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**PAVEMENT DESIGN REPORT  
STERLING RANCH EAST, FILING NO. 1, PHASE A, PART 2  
EL PASO COUNTY, COLORADO**

**PCD File No. SF22035**

Prepared for:  
**Classic Communities  
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Colorado Springs, CO 80921**

Attn: Austin Lenz

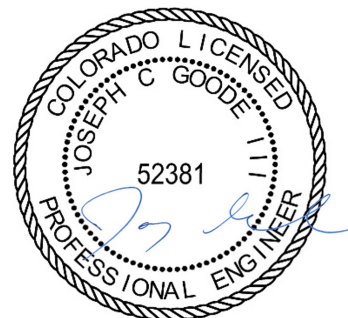
April 16, 2025  
Revised April 30, 2025

Respectfully Submitted,

ENTECH ENGINEERING, INC.

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Entech Job No. 240127

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## **1 Introduction**

Entech Engineering, Inc. (Entech) completed this pavement design report for roadways within Sterling Ranch East Filing No. 1, Phase A, Part 2. This revised report supersedes previous versions of the report. This report describes the subsurface exploration program and laboratory testing program conducted for the proposed roadway improvements and provides pavement section alternatives and construction recommendations. Entech participated in this project as a subconsultant to Classic Communities. The contents of this report, including the pavement design recommendations, are subject to the limitations and assumptions presented in Section 7.

## **2 Project Description**

The site is located east of Vollmer Road and north of Sterling Ranch Road within Sterling Ranch East Filing No. 1, Phase A, Part 2, in El Paso County, Colorado (Figure 1). The proposed improvements include paving portions of Santa Clara Place, Long Beach Terrace, Palo Alto Trail, and Newport Beach Drive within the proposed section of Sterling Ranch East, Filing No. 1. The extent of our investigation is shown in Figure 2.

At the time of our subsurface exploration program, the existing roadway was rough-graded and utilities had been installed. Surrounding properties comprise vacant land, land being developed for future residential lots, and an existing subdivision. Based on the development plans, the roadways are designated as urban local roadways.

## **3 Subsurface Explorations and Laboratory Testing**

### **3.1 Subsurface Exploration Program**

Subsurface conditions within Part 2 of the project site were explored by eight test borings, designated TB-10 through TB-17, drilled on February 28, 2025. Borings TB-1 through TB-9, completed for Part 1, were drilled on February 28, 2025, with the results presented in Entech's Pavement Design Report dated March 19, 2025. The locations of the test borings are shown on the Site and Exploration Plan (Figure 2). The borings were drilled to depths of 5 to 10 feet below the existing ground surface (bgs). The drilling was performed using a truck-mounted, continuous flight auger drill rig supplied and operated by Entech. Descriptive boring logs providing the lithologies of the subsurface conditions encountered during drilling are presented in Appendix A. Groundwater levels were measured in each of the open boreholes at the conclusion of drilling.

Soil and bedrock samples were obtained from the borings utilizing the Standard Penetration Test (ASTM D1586) using a split-barrel California sampler. Results of the Standard Penetration Test (SPT) are included on the boring logs in terms of N-values expressed in blows per foot (bpf). Soil and bedrock samples recovered from the borings were visually classified and recorded on the boring logs. The soil classifications were later verified utilizing laboratory testing and grouped by soil type. The soil type numbers are included on the boring logs. It should be understood that the soil descriptions shown on the boring logs may vary between boring locations and sample depths. It should also be noted that the lines of stratigraphic separation shown on the boring logs represent approximate boundaries between soil types and the actual stratigraphic transitions may be more gradual or variable with location.

### **3.2 Geotechnical Index and Engineering Property Testing**

Water content testing (ASTM D2216) was performed on the samples recovered from the borings, and the results are shown on the boring logs. Grain-Size Analysis (ASTM D422) and Atterberg Limits testing (ASTM D4318) were performed on selected samples to assist in classifying the materials encountered in the borings.

For pavement design, a modified proctor (ASTM D1557) and California Bearing Ratio (CBR) test (ASTM D1883) were completed. Soluble sulfate testing was performed on select soil samples to evaluate the potential for below-grade degradation of concrete due to sulfate attack. The laboratory testing results are presented in Appendix B and summarized in Table B-1.

Strength testing was performed on two sets of soil/cement composite samples from TB-4 within the adjacent Part 1 of Sterling Ranch East, Filing No. 1, Phase A. Testing was performed on soil samples prepared with 2% and 4% Portland Cement Type 1L. A compression strength of 125 pounds per square inch (psi) is recommended for cement-stabilized subgrade. The 5-day average strength value of the 2% mix was 127 psi, and the 5-day strength of the 4% mix was 195 psi. A 4% mix is recommended based on the laboratory test results. A summary of the testing results is attached in Appendix B, Table B-2.

## **4 Subgrade Conditions**

Two primary soil types and one bedrock type were encountered in the test borings drilled for the subsurface investigation. Each soil type was classified in accordance with the Unified Soil Classification System (USCS) and the American Association of State Highway and Transportation

Officials (AASHTO) soil classification system using the laboratory testing results and the observations made during drilling.

#### **4.1 Subsurface Conditions**

Subsurface conditions along the proposed roadways consisted of medium dense to dense clayey sand, silty sand, or sand with silt fill (Soil Type 1, SC, SM, SW-SM) and medium dense silty sand (Soil Type 2, SM). Very weak sandstone bedrock, or very dense clayey to silty sand when classified as a soil (Soil Type 3, SC-SM), was encountered in one of the test borings (TB-14) underlying Soil Type 1. Water-soluble sulfate tests indicated that the soils exhibit a negligible potential for sulfate attack.

Pavement subgrade soils generally consisted of Soil Type 1, which classified as AASHTO A-1-b, A-2-4, and A-4 soils. Soil Type 2 and Soil Type 3 classified as AASHTO A-1-b.

#### **4.2 Groundwater**

Groundwater was not encountered in the test borings. Groundwater fluctuations are possible and will depend on seasonal variations, local precipitation, runoff, and other factors; however, we do not anticipate groundwater to affect the proposed roadway construction.

### **5 Pavement Design Recommendations**

Pavement design recommendations were made in accordance with the *El Paso County Engineering Criteria Manual (ECM)*.

#### **5.1 Subgrade Conditions**

California Bearing Ratio (CBR) testing was performed on a representative sample of the Soil Type 1 silty sand fill from TB-11 to determine the support characteristics of the subgrade soils. The results of the CBR testing are presented in Appendix B and summarized in Exhibit 1.

**Exhibit 1: Subsurface Laboratory Testing Summary**

Design Parameter	Value
Soil Type	1 – Silty Sand
CBR at 95%	28.1
Design CBR	10
Liquid Limit	NV
Plasticity Index	NP
Percent Passing 200	23.4
AASHTO Classification	A-1-b
Unified Soils Classification	SM

**5.2 Swell Mitigation**

El Paso County requires swell mitigation for soils with swell testing results greater than 2% under a 150 pounds per square foot (psf) surcharge. Swell testing results are presented in Appendix B. Due to the granular nature of the pavement subgrade, swell testing of the majority of in-situ samples was not feasible. Based on the subgrade soils classification, mitigation will not be required on this site.

**5.3 Traffic Loading**

Traffic data is not available for the proposed roadways within Sterling Ranch East, Filing No. 1, Phase A, Part 2; however, the roadways are classified as urban local roadways based on current development plans. The *El Paso County Engineering Criteria Manual* provides default 18-kip equivalent single axle loadings (ESAL) based on the street classification. For design, a default ESAL value of 292,000 was used for the urban local road designation.

**5.4 Pavement Design**

The pavement sections were determined utilizing the *El Paso County Engineering Criteria Manual*, the CBR testing, and default ESALs. Design parameters used in the pavement analysis are presented in Exhibit 2.

### Exhibit 2: Pavement Design Parameters

Design Parameter	Value
Reliability	80%
Standard Deviation	0.45
Serviceability Loss ( $\Delta$ psi)	2.5
Design CBR	10
Resilient Modulus	15,000 psi
Structural Coefficients	
Hot Bituminous Pavement	0.44
Aggregate Base Course	0.11
Recycled Concrete Base	0.11
Cement Treated Soil	0.11

Pavement section alternatives recommended for the proposed roadways are summarized in Exhibit 3. The pavement design calculations are presented in Appendix C.

### Exhibit 3: Recommended Pavement Sections

Pavement Area	Design ESAL	Alternative <sup>1</sup>
Santa Clara Place, Long Beach Terrace, Palo Alto Trail, Newport Beach Drive	292,000	1. 4.0 inches HMA over 8.0 inches ABC/RCB
		2. 4.0 inches HMA over 8.0 inches CTS <sup>2</sup>

ABC = Aggregate Base Course; CTS = Cement Treated Soil; ESAL = Equivalent Single Axle Loads; HMA = Hot Mix Asphalt; RCB = Recycled Concrete Base

**Notes:**

1. All pavement alternatives meet the minimum sections required per the *El Paso County Engineering Criteria Manual*.
2. The use of CTS will require a deviation request approval.

## 6 Construction Recommendations

Pavement design recommendations provided herein are contingent on good construction practices, and poor construction techniques may result in poor performance. Our analyses assumed that this project would be constructed according to the *El Paso County Engineering Criteria Manual* and the *Pikes Peak Region Asphalt Paving Specifications*.

### 6.1 Earthwork Recommendations for Pavement Subgrade

Proper subgrade preparation is required for adequate pavement performance. Paving areas should be cleared of all deleterious materials, including but not limited to existing pavements, utility poles, and fence poles. Surface vegetation, if any, should be removed by stripping, with the depth to be field-determined.

### **6.1.1 Subgrade Preparation – Unbound Base Alternatives**

If pavement section alternatives are selected utilizing aggregate base course (ABC) or recycled concrete base (RCB), the final subgrade surface should be scarified to a depth of 8 inches, moisture conditioned within +/- 2% of the optimum water content, and recompact to 95% of the Modified Proctor (ASTM D1557) maximum dry density.

The compacted surface below pavements should be proof rolled with a fully loaded, tandem-axle, 10-yard dump truck or equivalent. Any areas that are delineated to be soft, loose, or yielding during proof rolling should be removed and reconditioned or replaced.

### **6.1.2 Subgrade Preparation – Cement Treated Base**

If pavement section alternatives are selected utilizing cement-treated soil (CTS), a preliminary proof roll should be completed with a fully loaded, tandem-axle, 10-yard dump truck or equivalent prior to placement of cement stabilization. Any areas that are delineated to be soft, loose, or yielding during proof rolling should be removed and reconditioned or replaced.

Following the preliminary proof roll, the subgrade shall be stabilized by the addition of cement. The amount of cement applied shall be a minimum of 4% (by weight) of the subgrade's maximum dry density as determined by the Modified Proctor (ASTM D1557) for granular soils or by the Standard Proctor (ASTM D698) for cohesive soils. The cement should be spread evenly on the subgrade surface and thoroughly mixed into the subgrade such that a uniform blend of soil and cement is achieved to the CTS design depth. Densification of the cement-stabilized subgrade should be completed to obtain a compaction of at least 95% of the subgrade's maximum dry density as determined by the Modified Proctor (ASTM D1557) or by the Standard Proctor (ASTM D698). 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 followed as part of the subgrade stabilization:

- Type I/II or Type 1L 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 degrees F. Cement-treated subgrades should be maintained at a temperature of 40 degrees 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 Entech Engineering. Testing should include in-situ compaction tests and representative compacted specimens of the treated subgrade material for subsequent laboratory quality assurance testing. Testing reports will be provided to El Paso County as construction progresses.
- A minimum 7-day CTS compressive strength of 125 psi must be achieved.
- Soil strengths in excess of 275 psi will require microfracturing. Microfracturing will be completed using the Standard Method as defined by the *City of Colorado Springs Draft Standard Specification*, Section 305 – Chemically Treated Subgrade. Microfracturing will be performed with the same (or equivalent tonnage) steel drum vibratory roller used for compaction of the CTS. A minimum 12-ton roller shall be used. Three full passes with the roller operating at maximum amplitude and traveling at 2- 3 mph shall be applied. If the treated material breaks up excessively at the surface, the vibration amplitude shall be decreased or eliminated.

