November 8, 2019
Revised December 11, 2019

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO 80907
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Approved
By: Elizabeth Nijkamp
Date:12/11/2019
El Paso County Planning & Community Development

Classic Communities
6385 Corporate Drive, Suite 200
Colorado Springs, CO 80919

Attn: Bill Ritchie

Re: Pavement Recommendations
Hannah Ridge at Feathergrass, Filing No. 7
El Paso County, Colorado

SF1840

Dear Mr. Ritchie:

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

Project Description

The project will consist of the paving of Electronic Drive, Breechers Way, and Show Hunter Way along with portions of Pony Club Lane and Grand Prix Court in the Hannah Ridge at Feathergrass, Filing No. 7 Subdivision. Subsurface Soil Investigation and laboratory testing was performed to determine the pavement support characteristics on the soil. The general layout of the site is presented in the Test Boring Location Plan, Figure 1.

Subgrade Conditions

Nine test borings were drilled on this filing, not to exceed 500 feet between each test boring. The test boring locations are shown in Figure No. 1. The Test Boring Logs are presented in Appendix A. Representative bulk samples of the subgrade soils were obtained from the test borings at the anticipated subgrade elevation. Soils encountered in the test borings consisted of predominantly silty to very silty sand fill and clayey to very clayey sand fill overlying native slightly silty to silty sand. The surficial soils were classified into three soil types. The clayey to silty sand fill was grouped into Type 1 soil, the very clayey to very silty sand fill into Type 2, and the native sand into Type 3. The Type 3 soils are at such a depth that are below the subgrade influence zone and will not affect the sections provided in this report.

Sieve Analyses was performed on the Type 1 subgrade soils for the purpose of classification. The Sieve Analyses on the Type 1 soils indicated that approximately 18 to 35 percent of the soil particles passed the No. 200 sieve for the soils at subgrade depth. The Type 2 soils at subgrade depth indicated that approximately 39 to 45 percent of the soil particles passed the No. 200 sieve. The Type 1 soils classify as A-2-4, A-2-6; whereas, the Type 2 soils classified as A-4 and A-6 soils using the AASHTO classification. The Type 1 soils typically provide good pavement support and the Type 2 soils typically provide fair to poor pavement support characteristics. Groundwater was not encountered in the test borings during or subsequent to drilling. The results of laboratory testing are presented Appendix B.

Swell/Consolidation testing was required on the site soils due to the soils AASHTO classifications. The results of all soils tested ranged in swells of 0.2 percent, no swell, and a consolidation of 0.2 percent. Based on these results, mitigation for expansive soils is not required on this filing.

California Bearing Ratio (CBR) testing was performed on a sample of the Soil Type 1 subgrade soils obtained from Test Boring No. 4. The results of the CBR and classification testing are summarized in Table 1 and presented in the following tables, and in Appendix B, attached.

Samples of the Soil Type 2 soils were not obtained from the borings during drilling. Since the Type 2 soils classify as A-6 soils, the data from a similar soil test from an adjacent filing were used to calculate the Type 2 sections. The results of the CBR testing from Hannah Ridge Filing # 4 were used for the Type 2 soils in Filing No. 7. The laboratory test results for the Type 2 materials from the adjacent filing are attached in Appendix D.

Soil Type 1 – Clayey Sand Fill

R @ 90% = 74.0
R @ 95% = 75.0
Use R = 50.0 for design

Classification Testing

Liquid Limit	34
Plasticity Index	21
Percent Passing 200	28.6
AASHTO Classification	A-2-6
Group Index	1
Unified Soils Classification	SC

Soil Type 2 – Very Clayey Sand Fill

R @ 90% = 1.0
R @ 95% = 6.0
Use R = 6.0 for design

Classification Testing

Liquid Limit	36
Plasticity Index	24
Percent Passing 200	43.9
AASHTO Classification	A-6
Group Index	6
Unified Soils Classification	SC

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". All of the roadways classify as local roadways which used an 18K ESAL value of 292,000 for design. Pavement alternatives for asphalt over aggregate basecourse and cement stabilized subgrade sections are provided. Design parameters used in the pavement analysis are as follows:

Reliability (Local Roads)	80%
Serviceability Index (Local Roads)	2.0
"R" Value Subgrade - Soil Type 1 "R" Value Subgrade - Soil Type 2	50.0 6.0
Resilient Modulus Soil Type 1 Resilient Modulus Soil Type 2	13,168 psi 3,126 psi
Structural Coefficients:	
Hot Bituminous Pavement	0.44
Aggregate Basecourse	0.11
Cement Stabilized Subgrade	0.12

Pavement calculations are attached in Appendix C. Pavement sections recommended for the site are summarized as follows:

Pavement Sections – Soil Type 1

Urban Local – ESAL = 292,000

Alternative	Asphalt** (in)	Basecourse (in)	Cement Stabilized Subgrade (in.)
1. Asphalt Over Basecourse	3.5	8.0*	--
2. Cement Stabilized Subgrade	4.0	--	10.0

Pavement Sections – Soil Type 2

Urban Local – ESAL = 292,000

Alternative	Asphalt (in)	Basecourse (in)	Cement Stabilized Subgrade (in.)
1. Asphalt Over Basecourse	5.0	12.5	--
2. Cement Stabilized Subgrade	5.0	--	12.0

* Minimum sections required per the El Paso County "Pavement Design Criteria and Report".
** Consideration should be given to using 4-inch asphalt at intersections due to trucks turning.

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. Samples tested resulted in no swell, a consolidation of 0.2 percent, and swells of 0.2 percent under a 150 pound per square foot surcharge. Overexcavation due to expansive soils is not required on the roadway sections included in this investigation. It should also be noted that the roadway soils were moisture-conditioned and compacted during the utility installations.

Roadway Construction - Full Depth Asphalt and Asphalt on Aggregate Basecourse 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. Any loose areas should be removed and replaced with suitable materials. Basecourse materials should be compacted to a minimum of 95 percent of its maximum Modified Proctor Dry Density, ASTM D-1557 at ±2 percent of optimum moisture content. Special attention should be given to areas adjacent to manholes, inlet structures and valves.

Roadway Construction – Cement Stabilized Subgrade Alternative

Prior to placement of the asphalt, the subgrade shall be stabilized by addition of cement to a depth of at least 10 inches for Soil Type 1 areas and 12 inches for Soil Type 2 areas. The amount of cement applied shall be 2.0 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 or 12-inch depth such that a uniform blend of soil and cement is achieved. Prior to application or mixing of the cement, the upper 10 or 12-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, cement, subgrade conditions, compaction of materials and roadway construction methods shall meet the El Paso County specifications.

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

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Daniel P. Stegman

DPS/ts
Encl.

Entech Job No. 191650
AAprojects/2019/191650/191650 pr_rev

Reviewed by:

Mark H. Hauschild, P. E.
Senior Engineer

TABLE

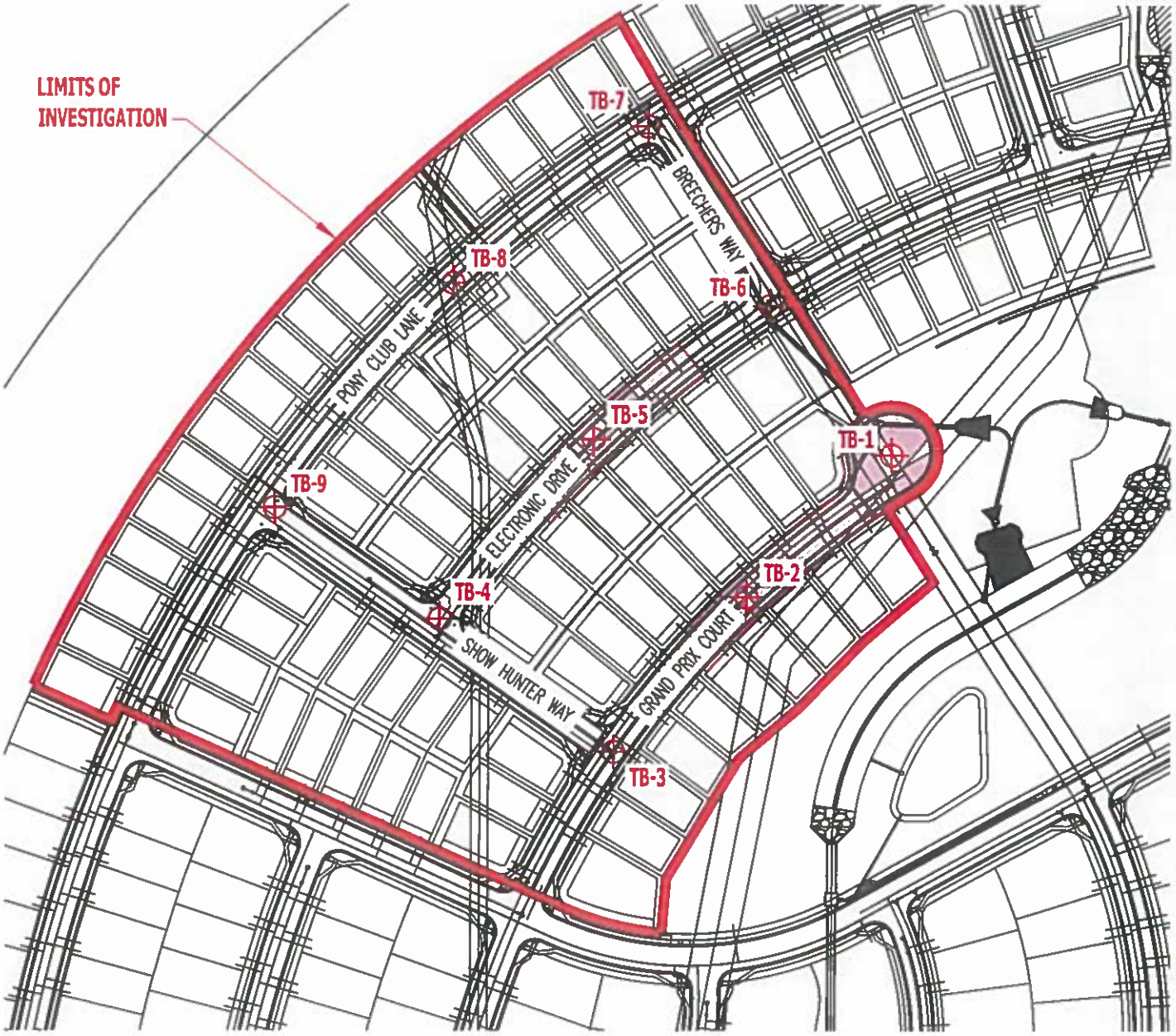
TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT CLASSIC COMMUNITIES
PROJECT FEATHERGRASS, FILING 7
JOB NO. 191650

