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PAVEMENT DESIGN REPORT

APPROVED
Engineering Department
09/20/2022 3:05:50 PM
dsdnijkamp
EPC Planning & Community
Development Department

Meadowbrook Parkway
El Paso County, Colorado

PREPARED FOR:

Colorado Springs Equities LLC
90 South Cascade Avenue, 1500
Colorado Springs, CO 80903

JOB NO. 188737

August 24, 2022
Revised: September 13, 2022

Respectfully Submitted,

RMG – Rocky Mountain Group

Jared McElmeel, E.I.
Geotechnical Staff Engineer

Reviewed by,

RMG – Rocky Mountain Group

COLORADO REGISTERED
ANTHONY P. MUNGER
9/15/22
39818
PROFESSIONAL ENGINEER

Tony Munger, P.E.
Sr. Geotechnical Project Manager

PCD File No. SF-21-029

TABLE OF CONTENTS

GENERAL SITE AND PROJECT DESCRIPTION

Location

Meadowbrook Parkway is generally located north and east of the intersection of Peterson Road and Space Village Avenue, in the eastern portion of Colorado Springs, Colorado. The location of the site is shown on the Site Vicinity Map, Figure 1.

Existing Site Conditions

At the time of our investigation the project site was not overlot graded, the roadways were rough graded and utilities had not been installed. Curb and gutter had not been installed.

Project Description

This pavement design includes the proposed street Meadowbrook Parkway, which is classified as an Urban Non-Residential Collector and Newt Drive, which is classified as an Urban Minor Arterial.

FIELD INVESTIGATION AND LABORATORY TESTING

Drilling

The field exploration was conducted by drilling six borings at the locations shown on Figure 2.1. The borings were drilled on May 23, 2022 with a truck mounted drill rig powering 4-inch diameter, solid stem augers. Borings extended to 5 and 10 feet depth. The borings were logged by a representative of RMG. Samples of the subsurface materials were obtained with 2 ½ inch O.D. modified California samplers in accordance with ASTM D3550. Depths at which the samples were taken and the penetration resistance values are shown on the Test Boring Logs. Bulk samples were also obtained from each boring from a depth of about 0 to 2 feet in each boring and returned to our laboratory for review and testing. An explanation of Test Boring Logs is presented in Figure 3. Test Boring Logs are presented in Figures 4 through 6.

Laboratory Testing

Grain-size analyses and Atterberg limits tests were performed on the combined samples obtained from the borings for purposes of classification and obtaining pertinent engineering parameters. A moisture-density relationship curve and a California Bearing Ratio (CBR) test were performed on a composite bulk sample obtained from all six Test Borings, TB-1 through TB-6. A Summary of Laboratory Test Results is presented in Figure 7. Soil Classification Data are presented in Figures 8 and 9. The Moisture Density Relationship Curve is presented in Figure 10. The CBR Test Results are presented in Figures 11 and 12.

SUBSURFACE CONDITIONS

Subsurface Materials

The soil encountered in all the borings, TB-1 through TB-6, consisted of silty sand. These soils classify as SM in accordance with the Unified Soil Classification System. For pavement design purposes, the soil classifies as A-1-b/A-2/A-3 with group index 0 in accordance with the American Association of State Highway and Transportation Officials (AASHTO) classification system.

A composite bulk sample from the six Test Borings, A-1-b/A-2/A-3 (0) soil, was tested to determine its moisture-density relationship curve in accordance with ASTM D1557A (Modified Proctor compaction test). Maximum Dry Density proved to be 120.5 pcf at 9.0 percent moisture. A CBR test was performed in accordance with Appendix D.2.4 of the El Paso County Engineering Criteria Manual (EPCECM) at varying densities at moisture content near optimum. At 95% of the maximum Modified Proctor density, 120.5 pcf, the CBR of the bulk sample was 20.9.

Groundwater

Groundwater was not encountered in the test borings during field exploration. While groundwater is not expected to be a factor in pavement construction on this site, fluctuations in groundwater and subsurface moisture conditions may occur due to variations in rainfall and other factors not readily apparent at this time. Development of the property and adjacent properties may also affect groundwater levels.

PAVEMENT DESIGN

The following pavement design is based on the subsurface conditions encountered in the test borings and on the project characteristics previously described. If conditions are different from those described in this report or the project characteristics change, RMG should be retained to review our recommendations and adjust them, if necessary.

Pavement Design

This pavement design was prepared in accordance with the El Paso County Pavement Design Criteria Manual. Pavement design is based on A-1-b/A-2/A-3 soil as gathered from TB-1 through TB-6.

Street Classification – Urban Non-Residential Collector

1) Meadowbrook Parkway
   ESAL = 821,000 (Table D-2)
   Serviceability Index = 2.5 (Table D-1)
   2040 Average Daily Traffic (ADT) = 11,400 (2021 Traffic Study Fig. 12)
   Percent Heavy Trucks (T) = 3

Design road life (T) = 20 years
ESAL = 1,994,000

2) Strength coefficients (Table D-3)
   Asphalt (HMA): $a_1 = 0.44$
   Aggregate Base Course (ABC): $a_2 = 0.11$

3) Subgrade
   M_r = CBR x 1500 = 20.9 x 1500 = 31,350 psi

4) Structural number (SN) = 2.14 (per 1993 AASHTO Empirical Equation for Flexible Pavements, presented in Appendix A)

5) Composite asphalt/base course section
   Minimum HMA thickness = D_1 = 4 inches (Table D-2)
   ABC thickness = $D_2 = \{SN - (D_1 \times a_1)\} / a_2 = \{2.14 - (4 \times 0.44)\} / 0.11 = 3.45$ inches
   Minimum ABC thickness = 8 inches (Table D-2)
   SN = (4 x 0.44) + (8 x 0.11) = 2.64 > 1.84 (Min. SN required)
   Use minimum HMA thickness = 4 inches (Paragraph D.4.1-F: base course thickness cannot exceed 2.5 times the HMA thickness)

Street Classification – Urban Minor Arterial

1) Newt Drive
   ESAL = 1,971,000 (Table D-2)
   Serviceability Index = 2.5 (Table D-1)

2) Strength coefficients (Table D-3)
   Asphalt (HMA): $a_1 = 0.44$
   Aggregate Base Course (ABC): $a_2 = 0.11$