### **6.1.3 Fill Placement and Compaction**

Granular fill placed as part of the pavement subgrade shall consist of nonexpansive, granular soil, free of organic matter, unsuitable materials, debris, and cobbles greater than 3 inches in diameter. Additionally, any granular fill placed as part of the roadway subgrade should have a minimum CBR of 10. All granular fill placed within the pavement subgrade should be compacted to a minimum of 95% of the Modified Proctor (ASTM D1557) maximum dry density at +/-2% of optimum moisture content. Fill material should be placed in horizontal lifts such that each finished lift has a compacted thickness of 6 inches or less. Entech should approve any imported fill to be used within the pavement subgrade area prior to delivery to the site.

### **6.1.4 Aggregate Base Course and Recycled Concrete Base**

ABC or RCB materials shall conform to the *El Paso County Standard Specifications Manual*, Appendix D, Table D-6. ABC or RCB materials should be compacted to a minimum of 95% of the Modified Proctor (ASTM D1557) maximum dry density within +/-2% of optimum moisture content.

## 6.2 Concrete Degradation Due to Sulfate Attack

Sulfate solubility testing was conducted on several samples recovered from the test borings to evaluate the potential for sulfate attack on concrete. The test results indicated less than 0.01% soluble sulfate (by weight). The test results indicate the sulfate component of the in-place soils presents a negligible to severe exposure threat to concrete placed below the site grade.

As presented in the *Evaluation of Selected Pavement Specifications and Responses to Questions Relevant to Design and Construction of Cement-Treated Soil and Aggregate Layers in El Paso County, Colorado* report from Spencer Guthrie and Robert Stevens dated March 13, 2024, soils with less than 3,000 ppm (0.3%) do not require special construction practices.

## 6.3 Construction Observation

Subgrade preparation for pavement structures should be observed by Entech in order to verify that (1) no anomalies are present, (2) materials similar to those described in this report have been encountered or placed, and (3) no soft spots, expansive or organic soil, or debris are present in the pavement subgrade prior to paving. Construction observation requirements, as presented in the Use of CTS for Paving Season Memorandum, should be followed.

## 7 Closure

The subsurface investigation, geotechnical evaluation, and recommendations presented in this report are intended for use by Classic Communities with application to the paving of Santa Clara Place, Westmont Drive, Palo Alto Trail, and San Diego Way within Sterling Ranch East, Filing No. 1, Phase A, Part 2, in El Paso County, Colorado. In conducting the subsurface investigation, laboratory testing, engineering evaluation, and reporting, Entech Engineering, Inc. endeavored to work in accordance with generally accepted professional geotechnical and geologic practices and principles consistent with the level of care and skill ordinarily exercised by members of the geotechnical profession currently practicing in the same locality and under similar conditions. No other warranty, expressed or implied, is made. During final design and/or construction, if conditions are encountered that appear different from those described in this report, Entech Engineering, Inc. requests to be notified so that the evaluation and recommendations presented herein can be reviewed and modified as appropriate.

If there are any questions regarding the information provided herein, or if Entech Engineering, Inc. can be of further assistance, please do not hesitate to contact us.



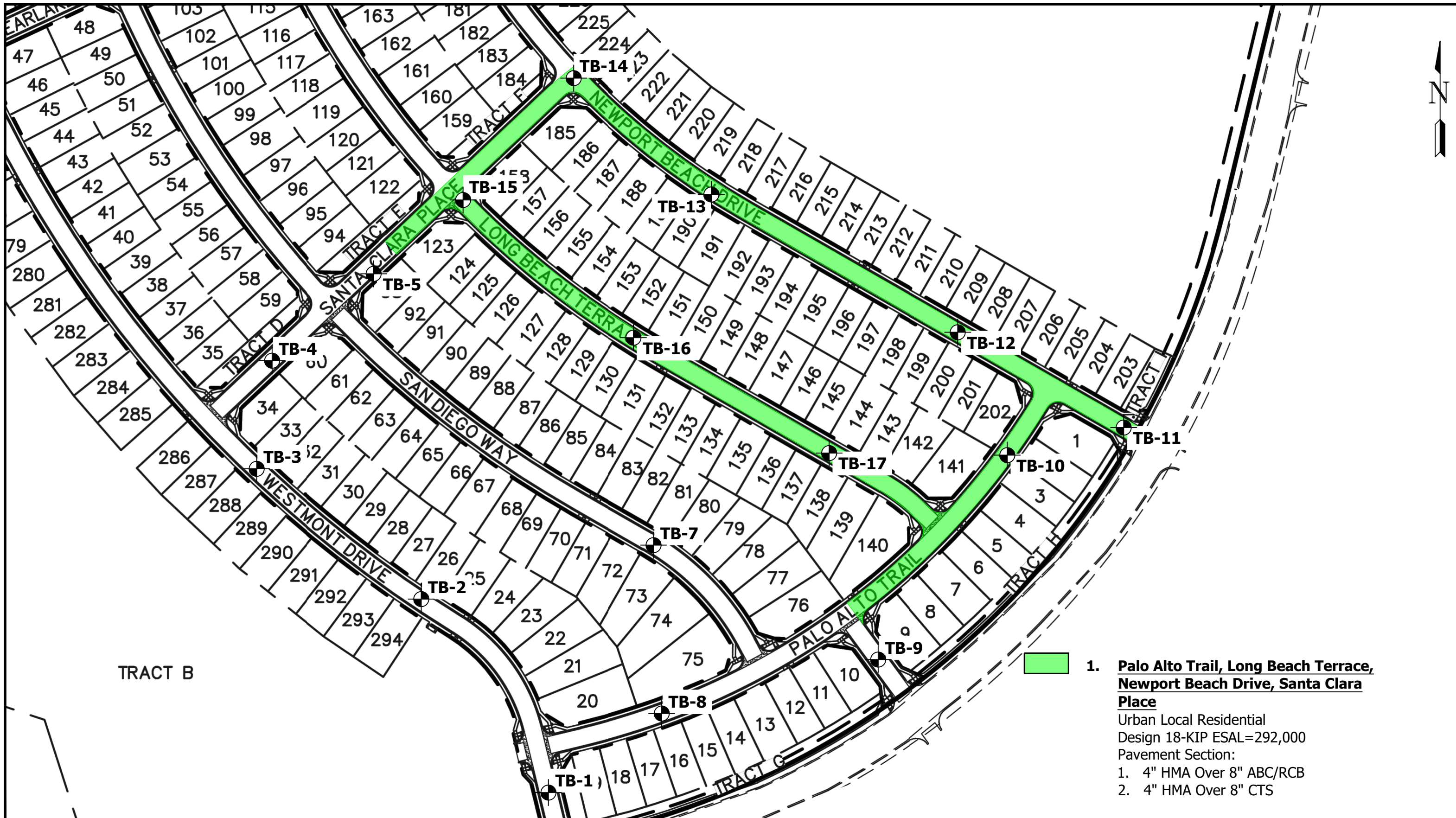


**VICINITY MAP**  
STERLING RANCH EAST F1, PHASE A, PART 2  
CLASSIC COMMUNITIES

JOB NO.  
240127

**FIG. 1**





BORING TB-1 THROUGH TB-9 ARE PRESENTED IN THE PART 1 REPORT

 **TB- APPROXIMATE TEST BORING LOCATION AND NUMBER**

SCALE: 0 50 100



**SITE AND EXPLORATION PLAN**  
STERLING RANCH EAST F1, PHASE A, PART 2  
CLASSIC COMMUNITIES

JOB NO.  
240127  
**FIG. 2**



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

TEST BORING 10  
 DATE DRILLED 3/13/2025  
 REMARKS

DRY TO 5', 3/13/25

FILL 0-5', SAND, SILTY, BROWN,  
 MEDIUM DENSE, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			14	7.9	1
5			17	6.7	1
10					
15					
20					

TEST BORING 11  
 DATE DRILLED 3/13/2025  
 REMARKS

DRY TO 10', 3/13/25

FILL 0-6', SAND, SILTY, BROWN,  
 MEDIUM DENSE, MOIST

SAND, SILTY, BROWN, MEDIUM  
 DENSE, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			10	7.9	1
5			24	10.2	1
10			24	10.0	2
15					
20					



## TEST BORING LOGS

STERLING RANCH EAST F1, PHASE A, PART 2  
 CLASSIC COMMUNITIES

JOB NO.  
 240127

**FIG. A-1**

TEST BORING 12  
DATE DRILLED 3/13/2025  
REMARKS

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 3/13/25						
FILL 0-5', SAND, SILTY, BROWN, MEDIUM DENSE, MOIST				18	7.9	1
	5			24	5.9	1
	10					
	15					
	20					

TEST BORING 13  
DATE DRILLED 3/13/2025  
REMARKS

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 3/13/25						
FILL 0-4', SAND, SILTY, BROWN, MEDIUM DENSE, MOIST				21	12.3	1
SAND, SILTY, MEDIUM DENSE, BROWN, MOIST	5			27	11.3	2
	10					
	15					
	20					



**TEST BORING LOGS**  
STERLING RANCH EAST F1, PHASE A, PART 2  
CLASSIC COMMUNITIES

JOB NO.  
240127

**FIG. A-2**

TEST BORING 14  
DATE DRILLED 3/13/2025  
REMARKS

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 3/13/25					
FILL 0-3', SAND, SILTY, BROWN, MEDIUM DENSE, MOIST			28	8.4	1
SANDSTONE, VERY WEAK, BROWN, HIGHLY WEATHERED (SAND, CLAYEY-SILTY, VERY DENSE, MOIST)			50 11"	6.8	3
5					
10					
15					
20					

TEST BORING 15  
DATE DRILLED 3/13/2025  
REMARKS

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 10', 3/13/25					
FILL 0-7', SAND, CLAYEY, BROWN, MEDIUM DENSE, MOIST			20	7.8	1
FILL, SAND, SILTY, BROWN, DENSE, MOIST			32	9.4	1
SAND, SILTY, TAN, DENSE, MOIST			38	8.1	2
5					
10					
15					
20					



**TEST BORING LOGS**  
STERLING RANCH EAST F1, PHASE A, PART 2  
CLASSIC COMMUNITIES

JOB NO.  
240127

**FIG. A-3**



TEST BORING 16  
 DATE DRILLED 3/13/2025  
 REMARKS

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 3/13/25						
FILL 0-5', SAND, CLAYEY, BROWN, MEDIUM DENSE, MOIST				18	8.4	1
	5			29	11.7	1
	10					
	15					
	20					

TEST BORING 17  
 DATE DRILLED 3/13/2025  
 REMARKS

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 3/13/25						
FILL 0-5', SAND, WITH SILT, BROWN, MEDIUM DENSE to DENSE, MOIST				15	9.1	1
	5			33	9.2	1
	10					
	15					
	20					



