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PAVEMENT DESIGN REPORT
ROLLING HILLS RANCH NORTH, FILING NO. 1, PHASE 1
EL PASO COUNTY, COLORADO

PCD File No. SF2411

Prepared for:
Tech Contractors
3575 Kenyon Street, Suite 200
San Diego, CA 92110

Attn: Raul Guzman

May 21, 2025

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Lucas Morrison
Geotechnical Engineering Staff

ACCEPTED for FILE
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Senior Engineer
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El Paso County Department of Pubic Works

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Sr. Engineer

LJM:JCG/ed

Entech Job No. 250235

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1 Introduction

Entech Engineering, Inc. (Entech) completed this pavement design report for roadways within Rolling Hills Ranch North, Filing No. 1, Phase 1. 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 Tech Contractors. 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 north of Rex Road and west of Eastonville Road within Rolling Hills Ranch North Filing No. 1, Phase 1, in El Paso County, Colorado (Figure 1). The proposed improvements include paving portions of Shelter Creek Drive, Sunrise Ridge Drive, Cardenas Drive, and the entirety of House Rock Drive and Crystal Falls Drive within the proposed section of Rolling Hills Ranch North, Filing No. 1, Phase 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 some 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 Phase 1 of the project site were explored by ten test borings, designated TB-1 through TB-10, drilled on April 8 and April 18, 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. One-dimensional swell/collapse testing (ASTM D4546) was performed to evaluate the expansive characteristics of the subsurface materials.

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. 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 191 psi, and the 5-day strength of the 4% mix was 223 psi. A 2% 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, clayey-silty sand, or sand with silt fill (Soil Type 1, SC, SM, SC-SM, SW-SM) and medium dense silty sand fill (Soil Type 2, SM). Weak to very weak sandstone bedrock, or very dense clayey to silty sand when classified as a soil (Soil Type 3, SC, SM), was encountered in four of the test borings (TB-1, TB-6, TB-8, and TB-9) underlying Soil Type 1 and Soil Type 2. 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-2-6 soils. Soil Type 2 classified as AASHTO A-4, and Soil Type 3 classified as AASHTO A-2-4, A-2-6, and A-6.

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 clayey sand fill from TB-4 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 – Clayey Sand
CBR at 95%	18.2
Design CBR	10
Liquid Limit	29
Plasticity Index	9
Percent Passing 200	26.1
AASHTO Classification	A-2-4
Unified Soils Classification	SC

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 pa+69/8547vement subgrade, swell testing of the majority of in-situ samples was not feasible. Based on the subgrade soils classification and swell testing completed, swell mitigation will not be required on this site.

5.3 Traffic Loading

Traffic data is not available for the proposed roadways within Rolling Hills Ranch North, Filing No. 1, Phase 1; however, the roadways are classified as urban local roadways based on current development plans. In addition, The Rolling Hills Ranch North PUD Transportation Memorandum PCD File No. PUDSP235 by LSC Transportation Consultants, dated February 23, 2024, provides an urban local roadway designation for the interior roadways. 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 (Δ psi) vnb	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 [1]
Sunrise Ridge Drive, Shelter Creek Drive, Cardenas Drive, House Rock Drive, Crystal Falls Drive	292,000	1. 4.0 inches HMA over 8.0 inches ABC/RCB
		2. 4.0 inches HMA over 8.0 inches CTS [2]

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 recompacted 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 2% (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 to 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 0.01% to 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 Gutherie and Robert Stevens dated March 13, 2024, soils with less than 3,000 ppm (0.3%) do not require special construction practices.

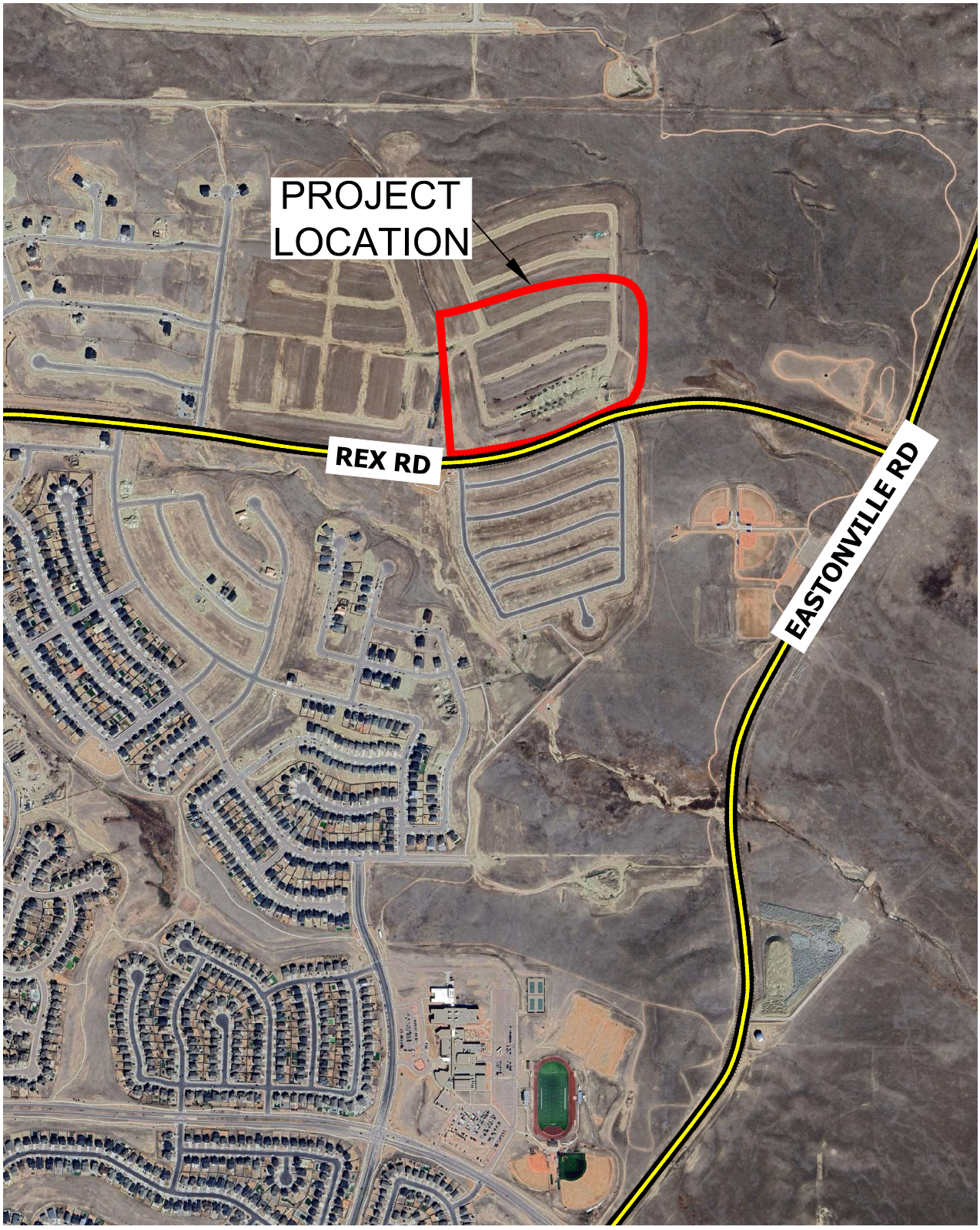
6.3 Construction Observation

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 Tech Contractors with application to the paving of Shelter Creek Drive, Sunrise Ridge Drive, Cardenas Drive, House Rock Drive, and Crystal Falls Drive within Rolling Hills Ranch North, Filing No. 1, Phase 1, 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.



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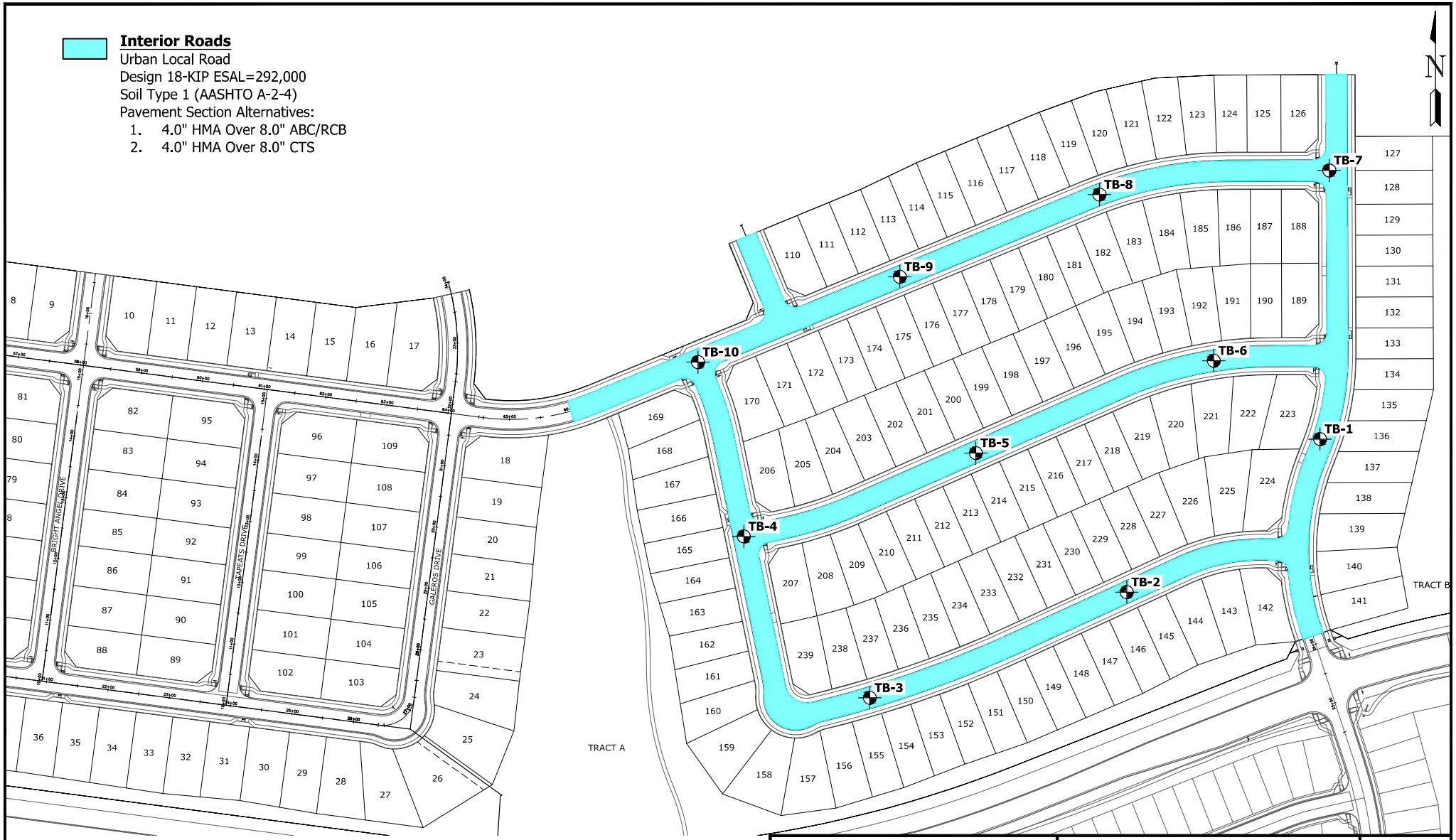
VICINITY MAP

ROLLING HILLS RANCH NORTH F1, PHASE 1
TECH CONTRACTORS

JOB NO.
250235

FIG. 1



ENTECH ENGINEERING, INC.