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	4	0-3			28.6	34	21		A-2-6		SC	FILL, SAND, CLAYEY
1	3	1-2			33.1	NV	NP		A-2-4		SM	FILL, SAND, SILTY
1	4	1-2	10.6	105.6	32.4	29	13		A-2-6	0.0	SC	FILL, SAND, CLAYEY
1	6	1-2			17.9	29	11		A-2-6		SC	FILL, SAND, CLAYEY
1	7	1-2			25.4	27	12		A-2-6		SC	FILL, SAND, CLAYEY
1	8	1-2			23.4	NV	NP	0.00	A-2-4		SM	FILL, SAND, SILTY
1	9	1-2			35.3	28	11		A-2-6		SC	FILL, SAND, CLAYEY
2	1	1-2	14.9	111.0	45.0	NV	NP		A-4	0.2	SM	FILL, SAND, VERY SILTY
2	2	1-2	12.0	107.1	40.4	30	13	0.00	A-6	0.2	SC	FILL, SAND, VERY CLAYEY
2	5	1-2			38.8	33	16	0.00	A-6		SC	FILL, SAND, VERY CLAYEY
2	9	10	12.3	91.4	82.2	NV	NP	<0.01	A-4	-0.2	ML	FILL, SILT, SANDY
3	3	10			11.8	NV	NP	0.00	A-1-b		SM-SW	SAND, SLIGHTLY SILTY

FIGURE



- APPROXIMATE EXTENTS OF SOIL TYPE 2
  UNHATCHED AREAS REPRESENT SOIL TYPE 1

TB-2 - APPROXIMATE TEST BORING LOCATION AND NUMBER

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TEST BORING LOCATION PLAN
HANNAH RIDGE AT FEATHERGRASS, F7
EL PASO COUNTY, CO
FOR: CLASSIC COMMUNITIES

DRAWN BY:	DATE DRAWN:	DESIGNED BY:	CHECKED:
SC	10/29/19	SC	

JOB NO.: 191650

FIG. NO.: 1

APPENDIX A: Test Boring Logs

TEST BORING NO. 1
DATE DRILLED 10/4/2019
Job # 191650

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 10/4/19						
FILL 0-5', SAND, VERY SILTY, FINE GRAINED, DARK BROWN, MEDIUM DENSE, MOIST				13	14.5	2
	5			15	15.2	2
	10					
	15					
	20					

TEST BORING NO. 2
DATE DRILLED 10/4/2019
CLIENT CLASSIC COMMUNITIES
LOCATION FEATHERGRASS, FILING 7

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 10/4/19						
FILL, SAND, VERY CLAYEY, FINE TO MEDIUM GRAINED, BROWN, MEDIUM DENSE TO LOOSE, MOIST				12	11.0	2
	5			7	12.0	2
	10					
	15					
	20					

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TEST BORING LOG

DRAWN:	DATE	CHECKED:	DATE:
			10/30/19

JOB NO.: 191650
FIG NO.: A- 1

TEST BORING NO. 3
DATE DRILLED 10/4/2019
Job # 191650

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 10', 10/4/19						
FILL 0-8', SAND, SILTY, FINE TO MEDIUM GRAINED, BROWN TO DARK BROWN, MEDIUM DENSE TO LOOSE, MOIST				19	8.4	1
	5			9	9.8	1
SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST	10			14	4.9	3
	15					
	20					

TEST BORING NO. 4
DATE DRILLED 10/4/2019
CLIENT CLASSIC COMMUNITIES
LOCATION FEATHERGRASS, FILING 7

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 10/4/19						
FILL 0-5', SAND, CLAYEY, FINE TO MEDIUM GRAINED, DARK BROWN, MEDIUM DENSE TO LOOSE, MOIST				12	10.8	1
	5			6	15.8	1
	10					
	15					
	20					

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TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE: 10/30/19

JOB NO.: 191650
FIG NO.: A- 2

TEST BORING NO. 5
DATE DRILLED 10/4/2019
Job # 191650

REMARKS

DRY TO 5', 10/4/19

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			16	13.2	2
5			28	9.0	2
10					
15					
20					

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

TEST BORING NO. 6
DATE DRILLED 10/4/2019
CLIENT CLASSIC COMMUNITIES
LOCATION FEATHERGRASS, FILING 7

REMARKS

DRY TO 10', 10/4/19

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			14	12.3	1
5			7	5.5	1
10			17	19.8	3
15					
20					

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

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

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TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE: 10/30/19

JOB NO.: 191650
FIG NO.: A- 3

TEST BORING NO. 7
DATE DRILLED 10/4/2019
Job # 191650

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 10/4/19						
FILL 0-5', SAND, CLAYEY, FINE TO MEDIUM GRAINED, BROWN, MEDIUM DENSE, MOIST				20	11.0	1
	5			13	10.0	1
	10					
	15					
	20					

TEST BORING NO. 8
DATE DRILLED 10/4/2019
CLIENT CLASSIC COMMUNITIES
LOCATION FEATHERGRASS, FILING 7

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 10/4/19						
FILL 0-5', SAND, SILTY, FINE TO MEDIUM GRAINED, BROWN, MEDIUM DENSE, MOIST				15	9.0	1
	5			12	11.1	1
	10					
	15					
	20					

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TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
			10/30/19

JOB NO.: 191650
FIG NO.: A- 4

TEST BORING NO. 9
DATE DRILLED 10/4/2019
Job # 191650

TEST BORING NO.
DATE DRILLED
CLIENT CLASSIC COMMUNITIES
LOCATION FEATHERGRASS, FILING 7

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 10', 10/4/19						
POSS. FILL 0-10', SAND, CLAYEY, FINE TO MEDIUM GRAINED, BROWN TO DARK BROWN, MEDIUM DENSE, MOIST				15	7.0	1
	5			11	9.1	1
POSS. FILL, SILT, SANDY, DARK BROWN, SOFT, MOIST	10			6	16.8	2
	15					
	20					

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
	5					
	10					
	15					
	20					

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TEST BORING LOG

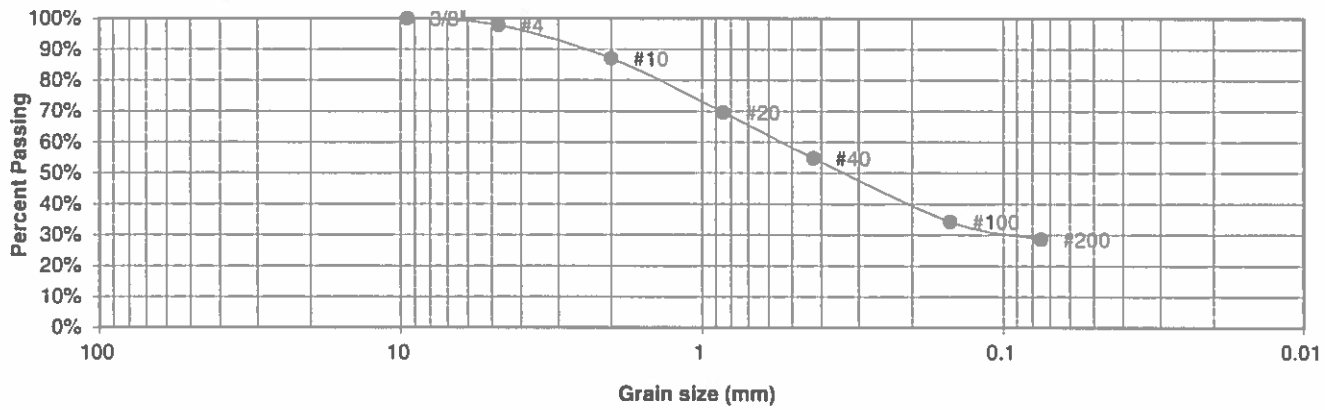
DRAWN	DATE	CHECKED:	DATE:
			10/30/19

JOB NO.: 191650
FIG NO.: A- 5

APPENDIX B: Laboratory Test Results

UNIFIED CLASSIFICATION	SC	CLIENT	CLASSIC COMMUNITIES
SOIL TYPE #	1, CBR	PROJECT	FEATHERGRASS, FILING 7
TEST BORING #	4	JOB NO.	191650
DEPTH (FT)	0-3	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	1

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.8%
10	87.1%
20	69.6%
40	54.9%
100	34.3%
200	28.6%

Atterberg Limits

Plastic Limit	13
Liquid Limit	34
Plastic Index	21

Swell

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

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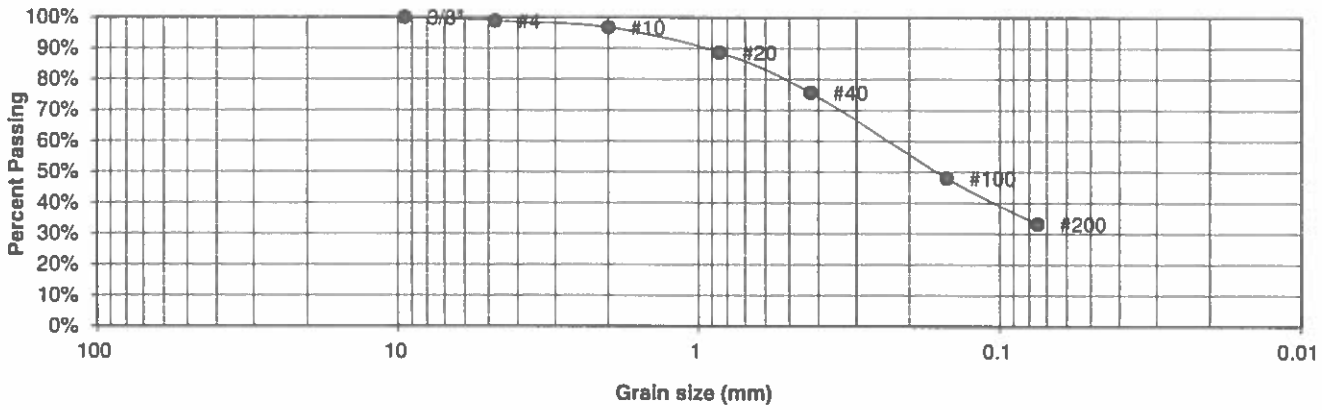
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			10/30/19

JOB NO. 191650
FIG NO. B-1

UNIFIED CLASSIFICATION	SM	CLIENT	CLASSIC COMMUNITIES
SOIL TYPE #	1	PROJECT	FEATHERGRASS, FILING 7
TEST BORING #	3	JOB NO.	191650
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.9%
10	96.8%
20	88.7%
40	75.7%
100	48.0%
200	33.1%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)