**TEST BORING LOGS**  
 STERLING RANCH EAST F1, PHASE A, PART 2  
 CLASSIC COMMUNITIES

JOB NO.  
 240127

**FIG. A-4**



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

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



SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX	SULFATE (WT %)	SWELL/ COLLAPSE (%)	AASHTO CLASS. (GROUP INDEX)	USCS	SOIL DESCRIPTION
1, CBR	11	0-3	6.9	123.9	23.4	NV	NP	NP			A-1-b (0)	SM	FILL, SAND, SILTY
1	13	0-3	6.3		25.9							SM	FILL, SAND, SILTY
1	17	0-3	6.6		22.6							SM	FILL, SAND, SILTY
1	10	1-2	7.9		12.8	NV	NP	NP	<0.01		A-1-b (0)	SM	FILL, SAND, SILTY
1	11	1-2	7.9		16.8	NV	NP	NP			A-1-b (0)	SM	FILL, SAND, SILTY
1	12	1-2	7.9		13.8	23	20	3			A-1-b (0)	SM	FILL, SAND, SILTY
1	13	1-2	13.4	116.8	34.3	29	23	6	<0.01	0.2	A-2-4 (0)	SM	FILL, SAND, SILTY
1	14	1-2	8.4		13.9	30	22	8			A-2-4 (0)	SC	FILL, SAND, CLAYEY
1	15	1-2	7.8		35.3	28	20	8			A-4 (0)	SC	FILL, SAND, CLAYEY
1	16	1-2	8.4		26.3	30	21	9			A-2-4 (0)	SC	FILL, SAND, CLAYEY
1	17	1-2	9.1		6.7	NV	NP	NP	<0.01		A-1-b (0)	SW-SM	FILL, SAND, WITH SILT
1	11	5	11.5	117.2	13.2	32	24	8		-0.5	A-1-b (0)	SM	FILL, SAND, SILTY
1	15	5	9.4		15.5	NV	NP	NP	<0.01		A-1-b (0)	SM	FILL, SAND, SILTY
2	13	5	11.3		21.2	NV	NP	NP			A-1-b (0)	SM	SAND, SILTY
3	14	5	6.8		16.6	26	21	5	<0.01		A-1-b (0)	SC-SM	SANDSTONE (SAND, CLAYEY-SILTY)

**TABLE B-2**  
**SUMMARY OF CTS TEST RESULTS**

FIELD SAMPLE ID	SOIL ADDITIVE	ADDITIVE PERCENTAGE (%)	WATER CONTENT (%)	DENSITY (dry)	AGE (days)	STRENGTH (psi)
TB-4 @ 0-3'	TYPE IL CEMENT	2	9.5	127.9	6	126
				127.8		125
				127.5		129
AVERAGE:						127
TB-4 @ 0-3'	TYPE IL CEMENT	4	9.5	128.1	6	204
				127.8		185
				128.0		197
AVERAGE:						195

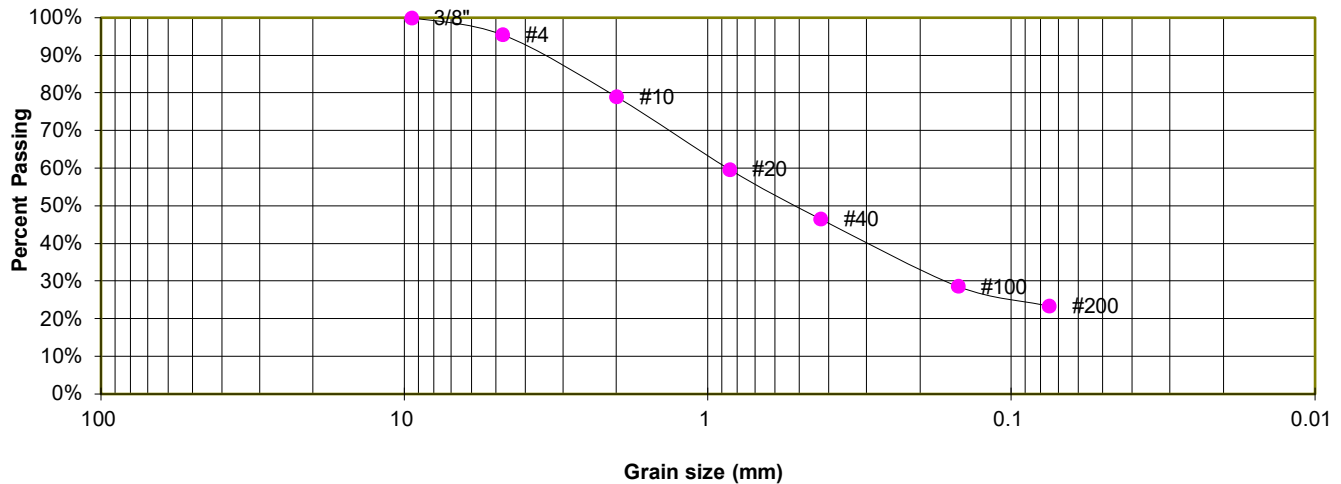
Notes:

1. CURING METHOD: 100° HUMIDIFIED OVEN

TEST BORING 11  
DEPTH (FT) 0-3

SOIL DESCRIPTION FILL, SAND, SILTY  
SOIL TYPE 1, CBR

### Sieve Analysis Grain Size Distribution



#### GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	95.5%
10	79.0%
20	59.8%
40	46.5%
100	28.7%
200	23.4%

#### ATTERBERG LIMITS

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

#### SOIL CLASSIFICATION

USCS CLASSIFICATION: SM  
AASHTO CLASSIFICATION: A-1-b  
AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**  
STERLING RANCH EAST F1, PHASE A, PART 2  
CLASSIC COMMUNITIES

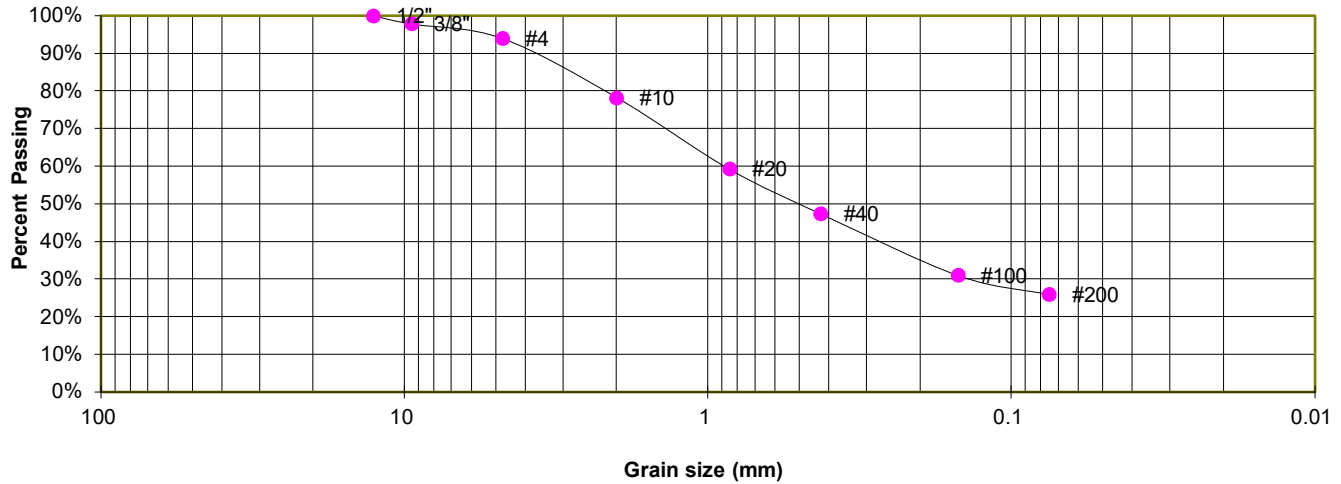
JOB NO.  
240127

**FIG. B-1**

TEST BORING 13  
DEPTH (FT) 0-3

SOIL DESCRIPTION FILL, SAND, SILTY  
SOIL TYPE 1

### Sieve Analysis Grain Size Distribution



#### GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	97.9%
4	94.0%
10	78.2%
20	59.3%
40	47.4%
100	31.1%
200	25.9%

#### SOIL CLASSIFICATION

USCS CLASSIFICATION: SM  
AASHTO CLASSIFICATION:  
AASHTO GROUP INDEX:



**LABORATORY TEST RESULTS**  
STERLING RANCH EAST F1, PHASE A, PART 2  
CLASSIC COMMUNITIES

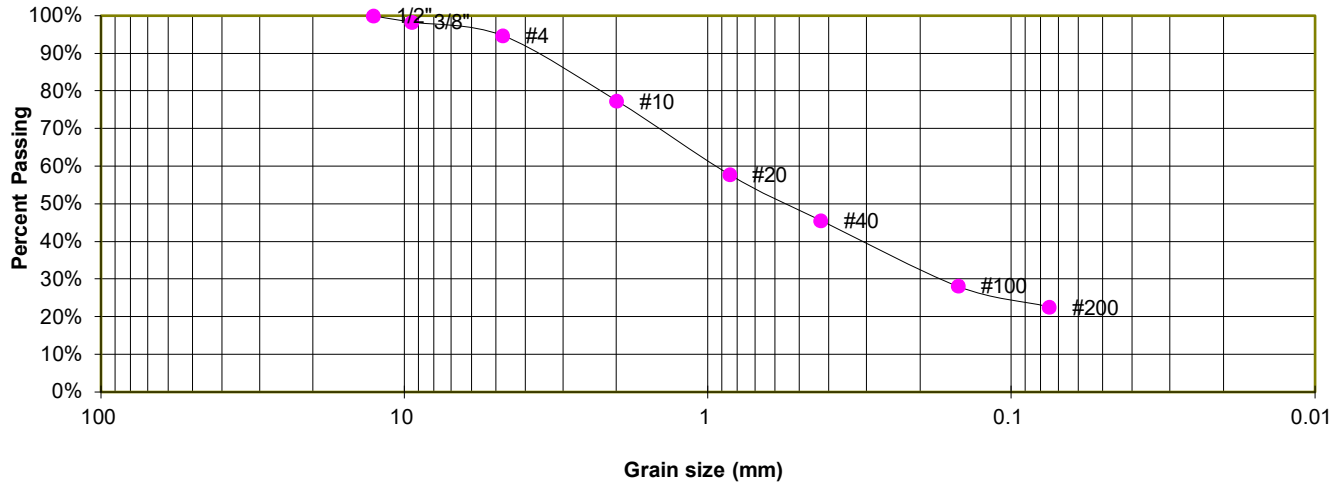
JOB NO.  
240127

**FIG. B-2**

TEST BORING 17  
DEPTH (FT) 0-3

SOIL DESCRIPTION FILL, SAND, SILTY  
SOIL TYPE 1

### Sieve Analysis Grain Size Distribution



#### GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	98.3%
4	94.7%
10	57.8%
20	45.6%
40	28.2%
100	22.6%
200	22.6%

#### SOIL CLASSIFICATION

USCS CLASSIFICATION: SM  
AASHTO CLASSIFICATION:  
AASHTO GROUP INDEX:



**LABORATORY TEST RESULTS**  
STERLING RANCH EAST F1, PHASE A, PART 2  
CLASSIC COMMUNITIES

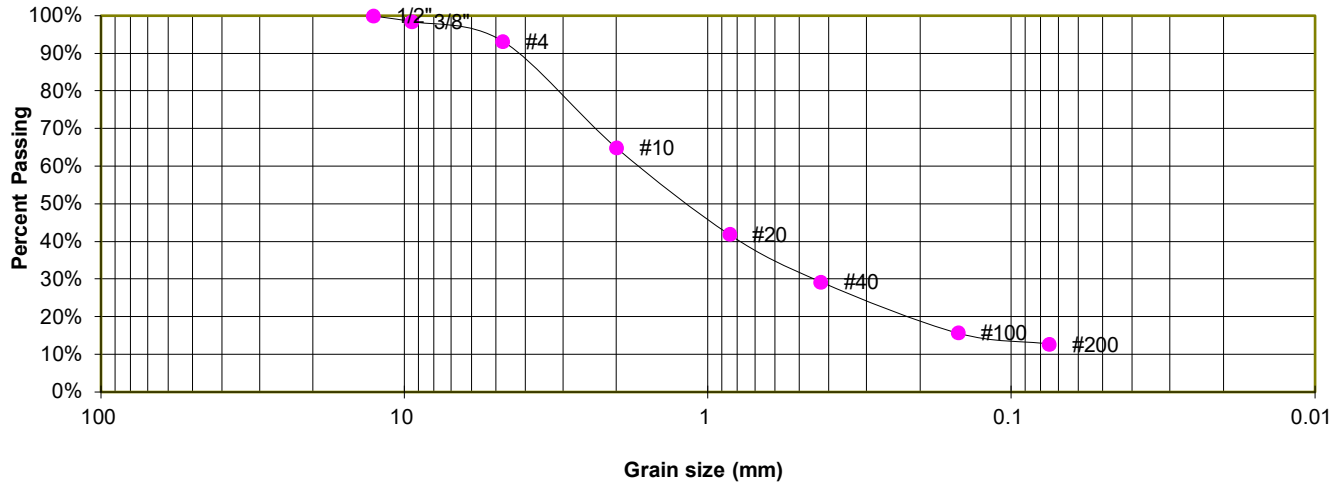
JOB NO.  
240127

**FIG. B-3**

TEST BORING 10  
DEPTH (FT) 1-2

SOIL DESCRIPTION FILL, SAND, SILTY  
SOIL TYPE 1

### Sieve Analysis Grain Size Distribution



#### GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	98.4%
4	93.2%
10	64.9%
20	41.9%
40	29.3%
100	15.7%
200	12.8%

#### ATTERBERG LIMITS

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

#### SOIL CLASSIFICATION

USCS CLASSIFICATION: SM  
AASHTO CLASSIFICATION: A-1-b  
AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**  
STERLING RANCH EAST F1, PHASE A, PART 2  
CLASSIC COMMUNITIES

JOB NO.  
240127

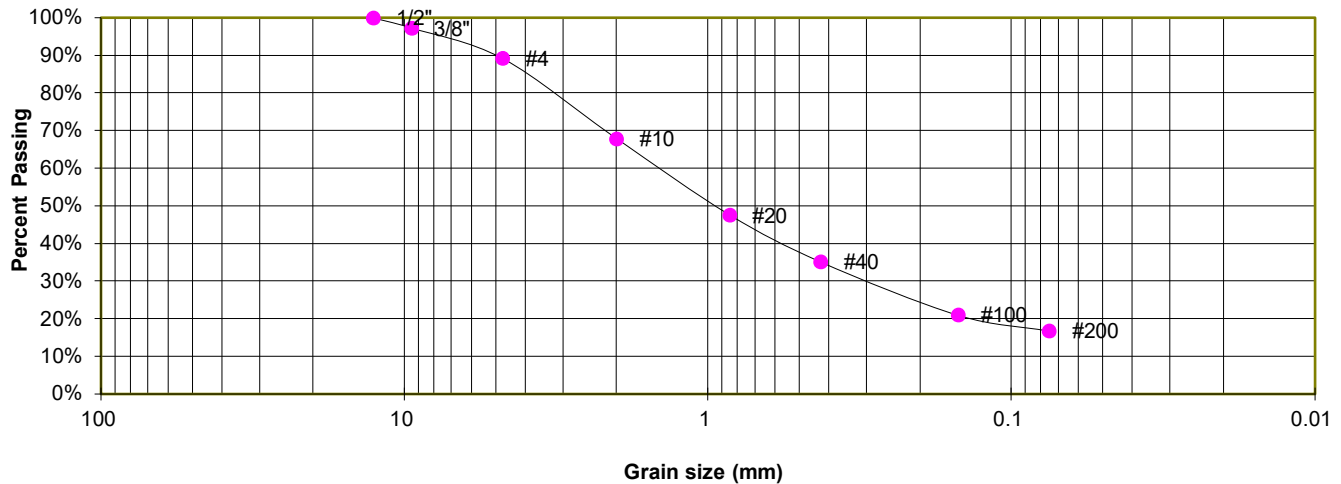
**FIG. B-4**



TEST BORING	11
DEPTH (FT)	1-2

SOIL DESCRIPTION FILL, SAND, SILTY
SOIL TYPE 1

### Sieve Analysis Grain Size Distribution



#### GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	97.3%
4	89.3%
10	67.8%
20	47.6%
40	35.2%
100	21.1%
200	16.8%

#### ATTERBERG LIMITS

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

#### SOIL CLASSIFICATION

USCS CLASSIFICATION: SM  
AASHTO CLASSIFICATION: A-1-b  
AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**  
STERLING RANCH EAST F1, PHASE A, PART 2  
CLASSIC COMMUNITIES

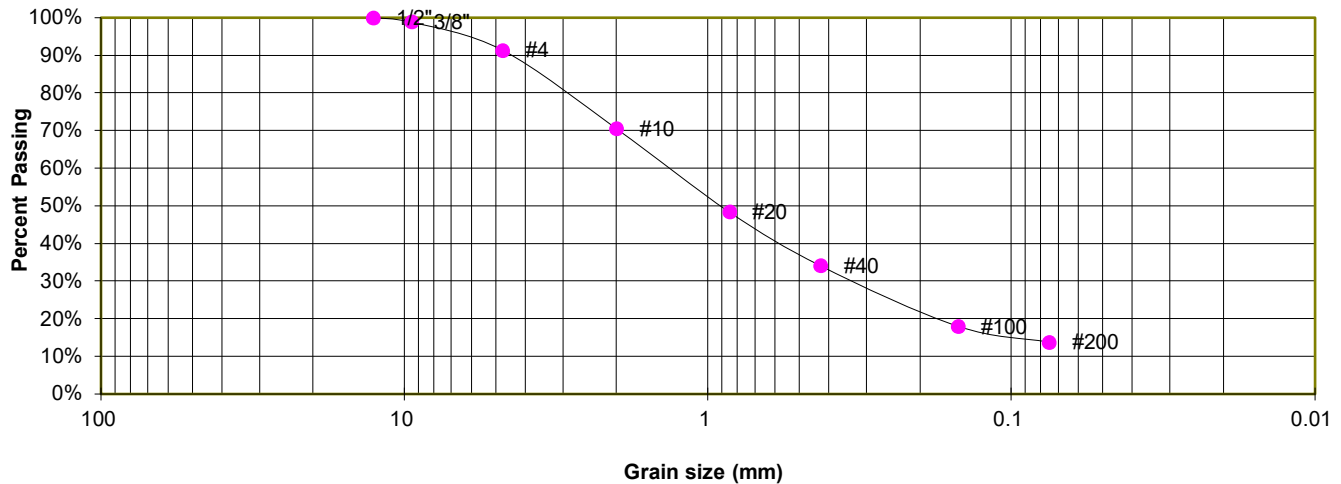
JOB NO.  
240127

**FIG. B-5**

TEST BORING	12
DEPTH (FT)	1-2

SOIL DESCRIPTION FILL, SAND, SILTY
SOIL TYPE 1

### Sieve Analysis Grain Size Distribution



#### GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	98.9%
4	91.4%
10	70.5%
20	48.4%
40	34.1%
100	18.0%
200	13.8%

#### ATTERBERG LIMITS

Plastic Limit	20
Liquid Limit	23
Plastic Index	3

#### SOIL CLASSIFICATION

USCS CLASSIFICATION:	SM
AASHTO CLASSIFICATION:	A-1-b
AASHTO GROUP INDEX:	0



**LABORATORY TEST RESULTS**  
STERLING RANCH EAST F1, PHASE A, PART 2  
CLASSIC COMMUNITIES

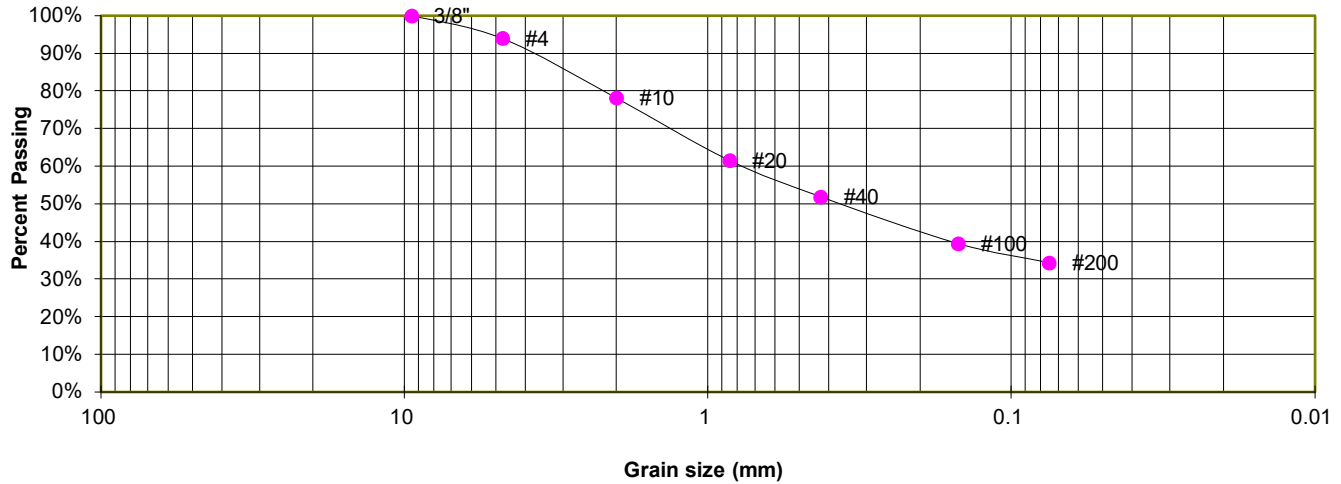
JOB NO.  
240127

**FIG. B-6**

TEST BORING 13  
DEPTH (FT) 1-2

SOIL DESCRIPTION FILL, SAND, SILTY  
SOIL TYPE 1

### Sieve Analysis Grain Size Distribution



#### GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	94.0%
10	78.1%
20	61.6%
40	51.9%
100	39.5%
200	34.3%

#### ATTERBERG LIMITS

Plastic Limit	23
Liquid Limit	29
Plastic Index	6

#### SOIL CLASSIFICATION

USCS CLASSIFICATION: SM  
AASHTO CLASSIFICATION: A-2-4  
AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**  
STERLING RANCH EAST F1, PHASE A, PART 2  
CLASSIC COMMUNITIES

