

June 24, 2019



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
COLORADO SPRINGS, CO 80907
PHONE (719) 531-5599
FAX (719) 531-5238

Tech Contractors
3575 Kenyon Street, Suite 200
San Diego, California 92110

Attn: Jeff Scheble

Re: Pavement Recommendations – Partial
Windingwalk, Filing 1, Phase 4
El Paso County File No. SF 18-002
El Paso County, Colorado

Approved

By: Elizabeth NijKamp

Date: 07/03/2019

El Paso County Planning & Community Development



Dear Mr. Scheble:

As requested, Entech Engineering, Inc. has obtained samples of the subgrade soils from sections of the roadways in the Windingwalk Subdivision, Filing 1, Phase 4, in El Paso County, Colorado. Laboratory testing to determine the pavement support characteristics of the soils was performed. This letter presents the results of the laboratory testing and pavement recommendations for the roadways.

Project Description

The project lies north and west of the initial phases of the development. The extent of the roadway construction is shown in Figure 1.

The roadways in this phase of the project consist of: a portion of Windingwalk Drive between Fairway Glen Drive and Windingpark Drive and between Rainbow Bridge Drive and Picket Fence Way, Porch Swing Lane, Arbor Walk Lane, a portion of Hiddenwalk Way between Arbor Walk Lane and Fairway Glen Drive, a portion of Lambert Road between Rainbow Bridge Drive and Stone Valley Drive, a portion of Morning Creek Lane between Rainbow Bridge Drive and Picket Fence Way, and Picket Fence Way. The site layout and the locations of the test borings, drilled at approximate 500-foot intervals, are shown on the Test Boring Location Plan, Figure 1.

Subgrade Conditions

Ten exploratory test borings were drilled in the roadways to depths of approximately 5 to 10 feet. The Boring Logs are presented in Appendix A. The subgrade soils encountered in the test borings consisted of clayey sand fill, silty clayey sand fill, native clayey sand, and clayey sandstone. Sieve Analysis and Atterberg Limit testing were performed on soil samples obtained from the test borings for the purpose of classification. Sieve analyses performed indicated the percent passing the No. 200 sieve for the roadway subgrade soils ranged from approximately 16 to 31 percent. Atterberg Limit Tests performed on the samples resulted in Liquid Limits ranging from 24 to 39 and Plastic Indexes of 6 to 20. The soil types were encountered at the subgrade depth: Soil Type 1 – sand fill, Soil Type 2 – native sand, and Soil Type 3 - sandstone. All soil types classified as A-2-4 and A-2-6 soils based on the AASHTO classification system. Type 1 and 2 soils encountered in this portion of the subdivision phasing typically have good pavement support characteristics. Sulfate testing of the subgrade indicated that the soils exhibit a negligible potential for sulfate attack. Groundwater was not encountered in the test borings.

Swell testing was conducted on three soil types which showed consolidations and swells ranging between -2.4 to 1.4 percent, indicating low to moderate consolidation potentials and low expansion potentials. The swell limits are below the level in which mitigation is required (2.0 percent). Laboratory test results are presented in Appendix B and are summarized on Table 1.

Figure 1 also depicts test borings that were drilled adjacent to the area covered by this report from previous phasing of Filing 1. Appendix C includes the summary table and test boring logs that pertain to the test borings from the previous pavement reports. The information for the pertinent test boring numbers contained in tables and logs show the similarities of the soil data and classifications for this phase of Filing 1.

California Bearing Ratio (CBR) testing was performed on a sample of Soil Type 2 to determine the support characteristic of the subgrade soils for the roadway sections. The results of the CBR testing, are presented in Appendix B and summarized as follows:

CBR Test Results
Soil Type 2 – Clayey Sand
R @ 90% = 51.0
R @ 95% = 78.0
Use R = 40.0 for design

<u>Classification Testing</u>	
Liquid Limit	24
Plasticity Index	11
Percent Passing 200	31.2
AASHTO Classification	A-2-6
Group Index	0
Unified Soils Classification	SC

Pavement Design

The CBR testing was used to determine pavement sections for this site. The pavement sections were determined utilizing the El Paso County "Pavement Design Criteria and Report". The following classifications and ESAL values were used for this portion of the filing. Windingwalk Drive, Porch Swing Lane, Arbor Walk Lane, Hiddenwalk Way, Picket Fence Way, and Morning Creek Lane classify as urban local road which use an 18K ESAL value of 292,000 for design. Lambert Road classifies as a non-residential collector which use an 18K ESAL value of 3,573,833 for design. Pavement alternatives for asphalt over aggregate basecourse and cement stabilized subgrade sections are provided. Design parameters used in the pavement analysis are as follows:

Reliability (Urban Local Roads)	80%
Reliability (Non-Residential Collector)	85%
Serviceability Index Urban Local Roads	2.0
Serviceability Index Non-Residential Collector	2.5
"R" Value Subgrade – ST 2	40.0
Resilient Modulus	9,497 psi
Structural Coefficients:	
Hot Bituminous Pavement	0.44
Aggregate Basecourse	0.11
Cement Stabilized Subgrade	0.12

Pavement calculations are attached in Appendix D. Pavement sections recommended for this phase of the filing are summarized as follows:

Pavement Sections – Soil Type 2

Urban Local – ESAL = 292,000 – Windingwalk Drive, Porch Swing Lane, Arbor Walk Lane, Hiddenwalk Way, Picket Fence Way, and Morning Creek Lane

<u>Alternative</u>	<u>Asphalt (in)</u>	<u>Basecourse (in)</u>	<u>Cement Stabilized Subgrade (in.)</u>
1. Asphalt Over Basecourse	3.5	8.0*	--
2. Cement Stabilized Subgrade	4.0*	--	10.0*

Pavement Sections – Soil Type 2

Urban Non-Residential Collector – ESAL = 3,573,833 – Lambert Road

<u>Alternative</u>	<u>Asphalt (in)</u>	<u>Basecourse (in)</u>	<u>Cement Stabilized Subgrade (in.)</u>
1. Asphalt Over Basecourse	5.0	12.0	--
2. Cement Stabilized Subgrade	5.0	--	11.0

¹ Full depth sections are only allowed over chemically treated or suitable subgrade.

* Minimum sections required by the El Paso County Pavement Design Criteria and Report.

Mitigation

El Paso County criteria requires mitigation of expansive soils for roadway subgrade that have a swell of 2 percent or greater with a 150 pound per square foot surcharge. Ten samples at subgrade depth were tested that resulted in volume changes ranging between -2.4 to 1.4 percent. Mitigation for expansive soils will not be required based on the lab testing.

Due to the limited areas in which the clayey sandstone was encountered at shallow depths, (Test Boring Nos. 4 and 5), it is recommended that areas requiring overexcavation, if any, should be determined during final subgrade preparation. Overexcavation is required if the sandstone lies within 1 foot of the roadway subgrade. The sandstone should be removed and recompacted to the compaction efforts and moisture contents for granular soils described below. The extents and depths of overexcavation should be field determined. Personnel of Entech Engineering, Inc. should be on-site to verify the locations and approximate depths of overexcavation during the subgrade preparation. Density testing should be performed on the fill material.

Roadway Construction - Full Depth Asphalt and Asphalt on Aggregate Basecourse Alternatives

Prior to placement of the asphalt, the subgrade should be proofrolled and compacted to a minimum of 95 percent of its maximum Standard Proctor Dry Density, ASTM D-698 at -1 to +2 percent of optimum moisture content or 95 percent of its maximum Modified Proctor Dry Density, ASTM D-1557 at ± 2 percent of optimum moisture content. Any loose or soft areas should be removed and replaced with suitable materials. Basecourse materials should be compacted to a minimum of 95 percent of its maximum Modified Proctor Dry Density, ASTM D-1557 at ± 2 percent of optimum moisture content. Special attention should be given to areas adjacent to manholes, inlet structures and valves.

Roadway Construction – Cement Stabilized Subgrade Alternative

Prior to placement of the asphalt, the subgrade shall be stabilized by addition of cement to a depth of at least 11 inches. The depth of the required cement stabilized subgrade is shown in the previous table. The amount of cement applied shall be 2.0 percent (by weight) of the subgrade's maximum dry density as determined by the Standard Proctor Test (ASTM D-698) based on laboratory cement stabilization testing. The cement should be spread evenly on the subgrade surface and be thoroughly mixed into the subgrade over a 11-inch depth such that a uniform blend of soil and cement is achieved. Prior to application or mixing of the cement, the upper 10 inches of subgrade should be thoroughly moisture conditioned to the soil's optimum water content or as much as 2 percent more than the optimum water content as necessary to provide a compactable soil condition. Densification of the cement-stabilized subgrade should be completed to obtain a compaction of at least 95 percent of the subgrade maximum dry density as determined by the Standard Proctor Test (ASTM D-698). Satisfactory compaction of the subgrade shall occur within 90 minutes from the time of mixing the cement into the subgrade.

The following conditions shall be observed as part of the subgrade stabilization:

- A local supplier shall be used to supply the Type I/II cement. All cement used for stabilization should come from the same source. If cement sources are changed a new laboratory mix design should be completed.
- Moisture conditioning of the subgrade and/or mixing of the cement into the subgrade shall not occur when soil temperatures are below 40° F. Cement treated subgrades should be maintained at a temperature of 40° F or greater until the subgrade has been compacted as required.
- Cement placement, cement mixing and compaction of the cement treated subgrade should be observed by a Soils Engineer. The Soils Engineer should complete in situ compaction tests and construct representative compacted specimens of the treated subgrade material for subsequent laboratory quality assurance testing.
- Microfracturing of the stabilized subgrade is recommended.

If significant grading is performed, the soils at subgrade may change. Modification to the pavement sections should be evaluated after site grading is completed.

In addition to the above guidance, the asphalt, cement, subgrade conditions, compaction of materials and roadway construction methods shall meet the El Paso County specifications.

We trust that this has provided you with the information you required. If you have any questions or need additional information, please do not hesitate to contact us.

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Reviewed by:


Stan C. Culp, P.E.
Senior Engineer




Joseph C. Goode, Jr., P.E.
President

SCC/sc

Encl.

Entech Job No. 190128
A\projects\2019\190128\190128 pr_ph4

TABLE

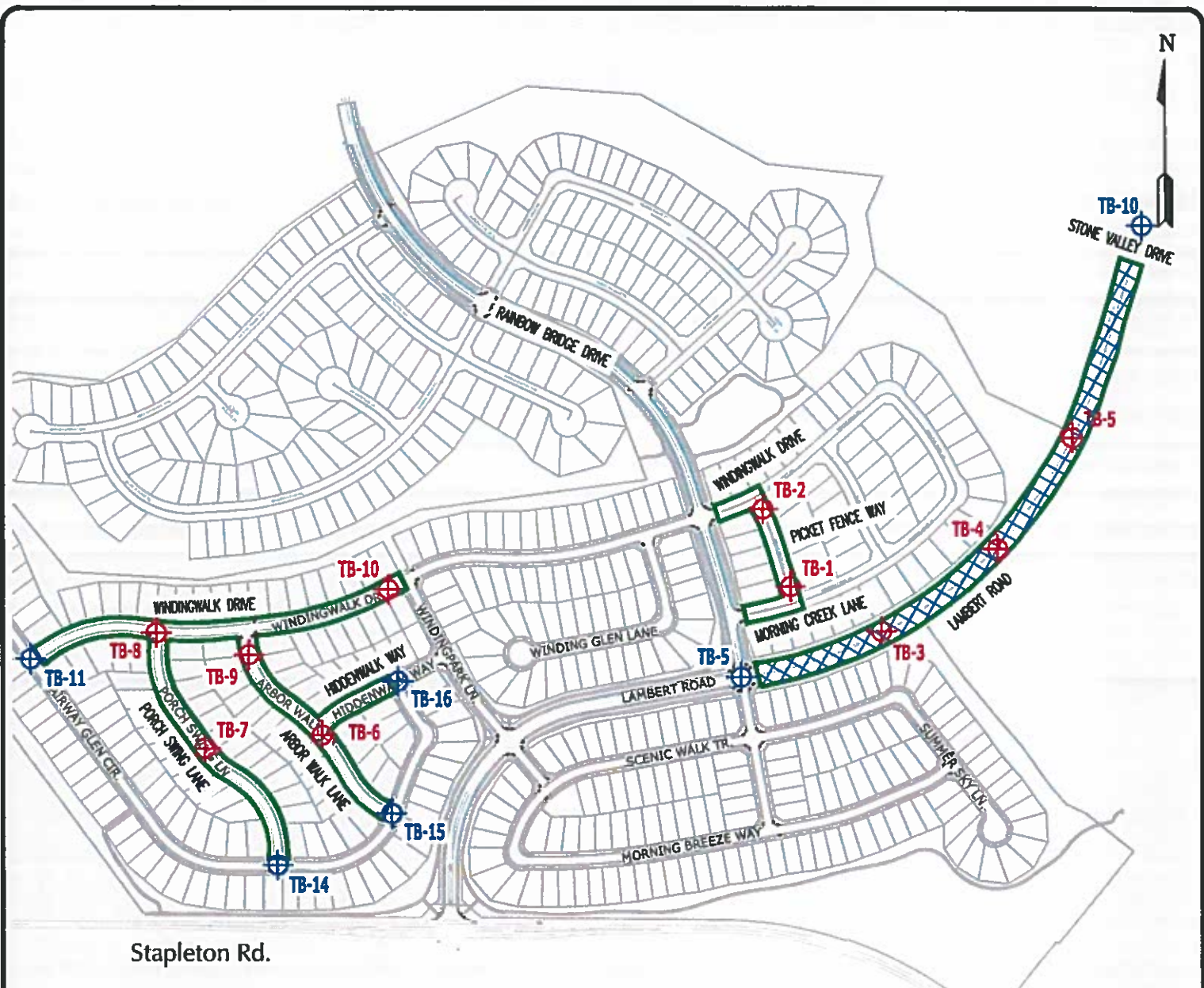
TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT TECH CONTRACTORS
 PROJECT WINDING WALK, PHASE 4
 JOB NO. 190128

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	AASHTO CLASS.	SWELL/ CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1	1	1-2	7.3	113.2	16.0	31	13		A-2-6	-0.7	SC	FILL, SAND, CLAYEY
1	2	1-2	6.5	105.2	25.7	30	12		A-2-6	-1.2	SC	FILL, SAND, CLAYEY
1	3	1-2			22.6	27	6	0.00	A-2-4		SC-SM	FILL, SAND, CLAYEY, SILTY
1	6	1-2	7.3	115.5	22.7	39	20		A-2-6	0.0	SC	FILL, SAND, CLAYEY
1	7	1-2	9.5	95.2	16.2	26	6		A-2-4	-2.4	SC-SM	FILL, SAND, CLAYEY, SILTY
1	8	1-2	7.3	111.1	26.1	31	15		A-2-6	-0.6	SC	FILL, SAND, CLAYEY
1	9	1-2	7.9	114.3	26.5	28	13		A-2-6	1.4	SC	FILL, SAND, CLAYEY
1	10	1-2	9.5	106.8	22.4	30	11	<0.01	A-2-6	-0.4	SC	FILL, SAND, CLAYEY
1	1	0-3			27.4						SC	FILL, SAND, CLAYEY
1	10	0-3			28.7	27	15		A-2-6		SC	FILL, SAND, CLAYEY
2, CBR	5	0-2	8.4	125.5	31.2	24	11	<0.01	A-2-6	0.3	SC	SAND, CLAYEY
2	4	1-2	8.2	103.1	23.2	36	17		A-2-6	-0.7	SC	SAND, CLAYEY
3	5	2-3	11.4	94.3	19.8	28	8		A-2-4	-0.9	SC	SANDSTONE, CLAYEY


FIGURE




Stapleton Rd.

SOIL TYPES 1 & 2

NOTES:

 : URBAN LOCAL - (292,000) - 3.5" ASPHALT OVER 8.0" BASECOURSE, OR 4.0" ASPHALT OVER 10.0" OF CEMENT-TREATED SUBGRADE.

 : URBAN NON-RESIDENTIAL COLLECTOR - (3,573,833) - 5.0" ASPHALT OVER 12.0" BASECOURSE, OR 5.0" ASPHALT OVER 11.0" OF CEMENT-TREATED SUBGRADE.

