.2									3,400		
				Light Brown Silty Sand with Gravel	SM	21.4	100	71	60	48	13.1	SNP	SNP	SNP			
20			31	Brown Silty Clay	--	19.6	100	98	95	91	76.6	--	--	--	6,040		
			17	Light Brown Silty Sand with Gravel	SM	13.7 / 13.7	100	71	60	48	13.1	SNP	SNP	SNP	2,950		

SPLIT SPOON SAMPLE AIR ROTARY WATER SHELBY SAMPLE

PETTIGREW & ASSOCIATES PA

ENGINEERING | SURVEYING | TESTING

DEFINING QUALITY SINCE 1965

BORING NO.: BH-6

CLIENT: County of Sierra
PROJECT NAME: Bank Stabilization Cuchillo Negro Arroyo
PROJECT NO.: 2016.1125
DATE DRILLED: 7/6/2016

COORDINATES: Lat.33.150202° Long. -107.224121°
SURFACE ELEVATION: 4262.36'
BOREHOLE DEPTH: 22'0"
DEPTH TO WATER: 15'0"

DEPTH (FT)	LITHOLOGIC SYMBOL	SAMPLE RECOVERED	BLOWS PER FOOT	DESCRIPTION	SOIL CLASSIFICATION	LABORATORY TEST DATA: % MOISTURE	% PASSING 3/4"	% PASSING #4	% PASSING #10	% PASSING #40	% PASSING #200	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	BEARING CAPACITY (psf)	qu (psf)	SHEAR STREGTH (tsf)
0			10	Tannish Brown Silty Sand with Gravel		2.3									1,410		
			19			2.3									3,400		
			40			3.4									>8,000		
			45		SM	3.4	100	59	51	38	14.2	SNP	SNP	SNP	>8,000		
			29			4.9									5,600		
5			21			4.9									3,840		
			7	Brown Sandy Silt		13.9									750		
			6		ML	11.6	100	98	97	93	55.1	22	20	2	530		
			3	Brown Lean Clay		25.7									0		
			3												0		
10			5	Unit Weight = 112.9 pcf	CL	27.3	100	100	100	99	87.1	27	8	19	410		

SPLIT SPOON SAMPLE AIR ROTARY WATER SHELBY SAMPLE

PETTIGREW & ASSOCIATES PA

ENGINEERING | SURVEYING | TESTING

DEFINING QUALITY SINCE 1965

BORING NO.: BH-6

CLIENT: County of Sierra
PROJECT NAME: Bank Stabilization Cuchillo Negro Arroyo
PROJECT NO.: 2016.1125
DATE DRILLED: 7/6/2016

COORDINATES: Lat.33.150202° Long. -107.224121°
SURFACE ELEVATION: 4262.36'
BOREHOLE DEPTH: 22'0"
DEPTH TO WATER: 15'0"

DEPTH (FT)	LITHOLOGIC SYMBOL	SAMPLE RECOVERED	BLOWS PER FOOT	DESCRIPTION	SOIL CLASSIFICATION	LABORATORY TEST DATA									BEARING CAPACITY (psf)	qu (psf)	SHEAR STREGTH (tsf)
						% MOISTURE	% PASSING 3/4"	% PASSING #4	% PASSING #10	% PASSING #40	% PASSING #200	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)			
			28			24.2									7,170		
				Tan to Brown Poorly Graded Gravel with Sand													
15			32/6"	Water @15' bgs		7.3									>8,000		
			24			7.2									4,500		
			7/6"		GP		71	47	39	29	4.2	SNP	SNP	SNP	2,290		
20			55			19.2									>8,000		
			15			9.3									2,510		

SPLIT SPOON SAMPLE AIR ROTARY WATER SHELBY SAMPLE

APPENDIX A – TERRACON LAB REPORTS (ASTM D 3080)

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS ASTM D3080

Terracon

PROJECT:	Arroyo Cuchillo	**JOB NO:**	66165113
LOCATION:	New Mexico	**WORK ORDER NO:**	66165113
MATERIAL:	Clayey Sand	**LAB NO:**	8923
SAMPLE SOURCE:	Insitu BH 1 @ 8' - 10'	**DATE SAMPLED:**	07/21/16

Sample Preparation: Insitu density and moisture
Shear not indudated prior to testing

Initial Parameters of specimen:

	Point 1	Point 2	Point 3
Normal Stress (psf):	**1000**	**2000**	**3000**
Dry mass (g):	109.61	111.60	103.70
Height (in):	1.0000	1.0000	1.0000
Diameter (in):	2.42	2.42	2.42
Moisture, %:	29.4	20.4	31.3
Dry Density (pcf):	90.8	92.4	85.9
Saturation, %:	95	69	90
Void Ratio:	0.81	0.78	0.91

Pre Shear Parameters of specimen:

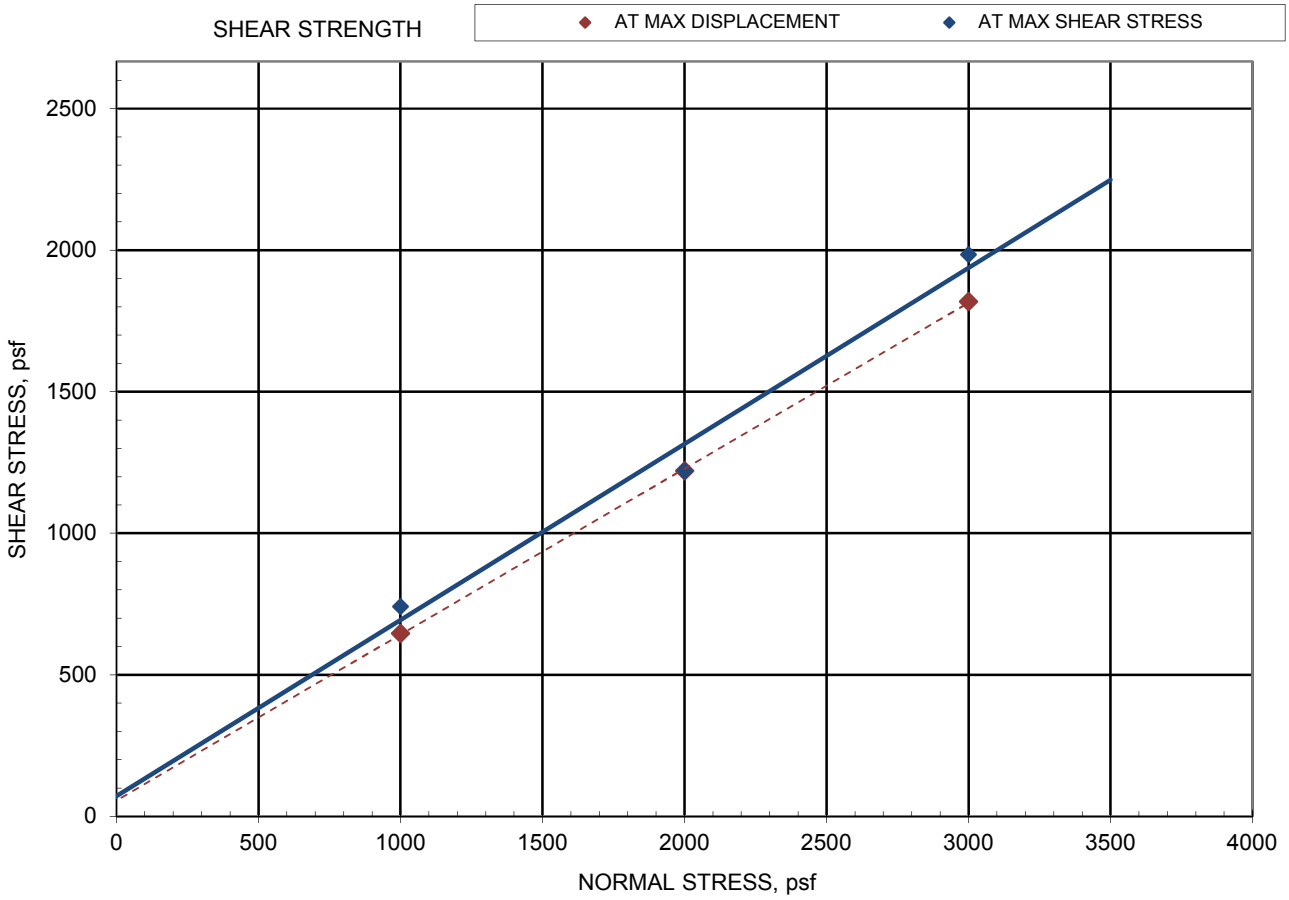
	Point 1	Point 2	Point 3
Normal Stress (psf):	**1000**	**2000**	**3000**
Dry mass (g):	109.61	111.60	103.70
Height (in):	0.9817	0.9777	0.9889
Diameter (in):	2.42	2.42	2.42
Moisture, % *:	28.5	19.5	29.2
Dry Density (pcf) *:	92.5	94.5	86.9
Saturation, % *:	97	70	86
Void Ratio:	0.78	0.74	0.89

