

July 8, 2021  
Revised: July 20, 2021



**ENTECH**  
ENGINEERING, INC.

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

Classic Communities  
2138 Flying Horse Club Drive  
Colorado Springs, CO 80921

Attn: Adam Doyle

Re: Pavement Recommendations - Revised  
Hannah Ridge at Feathergrass, Filing No. 5  
El Paso County, Colorado

**APPROVED**  
**Engineering Department**

07/20/2021 3:52:14 PM

*dsdnijkamp*

**EPC Planning & Community  
Development Department**

Dear Mr. Doyle:

As requested, Entech Engineering, Inc. obtained samples of the pavement subgrade soils from the proposed roadways at the above referenced site. Laboratory testing was performed in order to determine the pavement support characteristics of the soil. This letter presents the results of the laboratory testing and pavement recommendations for the roadways.

### **Project Description**

The project will consist of paving of sections of Electronic Drive, Equine Court, and Dapples Court in the Hannah Ridge at Feathergrass, Filing No. 5 subdivision in El Paso County, Colorado. Subsurface Soil Investigation and laboratory testing were performed to determine the pavement support characteristics on the soils. The general layout of the site is presented in the Test Boring Location Map in Figure 1.

### **Subgrade Conditions**

A total of seven test borings were drilled along the roadways to depths of approximately 5 and 10 feet below the existing subgrade surface at the required sample frequency. The soils at the roadway subgrade depth consisted of clayey to very clayey sand fill (Soil Type 1) and clayey sand fill (Soil Type 2). The Test Boring Logs are presented in Appendix A. Sieve Analyses and Atterberg Limit testing were performed on subgrade soil samples obtained from the test borings for the purpose of classification. The percent passing the No. 200 sieve for the Type 1 soils ranged from approximately 36 to 47 percent and 21 to 35 percent for the Type 2 soils. The Type 3, 4, and 5 soils are beneath the subgrade influence zone.

The Type 1 soils classified as A-6, which commonly exhibit poor pavement support characteristics. The Type 2 soils classified as A-2-6 soils, which exhibit fair to good pavement support characteristics. Groundwater was not encountered in the test borings. Sulfate testing resulted in 0.00 percent soluble sulfate by weight, indicating a negligible potential for below grade concrete degradation due to sulfate attack.

Swell/Consolidation tests were performed on a majority of the subgrade soils due to their classification and plastic indexes. Swell tests on the soils resulted in volume changes of -0.4 to 0.7, which are below the levels in which mitigation is required. Mitigation for expansive soils is not required on this site.

California Bearing Ratio (CBR) testing was performed on representative subgrade samples of the Type 1 and 2 materials to determine the support characteristics of the subgrade soils for the roadway sections. The results of the CBR testing, are presented in Appendix B and summarized as follows:

Soil Type 1 – Very Clayey Sand Fill

CBR 1  
 R @ 95% = 6.0  
 R @ 90% = 17.0  
 Use R = 17.0 for design

Soil Type 2 – Clayey Sand Fill

CBR 2  
 R @ 95% = 17.0  
 R @ 90% = 40.0  
 Use R = 40.0 for design

Classification Testing

Liquid Limit	33
Plasticity Index	17
Percent Passing 200	46.9
AASHTO Classification	A-6
Group Index	4
Unified Soils Classification	SC

Classification Testing

Liquid Limit	24
Plasticity Index	11
Percent Passing 200	26.9
AASHTO Classification	A-2-6
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 Pavement Design Criteria Manual. Electronic Drive and Equine Court east of Electronic Drive (approximately 250 feet) classify as Urban Local Roads, which used an 18k ESAL value of 292,000 for design purposes. Equine Court west of Electronic Drive and Dapples Court classify as Local Low Volume Roads, which used an 18K ESAL value of 36,500 for design purposes. Pavement sections were determined for asphalt on cement stabilized subgrade.

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

Reliability

Local Low Volume	80%
Local Residential	80%

Δpsi

Local Low Volume	2.0
Local Residential	2.0
“R” Value Subgrade (Soil Type 1)	17.0
“R” Value Subgrade (Soil Type 2)	40.0
Resilient Modulus (Soil Type 1)	4,478 psi
Resilient Modulus (Soil Type 2)	9,497 psi
Hot Bituminous Pavement	0.44
Basecourse Subgrade	0.11

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.

**Pavement Sections**  
**ESAL = 36,500 – Local Low Volume**

<b><u>Soil Type 1</u></b>		
<b><u>Alternative</u></b>	<b><u>Asphalt (in)</u></b>	<b><u>Cement Stabilized Subgrade (in)</u></b>
1. Cement Stabilized Subgrade	4.0*	10.0

<b><u>Soil Type 2</u></b>		
<b><u>Alternative</u></b>	<b><u>Asphalt (in)</u></b>	<b><u>Cement Stabilized Subgrade (in)</u></b>
1. Cement Stabilized Subgrade	4.0*	10.0

**Pavement Sections**  
**ESAL = 292,000 – Local Residential**

<b><u>Soil Type 1</u></b>		
<b><u>Alternative</u></b>	<b><u>Asphalt (in)</u></b>	<b><u>Cement Stabilized Subgrade (in)</u></b>
1. Cement Stabilized Subgrade	4.0*	10.0

<b><u>Soil Type 2</u></b>		
<b><u>Alternative</u></b>	<b><u>Asphalt (in)</u></b>	<b><u>Cement Stabilized Subgrade (in)</u></b>
1. Cement Stabilized Subgrade	4.0*	10.0

\*Minimum sections required per the El Paso County Engineering Criteria Manual.

**Mitigation**

The El Paso County Engineering Criteria Manual requires mitigation of subgrade soils that have a swell of 2.0 percent or greater with a 200 pound per square foot surcharge. None of the swell tests exceeded the threshold. Mitigation of the subgrade soils is not required.

**Roadway Construction – Cement Stabilized Subgrade**

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 3.0 percent (by weight) of the subgrade’s maximum dry density, as determined by the Standard Proctor Test (ASTM D-698), 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-inch 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 Standard Proctor Test (ASTM D-698). 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.

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 has provided you with the information you required. The pavement sections provided are based on general site soil types. If you have any questions or need additional information, please do not hesitate to contact us.

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Daniel P. Stegman

JCG/bs

Encl.

Entech Job No. 210984  
AAprojects/2021/210984 pr

Reviewed by



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

## TABLE

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

CLIENT CLASSIC COMMUNITIES  
 PROJECT HANNAH RIDGE, FEATHERGRASS, F5  
 JOB NO. 210984


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	1	0-3	10.8	115.2	46.9	33	17		A-6	0.5	SC	FILL, SAND, VERY CLAYEY
1	1	1-2	14.2	115.7	36.3	33	16		A-6	0.5	SC	FILL, SAND, VERY CLAYEY
1	6	1-2	12.8	114.5	36.1	39	20	0.00	A-6	0.7	SC	FILL, SAND, VERY CLAYEY
2, CBR	5	0-3			26.9	24	11		A-2-6		SC	FILL, SAND, CLAYEY
2	2	1-2	14.3	94.6	21.6	38	17	0.00	A-2-6	0.3	SC	FILL, SAND, CLAYEY
2	3	1-2	9.4	97.1	31.4	31	11		A-2-6	0.2	SC	FILL, SAND, CLAYEY
2	4	1-2	7.4	95.1	24.8	28	12		A-2-6	-0.2	SC	FILL, SAND, CLAYEY
2	5	1-2	10.8	98.9	34.6	32	16		A-2-6	0.1	SC	FILL, SAND, CLAYEY
2	7	1-2	8.5	113.0	20.8	29	12		A-2-6	0.0	SC	FILL, SAND, CLAYEY
3	4	5			23.8	NV	NP	0.00	A-2-4		SM	SAND, SILTY
3	7	10	10.7	95.6	23.5	31	15	0.00	A-2-6	-0.4	SC	SAND, CLAYEY
4	6	10	8.0	94.1	45.7	33	17		A-6	0.6	SC	SAND, VERY CLAYEY
5	1	10			23.0	NV	NP		A-2-4		SM	SANDSTONE, SILTY

**FIGURE**



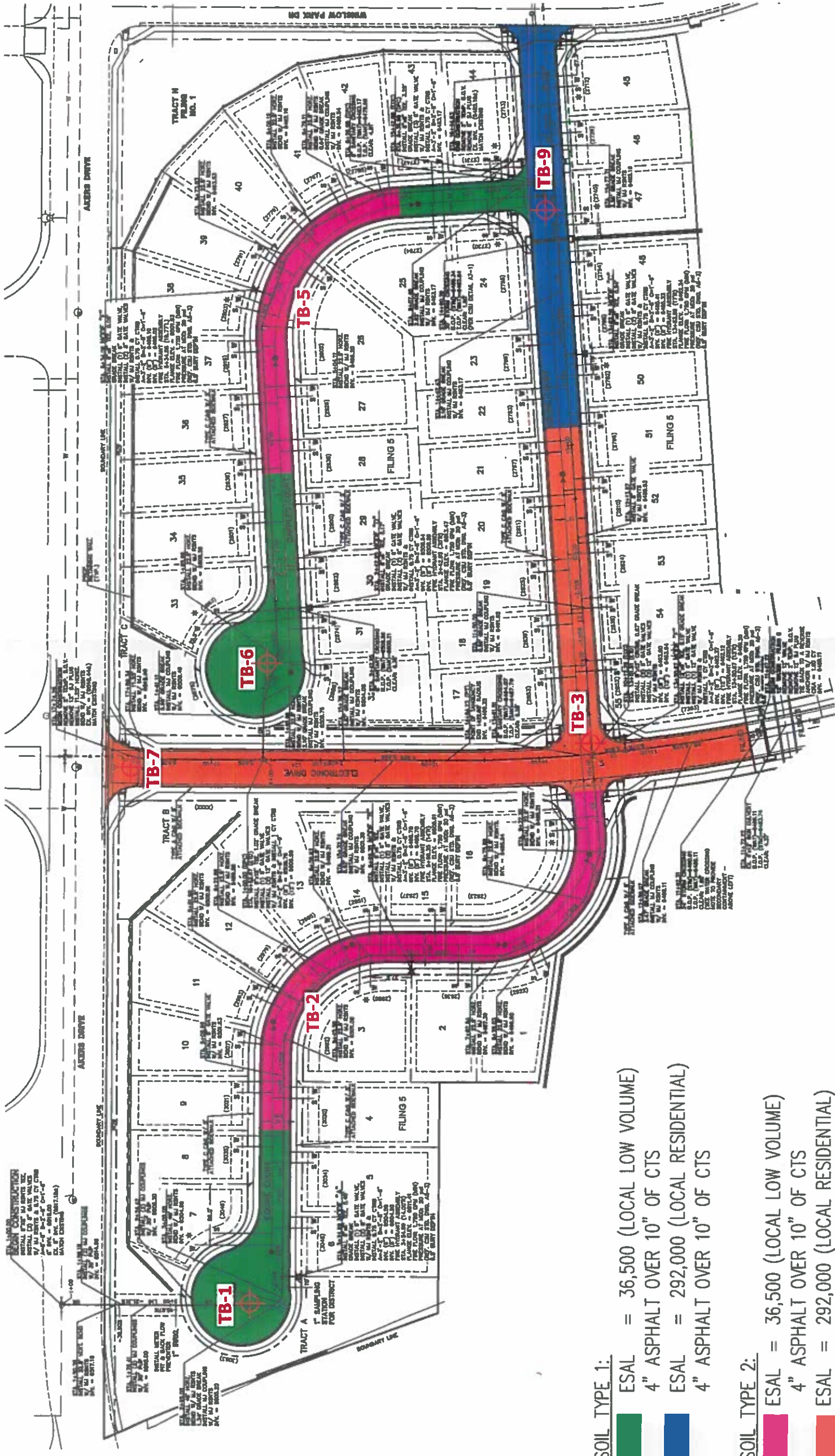
REVISION BY	DATE	DESCRIPTION

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305 ELKTON DRIVE  
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(719) 531-5599



TEST BORING LOCATION MAP #5  
HANNAH RIDGE AT FEATHERGRASS P#5  
FOR: CLASSIC COMMUNITIES

DRAWN	JAC
CHECKED	DS
DATE	7/06/21
SCALE	1" = 100'
JOB NO.	210924
PROJECT	FEATHER GR.
SHEET NO.	1



- SOIL TYPE 1:**
- ESAL = 36,500 (LOCAL LOW VOLUME)  
4" ASPHALT OVER 10" OF CTS
  - ESAL = 292,000 (LOCAL RESIDENTIAL)  
4" ASPHALT OVER 10" OF CTS
- SOIL TYPE 2:**
- ESAL = 36,500 (LOCAL LOW VOLUME)  
4" ASPHALT OVER 10" OF CTS
  - ESAL = 292,000 (LOCAL RESIDENTIAL)  
4" ASPHALT OVER 10" OF CTS

\*SOILS TRANSITIONS TO BE FIELD DETERMINED

⊕ TB- APPROXIMATE TEST BORING LOCATION AND NUMBER





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

TEST BORING NO. 1  
 DATE DRILLED 6/10/2021  
 Job # 210984

TEST BORING NO. 2  
 DATE DRILLED 6/10/2021  
 CLIENT CLASSIC COMMUNITIES  
 LOCATION HANNAH RIDGE, FEATHERGRASS, F5

REMARKS

DRY TO 10', 6/10/21

FILL 0-7', SAND, VERY CLAYEY,  
 FINE GRAINED, BROWN, MEDIUM  
 DENSE TO LOOSE, MOIST

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

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
0-7	(Symbol: dots and dashes)		21	11.4	1
5	(Symbol: dots and dashes)		9	6.5	1
10	(Symbol: dots and dashes)		50 6"	9.6	5

REMARKS

DRY TO 5', 6/10/21

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

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
0-5	(Symbol: dots and dashes)		11	13.5	2
5	(Symbol: dots and dashes)		24	9.2	2



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TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
		DS	7/8/21

JOB NO:  
 210984

FIG NO:  
 A-1

TEST BORING NO. 3  
 DATE DRILLED 6/10/2021  
 Job # 210984

TEST BORING NO. 4  
 DATE DRILLED 6/10/2021  
 CLIENT CLASSIC COMMUNITIES  
 LOCATION HANNAH RIDGE, FEATHERGRASS, F5

REMARKS

DRY TO 5', 6/10/21

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

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5	[Symbol]		12	7.1	2
5	[Symbol]		13	8.2	2

REMARKS

DRY TO 5', 6/10/21

FILL 0-2', SAND, CLAYEY, FINE TO MEDIUM GRAINED, BROWN, MEDIUM DENSE, MOIST  
 SAND, SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5	[Symbol]		13	7.3	1
5	[Symbol]		12	8.0	3



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TEST BORING LOG

DRAWN:

DATE:

CHECKED:

DATE: 7/5/21

JOB NO.  
 210984

FIG NO.  
 A- 2

TEST BORING NO. 5  
 DATE DRILLED 6/10/2021  
 Job # 210984

TEST BORING NO. 6  
 DATE DRILLED 6/10/2021  
 CLIENT CLASSIC COMMUNITIES  
 LOCATION HANNAH RIDGE, FEATHERGRASS, F5

REMARKS

DRY TO 5', 6/10/21

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

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5	[Symbol]		12	9.7	2
5	[Symbol]		9	9.9	2
10					
15					
20					

REMARKS

DRY TO 10', 6/10/21

FILL 0-8', SAND, VERY CLAYEY, FINE GRAINED, BROWN, MEDIUM DENSE TO DENSE, MOIST

SAND, VERY CLAYEY, FINE GRAINED, TAN, MEDIUM DENSE, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5	[Symbol]		15	12.3	1
5	[Symbol]		30	6.4	1
10	[Symbol]		27	7.3	4
15					
20					



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TEST BORING LOG

DRAWN:

DATE:

CHECKED:

DATE:

DS

7/6/21

JOB NO:  
 210984

FIG NO:  
 A-3

TEST BORING NO. 7  
 DATE DRILLED 6/10/2021  
 Job # 210984

TEST BORING NO.  
 DATE DRILLED  
 CLIENT CLASSIC COMMUNITIES  
 LOCATION HANNAH RIDGE, FEATHERGRASS, FS

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 10', 6/10/21													
FILL 0-9, SAND, CLAYEY, FINE TO MEDIUM GRAINED, BROWN, MEDIUM DENSE, MOIST	5			25	6.3	2							
	5			16	14.3	2							
SAND, CLAYEY, FINE GRAINED, BROWN, MEDIUM DENSE, MOIST	10			13	12.0	3							
	15												
	20												



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 COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:

DATE

CHECKED:

DS

DATE:

7/8/21

JOB NO:  
210984

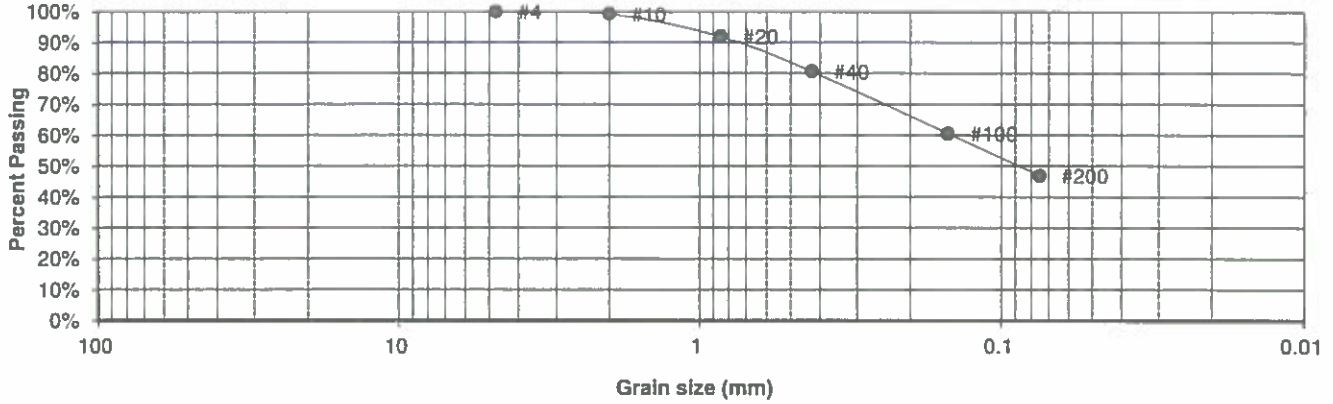
FIG NO:  
A- 4



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

<u>UNIFIED CLASSIFICATION</u>	SC	<u>CLIENT</u>	CLASSIC COMMUNITIES
<u>SOIL TYPE #</u>	1, CBR	<u>PROJECT</u>	HANNAH RIDGE, FEATHERGRASS, F5
<u>TEST BORING #</u>	1	<u>JOB NO.</u>	210984
<u>DEPTH (FT)</u>	0-3	<u>TEST BY</u>	BL
<u>AASHTO CLASSIFICATION</u>	A-6	<u>GROUP INDEX</u>	4

**Sieve Analysis  
Grain Size Distribution**



<u>U.S. Sieve #</u>	<u>Percent Finer</u>
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.2%
20	91.9%
40	80.6%
100	60.5%
200	46.9%

<u>Atterberg Limits</u>	
Plastic Limit	16
Liquid Limit	33
Plastic Index	17

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



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**LABORATORY TEST  
RESULTS**

DRAWN:

DATE:

CHECKED: *B*

DATE: *7/8/21*

JOB NO.:

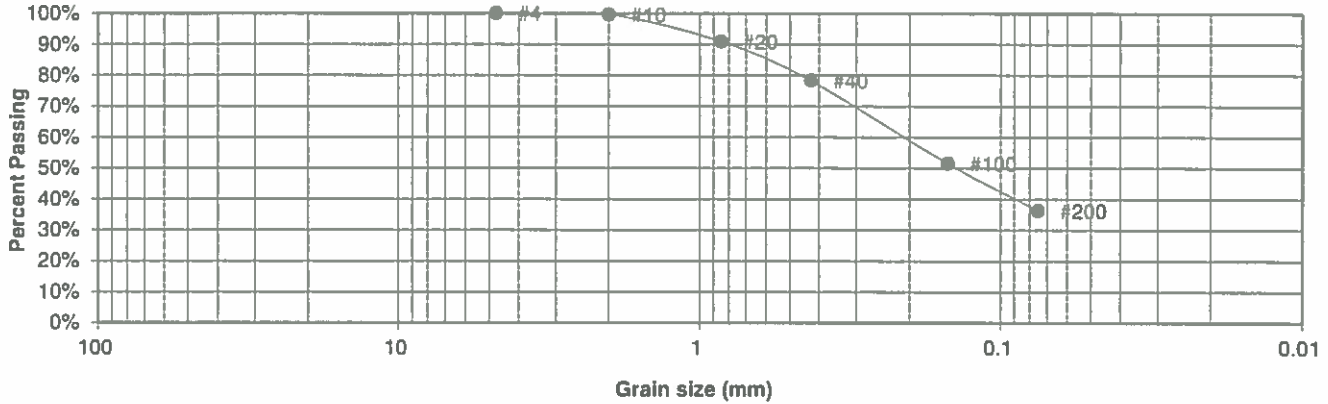
210984

FIG NO.:

*B-1*

<u>UNIFIED CLASSIFICATION</u>	SC	<u>CLIENT</u>	CLASSIC COMMUNITIES
<u>SOIL TYPE #</u>	1	<u>PROJECT</u>	HANNAH RIDGE, FEATHERGRASS, F5
<u>TEST BORING #</u>	1	<u>JOB NO.</u>	210984
<u>DEPTH (FT)</u>	1-2	<u>TEST BY</u>	BL
<u>AASHTO CLASSIFICATION</u>	A-6	<u>GROUP INDEX</u>	2

**Sieve Analysis  
Grain Size Distribution**



<u>U.S. Sieve #</u>	<u>Percent Finer</u>
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.6%
20	90.9%
40	78.3%
100	51.5%
200	36.3%

<u>Atterberg Limits</u>	
Plastic Limit	17
Liquid Limit	33
Plastic Index	16

<u>Swell</u>	
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:
		BS	7/8/21

JOB NO.:

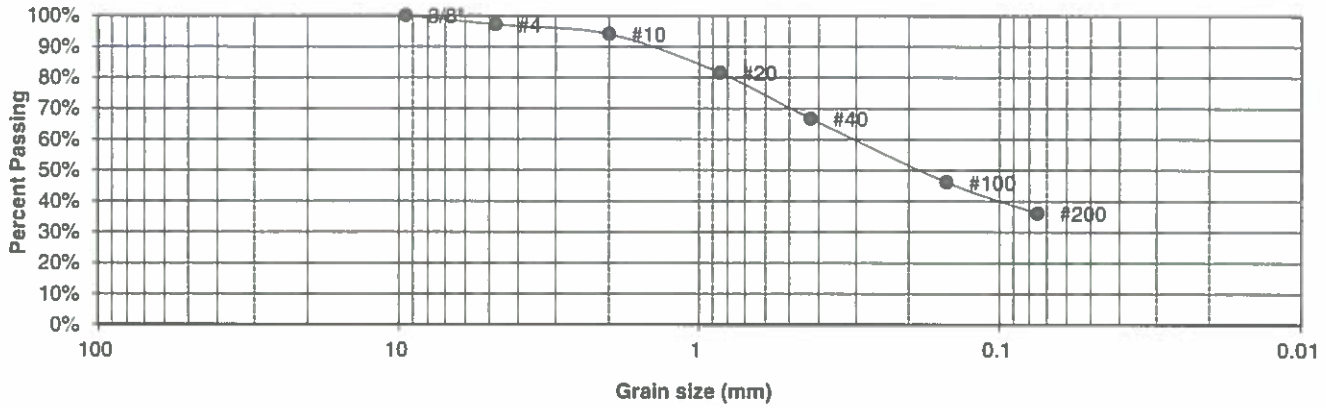
210984

FIG NO.:

B-2

<u>UNIFIED CLASSIFICATION</u>	SC	<u>CLIENT</u>	CLASSIC COMMUNITIES
<u>SOIL TYPE #</u>	1	<u>PROJECT</u>	HANNAH RIDGE, FEATHERGRASS, F5
<u>TEST BORING #</u>	6	<u>JOB NO.</u>	210984
<u>DEPTH (FT)</u>	1-2	<u>TEST BY</u>	BL
<u>AASHTO CLASSIFICATION</u>	A-6	<u>GROUP INDEX</u>	2

**Sieve Analysis  
Grain Size Distribution**



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.2%
10	94.0%
20	81.6%
40	66.7%
100	46.1%
200	36.1%

Atterberg Limits	
Plastic Limit	19
Liquid Limit	39
Plastic Index	20

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	7/18/21

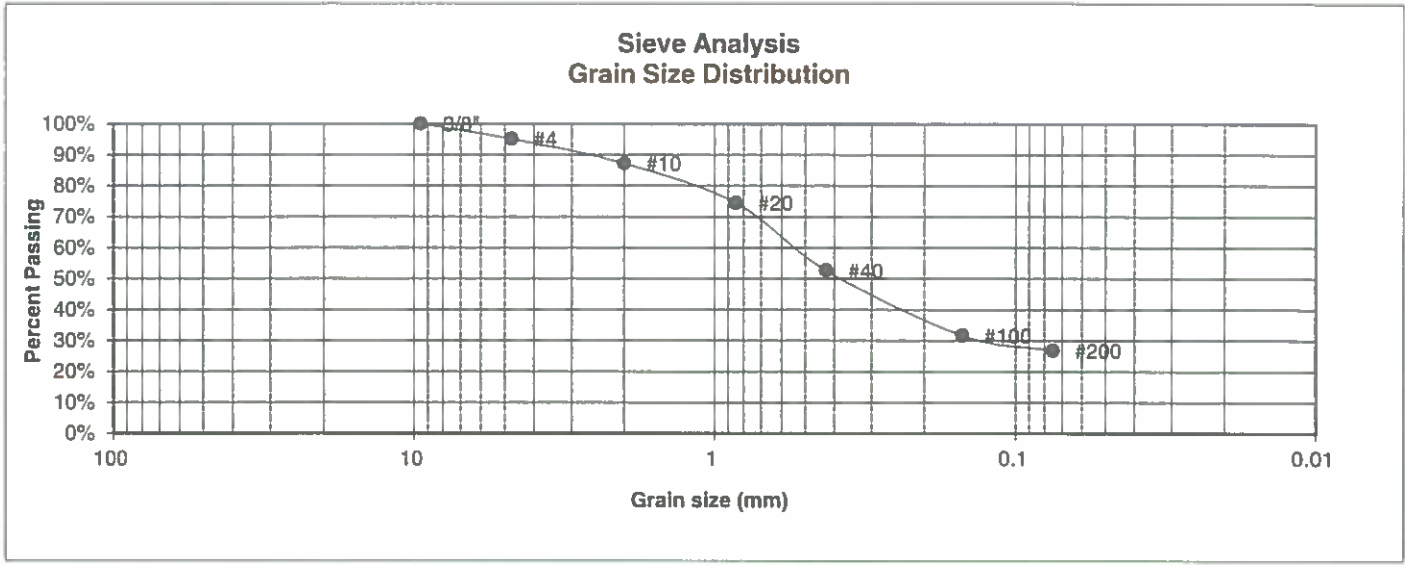
JOB NO.:

210984

FIG NO.:

B-3

<u>UNIFIED CLASSIFICATION</u>	SC	<u>CLIENT</u>	CLASSIC COMMUNITIES
<u>SOIL TYPE #</u>	2, CBR	<u>PROJECT</u>	HANNAH RIDGE, FEATHERGRASS, F5
<u>TEST BORING #</u>	5	<u>JOB NO.</u>	210984
<u>DEPTH (FT)</u>	0-3	<u>TEST BY</u>	BL
<u>AASHTO CLASSIFICATION</u>	A-2-6	<u>GROUP INDEX</u>	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	95.1%
10	87.2%
20	74.5%
40	52.6%
100	31.7%
200	26.9%

Atterberg Limits	
Plastic Limit	12
Liquid Limit	24
Plastic Index	11
Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	



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**LABORATORY TEST  
RESULTS**

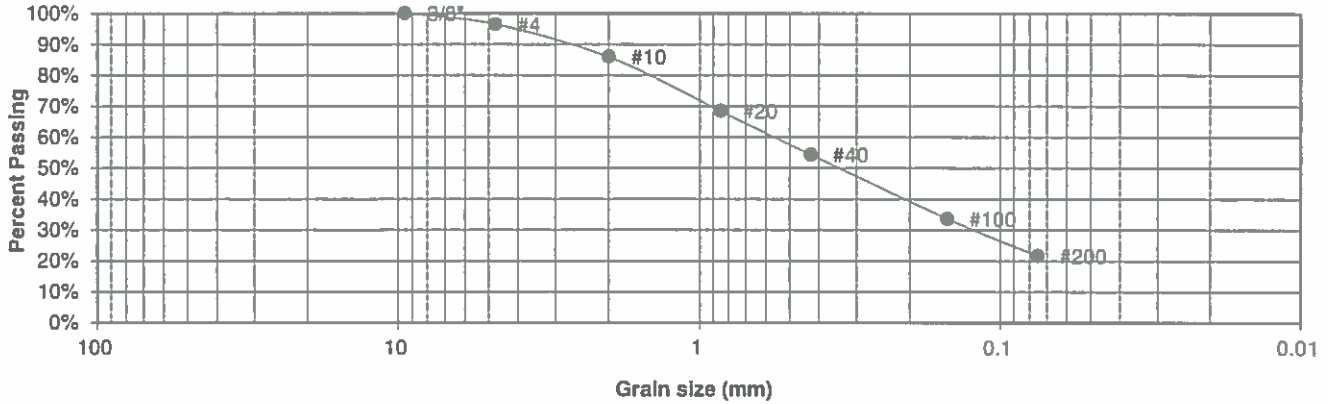
DRAWN:	DATE	CHECKED: <i>JS</i>	DATE: <i>7/8/21</i>
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JOB NO.:  
210984  
FIG NO.:  
*B-4*



<b>UNIFIED CLASSIFICATION</b>	SC	<b>CLIENT</b>	CLASSIC COMMUNITIES
<b>SOIL TYPE #</b>	2	<b>PROJECT</b>	HANNAH RIDGE, FEATHERGRASS, F5
<b>TEST BORING #</b>	2	<b>JOB NO.</b>	210984
<b>DEPTH (FT)</b>	1-2	<b>TEST BY</b>	BL
<b>AASHTO CLASSIFICATION</b>	A-2-6	<b>GROUP INDEX</b>	0

**Sieve Analysis  
Grain Size Distribution**



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	96.5%
10	86.0%
20	68.4%
40	54.4%
100	33.6%
200	21.6%

Atterberg Limits	
Plastic Limit	21
Liquid Limit	38
Plastic Index	17

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



**ENTECH  
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**LABORATORY TEST  
RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
		DS	7/8/21

JOB NO.:

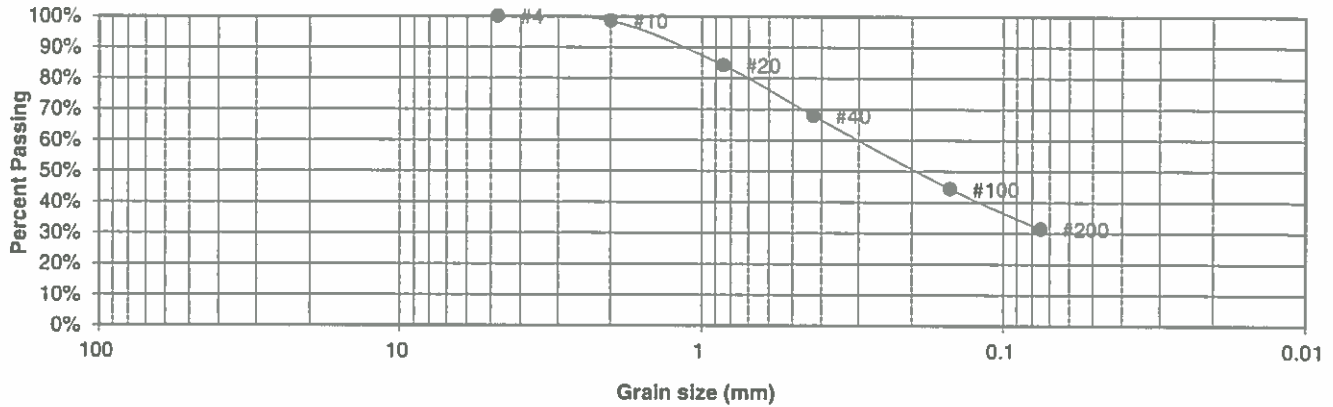
210984

FIG NO.:

B-5

<u>UNIFIED CLASSIFICATION</u>	SC	<u>CLIENT</u>	CLASSIC COMMUNITIES
<u>SOIL TYPE #</u>	2	<u>PROJECT</u>	HANNAH RIDGE, FEATHERGRASS, F5
<u>TEST BORING #</u>	3	<u>JOB NO.</u>	210984
<u>DEPTH (FT)</u>	1-2	<u>TEST BY</u>	BL
<u>AASHTO CLASSIFICATION</u>	A-2-6	<u>GROUP INDEX</u>	0

**Sieve Analysis  
Grain Size Distribution**



<u>U.S. Sieve #</u>	<u>Percent Finer</u>
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	98.5%
20	84.2%
40	67.9%
100	44.4%
200	31.4%

<u>Atterberg Limits</u>	
Plastic Limit	21
Liquid Limit	31
Plastic Index	11

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



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**LABORATORY TEST  
RESULTS**

