

Revised: June 30, 2020  
March 31, 2020



**ENTECH**  
ENGINEERING, INC.

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

John Jennings  
c/o OWA  
1046 Elkton Drive  
Colorado Springs, CO 80907

SF17-021

Attn: Roland Obering

Re: Pavement Recommendations - Revised  
Judge Orr Ranchettes  
Linder Drive, Jae Lynn Drive, and Bailiff Drive  
El Paso County, Colorado



\*To allow appropriate time to review, gravel source for Linder Drive, gradation, and PI, for the product, must be submitted to EPC one week prior to delivery to the site, and/or two weeks prior to installation.

Dear Mr. Obering:

As requested, Entech Engineering, Inc. has obtained samples of the subgrade soils from sections of the roadways in the Judge Orr Ranchettes subdivision in El Paso County, Colorado. Laboratory testing to determine the pavement support characteristics of the soils was performed. This letter presents the results of the laboratory testing and pavement recommendations for the roadways.

### Project Description

The roadways in this project consist of Jae Lynn Drive and Bailiff Drive, and a section of Linder Drive. Linder Drive will be partially paved. The section of Linder to be paved will be from Stapleton Drive extending approximately 50 feet west, where the remaining portion of Linder Drive will be a gravel/basecourse layer to Jae Lynn Road. The site layout and the locations of the test borings, drilled at approximate 500-foot intervals, are shown on the Test Boring Location Plan, Figure 1.

### Subgrade Conditions

Seven exploratory test borings were drilled in the roadways to depths of approximately 5 to 10 feet. The Boring Logs are presented in Appendix A. Sieve Analysis and Atterberg Limit testing were performed on soil samples obtained from the test borings for the purpose of classification. Sieve analyses performed indicated the percent passing the No. 200 sieve for the roadway subgrade soils ranged from approximately 6 to 23 percent. Atterberg Limit Tests performed on the samples resulted in Liquid Limits ranging from 22 to no value and Plastic Indexes of 6 to non-plastic. One general subgrade soil type was encountered (Soil Type 1). Soil Type 1 consisted of silty to clayey sand which classified as A-2-4 and A-1-b soils based on the AASHTO classification system. The Type 1 soils have good pavement support characteristics. The Type 2 very clayey sand soils were encountered at depths located beneath the subgrade influence zone. Sulfate testing of the subgrade indicated that the soils exhibit a negligible potential for sulfate attack. Groundwater was encountered in the two of the test borings at depths of 5 and 9 feet. The groundwater will not affect the pavement subgrade.

Swell testing was performed on the Soil Type 1 and Type 2 soils. Swells of zero and 0.3 were measured. Based on the swells and the soils AASHTO classifications, mitigation is not required. Laboratory test results are presented in Appendix B and are summarized on Table 1.

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 Pavement Recommendations - Revised  
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 El Paso County, Colorado  
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California Bearing Ratio (CBR) testing was performed on a sample of Soil Type 1 to determine the support characteristic of the subgrade soils for the roadway sections. The results of the CBR testing, are presented in Appendix B and summarized as follows:

Soil Type1 – Silty Sand

R @ 90% = 65.0  
 R @ 95% = 71.0  
 Use R = 50.0 for design\*

Classification Testing

Liquid Limit	NV
Plasticity Index	NP
Percent Passing 200	15.6
AASHTO Classification	A-1-b
Group Index	0
Unified Soils Classification	SM

\* An R Value of 50 is used for design calculations due to slight variability of the soils between borings and it results in minimum sections for the roadways.

**Pavement Design**

The CBR testing was used to determine pavement sections for this site. The pavement sections were determined utilizing the El Paso County "Pavement Design Criteria and Report". The following classifications and ESAL values were used for this the filing. All of the roadways classify as rural local roads which uses an 18K ESAL value of 36,500 for design. Pavement alternatives for asphalt over aggregate base course and aggregate base course sections are provided. Design parameters used in the pavement analysis are as follows:

Reliability (Local Roads)	80%
Serviceability Index Urban Local	2.2
Resilient Modulus	13,168 psi
"R" Value Subgrade – ST 1	50.0
<b>Structural Coefficients:</b>	
Hot Bituminous Pavement	0.44
Aggregate Base Course	0.11

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

**Pavement Sections – Soil Type 1**

**Rural Local – ESAL = 36,500 – All Roadways**

<u>Alternative</u>	<u>Asphalt (in)</u>	<u>Base Course (in)</u>
1. Asphalt Over Basecourse	3.0*	4.0*
2. Gravel Road** (Linder Drive)	-	6.0*

\* Minimum sections required by the El Paso County Pavement Design Criteria and Report.

\*\*The gravel for the section of Linder Drive shall meet the following sieve analysis. The contractor shall provide results of the sieve analysis for the materials used.

<u>Sieve Designation</u>	<u>Percent Passing by Weight</u>
¾"	100
#4	50 – 78
#8	37 – 67
#40	13 – 35
#200	4 – 15
Plastic Index (PI)	4 – 12

**Mitigation**

El Paso County criteria requires mitigation of expansive soils for roadway subgrade that have a swell of 2 percent or greater with a 150 pound per square foot surcharge. Due to the AASHTO classifications, mitigation for expansive soils will not be required.

**Roadway Construction - Full Depth Asphalt and Asphalt on Aggregate Base Course Alternatives**

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

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

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

We trust that this has provided you with the information you required. If you have any questions or need additional information, please do not hesitate to contact us.

Respectfully Submitted,

ENTECH ENGINEERING, INC.



Daniel P. Stegman

SCC/bs

Encl.

Entech Job No. 191776  
AAprojects/2019/191776/191776 pr-Revised



Reviewed by:



Mark H. Hauschild, P.E.  
Senior Engineer

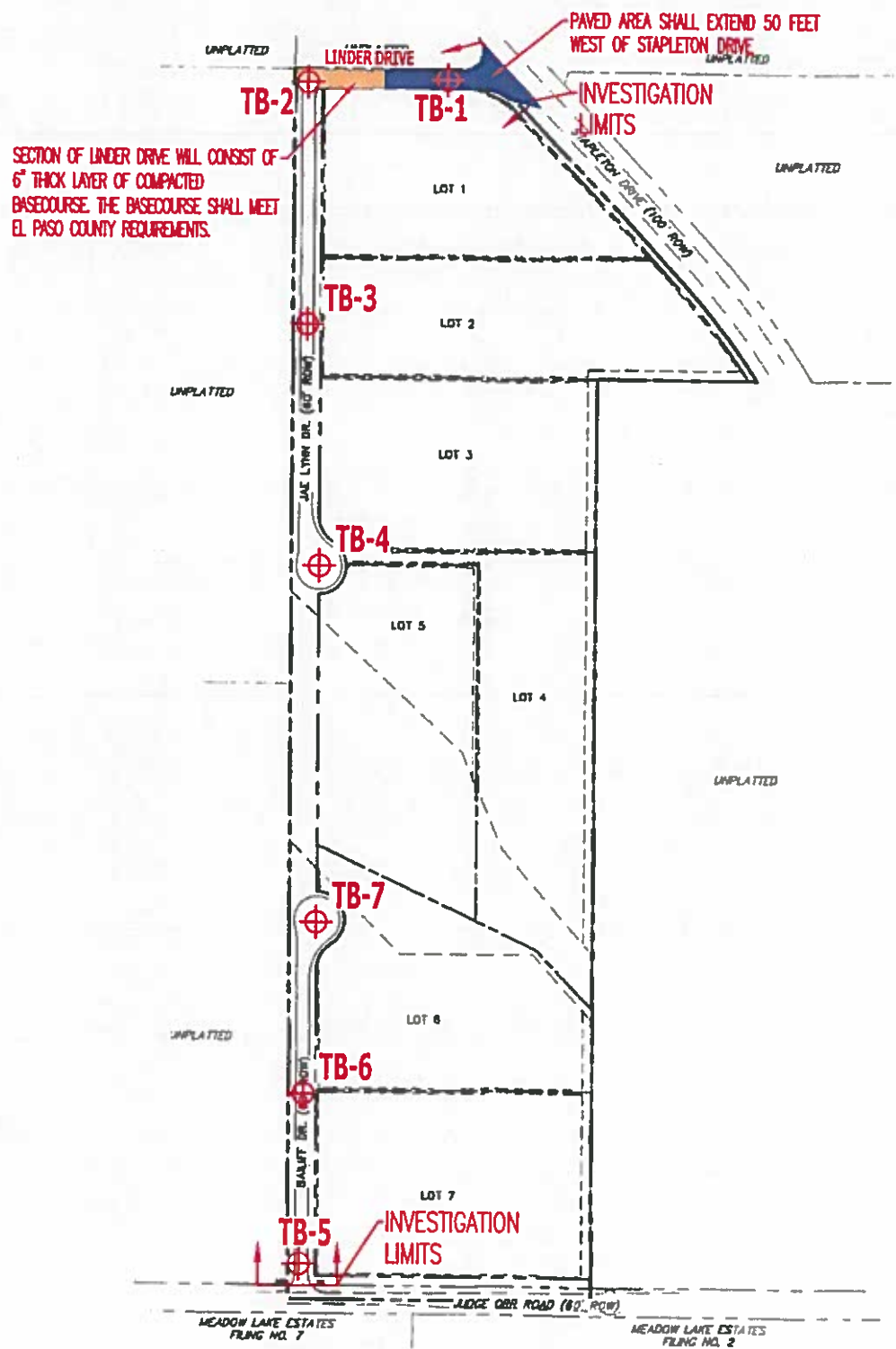
## TABLE

**TABLE 1**  
**SUMMARY OF LABORATORY TEST RESULTS**


CLIENT JOHN JENNINGS  
 PROJECT JUDGE ORR RANCHETTIES  
 JOB NO. 191776

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	AASHTO CLASS.	SWELL/ CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1, CBR	2	0-3			15.6	NV	NP		A-1-b		SM	SAND, SILTY
1	1	1-2			23.1	22	6		A-2-4		SC-SM	SAND, CLAYEY, SILTY
1	2	1-2			6.6	NV	NP		A-1-b		SM-SW	SAND, SLIGHTLY SILTY
1	3	1-2			19.7	NV	NP	<0.01	A-2-4		SM	SAND, SILTY
1	4	1-2			10.4	NV	NP		A-1-b		SM-SW	SAND, SLIGHTLY SILTY
1	5	1-2			6.2	NV	NP		A-1-b		SM-SW	SAND, SLIGHTLY SILTY
1	6	1-2			5.9	NV	NP		A-1-b		SM-SW	SAND, SLIGHTLY SILTY
1	7	1-2			18.7	NV	NP	<0.01	A-1-b		SM	SAND, SILTY
1	4	10	14.0	116.8	32.2	28	10	<0.01	A-2-4	0.0	SC	SAND, CLAYEY
1	7	10	10.5	122.4	29.1	31	9		A-2-4	0.0	SC	SAND, CLAYEY
2	2	10	22.0	98.6	49.8	34	13		A-6	0.3	SC	SAND, VERY CLAYEY

