March 18, 2022

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

SR Land, LLC
20 Boulder Crescent, 2nd Floor
Colorado Springs, CO 80903

Attn: Chaz Collins

Re: Pavement Recommendations
Sterling Ranch, Filing No. 2
El Paso County, Colorado

APPROVED
Engineering Department
04/21/2022 9:27:45 AM
dsdnijkamp
EPC Planning & Community
Development Department

*asphalt millings and full depth are not acceptable-- EN, PCD

Dear Mr. Collins:

As requested, Entech Engineering, Inc. has obtained samples of the pavement subgrade soils from the interior roadways in the Sterling Ranch Filing No. 2 subdivision. This letter presents the results of the laboratory testing and pavement recommendations for the roadway sections.

Project Description

The roadways for this project consist of sections of Bynum Drive, Cordgrass Drive, Beaverhead Circle, and Alzada Drive in northeast Colorado Springs, Colorado. Subsurface Soil Investigation and laboratory testing was performed in order to determine the pavement support characteristics of the soils. The limits of this investigation and the approximate locations of the test borings are presented in the Site/Test Boring Location Map, Figure 1.

Subgrade Conditions

Eight test borings were drilled along the above referenced roadways to depths of approximately 5 and 10 feet below the existing subgrade surface. The Test Boring Logs are presented in Appendix A. Sieve Analyses and Atterberg Limit testing were performed on the soil samples obtained from the test borings for the purpose of classification. The percent passing the No. 200 sieve for the soils at subgrade depth ranged from approximately 7 to 31 percent. The soils at the subgrade depth consisted of silty to slightly silty sand fill, native silty sand, and silty sandstone. The subgrade soils are generally underlain with silty to very clayey sandstone. The underlying Type 3 soils were encountered at depths below the subgrade influence zone. Based on the results of the laboratory testing, two general subgrade soil types were determined for the roadway sections at subgrade depths; silty to slightly silty sand fill (Soil Type 1), and silty sandstone (Soil Type 2). The soils classify as A-2-4 and A-1-b soils, based on the AASHTO Classification System. Based on the similar characteristics, Soil Types 1 and 2 were grouped together for laboratory testing. Groundwater was not encountered in any of the test borings.

Based on the subgrade soil characteristics, mitigation of the expansive potential of the subgrade soils will not be required for this site.

California Bearing Ratio (CBR) testing was performed on a representative sample of the Type 1 and 2 subgrade soils. The results of the CBR and classification testing are presented as follows and in Appendix B and on Table 1, attached. Based on the results of the classification and CBR testing, the soils on this site exhibit good pavement support characteristics. The results of the CBR testing and classification testing are presented in Appendix B and are summarized as follows:

Soil Type 1 – Silty Sand Fill

R @ 90% = 35.0
R @ 95% = 74.0
Use R = 50.0 for design*

Classification Testing

Liquid Limit	32
Plasticity Index	8
Percent Passing 200	30.8
AASHTO Classification	A-2-4
Group Index	0
Unified Soils Classification	SM

* The Type 1 slightly silty to silty sand fill and the Type 2 sandstone will be grouped together into one category due to the similarity of the soils.

Pavement Design

CBR testing was used to determine pavement sections for the roadway sections. Pavement sections were determined utilizing Pavement Design Criteria for the El Paso County. The cul-de-sac portion of Beaverhead Circle classifies as a local low-volume road, which used an 18k ESAL value of 36,500 for design. Bynum Drive, Cordgrass Drive, and Beaverhead Circle from Alzada Drive to Cordgrass Drive classify as local roads, which used an 18k ESAL volume of 292,000 for design. Alzada Drive classifies as a residential collector, which used on 18K ESAL value of 821,000 for design. Pavement sections were determined for asphalt supported on aggregate base course, asphalt millings, and on recycled concrete. County approval is required if asphalt millings or recycled concrete are to be utilized. *asphalt millings and full depth are not acceptable, EN, PCD

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

Reliability	
Local (Low-Volume)/Local	80%
Collector	85%
Standard Deviation	0.45
Resilient Modulus	13,168 psi
Δpsi –	
Local (Low-Volume)/Local	2.0
Collector	2.5
"R" Value Subgrade	50
Structural Coefficients	
Hot Bituminous Pavement	0.44
Aggregate Base Course	0.11
Asphalt Millings	0.07
Recycled Concrete	0.09

The pavement design calculations are presented in Appendix C. Pavement section alternatives for the roadway sections are presented below. 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.

Cul-de-sac on Beaverhead Circle – Local (Low-Volume)
Soil Types 1 and 2

Composite Section	Asphalt (in)	Basecourse (in)	Asphalt Millings (in)*	Recycled Concrete (in)*
1. Asphalt Over Basecourse	3.0[1]	4.0[1]	-	-
2. Asphalt Over Asphalt Millings	3.0	-	4.0	-
3. Asphalt Over Recycled Concrete	3.0	-	-	4.0

Bynum Drive, Cordgrass Drive, and Beaverhead Circle (not cul-de-sac) – Local Roadways
Soil Types 1 and 2

Composite Section	Asphalt (in)	Basecourse (in)	Asphalt Millings (in)*	Recycled Concrete (in)*
1. Asphalt Over Basecourse	3.5	8.0	-	-
2. Asphalt Over Asphalt Millings	3.5	-	8.0	-
3. Asphalt Over Recycled Concrete	3.5	-	-	8.0

Alzada Drive – Residential Collector
Soil Types 1 and 2

Composite Section	Asphalt (in)	Basecourse (in)	Asphalt Millings (in)*	Recycled Concrete (in)*
1. Asphalt Over Basecourse	4.0[1]	8.0[1]	-	-
2. Asphalt Over Asphalt Millings	5.0	-	8.0	-
3. Asphalt Over Recycled Concrete	4.5	-	-	8.0

[1]Minimum sections required per the El Paso County specifications.
*County approval pending.

Roadway Construction

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

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

We trust that this report contains the information you require. If you have questions or need additional information, please contact us.

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Daniel P. Stegman

DPS/el

Entech Job No. 220394
AAprojects/2022/220397/220394 pr-int

Reviewed by:

Mark Hauschild, P.E
Senior Engineer

TABLE

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT SR LAND
PROJECT STERLING RANCH, F-2
JOB NO. 220394

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			30.8	32	8		A-2-4		SM	FILL, SAND, SILTY
1	1	1-2			9.1	NV	NP		A-1-b		SM-SW	FILL, SAND, SLIGHTLY SILTY
1	2	1-2			10.5	NV	NP	<0.01	A-1-b		SM-SW	FILL, SAND, SLIGHTLY SILTY
1	3	1-2			5.9	NV	NP		A-1-b		SM-SW	FILL, SAND, SLIGHTLY SILTY
1	4	1-2			8.4	NV	NP		A-1-b		SM-SW	FILL, SAND, SLIGHTLY SILTY
1	5	1-2			6.6	NV	NP	<0.01	A-1-b		SM-SW	FILL, SAND, SLIGHTLY SILTY
1	6	1-2			18.3	NV	NP		A-1-b		SM	FILL, SAND, SILTY
1	7	1-2			23.9	NV	NP		A-2-4		SM	FILL, SAND, SILTY
2	8	1-2			15.3	NV	NP		A-2-4		SM	SANDSTONE, SILTY
2	7	10			15.6	NV	NP		A-1-b		SM	SANDSTONE, SILTY
3	4	10			42.9	36	18	<0.01	A-6		SC	SANDSTONE, VERY CLAYEY

FIGURE

SOIL TYPE:

RESIDENTIAL COLLECTOR (ESAL=821,000)
4.0" ASPHALT ON 8.0" BASE COURSE

LOCAL (ESAL=292,000)
3.5" ASPHALT ON 8.0" BASE COURSE

LOCAL LOW-VOLUME (ESAL=36,500)
3.0" ASPHALT ON 4.0" BASE COURS

TB- APPROXIMATE TEST BORING LOCATION AND NUMBER

-SEE REPORT FOR ASPHALT MILLINGS AND RECYCLED CONCRETE SECTIONS.