SITE AND EXPLORATION PLAN

ROLLING HILLS RANCH NORTH F1, PHASE 1
TECH CONTRACTORS

JOB NO. 250235

FIG. 2

APPENDIX A: Test Boring Logs

TABLE A-1

DEPTH TO BEDROCK

TEST BORING	DEPTH TO BEDROCK (ft.)
1	4.0
2	>5
3	>5
4	>10
5	>5
6	3.0

TEST BORING 1
DATE DRILLED 4/8/2025

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 4/8/25						
FILL 0-4', SAND, SILTY, BROWN to TAN, DENSE, MOIST				44	6.8	1
SANDSTONE, WEAK, TAN, WEATHERED (SAND, CLAYEY, VERY DENSE, MOIST)	5			50/11"	8.2	3
	10					
	15					
	20					

TEST BORING 2
DATE DRILLED 4/8/2025

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 4/8/25						
FILL 0-5', SAND, CLAYEY-SILTY, TAN to BROWN, MEDIUM DENSE, MOIST				14	9.2	1
	5			25	7.4	1
	10					
	15					
	20					

ENTECH ENGINEERING, INC.

TEST BORING LOGS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

JOB NO. 250235

FIG. A-1

TEST BORING 3
DATE DRILLED 4/8/2025

REMARKS

DRY TO 5', 4/8/25

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
			13	7.1	1	FILL 0-5', SAND, CLAYEY, TAN to BROWN, MEDIUM DENSE, MOIST
5			13	7.4	1	
10						
15						
20						

TEST BORING 4
DATE DRILLED 4/8/2025

REMARKS

DRY TO 10', 4/8/25

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
			14	7.3	1	FILL 0-10', SAND, CLAYEY-SILTY, TAN to BROWN, MEDIUM DENSE, MOIST
5			15	9.1	1	
10			11	6.2	1	
15						
20						

ENTECH ENGINEERING, INC.

TEST BORING LOGS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

JOB NO. 250235

FIG. A-2

TEST BORING 5
DATE DRILLED 4/8/2025

REMARKS

DRY TO 5', 4/8/25

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
FILL 0-5', SAND, CLAYEY, TAN to BROWN, MEDIUM DENSE, MOIST			12	8.6	1
5			22	9.2	1
10					
15					
20					

TEST BORING 6
DATE DRILLED 4/8/2025

REMARKS

DRY TO 5', 4/8/25

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
FILL 0-2', SAND, SILTY, TAN, MEDIUM DENSE, MOIST			13	14.7	
SANDSTONE, WEAK, TAN, WEATHERED (SAND, CLAYEY, VERY DENSE, MOIST)			50/7"	10.0	3
5					
10					
15					
20					

ENTECH ENGINEERING, INC.

TEST BORING LOGS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

JOB NO. 250235

FIG. A-3

TEST BORING 7
DATE DRILLED 4/18/2025

REMARKS

DRY TO 5', 4/18/25

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
FILL 0-5', SAND, CLAYEY, BROWN, MEDIUM DENSE, MOIST			10	6.9	1
5			25	6.9	1
10					
15					
20					

TEST BORING 8
DATE DRILLED 4/18/2025

REMARKS

DRY TO 10', 4/18/25

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
FILL 0-6', SAND, CLAYEY, BROWN, MEDIUM DENSE, MOIST			10	6.9	1
5			15	8.1	1
SANDSTONE, VERY WEAK, TAN, HIGHLY WEATHERED (SAND, SILTY, VERY DENSE, MOIST)					
10			50/5"	4.1	3
15					
20					

ENTECH ENGINEERING, INC.

TEST BORING LOGS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

JOB NO. 250235

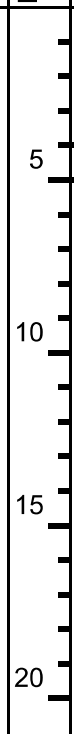
FIG. A-4

TEST BORING 9
DATE DRILLED 4/18/2025

REMARKS

DRY TO 5', 4/8/25

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
FILL 0-4', SAND, SILTY, BROWN to TAN, DENSE, MOIST			22	6.0	1
SANDSTONE, VERY WEAK, TAN, HIGHLY WEATHERED (SAND, CLAYEY, VERY DENSE, MOIST)			50/8"	5.2	3

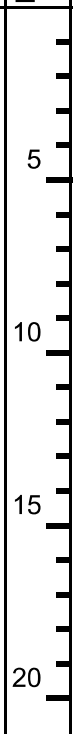


TEST BORING 10
DATE DRILLED 4/18/2025

REMARKS

DRY TO 5', 4/8/25

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
FILL 0-5', SAND, WITH SILT, BROWN, MEDIUM DENSE, MOIST			12	8.7	1
			12	6.7	1



ENTECH ENGINEERING, INC.

TEST BORING LOGS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

JOB NO. 250235

FIG. A-5

APPENDIX B: Laboratory Test Results

TABLE B-1
SUMMARY OF LABORATORY TEST RESULTS

ENTECH ENGINEERING, INC.

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	4	0-3	7.1	127.5	26.1	29	20	9			A-2-4 (0)	SC	FILL, SAND, CLAYEY
1	1	1-2	6.8		28.2	35	26	9			A-2-4 (0)	SM	FILL, SAND, SILTY
1	2	1-2	9.2		12.1	28	22	6			A-1-b (0)	SC-SM	FILL, SAND, CLAYEY-SILTY
1	3	1-2	7.1		15.7	28	20	8			A-2-4 (0)	SC	FILL, SAND, CLAYEY
1	4	1-2	7.3		21.6	24	18	6			A-2-4 (0)	SC-SM	FILL, SAND, CLAYEY-SILTY
1	5	1-2	8.6		14.2	33	23	10	<0.01		A-2-4 (0)	SC	FILL, SAND, CLAYEY
1	7	1-2	10.7	115.3	23.1	28	11	17		0.0	A-2-6 (1)	SC	FILL, SAND, CLAYEY
1	8	1-2	10.6	117.0	14.4	30	20	10		-0.1	A-2-4 (0)	SC	FILL, SAND, CLAYEY
1	9	1-2	6.0		15.2	NV	NP	NP			A-1-b (0)	SM	FILL, SAND, SILTY
1	10	1-2	8.7		11.7	NV	NP	NP			A-1-b (0)	SW-SM	FILL, SAND, WITH SILT
2	6	1-2	14.7		45.2	31	23	8	<0.01		A-4 (1)	SM	FILL, SAND, SILTY
3	9	5	5.2		19.3	33	22	11			A-2-6 (0)	SC	SANDSTONE (SAND, CLAYEY)
3	8	10	4.1		32.6	NV	NP	NP			A-2-4 (0)	SM	SANDSTONE (SAND, SILTY)
3	1	5	8.2		19.1	33	22	11	0.01		A-2-6 (0)	SC	SANDSTONE (SAND, CLAYEY)
3	6	5	11.5	124.2	48.8	35	23	12		1.4	A-6 (3)	SC	SANDSTONE (SAND, CLAYEY)

Project: Rolling Hills North, Filing No. 1
Client: Tech Contractors
Job No: 250235

ENTECH ENGINEERING, INC.

TABLE B-2

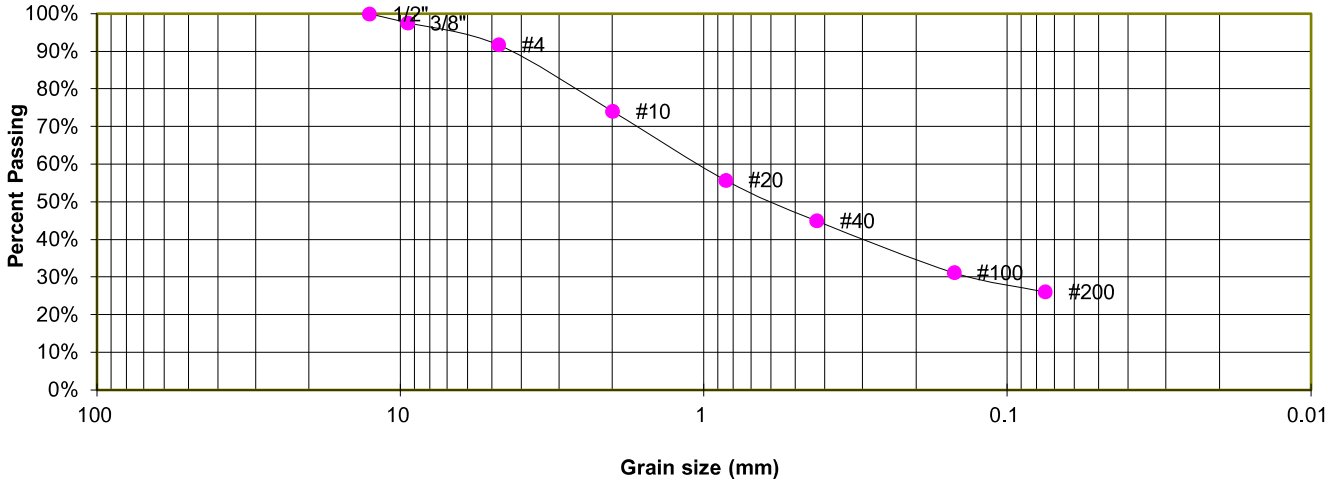
SUMMARY OF CTS TEST RESULTS

FIELD SAMPLE ID	*SOIL ADDITIVE*	*ADDITIVE PERCENTAGE (%)*	*WATER CONTENT (%)*	*DENSITY (dry)*	*AGE (days)*	*STRENGTH (psi)*
TB-4 @ 0-3'	TYPE IL CEMENT	2	7.1	121.7	5	184
				121.9		199
				121.9		189
					AVERAGE:	**191**
TB-4 @ 0-3'	TYPE IL CEMENT	4	7.1	122.0	5	216
				121.6		224
				121.7		230
					AVERAGE:	**223**

Notes:

1. CURING METHOD: 100° HUMIDIFIED OVEN

TEST BORING	4	SOIL DESCRIPTION	FILL, SAND, CLAYEY
DEPTH (FT)	0-3	SOIL TYPE	1, CBR



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	97.6%
4	91.7%
10	74.1%
20	55.8%
40	45.0%
100	31.2%
200	26.1%

ATTERBERG LIMITS

Plastic Limit	20
Liquid Limit	29
Plastic Index	9

SOIL CLASSIFICATION

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

ENTECH ENGINEERING, INC.