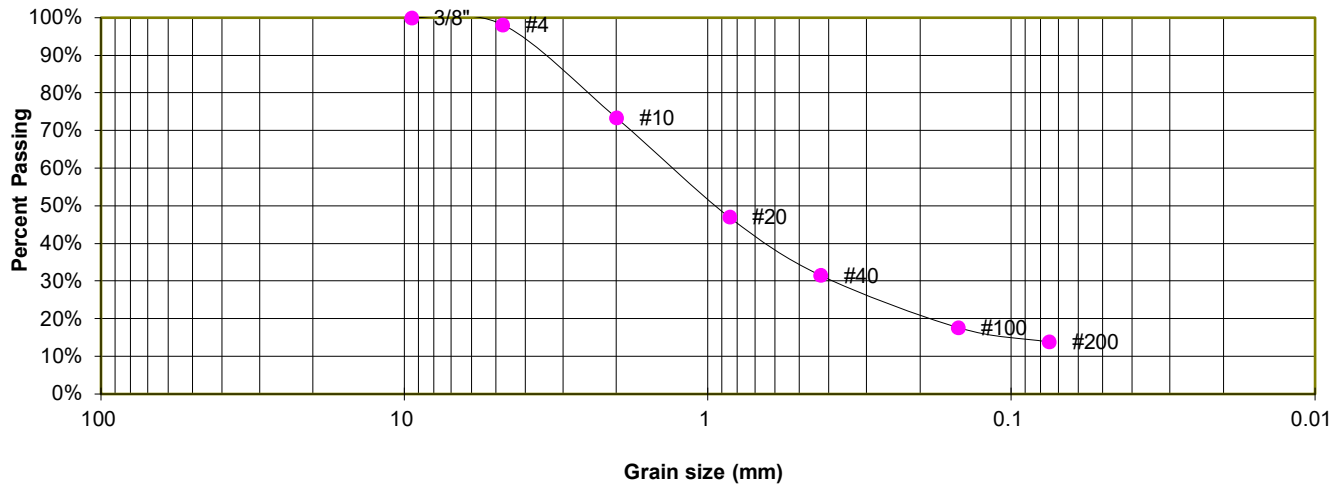
JOB NO.  
240127

**FIG. B-7**

TEST BORING	14
DEPTH (FT)	1-2

SOIL DESCRIPTION FILL, SAND, CLAYEY
SOIL TYPE 1

### Sieve Analysis Grain Size Distribution



#### GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.2%
10	73.4%
20	47.1%
40	31.6%
100	17.7%
200	13.9%

#### ATTERBERG LIMITS

Plastic Limit	22
Liquid Limit	30
Plastic Index	8

#### SOIL CLASSIFICATION

USCS CLASSIFICATION: SC  
AASHTO CLASSIFICATION: A-2-4  
AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**  
STERLING RANCH EAST F1, PHASE A, PART 2  
CLASSIC COMMUNITIES

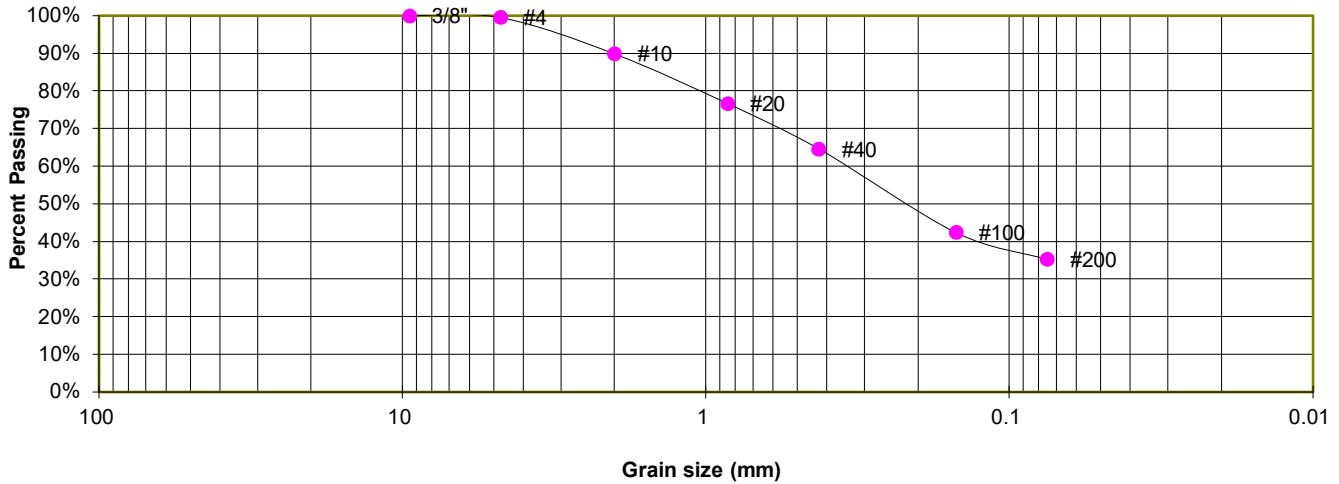
JOB NO.  
240127

**FIG. B-8**

TEST BORING 15  
DEPTH (FT) 1-2

SOIL DESCRIPTION FILL, SAND, CLAYEY  
SOIL TYPE 1

### Sieve Analysis Grain Size Distribution



#### GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.6%
10	89.9%
20	76.7%
40	64.6%
100	42.5%
200	35.3%

#### ATTERBERG LIMITS

Plastic Limit	20
Liquid Limit	28
Plastic Index	8

#### SOIL CLASSIFICATION

USCS CLASSIFICATION: SC  
AASHTO CLASSIFICATION: A-4  
AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**  
STERLING RANCH EAST F1, PHASE A, PART 2  
CLASSIC COMMUNITIES

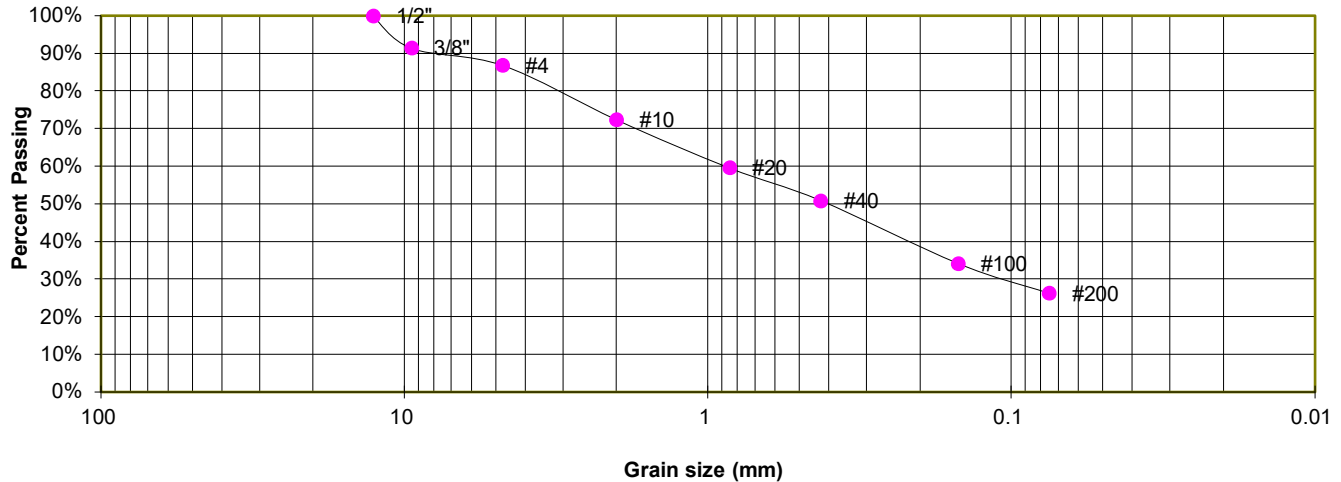
JOB NO.  
240127

**FIG. B-9**

TEST BORING	16
DEPTH (FT)	1-2

SOIL DESCRIPTION FILL, SAND, CLAYEY
SOIL TYPE 1

### Sieve Analysis Grain Size Distribution



#### GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	91.4%
4	86.8%
10	72.3%
20	59.6%
40	50.9%
100	34.2%
200	26.3%

#### ATTERBERG LIMITS

Plastic Limit	21
Liquid Limit	30
Plastic Index	9

#### SOIL CLASSIFICATION

USCS CLASSIFICATION: SC  
AASHTO CLASSIFICATION: A-2-4  
AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**  
STERLING RANCH EAST F1, PHASE A, PART 2  
CLASSIC COMMUNITIES

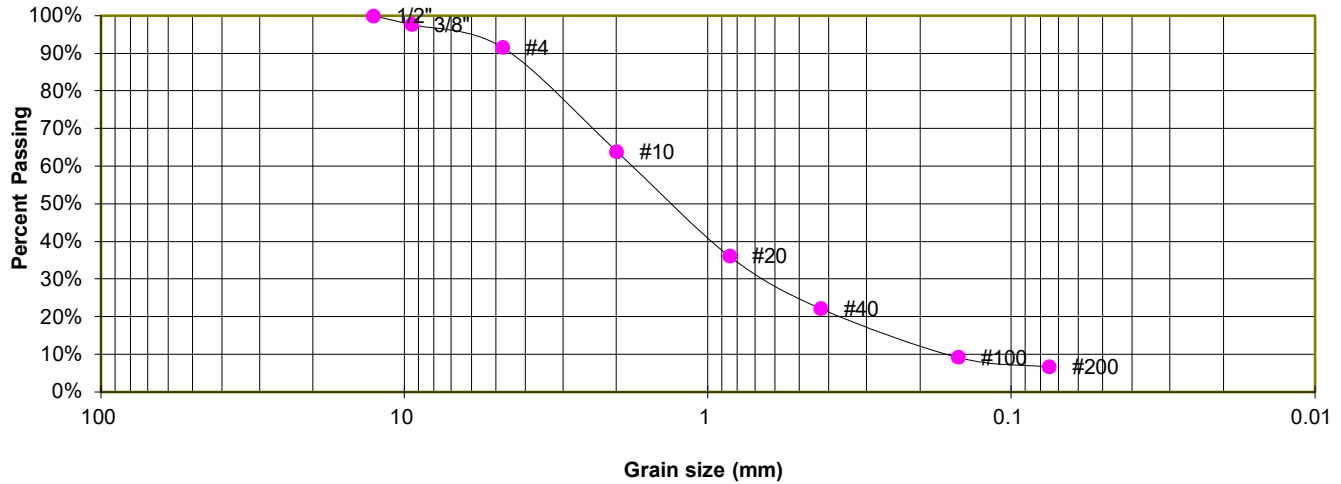
JOB NO.  
240127

**FIG. B-10**

TEST BORING 17  
DEPTH (FT) 1-2

SOIL DESCRIPTION FILL, SAND, WITH SILT  
SOIL TYPE 1

### Sieve Analysis Grain Size Distribution



#### GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	97.7%
4	91.6%
10	63.9%
20	36.2%
40	22.2%
100	9.3%
200	6.7%

#### ATTERBERG LIMITS

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

#### SOIL CLASSIFICATION

USCS CLASSIFICATION: SW-SM  
AASHTO CLASSIFICATION: A-1-b  
AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**  
STERLING RANCH EAST F1, PHASE A, PART 2  
CLASSIC COMMUNITIES

