ENTECH
ENGINEERING, INC.

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

September 2, 2022
September 12, 2022 – Revised

FLRD #7
2138 Flying Horse Club Drive
Colorado Springs, Colorado 80921

Attn: Mark Sherwood

Re: Pavement Recommendations – Revised
Forest Lakes Filing No. 7
El Paso County, Colorado
Entech Job No. 220622

*Mesa Top Drive is classified as an Urban Local road, and is not a collector.

Dear Mr. Sherwood:

As requested, Entech Engineering, Inc. has obtained samples of the pavement subgrade soils from the roadways in the Forest Lakes, Filing No. 7 subdivision in El Paso County, Colorado. This letter presents the results of the laboratory testing and pavement recommendations for the roadways.

Project Description

The roadways for this project consist of a section of Mesa Top Drive as well as Foothills Flash Court, Mountain Ledge Lane, Ute Mountain Court, and Horse Trader Place. A Subsurface Soil Investigation and laboratory testing was performed in order to determine the pavement support characteristics of the soils. The general layout of the site is presented in the Test Boring Location Map in Figure 1.

Subgrade Conditions

Eighteen test borings were drilled in the roadway alignments to depths of approximately 5 and 10 feet below the existing subgrade surface. The soils at the roadway subgrade depth consisted of silty and clayey sand (Soil Type 1). The Type 1 soils were encountered in all of the borings to depths drilled 5 to 10 feet. Groundwater was not encountered in the test borings. The Test Boring Logs are presented in Appendix A. Sieve Analyses and Atterberg Limit testing were performed on soil samples obtained from the test borings for the purpose of classification. The Type 1 soils passing the No. 200 sieve ranged from approximately 8 to 35 percent and classified as A-2-6, A-2-4 and A-1-b soils, using the AASHTO classification system. Atterberg Limits Testing resulted in liquid limits of no-value to 31 percent and plastic indexes of non-plastic to 11 percent. One general subgrade soil type was determined for pavement evaluation based on the laboratory testing (Type 1). Water-soluble sulfate tests results indicated that the soils exhibit a negligible potential for sulfate attack.

Swell/Consolidation Testing was performed on two samples which had plastic indexes exceeding a value of 10. Volume changes of 0.1 and 0.2 percent were measured. Based on the test results mitigation is not required on this site. Laboratory test results are presented in Appendix B and are summarized on Table 1.

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

Soil Type 1 – Clayey Sand
CBR 1
R @ 90% = 35
R @ 95% = 73
Use R = 50.0 for design

Classification Testing	
Liquid Limit	25
Plasticity Index	9
Percent Passing 200	33.7
AASHTO Classification	A-2-4
Group Index	0
Unified Soils Classification	SC

Pavement Design

CBR testing was used to determine pavement sections for the roadways. Pavement sections were determined utilizing El Paso County Engineering Criteria Manual. Mesa Top Drive classifies as an urban residential collector, which used an 18k ESAL value of 292,000 for design purposes. The cul-de-sacs classified as local (low volume) roadways and used an 18K ESAL value of 36,500 for design. Alternative pavement sections were determined for asphalt supported on aggregate basecourse, and asphalt on cement stabilized subgrade.

Design parameters used in the pavement analysis for the roadways are as follows:

Reliability -	
Local (Low Volume) and	
Urban Residential Collector	80%
Standard Deviation	0.45
Δpsi	2.0
"R" Value Subgrade	50.0
Resilient Modulus	13,168 psi
Structural Coefficients	
Hot Bituminous Pavement	0.44
Aggregate Basecourse	0.11
Cement Stabilized Subgrade	0.11*

The 7–day strength for Cement Stabilized Subgrade using a strength coefficient of 0.11 shall be at least 125 psi.

The pavement design calculations are presented in Appendix C. Pavement section alternatives for the roadway sections are presented as follows. Any additional grading may result in

subgrade soils with different support characteristics. The following pavement sections should be re-evaluated if additional grading is performed.

Pavement Sections – Soil Type 1

Urban Local Residential – ESAL = 292,000

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

Local (Low Volume) – ESAL = 36,500

Alternative	Asphalt (in)	Basecourse (in)	Cement Stabilized Subgrade (in.)
1. Asphalt Over Basecourse	3.0*	4.0*	--
2. Cement Stabilized Subgrade	4.0	--	10.0

* Minimum sections required in accordance with the El Paso County Pavement Design Criteria Manual.

Roadway Construction - Asphalt on Aggregate Basecourse Alternative

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

Roadway Construction – Cement Stabilized Subgrade Alternative

Prior to placement of the asphalt, the subgrade shall be stabilized by addition of cement to a depth of at least 10 inches. 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 a 10 inches depth such that a uniform blend of soil and cement is achieved. Prior to application or mixing of the cement, the upper 10 inches of subgrade should be thoroughly moisture conditioned to the soil's optimum water content or as much as 2 percent more than the optimum water content as necessary to provide a compactable soil condition. Densification of the cement-stabilized subgrade should be completed to obtain a compaction of at least 95 percent of the subgrade maximum dry density as determined by the 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.

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

Based on the soils encountered, subgrade soil problem areas, if any, will be identified at proof roll. We do not anticipate issues with the subgrade in regards to shallow water, frost susceptible soils, groundwater or drainage conditions, soluble sulfates, or cold weather construction.

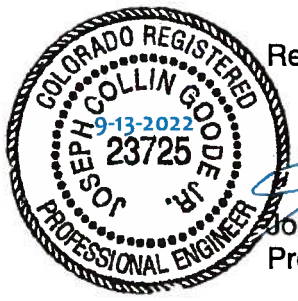
In addition to the above guidance, the asphalt, cement, subgrade conditions, compaction of materials and roadway construction methods shall meet the El Paso County specifications.

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.

Stuart Wood
Geologist



Reviewed By:

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

SW/rs

Encl.
AAprojects/2022/220622 – pr

TABLE

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT FLRD
PROJECT FOREST LAKES, FILING 7
JOB NO. 220622

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	7	0-3			33.7	25	9		A-2-4		SC	SAND, CLAYEY
1	1	0-3			29.0						SM	SAND, CLAYEY
1	1	1-2			29.2	26	9		A-2-4		SC	SAND, CLAYEY
1	2	1-2			25.9	25	5		A-2-4		SC-SM	SAND, CLAYEY, SILTY
1	3	1-2			15.0	NV	NP	<0.01	A-1-b		SM	SAND, SILTY
1	4	1-2	10.4	115.2	31.0	28	11		A-2-6	0.5	SC	SAND, CLAYEY
1	5	1-2			13.2	NV	NP		A-1-b		SM	SAND, SILTY
1	6	1-2	12.7	113.5	30.3	31	11		A-2-6	0.7	SC	SAND, CLAYEY
1	7	1-2			34.8	26	9	<0.01	A-2-4		SC	SAND, CLAYEY
1	8	1-2			23.2	NV	NP		A-1-b		SM	SAND, SILTY
1	9	1-2			24.7	NV	NP		A-2-4		SM	SAND, SILTY
1	10	1-2			15.9	NV	NP		A-2-4		SM	SAND, SILTY
1	11	1-2			27.3	NV	NP		A-2-4		SM	SAND, SILTY
1	12	1-2			29.1	NV	NP		A-2-4		SM	SAND, SILTY
1	13	1-2			31.4	NV	NP		A-2-4		SM	SAND, SILTY
1	14	1-2			12.4	NV	NP		A-1-b		SM	SAND, SILTY
1	15	1-2			11.2	NV	NP		A-1-b		SM-SW	SAND, SLIGHTLY SILTY
1	16	1-2			10.0	NV	NP		A-2-4		SM-SW	SAND, SLIGHTLY SILTY
1	17	1-2			8.1	NV	NP		A-1-b		SM-SW	SAND, SLIGHTLY SILTY
1	18	1-2			10.1	NV	NP		A-1-b		SM-SW	SAND, SLIGHTLY SILTY

FIGURE

LAKES FILING NO. 6

MESA TOP DRIVE NORTH

N

FOREST LAKES
FILING NO. 7

UTE
MOUNTAIN
COURT

TRACT
A

TRACT
B

TRACT
C

TRACT
D

MESA TOP DRIVE SOUTH

TIMBER TRIEK WAY

HORSETRADER PL

MESA TOP DRIVE

MOUNTAIN LEDGE LANE

FOOTHILLS FLASH COURT

MESA TOP DRIVE

TB-1
TB-2
TB-3
TB-4
TB-5
TB-6
TB-7
TB-8
TB-9
TB-10
TB-11
TB-12
TB-13
TB-14
TB-15
TB-16
TB-17
TB-18

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79

50' 0 100' 200' 400'

1"=200'

UNPLATTED

TB- APPROXIMATE TEST BORING LOCATION AND NUMBER

REVISION	BY

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

TEST BORING LOCATION MAP
FOREST LAKES, FILING 7
COLORADO SPRINGS, CO.
FOR: FLRD #7

DRAWN	JAC
CHECKED	DPS
DATE	8/15/22
SCALE	1"=200'
JOB NO.	220622
FIGURE No.	1

APPENDIX A: Test Boring Logs

TEST BORING NO. 1
DATE DRILLED 7/28/2022
Job # 220622

REMARKS

DRY TO 10', 7/28/22

SAND, CLAYEY, FINE TO COARSE GRAINED, RED BROWN, MEDIUM DENSE, MOIST

* - HIGH BLOW COUNT DUE TO BOULDERS AT 8'

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			16	8.5	1
5			10	6.3	1
10			50* / 6"	6.6	2
15					
20					

TEST BORING NO. 2
DATE DRILLED 7/28/2022
CLIENT FLRD
LOCATION FOREST LAKES, FILING 7

REMARKS

DRY TO 5', 7/28/22

SAND, CLAYEY, SILTY, FINE TO COARSE GRAINED, RED BROWN, MEDIUM DENSE, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			21	9.5	1
5			26	7.6	1
10					
15					
20					

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

TEST BORING LOG

DRAWN:	DATE:	CHECKED: SW	DATE: 8-9-22

JOB NO.: 220622
FIG NO.: A- 1

TEST BORING NO. 3
DATE DRILLED 7/28/2022
Job # 220622

REMARKS

DRY TO 5', 7/28/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
						SAND, SILTY, FINE TO COARSE GRAINED, RED BROWN, MEDIUM DENSE TO DENSE, MOIST
			14	5.5	1	
5			31	9.2	1	
10						
15						
20						

TEST BORING NO. 4
DATE DRILLED 7/28/2022
CLIENT FLRD
LOCATION FOREST LAKES, FILING 7

REMARKS

DRY TO 10', 7/28/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
						SAND, CLAYEY, FINE TO COARSE GRAINED, RED BROWN, MEDIUM DENSE TO DENSE, MOIST
			23	7.8	1	
5			48	6.3	1	
10			19	5.7	1	
15						
20						

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

TEST BORING LOG

DRAWN:	DATE:	CHECKED: SW	DATE: 8-5-22

JOB NO.: 220622
FIG NO.: A- 2

TEST BORING NO. 5
DATE DRILLED 7/28/2022
Job # 220622

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 7/28/22						
SAND, SILTY, FINE TO COARSE GRAINED, RED BROWN, MEDIUM DENSE TO DENSE, MOIST				23	6.5	1
	5			38	4.8	1
	10					
	15					
	20					