TB-1
TB-2
TB-3
TB-4
TB-5
TB-6
TB-7
TB-8

APPROXIMATE LIMITS OF INVESTIGATION

APPROXIMATE LIMITS OF INVESTIGATION

REVISION	BY

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COLORADO SPRINGS, CO. 80907

SITE/TEST BORING LOCATION MAP
STERLING RANCH FILING #2
COLORADO SPRINGS, CO.
FOR: SR LAND LLC

DRAWN	JAC
CHECKED	DPS
DATE	3/17/22
SCALE	NOT TO SCALE
JOB NO.	220394
FIGURE No.	1

APPENDIX A: Test Boring Logs

TEST BORING NO. 1
DATE DRILLED 2/21/2022
Job # 220394

REMARKS

DRY TO 10', 2/21/22

FILL 0-10', SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			19	6.4	1
5			23	4.4	1
10			20	5.7	1
15					
20					

TEST BORING NO. 2
DATE DRILLED 2/21/2022
CLIENT SR LAND
LOCATION STERLING RANCH, F-2

REMARKS

DRY TO 5', 2/21/22

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

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			16	8.2	1
5			9	8.7	1
10					
15					
20					

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TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
		DS	3/18/22

JOB NO.: 220394
FIG NO.: A- 1

TEST BORING NO. 3
DATE DRILLED 2/21/2022
Job # 220394

REMARKS

DRY TO 5', 2/21/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			15	4.3	1
5			17	7.8	1
10					
15					
20					

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

TEST BORING NO. 4
DATE DRILLED 2/21/2022
CLIENT SR LAND
LOCATION STERLING RANCH, F-2

REMARKS

DRY TO 10', 2/21/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			15	5.0	1
5			39	7.2	1A
10			50/10"	10.1	3
15					
20					

FILL 0-4', SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST

SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, GRAY BROWN, DENSE, MOIST

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

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TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
		DS	3/16/22

JOB NO.: 220394
FIG NO.: A- 2

TEST BORING NO. 5
DATE DRILLED 2/21/2022
Job # 220394

REMARKS

DRY TO 5', 2/21/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
			14	5.6	1	FILL 0-5', SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST
5			22	6.4	1	
10						
15						
20						

TEST BORING NO. 6
DATE DRILLED 2/21/2022
CLIENT SR LAND
LOCATION STERLING RANCH, F-2

REMARKS

DRY TO 5', 2/21/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
			15	8.2	1	FILL 0-5', SAND, SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE TO LOOSE, MOIST
5			5	7.0	1	
10						
15						
20						

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TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
		DS	3/10/22

JOB NO.: 220394
FIG NO.: A- 3

TEST BORING NO. 7
DATE DRILLED 2/21/2022
Job # 220394

REMARKS

DRY TO 10', 2/21/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
						FILL 0-10', SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST
			17	16.5	1	
5			17	8.0	1	
10			50/11"	13.8	2	SANDSTONE, SILTY, FINE TO COARSE GRAINED, GRAY BROWN, VERY DENSE, MOIST
15						
20						

TEST BORING NO. 8
DATE DRILLED 2/21/2022
CLIENT SR LAND
LOCATION STERLING RANCH, F-2

REMARKS

DRY TO 5', 2/21/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
					1	SAND, SILTY, TAN
			48	10.9	2	WEATHERED TO FORMATIONAL SANDSTONE, SILTY, FINE TO COARSE GRAINED, TAN, DENSE
5			50/8"	7.2	2	TO VERY DENSE, MOIST
10						
15						
20						

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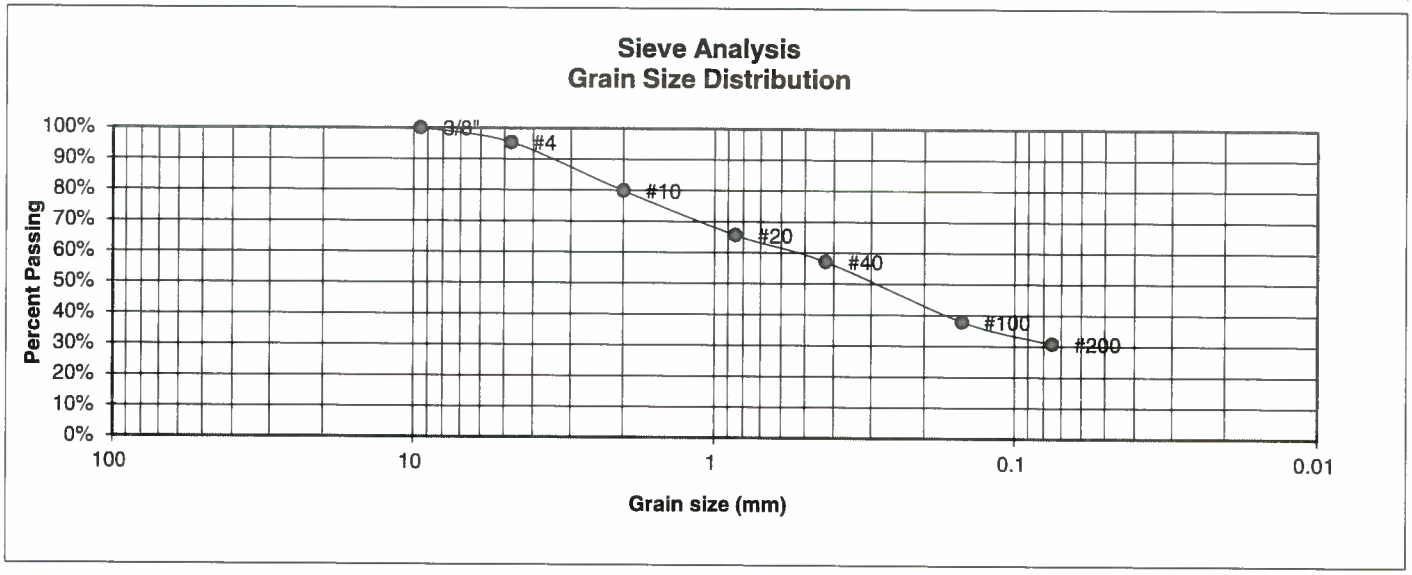
TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
		DS	3/18/22

JOB NO.: 220394
FIG NO.: A- 4

APPENDIX B: Laboratory Test Results

UNIFIED CLASSIFICATION	SM	CLIENT	SR LAND
SOIL TYPE #	1, CBR	PROJECT	STERLING RANCH, F-2
TEST BORING #	7	JOB NO.	220394
DEPTH (FT)	0-3	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	95.3%
10	79.8%
20	65.6%
40	57.1%
100	37.9%
200	30.8%

Atterberg Limits

Plastic Limit	24
Liquid Limit	32
Plastic Index	8

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)

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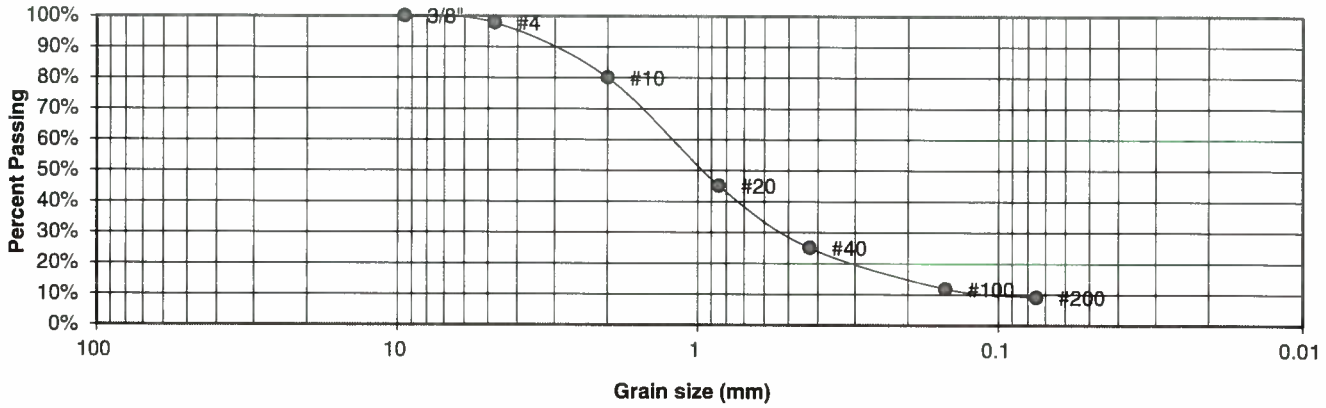
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		DS	3/16/22

