November 30, 2020
Revised: January 8, 2021

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: Raul Guzman

Re: Pavement Recommendations - Revised
The Estates at Rolling Hills Ranch Filing No.1
El Paso County, Colorado

Dear Mr. Guzman:

As requested, Entech Engineering, Inc. has obtained samples of the subgrade soils from sections of the roadways in the Estates at Rolling Hills Ranch, Filing No.1, 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 east of The Estates at Meridian Ranch Filing No. 3 development. The extent of the roadway construction is shown in Figure 1.

The roadways in this project consist of sections of Rex Road and Sunrise Ridge Drive, and Palmer Peak Place. 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

Eight exploratory test borings were drilled in the roadways to depths of approximately 5 to 10 feet. The Boring Logs are presented in Appendix A. Sieve Analysis and Atterberg Limit testing were performed on the subgrade 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 12 to 29 percent. Atterberg Limit Tests performed on the samples resulted in Liquid Limits ranging from no-value to 30 and Plastic Indexes of non-plastic to 15. One general soil type was encountered at the subgrade depth (Soil Type 1). Soil Type 1 consisted of silty to clayey sand fill which classified as A-2-4, A-2-6 and A-1-b soils based on the AASHTO classification system. The Type 1 soils have good pavement support characteristics. Soil Type 2 was encountered at depths below the subgrade influence zone. Sulfate testing of the subgrade indicated that the soils exhibit a negligible potential for sulfate attack. Ground water was not encountered in the test borings.

Swell testing was required on the several samples of the site soils based on their Plastic Indexes. Volume changes of 0.3 to 0.8 were measured. Based on the low volume changes, mitigation is not required. Laboratory test results are presented in Appendix B and are summarized on Table 1.

California Bearing Ratio (CBR) testing was performed on a sample of Soil Type 1 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:

Soil Type1 – Silty to Clayey Sand Fill

R @ 90% = 22.0
R @ 95% = 73.0
Use R = 50.0 for design

Classification Testing

Liquid Limit	23
Plasticity Index	6
Percent Passing 200	25.4
AASHTO Classification	A-2-4
Group Index	0
Unified Soils Classification	SC-SM

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. Palmer Peak Place classifies as a local (low-volume) roadway which uses an 18k ESAL value of 36, 500 for design. Sunrise Ridge Drive classifies as a local road which uses an 18K ESAL value of 292,000 for design. Rex Road classifies as a residential collector, which uses an 18K ESAL value of 821,000 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 (Local Low Volume)/Local	80%
Residential Collector	85%
Serviceability Index – Local – Low volume	2.0
Serviceability Index – Local	2.0
Serviceability Index – Residential Collector	2.5
Resilient Modulus	13,168 psi
"R" Value Subgrade	50.0
Structural Coefficients:	
Hot Bituminous Pavement	0.44
Aggregate Base Course	0.11
Cement Stabilized Subgrade	0.12

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

Pavement Sections – Soil Type 1

Local (low volume) – ESAL = 36,500 – Palmer Peak Place

Alternative	Asphalt (in)	Base Course (in)	Cement Stabilized Subgrade (in.)
1. Asphalt Over Base Course	3.0*	4.0*	--
2. Cement Stabilized Subgrade	4.0	--	8.0

Local – ESAL = 292,000 – Sunrise Ridge Drive

Alternative	Asphalt (in)	Base Course (in)	Cement Stabilized Subgrade (in.)
1. Asphalt Over Base Course	3.0*	8.0*	--
2. Cement Stabilized Subgrade	4.0	--	8.0

Residential Collector – ESAL = 821,000 – Rex Road

Alternative	Asphalt (in)	Base Course (in)	Cement Stabilized Subgrade (in.)
1. Asphalt Over Base Course	4.0*	8.0*	--
2. Cement Stabilized Subgrade	4.0	--	10.0

Full depth sections are not allowed.
* 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. Due to the results of the swell testing, mitigation for expansive soils will not be required on this site.

Roadway Construction - Full Depth Asphalt and Asphalt on Aggregate Base Course 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-1557 at ± 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. Base course 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 8 to 10 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 Modified Proctor Test (ASTM D-1557) based on laboratory cement stabilization testing. The cement should be spread evenly on the subgrade surface and be thoroughly mixed into the subgrade over an 8 to 10-inch depth such that a uniform blend of soil and cement is achieved. Prior to application or mixing of the cement, the upper 8 to 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 Modified Proctor Test (ASTM D-1557). 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:

- Type I/II cement as supplied. A local supplier shall be used. 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.

- Pending the results of the field density testing, microfracturing of the stabilized subgrade will likely be required. Soil strengths in excess of 200 psi require microfracturing.

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.

Daniel P. Stegman

Reviewed by:

Mark H. Hauschild, P.E.
Senior Engineer

SCC/bs

Encl.

Entech Job No. 202221
AAprojects/2020/202221 pr-REV

TABLE

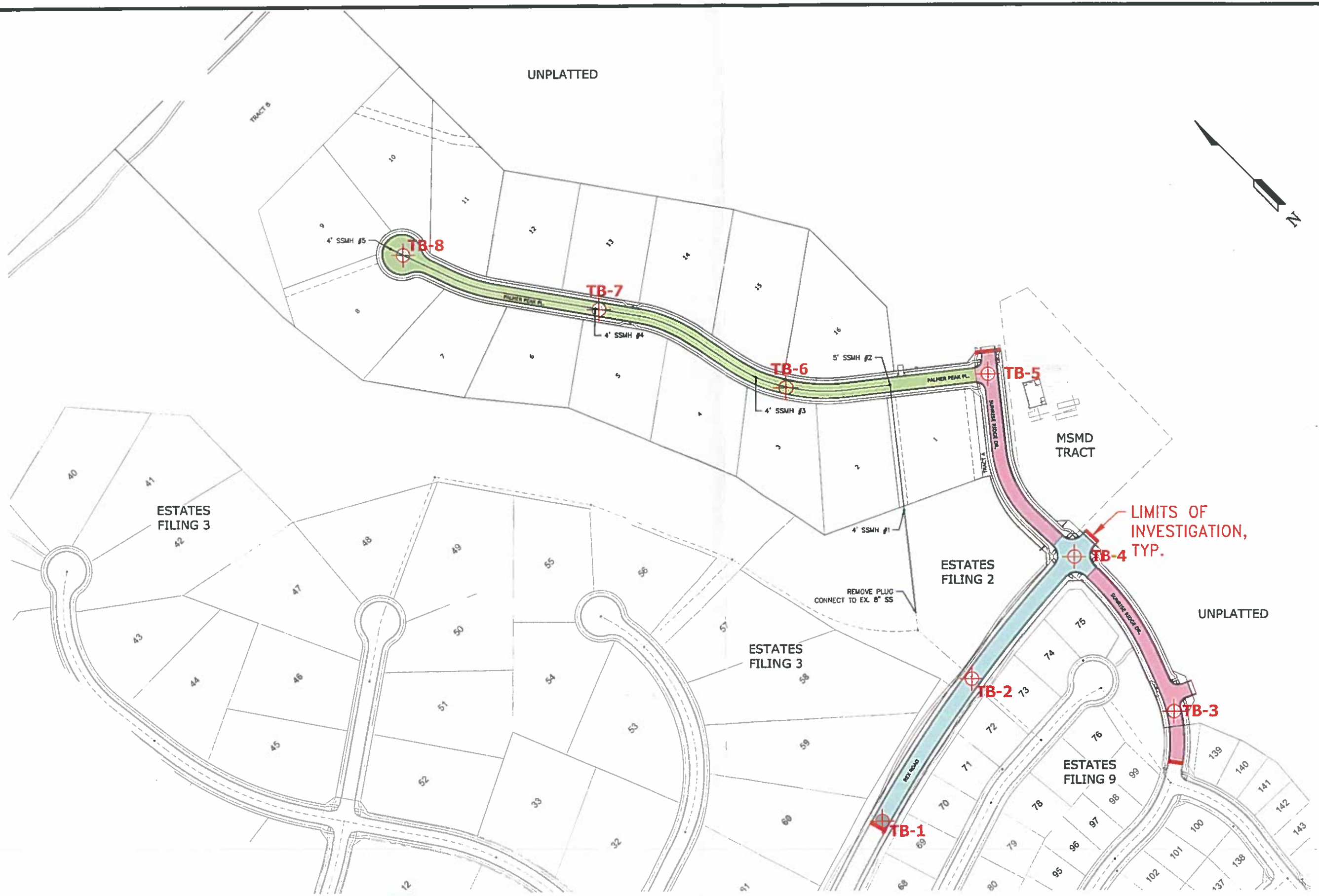
TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT TECH CONSTRACTORS
PROJECT ESTATES AT ROLLING HILLS
JOB NO. 202221

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	0-3			25.4	23	6		A-2-4		SC-SM	FILL, SAND, CLAYEY, SILTY
1	1	1-2	11.1	122.9	29.1	30	12		A-2-6	0.8	SC	FILL, SAND, CLAYEY
1	2	1-2			11.7	NV	NP		A-1-b		SM-SW	FILL, SAND, SLIGHTLY SILTY
1	3	1-2			19.6	NV	NP	0.00	A-1-b		SM	FILL, SAND, SILTY
1	4	1-2			25.0	NV	NP		A-2-4		SM	FILL, SAND, SILTY
1	5	1-2	9.4	119.4	27.7	28	15		A-2-6	0.3	SC	FILL, SAND, CLAYEY
1	6	1-2			15.7	NV	NP	<0.01	A-1-b		SM	FILL, SAND, SILTY
1	7	1-2			18.7	NV	NP		A-1-b		SM	FILL, SAND, SILTY
1	8	1-2			19.2	NV	NP		A-1-b		SM	FILL, SAND, SILTY
2	4	10			18.7	NV	NP		A-1-b		SM	SANDSTONE, SILTY
2	5	10			16.6	NV	NP	<0.01	A-1-b		SM	SANDSTONE, SILTY
2	6	5	5.7	111.2	24.4	34	18	<0.01	A-2-6	0.6	SC	SANDSTONE, CLAYEY
2	8	10			13.6	NV	NP		A-1-b		SM	SANDSTONE, SILTY

FIGURE



REVISION	BY

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE (719) 531-5599
COLORADO SPRINGS, CO. 80907