<u>DRAWN:</u>	<u>DATE:</u>	<u>CHECKED:</u> BS	<u>DATE:</u> 7/15/21
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JOB NO.:

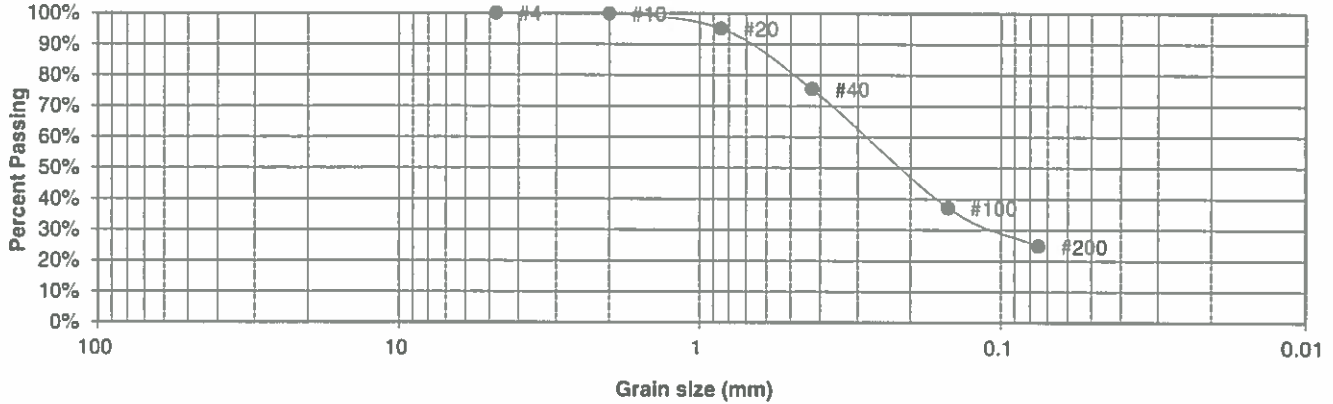
210984

FIG NO.:

Brl

<u>UNIFIED CLASSIFICATION</u>	SC	<u>CLIENT</u>	CLASSIC COMMUNITIES
<u>SOIL TYPE #</u>	2	<u>PROJECT</u>	HANNAH RIDGE, FEATHERGRASS, F5
<u>TEST BORING #</u>	4	<u>JOB NO.</u>	210984
<u>DEPTH (FT)</u>	1-2	<u>TEST BY</u>	BL
<u>AASHTO CLASSIFICATION</u>	A-2-6	<u>GROUP INDEX</u>	0

**Sieve Analysis  
Grain Size Distribution**



<u>U.S. Sieve #</u>	<u>Percent Finer</u>
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.8%
20	95.1%
40	75.5%
100	37.1%
200	24.8%

<u>Atterberg Limits</u>	
Plastic Limit	16
Liquid Limit	28
Plastic Index	12

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



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**LABORATORY TEST  
RESULTS**

<u>DRAWN:</u>	<u>DATE:</u>	<u>CHECKED:</u>	<u>DATE:</u>
		DS	7/8/21

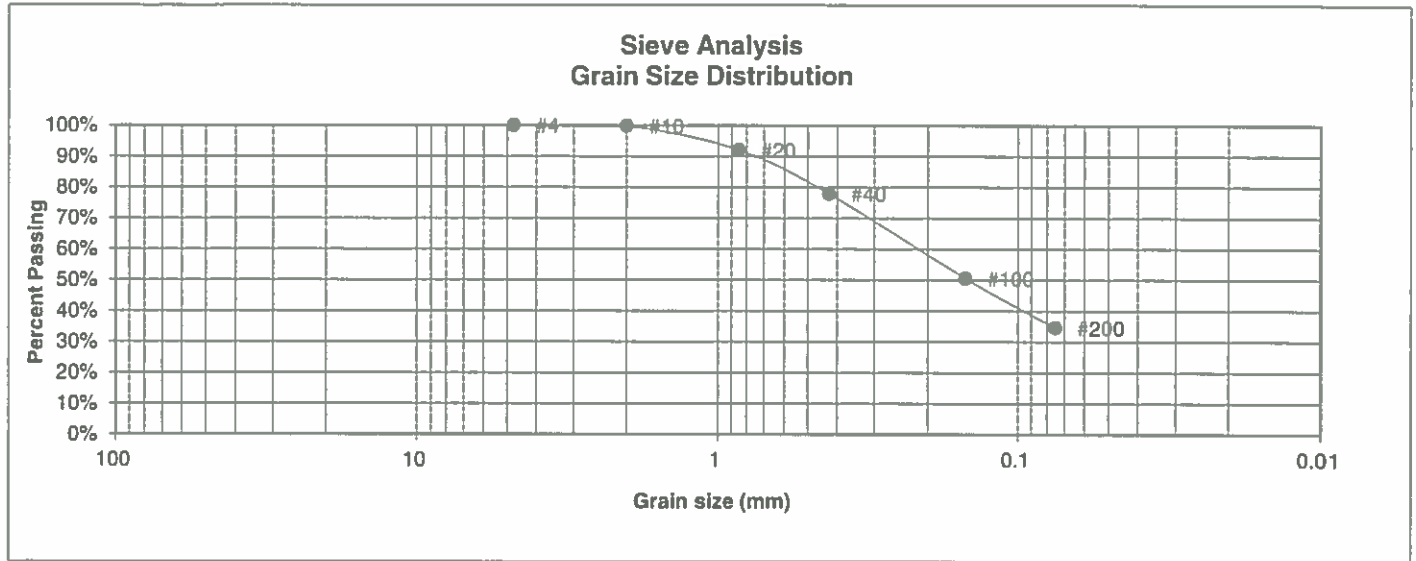
JOB NO.:

210984

FIG NO.:

B-1

<u>UNIFIED CLASSIFICATION</u>	SC	<u>CLIENT</u>	CLASSIC COMMUNITIES
<u>SOIL TYPE #</u>	2	<u>PROJECT</u>	HANNAH RIDGE, FEATHERGRASS, F5
<u>TEST BORING #</u>	5	<u>JOB NO.</u>	210984
<u>DEPTH (FT)</u>	1-2	<u>TEST BY</u>	BL
<u>AASHTO CLASSIFICATION</u>	A-2-6	<u>GROUP INDEX</u>	1



<u>U.S. Sieve #</u>	<u>Percent Finer</u>
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.8%
20	92.1%
40	78.0%
100	50.5%
200	34.6%

<u>Atterberg Limits</u>	
Plastic Limit	16
Liquid Limit	32
Plastic Index	16

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



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**LABORATORY TEST  
RESULTS**

<u>DRAWN:</u>	<u>DATE:</u>	<u>CHECKED:</u> BS	<u>DATE:</u> 7/5/21
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JOB NO:

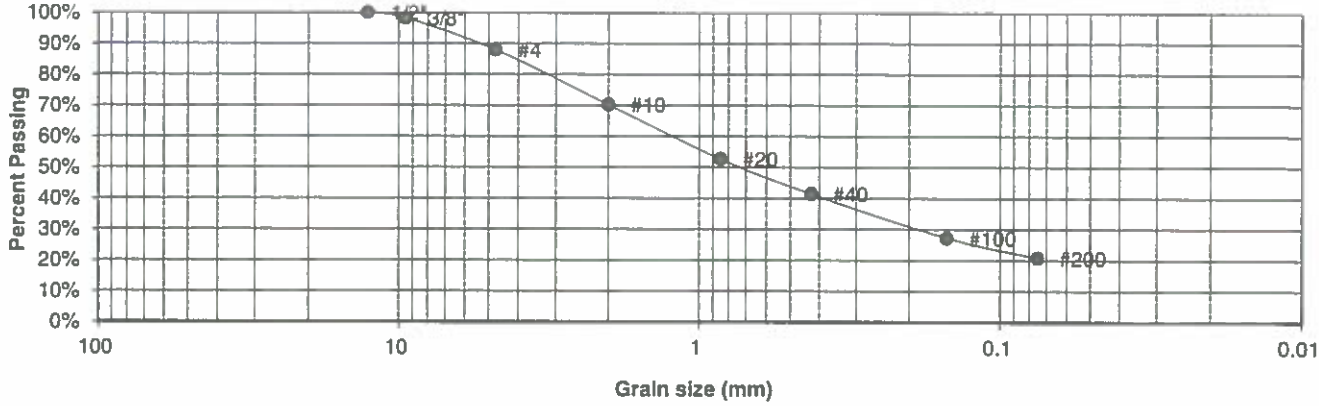
210984

FIG NO:

B-8

<u>UNIFIED CLASSIFICATION</u>	SC	<u>CLIENT</u>	CLASSIC COMMUNITIES
<u>SOIL TYPE #</u>	2	<u>PROJECT</u>	HANNAH RIDGE, FEATHERGRASS, F5
<u>TEST BORING #</u>	7	<u>JOB NO.</u>	210984
<u>DEPTH (FT)</u>	1-2	<u>TEST BY</u>	BL
<u>AASHTO CLASSIFICATION</u>	A-2-6	<u>GROUP INDEX</u>	0

**Sieve Analysis  
Grain Size Distribution**



<u>U.S. Sieve #</u>	<u>Percent Finer</u>
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	98.1%
#4	88.0%
#10	70.2%
#20	52.7%
#40	41.4%
#100	27.2%
#200	20.8%

<u>Atterberg Limits</u>	
Plastic Limit	17
Liquid Limit	29
Plastic Index	12

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



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**LABORATORY TEST  
RESULTS**

<u>DRAWN:</u>	<u>DATE:</u>	<u>CHECKED:</u>	<u>DATE:</u>
		DS	7/8/21

JOB NO.:

210984

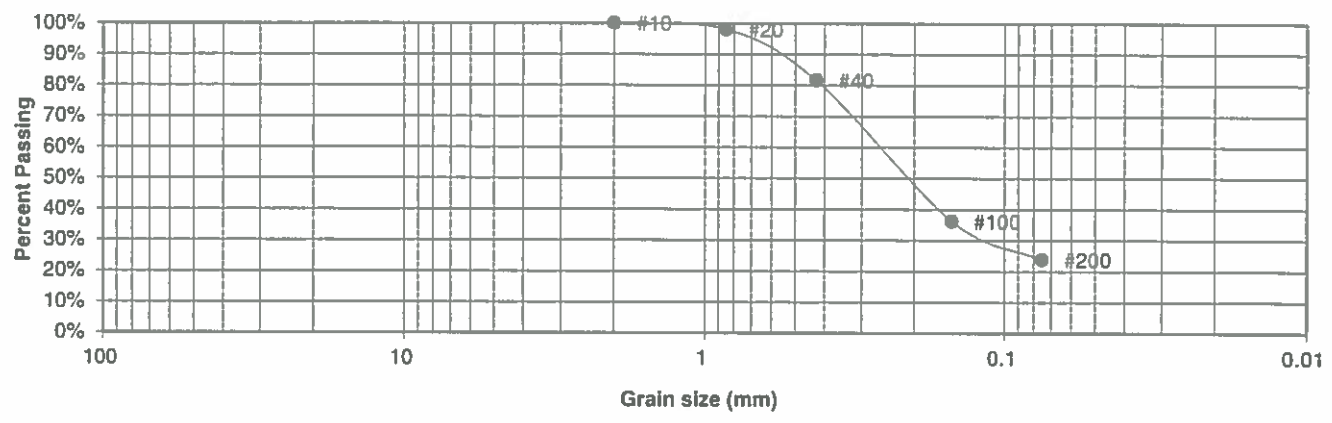
FIG NO.:

B-9



<u>UNIFIED CLASSIFICATION</u>	SM	<u>CLIENT</u>	CLASSIC COMMUNITIES
<u>SOIL TYPE #</u>	3	<u>PROJECT</u>	HANNAH RIDGE, FEATHERGRASS, F5
<u>TEST BORING #</u>	4	<u>JOB NO.</u>	210984
<u>DEPTH (FT)</u>	5	<u>TEST BY</u>	BL
<u>AASHTO CLASSIFICATION</u>	A-2-4	<u>GROUP INDEX</u>	0

**Sieve Analysis  
Grain Size Distribution**



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	100.0%
20	98.1%
40	81.6%
100	36.2%
200	23.8%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP
Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	



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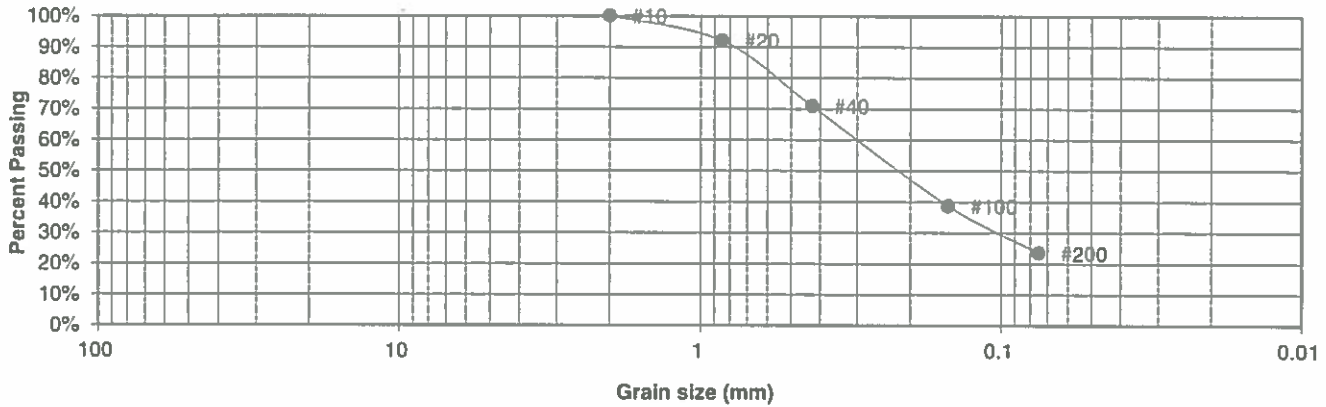
**LABORATORY TEST RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
		DJ	7/18/21

JOB NO.:  
210984  
FIG NO.:  
B-10

<u>UNIFIED CLASSIFICATION</u>	SC	<u>CLIENT</u>	CLASSIC COMMUNITIES
<u>SOIL TYPE #</u>	3	<u>PROJECT</u>	HANNAH RIDGE, FEATHERGRASS, F5
<u>TEST BORING #</u>	7	<u>JOB NO.</u>	210984
<u>DEPTH (FT)</u>	10	<u>TEST BY</u>	BL
<u>AASHTO CLASSIFICATION</u>	A-2-6	<u>GROUP INDEX</u>	0

**Sieve Analysis  
Grain Size Distribution**



<u>U.S. Sieve #</u>	<u>Percent Finer</u>
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	100.0%
20	92.1%
40	71.0%
100	38.7%
200	23.5%

<u>Atterberg Limits</u>	
Plastic Limit	15
Liquid Limit	31
Plastic Index	15

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



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**LABORATORY TEST  
RESULTS**

<u>DRAWN:</u>	<u>DATE:</u>	<u>CHECKED:</u> <i>DS</i>	<u>DATE:</u> 7/8/21
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JOB NO.:

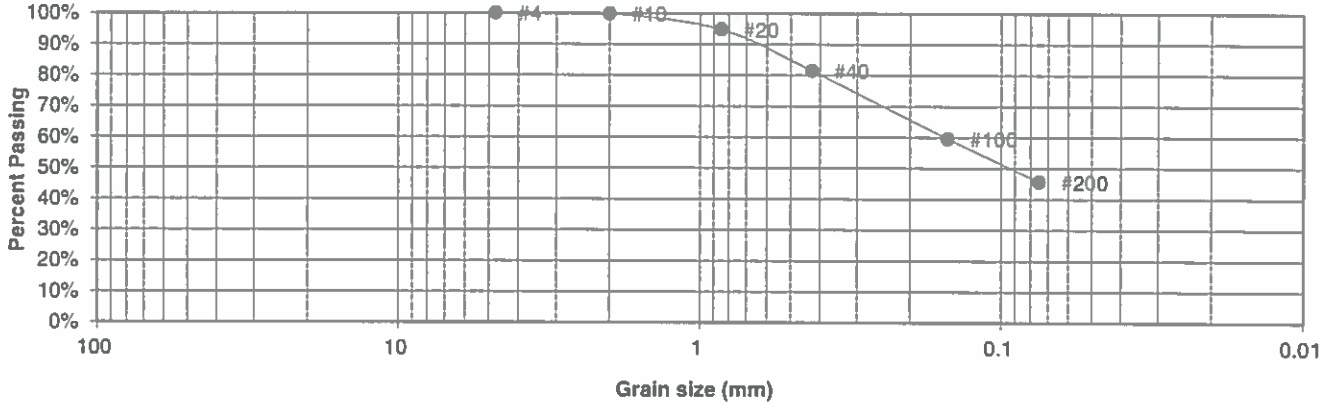
210984

FIG NO.:

*B-11*

<u>UNIFIED CLASSIFICATION</u>	SC	<u>CLIENT</u>	CLASSIC COMMUNITIES
<u>SOIL TYPE #</u>	4	<u>PROJECT</u>	HANNAH RIDGE, FEATHERGRASS, F5
<u>TEST BORING #</u>	6	<u>JOB NO.</u>	210984
<u>DEPTH (FT)</u>	10	<u>TEST BY</u>	BL
<u>AASHTO CLASSIFICATION</u>	A-6	<u>GROUP INDEX</u>	4

**Sieve Analysis  
Grain Size Distribution**



<u>U.S. Sieve #</u>	<u>Percent Finer</u>
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.8%
20	94.8%
40	81.5%
100	59.6%
200	45.7%

<u>Atterberg Limits</u>	
Plastic Limit	15
Liquid Limit	33
Plastic Index	17

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



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**LABORATORY TEST  
RESULTS**

DRAWN:

DATE:

CHECKED

*DS*

DATE:

*7/12/21*

JOB NO:

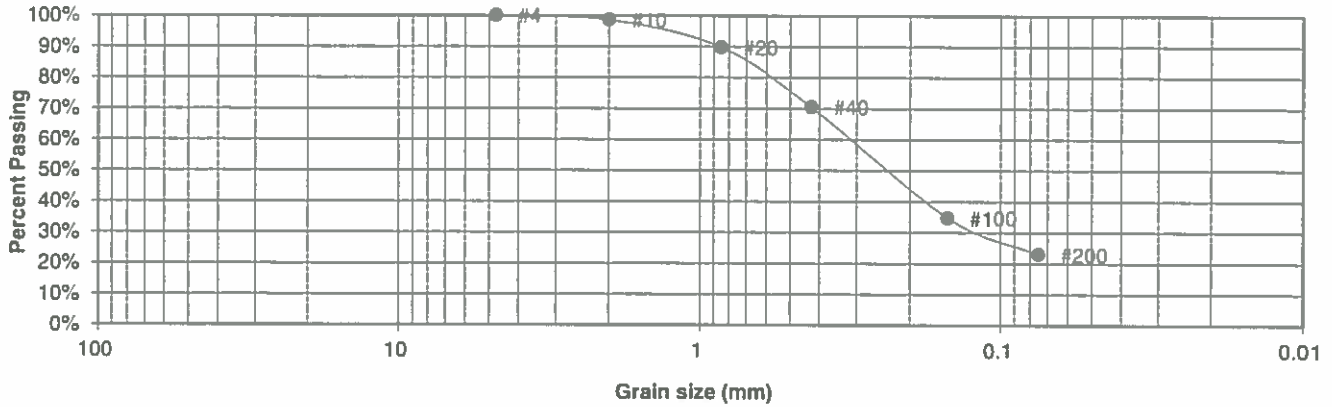
210984

FIG NO:

*B-12*

<u>UNIFIED CLASSIFICATION</u>	SM	<u>CLIENT</u>	CLASSIC COMMUNITIES
<u>SOIL TYPE #</u>	5	<u>PROJECT</u>	HANNAH RIDGE, FEATHERGRASS, F5
<u>TEST BORING #</u>	1	<u>JOB NO.</u>	210984
<u>DEPTH (FT)</u>	10	<u>TEST BY</u>	BL
<u>AASHTO CLASSIFICATION</u>	A-2-4	<u>GROUP INDEX</u>	0

**Sieve Analysis  
Grain Size Distribution**



<u>U.S. Sieve #</u>	<u>Percent Finer</u>
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	98.6%
20	89.8%
40	70.5%
100	34.8%
200	23.0%

<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 (psf)	



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**LABORATORY TEST  
RESULTS**

<u>DRAWN:</u>	<u>DATE:</u>	<u>CHECKED:</u> DS	<u>DATE:</u> 7/8/21
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JOB NO.:

210984

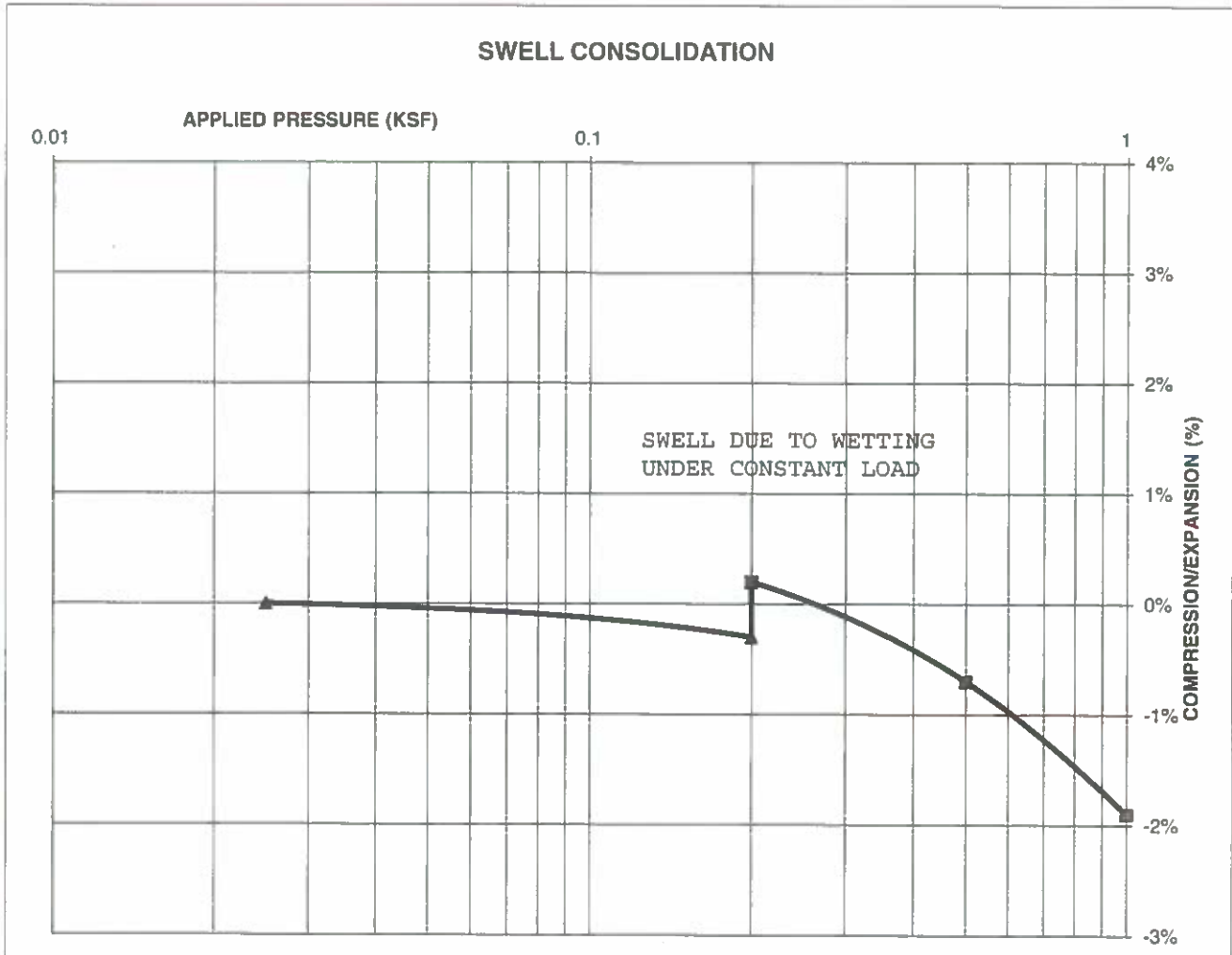
FIG NO.:

B-13

**CONSOLIDATION TEST RESULTS**

TEST BORING #	1	DEPTH(ft)	0-3
DESCRIPTION	SC	SOIL TYPE	1, CBR
NATURAL UNIT DRY WEIGHT (PCF)			115
NATURAL MOISTURE CONTENT			10.8%
SWELL/CONSOLIDATION (%)			0.5%

JOB NO. 210984  
 CLIENT CLASSIC COMMUNITIES  
 PROJECT HANNAH RIDGE, FEATHERGRASS, F5



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**SWELL CONSOLIDATION  
 TEST RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
		DJ	7/18/12

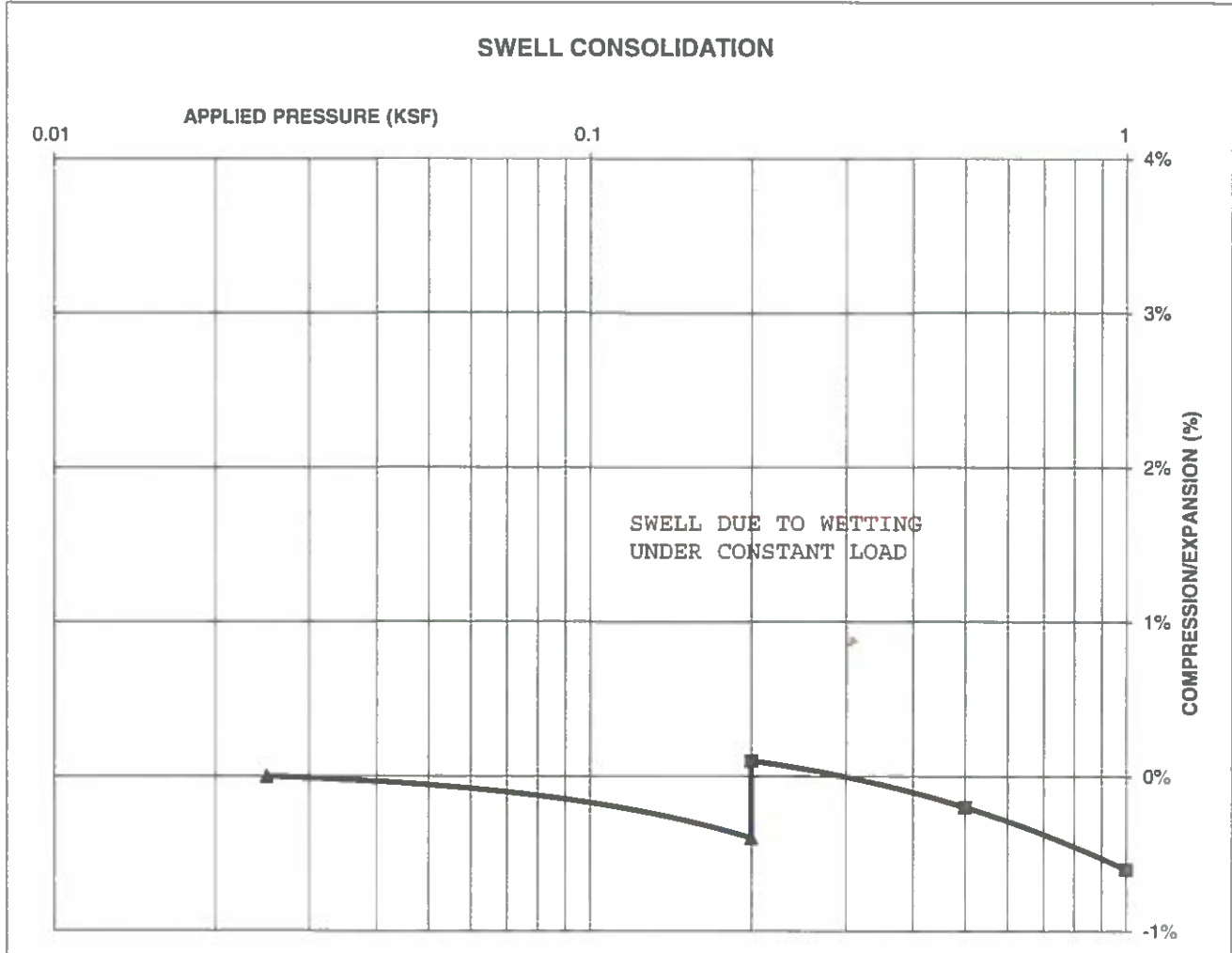
JOB NO.:  
 210984

FIG NO.:  
 B-4

**CONSOLIDATION TEST RESULTS**

TEST BORING #	1	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			116
NATURAL MOISTURE CONTENT			14.2%
SWELL/CONSOLIDATION (%)			0.5%

JOB NO. 210984  
 CLIENT CLASSIC COMMUNITIES  
 PROJECT HANNAH RIDGE, FEATHERGRASS, F5



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**SWELL CONSOLIDATION  
 TEST RESULTS**

DRAWN:

DATE:

CHECKED:

DATE:

*PS*

*7/8/21*

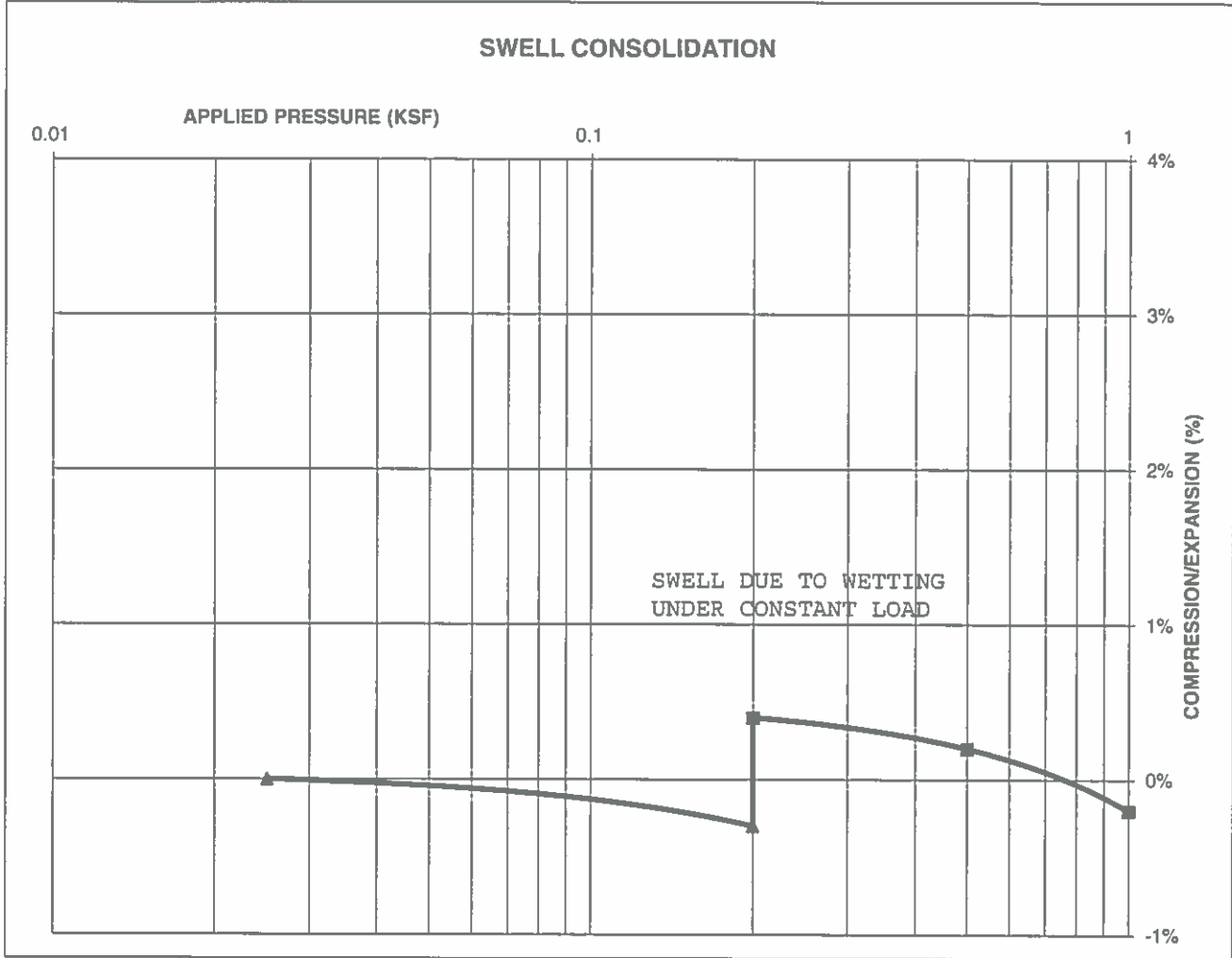
JOB NO.:  
 210984

FIG NO.:  
*B-15*

**CONSOLIDATION TEST RESULTS**

TEST BORING #	6	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			115
NATURAL MOISTURE CONTENT			12.8%
SWELL/CONSOLIDATION (%)			0.7%

JOB NO. 210984  
 CLIENT CLASSIC COMMUNITIES  
 PROJECT HANNAH RIDGE, FEATHERGRASS, F5



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**SWELL CONSOLIDATION  
 TEST RESULTS**