JOB NO.: 220394
FIG NO.: B-1

UNIFIED CLASSIFICATION	SM-SW	CLIENT	SR LAND
SOIL TYPE #	1	PROJECT	STERLING RANCH, F-2
TEST BORING #	1	JOB NO.	220394
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	97.8%
10	80.0%
20	45.1%
40	25.1%
100	11.8%
200	9.1%

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)	

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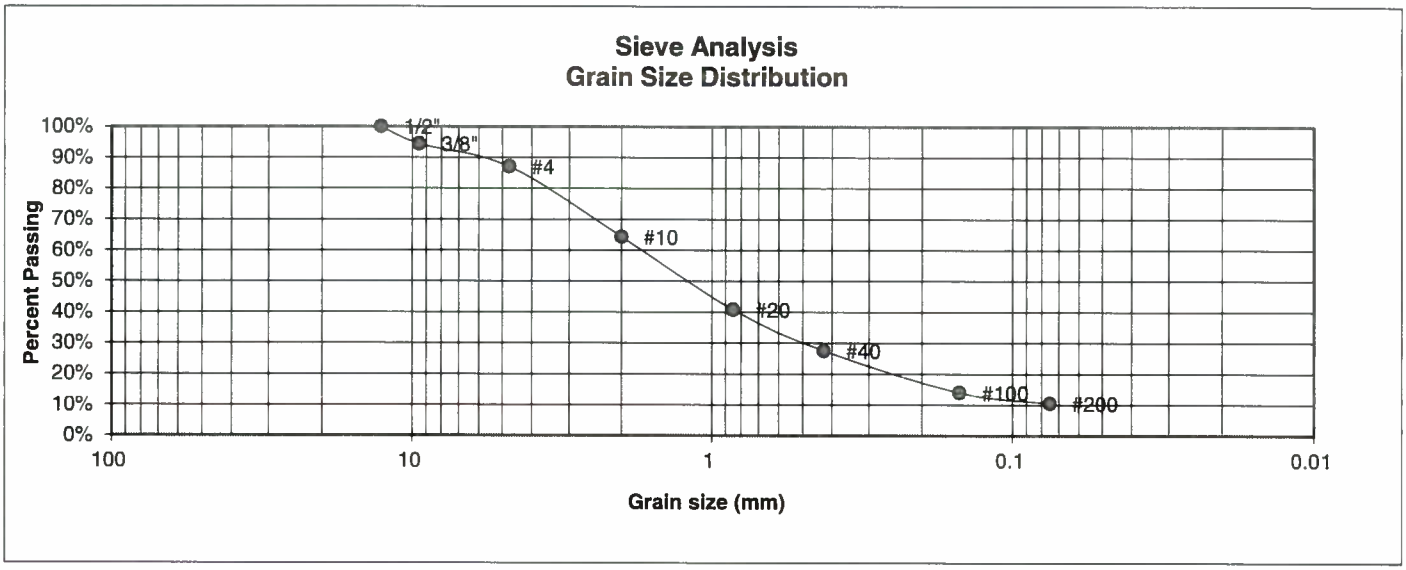
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		DS	3/16/22

JOB NO.: 220394
FIG NO.: B-2

UNIFIED CLASSIFICATION	SM-SW	CLIENT	SR LAND
SOIL TYPE #	1	PROJECT	STERLING RANCH, F-2
TEST BORING #	2	JOB NO.	220394
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	94.4%
4	87.1%
10	64.3%
20	40.8%
40	27.5%
100	13.9%
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)

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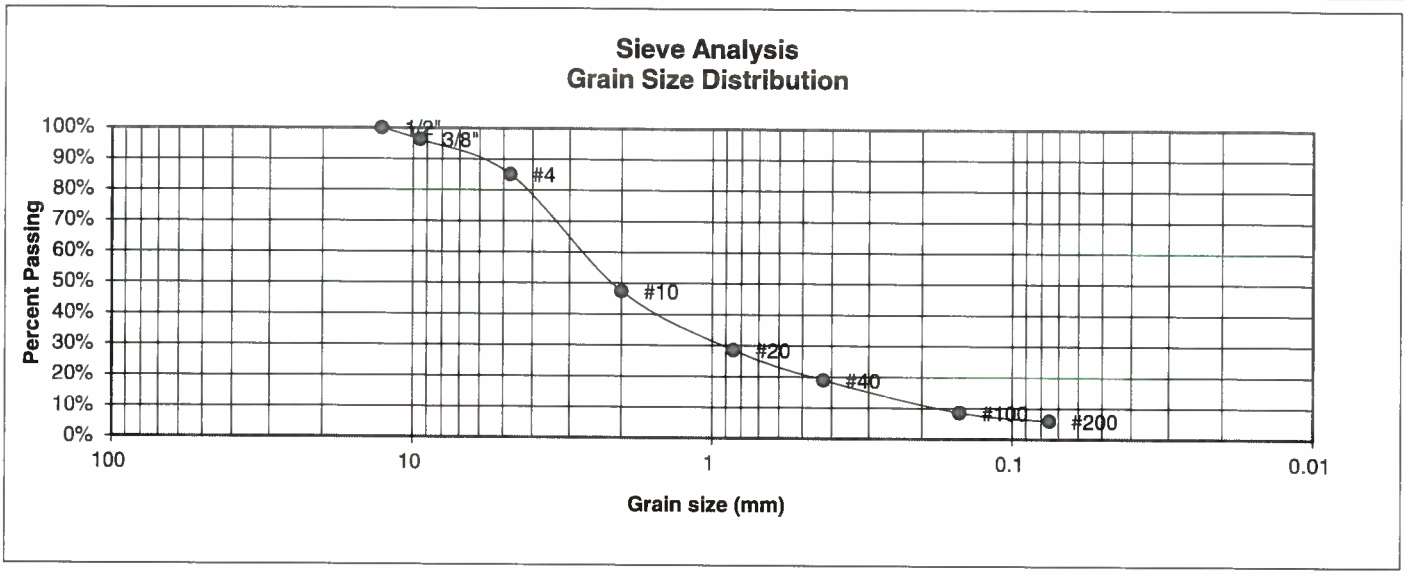
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		DS	3/16/22

JOB NO.: 220394
FIG NO.: B-3

UNIFIED CLASSIFICATION	SM-SW	CLIENT	SR LAND
SOIL TYPE #	1	PROJECT	STERLING RANCH, F-2
TEST BORING #	3	JOB NO.	220394
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	96.2%
4	85.1%
10	47.4%
20	28.5%
40	18.9%
100	8.5%
200	5.9%

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)