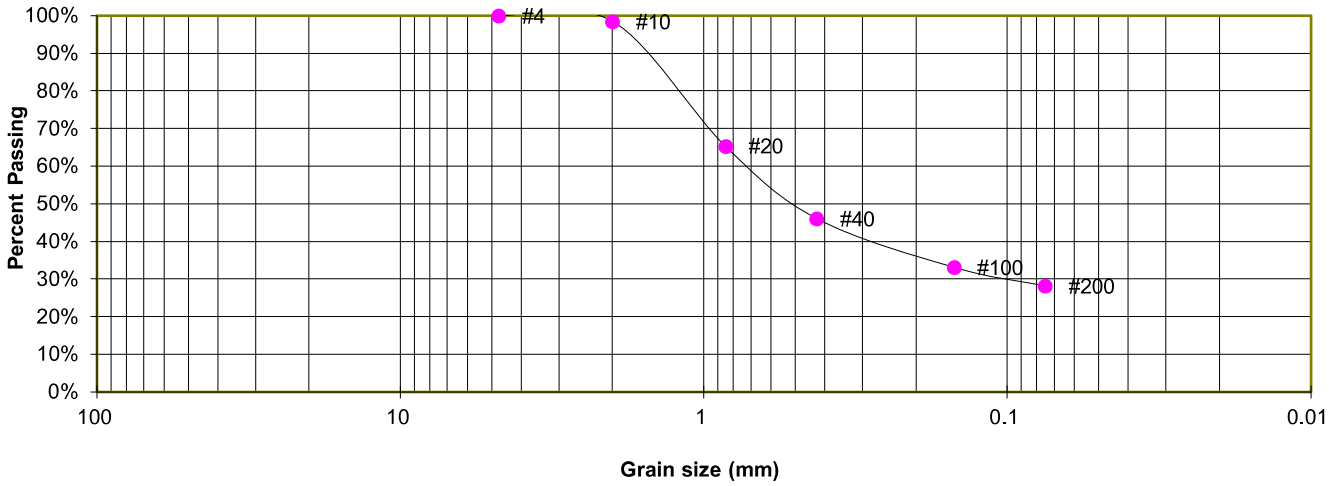
LABORATORY TEST RESULTS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

JOB NO. 250235

FIG. B-1

TEST BORING	1	SOIL DESCRIPTION	FILL, SAND, SILTY
DEPTH (FT)	1-2	SOIL TYPE	1



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	98.5%
20	65.3%
40	46.1%
100	33.2%
200	28.2%

ATTERBERG LIMITS

Plastic Limit	26
Liquid Limit	35
Plastic Index	9

SOIL CLASSIFICATION

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

ENTECH ENGINEERING, INC.

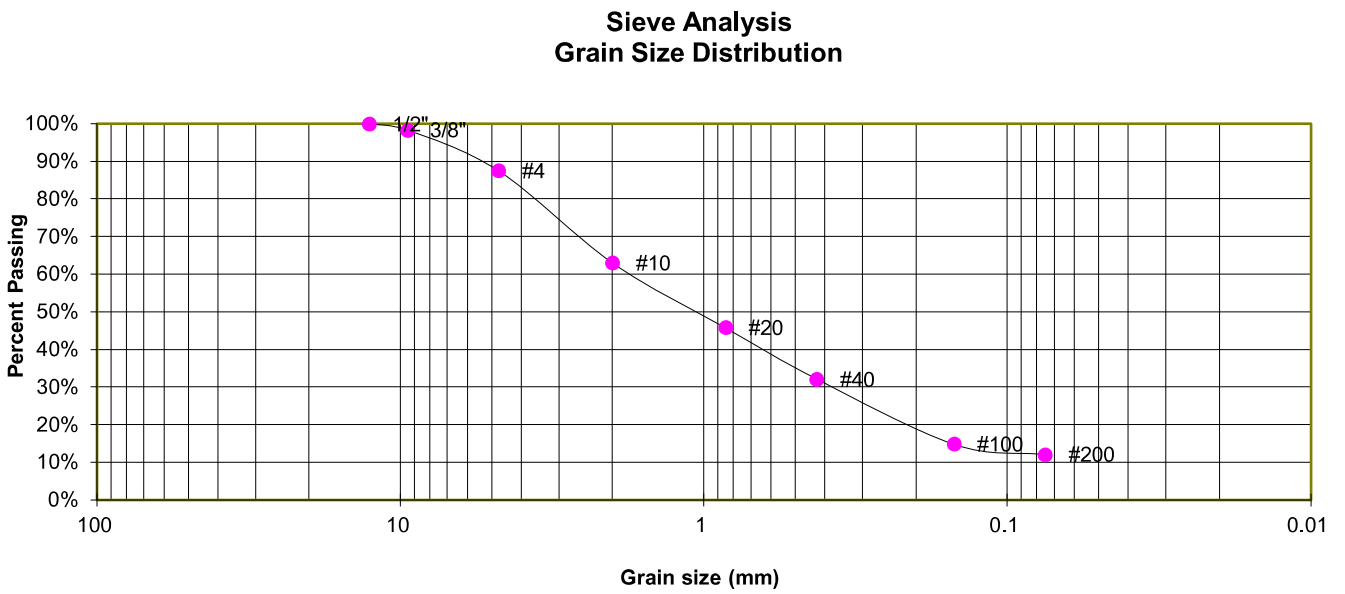
LABORATORY TEST RESULTS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

JOB NO. 250235

FIG. B-2

TEST BORING	2	SOIL DESCRIPTION	FILL, SAND, CLAYEY-SILTY
DEPTH (FT)	1-2	SOIL TYPE	1



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	98.3%
4	87.5%
10	63.0%
20	45.8%
40	32.2%
100	14.9%
200	12.1%

ATTERBERG LIMITS

Plastic Limit	22
Liquid Limit	28
Plastic Index	6

SOIL CLASSIFICATION

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

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

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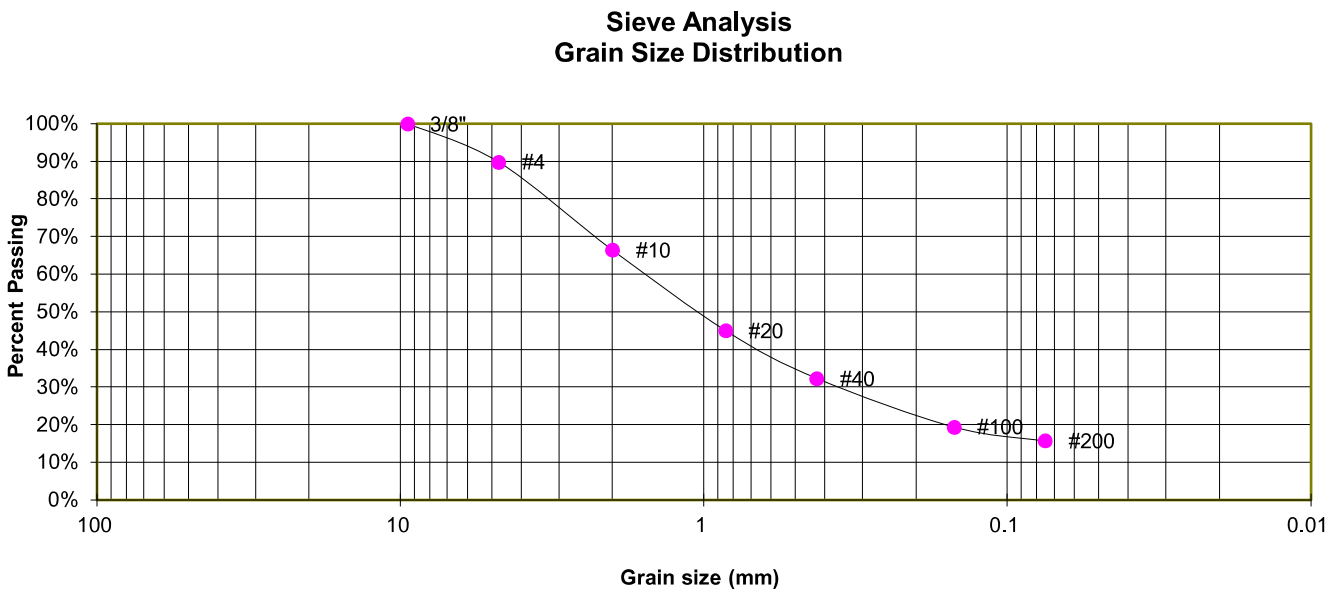
FIG. B-3

TEST BORING	3	SOIL DESCRIPTION	FILL, SAND, CLAYEY
DEPTH (FT)	1-2	SOIL TYPE	1



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	89.8%
10	66.5%
20	45.1%
40	32.3%
100	19.4%
200	15.7%

ATTERBERG LIMITS

Plastic Limit	20
Liquid Limit	28
Plastic Index	8

SOIL CLASSIFICATION

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

ENTECH ENGINEERING, INC.

