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*Approved
By: Elizabeth Nijkamp, PE
Date:05/23/2023
El Paso County Department of Public Works

*A mix design and analysis for depth will be required if CTS is used.

SUBGRADE INVESTIGATION AND PAVEMENT DESIGN CONSTITUTION AVENUE AND MARKSHEFFEL ROAD MULTIFAMILY DEVELOPMENT AKERS DRIVE EL PASO COUNTY, COLORADO

Prepared For:

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Greenwood, IN 46143

Attn: Karl Stout

Project No. CS19460-135

April 14, 2023
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Revised: May 11, 2023

PCD File No. SF226

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TABLE OF CONTENTS

SCOPE

This report presents the results of our Subgrade Investigation and Pavement Design for the portion of Akers Drive extending into the Multifamily Development located southwest of the intersection of Constitution Avenue and Marksheffel Road in El Paso County, Colorado. The purpose of our investigation was to evaluate the type of subgrade soils and the support characteristics of the subgrade materials present at the site.

This report was prepared from data developed during our field exploration and observations, results of laboratory testing, engineering analysis, and our experience with similar conditions. It includes a description of the subgrade materials found in our exploratory borings, laboratory test results, and design pavement sections for reconstruction, along with our recommendations for pavement construction based on the subgrade conditions found. The design pavement sections presented in this report were developed based on El Paso County design criteria for asphalt pavement.

SITE CONDITIONS

The portion of Akers Drive which will be maintained by El Paso County totals approximately 500 lineal feet. The general vicinity of the project is shown on Fig. 1. The road will slope from the north to the south with a round-about about 240 feet south of Constitution Avenue. At the time of our investigation, the roadway had not been graded for the current construction, and the site was covered with native grasses and weeds. Various utilities have been installed in the area during development of surrounding areas.

SUBGRADE INVESTIGATION

Subgrade conditions were evaluated by drilling a total of four (4) borings within the proposed right-of-way, out of the alignment of the storm sewer easements. The

borings extended to depths of 15 to 20 feet. Modified California drive samples were obtained at depths of 4, 9, 14, and 19 feet. The borings were extended to penetrate existing fill. Bulk samples of the subgrade materials were collected to a depth of 4 feet below the existing grade. The approximate boring locations are shown on Fig. 1. Graphical logs of the borings are presented in Fig. 4. The borings were backfilled upon completion of drilling.

SUBGRADE CONDITIONS

The subgrade materials encountered predominately consisted of very clayey sand fill with a single occurrence of silty sand fill in a slightly moist to moist condition. No free groundwater or abnormally high moisture contents were noted during drilling.

Laboratory testing was performed to provide index properties (sieve analysis and Atterberg Limits) for the bulk soil samples. The subgrade materials found classify as A-6 with a single occurrence of A-2-4 under the AASHTO system. The bulk samples of the very clayey sands (A-6 materials) were combined into a composite sample and subjected to Hveem Stabilometer testing. Results of Hveem stabilometer testing indicated a design “R” value of 25.

One bulk sample of the A-6 subgrade materials (very clayey sand) was subjected to water-soluble sulfate testing, indicating a sulfate concentration of less than 0.1 percent. The purpose of the sulfate testing was to determine the risk of increased swelling if chemical stabilization of the subgrade is performed and the likelihood of sulfate attack on plain Portland cement concrete. The influence is discussed in the applicable sections of the report. Laboratory test results are presented in Figures 5 through 10.

Undocumented Fill

Undocumented fill was identified during this investigation in the four test borings to depths ranging from 9 to 14 feet below the grades at the time of the investigation. Some fill materials may have been associated with utility installation, or

grading operations related to Constitution Avenue or surrounding development. Undocumented fill increases the risk of poor pavement structure performance, as it is possible that poorly compacted or unstable materials may be present within the fill. If documentation such as the field observation and density testing reports of the placement of the fill is available, we can review the documentation and determine the suitability of the existing fill. Field penetration resistance testing and results of our laboratory testing indicates the fill was likely placed at two different times. The penetration resistance testing of fill encountered to the south of the round-about indicated the fills to be medium dense to dense in the vicinity of the drainage control structures and may have been placed with compaction effort. Penetration resistance testing of the fills encountered north of the south side of the round-about indicated the materials were loose. The most reliable approach to reduce risk of settlement associated with variations of the existing fill is to remove all existing, undocumented fill from below the proposed roadway; however, this would result in substantial additional cost. Partial reconstruction or further evaluation of the fill is expected to be a suitable approach to pavement construction. We believe the existing fill south of the round-about may remain below the roadway, provided the fill material is further evaluated by a representative of this office during site grading.

The risk of poor pavement performance associated with undocumented fill north of the round-about can be reduced by constructing the road on at least a 5-foot-thick layer of new, densely compacted fill. The thickness of fill should be measured from the bottom of the aggregate base course elevation. The excavation zone should extend laterally at least 5 feet beyond the outer edges of the detached sidewalks. The excavation depth may transition quickly at the tie-in to Constitution Avenue where controlled fill materials are expected. Transitions to private roads should be more gradual to avoid abrupt changes in subgrade conditions. Figure 3 shows the area where fill mitigation is required. Additional areas to the south may still require mitigation.

The on-site materials consist of clayey to very clayey sands with occasional claystone and sandstone fragments. During placement, samples of the fill shall be

subjected to index property testing, and swell testing on remolded samples, to ensure the materials are of the same AASHTO Classification or better than samples as used in the pavement section design. If the placed fill differs from the samples utilized for the pavement design, we will need to re-evaluate the provided pavement sections.

Our representative should observe the completed excavation prior to any backfill placement to verify the conditions exposed in the excavation are as expected and the existing fill has been removed where appropriate. The placement and compaction of fill and subgrade preparation should be observed and tested by a representative of our firm during placement.

DESIGN PAVEMENT SECTION

A traffic study for the site was not provided for our preparation of this report. The portion of Akers Drive included has a raised center median, round-about, and detached sidewalks. The pavement widths vary throughout the length of the road to accommodate for turn lanes and approaches to the round-about, and the southern exit from the round-about leads to currently undeveloped property. We believe Akers Drive will classify as an Urban Non-residential Collector Street with a minimum 20-year, estimated single-axle load (ESAL) of 821,000 as specified by El Paso County.

The El paso County pavement design criteria was used to convert an “R” value of 25, to a Resilient Modulus (M_r) of 5,816 for the A-6 materials using the following equation:

$$M_r = 10^{(S+18.72)/6.24}$$

Where $S=[(R\text{-value}-5)/11.29]+3$

The 1993 AASHTO design method was used to calculate a structural number of 3.31. Utilizing the 20-year ESAL’s of 821,000 and a design “R” value of 25. Results are presented below in Table 1. We calculated two pavement section consisting of asphalt over an aggregate base course. Design calculations are presented in Figures 11 and 12.

TABLE 1
PAVEMENT THICKNESS ALTERNATIVES

CLASSIFICATION	ASPHALT OVER AGGREGATE BASE COURSE (ABC)
URBAN NON-RESIDENTIAL COLLECTOR AKERS DRIVE "R" = 25	~~4.5 AC + 12.5" ABC~~ or 6" AC + 8" ABC

5.0" AC + 10.5" ABC
change by EN per TM 5/23/23

El Paso County generally requires the pavement section to consist of asphalt over aggregate base course, but will currently allow a cement treated subgrade layer in place of the base course. A mix design would be required to use the cement treated option, which may impact the feasibility of this type of section. We anticipate a section consisting of 5 inches of asphalt over 12 inches of cement stabilized subgrade would be required. We can explore the cement stabilization option further, if desired.

PAVEMENT CONSTRUCTION DETAILS

We recommend fill and the subgrade be prepared in accordance with the El Paso County Standard Specifications for roadways. These specifications contain recommendations for scarification, moisture conditioning and compaction of the subgrade. We recommend a proof roll and density testing be performed prior to aggregate base course and asphalt pavement installation.

The design of a pavement system is as much a function of the quality of the paving materials and construction, as the support characteristics of the subgrade. The construction process should follow procedures and specifications accepted by El Paso County for subgrade preparation and compaction, and the Pikes Peak Region Asphalt Paving Specifications for asphaltic concrete mixes and strength of materials criteria. Regionally specified construction materials are considered to possess sufficient quality to be in accordance with the material strength coefficients used in

the design calculations. During construction, careful attention should be paid to compaction at utility crossings, manholes, valve boxes, and grading fill placement.

