



ENTECH
ENGINEERING, INC.

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

February 3, 2022
Revised March 29, 2022

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

Attn: Raul Guzman

Re: Pavement Recommendations - Revised
Rolling Hills at Meridian Ranch Filing No. 2, Phase 2
El Paso County, Colorado

APPROVED
Engineering Department

03/31/2022 4:50:23 PM

dsdnijkamp

**EPC Planning & Community
Development Department**

Dear Mr. Guzman:

As requested, Entech Engineering, Inc. has obtained samples of the subgrade soils from sections of the roadways in the Rolling Hills at Meridian Ranch, Filing No. 2, Phase 2, 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 provides pavement recommendations for the roadways.

Project Description

The roadways in this project consist of sections of Morning Hills Drive, Valley Peak Drive, and Rolling Ranch Drive, and includes Overlook Bluff Drive, Foggy Meadows Drive, Foggy Bend Lane, and Morning Ridge Drive. The site layout and the locations of the test borings, drilled at approximate 500-foot intervals, are shown on the Test Boring Location Map, Figure 1.

Subgrade Conditions

Thirteen 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. Two soil types and one bedrock type were encountered in the test borings. The soils encountered at subgrade depth consisted of one general soil type; Soil Type 1. The Type 1 soils consist of silty to slightly silty to clayey sand fill. Soil Type 2 and 3 were encountered at depths below the subgrade influence zone. This report evaluates and presents recommendations for the Type 1 soils, which design values were used for all of the roadway sections.

Sieve analyses performed on Type 1 subgrade soils indicated the percent passing the No. 200 sieve ranged from approximately 9 to 34 percent. Atterberg Limit Tests performed on the samples resulted in Liquid Limits ranging from no value to 39 and Plastic Indexes of non-plastic to 22 percent. Soil Type 1 classified as A-1-b, A-2-6, and A-2-4 soils based on the AASHTO classification system. These soils 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 performed on several samples of the site subgrade soils based on their Plastic Indexes. Volume changes of 0.1 to 1.9 percent were measured on the soils at subgrade depth. Based on the low volume changes, mitigation is not required. Laboratory test results are presented in Appendix B and are summarized on Table 1.

EPC Project No. SF-2020

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 – Clayey Sand Fill

R @ 90% = 10.0
R @ 95% = 22.0
Use R = 20.0 for design

Classification Testing

Liquid Limit	30
Plasticity Index	14
Percent Passing 200	26.2
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. The cul-de-sac portions of Overlook Bluff Drive classifies as an urban local (low-volume) roadways, which used an 18k ESAL value of 36,500 for design. All of the remaining roadways in this phase classify as urban local roads, which used an 18K ESAL value of 292,000 for design. Pavement alternatives for asphalt over aggregate basecourse and cement stabilized subgrade sections are provided. Full depth asphalt sections are not allowed, per El Paso County. Design parameters used in the pavement analysis are as follows:

Reliability	
Local Low Volume & Urban Local	80%
Serviceability Index	
Local Low Volume & Urban Local	2.0
Resilient Modulus	4,940 psi
"R" Value Subgrade	20.0
Structural Coefficients:	
Hot Bituminous Pavement	0.44
Aggregate Basecourse	0.11
Cement Stabilized Subgrade	0.11

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

Urban Local (low volume) – ESAL = 36,500

Overlook Bluff Drive - Cul-de-sac

<u>Alternative</u>	<u>Asphalt (in)</u>	<u>Basecourse (in)</u>	<u>Cement Stabilized Subgrade (in.)</u>
1. Asphalt + Basecourse	3.5*	6.5	--
2. Asphalt + Cement Subgrade	4.0	--	8.0

Urban Local – ESAL = 292,000

Valley Peak Drive, Rolling Ranch Drive, Morning Ridge Drive
Morning Hills Drive, Foggy Meadows Drive, Overlook Bluff Drive
And Foggy Bend Lane

<u>Alternative</u>	<u>Asphalt (in)</u>	<u>Basecourse (in)</u>	<u>Cement Stabilized Subgrade (in.)</u>
1. Asphalt + Basecourse	5.0	8.0	--
2. Asphalt + Cement Subgrade	4.5	--	10.0

* 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. All of the site subgrade soils tested exhibited low swell potentials which did not exceed the threshold. Mitigation is not required.

Roadway Construction - 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 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 8 inches, as determined by Roadway Classification. 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 the appropriate 8 inches depth such that a uniform blend of soil and cement is achieved. Prior to application or mixing of the cement, the upper 8 inches of subgrade, as recommended 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 section recommendations 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,

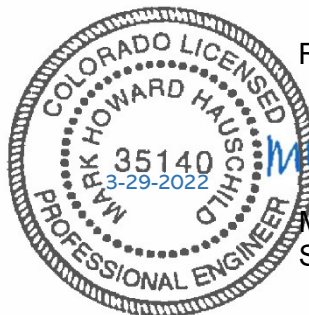
ENTECH ENGINEERING, INC.



Daniel P. Stegman

DPS/bs

Entech Job No. 213333
AAprojects/2021/213333 pr1 - Rev



Reviewed by:



Mark H. Hauschild, P.E.
Senior Engineer

TABLE

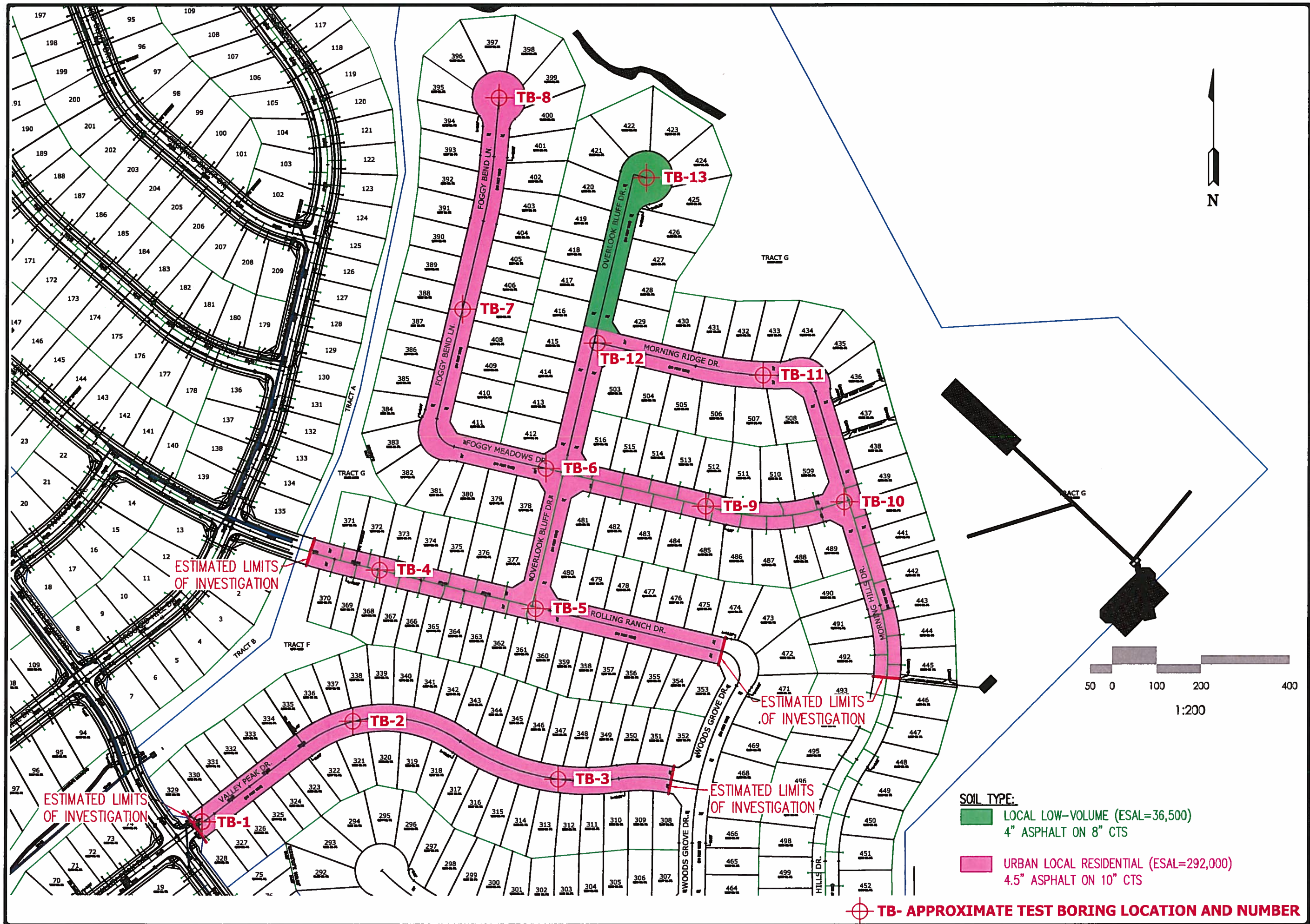
TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT TECH CONTRACTORS
 PROJECT ROLLING HILLS RANCH, F-2
 JOB NO. 213333

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	2	0-3			26.2	30	14		A-2-6		SC	FILL, SAND, CLAYEY
1	1	1-2	10.1	121.0	33.8	39	22		A-2-6	0.9	SC	SAND, CLAYEY
1	2	1-2	9.3	121.5	22.5	31	13		A-2-6	0.1	SC	FILL, SAND, CLAYEY
1	3	1-2			18.6	NV	NP		A-1-b		SM	FILL, SAND, SILTY
1	4	1-2			8.5	NV	NP	<0.01	A-1-b		SM-SW	FILL, SAND, SLIGHTLY SILTY
1	5	1-2	14.8	111.3	25.0	32	15		A-2-6	0.6	SC	FILL, SAND, CLAYEY
1	6	1-2	14.7	111.4	23.9	29	14		A-2-6	1.9	SC	FILL, SAND, CLAYEY
1	7	1-2			11.5	NV	NP	<0.01	A-1-b		SM-SW	FILL, SAND, SLIGHTLY SILTY
1	8	1-2			17.5	NV	NP		A-1-b		SM	FILL, SAND, SILTY
1	9	1-2			16.8	NV	NP		A-1-b		SM	FILL, SAND, SILTY
1	10	1-2			12.5	NV	NP		A-1-b		SM	FILL, SAND, SILTY
1	11	1-2			25.8	32	16	<0.01	A-2-6		SC	FILL, SAND, CLAYEY
1	12	1-2			18.5	NV	NP		A-1-b		SM	FILL, SAND, SILTY
1	13	1-2			20.5	NV	NP		A-2-4		SM	FILL, SAND, SILTY
2	6	10	17.1	112.3	61.7	45	23	<0.01	A-7-6	6.6	CL	CLAY, VERY SANDY
3	2	10			26.0	NV	NP	<0.01	A-2-4		SM	SANDSTONE, SILTY
3	4	5			10.5	NV	NP		A-1-b		SM-SW	SANDSTONE, SLIGHTLY SILTY
3	7	10			24.4	NV	NP		A-2-4		SM	SANDSTONE, SILTY
3	11	10	11.0	116.3	30.8	40	21	<0.01	A-2-6	0.4	SC	SANDSTONE, CLAYEY

FIGURES



REVISION	BY

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

TEST BORING LOCATION MAP
ROLLING HILLS RANCH, F#2, PH#2
EL PASO, COUNTY
FOR: TECH CONTRACTORS

DRAWN JAC
CHECKED DS
DATE 2/15/22
SCALE 1:200
BY JAC
FILE NO. 213333
1

APPENDIX A: Test Boring Logs

TEST BORING NO. 1
 DATE DRILLED 1/7/2022
 Job # 213333

TEST BORING NO. 2
 DATE DRILLED 12/27/2021
 CLIENT TECH CONTRACTORS
 LOCATION ROLLING HILLS RANCH, F-2

REMARKS

DRY TO 5', 1/7/22
 FILL 0-5', SAND, CLAYEY, FINE
 TO MEDIUM GRAINED, DARK
 BROWN TO BROWN, DENSE TO
 MEDIUM DENSE, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			35	9.4	1
5			12	7.9	1
10					
15					
20					

REMARKS

DRY TO 10', 12/27/21
 FILL 0-9', SAND, CLAYEY, FINE
 TO MEDIUM GRAINED, DARK
 BROWN, MEDIUM DENSE, MOIST

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

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			24	8.2	1
5			12	8.3	1
10			50 6"	11.3	3
15					
20					



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:

DATE:

CHECKED:

DATE:

DS

1/16/22

JOB NO.:
 213333

FIG NO.:
 A- 1

TEST BORING NO. 3
 DATE DRILLED 12/27/2021
 Job # 213333

TEST BORING NO. 4
 DATE DRILLED 12/27/2021
 CLIENT TECH CONTRACTORS
 LOCATION ROLLING HILLS RANCH, F-2

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', 12/27/21							DRY TO 5', 12/27/21						
FILL 0-5', SAND, SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST				17	8.8	1	FILL 0-5', SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST				20	8.1	1
	5			13	6.2	1	SANDSTONE, SILTY, FINE TO COARSE GRAINED, TAN, VERY DENSE, MOIST	5			50 8"	7.2	3
	10							10					
	15							15					
	20							20					