DRAWN:

DATE:

CHECKED:

DATE: 7/18/21

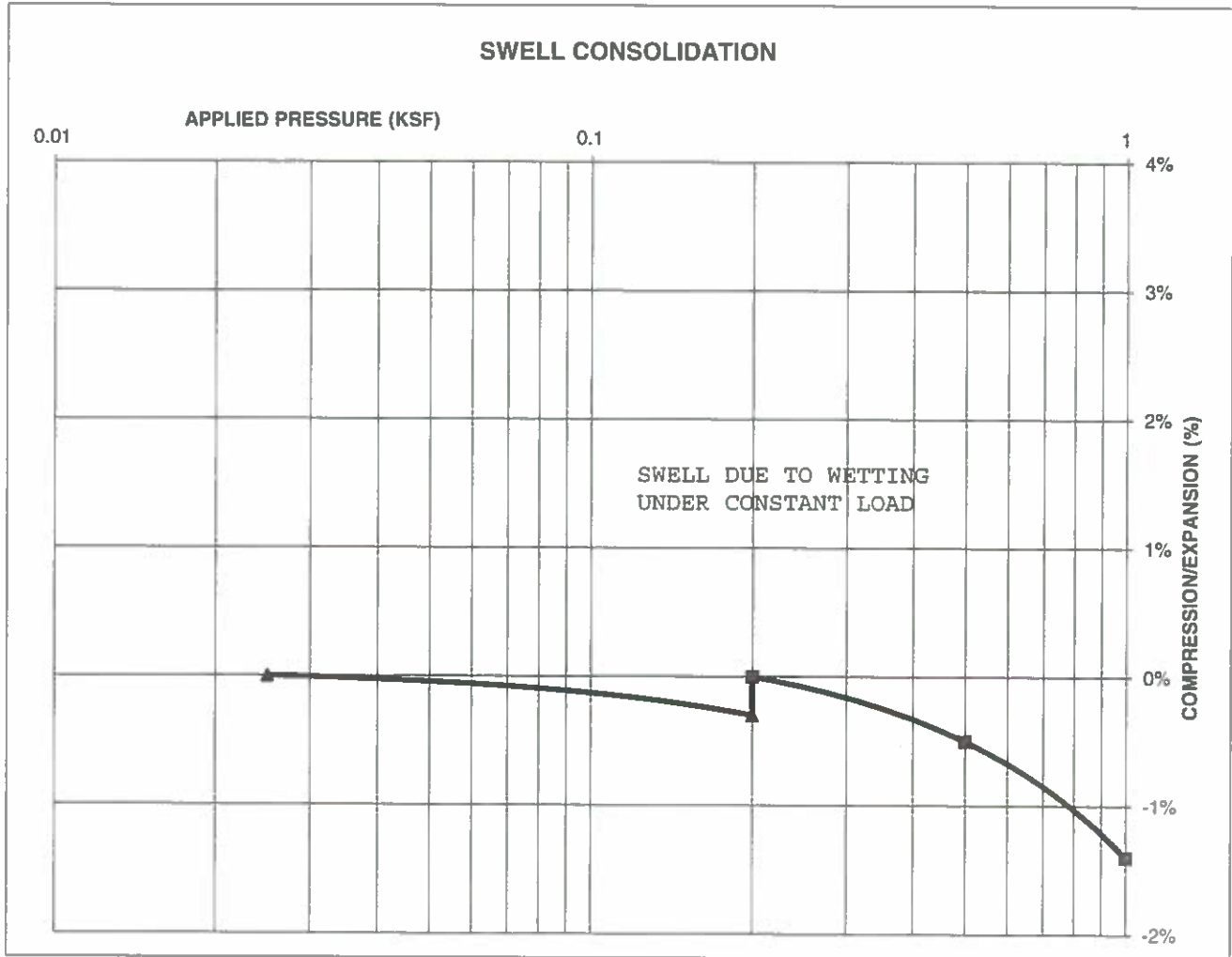
JOB NO:  
 210984

FIG NO:  
 B-16

**CONSOLIDATION TEST RESULTS**

TEST BORING #	2	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	2
NATURAL UNIT DRY WEIGHT (PCF)	95		
NATURAL MOISTURE CONTENT	14.3%		
SWELL/CONSOLIDATION (%)	0.3%		

JOB NO. 210984  
 CLIENT CLASSIC COMMUNITIES  
 PROJECT HANNAH RIDGE, FEATHERGRASS, F5




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**SWELL CONSOLIDATION  
TEST RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
		DS	7/8/21

JOB NO.:  
210984

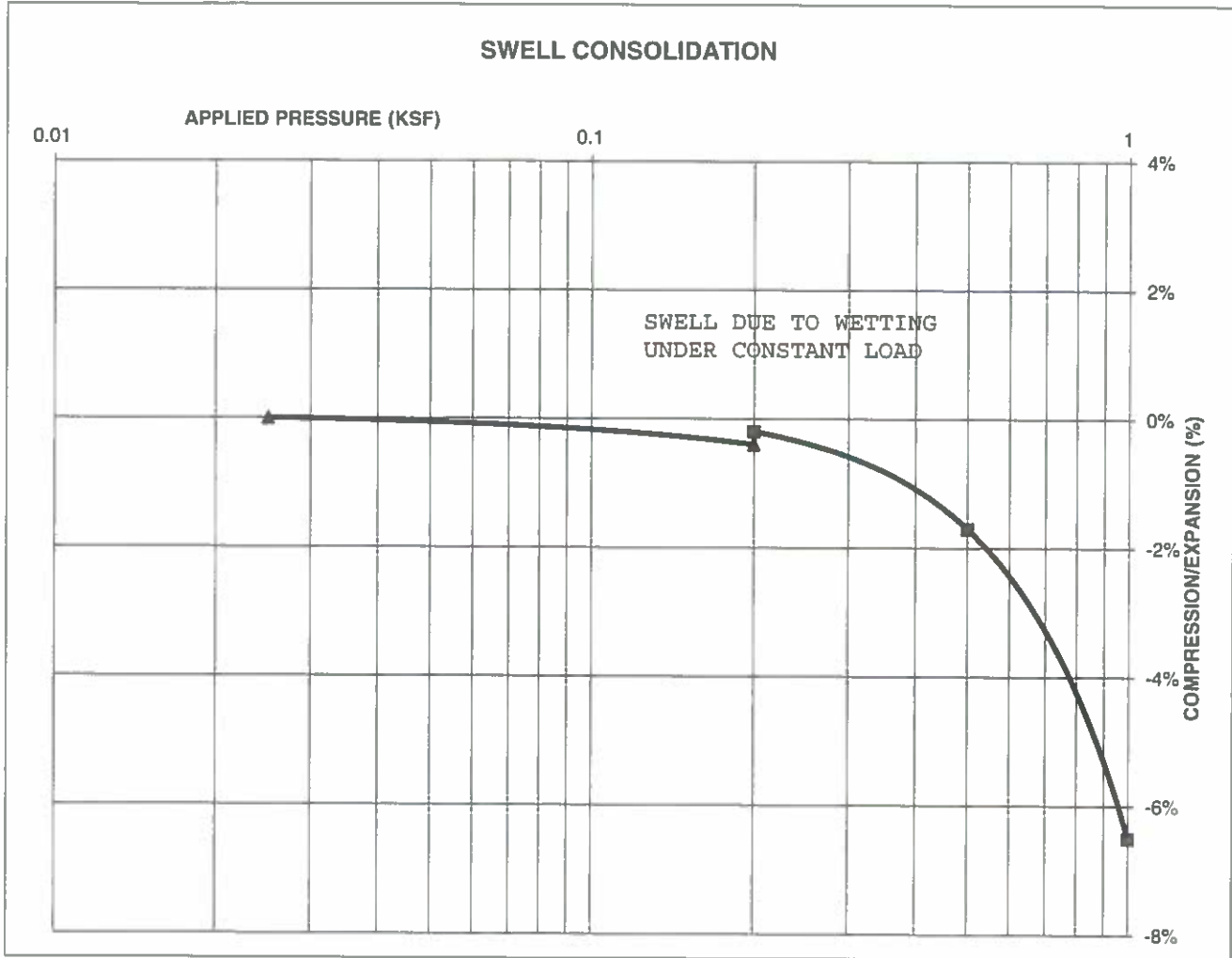
FIG NO.:  
677



**CONSOLIDATION TEST RESULTS**

TEST BORING #	3	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	2
NATURAL UNIT DRY WEIGHT (PCF)	97		
NATURAL MOISTURE CONTENT	9.4%		
SWELL/CONSOLIDATION (%)	0.2%		

JOB NO. 210984  
CLIENT CLASSIC COMMUNITIES  
PROJECT HANNAH RIDGE, FEATHERGRASS, F5



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**SWELL CONSOLIDATION TEST RESULTS**

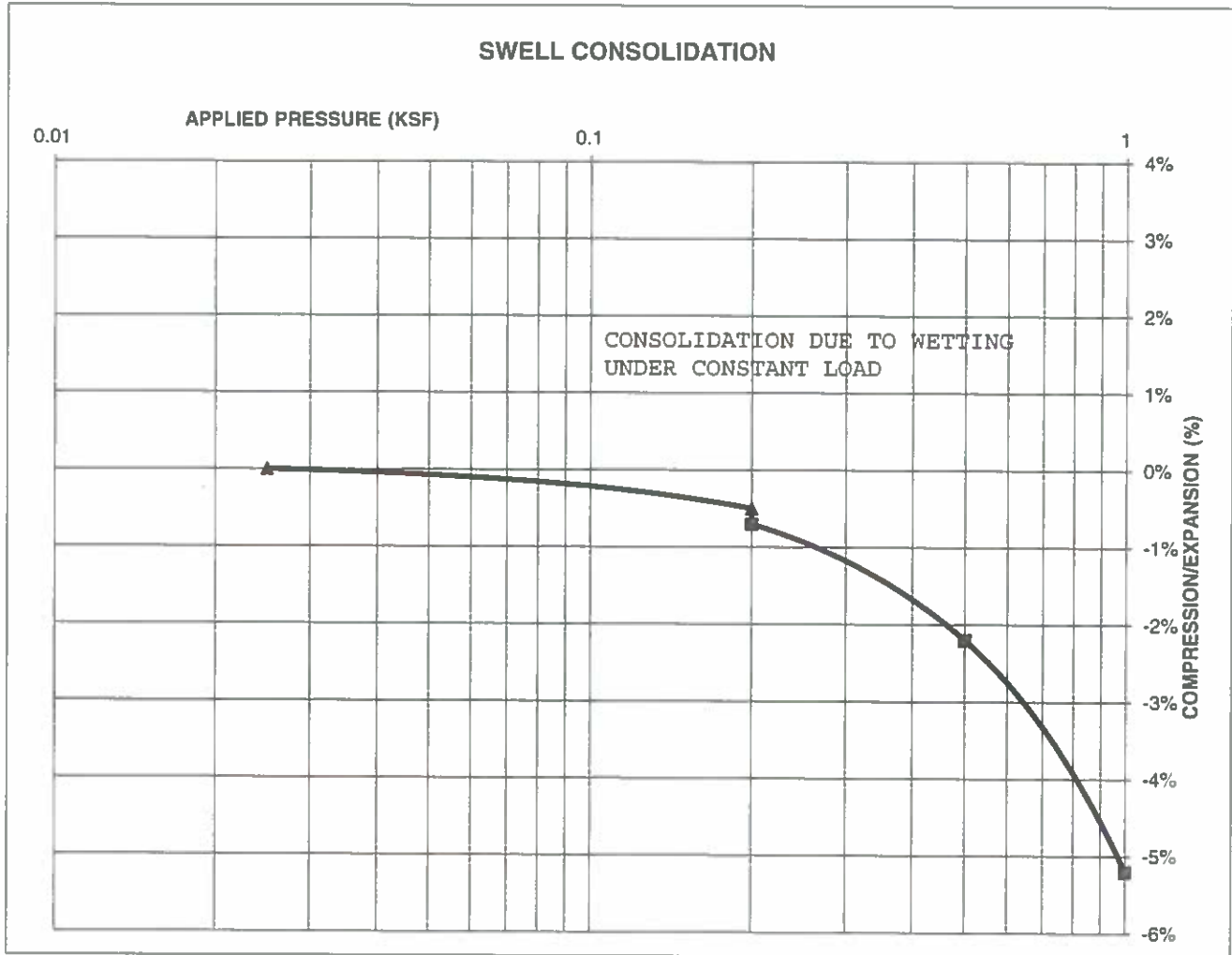
DRAWN:	DATE:	CHECKED:	DATE:
		<i>[Signature]</i>	7/8/21

JOB NO.: 210984  
 FIG NO. *[Signature]*

**CONSOLIDATION TEST RESULTS**

TEST BORING #	4	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	2
NATURAL UNIT DRY WEIGHT (PCF)	95		
NATURAL MOISTURE CONTENT	7.4%		
SWELL/CONSOLIDATION (%)	-0.2%		

JOB NO. 210984  
 CLIENT CLASSIC COMMUNITIES  
 PROJECT HANNAH RIDGE, FEATHERGRASS, F5



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**SWELL CONSOLIDATION  
 TEST RESULTS**

DRAWN:

DATE:

CHECKED:

DATE:

DS

7/18/21

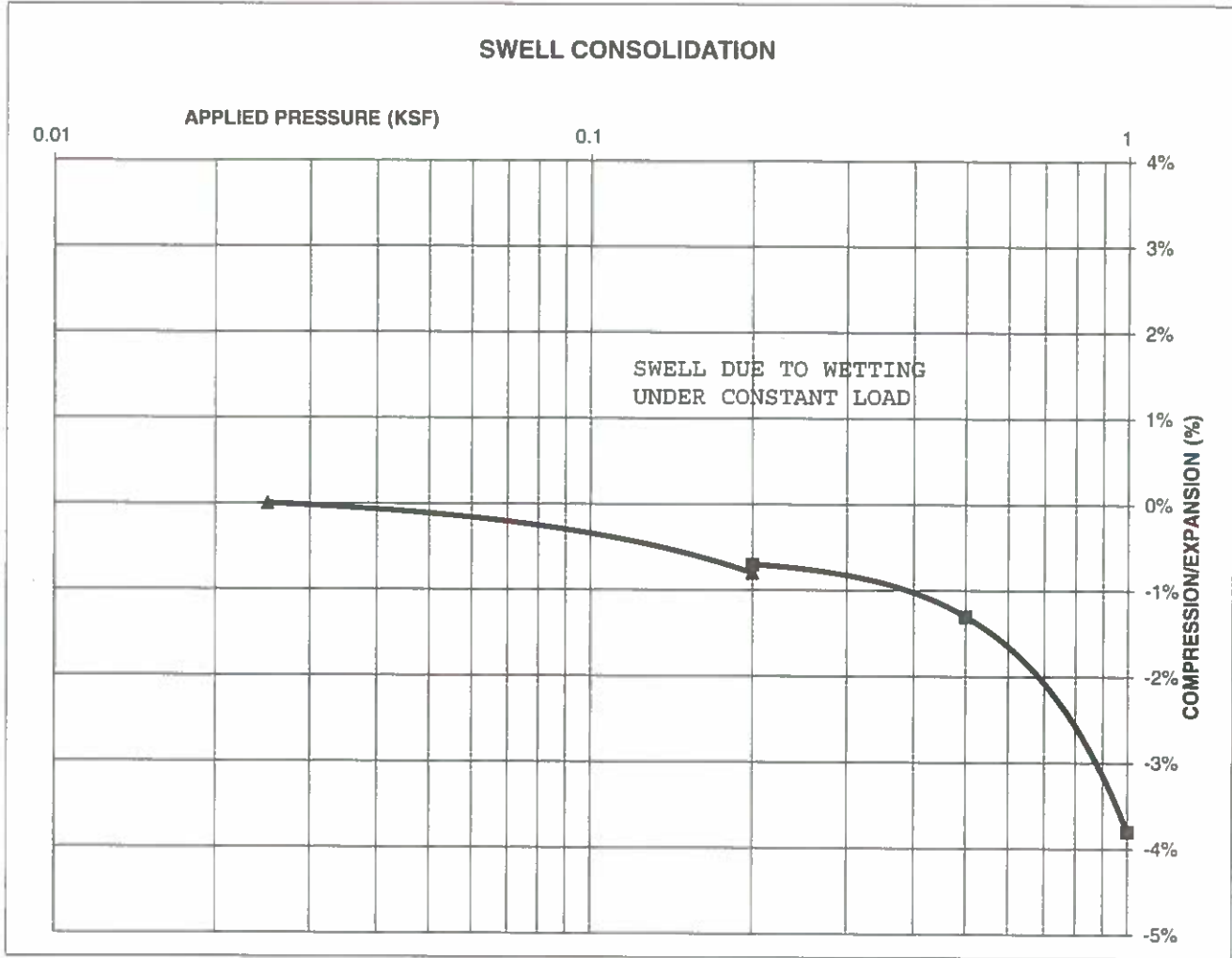
JOB NO.:  
 210984

FIG NO.:  
 B-19

**CONSOLIDATION TEST RESULTS**

TEST BORING #	5	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	2
NATURAL UNIT DRY WEIGHT (PCF)			99
NATURAL MOISTURE CONTENT			10.8%
SWELL/CONSOLIDATION (%)			0.1%