3) Subgrade
   M_r = CBR x 1500 = 20.9 x 1500 = 31,350 psi

4) Structural number (SN) = 2.13 (per 1993 AASHTO Empirical Equation for Flexible Pavements, presented in Appendix A)

5) Composite asphalt/base course section
   Minimum HMA thickness = D_1 = 5 inches (Table D-2)
   ABC thickness = $D_2 = \{SN - (D_1 \times a_1)\} / a_2 = \{2.13 - (5 \times 0.44)\} / 0.11 < 0$ inches
   Minimum ABC thickness = 8 inches (Table D-2)
   SN = (5 x 0.44) + (8 x 0.11) = 3.08 > 2.13 (Min. SN required)
   Use minimum HMA thickness = 5 inches (Paragraph D.4.1-F: base course thickness cannot

exceed 2.5 times the HMA thickness)

Pavement Thickness

Based on the design calculations, the recommended pavement sections are presented below and on Figure 2.2. If the existing pavement has greater thickness than recommendation, then pave to match.

Street	Required SN	HMA (in.)	ABC (in.)	Calculated SN	OK
Meadowbrook Parkway	1.84	4	8	2.64	Y
Newt Drive	2.13	5	8	3.08	Y

Pavement Materials

Pavement materials should be selected, prepared, and placed in accordance with El Paso County specifications and the *Pikes Peak Region Asphalt Paving Specifications*. Tests should be performed in accordance with the applicable procedures presented in the specifications.

The subsurface soils at this site are anticipated to present Class 0 (negligible) sulfate exposure. Type I/II cement or an equivalent mixture according to ACI 201.2R-10 is suggested for concrete in contact with the subsurface materials. Cement type shall be designed and approved by a licensed Colorado Professional Engineer and Foundation Designer. Calcium chloride should not be used for the onsite soils. The concrete should not be placed on frozen ground. If placed during periods of cold temperatures, the concrete should be kept from freezing. This may require covering the concrete with insulated blankets and heating. Concrete work should be completed in accordance with the latest applicable guidelines and standards published by ACI.

Expansive Soil Mitigation

The EPCECM notes that mitigation measures may be required for expansive soils, shallow ground water, subgrade instability, etc. Based on the AASHTO classification for the soils in this subdivision, the subgrade soils evaluated for this pavement design can be expected to be non-expansive. Groundwater or wet and unstable soils were not encountered in the borings. Therefore, special mitigation measures do not appear to be necessary for subgrade preparation.

Subgrade Preparation

All fill placed below pavements should be moisture conditioned and compacted in accordance with El Paso County *Standard Specifications Manual*. Prior to placement of the pavement section, the final subgrade should be scarified to a depth of 12 inches, adjusted to within 2 percent of the optimum moisture content and compacted to County specifications. The subgrade should then be

proofrolled with a heavy, pneumatic tired vehicle. Areas which deform under wheel loads should be removed and replaced. Base course place atop prepared subgrade should be compacted to at least 95 percent of the maximum modified Proctor density (ASTM D1557).

Surface Drainage

Surface drainage is important for the satisfactory performance of pavement. Wetting of the subgrade soils or base course will cause a loss of strength which can result in pavement distress. Surface drainage should provide for efficient removal of storm-water runoff. Water should not be allowed to pond on the pavement or near the edges of the pavement.

Subgrade Observations and Testing

The pavement thicknesses presented above assume pavement construction is completed in accordance with El Paso County specifications and the *Pikes Peak Region Asphalt Paving Specifications*. RMG should be present at the site during subgrade preparation, placement of fill, and construction of pavements to perform site observations and testing.

CLOSING

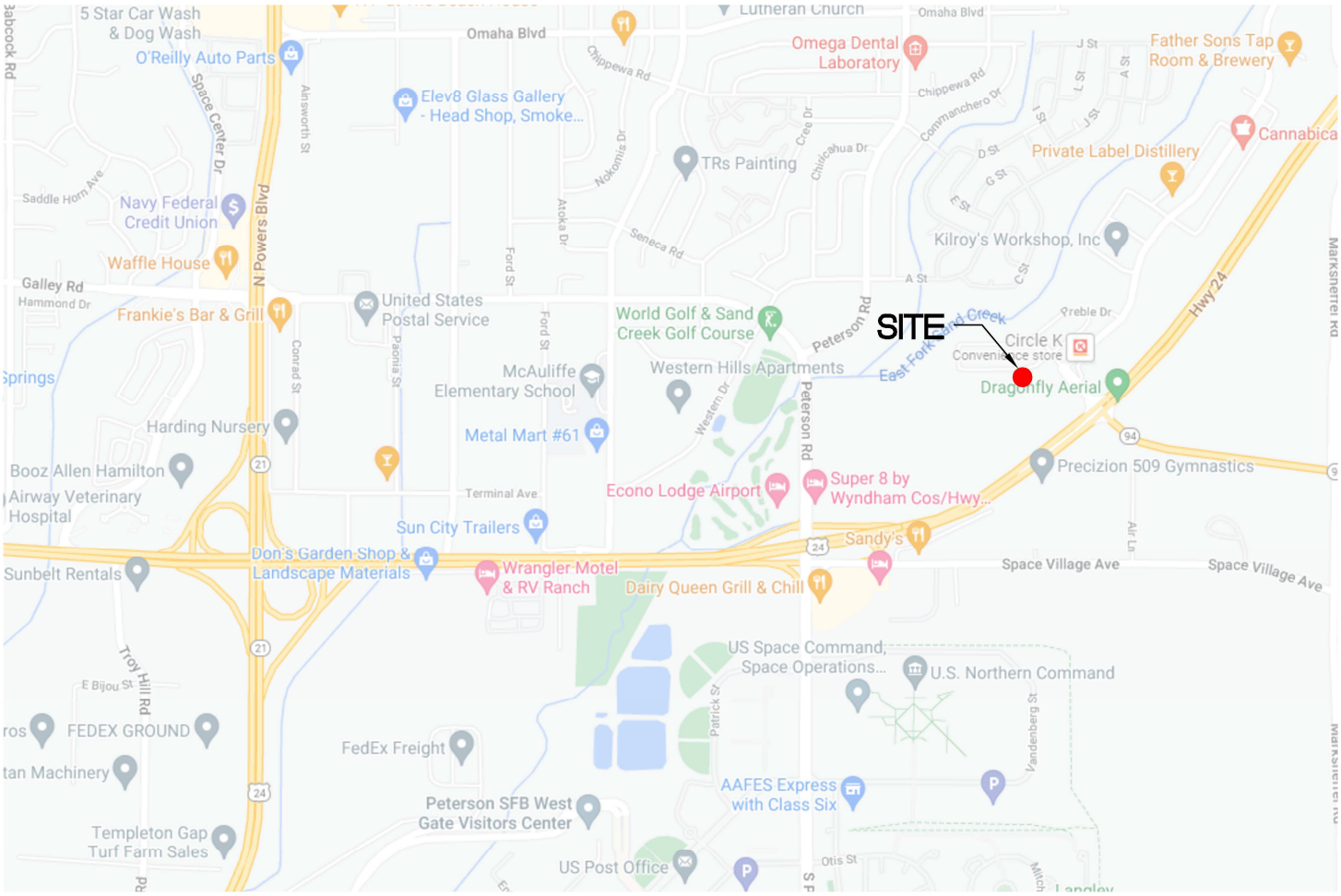
Our field exploration was conducted to provide geotechnical information for pavement thickness design. Variations in subsurface conditions not indicated by the borings may be encountered. This report has been prepared for **Colorado Springs Equities LLC** for application as an aid in the design of the proposed development in accordance with generally accepted geotechnical engineering practices. The analyses and recommendations in this report are based in part upon data obtained from exploratory borings and test pits, site observations and the information presented in referenced reports. The nature and extent of variations may not become evident until construction. If variations then become evident, RMG should be retained to re-evaluate the recommendations of this report, if necessary.