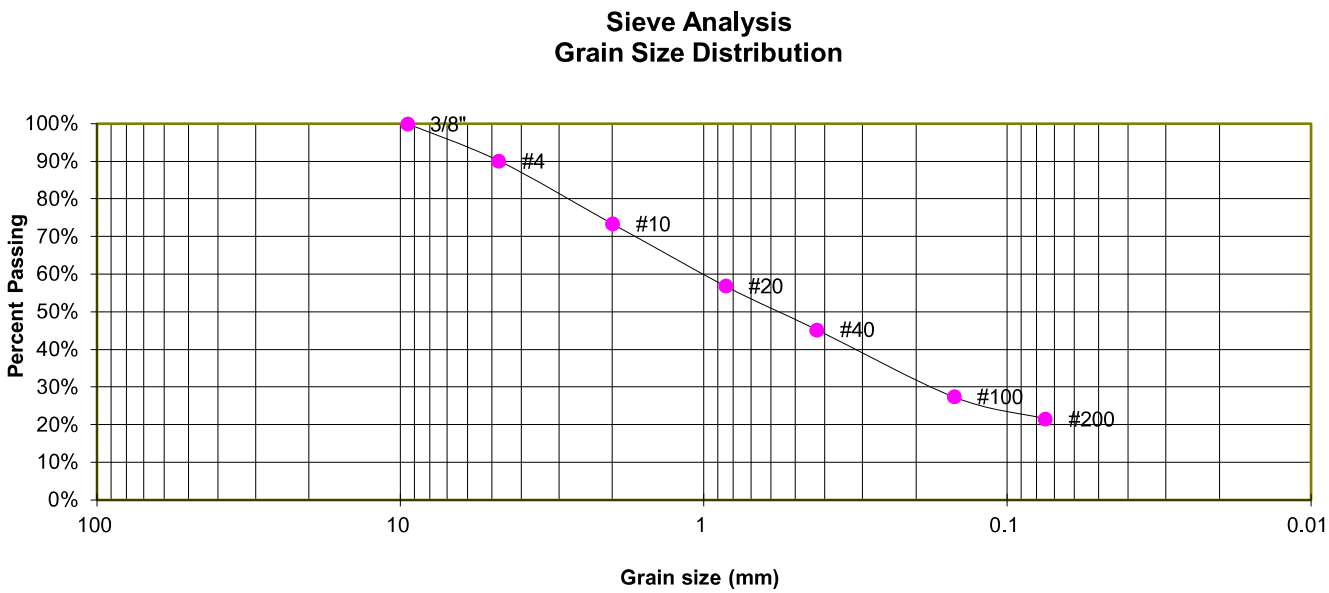
LABORATORY TEST RESULTS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

JOB NO. 250235

FIG. B-4

TEST BORING	4	SOIL DESCRIPTION	FILL, SAND, CLAYEY-SILTY
DEPTH (FT)	1-2	SOIL TYPE	1



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	90.1%
10	73.4%
20	56.9%
40	45.3%
100	27.5%
200	21.6%

ATTERBERG LIMITS

Plastic Limit	18
Liquid Limit	24
Plastic Index	6

SOIL CLASSIFICATION

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

ENTECH ENGINEERING, INC.

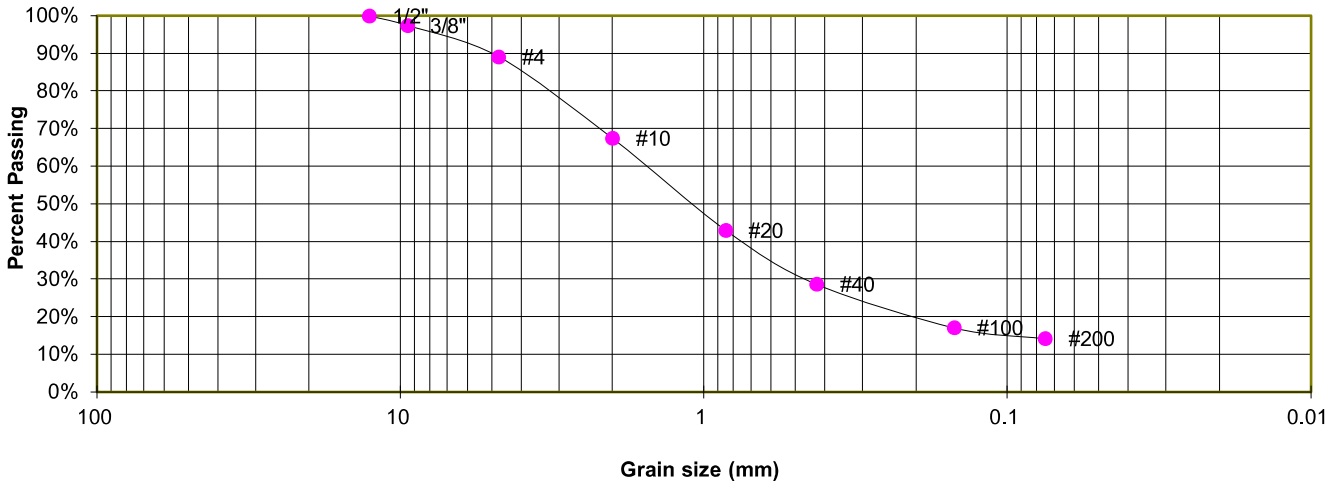
LABORATORY TEST RESULTS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

JOB NO. 250235

FIG. B-5

TEST BORING	5	SOIL DESCRIPTION	FILL, SAND, CLAYEY
DEPTH (FT)	1-2	SOIL TYPE	1



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	97.4%
4	89.1%
10	67.4%
20	43.1%
40	28.6%
100	17.1%
200	14.2%

ATTERBERG LIMITS

Plastic Limit	23
Liquid Limit	33
Plastic Index	10

SOIL CLASSIFICATION

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

ENTECH ENGINEERING, INC.

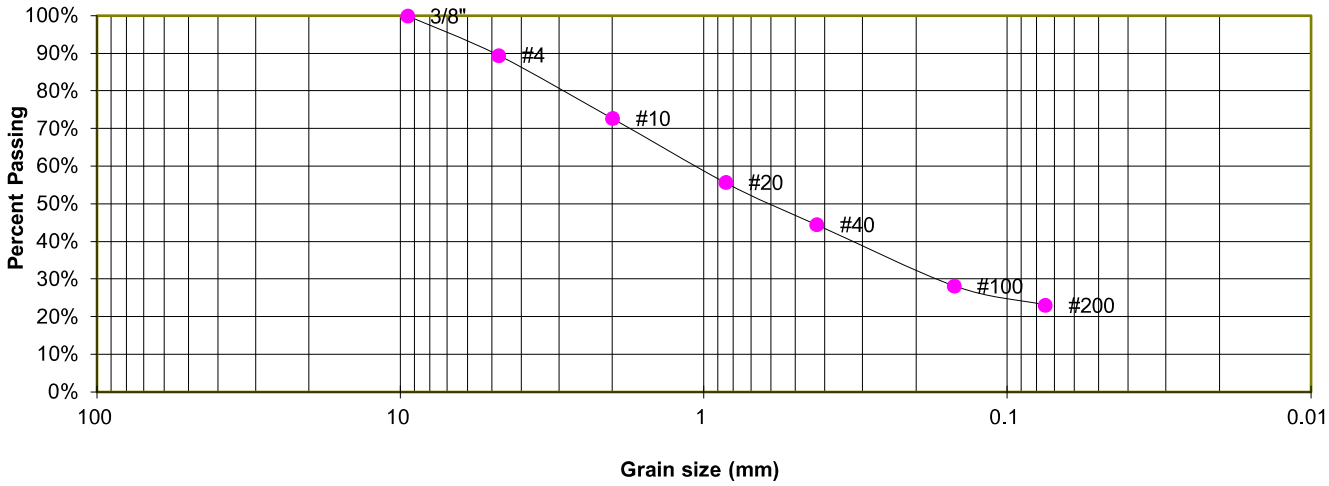
LABORATORY TEST RESULTS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

JOB NO. 250235

FIG. B-6

TEST BORING	7	SOIL DESCRIPTION	FILL, SAND, CLAYEY
DEPTH (FT)	1-2	SOIL TYPE	1



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	89.5%
10	72.7%
20	55.7%
40	44.5%
100	28.2%
200	23.1%

ATTERBERG LIMITS

Plastic Limit	11
Liquid Limit	28
Plastic Index	17

SOIL CLASSIFICATION

USCS CLASSIFICATION:	SC
AASHTO CLASSIFICATION:	A-2-6
AASHTO GROUP INDEX:	1

ENTECH ENGINEERING, INC.

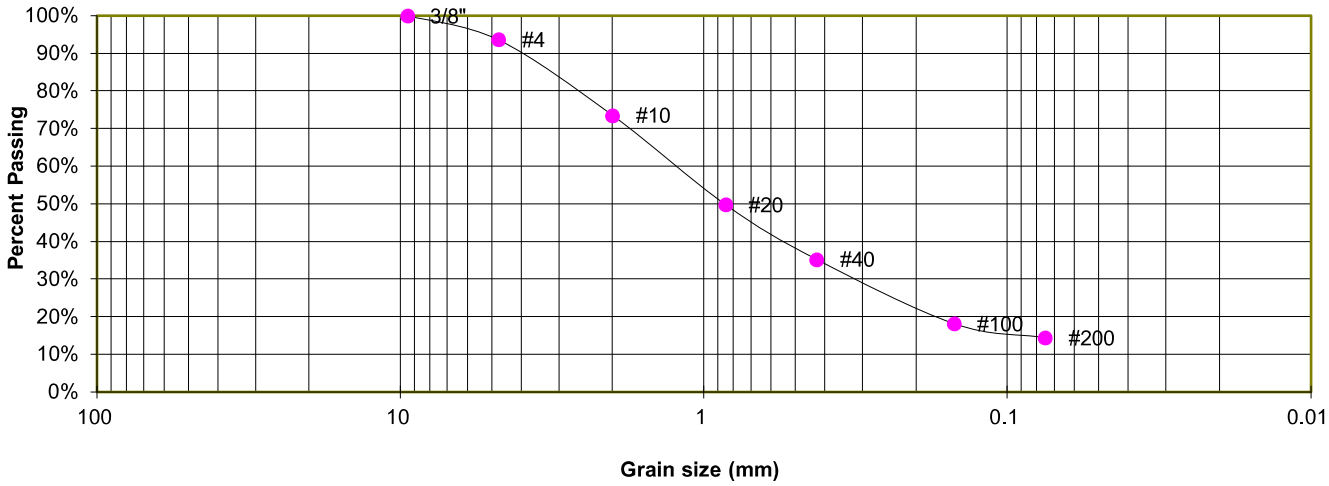
LABORATORY TEST RESULTS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

JOB NO. 250235

FIG. B-7

TEST BORING	8	SOIL DESCRIPTION	FILL, SAND, CLAYEY
DEPTH (FT)	1-2	SOIL TYPE	1



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	93.6%
10	73.5%
20	49.8%
40	35.3%
100	18.2%
200	14.4%

ATTERBERG LIMITS

Plastic Limit	20
Liquid Limit	30
Plastic Index	10

SOIL CLASSIFICATION

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

ENTECH ENGINEERING, INC.