JOB NO. 210984  
 CLIENT CLASSIC COMMUNITIES  
 PROJECT HANNAH RIDGE, FEATHERGRASS, F5



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**SWELL CONSOLIDATION  
TEST RESULTS**

DRAWN:	DATE:	CHECKED: <i>DS</i>	DATE: <i>7/8/21</i>
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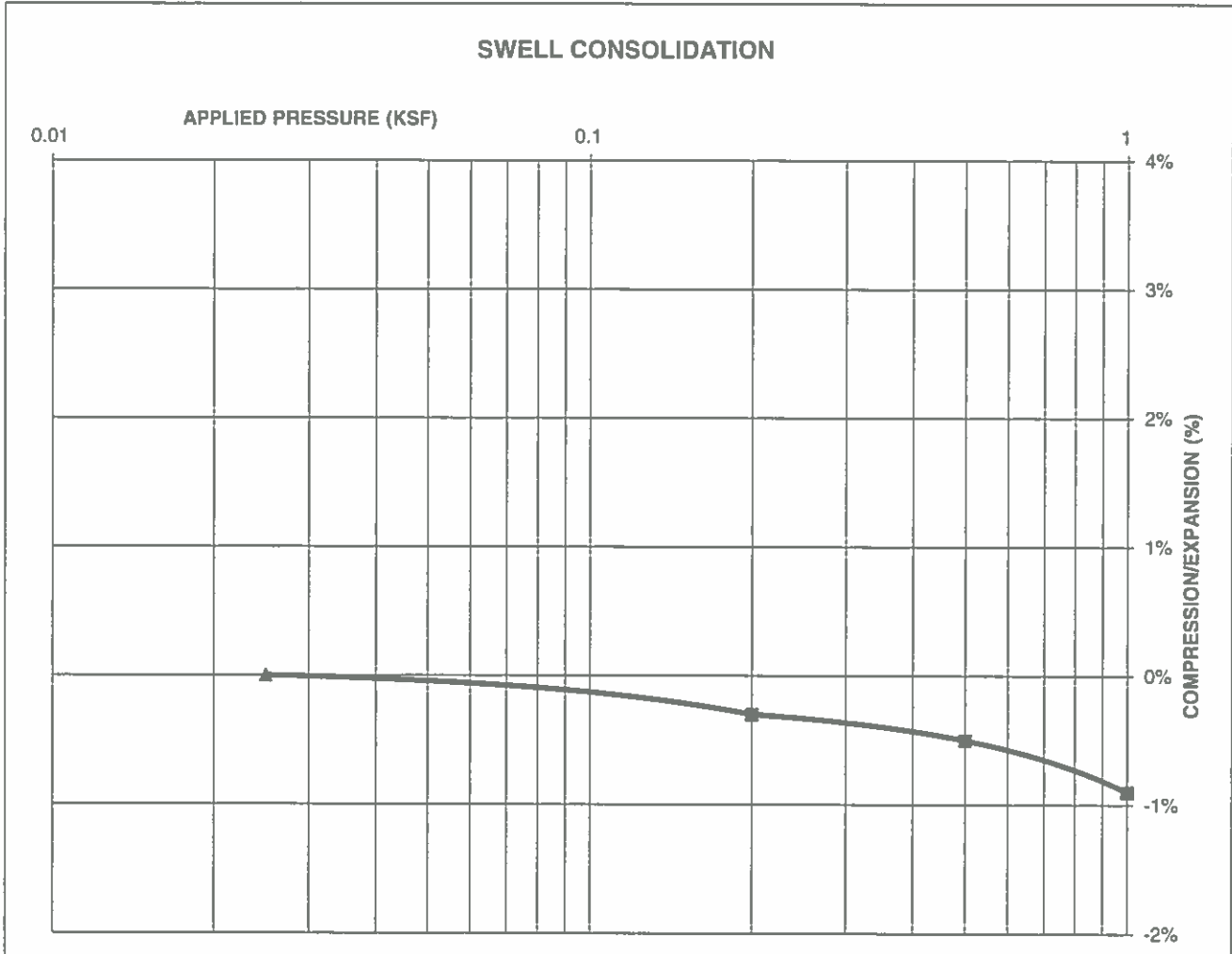
JOB NO:  
210984

FIG NO:  
*B-20*

**CONSOLIDATION TEST RESULTS**

TEST BORING #	7	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	2
NATURAL UNIT DRY WEIGHT (PCF)			113
NATURAL MOISTURE CONTENT			8.5%
SWELL/CONSOLIDATION (%)			0.0%

JOB NO. 210984  
 CLIENT CLASSIC COMMUNITIES  
 PROJECT HANNAH RIDGE, FEATHERGRASS, F5



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**SWELL CONSOLIDATION  
 TEST RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
		<i>DS</i>	7/18/21

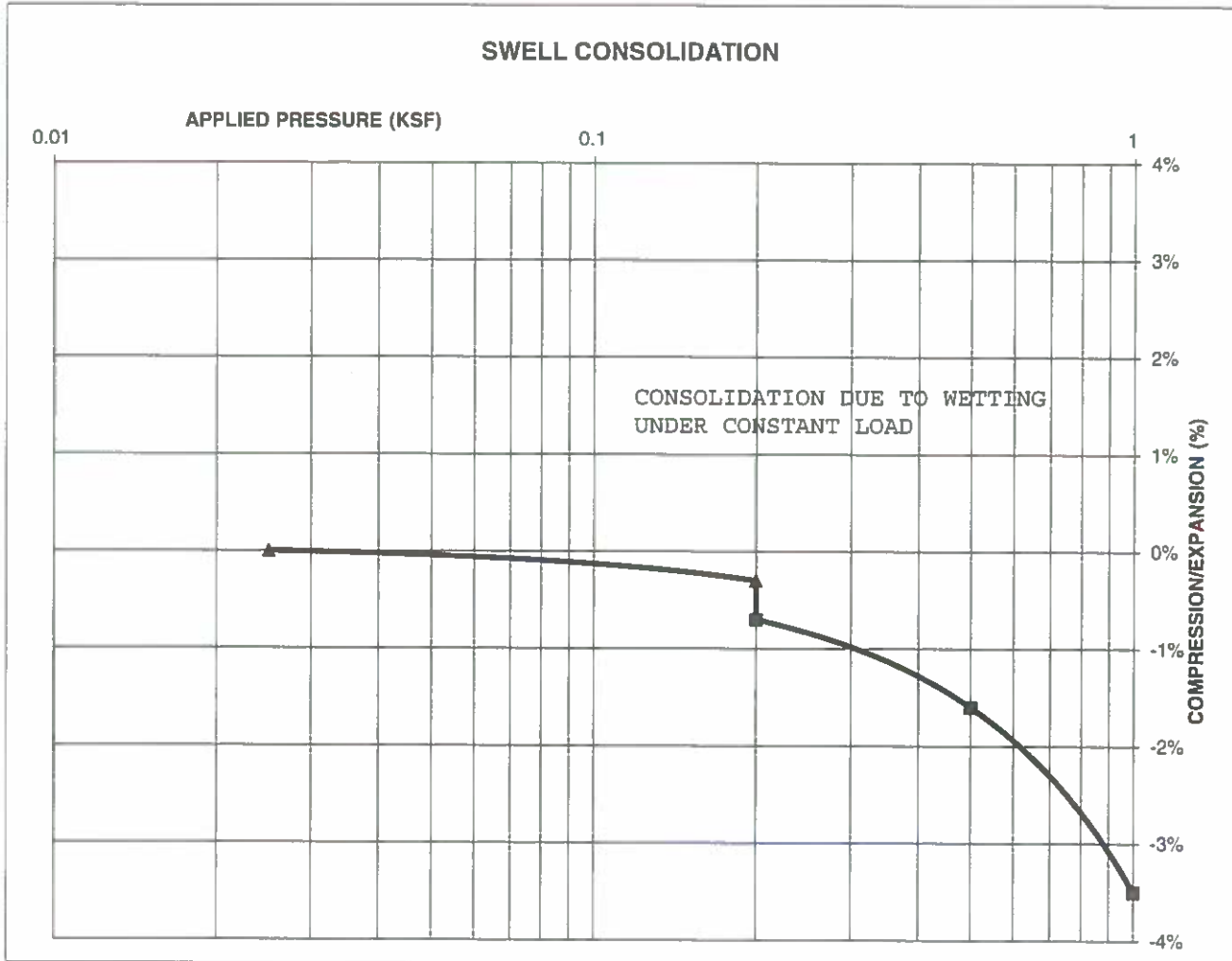
JOB NO.:  
 210984

FIG NO.:  
*B21*

**CONSOLIDATION TEST RESULTS**

TEST BORING #	7	DEPTH(ft)	10
DESCRIPTION	SC	SOIL TYPE	3
NATURAL UNIT DRY WEIGHT (PCF)			96
NATURAL MOISTURE CONTENT			10.7%
SWELL/CONSOLIDATION (%)			-0.4%

JOB NO. 210984  
 CLIENT CLASSIC COMMUNITIES  
 PROJECT HANNAH RIDGE, FEATHERGRASS, F5



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**SWELL CONSOLIDATION  
 TEST RESULTS**

DRAWN:

DATE:

CHECKED: DS

DATE: 7/8/21

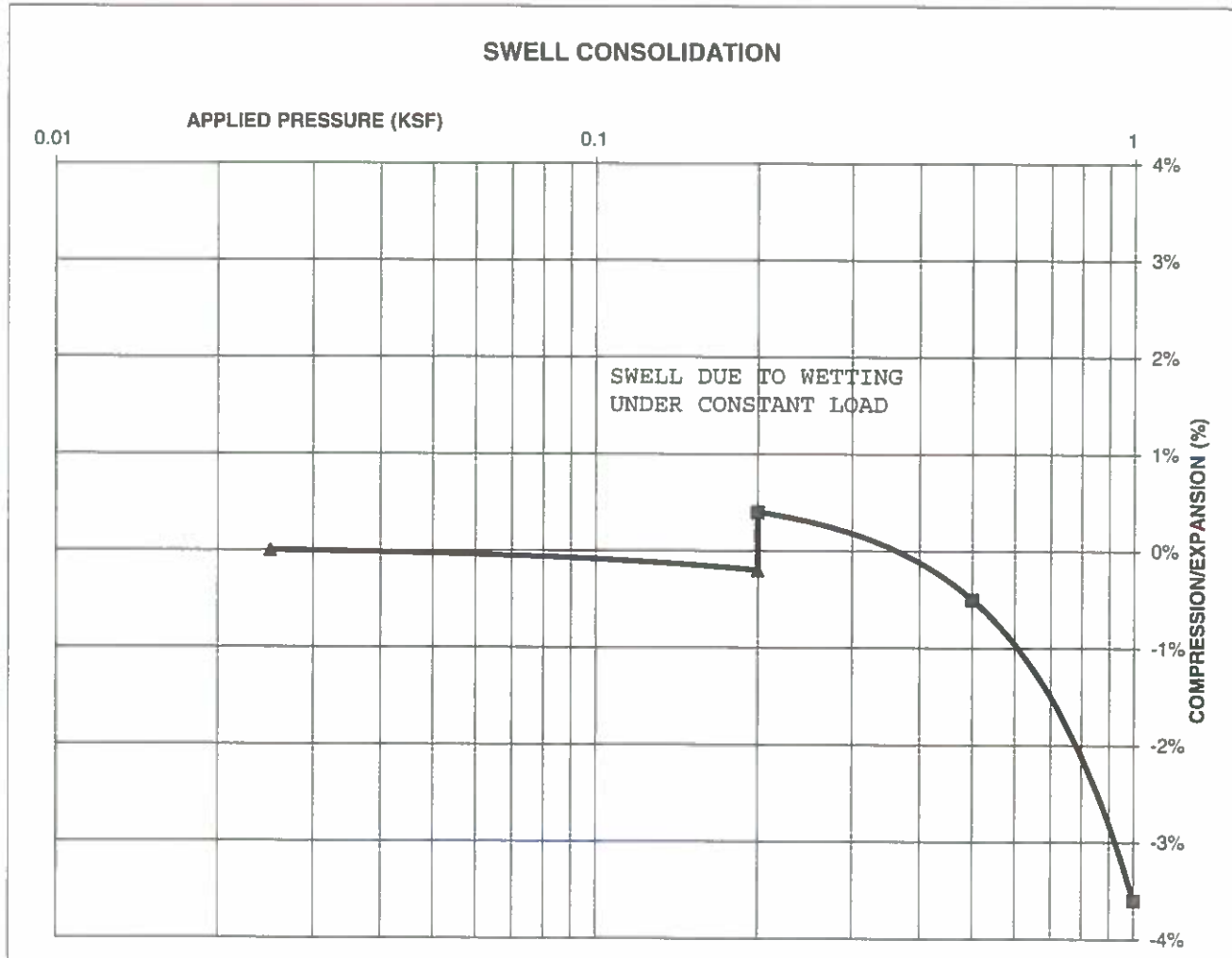
JOB NO.:  
 210984

FIG NO.:  
 B-22

**CONSOLIDATION TEST RESULTS**

TEST BORING #	6	DEPTH(ft)	10
DESCRIPTION	SC	SOIL TYPE	4
NATURAL UNIT DRY WEIGHT (PCF)			94
NATURAL MOISTURE CONTENT			8.0%
SWELL/CONSOLIDATION (%)			0.6%

JOB NO. 210984  
 CLIENT CLASSIC COMMUNITIES  
 PROJECT HANNAH RIDGE, FEATHERGRASS, F5



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**SWELL CONSOLIDATION  
TEST RESULTS**

DRAWN:

DATE:

CHECKED: *DS*

DATE: *7/8/21*

JOB NO.:  
210984

FIG NO:  
*8-23*

CLIENT	CLASSIC COMMUNITIES	JOB NO.	210984
PROJECT	HANNAH RIDGE, FEATHERGRASS, F5	DATE	6/17/2021
LOCATION	HANNAH RIDGE, FEATHERGRASS, F5	TEST BY	BL

BORING NUMBER	DEPTH, (ft)	SOIL TYPE NUMBER	UNIFIED CLASSIFICATION	WATER SOLUBLE SULFATE, (wt%)
TB-2	1-2	2	SC	0.00
TB-4	5	3	SM	0.00
TB-6	1-2	1	SC	0.00
TB-7	10	3	SC	0.00

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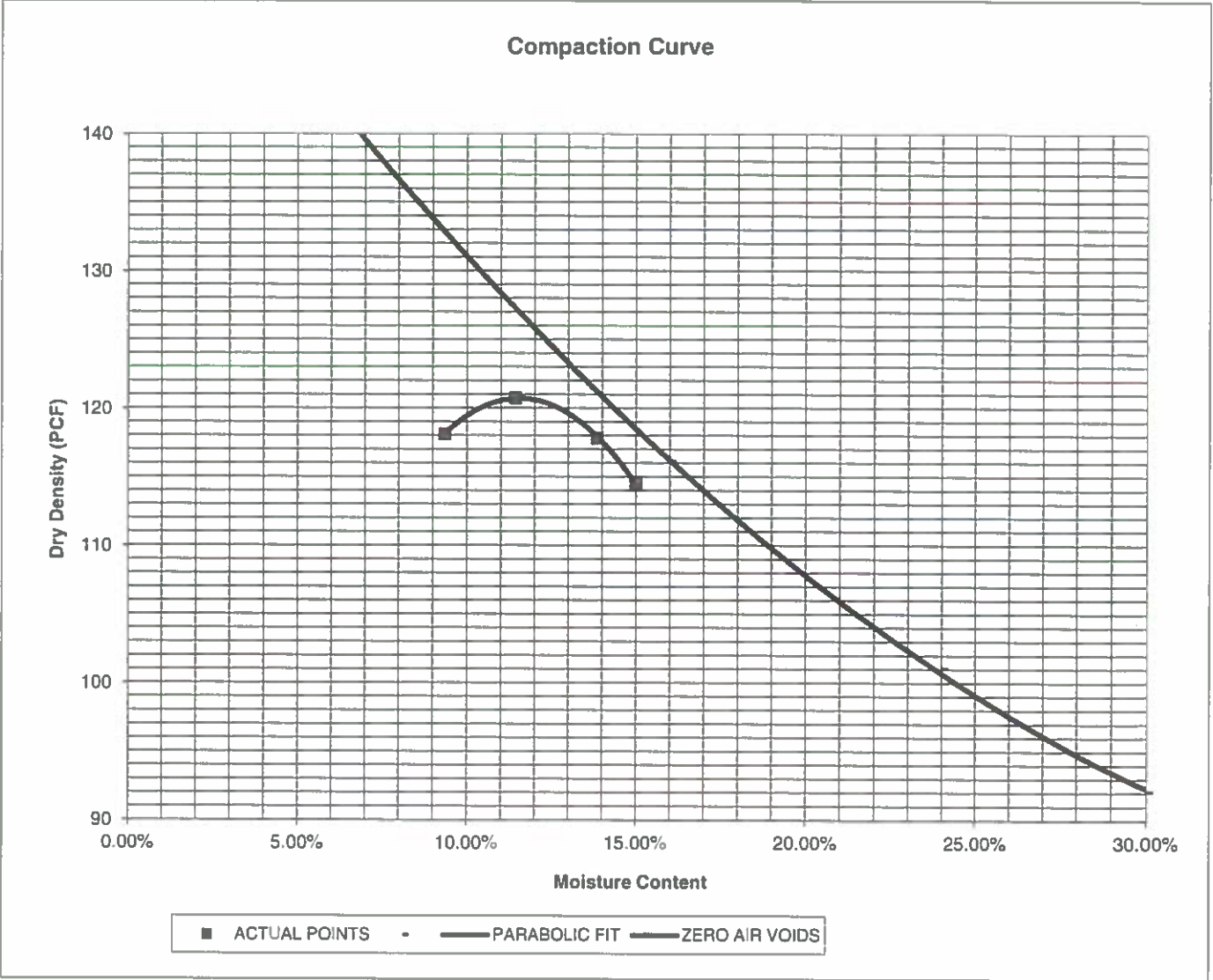
**LABORATORY TEST  
SULFATE RESULTS**