TEST BORING NO. 6
DATE DRILLED 7/28/2022
CLIENT FLRD
LOCATION FOREST LAKES, FILING 7

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 7/28/22						
SAND, CLAYEY, FINE TO COARSE GRAINED, RED BROWN, MEDIUM DENSE TO LOOSE, MOIST				12	13.4	1
	5			8	15.4	1
	10					
	15					
	20					

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

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
		SW	8-5-22

JOB NO.: 220622
FIG NO.: A- 3

TEST BORING NO. 7
DATE DRILLED 7/28/2022
Job # 220622

REMARKS

DRY TO 5', 7/28/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			17	8.9	1
5			15	7.9	1
10					
15					
20					

SAND, CLAYEY, FINE TO COARSE GRAINED, RED BROWN, MEDIUM DENSE, MOIST

TEST BORING NO. 8
DATE DRILLED 7/28/2022
CLIENT FLRD
LOCATION FOREST LAKES, FILING 7

REMARKS

DRY TO 10', 7/28/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			10	9.2	1
5			9	7.7	1
10			8	9.9	1
15					
20					

SAND, SILTY, FINE TO COARSE GRAINED, RED BROWN, MEDIUM DENSE TO LOOSE, MOIST

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

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
		SW	8-5-22

JOB NO.: 220622
FIG NO.: A- 4

TEST BORING NO. 9
DATE DRILLED 7/28/2022
Job # 220622

REMARKS

DRY TO 5', 7/28/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
						SAND, SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST
			11	3.1	1	
5			13	3.7	1	
10						
15						
20						

TEST BORING NO. 10
DATE DRILLED 7/29/2022
CLIENT FLRD
LOCATION FOREST LAKES, FILING 7

REMARKS

DRY TO 5', 7/29/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
						SAND, SILTY, FINE TO COARSE GRAINED, RED BROWN, MEDIUM DENSE, MOIST
			25	4.6	1	
5			14	4.9	1	
10						
15						
20						

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

TEST BORING LOG

DRAWN:	DATE:	CHECKED: SW	DATE: 8-5-22

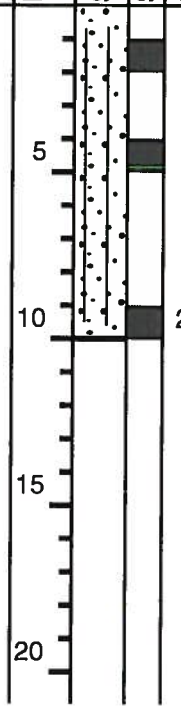
JOB NO.: 220622
FIG NO.: A- 5

TEST BORING NO. 11
DATE DRILLED 7/29/2022
Job # 220622

REMARKS

DRY TO 10', 7/29/22

SAND, SILTY, FINE TO COARSE GRAINED, RED BROWN, LOOSE TO MEDIUM DENSE, MOIST



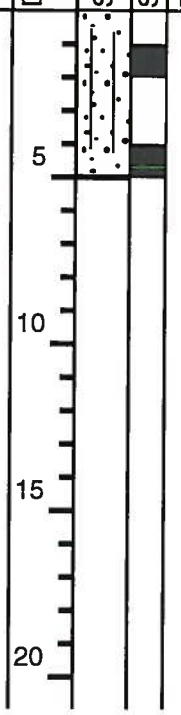
Blows per foot	Watercontent %	Soil Type
6	11.2	1
7	9.1	1
28	8.7	1

TEST BORING NO. 12
DATE DRILLED 7/29/2022
CLIENT FLRD
LOCATION FOREST LAKES, FILING 7

REMARKS

DRY TO 5', 7/29/22

SAND, SILTY, FINE TO COARSE GRAINED, RED BROWN, LOOSE, MOIST



Blows per foot	Watercontent %	Soil Type
7	9.3	1
9	8.1	1

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

TEST BORING LOG

DRAWN:	DATE:	CHECKED: SW	DATE: 8-3-22

JOB NO.: 220622
FIG NO.: A- 6

TEST BORING NO. 13
DATE DRILLED 7/29/2022
Job # 220622

REMARKS

DRY TO 10', 7/29/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
	SAND, SILTY, FINE TO COARSE GRAINED, RED BROWN, LOOSE, MOIST		6	7.1	1
5			4	13.2	1
10			6	16.6	1
15					
20					

TEST BORING NO. 14
DATE DRILLED 7/29/2022
CLIENT FLRD
LOCATION FOREST LAKES, FILING 7

REMARKS

DRY TO 5', 7/29/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
	SAND, SILTY, FINE TO COARSE GRAINED, RED BROWN, MEDIUM DENSE, MOIST		16	6.5	1
5			16	5.2	1
10					
15					
20					

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

TEST BORING LOG

DRAWN:	DATE:	CHECKED: SW	DATE: 8-5-22

JOB NO.: 220622
FIG NO.: A- 7

TEST BORING NO. 15
DATE DRILLED 7/29/2022
Job # 220622

REMARKS

DRY TO 5', 7/29/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
			19	7.9	1	SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, RED BROWN, MEDIUM DENSE, MOIST
5			22	6.7	1	
10						
15						
20						

TEST BORING NO. 16
DATE DRILLED 7/29/2022
CLIENT FLRD
LOCATION FOREST LAKES, FILING 7

REMARKS

DRY TO 10', 7/29/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
			26	4.7	1	SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, RED BROWN, MEDIUM DENSE, MOIST
5			23	3.1	1	
10			21	4.8	1	
15						
20						

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

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
		SW	8-5-22

JOB NO.: 220622
FIG NO.: A- 8

TEST BORING NO. 17
DATE DRILLED 7/29/2022
Job # 220622

REMARKS

DRY TO 5', 7/29/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
			20	6.6	1	SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, RED BROWN, MEDIUM DENSE, MOIST
5			21	3.9	1	
10						
15						
20						

TEST BORING NO. 18
DATE DRILLED 7/29/2022
CLIENT FLRD
LOCATION FOREST LAKES, FILING 7

REMARKS

DRY TO 5', 7/29/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
			26	5.0	1	SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, RED BROWN, MEDIUM DENSE, MOIST
5			22	6.3	1	
10						
15						
20						

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

TEST BORING LOG

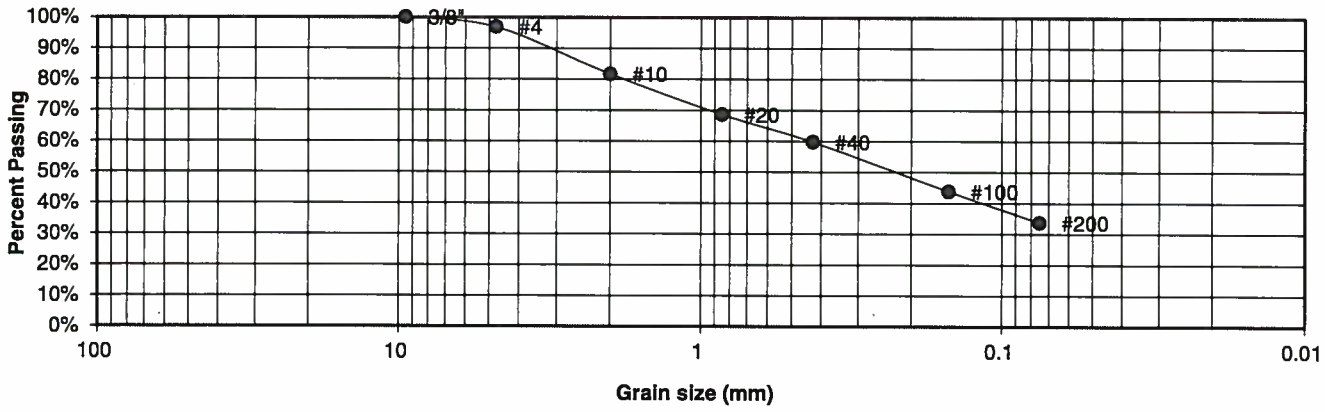
DRAWN:	DATE:	CHECKED: SW	DATE: 8-5-22

JOB NO.: 220622
FIG NO.: A- 9

APPENDIX B: Laboratory Test Results

UNIFIED CLASSIFICATION	SC	CLIENT	FLRD
SOIL TYPE #	1, CBR	PROJECT	FOREST LAKES, FILING 7
TEST BORING #	7	JOB NO.	220622
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	96.9%
10	81.7%
20	68.6%
40	59.8%
100	43.8%
200	33.7%

Atterberg Limits	
Plastic Limit	17
Liquid Limit	25
Plastic Index	9

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

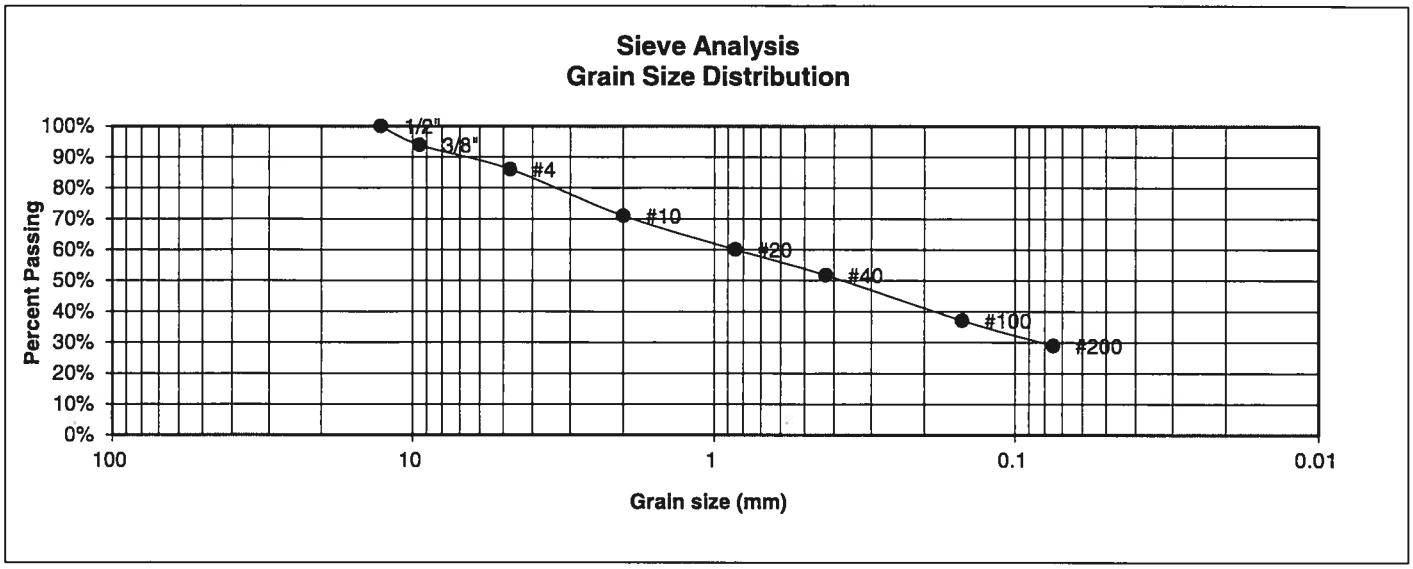
ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 8-9-22

JOB NO.: 220622
FIG NO.: B-1

UNIFIED CLASSIFICATION	SM	CLIENT	FLRD
SOIL TYPE #	1	PROJECT	FOREST LAKES, FILING 7
TEST BORING #	1	JOB NO.	220622
DEPTH (FT)	0-3	TEST BY	BL
AASHTO CLASSIFICATION		GROUP INDEX	