**ENTECH
ENGINEERING, INC.**

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:

DATE:

CHECKED: *SW*

DATE: *1-10-22*

JOB NO.:
213333

FIG NO.:
A- 2

TEST BORING NO. 5
 DATE DRILLED 12/27/2021
 Job # 213333

TEST BORING NO. 6
 DATE DRILLED 12/27/2021
 CLIENT TECH CONTRACTORS
 LOCATION ROLLING HILLS RANCH, F-2

REMARKS

DRY TO 5', 12/27/21

FILL 0-5', SAND, CLAYEY, FINE
 TO MEDIUM GRAINED, TAN,
 MEDIUM DENSE, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			11	8.1	1
5			10	6.4	1
10					
15					
20					

REMARKS

DRY TO 10', 12/27/21

FILL 0-9', SAND, CLAYEY, FINE
 TO MEDIUM GRAINED, BROWN,
 MEDIUM DENSE, MOIST

CLAY, VERY SANDY, BROWN,
 STIFF, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			15	11.3	1
5			20	10.1	1
10			29	15.3	2
15					
20					



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:

DATE:

CHECKED: SW

DATE: 1-10-22

JOB NO.
 213333

FIG NO.
 A- 3

TEST BORING NO. 7
 DATE DRILLED 12/27/2021
 Job # 213333

TEST BORING NO. 8
 DATE DRILLED 12/27/2021
 CLIENT TECH CONTRACTORS
 LOCATION ROLLING HILLS RANCH, F-2

REMARKS

DRY TO 10', 12/27/21

FILL 0-7', SAND, SLIGHTLY SILTY,
 FINE TO COARSE GRAINED, TAN,
 LOOSE TO DENSE, MOIST

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

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			7	5.3	1
5			36	9.0	1
10			50 8"	16.1	3
15					
20					

REMARKS

DRY TO 5', 12/27/21

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
			7	4.1	1
5			16	8.6	1
10					
15					
20					



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:

DATE:

CHECKED

DATE:

SW

1-10-22

JOB NO.:
 213333

FIG NO.:
 A- 4

TEST BORING NO. 9
DATE DRILLED 12/27/2021
Job # 213333

TEST BORING NO. 10
DATE DRILLED 12/27/2021
CLIENT TECH CONTRACTORS
LOCATION ROLLING HILLS RANCH, F-2

REMARKS

DRY TO 5', 12/27/21

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

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			16	8.2	1
5			18	9.8	1
10					
15					
20					

REMARKS

DRY TO 5', 12/27/21

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

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			24	6.7	1
5			18	7.5	1
10					
15					
20					



**ENTECH
ENGINEERING, INC.**

505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:

DATE:

CHECKED: SW

DATE: 1-10-22

JOB NO.:
213333

FIG NO.:
A- 5

TEST BORING NO. 11
 DATE DRILLED 12/27/2021
 Job # 213333

TEST BORING NO. 12
 DATE DRILLED 12/27/2021
 CLIENT TECH CONTRACTORS
 LOCATION ROLLING HILLS RANCH, F-2

REMARKS

DRY TO 10', 12/27/21

FILL 0-9', SAND, CLAYEY, FINE TO MEDIUM GRAINED, TAN, MEDIUM DENSE TO LOOSE, MOIST

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

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			17	8.7	1
5			7	10.2	1
10			50 11"	12.7	3
15					
20					

REMARKS

DRY TO 5', 12/27/21

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
5			9	5.9	1
5			11	17.9	1
10					
15					
20					



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:

DATE:

CHECKED: SW

DATE: 1-10-22

JOB NO.:
 213333

FIG NO.:
 A- 6

TEST BORING NO. 13
DATE DRILLED 12/27/2021
Job # 213333

TEST BORING NO.
DATE DRILLED
CLIENT
LOCATION TECH CONTRACTORS
ROLLING HILLS RANCH, F-2

REMARKS

DRY TO 5', 12/27/21

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

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			7	6.2	1
15			15	1.3	1
10					
15					
20					

REMARKS

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5					
10					
15					
20					



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:

DATE:

CHECKED:

DATE:

SW

1-10-22

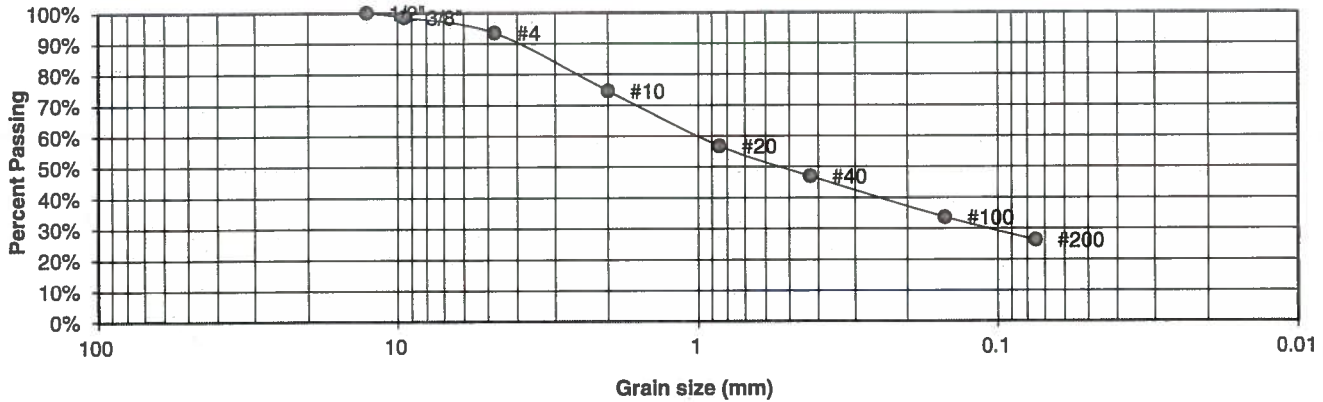
JOB NO.:
213333

FIG NO.:
A-7

APPENDIX B: Laboratory Testing Results

<u>UNIFIED CLASSIFICATION</u>	SC	<u>CLIENT</u>	TECH CONTRACTORS
<u>SOIL TYPE #</u>	1, CBR	<u>PROJECT</u>	ROLLING HILLS RANCH, F-2
<u>TEST BORING #</u>	2	<u>JOB NO.</u>	213333
<u>DEPTH (FT)</u>	0-3	<u>TEST BY</u>	BL
<u>AASHTO CLASSIFICATION</u>	A-2-6	<u>GROUP INDEX</u>	0

**Sieve Analysis
Grain Size Distribution**



<u>U.S. Sieve #</u>	<u>Percent Finer</u>
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	98.5%
4	93.5%
10	74.6%
20	56.8%
40	47.0%
100	33.6%
200	26.2%

<u>Atterberg Limits</u>	
Plastic Limit	16
Liquid Limit	30
Plastic Index	14

<u>Swell</u>	
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: *SW*

DATE:

1-11-22

JOB NO.:

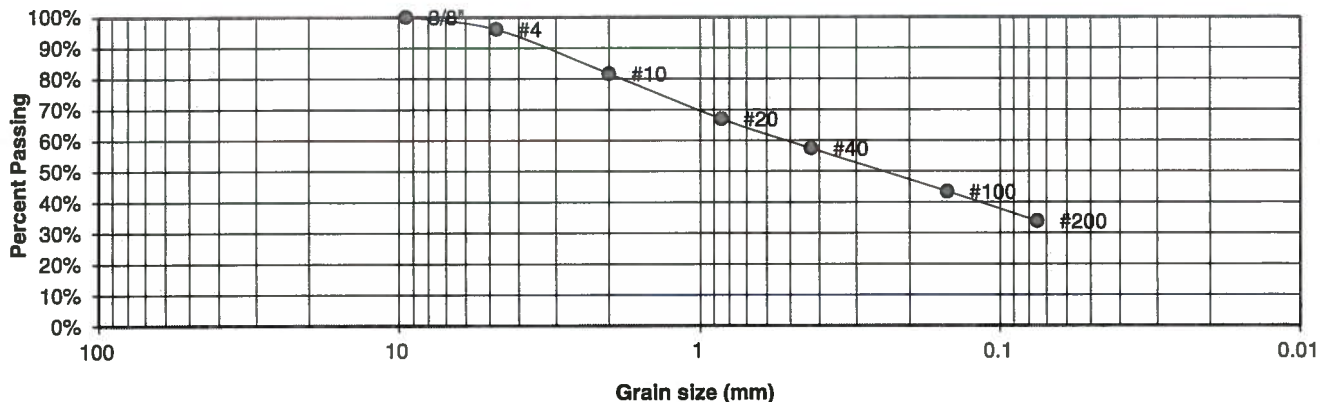
213333

FIG NO.:

B-1

<u>UNIFIED CLASSIFICATION</u>	SC	<u>CLIENT</u>	TECH CONTRACTORS
<u>SOIL TYPE #</u>	1	<u>PROJECT</u>	ROLLING HILLS RANCH, F-2
<u>TEST BORING #</u>	1	<u>JOB NO.</u>	213333
<u>DEPTH (FT)</u>	1-2	<u>TEST BY</u>	BL
<u>AASHTO CLASSIFICATION</u>	A-2-6	<u>GROUP INDEX</u>	2

**Sieve Analysis
Grain Size Distribution**



<u>U.S. Sieve #</u>	<u>Percent Finer</u>
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	96.1%
10	81.7%
20	67.0%
40	57.4%
100	43.4%
200	33.8%

<u>Atterberg Limits</u>	
Plastic Limit	17
Liquid Limit	39
Plastic Index	22

<u>Swell</u>	
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: <i>SW</i>	DATE: <i>1-12-22</i>
--------	-------	--------------------	----------------------

JOB NO.:

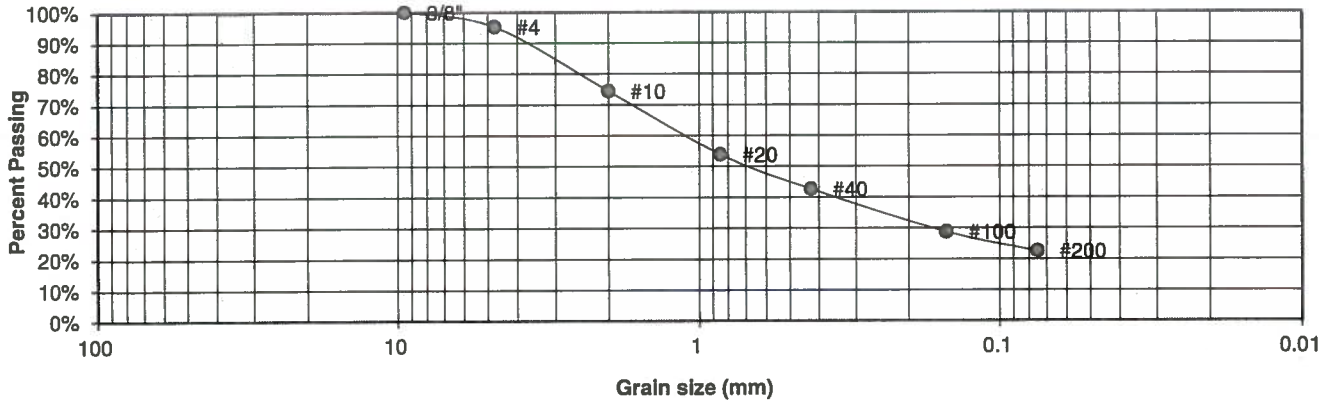
213333
FIG NO.:

B-2

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

CLIENT TECH CONTRACTORS
PROJECT ROLLING HILLS RANCH, F-2
JOB NO. 213333
TEST BY BL
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	95.3%
10	74.4%
20	53.9%
40	42.7%
100	28.7%
200	22.5%

**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: SW

DATE:

1-11-22

JOB NO.:

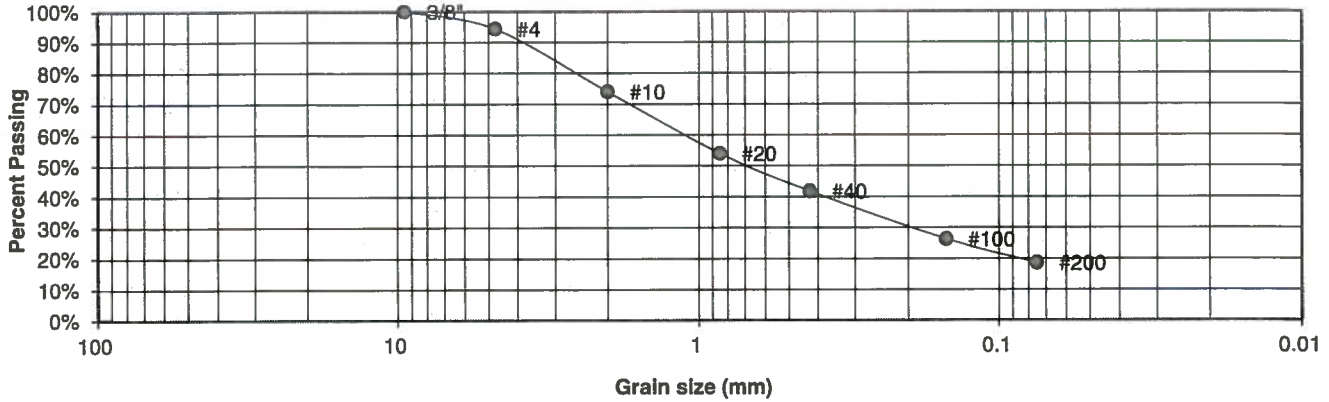
213333
 FIG NO.:

B-3

UNIFIED CLASSIFICATION SM
 SOIL TYPE # 1
 TEST BORING # 3
 DEPTH (FT) 1-2
 AASHTO CLASSIFICATION A-1-b

CLIENT TECH CONTRACTORS
 PROJECT ROLLING HILLS RANCH, F-2
 JOB NO. 213333
 TEST BY BL
 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	94.3%
10	74.0%
20	53.9%
40	41.8%
100	26.3%
200	18.6%

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: SW

DATE: 1-11-22

JOB NO.:

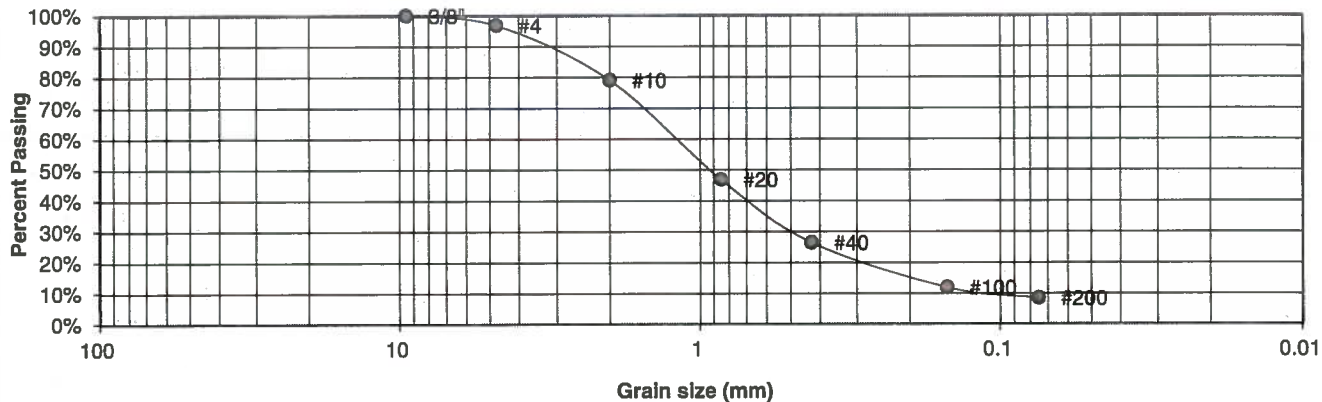
213333
 FIG NO.:

B-4

UNIFIED CLASSIFICATION	SM-SW
SOIL TYPE #	1
TEST BORING #	4
DEPTH (FT)	1-2
AASHTO CLASSIFICATION	A-1-b

CLIENT	TECH CONTRACTORS
PROJECT	ROLLING HILLS RANCH, F-2
JOB NO.	213333
TEST BY	BL
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	96.9%
10	79.1%
20	46.9%
40	26.4%
100	11.9%
200	8.5%

**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:

SW

DATE:

1-11-22

JOB NO.:

213333

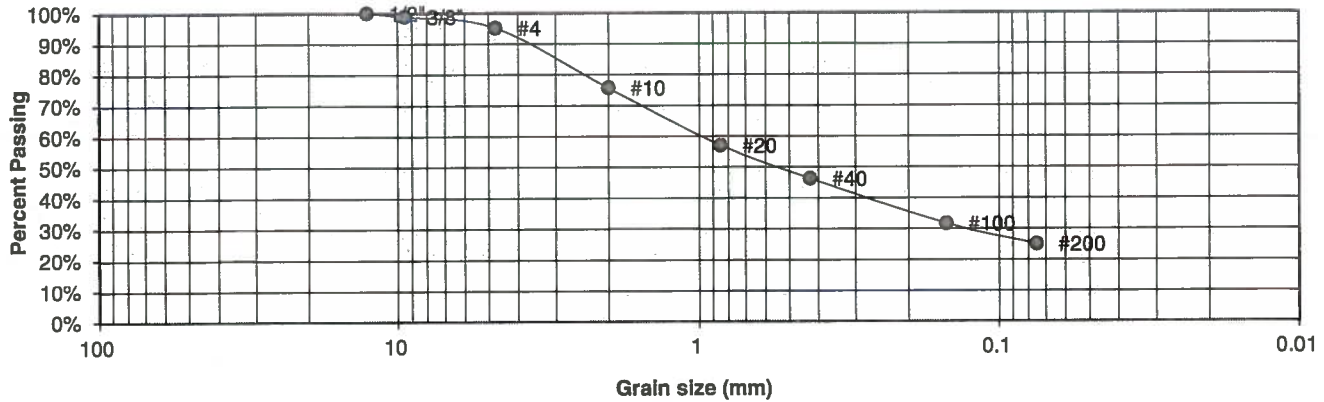
FIG NO.:

B-5

UNIFIED CLASSIFICATION SC
SOIL TYPE # 1
TEST BORING # 5
DEPTH (FT) 1-2
AASHTO CLASSIFICATION A-2-6

CLIENT TECH CONTRACTORS
PROJECT ROLLING HILLS RANCH, F-2
JOB NO. 213333
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"	98.9%
4	95.2%
10	75.7%
20	57.1%
40	46.3%
100	31.6%
200	25.0%

Atterberg
Limits
 Plastic Limit 17
 Liquid Limit 32
 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:

SW

DATE:

1-11-22

JOB NO.:

213333

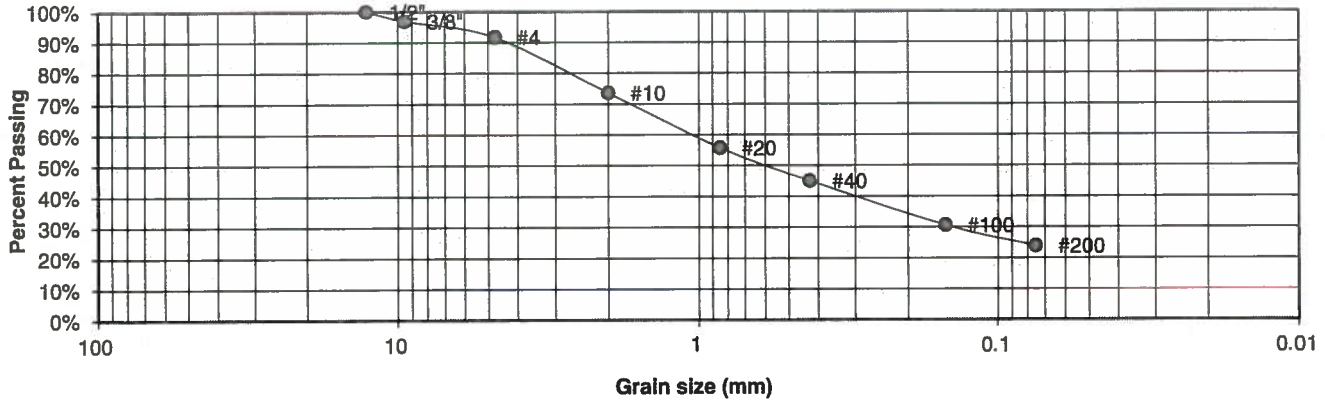
FIG NO.:

B-6

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

CLIENT TECH CONTRACTORS
PROJECT ROLLING HILLS RANCH, F-2
JOB NO. 213333
TEST BY BL
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"	96.9%
4	91.7%
10	73.6%
20	55.7%
40	45.0%
100	30.6%
200	23.9%

Atterberg
Limits
 Plastic Limit 16
 Liquid Limit 29
 Plastic Index 14

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: SW

DATE:

1-11-22

JOB NO.:

213333

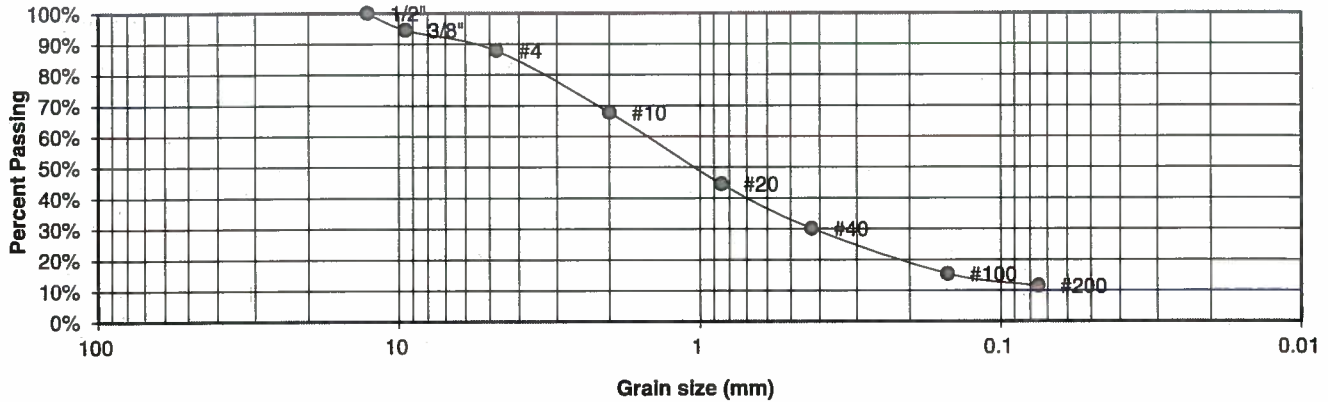
FIG NO.:

B 7

UNIFIED CLASSIFICATION SM-SW
 SOIL TYPE # 1
 TEST BORING # 7
 DEPTH (FT) 1-2
 AASHTO CLASSIFICATION A-1-b

CLIENT TECH CONTRACTORS
 PROJECT ROLLING HILLS RANCH, F-2
 JOB NO. 213333
 TEST BY BL
 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"	94.5%
4	87.8%
10	67.8%
20	44.6%
40	30.1%
100	15.4%
200	11.5%

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: SW

DATE:

1-11-22

JOB NO.:

213333

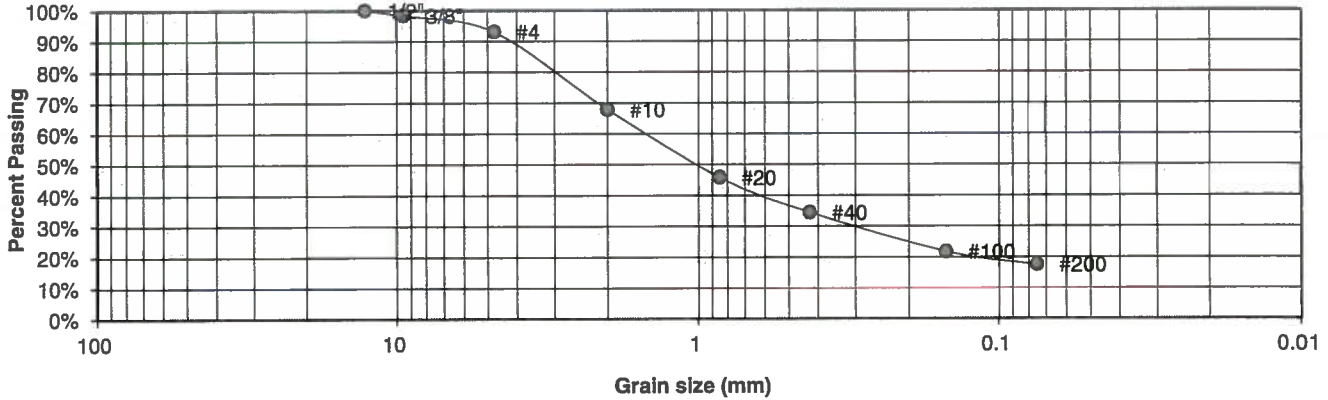
FIG NO.:

B-8

UNIFIED CLASSIFICATION SM
SOIL TYPE # 1
TEST BORING # 8
DEPTH (FT) 1-2
AASHTO CLASSIFICATION A-1-b

CLIENT TECH CONTRACTORS
PROJECT ROLLING HILLS RANCH, F-2
JOB NO. 213333
TEST BY BL
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"	98.3%
4	93.0%
10	67.9%
20	45.8%
40	34.5%
100	21.7%
200	17.5%

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: SW

DATE:

1-11-22

JOB NO.:

213333

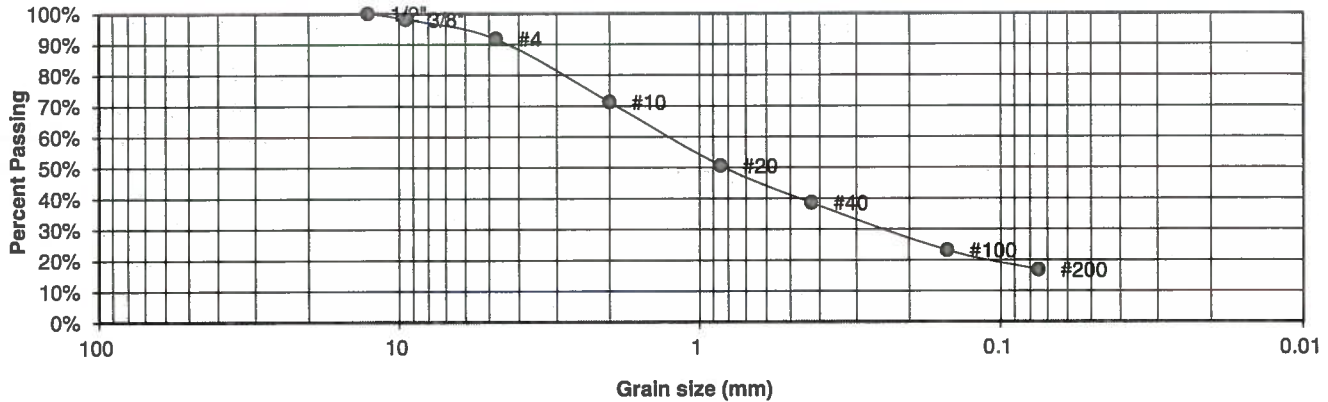
FIG NO.:

B.9

UNIFIED CLASSIFICATION SM
SOIL TYPE # 1
TEST BORING # 9
DEPTH (FT) 1-2
AASHTO CLASSIFICATION A-1-b

CLIENT TECH CONTRACTORS
PROJECT ROLLING HILLS RANCH, F-2
JOB NO. 213333
TEST BY BL
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"	98.1%
4	91.8%
10	71.3%
20	50.7%
40	38.6%
100	23.1%
200	16.8%

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: SW

DATE:

1-11-22

JOB NO.:

213333

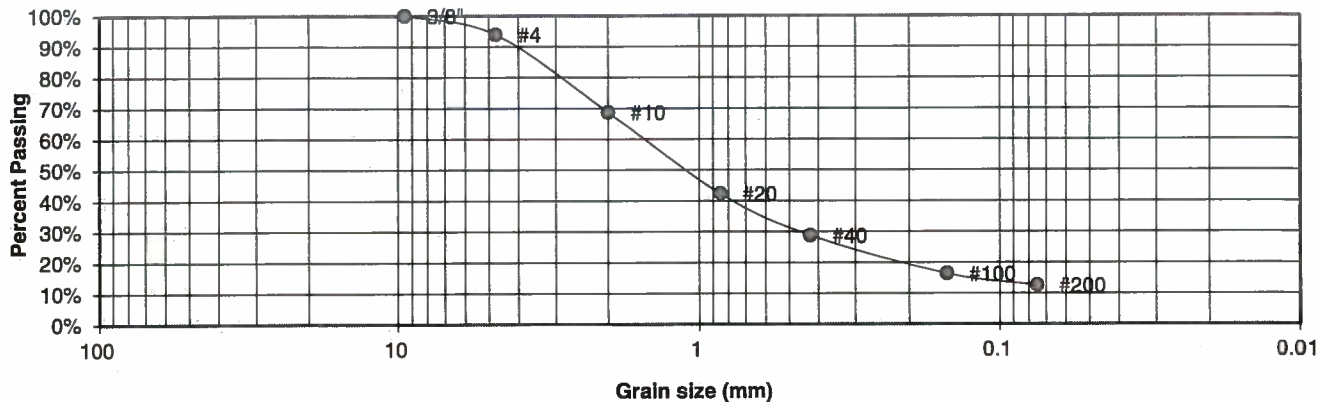
FIG NO.:

B10

UNIFIED CLASSIFICATION	SM
SOIL TYPE #	1
TEST BORING #	10
DEPTH (FT)	1-2
AASHTO CLASSIFICATION	A-1-b

CLIENT	TECH CONTRACTORS
PROJECT	ROLLING HILLS RANCH, F-2
JOB NO.	213333
TEST BY	BL
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	93.9%
10	68.7%
20	42.3%
40	28.7%
100	16.3%
200	12.5%

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:

SW

DATE:

1-11-22

JOB NO.:

213333

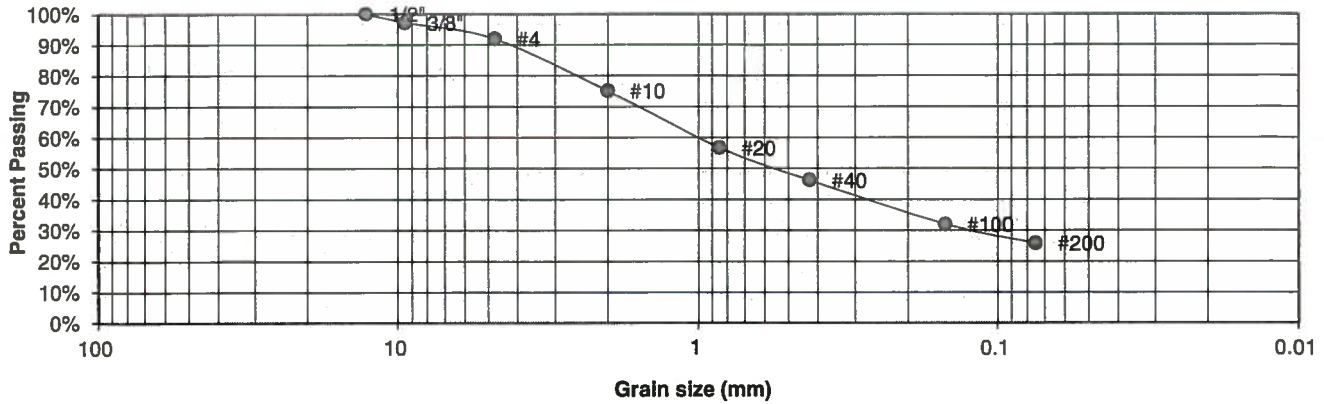
FIG NO.:

B-11

UNIFIED CLASSIFICATION SC
SOIL TYPE # 1
TEST BORING # 11
DEPTH (FT) 1-2
AASHTO CLASSIFICATION A-2-6

CLIENT TECH CONTRACTORS
PROJECT ROLLING HILLS RANCH, F-2
JOB NO. 213333
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"	97.1%
4	91.9%
10	75.1%
20	56.7%
40	46.2%
100	31.9%
200	25.8%

Atterberg
Limits
 Plastic Limit 16
 Liquid Limit 32
 Plastic Index 16

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: SW

DATE:

1-11-22

JOB NO.:

213333

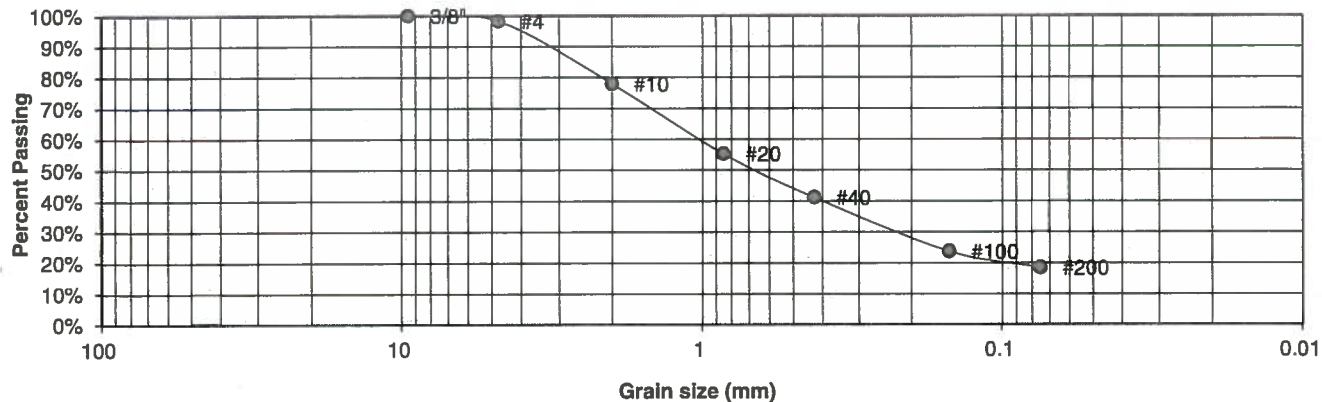
FIG NO.:

B-12

UNIFIED CLASSIFICATION SM
SOIL TYPE # 1
TEST BORING # 12
DEPTH (FT) 1-2
AASHTO CLASSIFICATION A-1-b

CLIENT TECH CONTRACTORS
PROJECT ROLLING HILLS RANCH, F-2
JOB NO. 213333
TEST BY BL
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	98.2%
10	77.9%
20	55.3%
40	41.2%
100	23.7%
200	18.5%

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:

SW

DATE:

1-11-22

JOB NO.:

213333

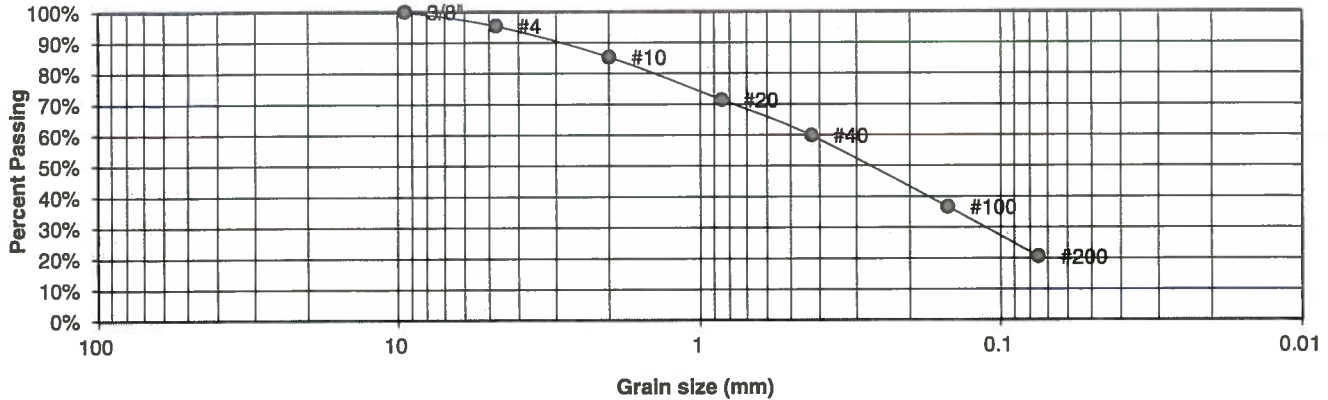
FIG NO.:

B-13

UNIFIED CLASSIFICATION SM
 SOIL TYPE # 1
 TEST BORING # 13
 DEPTH (FT) 1-2
 AASHTO CLASSIFICATION A-2-4

CLIENT TECH CONTRACTORS
 PROJECT ROLLING HILLS RANCH, F-2
 JOB NO. 213333
 TEST BY BL
 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	95.4%
10	85.3%
20	71.4%
40	59.8%
100	36.6%
200	20.5%

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: SW

DATE:

1-11-22

JOB NO.:

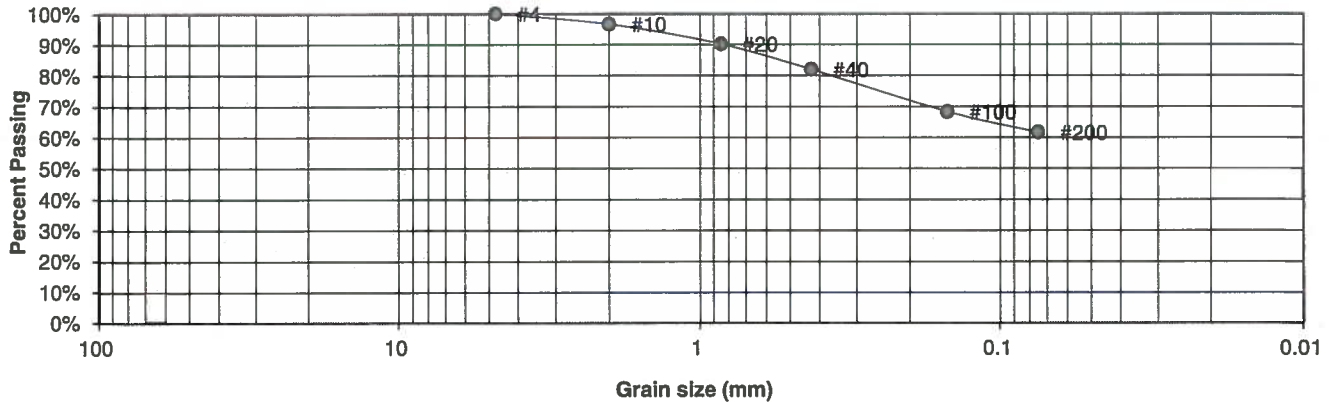
213333
 FIG NO

B-14

UNIFIED CLASSIFICATION CL
 SOIL TYPE # 2
 TEST BORING # 6
 DEPTH (FT) 10
 AASHTO CLASSIFICATION A-7-6

CLIENT TECH CONTRACTORS
 PROJECT ROLLING HILLS RANCH, F-2
 JOB NO. 213333
 TEST BY BL
 GROUP INDEX 12

Sieve Analysis Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	96.6%
20	90.2%
40	82.0%
100	68.3%
200	61.7%