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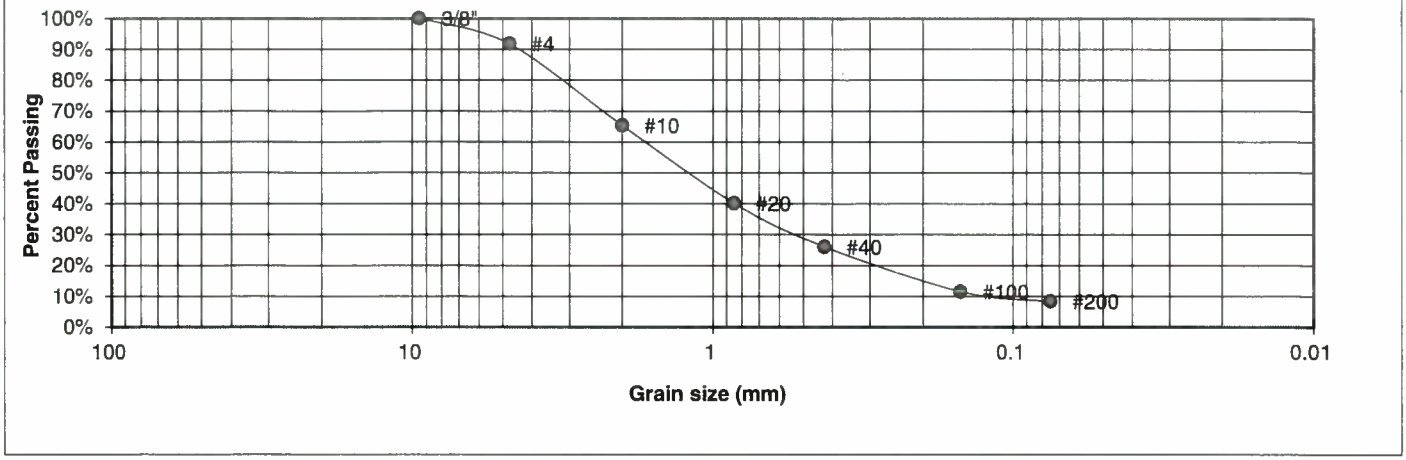
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		DS	3/16/22

JOB NO.: 220394
FIG NO.: B-4

UNIFIED CLASSIFICATION	SM-SW	CLIENT	SR LAND
SOIL TYPE #	1	PROJECT	STERLING RANCH, F-2
TEST BORING #	4	JOB NO.	220394
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	91.8%
10	65.4%
20	40.2%
40	26.0%
100	11.5%
200	8.4%

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.
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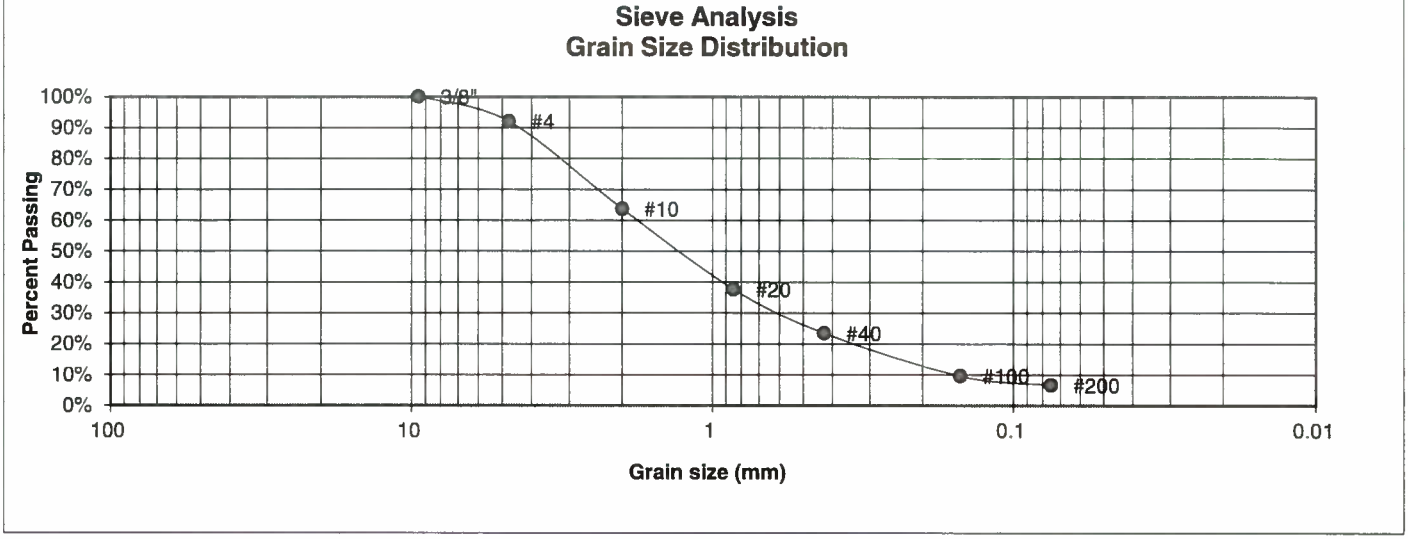
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		DS	3/16/22

JOB NO.: 220394
FIG NO.: B-5

UNIFIED CLASSIFICATION	SM-SW	CLIENT	SR LAND
SOIL TYPE #	1	PROJECT	STERLING RANCH, F-2
TEST BORING #	5	JOB NO.	220394
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	92.0%
10	63.7%
20	37.7%
40	23.4%
100	9.6%
200	6.6%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell

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

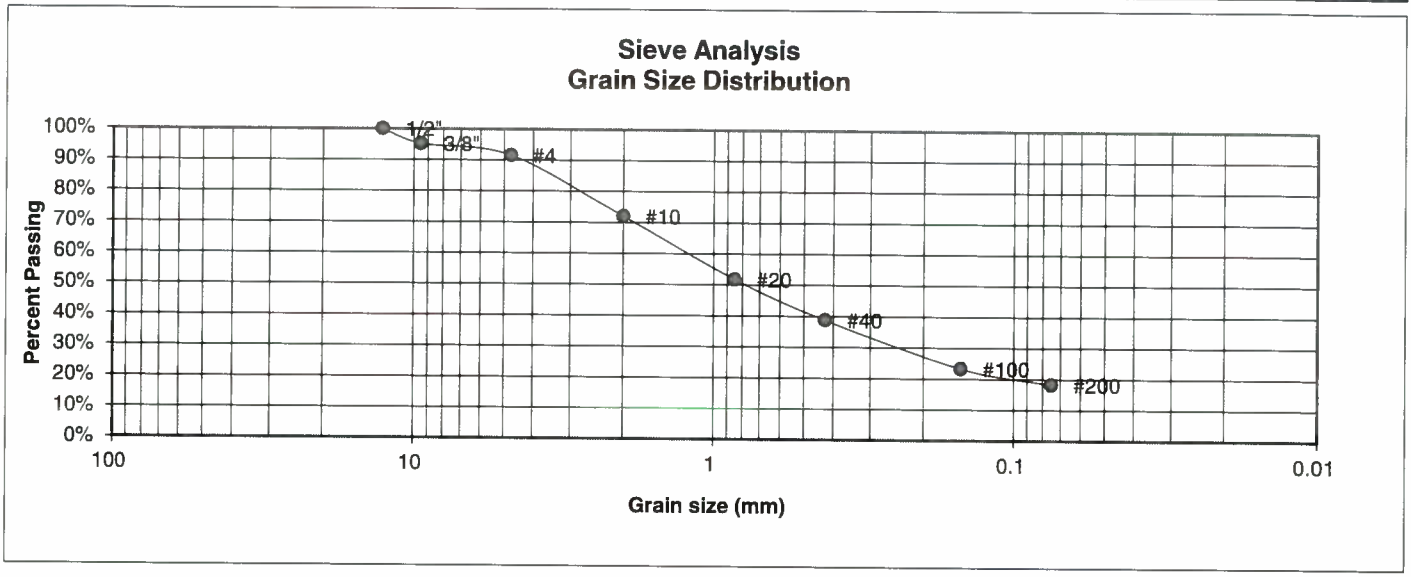
ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		DS	3/16/22

JOB NO.: 220394
FIG NO.: B-6

UNIFIED CLASSIFICATION	SM	CLIENT	SR LAND
SOIL TYPE #	1	PROJECT	STERLING RANCH, F-2
TEST BORING #	6	JOB NO.	220394
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	95.2%
4	91.5%
10	72.0%
20	51.8%
40	38.8%
100	23.3%
200	18.3%

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)

