GEOTECHNICAL INVESTIGATION

CITY OF HOUSTON
WATER LINE REPLACEMENT IN COMMERCE AREA
WBS NO. S-000035-0153-4
HOUSTON, TEXAS

Reported to:
Sander Engineering Corporation
Houston, Texas

by

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REPORT NO. G159-13R1

March 2014

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March 11, 2014
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Reference: Geotechnical Investigation
Water Line Replacement in Commerce Area
WBS NO. S-000035-0153-4
Houston, Texas
Revised AEC Report No. G159-13R1

Dear Mr. Miller,

Aviles Engineering Corporation (AEC) is pleased to present this revised final report and trench safety report of our geotechnical investigation for the above referenced project. This geotechnical investigation was authorized to proceed on September 11, 2013 by Mr. Dennis W. Sander, P.E., President of SEC, based upon AEC Proposal No. G2012-11-13R3, dated August 19, 2013. This revised final report will supersede the previously submitted reports and transmittals for the referenced project.

AEC appreciates the opportunity to be of service to you. Please call us if you have any questions or comments concerning this report or when we can be of further assistance.

Respectfully submitted,
Aviles Engineering Corporation
(TBPE Firm Registration No. F-42)

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AVILES ENGINEERING CORP.

EXECUTIVE SUMMARY

This report presents the results of a geotechnical investigation performed by Aviles Engineering Corporation (AEC) for the water line replacement in Commerce Area in Houston, Texas. The project includes design and construction of 8- and 12-inch diameter water line in Commerce Area and Holmes Road, between Almeda and SH288 (designated as Area 1 and 2 in this report, respectively). A vicinity map is presented on Plate A-1, in Appendix A. AEC understands that the underground utilities will be installed by trenchless method.

Our findings and recommendations are summarized below.

1. Based on Borings B-1 through B-28, the subsurface conditions along the alignment in Area 1 generally consist of approximately 2 to 10 feet fill (encountered below existing pavements in Borings B-1, B-2, B-6, B-9, B-12 through B-16, B-18, B-19, B-25, B-26, and B-28) of firm to hard lean clay/fat clay (CL/CH), underlain by soft to hard fat clay/lean clay/silty clay (CH/CL/CL-ML) to the termination depths of 13 to 25 feet below existing grade. Approximately 2 to 12 feet of loose to medium dense clayey sand/silty sand/silty clayey sand (SC/SM/SC-SM) were generally encountered in Borings B-1, B-2, B-3, B-5, and B-9 through B-12 (in the vicinity of Engelke Street, Navigation Boulevard, and Canal Street) at a depth ranging from 8 to 18 feet below existing grade.

2. Based on Borings B-29 through B-37, the subsurface conditions along the alignment in Area 2 generally consist of 6 to 8 feet fill [soft to very stiff fat clay/lean clay (CH/CL) or lime-stabilized clayey sand], underlain by approximately 5 to 9 feet firm to very stiff fat clay/lean clay (CH/CL) to the termination depths of 14 to 15 feet below grade.

3. In Borings B-1, B-4, B-5, and B-9 through B-12, groundwater was initially encountered during drilling at depths of about 14 to 18 feet, and subsequently rose to depths of about 9.8 to 16 feet approximately 15 minutes after the initial encounter, indicating that the groundwater along the alignment may be pressurized. Groundwater was not encountered in the remaining borings in Area 1.

4. In Borings B-34 and B-35, groundwater was initially encountered during drilling at a depth of about 13 feet below existing grade, and was measured to depths of about 11.3 to 12.6 feet approximately 15 minutes after the initial encounter. Groundwater was not encountered in the remaining borings in Area 2.

5. Gasoline/chemical odors were detected in the soil samples recovered from depths of 4 to 6 feet in Borings B-30 and B-31, 6 to 8 feet in Borings B-33, and 6 to 10 feet in Boring B-34.

6. Recommendations for design and installation of water lines by trenchless method are presented in Section 5.2 of this report**.**

7. Dewatering guidelines for excavation pits are presented in Section 6.2 of this report**.**

This Executive Summary only provides an overview of the geotechnical investigation and should not be used without the full text of this report.

TABLE OF CONTENTS

EXECUTIVE SUMMARY i
1.0 INTRODUCTION 1
1.1 General 1
1.2 Purpose and Scope 1
2.0 SUBSURFACE EXPLORATION 1
3.0 LABORATORY TESTING 4
4.0 SITE CONDITIONS 4
4.1 Existing Pavements 4
4.2 Subsurface Conditions 6
4.3 Groundwater Conditions 7
4.4 Geologic Hazards 9
4.5 Hazardous Materials 11
4.6 Subsurface Variations 11
5.0 GEOTECHNICAL ENGINEERING RECOMMENDATIONS 11
5.1 Geotechnical Parameters for Underground Utilities 11
5.2 Utility Lines Installed by Trenchless Method 12
5.2.1 Loadings on Pipes 12
5.2.2 Deflection of Flexible Pipes 13
5.2.3 Pipe Entry and Receiving Pits 14
5.2.4 Pit Excavation Stability 15
5.2.5 Thrust Force Design Recommendations 18
5.2.6 Face Stability During Construction 19
5.2.7 Backfill for the Entry and Receiving Pits 20
5.2.8 Influence of Augering on Adjacent Structures 20
5.3 Select Fill 21
6.0 CONSTRUCTION CONSIDERATIONS 22
6.1 Site Preparation 22
6.2 Groundwater Control 22
6.3 Monitoring of Existing Structures 23
6.4 Construction Monitoring 24
7.0 LIMITATIONS 24

APPENDICES

APPENDIX A

Plate A-1	Vicinity Map
Plates A-2a to A-2e	Boring Location Plans
Plates A-3 to A-39	Boring Logs
Plate A-40	Key to Symbols
Plate A-41	Classification of Soils for Engineering Purposes
Plate A-42	Terms Used on Boring Logs
Plate A-43	ASTM & TXDOT Designation for Soil Laboratory Tests
Plate A-44	Sieve Analysis Results
Plates A-45 to A-53	Summary of Laboratory Test Results

APPENDIX B

Plates B-1 to B-7	Generalized Subsurface Profile
Plate B-8	Piezometer Installation Details

APPENDIX C

Plates C-1a to C-1d	Recommended Geotechnical Design Parameters
Plate C-2	Load Coefficients for Pipe Loading
Plate C-3	Live Loads on Pipe Crossing Under Roadway
Plate C-4	Live Load on Pipe Crossing Under Railroad Track

APPENDIX D

Plate D-1	Critical Heights of Cuts in Nonfissured Clays
Plate D-2	Maximum Allowable Slopes
Plate D-3	A Combination of Bracing and Open Cut
Plate D-4	Lateral Pressure Diagrams - For Open Cuts in Cohesive Soils - Long Term Conditions
Plate D-5	Lateral Pressure Diagrams - For Open Cuts in Cohesive Soils - Short Term Conditions
Plate D-6	Lateral Pressure Diagrams - For Open Cuts in Sand
Plate D-7	Bottom Stability for Braced Excavation
Plate D-8	Thrust Force Calculation
Plate D-9	Thrust Force Example Calculation
Plate D-10	Design Parameters for Bearing Thrust Block
Plate D-11	Relation between the Width of Surface Depression and Depth of Cavity for Tunnels

APPENDIX E Piezometer Installation and Plugging Reports

APPENDIX F Previous Geotechnical Borings Performed by Geotest Engineering, Inc., and HVJ Associates, Inc.

GEOTECHNICAL INVESTIGATION
WATER LINE REPLACEMENT IN COMMERCE AREA
WBS NO. S-000035-0153-4
HOUSTON, TEXAS

1.0 INTRODUCTION

1.1 General

This report presents the results of a geotechnical investigation performed by Aviles Engineering Corporation (AEC) for the water line replacement in Commerce Area in Houston, Texas (Houston Key Maps: 493R, 494J, and N, and 533 S and T). The project includes design and construction of 8- and 12-inch diameter water line in Commerce Area and Holmes Road, between Almeda and SH288 (designated as Area 1 and 2 in this report, respectively). A vicinity map is presented on Plate A-1, in Appendix A. AEC understands that the underground utilities will be installed by trenchless method.

1.2 Purpose and Scope

The purpose of this geotechnical investigation is to evaluate the subsurface soil and groundwater conditions along the alignments and develop geotechnical engineering recommendations for design and construction of water lines by trenchless method. The scope of this geotechnical investigation is summarized below:

1. Drilling and sampling 37 geotechnical borings ranging from 13 to 25 feet below existing grade;
2. Soil laboratory testing on selected soil samples;
3. Engineering analyses and recommendations for the installation of underground utilities by trenchless method, including loadings on pipes, auger face stability, entry and receiving pit excavations, shoring, lateral earth pressure parameters, and backfill requirements;
4. Construction recommendations for installation of underground utilities.

2.0 SUBSURFACE EXPLORATION

The subsurface exploration consisted of drilling and sampling a total of 37 soil borings ranging from 13 to 25 feet below existing grade. Borings B-1 through B-28 were drilled for the alignments in Area 1 while Borings B-29 through B-37 were drilled for the alignment in Area 2. The boring locations are shown on the Boring Location Plan on Plates A-2a through A-2e, in Appendix A. Additional 2 to 6 feet was drilled below the

termination depth in Borings B-1, B-2, B-3, B-5, B-9, B-10, and B-12 due to granular soils were encountered in the last planned sample in accordance with Chapter 11 of the latest edition of the COH Engineering Design Manual. The total drilling footage is 632 feet. Borings were surveyed after completion of drilling and the boring survey data are presented in the representative boring logs. The boring designations and depths and proposed waterline invert depths are presented in Table 1 below.