The Pikes Peak Region Asphalt Pavement Specifications (PPRAPS) currently recommend an oil content for moderate volume pavements like those addressed in this investigation. The PPRAPS criteria requires the use of PG 58-28 for the asphalt binder or PG 64-22 with the approval of the County. The specifications recommend the super pave mix be based on 75 Design Gyrations (N_{des}) for roadways of all traffic levels.

LIMITATIONS

The pavement sections and construction recommendations provided are based on our field observations and laboratory testing and El Paso County design criteria. The design procedures were formulated to provide pavement sections with adequate structural strength. Routine maintenance, such as sealing and repair of cracks, is necessary to achieve the long-term life of a pavement system. If the design and construction recommendations cannot be followed, or anticipated traffic loads change considerably, we should be contacted to review our recommendations.

We believe the geotechnical services for this project were performed in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing under similar conditions in the locality of the project. No warranty, express or implied, is made.

If we can be of further service in discussing the contents of this report or in the analyses of the proposed pavement system from a geotechnical point-of-view, please call.

CTL|THOMPSON, INC.

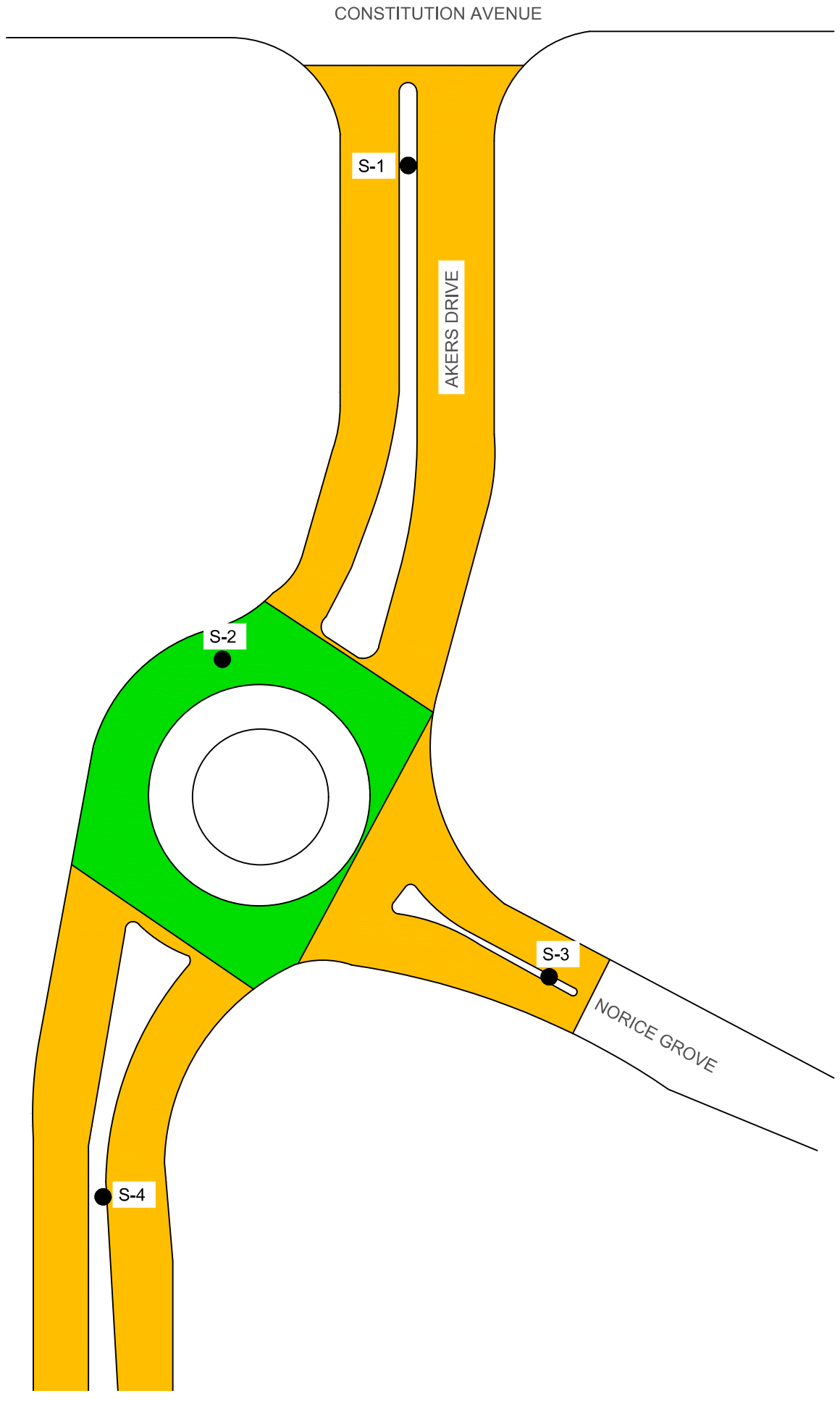
Dave Groenendale
Staff Engineer/Project Manager

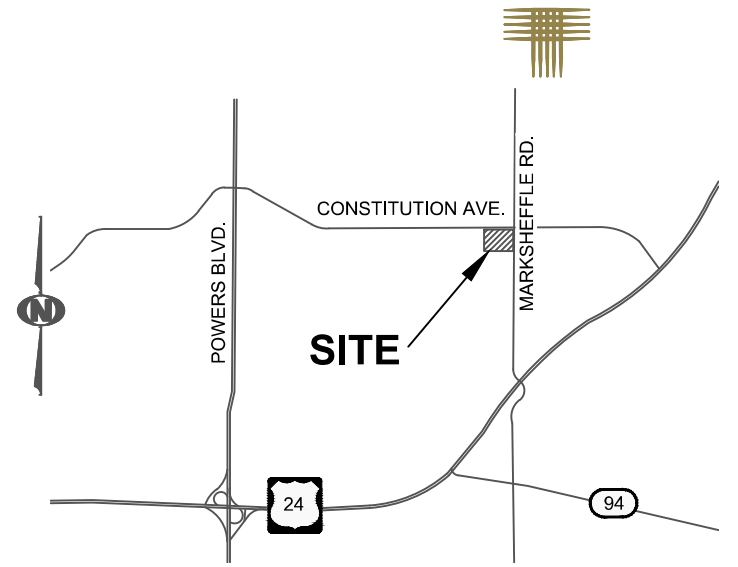
DG:TAM:cw
Via e-mail: karl@thegarrettco.com

Reviewed by:

Timothy A. Mitchell, P.E.
Principal Engineer

Timothy Mitchell
May 12 2023 2:14 PM





VICINITY MAP

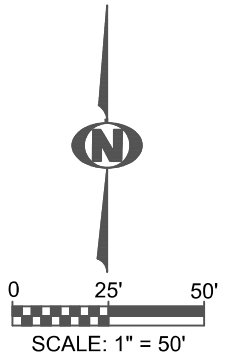
(NOT TO SCALE)

LEGEND:

S-1 APPROXIMATE LOCATION OF SUBGRADE SAMPLE.