* Based on the final specimen parameters

Normal Stress (psf):	1000	2000	3000
Maximum Shear Stress, (psf):	741	1220	1985
Displacement at Maximum Shear, (in):	0.121	0.442	0.162
Shear Stress at Max Displacement, (psf)	646	1220	1818
Maximum Displacement, (in):	0.448	0.449	0.451
Rate of Deformation, in/min	0.0100	0.0100	0.0100

SHEAR DEVICE: Geomatic model 8914, Dead Weight load force

	FRICTION ANGLE	COHESION
AT MAX SHEAR STRESS	**31.9**	**71**
Specs:		
AT MAX DISPLACEMENT	30.4	56
Specs:		

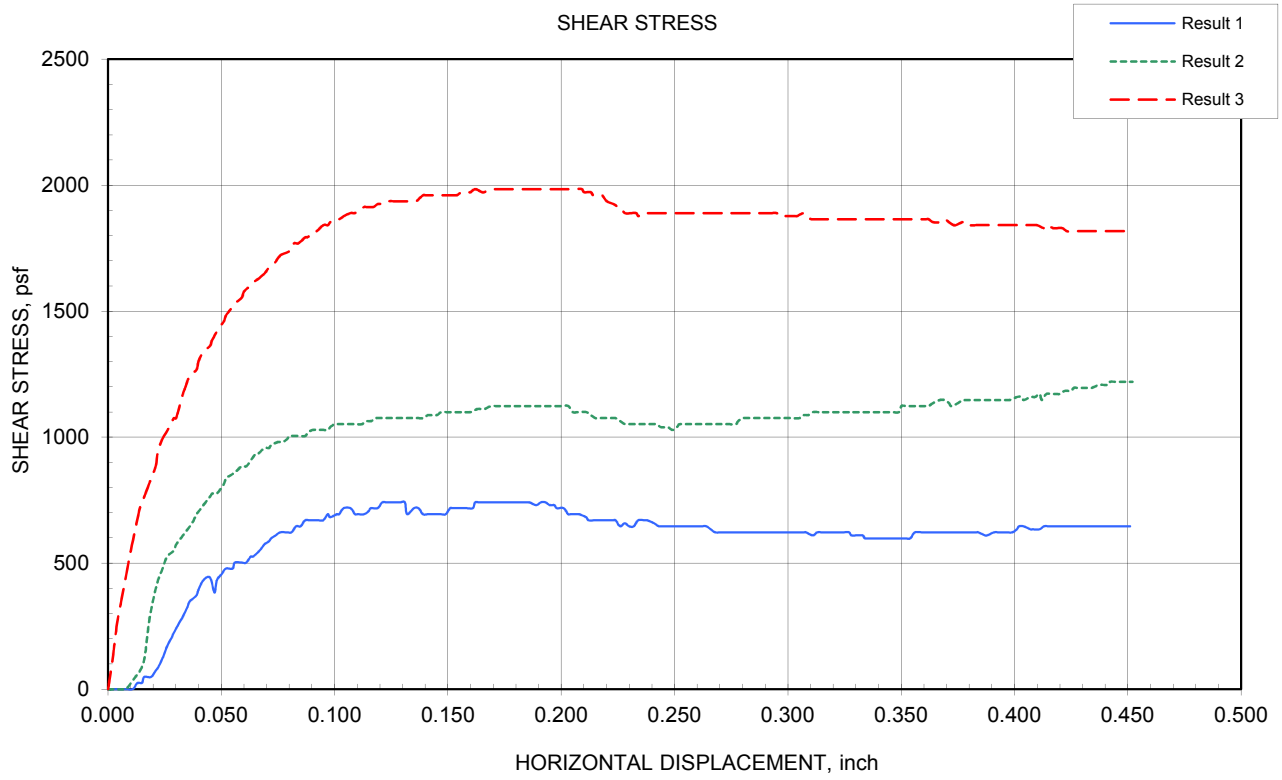


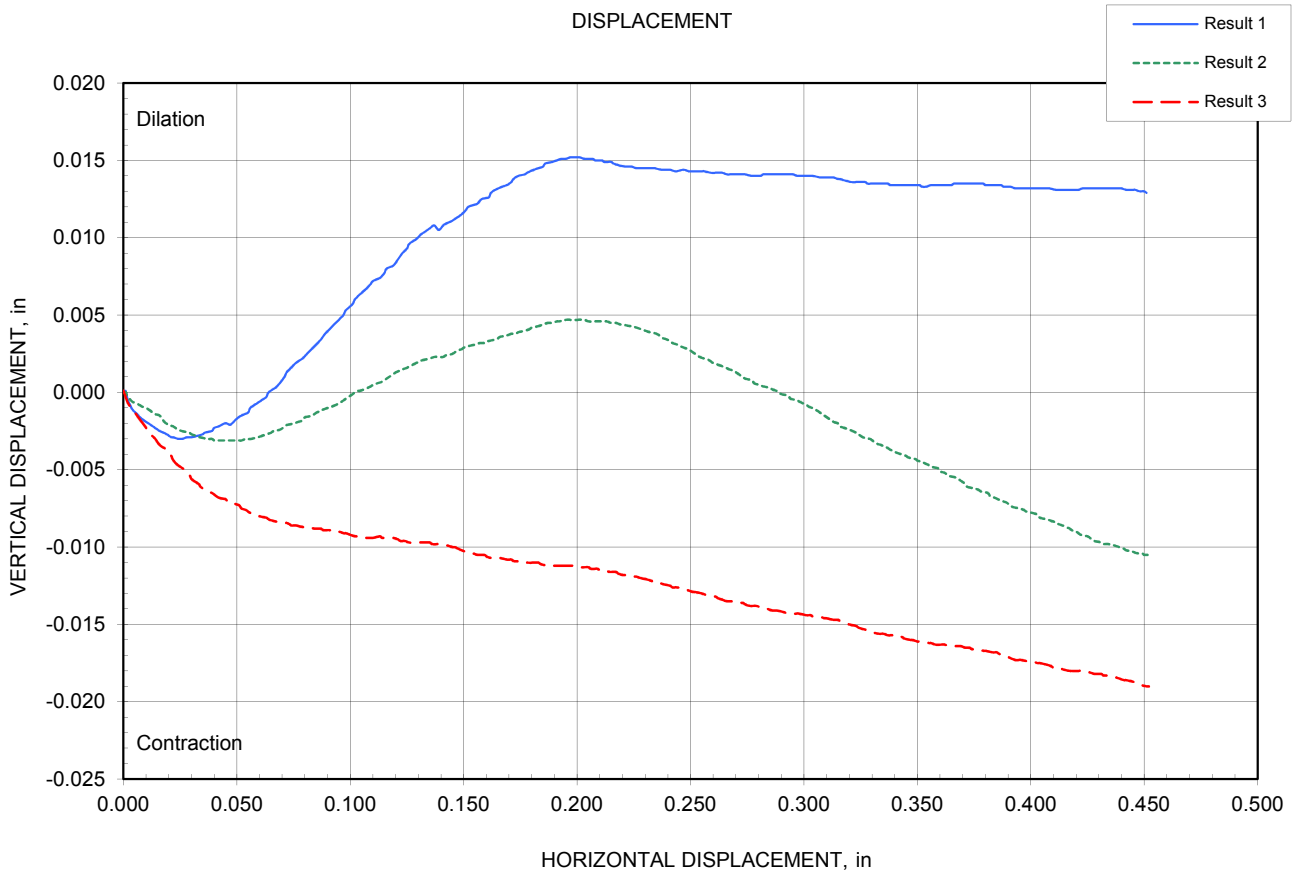
Note: The friction angle presented is applicable only to the load ranges and sample conditions tested

Reviewed By: _____

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS ASTM D3080

PROJECT:	Arroyo Cuchillo	**JOB NO:**	66165113
LOCATION:	New Mexico	**WORK ORDER NO:**	66165113
MATERIAL:	Clayey Sand	**LAB NO:**	8923
SAMPLE SOURCE:	Insitu BH 1 @ 8' - 10'	**DATE SEMPLED:**	7/21/2016





DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS ASTM D3080

Terracon

PROJECT:	Arroyo Cuchillo	**JOB NO:**	66165113
LOCATION:	New Mexico	**WORK ORDER NO:**	66165113
MATERIAL:	Sandy Soil	**LAB NO:**	8923
SAMPLE SOURCE:	Insitu BH-3 @ 8'-10'	**DATE SAMPLED:**	07/21/16