Table 1. Boring Number, Location, Approximate Invert Depths, and Boring Depths

Boring No.	Street Name	Station	Elev. (ft)	Easting	Northing	Final Invert Depth (ft)(1)	Boring Depth (ft)(2)
B-1	ST. CHARLES ST	21+34.63	33.5	3128719.95	13843060.95	9	18
B-2	ENGELKE ST	5+93.41	36.2	3129115.42	13842776.16	12	22(4)
B-3	PALMER ST	24+59.11	37.6	3130192.61	13841917.40	12	24(4)
B-4 (PZ-1)	ST. CHARLES ST	17+02.69	36.7	3128477.41	13842703.40	19	25
B-5	N. ENNIS ST	5+19.71	33.6	3129812.22	13841859.93	9	23(4)
B-6	CANAL ST.	2+85.88	43.3	3127596.50	13842809.50	15(3)	19
B-7	CANAL ST.	7+79.70	42.4	3128029.64	13842569.47	15(3)	16
B-8	ST. CHARLES ST	11+45.98	40.5	3128180.42	13842232.49	13	19
B-9	N. LIVE OAK	7+53.25	37.5	3128571.37	13842260.26	8	19(4)
B-10	CANAL ST.	18+99.83	35.1	3128957.07	13841941.27	11	25(4)
B-11	CANAL ST.	25+31.20	35.8	3129483.54	13841592.72	8	16
B-12	PALMER ST	18+49.55	36.4	3129865.22	13841403.21	12	25(4)
B-13	COMMERCE AVE	3+23.11	44.2	3127124.54	13842440.10	13	18
B-14	COMMERCE AVE	8+87.45	43.0	3127596.29	13842129.48	9	15
B-15	ST. CHARLES ST	6+76.70	43.2	3127919.83	13841842.33	11	17
B-16	N. NAGLE ST.	18+86.64	39.8	3128387.09	13841511.20	9	16
B-17	PAIGE ST	10+36.81	41.7	3128822.87	13841254.88	11	17
B-18	COMMERCE AVE	27+80.59	41.7	3129183.75	13841098.70	7	13
B-19	PALMER ST	12+71.50	41.8	3129550.65	13840918.25	11	16
B-20	SHERMAN ST	5+97.34	41.3	3129091.84	13840741.24	11(3)	13
B-21	ST. CHARLES ST	1+72.22	41.6	3127623.73	13841433.87	9	17
B-22	GARROW AVE	6+56.28	42.9	3128018.06	13841024.92	11	16
B-23	GARROW AVE	11+76.40	41.8	3128453.26	13840740.08	12	18
B-24	MIDDLETON ST	3+93.38	42.5	3128626.65	13840460.24	9	15
B-25	S. ENNIS ST	4+68.83	41.3	3128901.87	13840383.60	10	18

Table 1. (Cont.)

Boring No.	Street Name	Station	Elev. (ft)	Easting	Northing	Final Invert Depth (ft)(1)	Boring Depth (ft)(2)
B-26	PALMER ST	5+47.03	40.5	3129185.80	13840291.56	11	17
B-27	PRESTON AVE	1+66.64	41.8	3128374.38	13840420.82	8	18
B-28	PALMER ST	1+42.24	41.5	3128941.73	13839967.23	8	15
B-29	HOLMES RD	1+14.40	50.3	3113131.73	13810656.59	10	15
B-30	HOLMES RD	5+93.59	48.6	3113585.71	13810813.76	8	14
B-31	HOLMES RD	10+87.59	47.8	3114046.31	13810992.36	7	14
B-32	HOLMES RD	15+65.07	47.8	3114494.22	13811157.82	8	13
B-33	HOLMES RD	20+66.00	47.8	3114961.18	13811339.20	9	15
B-34	HOLMES RD	25+88.29	47.7	3115450.46	13811521.96	7	14
B-35	HOLMES RD	30+91.26	47.5	3115920.71	13811700.41	7	13
B-36	HOLMES RD	36+10.72	47.7	3116406.52	13811884.31	8	13
B-37	HOLMES RD	41+33.75	46.8	3116899.89	13812056.06	8	14

Note: (1) Final invert depths were measured based on the most updated drawings provided on February 13, 2014;
(2) Boring depths were selected based on 70 Percent Submittal Drawings, dated June 5, 2013;
(3) Boring depths in B-6, B-7, and B-19 may not sufficient to cover the required information (a minimum of 5 feet deeper than the proposed invert depths is required based on the COH Engineering Design Manual);
(4) Borings were drilled deeper than the proposed depths due to granular soils were encountered in the last planned sample in accordance with Chapter 11 of the latest edition of the COH Engineering Design Manual.

Existing concrete pavement at some boring locations was cored prior to drilling in order to facilitate the drilling. The field drilling was performed with a truck-mounted drilling rig and was generally advanced using dry auger method; wet rotary method was subsequently used to complete the borings when the borehole caved in or water-bearing granular soils were encountered. Undisturbed samples of cohesive soils were obtained from the borings by pushing 3-inch diameter thin-wall, seamless steel Shelby tube samplers in general accordance with ASTM D 1587. Granular soils were sampled with a 2-inch split-barrel sampler in accordance with ASTM D 1586. Standard Penetration Test resistance (N) values were recorded for the granular soils as "Blows per Foot" and are shown on the boring logs. The strength of the cohesive soils was estimated in the field using a hand penetrometer. The undisturbed samples of cohesive soils were extruded mechanically from the core barrels in the field and wrapped in aluminum foil; all samples were sealed in plastic bags to reduce moisture loss and disturbance. The samples were then placed in core boxes and transported to the AEC laboratory for testing and further study. The boreholes were grouted with cement-bentonite grout except for Boring B-4 which was converted to piezometers for 24-hour and 30-day water readings. The pavement was patched with lean concrete or asphalt on completion of drilling based on the original pavement type.

3.0 LABORATORY TESTING

Soil laboratory testing was performed by AEC personnel. Samples from the borings were examined and classified in the laboratory under the supervision of a geotechnical engineer. Laboratory tests were performed on representative soil samples in order to evaluate the engineering properties of the subsurface soils in accordance with applicable ASTM Standards. Atterberg limits, moisture contents, percent passing a No. 200 sieve, sieve analysis, and dry unit weight tests were performed on selected samples to establish the index properties and confirm field classification of the subsurface soils. Strength properties of undisturbed cohesive soils were evaluated by means of unconfined compression tests (UC), unconsolidated undrained (UU) triaxial and torvane shear tests. The test results are presented on the boring logs. Soil classifications along with the laboratory test results are presented on Plates A-3 through A-39, in Appendix A. A key to the boring logs, classification of soils for engineering purposes, terms used on boring logs, and reference ASTM Standards for laboratory testing are presented on Plates A-40 through A-43, in Appendix A. Sieve analyses results are presented on Plate A-44, in Appendix A. A summary of laboratory test results are presented on Plates A-45 through A-53, in Appendix A

As requested by COH, AEC included borings that were previously performed by Geotest Engineering, Inc., and HVJ Associates, Inc. in Appendix F of this report. AEC will not liable for the boring logs performed by others.

4.0 SITE CONDITIONS

4.1 Existing Pavements

A summary of existing pavement encountered at the boring locations is presented in Table 2.

Table 2. Existing Pavement at Boring Locations

Boring No.	Street Name	Pavement Section	Base
B-1	ST. CHARLES ST	2.5" Asphalt	5" sand and crushed limestone
B-2	ENGELKE ST	8" Asphalt	10" sand and crushed limestone
B-3	PALMER ST	4" Asphalt	13.5" sand and gravel
B-4 (PZ-1)	ST. CHARLES ST	1.5" Asphalt + 7" Concrete	-

Table 2. (Cont.)

Boring No.	Street Name	Pavement Section	Base
B-5	N. ENNIS ST	2" Asphalt + 8" Concrete	-
B-6	CANAL ST.	4" Asphalt + 7.5" Concrete	-
B-7	CANAL ST.	3.5" Asphalt + 7" Concrete	-
B-8	ST. CHARLES ST	2" Asphalt + 6" Concrete	-
B-9	N. LIVE OAK	4" Asphalt	11" sand, gravel, and crushed limestone
B-10	CANAL ST.	3.5" Asphalt + 6.5" Concrete	-
B-11	CANAL ST.	3" Asphalt + 5.5" Concrete	-
B-12	PALMER ST	5.5" Asphalt	5.5" stabilized sand with shell and gravel
B-13	COMMERCE AVE	7" Asphalt	-
B-14	COMMERCE AVE	3.5" Asphalt + 5" Concrete	6" sand
B-15	ST. CHARLES ST	3.5" Asphalt + 6" Concrete	-
B-17	PAIGE ST	7" Asphalt	4" stabilized sand and gravel
B-18	COMMERCE AVE	2" Asphalt + 8" Concrete	2" shell, sand, and gravel
B-19	PALMER ST	7.5" Asphalt	9.5" stabilized sand with gravel and shell
B-20	SHERMAN ST	4.5" Asphalt	6.5" stabilized sand and gravel
B-21	ST. CHARLES ST	3.5" Asphalt + 6" Concrete	-
B-22	GARROW AVE	9" Asphalt	3" stabilized sand and gravel
B-23	GARROW AVE	4" Asphalt	5" stabilized crushed limestone
B-24	MIDDLETON ST	6" Asphalt	6" stabilized sand and gravel
B-25	S. ENNIS ST	5" Asphalt	6" stabilized sand and gravel
B-26	PALMER ST	6" Asphalt	10" stabilized sand with gravel
B-27	PRESTON AVE	5" Asphalt	7" stabilized sand and gravel
B-28	PALMER ST	4" Asphalt	6" stabilized sand and gravel
B-29	HOLMES RD	9" Concrete	-

Table 2. (Cont.)

Boring No.	Street Name	Pavement Section	Base
B-30	HOLMES RD	3" Asphalt	8" stabilized sand, gravel, and crushed limestone
B-31	HOLMES RD	-	-
B-32	HOLMES RD	-	-
B-33	HOLMES RD	-	-
B-34	HOLMES RD	-	8" clay with sand and gravel
B-35	HOLMES RD	-	11" clay with shell and gravel
B-36	HOLMES RD	-	-
B-37	HOLMES RD	-	-

4.2 Subsurface Conditions

Generalized subsurface profiles along the project alignment are presented on Plates B-1 through B-7, in Appendix B.

Area 1: Based on Borings B-1 through B-34, the subsurface conditions along the alignment generally consist of approximately 2 to 10 feet fill (encountered below existing pavements in Borings B-1, B-2, B-6, B-9, B-12 through B-16, B-18, B-19, B-25, B-26, and B-38) of firm to hard lean clay/fat clay (CL/CH), underlain by soft to hard fat clay/lean clay/silty clay (CH/CL/CL-ML) to the termination depths of 13 to 25 feet below existing grade. Approximately 2 to 12 feet of loose to medium dense clayey sand/silty sand/silty clayey sand (SC/SM/SC-SM) were generally encountered in Borings B-1, B-2, B-3, B-5, and B-9 through B-12 (in the vicinity of Engelke Street, Navigation Boulevard, and Canal Street) at a depth ranging from 8 to 18 feet below existing grade.

In Area 1, the clayey soils have low- to very high-plasticity, with liquid limits (LL) ranging from 23 to 76 and plasticity indices (PI) ranging from 7 to 54. The cohesive soils encountered are classified as “CL”, “CL-ML”, and “CH” type soils and the granular soils are classified as “SC”, “SM”, and “SC-SM” in accordance with ASTM D 2487.