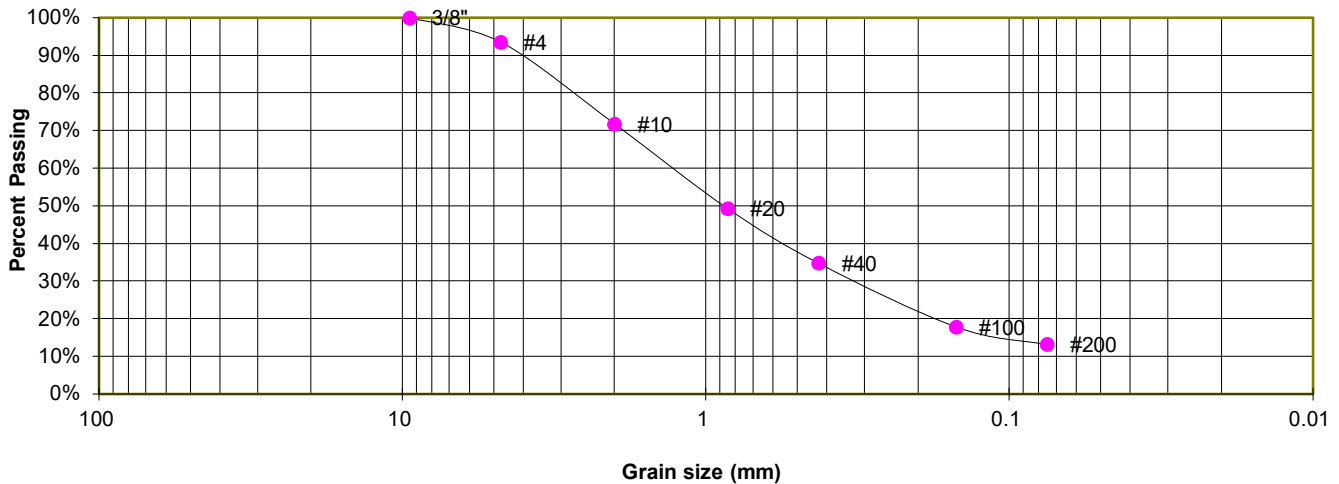
JOB NO.  
240127

**FIG. B-11**

TEST BORING 11  
DEPTH (FT) 5

SOIL DESCRIPTION FILL, SAND, SILTY  
SOIL TYPE 1

### Sieve Analysis Grain Size Distribution



#### GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	93.6%
10	71.8%
20	49.3%
40	34.8%
100	17.8%
200	13.2%

#### ATTERBERG LIMITS

Plastic Limit	24
Liquid Limit	32
Plastic Index	8

#### SOIL CLASSIFICATION

USCS CLASSIFICATION: SM  
AASHTO CLASSIFICATION: A-1-b  
AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**  
STERLING RANCH EAST F1, PHASE A, PART 2  
CLASSIC COMMUNITIES

JOB NO.  
240127

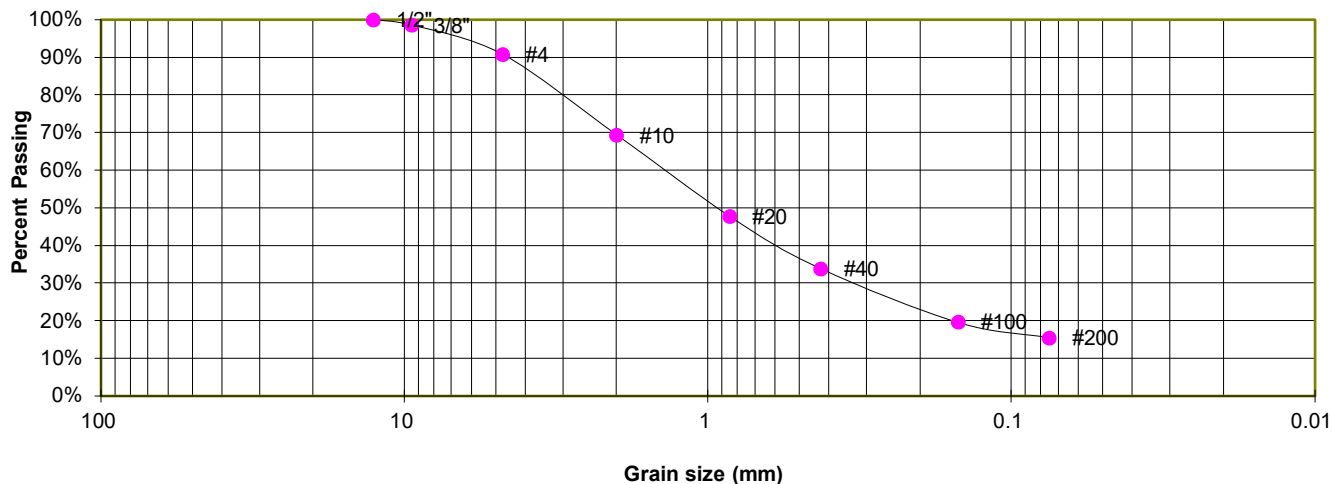
**FIG. B-12**



TEST BORING	15
DEPTH (FT)	5

SOIL DESCRIPTION FILL, SAND, SILTY
SOIL TYPE 1

### Sieve Analysis Grain Size Distribution



#### GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	98.6%
4	90.8%
10	69.4%
20	47.8%
40	33.9%
100	19.6%
200	15.5%

#### ATTERBERG LIMITS

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

#### SOIL CLASSIFICATION

USCS CLASSIFICATION: SM  
AASHTO CLASSIFICATION: A-1-b  
AASHTO GROUP INDEX: 0



**LABORATORY TEST RESULTS**  
STERLING RANCH EAST F1, PHASE A, PART 2  
CLASSIC COMMUNITIES

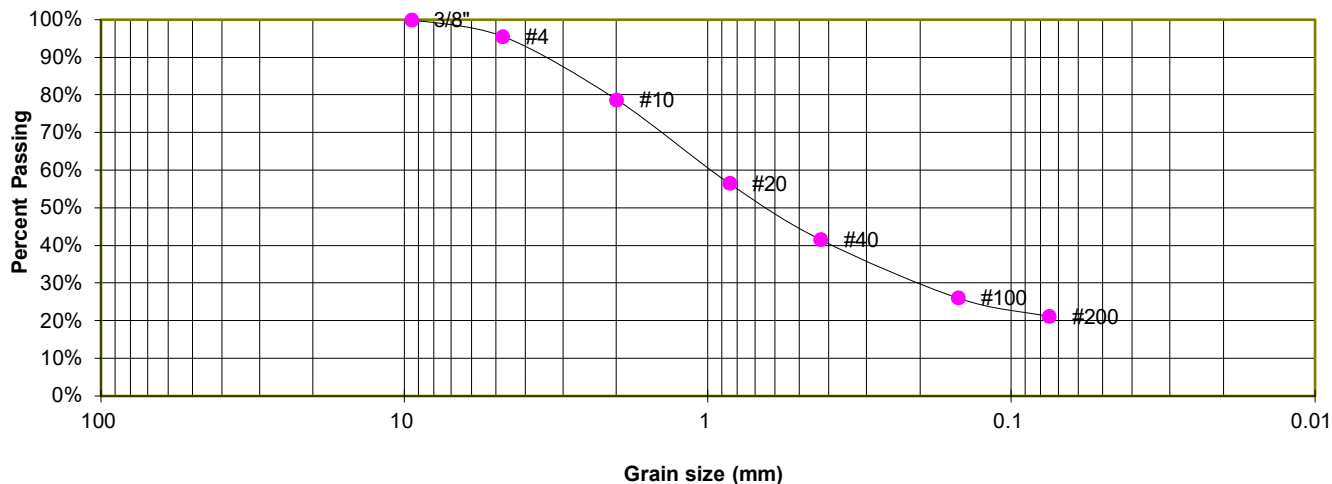
JOB NO.  
240127

**FIG. B-13**

TEST BORING 13  
DEPTH (FT) 5

SOIL DESCRIPTION SAND, SILTY  
SOIL TYPE 2

### Sieve Analysis Grain Size Distribution



#### GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	95.6%
10	78.7%
20	56.5%
40	41.6%
100	26.1%
200	21.2%

#### ATTERBERG LIMITS

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

#### SOIL CLASSIFICATION

USCS CLASSIFICATION: SM  
AASHTO CLASSIFICATION: A-1-b  
AASHTO GROUP INDEX: 0

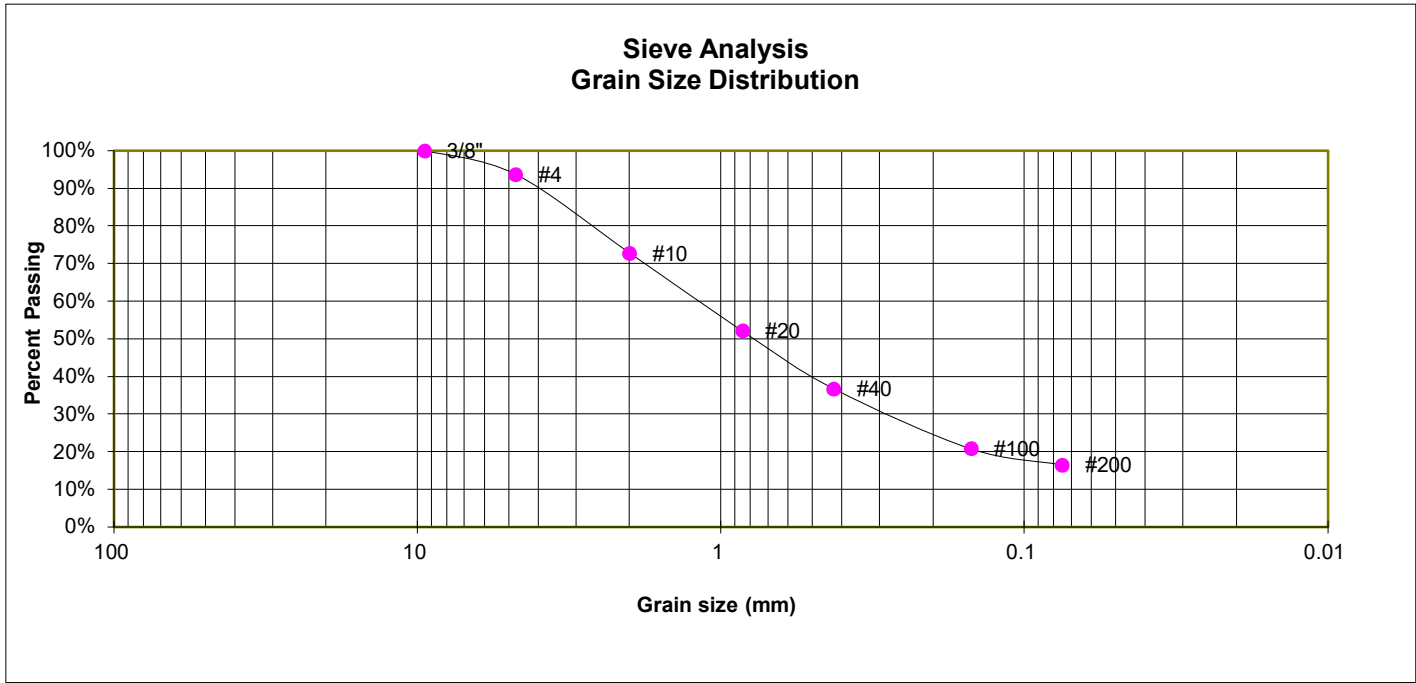


**LABORATORY TEST RESULTS**  
STERLING RANCH EAST F1, PHASE A, PART 2  
CLASSIC COMMUNITIES

JOB NO.  
240127

**FIG. B-14**

TEST BORING	14	SOIL DESCRIPTION	SANDSTONE (SAND, CLAYEY-SILTY)
DEPTH (FT)	5	SOIL TYPE	3



**GRAIN SIZE ANALYSIS**

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	93.7%
10	72.8%
20	52.2%
40	36.7%
100	20.9%
200	16.6%