Our professional services were performed using that degree of care and skill ordinarily exercised, under similar circumstances, by geotechnical engineers practicing in this or similar localities. RMG Engineers does not warrant the work of regulatory agencies or other third parties supplying information which may have been used during the preparation of this report. No warranty, express or implied is made. Any contractor reviewing this report for bidding purposes must draw his own conclusions regarding site conditions and specific construction techniques to be used on this project.

This report is for the exclusive purpose of providing geotechnical information and pavement thickness design recommendations. The scope of services for this project does not include, either specifically or by implication, environmental assessment of the site or identification of contaminated or hazardous materials or conditions. Development of recommendations for the mitigation of environmentally related conditions, including but not limited to biological or toxicological issues, are beyond the scope of this report. If the Client desires investigation into the potential for such contamination or conditions, other studies should be undertaken.

If we can be of further assistance in discussing the contents of this report or analysis of the proposed development, from a geotechnical engineering point-of-view, please feel free to contact us.

FIGURES



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SITE VICINITY MAP

MEADOWBROOK PARKWAY
PAVEMENT DESIGN
EL PASO COUNTY, COLORADO
COLORADO SPRINGS EQUITIES, LLC

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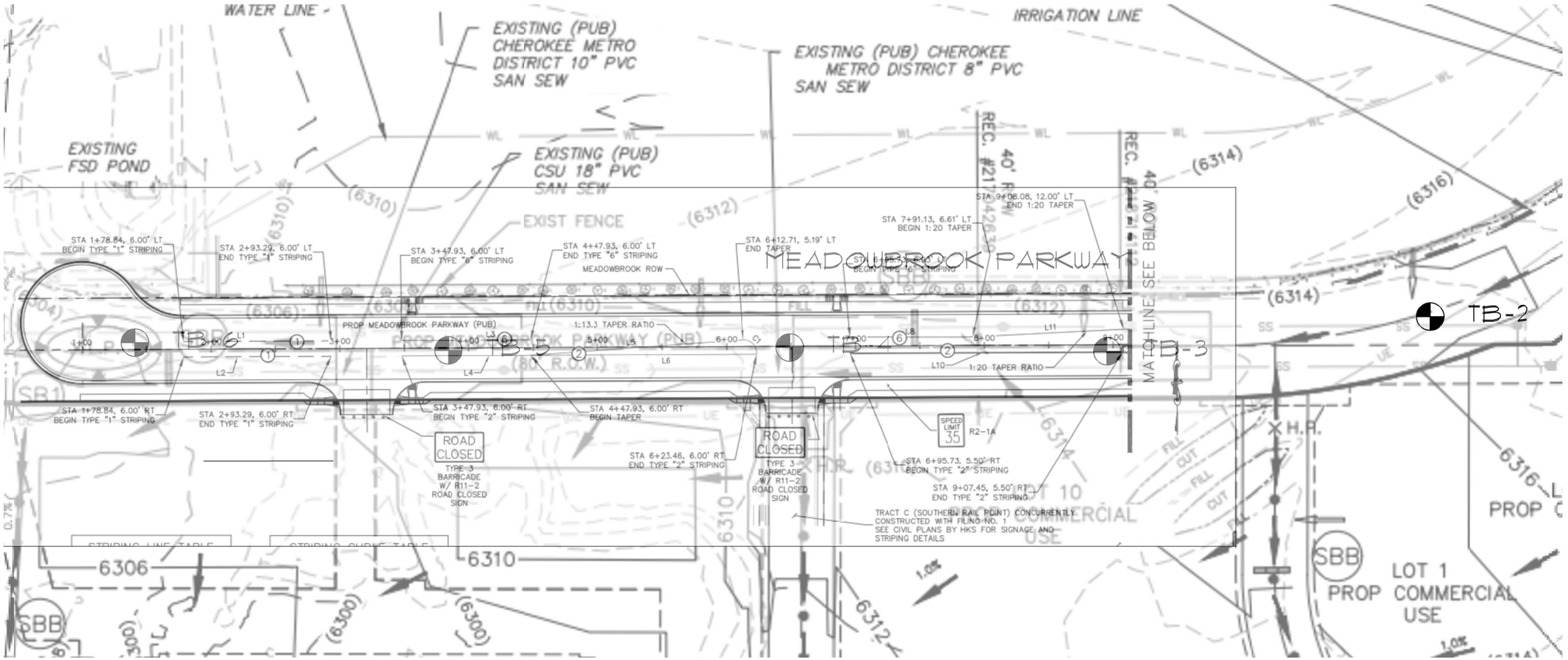
FIG No. 1