DRAWN:	DATE:	CHECKED: <i>DS</i>	DATE: <i>7/8/21</i>
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JOB NO.:  
210984  
FIG NO.:  
*B-2A*

<u>PROJECT</u>	HANNAH RIDGE, FEATHERGRASS, F5	<u>CLIENT</u>	CLASSIC COMMUNITIES
<u>SAMPLE LOCATION</u>	TB-1 @ 0-3'	<u>JOB NO.</u>	210984
<u>SOIL DESCRIPTION</u>	FILL, SAND, VERY CLAYEY, BROWN	<u>DATE</u>	06/17/21

<u>IDENTIFICATION</u>	SC	<u>COMPACTION TEST #</u>	1
<u>TEST DESIGNATION / METHOD</u>	ASTM D-698-A	<u>TEST BY</u>	BL
<u>MAXIMUM DRY DENSITY (PCF)</u>	120.9	<u>OPTIMUM MOISTURE</u>	11.5%




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505 ELKTON DRIVE  
COLORADO SPRINGS, COLORADO 80907

**MOISTURE DENSITY RELATION**

DRAWN:	DATE:	CHECKED:	DATE
		DS	7/18/21

JOB NO:  
210984  
FIG NO:  
B-25



**CBR TEST LOAD DATA**

JOB NO: 210984  
 CLIENT: CLASSIC COMMUNITIES  
 PROJECT: HANNAH RIDGE, FEATHERGRASS, F5  
 SOIL TYPE: 1

PISTON DIAMETER (cm) 4.958	PISTON AREA (in <sup>2</sup> ) 2.993	10 BLOWS		25 BLOWS		56 BLOWS	
		MOLD # 1	MOLD # 2	MOLD # 1	MOLD # 2	MOLD # 3	MOLD # 3
PENETRATION DEPTH (INCHES)		LOAD(LBS) (LBS)	STRESS (PSI)	LOAD(LBS) (LBS)	STRESS (PSI)	LOAD(LBS) (LBS)	STRESS (PSI)
0.000		0	0.00	0	0.00	0	0.00
0.025		72	24.06	102	34.09	177	59.15
0.050		118	39.43	172	57.48	246	82.21
0.075		169	56.47	225	75.19	291	97.24
0.100		190	63.49	253	84.54	334	111.61
0.125		225	75.19	290	96.91	358	119.63
0.150		241	80.53	318	106.27	386	128.99
0.175		273	91.23	338	112.95	429	143.36
0.200		306	102.26	363	121.30	466	155.72
0.300		343	114.62	434	145.03	572	191.14
0.400		374	124.98	497	166.08	672	224.56
0.500		401	134.00	552	184.46	768	256.64

**FINAL MOISTURE CONTENT**

	MOLD # 1	MOLD # 2	MOLD # 3
<u>CAN #</u>	309	310	307
<u>WT. CAN</u>	6.7	8.39	8.42
<u>WT. CAN+WET</u>	366.04	339.53	268.15
<u>WT. CAN+DRY</u>	315.53	295.91	236.83
<u>WT. H2O</u>	50.51	43.62	31.32
<u>WT. DRY SOIL</u>	308.83	287.52	228.41
<u>MOISTURE CONTENT</u>	16.36%	15.17%	13.71%

<u>WET DENSITY (PCF)</u>	124.5	127.2	132.9
<u>DRY DENSITY (PCF)</u>	111.6	114.1	119.2

BEARING RATIO                                          6.35                                          8.45                                          11.16

90% OF DRY DENSITY                                          107.3  
95% OF DRY DENSITY                                          113.3

<u>BEARING RATIO AT 90% OF MAX</u>	2.63 - R VALUE	6
<u>BEARING RATIO AT 95% OF MAX</u>	7.75 - R VALUE	17



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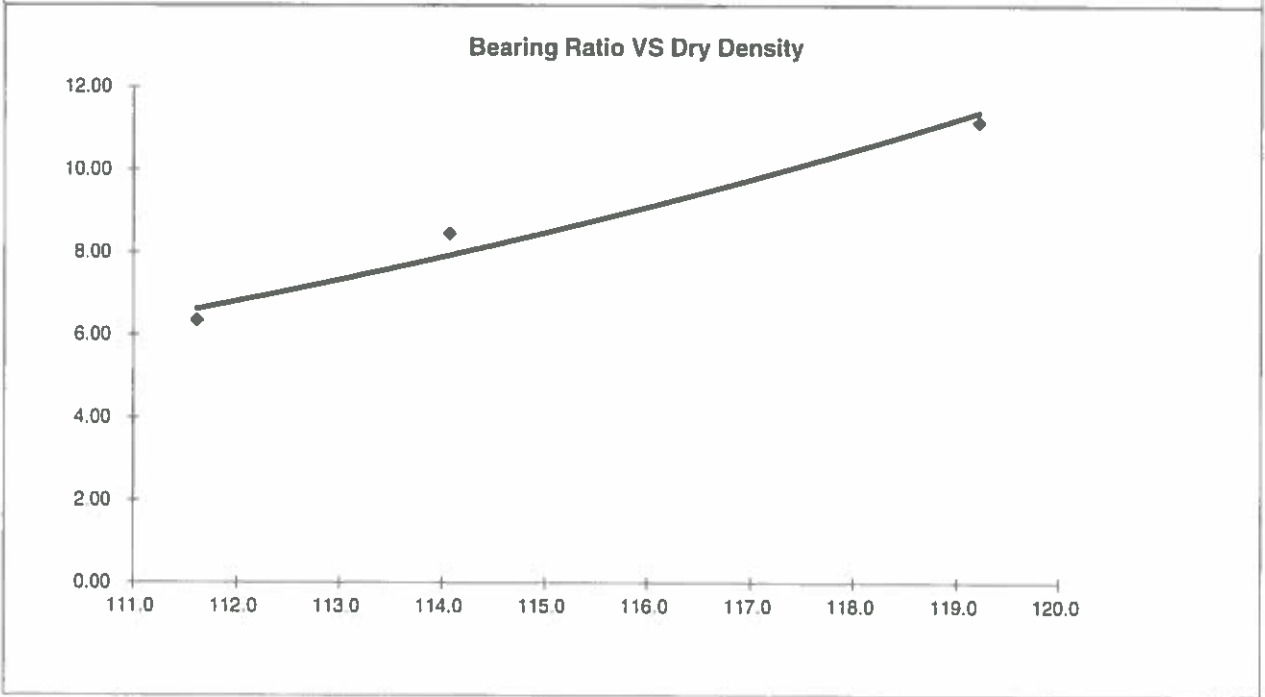
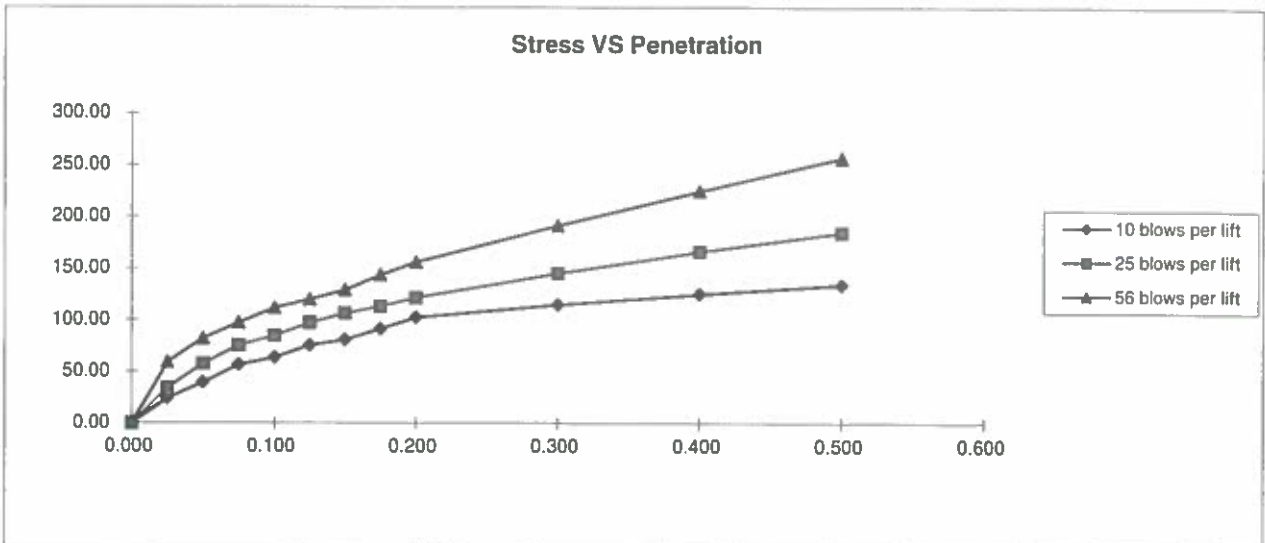
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**CBR TEST DATA**

DRAWN:                                          DATE:                                          CHECKED: **DS**                                          DATE: **7/18/21**

JOB NO:  
 210984

FIG NO:  
**B-26**



BEARING RATIO AT 90% OF MAX	2.63 ~ R VALUE	6.00
BEARING RATIO AT 95% OF MAX	7.75 ~ R VALUE	17.00

JOB NO: 210984  
SOIL TYPE: I



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**CALIFORNIA BEARING RATIO**

DRAWN:

DATE:

CHECKED:

DATE:

DS

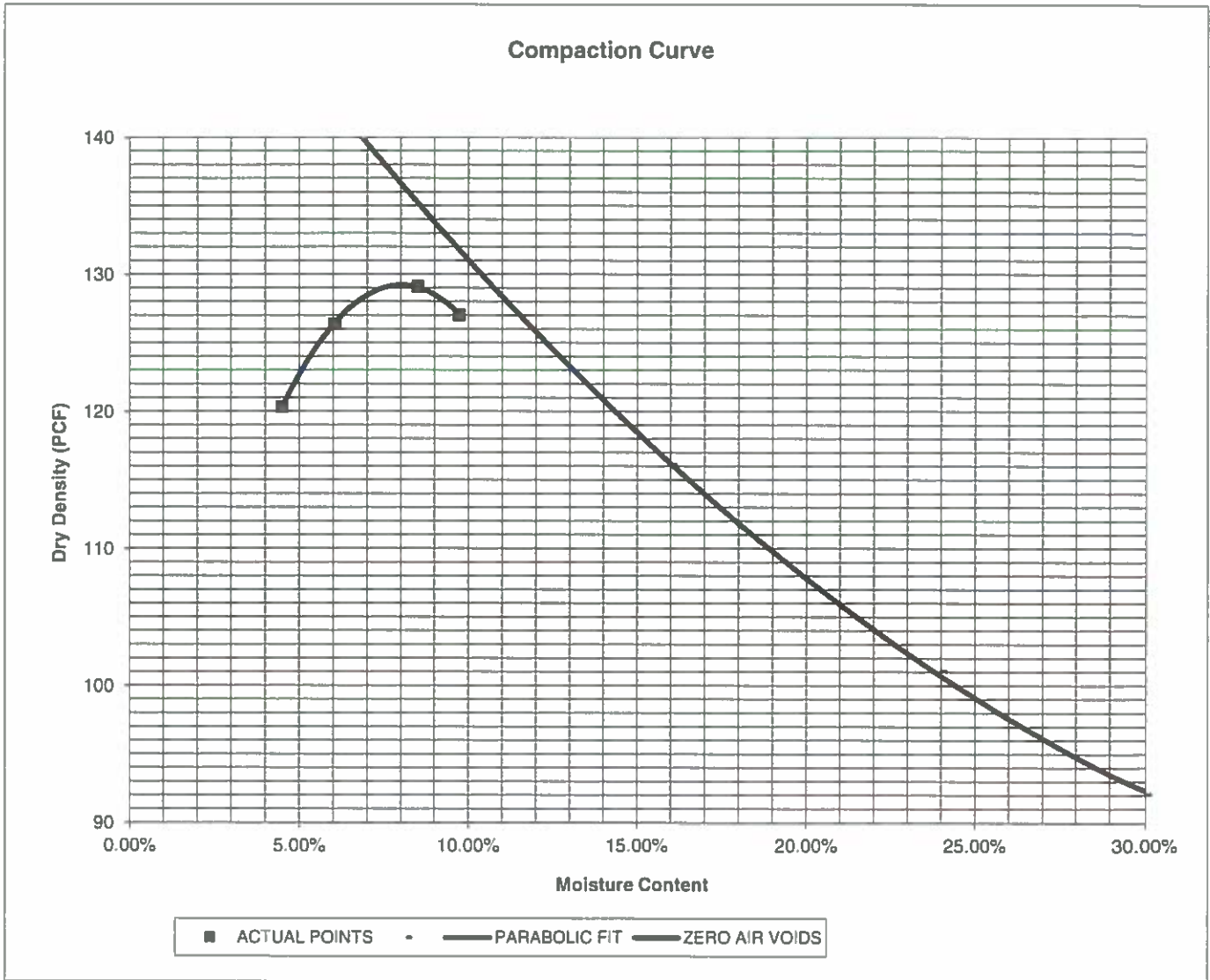
7/18/21

JOB NO:  
210984

FIG NO:  
B-27

<b>PROJECT</b>	HANNAH RIDGE, FEATHERGRASS, F5	<b>CLIENT</b>	CLASSIC COMMUNITIES
<b>SAMPLE LOCATION</b>	TB-5 @ 0-3'	<b>JOB NO.</b>	210984
<b>SOIL DESCRIPTION</b>	FILL, SAND, CLAYEY, BROWN	<b>DATE</b>	06/17/21

<b>IDENTIFICATION</b>	SC	<b>COMPACTION TEST #</b>	2
<b>TEST DESIGNATION / METHOD</b>	ASTM D-1557-A	<b>TEST BY</b>	BL
<b>MAXIMUM DRY DENSITY (PCF)</b>	129.2	<b>OPTIMUM MOISTURE</b>	8.1%



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505 ELKTON DRIVE  
COLORADO SPRINGS, COLORADO 80907

**MOISTURE DENSITY RELATION**

DRAWN:

DATE:

CHECKED:

DATE:

*DJ*

*7/8/21*

JOB NO.:

210984

FIG NO.