A-2-4 MATERIAL

A-6 MATERIAL



Location of Exploratory Borings and Estimated Extent of Subgrade Materials Types

FIG. 1

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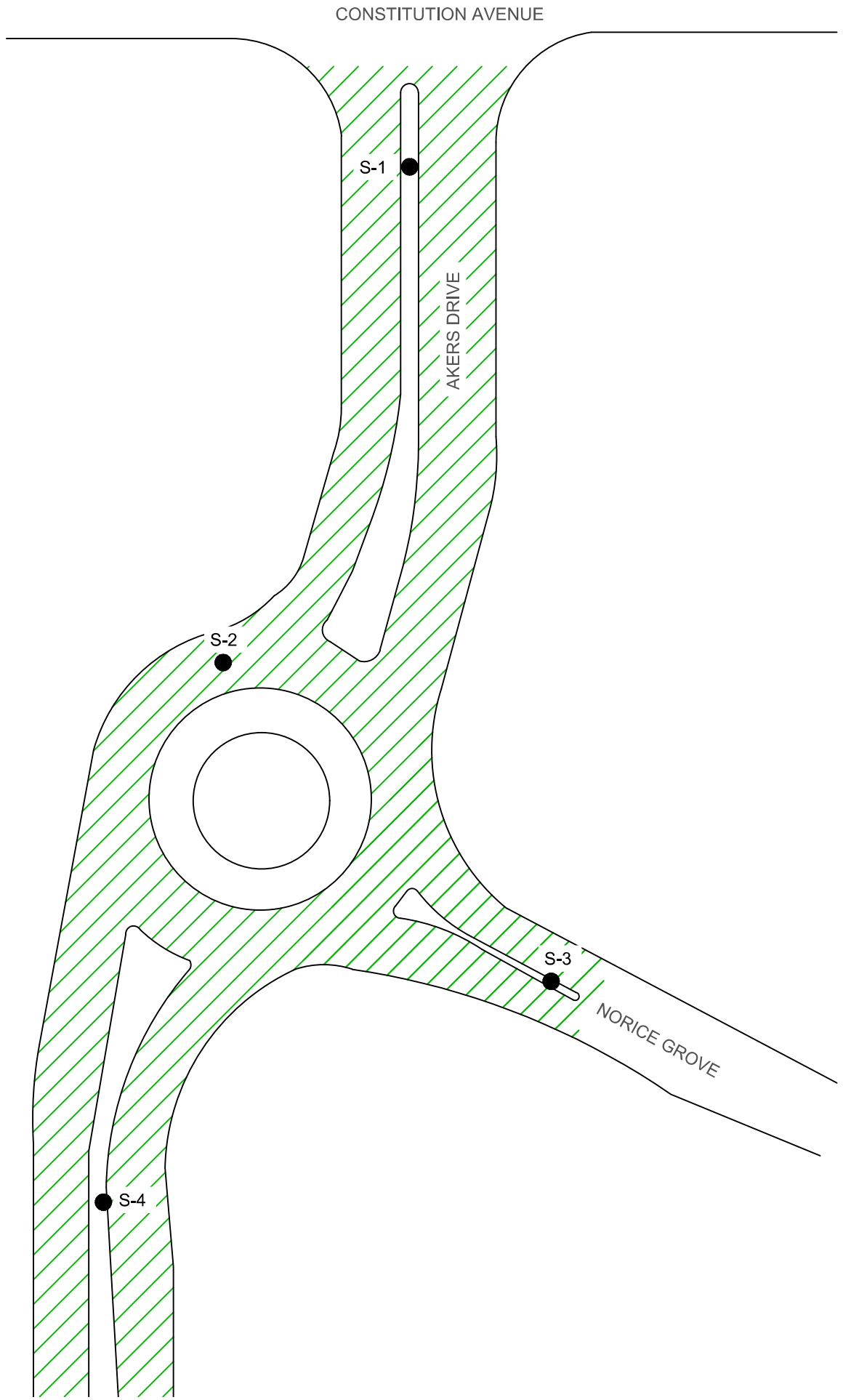
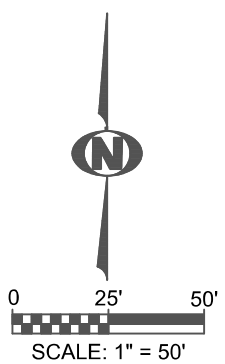


LEGEND:

URBAN NON-RESIDENTIAL COLLECTOR:
ESAL=821,000 "R"=25
~~4.5 INCHES ASPHALTIC CONCRETE OVER~~
~~12.5 INCHES AGGREGATE BASE COURSE~~

5.0" AC + 10.5" ABC

OR
6.0 INCHES ASPHALTIC CONCRETE OVER
8.0 INCHES AGGREGATE BASE COURSE



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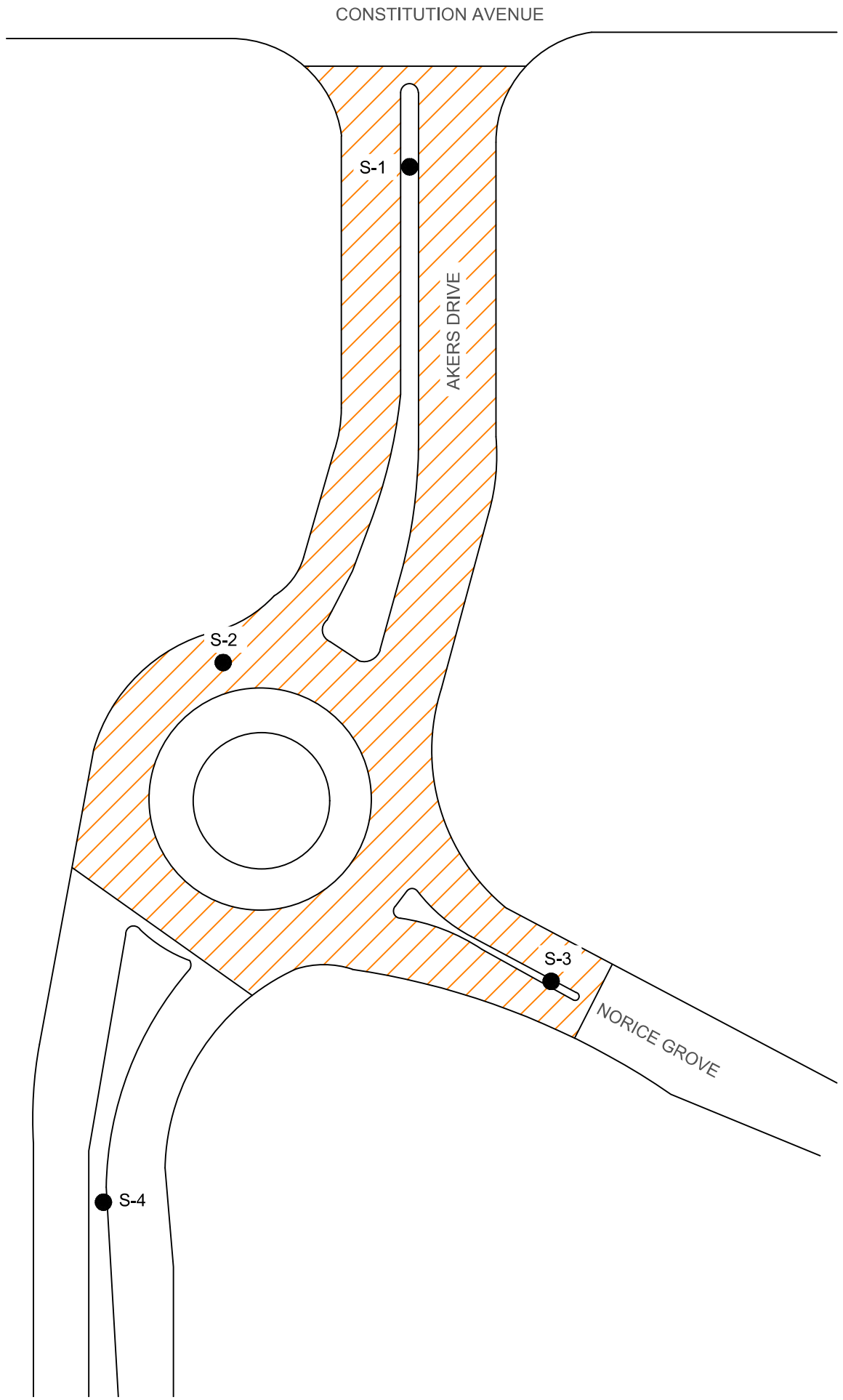
Design Pavement Options FIG. 2



LEGEND:

ESTIMATED EXTENT OF EXISTING FILL REQUIRING SUB-EXCAVATION

N

0 25' 50'

SCALE: 1" = 50'