DATE 8-24-2022



0.75″

100 ft

TB-# DENOTES APPROXIMATE LOCATION OF TEST BORINGS

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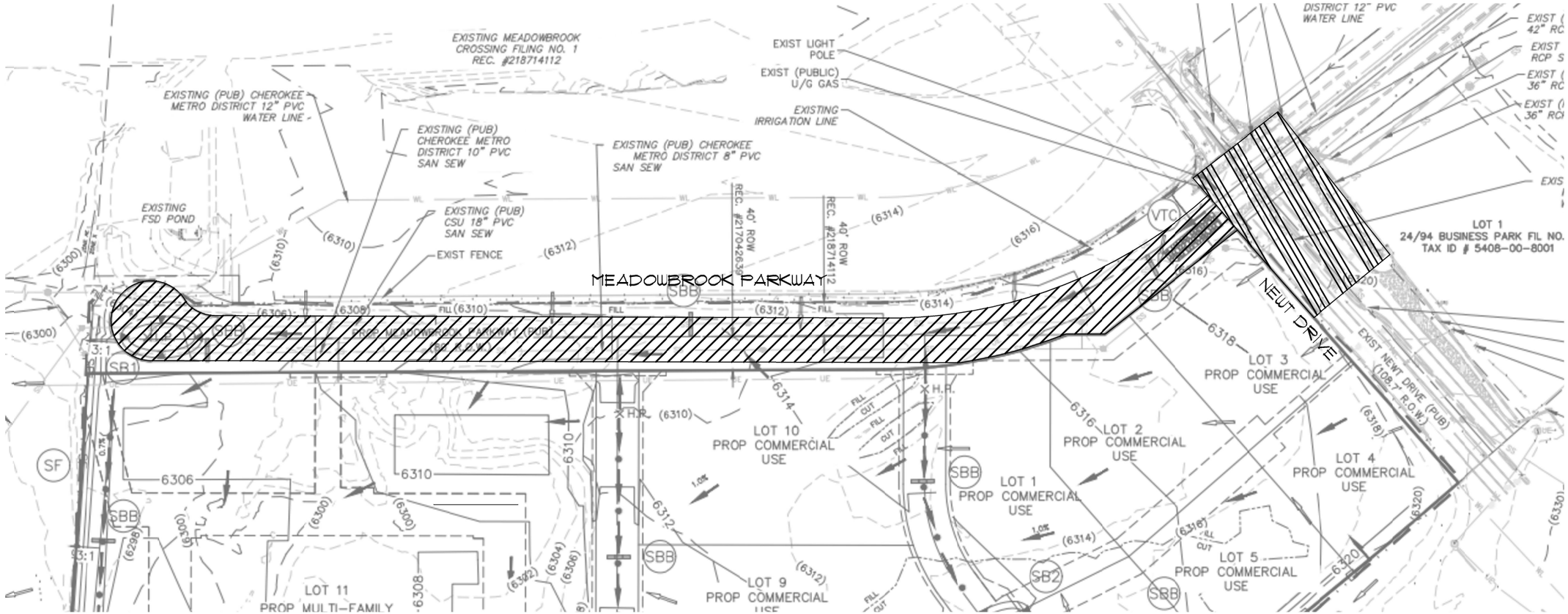
EL PASO COUNTY, COLORADO
COLORADO SPRINGS EQUITIES, LLC

ENGINEER:	TM
DRAWN BY:	NM
CHECKED BY:	TM
ISSUED:	8-24-2022
	9/14/22
GENERAL REVISION	188737

TEST BORING LAYOUT PLAN

SHEET No.
FIG-2.1



4" HMA
OVER
8" ABC

5" HMA♦
OVER
8" ABC♦

♦ OR MATCH EXISTING ASPHALT AND BASE COURSE THICKNESSES IF GREATER THAN SHOWN ABOVE

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ENGINEER:	TM
DRAWN BY:	JM
CHECKED BY:	TM
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	9-14-22
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PAVEMENT RECOMMENDATIONS

SHEET No.
FIG-2.2

SOILS DESCRIPTION


SANDY CLAY


SILTY SAND

UNLESS NOTED OTHERWISE, ALL LABORATORY
TESTS PRESENTED HEREIN WERE PERFORMED BY:
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COLORADO SPRINGS, COLORADO

SYMBOLS AND NOTES


XX — STANDARD PENETRATION TEST - MADE BY DRIVING A SPLIT-BARREL SAMPLER INTO THE SOIL BY DROPPING A 140 LB. HAMMER 30", IN GENERAL ACCORDANCE WITH ASTM D-1586. NUMBER INDICATES NUMBER OF HAMMER BLOWS PER FOOT (UNLESS OTHERWISE INDICATED).


XX — UNDISTURBED CALIFORNIA SAMPLE - MADE BY DRIVING A RING-LINED SAMPLER INTO THE SOIL BY DROPPING A 140 LB. HAMMER 30", IN GENERAL ACCORDANCE WITH ASTM D-3550. NUMBER INDICATES NUMBER OF HAMMER BLOWS PER FOOT (UNLESS OTHERWISE INDICATED).


FREE WATER TABLE


DEPTH AT WHICH BORING CAVED


BULK — DISTURBED BULK SAMPLE


AUG — AUGER "CUTTINGS"

4.5 — WATER CONTENT (%)

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EXPLANATION OF TEST BORING LOGS