TEST BORING LOCATION MAP
THE ESTATES AT ROLLING HILLS RANCH
EL PASO COUNTY, CO
For: TECH CONTRACTORS

DRAWN	JAC
CHECKED	KAH
DATE	11/03/20
SCALE	AS SHOWN
JOB NO.	202221
FIGURE No.	1

APPENDIX A: Test Boring Logs

TEST BORING NO. 1
DATE DRILLED 10/15/2020
Job # 202221

REMARKS

DRY TO 5', 10/15/20

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
						FILL 0-5', SAND, CLAYEY TO SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST
			25	11.2	1	
5			16	10.2	1	
10						
15						
20						

TEST BORING NO. 2
DATE DRILLED 10/15/2020
CLIENT TECH CONSTRACTORS
LOCATION ESTATES AT ROLLING HILLS

REMARKS

DRY TO 5', 10/15/20

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
						FILL 0-5', SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, BROWN, DENSE TO MEDIUM DENSE, MOIST
			31	8.5	1	
5			19	6.6	1	
10						
15						
20						

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

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
			11/2/20

JOB NO.: 202221
FIG NO.: A- 1

TEST BORING NO. 3
DATE DRILLED 10/15/2020
Job # 202221

REMARKS

DRY TO 5', 10/15/20

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	Description
			45	7.2	1	FILL 0-5', SAND, SILTY, FINE TO COARSE GRAINED, BROWN TO TAN, DENSE, MOIST
5			43	7.0	1	
10						
15						
20						

TEST BORING NO. 4
DATE DRILLED 10/15/2020
CLIENT TECH CONSTRACTORS
LOCATION ESTATES AT ROLLING HILLS

REMARKS

DRY TO 10', 10/15/20

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	Description
			46	8.3	1	FILL 0-5', SAND, SILTY, FINE TO COARSE GRAINED, BROWN, DENSE TO MEDIUM DENSE, MOIST
5			16	4.5	1	
						SANDSTONE, SILTY, FINE TO COARSE GRAINED, TAN, VERY DENSE, MOIST
10			50/10"	9.4	2	
15						
20						

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

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
			4/27/20

JOB NO. 202221
FIG NO. A- 2

TEST BORING NO. 5
DATE DRILLED 10/15/2020
Job # 202221

REMARKS

DRY TO 10', 10/15/20

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	Description
			29	3.5	1	FILL 0-5', SAND, CLAYEY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST
5			11	5.2	1	
						SANDSTONE, SILTY, FINE TO COARSE GRAINED, TAN, VERY DENSE, MOIST
10			50/6"	6.5	2	
15						
20						

TEST BORING NO. 6
DATE DRILLED 10/15/2020
CLIENT TECH CONSTRACTORS
LOCATION ESTATES AT ROLLING HILLS

REMARKS

DRY TO 5', 10/15/20

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	Description
			12	5.7	1	FILL 0-4', SAND, SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST
5			50/9"	9.8	2	SANDSTONE, CLAYEY, FINE TO COARSE GRAINED, TAN, VERY DENSE, MOIST
10						
15						
20						

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

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
			11/2/20

JOB NO: 202221
FIG NO.: A- 3

TEST BORING NO. 7
DATE DRILLED 10/15/2020
Job # 202221

REMARKS

DRY TO 5', 10/15/20

POSS.. FILL 0-5', SAND, SILTY, FINE TO COARSE GRAINED, BROWN TO TAN, DENSE, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			35	8.1	1
5			44	6.9	1
10					
15					
20					

TEST BORING NO. 8
DATE DRILLED 10/15/2020
CLIENT TECH CONSTRACTORS
LOCATION ESTATES AT ROLLING HILLS

REMARKS

DRY TO 10', 10/15/20

FILL 0-6', SAND, SILTY, FINE TO COARSE GRAINED, BROWN TO TAN, DENSE, MOIST

SANDSTONE, SILTY, FINE TO COARSE GRAINED, TAN, VERY DENSE, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			23	10.5	1
5			29	5.3	1
10			50/8"	8.3	2
15					
20					

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

TEST BORING LOG

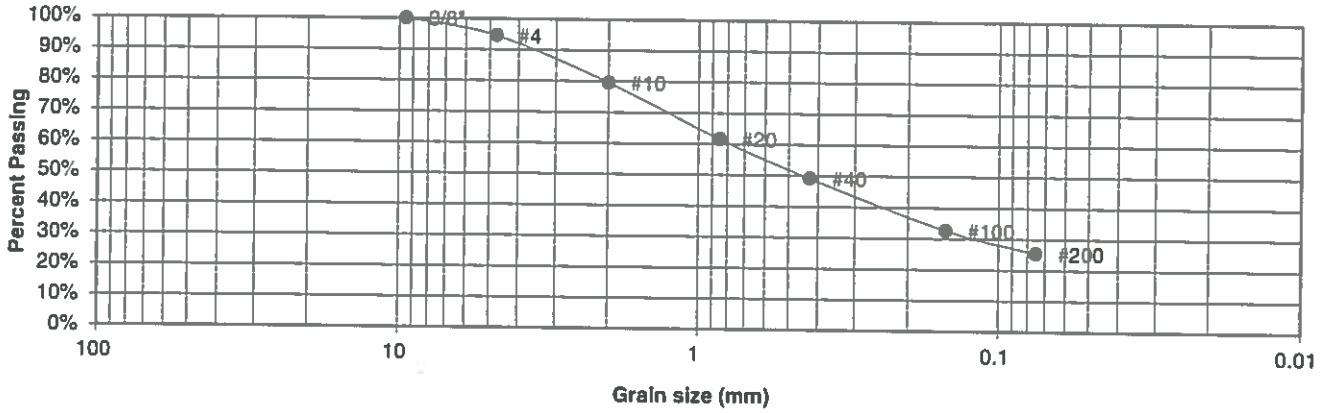
DRAWN:	DATE:	CHECKED:	DATE: 11/2/20

JOB NO.: 202221
FIG NO.: A- 4

APPENDIX B: Laboratory Test Results

UNIFIED CLASSIFICATION	SC-SM	CLIENT	TECH CONSTRACTORS
SOIL TYPE #	1, CBR	PROJECT	ESTATES AT ROLLING HILLS
TEST BORING #	1	JOB NO.	202221
DEPTH (FT)	0-3	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	94.5%
10	79.6%
20	61.6%
40	49.1%
100	32.6%
200	25.4%

Atterberg Limits

Plastic Limit	16
Liquid Limit	23
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

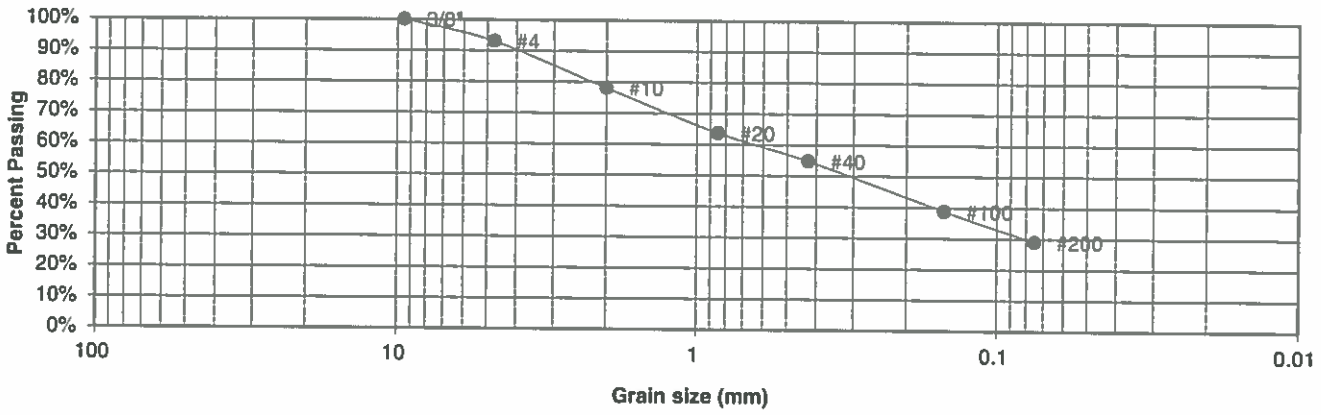
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE: 11/2/20

JOB NO.: 202221
FIG NO.: b-1

UNIFIED CLASSIFICATION	SC	CLIENT	TECH CONSTRACTORS
SOIL TYPE #	1	PROJECT	ESTATES AT ROLLING HILLS
TEST BORING #	1	JOB NO.	202221
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	93.1%
10	78.1%
20	63.7%
40	54.8%
100	38.8%
200	29.1%

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)	

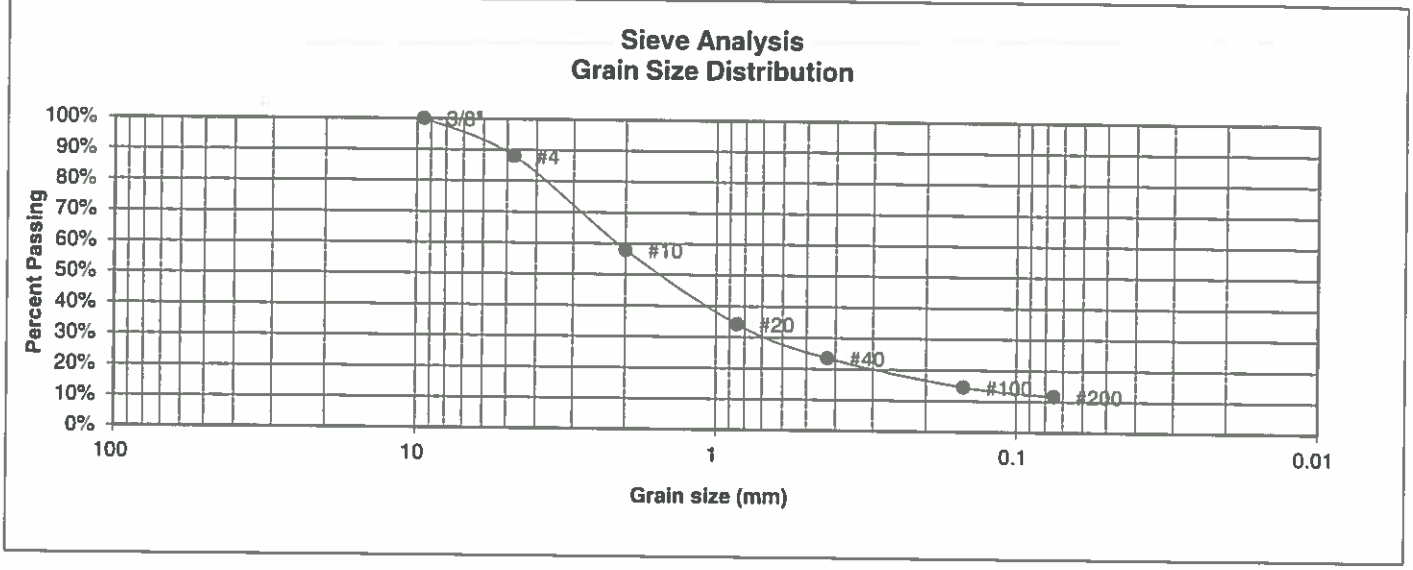
ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			11/24/20