**ATTERBERG LIMITS**

Plastic Limit	21
Liquid Limit	26
Plastic Index	5

**SOIL CLASSIFICATION**

USCS CLASSIFICATION: SC-SM  
AASHTO CLASSIFICATION: A-1-b  
AASHTO GROUP INDEX: 0



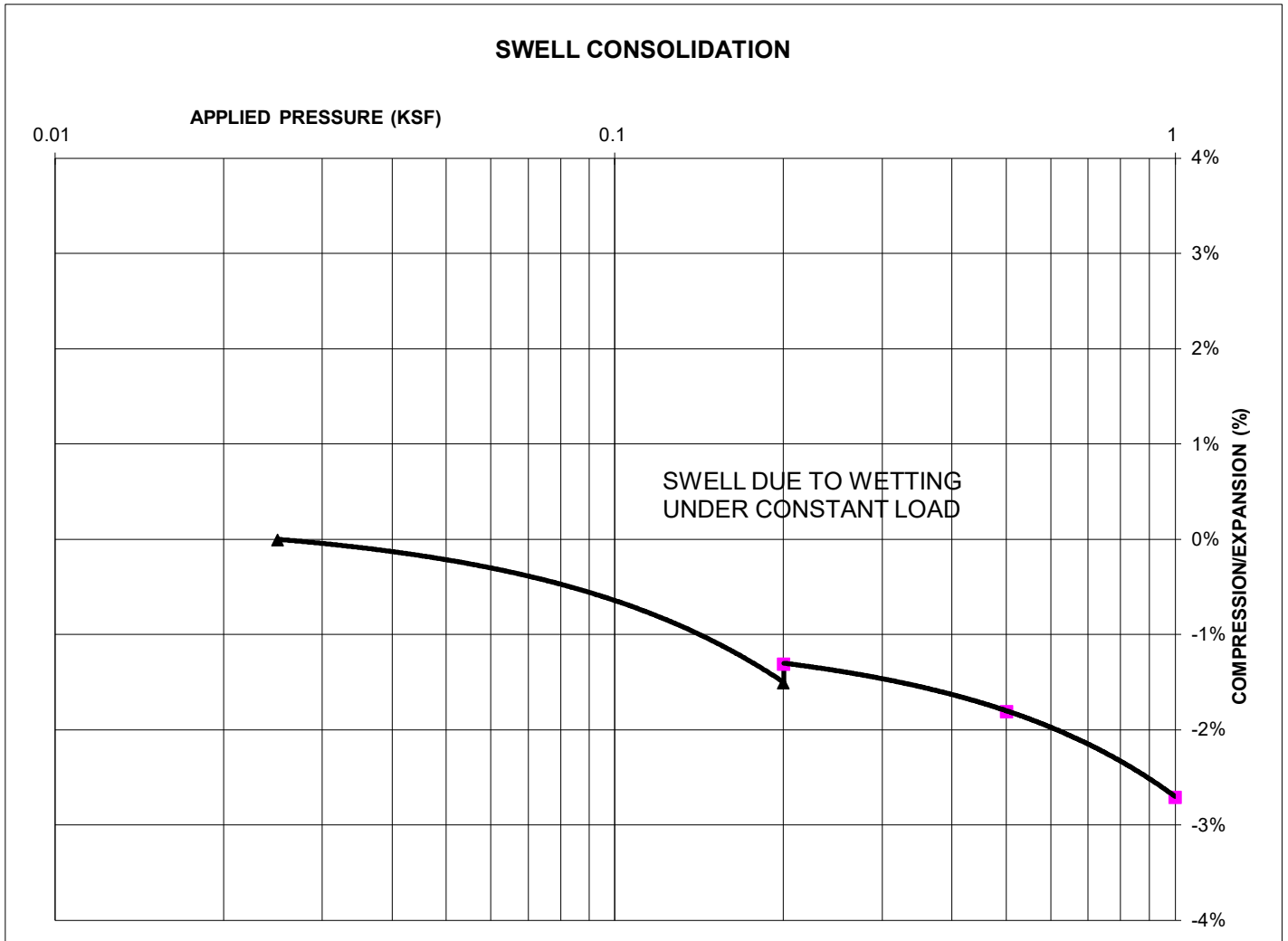
**LABORATORY TEST RESULTS**  
STERLING RANCH EAST F1, PHASE A, PART 2  
CLASSIC COMMUNITIES

JOB NO.  
240127

**FIG. B-15**

TEST BORING 13  
DEPTH (FT) 1-2

SOIL DESCRIPTION FILL, SAND, SILTY  
SOIL TYPE 1



**SWELL/COLLAPSE TEST RESULTS**

NATURAL UNIT DRY WEIGHT (PCF): 117  
NATURAL MOISTURE CONTENT: 13.4%  
SWELL/COLLAPSE (%): 0.2%



**SWELL TEST RESULTS**

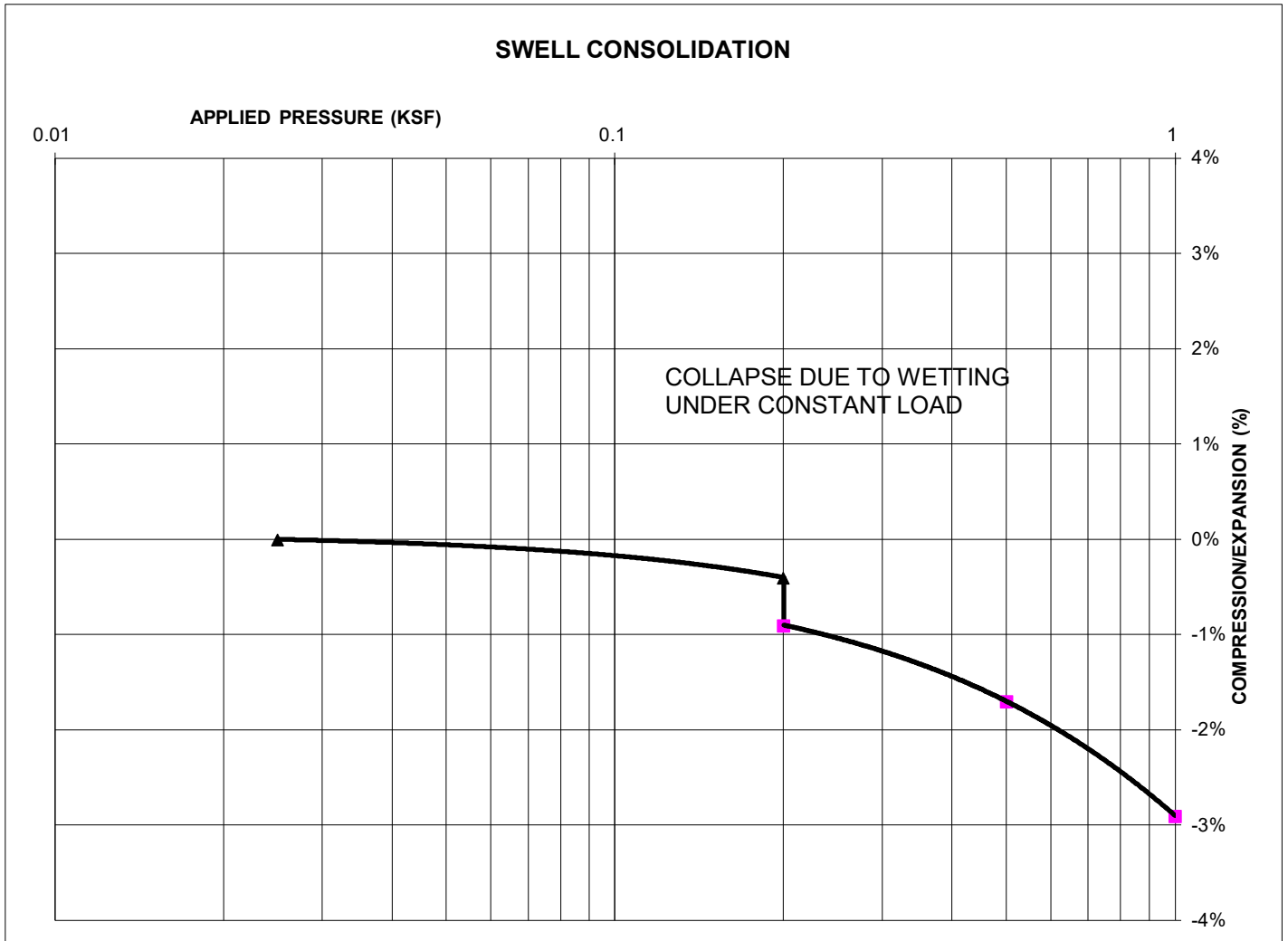
STERLING RANCH EAST F1, PHASE A, PART 2  
CLASSIC COMMUNITIES

JOB NO.  
240127

**FIG. B-16**

TEST BORING 11  
DEPTH (FT) 5

SOIL DESCRIPTION FILL, SAND, SILTY  
SOIL TYPE 1



**SWELL/COLLAPSE TEST RESULTS**

NATURAL UNIT DRY WEIGHT (PCF): 117  
NATURAL MOISTURE CONTENT: 11.5%  
SWELL/COLLAPSE (%): -0.5%



**SWELL TEST RESULTS**

STERLING RANCH EAST F1, PHASE A, PART 2  
CLASSIC COMMUNITIES

JOB NO.  
240127

**FIG. B-17**

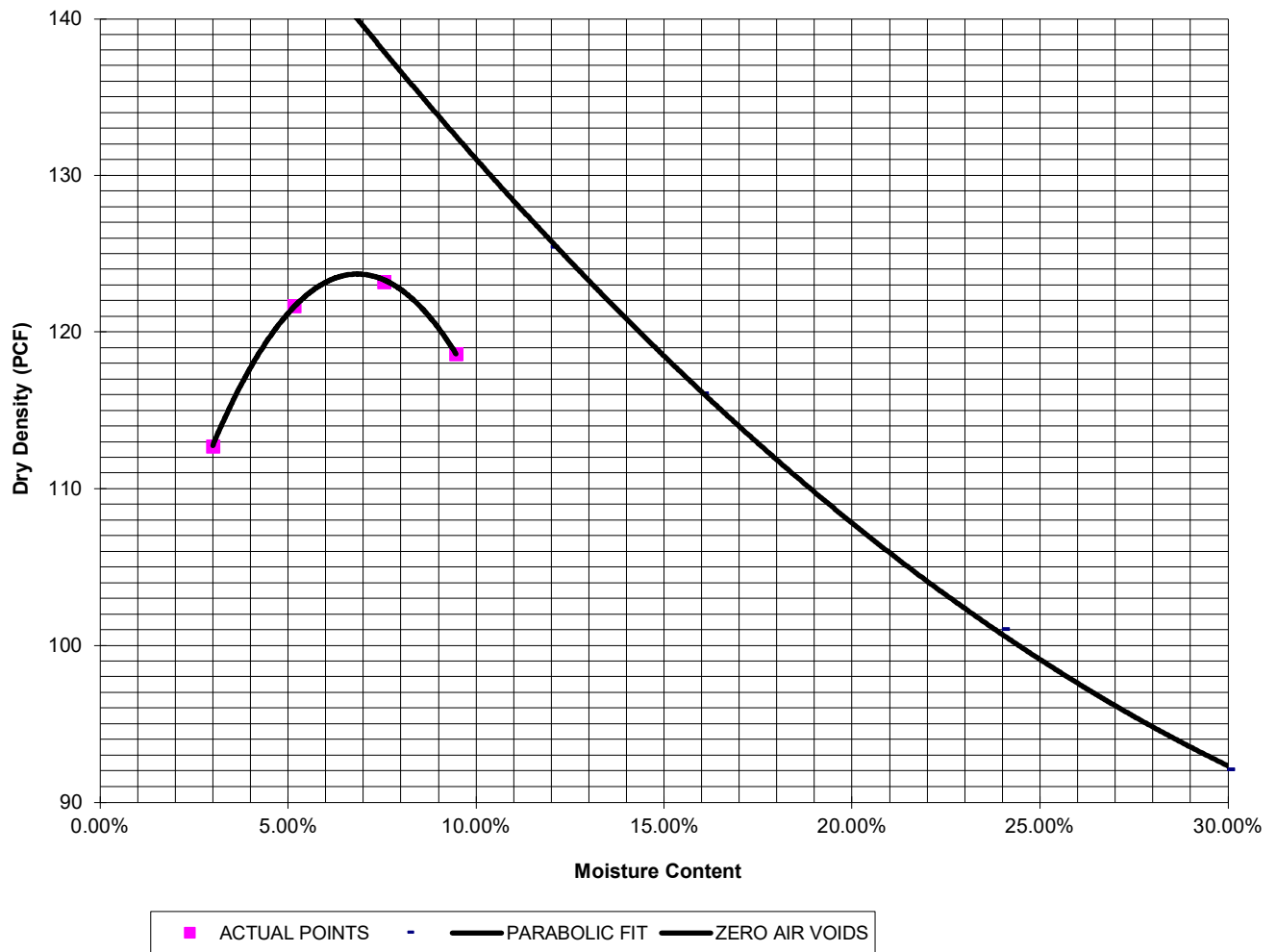
SAMPLE LOCATION TB-11 @ 0-3'