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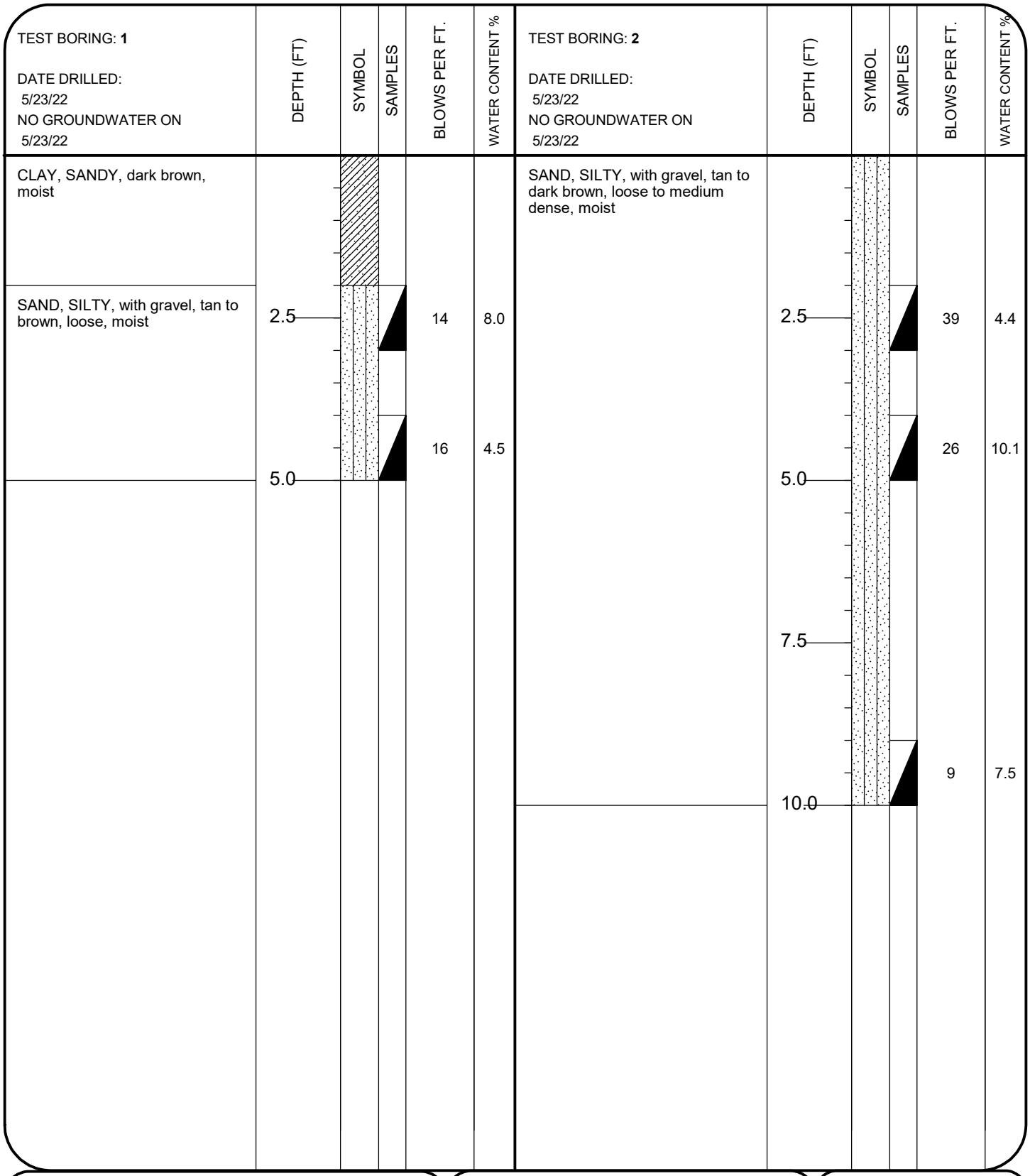
FIGURE No. 3

DATE Sep/13/2022



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TEST BORING LOG

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FIGURE No. 4

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TEST BORING: **3** DATE DRILLED: 5/23/22 NO GROUNDWATER ON 5/23/22	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SAND, SILTY, with gravel, tan to brown, loose to medium dense, moist	2.5			19	6.1
				11	8.2
	5.0				

TEST BORING: **4** DATE DRILLED: 5/23/22 NO GROUNDWATER ON 5/23/22	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SAND, SILTY, with gravel, tan to dark brown, medium dense, moist	2.5			45	8.6
				23	8.9
	5.0				

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TEST BORING LOG

JOB No. 188737

FIGURE No. 5

DATE Sep/13/2022

TEST BORING: **5** DATE DRILLED: 5/23/22 NO GROUNDWATER ON 5/23/22	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SAND, SILTY, with gravel, tan to dark brown, medium dense to dense, moist	2.5			50/11"	7.6
				50/10"	6.0
	5.0				

TEST BORING: **6** DATE DRILLED: 5/23/22 NO GROUNDWATER ON 5/23/22	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SAND, SILTY, with gravel, tan, medium dense, moist	2.5			49	5.7
				19	7.2
	5.0				

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TEST BORING LOG

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FIGURE No. 6

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Test Boring No.	Depth	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plasticity Index	% Retained No.10 Sieve	% Retained No.40 Sieve	% Passing No. 200 Sieve	% Swell @ 100 psf	AASHTO Classification
1	2.0	8.0		NP	NP	30.2	64.0	14.2		A-1-b (0)
1	4.0	4.5								
2	2.0	4.4		NP	NP	1.6	45.6	8.6		A-3 (0)
2	4.0	10.1								
2	9.0	7.5								
3	2.0	6.1		NP	NP	2.3	42.7	11.1		A-2-4 (0)
3	4.0	8.2								
4	2.0	8.6		NP	NP	0.6	43.6	9.8		A-3 (0)
4	4.0	8.9								
5	2.0	7.6		NP	NP	0.6	45.1	7.5		A-3 (0)
5	4.0	6.0								
6	2.0	5.7		NP	NP	0.6	46.0	8.5		A-3 (0)
6	4.0	7.2								