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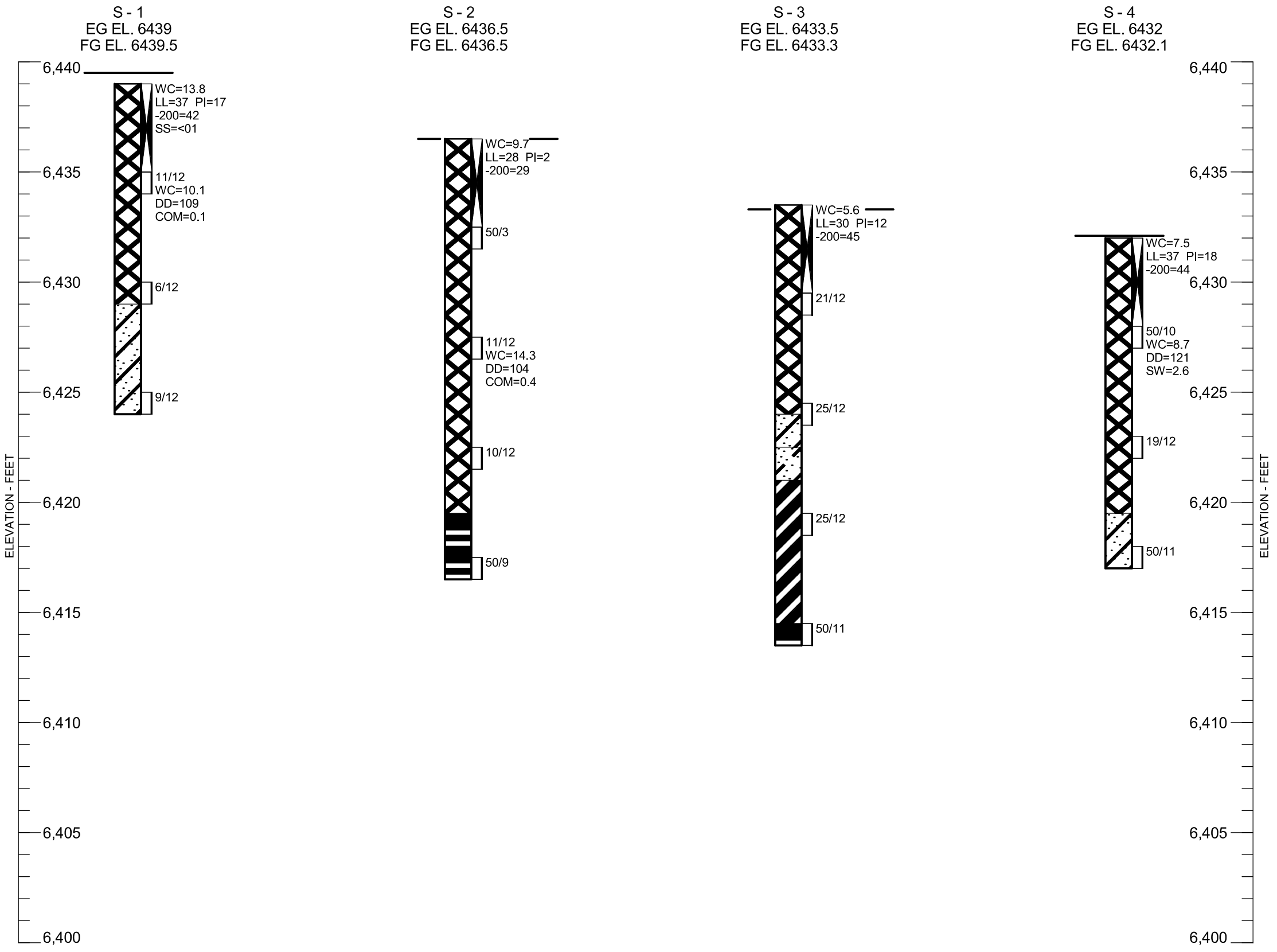
CTL|T PROJECT NO. CS19460-135

Estimated Limits of Fill Mitigation

FIG. 3



LEGEND:

- FILL, SAND, CLAYEY TO VERY CLAYEY, LOOSE TO MEDIUM DENSE, SLIGHTLY MOIST, BROWN, DARK BROWN.
- SAND, SLIGHTLY SILTY TO SILTY, LOOSE, SLIGHTLY MOIST TO MOIST, MEDIUM BROWN (SM).
- SAND, CLAYEY, MEDIUM DENSE, SLIGHTLY MOIST, BROWN, LIGHT BROWN (SC).
- WEATHERED CLAYSTONE, MOIST, BROWN, YELLOW.
- BEDROCK, CLAYSTONE, SANDY, HARD, SLIGHTLY MOIST, YELLOW-BROWN.
- DRIVE SAMPLE. THE SYMBOL INDICATES BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.5-INCH O.D. SAMPLER INCHES.
- INDICATES BULK SAMPLE OBTAINED FROM AUGER CUTTINGS.
- INDICATES PROPOSED GRADE.

NOTES:

1. THE BORINGS WERE DRILLED MARCH 15, 2023 USING A 4-INCH DIAMETER, CONTINUOUS-FLIGHT AUGER AND A CME-45, TRUCK-MOUNTED DRILL RIG.

2. GROUNDWATER WAS NOT ENCOUNTERED IN THE EXPLORATORY BORINGS DURING THIS INVESTIGATION.

3. WC - INDICATES MOISTURE CONTENT. (%)
   DD - INDICATES DRY DENSITY. (PCF)
   SW - INDICATES SWELL WHEN WETTED UNDER APPROXIMATE OVERBURDEN PRESSURE. (%)
   LL - INDICATES LIQUID LIMIT. (NV : NO VALUE)
   PI - INDICATES PLASTICITY INDEX. (NP : NON-PLASTIC)
   -200 - INDICATES PASSING NO. 200 SIEVE. (%)
   SS - INDICATES WATER-SOLUBLE SULFATE CONTENT. (%)

4. THESE LOGS ARE SUBJECT TO THE EXPLANATIONS, LIMITATIONS, AND CONCLUSIONS AS CONTAINED IN THIS REPORT.

5. ELEVATIONS SHOWN ARE ESTIMATED FROM THE EXISTING AND PROPOSED TOPOGRAPHY INDICATES ON THE PLANS.

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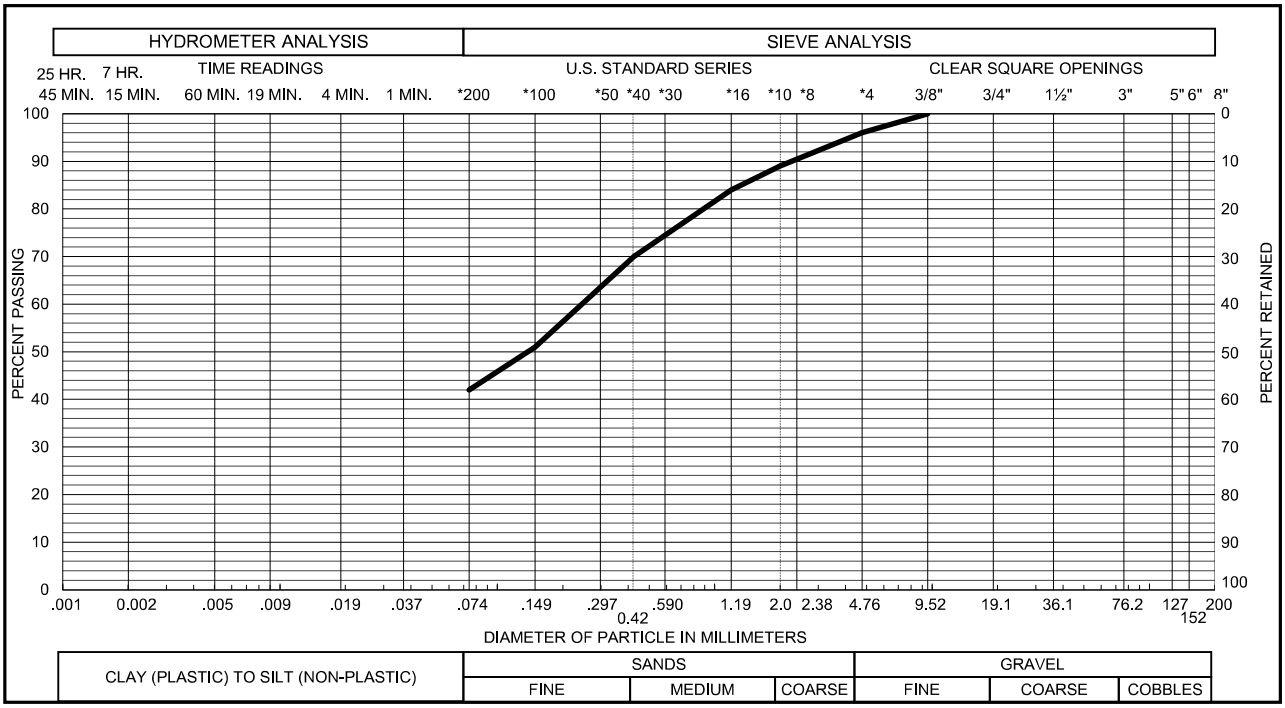
CTL|T PROJECT NO. CS19460-135