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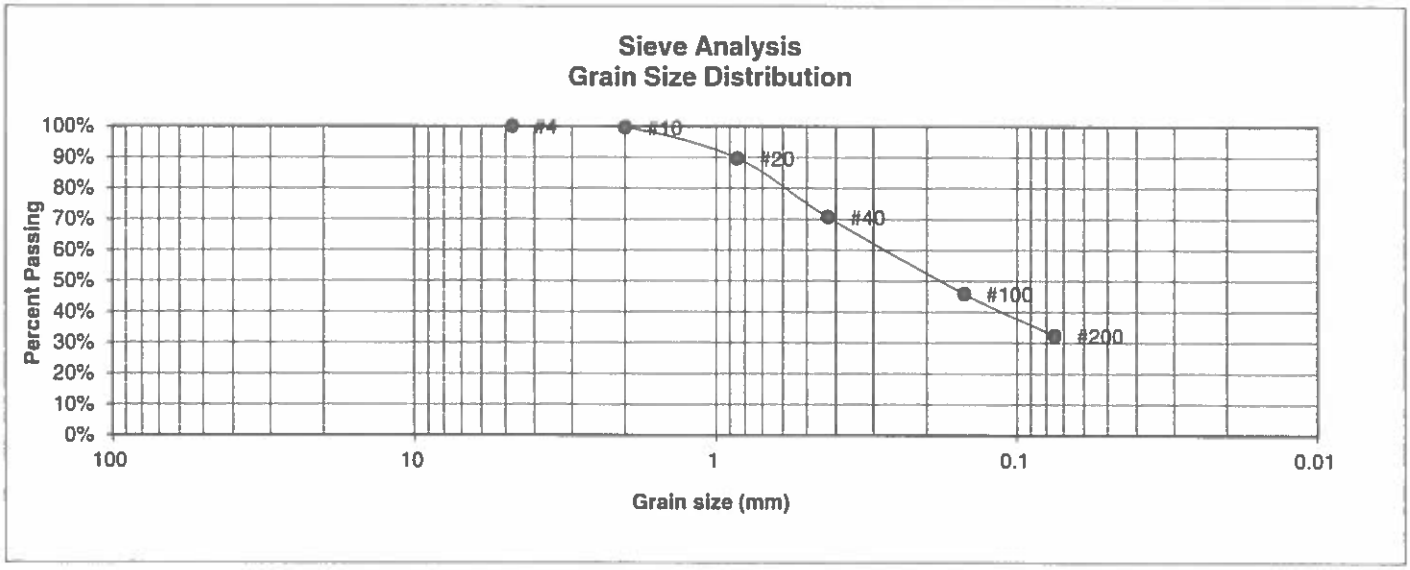
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			10/30/19

JOB NO.: 191650
FIG NO.: B-2

UNIFIED CLASSIFICATION	SC	CLIENT	CLASSIC COMMUNITIES
SOIL TYPE #	1	PROJECT	FEATHERGRASS, FILING 7
TEST BORING #	4	JOB NO.	191650
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.7%
20	89.7%
40	70.7%
100	45.9%
200	32.4%

Atterberg Limits	
Plastic Limit	16
Liquid Limit	29
Plastic Index	13

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

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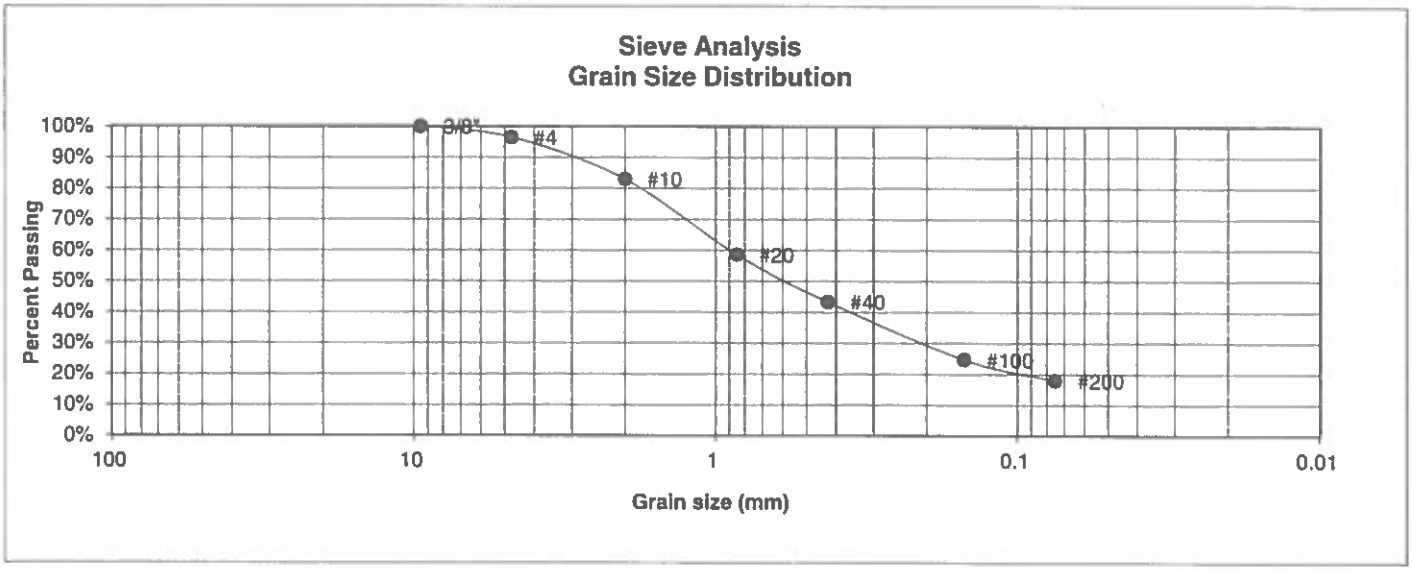
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			10/30/19

JOB NO. 191650
FIG NO. B-3

UNIFIED CLASSIFICATION	SC	CLIENT	CLASSIC COMMUNITIES
SOIL TYPE #	1	PROJECT	FEATHERGRASS, FILING 7
TEST BORING #	6	JOB NO.	191650
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	96.5%
10	83.0%
20	58.6%
40	43.3%
100	24.7%
200	17.9%

Atterberg Limits	
Plastic Limit	18
Liquid Limit	29
Plastic Index	11

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

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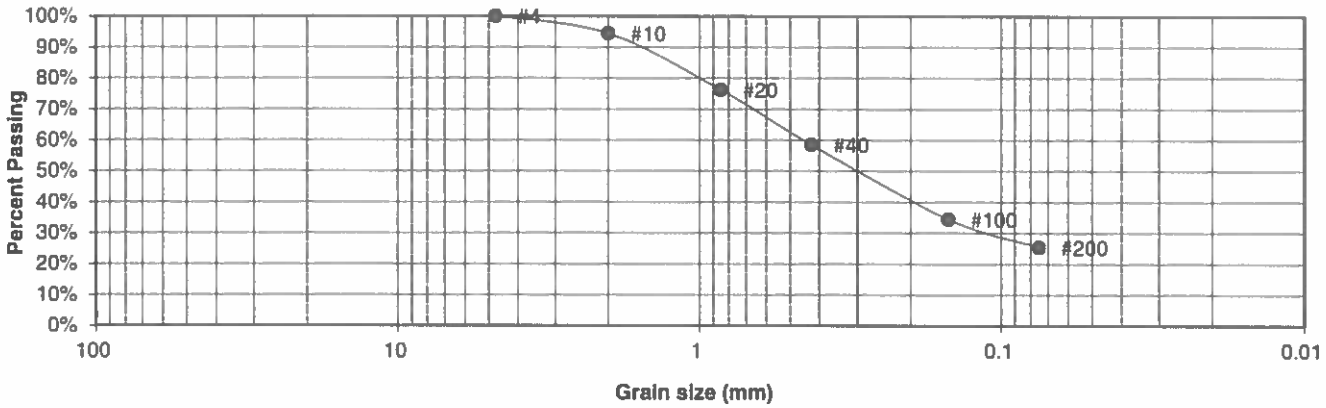
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			10/30/17

JOB NO.: 191650
FIG NO.: B-4

UNIFIED CLASSIFICATION	SC	CLIENT	CLASSIC COMMUNITIES
SOIL TYPE #	1	PROJECT	FEATHERGRASS, FILING 7
TEST BORING #	7	JOB NO.	191650
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	94.5%
20	76.3%
40	58.6%
100	34.5%
200	25.4%

Atterberg Limits	
Plastic Limit	15
Liquid Limit	27
Plastic Index	12

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

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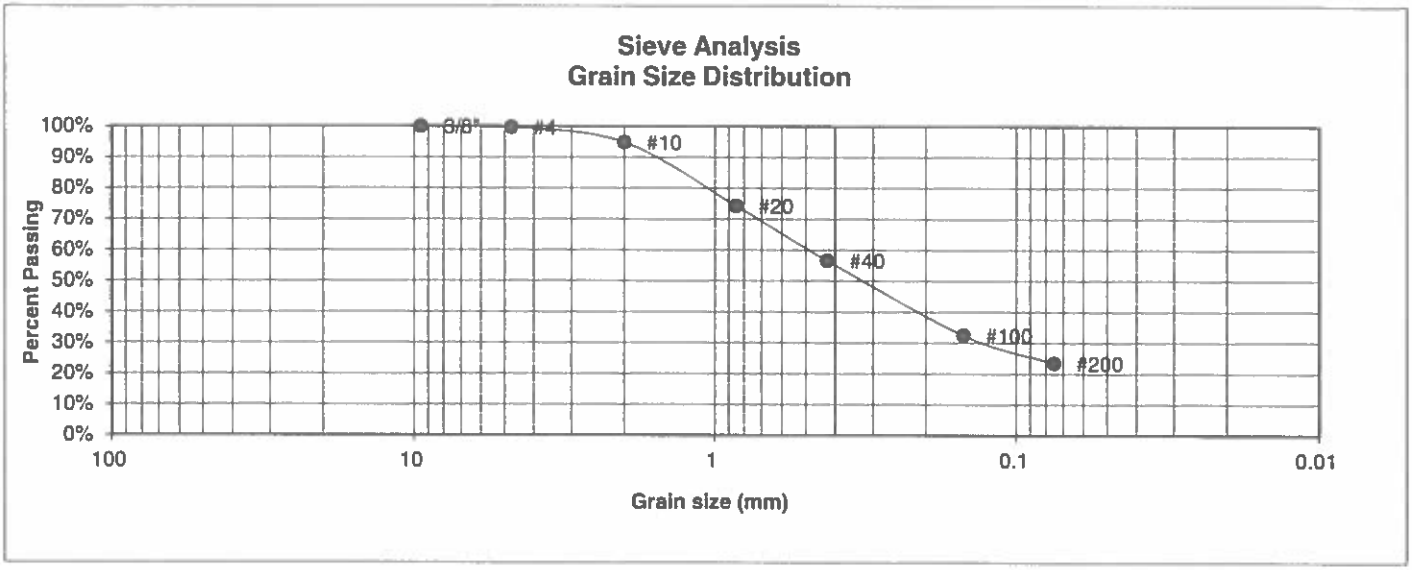
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			10/30/19

JOB NO. 191650
FIG NO. B-5

UNIFIED CLASSIFICATION	SM	CLIENT	CLASSIC COMMUNITIES
SOIL TYPE #	1	PROJECT	FEATHERGRASS, FILING 7
TEST BORING #	8	JOB NO.	191650
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.7%
10	94.8%
20	74.3%
40	56.6%
100	32.4%
200	23.4%