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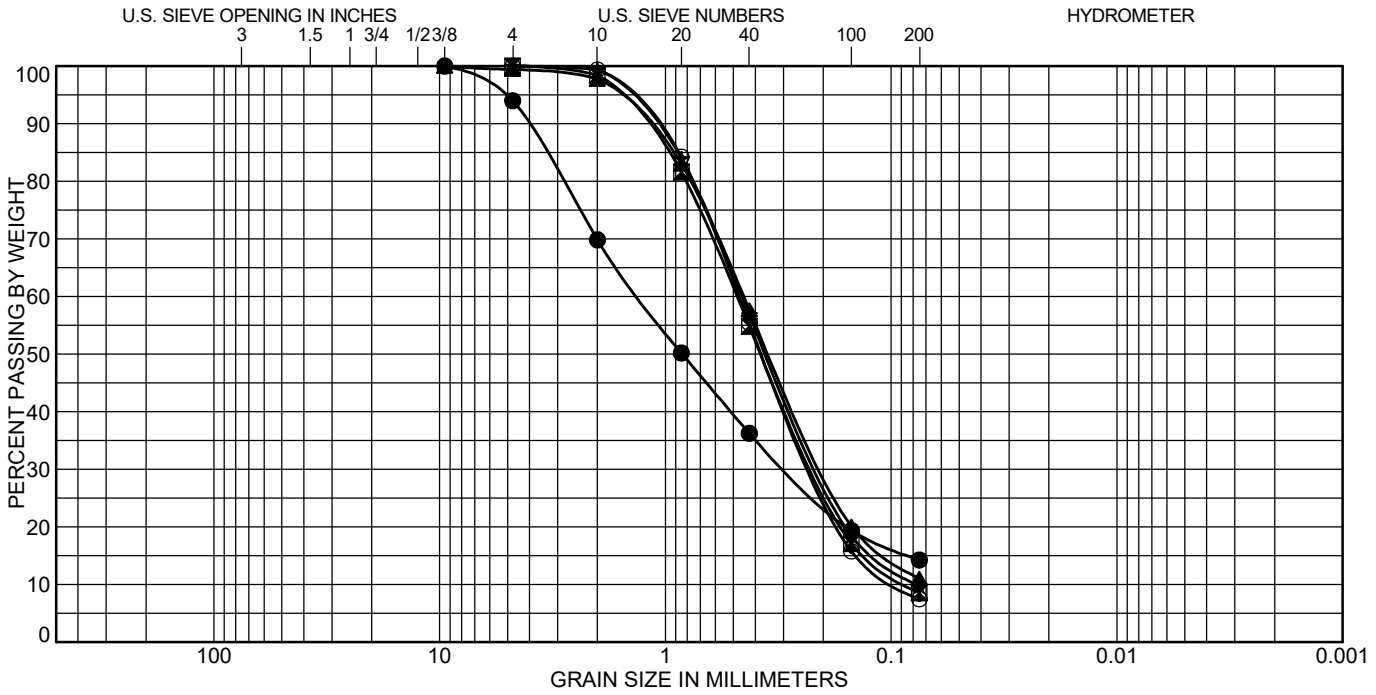
SUMMARY OF LABORATORY TEST RESULTS

JOB No. 188737
FIGURE No. 7
PAGE 1 OF 1
DATE Sep/13/2022



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Test Boring	Depth (ft)	Classification	LL	PL	PI
●	1	2.0	SILTY SAND(SM)	NP	NP	NP
⊠	2	2.0	POORLY GRADED SAND with SILT(SP-SM)	NP	NP	NP
▲	3	2.0	WELL-GRADED SAND with SILT(SW-SM)	NP	NP	NP
★	4	2.0	WELL-GRADED SAND with SILT(SW-SM)	NP	NP	NP
⊙	5	2.0	POORLY GRADED SAND with SILT(SP-SM)	NP	NP	NP

	Test Boring	Depth (ft)	%Gravel	%Sand	%Silt	%Clay
●	1	2.0	6.0	79.7	14.2	
⊠	2	2.0	0.0	91.4	8.6	
▲	3	2.0	0.6	88.4	11.1	
★	4	2.0	0.0	90.2	9.8	
⊙	5	2.0	0.0	92.5	7.5	

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SOIL CLASSIFICATION DATA

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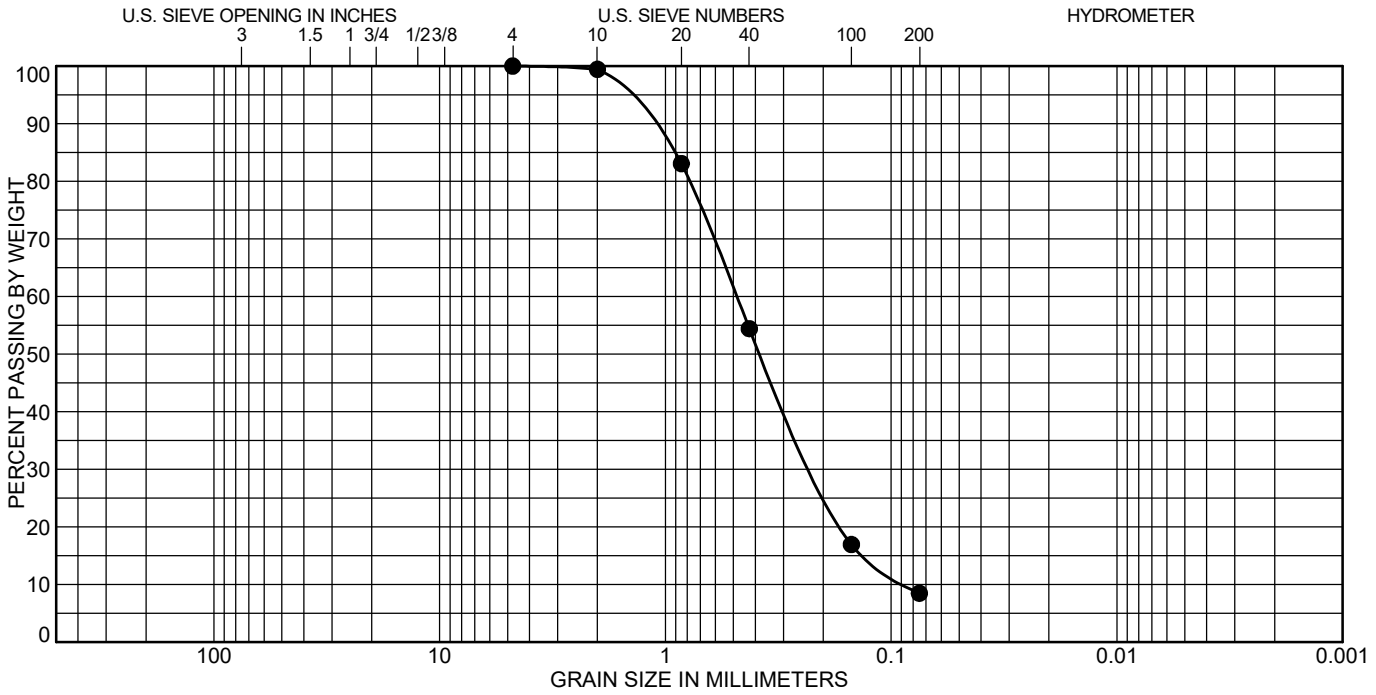
FIGURE No. 8

DATE Sep/13/2022



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Test Boring	Depth (ft)	Classification	LL	PL	PI
●	6	2.0	**POORLY GRADED SAND with SILT(SP-SM)**	**NP**	**NP**	**NP**