Summary Logs of Exploratory Borings

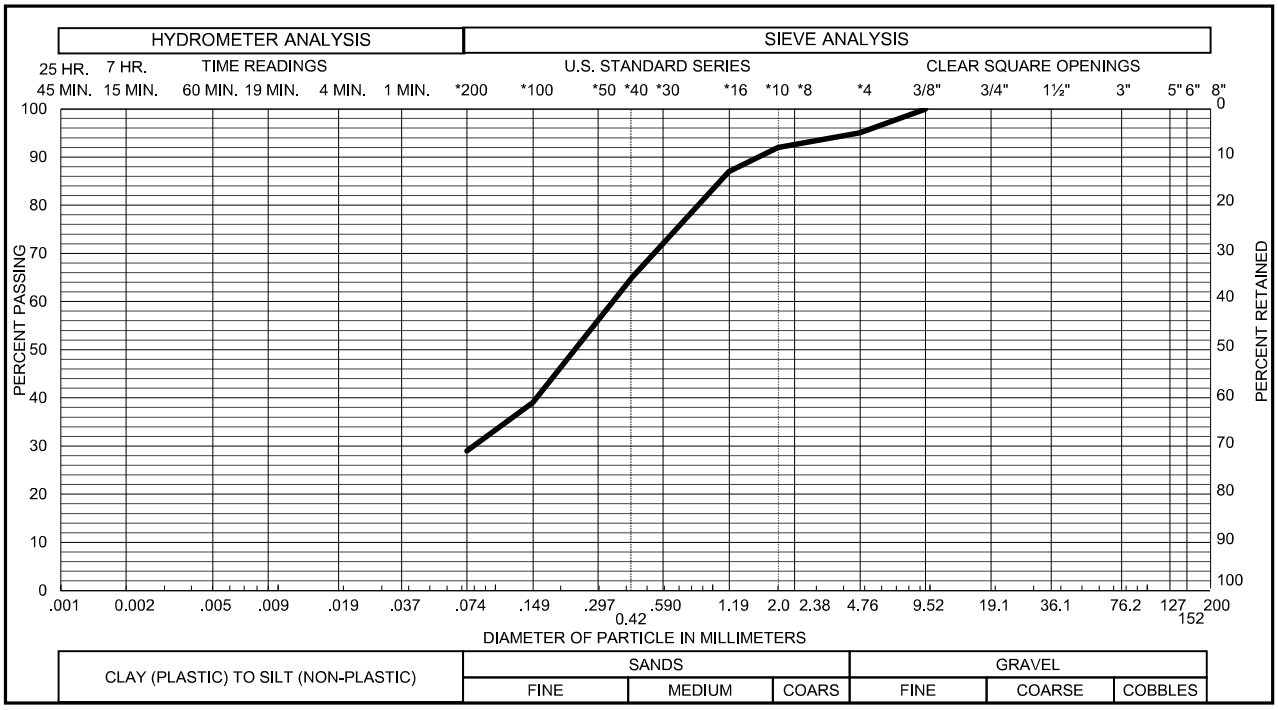
FIG. 4



Sample of FILL, SAND, VERY CLAYEY, SL. GRAVELLY (SC)(A-4

From S - 1 AT 0-5 FEET

GRAVEL	4 %	SAND	54 %
SILT & CLAY	42 %	LIQUID LIMIT	37
PLASTICITY INDEX			17



Sample of SAND, SILTY, SL. GRAVELLY (SM)(A-2-4)

From S - 2 AT 0-5 FEET

GRAVEL	5 %	SAND	66 %
SILT & CLAY	29 %	LIQUID LIMIT	28
PLASTICITY INDEX			2

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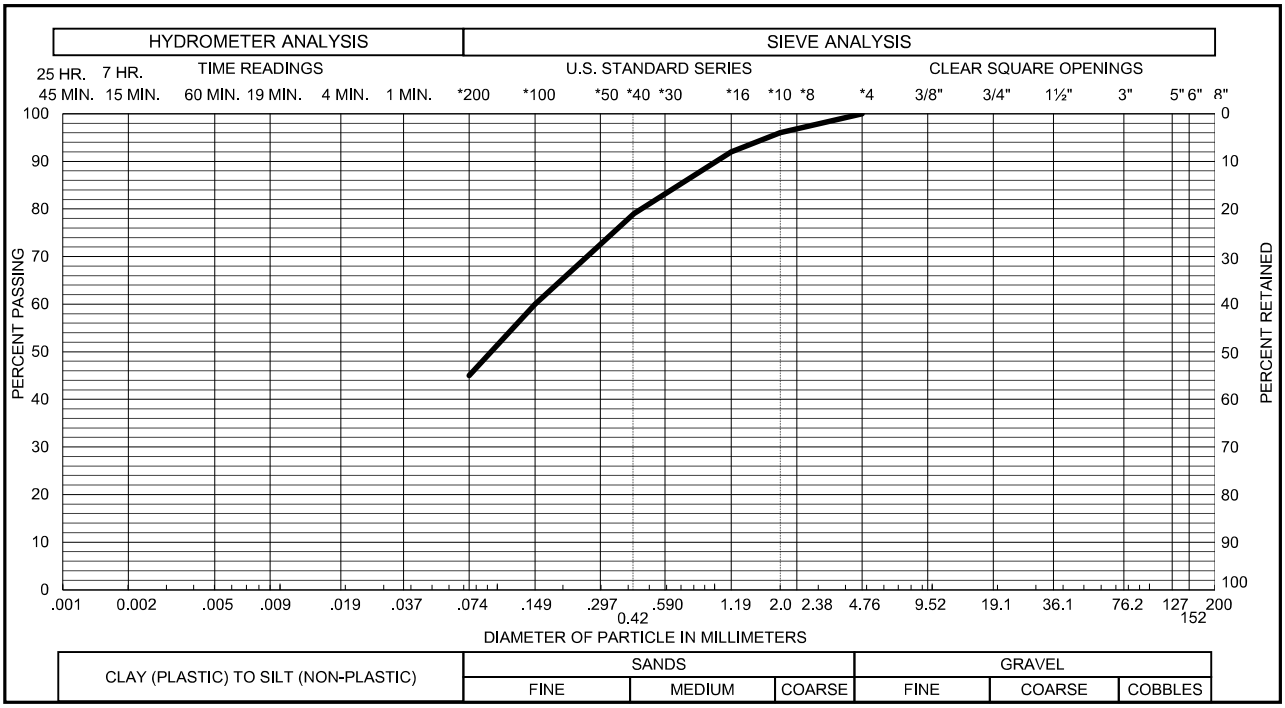
CTL|T PROJECT NO. CS19460-135