JOB NO.: 202221
FIG NO.: B-2

UNIFIED CLASSIFICATION	SM-SW	CLIENT	TECH CONSTRACTORS
SOIL TYPE #	1	PROJECT	ESTATES AT ROLLING HILLS
TEST BORING #	2	JOB NO.	202221
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	88.0%
10	57.9%
20	34.3%
40	23.4%
100	14.5%
200	11.7%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

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

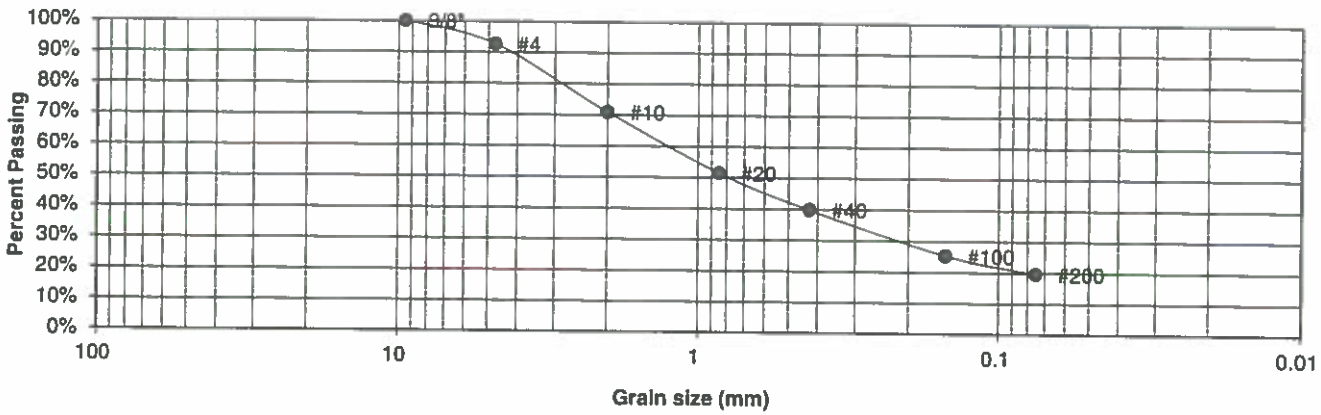
DRAWN:	DATE:	CHECKED:	DATE:
		h	1/12/20

JOB NO.: 202221

FIG NO.: B-3

UNIFIED CLASSIFICATION	SM	CLIENT	TECH CONSTRACTORS
SOIL TYPE #	1	PROJECT	ESTATES AT ROLLING HILLS
TEST BORING #	3	JOB NO.	202221
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	92.7%
10	70.9%
20	51.5%
40	39.8%
100	25.3%
200	19.6%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

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

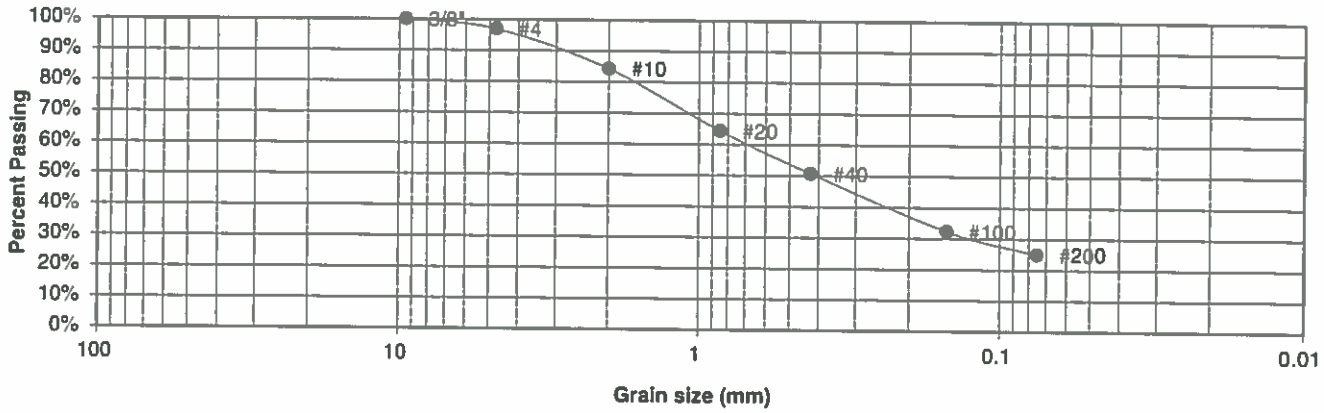
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			11/12/20

JOB NO.: 202221
FIG NO.: B-4

UNIFIED CLASSIFICATION	SM	CLIENT	TECH CONSTRACTORS
SOIL TYPE #	1	PROJECT	ESTATES AT ROLLING HILLS
TEST BORING #	4	JOB NO.	202221
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.0%
10	84.3%
20	64.4%
40	50.7%
100	32.3%
200	25.0%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

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

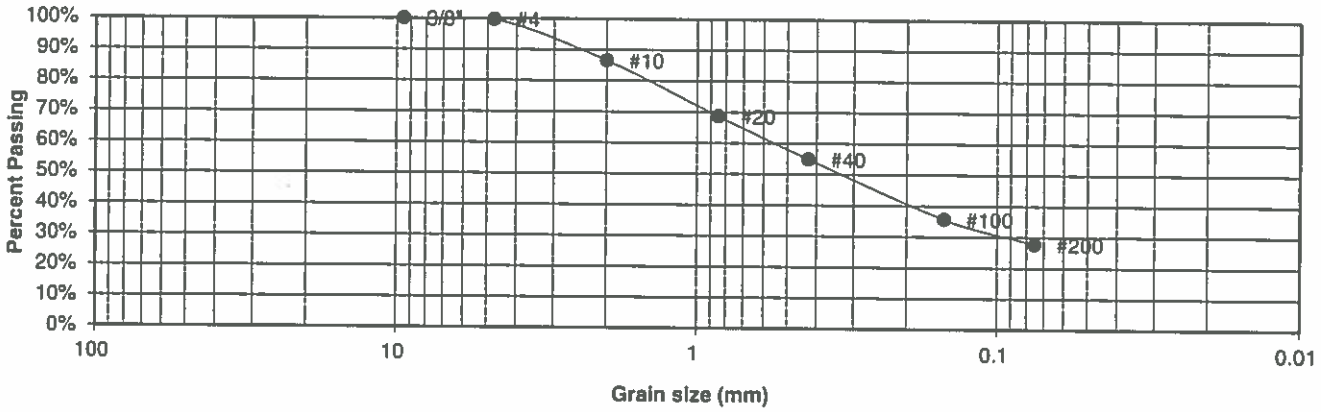
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			11/2/20

JOB NO.: 202221
FIG NO.: B-5

UNIFIED CLASSIFICATION	SC	CLIENT	TECH CONSTRACTORS
SOIL TYPE #	1	PROJECT	ESTATES AT ROLLING HILLS
TEST BORING #	5	JOB NO.	202221
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	1

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.7%
10	86.5%
20	68.7%
40	54.9%
100	35.6%
200	27.7%

Atterberg Limits

Plastic Limit	13
Liquid Limit	28
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

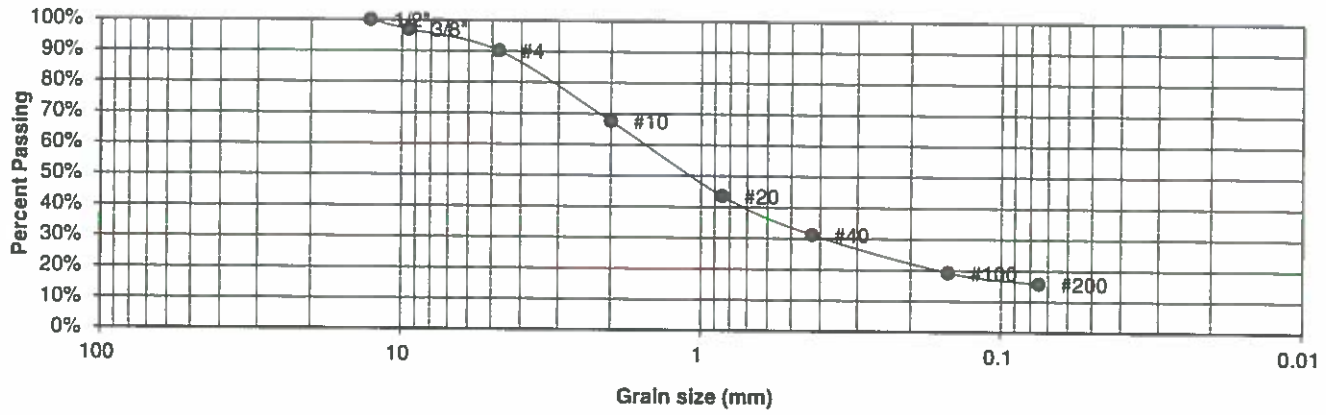
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			11/2/20

JOB NO.: 202221
FIG NO.: B-6

UNIFIED CLASSIFICATION	SM	CLIENT	TECH CONSTRACTORS
SOIL TYPE #	1	PROJECT	ESTATES AT ROLLING HILLS
TEST BORING #	6	JOB NO.	202221
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	97.0%
4	90.1%
10	67.6%
20	43.6%
40	31.2%
100	19.2%
200	15.7%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell

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

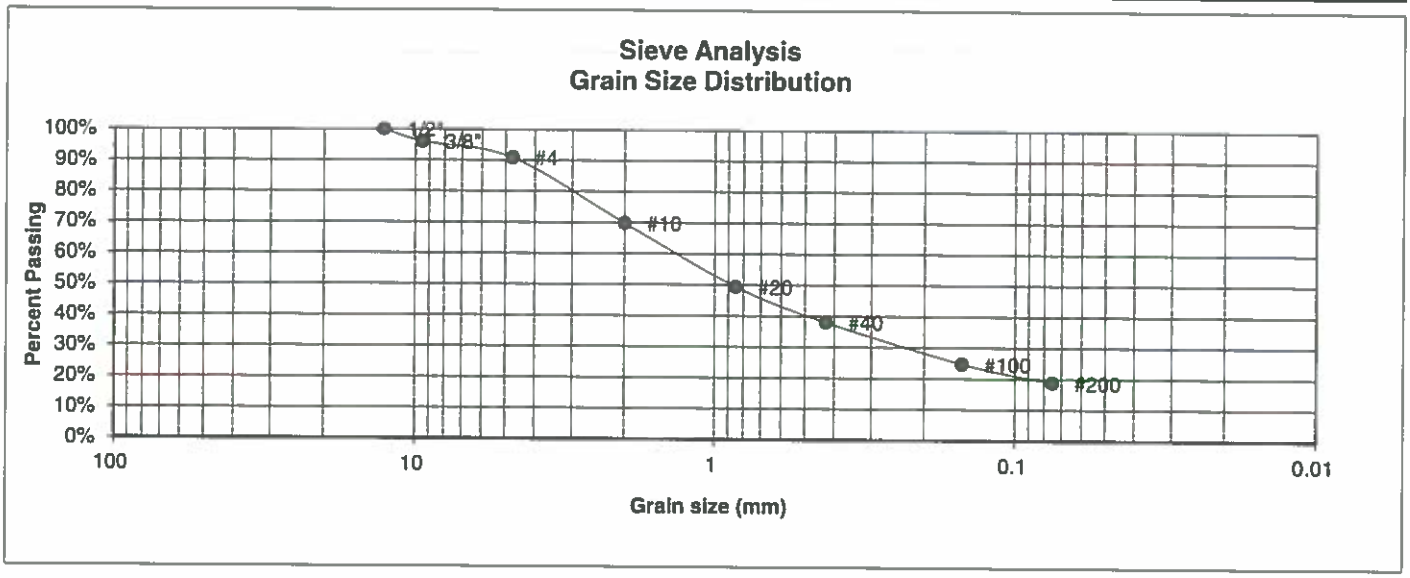
ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		h	4/2/20

JOB NO: 202221
FIG NO: B-7

UNIFIED CLASSIFICATION	SM	CLIENT	TECH CONSTRACTORS
SOIL TYPE #	1	PROJECT	ESTATES AT ROLLING HILLS
TEST BORING #	7	JOB NO.	202221
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	96.0%
4	90.8%
10	69.8%
20	49.4%
40	38.0%
100	24.7%
200	18.7%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)

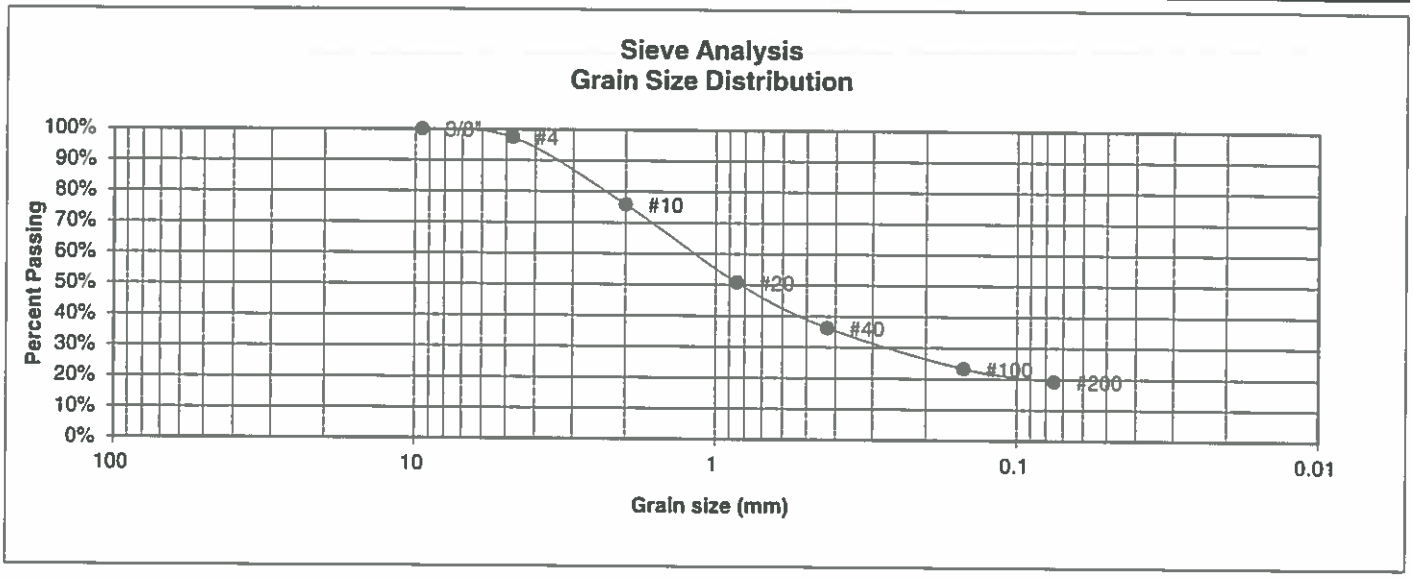
ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE: 11/2/20

JOB NO.: 202221
FIG NO.: B-8

UNIFIED CLASSIFICATION	SM	CLIENT	TECH CONSTRACTORS
SOIL TYPE #	1	PROJECT	ESTATES AT ROLLING HILLS
TEST BORING #	8	JOB NO.	202221
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.4%
10	75.9%
20	50.8%
40	36.2%
100	23.2%
200	19.2%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)

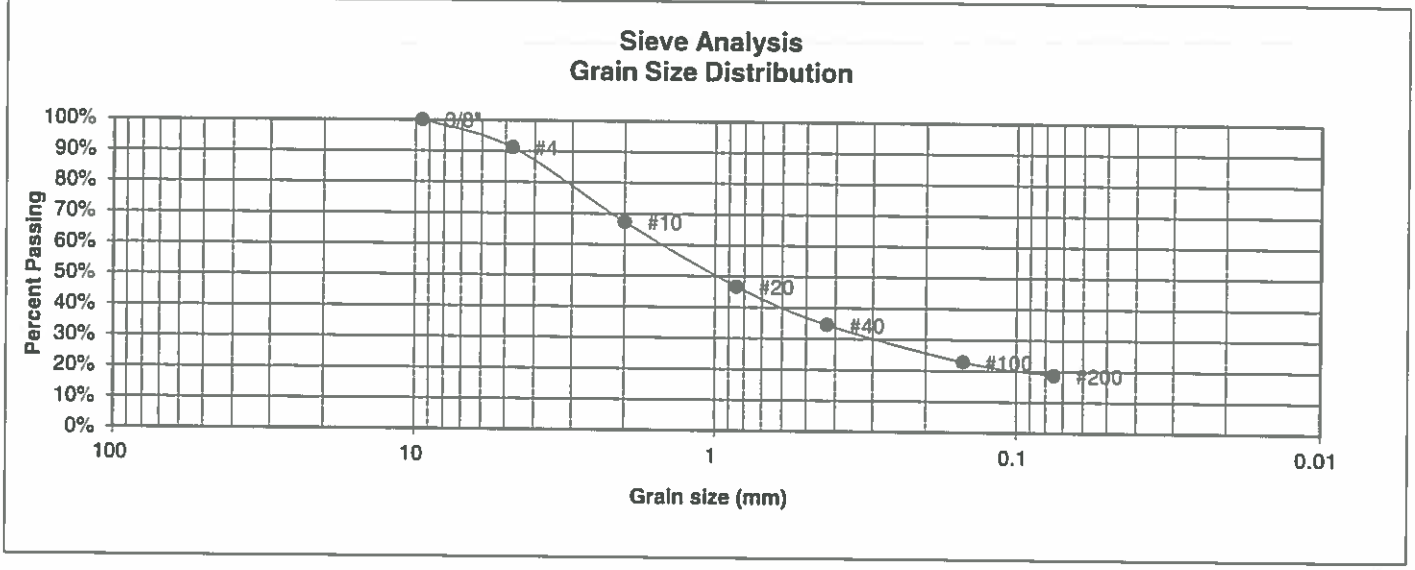
ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			11/2/20

JOB NO: 202221
FIG NO: B-9

UNIFIED CLASSIFICATION	SM	CLIENT	TECH CONSTRACTORS
SOIL TYPE #	2	PROJECT	ESTATES AT ROLLING HILLS
TEST BORING #	4	JOB NO.	202221
DEPTH (FT)	10	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	91.2%
10	67.3%
20	46.7%
40	34.5%
100	22.8%
200	18.7%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

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

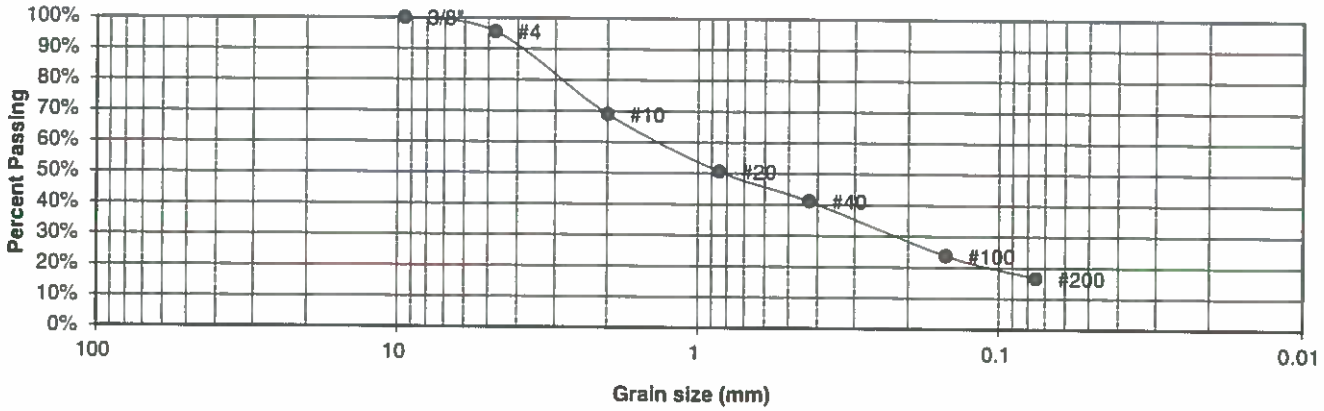
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			11/2/20