Area 2: Based on Borings B-29 through B-37, the subsurface conditions along the alignment generally consist of 6 to 8 feet fill [soft to very stiff fat clay/lean clay (CH/CL) or lime-stabilized clayey sand], underlain by approximately 5 to 9 feet firm to very stiff fat clay/lean clay (CH/CL) to the termination depths of 14 to 15 feet below grade.

In Area 2, the clayey soils have high to very high-plasticity, with liquid limits (LL) ranging from 43 to 74 and plasticity indices (PI) ranging from 28 to 57. The cohesive soils encountered are classified as "CL" and "CH" type soils and the granular soils are classified as "SC" in accordance with ASTM D 2487.

Based on our soil borings, soft clays and/or granular soils that we encountered in Areas 1 and 2 are summarized in Table 3.

Table 3. Borings and Depths of Encountered Granular Soils and Soft Clays

Area	Boring	Location	Depth (feet)	Soil Type*
1	B-1	St. Charles Street	10-18	Medium dense SC
	B-2	Engelke Street	12-22	Loose to medium dense SC
	B-3	Palmer Street	8-18	Medium dense SC
	B-4	St. Charles Street	18-20	Soft CL
	B-5	N. Ennis Street	8-20	Medium dense SC/SM
	B-9	N. Live Oak	14-16	Medium dense SM
	B-10	Canal Street	18-20	Dense SM
	B-11	Canal Street	12-16	Medium dense SC
	B-12	Palmer Street	12-16	SC-SM
	B-12	Palmer Street	16-22	Medium dense SM
2	B-33	Holmes Road	6-8	Fill: soft CH
	B-36	Holmes Road	0-4	Fill: SC

*Note: SC= Clayey Sand, CL= Lean Clay, SM= Silty Sand, SC-SM=Silty Clayey Sand, and CH=Fat Clay

"CH" soils undergo significant volume changes due to seasonal changes in soil moisture contents. "CL" type soils with lower LL (less than 40) and PI (less than 20) generally do not undergo significant volume changes with changes in moisture content. However, "CL" soils with LL approaching 50 and PI greater than 20 essentially behave as "CH" soils and could undergo significant volume changes. Slickensides were encountered in the clay soils.

4.3 Groundwater Conditions

Area 1: In Borings B-1, B-4, B-5, and B-9 through B-12, groundwater was initially encountered during drilling at depths of about 12 to 18 feet, and subsequently rose to depths of about 9.8 to 16 feet approximately 15 minutes after the initial encounter, indicating that the groundwater along the alignment may be pressurized.

Area 2: In Borings B-34 and B-35, groundwater was initially encountered during drilling at a depth of about 13 feet below existing grade, and was measured to depths of about 11.3 to 12.6 feet approximately 15 minutes after the initial encounter.

Detailed groundwater level measurements are summarized in Table 4. Piezometer installation and plugging reports are presented in Appendix E.

Table 4. Groundwater Depths below Existing Ground Surface

Boring No.	Date Drilled	Boring/ Piezometer Depth (ft)	Groundwater Depth Encountered during Drilling (ft)	Groundwater Depth 15 min. after Initial Encounter (ft)	Groundwater Depth in Piezometer (ft)
B-1	10/1/2013	18	16.0	15.3 (cave in)	N/A
B-2	10/1/2013	22	16.0	16.0 (cave in)	N/A
B-3	10/1/2013	24	12	12.2 (cave in)	N/A
B-4	10/3/2013	25/20	18	14.2 16.8 (cave in)	13.3 (10/4/13) 12.7 (11/11/13)
B-5	10/3/2013	23	14	9.8	N/A
B-6	10/3/2013	19	17.8 (cave in)	N/A	N/A
B-7	10/3/2013	15	15.0 (cave in)	N/A	N/A
B-8	10/4/2013	19	N/A	N/A	N/A
B-9	10/1/2013	19	14.0	11.5 13.2 (cave in)	N/A
B-10	10/3/2013	25	18.0	12.5 14.8 (cave in)	N/A
B-11	10/3/2013	16	14.0	10.7 13.0 (cave in)	N/A
B-12	9/27/2013	25	14.0	10.2 11.6 (cave in)	N/A
B-13	10/4/2013	18	N/A	N/A	N/A
B-14	10/7/2013	15	N/A	N/A	N/A
B-15	10/4/2013	17	N/A	N/A	N/A
B-16	10/2/2013	16	N/A	N/A	N/A
B-17	10/2/2013	17	N/A	N/A	N/A
B-18	10/4/2013	13	N/A	N/A	N/A

Table 4 Cont…

Boring No.	Date Drilled	Boring/ Piezometer Depth (ft)	Groundwater Depth Encountered during Drilling (ft)	Groundwater Depth 15 min. after Initial Encounter (ft)	Groundwater Depth in Piezometer (ft)
B-19	9/27/2013	16	N/A	N/A	N/A
B-20	9/27/2013	13	N/A	N/A	N/A
B-21	10/4/2013	17	N/A	N/A	N/A
B-22	10/2/2013	16	N/A	N/A	N/A
B-27	10/2/2013	18	N/A	N/A	N/A
B-28	10/2/2013	15	N/A	N/A	N/A
B-29	10/4/2013	15	N/A	N/A	N/A
B-30	9/30/2013	14	N/A	N/A	N/A
B-31	9/30/2013	14	N/A	N/A	N/A
B-32	9/30/2013	13	N/A	N/A	N/A
B-33	9/30/2013	15	N/A	N/A	N/A
B-34	9/30/2013	14	13.0	11.3	N/A
B-35	9/30/2013	13	13.0	12.6	N/A
B-36	9/30/2013	13	N/A	N/A	N/A
B-37	9/30/2013	14	N/A	N/A	N/A

The information in this report summarizes conditions found on the dates the borings were drilled. It should be noted that our groundwater observations are short-term; groundwater depths and subsurface soil moisture contents will vary with environmental variations such as frequency and magnitude of rainfall and the time of year when construction is in progress.

4.4 Geologic Hazards

AEC performed a preliminary fault investigation for each of Area 1 (Commerce Street area) and Area 2 (Holmes Road area), which included a review of available literature, aerial photographs, public maps and limited field observations.

Area 1 (Commerce Street Area): According to the published maps "*Principal Active Faults of the Houston Area (after O'Neill and Van Siclen, May 1984)*", and "*Principal Surface Faults in the Central Houston Metropolitan Area (after O' Neill, Van Siclen, with additions by C. Norman, May 13, 2004)"*, no known faults occur in Area 1. The closest surface fault to this area is the Pecore Fault located approximately 2.7 miles to the northwest. Limited field observations were conducted by AEC on October 7, 2013 to determine if

evidences of surface faulting could be observed in the project alignment of Area 1. No indication of surface faults or features associated with surface faults, were observed.

Area 2 (Holmes Road Area): According to the published maps "*Principal Active Faults of the Houston Area (after O'Neill and Van Siclen, May 1984)*", and "*Principal Surface Faults in the Central Houston Metropolitan Area (after O' Neill, Van Siclen, with additions by C. Norman, May 13, 2004)"*, an unnamed surface fault associated with the Pierce Junction Salt Dome extends east-northeast to south-southwest along Almeda Road from just north of Interstate Highway 610 to Holmes Road and could impact the western end of the project alignment (damage from surface faulting can extend up to approximately 70 meters from the fault-Verbeek, Earl R., Ratzlaff, Karl W., and Clanton, Uel S., Faults in Parts of North-Central and Western Houston Metropolitan Area, Texas, 1979, USGS Miscellaneous Field Studies Map 1136). The downthrown side of the fault is to the west-northwest. A second surface fault, with downward side of the fault to the east-northeast, crosses Almeda Road approximately 1.3 miles south of the intersection of Holmes and Almeda Roads, but this second fault is too far away to be of concern to the project alignment. Rates of movement along either of these surface faults are unknown. Limited field observations were conducted by AEC on October 7, 2013 to determine if evidences of surface faulting could be observed in the project alignment. No indication of surface faults or features associated with these faults, were noted crossing or adjoining the project alignment. Fractured bricks were observed on the side of the Allchem Services Inc. building on Broiler Road approximately 0.25 miles northeast of the Almeda Road and Holmes Road intersection and a rupture was observed in the foundation of a warehouse on Magnet approximately 0.5 miles northeast of the Almeda Road and Holmes Road intersection. Whether these structural damages were related to surface faulting or expansive soils could not be ascertained from the observations as the damage was confined to the buildings and the damage could not be correlated between locations.

Limitations: The preliminary fault investigation provided in this report is limited to a review of literature, aerial photographs, maps and our limited field observations; distances are scaled from maps. Surface faults may exist in the project alignment or surrounding areas but which were not discovered during this project due to the following reasons: not observed during the reconnaissance due to limitations of the scope of work and cost; the presence of obscuring vegetation and environmental features; modification of the land surface by human activities; and lack of documentation in the literature. Faults may also be present below ground which may not currently have surface expressions. Identification of these faults is beyond the scope of work for this project. The observations made during the fault reconnaissance represent conditions at the time of the reconnaissance. Fault movement is often episodic with the result that future movement or faster movement

could occur along faults and could result in features associated with surface faulting and fault damage which are not currently present. In addition, surface faults might appear in areas where none currently exist.

4.5 Hazardous Materials

Gasoline/chemical odors were detected in the soil samples recovered from depths of 4 to 6 feet in Borings B-30 and B-31, 6 to 8 feet in Boring B-33, and 6 to 10 feet in Boring B-34. AEC informed SEC about encountering gasoline odor via an email notification on October 22, 2013.

4.6 Subsurface Variations

It should be emphasized that: (i) at any given time, groundwater depths can vary from location to location, and (ii) at any given location, groundwater depths can change with time. Groundwater depths will vary with seasonal rainfall and other climatic/environmental events. Subsurface conditions may vary between and away from the boring locations.

Clay soils in the Houston area typically have secondary features such as slickensides and contain sand/silt seams/lenses/layers/pockets. It should be noted that the information in the boring logs are based on 3-inch diameter soil samples which were generally obtained at intervals of 2 feet in the top 20 feet of the borings and at intervals of 5 feet thereafter to the boring termination depths. A detailed description of the soil secondary features may not have been obtained due to the small sample size and sampling interval between the samples. Therefore, while a boring log shows some soil secondary features, it should not be assumed that the features are absent where not indicated on the boring logs.