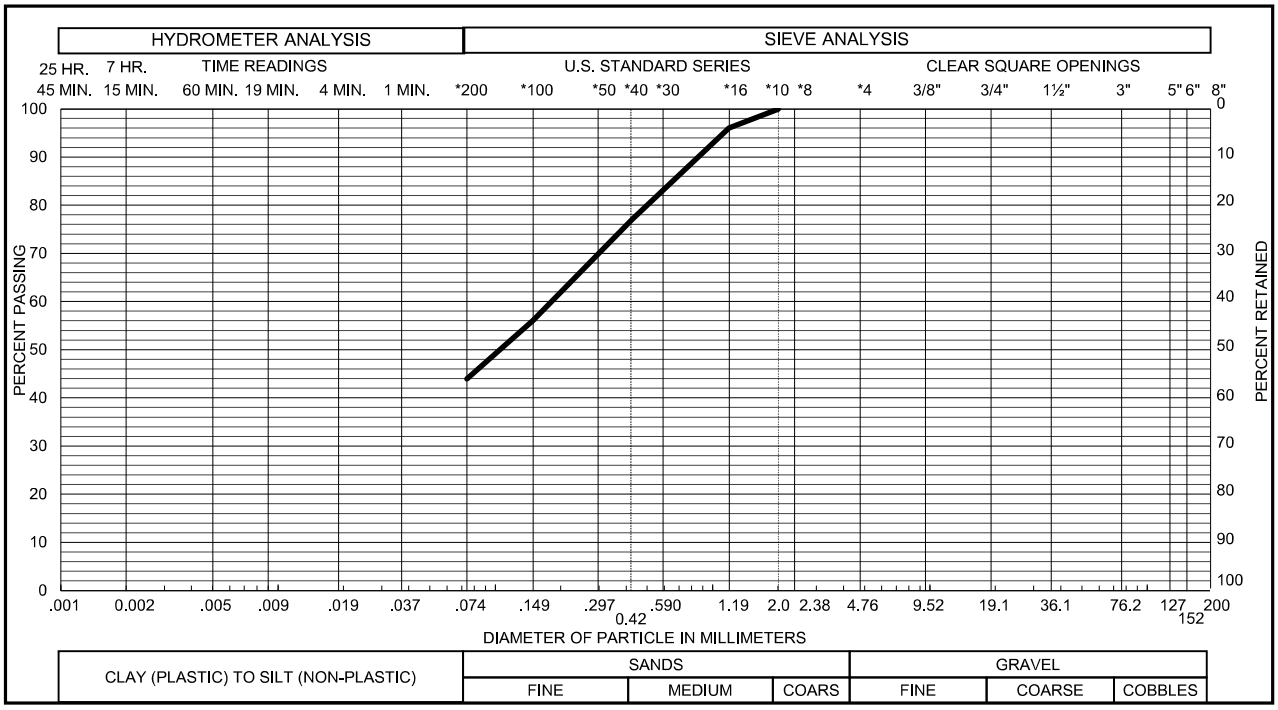
Gradation Test Results

FIG. 5



Sample of FILL, SAND, VERY CLAYEY, (SC)(A-6)
From S - 3 AT 0-5 FEET

GRAVEL	0 %	SAND	55 %
SILT & CLAY	45 %	LIQUID LIMIT	30
PLASTICITY INDEX			12



Sample of FILL, SAND, VERY CLAYEY, (SC)(A-6)
From S - 4 AT 0-5 FEET

GRAVEL	0 %	SAND	56 %
SILT & CLAY	44 %	LIQUID LIMIT	37
PLASTICITY INDEX			18

THE GARRETT COMPANIES
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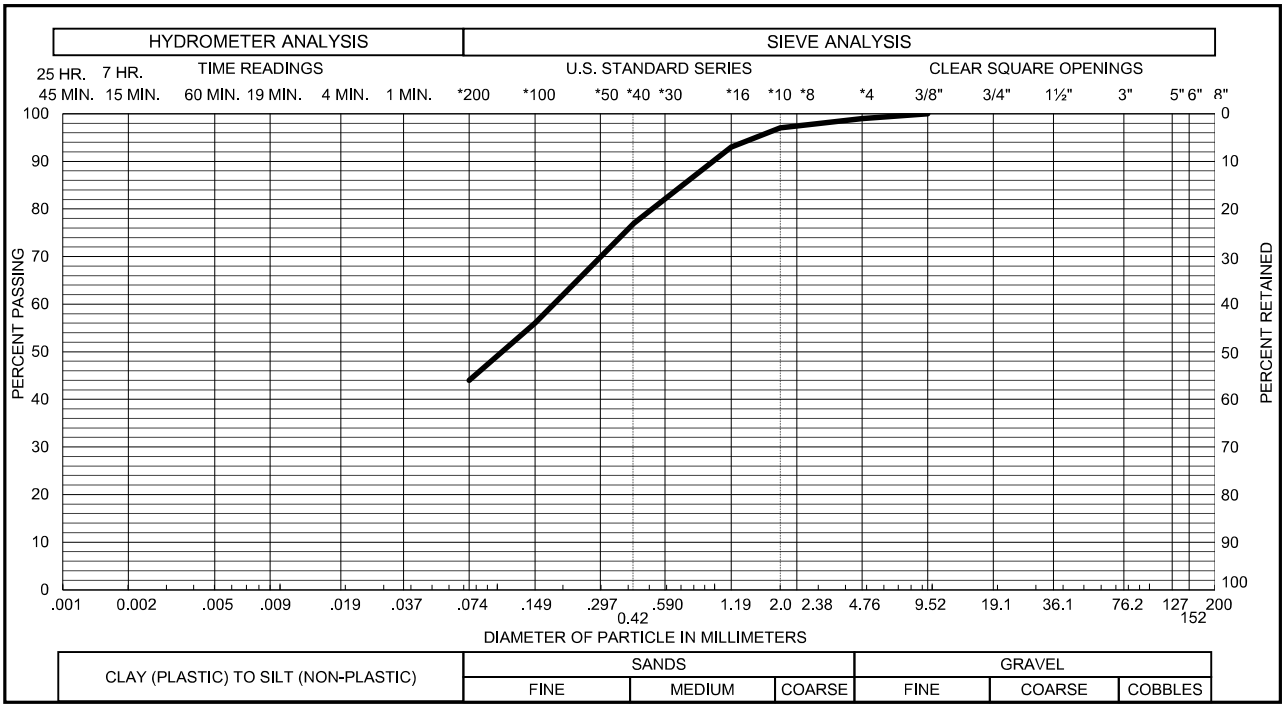
CTL|T PROJECT NO. CS19460-135