JOB NO.: 202221
FIG NO.: B-10

UNIFIED CLASSIFICATION	SM	CLIENT	TECH CONSTRACTORS
SOIL TYPE #	2	PROJECT	ESTATES AT ROLLING HILLS
TEST BORING #	5	JOB NO.	202221
DEPTH (FT)	10	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	95.6%
10	69.0%
20	50.7%
40	41.1%
100	23.8%
200	16.6%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

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

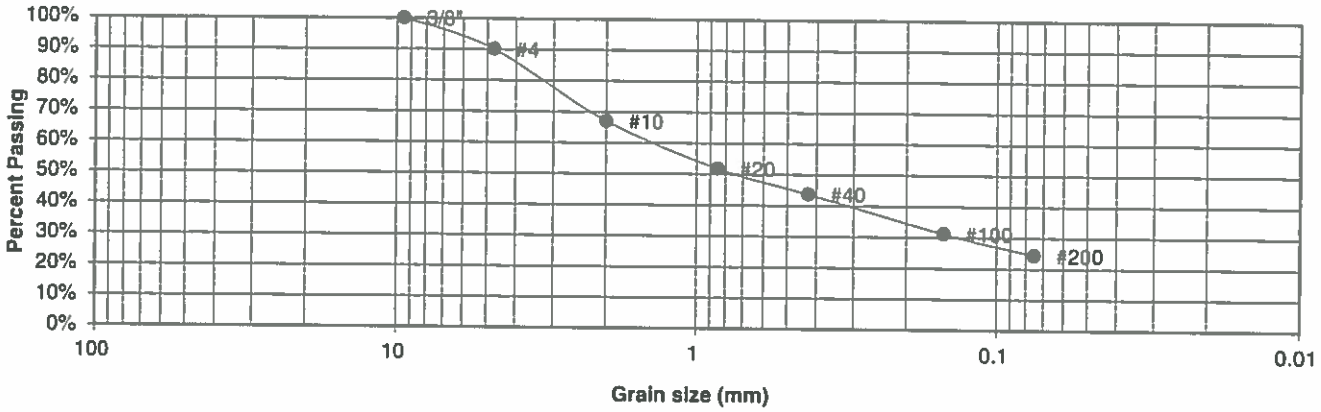
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			11/27/20

JOB NO.: 202221
FIG NO.: B-11

UNIFIED CLASSIFICATION	SC	CLIENT	TECH CONSTRACTORS
SOIL TYPE #	2	PROJECT	ESTATES AT ROLLING HILLS
TEST BORING #	6	JOB NO.	202221
DEPTH (FT)	5	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	1

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	90.1%
10	67.1%
20	51.8%
40	43.7%
100	31.2%
200	24.4%

Atterberg Limits	
Plastic Limit	16
Liquid Limit	34
Plastic Index	18

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

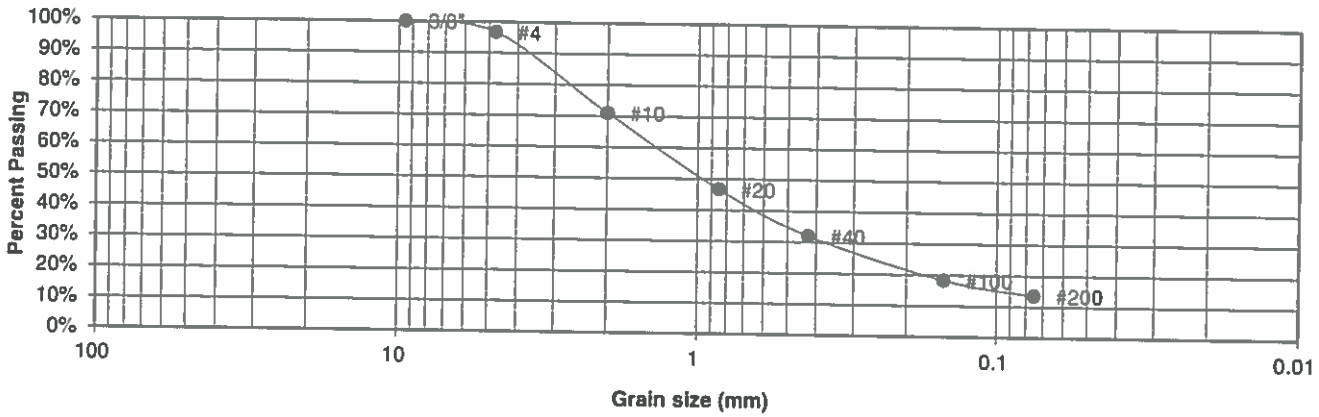
LABORATORY TEST RESULTS

DRAWN	DATE	CHECKED	DATE
			11/2/20

JOB NO.: 202221
FIG NO.: B-12

UNIFIED CLASSIFICATION	SM	CLIENT	TECH CONSTRACTORS
SOIL TYPE #	2	PROJECT	ESTATES AT ROLLING HILLS
TEST BORING #	8	JOB NO.	202221
DEPTH (FT)	10	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	96.7%
10	71.0%
20	46.7%
40	32.0%
100	18.2%
200	13.6%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

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

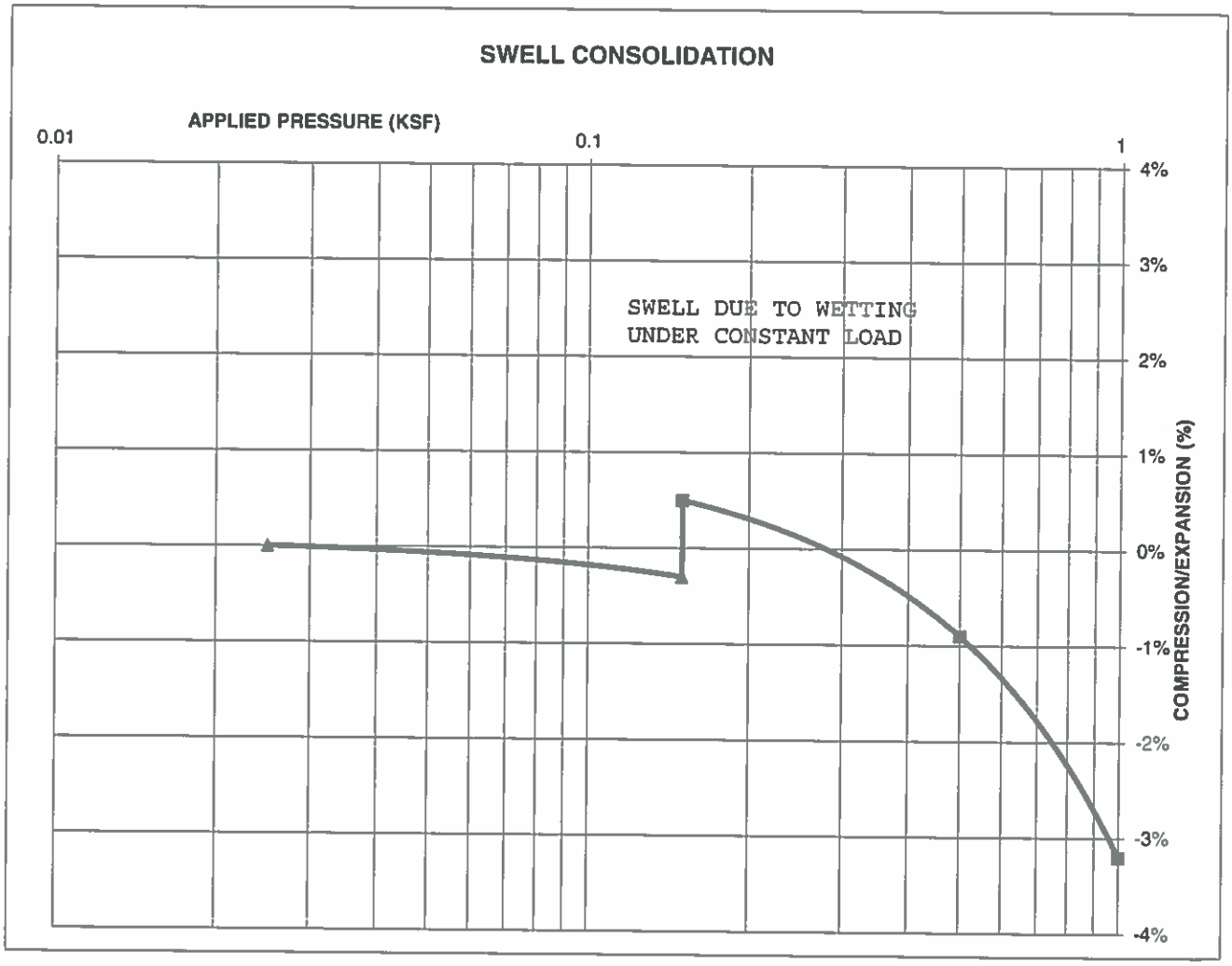
DRAWN:	DATE:	CHECKED:	DATE: 4/2/20

JOB NO.: 202221
FIG NO.: B-13

CONSOLIDATION TEST RESULTS

TEST BORING #	1	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			123
NATURAL MOISTURE CONTENT			11.1%
SWELL/CONSOLIDATION (%)			0.8%