 TB-2 - APPROXIMATE TEST BORING LOCATION AND NUMBER

 TB-5 - APPROXIMATE TEST BORING LOCATION AND NUMBER FROM PREVIOUS PAVEMENT REPORTS



ENTECH
ENGINEERING, INC.
305 ELIJAH DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-0200

TEST BORING LOCATION PLAN
WINDINGWALK, F1, PHASE 4
EL PASO COUNTY, CO
FOR: TECH CONTRACTORS

DRAWN BY: SC	DATE DRAWN: 06/24/19	DESIGNED BY: SC	CHECKED: SC
-----------------	-------------------------	--------------------	----------------

JOB NO.:
190128
FIG. NO.:
1

APPENDIX A: Test Boring Logs

TEST BORING NO. 1
 DATE DRILLED 5/9/2019
 Job # 190128

TEST BORING NO. 2
 DATE DRILLED 5/9/2019
 CLIENT TECH CONTRACTORS
 LOCATION WINDING WALK, PHASE 4

REMARKS						REMARKS					
Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 5/9/19 FILL 0-5', SAND, CLAYEY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST						DRY TO 10', 5/9/19 FILL 0-10', SAND, CLAYEY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE TO DENSE, MOIST					
5	[Symbol]		18	7.5	1	5	[Symbol]		14	10.7	1
5	[Symbol]		14	8.2	1	5	[Symbol]		22	9.4	1
10	[Symbol]					10	[Symbol]		32	11.7	1
15	[Symbol]					15	[Symbol]				
20	[Symbol]					20	[Symbol]				



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:

DATE:

CHECKED:

DATE:

SCC

6/24/19

JOB NO:
 190128

FIG NO:
 A- 1

TEST BORING NO. 3
 DATE DRILLED 5/9/2019
 Job # 190128

TEST BORING NO. 4
 DATE DRILLED 5/9/2019
 CLIENT TECH CONTRACTORS
 LOCATION WINDING WALK, PHASE 4

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 5/9/19							DRY TO 5', 5/9/19						
FILL 0-4', SAND, CLAYEY, SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST				14	5.6	1	SAND, CLAYEY, FINE TO COARSE GRAINED, BROWN, DENSE, MOIST				30	9.4	2
SANDSTONE, SILTY, FINE TO COARSE GRAINED, TAN, VERY DENSE, MOIST	5			50	6.8	3	SANDSTONE, CLAYEY, FINE TO COARSE GRAINED, BROWN, VERY DENSE, MOIST	5			50	9.4	3
	10						CLAYSTONE, SANDY, BLUE GRAY, HARD, MOIST	10			50 11"	13.7	4
	15							15					
	20							20					



ENTECH
 ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	6/24/19

JOB NO:
 190128

FIG NO:
 A- 2

TEST BORING NO. 5
 DATE DRILLED 5/9/2019
 Job # 190128

TEST BORING NO. 6
 DATE DRILLED 5/9/2019
 CLIENT TECH CONTRACTORS
 LOCATION WINDING WALK, PHASE 4

REMARKS						REMARKS					
Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 5/9/19						DRY TO 5', 5/9/19					
SAND, CLAYEY, BROWN						FILL 0-4', SAND, CLAYEY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST					
			50	7.5	2				33	6.9	1
			10"		3						
5			50	7.4	3	5			30	8.1	2
			6"								
SANDSTONE, CLAYEY, FINE TO COARSE GRAINED, TAN, VERY DENSE, MOIST						SAND, SILTY, FINE TO COARSE GRAINED, BROWN, DENSE, MOIST					
10						10			50	15.0	4
									6"		
CLAYSTONE, SANDY, GRAY BROWN, HARD, MOIST											



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:

DATE:

CHECKED:

DATE:

SCC

6/24/19

JOB NO:
 190128

FIG NO:
 A- 3

TEST BORING NO. 7
 DATE DRILLED 5/9/2019
 Job # 190128

TEST BORING NO. 8
 DATE DRILLED 5/9/2019
 CLIENT TECH CONTRACTORS
 LOCATION WINDING WALK, PHASE 4

REMARKS

DRY TO 5', 5/9/19

FILL 0-5', SAND, CLAYEY, SILTY,
 FINE TO COARSE GRAINED,
 DARK BROWN TO BROWN,
 LOOSE TO MEDIUM DENSE,
 MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
0-5	[Symbol]		7	5.5	1
5	[Symbol]		11	5.7	1
10					
15					
20					

REMARKS

DRY TO 5', 5/9/19

FILL 0-7', SAND, CLAYEY, FINE
 TO COARSE GRAINED, BROWN,
 MEDIUM DENSE, MOIST

SAND, SILTY, FINE GRAINED,
 BROWN, DENSE, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
0-7	[Symbol]		14	8.9	1
5	[Symbol]		16	7.2	1
10	[Symbol]		37	10.2	2
15					
20					



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:

DATE:

CHECKED:

DATE:

SCC

6/24/19

JOB NO.:
 190128

FIG NO.:
 A- 4

TEST BORING NO. 9
 DATE DRILLED 5/9/2019
 Job # 190128

TEST BORING NO. 10
 DATE DRILLED 5/9/2019
 CLIENT TECH CONTRACTORS
 LOCATION WINDING WALK, PHASE 4

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 5/9/19							DRY TO 5', 5/9/19						
FILL 0-5', SAND, CLAYEY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST	0-5	[Symbol]		19	6.1	1	FILL 0-5', SAND, CLAYEY, FINE TO COARSE GRAINED, BROWN, LOOSE TO MEDIUM DENSE, MOIST	0-5	[Symbol]		9	7.8	1
	5	[Symbol]		29	6.6	1		5	[Symbol]		10	10.4	1
	10							10					
	15							15					
	20							20					



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:

DATE:

CHECKED:

DATE:

SCC

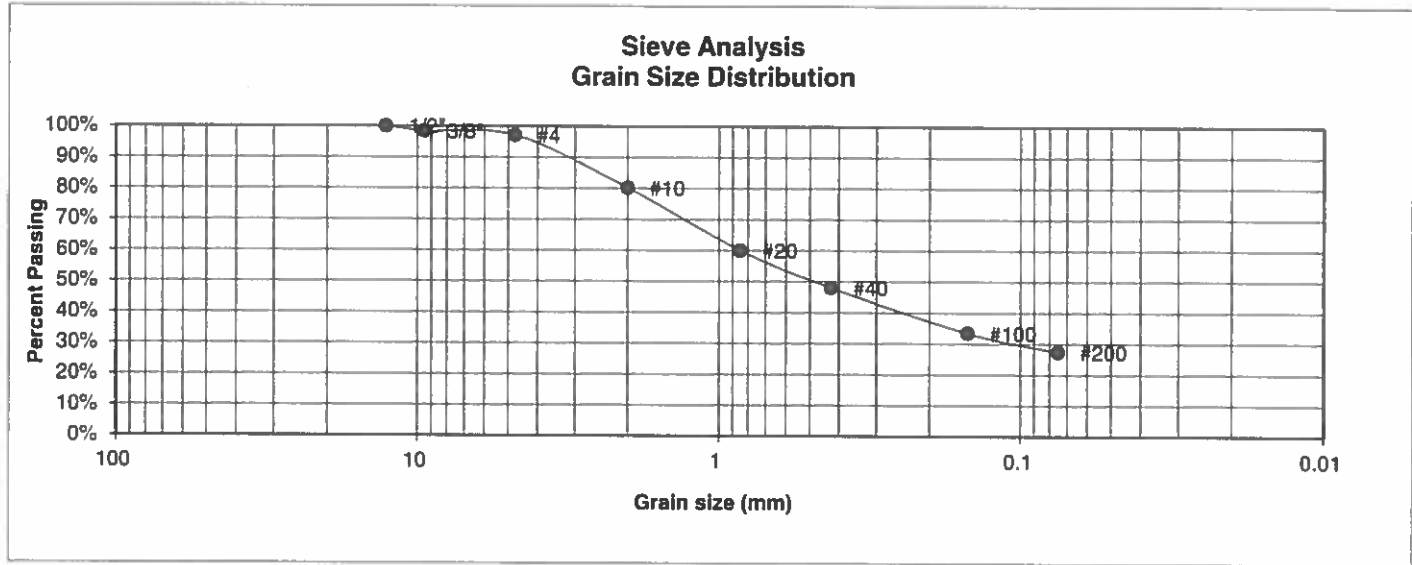
6/24/19

JOB NO:
 190128

FIG NO:
 A- 5

APPENDIX B: Laboratory Test Results

UNIFIED CLASSIFICATION	SC	CLIENT	TECH CONTRACTORS
SOIL TYPE #	1	PROJECT	WINDING WALK, PHASE 4
TEST BORING #	1	JOB NO.	190128
DEPTH (FT)	0-3	TEST BY	BL
AASHTO CLASSIFICATION		GROUP INDEX	



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	98.5%
4	97.1%
10	80.2%
20	60.1%
40	48.1%
100	33.5%
200	27.4%

Atterberg Limits
 Plastic Limit
 Liquid Limit
 Plastic Index

Swell
 Moisture at start
 Moisture at finish
 Moisture increase
 Initial dry density (pcf)
 Swell (psf)



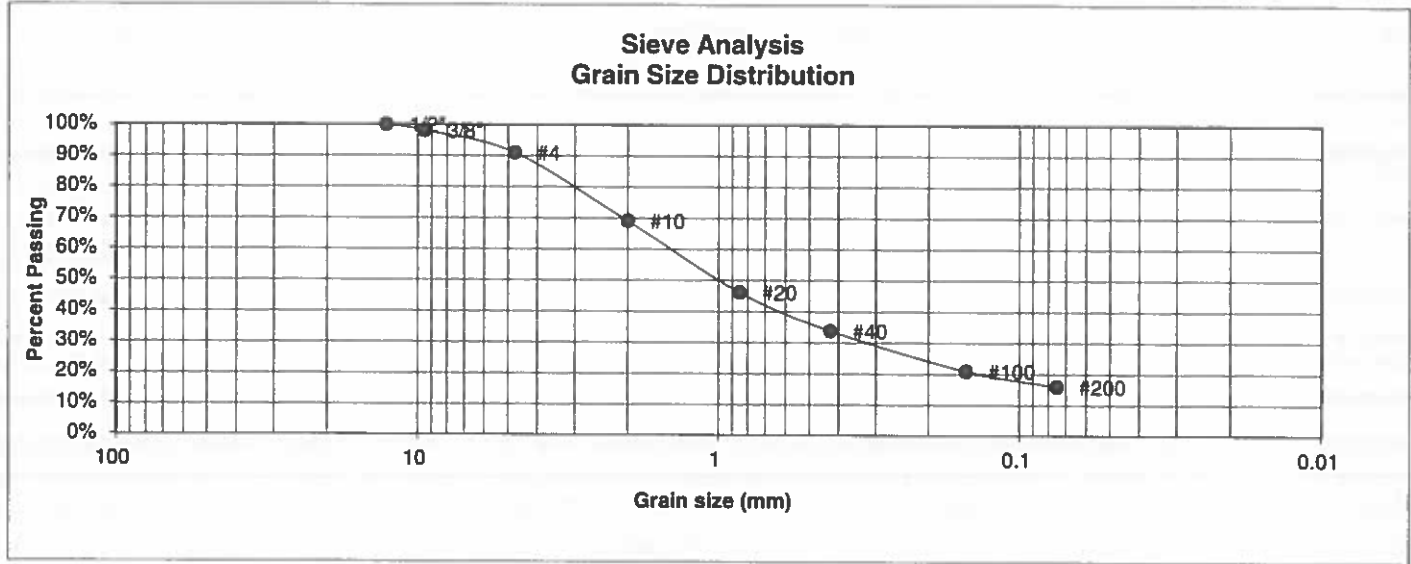
ENTECH ENGINEERING, INC.
 505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCL	9/24/19

JOB NO:
190128
FIG NO:
B-1

UNIFIED CLASSIFICATION	SC	CLIENT	TECH CONTRACTORS
SOIL TYPE #	1	PROJECT	WINDING WALK, PHASE 4
TEST BORING #	1	JOB NO.	190128
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	98.1%
4	90.9%
10	69.1%
20	46.2%
40	33.8%
100	20.9%
200	16.0%

Atterberg Limits	
Plastic Limit	18
Liquid Limit	31
Plastic Index	13
Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	



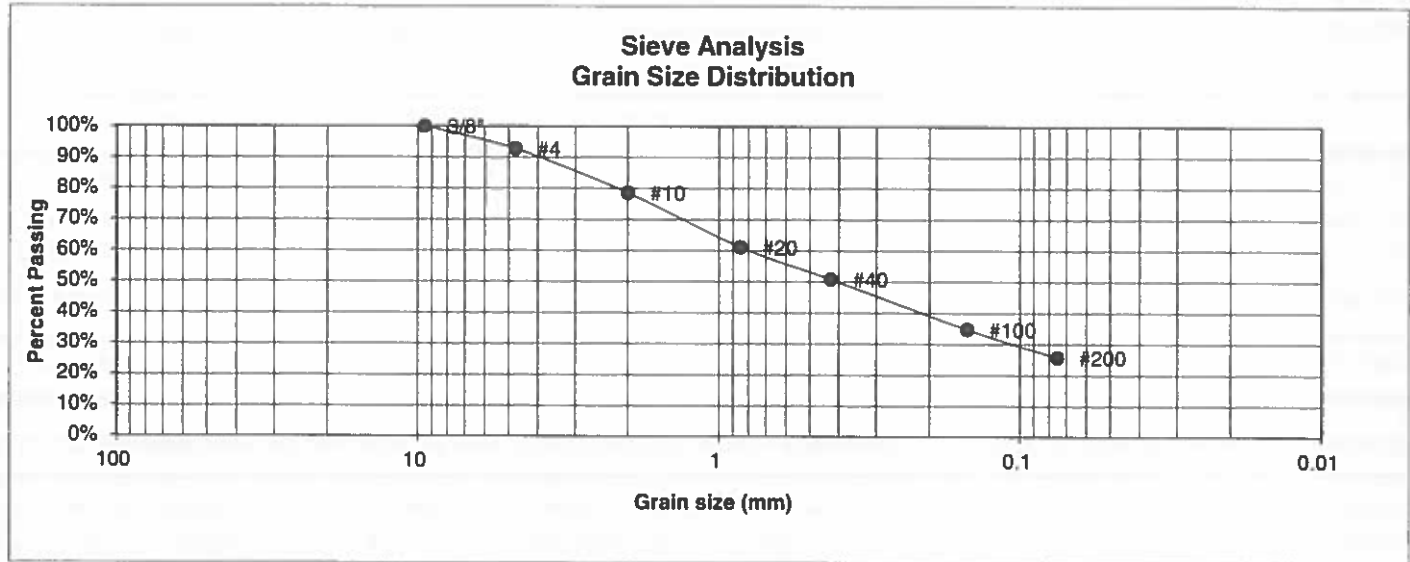
ENTECH
ENGINEERING, INC.
 505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	9/24/19

JOB NO.:
 190128
 FIG NO.:
 B-2

UNIFIED CLASSIFICATION	SC	CLIENT	TECH CONTRACTORS
SOIL TYPE #	1	PROJECT	WINDING WALK, PHASE 4
TEST BORING #	2	JOB NO.	190128
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	92.7%
10	78.5%
20	61.1%
40	50.8%
100	34.8%
200	25.7%

Atterberg Limits	
Plastic Limit	18
Liquid Limit	30
Plastic Index	12

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	



**ENTECH
ENGINEERING, INC.**

505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

**LABORATORY TEST
RESULTS**

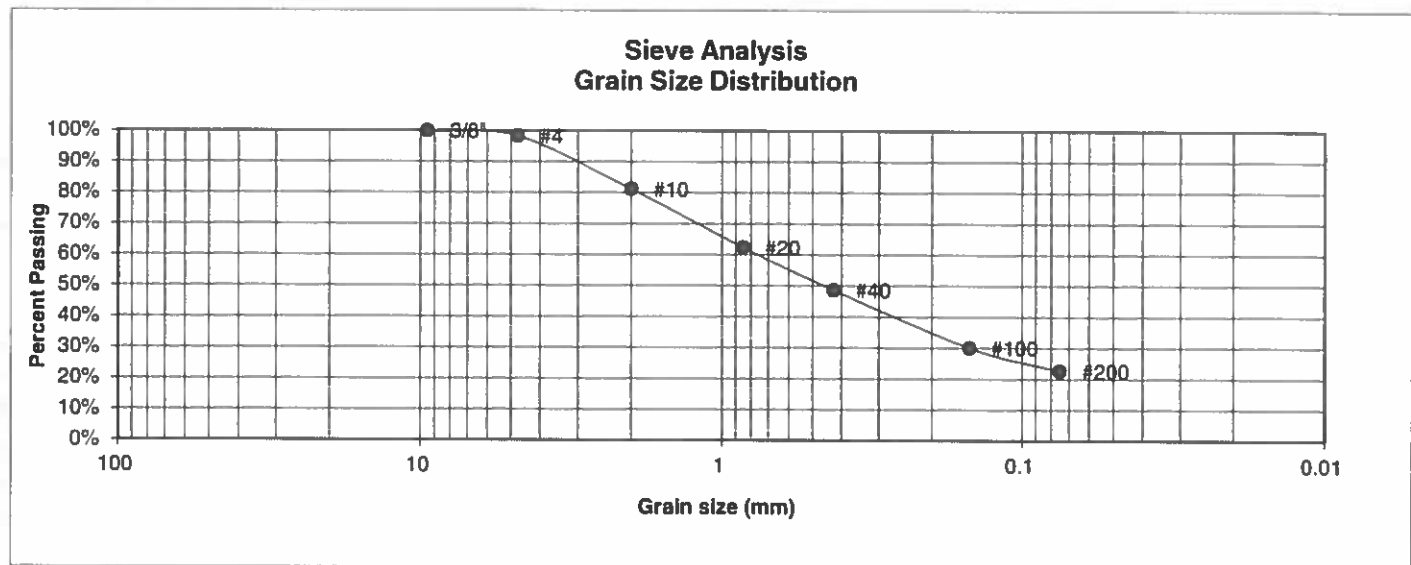
DRAWN:	DATE:	CHECKED:	DATE:
		BCC	9/24/19