	Test Boring	Depth (ft)	%Gravel	%Sand	%Silt	%Clay
●	6	2.0	**0.0**	**91.5**	**8.5**	

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SOIL CLASSIFICATION DATA

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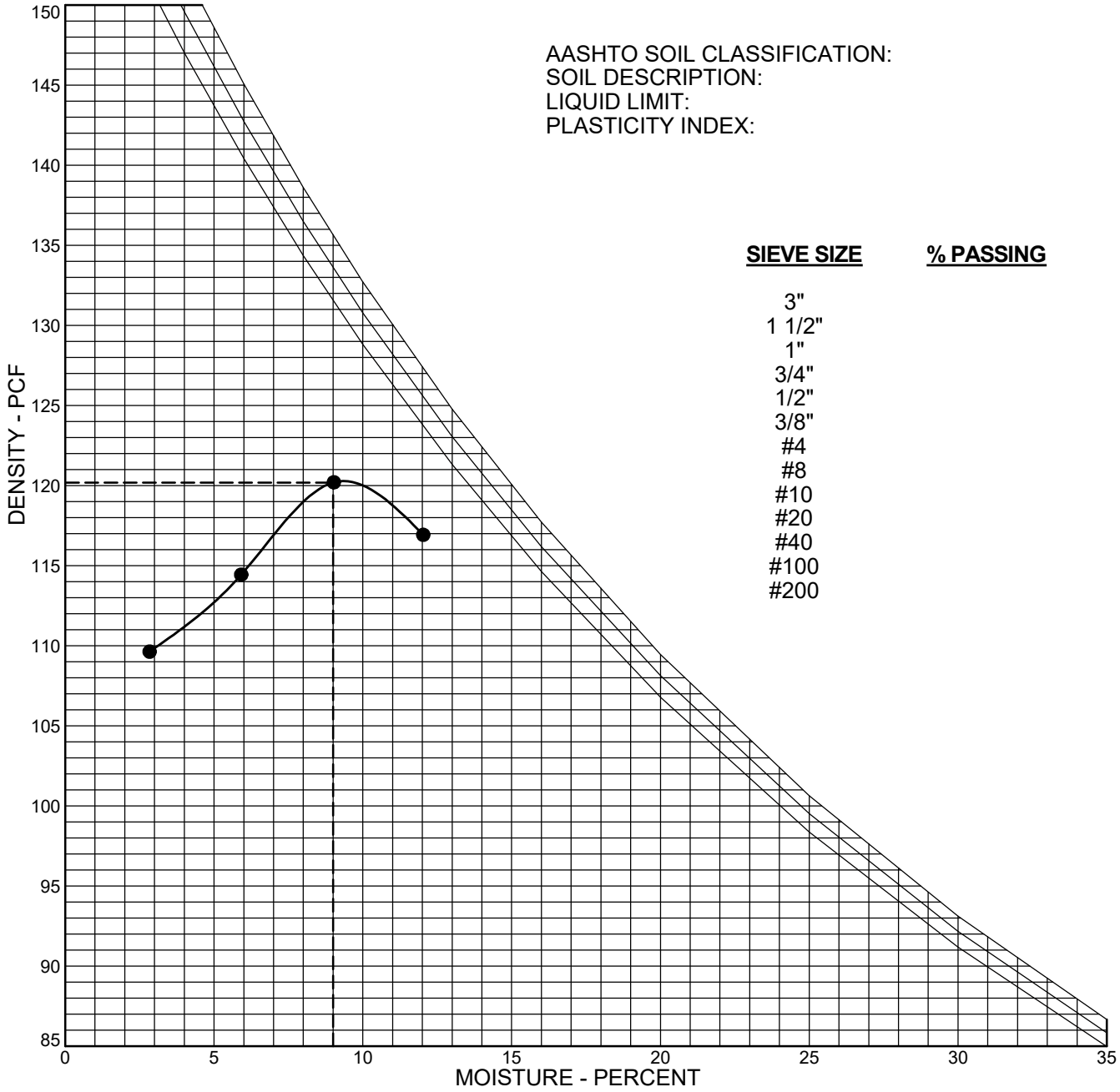
FIGURE No. 9

DATE Sep/13/2022

CLIENT: **Colorado Springs Equities LLC** SAMPLE NUMBER: **Proctor 1**

PROJECT: Meadowbrook Parkway, El Paso County, Colorado



AASHTO SOIL CLASSIFICATION:
SOIL DESCRIPTION:
LIQUID LIMIT:
PLASTICITY INDEX:

SIEVE SIZE	% PASSING
3"	
1 1/2"	
1"	
3/4"	
1/2"	
3/8"	
#4	
#8	
#10	
#20	
#40	
#100	
#200	

DESIGNATION **AASHTO 1557A**
MAX. DRY DENSITY **120.5 pcf**
OPTIMUM MOISTURE **9 %**
FRACTION USED **#4**
MOLD VOLUME **0.0333 cu.ft.**

NOTE:
ZERO AIR VOIDS CURVES PLOTTED FOR:
Gs = 2.60
Gs = 2.65
Gs = 2.70

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MOISTURE-DENSITY RELATION CURVE