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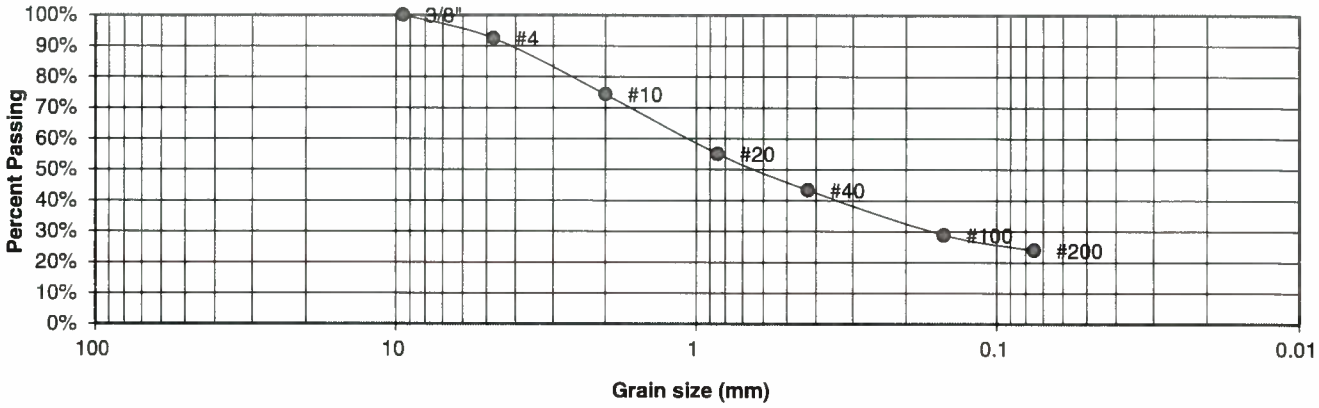
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		DS	3/16/22

JOB NO.: 220394
FIG NO.: B-7

UNIFIED CLASSIFICATION	SM	CLIENT	SR LAND
SOIL TYPE #	1	PROJECT	STERLING RANCH, F-2
TEST BORING #	7	JOB NO.	220394
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	92.4%
10	74.4%
20	55.1%
40	43.4%
100	28.9%
200	23.9%

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)	

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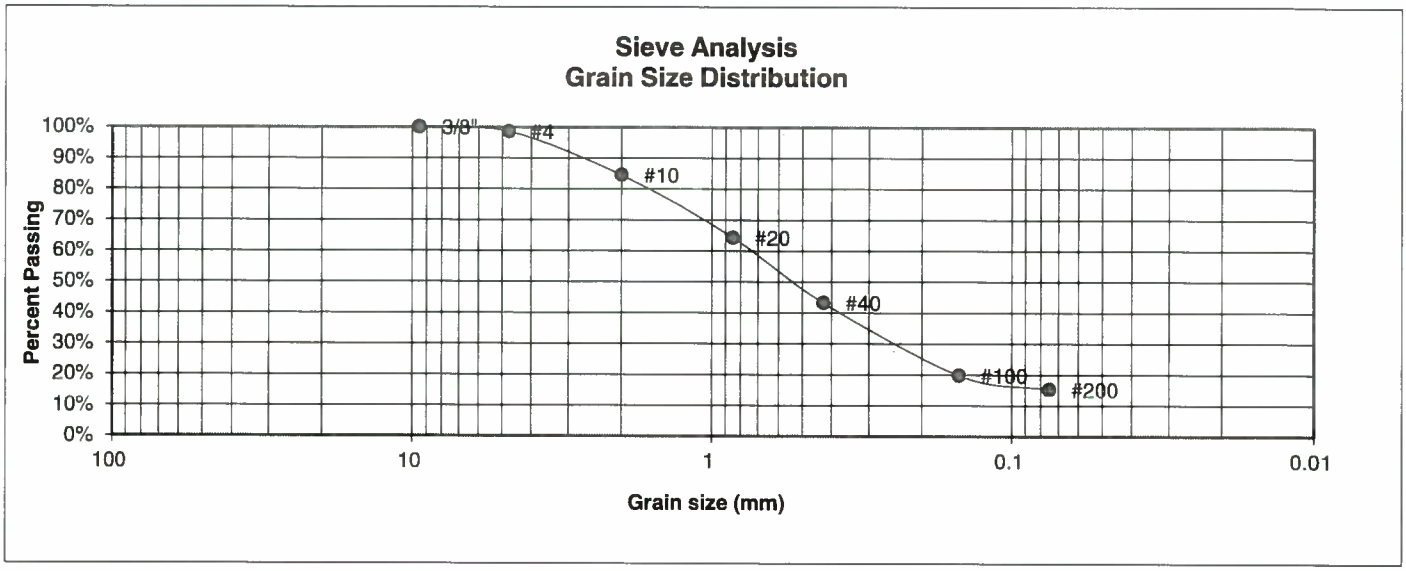
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		DS	3/16/22

JOB NO.: 220394
FIG NO.: B-8

UNIFIED CLASSIFICATION	SM	CLIENT	SR LAND
SOIL TYPE #	2	PROJECT	STERLING RANCH, F-2
TEST BORING #	8	JOB NO.	220394
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.6%
10	84.5%
20	64.3%
40	43.2%
100	19.8%
200	15.3%

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)	

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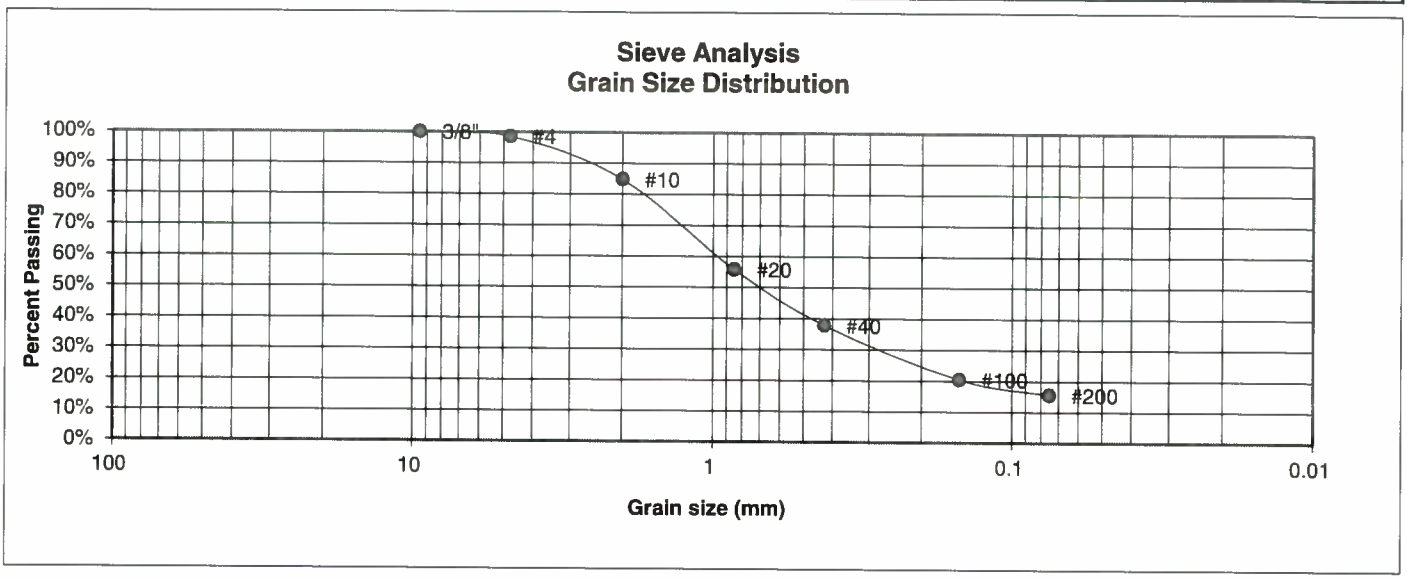
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		DS	3/16/22

JOB NO.: 220394
FIG NO.: B-9

UNIFIED CLASSIFICATION	SM	CLIENT	SR LAND
SOIL TYPE #	2	PROJECT	STERLING RANCH, F-2
TEST BORING #	7	JOB NO.	220394
DEPTH (FT)	10	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.5%
10	84.8%
20	55.8%
40	37.8%
100	20.4%
200	15.6%

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)