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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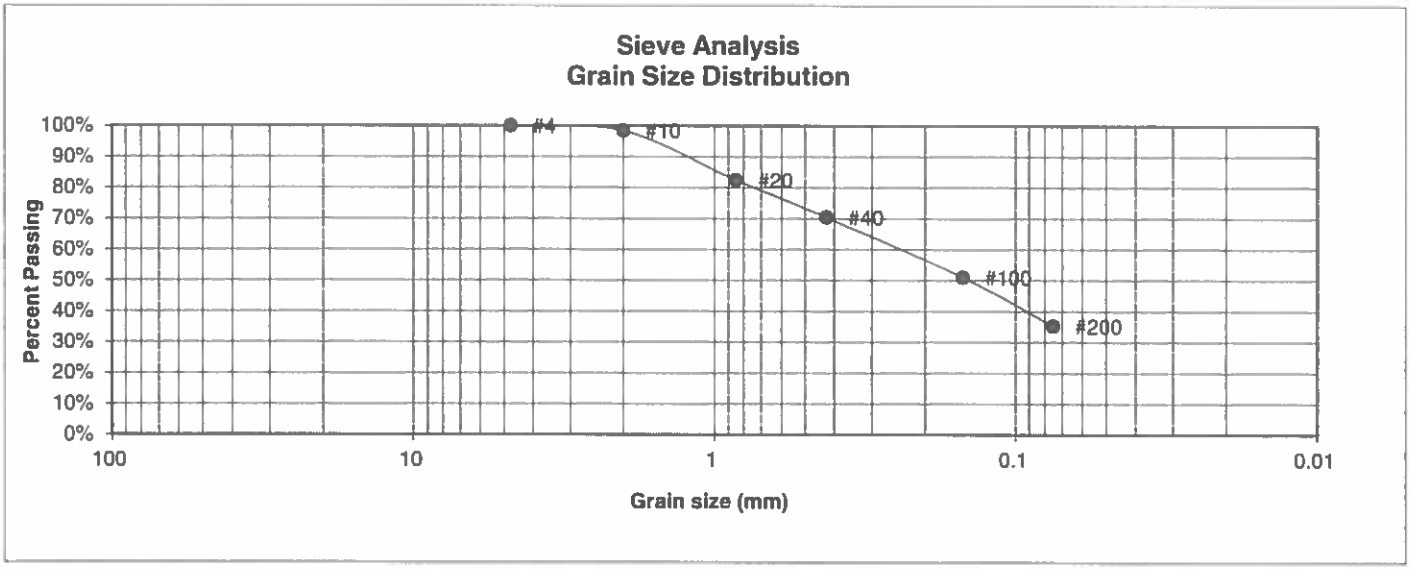
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			10/30/17

JOB NO.: 191650
FIG NO.: B-2

UNIFIED CLASSIFICATION	SC	CLIENT	CLASSIC COMMUNITIES
SOIL TYPE #	1	PROJECT	FEATHERGRASS, FILING 7
TEST BORING #	9	JOB NO.	191650
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	98.5%
20	82.5%
40	70.4%
100	51.0%
200	35.3%

Atterberg Limits	
Plastic Limit	17
Liquid Limit	28
Plastic Index	11

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

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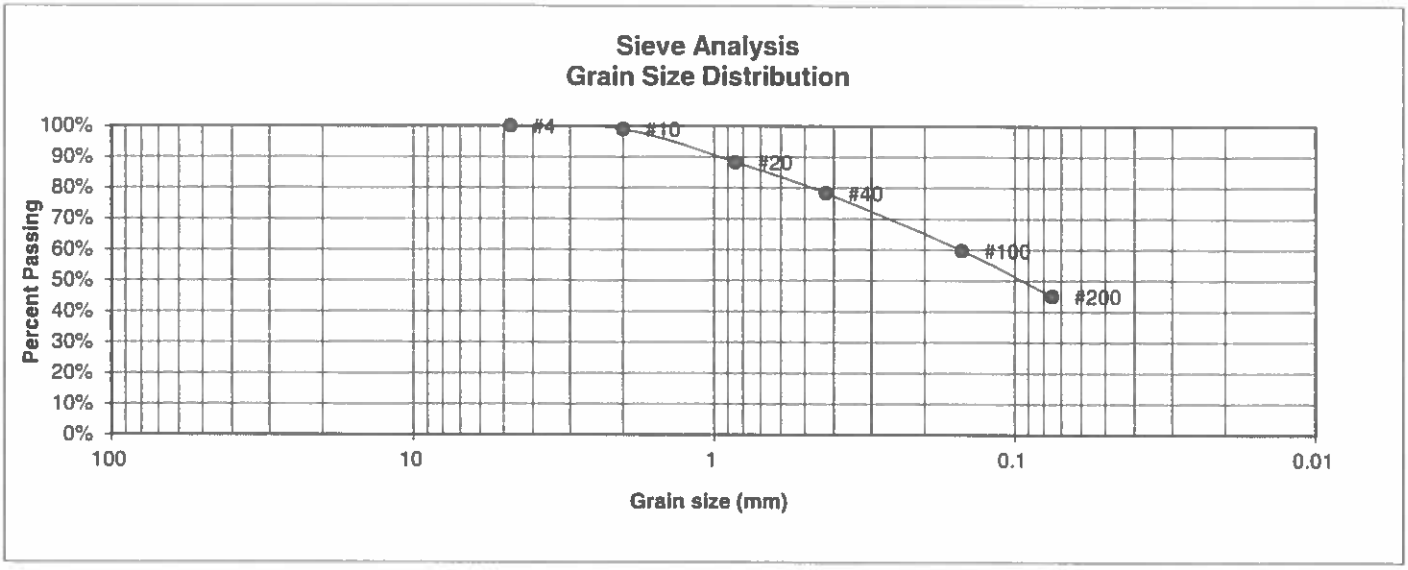
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			10/30/19

JOB NO.: 191650
FIG NO.: B-7

UNIFIED CLASSIFICATION	SM	CLIENT	CLASSIC COMMUNITIES
SOIL TYPE #	2	PROJECT	FEATHERGRASS, FILING 7
TEST BORING #	1	JOB NO.	191650
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-4	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.0%
20	88.3%
40	78.3%
100	59.8%
200	45.0%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell

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

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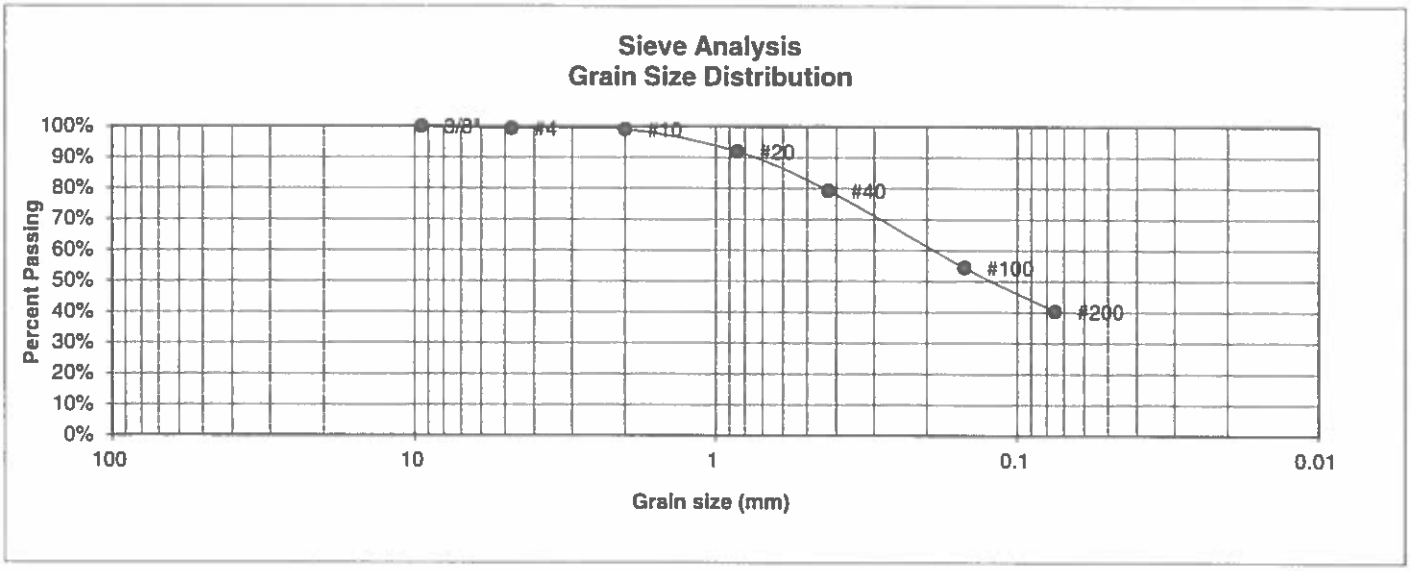
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			10/30/19

JOB NO.: 191650
FIG NO.: B-8

UNIFIED CLASSIFICATION	SC	CLIENT	CLASSIC COMMUNITIES
SOIL TYPE #	2	PROJECT	FEATHERGRASS, FILING 7
TEST BORING #	2	JOB NO.	191650
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-6	GROUP INDEX	2



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.4%
10	99.1%
20	91.9%
40	79.3%
100	54.4%
200	40.4%

Atterberg Limits	
Plastic Limit	17
Liquid Limit	30
Plastic Index	13

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

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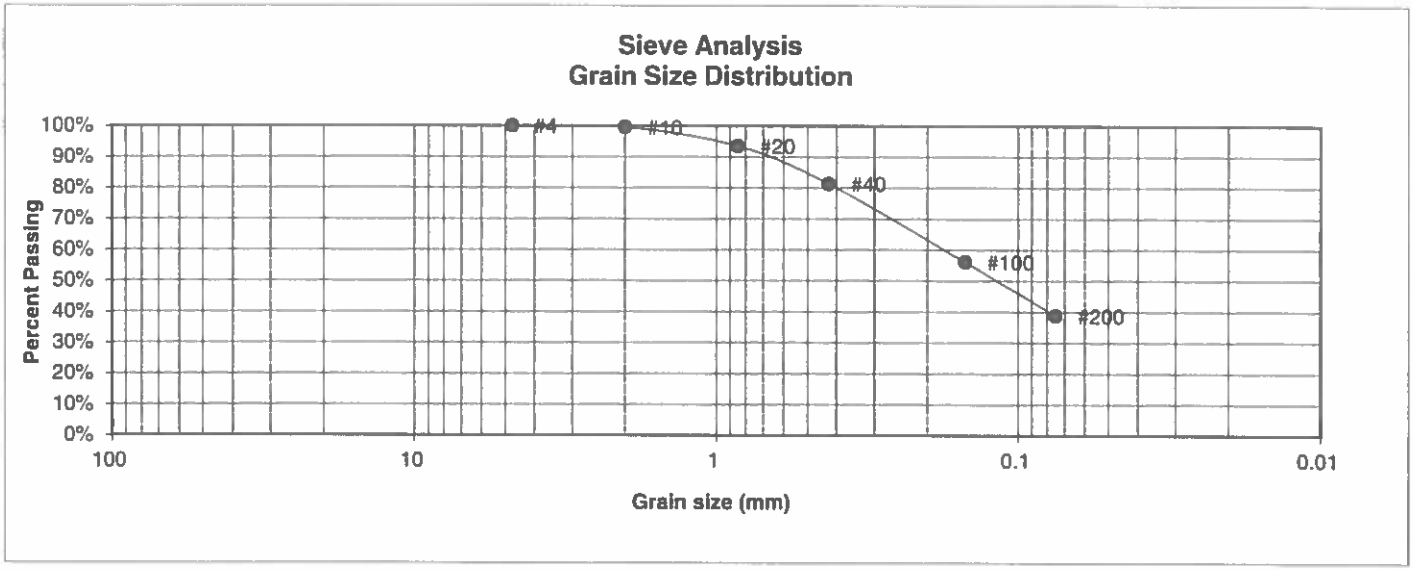
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE: 10/30/19