JOB No. 188737

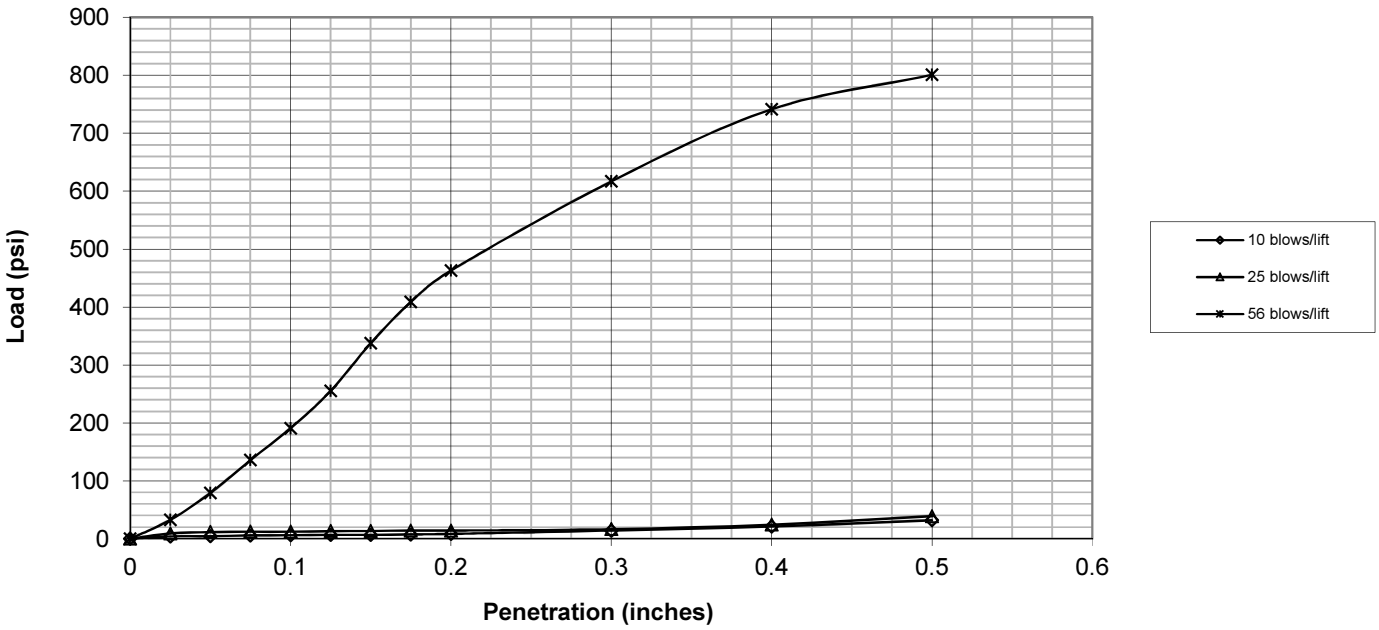
FIGURE No. 10

DATE Sep/13/2022

CALIFORNIA BEARING RATIO TEST RESULTS

Project: Meadowbrook Parkway
Job No.: 188737
AASHTO Classification" A-2/A-3
Sample Number: CBR
Sample Location: Combined Bulk Sample
Soil Description: Silty Sand

Penetration (in)	10 blows/lift Load (psi)	25 blows/lift Load (psi)	56 blows/lift Load (psi)
0.000	0.0	0.0	0.0
0.025	4.0	9.1	32.6
0.050	4.4	11.4	78.9
0.075	5.7	12.1	135.7
0.100	6.0	12.1	190.8
0.125	6.7	13.1	255.3
0.150	6.7	13.4	337.6
0.175	7.4	14.1	408.8
0.200	8.4	14.1	462.9
0.300	14.1	16.5	616.8
0.400	21.2	24.2	741.4
0.500	31.9	39.0	800.9



	Corrected Penetration (in)	Corrected Load (psi)
10 blows/lift	0.100	0.6
25 blows/lift	0.100	1.2
56 blows/lift	0.125	25.5

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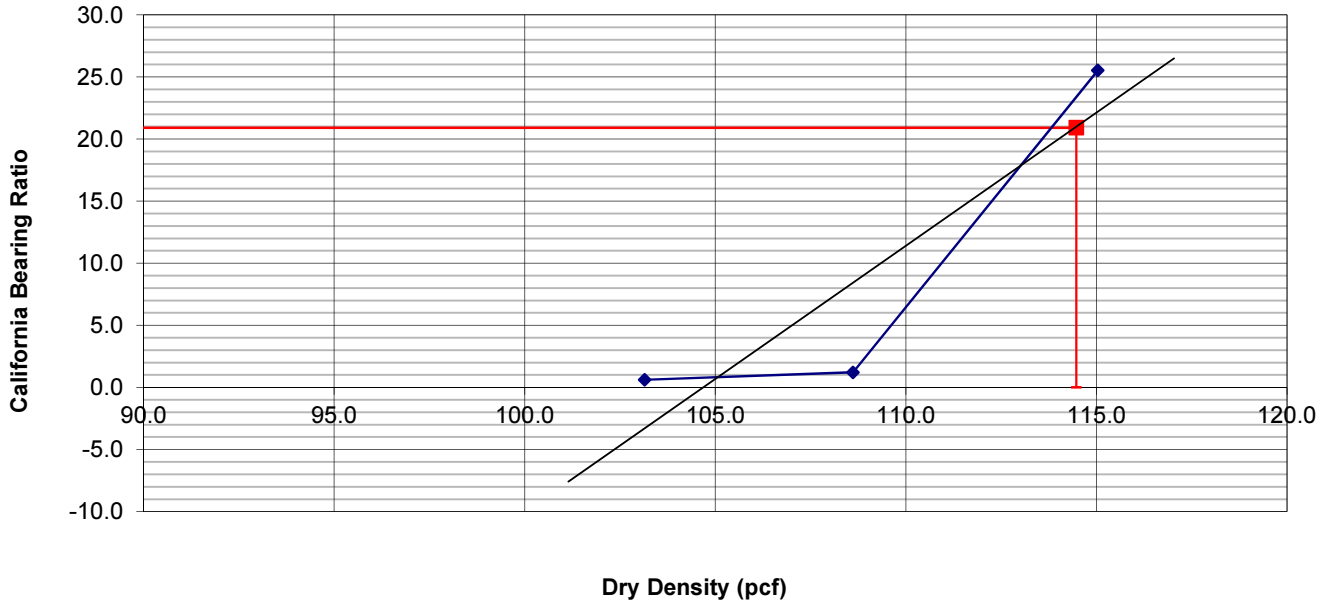
Figure No. 11

CALIFORNIA BEARING RATIO TEST RESULTS

Project: Meadowbrook Parkway
Job No.: 188737
AASHTO Classification" A-2/A-3
Sample Number: CBR
Sample Location: Combined Bulk Sample
Soil Description: Silty Sand

	10 blows/lift	25 blows/lift	56 blows/lift
Corrected California Bearing Ratio	0.6	1.2	25.5
Dry Density (pcf)	103.1	108.6	115.0
Percent Compaction	86	90	95
Percent Moisture After Soaking	12.4	11.3	12.4
Percent Expansion (+) / Compression (-)	-0.3%	-0.1%	0.0%
Surcharge Weight (lbs)	12.60	12.60	12.60



California Bearing Ratio	20.9
Dry Density (pcf)	120.5
Percent Compaction	95%
Target Dry Density	114.5
Compaction Test Method	ASTM D-1557A
Condition of sample	Soaked

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Figure No. 12