Sample Preparation: Insitu density and moisture
Shear not indudated prior to testing

Initial Parameters of specimen:

	Point 1	Point 2	Point 3
Normal Stress (psf):	**1000**	**2000**	**3000**
Dry mass (g):	110.00	113.40	111.60
Height (in):	1.0000	1.0000	1.0000
Diameter (in):	2.42	2.42	2.42
Moisture, %:	26.6	25.7	28.6
Dry Density (pcf):	91.1	93.9	92.4
Saturation, %:	87	90	97
Void Ratio:	0.80	0.75	0.78

Pre-Shear Parameters of specimen:

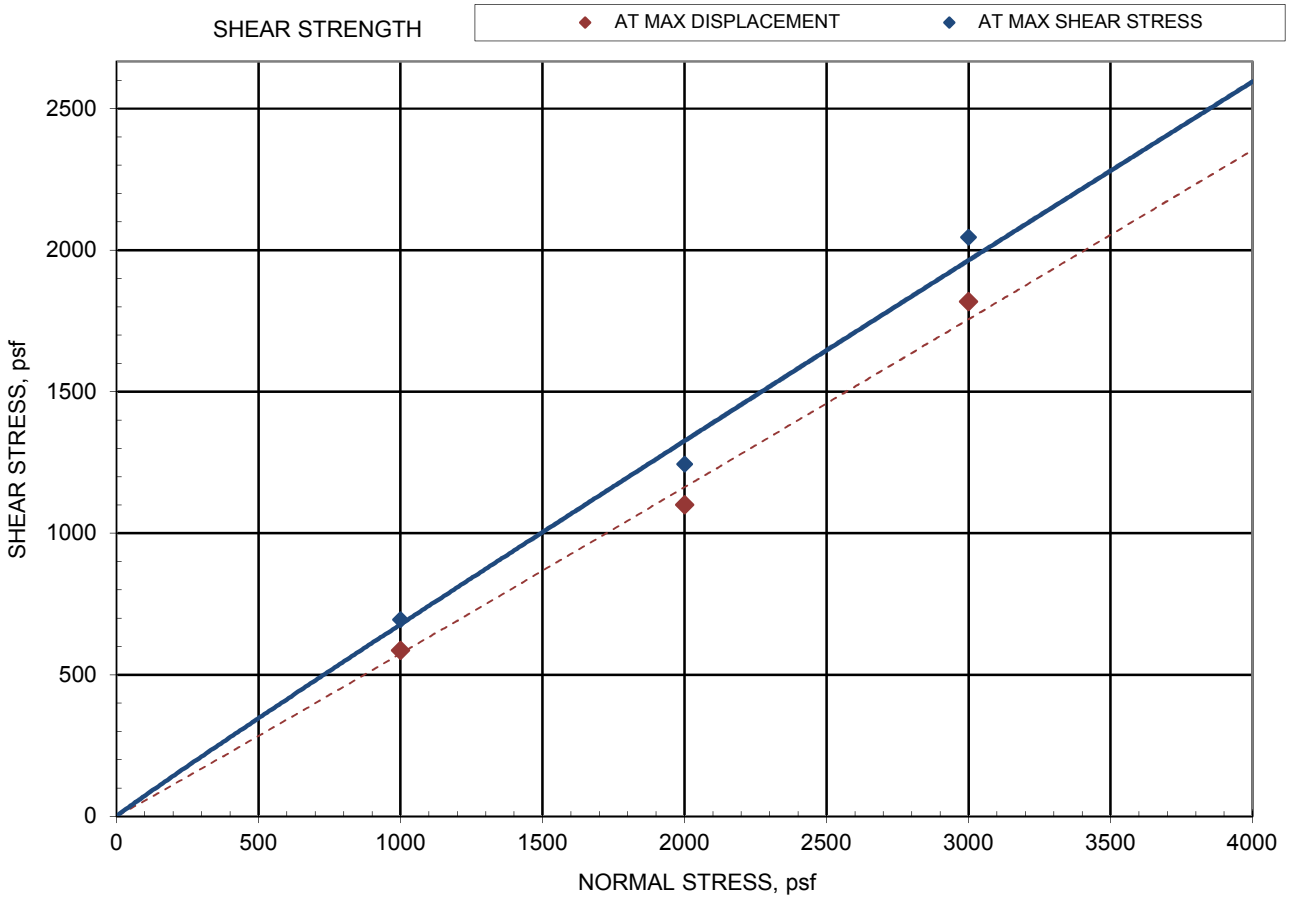
	Point 1	Point 2	Point 3
Normal Stress (psf):	**1000**	**2000**	**3000**
Dry mass (g):	110.00	113.40	111.60
Height (in):	0.9889	0.9559	0.9662
Diameter (in):	2.42	2.42	2.42
Moisture, % *:	24.7	24.1	26.9
Dry Density (pcf) *:	92.1	98.3	95.7
Saturation, % *:	83	94	99
Void Ratio:	0.78	0.67	0.72

* Based on the final specimen parameters

Normal Stress (psf):	1000	2000	3000
Maximum Shear Stress, (psf):	694	1244	2045
Displacement at Maximum Shear, (in):	0.247	0.123	0.157
Shear Stress at Max Displacement, (psf)	586	1100	1818
Maximum Displacement, (in):	0.450	0.449	0.450
Rate of Deformation, in/min	0.0100	0.0100	0.0100

SHEAR DEVICE: Geomatic model 8914, Dead Weight load force

	FRICTION ANGLE	COHESION
AT MAX SHEAR STRESS	**33.6**	**0**
Specs:		
AT MAX DISPLACEMENT	30.5	0
Specs:		