JOB NO. 202221
CLIENT TECH CONSTRACTORS
PROJECT ESTATES AT ROLLING HILLS



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

SWELL CONSOLIDATION
TEST RESULTS

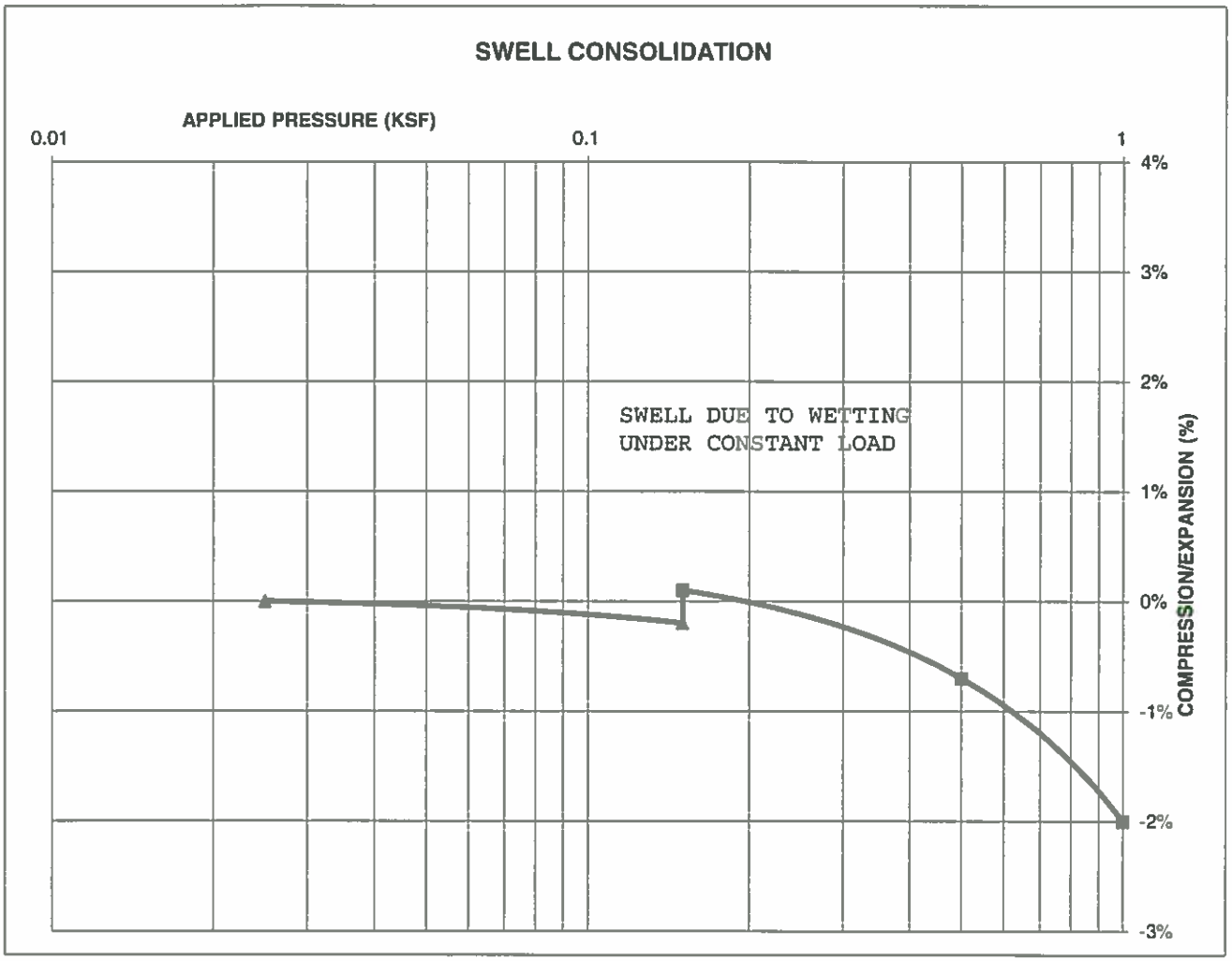
DRAWN:	DATE:	CHECKED:	DATE:
		h	11/2/20

JOB NO.: 202221
FIG NO.: B-14

CONSOLIDATION TEST RESULTS

TEST BORING #	6	DEPTH(ft)	5
DESCRIPTION	SC	SOIL TYPE	2
NATURAL UNIT DRY WEIGHT (PCF)			119
NATURAL MOISTURE CONTENT			9.4%
SWELL/CONSOLIDATION (%)			0.3%

JOB NO. 202221
CLIENT TECH CONSTRACTORS
PROJECT ESTATES AT ROLLING HILLS



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

SWELL CONSOLIDATION
TEST RESULTS

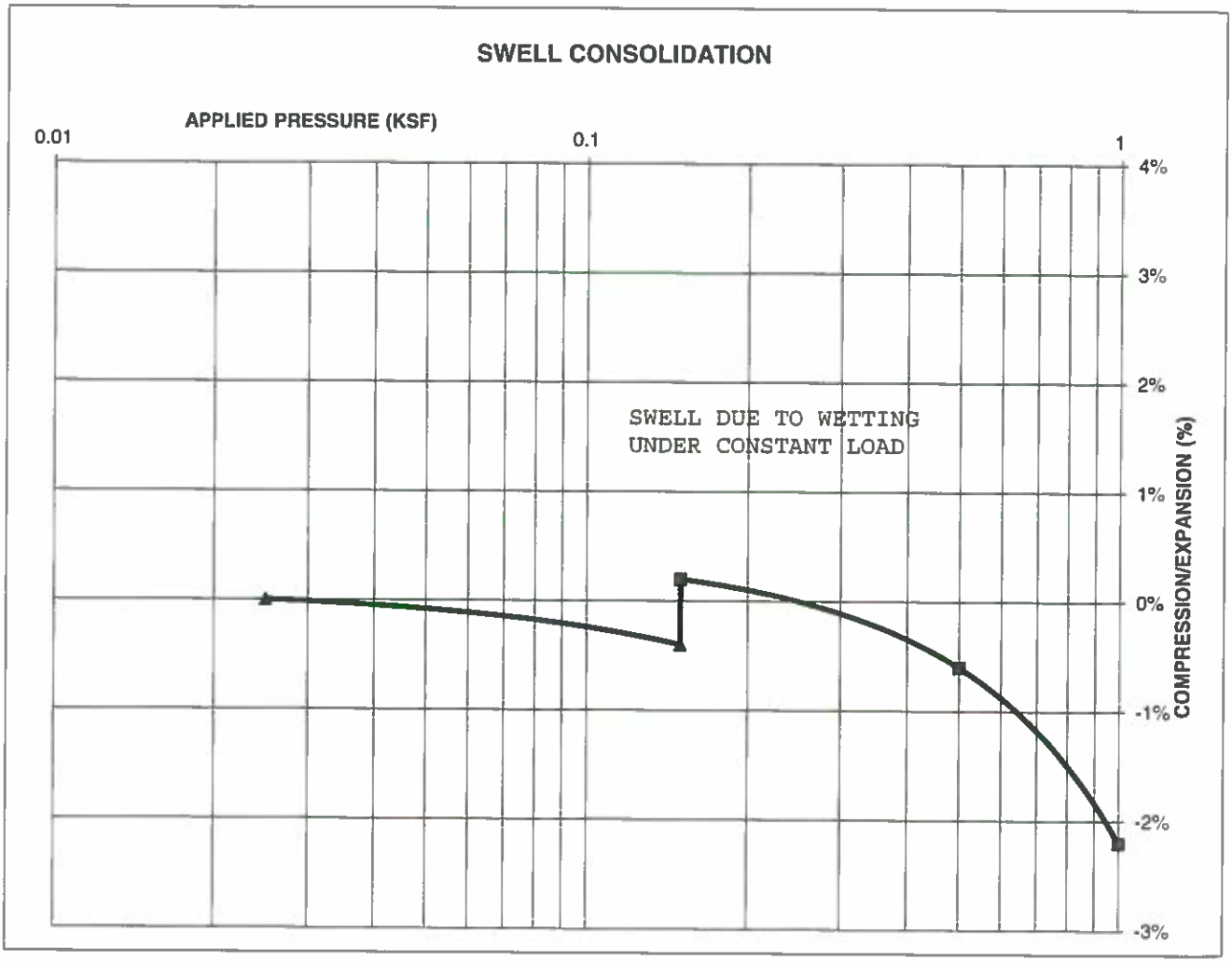
DRAWN:	DATE:	CHECKED:	DATE:
			11/2/20

JOB NO.: 202221
FIG NO.: B-15

CONSOLIDATION TEST RESULTS

TEST BORING #	5	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			111
NATURAL MOISTURE CONTENT			5.7%
SWELL/CONSOLIDATION (%)			0.6%

JOB NO. 202221
CLIENT TECH CONSTRACTORS
PROJECT ESTATES AT ROLLING HILLS



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

SWELL CONSOLIDATION
TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			11/2/20

JOB NO.: 202221
FIG NO.: B-16

CLIENT	TECH CONSTRACTORS	JOB NO.	202221
PROJECT	ESTATES AT ROLLING HILLS	DATE	10/23/2020
LOCATION	ESTATES AT ROLLING HILLS	TEST BY	BL

BORING NUMBER	DEPTH, (ft)	SOIL TYPE NUMBER	UNIFIED CLASSIFICATION	WATER SOLUBLE SULFATE, (wt%)
TB-3	1-2	1	SM-SW	0.00
TB-5	10	2	SM	<0.01
TB-6	1-2	1	SM	<0.01
TB-6	5	2	SC	<0.01

QC BLANK PASS

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

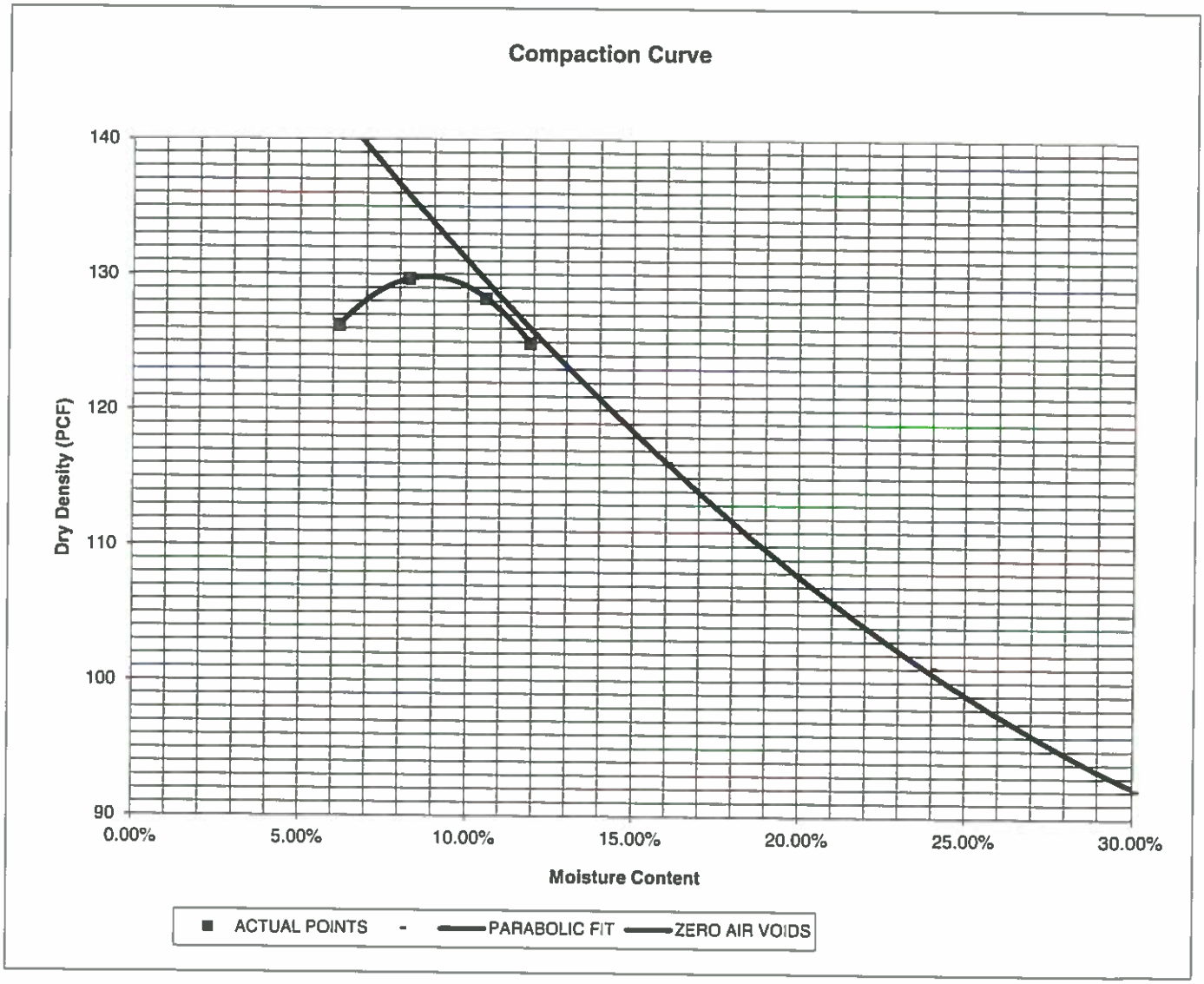
LABORATORY TEST
SULFATE RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			11/2/20