5.0 GEOTECHNICAL ENGINEERING RECOMMENDATIONS

The project includes design and construction of 8- and 12-inch diameter water line using trenchless construction

5.1 Geotechnical Parameters for Underground Utilities

Recommended geotechnical parameters for the subsurface soils along the alignment to be used for the design of underground utilities are presented on Plates C-1a through C-1d, in Appendix C. The design values are

based on the results of field and laboratory test data on individual boring logs as well as our experience. It should be noted that because of the variable nature of soil stratigraphy, soil types and properties along the alignments or at locations away from a particular boring may vary substantially.

5.2 Utility Lines Installed by Trenchless Method

The Contractor is responsible for selecting, designing, installing, maintaining and monitoring safe systems and retaining professionals who are qualified and experienced to perform the tasks and who are capable of modifying the system, as required. The following discussion provides general guidelines to the Contractor for trenchless methods. The information in this report should be reviewed so that appropriate equipment and techniques can be planned and factored into the construction plan and cost estimate.

5.2.1 Loadings on Pipes

Underground conduits support the weight of the soil and water above the crown, as well as roadway traffic and any structures that exist above the conduits.

Earth Loads: The vertical soil load, W_e, can be calculated as the larger of the two values from Equations (1) and (3):

$$W_e = C_d \gamma' B_d^2 \qquad \text{.....Equation (1)}$$

$$C_d = [1 - e^{-2K\gamma'(H/Bd)}]/(2K\gamma') \qquad \text{.....Equation (2)}$$

$$W_e = \gamma B_c H \qquad \text{.....Equation (3)}$$

where:
- W_e = vertical soil load over the conduit, in pounds per linear foot (lb/ft);
- C_d = load coefficient, see Plate C-2, in Appendix C;
- γ' = effective unit weight of soil over the conduit, in pounds per cubic foot (pcf);
- B_d = Pit width at top of the conduit < 1.5 B_c (ft);
- B_c = outside diameter of the conduit (ft);
- H = variable height of fill (ft);
  when the height of fill above the top of the conduit H_c >2 B_d, H = H_h (height of fill above the middle of the conduit). When H_c < 2 B_d, H varies over the height of the conduit; and
- $K\gamma'$ = 0.1650 maximum for sand and gravel,
  0.1500 maximum for saturated top soil,
  0.1300 maximum for ordinary clay,
  0.1100 maximum for saturated clay.

When underground conduits are located below ground water, the total vertical dead loads should include the weight of the projected volume of water above the conduits.

Vehical/Railroad Traffic Loads: The vertical stress on top of an underground conduit, p_L (psf), resulting from vehicle traffic loads (from a H-20 or HS-20 truck) can be obtained from Plate C-3 and railroad traffic load can be obtained from Plate C-4, in Appendix C. The live load on top of the underground conduit can be calculated from Equation (4):

$$W_L = p_L B_c \qquad \text{.....Equation (4)}$$

where: W_L = live load on the top of the conduit (lb/ft);
p_L = vertical stress (on the top of the conduit) resulting from vehicle/railroad traffic loads, see Plates C-3 and C-4, in Appendix C (psf);
B_c = outside diameter of the conduit, (ft).

Lateral Loads: The lateral soil pressure p_l can be calculated from Equation (5); hydrostatic pressure should be added, if applicable.

$$p_l = 0.5\,(\gamma H_h + p_s) \qquad \text{.....Equation (5)}$$

where: H_h = height of soil/fill above the center of the conduit (ft);
γ = effective unit weight of soil over the conduit (pcf);
p_s = vertical pressure on conduit resulting from traffic and/or construction equipment (psf).

5.2.2 Deflection of Flexible Pipes

Deflection is one of the controlling factors in the design of buried flexible or semi-rigid pipes, such as PVC and ductile iron pipes. These pipes deflect under soil and surcharge loads; the amount of deflection is a function of the service load on the pipe, the stiffness of the pipe, and the surrounding soil.

The deflection can be calculated using the Modified Iowa Formula, expressed as Equation (6), and the effective stiffness, E' of the surrounding soil. The E' is a combination of the stiffness of the pipe bedding material, E'_B and the stiffness of the native soil, E'_N. Long-term deflection values are typically used for flexible/semi-rigid pipe design; these values may be obtained by applying an appropriate deflection lag factor, D_L, to the short-term deflection values used in the Modified Iowa Formula.

$$\Delta x = \frac{D_L KW}{\frac{EI}{R^3} + 0.061E'} \qquad \text{.....Equation (6)}$$

where: Δx = pipe deflection (in);
D_L = deflection lag factor;
(a) use minimum 1.0 for granular backfill and the full prism load is assumed to act on the pipe, (b) use minimum 1.5 for granular backfill and assumed trench loadings, (c) use minimum 2.5 for sandy lean clay (CL) where the backfill can become saturated;
K = bedding constant, typically 0.11;
W = [W_e (from Eq. 3) + W_L (from Eq. 4) +W_w], total service load on the crown of the pipe, (lb/in); W_w = weight of water prism (if any) above the crown of the pipe ;
E = initial modulus (Young's modulus) of the pipe material (psi);
I = pipe wall moment of inertia (in.^{4}/in);
R = mean pipe radius (in);
E' = effective modulus of soil reaction (psi).

The effective modulus of soil reaction, E', may be obtained from the equations presented below:

$$E' = \text{zeta} * E'_B \qquad \text{.....Equation (7)}$$

$$\text{zeta} = \frac{1.44}{f + (1.44 - f) * E_B' / E_N'} \qquad \text{.....Equation (8)}$$

where: $$f = \frac{B_d / B_c - 1}{1.154 + 0.444(B_d / B_c - 1)} \qquad \text{.....Equation (9)}$$

and: B_d = trench width at the top of the pipe (ft);
B_c = outside diameter of the pipe (ft).

For the stiffness of the pipe bedding material E'_B, 2,000 psi can be used for granular materials such as clayey sand, silty sand, silty gravel or clayey gravel (containing less than 12 percent fines) with a minimum 95 percent ASTM D-698 (Standard Proctor) compaction. Effective modulus of soil reaction for natural soil, E'_N is presented on Plates C-1a through C-1d, in Appendix C.

5.2.3 Pipe Entry and Receiving Pits

Pits are required for starting and ending pipes. They should be constructed in accordance with Section 02447, Subsection 3.04 of the latest edition of the COHSCS.

Reaction Walls: For the braced pit walls to be used to provide passive reaction for pipe jacking, passive earth pressure can be calculated using Equation (10); we recommend that a factor of safety of 2.0 be used for passive earth pressure. The design soil parameters for reaction wall design are presented on Plates C-1a through C-1d, in Appendix C.

$$p_p = \gamma z K_p + 2c(K_p)^{1/2} \qquad \text{.....Equation (10)}$$

where, p_p = passive earth pressure (psf);
γ = wet unit weight of soil (pcf);
z = depth below ground surface for the point under consideration (ft);
K_p = coefficient of passive earth pressure;
c = cohesion of clayey soils (psf).

5.2.4 Pit Excavation Stability

Cohesive soils in the Houston area contain many secondary features which affect pit excavation stability, including sand seams and slickensides. Slickensides are shiny weak failure planes which are commonly present in fat clays; such clays often fail along these weak planes when they are not laterally supported, such as in an unbraced excavation. The Contractor should not assume that slickensides and sand seams/layers/pockets are absent where not indicated on the logs.

The Contractor should be responsible for designing, constructing and maintaining safe excavations. The excavations should not cause any distress to existing structures.

Pit 20 feet and Deeper: OSHA requires that shoring or bracing for pits 20 feet and deeper be specifically designed by a licensed professional engineer.

Pit Less than 20 Feet Deep: Pit excavations that are less than 20 feet deep may be shored, sheeted and braced, or laid back to a stable slope for the safety of workers, the general public, and adjacent structures, except for excavations which are less than 5 feet deep and verified by a competent person to have no cave-in potential. The excavation should be in accordance with Occupational Safety and Health Administration (OSHA), Safety and Health Regulations, 29 CFR, Part 1926. Recommended OSHA Soil Types for pit design for existing soils are presented on Plates C-1a through C-1d, in Appendix C. Granular soils and fill soils should be considered

OSHA Class "C" soils. Submerged cohesive soils should also be considered OSHA Class "C" soils, unless dewatering is conducted to lower the groundwater level below the excavation.

Critical Height is defined as the height a slope will stand unsupported for a short time; in cohesive soils, it is used to estimate the maximum depth of open-cuts at given side slopes. Critical Height may be calculated based on the soil cohesion. Values for various slopes and cohesion are shown on Plate D-1, in Appendix D. Cautions listed below should be exercised in use of Critical Height applications:

1. No more than 50 percent of the Critical Height computed should be used for vertical slopes. Unsupported vertical slopes are not recommended where granular soils or soils that will slough when not laterally supported are encountered within the excavation depth.

2. If the soil at the surface is dry to the point where tension cracks occur, any water in the crack will increase the lateral pressure considerably. In addition, if tension cracks occur, no cohesion should be assumed for the soils within the depth of the crack. The depth of the first waler should not exceed the depth of the potential tension crack. Struts should be installed before lateral displacement occurs.

3. Shoring should be provided for excavations where limited space precludes adequate side slopes, e.g., where granular soils will not stand on stable slopes and/or for deep open-cuts.

4. All excavation, trenching and shoring should be designed and constructed by qualified professionals in accordance with OSHA requirements.

Plate D-2, in Appendix D, presents the maximum (steepest) allowable slopes for OSHA Soil Types for excavations less than 20 feet. If limited space is available for the required open pit/trench side slopes, the space required for the slope can be reduced by using a combination of bracing and open-cut as illustrated on Plate D-3, in Appendix D. Guidelines for bracing and calculating bracing stress are presented below.

<u>Computation of Bracing Pressures:</u> The following method can be used for calculating earth pressure against bracing for open-cuts. Lateral pressure resulting from construction equipment, traffic loads, or other surcharge should be taken into account by adding the equivalent uniformly distributed surcharge to the design lateral pressure. Hydrostatic pressure, if any, should also be considered. The active earth pressure at depth z can be determined by Equation (11). The design soil parameters for pit/trench bracing design are presented on Plates C-1a through C-1d, in Appendix C.

$$p_a = (q_s + \gamma h_1 + \gamma' h_2)K_a - 2c\sqrt{K_a} + \gamma_w h_2 \qquad \text{.....Equation (11)}$$

where: p_a = active earth pressure (psf);
q_s = uniform surcharge pressure (psf);
γ, γ' = wet unit weight and buoyant unit weight of soil (pcf);
h_1 = depth from ground surface to groundwater table (ft);
h_2 = $z-h_1$, depth from groundwater table to the point under consideration (ft);
z = depth below ground surface for the point under consideration (ft);
K_a = coefficient of active earth pressure;
c = cohesion of clayey soils (psf); c can be omitted conservatively;
γ_w = unit weight of water, 62.4 pcf.