**FIGURE**



**NOTES:**  
 RURAL LOCAL : (ESAL = 36,500) - 3.0" ASPHALT OVER 4.0" BASECOURSE  
 ⊕ TB-2- APPROXIMATE TEST BORING LOCATION AND NUMBER



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 COLORADO SPRINGS, CO. 80907 (719) 531-5500

*TEST BORING LOCATION PLAN*  
*JUDGE ORR RANCHETTES*  
*EL PASO COUNTY, CO*  
*FOR: JOHN JENNINGS*

<b>DRAWN BY:</b> JAC	<b>DATE DRAWN:</b> 03/16/20	<b>DESIGNED BY:</b> KAH	<b>CHECKED:</b> DS
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**JOB NO.:**  
191776

**FIG. NO.:**  
1



## **APPENDIX A: Test Boring Logs**

TEST BORING NO. 1  
 DATE DRILLED 2/13/2020  
 Job # 191776

TEST BORING NO. 2  
 DATE DRILLED 2/13/2020  
 CLIENT JOHN JENNINGS  
 LOCATION JUDGE ORR RANCHETTTS

REMARKS

DRY TO 5', 2/13/20  
 6" TOPSOIL, SAND, CLAYEY,  
 SILTY, FINE TO COARSE  
 GRAINED, DARK BROWN TO  
 BROWN, MEDIUM DENSE, DRY

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
0-6	(Symbol)		12	2.6	1
6-10	(Symbol)		10	0.2	1
10-15					
15-20					

REMARKS

WATER @ 9', 2/13/20  
 6" TOPSOIL, SAND, SLIGHTLY  
 SILTY, FINE TO COARSE  
 GRAINED, BROWN, MEDIUM  
 DENSE, DRY TO MOIST

SAND, VERY CLAYEY, FINE  
 GRAINED, BROWN, LOOSE,  
 MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
0-6	(Symbol)		12	1.1	1
6-10	(Symbol)		17	3.5	1
10-15					
15-20					



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TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
		RS	2/21/20

JOB NO:  
 191776

FIG NO:  
 A-1

TEST BORING NO. 3  
 DATE DRILLED 2/13/2020  
 Job # 191776

TEST BORING NO. 4  
 DATE DRILLED 2/13/2020  
 CLIENT JOHN JENNINGS  
 LOCATION JUDGE ORR RANCHETTTS

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 2/13/20							WATER @ 5', 2/13/20						
SAND, SILTY, FINE TO COARSE GRAINED, BROWN, LOOSE, DRY	0-5	(Symbol)		4	2.4	1	6" TOP SOIL, SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, BROWN, LOOSE TO MEDIUM DENSE, DRY TO MOIST	0-6	(Symbol)	8	1.8	1	
	5			6	3.0	1		5		25	3.2	1	
	10						SAND, CLAYEY, FINE GRAINED, BROWN, MEDIUM DENSE, MOIST	10	(Symbol)	28	14.7	1	
	15							15					
	20							20					



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TEST BORING LOG

DRAWN:

DATE:

CHECKED:

DATE

DS

2/23/20

JOB NO.  
 191776

FIG NO.  
 A-2

TEST BORING NO. 5  
 DATE DRILLED 2/13/2020  
 Job # 191776

TEST BORING NO. 6  
 DATE DRILLED 2/13/2020  
 CLIENT JOHN JENNINGS  
 LOCATION JUDGE ORR RANCHETTTS

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 2/13/20							DRY TO 5', 2/13/20						
SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, LOOSE, MOIST				6	2.8	1	6" TOPSOIL, SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, DRY TO MOIST				19	1.6	1
SAND, CLAYEY, FINE TO MEDIUM GRAINED, GRAY BROWN, MEDIUM DENSE, MOIST	5			13	14.9	1	SLIGHTLY CLAYEY LENSES	5			21	7.1	1
	10							10					
	15							15					
	20							20					



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TEST BORING LOG

DRAWN	DATE	CHECKED	DATE
		DS	3/31/20

JOB NO.  
 191776

FIG NO  
 A-3

TEST BORING NO. 7  
 DATE DRILLED 2/13/2020  
 Job # 191776

TEST BORING NO.  
 DATE DRILLED  
 CLIENT JOHN JENNINGS  
 LOCATION JUDGE ORR RANCHETTTS

REMARKS

REMARKS

DRY TO 5', 2/13/20

6" TOPSOIL, SAND, SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, DRY TO MOIST

SAND, CLAYEY, FINE GRAINED, GRAY BROWN, DENSE, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
0-5	*		10	2.5	1	0-5					
5-10	*		23	4.1	1	5-10					
10-15	/		32	13.8	1	10-15					
15-20						15-20					
20-25						20-25					



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TEST BORING LOG

DRAWN:

DATE:

CHECKED:

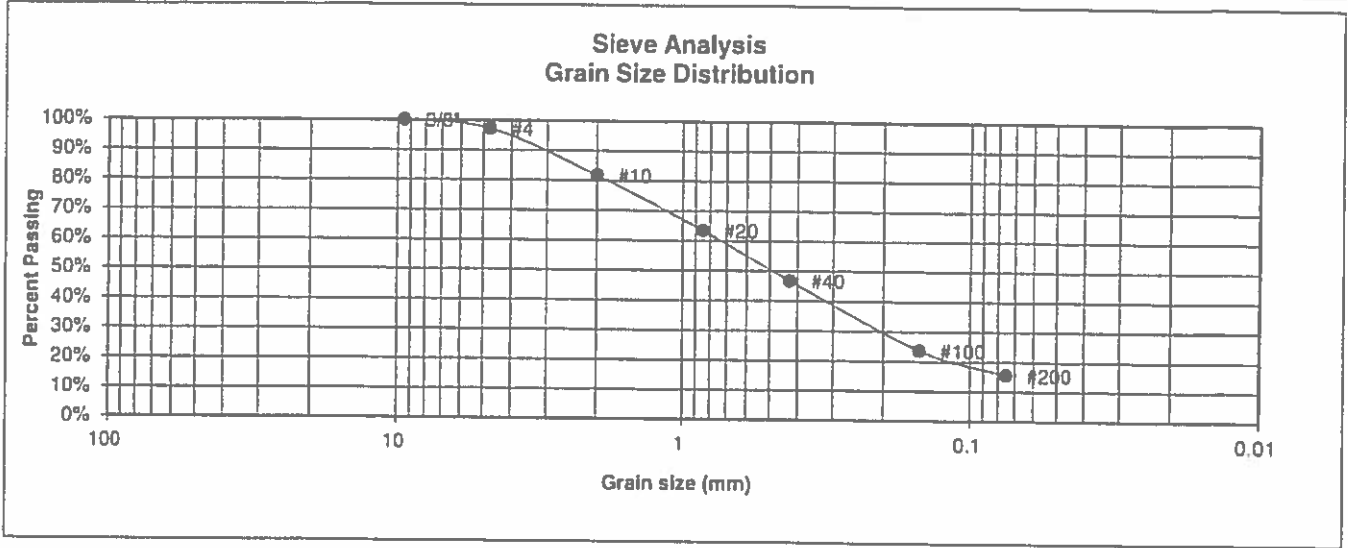
DATE: 3/27/20

JOB NO:  
 191776

FIG NO:  
 A-4

## **APPENDIX B: Laboratory Test Results**

<b>UNIFIED CLASSIFICATION</b>	SM	<b>CLIENT</b>	JOHN JENNINGS
<b>SOIL TYPE #</b>	1, CBR	<b>PROJECT</b>	JUDGE ORR RANCHETTTS
<b>TEST BORING #</b>	2	<b>JOB NO.</b>	191776
<b>DEPTH (FT)</b>	0-3	<b>TEST BY</b>	BL
<b>AASHTO CLASSIFICATION</b>	A-1-b	<b>GROUP INDEX</b>	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.2%
10	81.7%
20	63.5%
40	46.8%
100	23.6%
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)	