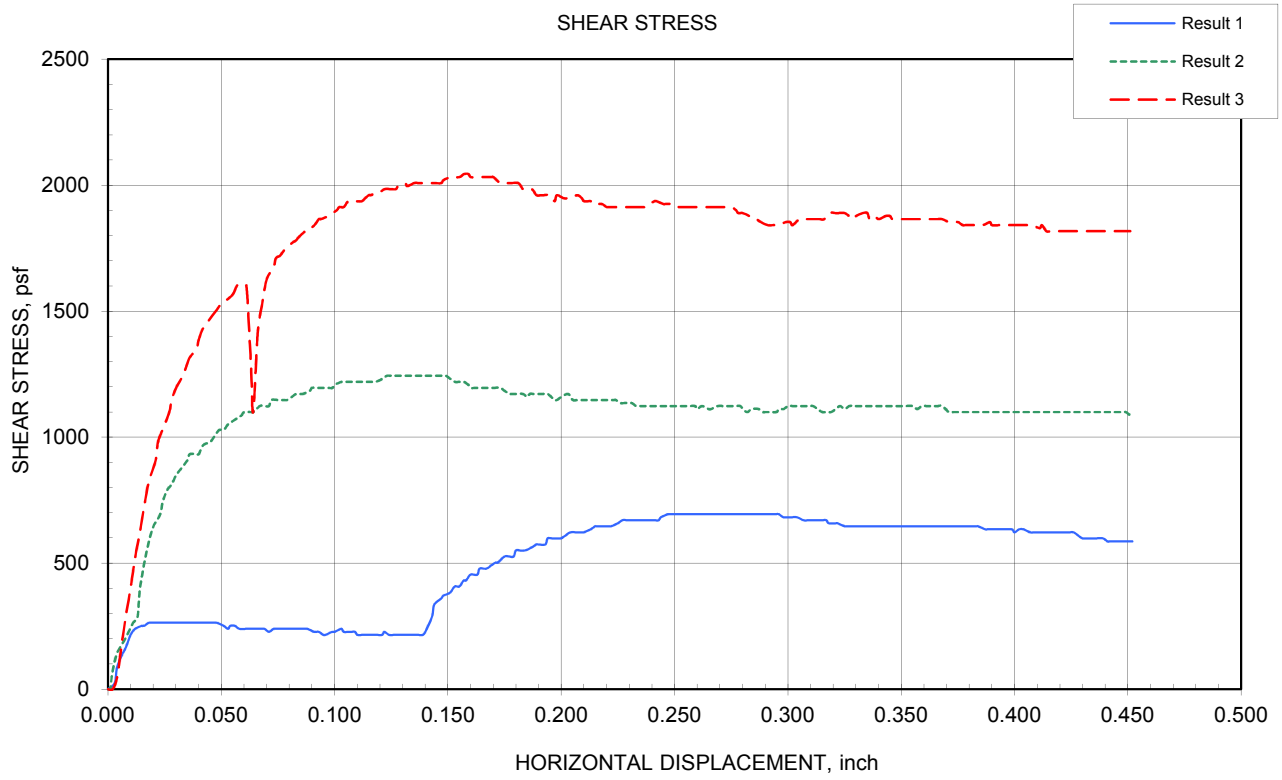


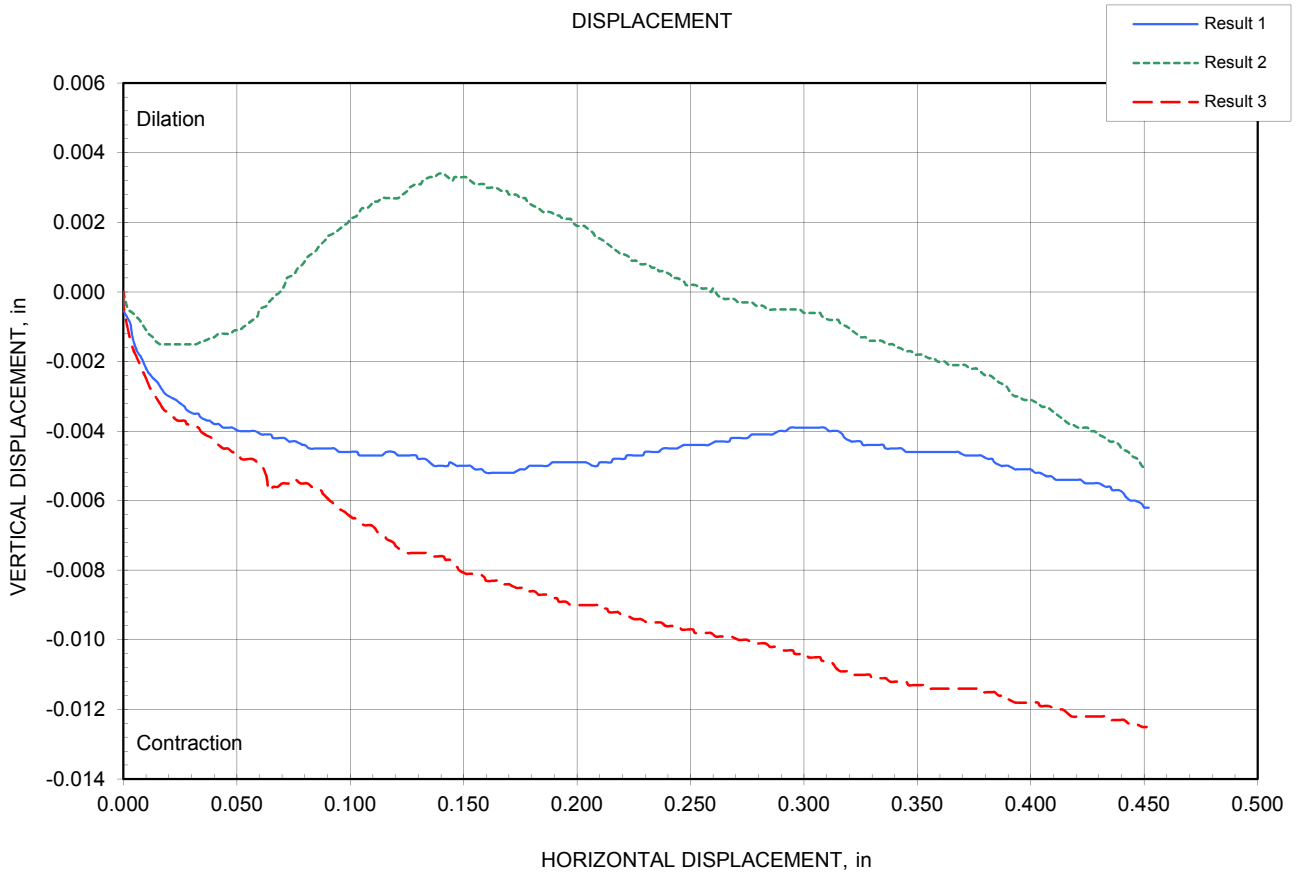
Note: The friction angle presented is applicable only to the load ranges and sample conditions tested

Reviewed By: _____

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS ASTM D3080

PROJECT:	Arroyo Cuchillo	**JOB NO:**	66165113
LOCATION:	New Mexico	**WORK ORDER NO:**	66165113
MATERIAL:	Sandy Soil	**LAB NO:**	8923
SAMPLE SOURCE:	Insitu BH-3 @ 8'-10'	**DATE SEMPLED:**	7/21/2016





DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS ASTM D3080

Terracon

PROJECT:	Arroyo Cuchillo	**JOB NO:**	66165113
LOCATION:	New Mexico	**WORK ORDER NO:**	66165113
MATERIAL:	Clayey Sand	**LAB NO:**	8921
SAMPLE SOURCE:	Insitu BH 4 @ 8' - 10'	**DATE SAMPLED:**	07/21/16

Sample Preparation: Insitu density and moisture
Shear not indudated prior to testing

Initial Parameters of specimen:

	Point 1	Point 2	Point 3
Normal Stress (psf):	**1000**	**2000**	**3000**
Dry mass (g):	124.60	119.10	114.10
Height (in):	1.0000	1.0000	1.0000
Diameter (in):	2.42	2.42	2.42
Moisture, %:	13.6	13.6	14.6
Dry Density (pcf):	103.2	98.6	94.5
Saturation, %:	60	54	52
Void Ratio:	0.59	0.66	0.74

Pre-Shear Parameters of specimen:

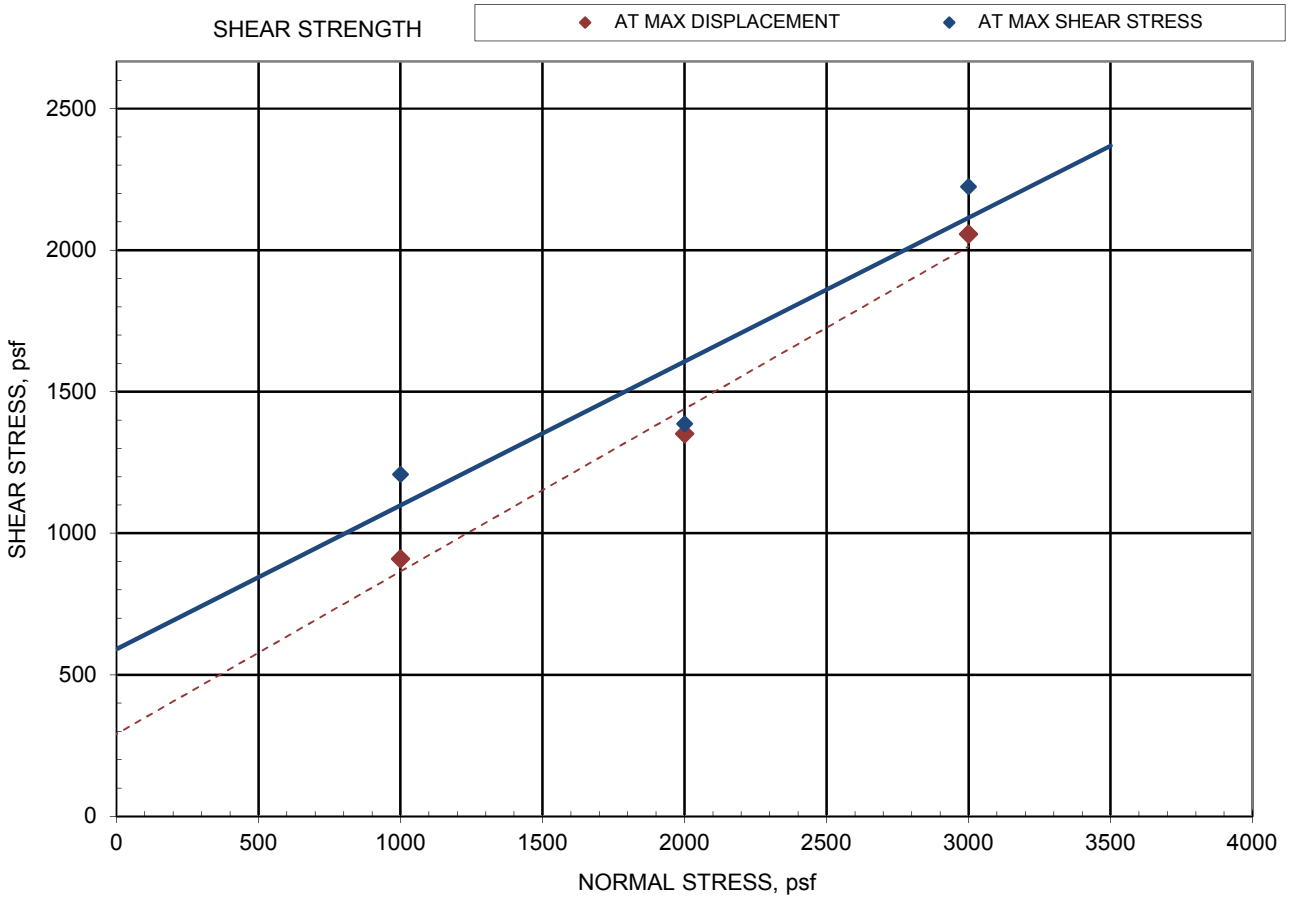
	Point 1	Point 2	Point 3
Normal Stress (psf):	**1000**	**2000**	**3000**
Dry mass (g):	124.60	119.10	114.10
Height (in):	0.9926	0.9777	0.963
Diameter (in):	2.42	2.42	2.42
Moisture, % *:	7.9	9.6	13.9
Dry Density (pcf) *:	104.0	100.9	98.1
Saturation, % *:	36	40	54
Void Ratio:	0.58	0.63	0.67