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	93.9%
4	86.0%
10	71.0%
20	60.0%
40	51.8%
100	37.1%
200	29.0%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

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

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

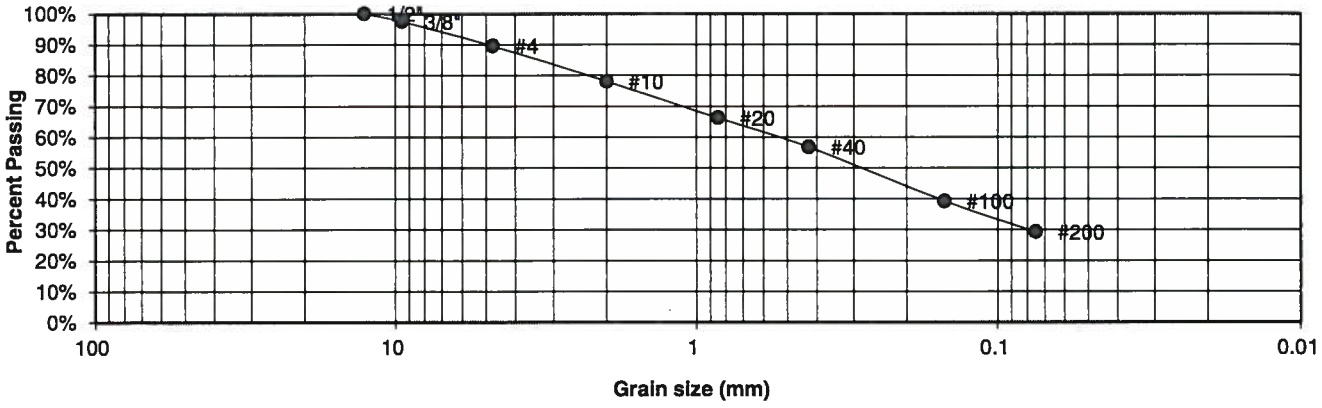
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 8-9-22

JOB NO.: 220622
FIG NO.: B-2

UNIFIED CLASSIFICATION	SC	CLIENT	FLRD
SOIL TYPE #	1	PROJECT	FOREST LAKES, FILING 7
TEST BORING #	1	JOB NO.	220622
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"	100.0%
3/8"	97.5%
4	89.6%
10	78.1%
20	66.2%
40	56.8%
100	39.3%
200	29.2%

Atterberg Limits

Plastic Limit	17
Liquid Limit	26
Plastic Index	9

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

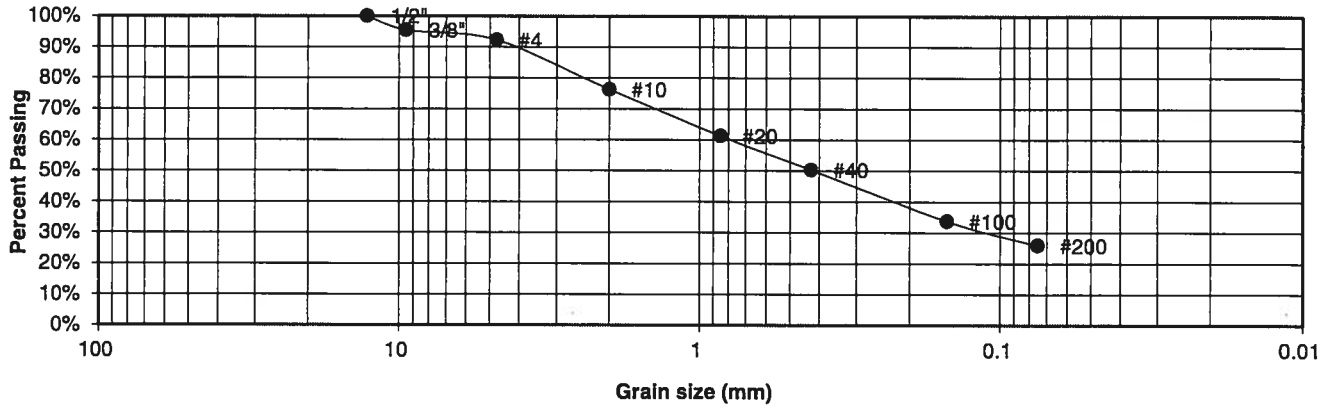
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 8-9-22

JOB NO.: 220622
FIG NO.: B-3

UNIFIED CLASSIFICATION	SC-SM	CLIENT	FLRD
SOIL TYPE #	1	PROJECT	FOREST LAKES, FILING 7
TEST BORING #	2	JOB NO.	220622
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"	100.0%
3/8"	95.4%
4	92.2%
10	76.3%
20	61.3%
40	50.3%
100	33.7%
200	25.9%

Atterberg Limits	
Plastic Limit	20
Liquid Limit	25
Plastic Index	5

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

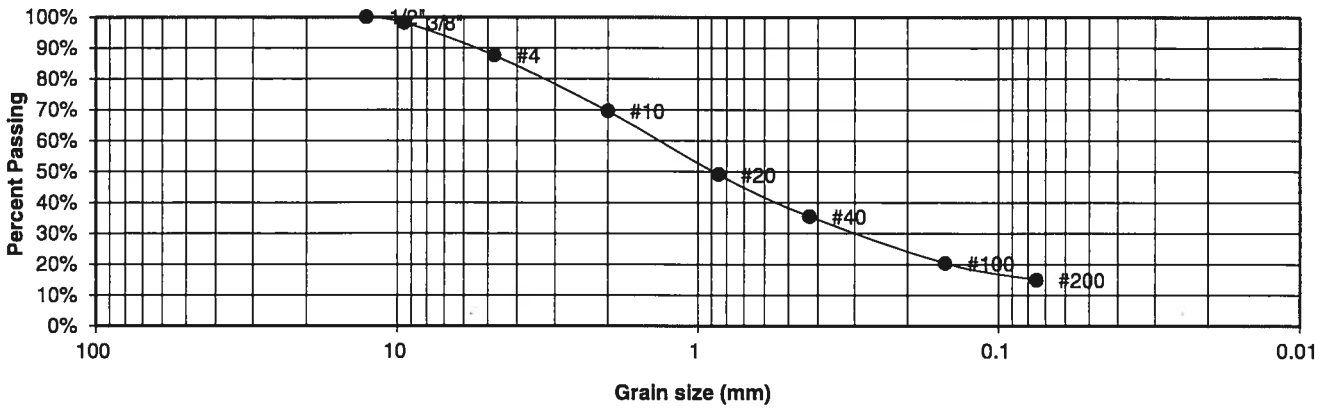
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 8-9-22

JOB NO.: 220622
FIG NO.: B-4

UNIFIED CLASSIFICATION	SM	CLIENT	FLRD
SOIL TYPE #	1	PROJECT	FOREST LAKES, FILING 7
TEST BORING #	3	JOB NO.	220622
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"	98.2%
4	87.6%
10	69.6%
20	49.0%
40	35.5%
100	20.4%
200	15.0%

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

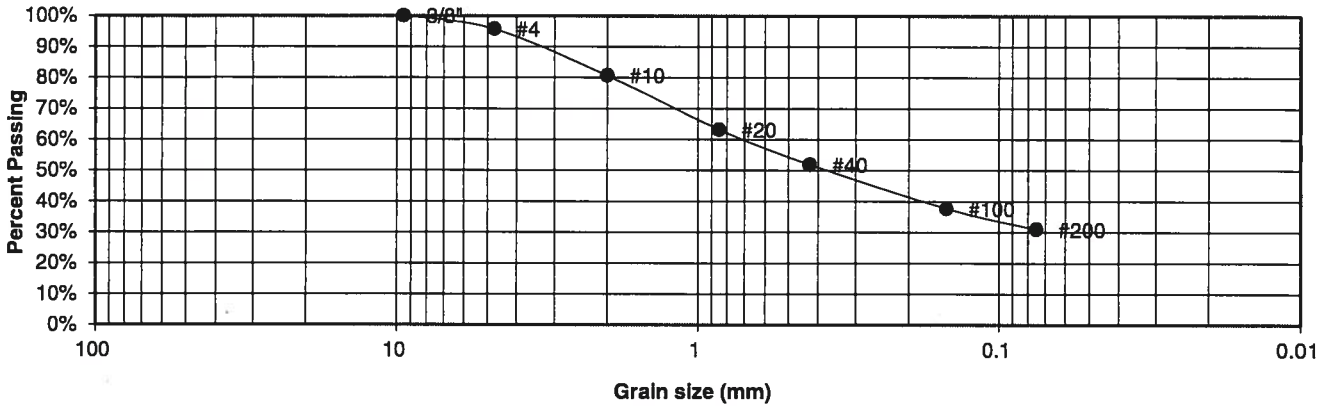
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 8-9-22

JOB NO.: 220622
FIG NO.: B-5

UNIFIED CLASSIFICATION	SC	CLIENT	FLRD
SOIL TYPE #	1	PROJECT	FOREST LAKES, FILING 7
TEST BORING #	4	JOB NO.	220622
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	95.7%
10	80.7%
20	63.2%
40	51.9%
100	37.7%
200	31.0%

Atterberg Limits	
Plastic Limit	18
Liquid Limit	28
Plastic Index	11

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

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

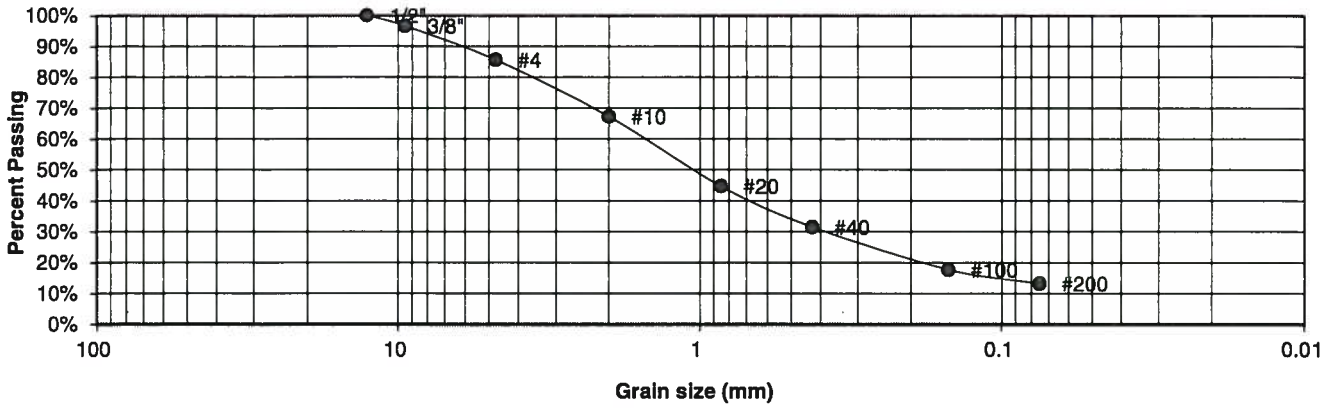
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 8-9-22