Pressure distribution for the practical design of struts in open-cuts for clays and sands are illustrated on Plates D-4 through D-6, in Appendix D.

Bottom Stability: In open-cuts, it is necessary to consider the possibility of the bottom failing by heaving, due to the removal of the weight of excavated soil. Heaving typically occurs in soft plastic clays when the excavation depth is sufficiently deep enough to cause the surrounding soil to displace vertically due to bearing capacity failure of the soil beneath the excavation bottom, with a corresponding upward movement of the soils in the bottom of the excavation. In fat and lean clays, heave normally does not occur unless the ratio of Critical Height to Depth of Cut approaches one. In very sandy and silty lean clays and granular soils, heave can occur if an artificially large head of water is created due to installation of impervious sheeting while bracing the cut. This can be mitigated if groundwater is lowered below the excavation by dewatering the area. Guidelines for evaluating bottom stability in clay soils are presented on Plate D-7, in Appendix D. Based on our soil borings, soft clays and granular soil that we encountered in Areas 1 and 2 are summarized in Table 3 in Section 4.2 of this report.

Based on the invert depths in Table 1 of Section 2.1 and water level reading in Table 4 of Section 4.3, open cut excavations in the vicinity of Engelke Street, Navigation Boulevard, and Canal Street in Area 1, and Holmes Road in Area 2 will likely encounter ground water or granular soils. If the excavation extends below groundwater and the soils at or near the bottom of the excavation are mainly sands or silts, the bottom can fail by blow-out (boiling) when a sufficient hydraulic head exists. The potential for boiling or in-flow of granular soils increases where the groundwater is pressurized. To reduce the potential for boiling of excavations terminating in granular soils below pressurized groundwater, the groundwater table should be lowered at least 3 feet below the excavation, in accordance with Section 01578 of the latest edition of the City of Houston Standard General Requirements (COHSGR).

Calcareous nodules, silt/sand seams, and fat clays with slickensides were encountered in some of the borings. These secondary structures may become sources of localized instability when they are exposed during excavation, especially when they become saturated. Such soils have a tendency to slough or cave in when not laterally confined, such as in trench excavations. The Contractor should be aware of the potential for cave-in of the soils. Low plasticity soils (silts and clayey silts) will lose strength and may behave like granular soils when saturated.

5.2.5 Thrust Force Design Recommendations

Thrust forces are generated in pressurized pipes such as water lines or force mains, typically as a result of changes in pipe diameter, pipe direction or at the termination point of the pipes. The pipes could disengage at the joints if the forces are not balanced and if the pipe restraint is not adequate. Various methods of thrust restraint are used including thrust blocks, restrained joints, encasement, and tie-rods.

Thrust restraint design procedure based on the 2008 American Water Works Association (AWWA) Manual "Concrete Pressure Pipe (M9)" is discussed below. Plate D-8, in Appendix D, shows the force diagram generated by flow in a bend in a pipe and also gives the equation for computing the thrust force. An example computation of a thrust force for a given surge pressure and a bend angle is presented on Plate D-9, in Appendix D.

Frictional Resistance: The unbalanced force due to changes in grade and alignment can be resisted by frictional force F_R, between the pipe and the surrounding soil. The resisting frictional force per linear foot of pipe against soil can be calculated from Equation (12):

$$F_R = f\,(2W_e + W_w + W_p) \qquad \text{Equation (12)}$$

where: f = Coefficient of friction between pipe and soil;
W_e = Weight of soil over pipe (lb/ft);
W_w = Weight of water inside the pipe (lb/ft);
W_p = Weight of pipe (lb/ft).

The value of the frictional resistance depends on the material in contact with the backfill and the soil used in the backfill. For a ductile iron pipe or PVC pipe with crushed stone or compacted sand backfill, an allowable

coefficient of friction of 0.3 can be used. To account for submerged conditions, a soil unit weight of 60 pcf should be used to compute the weight of compacted backfill on the pipe.

Thrust Blocks: Thrust blocks utilize passive earth pressures to resist forces generated by changes in direction or diameter of pressurized pipes. Passive earth pressure can be calculated using Equation (10); we recommend that a factor safety of 2.0 be used when using passive earth pressure for design of thrust blocks. The design soil parameters for thrust block design are presented on Plates C-1a through C-1d, in Appendix C. Design guidelines for bearing thrust blocks are presented on Plate D-10, in Appendix D.

5.2.6 Face Stability During Construction

If auger method is to be used, a Stability Factor, $N_t = (P_z - P_a)/C_u$ may be used to evaluate the stability of an unsupported bore face in cohesive soils (N_t is not applicable to granular soils), where P_z is the overburden pressure to the bore centerline; P_a is the equivalent uniform interior pressure applied to the face; and C_u is the soil undrained shear strength. For augering operations, no interior pressure is applied. Generally, N_t values of 4 or less are desirable as it represents a practical limit below which augering may be accomplished without significant difficulty. Higher N_t values usually lead to large deformations of the soil around the bore and problems associated with increased subsidence. It should be noted that the exposure time of the face is most important; with time, creep of the soil will occur, resulting in a reduction of shear strength. The N_t values will therefore increase when construction is slow.

An N_t value of about 3.1 or less was estimated for the cohesive soils encountered in our soil borings within the invert depths of about 8 to 20 feet below existing grade, except for Boring B-8, where a N_t was estimated to be 5.2, based on an invert depth of 20 feet below existing grade. Note that the cohesive soils have secondary structures such as fissures, sand seams, and sand lenses which can cause the bore face to become unstable. **Since loose to dense granular or soft cohesive soils were encountered in Borings B-1, B-2, B-3, B-4, B-5, B-9 through B-12, B-33, and B-36 (see Table 3 also), the Contractor should make necessary provisions such as casing to stabilize the auger holes.** The Contractor should not base their bid on the above information alone, since granular soils may be encountered between boring locations; the Contractor should verify the subsurface conditions between boring locations or add a contingency.

5.2.7 Backfill for the Entry and Receiving Pits

Backfill for auger pits should be in accordance with Section 02317 of the latest edition of the COHSCS. Embedment material and backfill should be placed in loose lifts not exceeding 8 inches and compacted in accordance with Section 02317 of the latest edition of the COHSCS.

5.2.8 Influence of Augering on Adjacent Structures

Ground Subsidence: Augering in soft ground often induces some degree of settlement (ground subsidence) of the overlying ground surface. If such settlement is excessive, it may cause damage to existing structures and services located above and/or near the auger zone.

Predicting the amount of loss of ground (or ground subsidence) due to augering is very difficult, primarily because of the uncertainty involved in the analysis: such as heterogeneous soil properties, subsurface variability, or lack of information about proposed construction equipment and techniques.

Loss of Soil Support for Adjoining Structures: Augering operations, when located close to existing structures, will relieve the vertical and lateral soil support that these structures rely upon for their foundation bearing capacity and lateral soil support. This can result in distress to the existing structures if appropriate precautions are not taken.

Measures to Reduce Distress from Augering: Impact to existing foundations and structures can be mitigated by following proper augering procedures. Some methods to mitigate movement and/or distress to existing structures include:

- Supporting the augering excavation with steel or rigid concrete casing or the pipe material itself, as soon as the excavation is advanced and at short intervals; and
- proper grouting of the annular spaces; the type of equipment and method chosen will require the services of a specialty contractor.

To reduce the potential for the augering to influence the existing foundations or structures, we recommend that the outer edge of the influence zone of the auger tunnel be a minimum of 5 feet from the outer edge of the bearing (stress) zone of existing foundations. The bearing (stress) zone is defined by a line drawn downward from the outer edge of an existing foundation and inclined at an angle of 45 degrees to the vertical.

The auger influence zone is assumed to extend a distance of about 2.5i from the center of the auger tunnel, as shown on Plate D-11, in Appendix D. We emphasize that the size of the influence zone of an auger tunnel is difficult to determine because several factors influence the response of the soil to augering operations including type of soil, ground water level, type of augering equipment, method of augering, experience of operator and other construction in the vicinity.

We recommend that the following situations be evaluated on a case by case basis, where:

- augering cannot be located farther than the minimum distance recommended above;
- augering cannot be located outside the stress zone of the foundations for existing structures;
- unstable soils are encountered near existing structures;
- heavily loaded or critical structures are located close to the influence zone of the auger tunnels;

As an option, existing structure foundations should be protected by adequate shoring or strengthened by underpinning or other techniques, provided that augering cannot be located outside the stress zone of the existing foundations.

Disturbance and loss of ground from the augering operation may create surface soil disturbance and subsidence which in turn may cause distress to existing structures (including pavements) located in the zone of soil disturbance. Any open-cut excavation in the proposed augering areas should be adequately shored.

5.3 Select Fill

Select fill should consist of uniform, non-active inorganic lean clays with a PI between 10 and 20 percent, and more than 50 percent passing a No. 200 sieve. Excavated material delivered to the site for use as select fill shall not have clay clods with PI greater than 20, clay clods greater than 2 inches in diameter, or contain sands/silts with PI less than 10. Prior to construction, the Contractor should determine if he or she can obtain qualified select fill meeting the above select fill criteria.

As an alternative to imported fill, on-site soils excavated during construction can be stabilized with hydrated lime. Excavated clay soils should be stabilized with at least 7 percent hydrated lime by dry soil weight. Lime stabilization shall be performed in accordance with Section 02336 of the latest edition of the COHSCS. The percentage of lime required for stabilization is a preliminary estimate for planning purposes only; laboratory testing should be performed to determine optimum contents for stabilization prior to construction. AEC

prefers using stabilized on-site clay as select fill since compacted lime-stabilized clay generally has high shear strength, low compressibility, and relatively low permeability. Blended or mixed soils (sand and clay) should not be used as select fill.

All material intended for use as select fill should be tested prior to use to confirm that it meets select fill criteria. The fill should be placed in loose lifts not exceeding 8 inches in thickness. Backfill within 3 feet of walls or columns should be placed in loose lifts no more than 4-inches thick and compacted using hand tampers, or small self-propelled compactors. The lime-stabilized onsite soils or select fill should be compacted to a minimum of 95 percent of the ASTM D 698 (Standard Proctor) maximum dry unit weight at a moisture content ranging between optimum and 3 percent above optimum.