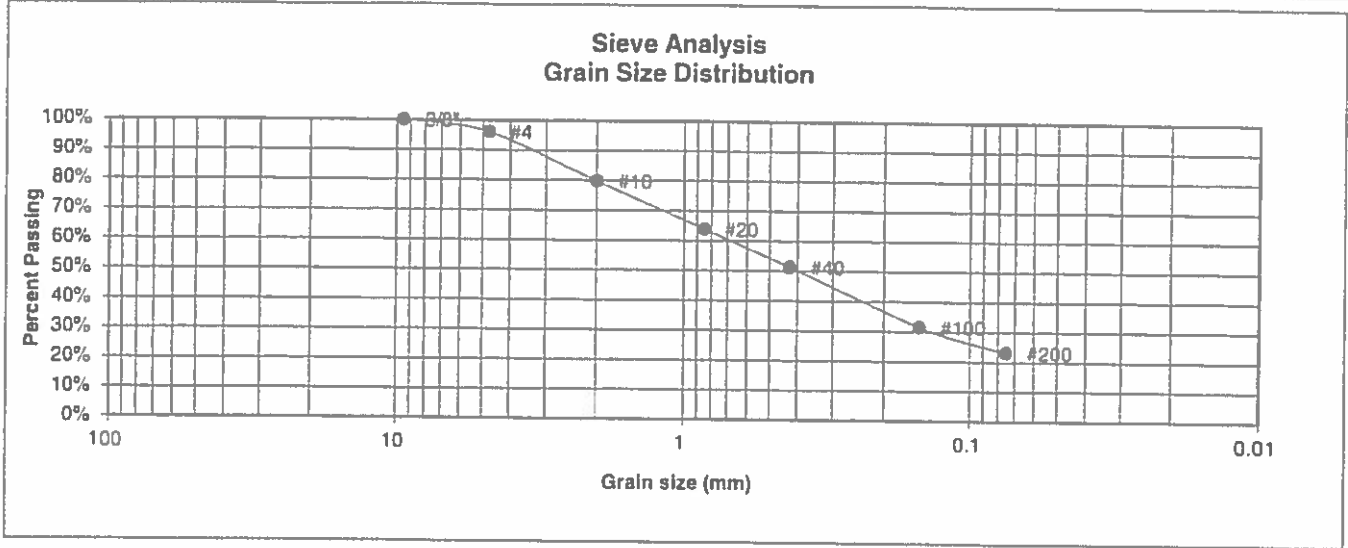
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**LABORATORY TEST  
RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
		<i>W</i>	5/9/20

JOB NO:  
191776  
FIG NO:  
*B-1*

<b>UNIFIED CLASSIFICATION</b>	SC-SM	<b>CLIENT</b>	JOHN JENNINGS
<b>SOIL TYPE #</b>	1	<b>PROJECT</b>	JUDGE ORR RANCHETTTS
<b>TEST BORING #</b>	1	<b>JOB NO.</b>	191776
<b>DEPTH (FT)</b>	1-2	<b>TEST BY</b>	BL
<b>AASHTO CLASSIFICATION</b>	A-2-4	<b>GROUP INDEX</b>	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	96.1%
10	79.8%
20	63.9%
40	51.4%
100	31.5%
200	23.1%

Atterberg Limits	
Plastic Limit	16
Liquid Limit	22
Plastic Index	6

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



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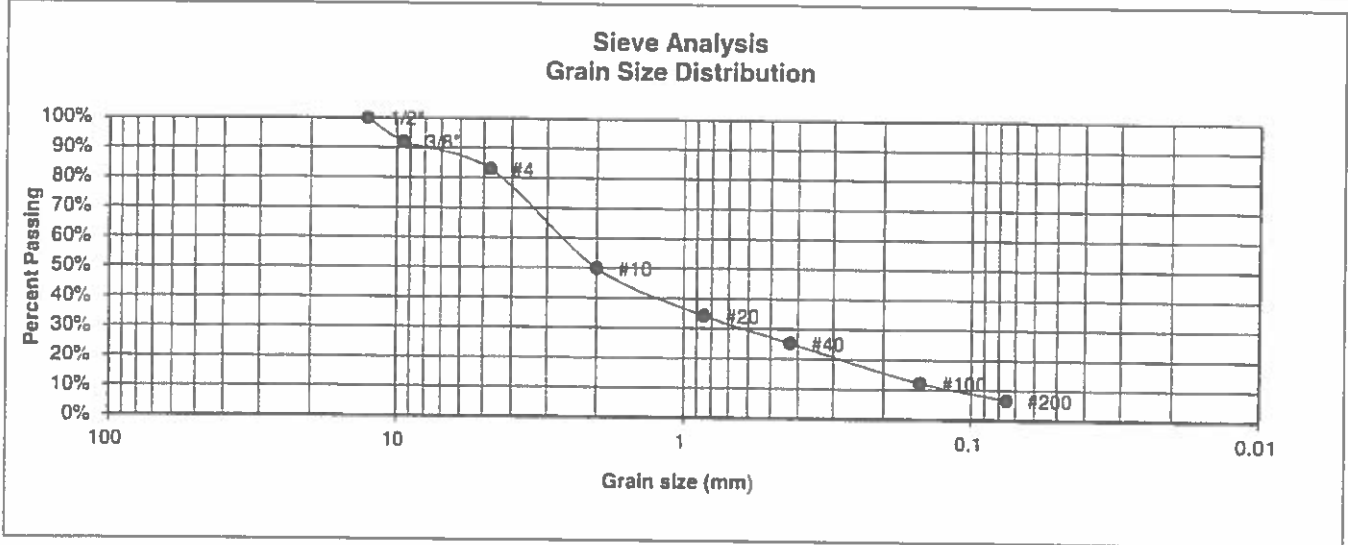
**LABORATORY TEST  
RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
		<i>CR</i>	3/9/20

JOB NO:  
191776  
FIG NO  
B-2



<u>UNIFIED CLASSIFICATION</u>	SM-SW	<u>CLIENT</u>	JOHN JENNINGS
<u>SOIL TYPE #</u>	1	<u>PROJECT</u>	JUDGE ORR RANCHETTTS
<u>TEST BORING #</u>	2	<u>JOB NO.</u>	191776
<u>DEPTH (FT)</u>	1-2	<u>TEST BY</u>	BL
<u>AASHTO CLASSIFICATION</u>	A-1-b	<u>GROUP INDEX</u>	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	92.1%
4	82.9%
10	49.9%
20	34.2%
40	25.2%
100	12.2%
200	6.6%

<u>Atterberg Limits</u>	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

<u>Swell</u>	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psi)	



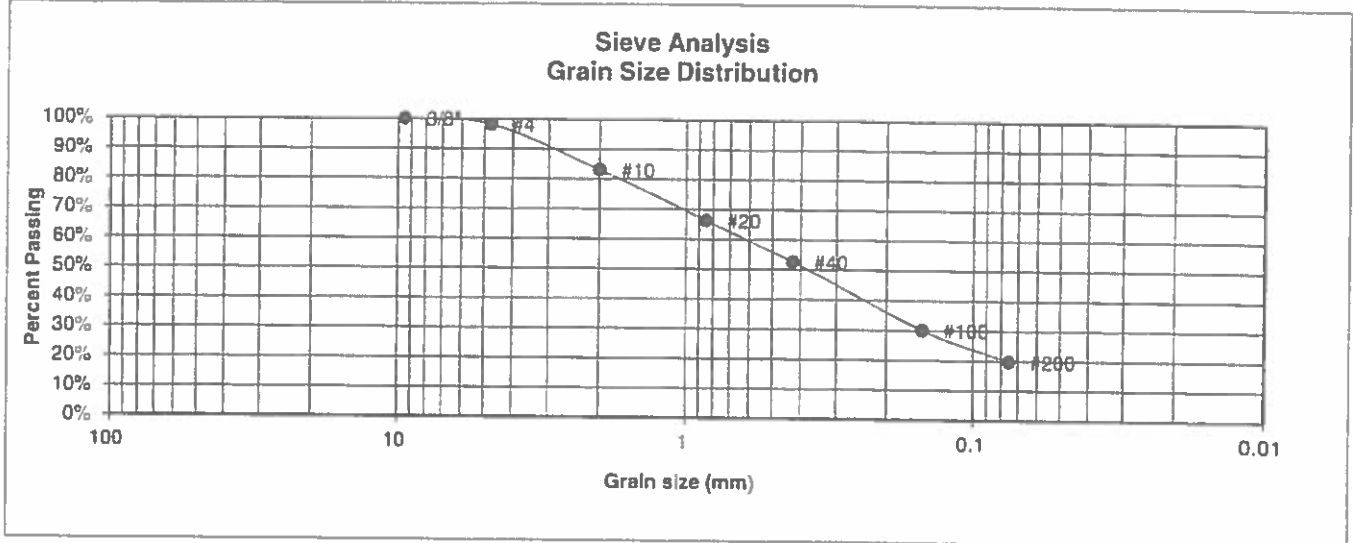
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505 ELKTON DRIVE  
COLORADO SPRINGS, COLORADO 80907

**LABORATORY TEST  
RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
		<i>BL</i>	3/9/20

JOB NO.:  
191776  
FIG NO.:  
*B-3*

<u>UNIFIED CLASSIFICATION</u>	SM	<u>CLIENT</u>	JOHN JENNINGS
<u>SOIL TYPE #</u>	1	<u>PROJECT</u>	JUDGE ORR RANCHETTETS
<u>TEST BORING #</u>	3	<u>JOB NO.</u>	191776
<u>DEPTH (FT)</u>	1-2	<u>TEST BY</u>	BL
<u>AASHTO CLASSIFICATION</u>	A-2-4	<u>GROUP INDEX</u>	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
#4	98.2%
#10	83.1%
#20	66.3%
#40	52.6%
#100	30.1%
#200	19.7%

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)	