JOB NO: 191650
FIG NO: B-9

UNIFIED CLASSIFICATION	SC	CLIENT	CLASSIC COMMUNITIES
SOIL TYPE #	2	PROJECT	FEATHERGRASS, FILING 7
TEST BORING #	5	JOB NO.	191650
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-6	GROUP INDEX	2



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.5%
20	93.5%
40	81.3%
100	56.1%
200	38.8%

Atterberg Limits	
Plastic Limit	17
Liquid Limit	33
Plastic Index	16

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

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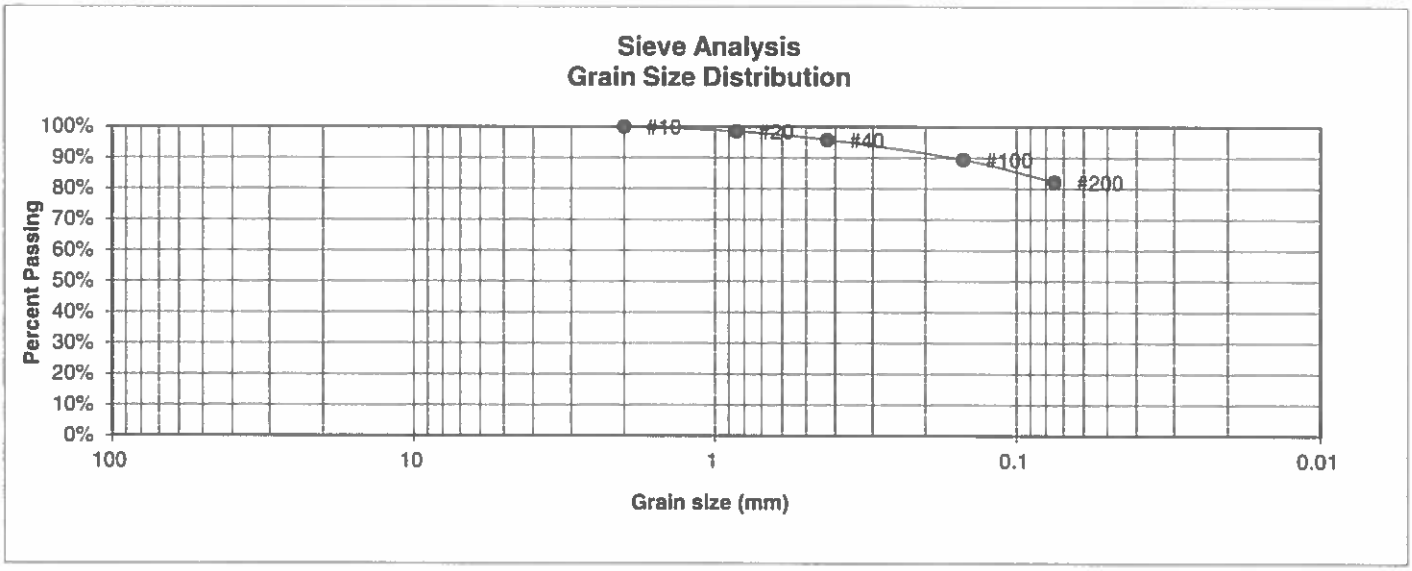
LABORATORY TEST RESULTS

DRAWN:	DATE	CHECKED:	DATE: 10/30/19

JOB NO. 191650
FIG NO. B-10

UNIFIED CLASSIFICATION	ML	CLIENT	CLASSIC COMMUNITIES
SOIL TYPE #	2	PROJECT	FEATHERGRASS, FILING 7
TEST BORING #	9	JOB NO.	191650
DEPTH (FT)	10	TEST BY	BL
AASHTO CLASSIFICATION	A-4	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	100.0%
20	98.6%
40	95.8%
100	89.4%
200	82.2%

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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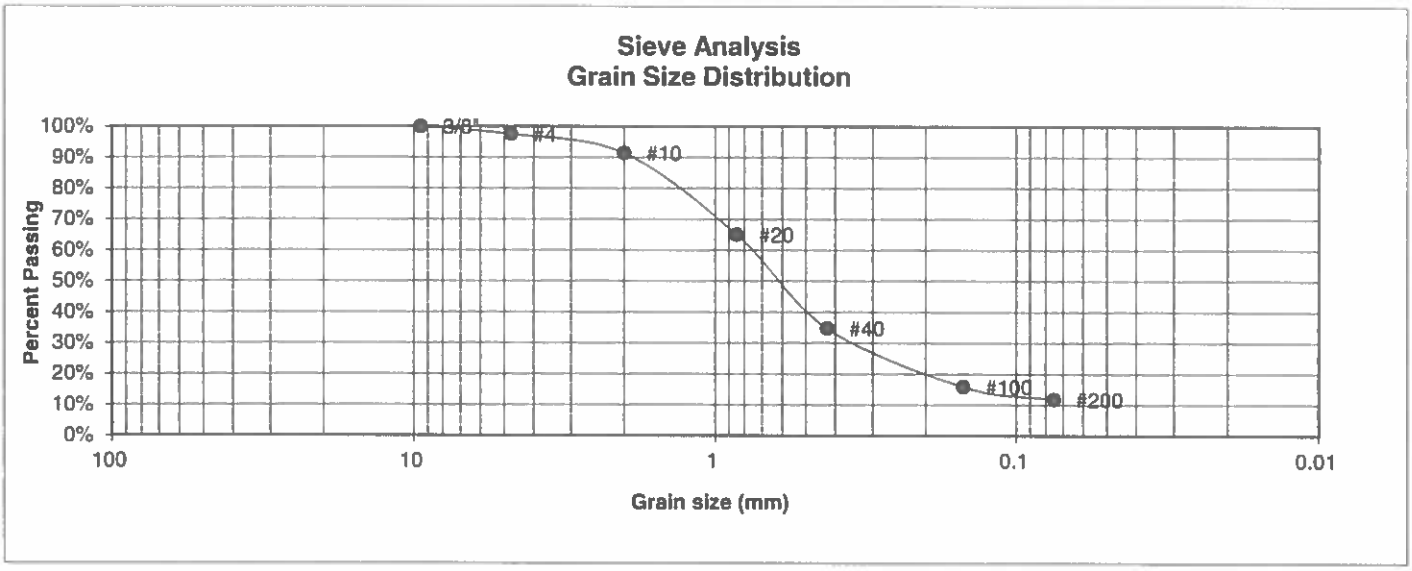
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			10/30/19

JOB NO: 191650
FIG NO: B-11

UNIFIED CLASSIFICATION	SM-SW	CLIENT	CLASSIC COMMUNITIES
SOIL TYPE #	3	PROJECT	FEATHERGRASS, FILING 7
TEST BORING #	3	JOB NO.	191650
DEPTH (FT)	10	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.5%
10	91.4%
20	65.1%
40	34.7%
100	15.9%
200	11.8%

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

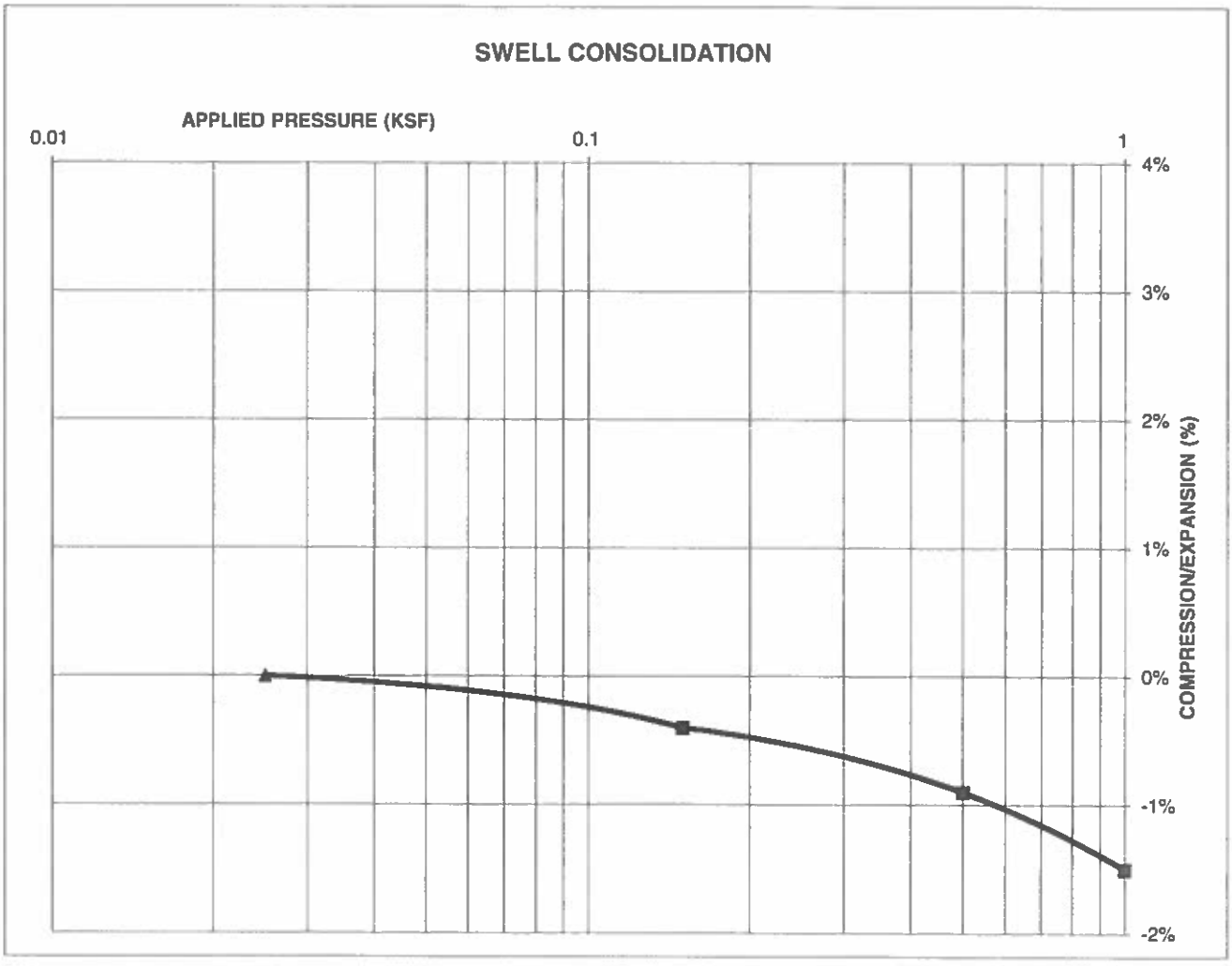
DRAWN:	DATE:	CHECKED:	DATE:
			10/30/19

JOB NO. 191650
FIG NO. B-12

CONSOLIDATION TEST RESULTS

TEST BORING #	4	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			106
NATURAL MOISTURE CONTENT			10.6%
SWELL/CONSOLIDATION (%)			0.0%