* Based on the final specimen parameters

Normal Stress (psf):	1000	2000	3000
Maximum Shear Stress, (psf):	1208	1387	2224
Displacement at Maximum Shear, (in):	0.071	0.249	0.191
Shear Stress at Max Displacement, (psf)	909	1351	2057
Maximum Displacement, (in):	0.448	0.450	0.451
Rate of Deformation, in/min	0.0100	0.0100	0.0100

SHEAR DEVICE: Geomatic model 8914, Dead Weight load force

	FRICTION ANGLE	COHESION
AT MAX SHEAR STRESS	**26.9**	**590**
Specs:		
AT MAX DISPLACEMENT	29.9	291
Specs:		

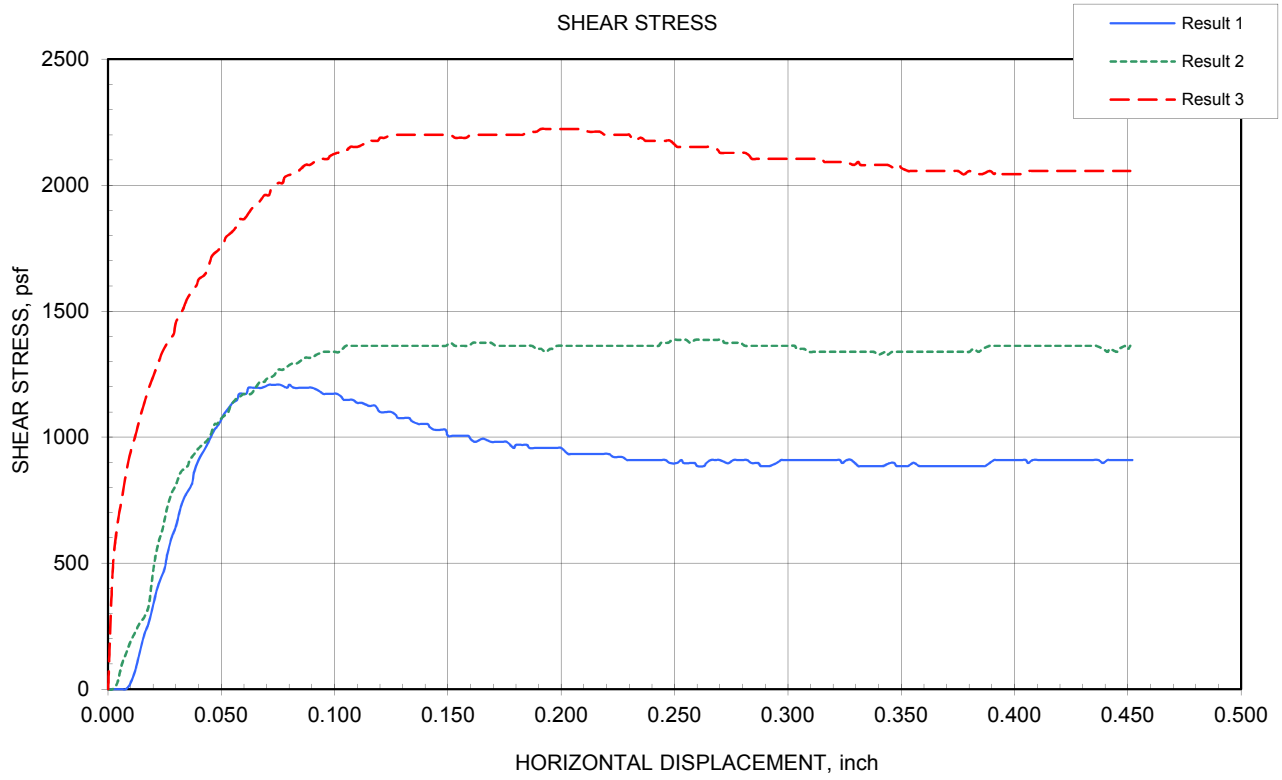


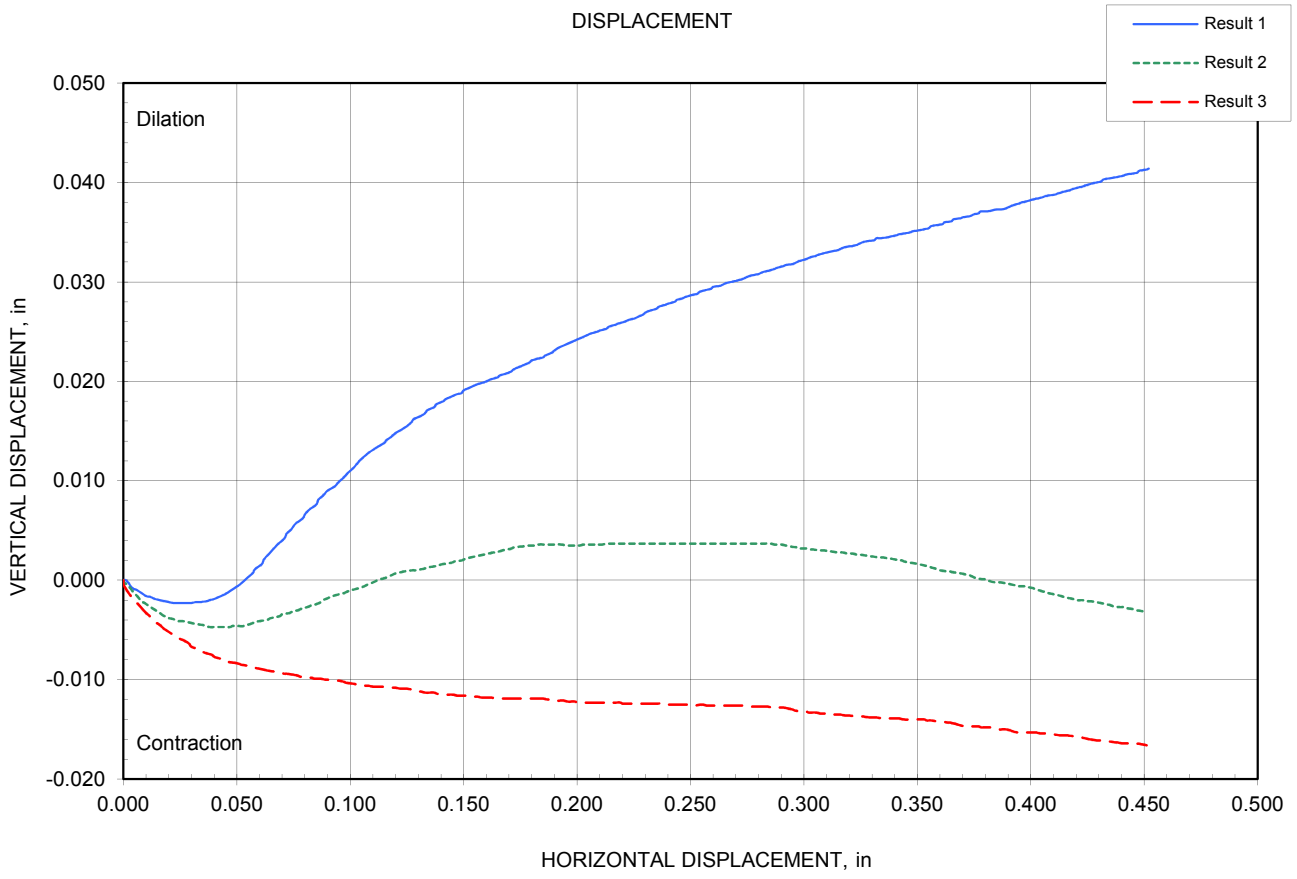
Note: The friction angle presented is applicable only to the load ranges and sample conditions tested

Reviewed By: _____

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS ASTM D3080

PROJECT:	Arroyo Cuchillo	**JOB NO:**	66165113
LOCATION:	New Mexico	**WORK ORDER NO:**	66165113
MATERIAL:	Clayey Sand	**LAB NO:**	8923
SAMPLE SOURCE:	Insitu BH 4 @ 8' - 10'	**DATE SEMPLED:**	7/21/2016





DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS ASTM D3080

Terracon

PROJECT:	Arroyo Cuchillo	**JOB NO:**	66165113
LOCATION:	New Mexico	**WORK ORDER NO:**	66165113
MATERIAL:	Clayey Sand	**LAB NO:**	8923
SAMPLE SOURCE:	Insitu BH 5 @ 10' - 12'	**DATE SAMPLED:**	07/21/16

Sample Preparation: Insitu density and moisture
Shear not indudated prior to testing

Initial Parameters of specimen:

	Point 1	Point 2	Point 3
Normal Stress (psf):	**1000**	**2000**	**3000**
Dry mass (g):	115.43	106.62	108.02
Height (in):	1.0000	1.0000	1.0000
Diameter (in):	2.42	2.42	2.42
Moisture, %:	23.3	29.5	26.4
Dry Density (pcf):	95.6	88.3	89.5
Saturation, %:	85	90	83
Void Ratio:	0.72	0.86	0.84

Pre Shear Parameters of specimen:

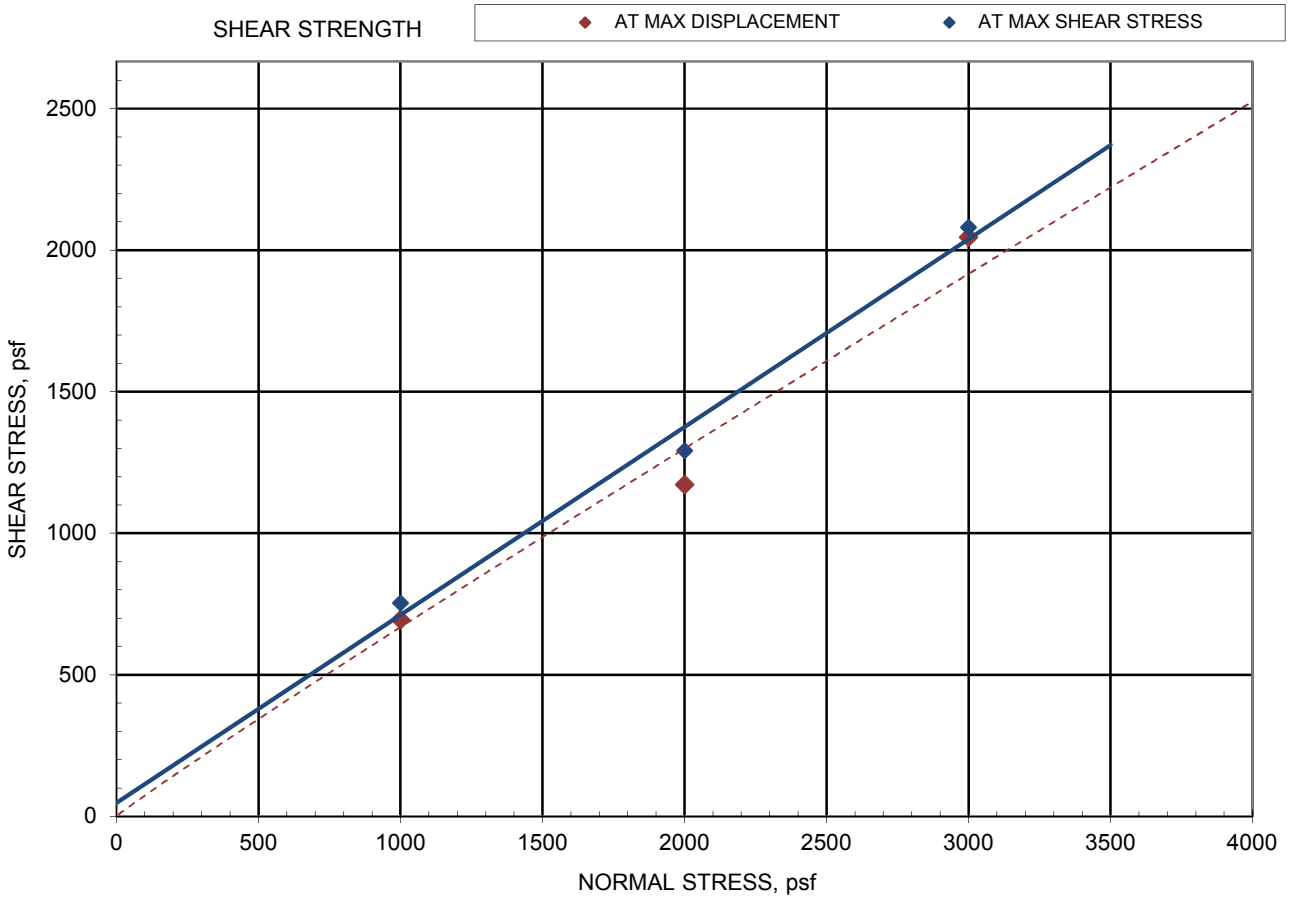
	Point 1	Point 2	Point 3
Normal Stress (psf):	**1000**	**2000**	**3000**
Dry mass (g):	115.43	106.62	108.02
Height (in):	0.9825	0.9248	0.9577
Diameter (in):	2.42	2.42	2.42
Moisture, % *:	21.9	27.3	24.3
Dry Density (pcf) *:	97.3	95.5	93.4
Saturation, % *:	84	100	84
Void Ratio:	0.69	0.72	0.76

* Based on the final specimen parameters

Normal Stress (psf):	1000	2000	3000
Maximum Shear Stress, (psf):	753	1292	2081
Displacement at Maximum Shear, (in):	0.149	0.148	0.193
Shear Stress at Max Displacement, (psf)	694	1172	2045
Maximum Displacement, (in):	0.450	0.451	0.450
Rate of Deformation, in/min	0.0100	0.0100	0.0100

SHEAR DEVICE: Geomatic model 8914, Dead Weight load force

	FRICTION ANGLE	COHESION
AT MAX SHEAR STRESS	**33.6**	**47**
Specs:		
AT MAX DISPLACEMENT	33.2	0
Specs:		