JOB NO.:

190128
FIG NO.:

B-3

UNIFIED CLASSIFICATION	SC-SM	CLIENT	TECH CONTRACTORS
SOIL TYPE #	1	PROJECT	WINDING WALK, PHASE 4
TEST BORING #	3	JOB NO.	190128
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.3%
10	81.2%
20	62.4%
40	48.6%
100	30.1%
200	22.6%

Atterberg Limits	
Plastic Limit	21
Liquid Limit	27
Plastic Index	6

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	



ENTECH
ENGINEERING, INC.
 505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

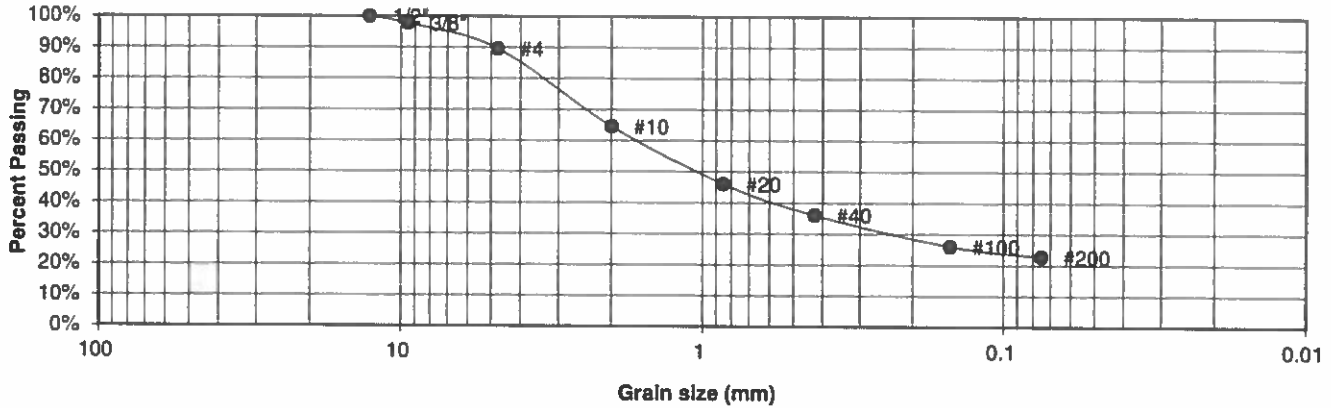
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	9/24/19

JOB NO.:
 190128
 FIG NO.:
 B-4

UNIFIED CLASSIFICATION SC
SOIL TYPE # 1
TEST BORING # 6
DEPTH (FT) 1-2
AASHTO CLASSIFICATION A-2-6

CLIENT TECH CONTRACTORS
PROJECT WINDING WALK, PHASE 4
JOB NO. 190128
TEST BY BL
GROUP INDEX 1

**Sieve Analysis
Grain Size Distribution**



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	97.8%
4	89.6%
10	64.6%
20	46.1%
40	36.1%
100	26.0%
200	22.7%

Atterberg Limits	
Plastic Limit	19
Liquid Limit	39
Plastic Index	20

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	



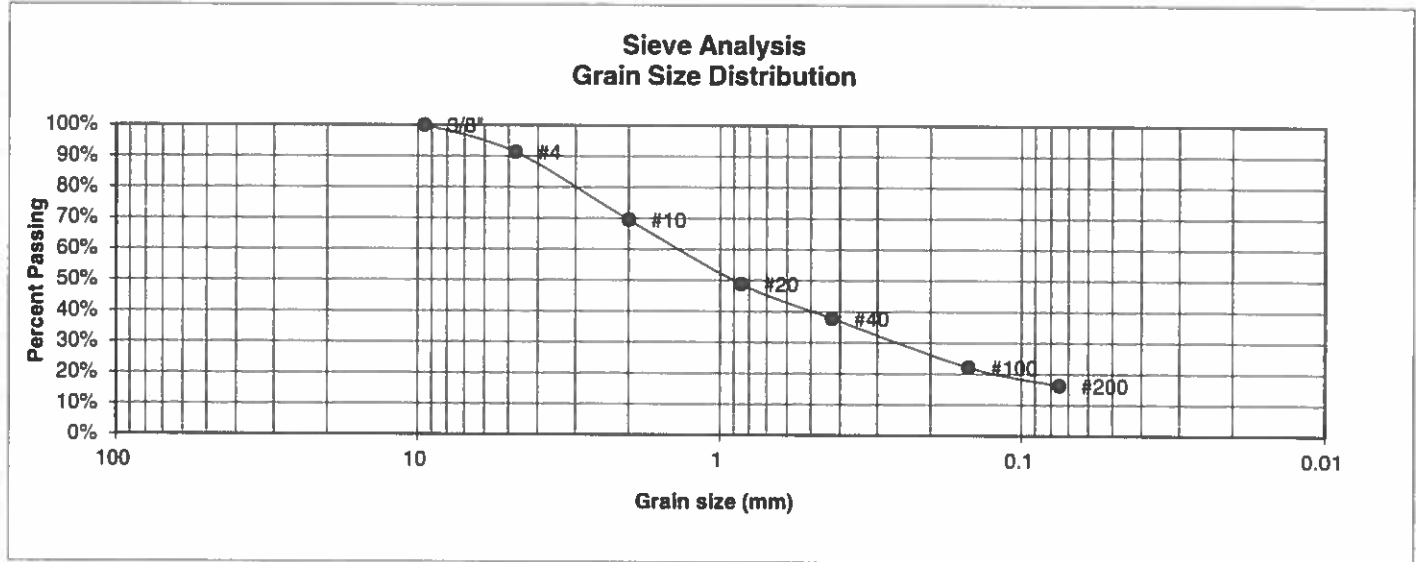
ENTECH
ENGINEERING, INC.
 505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

**LABORATORY TEST
RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	9/24/19

JOB NO.:
 190128
 FIG NO.:
 B-5

UNIFIED CLASSIFICATION	SC-SM	CLIENT	TECH CONTRACTORS
SOIL TYPE #	1	PROJECT	WINDING WALK, PHASE 4
TEST BORING #	7	JOB NO.	190128
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	91.3%
10	69.5%
20	48.8%
40	37.8%
100	22.1%
200	16.2%

Atterberg Limits	
Plastic Limit	20
Liquid Limit	26
Plastic Index	6

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	



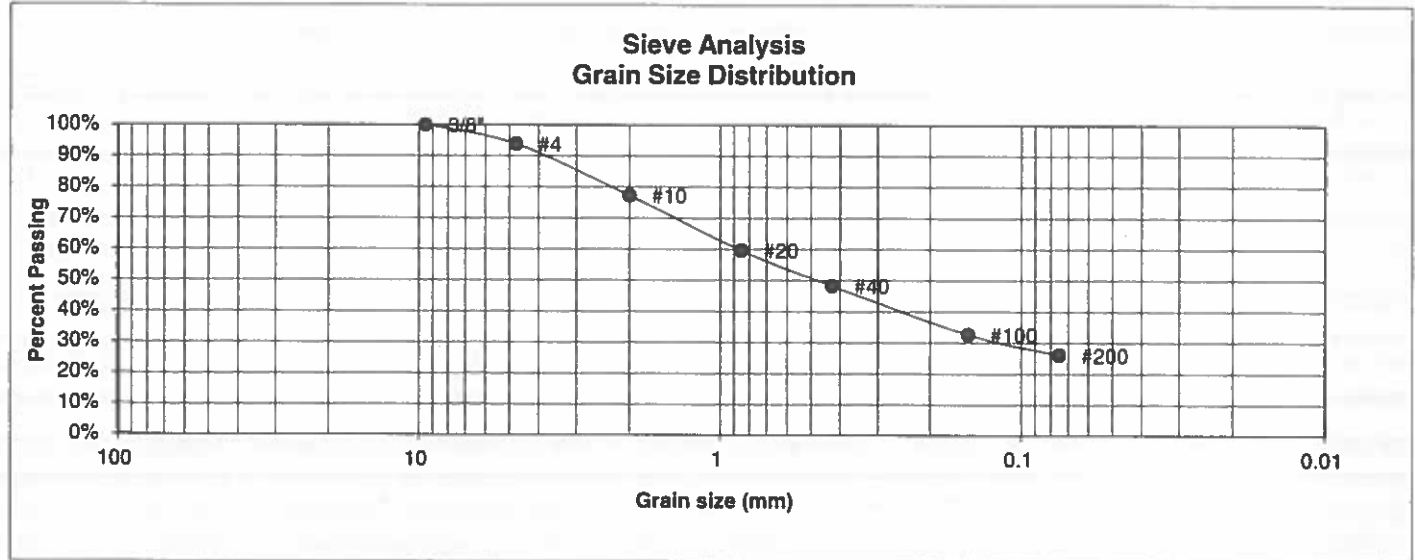
**ENTECH
ENGINEERING, INC.**
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

**LABORATORY TEST
RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	9/24/19

JOB NO.:
190128
FIG NO.:
B-6

UNIFIED CLASSIFICATION	SC	CLIENT	TECH CONTRACTORS
SOIL TYPE #	1	PROJECT	WINDING WALK, PHASE 4
TEST BORING #	8	JOB NO.	190128
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	1



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	93.8%
10	77.3%
20	59.7%
40	48.3%
100	32.7%
200	26.1%

Atterberg Limits	
Plastic Limit	16
Liquid Limit	31
Plastic Index	15

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	



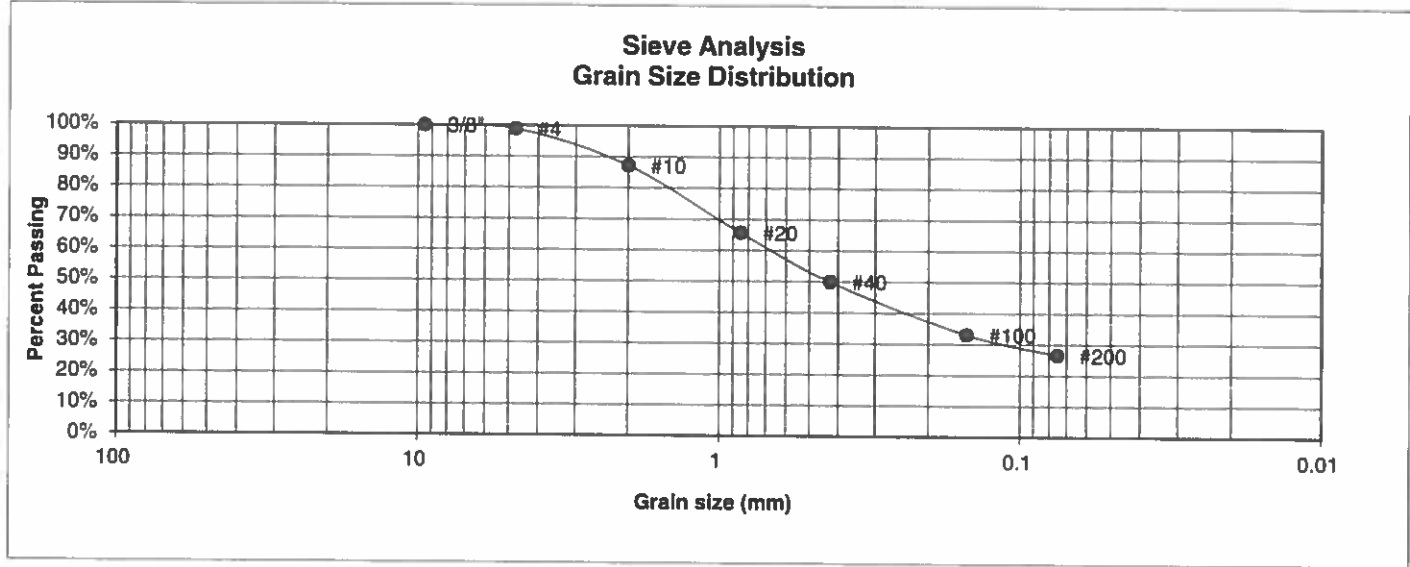
ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	9/24/19

JOB NO.:
190128
FIG NO.:
B-7

UNIFIED CLASSIFICATION	SC	CLIENT	TECH CONTRACTORS
SOIL TYPE #	1	PROJECT	WINDING WALK, PHASE 4
TEST BORING #	9	JOB NO.	190128
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.9%
10	87.2%
20	65.6%
40	50.0%
100	33.1%
200	26.5%

Atterberg Limits	
Plastic Limit	16
Liquid Limit	28
Plastic Index	13

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	



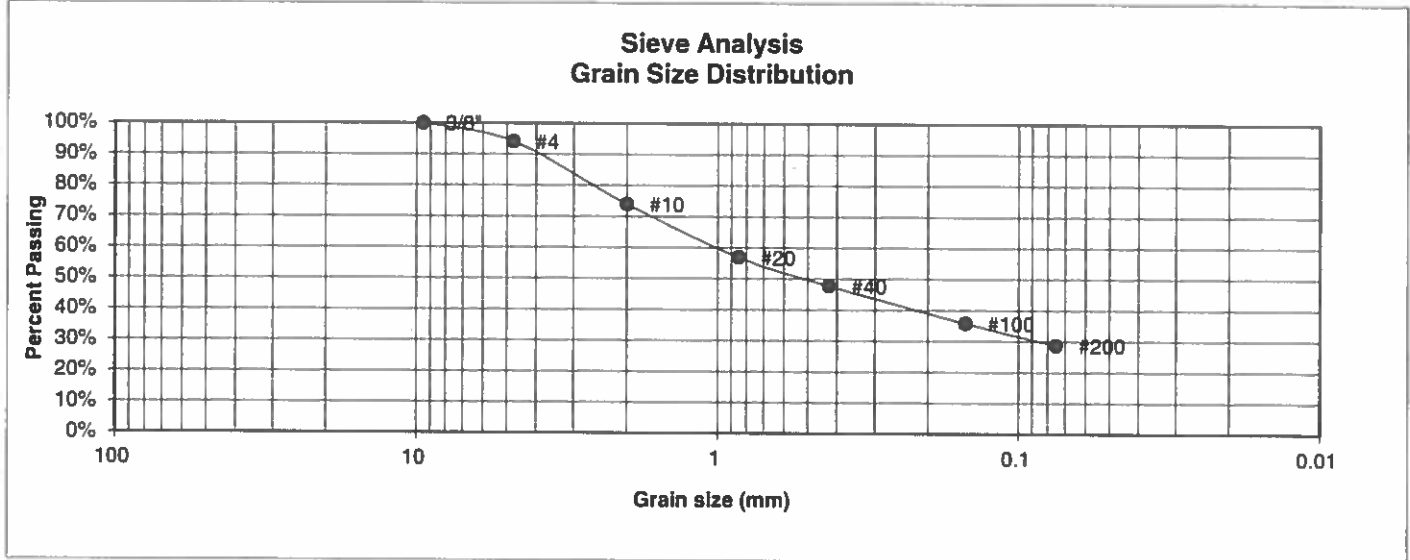
**ENTECH
ENGINEERING, INC.**
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

**LABORATORY TEST
RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	9/24/19

JOB NO.:
190128
FIG NO.:
B-8

UNIFIED CLASSIFICATION	SC	CLIENT	TECH CONTRACTORS
SOIL TYPE #	1	PROJECT	WINDING WALK, PHASE 4
TEST BORING #	10	JOB NO.	190128
DEPTH (FT)	0-3	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	1



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	94.1%
10	74.0%
20	56.9%
40	47.8%
100	35.8%
200	28.7%