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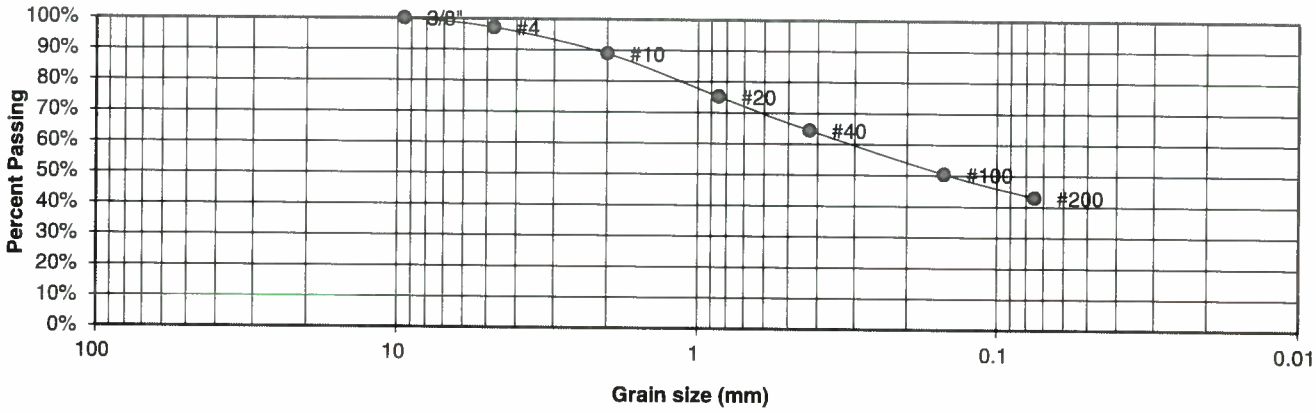
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		DJ	3/16/22

JOB NO.: 220394
FIG NO.: B-16

UNIFIED CLASSIFICATION	SC	CLIENT	SR LAND
SOIL TYPE #	3	PROJECT	STERLING RANCH, F-2
TEST BORING #	4	JOB NO.	220394
DEPTH (FT)	10	TEST BY	BL
AASHTO CLASSIFICATION	A-6	GROUP INDEX	4



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.1%
10	88.9%
20	75.2%
40	64.4%
100	50.5%
200	42.9%

Atterberg Limits	
Plastic Limit	17
Liquid Limit	36
Plastic Index	18

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

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LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		DS	3/16/22

JOB NO.: 220394
FIG NO.: B-11

CLIENT	SR LAND	JOB NO.	220394
PROJECT	STERLING RANCH, F-2	DATE	2/25/2022
LOCATION	STERLING RANCH, F-2	TEST BY	BL

BORING NUMBER	DEPTH, (ft)	SOIL TYPE NUMBER	UNIFIED CLASSIFICATION	WATER SOLUBLE SULFATE, (wt%)
TB-2	1-2	1	SM-SW	<0.01
TB-5	1-2	1	SM-SW	<0.01
TB-4	10	2	SC	<0.01

QC BLANK PASS

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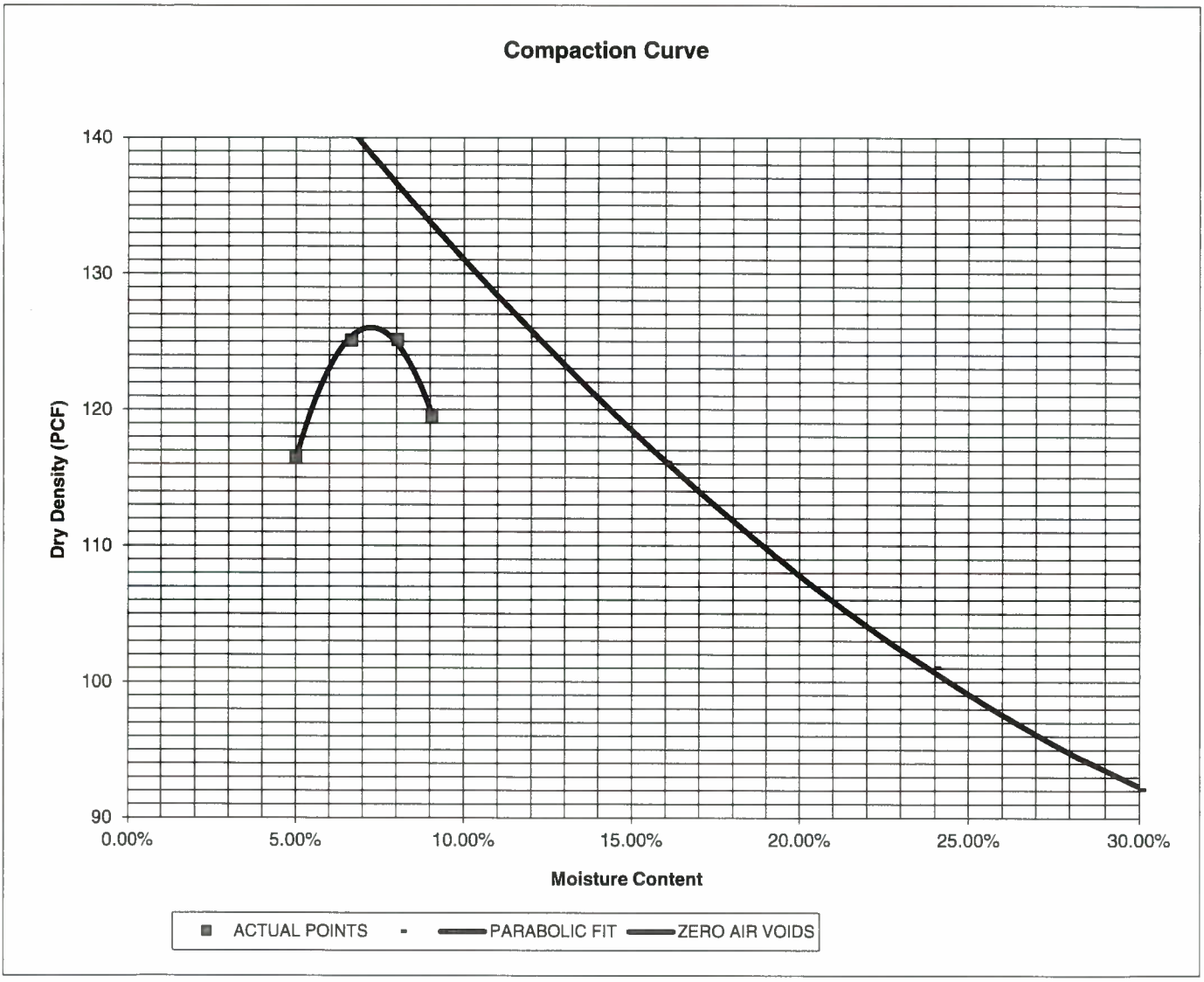
LABORATORY TEST
SULFATE RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		DS	3/14/22

JOB NO.: 220394
FIG NO.: B-12

PROJECT	STERLING RANCH, F-2	CLIENT	SR LAND
SAMPLE LOCATION	TB-7 @ 0-3'	JOB NO.	220394
SOIL DESCRIPTION	FILL, SAND, SILTY, BROWN	DATE	02/24/22

IDENTIFICATION	SM	COMPACTION TEST #	1
TEST DESIGNATION / METHOD	ASTM D-1557-A	TEST BY	AL
MAXIMUM DRY DENSITY (PCF)	126.1	OPTIMUM MOISTURE	7.1%



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MOISTURE DENSITY RELATION

DRAWN:	DATE:	CHECKED:	DATE:
		DS	3/16/22

JOB NO.: 220394
FIG NO.: B-13

CBR TEST LOAD DATA

JOB NO: 220394
CLIENT: SR LAND
PROJECT: STERLING RANCH, F-2
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	151	50.46	310	103.59	330	110.28
0.050	226	75.52	628	209.86	824	275.35
0.075	294	98.25	802	268.00	1088	363.57
0.100	370	123.64	1014	338.85	1498	500.58
0.125	380	126.98	1132	378.28	2008	671.01
0.150	422	141.02	1241	414.70	2441	815.70
0.175	443	148.04	1319	440.77	2720	908.94
0.200	463	154.72	1434	479.20	3238	1082.04
0.300	518	173.10	1766	590.14	4017	1342.35
0.400	576	192.48	2010	671.68	4553	1521.47
0.500	659	220.22	2279	761.57	5018	1676.85