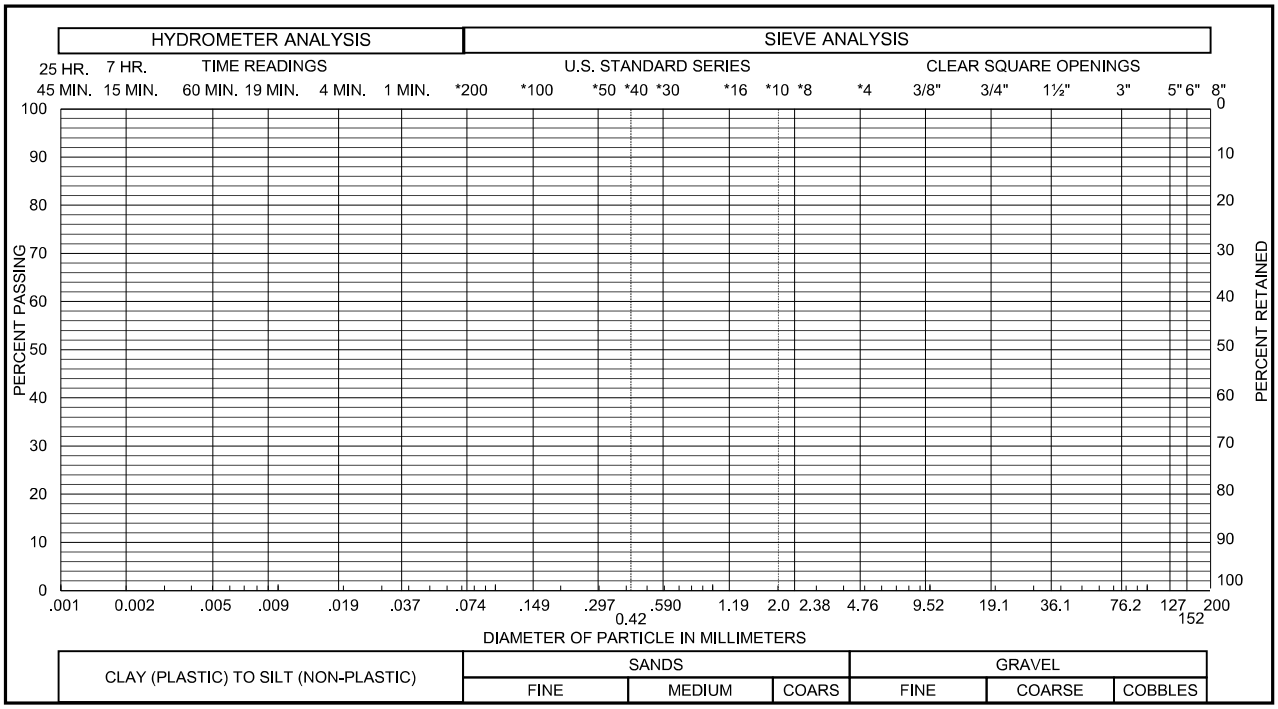
Gradation Test Results

FIG. 6



Sample of FILL, SAND, VERY CLAYEY, (SC)(A-6)
From GROUP B COMPOSITE

GRAVEL	1 %	SAND	55 %
SILT & CLAY	44 %	LIQUID LIMIT	35
PLASTICITY INDEX			16



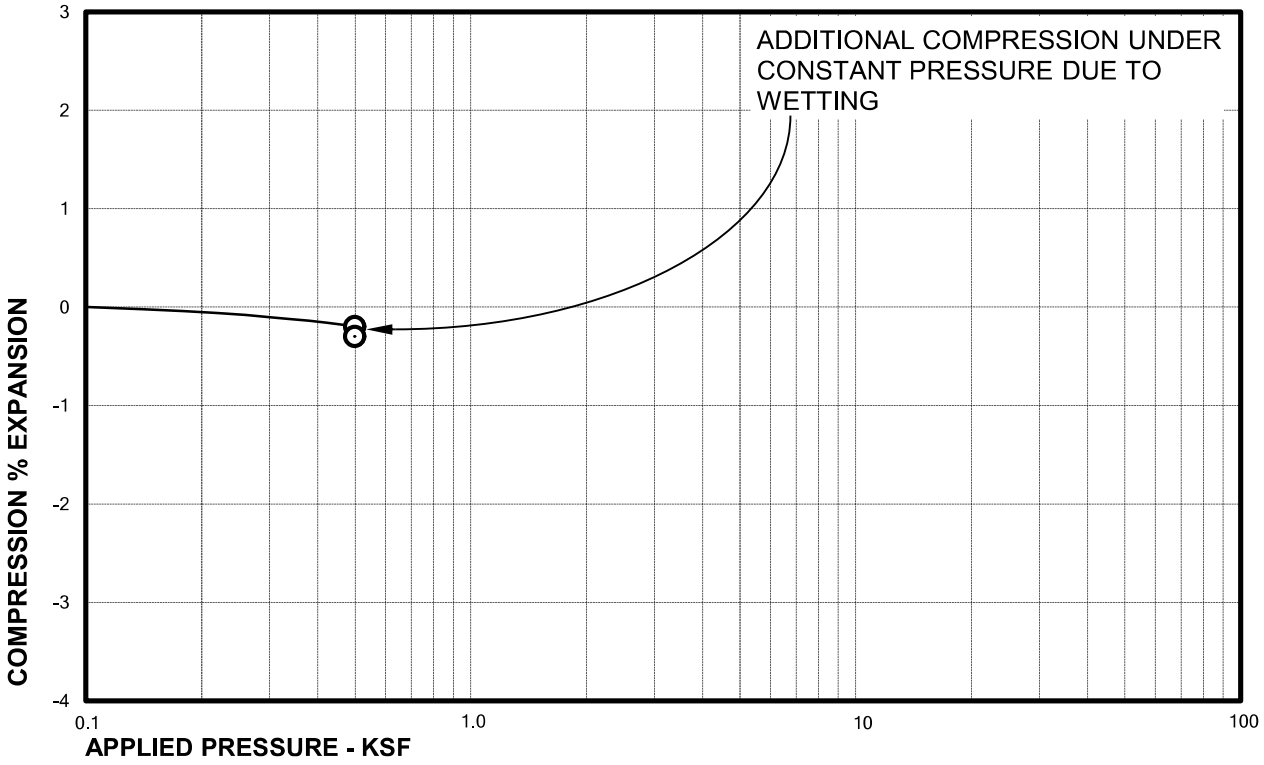
Sample of
From

GRAVEL	%	SAND	%
SILT & CLAY	%	LIQUID LIMIT	
PLASTICITY INDEX			

THE GARRETT COMPANIES
CONSTITUTION AVENUE AND MARKSHEFFEL ROAD MULTIFAMILY DEVELOPMENT
CTL|T PROJECT NO. CS19460-135

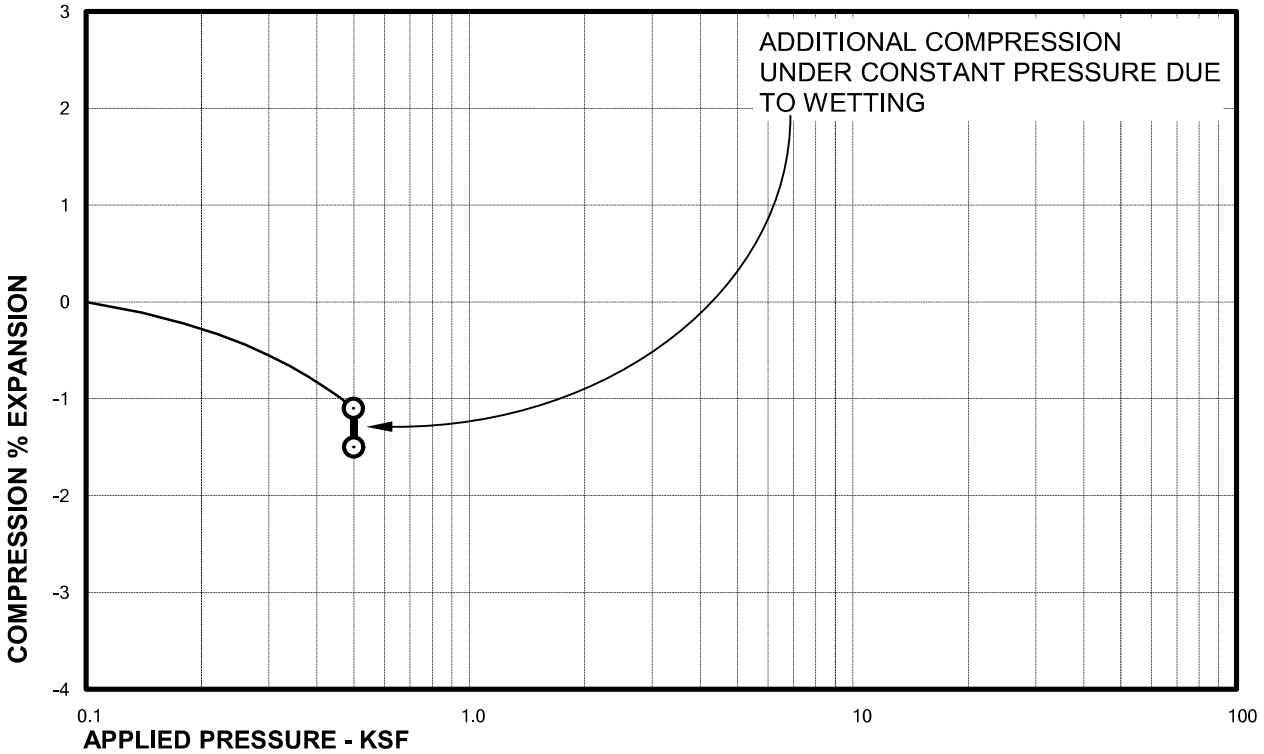
Gradation Test Results

FIG. 7



Sample of FILL, SAND, VERY CLAYEY, SL. GRAAVELLY (SC)(A-6) DRY UNIT WEIGHT= 109 PCF

From S-1 AT 4 FEET MOISTURE CONTENT= 10.1 %



Sample of FILL, SAND, SILTY, SL. GRAVELLY (SM)(A-2-4) DRY UNIT WEIGHT= 104 PCF

From S-2 AT 9 FEET MOISTURE CONTENT= 14.3 %

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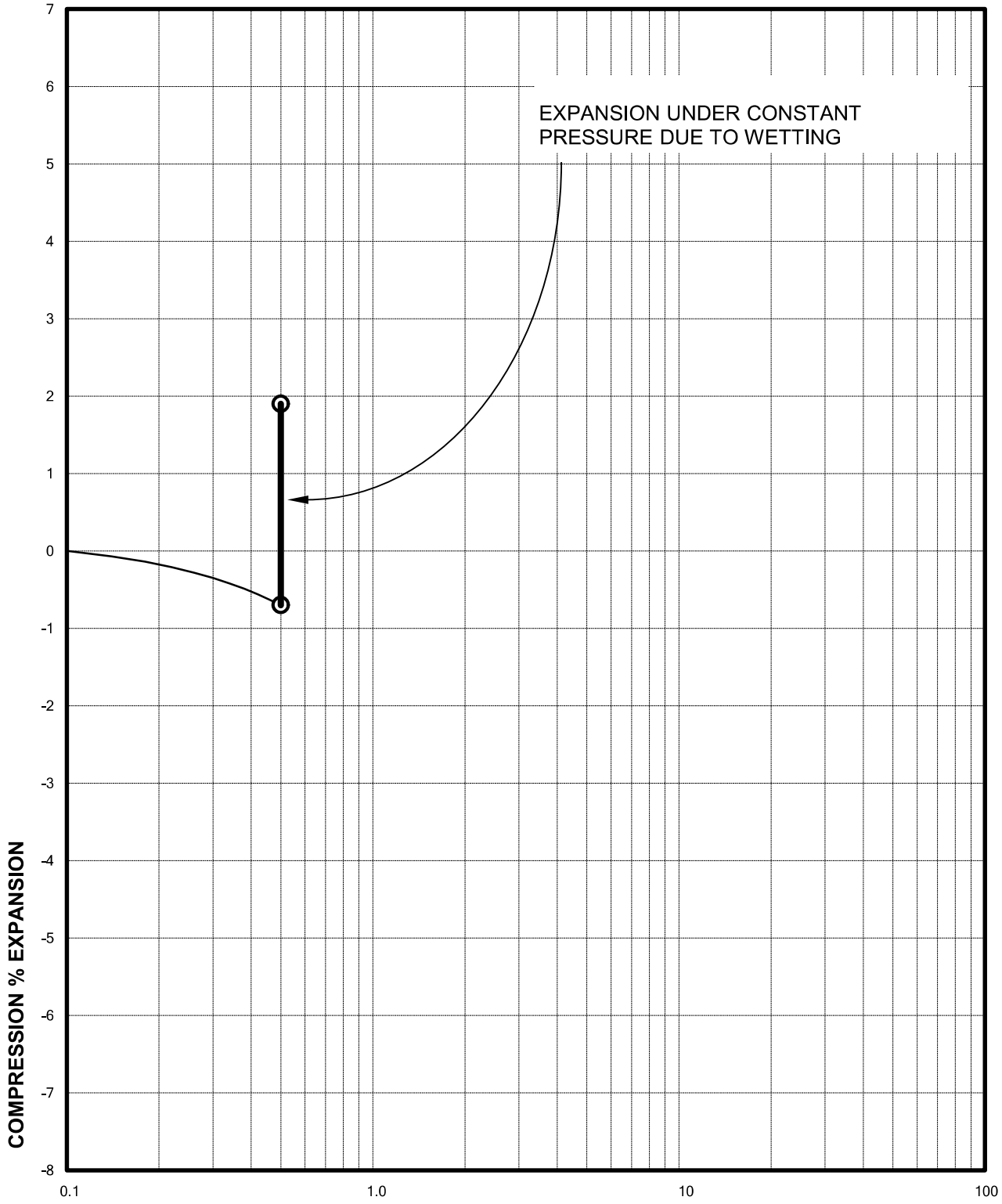
CTL|T PROJECT NO. CS19460-135