Atterberg Limits	
Plastic Limit	13
Liquid Limit	27
Plastic Index	15

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	



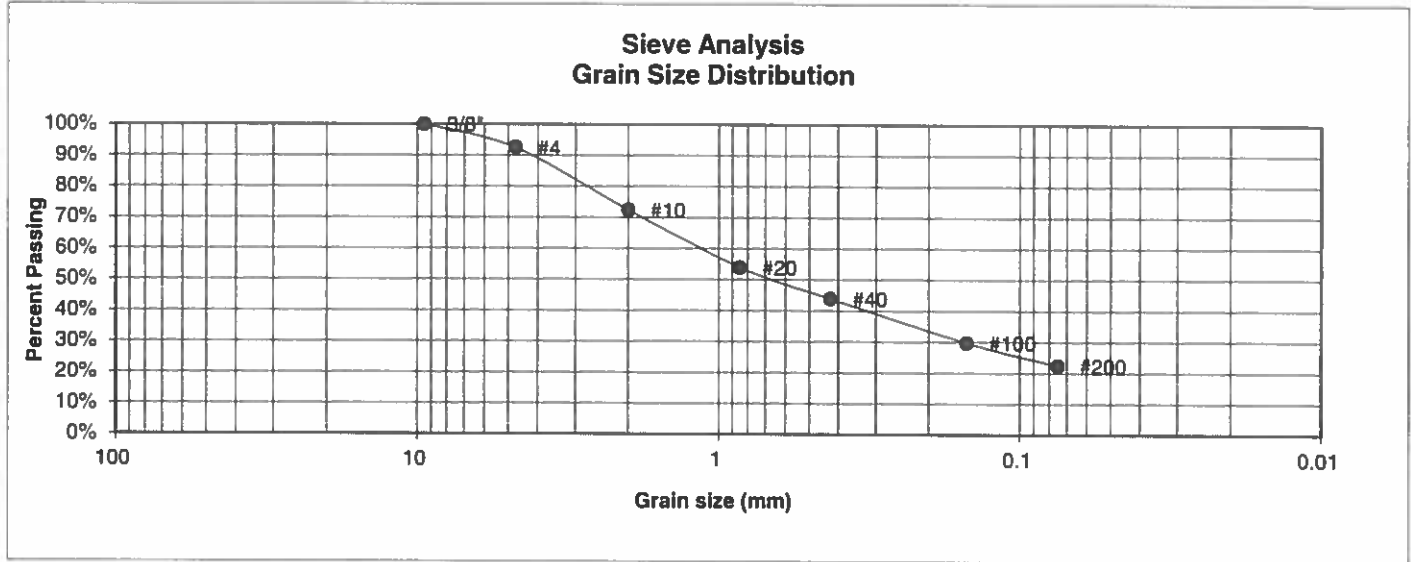
**ENTECH
ENGINEERING, INC.**
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

**LABORATORY TEST
RESULTS**

DRAWN	DATE	CHECKED	DATE
		SCC	9/24/19

JOB NO.:
190128
FIG NO.:
B-9

UNIFIED CLASSIFICATION	SC	CLIENT	TECH CONTRACTORS
SOIL TYPE #	1	PROJECT	WINDING WALK, PHASE 4
TEST BORING #	10	JOB NO.	190128
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	92.5%
10	72.4%
20	54.0%
40	43.9%
100	29.8%
200	22.4%

Atterberg Limits	
Plastic Limit	19
Liquid Limit	30
Plastic Index	11

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	



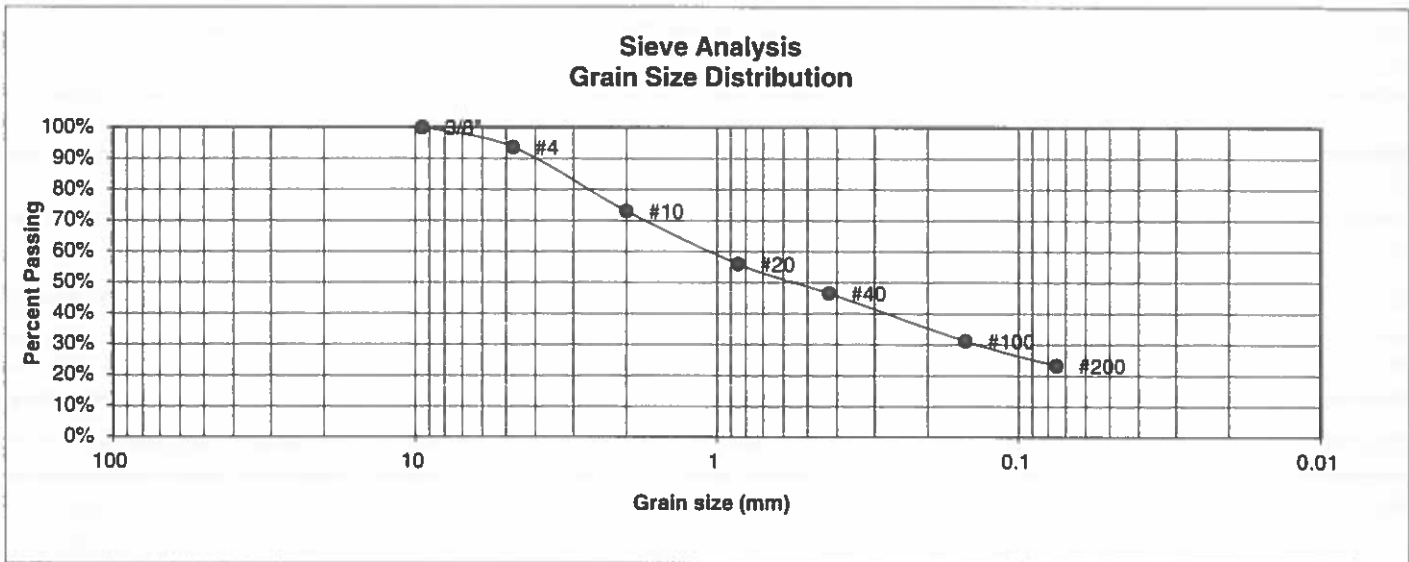
ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	9/24/19

JOB NO.:
190128
FIG NO.:
B-10

<u>UNIFIED CLASSIFICATION</u>	SC	<u>CLIENT</u>	TECH CONTRACTORS
<u>SOIL TYPE #</u>	2	<u>PROJECT</u>	WINDING WALK, PHASE 4
<u>TEST BORING #</u>	4	<u>JOB NO.</u>	190128
<u>DEPTH (FT)</u>	1-2	<u>TEST BY</u>	BL
<u>AASHTO CLASSIFICATION</u>	A-2-6	<u>GROUP INDEX</u>	1



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	93.7%
10	73.1%
20	56.0%
40	46.6%
100	31.2%
200	23.2%

Atterberg Limits	
Plastic Limit	18
Liquid Limit	36
Plastic Index	17

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	



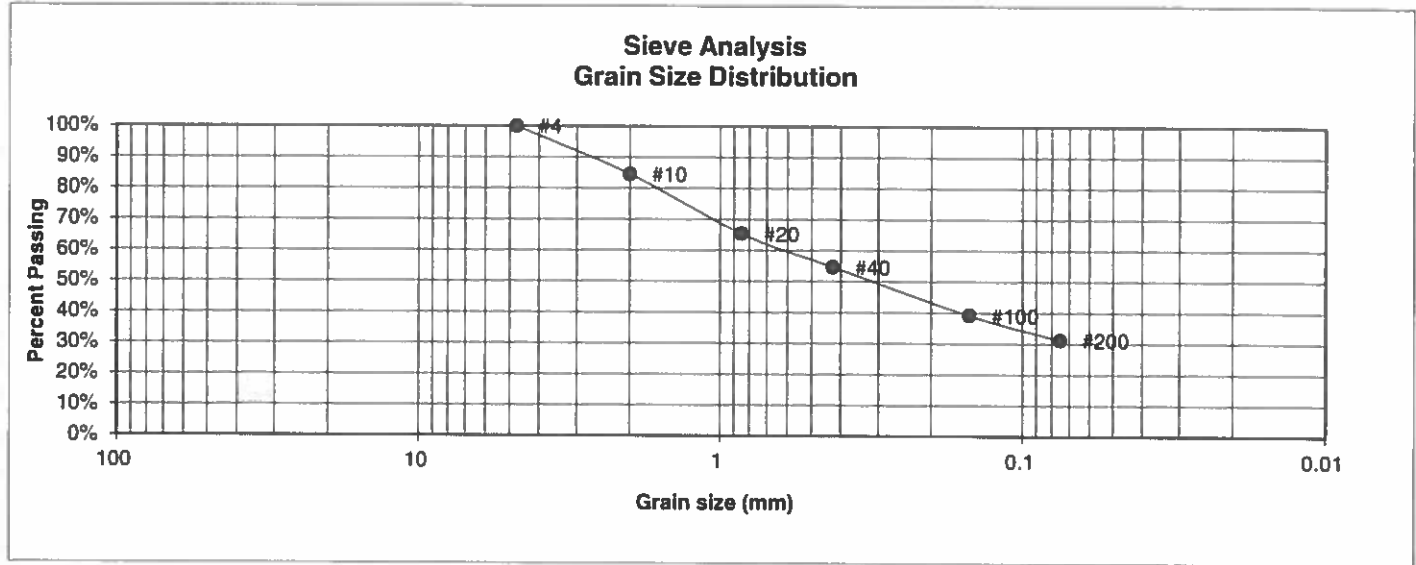
**ENTECH
ENGINEERING, INC.**
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

**LABORATORY TEST
RESULTS**

DRAWN	DATE	CHECKED: SCC	DATE: 9/24/19
-------	------	-----------------	------------------

JOB NO.:
190128
FIG NO.:
B-11

UNIFIED CLASSIFICATION	SC	CLIENT	TECH CONTRACTORS
SOIL TYPE #	2, CBR	PROJECT	WINDING WALK, PHASE 4
TEST BORING #	5	JOB NO.	190128
DEPTH (FT)	0-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	84.5%
20	65.4%
40	54.7%
100	39.2%
200	31.2%

Atterberg Limits	
Plastic Limit	13
Liquid Limit	24
Plastic Index	11

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

**LABORATORY TEST
RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	9/24/19

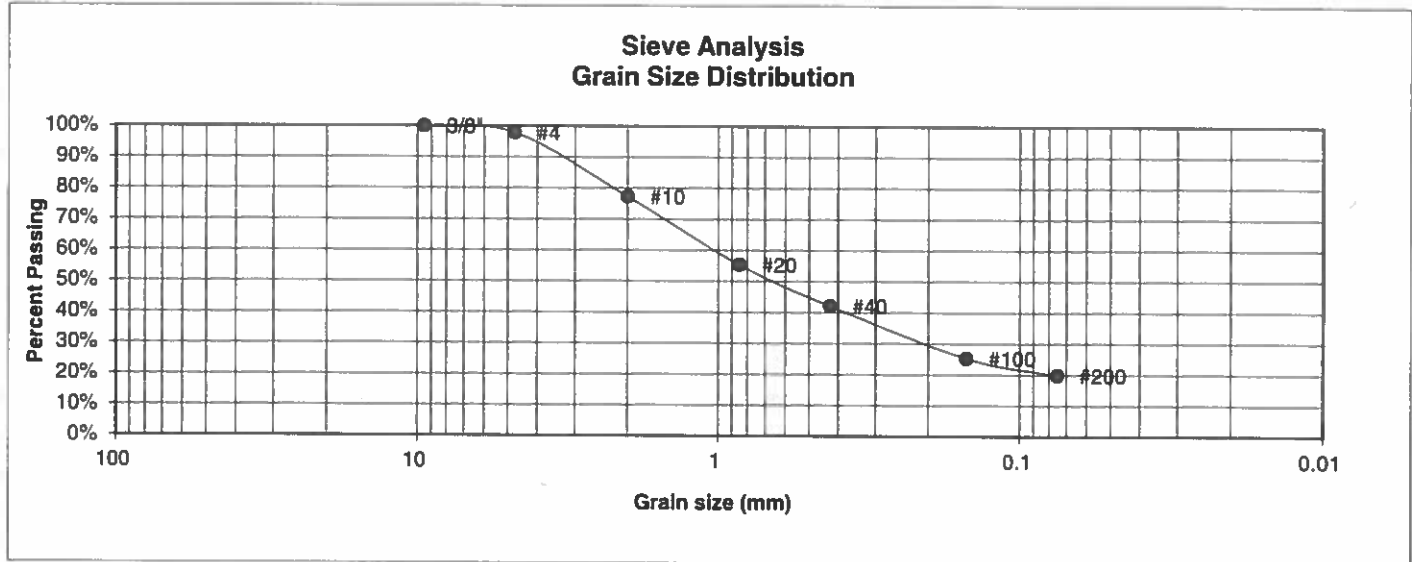
JOB NO.:

190128

FIG NO.:

B-12

UNIFIED CLASSIFICATION	SC	CLIENT	TECH CONTRACTORS
SOIL TYPE #	3	PROJECT	WINDING WALK, PHASE 4
TEST BORING #	5	JOB NO.	190128
DEPTH (FT)	2-3	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.8%
10	77.3%
20	55.4%
40	42.1%
100	25.3%
200	19.8%

Atterberg Limits	
Plastic Limit	20
Liquid Limit	28
Plastic Index	8

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	



**ENTECH
ENGINEERING, INC.**
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

**LABORATORY TEST
RESULTS**

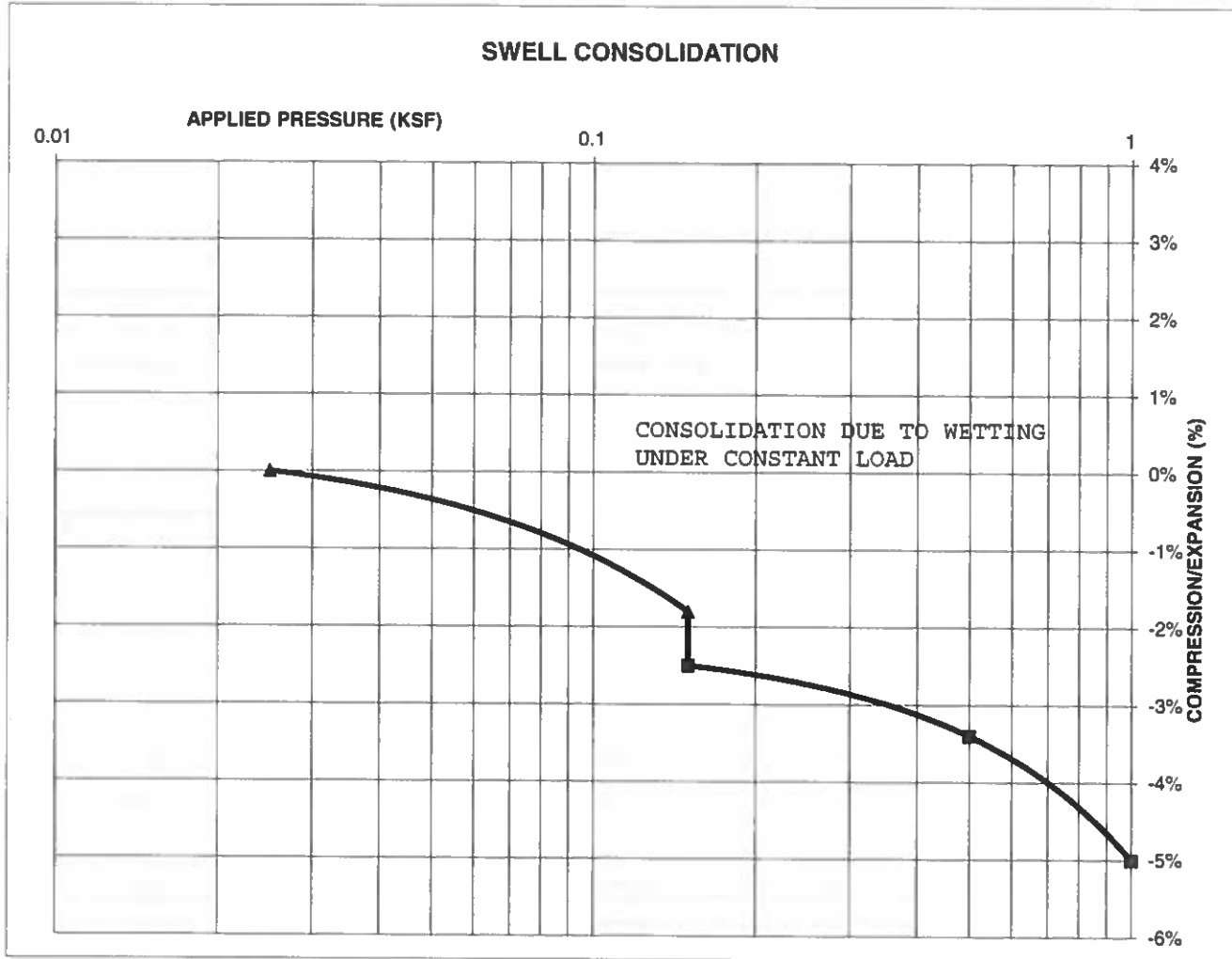
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	9/24/19

JOB NO.:
190128
FIG NO.:
B-13

CONSOLIDATION TEST RESULTS

TEST BORING #	1	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			113
NATURAL MOISTURE CONTENT			7.3%
SWELL/CONSOLIDATION (%)			-0.7%

JOB NO. 190128
 CLIENT TECH CONTRACTORS
 PROJECT WINDING WALK, PHASE 4



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

**SWELL CONSOLIDATION
 TEST RESULTS**

DRAWN:

DATE:

CHECKED

SCC

DATE

9/24/19

JOB NO.