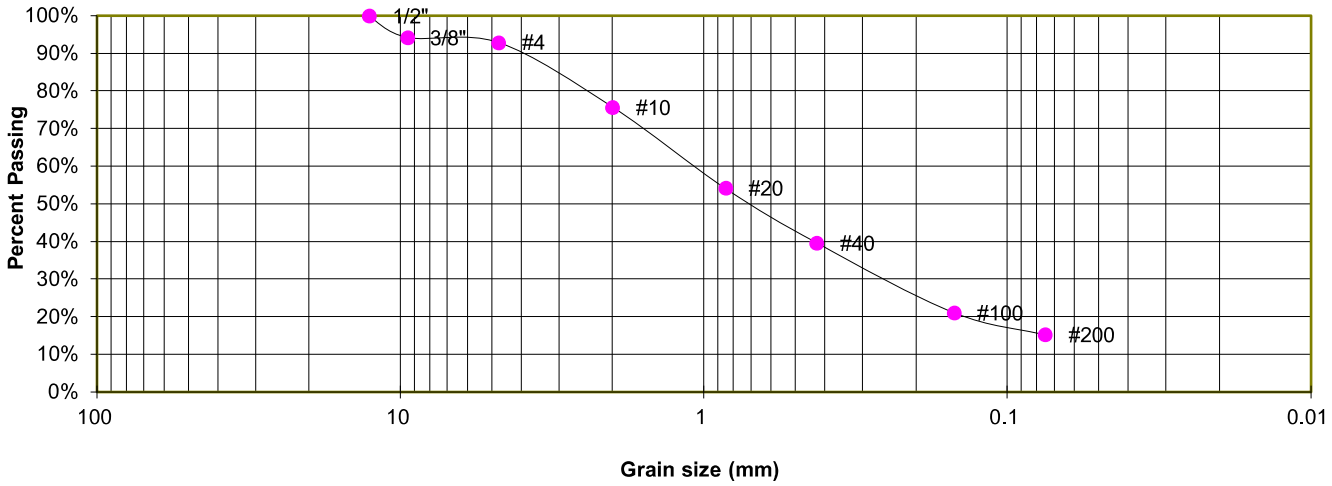
LABORATORY TEST RESULTS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

JOB NO. 250235

FIG. B-8

TEST BORING	9	SOIL DESCRIPTION	FILL, SAND, SILTY
DEPTH (FT)	1-2	SOIL TYPE	1



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	94.3%
4	92.9%
10	75.7%
20	54.1%
40	39.6%
100	21.1%
200	15.2%

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

ENTECH ENGINEERING, INC.

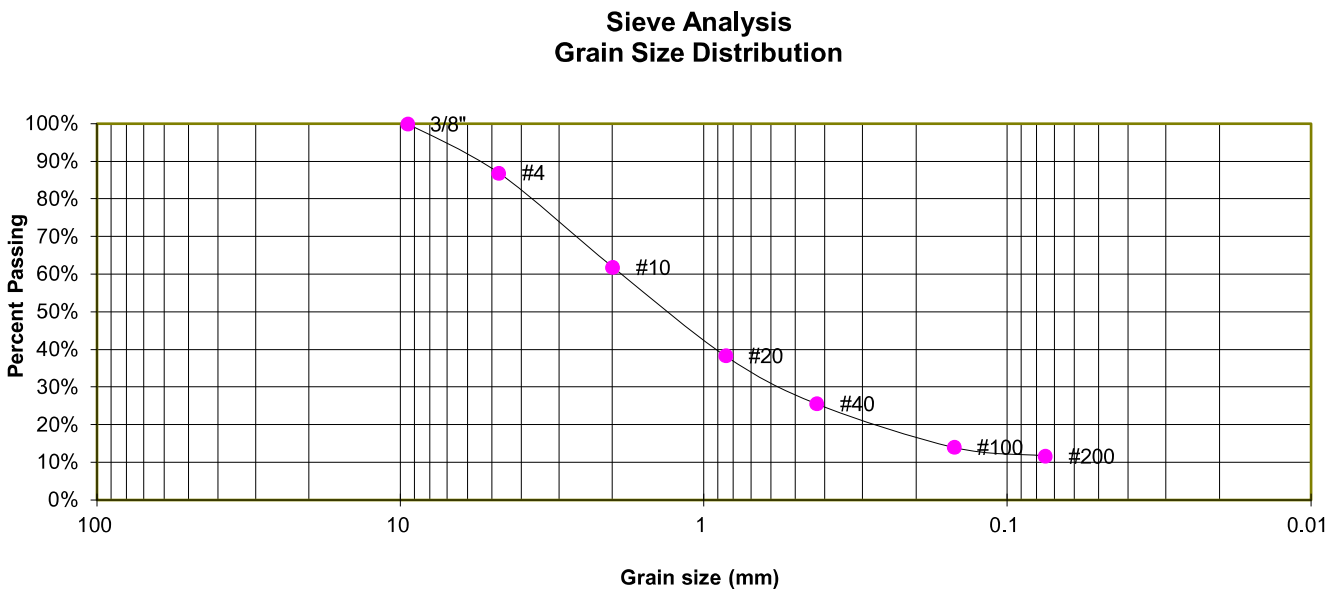
LABORATORY TEST RESULTS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

JOB NO. 250235

FIG. B-9

TEST BORING	10	SOIL DESCRIPTION	FILL, SAND, WITH SILT
DEPTH (FT)	1-2	SOIL TYPE	1



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	87.0%
10	61.9%
20	38.4%
40	25.6%
100	14.0%
200	11.7%

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

ENTECH ENGINEERING, INC.

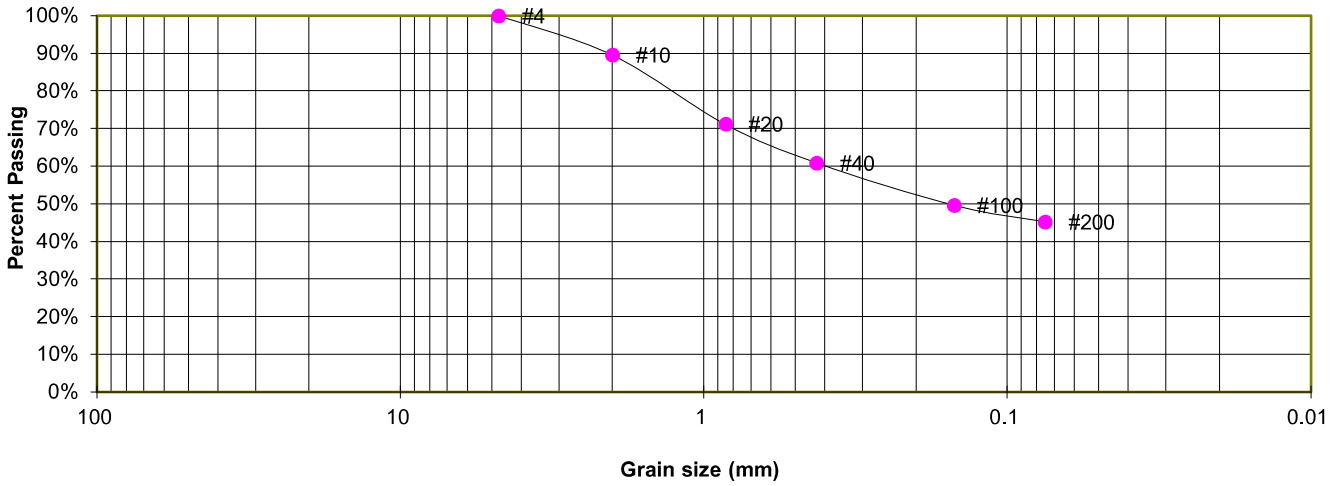
LABORATORY TEST RESULTS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

JOB NO. 250235

FIG. B-10

TEST BORING	6	SOIL DESCRIPTION	FILL, SAND, SILTY
DEPTH (FT)	1-2	SOIL TYPE	2



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	89.6%
20	71.2%
40	60.9%
100	49.7%
200	45.2%

ATTERBERG LIMITS

Plastic Limit	23
Liquid Limit	31
Plastic Index	8

SOIL CLASSIFICATION

USCS CLASSIFICATION:	SM
AASHTO CLASSIFICATION:	A-4
AASHTO GROUP INDEX:	1

ENTECH ENGINEERING, INC.

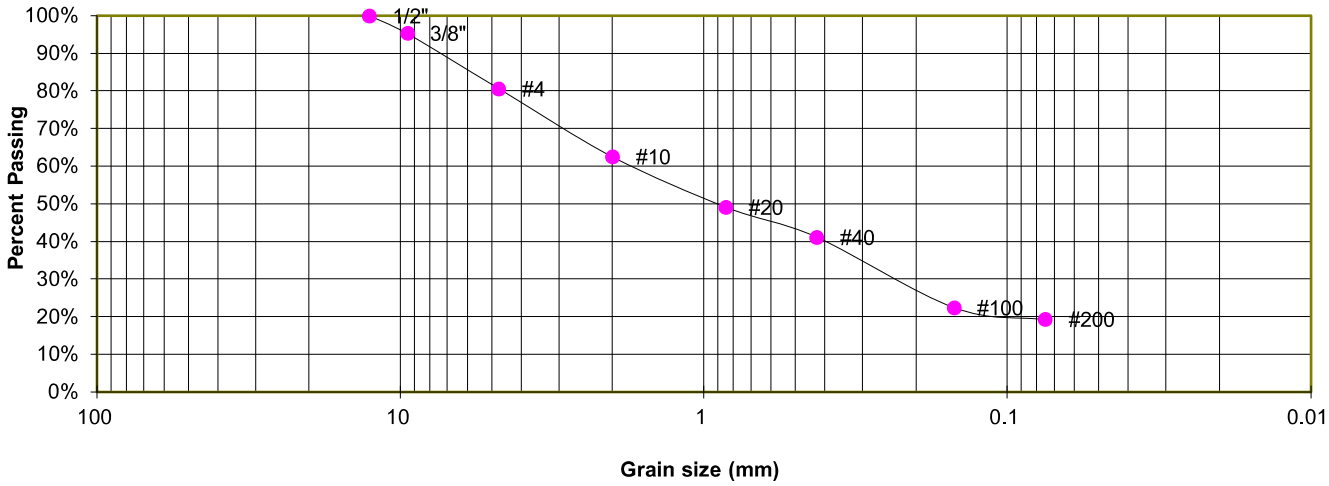
LABORATORY TEST RESULTS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

JOB NO. 250235

FIG. B-11

TEST BORING	9	SOIL DESCRIPTION	SANDSTONE (SAND, CLAYEY)
DEPTH (FT)	5	SOIL TYPE	3



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	95.3%
4	80.6%
10	62.5%
20	49.1%
40	41.1%
100	22.5%
200	19.3%

ATTERBERG LIMITS

Plastic Limit	22
Liquid Limit	33
Plastic Index	11

SOIL CLASSIFICATION

USCS CLASSIFICATION:	SC
AASHTO CLASSIFICATION:	A-2-6
AASHTO GROUP INDEX:	0

ENTECH ENGINEERING, INC.