JOB NO.: 202221
FIG NO.: B-17

PROJECT	ESTATES AT ROLLING HILLS	CLIENT	TECH CONSTRACTORS
SAMPLE LOCATION	TB-1 @ 0-3'	JOB NO.	202221
SOIL DESCRIPTION	FILL, SAND, CLAYEY, SILTY, BROWN	DATE	10/23/20

IDENTIFICATION	SC-SM	COMPACTION TEST #	1
TEST DESIGNATION / METHOD	ASTM D-1557-A	TEST BY	BL
MAXIMUM DRY DENSITY (PCF)	130.1	OPTIMUM MOISTURE	8.9%



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

MOISTURE DENSITY RELATION

DRAWN:	DATE:	CHECKED:	DATE:
			11/2/20

JOB NO.: 202221
FIG NO.: B-18

CBR TEST LOAD DATA

JOB NO: 202221
CLIENT: TECH CONSTRACTORS
PROJECT: ESTATES AT ROLLING HILLS
SOIL TYPE: 1

PISTON DIAMETER (cm)	PISTON AREA (in^2)
4.958	2.993

PENETRATION DEPTH (INCHES)	*10 BLOWS* MOLD # 1 LOAD(LBS) (LBS)	STRESS (PSI)	*25 BLOWS* MOLD # 2 LOAD(LBS) (LBS)	STRESS (PSI)	*56 BLOWS* MOLD # 3 LOAD(LBS) (LBS)	STRESS (PSI)
0.000	0	0.00	0	0.00	0	0.00
0.025	81	27.07	158	52.80	374	124.98
0.050	197	65.83	339	113.28	652	217.88
0.075	334	111.61	474	158.40	1077	359.90
0.100	499	166.75	849	283.71	1193	398.66
0.125	664	221.89	1039	347.20	1432	478.53
0.150	782	261.32	1172	391.64	1743	582.45
0.175	858	286.72	1447	483.54	1919	641.27
0.200	1087	363.24	1779	594.48	2140	715.12
0.300	1202	401.67	2914	973.76	3225	1077.69
0.400	1452	485.21	3580	1196.32	4691	1567.58
0.500	1786	596.82	4014	1341.35	6000	2005.01

FINAL MOISTURE CONTENT

	MOLD # 1	MOLD # 2	MOLD # 3
CAN #	A-166	A-7	A-51
WT. CAN	239.12	237.71	150.08
WT. CAN+WET	746.42	974.4	728.11
WT. CAN+DRY	680.44	898.12	678.74
WT. H20	65.98	76.28	49.37
WT. DRY SOIL	441.32	660.41	528.66
MOISTURE CONTENT	14.95%	11.55%	9.34%
WET DENSITY (PCF)	130.7	135.2	141.0
DRY DENSITY (PCF)	120.0	124.2	129.5
BEARING RATIO	16.67	28.37	39.87

90% OF DRY DENSITY	117.1
95% OF DRY DENSITY	123.6

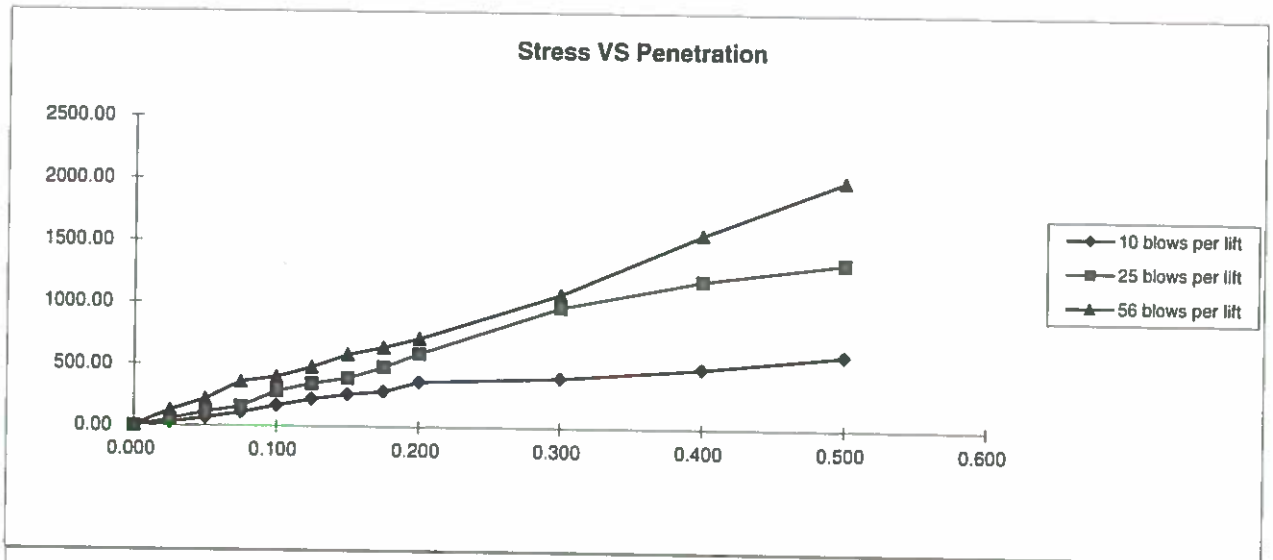
BEARING RATIO AT 90% OF MAX	8.47	~ R VALUE	22
BEARING RATIO AT 95% OF MAX	26.77	~ R VALUE	73

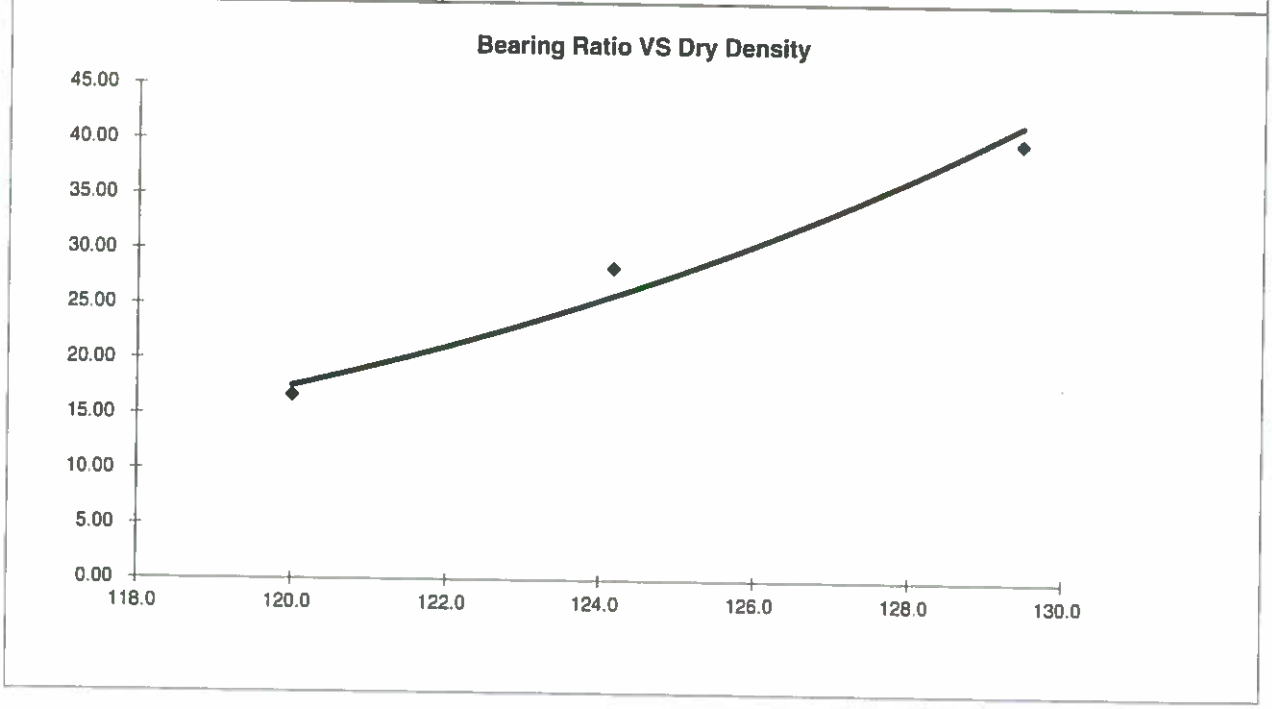
ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

CBR TEST DATA

DRAWN:	DATE:	CHECKED:	DATE:
			11/2/20

JOB NO.: 202221
FIG NO.: B-19





BEARING RATIO AT 90% OF MAX	8.47	~ R VALUE	22.00
BEARING RATIO AT 95% OF MAX	26.77	~ R VALUE	73.00

JOB NO: 202221
SOIL TYPE: 1

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

CALIFORNIA BEARING RATIO

DRAWN:	DATE:	CHECKED:	DATE: 11/2/20

JOB NO.: 202221
FIG NO.: B-20

APPENDIX C: Pavement Design Calculations

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA

THE ESTATES AT ROLLING HILLS # 1
PALMER PEAK PLACE - LOCAL LOW-VOLUME ROAD

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	36,500
Hveem Stabilometer (R Value) Results:	R =	50
Standard Deviation	S_o =	0.45
Loss in Serviceability	Δpsi =	2.0
Reliability	Reliability =	80
Reliability (z-statistic)	Z_R =	-0.84
Soil Resilient Modulus	M_R =	13168