Swell Consolidation

FIG. 8



Sample of FILL, SAND, VERY CLAYEY (SC)
From S-4 AT 4 FEET

DRY UNIT WEIGHT= 121 PCF
MOISTURE CONTENT= 8.7 %

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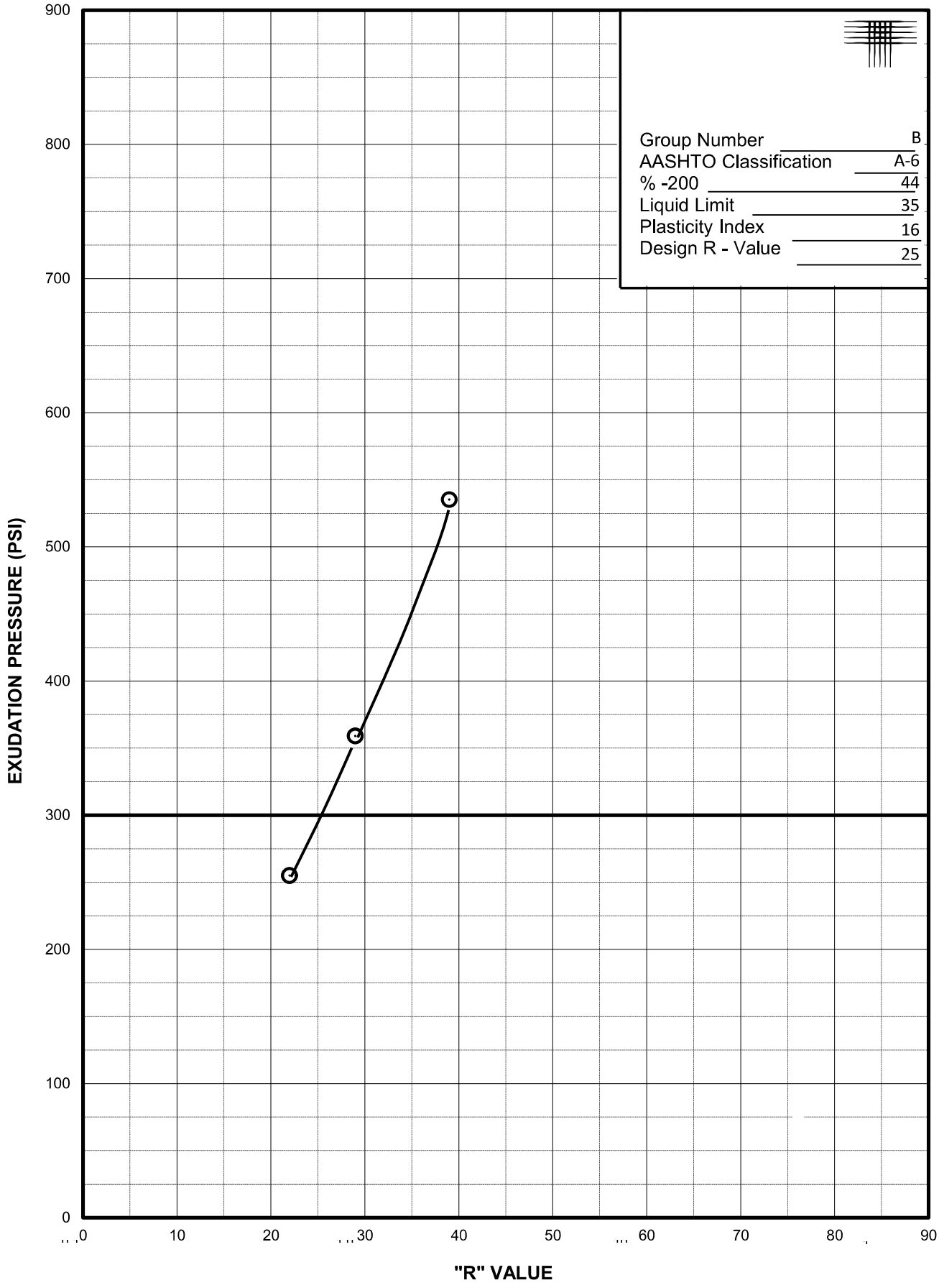
CONSTITUTION AVENUE AND AKERS DRIVE
CTL|T PROJECT NO. CS19460-135

Swell Consolidation Test Results

FIG. 9



THE GARRETT COMPINES
CONSTITUTION AVENUE AND AKERS DRIVE
CTL|T PROJECT NO.CS19460-135
J:\LAB_TEMPLATES\To be Released\Hveem.xls

Hveem Stabilometer Test Results

FIG. 10

Flexible Structural Design

AKERS DRIVE
URBAN NON-RESIDENTIAL COLLECTOR
A-6 MATERIALS

not per EPC criteria, may not be used.

Reliability	85 %
Standard Deviation	0.44
Initial Serviceability	4.5
Terminal Serviceability	2.5
Resilient Modulus	5,816 psi
Design ESALs	1,000

Design Structural
3.31

Layers	Structur Coefficien	nage	Thickness	SN
HMA	0.44		4.5	1.98
ABC	0.11		12.5	1.38
CSS	0.14			0.00
			SUM	3.36

Flexible Structural Design

AKERS DRIVE
URBAN NON-RESIDENTIAL COLLECTOR
A-6 MATERIALS

Reliability	85	%
Standard Deviation	0.44	
Initial Serviceability	4.5	
Terminal Serviceability	2.5	
Resilient Modulus	5,816	psi
Design ESALs	821,000	

Design Structural Number
3.31

Layers	Structural Coefficient	Drainage	Thickness	SN
HMA	0.44	1	6.0	2.64
ABC	0.11	1	8.0	0.88
CSS	0.14	1		0.00
			SUM	3.52

TABLE 1

SUMMARY OF LABORATORY TESTING
CTL|T PROJECT NO. CS19460-135

SUBGRADE SAMPLE	DEPTH (FEET)	GROUP NAME	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	ATTERBERG LIMITS		SWELL* (%)	PASSING NO. 200 SIEVE (%)	WATER SOLUBLE SULFATES (%)	OTHER (1)	GROUP INDEX	CLASSIFICATION		DESCRIPTION
					LIQUID LIMIT (%)	PLASTICITY INDEX (%)						AASHTO	UNIFIED	
S-1	4	B	10.1	109			-0.1						SC	FILL, SAND, VERY CLAYEY, SL. GRAVELLY
S-1	0-5	B	13.8		37	17		42	<01		3	A-6	SC	FILL, SAND, VERY CLAYEY, SL. GRAVELLY
S-2	9	B	14.3	104			-0.4						SC	FILL, SAND, VERY CLAYEY
S-2	0-5	A	9.7		28	2		29			0	A-2-4	SM	FILL, SAND, SILTY
S-3	0-5	B	5.6		30	12		45			2	A-6	SC	FILL, SAND, VERY CLAYEY
S-4	4	B	8.7	121			2.6						SC	FILL, SAND, VERY CLAYEY
S-4	0-5	B	7.5		37	18		44			4	A-6	SC	FILL, SAND, VERY CLAYEY
Group B	Composite	B			35	16		44			3		SC	FILL, SAND, VERY CLAYEY

* SWELL MEASURED WITH 200 PSF APPLIED PRESSURE.