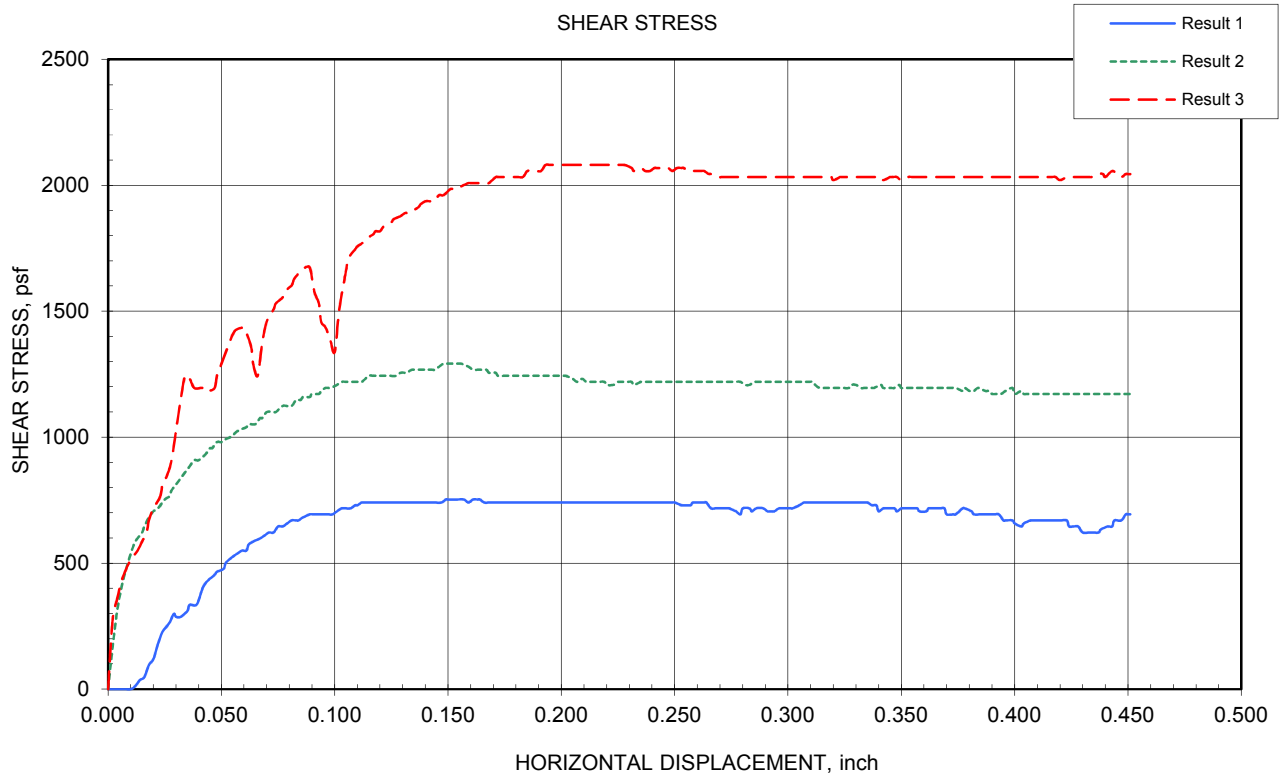


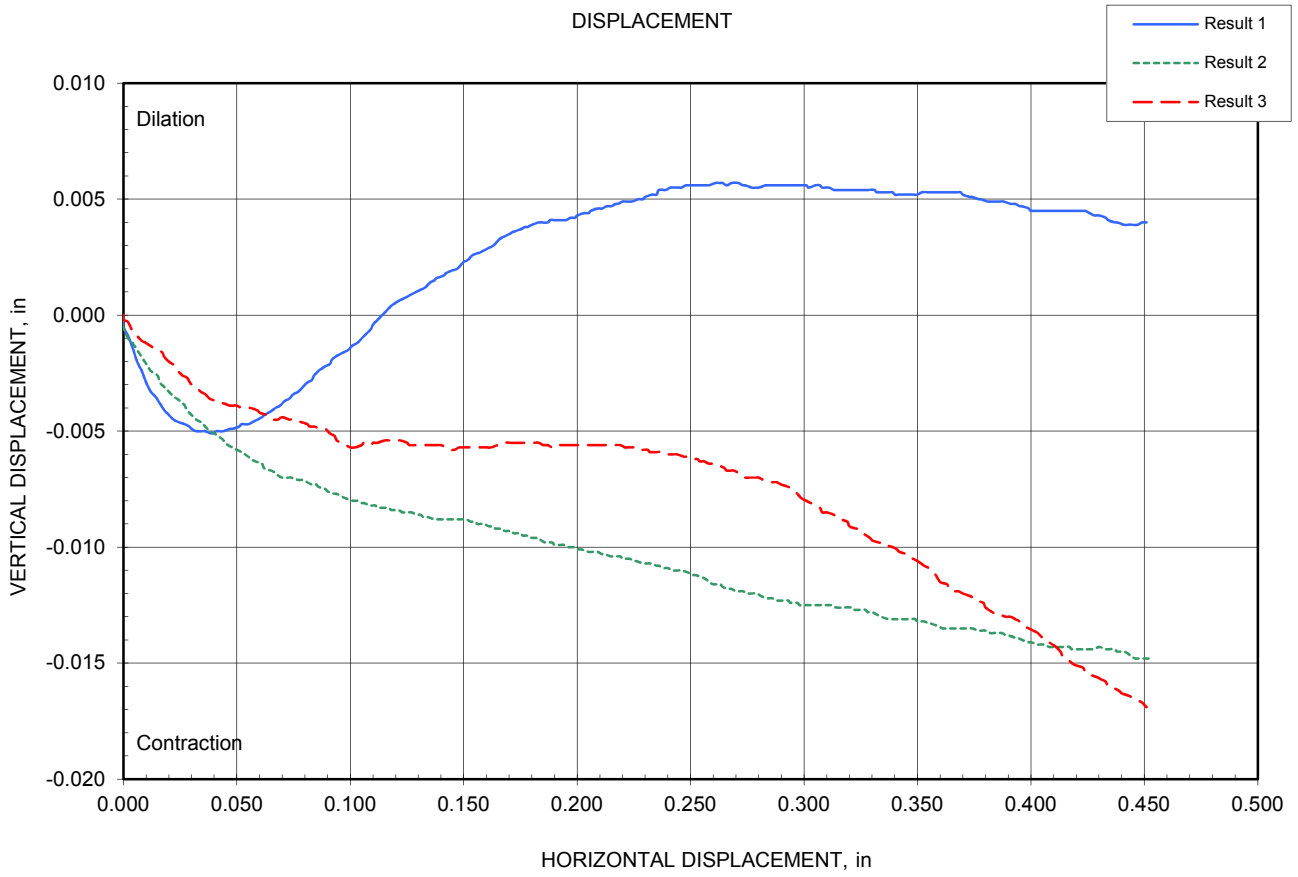
Note: The friction angle presented is applicable only to the load ranges and sample conditions tested

Reviewed By: _____

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS ASTM D3080

PROJECT:	Arroyo Cuchillo	**JOB NO:**	66165113
LOCATION:	New Mexico	**WORK ORDER NO:**	66165113
MATERIAL:	Clayey Sand	**LAB NO:**	8923
SAMPLE SOURCE:	Insitu BH 5 @ 10' - 12'	**DATE SAMPLED:**	7/21/2016





APPENDIX B – USGS SEISMIC DESIGN MAPS

USGS Design Maps Summary Report

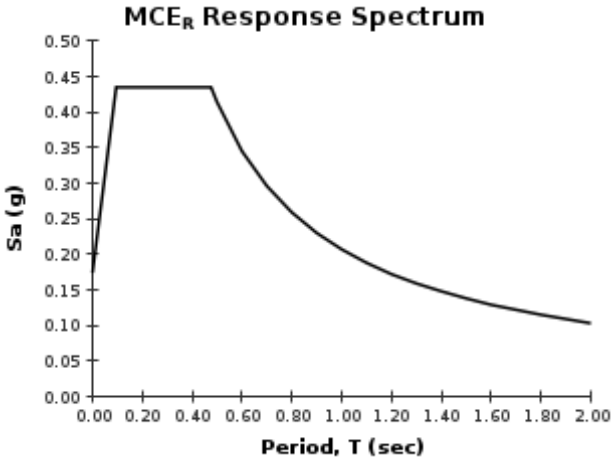
User–Specified Input

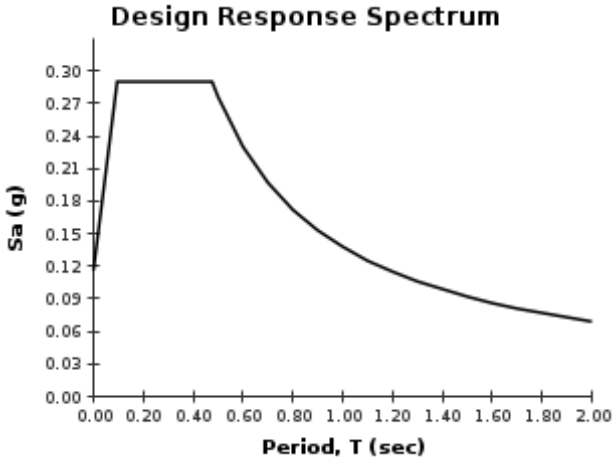
Report Title	Arroyo Cuchillo Thu November 17, 2016 17:57:25 UTC
Building Code Reference Document	2012/2015 International Building Code (which utilizes USGS hazard data available in 2008)
Site Coordinates	33.14945°N, 107.22148°W
Site Soil Classification	Site Class D – "Stiff Soil"
Risk Category	I/II/III

USGS–Provided Output

S_S =	0.275 g	S_{MS} =	0.435 g	S_{DS} =	0.290 g
S_1 =	0.086 g	S_{M1} =	0.207 g	S_{D1} =	0.138 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.





Although this information is a product of the U.S. Geological Survey, we provide no warranty, expressed or implied, as to the accuracy of the data contained therein. This tool is not a substitute for technical subject-matter knowledge.

USGS Design Maps Detailed Report

2012/2015 International Building Code (33.14945°N, 107.22148°W)

Site Class D – "Stiff Soil", Risk Category I/II/III

Section 1613.3.1 — Mapped acceleration parameters

Note: Ground motion values provided below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_S) and 1.3 (to obtain S_1). Maps in the 2012/2015 International Building Code are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 1613.3.3.

From Figure 1613.3.1(1) [1]	S_S = 0.275 g
From Figure 1613.3.1(2) [2]	S_1 = 0.086 g

Section 1613.3.2 — Site class definitions

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Section 1613.