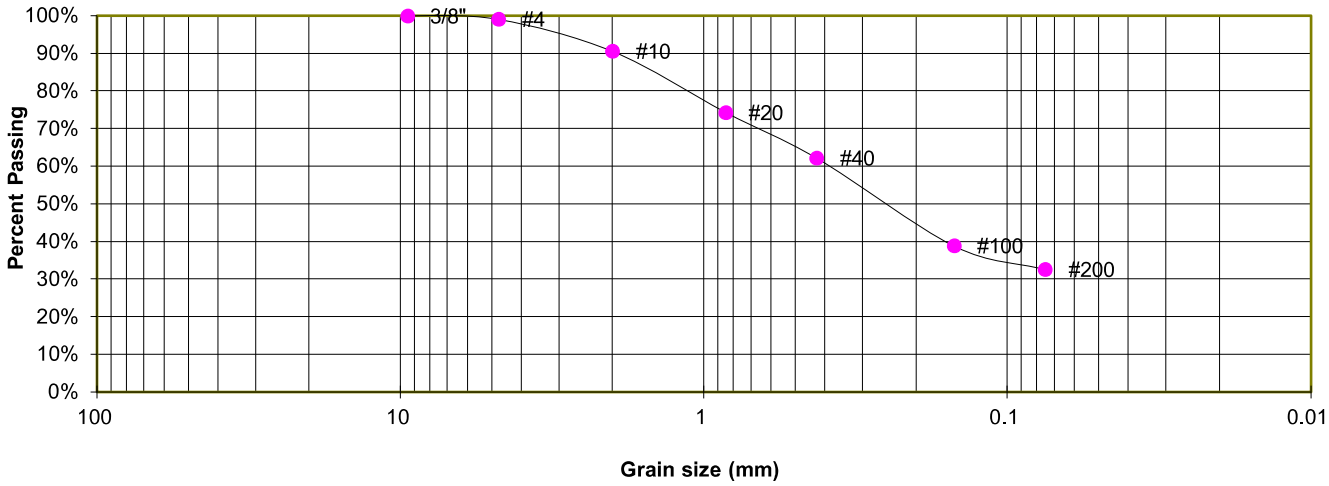
LABORATORY TEST RESULTS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

JOB NO. 250235

FIG. B-12

TEST BORING	8	SOIL DESCRIPTION	SANDSTONE (SAND, SILTY)
DEPTH (FT)	10	SOIL TYPE	3



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.1%
10	90.6%
20	74.3%
40	62.2%
100	38.9%
200	32.6%

ATTERBERG LIMITS

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

SOIL CLASSIFICATION

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

ENTECH ENGINEERING, INC.

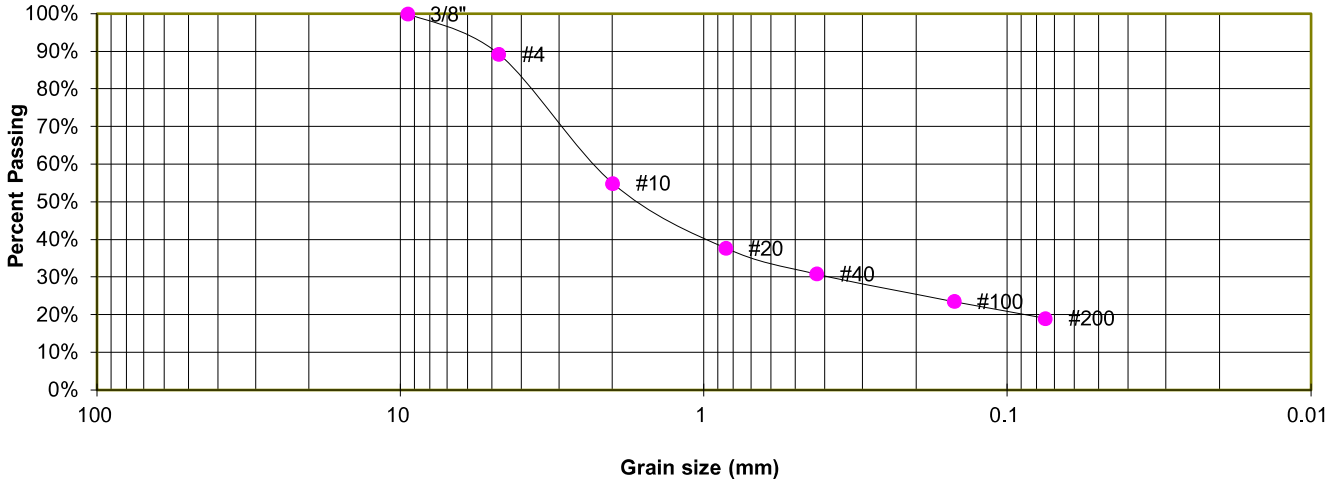
LABORATORY TEST RESULTS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

JOB NO. 250235

FIG. B-13

TEST BORING	1	SOIL DESCRIPTION	SANDSTONE (SAND, CLAYEY)
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	89.3%
10	55.0%
20	37.8%
40	30.9%
100	23.6%
200	19.1%

ATTERBERG LIMITS

Plastic Limit	22
Liquid Limit	33
Plastic Index	11

SOIL CLASSIFICATION

USCS CLASSIFICATION:	SC
AASHTO CLASSIFICATION:	A-2-6
AASHTO GROUP INDEX:	0

ENTECH ENGINEERING, INC.

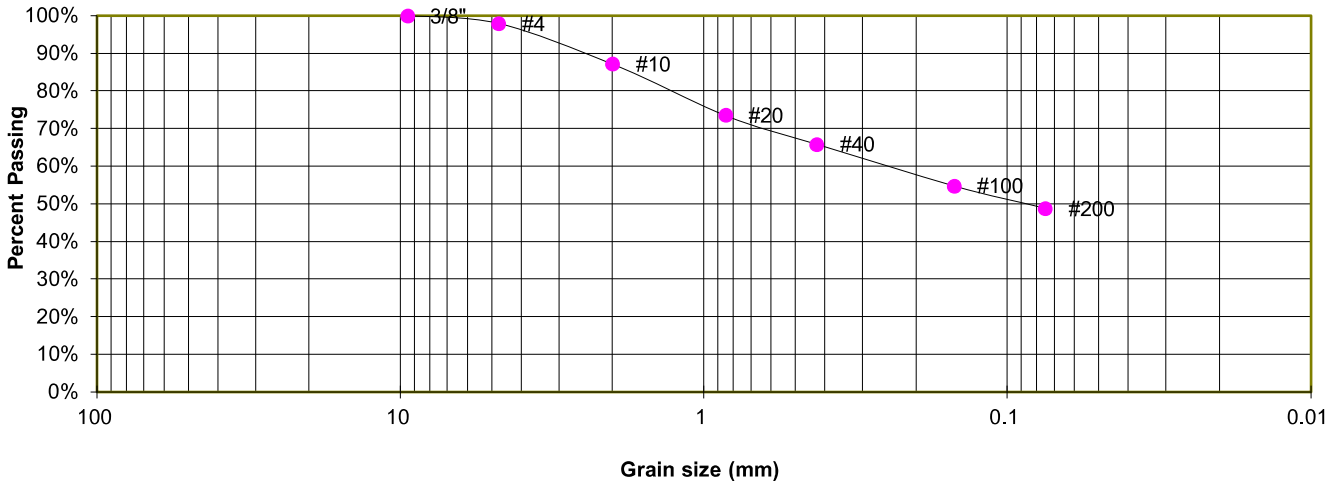
LABORATORY TEST RESULTS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

JOB NO. 250235

FIG. B-14

TEST BORING	6	SOIL DESCRIPTION	SANDSTONE (SAND, CLAYEY)
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	98.0%
10	87.2%
20	73.6%
40	65.9%
100	54.8%
200	48.8%

ATTERBERG LIMITS

Plastic Limit	23
Liquid Limit	35
Plastic Index	12

SOIL CLASSIFICATION

USCS CLASSIFICATION:	SC
AASHTO CLASSIFICATION:	A-6
AASHTO GROUP INDEX:	3

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

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FIG. B-15

TEST BORING	7	SOIL DESCRIPTION	FILL, SAND, CLAYEY
DEPTH (FT)	1-2	SOIL TYPE	1

SWELL/COLLAPSE TEST RESULTS

NATURAL UNIT DRY WEIGHT (PCF): 115
NATURAL MOISTURE CONTENT: 10.7%
SWELL/COLLAPSE (%): 0.0%

ENTECH ENGINEERING, INC.