190128

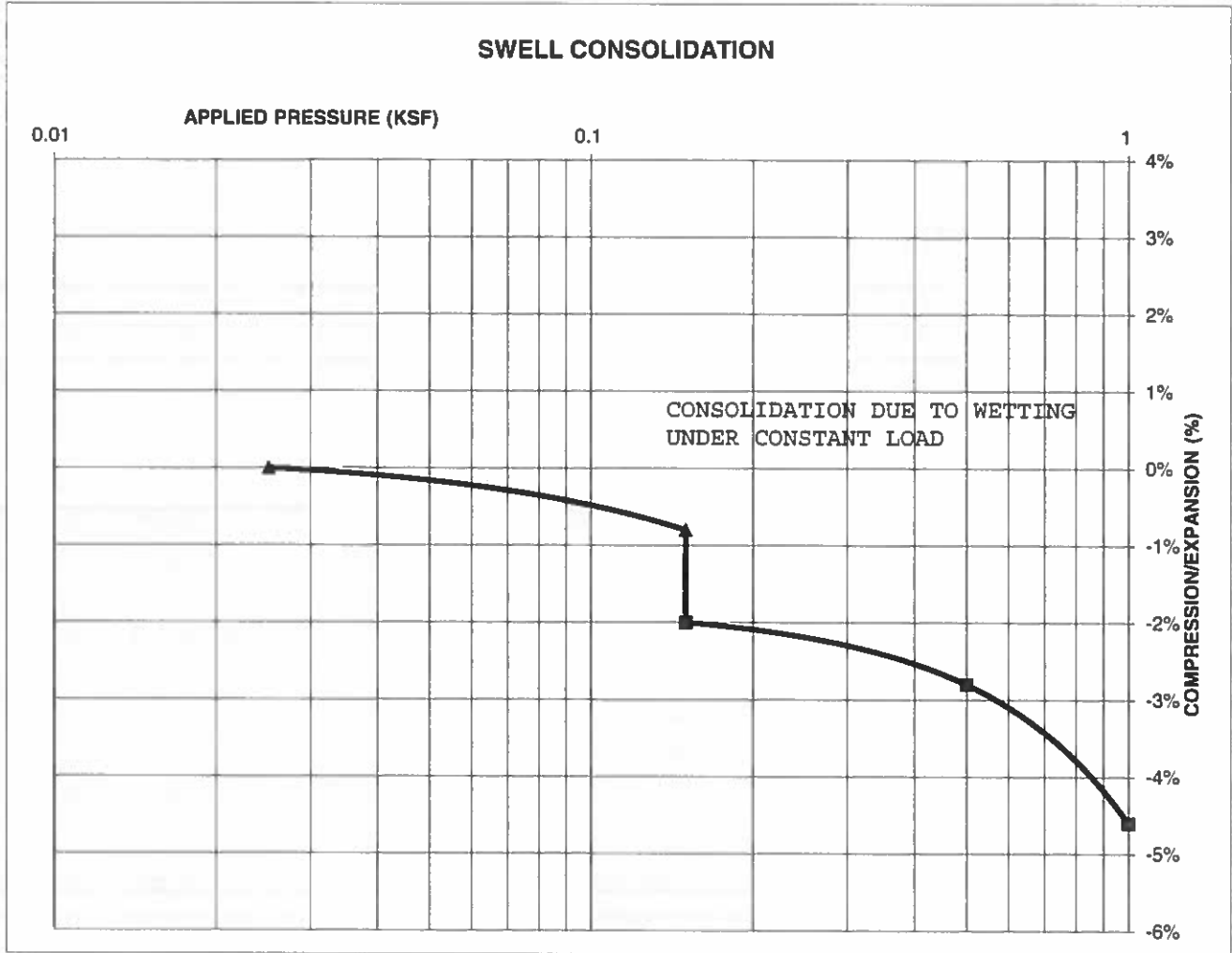
FIG NO.

B-14

CONSOLIDATION TEST RESULTS

TEST BORING #	2	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			105
NATURAL MOISTURE CONTENT			6.5%
SWELL/CONSOLIDATION (%)			-1.2%

JOB NO. 190128
 CLIENT TECH CONTRACTORS
 PROJECT WINDING WALK, PHASE 4



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

**SWELL CONSOLIDATION
 TEST RESULTS**

DRAWN:

DATE:

CHECKED:

DATE

SCC

9/24/19

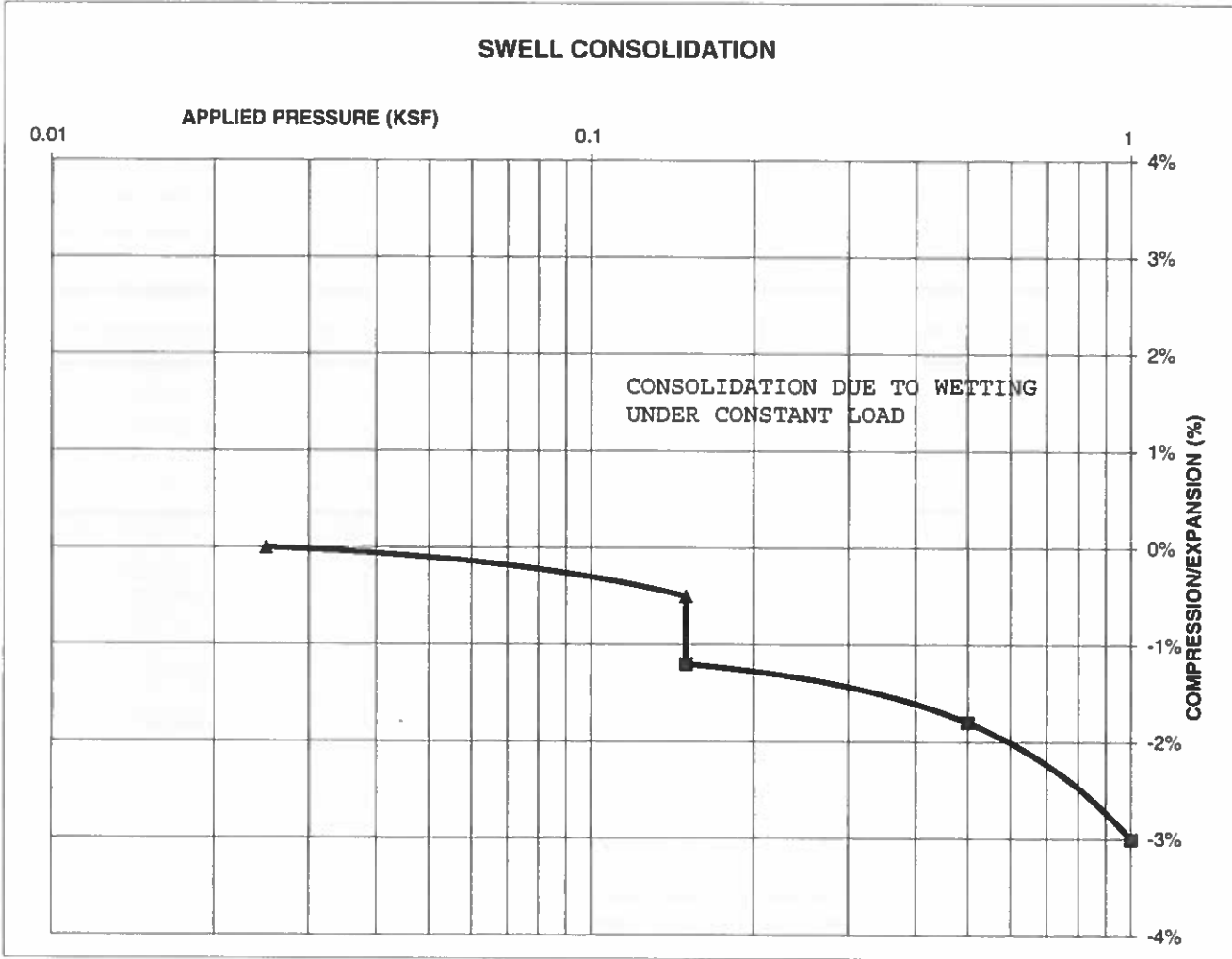
JOB NO.:
 190128

FIG NO.:
 B-15

CONSOLIDATION TEST RESULTS

TEST BORING #	4	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			103
NATURAL MOISTURE CONTENT			8.2%
SWELL/CONSOLIDATION (%)			-0.7%

JOB NO. 190128
 CLIENT TECH CONTRACTORS
 PROJECT WINDING WALK, PHASE 4



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

**SWELL CONSOLIDATION
 TEST RESULTS**

DRAWN:

DATE:

CHECKED:

DATE:

SCC

9/24/19

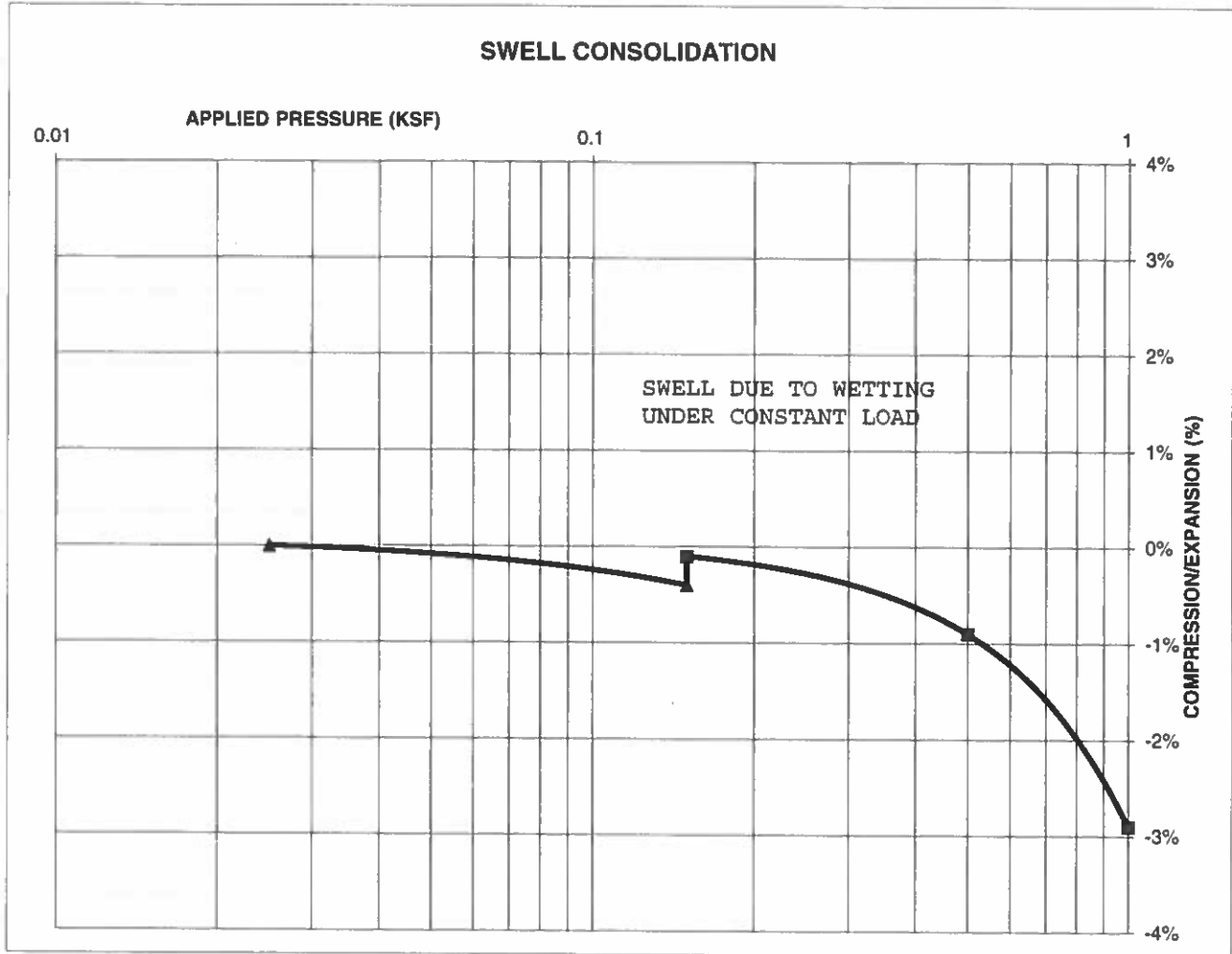
JOB NO:
 190128

FIG NO:
 B-16

CONSOLIDATION TEST RESULTS

TEST BORING #	5	DEPTH(ft)	0-3
DESCRIPTION	SC	SOIL TYPE	1, CBR
NATURAL UNIT DRY WEIGHT (PCF)			126
NATURAL MOISTURE CONTENT			8.4%
SWELL/CONSOLIDATION (%)			0.3%

JOB NO. 190128
CLIENT TECH CONTRACTORS
PROJECT WINDING WALK, PHASE 4



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

**SWELL CONSOLIDATION
 TEST RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	9/24/19

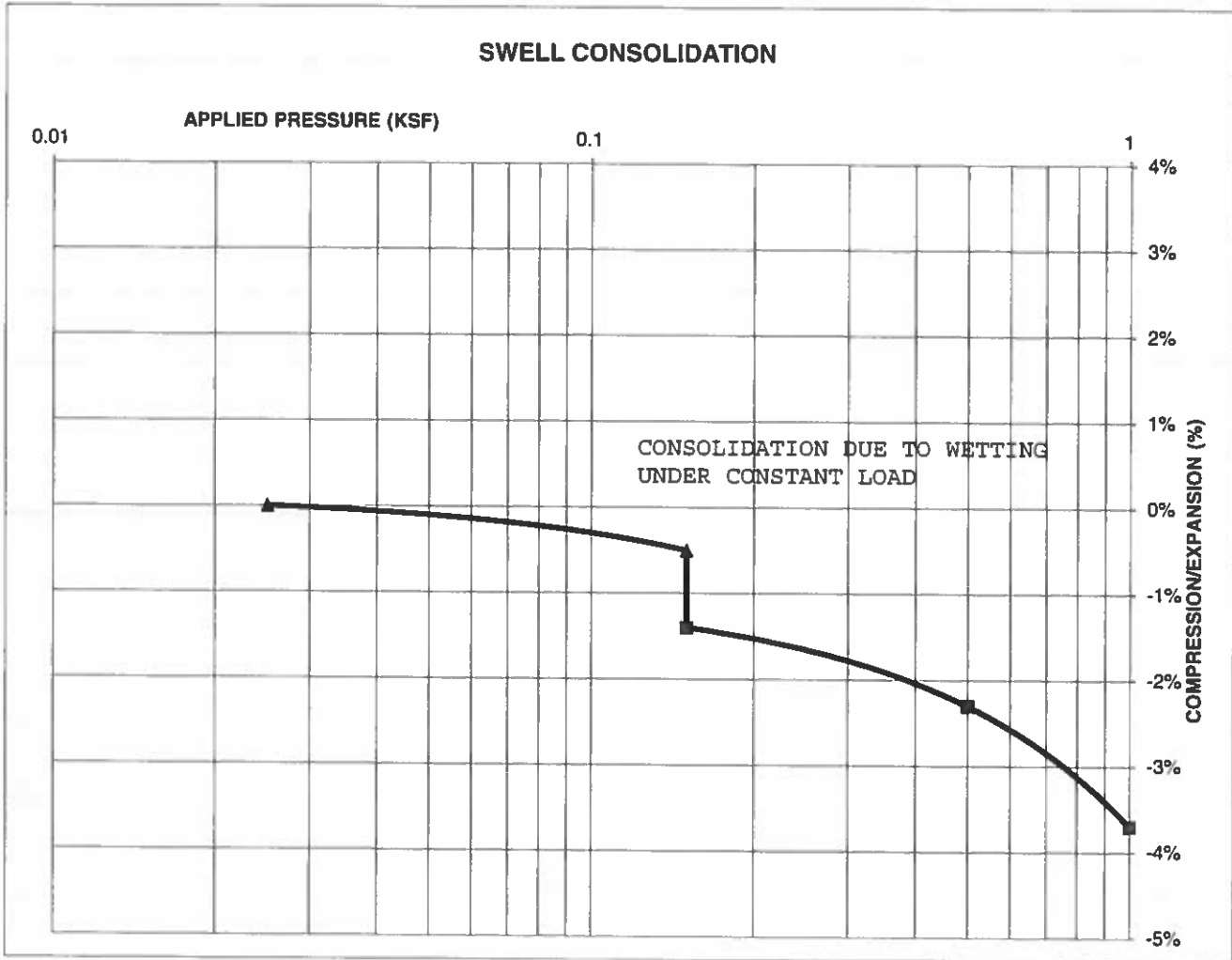
JOB NO.:
 190128

FIG NO.:
 B-17

CONSOLIDATION TEST RESULTS

TEST BORING #	5	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			94
NATURAL MOISTURE CONTENT			11.4%
SWELL/CONSOLIDATION (%)			-0.9%