Min 1.47

Weighted Structural Number (WSN): → WSN = 1.46

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

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

Left	Right	Difference
4.56	4.56	0.0

Job No. 202221
Fig. No. C-1

DESIGN CALCULATIONS

DESIGN DATA

THE ESTATES AT ROLLING HILLS # 1
PALMER PEAK PLACE - LOCAL LOW-VOLUME ROAD

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	36,500
Hveem Stabilometer (R Value) Results:	R =	50
Weighted Structural Number (WSN):	WSN =	1.46

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

C_1 = 0.44 Strength Coefficient - Hot Bituminous Asphalt
C_2 = 0.11 Strength Coefficient - Aggregate Base Course

D_1 = Depth of Asphalt (inches)
D_2 = Depth of Base Course (inches)

FOR FULL DEPTH ASPHALT SECTION (CURRENTLY NOT ALLOWED)

$D_1 = (WSN)/C_1$ = 3.3 inches of Full Depth Asphalt
Use 4.0 inches Full Depth

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = [3] inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 1.3 inches of Aggregate
Base Course, use 4.0 inches

RECOMMENDED ALTERNATIVES

1. 3.0 inches of Asphalt + 4.0 inches of Aggregate Base Course, or
2. 4.0 inches of Full Depth Asphalt

Job No. 202221
Fig. No. C-2

DESIGN CALCULATIONS

CEMENT TREATED SECTIONS

DESIGN DATA: THE ESTATES AT ROLLING HILLS # 1
PALMER PEAK PLACE - LOCAL LOW-VOLUME ROAD

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	36,500
Hveem Stabilometer (R Value) Results:	R =	50
Weighted Structural Number (WSN):	WSN =	1.46

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

C_1 = 0.44 Strength Coefficient - Hot Bituminous Asphalt
C_2 = 0.11 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)

$D_1 = (WSN)/C_1$ = 3.3 inches of Full Depth Asphalt
Use 4.0 inches Full Depth

FOR ASPHALT + CEMENT TREATED SUBGRADE SECTION

Asphalt Thickness (t) = 4 inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = -2.7 inches
Use 8.0 inches of Cement Treated Subgrade.

RECOMMENDED ALTERNATIVES

1. 4.0 inches of Asphalt + 8 inches of Cement Treated Subgrade.
2. 4.0 inches of Full Depth Asphalt

Job No. 202221
Fig. No. C-3

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA

THE ESTATES AT ROLLING HILLS # 1
SUNRISE RIDGE - LOCAL RESIDENTIAL ROAD

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	292,000
Hveem Stabilometer (R Value) Results:	R =	50
Standard Deviation	S_o =	0.45
Loss in Serviceability	Δpsi =	2.0
Reliability	Reliability =	80
Reliability (z-statistic)	Z_R =	-0.84
Soil Resilient Modulus	M_R =	13168

Weighted Structural Number (WSN): → WSN = 2.10 ✓

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

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

Left	Right	Difference
5.47	5.47	0.0

Job No. 202221
Fig. No. C-4

DESIGN CALCULATIONS

DESIGN DATA

THE ESTATES AT ROLLING HILLS # 1
SUNRISE RIDGE - LOCAL RESIDENTIAL ROAD

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL = 292,000
Hveem Stabilometer (R Value) Results:	R = 50
Weighted Structural Number (WSN):	WSN = 2.09

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

C_1 = 0.44 Strength Coefficient - Hot Bituminous Asphalt
C_2 = 0.11 Strength Coefficient - Aggregate Base Course

D_1 = Depth of Asphalt (inches)
D_2 = Depth of Base Course (inches)

FOR FULL DEPTH ASPHALT SECTION (CURRENTLY NOT ALLOWED)

$D_1 = (WSN)/C_1$ = 4.7 inches of Full Depth Asphalt
Use 5.0 inches Full Depth

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = [3] inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 7.0 inches of Aggregate
Base Course, use 8.0 inches

RECOMMENDED ALTERNATIVES

1. 3.0 inches of Asphalt + 8.0 inches of Aggregate Base Course, or
2. 5.0 inches of Full Depth Asphalt

Job No. 202221
Fig. No. C-5

DESIGN CALCULATIONS

CEMENT TREATED SECTIONS

DESIGN DATA: THE ESTATES AT ROLLING HILLS # 1
SUNRISE RIDGE - LOCAL RESIDENTIAL ROAD

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	292,000
Hveem Stabilometer (R Value) Results:	R =	50
Weighted Structural Number (WSN):	WSN =	2.09

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

C_1 = 0.44 Strength Coefficient - Hot Bituminous Asphalt
C_2 = 0.11 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)

$D_1 = (WSN)/C_1$ = 4.8 inches of Full Depth Asphalt
Use 5.0 inches Full Depth

FOR ASPHALT + CEMENT TREATED SUBGRADE SECTION

Asphalt Thickness (t) = 4 inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 3.0 inches
Use 8.0 inches of Cement Treated Subgrade.

RECOMMENDED ALTERNATIVES

1. 4.0 inches of Asphalt + 8 inches of Cement Treated Subgrade.
2. 5.0 inches of Full Depth Asphalt

Job No. 202221
Fig. No. C-6

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA

THE ESTATES AT ROLLING HILLS # 1
REX ROAD - RESIDENTIAL COLLECTOR ROAD

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	821,000
Hveem Stabilometer (R Value) Results:	R =	50
Standard Deviation	S_o =	0.45
Loss in Serviceability	Δpsi =	2.5
Reliability	Reliability =	85
Reliability (z-statistic)	Z_R =	-1.04
Soil Resilient Modulus	M_R =	13168

Min. 2.53

Weighted Structural Number (WSN): → WSN = 2.52

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

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

Left	Right	Difference
5.91	5.91	0.0

Job No. 202221
Fig. No. C-7

DESIGN CALCULATIONS

DESIGN DATA

THE ESTATES AT ROLLING HILLS # 1
REX ROAD - RESIDENTIAL COLLECTOR ROAD

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	821,000
Hveem Stabilometer (R Value) Results:	R =	50
Weighted Structural Number (WSN):	WSN =	2.54

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

C_1 = 0.44 Strength Coefficient - Hot Bituminous Asphalt
C_2 = 0.11 Strength Coefficient - Aggregate Base Course

D_1 = Depth of Asphalt (inches)
D_2 = Depth of Base Course (inches)

FOR FULL DEPTH ASPHALT SECTION (CURRENTLY NOT ALLOWED)

$D_1 = (WSN)/C_1$ = 5.8 inches of Full Depth Asphalt
Use 6.0 inches Full Depth

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = [4] inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 7.1 inches of Aggregate
Base Course, use 8.0 inches

RECOMMENDED ALTERNATIVES

1. 4.0 inches of Asphalt + 8.0 inches of Aggregate Base Course, or
2. 6.0 inches of Full Depth Asphalt

Job No. 202221
Fig. No. C-8

DESIGN CALCULATIONS

CEMENT TREATED SECTIONS

DESIGN DATA: THE ESTATES AT ROLLING HILLS # 1
SUNRISE RIDGE - RESIDENTIAL COLLECTOR ROAD

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	821,000
Hveem Stabilometer (R Value) Results:	R =	50
Weighted Structural Number (WSN):	WSN =	2.54

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

C_1 = 0.44 Strength Coefficient - Hot Bituminous Asphalt
C_2 = 0.11 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)

$D_1 = (WSN)/C_1$ = 5.8 inches of Full Depth Asphalt
Use 6.0 inches Full Depth

FOR ASPHALT + CEMENT TREATED SUBGRADE SECTION

Asphalt Thickness (t) = 4 inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 7.1 inches
Use 10.0 inches of Cement Treated Subgrade.

RECOMMENDED ALTERNATIVES

1. 4.0 inches of Asphalt + 10 inches of Cement Treated Subgrade.
2. 6.0 inches of Full Depth Asphalt

Job No. 202221
Fig. No. C-9

November 30, 2020

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: Raul Guzman

Re: Cement Stabilized Subgrade Results - Laboratory Testing
The Estate at Rolling Hills Ranch, Filing No. 1
El Paso County, Colorado

Ref: Pavement Recommendations Report by Entech Engineering, Inc., dated November 24, 2020, Entech Job No. 200221

Dear Mr. Guzman:

As requested, personnel of Entech Engineering, Inc. have performed strength testing on two sets of three soil/cement composite samples for the above reference project. Testing was performed on soil samples prepared with 2% and 4% Portland Cement Type 1/2, from Martin Marietta, near Pueblo, Colorado.

A minimum compression strength of 160 psi is recommended for cement stabilized subgrade. The 5-day average strength values of the 2% mix was 204 psi. The 5-day average strength values of the 4% mix was 243 psi. A 2% mix is recommended based on the laboratory test results. A summary of the testing results is attached.

Pending the results of the field density testing, microfracturing of the stabilized subgrade will likely be required. Soil strengths in excess 200 psi require microfracturing.

We trust 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.

Daniel P. Stegman

COLORADO LICENSED
MARK HOWARD HAUSCHILD
35140
12/4/2020
PROFESSIONAL ENGINEER

Reviewed by:

Mark H. Hauschild, P.E.
Senior Engineer

DPS/bs

Encl.

Entech Job No. 202221
AAprojects/2020/202221 - cssr — lab

SUMMARY OF CTS TEST RESULTS

LAB TESTING

CLIENT TECH CONSTRACTORS
PROJECT ESTATES AT ROLLING HILLS
FIELD SAMPLE ID TB-1 @ 0-3'
SOIL ADDITIVE TYPE I/II CEMENT

JOB NO 202221
DATE 11/24/20
BY BL

ADDITIVE %	*WATER %*	*DENSITY (dry)*	*AGE (days)*	*STRENGTH (psi)*
2	7.9	124.6	5	184
2	7.9	124.8	5	219
2	7.9	124.8	5	208
			AVERAGE:	**204**
4	7.9	124.6	5	232
4	7.9	124.7	5	240
4	7.9	124.6	5	257
			AVERAGE:	**243**

CURING METHOD

100° HUMIDIFIED OVEN