SOIL DESCRIPTION FILL, SAND, SILTY  
SOIL TYPE 1

**PROCTOR DATA**

IDENTIFICATION: SM  
PROCTOR TEST #: 1  
TEST BY: BL  
TEST DESIGNATION: ASTM-1557-A  
MAXIMUM DRY DENSITY (PCF): 123.9  
OPTIMUM MOISTURE: 6.9

**Compaction Curve**



**LABORATORY TEST RESULTS**  
STERLING RANCH EAST F1, PHASE A, PART 2  
CLASSIC COMMUNITIES

JOB NO.  
240127

**FIG. B-18**

SAMPLE LOCATION TB-11 @ 0-3'

SOIL DESCRIPTION FILL, SAND, SILTY

SOIL TYPE 1

**CBR TEST LOAD DATA**

Piston Diameter (cm): 4.958

Piston Area (in<sup>2</sup>): 2.993

Penetration Depth (inches)	10 BLOWS Mold # 1		25 BLOWS Mold # 2		56 BLOWS Mold # 3	
	Load (lbs)	Stress (psi)	Load (lbs)	Stress (psi)	Load (lbs)	Stress (psi)
0.000	0	0.00	0	0.00	0	0.00
0.025	108	36.09	427	142.69	634	211.86
0.050	136	45.45	560	187.13	820	274.02
0.075	145	48.45	610	203.84	901	301.09
0.100	158	52.80	653	218.21	1239	414.03
0.125	173	57.81	721	240.93	1374	459.15
0.150	188	62.82	791	264.33	1630	544.69
0.175	194	64.83	846	282.71	1874	626.23
0.200	198	66.17	899	300.42	2013	672.68
0.300	223	74.52	964	322.14	2336	780.62
0.400	250	83.54	1122	374.94	2569	858.48
0.500	281	93.90	1205	402.67	2897	968.08

**MOISTURE AND DENSITY DATA**

	Mold # 1	Mold # 2	Mold # 3
Can #	343	345	361
Wt. Can	8.62	8.59	8.63
Wt. Can+Wet	203	117.65	111.82
Wt. Can+Dry	174.43	103.69	99.47
Wt. H2O	28.57	13.96	12.35
Wt. Dry Soil	165.81	95.1	90.84
Moisture Content	17.23%	14.68%	13.60%
Wet Density (PCF)	118.9	124.0	129.8
Dry Density (PCF)	111.3	116.0	121.4
% Compaction	90%	94%	98%
CBR	5.28	21.82	41.40

**PROCTOR DATA**

Maximum Dry Density (pcf)	123.9
Optimum Moisture	6.9
90% of Max. Dry Density (pcf)	111.5
95% of Max. Dry Density (pcf)	117.7

CBR at 90% of Max. Density = 6.2 ~ R VALUE 14  
 CBR at 95% of Max. Density = 28.1 ~ R VALUE 73

**LABORATORY TEST RESULTS**

STERLING RANCH EAST F1, PHASE A, PART 2  
 CLASSIC COMMUNITIES

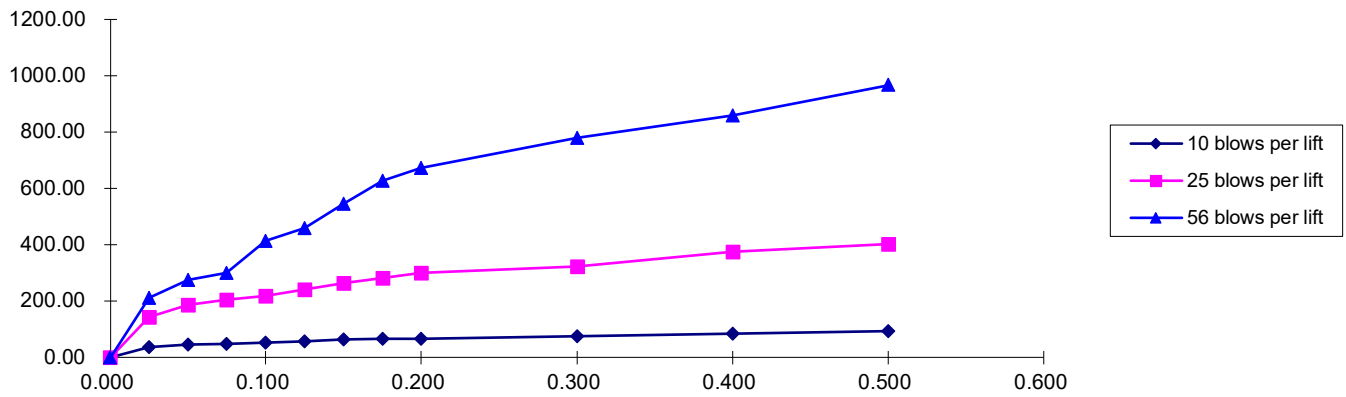
JOB NO.  
 240127

**FIG. B-19**

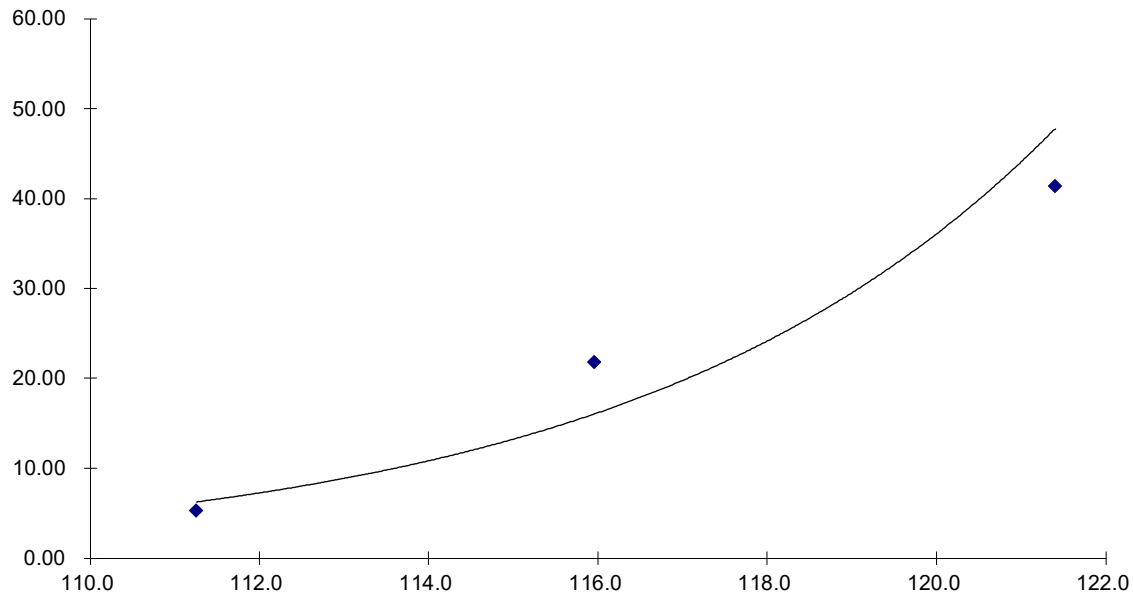
SAMPLE LOCATION TB-11 @ 0-3'

SOIL DESCRIPTION FILL, SAND, SILTY  
SOIL TYPE 1

### Stress VS Penetration



### Bearing Ratio VS Dry Density



**LABORATORY TEST RESULTS**  
STERLING RANCH EAST F1, PHASE A, PART 2  
CLASSIC COMMUNITIES

JOB NO.  
240127

**FIG. B-20**





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

## FLEXIBLE PAVEMENT DESIGN

### PROJECT DATA

Project Location: Sterling Ranch East Filing No. 1, Phase A, Part 2

Job Number: 240127

### DESIGN DATA

Equivalent (18-kip) Single Axle Load Applications (ESAL):	ESAL ( $W_{18}$ ) =	292,000
Design CBR	CBR =	10
Standard Deviation	$S_o$ =	0.45
Loss in Serviceability	$\Delta\psi$ =	2.5
Reliability	Reliability =	80
Reliability (z-statistic)	$Z_R$ =	-0.84
Soil Resilient Modulus	$M_R$ =	15,000 psi

Required Structural Number (SN): ➔ SN = 1.98

### DESIGN EQUATIONS

#### Resilient Modulus

If using CBR:

$$M_R = (\text{CBR}) \times 1,500$$

If using R-Value:

$$M_R = 10^{[(S_1 + 18.72) / 6.24]} \text{ where: } S_1 = [(R\text{-value} - 5) / 11.29] + 3$$

#### Required Structural Number

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

#### Pavement Section Thickness

$$SN^* = C_1 D_1 + C_2 D_2 \quad \text{where:}$$

$C_1$  = Strength Coefficient - HMA  
 $C_2$  = Strength Coefficient - ABC/RCB  
 $D_1$  = Depth of HMA (inches)  
 $D_2$  = Depth of ABC/RCB (inches)

### RECOMMENDED THICKNESSES

Layer	Material	Structural Layer	Thickness ( $D_i$ )	$SN^*_i$	SN
1	HMA	$C_1 = 0.44$	4.0 inches	1.760	-
2	ABC/RCB	$C_2 = 0.11$	8.0 inches	0.880	
				<b>SN* = 2.640</b>	<b>1.98</b>

Pavement SN > Required SN, Design is Acceptable

FIG. C-1

## FLEXIBLE PAVEMENT DESIGN

### PROJECT DATA

Project Location: Sterling Ranch East Filing No. 1, Phase A, Part 2

Job Number: 240127

### DESIGN DATA

Equivalent (18-kip) Single Axle Load Applications (ESAL):	ESAL ( $W_{18}$ ) =	292,000
Design CBR	CBR =	10
Standard Deviation	$S_o$ =	0.45
Loss in Serviceability	$\Delta\psi$ =	2.5
Reliability	Reliability =	80
Reliability (z-statistic)	$Z_R$ =	-0.84
Soil Resilient Modulus	$M_R$ =	15,000 psi

Required Structural Number (SN): ➔ SN = 1.98

### DESIGN EQUATIONS

#### Resilient Modulus

If using CBR:

$$M_R = (\text{CBR}) \times 1,500$$

If using R-Value:

$$M_R = 10^{[(S_1 + 18.72) / 6.24]} \text{ where: } S_1 = [(R\text{-value} - 5) / 11.29] + 3$$

#### Required Structural Number

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

#### Pavement Section Thickness

$$SN^* = C_1 D_1 + C_2 D_2 \quad \text{where:}$$

$C_1$  = Strength Coefficient - HMA  
 $C_2$  = Strength Coefficient - CTS  
 $D_1$  = Depth of HMA (inches)  
 $D_2$  = Depth of CTS (inches)

### RECOMMENDED THICKNESSES

Layer	Material	Structural Layer	Thickness ( $D_i$ )	$SN^*_i$	SN
1	HMA	$C_1 = 0.44$	4.0 inches	1.760	-
2	CTS	$C_2 = 0.11$	8.0 inches	0.880	
SN* = 2.640					1.98

Pavement SN > Required SN, Design is Acceptable

FIG. C-2