6.0 CONSTRUCTION CONSIDERATIONS

6.1 Site Preparation

To mitigate site problems that may develop following prolonged periods of rainfall, it is essential to have adequate drainage to maintain a relatively dry and firm surface prior to starting any work at the site. Adequate drainage should be maintained throughout the construction period. Methods for controlling surface runoff and ponding include proper site grading, berm construction around exposed areas, and installation of sump pits with pumps.

6.2 Groundwater Control

The need for groundwater control will depend on the depth of excavation relative to the groundwater depth at the time of construction. In the event that there is heavy rain prior to or during construction, the groundwater table may be higher than indicated in this report; higher seepage is also likely and may require a more extensive groundwater control program. In addition, groundwater may be pressurized in certain areas of the alignment, requiring further evaluation and consideration of the excess hydrostatic pressures. Groundwater control should be in general accordance with Section 01578 of the latest edition of the COHSGR.

The Contractor should be responsible for selecting, designing, constructing, maintaining, and monitoring a groundwater control system and adapt his trenching operations to ensure the stability of the excavations. Groundwater information presented in Section 4.3 and elsewhere in this report, along with consideration for

potential environmental and site variation between the time of our field exploration and construction, should be incorporated in evaluating ground water depths.

As discussed in Section 4.3 of this report, the depth to groundwater varies with changes in the environment such as frequency and magnitude of rainfall and the time of year when construction is in progress. Therefore, we recommend that the Contractor verify the groundwater depths and seepage rates prior to and during construction and retain the services of a dewatering expert (as necessary) to assist him in identifying the most suitable and cost-effective method of controlling groundwater. The Contractor should take necessary precautions to avoid distressing existing structures as a result of dewatering.

The following recommendations are intended to guide the Contractor during design and construction of the dewatering system. For saturated silty sand or sand, groundwater can be controlled by the installation of wellpoints. The practical maximum dewatering depth for well points is about 15 feet. When groundwater control is required below 15 feet, multiple staged well points or deep wells with submersible pumps have generally proved successful. In cohesive soils seepage rates are lower than in granular soils and groundwater is usually collected in sumps and channeled by gravity flow to storm sewers. If cohesive soils contain significant secondary features, seepage rates will be higher. This may require larger sumps and drainage channels, or if significant granular layers are interbedded within the cohesive soils, methods used for granular soils may be required. Where it is present, pressurized groundwater will also yield higher seepage rates.

Extended and/or excessive dewatering can result in settlement of existing structures in the vicinity; the Contractor should take the necessary precautions to minimize the effect on existing structures in the vicinity of the dewatering operation. We recommend that the Contractor verify the groundwater depths and seepage rates prior to and during construction and retain the services of a dewatering expert (if necessary) to assist them in identifying, implementing, and monitoring the most suitable and cost-effective method of controlling groundwater.

6.3 Monitoring of Existing Structures

Existing structures in the vicinity of the proposed alignment should be closely monitored prior to, during, and for a period after excavation or augering operations. Several factors (including soil type and stratification, construction methods, weather conditions, other construction in the vicinity, construction personnel experience and supervision) may impact ground movement in the vicinity of the alignment. We therefore recommend that

the Contractor be required to survey and adequately document condition of existing structures in the vicinity of the proposed alignment.

6.4 Construction Monitoring

Site preparation, trenching, bedding, and backfilling should be monitored by qualified geotechnical professionals to check for compliance with project documents and changed conditions, if encountered. AEC should be allowed to review the design and construction plans and specifications prior to release to check that the geotechnical recommendations and design criteria presented herein are properly interpreted.

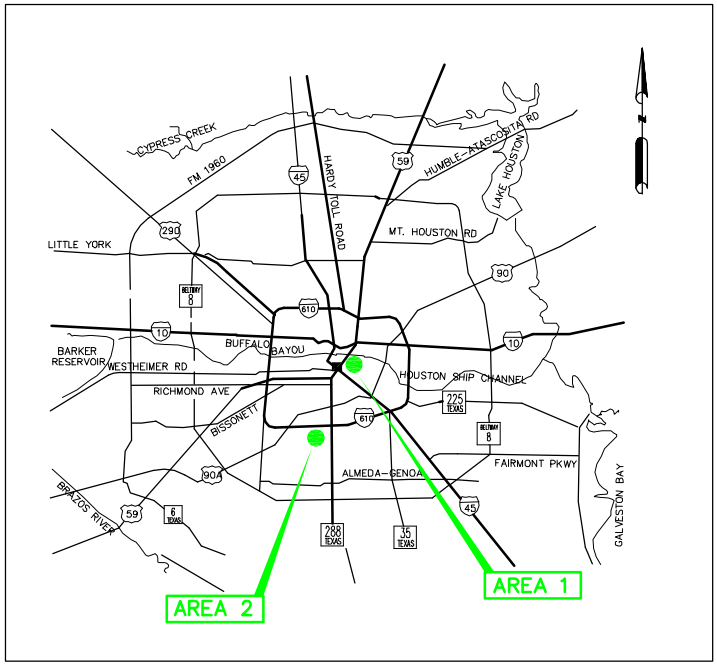
7.0 LIMITATIONS

The information contained in this report summarizes conditions found on the dates the borings were drilled. The attached boring logs are true representations of the soils encountered at the specific boring locations on the dates of drilling. Reasonable variations from the subsurface information presented in this report should be anticipated. If conditions encountered during construction are significantly different from those presented in this report; AEC should be notified immediately.

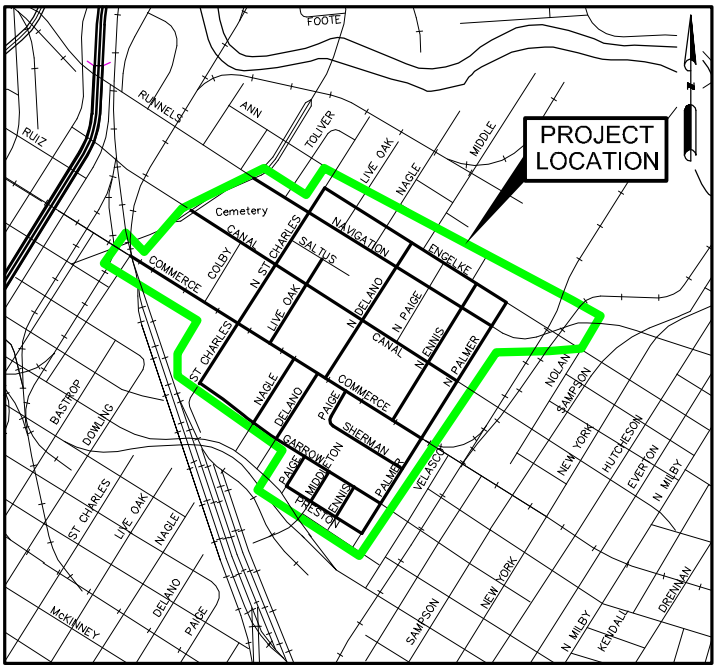
This investigation was performed using the standard level of care and diligence normally practiced by recognized geotechnical engineering firms in this area, presently performing similar services under similar circumstances. This report is intended to be used in its entirety. The report has been prepared exclusively for the project and location described in this report. If pertinent project details change or otherwise differ from those described herein, AEC should be notified immediately and retained to evaluate the effect of the changes on the recommendations presented in this report, and revise the recommendations if necessary. The recommendations presented in this report should not be used for other structures located along these alignments or similar structures located elsewhere, without additional evaluation and/or investigation.

APPENDIX A

Plate A-1	Vicinity Map
Plates A-2a to A-2e	Boring Location Plans
Plates A-3 to A-39	Boring Logs
Plate A-40	Key to Symbols
Plate A-41	Classification of Soils for Engineering Purposes
Plate A-42	Terms Used on Boring Logs
Plate A-43	ASTM & TXDOT Designation for Soil Laboratory Tests
Plate A-44	Sieve Analysis Results
Plates A-45 to A-53	Summary of Laboratory Test Results