*B-28*

**CBR TEST LOAD DATA**

JOB NO: 210984  
 CLIENT: CLASSIC COMMUNITIES  
 PROJECT: HANNAH RIDGE, FEATHERGRASS, F5  
 SOIL TYPE: 2

PISTON DIAMETER (cm) 4.958	PISTON AREA (in <sup>2</sup> ) 2.993
----------------------------------	--------------------------------------------

PENETRATION DEPTH (INCHES)	10 BLOWS		25 BLOWS		56 BLOWS	
	MOLD # 1		MOLD # 2		MOLD # 3	
	LOAD(LBS) (LBS)	STRESS (PSI)	LOAD(LBS) (LBS)	STRESS (PSI)	LOAD(LBS) (LBS)	STRESS (PSI)
0.000	0	0.00	0	0.00	0	0.00
0.025	101	33.75	134	44.78	163	54.47
0.050	185	61.82	221	73.85	258	86.22
0.075	235	78.53	344	114.95	404	135.00
0.100	275	91.90	406	135.67	606	202.51
0.125	313	104.59	531	177.44	720	240.60
0.150	346	115.62	597	199.50	989	330.49
0.175	370	123.64	688	229.91	1124	375.60
0.200	409	136.67	830	277.36	1482	495.24
0.300	484	161.74	1207	403.34	2301	768.92
0.400	582	194.49	1521	508.27	2883	963.41
0.500	687	229.57	1622	542.02	3013	1006.85

**FINAL MOISTURE CONTENT**

	MOLD # 1	MOLD # 2	MOLD # 3
CAN #	300	306	314
WT. CAN	6.76	6.64	6.51
WT. CAN+WET	334.27	370.57	342.48
WT. CAN+DRY	297.42	334.055	311.13
WT. H2O	36.85	36.515	31.35
WT. DRY SOIL	290.66	327.415	304.62
MOISTURE CONTENT	12.68%	11.15%	10.29%

WET DENSITY (PCF)	127.9	133.0	136.9
DRY DENSITY (PCF)	118.3	123.1	126.6

BEARING RATIO                              9.19                              13.57                              20.25

90% OF DRY DENSITY                      116.3  
 95% OF DRY DENSITY                      122.7

BEARING RATIO AT 90% OF MAX	7.28 ~ R VALUE	17
BEARING RATIO AT 95% OF MAX	13.26 ~ R VALUE	40



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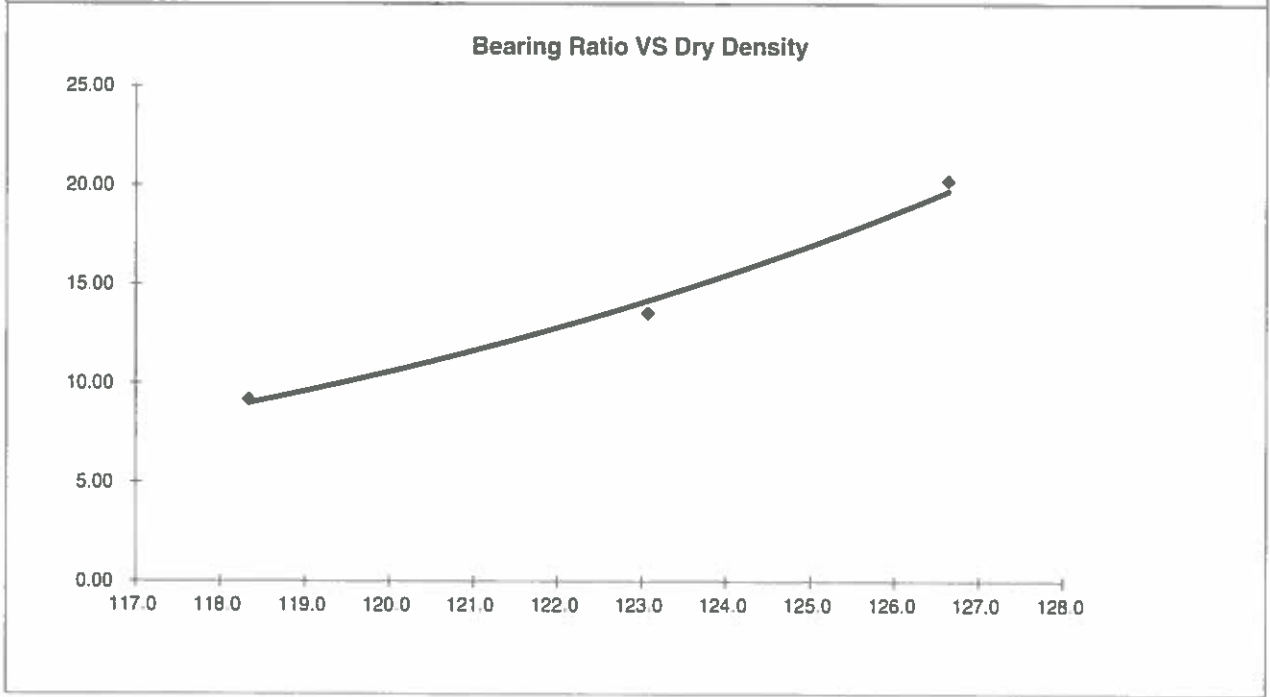
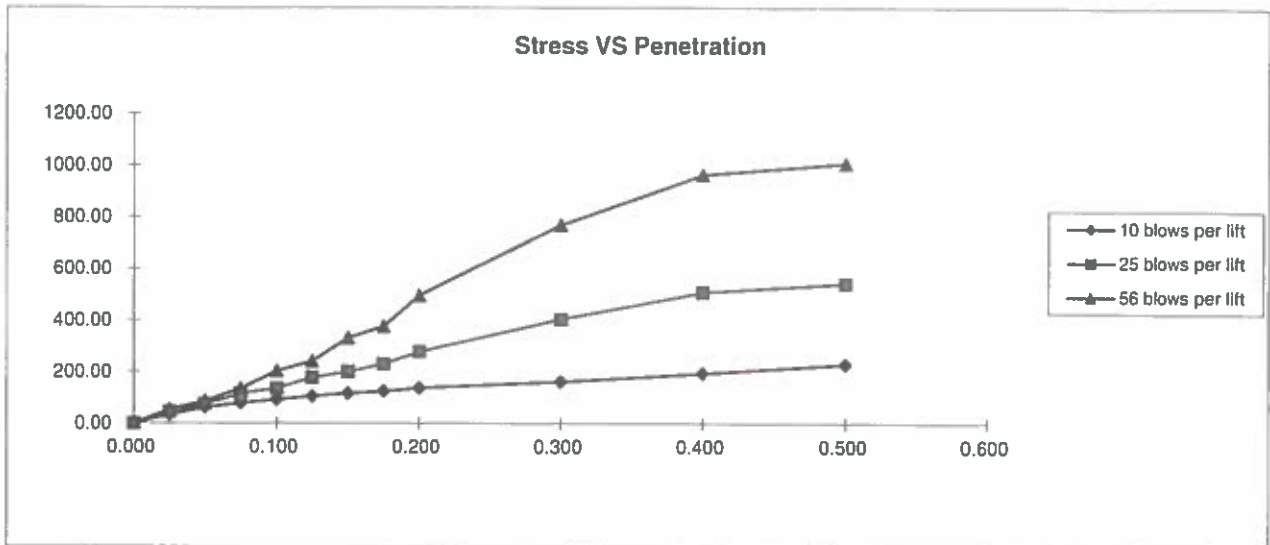
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**CBR TEST DATA**

DRAWN:	DATE:	CHECKED: <i>DB</i>	DATE: <i>7/18/21</i>
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JOB NO.:  
210984

FIG NO.:  
*B-29*



BEARING RATIO AT 90% OF MAX	7.28 ~ R VALUE	17.00
BEARING RATIO AT 95% OF MAX	13.26 ~ R VALUE	40.00

JOB NO: 210984  
SOIL TYPE: 2



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505 ELKTON DRIVE  
COLORADO SPRINGS, COLORADO 80907

**CALIFORNIA BEARING RATIO**

DRAWN:	DATE:	CHECKED:	DATE:
		<i>DS</i>	<i>11/12/21</i>

JOB NO: 210984  
FIG NO: *B-30*

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

# FLEXIBLE PAVEMENT DESIGN

## DESIGN DATA

CLASSIC COMMUNITIES - HANNAH RIDGE AT FEATHERGRASS, F5  
SOILTYPE 1 - LOCAL LOW VOULME

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL ( $W_{18}$ ) =	36,500
Hveem Stabilometer (R Value) Results:	R =	17
Standard Deviation	$S_o$ =	0.45
Loss in Serviceability	$\Delta\psi$ =	2.0
Reliability	Reliability =	80
Reliability (z-statistic)	$Z_R$ =	-0.84
Soil Resilient Modulus	$M_R$ =	4478

Weighted Structural Number (WSN): ➔ WSN = 2.25

## DESIGN TABLES AND EQUATIONS

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

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

$$k = M_R / 19.4$$

Where:

$M_R$  = resilient modulus (psi)

$S_1$  = the soil support value

R = R-value obtained from the Hveem stabilometer

CBR = California Bearing Ratio

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

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

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

Left	Right	Difference
4.56	4.56	0.0

Job No. 210894  
Fig. No. C-1

## DESIGN CALCULATIONS

### CEMENT TREATED SECTIONS - SOIL TYPE 1

DESIGN DATA: CLASSIC COMMUNITIES - HANNAH RIDGE AT FEATHERGRASS, F5  
LOCAL LOW VOLUME

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

### DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

$C_1 = 0.44$  Strength Coefficient - Hot Bituminous Asphalt

$C_2 = 0.12$  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)

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

### FOR ASPHALT + CEMENT TREATED SUBGRADE SECTION

Asphalt Thickness (t) = 4 inches

$D_2 = ((WSN) - (t)(C_1))/C_2 = 4.1$  inches

Use 10.0 inches of Cement Treated Subgrade

### RECOMMENDED ALTERNATIVES

1. 4.0 inches of Asphalt + 10 inches of Cement Treated Subgrade
2. 5.5 inches of Full Depth Asphalt

Job No. 210984

Fig. No. C-2



## FLEXIBLE PAVEMENT DESIGN

### DESIGN DATA

CLASSIC COMMUNITIES - HANNAH RIDGE AT FEATHERGRASS, F5  
SOILTYPE 2 - LOCAL LOW VOULME

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL ( $W_{18}$ ) =	36,500
Hveem Stabilometer (R Value) Results:	R =	40
Standard Deviation	$S_o$ =	0.45
Loss in Serviceability	$\Delta\psi$ =	2.0
Reliability	Reliability =	80
Reliability (z-statistic)	$Z_R$ =	-0.84
Soil Resilient Modulus	$M_R$ =	9497

Weighted Structural Number (WSN): ➔ WSN = 1.68

### 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

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

Left	Right	Difference
4.56	4.56	0.0

Job No. 210894  
Fig. No. C-3

## DESIGN CALCULATIONS

### CEMENT TREATED SECTIONS - SOIL TYPE 2

DESIGN DATA: CLASSIC COMMUNITIES - HANNAH RIDGE AT FEATHERGRASS, F5  
LOCAL LOW VOLUME

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	36,500
Hveem Stabilometer (R Value) Results:	R =	40
Weighted Structural Number (WSN):	WSN =	1.68

### DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

$C_1 = 0.44$  Strength Coefficient - Hot Bituminous Asphalt

$C_2 = 0.12$  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)

$$D_1 = (WSN)/C_1 = 3.8 \text{ inches of Full Depth Asphalt}$$

Use 4.0 inches Full Depth

### FOR ASPHALT + CEMENT TREATED SUBGRADE SECTION

Asphalt Thickness (t) = 4 inches

$$D_2 = ((WSN) - (t)(C_1))/C_2 = -0.7 \text{ inches}$$

Use 10.0 inches of Cement Treated Subgrade

### RECOMMENDED ALTERNATIVES

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

Job No. 210984

Fig. No. C-4

## FLEXIBLE PAVEMENT DESIGN

### DESIGN DATA

CLASSIC COMMUNITIES - HANNAH RIDGE AT FEATHERGRASS, F5  
SOILTYPE 2 - LOCAL RESIDENTIAL

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL ( $W_{18}$ ) =	292,000
Hveem Stabilometer (R Value) Results:	R =	40
Standard Deviation	$S_o$ =	0.45
Loss in Serviceability	$\Delta psi$ =	2.0
Reliability	Reliability =	80
Reliability (z-statistic)	$Z_R$ =	-0.84
Soil Resilient Modulus	$M_R$ =	9497

Weighted Structural Number (WSN): ➔ WSN = 2.37

### DESIGN TABLES AND EQUATIONS

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

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

$$k = M_R / 19.4$$

Where:

$M_R$  = resilient modulus (psi)

$S_1$  = the soil support value

R = R-value obtained from the Hveem stabilometer

CBR = California Bearing Ratio

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

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

Left	Right	Difference
5.47	5.46	0.0

Job No. 210894  
Fig. No. C-5

## DESIGN CALCULATIONS

### CEMENT TREATED SECTIONS - SOIL TYPE 2

DESIGN DATA: CLASSIC COMMUNITIES - HANNAH RIDGE AT FEATHERGRASS, F5  
LOCAL RESIDENTIAL

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL = 292,000
Hveem Stabilometer (R Value) Results:	R = 40
Weighted Structural Number (WSN):	WSN = 2.37

### DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

$C_1 = 0.44$  Strength Coefficient - Hot Bituminous Asphalt

$C_2 = 0.12$  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)

$$D_1 = (WSN)/C_1 = 5.4 \text{ inches of Full Depth Asphalt}$$

Use 5.5 inches Full Depth

### FOR ASPHALT + CEMENT TREATED SUBGRADE SECTION

Asphalt Thickness (t) = 4 inches

$$D_2 = ((WSN) - (t)(C_1))/C_2 = 5.1 \text{ inches}$$

Use 10.0 inches of Cement Treated Subgrade

### RECOMMENDED ALTERNATIVES

1. 4.0 inches of Asphalt + 10 inches of Cement Treated Subgrade
2. 5.5 inches of Full Depth Asphalt

Job No. 210984

Fig. No. C-6



**ENTECH**  
ENGINEERING, INC.

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

July 8, 2021

Classic Communities  
2138 Flying Horse Club Drive  
Colorado Springs, CO 80921

Attn: Adam Doyle

Re: Cement Stabilized Subgrade Results - Laboratory Testing  
Hannah Ridge at Feathergrass, Filing No. 5  
El Paso County, Colorado

Ref: Pavement Recommendations Report by Entech Engineering, Inc., dated July 8, 2021,  
Entech Job No. 210984.

Dear Mr. Doyle:

As requested, personnel of Entech Engineering, Inc. have performed strength testing on two sets of three soil/cement composite samples for Soil Type 1 and Soil Type 2 for the above referenced project. Testing was performed on soil samples prepared with 2% and 4% Portland Cement Type 1/2, from Martin Marietta, near Pueblo, Colorado.

A compression strength of 160 psi is recommended for cement stabilized subgrade. The 5-day average strength value of the Type 1 samples with a 2% mix was 175 psi, and the 5-day average strength value of the 4% mix was 188 psi. The 5-day average strength value of the Type 2 samples of the 2% mix was 196 psi, and the 5-day average strength value of the 4% was 216 psi. A 3% mix is recommended based on the laboratory test results. A summary of the testing results is attached.

Pending the results of the field density testing, microfracturing of the stabilized subgrade will likely be required on this site. Soil strengths in excess of 200 psi require microfracturing.

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

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Daniel P. Stegman

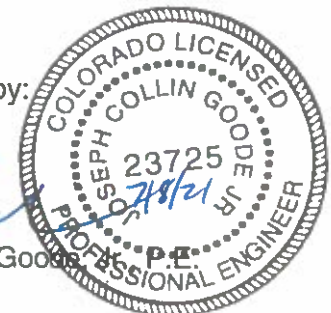
DPS/kc

Encl.

Entech Job No. 210984  
AAprojects/2021/210984 cssr - lab

Reviewed by:

Joseph C. Goode  
President



**El Paso County File No. SF-18-038**

**SUMMARY OF CTS TEST RESULTS**  
**LAB TESTING**

CLIENT CLASSIC COMMUNITIES  
 PROJECT HANNAH RIDGE, FEATHERGRASS, F5  
 FIELD SAMPLE ID TB-1 @ 0-3', SOIL TYPE #1  
 SOIL ADDITIVE TYPE I/II CEMENT

JOB NO 210984  
 DATE 7/7/21  
 BY BL

<i>ADDITIVE %</i>	<i>WATER %</i>	<i>DENSITY (dry)</i>	<i>AGE (days)</i>	<i>STRENGTH (psi)</i>
2	11.5	114.9	5	161
2	11.5	115.0	5	185
2	11.5	114.7	5	178
AVERAGE:				175
4	11.5	114.6	5	171
4	11.5	114.8	5	214
4	11.5	115.0	5	178
AVERAGE:				188

CURING METHOD  
 100° HUMIDIFIED OVEN

**SUMMARY OF CTS TEST RESULTS**  
**LAB TESTING**

CLIENT CLASSIC COMMUNITIES  
 PROJECT HANNAH RIDGE, FEATHERGRASS, F5  
 FIELD SAMPLE ID TB-5 @ 0-3', SOIL TYPE #2  
 SOIL ADDITIVE TYPE III CEMENT

JOB NO 210984  
 DATE 7/7/21  
 BY BL

<i>ADDITIVE %</i>	<i>WATER %</i>	<i>DENSITY (dry)</i>	<i>AGE (days)</i>	<i>STRENGTH (psi)</i>
2	8.1	122.7	6	193
2	8.1	122.8	6	199
2	8.1	122.9	6	197
AVERAGE:				<b>196</b>
4	8.1	123.0	6	222
4	8.1	122.7	6	211
4	8.1	122.6	6	216
AVERAGE:				<b>216</b>

**CURING METHOD**

100° HUMIDIFIED OVEN