JOB NO. 190128
CLIENT TECH CONTRACTORS
PROJECT WINDING WALK, PHASE 4



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

**SWELL CONSOLIDATION
 TEST RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	9/24/19

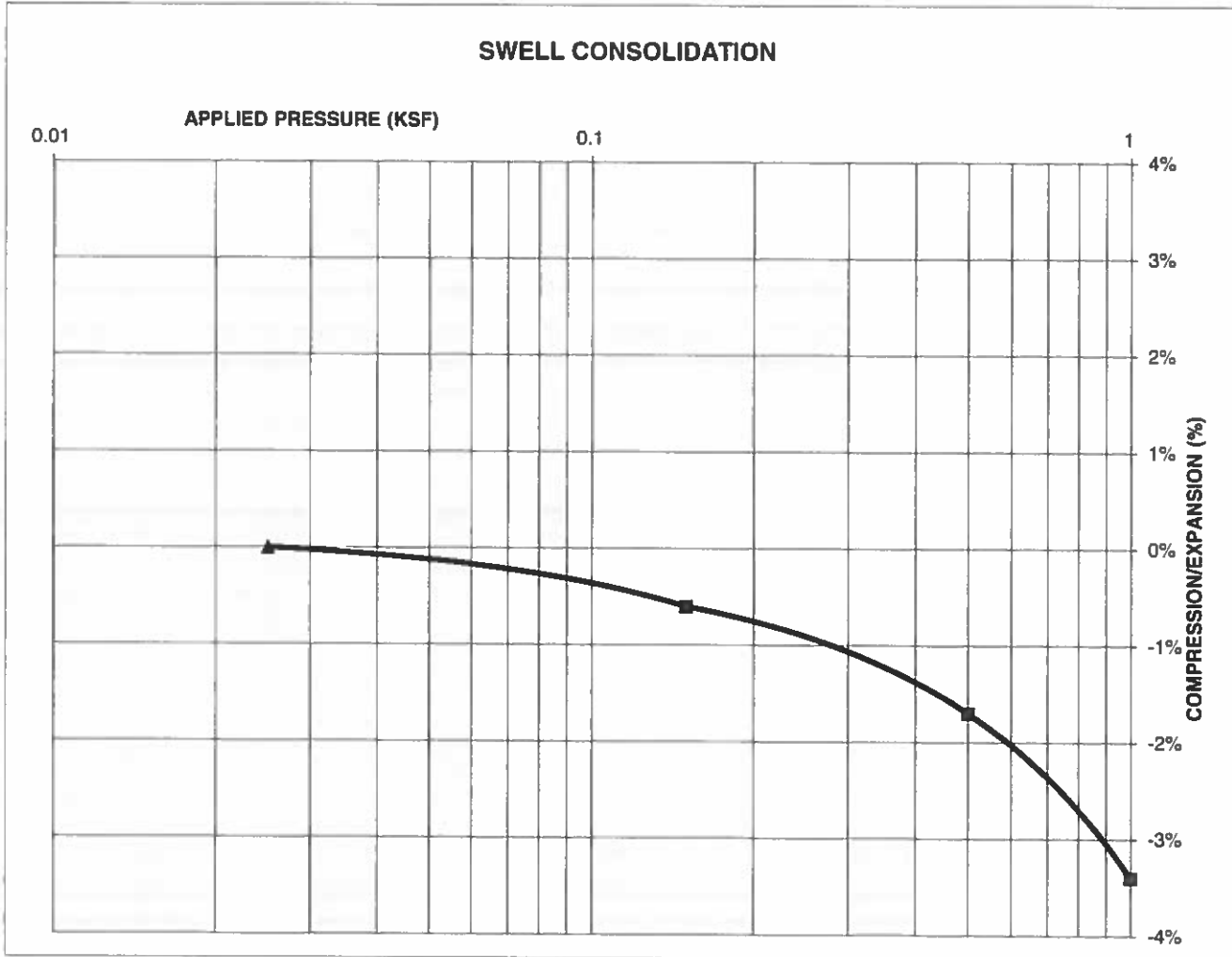
JOB NO:
190128

FIG NO:
B-18

CONSOLIDATION TEST RESULTS

TEST BORING #	6	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			115
NATURAL MOISTURE CONTENT			7.3%
SWELL/CONSOLIDATION (%)			0.0%

JOB NO. 190128
 CLIENT TECH CONTRACTORS
 PROJECT WINDING WALK, PHASE 4



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

**SWELL CONSOLIDATION
 TEST RESULTS**

DRAWN:

DATE:

CHECKED:

DATE:

SCC

9/24/19

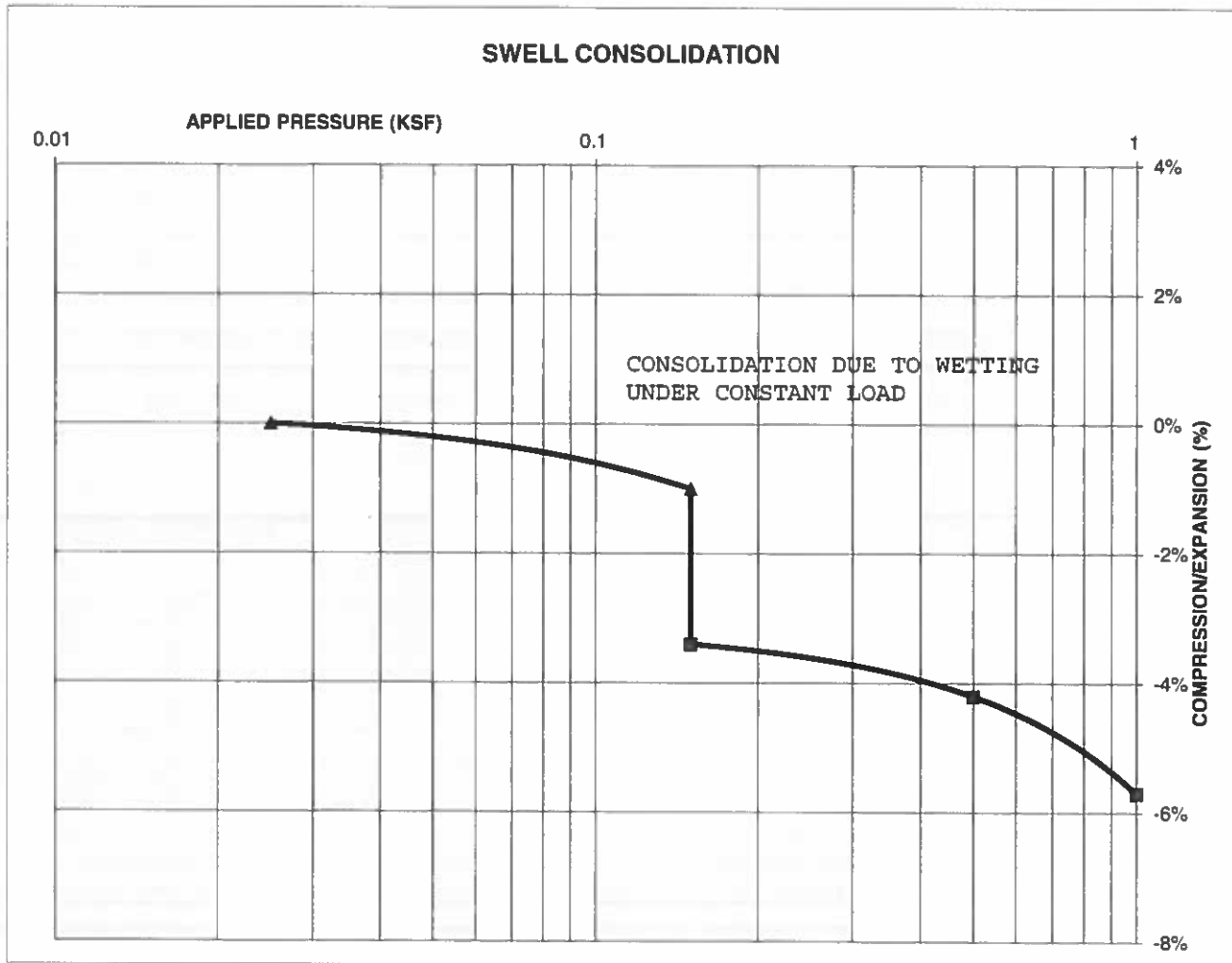
JOB NO:
190128

FIG NO:
B-19

CONSOLIDATION TEST RESULTS

TEST BORING #	7	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			95
NATURAL MOISTURE CONTENT			9.5%
SWELL/CONSOLIDATION (%)			-2.4%

JOB NO. 190128
 CLIENT TECH CONTRACTORS
 PROJECT WINDING WALK, PHASE 4



**ENTECH
ENGINEERING, INC.**

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

**SWELL CONSOLIDATION
TEST RESULTS**

DRAWN:

DATE:

CHECKED:
SCC

DATE:
9/24/19

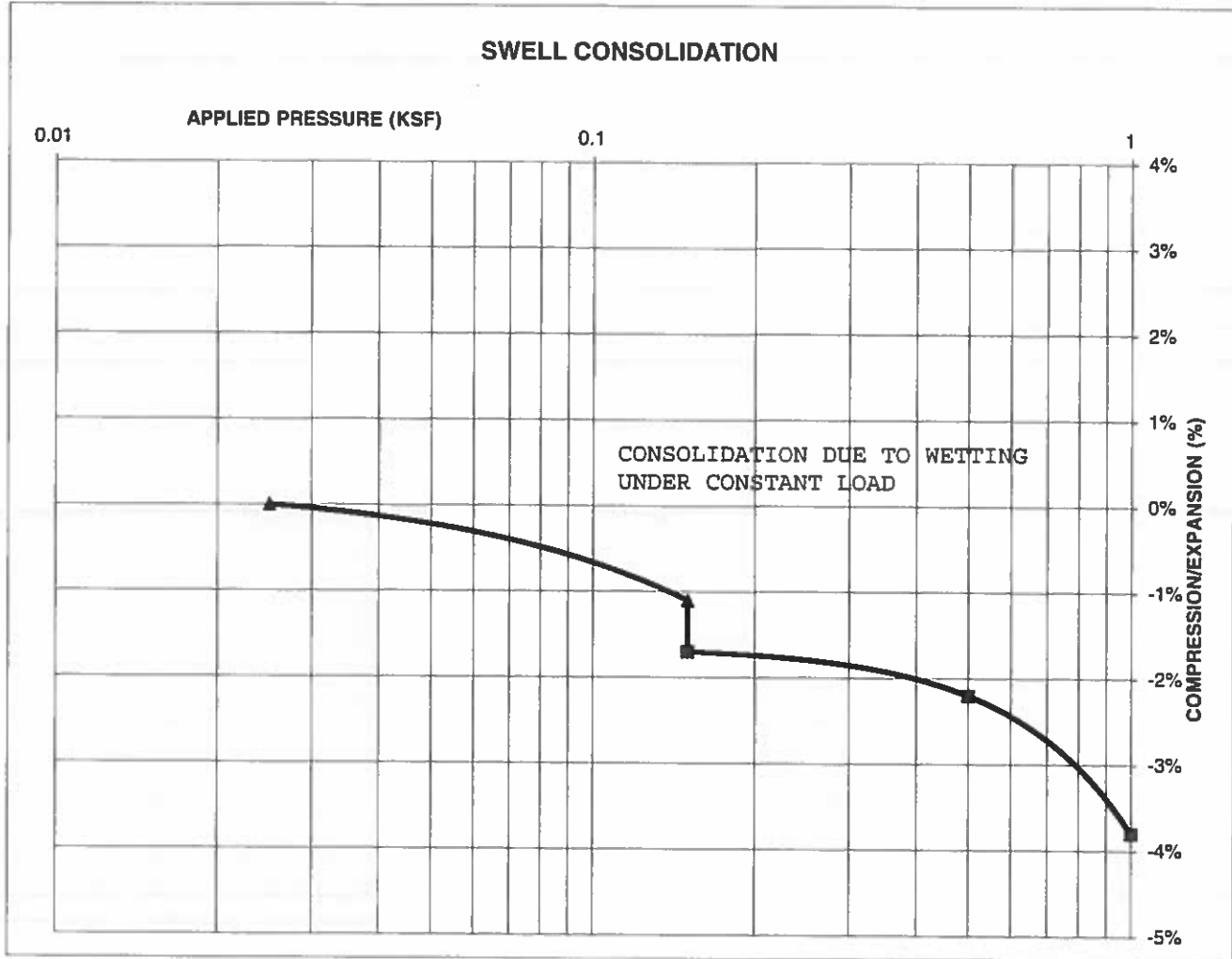
JOB NO.
190128

FIG NO.
B-20

CONSOLIDATION TEST RESULTS

TEST BORING #	8	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			111
NATURAL MOISTURE CONTENT			7.3%
SWELL/CONSOLIDATION (%)			-0.6%

JOB NO. 190128
 CLIENT TECH CONTRACTORS
 PROJECT WINDING WALK, PHASE 4



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

**SWELL CONSOLIDATION
 TEST RESULTS**

DRAWN:

DATE:

CHECKED:

DATE
 9/24/19

SCC

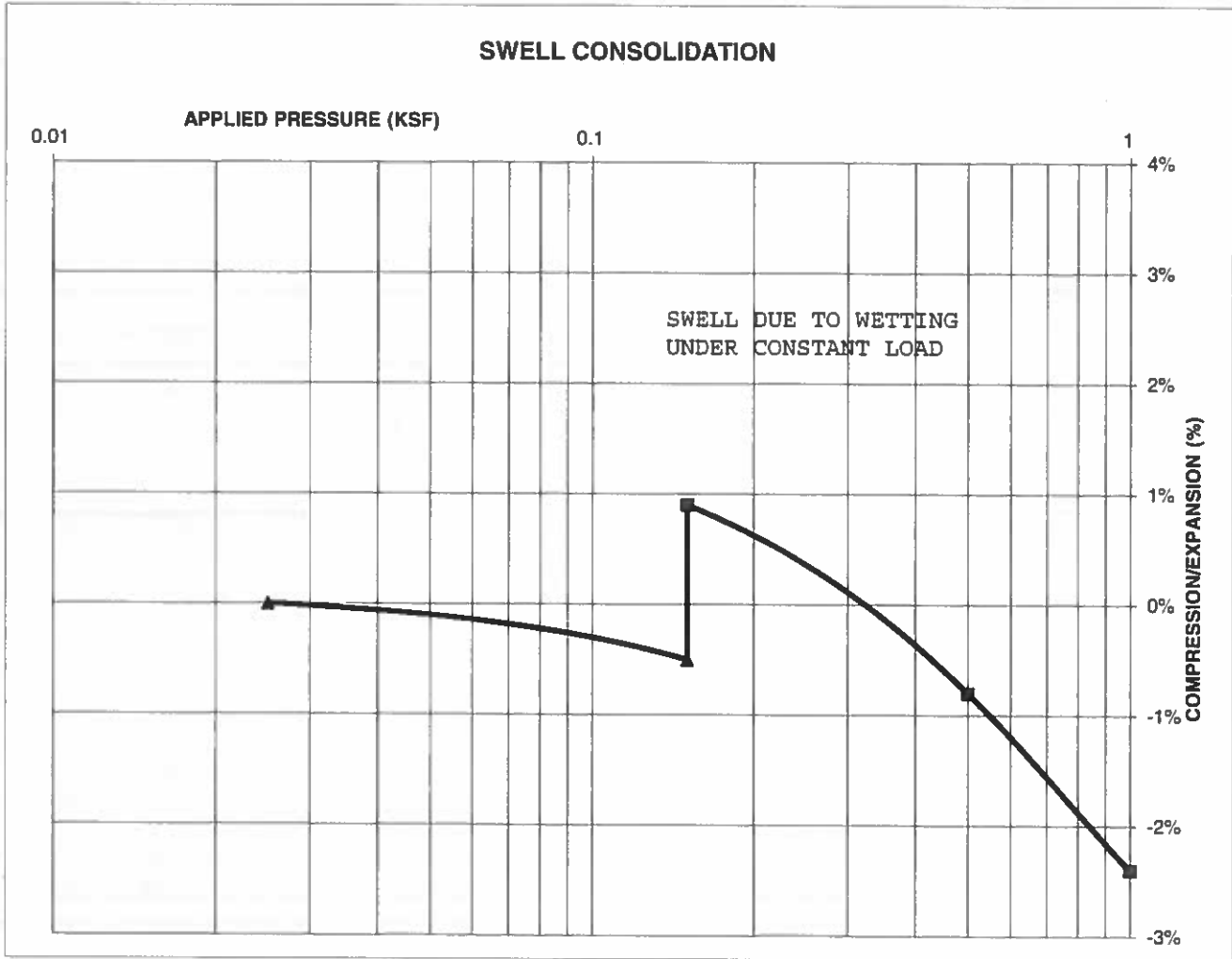
JOB NO:
 190128

FIG NO:
 B-21

CONSOLIDATION TEST RESULTS

TEST BORING #	9	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			114
NATURAL MOISTURE CONTENT			7.9%
SWELL/CONSOLIDATION (%)			1.4%