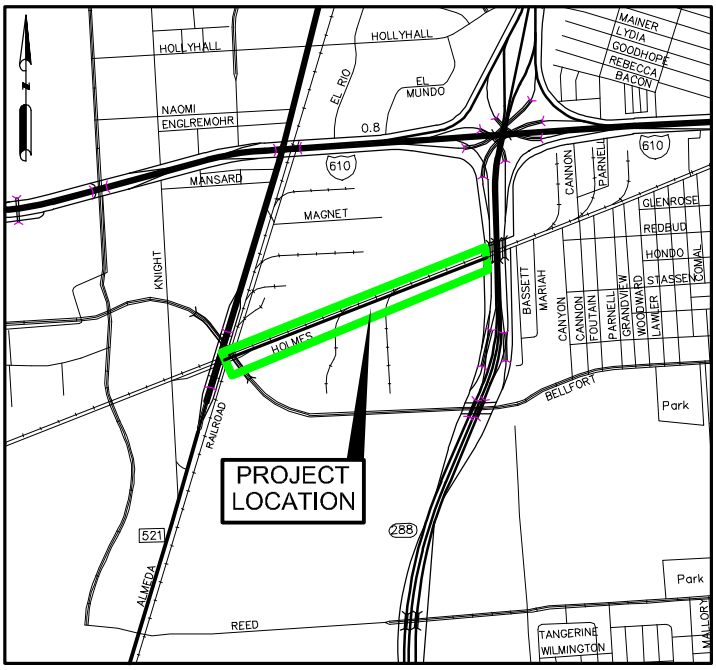


LOCATION MAP



VICINITY MAP – AREA 1

KEY MAP NO. 493R, 494J&N
GIMS MAP NO. 5457A–D
COUNCIL DISTRICT H



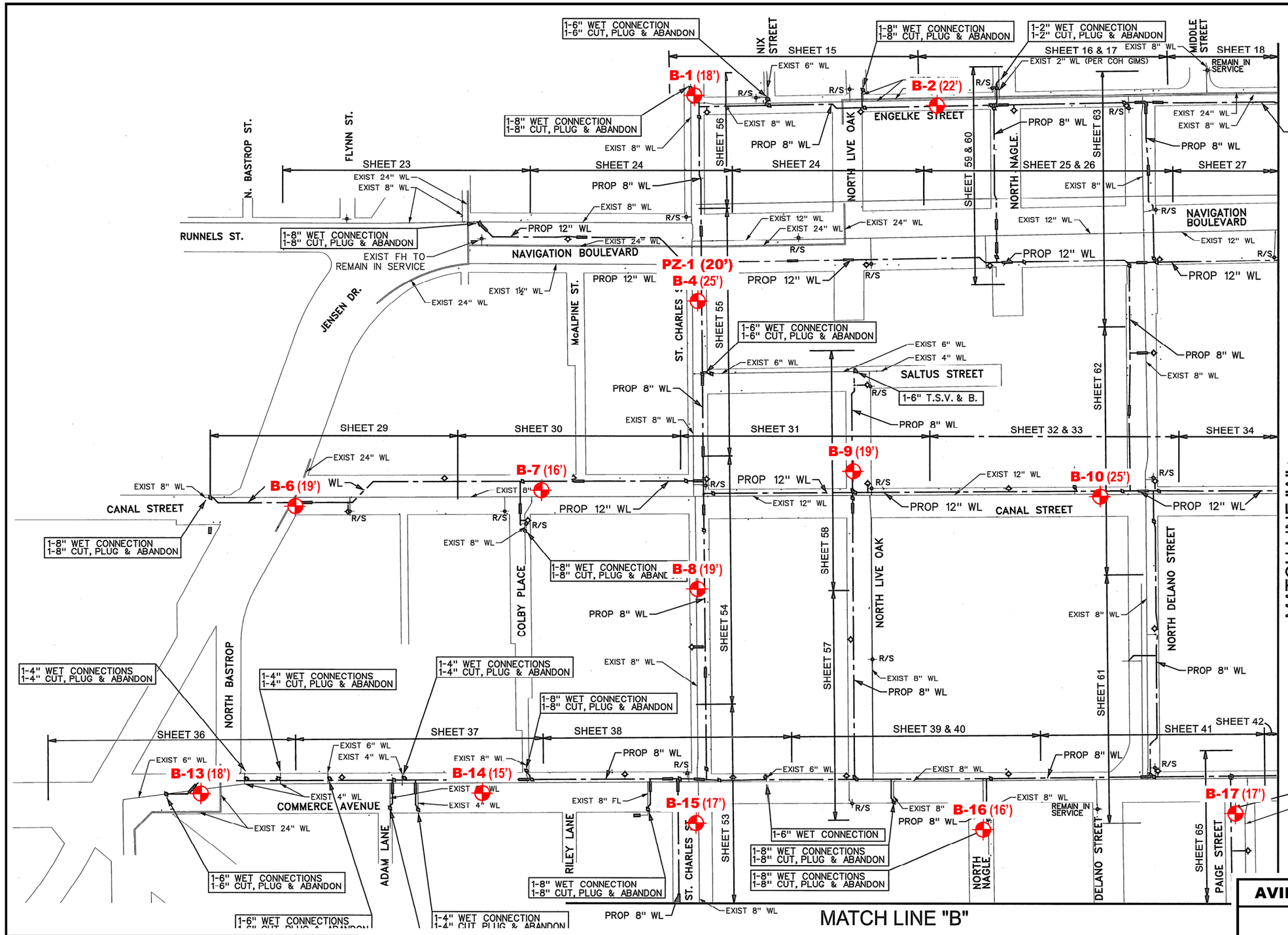
VICINITY MAP – AREA 2

KEY MAP NO. 533S
GIMS MAP NO. 5353A&B
COUNCIL DISTRICT D

AVILES ENGINEERING CORPORATION

VICINITY MAP
WATER LINE REPLACEMENT IN COMMERCE AREA
WBS NO. S-000035-0153-4
HOUSTON, TEXAS

AEC PROJECT NO.:	DATE:	SOURCE DRAWING PROVIDED BY:
G159-13	02-17-14	SANDER ENGINEERING
SCALE: N.T.S.	DRAFTED BY: BpJ	PLATE NO.: PLATE A-1



BENCHMARK 1:
CITY OF HOUSTON SURVEY MARKER 5457-1010 LOCATED AT THE SOUTHEAST CORNER OF NAVIGATION BOULEVARD AND SOUTH JENSEN DRIVE.
ELEV. = 37.68' (NAVD 1988, 2001 ADJUSTMENT)

BENCHMARK 2:
CITY OF HOUSTON SURVEY MARKER 5457-1105 LOCATED AT THE NORTHWEST CORNER OF COMMERCE AVENUE AND NORTH ENNIS STREET.
ELEV. = 41.60' (NAVD 1988, 2001 ADJUSTMENT)

N

0 100 200

LEGEND

- PROPOSED WATER LINE
- PROPOSED DUCTLE IRON PIPE
- PROPOSED FIRE HYDRANT
- PROPOSED GATE VALVE
- R/S — REMOVE AND SALVAGE EXIST. FIRE HYDRANT
- EXIST. FIRE HYDRANT

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NOTICE:

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PRIVATE UTILITY LINES SHOWN

AT&T TEXAS/SBC UTILITY LINES SHOWN

Date:

Approved for AT&T TEXAS/SBC underground conduit facilities only.
Signature valid for one year.

Date:

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Date:

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(Gas service lines are not shown.)

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DENNIS W. SANDER
P.E. 30647

12/3/2012
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SURVEYED BY:
WESTERN GROUP CONSULTANTS
FB NO.: P5675

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

WATER LINE REPLACEMENT IN COMMERCE AREA

AREA 1

NO.	DATE	REVISIONS	APP.

LEGEND

B-# (#') — BORING NO. AND (DEPTH IN FEET)
BORING LOCATION – APPROX.

AVILES ENGINEERING CORPORATION

BORING LOCATION PLAN
WATER LINE REPLACEMENT IN COMMERCE AREA
AND ALONG HOLMES ROAD, COH WBS NO. S-000035-0153-4
HOUSTON, TEXAS

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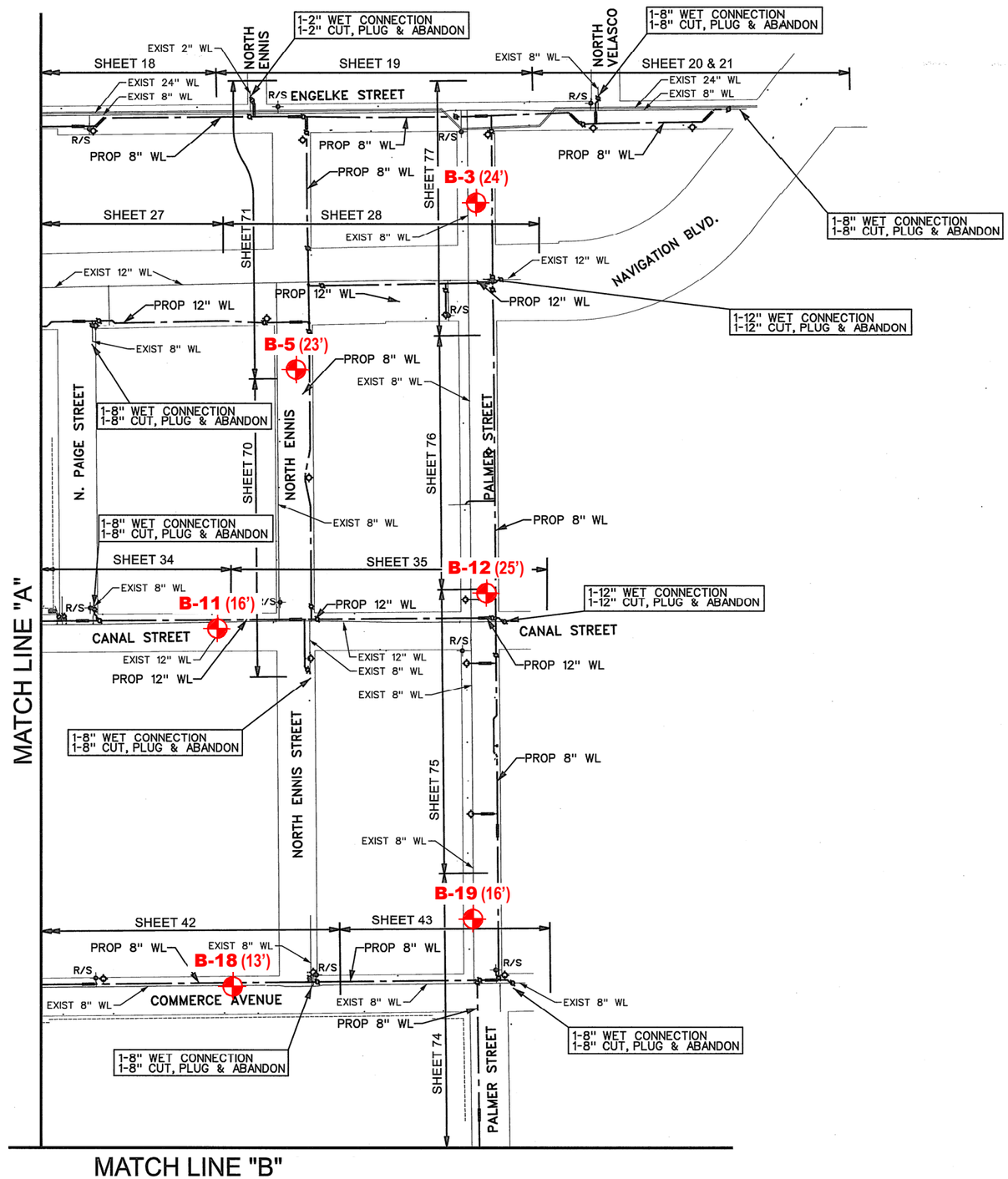

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CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