2010 ASCE-7 Standard – Table 20.3-1
SITE CLASS DEFINITIONS

Site Class	$\overline{v}_s$	$\overline{N}$ or $\overline{N}_{ch}$	$\overline{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index PI > 20, • Moisture content w ≥ 40%, and • Undrained shear strength $\overline{s}_u$ < 500 psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 1613.3.3 — Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters

TABLE 1613.3.3(1)
VALUES OF SITE COEFFICIENT F_a

Site Class	Mapped Spectral Response Acceleration at Short Period				
	$S_S \le 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \ge 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_S

For Site Class = D and S_S = 0.275 g, F_a = 1.580

TABLE 1613.3.3(2)
VALUES OF SITE COEFFICIENT F_v

Site Class	Mapped Spectral Response Acceleration at 1–s Period				
	$S_1 \le 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \ge 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_1

For Site Class = D and S_1 = 0.086 g, F_v = 2.400

Equation (16-37):	$S_{MS} = F_a S_S = 1.580 \times 0.275 = 0.435$ g
Equation (16-38):	$S_{M1} = F_v S_1 = 2.400 \times 0.086 = 0.207$ g

Section 1613.3.4 — Design spectral response acceleration parameters

Equation (16-39):	$S_{DS} = ⅔ S_{MS} = ⅔ \times 0.435 = 0.290$ g
Equation (16-40):	$S_{D1} = ⅔ S_{M1} = ⅔ \times 0.207 = 0.138$ g

Section 1613.3.5 — Determination of seismic design category

TABLE 1613.3.5(1)
SEISMIC DESIGN CATEGORY BASED ON SHORT-PERIOD (0.2 second) RESPONSE ACCELERATION

VALUE OF S_{DS}	RISK CATEGORY		
	I or II	III	IV
$S_{DS} < 0.167g$	A	A	A
$0.167g \le S_{DS} < 0.33g$	B	B	C
$0.33g \le S_{DS} < 0.50g$	C	C	D
$0.50g \le S_{DS}$	D	D	D

For Risk Category = I and S_{DS} = 0.290 g, Seismic Design Category = B

TABLE 1613.3.5(2)
SEISMIC DESIGN CATEGORY BASED ON 1-SECOND PERIOD RESPONSE ACCELERATION

VALUE OF S_{D1}	RISK CATEGORY		
	I or II	III	IV
$S_{D1} < 0.067g$	A	A	A
$0.067g \le S_{D1} < 0.133g$	B	B	C
$0.133g \le S_{D1} < 0.20g$	C	C	D
$0.20g \le S_{D1}$	D	D	D

For Risk Category = I and S_{D1} = 0.138 g, Seismic Design Category = C

Note: When S_1 is greater than or equal to 0.75g, the Seismic Design Category is **E** for buildings in Risk Categories I, II, and III, and **F** for those in Risk Category IV, irrespective of the above.

Seismic Design Category ≡ "the more severe design category in accordance with Table 1613.3.5(1) or 1613.3.5(2)" = C

Note: See Section 1613.3.5.1 for alternative approaches to calculating Seismic Design Category.

References

1. *Figure 1613.3.1(1)*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(1).pdf
2. *Figure 1613.3.1(2)*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(2).pdf

APPENDIX C – UNIFIED SOIL CLASSIFICATION

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE-GRAINED SOILS (major portions retained on No. 200 sieve): includes (1) clean gravel and sands and (2) silty or clayey gravels and sands. Condition is rated according to relative density as determined by laboratory tests or standard penetration resistance tests.

Descriptive Terms	Relative Density	SPT Blow Count
Very loose	0 to 15 %	< 4
Loose	15 to 35 %	4 to 10
Medium dense	35 to 65 %	10 to 30
Dense	65 to 85 %	30 to 50
Very dense	85 to 100 %	> 50

FINE-GRAINED SOILS (major portions passing on No. 200 sieve): includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings, SPT blow count, or unconfined compression tests.

Descriptive Terms	Unconfined Compressive Strength kPa	SPT Blow Count
Very soft	< 25	< 2
Soft	25 to 50	2 to 4
Medium stiff	50 to 100	4 to 8
Stiff	100 to 200	8 to 15
Very Stiff	200 to 400	15 to 30
Hard	> 400	> 30

GENERAL NOTES

1. Classifications are based on the United Soil Classification System and include consistency, moisture, and color. Field descriptions have been modified to reflect results of laboratory tests where deemed appropriate.

2. Surface elevations are based on topographic maps and estimated locations.

3. Descriptions on these boring logs apply only at the specific boring locations and at the time the borings were made. they are not guaranteed to be representative of subsurface conditions at other locations or times.

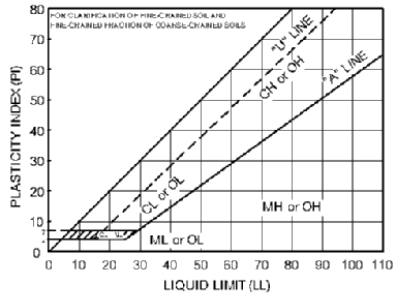
Major Divisions			Group Symbols	Typical Names	Laboratory Classification Criteria
Coarse-Grained soils (more than half the material is larger than No. 200 sieve size)	Gravels (more than half of coarse fraction is larger than No. 4 sieve size)	Clean gravel (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
			GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines	Not meeting all gradation requirements for GW
		Gravel with fines (Appreciable amount of fines)	GM* d / u	Silty gravels, gravel-sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4
			GC	Clayey gravels, gravel-sand-silt mixtures	Atterberg limits below "A" line or P.I. greater than 7
	Sands (more than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
			SP	Poorly-graded sands, gravelly sands, little or no fines	Not meeting all gradation requirements for SW
		Sands with fines (Appreciable amount of fines)	SM* d / u	Silty sands, sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4
			SC	Clayey sands, sand-clay mixtures	Atterberg limits below "A" line or P.I. greater than 7
Fine-Grained soils (more than half the material is smaller than No. 200 sieve size)	Silts and Clays (Liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock floor, silty or clayey fine sands or clayey silts with slight plasticity	
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
			OL	Organic silts and organic silty clays of low plasticity	
	Silts and Clays (Liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, organic silts	
			CH	Inorganic clays of high plasticity, fat clays	
			OH	Organic clays of medium to high plasticity, organic silts	
	Highly Organic Soils		Pt	Peat and other highly organic soils	

Determine percentages of sand and gravel from grain size curve, Depending on percentage of fines (fraction smaller than No. 200 sieve) coarse-grained soils are classified as follows:

Less than 5 percent..... GW, GP, SW, SP
More than 12 percent..... GM, GC, SM, SC
5 to 12 percent..... Borderline cases requiring dual symbols**

Above "A" line with P.I. between 4 and 7 are border-line cases requiring use of dual symbols

Above "A" line with P.I. between 4 and 7 are border-line cases requiring use of dual symbols



Plasticity Chart

Particle Size	Material	mm	Sieve sizes
	Silt or Clay	< 0.074	< #200
	Sand		# 200 to # 400
	Fine	0.074 to 0.42	# 40 to #10
	Medium	0.42 to 2.00	#10 to #4
	Coarse	2.00 to 4.76	

Particle Size	Material	mm	Sieve
	Gravel		
	Fine	4.76 to 19.1	#4 to 3/4 in.
	Coarse	19.1 to 76.2	3/4 in. to 3 in.
	Cobble	76.2 to 304.8	3 in. to 12 in.
	Boulders	304.8 to 914.4	12 in. to 36 in.

* Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 23 or less; the suffix is used when L.L. is greater than 25.

** Borderline classifiactions used for soils possessing characteristics of two groups are designated by combinations of groups symbols. For example; GW-GC, well-graded gravel-sand mixture with clay binder.

APPENDIX D – TERMINOLOGY

TERMINOLOGY USED TO DESCRIBE THE RELATIVE DENSITY,
CONSISTENCY, OR FIRMNESS OF SOILS

The terminology used on the boring logs to describe the relative density, consistency, or firmness of soils relative to the standard penetration resistance is presented below. The standard penetration resistance (N) in blows per foot is obtained by ASTM D1586 procedure using 2" O.D., 1-3/8" I.D. samplers.

1. Relative Density. Terms for description of relative density of cohesionless, uncemented sands and sand-gravel mixtures.

N	Relative Density
0 - 4	Very Loose
5 - 10	Loose
11 - 30	Medium Dense
31 - 50	Dense
50+	Very Dense

2. Relative Consistency. Terms for the description of clays which are saturated or near saturation.

N	Relative Consistency	Remarks
0 - 2	Very Soft	Easily penetrated several inches with fist
3 - 4	Soft	Easily penetrated several inches
5 - 8	Medium Stiff	Can be penetrated several inches with thumb with moderate effort
9 - 15	Stiff	Readily indented with thumb, but penetrated only with great effort
16 - 30	Very Stiff	Readily indented with thumbnail
30+	Hard	Indented only with difficulty with thumbnail

3. Relative Firmness. Terms for the description of partially saturated and/or cemented soils which commonly occur in the Southwest including clays cemented granular materials, silts, and silty and clayey granular soils.

N	Relative Firmness
0 - 4	Very Soft
5 - 8	Soft
9 - 15	Moderately Firm
16 - 30	Firm
31 - 50	Very Firm
50+	Hard