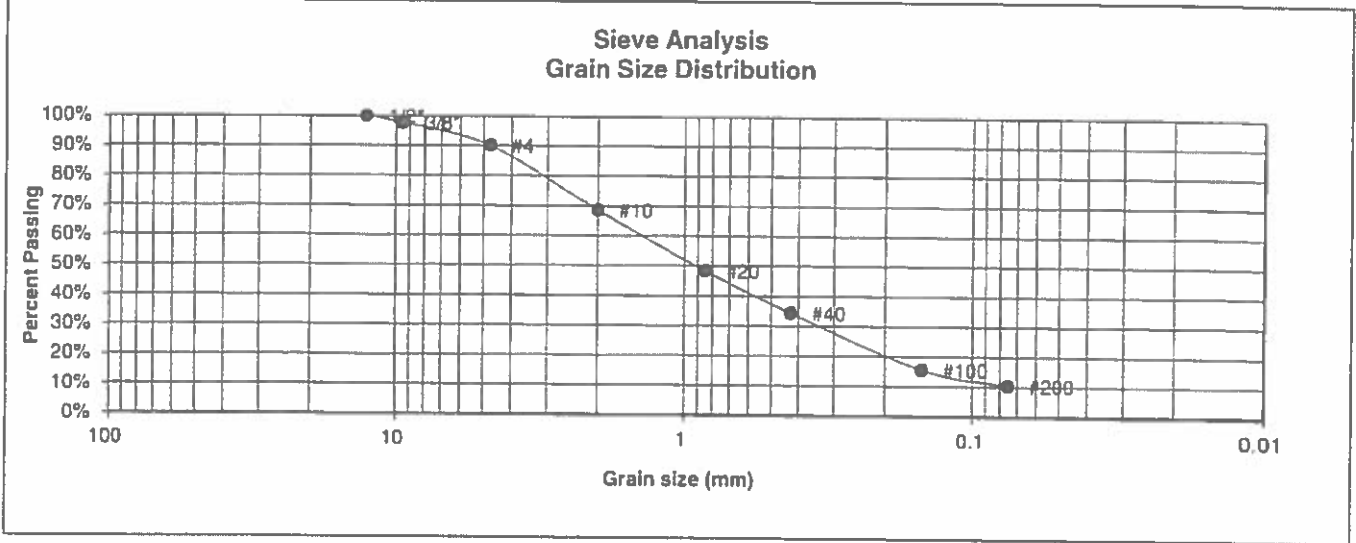
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**LABORATORY TEST  
RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
			3/9/20

JOB NO:  
191776  
FIG NO:  
B-4

<u>UNIFIED CLASSIFICATION</u>	SM-SW	<u>CLIENT</u>	JOHN JENNINGS
<u>SOIL TYPE #</u>	1	<u>PROJECT</u>	JUDGE ORR RANCHETTTS
<u>TEST BORING #</u>	4	<u>JOB NO.</u>	191776
<u>DEPTH (FT)</u>	1-2	<u>TEST BY</u>	BL
<u>AASHTO CLASSIFICATION</u>	A-1-b	<u>GROUP INDEX</u>	0



<u>U.S. Sieve #</u>	<u>Percent Finer</u>
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	97.7%
4	90.0%
10	68.6%
20	48.4%
40	34.3%
100	15.6%
200	10.4%

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)	



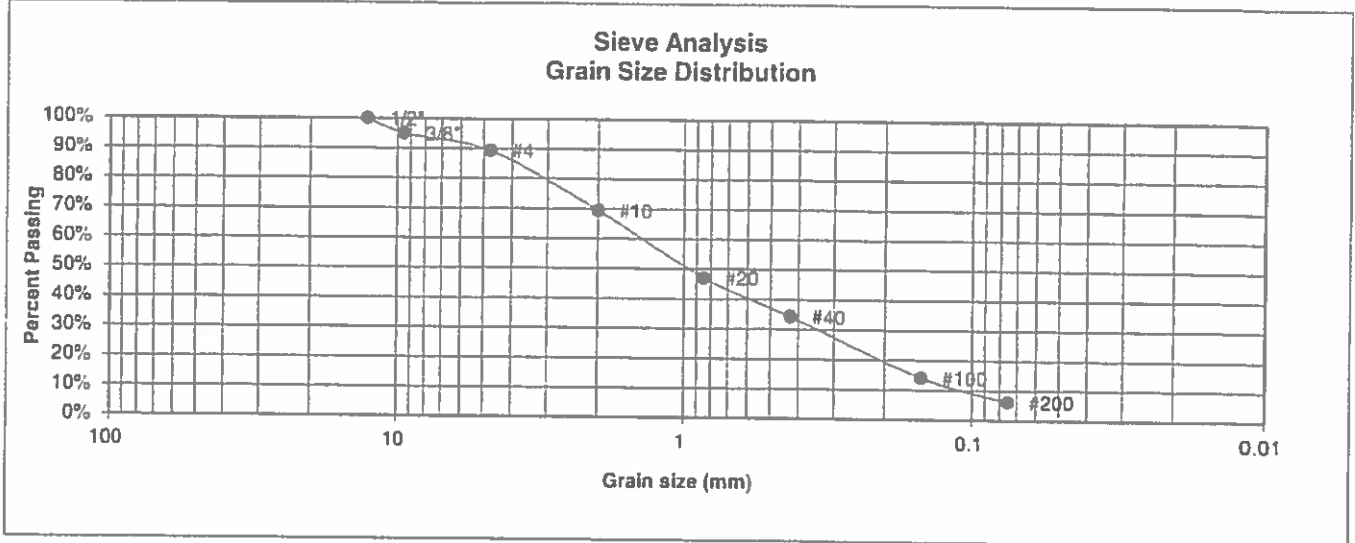
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505 ELKTON DRIVE  
COLORADO SPRINGS, COLORADO 80907

**LABORATORY TEST  
RESULTS**

DRAWN:	DATE:	CHECKED:	DATE: 3/9/20
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JOB NO:  
191776  
FIG NO  
B-5

<b>UNIFIED CLASSIFICATION</b>	SM-SW	<b>CLIENT</b>	JOHN JENNINGS
<b>SOIL TYPE #</b>	1	<b>PROJECT</b>	JUDGE ORR RANCHETTTS
<b>TEST BORING #</b>	5	<b>JOB NO.</b>	191776
<b>DEPTH (FT)</b>	1-2	<b>TEST BY</b>	BL
<b>AASHTO CLASSIFICATION</b>	A-1-b	<b>GROUP INDEX</b>	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	95.0%
4	89.3%
10	69.4%
20	47.1%
40	34.3%
100	14.1%
200	6.2%

**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)



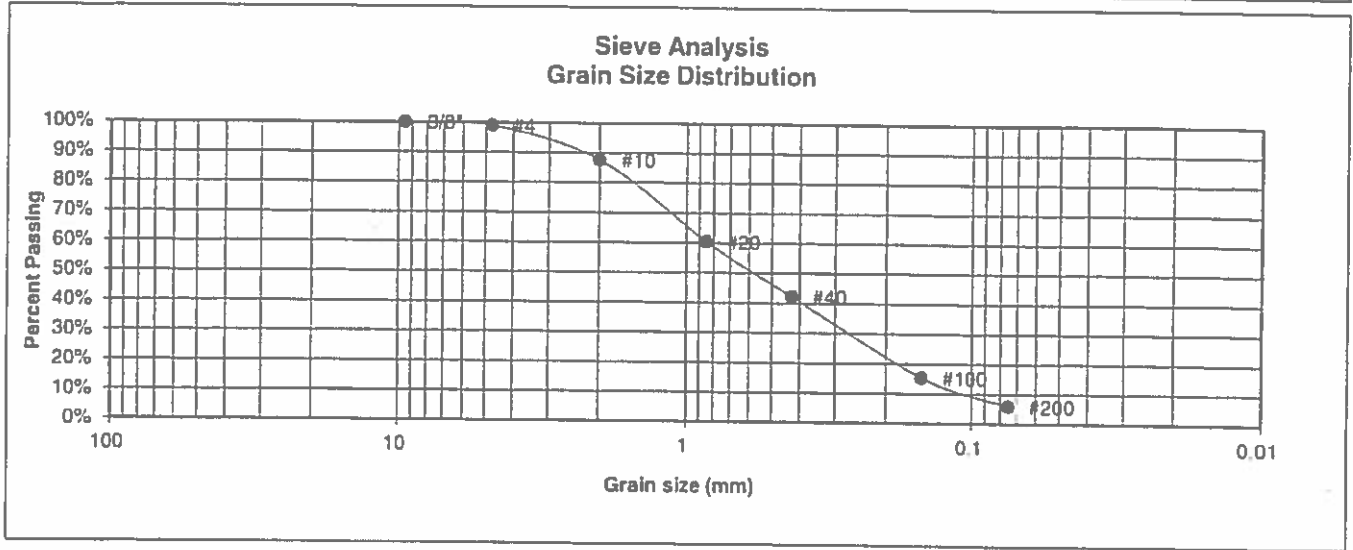
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505 ELKTON DRIVE  
COLORADO SPRINGS, COLORADO 80907

**LABORATORY TEST  
RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
		<i>[Signature]</i>	2/9/20

JOB NO:  
191776  
FIG NO  
B-6

<u>UNIFIED CLASSIFICATION</u>	SM-SW	<u>CLIENT</u>	JOHN JENNINGS
<u>SOIL TYPE #</u>	1	<u>PROJECT</u>	JUDGE ORR RANCHETTTS
<u>TEST BORING #</u>	6	<u>JOB NO.</u>	191776
<u>DEPTH (FT)</u>	1-2	<u>TEST BY</u>	BL
<u>AASHTO CLASSIFICATION</u>	A-1-b	<u>GROUP INDEX</u>	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.0%
10	87.6%
20	60.4%
40	42.3%
100	15.4%
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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505 ELKTON DRIVE  
COLORADO SPRINGS, COLORADO 80907

**LABORATORY TEST  
RESULTS**

DRAWN:

DATE:

CHECKED:

DATE:  
3/9/20

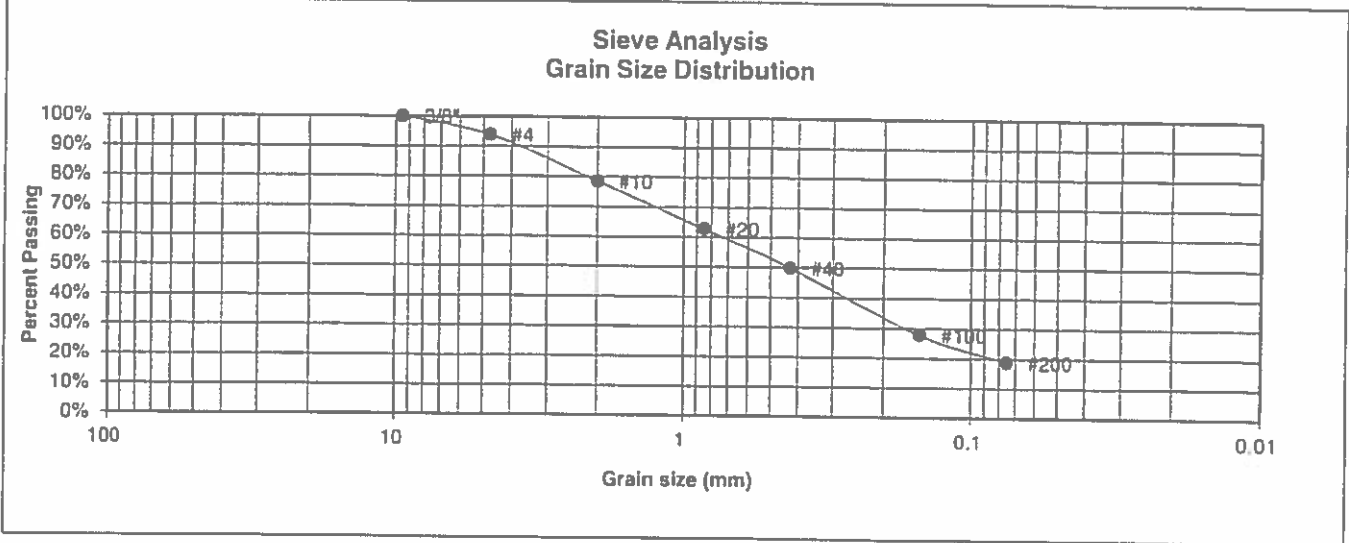
JOB NO:

191776

FIG NO

B-7

<b>UNIFIED CLASSIFICATION</b>	SM	<b>CLIENT</b>	JOHN JENNINGS
<b>SOIL TYPE #</b>	1	<b>PROJECT</b>	JUDGE ORR RANCHETTTS
<b>TEST BORING #</b>	7	<b>JOB NO.</b>	191776
<b>DEPTH (FT)</b>	1-2	<b>TEST BY</b>	BL
<b>AASHTO CLASSIFICATION</b>	A-1-b	<b>GROUP INDEX</b>	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	93.9%
10	78.4%
20	62.8%
40	49.9%
100	27.8%
200	18.7%

**Atterberg Limits**

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

**Swell**

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



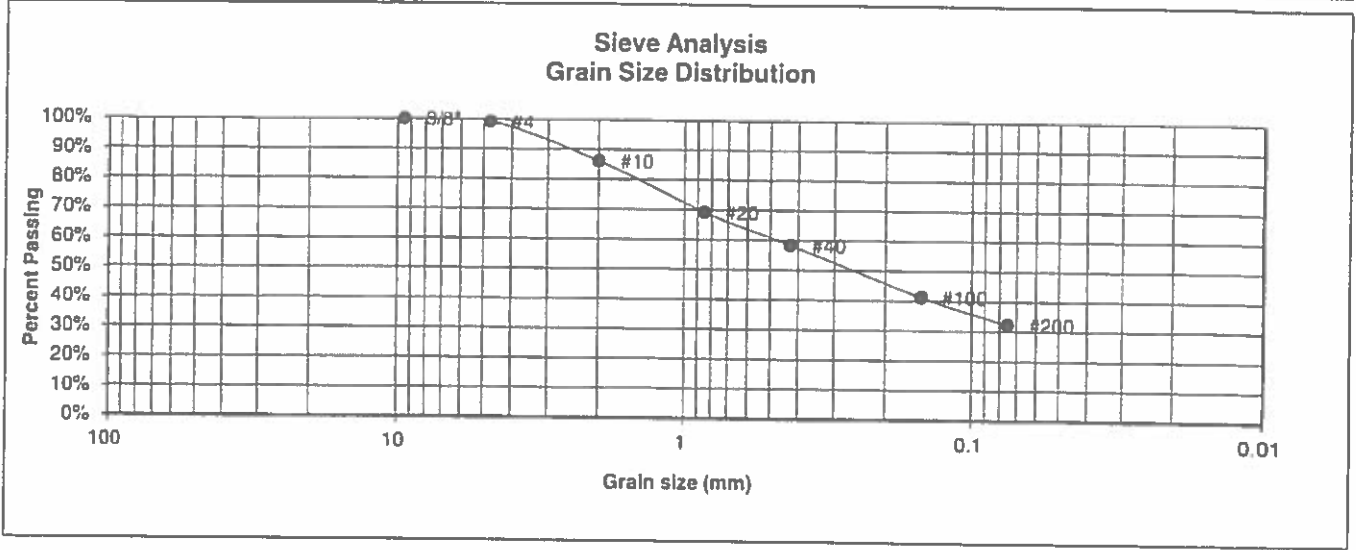
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**LABORATORY TEST  
RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
		<i>[Signature]</i>	3/9/20

JOB NO  
191776  
FIG NO  
88

UNIFIED CLASSIFICATION	SC	CLIENT	JOHN JENNINGS
SOIL TYPE #	1	PROJECT	JUDGE ORR RANCHETTTS
TEST BORING #	4	JOB NO.	191776
DEPTH (FT)	10	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	99.2%
#10	86.1%
#20	69.2%
#40	58.3%
#100	41.3%
#200	32.2%

Atterberg Limits	
Plastic Limit	18
Liquid Limit	28
Plastic Index	10

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



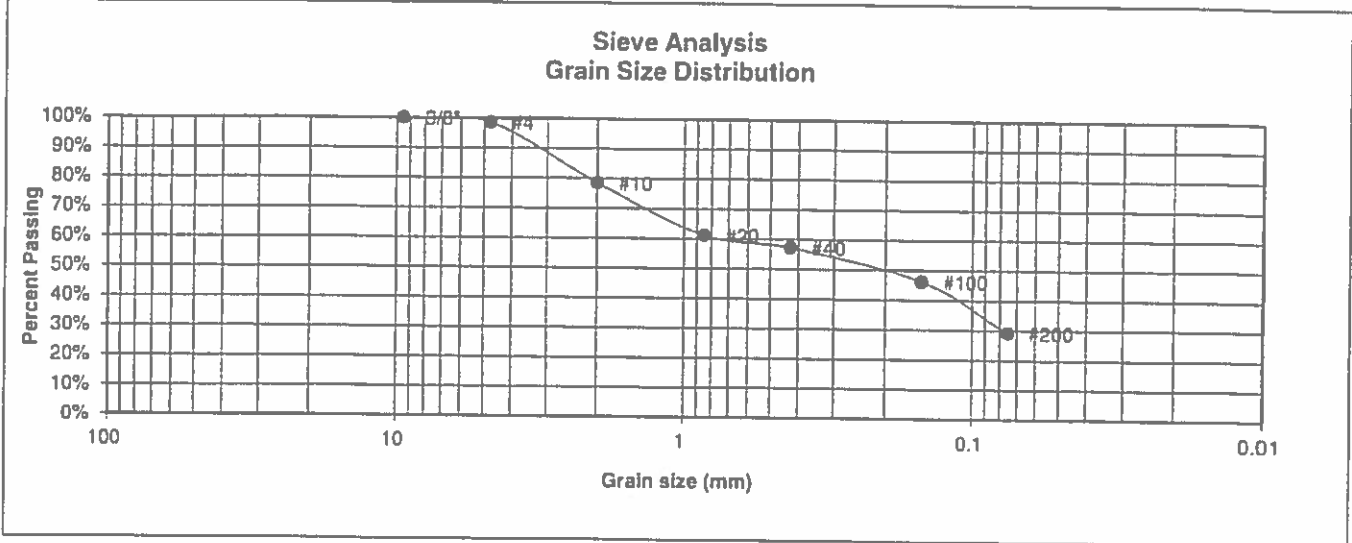
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COLORADO SPRINGS, COLORADO 80907

**LABORATORY TEST  
RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
		<i>[Signature]</i>	3/9/20

JOB NO  
191776  
FIG NO:  
B-5

<b>UNIFIED CLASSIFICATION</b>	SC	<b>CLIENT</b>	JOHN JENNINGS
<b>SOIL TYPE #</b>	1	<b>PROJECT</b>	JUDGE ORR RANCHETTTS
<b>TEST BORING #</b>	7	<b>JOB NO.</b>	191776
<b>DEPTH (FT)</b>	10	<b>TEST BY</b>	BL
<b>AASHTO CLASSIFICATION</b>	A-2-4	<b>GROUP INDEX</b>	-1



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.5%
10	78.5%
20	61.1%
40	57.2%
100	46.2%
200	29.1%