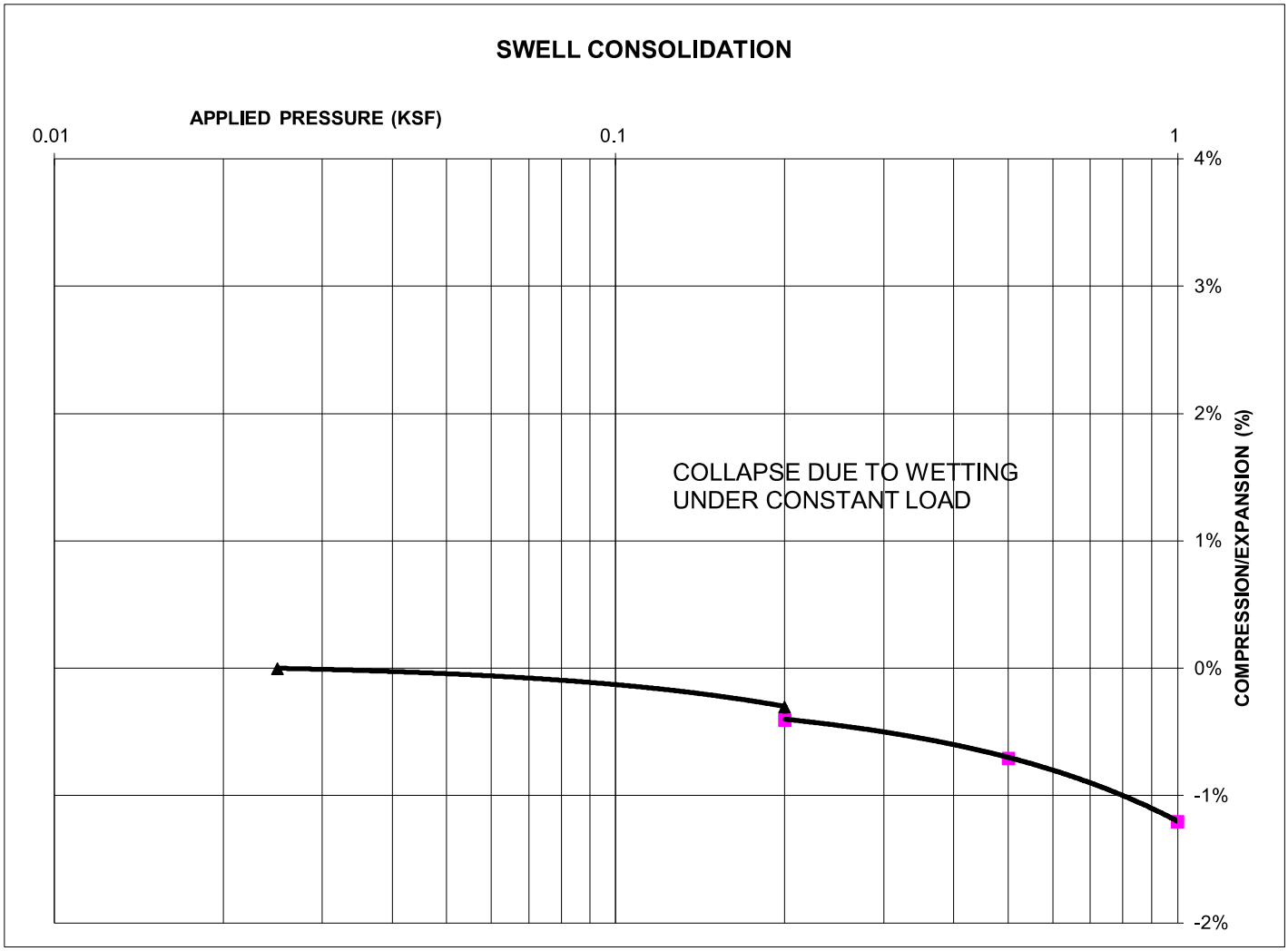
SWELL TEST RESULTS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

JOB NO. 250235

FIG. B-16

TEST BORING	8	SOIL DESCRIPTION	FILL, SAND, CLAYEY
DEPTH (FT)	1-2	SOIL TYPE	1



SWELL/COLLAPSE TEST RESULTS

NATURAL UNIT DRY WEIGHT (PCF):	117
NATURAL MOISTURE CONTENT:	10.6%
SWELL/COLLAPSE (%):	-0.1%

ENTECH ENGINEERING, INC.

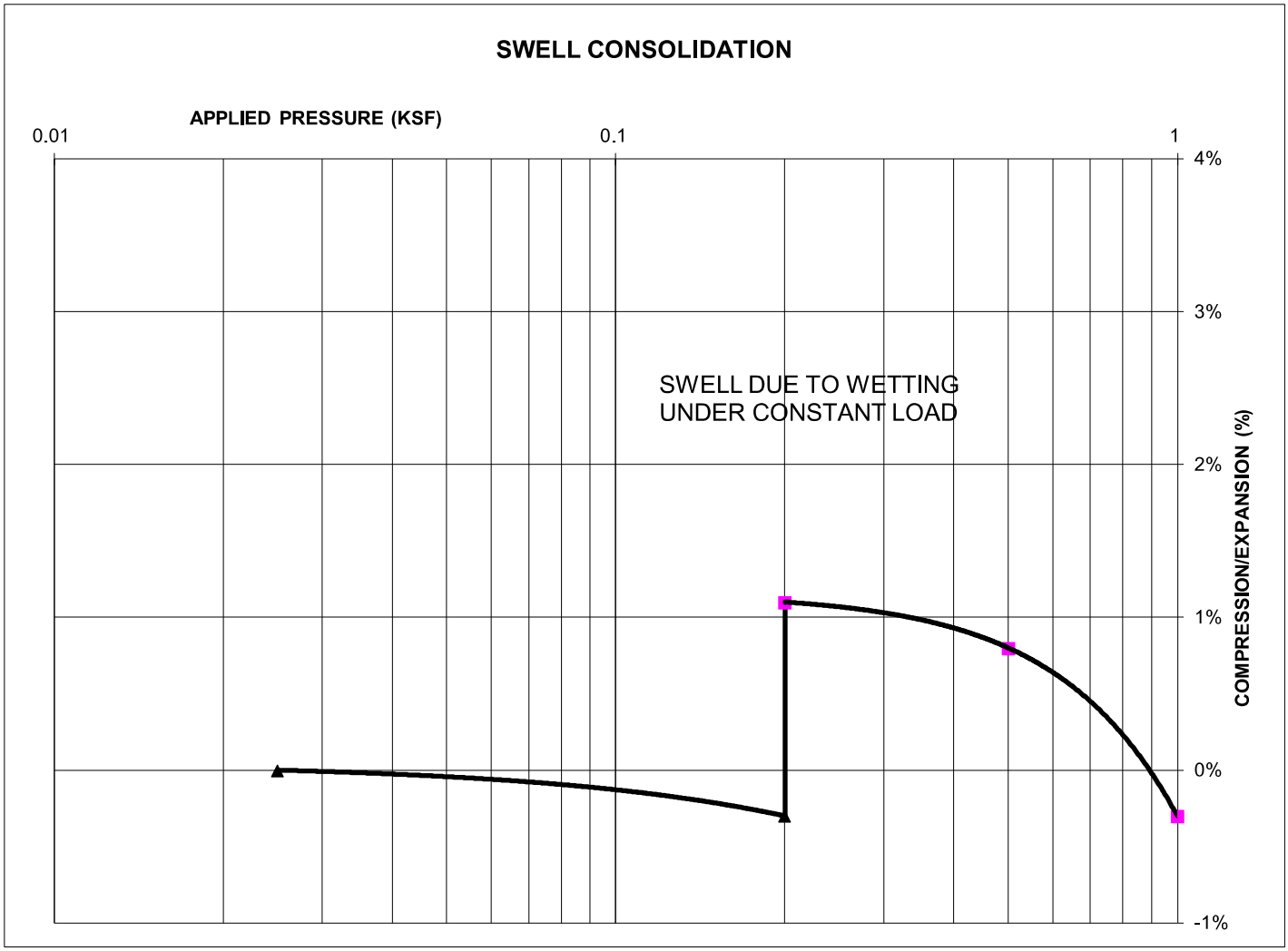
SWELL TEST RESULTS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

JOB NO. 250235

FIG. B-17

TEST BORING	6	SOIL DESCRIPTION	SANDSTONE (SAND, CLAYEY)
DEPTH (FT)	5	SOIL TYPE	3



SWELL/COLLAPSE TEST RESULTS

NATURAL UNIT DRY WEIGHT (PCF): 124
NATURAL MOISTURE CONTENT: 11.5%
SWELL/COLLAPSE (%): 1.4%

ENTECH ENGINEERING, INC.

SWELL TEST RESULTS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

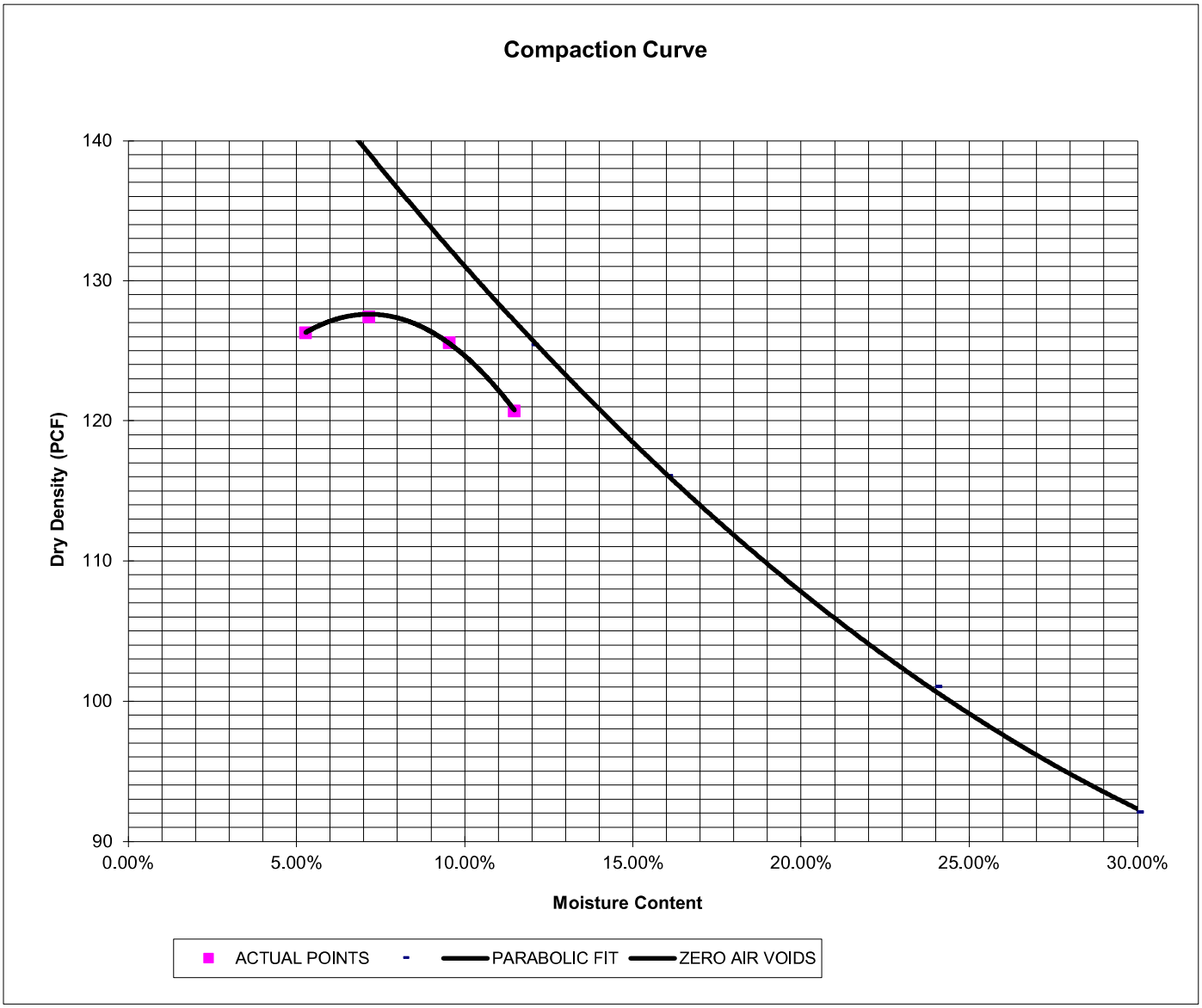
JOB NO. 250235

FIG. B-18

SAMPLE LOCATION TB-4 @ 0-3'	SOIL DESCRIPTION FILL, SAND, CLAYEY, BROWN
	SOIL TYPE 1

PROCTOR DATA

IDENTIFICATION:	SC
PROCTOR TEST #:	1
TEST BY:	PH
TEST DESIGNATION:	ASTM-1557-A
MAXIMUM DRY DENSITY (PCF):	127.5
OPTIMUM MOISTURE:	7.1



ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

JOB NO. 250235

FIG. B-19

SAMPLE LOCATION TB-4 @ 0-3' | SOIL DESCRIPTION FILL, SAND, CLAYEY, BROWN
SOIL TYPE 1

CBR TEST LOAD DATA

Piston Diameter (cm): 4.958
Piston Area (in^2): 2.993

Penetration Depth (inches)	*10 BLOWS* Mold # 1 Load (lbs)	Stress (psi)	*25 BLOWS* Mold # 2 Load (lbs)	Stress (psi)	*56 BLOWS* Mold # 3 Load (lbs)	Stress (psi)
0.000	0	0.00	0	0.00	0	0.00
0.025	138	46.12	184	61.49	410	137.01
0.050	264	88.22	292	97.58	673	224.89
0.075	375	125.31	390	130.33	836	279.36
0.100	435	145.36	556	185.80	1118	373.60
0.125	502	167.75	892	298.08	1366	456.47
0.150	566	189.14	1103	368.59	1457	486.88
0.175	615	205.51	1258	420.38	1566	523.31
0.200	643	214.87	1498	500.58	1723	575.77
0.300	736	245.95	2242	749.20	2646	884.21
0.400	844	282.04	2536	847.45	3542	1183.62
0.500	927	309.77	2793	933.33	4372	1460.98

MOISTURE AND DENSITY DATA

	Mold # 1	Mold # 2	Mold # 3
Can #	307	117	343
Wt. Can	6.83	9.45	6.96
Wt. Can+Wet	188.68	226.04	187.7
Wt. Can+Dry	169.39	204.72	172.82
Wt. H20	19.29	21.32	14.88
Wt. Dry Soil	162.56	195.27	165.86
Moisture Content	11.87%	10.92%	8.97%
Wet Density (PCF)	125.9	130.1	137.0
Dry Density (PCF)	117.6	121.5	127.9
% Compaction	92%	95%	100%
CBR	14.54	18.58	37.36

PROCTOR DATA

Maximum Dry Density (pcf)	127.5
Optimum Moisture	7.1
90% of Max. Dry Density (pcf)	114.8
95% of Max. Dry Density (pcf)	121.1

CBR at 90% of Max. Density = 11.7 ~ R VALUE 35
CBR at 95% of Max. Density = 18.2 ~ R VALUE 65

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

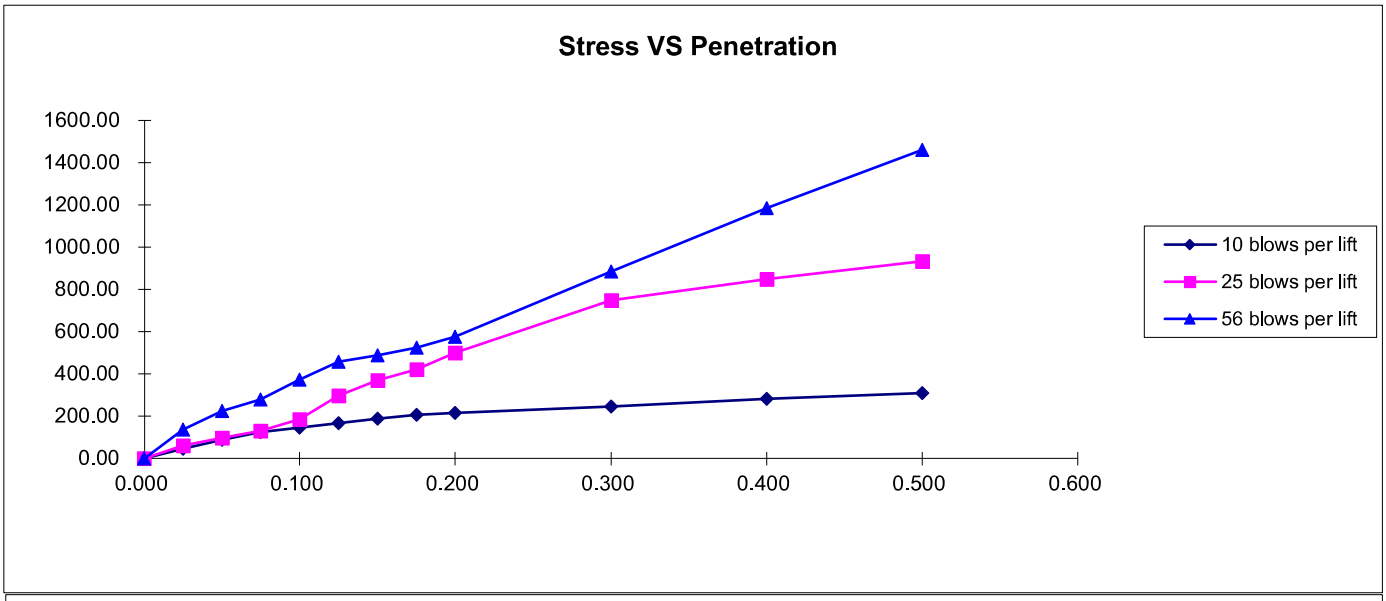
ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

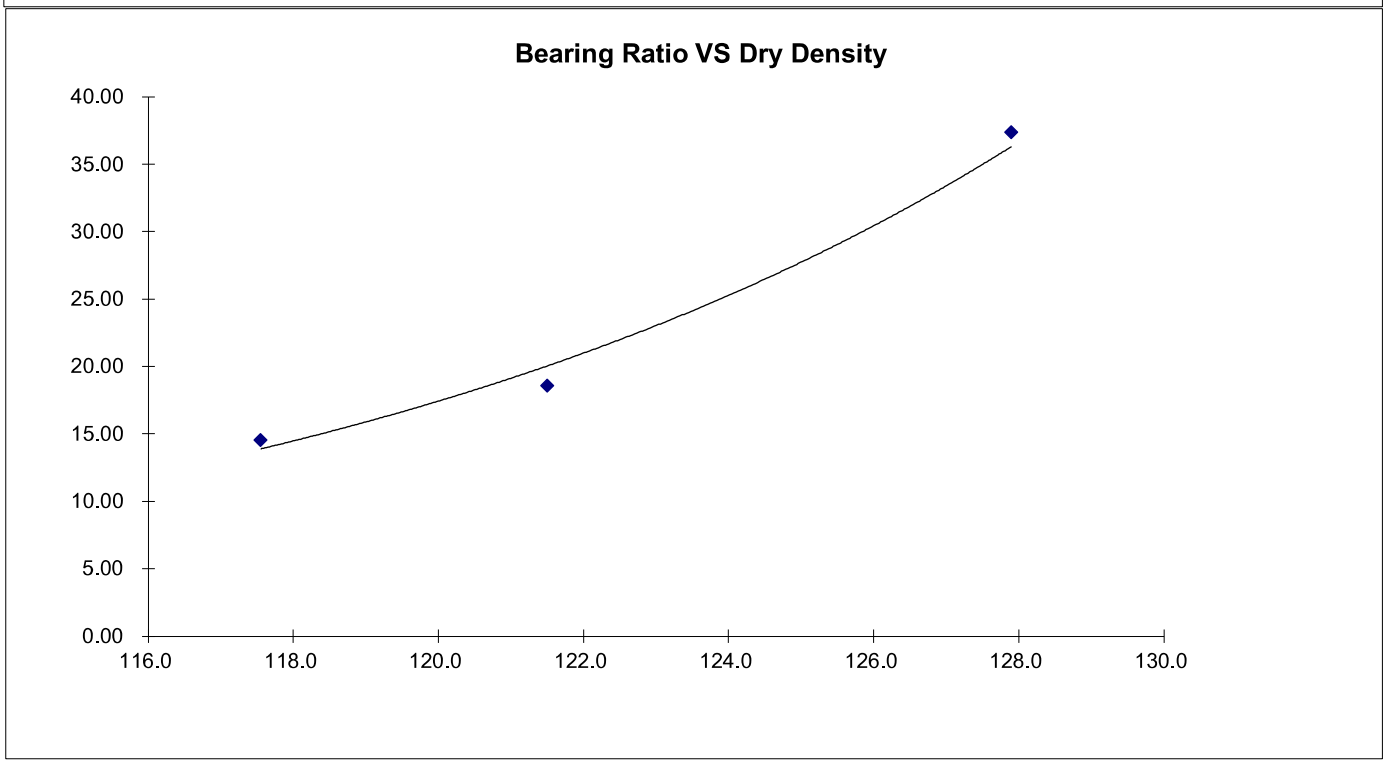
JOB NO. 250235

FIG. B-20

SAMPLE LOCATION TB-4 @ 0-3'

SOIL DESCRIPTION FILL, SAND, CLAYEY, BROWN
SOIL TYPE 1





ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

ROLLING HILLS RANCH NORTH, F1, PHASE 1
TECH CONTRACTORS

JOB NO. 250235

FIG. B-21

APPENDIX C: Pavement Design Calculations

FLEXIBLE PAVEMENT DESIGN

PROJECT DATA

Project Location: Rolling Hills Ranch North, Filing No. 1, Phase 1

Job Number: 250235

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	Δpsi =	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 = (CBR) x 1,500

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

Required Structural Number

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

Pavement Section Thickness

$SN^* = C_1D_1 + C_2D_2$ where:

C_1 = Strength Coefficient - HMA

C_2 = Strength Coefficient - ABC

D_1 = Depth of HMA (inches)

D_2 = Depth of ABC (inches)

RECOMMENED THICKNESSES

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

Pavement SN > Required SN, Design is Acceptable

FIG. C-1

FLEXIBLE PAVEMENT DESIGN

PROJECT DATA

Project Location: Rolling Hills Ranch North, Filing No Phase 1

Job Number: 250235

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	Δpsi =	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 = (CBR) x 1,500

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

Required Structural Number

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

Pavement Section Thickness

$SN^* = C_1D_1 + C_2D_2$ where:

C_1 = Strength Coefficient - HMA

C_2 = Strength Coefficient - CTS

D_1 = Depth of HMA (inches)

D_2 = Depth of CTS (inches)

RECOMMENED 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