JOB NO. 190128
 CLIENT TECH CONTRACTORS
 PROJECT WINDING WALK, PHASE 4



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

**SWELL CONSOLIDATION
 TEST RESULTS**

DRAWN:

DATE:

CHECKED:

DATE: 9/24/19

SCC

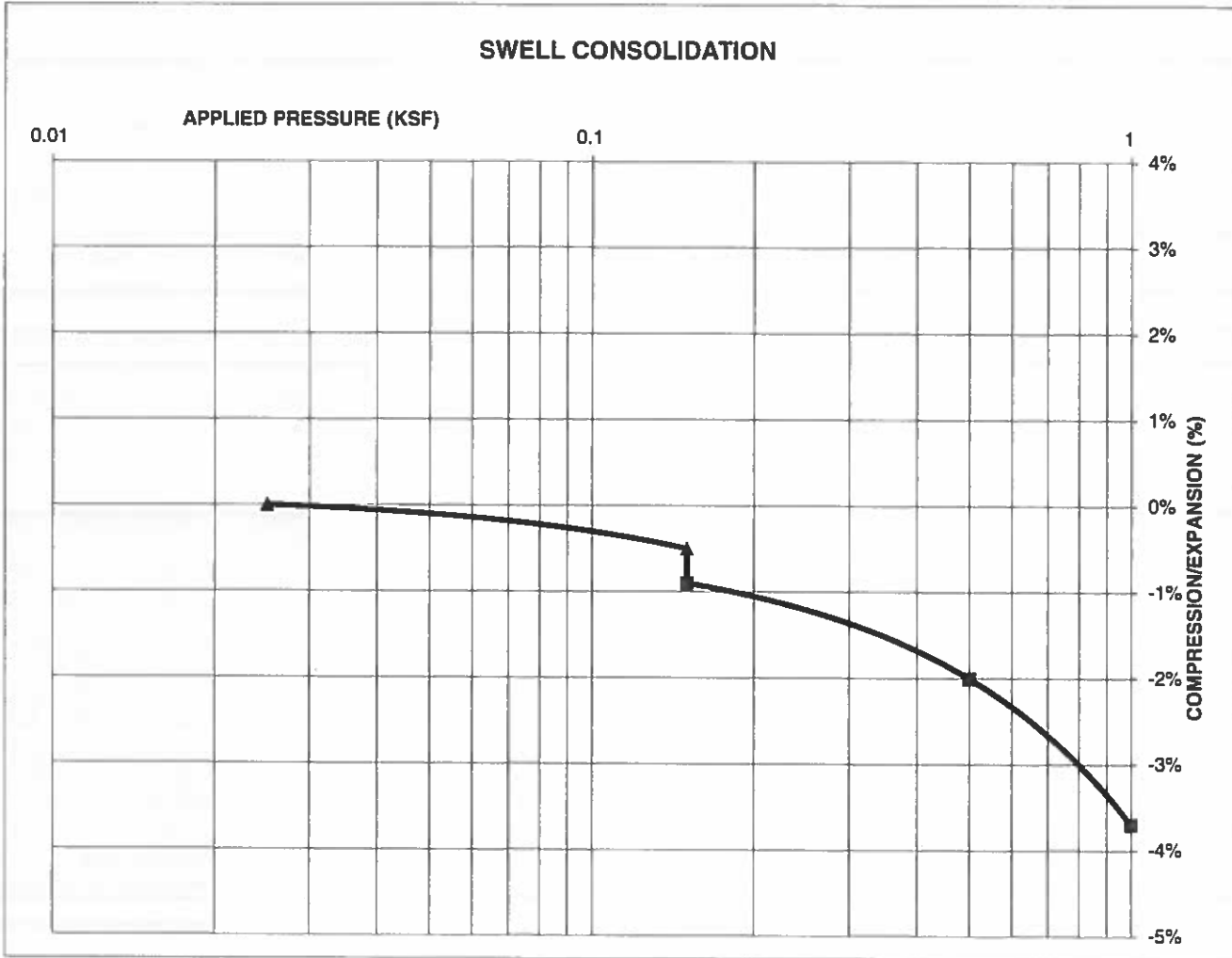
JOB NO.: 190128

FIG NO.: B-22

CONSOLIDATION TEST RESULTS

TEST BORING #	10	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)	107		
NATURAL MOISTURE CONTENT	9.5%		
SWELL/CONSOLIDATION (%)	-0.4%		

JOB NO. 190128
 CLIENT TECH CONTRACTORS
 PROJECT WINDING WALK, PHASE 4



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

**SWELL CONSOLIDATION
 TEST RESULTS**

DRAWN:

DATE:

CHECKED:
SCC

DATE:
9/24/19

JOB NO.:
 190128

FIG NO.:
 B-23

PROJECT	WINDING WALK, PHASE 4	CLIENT	TECH CONTRACTORS
SAMPLE LOCATION	TB-5 @ 0-2'	JOB NO.	190128
SOIL DESCRIPTION	SAND, CLAYEY, BROWN	DATE	05/28/19

IDENTIFICATION	SC	COMPACTION TEST #	1
TEST DESIGNATION / METHOD	ASTM D-1557-A	TEST BY	KG
MAXIMUM DRY DENSITY (PCF)	133.2	OPTIMUM MOISTURE	7.8%

Compaction Curve



■ ACTUAL POINTS - — PARABOLIC FIT — ZERO AIR VOIDS



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

MOISTURE DENSITY RELATION

DRAWN:

DATE:

CHECKED:

DATE:

SCC

9/24/19

JOB NO.:

190128

FIG NO.:

B-24

CBR TEST LOAD DATA

JOB NO: 190128
 CLIENT: TECH CONTRACTORS
 PROJECT: WINDING WALK, PHASE 4
 SOIL TYPE: I

PISTON		PISTON					
DIAMETER (cm)		AREA (in ²)					
4.958		2.99250919					
PENETRATION DEPTH (INCHES)	10 BLOWS		25 BLOWS		56 BLOWS		
	MOLD # 1	MOLD # 2	MOLD # 3	MOLD # 3	MOLD # 3	MOLD # 3	
	LOAD(LBS)	STRESS (PSI)	LOAD(LBS)	STRESS (PSI)	LOAD(LBS)	STRESS (PSI)	
0.000	0	0.00	0	0.00	0	0.00	
0.025	76	25.40	103	34.42	233	77.86	
0.050	148	49.46	170	56.81	607	202.84	
0.075	208	69.51	251	83.88	774	258.65	
0.100	248	82.87	314	104.93	1161	387.97	
0.125	291	97.24	387	129.32	1375	459.48	
0.150	309	103.26	434	145.03	1701	568.42	
0.175	329	109.94	485	162.07	1850	618.21	
0.200	344	114.95	517	172.76	2003	669.34	
0.300	391	130.66	610	203.84	2362	789.30	
0.400	429	143.36	686	229.24	2597	867.83	
0.500	462	154.39	760	253.97	2850	952.38	

FINAL MOISTURE CONTENT

	MOLD # 1	MOLD # 2	MOLD # 3
CAN #	112	102	118
WT. CAN	9.18	9.24	9.18
WT. CAN+WET	303.03	244.17	244.39
WT. CAN+DRY	267.73	215.27	223.42
WT. H2O	35.3	28.9	20.97
WT. DRY SOIL	258.55	206.03	214.24
MOISTURE CONTENT	13.65%	14.03%	9.79%

WET DENSITY (PCF)	121.5	125.4	136.8
DRY DENSITY (PCF)	112.7	116.3	126.9

BEARING RATIO 8.29 10.49 38.80

90% OF DRY DENSITY 114.2

95% OF DRY DENSITY 120.6

BEARING RATIO AT 90% OF MAX	9.21 - R VALUE	51
BEARING RATIO AT 95% OF MAX	21.86 - R VALUE	78



**ENTECH
ENGINEERING, INC.**

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

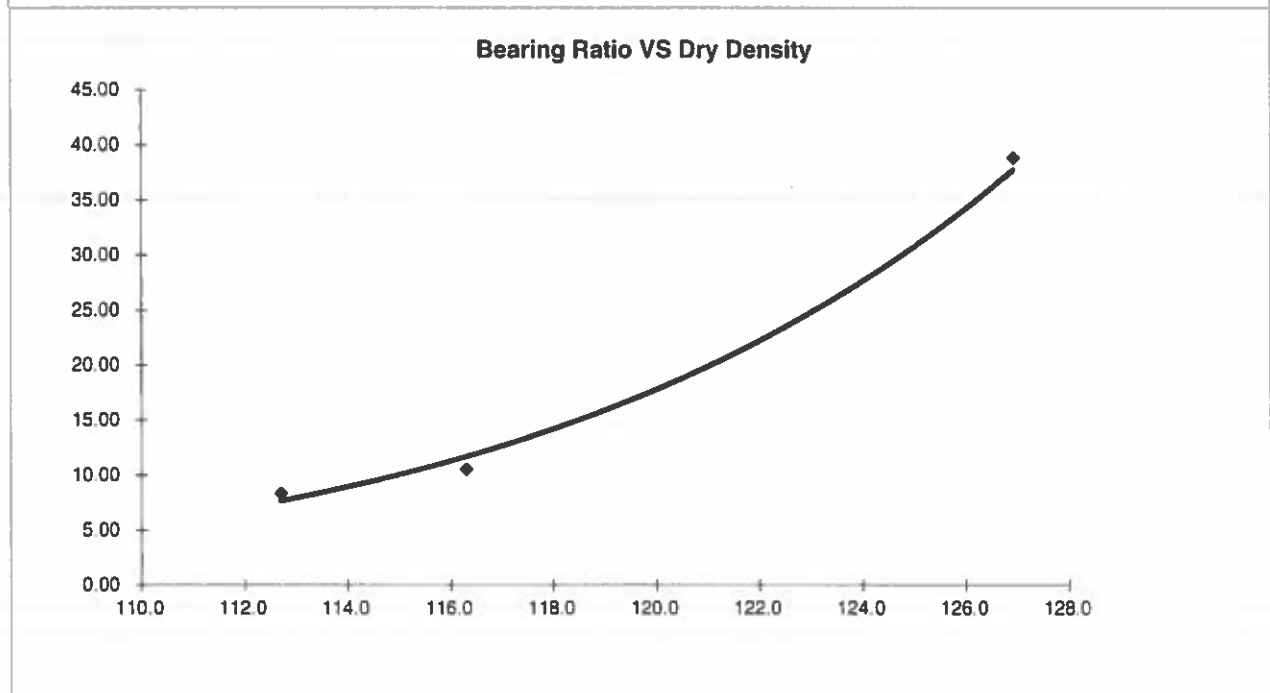
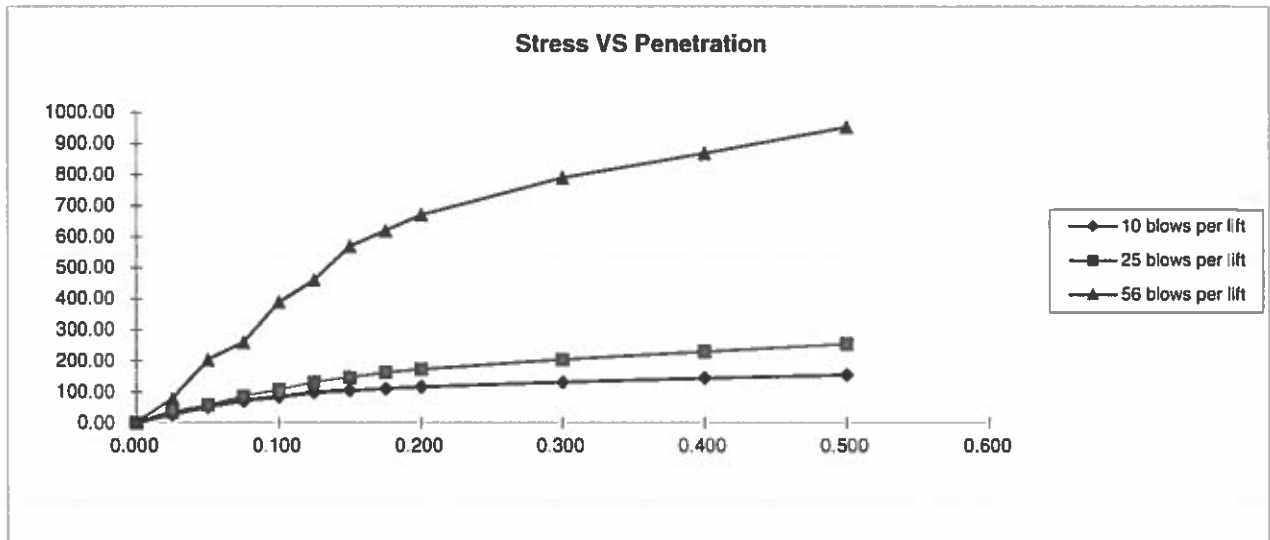
CBR TEST DATA

DRAWN: DATE: CHECKED: *SCC* DATE: *9/24/19*

JOB NO:
190128

FIG NO:

B-25



BEARING RATIO AT 90% OF MAX	9.21 - R VALUE	51.48
BEARING RATIO AT 95% OF MAX	21.86 - R VALUE	77.92

JOB NO: 190128
SOIL TYPE: 1



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

CALIFORNIA BEARING RATIO

DRAWN:

DATE:

CHECKED:

DATE:

SCC

9/24/19

JOB NO:
190128

FIG NO:
B-26

CLIENT	TECH CONTRACTORS	JOB NO.	190128
PROJECT	WINDING WALK, PHASE 4	DATE	6/6/2019
LOCATION	WINDING WALK, PHASE 4	TEST BY	BL

BORING NUMBER	DEPTH, (ft)	SOIL TYPE NUMBER	UNIFIED CLASSIFICATION	WATER SOLUBLE SULFATE, (wt%)
TB-3	1-2	1	SC-SM	0.00
TB-5	1-2	2	SC	<0.01
TB-10	1-2	1	SC	<0.01

QC BLANK PASS



**LABORATORY TEST
SULFATE RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	9/24/19

JOB NO.:
190128
FIG NO.:
B-27

APPENDIX C: Previous Investigations

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT: TECH CONTRACTORS
 PROJECT: WINDING WALK
 JOB NO. 181360

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	AASHTO CLASS.	SWELL/ CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1	3	1-2			18.2	NV	NP	0.01	A-1-b		SM	FILL, SAND, SILTY
1	5	1-2			13.3	NV	NP		A-1-b		SM	SAND, SILTY
1	6	1-2	10.5	115.4	16.5	27	13		A-2-8	1.2	SC	SAND, CLAYEY
1	7	1-2			30.7	26	10		A-2-4		SC	FILL, SAND, CLAYEY
1	8	1-2			18.4	27	8		A-2-4		SC	FILL, SAND, CLAYEY
1	11	1-2			17.2	29	8		A-2-4		SC	FILL, SAND, CLAYEY
2, CBR #1	3	0-3	10.9	115.9	47.1	31	16		A-6	1.6	SC	FILL, SAND, VERY CLAYEY
2	10	1-2	10.0	117.7	43.0	24	5		A-4	1.3	SC-SM	FILL, SAND, VERY CLAYEY, SILTY
2	8	5	16.4	113.3	75.7	38	15	<0.01	A-6	2.0	CL	CLAY, SANDY
2	11	10			37.5	32	11		A-6		SC	SAND, VERY CLAYEY
3, CBR #2	1	0-3			21.4	26	2		A-2-4		SM	SANDSTONE, SILTY
3	5	0-3			15.0	NV	NP		A-1-b		SM	SANDSTONE, SILTY
3	1	1-2	8.8	123.2	30.7	30	19	0.01	A-2-6	2.4	SC	SANDSTONE, CLAYEY
3	2	1-2			14.5	NV	NP		A-1-b		SM	SANDSTONE, SILTY
3	10	5			12.6	29	3		A-2-4		SM	SANDSTONE, SILTY
4	4	1-2	6.0	126.1	41.2	31	13	<0.01	A-5	0.9	SC	SANDSTONE, VERY CLAYEY
4	9	1-2	13.5	112.1	71.9	31	12		A-6	1.8	CL	CLAYSTONE, SANDY
4	5	5	15.3	116.5	90.4	33	13		A-6	2.2	CL	CLAYSTONE, SANDY
4	8	10			46.7	28	14		A-6		SC	SANDSTONE, VERY CLAYEY

TEST BORING NO. **5**
 DATE DRILLED 8/1/2018
 Job # 181360

TEST BORING NO. **6**
 DATE DRILLED 8/1/2018
 CLIENT TECH CONTRACTORS
 LOCATION WINDING WALK

REMARKS

DRY TO 10', 8/1/18
 SAND, SILTY, FINE TO COARSE
 GRAINED, TAN, MEDIUM
 DENSE, MOIST

 CLAYSTONE, SANDY, GRAY
 BROWN, HARD, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
0 - 5	(Symbol: Dotted pattern)		22	3.8	1
5 - 10	(Symbol: Cross-hatched pattern)		50	16.5	4
10 - 15	(Symbol: Cross-hatched pattern)		50	12.9	4
15 - 20					