JOB NO. 191650
CLIENT CLASSIC COMMUNITIES
PROJECT FEATHERGRASS, FILING 7



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SWELL CONSOLIDATION
TEST RESULTS

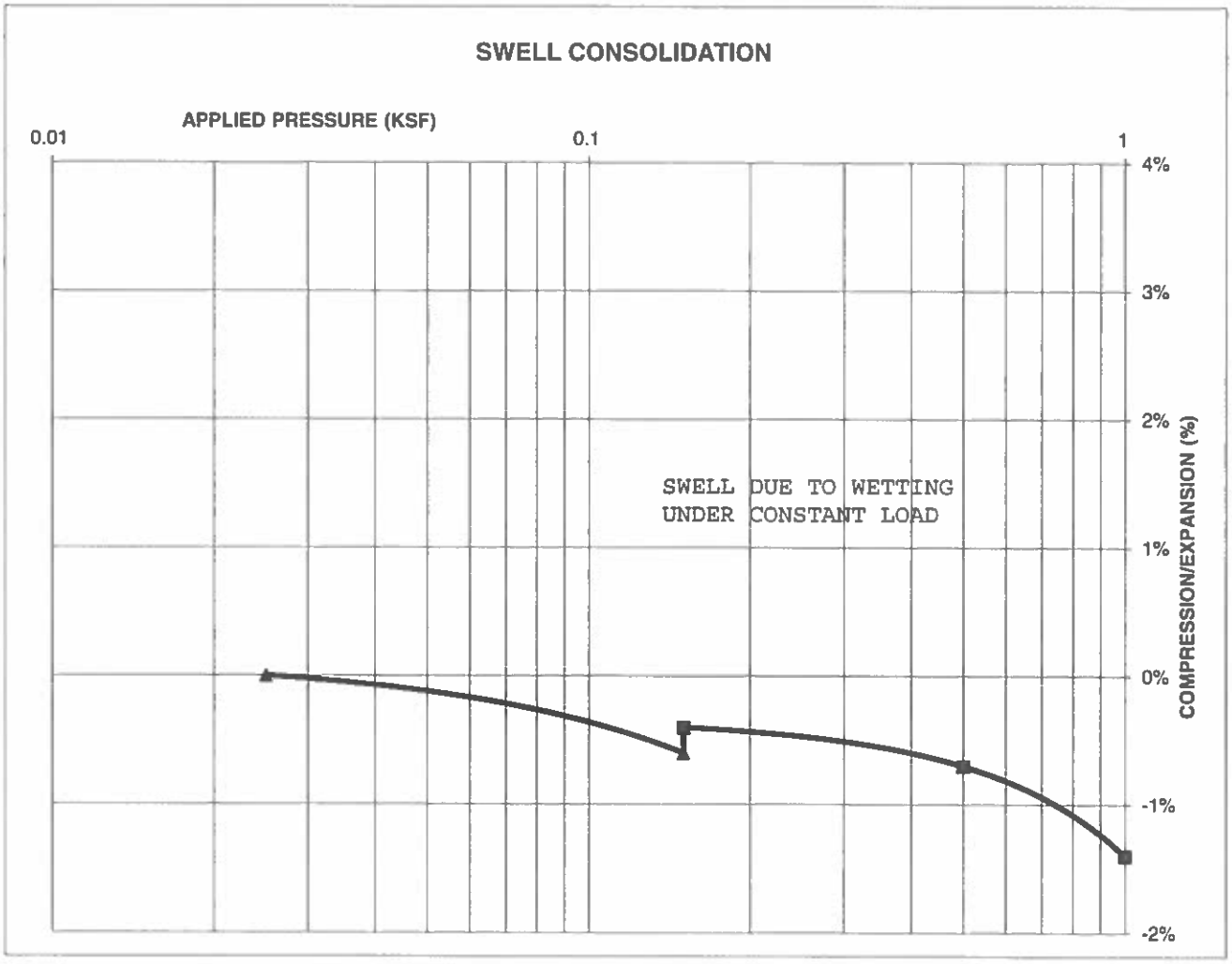
DRAWN:	DATE:	CHECKED:	DATE:
		DS	11/4/19

JOB NO.: 191650
FIG NO.: B-13

CONSOLIDATION TEST RESULTS

TEST BORING #	1	DEPTH(ft)	1-2
DESCRIPTION	SM	SOIL TYPE	2
NATURAL UNIT DRY WEIGHT (PCF)			111
NATURAL MOISTURE CONTENT			14.9%
SWELL/CONSOLIDATION (%)			0.2%

JOB NO. 191650
CLIENT CLASSIC COMMUNITIES
PROJECT FEATHERGRASS, FILING 7



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SWELL CONSOLIDATION
TEST RESULTS

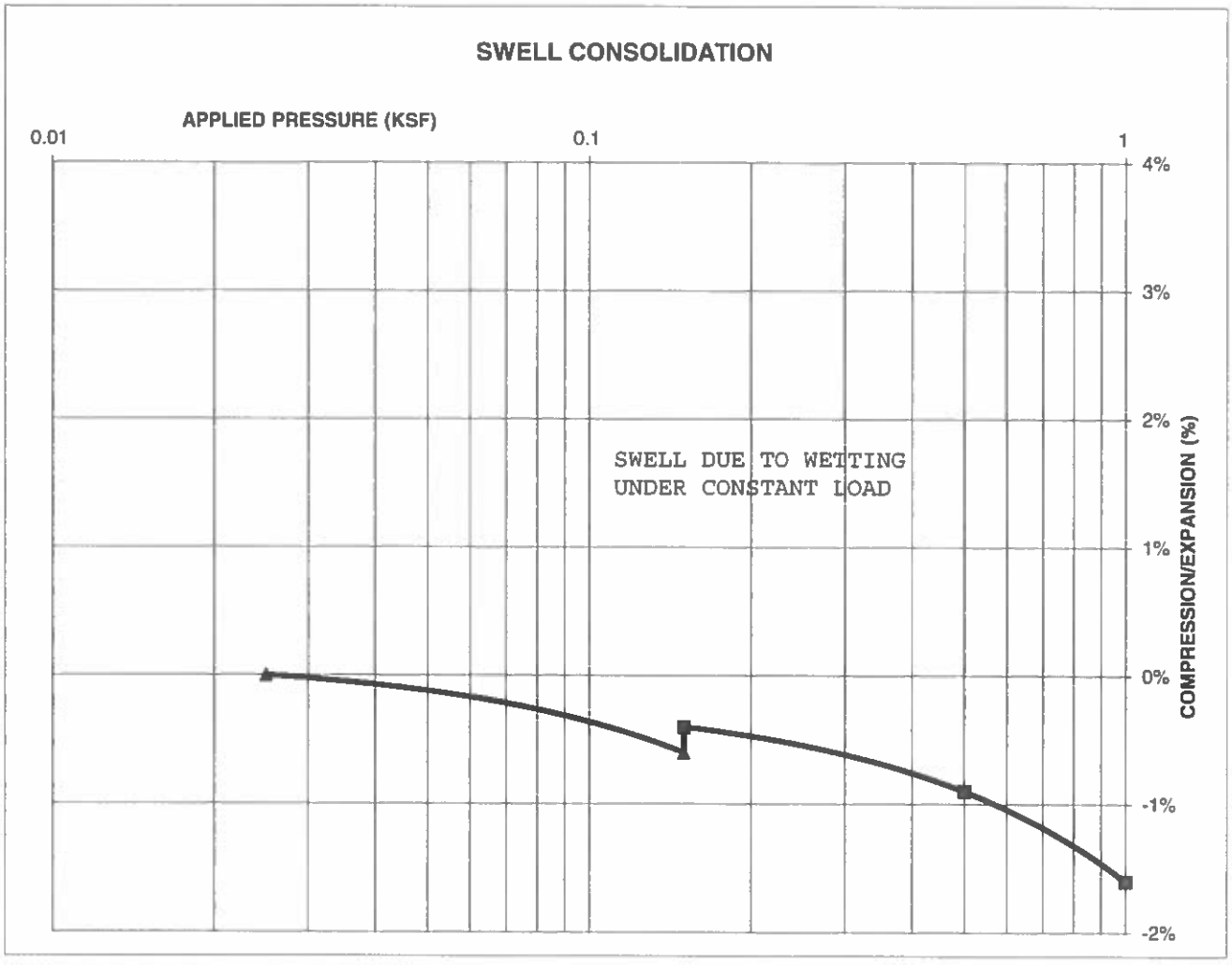
DRAWN	DATE	CHECKED:	DATE:
		TDS	11/4/19

JOB NO.: 191650
FIG NO.: B-14

CONSOLIDATION TEST RESULTS

TEST BORING #	2	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	2
NATURAL UNIT DRY WEIGHT (PCF)			107
NATURAL MOISTURE CONTENT			12.0%
SWELL/CONSOLIDATION (%)			0.2%

JOB NO. 191650
CLIENT CLASSIC COMMUNITIES
PROJECT FEATHERGRASS, FILING 7



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SWELL CONSOLIDATION
TEST RESULTS