JOB NO.: 220622
FIG NO.: B-6

UNIFIED CLASSIFICATION	SM	CLIENT	FLRD
SOIL TYPE #	1	PROJECT	FOREST LAKES, FILING 7
TEST BORING #	5	JOB NO.	220622
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"	96.6%
4	85.6%
10	67.2%
20	44.7%
40	31.5%
100	17.7%
200	13.2%

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)	

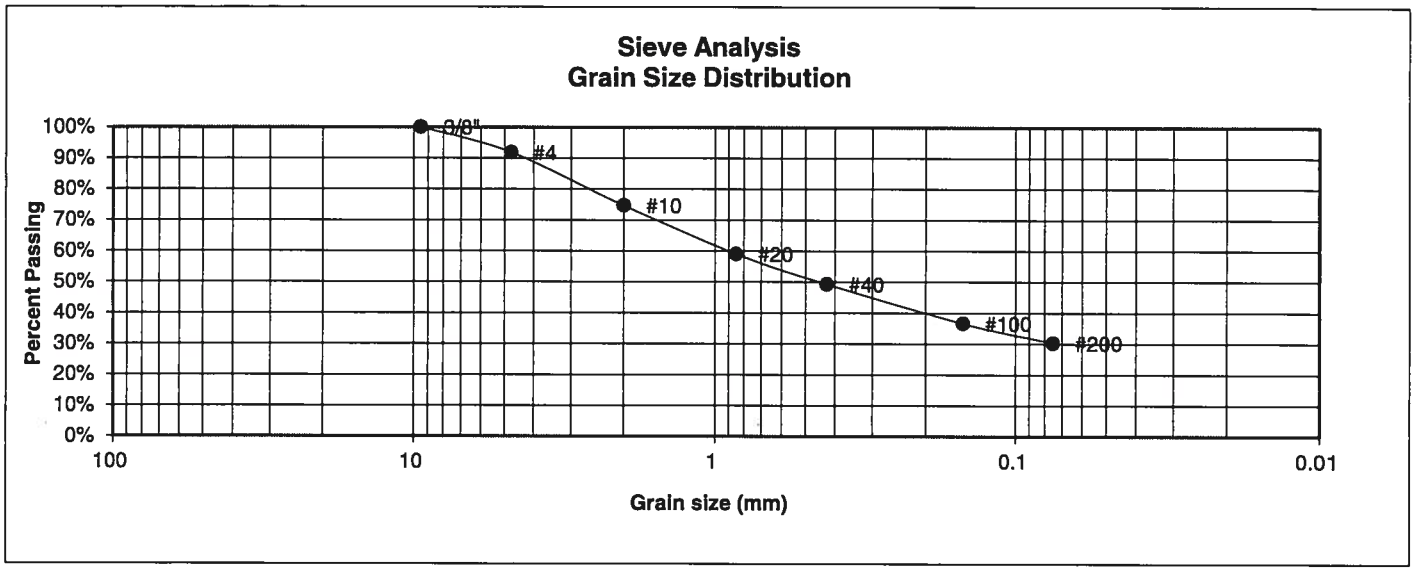
ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 8-9-22

JOB NO.: 220622
FIG NO.: B-7

UNIFIED CLASSIFICATION	SC	CLIENT	FLRD
SOIL TYPE #	1	PROJECT	FOREST LAKES, FILING 7
TEST BORING #	6	JOB NO.	220622
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	91.8%
10	74.7%
20	59.0%
40	49.3%
100	36.6%
200	30.3%

Atterberg Limits	
Plastic Limit	20
Liquid Limit	31
Plastic Index	11

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

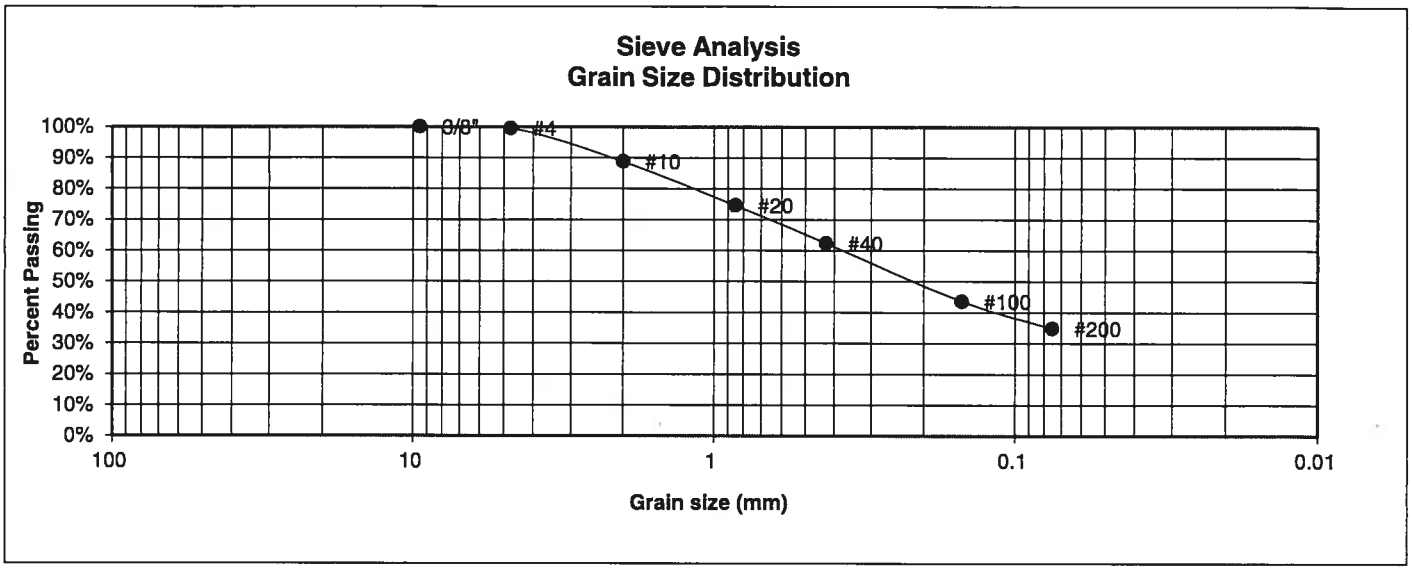
ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 8-9-22

JOB NO.: 220622
FIG NO.: B-8

UNIFIED CLASSIFICATION	SC	CLIENT	FLRD
SOIL TYPE #	1	PROJECT	FOREST LAKES, FILING 7
TEST BORING #	7	JOB NO.	220622
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.5%
10	88.8%
20	74.6%
40	62.4%
100	43.6%
200	34.8%

Atterberg Limits	
Plastic Limit	17
Liquid Limit	26
Plastic Index	9

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

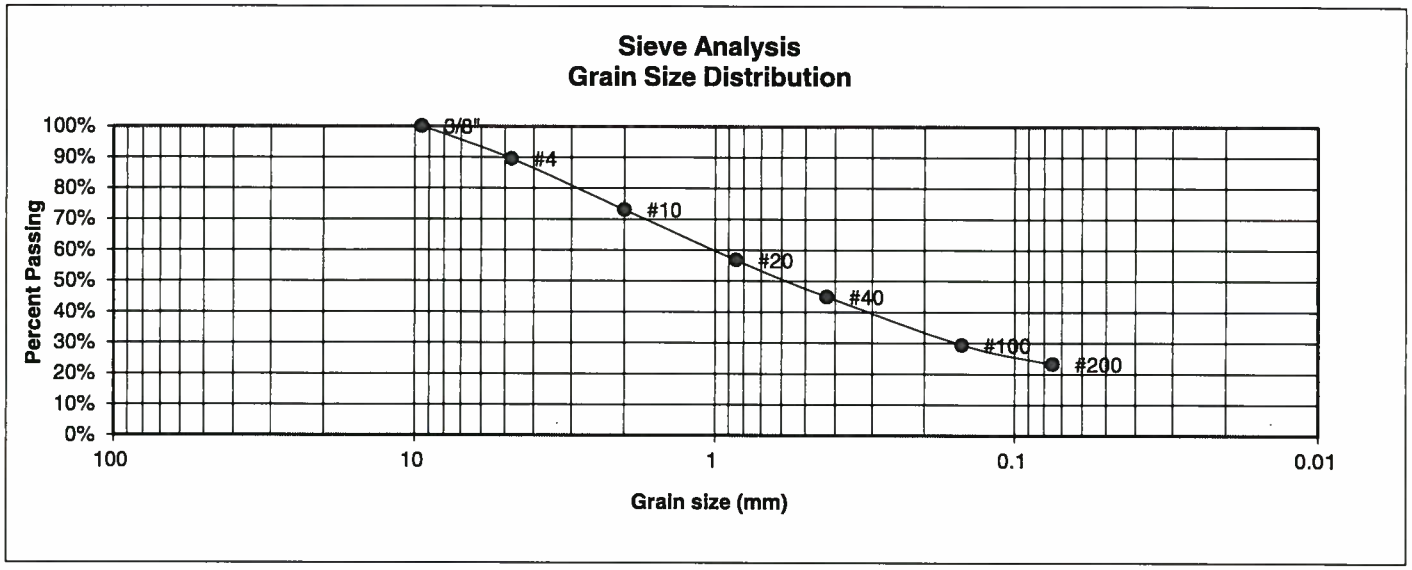
ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 8-9-22

JOB NO.: 220622
FIG NO.: B-9

UNIFIED CLASSIFICATION	SM	CLIENT	FLRD
SOIL TYPE #	1	PROJECT	FOREST LAKES, FILING 7
TEST BORING #	8	JOB NO.	220622
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	89.6%
10	73.0%
20	56.8%
40	44.9%
100	29.4%
200	23.2%

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)

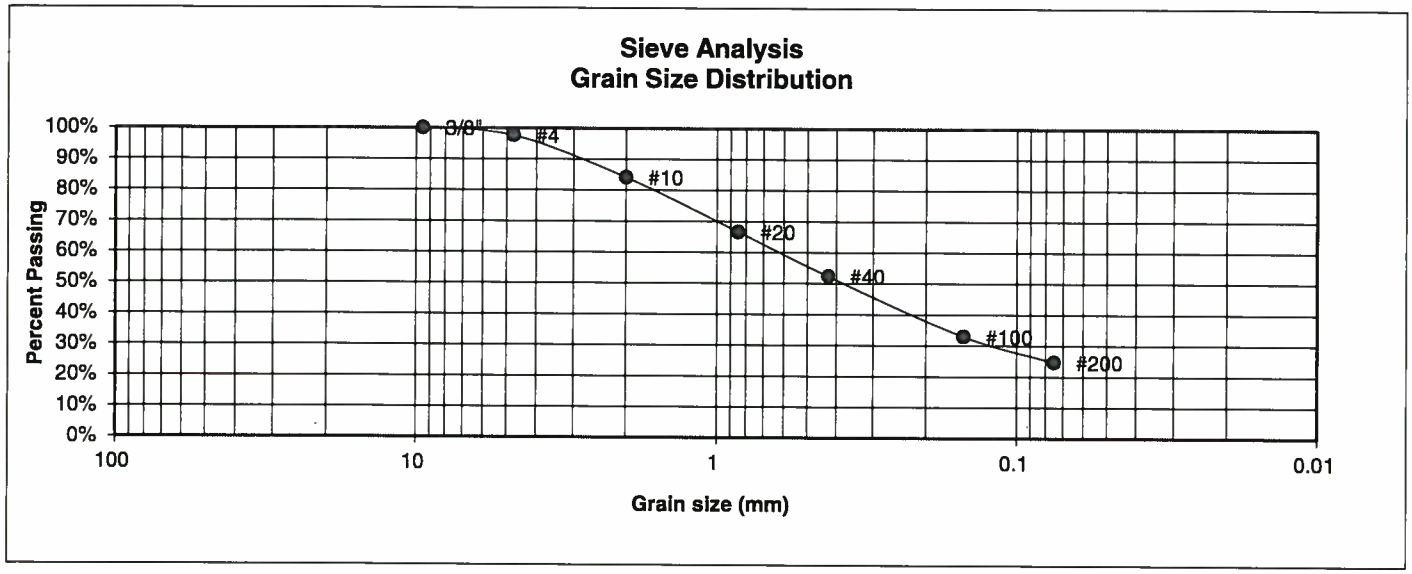
ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 8-9-22