FINAL MOISTURE CONTENT

	MOLD # 1	MOLD # 2	MOLD # 3
CAN #	345	348	340
WT. CAN	8.51	6.9	8.56
WT. CAN+WET	283.37	247.82	210.63
WT. CAN+DRY	252.67	22.68	192.34
WT. H20	30.7	225.14	18.29
WT. DRY SOIL	244.16	15.78	183.78
MOISTURE CONTENT	12.57%	1426.74%	9.95%

WET DENSITY (PCF)	121.9	128.2	135.2
DRY DENSITY (PCF)	113.8	119.7	126.3

BEARING RATIO		12.36	33.88	50.06
90% OF DRY DENSITY	113.5			
95% OF DRY DENSITY	119.8			

BEARING RATIO AT 90% OF MAX	11.06	~ R VALUE	35
BEARING RATIO AT 95% OF MAX	34.01	~ R VALUE	74

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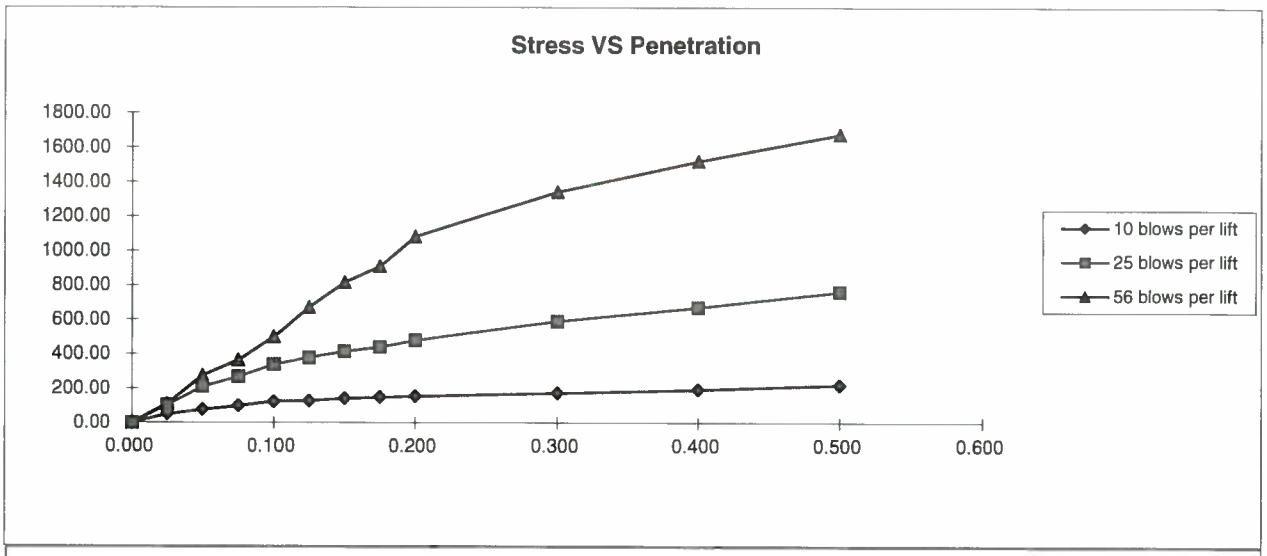
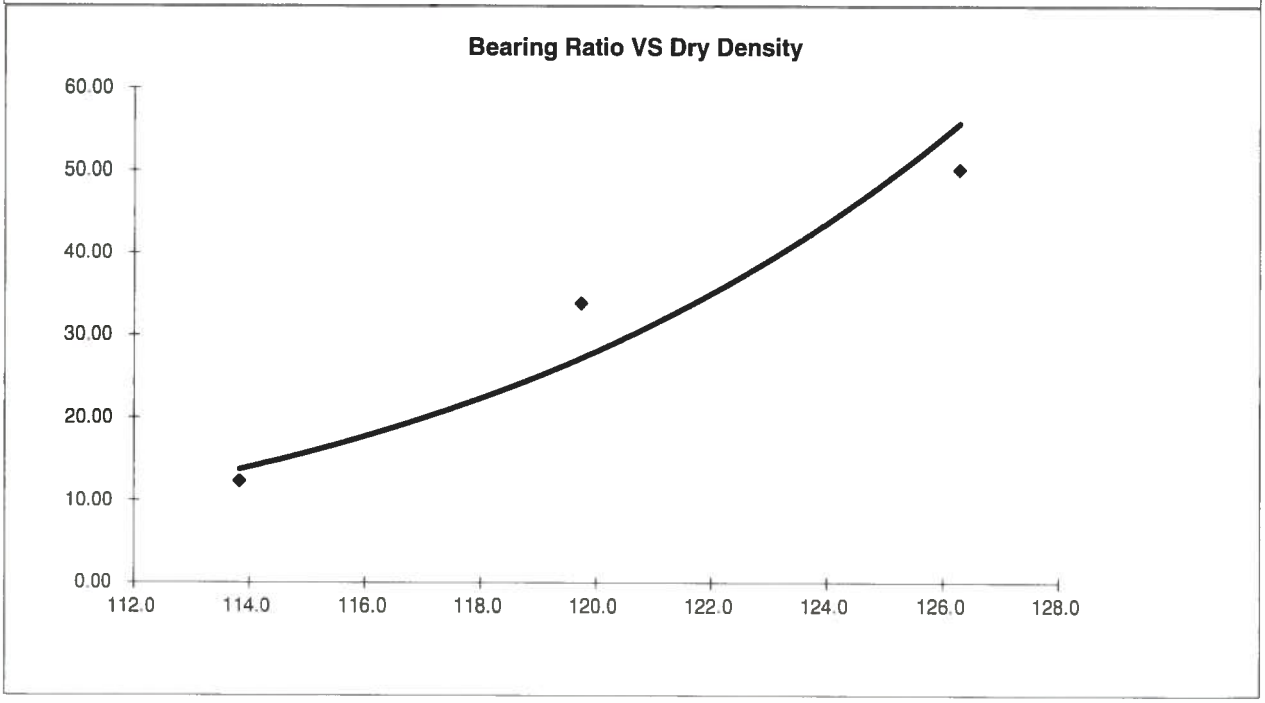
COLORADO SPRINGS, COLORADO 80907

CBR TEST DATA

DRAWN:	DATE:	CHECKED:	DATE:
		DS	3/16/22

JOB NO.: 220394
FIG NO.: B-14





BEARING RATIO AT 90% OF MAX	11.06	~ R VALUE	35.00
BEARING RATIO AT 95% OF MAX	34.01	~ R VALUE	74.00

JOB NO: 220394
SOIL TYPE: 1

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CALIFORNIA BEARING RATIO

DRAWN:	DATE:	CHECKED:	DATE:
		DS	3/16/22

JOB NO.: 220394
FIG NO.: B-15

APPENDIX C: Pavement Design Calculations

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA

SR LAND, LLC - SOIL TYPE 1 - LOCAL (LOW-VOLUME)
BEAVERHEAD CIRCLE CUL-DE-SAC

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. 220394
Fig. No. C-1

DESIGN CALCULATIONS

AGGREGATE BASE COURSE

DESIGN DATA

SR LAND, LLC - SOIL TYPE 1 - LOCAL (LOW-VOLUME)
BEAVERHEAD CIRCLE CUL-DE-SAC

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

$D_1 = (WSN)/C_1$ = 3.3 inches of Full Depth Asphalt
Use 3.5 inches Full Depth

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

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

RECOMMENDED ALTERNATIVES

1. 3.0 inches of Asphalt + 4.0 inches of Aggregate Base Course, or
3. 3.5 inches of Asphalt