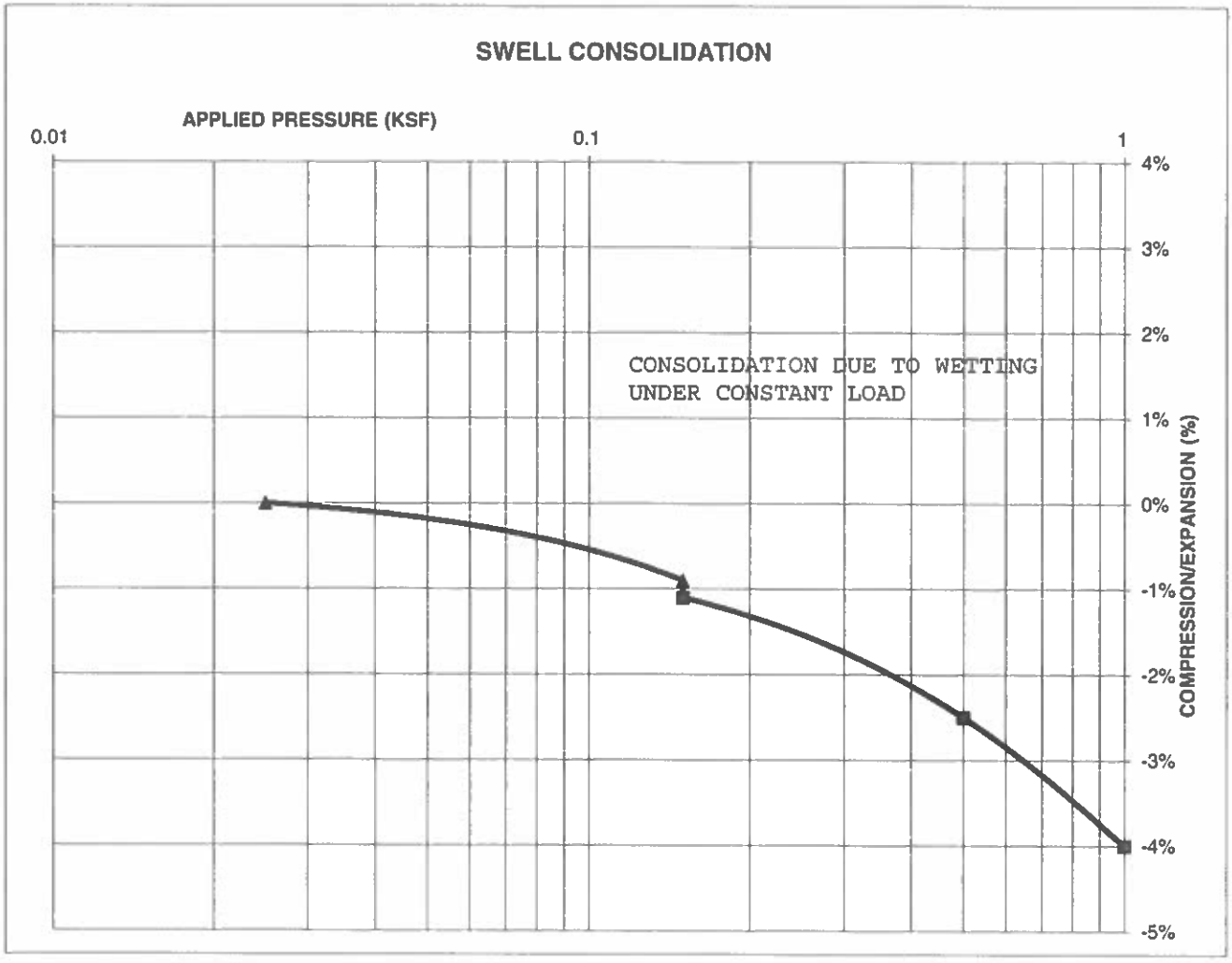
DRAWN:	DATE:	CHECKED:	DATE:
		DS	11/21/19

JOB NO.: 191650
FIG NO.: B-15

CONSOLIDATION TEST RESULTS

TEST BORING #	9	DEPTH(ft)	10
DESCRIPTION	ML	SOIL TYPE	2
NATURAL UNIT DRY WEIGHT (PCF)			91
NATURAL MOISTURE CONTENT			12.3%
SWELL/CONSOLIDATION (%)			-0.2%

JOB NO. 191650
CLIENT CLASSIC COMMUNITIES
PROJECT FEATHERGRASS, FILING 7



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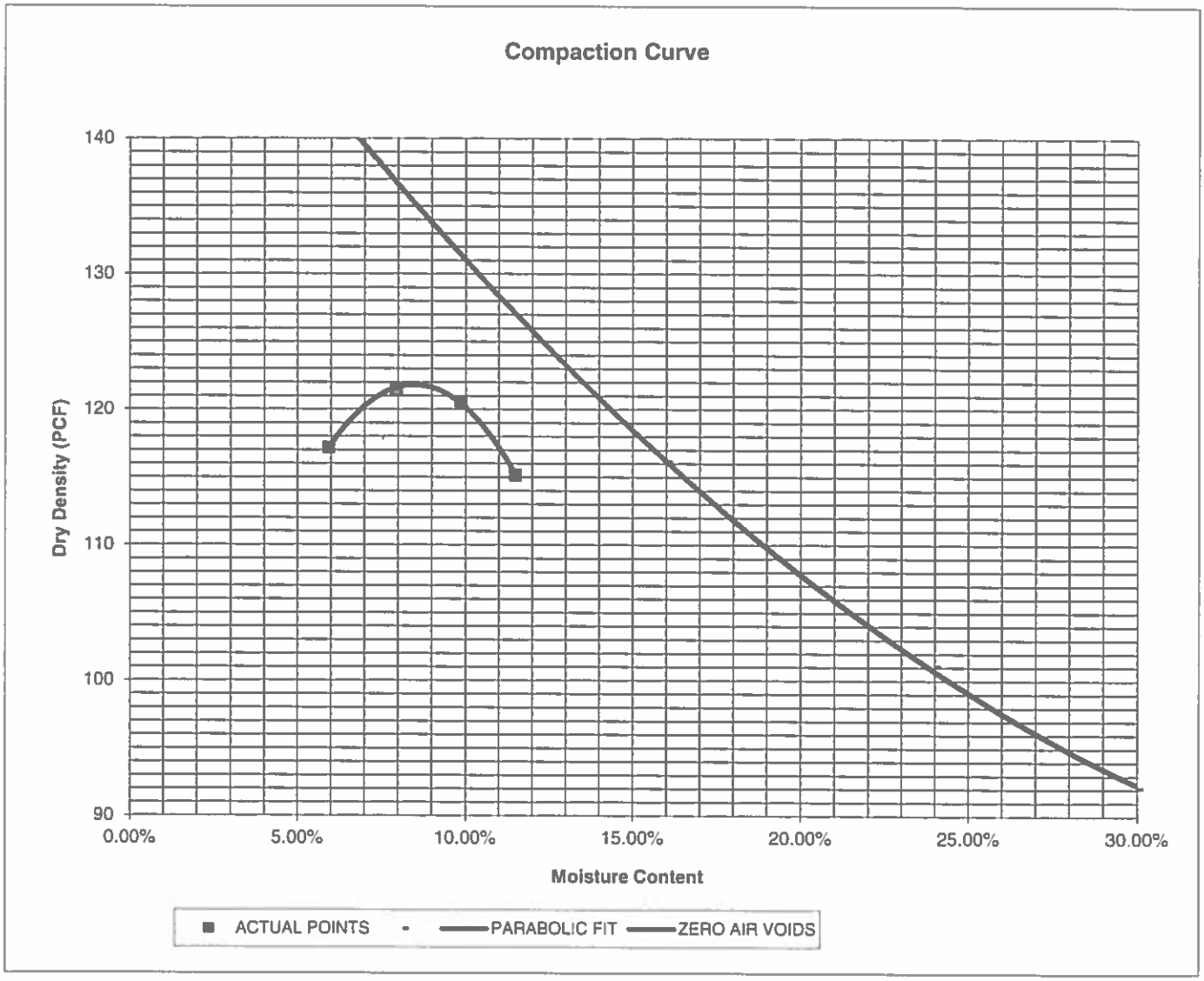
SWELL CONSOLIDATION
TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		DS	11/4/19

JOB NO.: 191650
FIG NO.: B-1C

PROJECT	FEATHERGRASS, FILING 7	CLIENT	CLASSIC COMMUNITIES
SAMPLE LOCATION	TB-4 @ 0-3'	JOB NO.	191650
SOIL DESCRIPTION	FILL, SAND, CLAYEY, BROWN	DATE	10/16/19

IDENTIFICATION	SC	COMPACTION TEST #	1
TEST DESIGNATION / METHOD	ASTM D-1557-A	TEST BY	BL
MAXIMUM DRY DENSITY (PCF)	121.9	OPTIMUM MOISTURE	8.5%



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MOISTURE DENSITY RELATION

DRAWN:	DATE:	CHECKED:	DATE:
			10/30/19

JOB NO.: 191650

FIG NO.: B-17

CBR TEST LOAD DATA

JOB NO: 191650
CLIENT: CLASSIC COMMUNITIES
PROJECT: FEATHERGRASS, FILING 7
SOIL TYPE: 1

PISTON DIAMETER (cm)	PISTON AREA (in^2)
4.958	2.99250919

PENETRATION DEPTH (INCHES)	*10 BLOWS* MOLD # 1 LOAD(LBS) (LBS)	STRESS (PSI)	*25 BLOWS* MOLD # 2 LOAD(LBS) (LBS)	STRESS (PSI)	*56 BLOWS* MOLD # 3 LOAD(LBS) (LBS)	STRESS (PSI)
0.000	0	0.00	0	0.00	0	0.00
0.025	158	52.80	194	64.83	256	85.55
0.050	389	129.99	445	148.70	789	263.66
0.075	633	211.53	837	279.70	1219	407.35
0.100	904	302.09	1336	446.45	1616	540.02
0.125	1128	376.94	1835	613.20	1963	655.97
0.150	1341	448.12	2054	686.38	2269	758.23
0.175	1532	511.94	2324	776.61	2707	904.59
0.200	1704	569.42	2530	845.44	2905	970.76
0.300	2255	753.55	3291	1099.75	4978	1663.49
0.400	2491	832.41	4058	1356.05	5813	1942.52
0.500	2664	890.22	4456	1489.05	6000	2005.01

FINAL MOISTURE CONTENT

	MOLD # 1	MOLD # 2	MOLD # 3
CAN #	346	348	358
WT. CAN	6.89	6.93	6.76
WT. CAN+WET	161.37	169.83	190.8
WT. CAN+DRY	145.55	155.24	174.92
WT. H20	15.82	14.59	15.88
WT. DRY SOIL	138.66	148.31	168.16
MOISTURE CONTENT	11.41%	9.84%	9.44%