JOB NO.: 220622
FIG NO.: B-10

UNIFIED CLASSIFICATION	SM	CLIENT	FLRD
SOIL TYPE #	1	PROJECT	FOREST LAKES, FILING 7
TEST BORING #	9	JOB NO.	220622
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.6%
10	84.1%
20	66.6%
40	52.4%
100	32.9%
200	24.7%

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

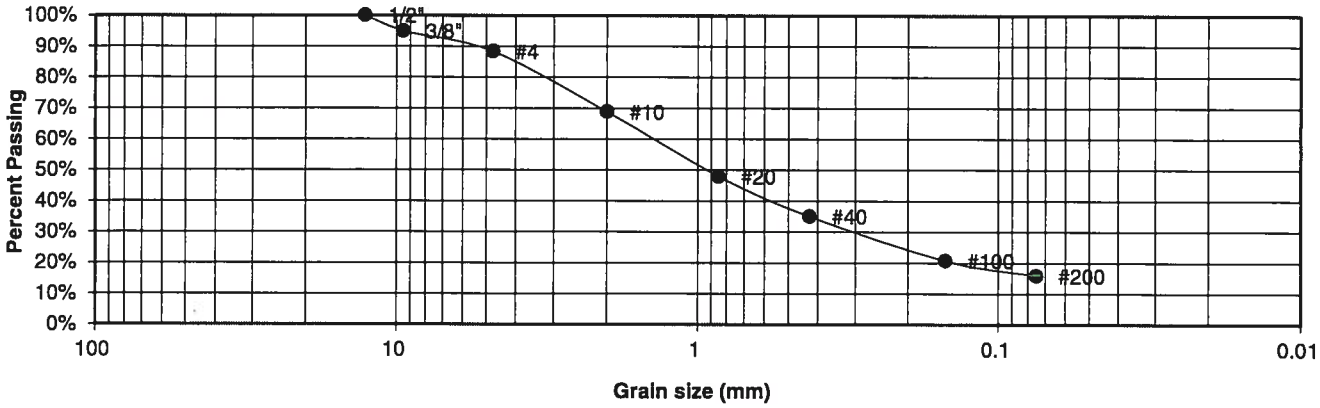
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 8-9-22

JOB NO.: 220622
FIG NO.: B-11

UNIFIED CLASSIFICATION	SM	CLIENT	FLRD
SOIL TYPE #	1	PROJECT	FOREST LAKES, FILING 7
TEST BORING #	10	JOB NO.	220622
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"	100.0%
3/8"	94.9%
4	88.3%
10	68.8%
20	48.0%
40	35.0%
100	20.7%
200	15.9%

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

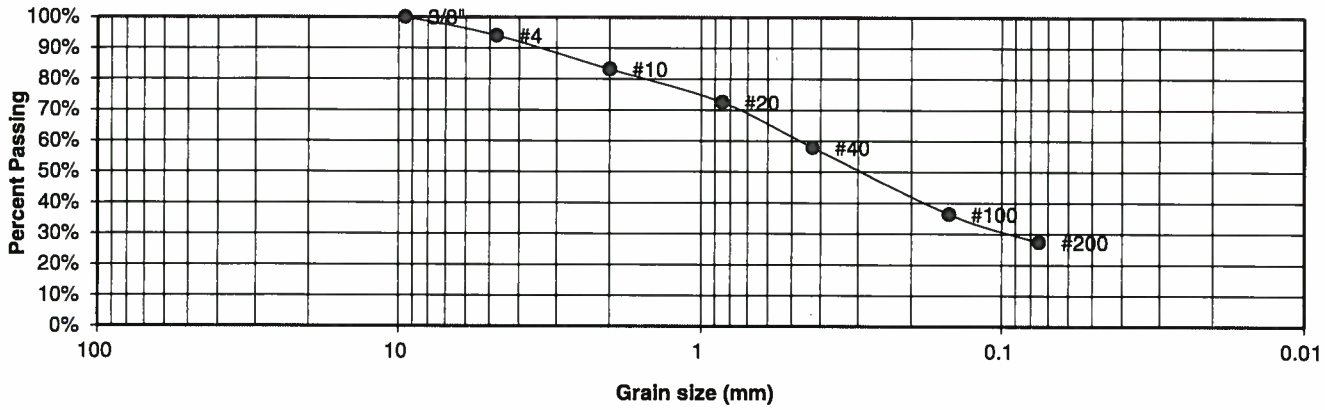
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 8-9-22

JOB NO.: 220622
FIG NO.: B-12

UNIFIED CLASSIFICATION	SM	CLIENT	FLRD
SOIL TYPE #	1	PROJECT	FOREST LAKES, FILING 7
TEST BORING #	11	JOB NO.	220622
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	94.0%
10	83.2%
20	72.5%
40	57.9%
100	36.4%
200	27.3%

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)	

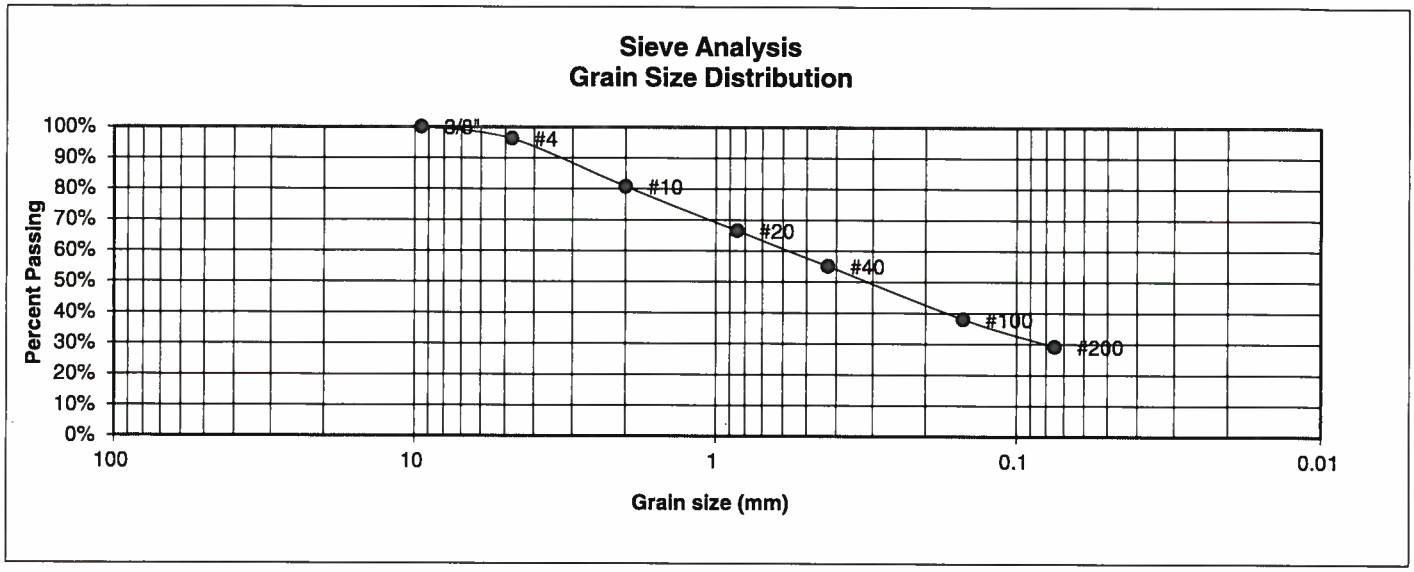
ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SW	8-9-22

JOB NO.: 220622
FIG NO.: B-13

UNIFIED CLASSIFICATION	SM	CLIENT	FLRD
SOIL TYPE #	1	PROJECT	FOREST LAKES, FILING 7
TEST BORING #	12	JOB NO.	220622
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	96.2%
10	80.7%
20	66.5%
40	55.1%
100	38.0%
200	29.1%

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

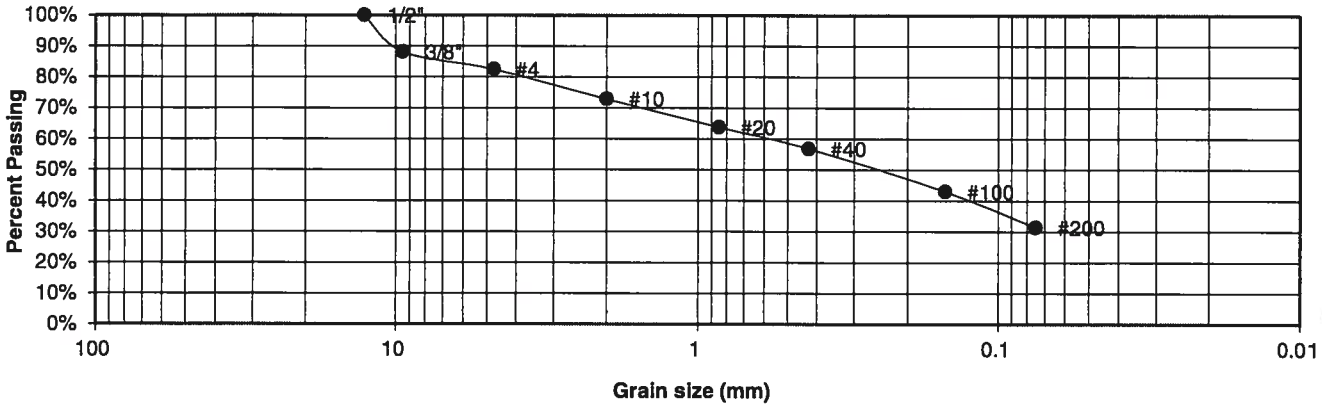
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 8-9-22

JOB NO.: 220622
FIG NO.: B-14

UNIFIED CLASSIFICATION	SM	CLIENT	FLRD
SOIL TYPE #	1	PROJECT	FOREST LAKES, FILING 7
TEST BORING #	13	JOB NO.	220622
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"	100.0%
3/8"	88.1%
4	82.5%
10	72.9%
20	63.8%
40	56.9%
100	43.0%
200	31.4%