REMARKS

DRY TO 5', 8/1/18
 SAND, CLAYEY, FINE TO COARSE
 GRAINED, TAN, MEDIUM DENSE,
 MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
0 - 5	(Symbol: Dotted pattern)		10	9.0	1
5 - 10	(Symbol: Dotted pattern)		14	5.9	1
10 - 15					
15 - 20					



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:

DATE:

CHECKED:

DATE: 8/20/18

JOB NO:
 181360

FIG NO:
 A- 3

TABLE 1
SUMMARY OF LABORATORY TEST RESULTS

CLIENT: TECH CONTRACTORS
 PROJECT: WINDING WALK, PHASE 3
 JOB NO.: 190128

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	AASHTO CLASS.	SWELL/ CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1A, CBR	11	0-3			23.8	NV	NP		A-2-4		SM	FILL, SAND, SILTY
1A	10	1-2			21.9	NV	NP	<0.01	A-1-b		SM	FILL, SAND, SILTY
1A	11	1-2			20.5	NV	NP		A-1-b		SM	FILL, SAND, SILTY
1A	12	1-2	6.6	107.8	16.3	27	14		A-2-6	0.1	SC	FILL, SAND, CLAYEY
1A	13	1-2	8.9	120.6	20.5	35	20		A-2-6	0.2	SC	FILL, SAND, CLAYEY
1A	15	1-2			29.6	NV	NP		A-2-4		SM	FILL, SAND, SILTY
1A	16	1-2	8.8	112.5	24.0	33	19		A-2-6	0.4	SC	FILL, SAND, CLAYEY
1A	14	1-2	7.9	105.0	13.7	24	9		A-2-4	-0.1	SC	FILL, SAND, CLAYEY
1A	17	1-2			26.7	33	19	<0.01	A-2-6		SC	FILL, SAND, CLAYEY
1A	18	1-2	9.2	108.8	19.1	34	20	<0.01	A-2-6	0.1	SC	FILL, SAND, CLAYEY

TEST BORING NO. 10
 DATE DRILLED 3/6/2019
 Job # 190128

TEST BORING NO. 11
 DATE DRILLED 3/6/2019
 CLIENT TECH CONTRACTORS
 LOCATION WINDING WALK, PHASE 3

REMARKS

DRY TO 5', 3/6/19
 FILL 0-5', SAND, SILTY, FINE
 TO COARSE GRAINED, BROWN,
 LOOSE TO MEDIUM DENSE,
 MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
0-5			9	7.2	1A
5			16	6.2	1A
10					
15					
20					

REMARKS

DRY TO 10', 3/6/19
 FILL 0-10', SAND, SILTY, FINE
 TO COARSE GRAINED, BROWN,
 VERY LOOSE TO MEDIUM
 DENSE, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
0-10			4	8.5	1A
5			3	8.5	1A
10			27	9.4	1A
15					
20					



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:

DATE:

CHECKED:

DATE:

SCC

4/4/19

JOB NO:
 190128

FIG NO:
 A- 1

TEST BORING NO. 14
 DATE DRILLED 3/6/2019
 Job # 190128

TEST BORING NO. 15
 DATE DRILLED 3/6/2019
 CLIENT TECH CONTRACTORS
 LOCATION WINDING WALK, PHASE 3

REMARKS

DRY TO 10', 3/6/19
 FILL 0-9', SAND, CLAYEY, FINE
 TO COARSE GRAINED, BROWN,
 MEDIUM DENSE, MOIST

SAND, CLAYEY, FINE GRAINED,
 TAN, MEDIUM DENSE, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
0-5	(Symbol)		19	6.5	1A
5-10	(Symbol)		20	9.1	1A
10-15	(Symbol)		23	17.0	1

REMARKS

DRY TO 5', 3/6/19
 FILL 0-5', SAND, SILTY, FINE
 TO COARSE GRAINED, BROWN,
 LOOSE TO MEDIUM DENSE,
 MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
0-5	(Symbol)		5	10.3	1A
5-10	(Symbol)		21	16.4	1A



ENTECH
 ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN

DATE

CHECKED
 SCC

DATE
 4/4/19

JOB NO.
 190128

FIG NO.
 A-3

TEST BORING NO. 16
 DATE DRILLED 3/6/2019
 Job # 190128

TEST BORING NO. 17
 DATE DRILLED 3/6/2019
 CLIENT TECH CONTRACTORS
 LOCATION WINDING WALK, PHASE 3

REMARKS

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 3/6/19 FILL 0-5', SAND, CLAYEY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST	5	[Symbol]		17	9.6	1A
	5	[Symbol]		16	10.4	1A

REMARKS

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 10', 3/6/19 FILL 0-4', SAND, CLAYEY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST	5	[Symbol]		15	11.1	1A
WEATHERED TO FORMATIONAL SANDSTONE, CLAYEY, FINE TO COARSE GRAINED, BROWN, DENSE TO VERY DENSE, MOIST	5	[Symbol]		40	9.6	4
	10	[Symbol]		50 11"	10.6	4



ENTECH
 ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:

DATE:

CHECKED:

DATE:

SCC

4/4/19

JOB NO:
190128

FIG NO:
A-4

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT: TECH CONTRACTORS
 PROJECT: VISTAS AT MERIDIAN RANCH
 JOB NO. 170157

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	AASHTO CLASS.	SWELL/CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1, CBR #1	1	0-3			22.7	20	2		A-2-4		SM	SAND, SILTY
1	1	1-2			20.0	NV	NP		A-2-4		SM	SAND, SILTY
1	2	1-2			15.3	27	5		A-1-b		SM	SAND, SILTY
1	3	1-2			23.5	NV	NP		A-1-b		SM	SAND, SILTY
1	4	1-2			35.8	19	8	<0.01	A-4		SC	SAND, CLAYEY
1	5	1-2			26.8	23	2		A-2-4		SM	SAND, SILTY
1	6	1-2			17.9	NV	NP		A-1-b		SM	SAND, SILTY
1	7	1-2			12.6	NV	NP		A-1-b		SM	SAND, SILTY
1	8	1-2			18.6	NV	NP	0.02	A-1-b		SM	SAND, SILTY
1	9	1-2			22.4	NV	NP		A-1-b		SM	SAND, SILTY
1	12	1-2			14.5	NV	NP		A-1-b		SM	SAND, SILTY
1	1	10			18.2	NV	NP		A-1-b		SM	SAND, SILTY
1	7	0-3			21.0						SM	SAND, SILTY
2	7	10			29.7	25	5		A-2-4		SC-SM	SANDSTONE, CLAYEY, SILTY
2	11	5	10.0	112.3	24.6	34	13	0.01	A-2-6	0.2	SC	SANDSTONE, CLAYEY
2	12	5	9.4	113.3	23.3	36	15		A-2-6	0.1	SC	SANDSTONE, CLAYEY
3, CBR #2	10	0-3	15.3	107.5	62.5	39	16		A-6	1.8'	CL	CLAYSTONE, SANDY
3	10	1-2	15.1	119.4	71.8	39	16	0.00	A-6	4.6	CL	CLAYSTONE, SANDY
3	11	1-2	13.3	106.7	54.1	50	25		A-7-6	6.1	CH	CLAYSTONE, VERY SANDY
3	4	10	16.6	112.1	72.4	39	15	<0.01	A-6	4.2	CL	CLAYSTONE, SANDY

* - REMOLDED SAMPLE

TEST BORING NO. 9
 DATE DRILLED 2/15/2017
 Job # 170157

TEST BORING NO. 10
 DATE DRILLED 2/15/2017
 CLIENT TECH CONTRACTORS
 LOCATION VISTAS AT MERIDIAN RANCH

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 2/15/17						
SAND, SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST	5			11	7.1	1
	5			19	3.1	1
	10					
	15					
	20					

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 2/15/17						
CLAYSTONE, SANDY, GREEN BROWN, HARD, MOIST	5			50 8"	13.9	3
	5			50 7"	13.5	3
	10					
	15					
	20					



TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
		DS	3/2/17

JOB NO.: 170157
 FIG NO.: A- 5

APPENDIX D: Pavement Design Calculations

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA

WINDINGWALK, F1, PH4 - URBAN LOCAL ROADS - 292K

SOIL TYPE 2, CBR # 2

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	292,000
Hveem Stabilometer (R Value) Results:	R =	40
Standard Deviation	S_o =	0.45
Loss in Serviceability	$\Delta\psi$ =	2.0
Reliability	Reliability =	80
Reliability (z-statistic)	Z_R =	-0.84
Soil Resilient Modulus	M_R =	9497

Weighted Structural Number (WSN): ➔ WSN = 2.37

DESIGN TABLES AND EQUATIONS

$$S_1 = [(R - 5) / 11.29] + 3$$

$$M_R = 10^{[(S_1 + 18.72) / 6.24]}$$

$$k = M_R / 19.4$$

Where:

M_R = resilient modulus (psi)

S_1 = the soil support value

R = R-value obtained from the Hveem stabilometer

CBR = California Bearing Ratio

Reliability (%)	Z_R (z-statistic)
80	-0.84
85	-1.04
90	-1.28
93	-1.48
94	-1.56
95	-1.65
96	-1.75
97	-1.88
98	-2.05
99	-2.33
99.9	-3.09
99.99	-3.75

$$\log_{10} W_{18} = Z_R \cdot S_o + 9.36 \cdot \log_{10} (SN+1) - 0.20 + \frac{\log_{10} \left[\frac{\Delta \text{PSI}}{4.2 - 1.5} \right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 \cdot \log_{10} M_R - 8.07$$

Left	Right	Difference
5.47	5.47	0.0

Job No. 190128

Fig. No. D-1

DESIGN CALCULATIONS

DESIGN DATA WINDINGWALK, F1, PH4 - URBAN LOCAL ROADS - 292K

SOIL TYPE 2, CBR # 2

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL = 292,000
Hveem Stabilometer (R Value) Results:	R = 40
Weighted Structural Number (WSN):	WSN = 2.37

DESIGN EQUATION

$$WSN = C_1 D_1 + C_2 D_2$$

$C_1 = 0.44$ Strength Coefficient - Hot Bituminous Asphalt

$C_2 = 0.11$ Strength Coefficient - Aggregate Basecourse

D_1 = Depth of Asphalt (inches)

D_2 = Depth of Basecourse (inches)

FOR FULL DEPTH ASPHALT SECTION (CURRENTLY NOT ALLOWED)

$$D_1 = (WSN)/C_1 = 5.4 \text{ inches of Full Depth Asphalt}$$

Use 5.5 inches Full Depth

FOR ASPHALT + AGGREGATE BASECOURSE SECTION

Asphalt Thickness (t) = 3.5 inches

$$D_2 = ((WSN) - (t)(C_1))/C_2 = 7.6 \text{ inches of Aggregate}$$

Basecourse, use 8.0 inches

RECOMMENDED ALTERNATIVES

1. 3.5 inches of Asphalt + 8.0 inches of Aggregate Basecourse, or
2. 5.5 inches of Asphalt

Job No. 190128
Fig. No. D-2

DESIGN CALCULATIONS

CEMENT TREATED SECTIONS

DESIGN DATA: WINDINGWALK, F1, PH4 - URBAN LOCAL ROADS - 292K

SOIL TYPE 2, CBR # 2

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL = 292,000
Hveem Stabilometer (R Value) Results:	R = 40
Weighted Structural Number (WSN):	WSN = 2.37

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

$C_1 = 0.44$ Strength Coefficient - Hot Bituminous Asphalt

$C_2 = 0.12$ Strength Coefficient - Cement Treated Subgrade.

D_1 = Depth of Asphalt (inches)

D_2 = Depth of Cement Treated Subgrade (inches)

FOR FULL DEPTH ASPHALT SECTION - (CURRENTLY NOT ALLOWED)

$D_1 = (WSN)/C_1 = 5.4$ inches of Full Depth Asphalt
Use 5.5 inches Full Depth

FOR ASPHALT + CEMENT TREATED SUBGRADE SECTION

Asphalt Thickness (t) = 4 inches USE 4 INCH MINIMUM.

$D_2 = ((WSN) - (t)(C_1))/C_2 = 5.1$ inches
Use 10.0 inches of Cement Treated Subgrade.

RECOMMENDED ALTERNATIVES

1. 4.0 inches of Asphalt + 10.0 inches of Cement Treated Subgrade.
2. 5.5 inches of Full Depth Asphalt

Job No. 190128

Fig. No. D-3

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA

WINDINGWALK, F1, PH4 - URBAN NON-RESIDENTIAL COLLECTOR

SOIL TYPE 2, CBR # 2

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	3,573,833
Hveem Stabilometer (R Value) Results:	R =	40
Standard Deviation	S_o =	0.45
Loss in Serviceability	$\Delta\psi$ =	2.5
Reliability	Reliability =	85
Reliability (z-statistic)	Z_R =	-1.04
Soil Resilient Modulus	M_R =	9497

Weighted Structural Number (WSN): ➔ WSN = 3.49

DESIGN TABLES AND EQUATIONS

$$S_1 = [(R - 5) / 11.29] + 3$$

$$M_R = 10^{[(S_1 + 18.72) / 6.24]}$$

$$k = M_R / 19.4$$

Where:

M_R = resilient modulus (psi)

S_1 = the soil support value

R = R-value obtained from the Hveem stabilometer

CBR = California Bearing Ratio

Reliability (%)	Z_R (z-statistic)
80	-0.84
85	-1.04
90	-1.28
93	-1.48
94	-1.56
95	-1.65
96	-1.75
97	-1.88
98	-2.05
99	-2.33
99.9	-3.09
99.99	-3.75

$$\log_{10} W_{18} = Z_R * S_o + 9.36 * \log_{10} (SN+1) - 0.20 + \frac{\log_{10} \left[\frac{\Delta \text{PSI}}{4.2 - 1.5} \right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10} M_R - 8.07$$

Left	Right	Difference
6.55	6.55	0.0

Job No. 190128

Fig. No. D-4

DESIGN CALCULATIONS

DESIGN DATA WINDINGWALK, F1, PH4 - URBAN NON-RESIDENTIAL COLLECTOR

SOIL TYPE 2, CBR # 2

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL = 3,573,833
Hveem Stabilometer (R Value) Results:	R = 40
Weighted Structural Number (WSN):	WSN = 3.49

DESIGN EQUATION

$$WSN = C_1 D_1 + C_2 D_2$$

$C_1 = 0.44$ Strength Coefficient - Hot Bituminous Asphalt

$C_2 = 0.11$ Strength Coefficient - Aggregate Basecourse

$D_1 =$ Depth of Asphalt (inches)

$D_2 =$ Depth of Basecourse (inches)

FOR FULL DEPTH ASPHALT SECTION (CURRENTLY NOT ALLOWED)

$$D_1 = (WSN)/C_1 = 7.9 \text{ inches of Full Depth Asphalt}$$

Use 8.0 inches Full Depth

FOR ASPHALT + AGGREGATE BASECOURSE SECTION

Asphalt Thickness (t) = inches

$$D_2 = ((WSN) - (t)(C_1))/C_2 = 11.7 \text{ inches of Aggregate}$$

Basecourse, use 12.0 inches

RECOMMENDED ALTERNATIVES

1. 5.0 inches of Asphalt + 12.0 inches of Aggregate Basecourse, or
2. 8.0 inches of Asphalt

Job No. 190128

Fig. No. D-5

DESIGN CALCULATIONS

CEMENT TREATED SECTIONS

DESIGN DATA: WINDINGWALK, F1, PH4 - URBAN NON-RESIDENTIAL COLLECTOR

SOIL TYPE 2, CBR # 2

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL = 3,573,833
Hveem Stabilometer (R Value) Results:	R = 40
Weighted Structural Number (WSN):	WSN = 3.49

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

$C_1 = 0.44$ Strength Coefficient - Hot Bituminous Asphalt

$C_2 = 0.12$ Strength Coefficient - Cement Treated Subgrade.

$D_1 =$ Depth of Asphalt (inches)

$D_2 =$ Depth of Cement Treated Subgrade (inches)

FOR FULL DEPTH ASPHALT SECTION - (CURRENTLY NOT ALLOWED)

$$D_1 = (WSN)/C_1 = 7.9 \text{ inches of Full Depth Asphalt}$$

Use 8.0 inches Full Depth

FOR ASPHALT + CEMENT TREATED SUBGRADE SECTION

Asphalt Thickness (t) = 5 inches USE 4 INCH MINIMUM.

$$D_2 = ((WSN) - (t)(C_1))/C_2 = 10.8 \text{ inches}$$

Use 11.0 inches of Cement Treated Subgrade.

RECOMMENDED ALTERNATIVES

1. 5.0 inches of Asphalt + 11.0 inches of Cement Treated Subgrade.
2. 8.0 inches of Full Depth Asphalt

Job No. 190128

Fig. No. D-6