WET DENSITY (PCF)	117.9	125.3	130.5
DRY DENSITY (PCF)	108.7	115.5	120.3

BEARING RATIO	30.21	44.64	54.00

90% OF DRY DENSITY	109.7
95% OF DRY DENSITY	115.8

BEARING RATIO AT 90% OF MAX	32.41	~ R VALUE	74
BEARING RATIO AT 95% OF MAX	45.20	~ R VALUE	75

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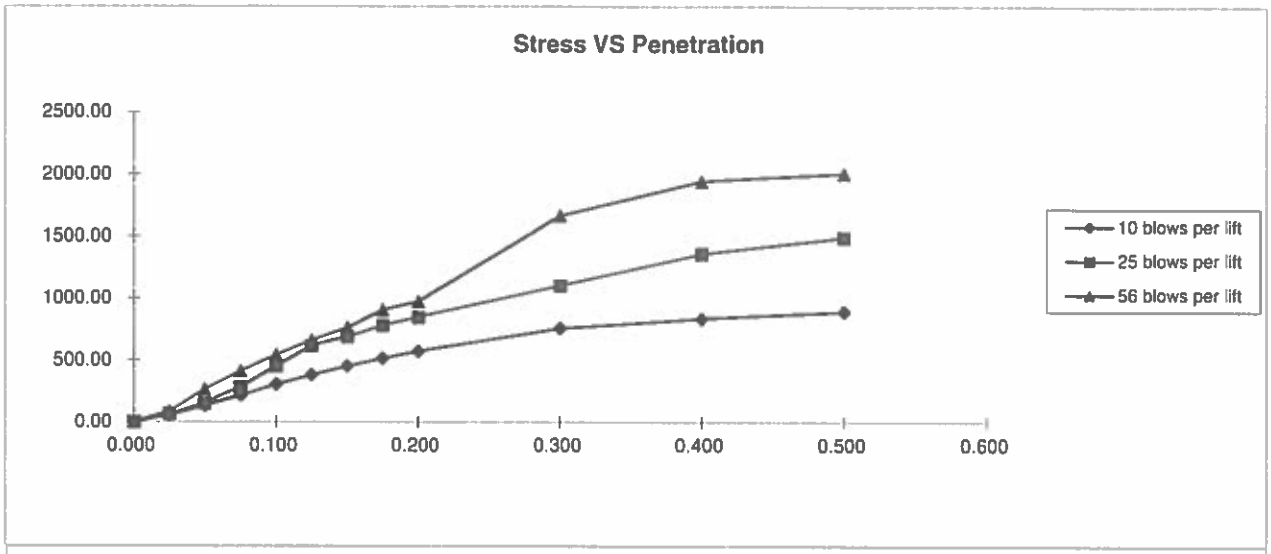
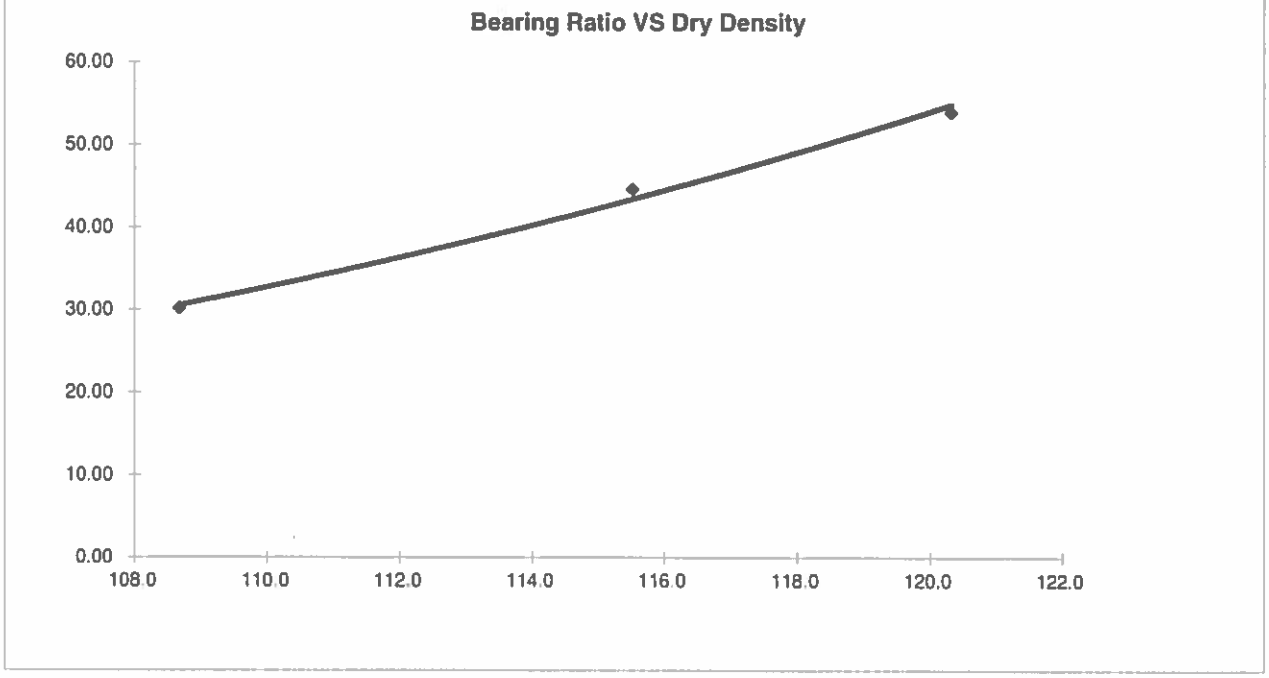
CBR TEST DATA

DRAWN:	DATE:	CHECKED:	DATE:
		DS	11/14/19

JOB NO.: 191650
FIG NO.: B-8





BEARING RATIO AT 90% OF MAX	32.41	~ R VALUE	74.00
BEARING RATIO AT 95% OF MAX	45.20	~ R VALUE	75.00

JOB NO: 191650
SOIL TYPE: 1

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CALIFORNIA BEARING RATIO

DRAWN:	DATE:	CHECKED:	DATE:
		DS	10/4/19

JOB NO.: 191650
FIG NO.: B-5

CLIENT	CLASSIC COMMUNITIES	JOB NO.	191650
PROJECT	FEATHERGRASS, FILING 7	DATE	10/16/2019
LOCATION	FEATHERGRASS, FILING 7	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-3	10	3	SM-SW	0.00
TB-5	1-2	2	SC	0.00
TB-8	1-2	1	SM	0.00
TB-9	10	4	ML	<0.01

QC BLANK PASS

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LABORATORY TEST SULFATE RESULTS

DRAWN:	DATE:	CHECKED:	DATE: 10/30/19

JOB NO.: 191650
FIG NO.: B-20

APPENDIX C: Pavement Design Calculations

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA — CLASSIC COMMUNITIES - HANNAH RIDGE AT FEATHERGRASS, F7
LOCAL ROADS - SOIL TYPE 1

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	292,000
Hveem Stabilometer (R Value) Results:	R =	50
Standard Deviation	S_o =	0.45
Loss in Serviceability	Δpsi =	2.0
Reliability	Reliability =	80
Reliability (z-statistic)	Z_R =	-0.84
Soil Resilient Modulus	M_R =	13168

Weighted Structural Number (WSN): → WSN = 2.10

DESIGN TABLES AND EQUATIONS

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

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

$k = M_R / 19.4$

Where:

M_R = resilient modulus (psi)

S_1 = the soil support value

R = R-value obtained from the Hveem stabilometer

CBR = California Bearing Ratio

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

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

Left	Right	Difference
5.47	5.47	0.0

Job No. 191650
Fig. No. C-1

DESIGN CALCULATIONS

DESIGN DATA CLASSIC COMMUNITIES - HANNAH RIDGE AT FEATHERGRASS, F7
LOCAL ROADS - SOIL TYPE 1

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

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

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

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

FOR FULL DEPTH ASPHALT SECTION (CURRENTLY NOT ALLOWED)

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

FOR ASPHALT + AGGREGATE BASECOURSE SECTION

Asphalt Thickness (t) = [3.5] inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 5.1 inches of Aggregate
Basecourse, use 8.0 inches

RECOMMENDED ALTERNATIVES

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

Job No. 191650
Fig. No. C-2

DESIGN CALCULATIONS

CEMENT TREATED SECTIONS - SOIL TYPE 1

DESIGN DATA: CLASSIC COMMUNITIES - HANNAH RIDGE AT FEATHERGRASS, F7
LOCAL RESIDENTIAL - SOIL TYPE 1

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

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

C_1 = 0.44 Strength Coefficient - Hot Bituminous Asphalt
C_2 = 0.12 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)

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

FOR ASPHALT + CEMENT TREATED SUBGRADE SECTION

Asphalt Thickness (t) = 4 inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 2.8 inches
Use 10.0 inches of Cement Treated Subgrade

RECOMMENDED ALTERNATIVES

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

Job No. 191650
Fig. No. C-3

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA — CLASSIC COMMUNITIES - HANNAH RIDGE AT FEATHERGRASS, F7
LOCAL ROADS - SOIL TYPE 2

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	292,000
Hveem Stabilometer (R Value) Results:	R =	6
Standard Deviation	S_o =	0.45
Loss in Serviceability	Δpsi =	2.0
Reliability	Reliability =	80
Reliability (z-statistic)	Z_R =	-0.84
Soil Resilient Modulus	M_R =	3126

Weighted Structural Number (WSN): → WSN = 3.56

DESIGN TABLES AND EQUATIONS

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

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

$k = M_R / 19.4$

Where:

M_R = resilient modulus (psi)

S_1 = the soil support value

R = R-value obtained from the Hveem stabilometer

CBR = California Bearing Ratio

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

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

Left	Right	Difference
5.47	5.47	0.0

Job No. 191650
Fig. No. C-4

DESIGN CALCULATIONS

DESIGN DATA CLASSIC COMMUNITIES - HANNAH RIDGE AT FEATHERGRASS, F7
LOCAL ROADS - SOIL TYPE 2

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	292,000
Hveem Stabilometer (R Value) Results:	R =	6
Weighted Structural Number (WSN):	WSN =	3.56

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 Basecourse

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

FOR FULL DEPTH ASPHALT SECTION (CURRENTLY NOT ALLOWED)

$D_1 = (WSN)/C_1$ = 8.1 inches of Full Depth Asphalt
Use 8.5 inches Full Depth

FOR ASPHALT + AGGREGATE BASECOURSE SECTION

Asphalt Thickness (t) = [5] inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 12.3 inches of Aggregate
Basecourse, use 12.5 inches

RECOMMENDED ALTERNATIVES

1. 5.0 inches of Asphalt + 12.5 inches of Aggregate Basecourse, or
2. 8.5 inches of Asphalt

Job No. 191650
Fig. No. C-5

DESIGN CALCULATIONS

CEMENT TREATED SECTIONS - SOIL TYPE 2

DESIGN DATA: CLASSIC COMMUNITIES - HANNAH RIDGE AT FEATHERGRASS, F7
LOCAL RESIDENTIAL - SOIL TYPE 2

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	292,000
Hveem Stabilometer (R Value) Results:	R =	6
Weighted Structural Number (WSN):	WSN =	3.56

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)

$D_1 = (WSN)/C_1$ = 8.1 inches of Full Depth Asphalt
Use 8.5 inches Full Depth

FOR ASPHALT + CEMENT TREATED SUBGRADE SECTION

Asphalt Thickness (t) = 5 inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 11.3 inches
Use 12.0 inches of Cement Treated Subgrade

RECOMMENDED ALTERNATIVES

1. 5.0 inches of Asphalt + 12 inches of Cement Treated Subgrade
2. 8.5 inches of Full Depth Asphalt

Job No. 191650
Fig. No. C-6