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

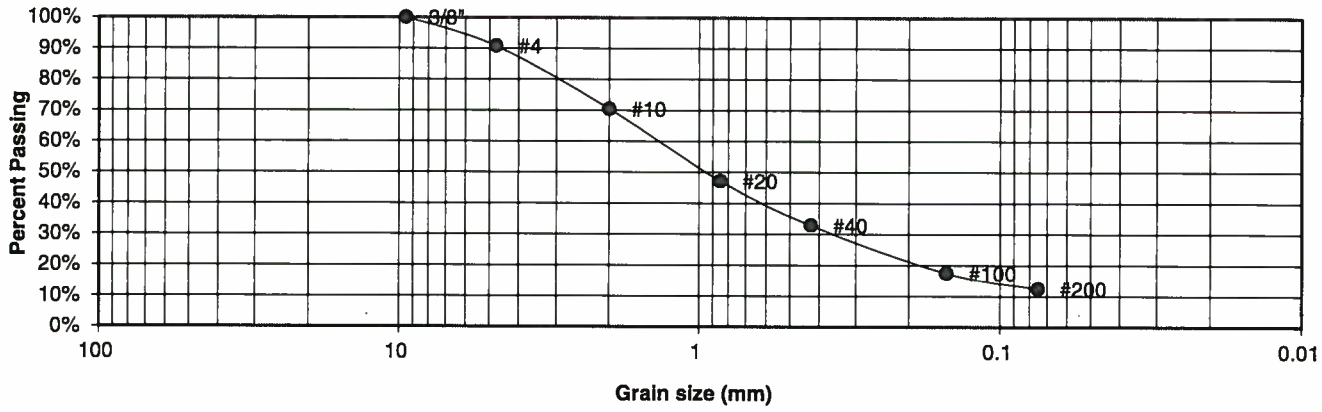
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 8-9-22

JOB NO.: 220622
FIG NO.: B-15

UNIFIED CLASSIFICATION	SM	CLIENT	FLRD
SOIL TYPE #	1	PROJECT	FOREST LAKES, FILING 7
TEST BORING #	14	JOB NO.	220622
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	90.8%
10	70.4%
20	47.2%
40	32.9%
100	17.4%
200	12.4%

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

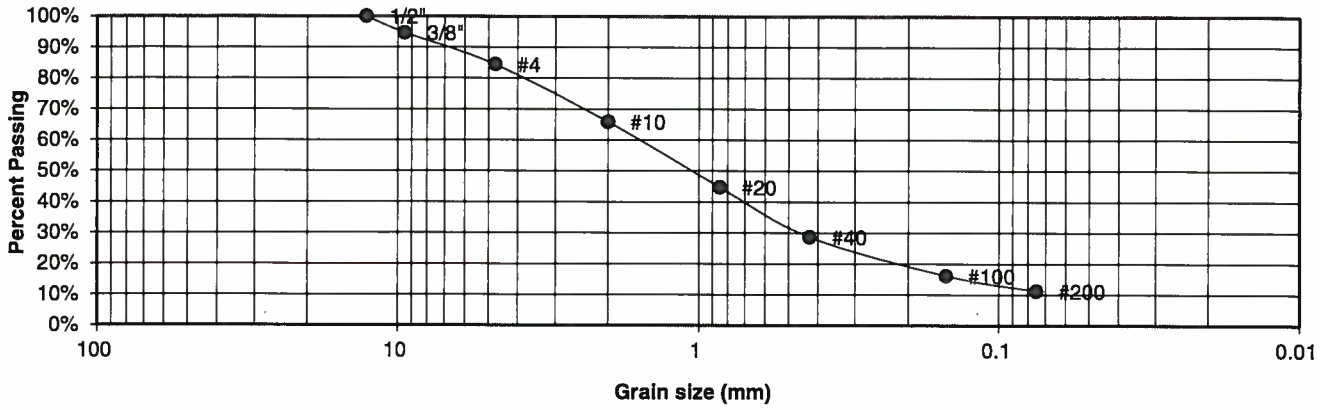
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 8-9-22

JOB NO.: 220622
FIG NO.: B-16

UNIFIED CLASSIFICATION	SM-SW	CLIENT	FLRD
SOIL TYPE #	1	PROJECT	FOREST LAKES, FILING 7
TEST BORING #	15	JOB NO.	220622
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"	94.6%
4	84.4%
10	65.9%
20	44.7%
40	28.6%
100	16.1%
200	11.2%

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

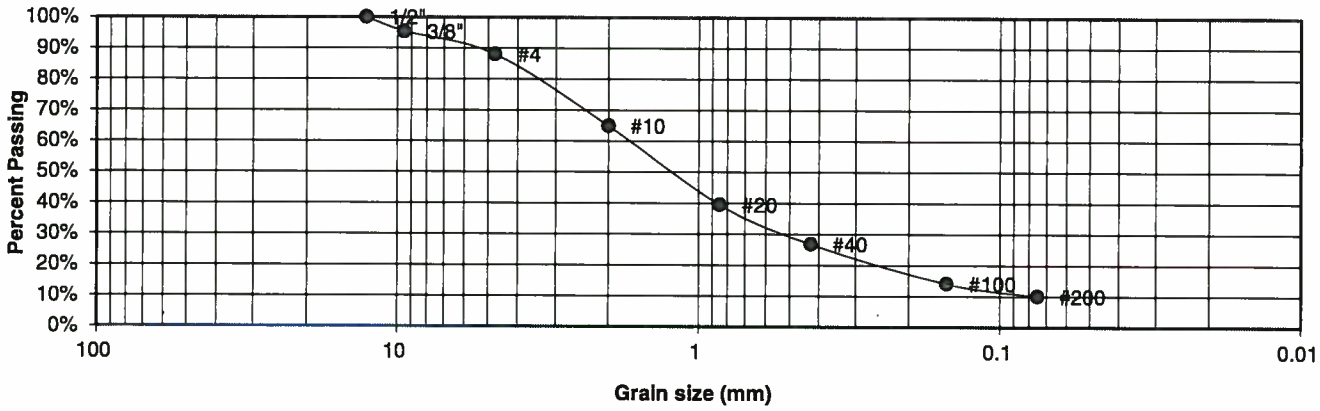
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 8-9-22

JOB NO.: 220622
FIG NO.: B-17

UNIFIED CLASSIFICATION	SM-SW	CLIENT	FLRD
SOIL TYPE #	1	PROJECT	FOREST LAKES, FILING 7
TEST BORING #	16	JOB NO.	220622
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"	100.0%
3/8"	95.3%
4	88.0%
10	64.9%
20	39.5%
40	26.8%
100	14.1%
200	10.0%

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

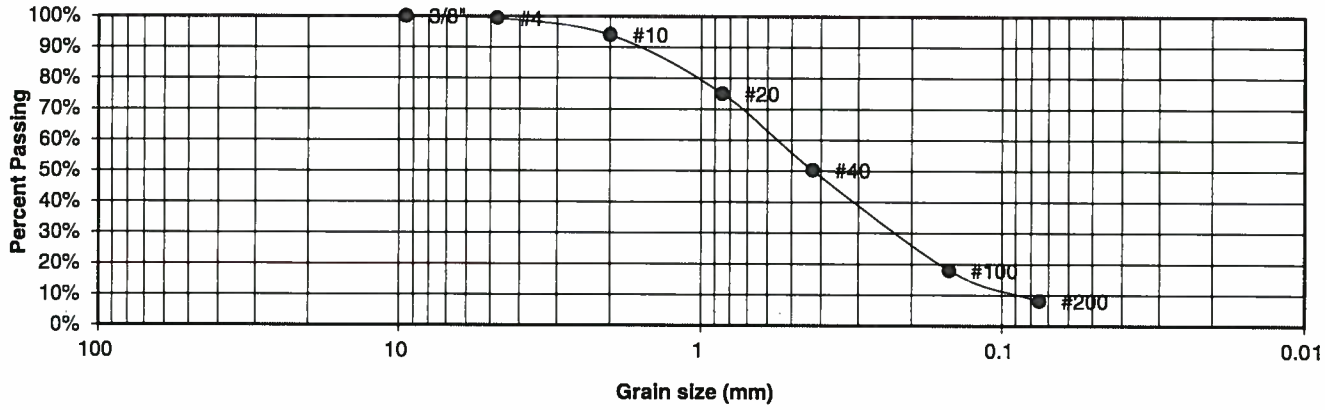
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 8-9-22

JOB NO.: 220622
FIG NO.: B-18

UNIFIED CLASSIFICATION	SM-SW	CLIENT	FLRD
SOIL TYPE #	1	PROJECT	FOREST LAKES, FILING 7
TEST BORING #	17	JOB NO.	220622
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	99.3%
10	94.0%
20	75.0%
40	50.3%
100	18.0%
200	8.1%

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

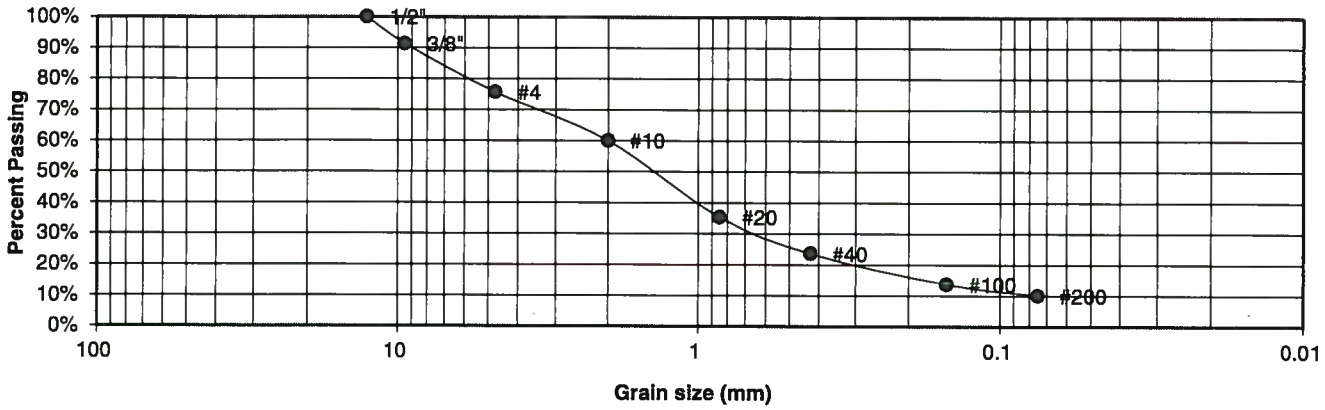
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 8-9-22

JOB NO.: 220622
FIG NO.: B-19

UNIFIED CLASSIFICATION	SM-SW	CLIENT	FLRD
SOIL TYPE #	1	PROJECT	FOREST LAKES, FILING 7
TEST BORING #	18	JOB NO.	220622
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"	91.3%
4	75.7%
10	60.0%
20	35.4%
40	23.6%
100	13.7%
200	10.1%