Atterberg Limits	
Plastic Limit	22
Liquid Limit	31
Plastic Index	9

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



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**LABORATORY TEST RESULTS**

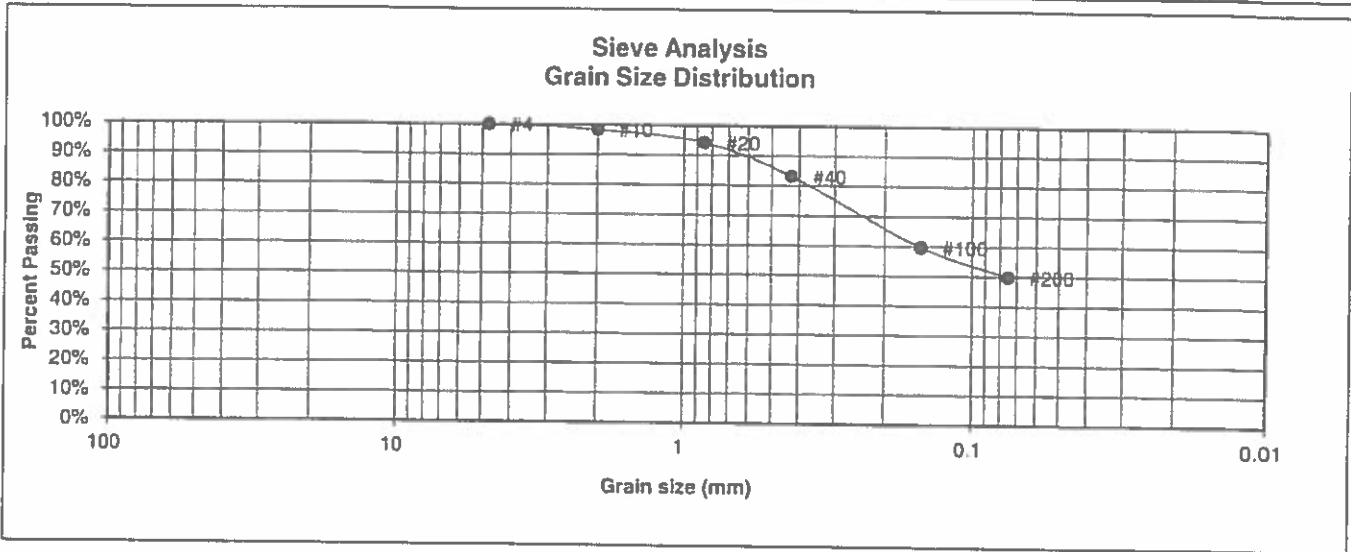
DRAWN:	DATE:	CHECKED:	DATE:
			12/9/20

JOB NO:  
 191776  
 FIG NO:  
 B-10



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

CLIENT JOHN JENNINGS  
PROJECT JUDGE ORR RANCHETTTS  
JOB NO. 191776  
TEST BY BL  
GROUP INDEX 3



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	98.3%
20	94.2%
40	83.1%
100	59.7%
200	49.8%

Atterberg Limits	
Plastic Limit	22
Liquid Limit	34
Plastic Index	13

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



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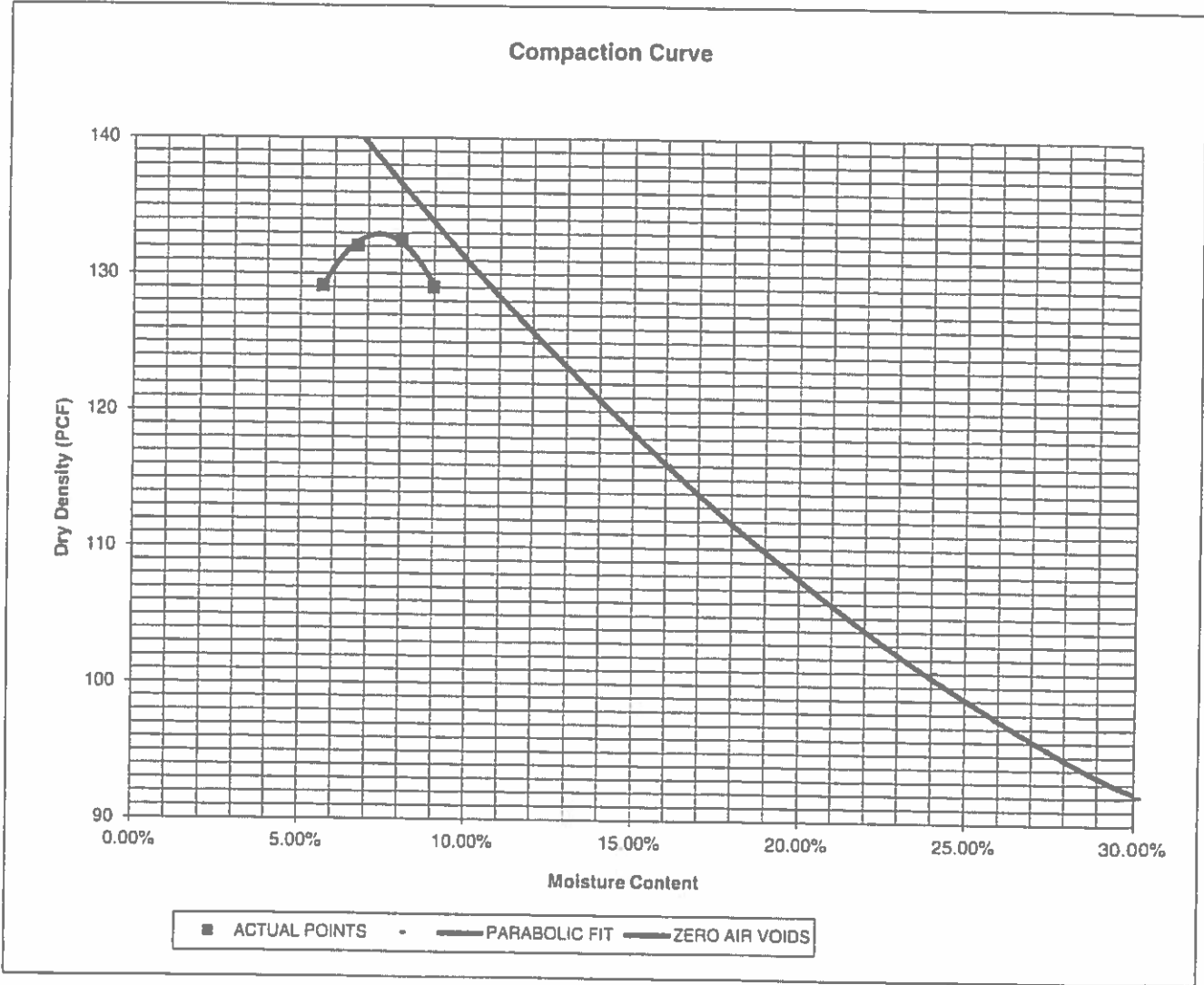
**LABORATORY TEST  
 RESULTS**

DRAWN:	DATE	CHECKED	DATE
		<i>h</i>	3/9/20

JOB NO  
 191776  
 FIG NO  
 B-11

<u>PROJECT</u>	JUDGE ORR RANCHETTTS	<u>CLIENT</u>	JOHN JENNINGS
<u>SAMPLE LOCATION</u>	TB-2 @ 0-3'	<u>JOB NO.</u>	191776
<u>SOIL DESCRIPTION</u>	SAND, SILTY, BROWN	<u>DATE</u>	02/17/20

<u>IDENTIFICATION</u>	SM	<u>COMPACTION TEST #</u>	1
<u>TEST DESIGNATION / METHOD</u>	ASTM D-1557-A	<u>TEST BY</u>	KW
<u>MAXIMUM DRY DENSITY (PCF)</u>	132.9	<u>OPTIMUM MOISTURE</u>	7.3%



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**MOISTURE DENSITY RELATION**

DRAWN	DATE	CHECKED: <i>[Signature]</i>	DATE: 3/9/20
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JOB NO.

191776

FIG NO

B-12

**CBR TEST LOAD DATA**

JOB NO: 191776  
 CLIENT: JOHN JENNINGS  
 PROJECT: JUDGE ORR RANCHETTTS  
 SOIL TYPE: 1

PISTON		PISTON		10 BLOWS		25 BLOWS		56 BLOWS	
DIAMETER (cm)		AREA (in <sup>2</sup> )		MOLD # 1		MOLD # 2		MOLD # 3	
4.958		2.99250919		LOAD(LBS)	STRESS (PSI)	LOAD(LBS)	STRESS (PSI)	LOAD(LBS)	STRESS (PSI)
PENETRATION DEPTH (INCHES)		(LBS)	(PSI)	(LBS)	(PSI)	(LBS)	(PSI)	(LBS)	(PSI)
0.000		0	0.00	0	0.00	0	0.00	0	0.00
0.025		91	30.41	157	52.46	177	59.15		
0.050		219	73.18	330	110.28	418	139.68		
0.075		484	161.74	506	169.09	757	252.96		
0.100		576	192.48	680	227.23	1086	362.91		
0.125		800	267.33	970	324.14	1531	511.61		
0.150		923	308.44	1393	465.50	1966	656.97		
0.175		1083	361.90	1656	553.38	2289	764.91		
0.200		1196	399.66	2096	700.42	2718	908.27		
0.300		1659	554.38	3901	1303.59	4493	1501.42		
0.400		1820	608.19	4751	1587.63	5978	1997.65		
0.500		2122	709.10	5501	1838.26	6000	2005.01		

**FINAL MOISTURE CONTENT**

	MOLD # 1	MOLD # 2	MOLD # 3
CAN #	345	357	106
WT. CAN	6.8	6.7	9.34
WT. CAN+WET	170.43	197.03	176.21
WT. CAN+DRY	148.42	175.42	160.62
WT. H2O	22.01	21.61	15.59
WT. DRY SOIL	141.62	168.72	151.28
MOISTURE CONTENT	15.54%	12.81%	10.31%