Atterberg
Limits
 Plastic Limit 22
 Liquid Limit 45
 Plastic Index 23

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: SW

DATE: 1-11-22

JOB NO.:

213333

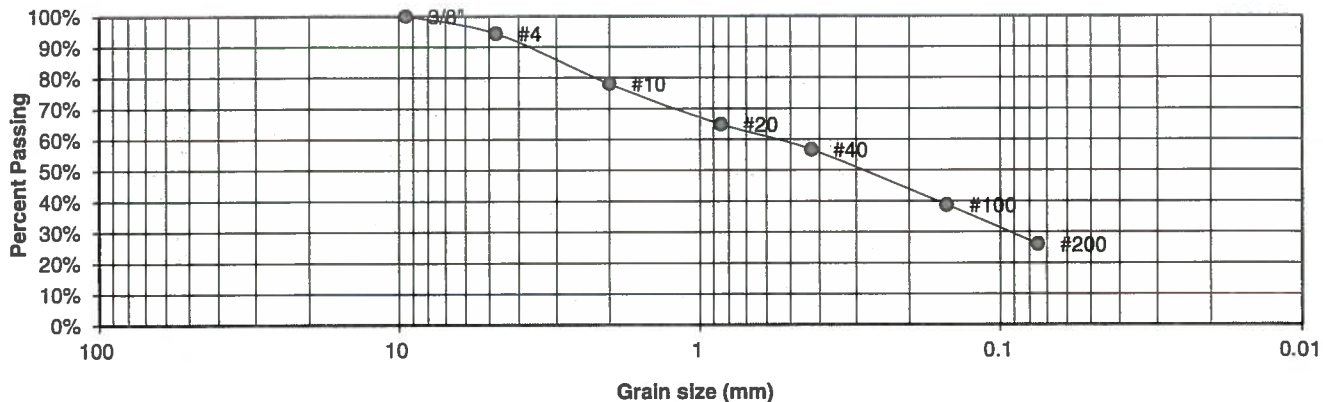
FIG NO.:

B-15

UNIFIED CLASSIFICATION SM
SOIL TYPE # 3
TEST BORING # 2
DEPTH (FT) 10
AASHTO CLASSIFICATION A-2-4

CLIENT TECH CONTRACTORS
PROJECT ROLLING HILLS RANCH, F-2
JOB NO. 213333
TEST BY BL
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	94.3%
10	78.0%
20	64.9%
40	56.7%
100	38.7%
200	26.0%

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: SW

DATE:

1-11-22

JOB NO.:

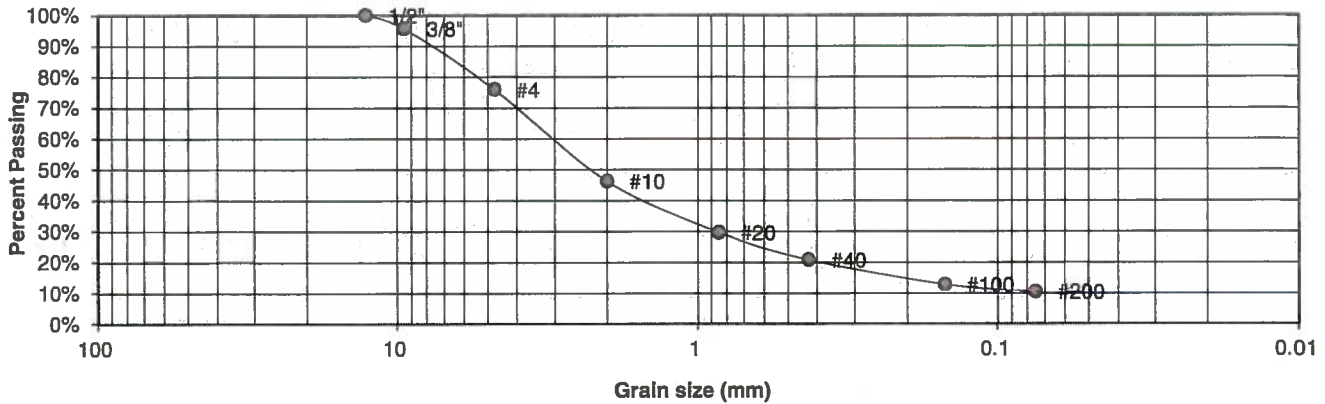
213333
 FIG NO.:

B16

UNIFIED CLASSIFICATION SM-SW
 SOIL TYPE # 3
 TEST BORING # 4
 DEPTH (FT) 5
 AASHTO CLASSIFICATION A-1-b

CLIENT TECH CONTRACTORS
 PROJECT ROLLING HILLS RANCH, F-2
 JOB NO. 213333
 TEST BY BL
 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"	95.7%
4	76.0%
10	46.3%
20	29.7%
40	20.8%
100	12.8%
200	10.5%

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: SW

DATE:

1-11-22

JOB NO.:

213333

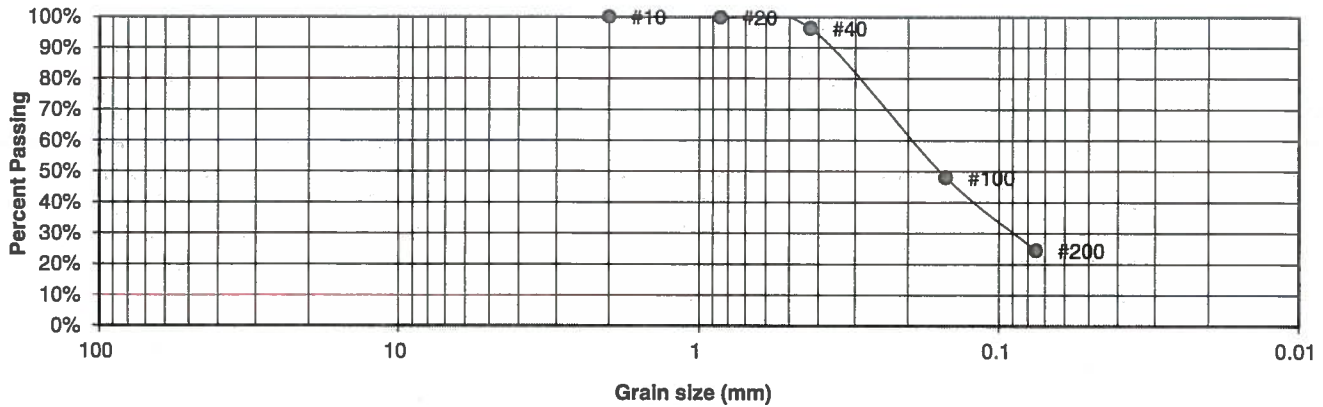
FIG NO.:

B-17

UNIFIED CLASSIFICATION SM
SOIL TYPE # 3
TEST BORING # 7
DEPTH (FT) 10
AASHTO CLASSIFICATION A-2-4

CLIENT TECH CONTRACTORS
PROJECT ROLLING HILLS RANCH, F-2
JOB NO. 213333
TEST BY BL
GROUP INDEX 0

**Sieve Analysis
Grain Size Distribution**



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	100.0%
20	99.8%
40	96.2%
100	48.1%
200	24.4%

**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: *SW*

DATE:

1-11-22

JOB NO.:

213333

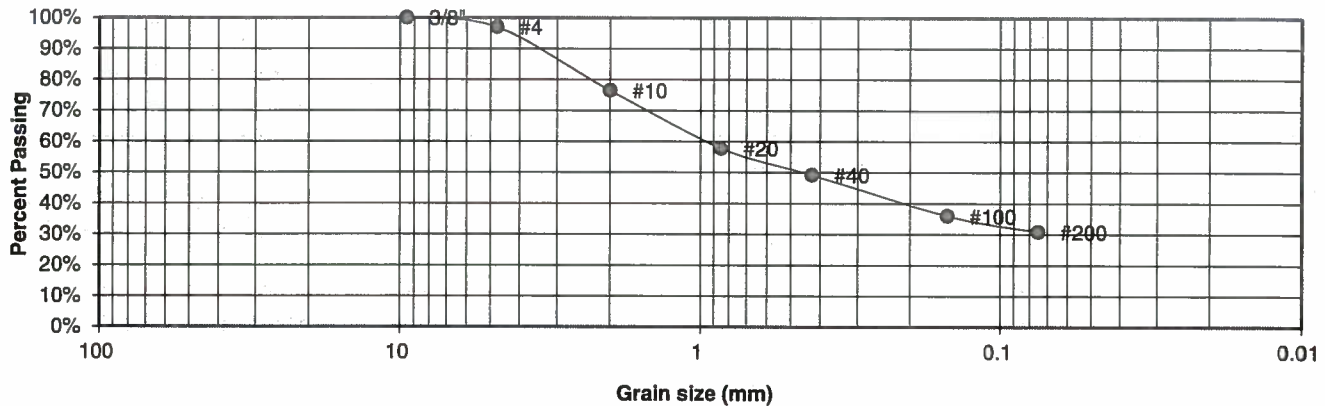
FIG NO.:

B-18

UNIFIED CLASSIFICATION	SC
SOIL TYPE #	3
TEST BORING #	11
DEPTH (FT)	10
AASHTO CLASSIFICATION	A-2-6

CLIENT	TECH CONTRACTORS
PROJECT	ROLLING HILLS RANCH, F-2
JOB NO.	213333
TEST BY	BL
GROUP INDEX	2

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	76.4%
20	57.8%
40	49.2%
100	35.9%
200	30.8%

Atterberg Limits	
Plastic Limit	19
Liquid Limit	40
Plastic Index	21

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: <i>SW</i>	DATE: <i>1-11-22</i>
--------	-------	--------------------	----------------------

JOB NO.:

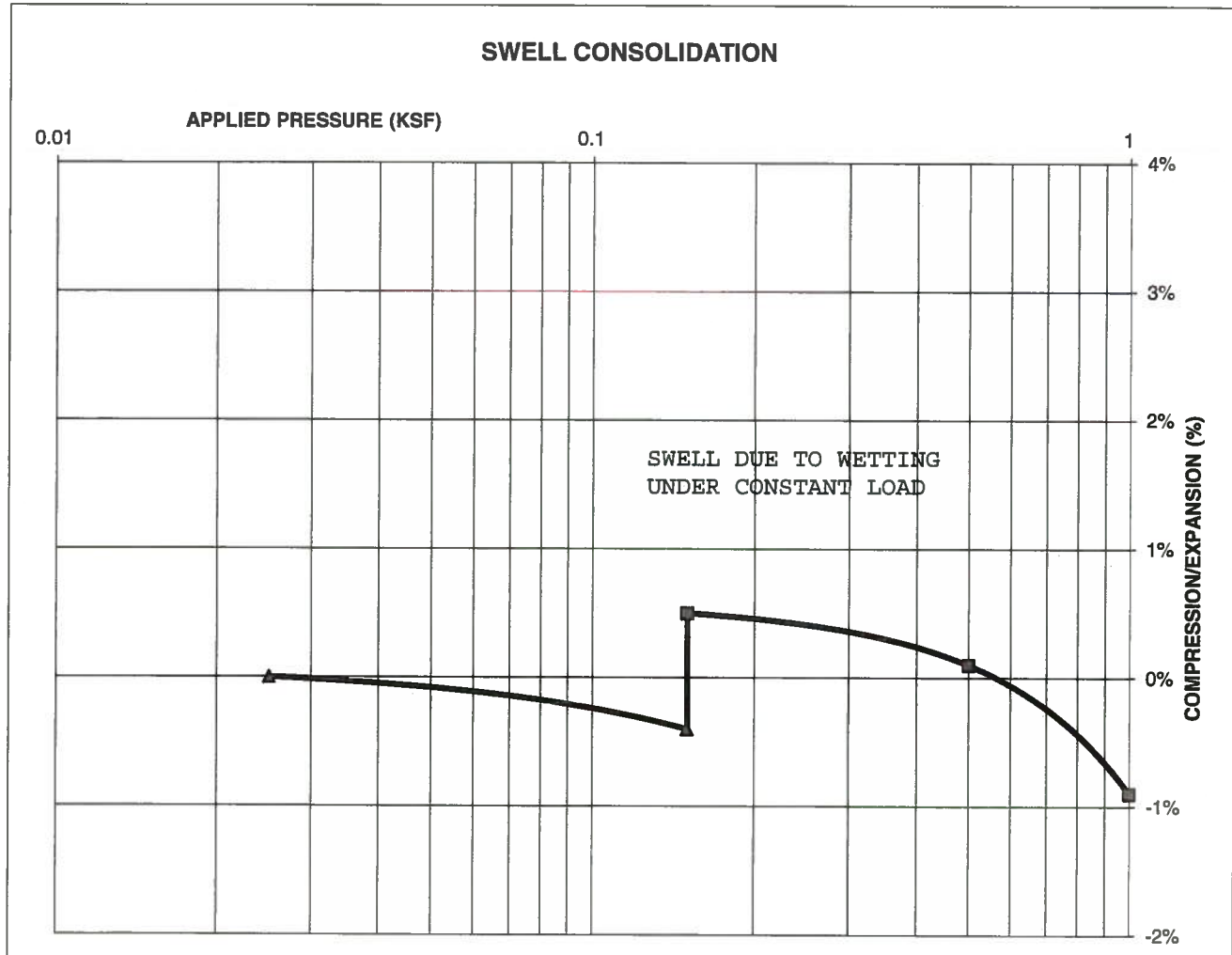
213333
FIG NO.:

B 19

CONSOLIDATION TEST RESULTS

TEST BORING #	1	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)	121		
NATURAL MOISTURE CONTENT	10.1%		
SWELL/CONSOLIDATION (%)	0.9%		

JOB NO. 213333
 CLIENT TECH CONTRACTORS
 PROJECT ROLLING HILLS RANCH, F-2



ENTECH
 ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

SWELL CONSOLIDATION TEST RESULTS

DRAWN:

DATE:

CHECKED:

DATE:

SW 1-11-22

JOB NO.:

213333

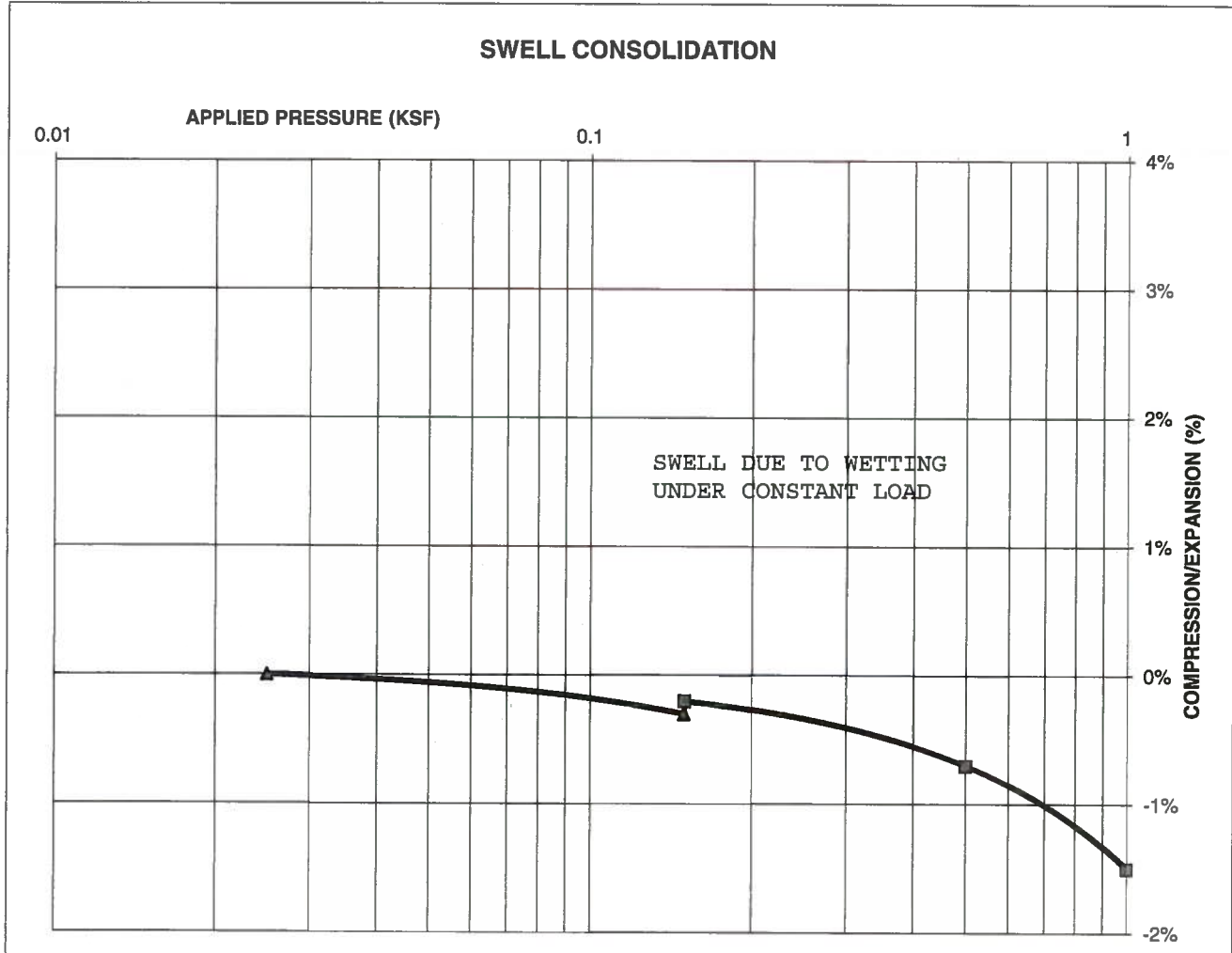
FIG NO.:

B-20

CONSOLIDATION TEST RESULTS

TEST BORING #	2	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)	122		
NATURAL MOISTURE CONTENT	9.3%		
SWELL/CONSOLIDATION (%)	0.1%		

JOB NO. 213333
CLIENT TECH CONTRACTORS
PROJECT ROLLING HILLS RANCH, F-2



**ENTECH
ENGINEERING, INC.**

505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

SWELL CONSOLIDATION TEST RESULTS

DRAWN:

DATE:

CHECKED:

DATE:

SW

1-11-22

JOB NO.:

213333

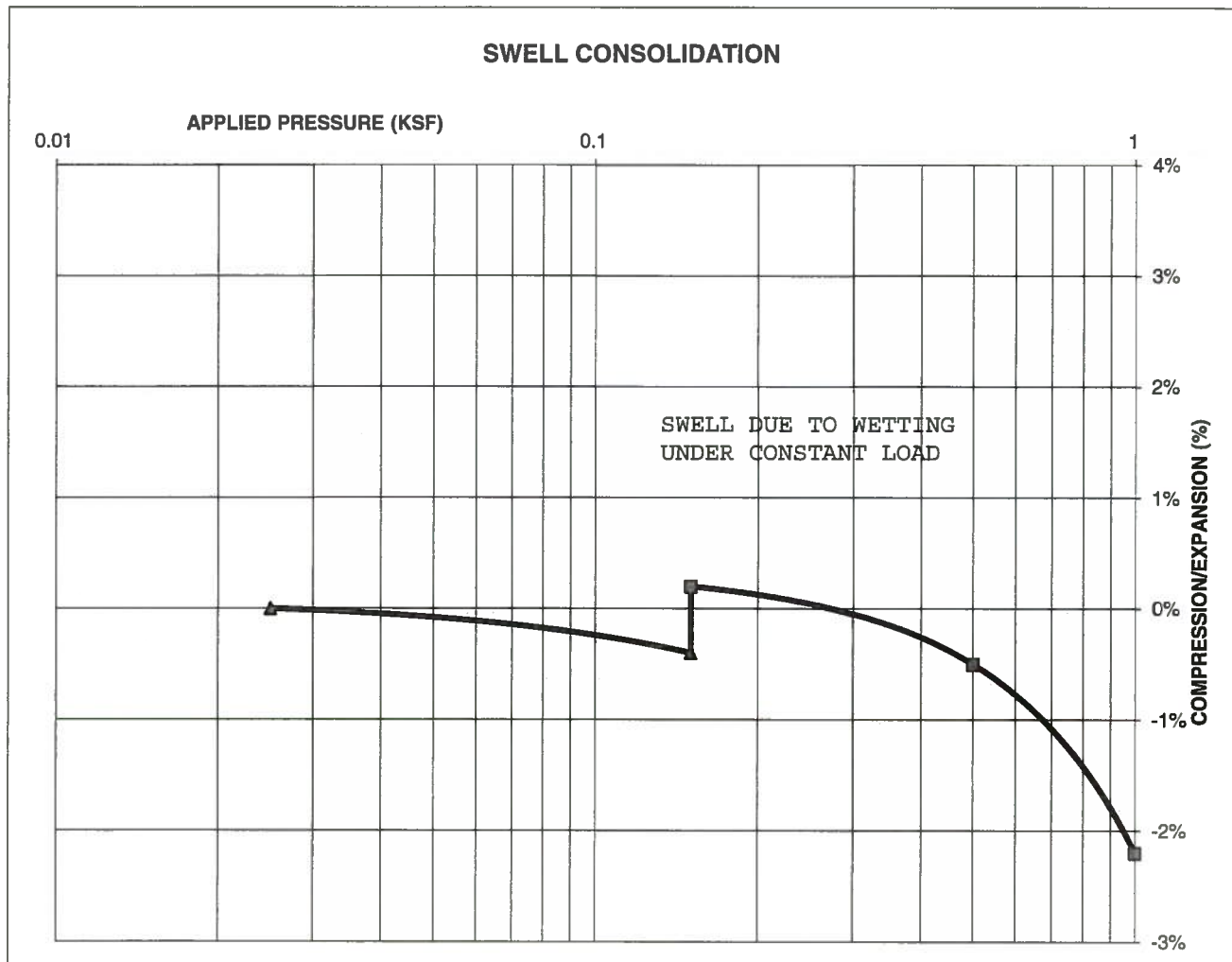
FIG NO.:

B-21

CONSOLIDATION TEST RESULTS

TEST BORING #	5	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)	111		
NATURAL MOISTURE CONTENT	14.8%		
SWELL/CONSOLIDATION (%)	0.6%		

JOB NO. 213333
 CLIENT TECH CONTRACTORS
 PROJECT ROLLING HILLS RANCH, F-2



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

SWELL CONSOLIDATION TEST RESULTS

DRAWN:

DATE:

CHECKED:

SW

DATE:

1-11-22

JOB NO.:

213333

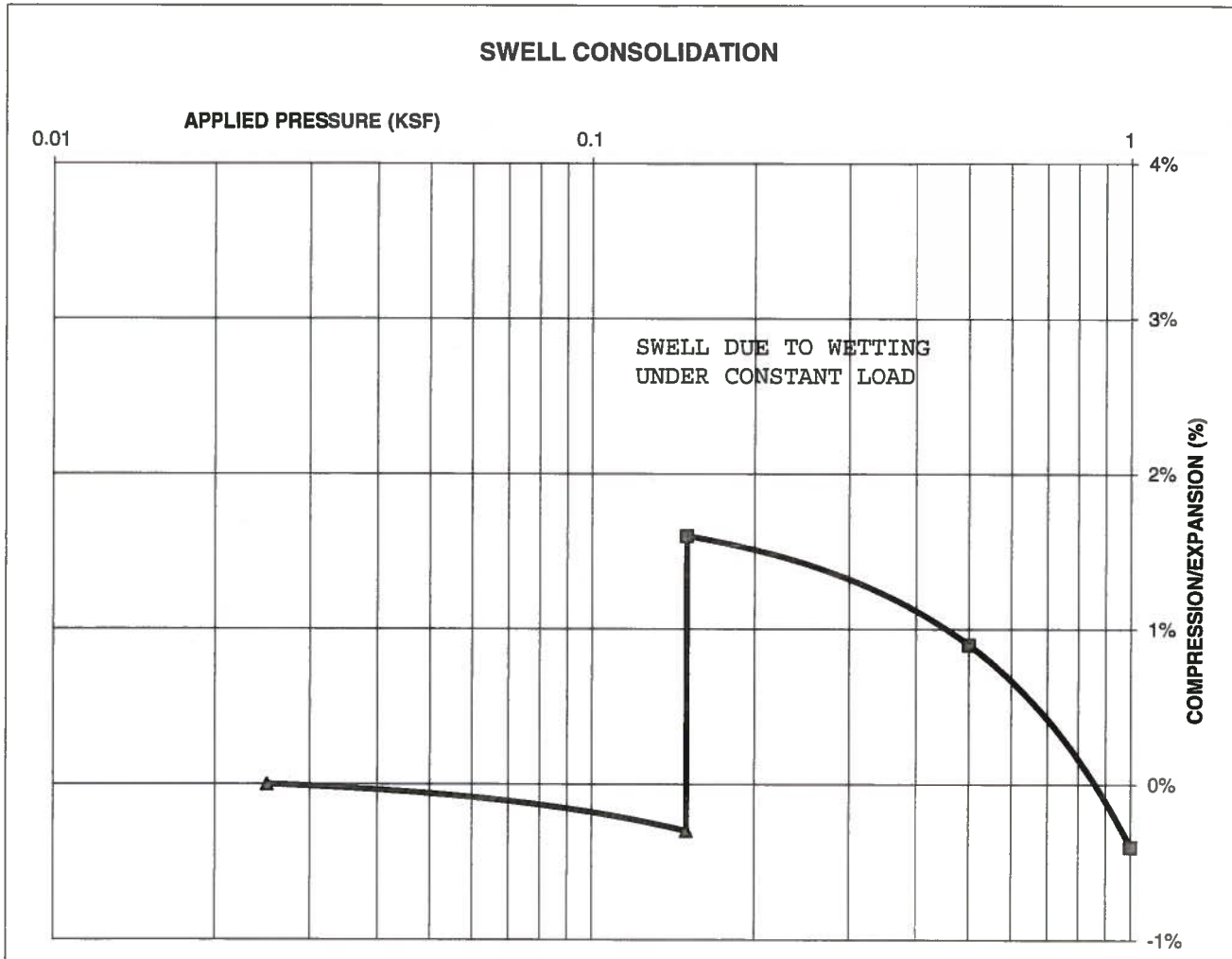
FIG NO.:

B-22

CONSOLIDATION TEST RESULTS

TEST BORING #	6	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)	111		
NATURAL MOISTURE CONTENT	14.7%		
SWELL/CONSOLIDATION (%)	1.9%		

JOB NO.	213333
CLIENT	TECH CONTRACTORS
PROJECT	ROLLING HILLS RANCH, F-2



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

SWELL CONSOLIDATION TEST RESULTS

DRAWN:

DATE:

CHECKED: *SW*

DATE: *1-11-22*

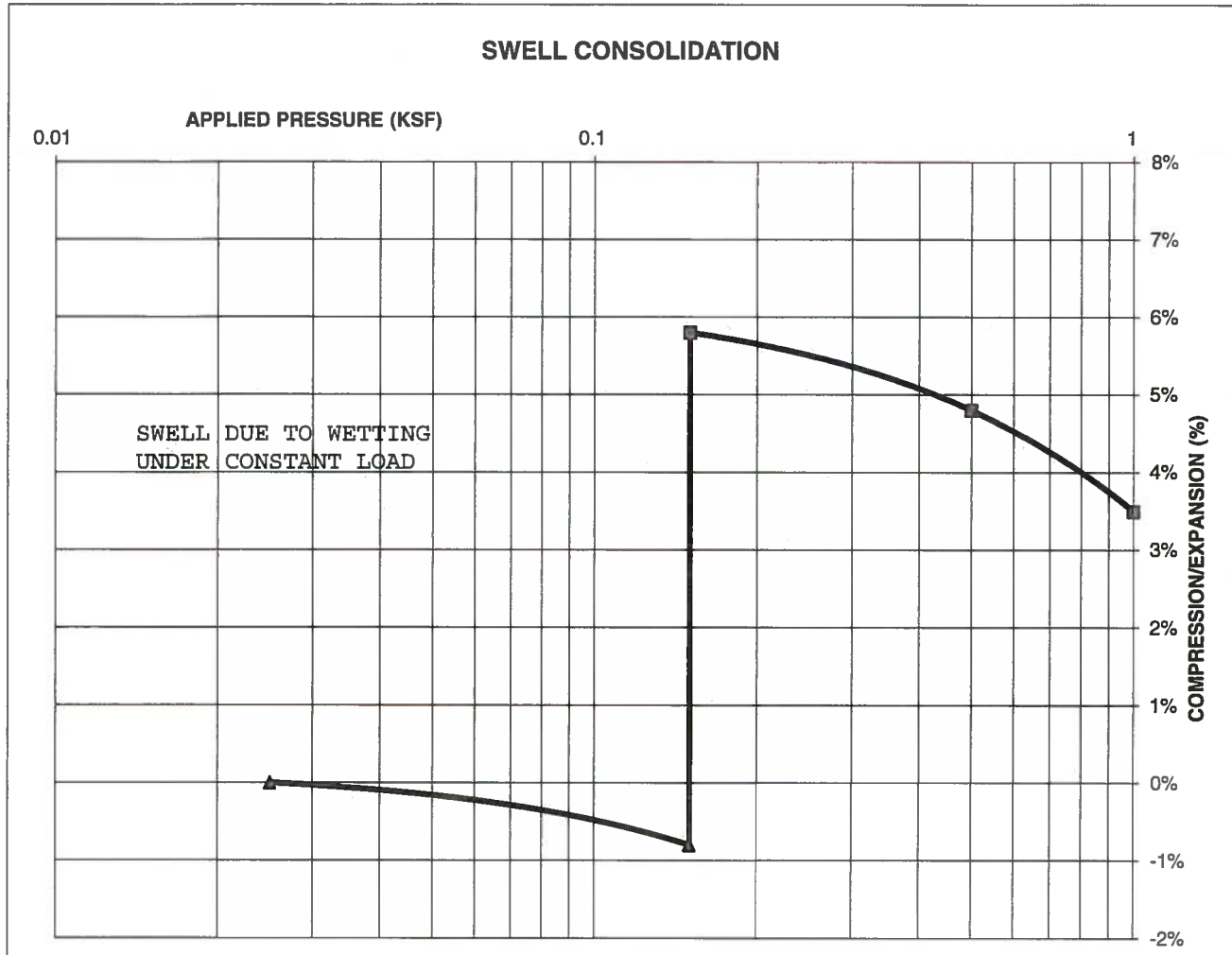
JOB NO.:
213333

FIG NO.:
B-23

CONSOLIDATION TEST RESULTS

TEST BORING #	6	DEPTH(ft)	10
DESCRIPTION	CL	SOIL TYPE	2
NATURAL UNIT DRY WEIGHT (PCF)	112		
NATURAL MOISTURE CONTENT	17.1%		
SWELL/CONSOLIDATION (%)	6.6%		

JOB NO. 213333
 CLIENT TECH CONTRACTORS
 PROJECT ROLLING HILLS RANCH, F-2



**ENTECH
ENGINEERING, INC.**

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

SWELL CONSOLIDATION TEST RESULTS

DRAWN:

DATE:

CHECKED:

SW

DATE:

1-11-22

JOB NO.:

213333

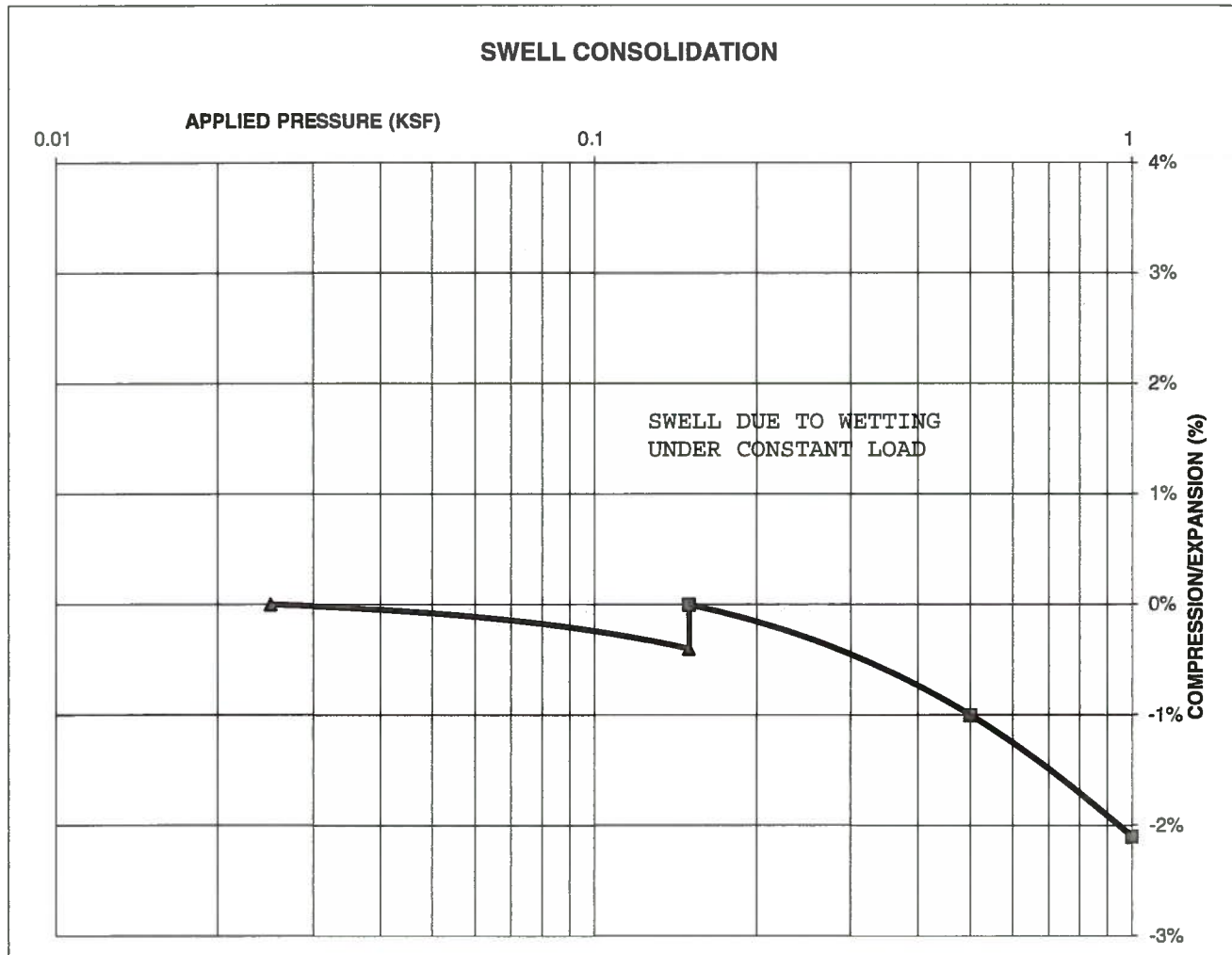
FIG NO.:

B 24

CONSOLIDATION TEST RESULTS

TEST BORING #	11	DEPTH(ft)	10
DESCRIPTION	SC	SOIL TYPE	3
NATURAL UNIT DRY WEIGHT (PCF)	116		
NATURAL MOISTURE CONTENT	11.0%		
SWELL/CONSOLIDATION (%)	0.4%		

JOB NO.	213333
CLIENT	TECH CONTRACTORS
PROJECT	ROLLING HILLS RANCH, F-2



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

SWELL CONSOLIDATION TEST RESULTS

DRAWN:

DATE:

CHECKED:

DATE:

SW

1-11-22

JOB NO.:

213333

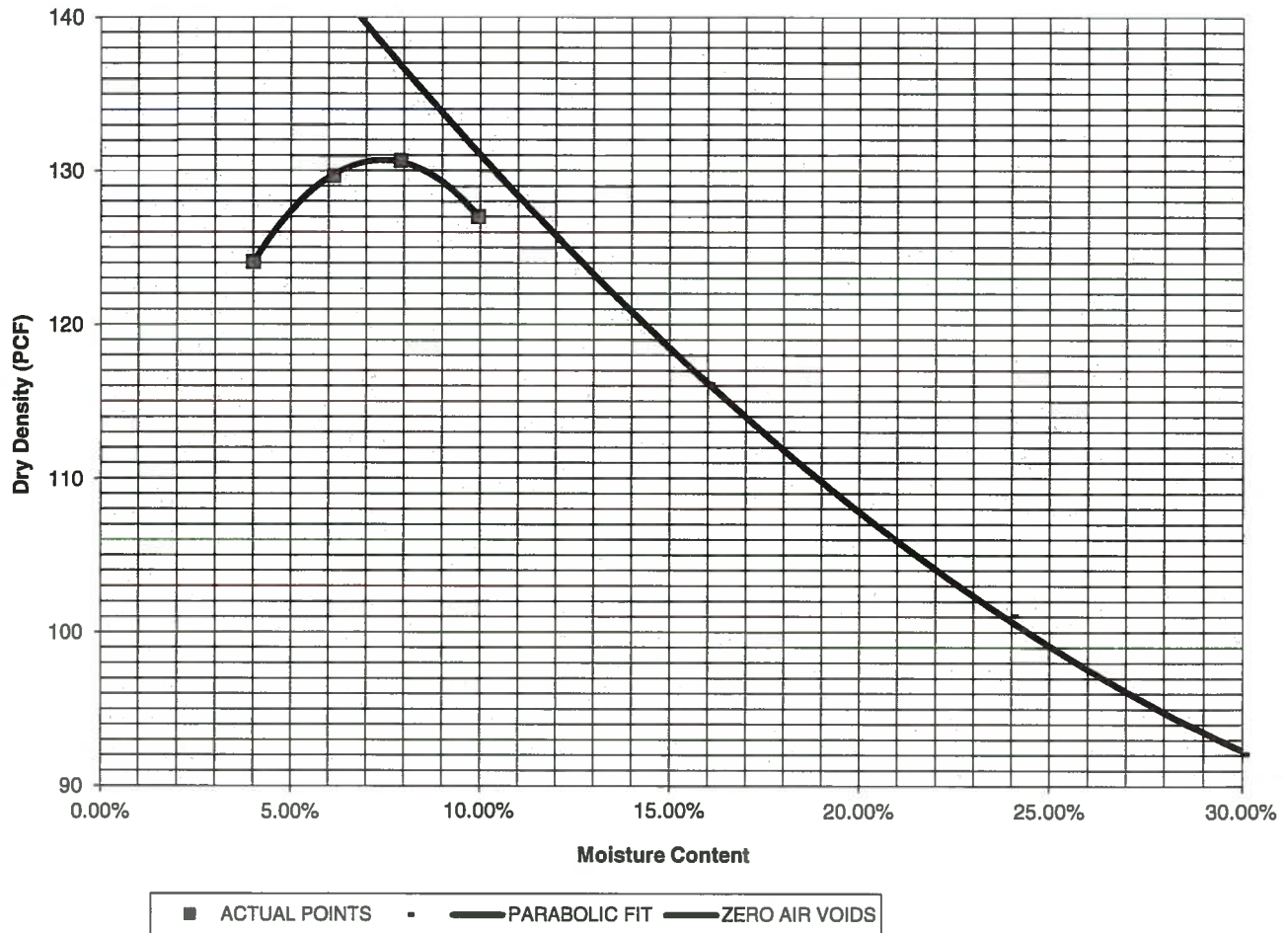
FIG NO.:

B-25

<u>PROJECT</u>	ROLLING HILLS RANCH, F-2	<u>CLIENT</u>	TECH CONTRACTORS
<u>SAMPLE LOCATION</u>	TB-2 @ 0-3'	<u>JOB NO.</u>	213333
<u>SOIL DESCRIPTION</u>	FILL, SAND, CLAYEY, BROWN	<u>DATE</u>	12/29/21

<u>IDENTIFICATION</u>	SC	<u>COMPACTION TEST #</u>	1
<u>TEST DESIGNATION / METHOD</u>	ASTM D-1557-A	<u>TEST BY</u>	BC
<u>MAXIMUM DRY DENSITY (PCF)</u>	130.8	<u>OPTIMUM MOISTURE</u>	7.7%

Compaction Curve



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

MOISTURE DENSITY RELATION

DRAWN:

DATE:

CHECKED:

SW

DATE: 1-11-22

JOB NO.:

213333

FIG NO.:

B-27

CBR TEST LOAD DATA

JOB NO: 213333
 CLIENT: TECH CONTRACTORS
 PROJECT: ROLLING HILLS RANCH, F-2
 SOIL TYPE: 1

PISTON DIAMETER (cm) 4.958	PISTON AREA (in ²) 2.993						
		10 BLOWS		25 BLOWS		56 BLOWS	
		MOLD # 1		MOLD # 2		MOLD # 3	
PENETRATION DEPTH (INCHES)		LOAD(LBS) (LBS)	STRESS (PSI)	LOAD(LBS) (LBS)	STRESS (PSI)	LOAD(LBS) (LBS)	STRESS (PSI)
0.000		0	0.00	0	0.00	0	0.00
0.025		84	28.07	126	42.11	159	53.13
0.050		97	32.41	173	57.81	221	73.85
0.075		121	40.43	201	67.17	251	83.88
0.100		132	44.11	249	83.21	309	103.26
0.125		149	49.79	286	95.57	369	123.31
0.150		174	58.15	365	121.97	468	156.39
0.175		199	66.50	425	142.02	542	181.12
0.200		224	74.85	510	170.43	651	217.54
0.300		256	85.55	788	263.32	1007	336.51
0.400		278	92.90	1042	348.20	1283	428.74
0.500		333	111.28	1354	452.46	1625	543.02

FINAL MOISTURE CONTENT

	MOLD # 1	MOLD # 2	MOLD # 3
CAN #	303	349	307
WT. CAN	7.14	8.98	8.42
WT. CAN+WET	147.59	152.73	141.08
WT. CAN+DRY	132.25	135.54	125.18
WT. H2O	15.34	17.19	15.9
WT. DRY SOIL	125.11	126.56	116.76
MOISTURE CONTENT	12.26%	13.58%	13.62%

WET DENSITY (PCF)	126.3	133.4	139.2
DRY DENSITY (PCF)	117.3	123.9	129.2

BEARING RATIO 4.41 8.32 10.33

90% OF DRY DENSITY 117.7

95% OF DRY DENSITY 124.3

BEARING RATIO AT 90% OF MAX	4.67 ~ R VALUE	10
BEARING RATIO AT 95% OF MAX	8.45 ~ R VALUE	22



ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
 COLORADO SPRINGS, COLORADO 80907

CBR TEST DATA

DRAWN:

DATE:

CHECKED:

SW

DATE:

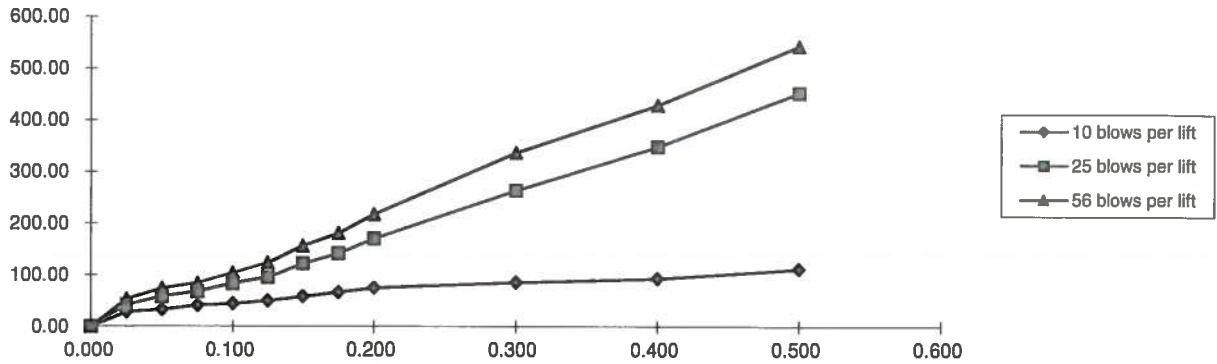
1-11-22

JOB NO.:
 213333

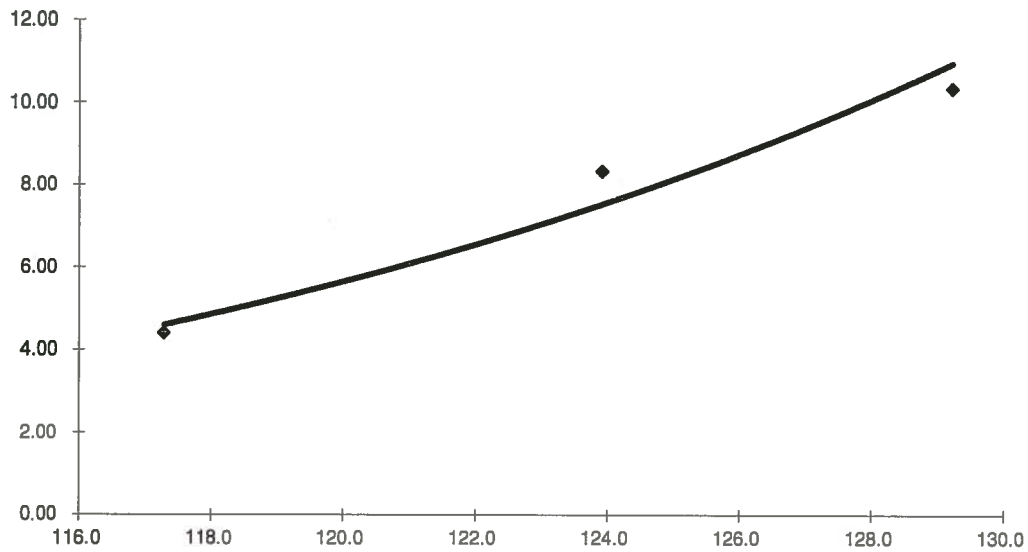
FIG NO.:

B-28

Stress VS Penetration



Bearing Ratio VS Dry Density



BEARING RATIO AT 90% OF MAX	4.67 ~ R VALUE	10.00
BEARING RATIO AT 95% OF MAX	8.45 ~ R VALUE	22.00

JOB NO: 213333
SOIL TYPE: 1



**ENTECH
ENGINEERING, INC.**

505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

CALIFORNIA BEARING RATIO

DRAWN:

DATE:

CHECKED: *SW*

DATE: *1-11-22*

JOB NO: 213333

FIG NO: *B-29*

APPENDIX C: Pavement Design Calculations

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA

ROLLING HILLS AT MERIDIAN RANCH FILING 2, PHASE 2
OVERLOOK BLUFF DRIVE - CUL-DE-SAC -LOCAL LOW-VOLUME

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	36,500
Hveem Stabilometer (R Value) Results:	R =	17
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 =	4478

Weighted Structural Number (WSN): → WSN = 2.25

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. 213333

Fig. No. C-1

DESIGN CALCULATIONS

DESIGN DATA

ROLLING HILLS AT MERIDIAN RANCH FILING 2, PHASE 2

OVERLOOK BLUFF DRIVE - CUL-DE-SAC -LOCAL LOW-VOLUME

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL = 36,500
Hveem Stabilometer (R Value) Results:	R = 17
Weighted Structural Number (WSN):	WSN = 2.25

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 Base Course

D_1 = Depth of Asphalt (inches)

D_2 = Depth of Base Course (inches)

FOR FULL DEPTH ASPHALT SECTION (CURRENTLY NOT ALLOWED)

$D_1 = (WSN)/C_1 = 5.1$ inches of Full Depth Asphalt
Use 5.5 inches Full Depth

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = 3.5 inches

$D_2 = ((WSN) - (t)(C_1))/C_2 = 6.5$ inches of Aggregate
Base Course, use 6.5 inches

RECOMMENDED ALTERNATIVES

1. 3.5 inches of Asphalt + 6.5 inches of Aggregate Base Course, or
2. 5.5 inches of Full Depth Asphalt

Job No. 213333

Fig. No. C-2

DESIGN CALCULATIONS

CEMENT TREATED SECTIONS

DESIGN DATA:

ROLLING HILLS AT MERIDIAN RANCH FILING 2, PHASE 2

OVERLOOK BIUFF LANE - CUL-DE-SAC -LOCAL LOW-VOLUME

Equivalent (18 kip) Single Axle Load Applications (ESAL): ESAL = 36,500

Hveem Stabilometer (R Value) Results: R = 20

Weighted Structural Number (WSN): WSN = 2.16

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 - 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)

$D_1 = (WSN)/C_1 = 4.9$ inches of Full Depth Asphalt

Use 5.0 inches Full Depth

FOR ASPHALT + CEMENT TREATED SUBGRADE SECTION

Asphalt Thickness (t) = 4 inches

$D_2 = ((WSN) - (t)(C_1))/C_2 = 4.0$ 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. 213333

Fig. No. C-3

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA

ROLLING HILLS AT MERIDIAN RANCH FILING 2, PHASE 2

LOCAL RESIDENTIAL

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	292,000
Hveem Stabilometer (R Value) Results:	R =	20
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 =	4940

Weighted Structural Number (WSN): ➔ WSN = 3.02

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

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

Left	Right	Difference
5.47	5.47	0.0

Job No. 213333

Fig. No. C-4

DESIGN CALCULATIONS

DESIGN DATA

ROLLING HILLS AT MERIDIAN RANCH FILING 2, PHASE 2

LOCAL RESIDENTIAL

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL = 292,000
Hveem Stabilometer (R Value) Results:	R = 20
Weighted Structural Number (WSN):	WSN = 3.02

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 Base Course

D_1 = Depth of Asphalt (inches)

D_2 = Depth of Base Course (inches)

FOR FULL DEPTH ASPHALT SECTION (CURRENTLY NOT ALLOWED)

$D_1 = (WSN)/C_1 = 6.9$ inches of Full Depth Asphalt
Use 7.0 inches Full Depth

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = inches

$D_2 = ((WSN) - (t)(C_1))/C_2 = 7.4$ inches of Aggregate
Base Course, use 8.0 inches

RECOMMENDED ALTERNATIVES

1. 5.0 inches of Asphalt + 8.0 inches of Aggregate Base Course, or
2. 7.0 inches of Full Depth Asphalt

Job No. 213333

Fig. No. C-5

DESIGN CALCULATIONS

CEMENT TREATED SECTIONS

DESIGN DATA:

ROLLING HILLS AT MERIDIAN RANCH FILING 2, PHASE 2

LOCAL RESIDENTIAL

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	292,000
Hveem Stabilometer (R Value) Results:	R =	20
Weighted Structural Number (WSN):	WSN =	3.02

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 - 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)

$D_1 = (WSN)/C_1 = 6.9$ inches of Full Depth Asphalt

Use 7.0 inches Full Depth

FOR ASPHALT + CEMENT TREATED SUBGRADE SECTION

Asphalt Thickness (t) = 4.5 inches

$D_2 = ((WSN) - (t)(C_1))/C_2 = 9.5$ inches

Use 10.0 inches of Cement Treated Subgrade.

RECOMMENDED ALTERNATIVES

1. 4.5 inches of Asphalt + 10 inches of Cement Treated Subgrade.
2. 7.0 inches of Full Depth Asphalt

Job No. 213333

Fig. No. C-6