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

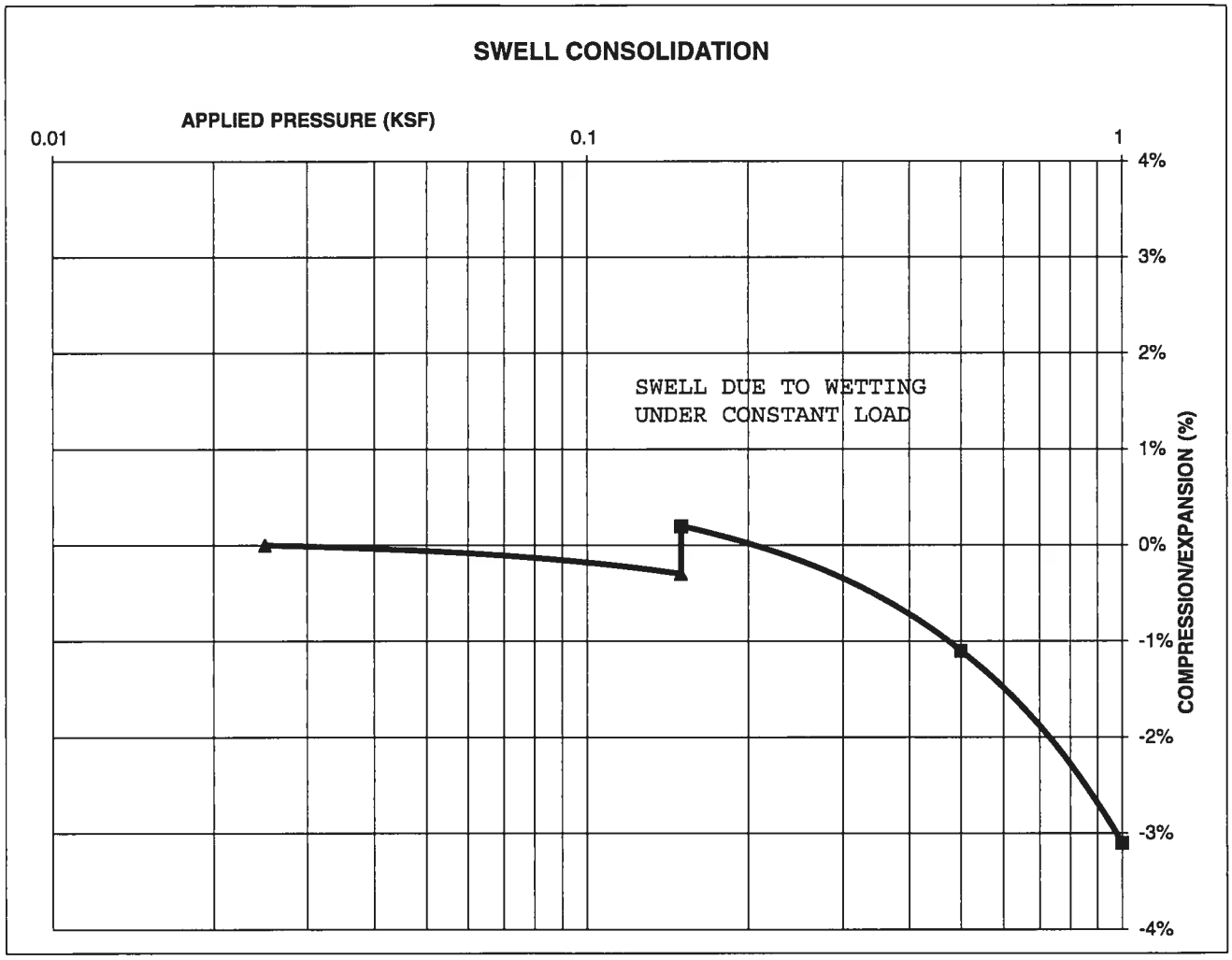
DRAWN:	DATE:	CHECKED:	DATE:
		SW	8-9-22

JOB NO.: 220622
FIG NO.: B-20

CONSOLIDATION TEST RESULTS

TEST BORING #	4	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			115
NATURAL MOISTURE CONTENT			10.4%
SWELL/CONSOLIDATION (%)			0.5%

JOB NO. 220622
CLIENT FLRD
PROJECT FOREST LAKES, FILING 7



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

SWELL CONSOLIDATION
TEST RESULTS

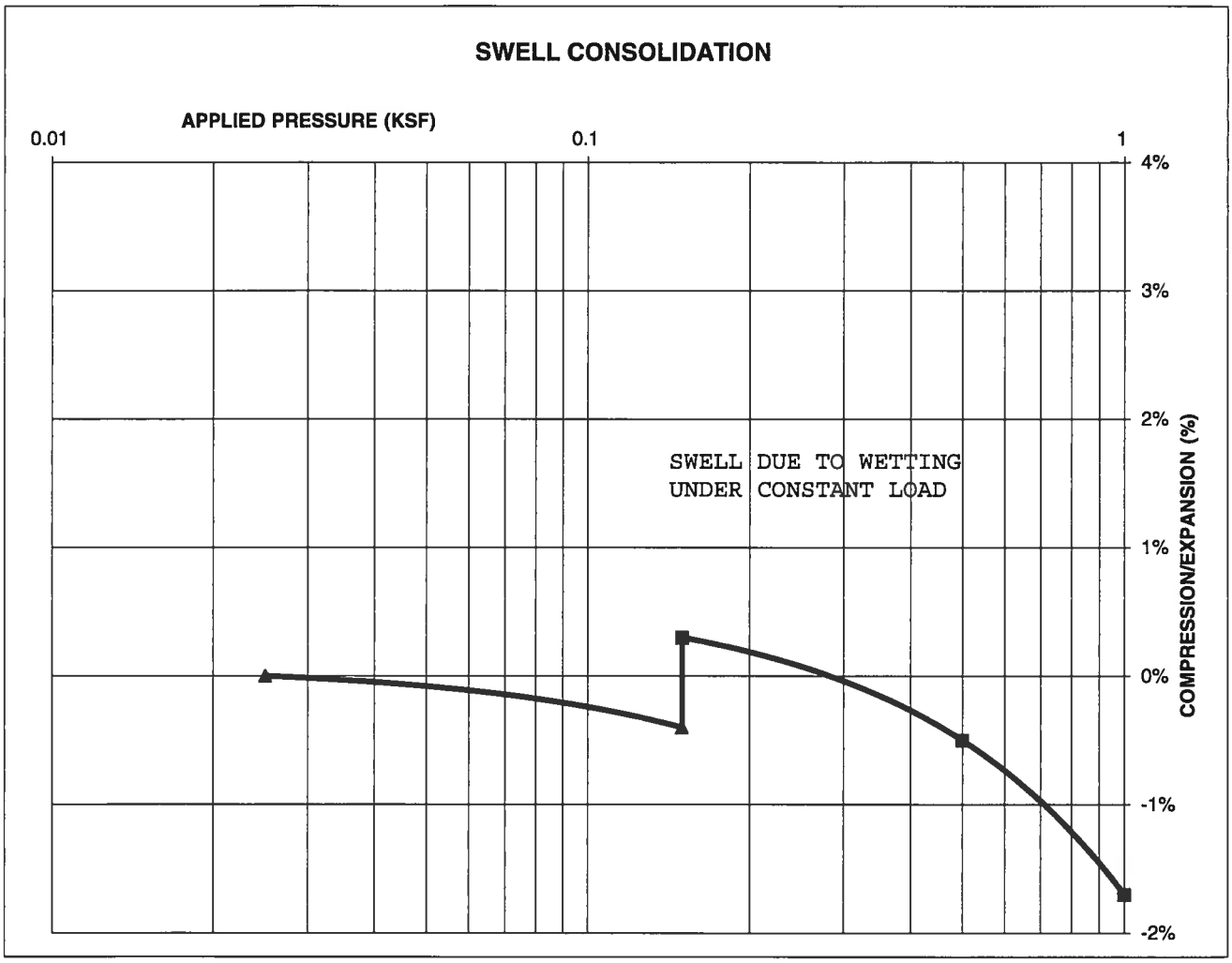
DRAWN:	DATE:	CHECKED:	DATE:
		BS	9/13/21

JOB NO.: 220622
FIG NO.: B-21

CONSOLIDATION TEST RESULTS

TEST BORING #	6	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			113
NATURAL MOISTURE CONTENT			12.5%
SWELL/CONSOLIDATION (%)			0.7%

JOB NO. 220622
CLIENT FLRD
PROJECT FOREST LAKES, FILING 7



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

SWELL CONSOLIDATION
TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		DS	9/13/22

JOB NO.: 220622
FIG NO.: B-22

CLIENT	FLRD	JOB NO.	220622
PROJECT	FOREST LAKES, FILING 7	DATE	8/3/2022
LOCATION	FOREST LAKES, FILING 7	TEST BY	BL

BORING NUMBER	DEPTH, (ft)	SOIL TYPE NUMBER	UNIFIED CLASSIFICATION	WATER SOLUBLE SULFATE, (wt%)
TB-3	1-2	1	SM	<0.01
TB-7	1-2	1	SM	<0.01

QC BLANK PASS

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

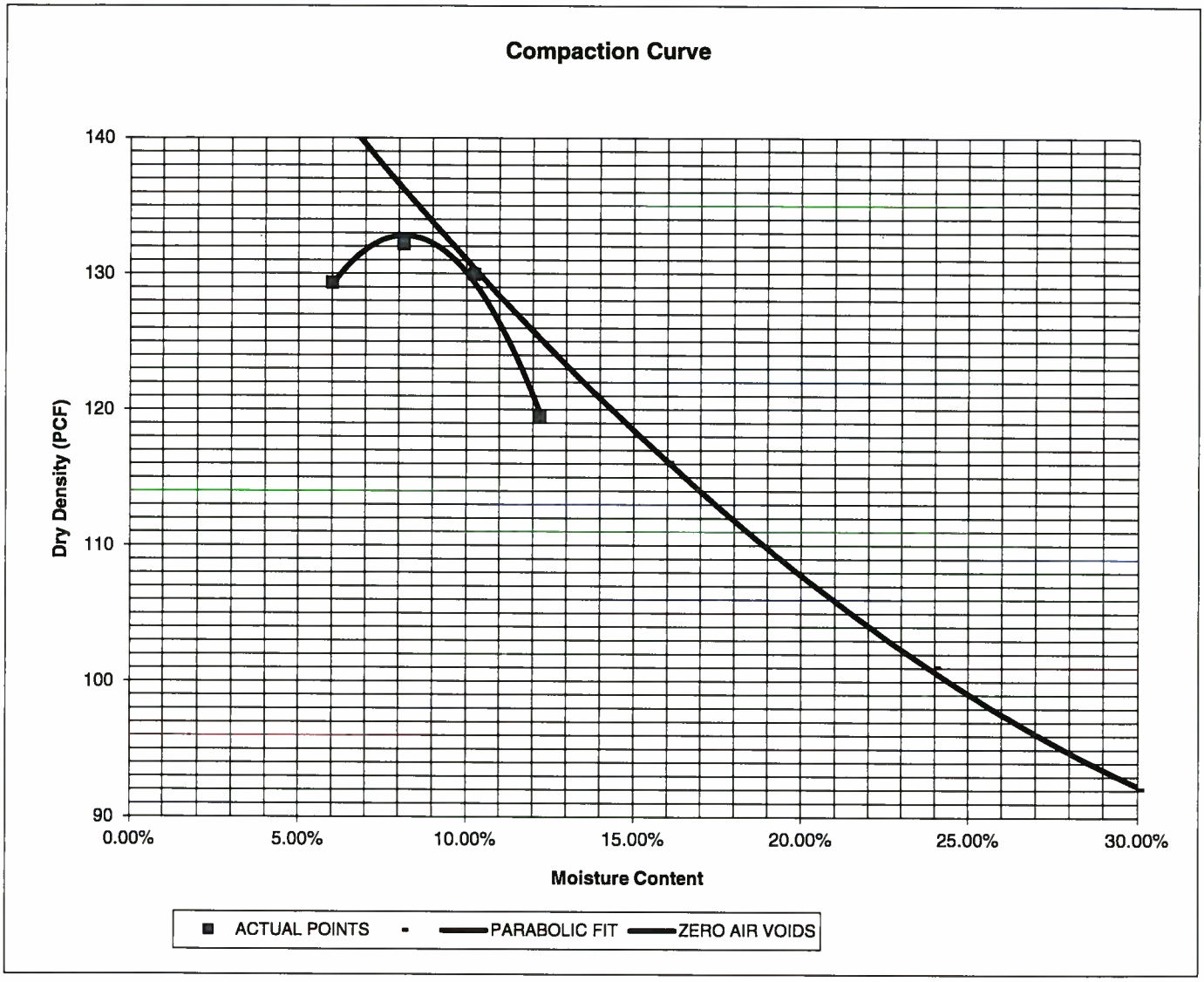
LABORATORY TEST
SULFATE RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 8-9-22