WET DENSITY (PCF)	130.2	135.8	141.8
DRY DENSITY (PCF)	121.4	126.5	132.1

BEARING RATIO	19.25	22.72	36.29
---------------	-------	-------	-------

90% OF DRY DENSITY	119.6
95% OF DRY DENSITY	126.3

BEARING RATIO AT 90% OF MAX	18.05 - R VALUE	65
BEARING RATIO AT 95% OF MAX	22.53 - R VALUE	71



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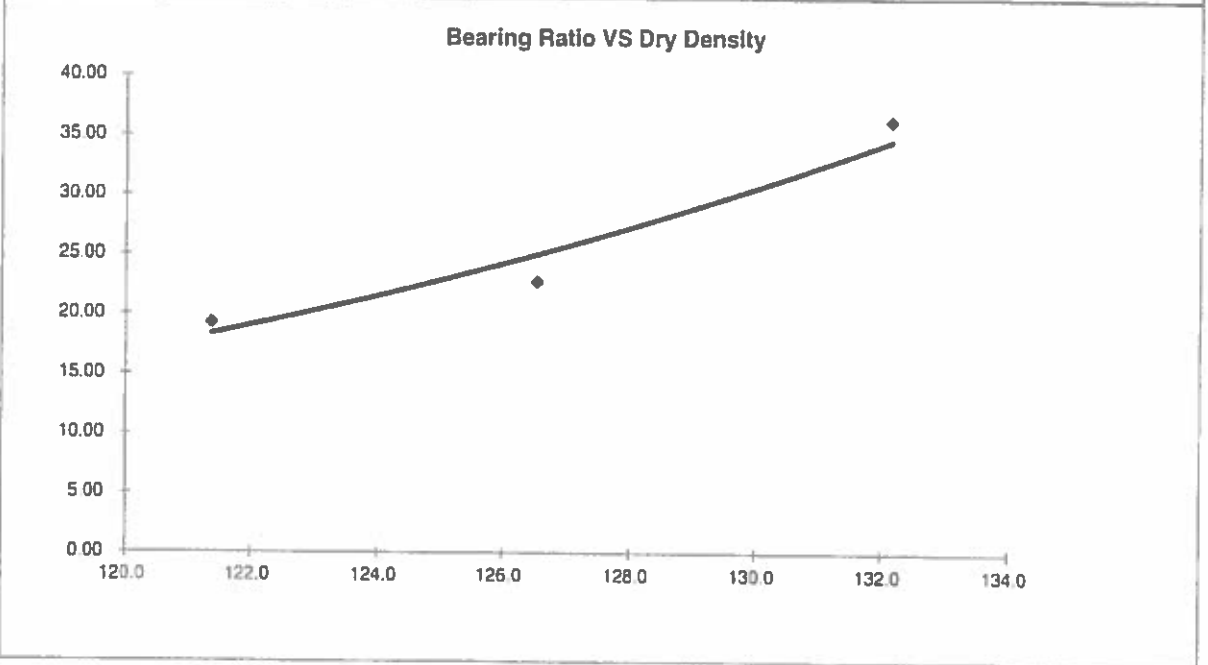
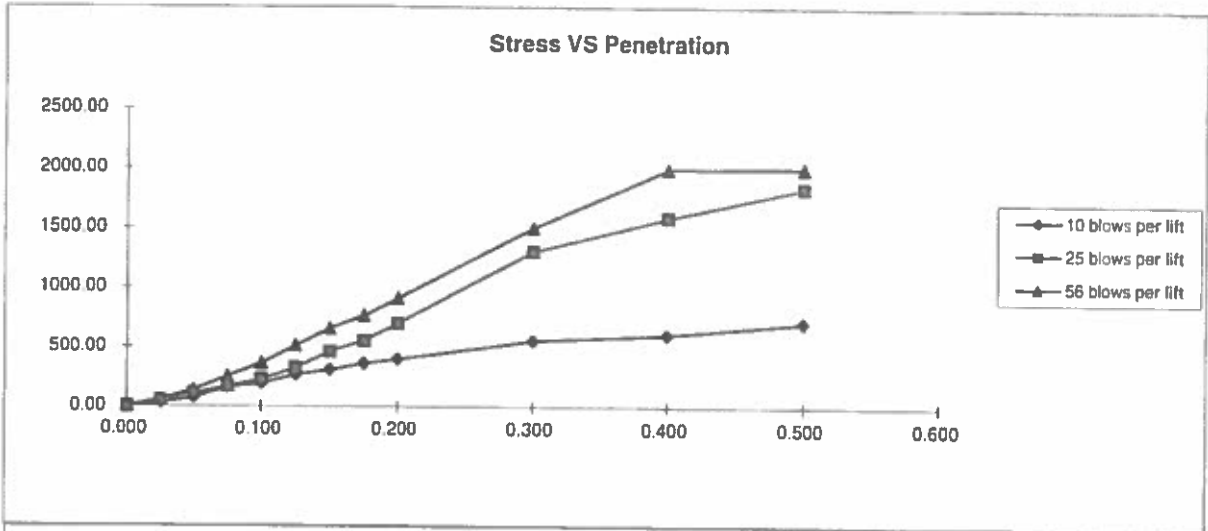
505 ELKTON DRIVE  
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**CBR TEST DATA**

DRAWN:	DATE:	CHECKED:	DATE:
		DS	3/26/04

JOB NO:  
 191776

FIG NO  
 B-13



BEARING RATIO AT 90% OF MAX	18.05 - R VALUE	65.00
BEARING RATIO AT 95% OF MAX	22.53 - R VALUE	71.00

JOB NO: 191776  
 SOIL TYPE: !



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**CALIFORNIA BEARING RATIO**

DRAWN	DATE:	CHECKED:	DATE:
		<i>DS</i>	3/26/00

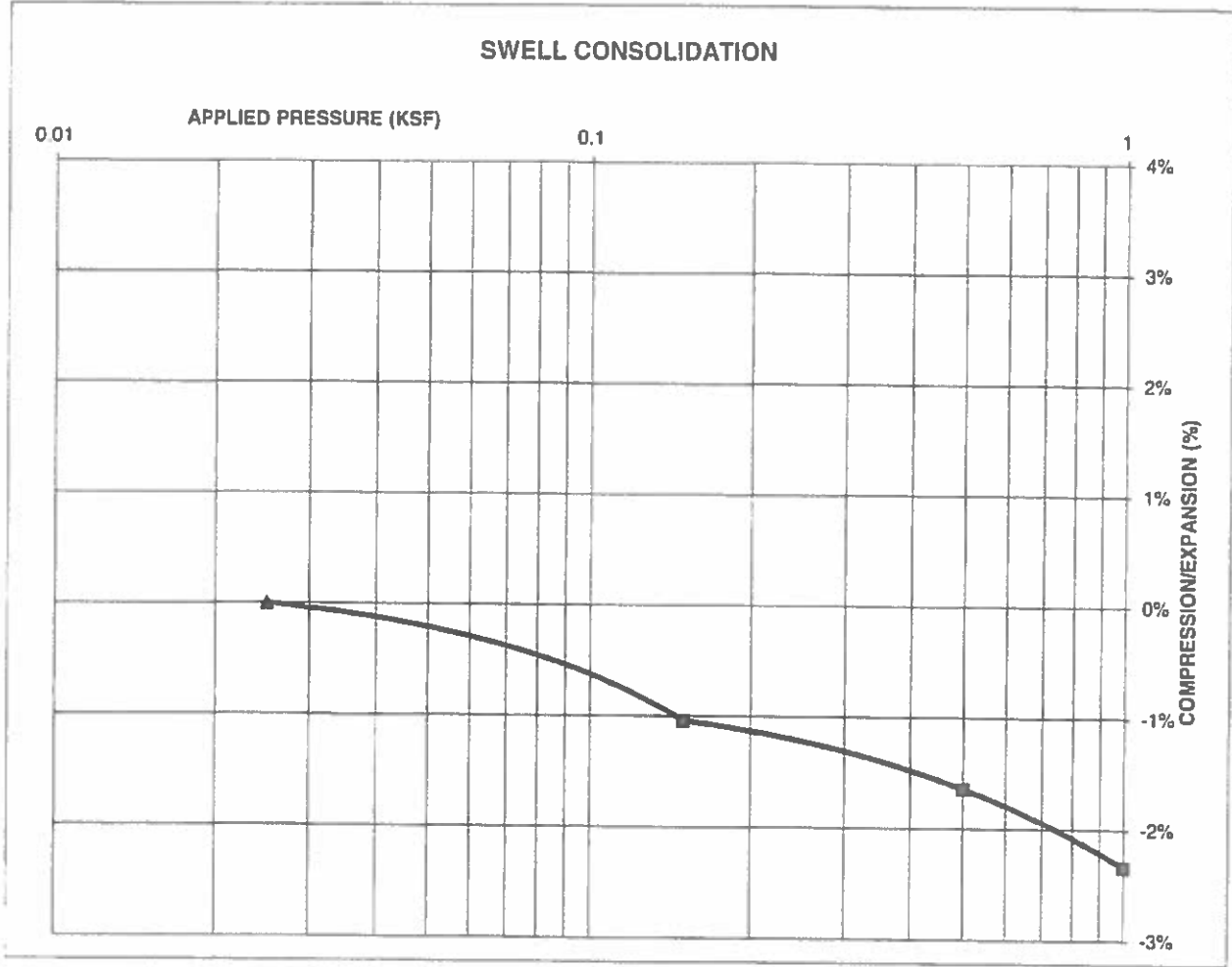
JOB NO: 191776  
 FIG NO: *B-4*



**CONSOLIDATION TEST RESULTS**

TEST BORING #	7	DEPTH(ft)	10
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			122
NATURAL MOISTURE CONTENT			10.5%
SWELL/CONSOLIDATION (%)			0.0%

JOB NO. 191776  
 CLIENT JOHN JENNINGS  
 PROJECT JUDGE ORR RANCHETTES



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**SWELL CONSOLIDATION  
 TEST RESULTS**

DRAWN:

DATE:

CHECKED:  
*DS*

DATE  
 3/21/00

JOB NO.:  
 191776

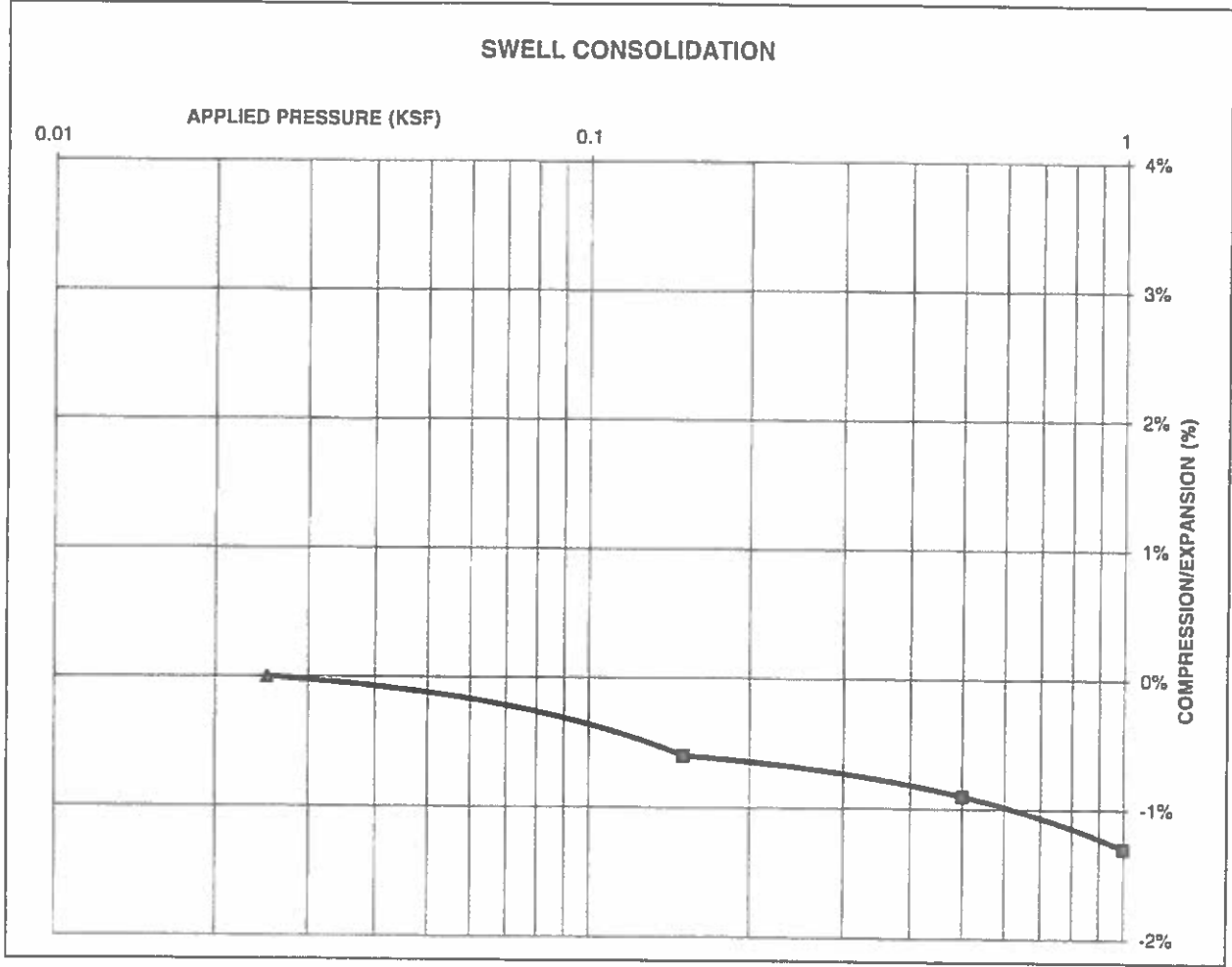
FIG NO.:

*b1c*

**CONSOLIDATION TEST RESULTS**

TEST BORING #	4	DEPTH(ft)	10
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			117
NATURAL MOISTURE CONTENT			14.0%
SWELL/CONSOLIDATION (%)			0.0%

JOB NO. 191776  
 CLIENT JOHN JENNINGS  
 PROJECT JUDGE ORR RANCHETTES



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 COLORADO SPRINGS, COLORADO 80907

**SWELL CONSOLIDATION  
 TEST RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
		DS	5/31/2

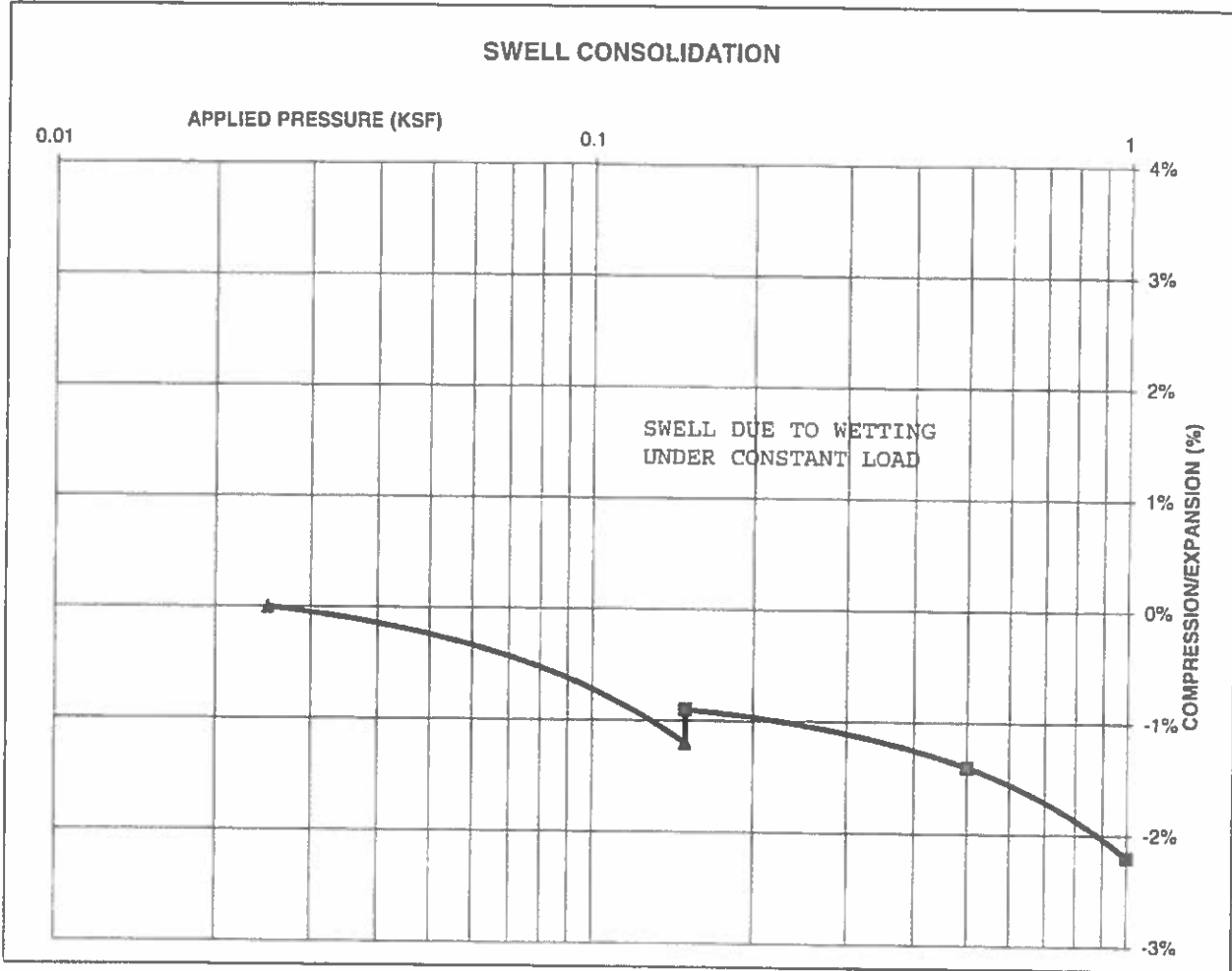
JOB NO.:  
 191776

FIG NO.:  
 17

**CONSOLIDATION TEST RESULTS**

TEST BORING #	2	DEPTH(ft)	10
DESCRIPTION	SC	SOIL TYPE	2
NATURAL UNIT DRY WEIGHT (PCF)			99
NATURAL MOISTURE CONTENT			22.0%
SWELL/CONSOLIDATION (%)			0.3%

JOB NO. 191776  
 CLIENT JOHN JENNINGS  
 PROJECT JUDGE ORR RANCHETTTS



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**SWELL CONSOLIDATION  
 TEST RESULTS**

DRAWN:

DATE:

CHECKED:

DATE  
 3/22/20

JOB NO:  
 191776

FIG NO:  
 B-10



## **APPENDIX C: Pavement Design Calculations**

## FLEXIBLE PAVEMENT DESIGN

### DESIGN DATA

JUDGE ORR RANCHETTES - RURAL LOCAL - ESAL = 36,500

SOIL TYPE I, CBR # 1

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	$\Delta psi$ =	2.2
Reliability	Reliability =	80
Reliability (z-statistic)	$Z_R$ =	-0.84
Soil Resilient Modulus	$M_R$ =	13168

Weighted Structural Number (WSN): ➔ WSN = 1.50

### DESIGN TABLES AND EQUATIONS

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

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

$$k = M_R / 19.4$$

Where:

$M_R$  = resilient modulus (psi)

$S_1$  = the soil support value

R = R-value obtained from the Hveem stabilometer

CBR = California Bearing Ratio

Reliability (%)	$Z_R$ (z-statistic)
-----------------	---------------------

80	-0.84
85	-1.04
90	-1.28
93	-1.48
94	-1.56
95	-1.65
96	-1.75
97	-1.88
98	-2.05
99	-2.33
99.9	-3.09
99.99	-3.75

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

Left	Right	Difference
4.56	4.63	-0.1

Job No. 191776  
Fig. No. C-1

## DESIGN CALCULATIONS

DESIGN DATA JUDGE ORR RANCHETTES - RURAL LOCAL - ESAL = 36,500

SOIL TYPE 1, CBR # 1

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL = 36,500
Hveem Stabilometer (R Value) Results:	R = 50
Weighted Structural Number (WSN):	WSN = 1.50

### 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)

$$D_1 = (WSN)/C_1 = 3.4 \text{ inches of Full Depth Asphalt}$$

Use 4.0 inches Full Depth

### FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) =  inches

$$D_2 = ((WSN) - (t)(C_1))/C_2 = 1.7 \text{ inches of Aggregate}$$

Base Course, use 4.0 inches

### RECOMMENDED ALTERNATIVES

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

Job No. 191776

Fig. No. C-2