Job No. 220394
Fig. No. C-2

DESIGN CALCULATIONS

ASPHALT MILLINGS

DESIGN DATA

SR LAND, LLC - SOIL TYPES 1 AND 2 - LOCAL (LOW-VOLUME)
BEAVERHEAD CIRCLE CUL-DE-SAC

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 = 0.07 Strength Coefficient - Asphalt Millings

D_1 = Depth of Asphalt (inches)
D_2 = Depth of Asphalt Millings (inches)

FOR FULL DEPTH ASPHALT SECTION

$D_1 = (WSN)/C_1$ = 3.3 inches of Full Depth Asphalt
Use 3.5 inches Full Depth

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = [3] inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 2.0 inches of Asphalt Millings
Asphalt Millings, use 4.0 inches

RECOMMENDED ALTERNATIVES

1. 3.0 inches of Asphalt + 4.0 inches of Asphalt Millings, or
2. 3.5 inches of Asphalt

Job No. 220394
Fig. No. C-3

DESIGN CALCULATIONS

RECYCLED CONCRETE

DESIGN DATA

SR LAND, LLC - SOIL TYPE 1 AND 2 - LOCAL (LOW-VOLUME)
BEAVERHEAD CIRCLE CUL-DE-SAC

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 = 0.09 Strength Coefficient - Recycled Concrete

D_1 = Depth of Asphalt (inches)
D_2 = Depth of Recycled Concrete (inches)

FOR FULL DEPTH ASPHALT SECTION

$D_1 = (WSN)/C_1$ = 3.3 inches of Full Depth Asphalt
Use 3.5 inches Full Depth

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = [3] inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 1.6 inches of Recycled Concrete
Recycled Concrete, use 4.0 inches

RECOMMENDED ALTERNATIVES

1. 3.0 inches of Asphalt + 4.0 inches of Recycled Concrete, or
2. 3.5 inches of Asphalt

Job No. 220394
Fig. No. C-4

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA

SR LAND, LLC - SOIL TYPE 1 AND 2 - LOCAL
BEAVERHEAD CIRCLE, CORDGRASS DRIVE AND BYNUM 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 = 2.09

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	5.46	0.0

Job No. 220394
Fig. No. C-5

DESIGN CALCULATIONS

AGGREGATE BASE COURSE

DESIGN DATA

SR LAND, LLC - SOIL TYPE 1 - LOCAL
BEAVERHEAD CIRCLE, CORDGRASS DRIVE, AND BYNUM DRIVE

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

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

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

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

FOR FULL DEPTH ASPHALT SECTION

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

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = [3.5] inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 5.0 inches of Aggregate
Base Course, use 8.0 inches

RECOMMENDED ALTERNATIVES

1. 3.5 inches of Asphalt + 8.0 inches of Aggregate Base Course, or
3. 5.0 inches of Asphalt

Job No. 220394
Fig. No. C-6

DESIGN CALCULATIONS

ASPHALT MILLINGS

DESIGN DATA

SR LAND, LLC - SOIL TYPES 1 AND 2 - LOCAL
BEAVERHEAD CIRCLE, CORDGRASS DRIVEAND BYNUM DRIVE

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

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

C_1 = 0.44 Strength Coefficient - Hot Bituminous Asphalt
C_2 = 0.07 Strength Coefficient - Asphalt Millings

D_1 = Depth of Asphalt (inches)
D_2 = Depth of Asphalt Millings (inches)

FOR FULL DEPTH ASPHALT SECTION

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

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = 3.5 inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 7.9 inches of Asphalt Millings
Asphalt Millings, use 8.0 inches

RECOMMENDED ALTERNATIVES

1. 3.5 inches of Asphalt + 8.0 inches of Asphalt Millings, or
2. 5.0 inches of Asphalt

Job No. 220394
Fig. No. C-7

DESIGN CALCULATIONS

RECYCLED CONCRETE

DESIGN DATA

SR LAND, LLC - SOIL TYPE 1 AND 2 - LOCAL
BEAVERHEAD CIRCLE, CORDGRASS DRIVE AND BYNUM DRIVE

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

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

C_1 = 0.44 Strength Coefficient - Hot Bituminous Asphalt
C_2 = 0.09 Strength Coefficient - Recycled Concrete

D_1 = Depth of Asphalt (inches)
D_2 = Depth of Recycled Concrete (inches)

FOR FULL DEPTH ASPHALT SECTION

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

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = [3.5] inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 6.2 inches of Recycled Concrete
Recycled Concrete, use 8.0 inches

RECOMMENDED ALTERNATIVES

1. 3.5 inches of Asphalt + 8.0 inches of Recycled Concrete, or
2. 5.0 inches of Asphalt

Job No. 220394
Fig. No. C-8

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA

SR LAND, LLC - SOIL TYPES 1 AND 2 - RESIDENTIAL COLLECTOR
ALZADA DRIVE

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

Weighted Structural Number (WSN): → WSN = 2.52

DESIGN TABLES AND EQUATIONS

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

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

$k = M_R / 19.4$

Where:

M_R = resilient modulus (psi)

S_1 = the soil support value

R = R-value obtained from the Hveem stabilometer

CBR = California Bearing Ratio

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

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

Left	Right	Difference
5.91	5.91	0.0

Job No. 220394
Fig. No. C-9

DESIGN CALCULATIONS

AGGREGATE BASE COURSE

DESIGN DATA

SR LAND, LLC - SOIL TYPES 1 AND 2 - RESIDENTIAL COLLECTOR
ALZADA DRIVE

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	821,000
Hveem Stabilometer (R Value) Results:	R =	50
Weighted Structural Number (WSN):	WSN =	2.52

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

$D_1 = (WSN)/C_1$ = 5.7 inches of Full Depth Asphalt
Use 6.0 inches Full Depth

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = [4] inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 6.9 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
3. 6.0 inches of Asphalt

Job No. 220394
Fig. No. C-10

DESIGN CALCULATIONS

ASPHALT MILLINGS

DESIGN DATA

SR LAND, LLC - SOIL TYPE 1 AND 2 - RESIDENTIAL COLLECTOR
ALZADA DRIVE

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	821,000
Hveem Stabilometer (R Value) Results:	R =	50
Weighted Structural Number (WSN):	WSN =	2.52

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

C_1 = 0.44 Strength Coefficient - Hot Bituminous Asphalt
C_2 = 0.07 Strength Coefficient - Asphalt Millings

D_1 = Depth of Asphalt (inches)
D_2 = Depth of Asphalt Millings (inches)

FOR FULL DEPTH ASPHALT SECTION

$D_1 = (WSN)/C_1$ = 5.7 inches of Full Depth Asphalt
Use 6.0 inches Full Depth

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = [5] inches
4.5))/C_2 = 4.5 inches of Asphalt Millings
Asphalt Millings, use 8.0 inches

RECOMMENDED ALTERNATIVES

1. 5.0 inches of Asphalt + 8.0 inches of Asphalt Millings, or
2. 6.0 inches of Asphalt

Job No. 220394
Fig. No. C-11

DESIGN CALCULATIONS

RECYCLED CONCRETE

DESIGN DATA

SR LAND, LLC - SOIL TYPE 1 AND 2 - RESIDENTIAL COLLECTOR
ALZADA SRIVE

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL = 821,000
Hveem Stabilometer (R Value) Results:	R = 50
Weighted Structural Number (WSN):	WSN = 2.52

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

C_1 = 0.44 Strength Coefficient - Hot Bituminous Asphalt
C_2 = 0.09 Strength Coefficient - Recycled Concrete

D_1 = Depth of Asphalt (inches)
D_2 = Depth of Recycled Concrete (inches)

FOR FULL DEPTH ASPHALT SECTION

$D_1 = (WSN)/C_1$ = 5.7 inches of Full Depth Asphalt
Use 6.0 inches Full Depth

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = [4.5] inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 6.0 inches of Recycled Concrete
Recycled Concrete, use 8.0 inches

RECOMMENDED ALTERNATIVES

1. 4.5 inches of Asphalt + 8.0 inches of Recycled Concrete, or
2. 6.0 inches of Asphalt

Job No. 220394
Fig. No. C-12