JOB NO.: 220622
FIG NO.: B-23

PROJECT	FOREST LAKES, FILING 7	CLIENT	FLRD
SAMPLE LOCATION	TB-7 @ 0-3'	JOB NO.	220622
SOIL DESCRIPTION	SAND, CLAYEY, RED BROWN	DATE	08/03/22

IDENTIFICATION	SC	COMPACTION TEST #	1
TEST DESIGNATION / METHOD	ASTM D-1557-A	TEST BY	FV
MAXIMUM DRY DENSITY (PCF)	132.2	OPTIMUM MOISTURE	8.1%



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

MOISTURE DENSITY RELATION

DRAWN:	DATE:	CHECKED:	DATE:
		SW	8-9-22

JOB NO.: 220622
FIG NO.: B-24

CBR TEST LOAD DATA

JOB NO: 220622
CLIENT: FLRD
PROJECT: FOREST LAKES, FILING 7
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	121	40.43	242	80.87	523	174.77
0.050	152	50.79	304	101.59	1019	340.52
0.075	195	65.16	389	129.99	1178	393.65
0.100	263	87.89	526	175.77	1664	556.06
0.125	268	89.56	535	178.78	2048	684.38
0.150	291	97.24	581	194.15	2206	737.17
0.175	310	103.59	620	207.18	2265	756.89
0.200	349	116.62	698	233.25	2531	845.78
0.300	431	144.03	862	288.05	3509	1172.59
0.400	499	166.75	991	331.16	4108	1372.76
0.500	589	196.82	1120	374.27	4821	1611.02

FINAL MOISTURE CONTENT

	MOLD #	1	MOLD #	2	MOLD #	3
CAN #		303		345		117
WT. CAN		8.83		8.63		8.4
WT. CAN+WET		115.69		185.87		210.02
WT. CAN+DRY		105.21		164.32		186.85
WT. H20		10.48		21.55		23.17
WT. DRY SOIL		96.38		155.69		178.45
MOISTURE CONTENT		10.87%		13.84%		12.98%
WET DENSITY (PCF)		125.5		134.3		140.7
DRY DENSITY (PCF)		116.1		124.2		130.2
BEARING RATIO		8.79		17.58		55.61
90% OF DRY DENSITY	119.0					
95% OF DRY DENSITY	125.6					

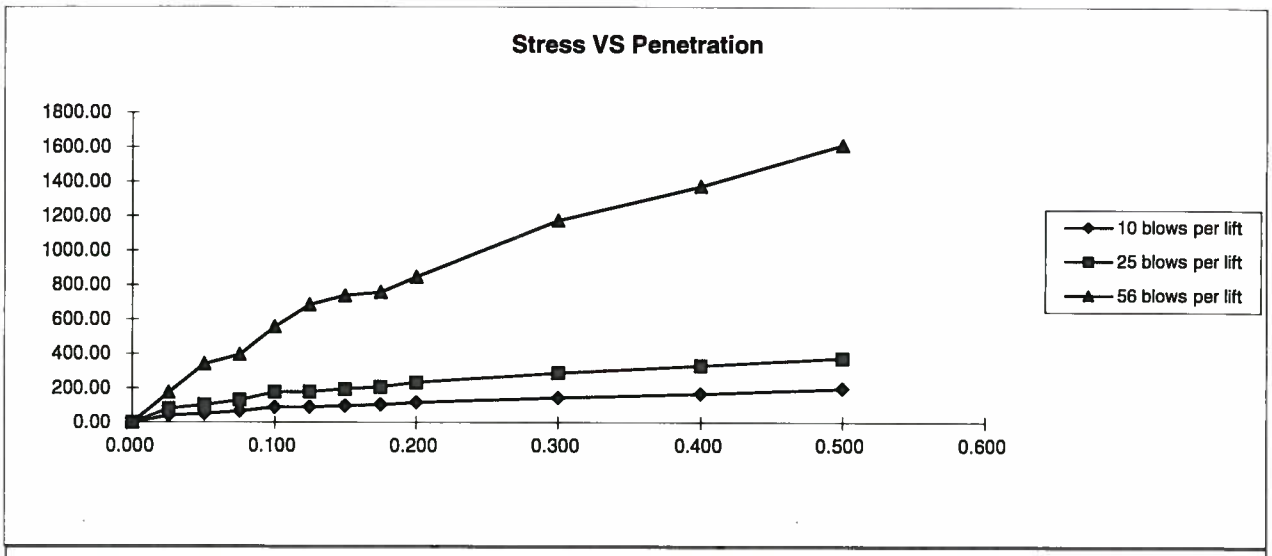
BEARING RATIO AT 90% OF MAX	11.92	~ R VALUE	35
BEARING RATIO AT 95% OF MAX	26.34	~ R VALUE	73

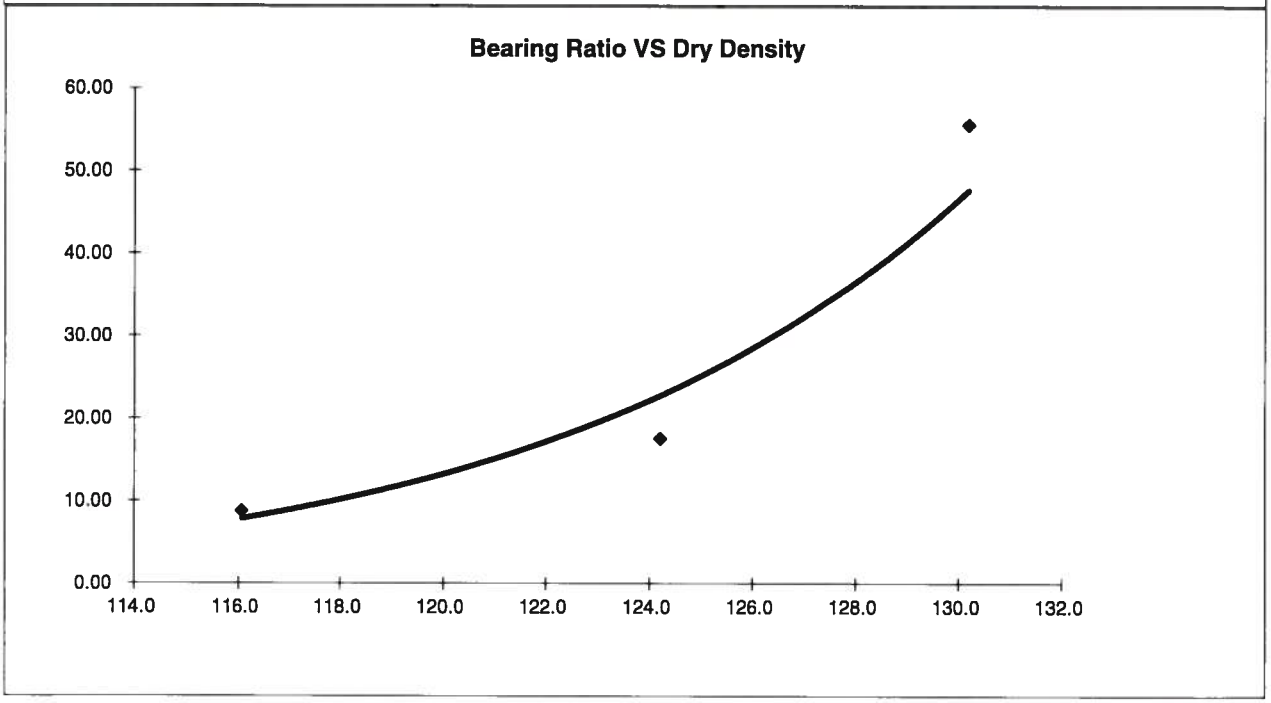
ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

CBR TEST DATA

DRAWN:	DATE:	CHECKED: SW	DATE: 8-9-22

JOB NO.: 220622
FIG NO.: B25.





BEARING RATIO AT 90% OF MAX	11.92	~ R VALUE	35.00
BEARING RATIO AT 95% OF MAX	26.34	~ R VALUE	73.00

JOB NO: 220622
SOIL TYPE: 1

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

CALIFORNIA BEARING RATIO

DRAWN:	DATE:	CHECKED: SW	DATE: 8-9-22

JOB NO.: 220622
FIG NO.: B-26

APPENDIX C: Pavement Design Calculations

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA — FLRD #7 FOREST LAKES FILING 7
SOIL TYPE 1 MESA TOP DRIVE

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. 220622
Fig. No. C-1

DESIGN CALCULATIONS

AGGREGATE BASECOURSE SECTIONS

DESIGN DATA FLRD #7 FOREST LAKES FILING 7
SOIL TYPE 1 MESA TOP DRIVE

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	292,000
Hveem Stabilometer (R Value) Results:	R =	50
Weighted Structural Number (WSN):	WSN =	2.10

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)

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

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = [4] inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 2.9 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. 5.0 inches of Full Depth Asphalt

Job No. 220622
Fig. No. C-2

DESIGN CALCULATIONS

CEMENT TREATED SECTIONS

DESIGN DATA: FLRD #7 FOREST LAKES DRIVE #7
SOIL TYPE 1 MESA TOP DRIVE

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	292,000
Hveem Stabilometer (R Value) Results:	R =	50
Weighted Structural Number (WSN):	WSN =	2.1

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
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 3.1 inches
Use 10.0 inches of Cement Treated Subgrade.

RECOMMENDED ALTERNATIVES

1. 4.0 inches of Asphalt + 10 inches of Cement Treated Subgrade.
2. 5.0 inches of Full Depth Asphalt

Job No. 220622
Fig. No. C-3

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA — FLRD #7 FOREST LAKES FILING 7
SOIL TYPE 1 LOCAL (LOW VOLUME) CUL-DE-SACS

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

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. 220622
Fig No C-4

DESIGN CALCULATIONS

AGGREGATE BASECOURSE SECTIONS

DESIGN DATA FLRD # 7 FOREST LAKES FILING 7
SOIL TYPE 1 LOCAL (LOW VOLUME) CUL-DE-SACS

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 5.0 inches Full Depth

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = [4] inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = -2.6 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. 5.0 inches of Full Depth Asphalt

Job No. 220622
Fig. No. C-5

DESIGN CALCULATIONS

CEMENT TREATED SECTIONS

DESIGN DATA: FLRD #7 FOREST LAKES #7
SOIL TYPE 1 LOCAL (LOW VOLUME)

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 5.0 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 10.0 inches of Cement Treated Subgrade.

RECOMMENDED ALTERNATIVES

1. 4.0 inches of Asphalt + 10 inches of Cement Treated Subgrade.
2. 5.0 inches of Full Depth Asphalt

Job No.220622
Fig. No. C-6