WATER LINE REPLACEMENT
IN
COMMERCE AREA

AREA 1

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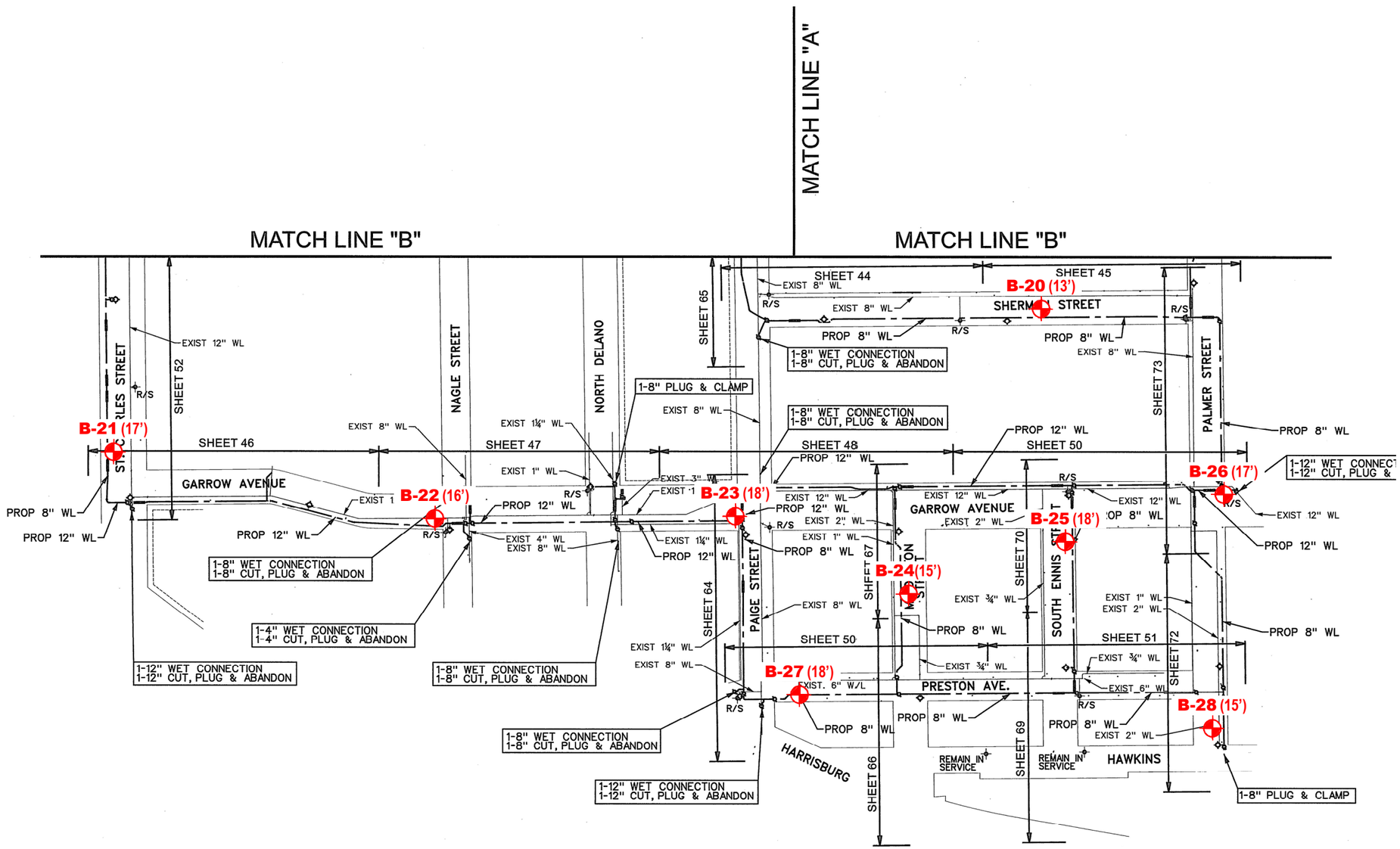

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CITY OF HOUSTON

DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

WATER LINE REPLACEMENT
IN
COMMERCE AREA

AREA 1

LEGEND

B-# (#') — BORING NO. AND (DEPTH IN FEET)
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AVILES ENGINEERING CORPORATION

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WATER LINE REPLACEMENT IN COMMERCE AREA
AND ALONG HOLMES ROAD, COH WBS NO. S-000035-0153-4
HOUSTON, TEXAS

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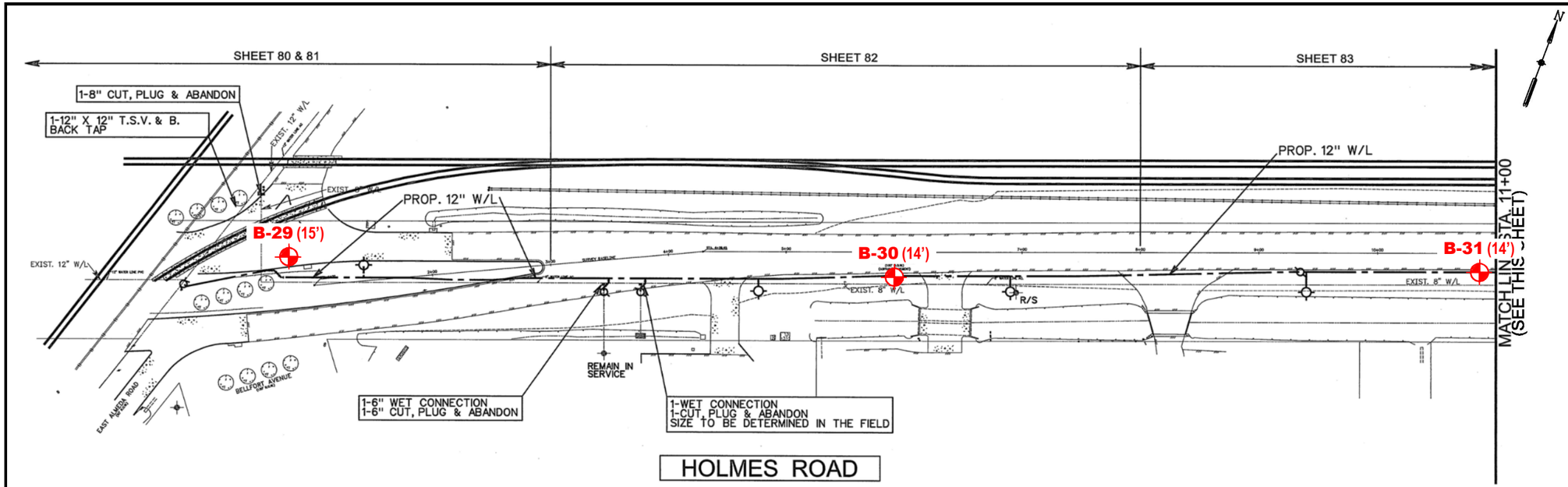

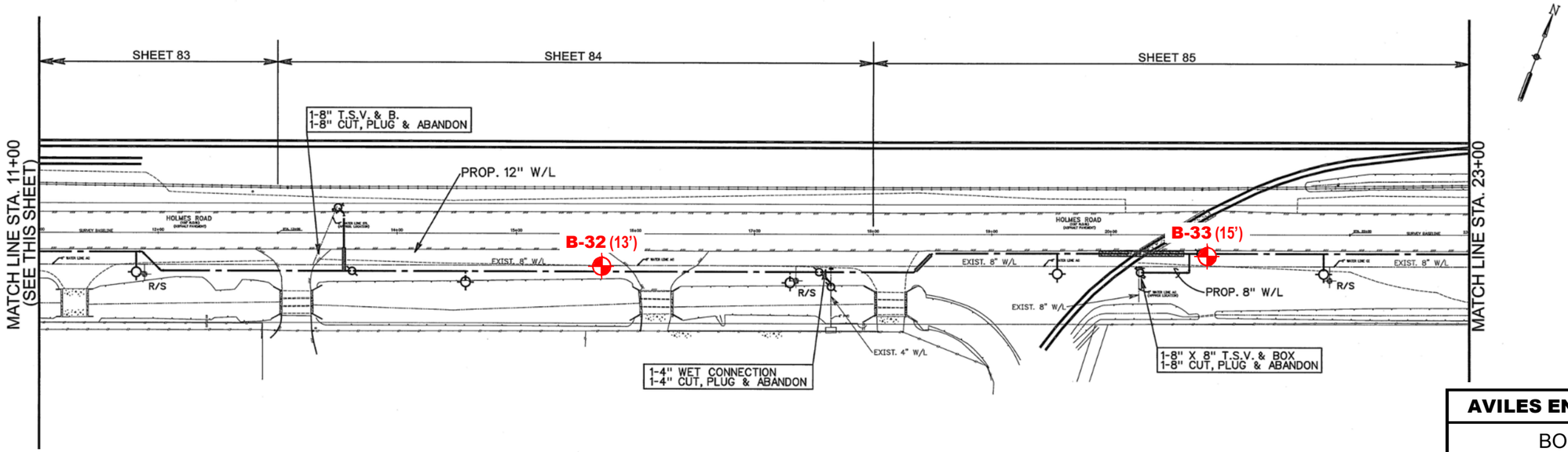

BENCHMARK:

CITY OF HOUSTON SURVEY MARKER 5353-1216
LOCATED ALONG THE EASTSIDE OF HOLMES ROAD AT STATE HIGHWAY 288 FRONTAGE ROAD.

ELEV. = 45.48' (NAVD 1988, 2001 ADJUSTMENT)

TEMPORARY BENCHMARKS:

T.B.M. #1: SET SQUARE CUT ON INLET LOCATED AT THE SOUTHEAST CORNER OF HOLMES ROAD AND EAST ALMEDA.
STA. 0+31.33, 44.56' RT.
ELEV.=49.74'

T.B.M. #2: SET RAILROAD SPIKE IN POWER POLE ALONG THE SOUTH RIGHT-OF-WAY OF HOLMES ROAD.
STA. 10+24.38, 72.97' RT.
ELEV.=48.34'

T.B.M. #3: SET RAILROAD SPIKE IN POWER POLE ALONG THE SOUTH RIGHT-OF=WAY OF HOLMES ROAD.
STA. 19+10.87, 72.50' RT.
ELEV.=48.39'

T.B.M. #4: SET RAILROAD SPIKE IN POWER POLE ALONG THE SOUTH RIGHT-OF=WAY OF HOLMES ROAD.
STA. 27+95.30, 74.02' RT.
ELEV.=48.95'

T.B.M. #5: SET RAILROAD SPIKE IN POWER POLE ALONG THE SOUTH RIGHT-OF=WAY OF HOLMES ROAD.
STA. 38+77.28, 76.28' RT.
ELEV.=47.80'

T.B.M. #6: SET SQUARE CUT ON TOP OF A "BB" INLET ALONG THE NORTH CURB LINE OF HOLMES ROAD.
STA. 47+12.65, 37.48' LT.
ELEV.=44.54'

NO.	DATE	REVISIONS	APP.

LEGEND

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DENNIS W. SANDER
P.E. 30647

12/3/2012
DATE:

SURVEYED BY:
WESTERN GROUP CONSULTANTS
FB NO.: P5675

CITY OF HOUSTON

DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

WATER LINE REPLACEMENT
IN
COMMERCE AREA

AREA 2

LEGEND

B-# (#') — BORING NO. AND (DEPTH IN FEET)
BORING LOCATION – APPROX.

AVILES ENGINEERING CORPORATION

BORING LOCATION PLAN
WATER LINE REPLACEMENT IN COMMERCE AREA
AND ALONG HOLMES ROAD, COH WBS NO. S-000035-0153-4
HOUSTON, TEXAS

AEC PROJECT NO.:	DATE:	SOURCE DRAWING PROVIDED BY:
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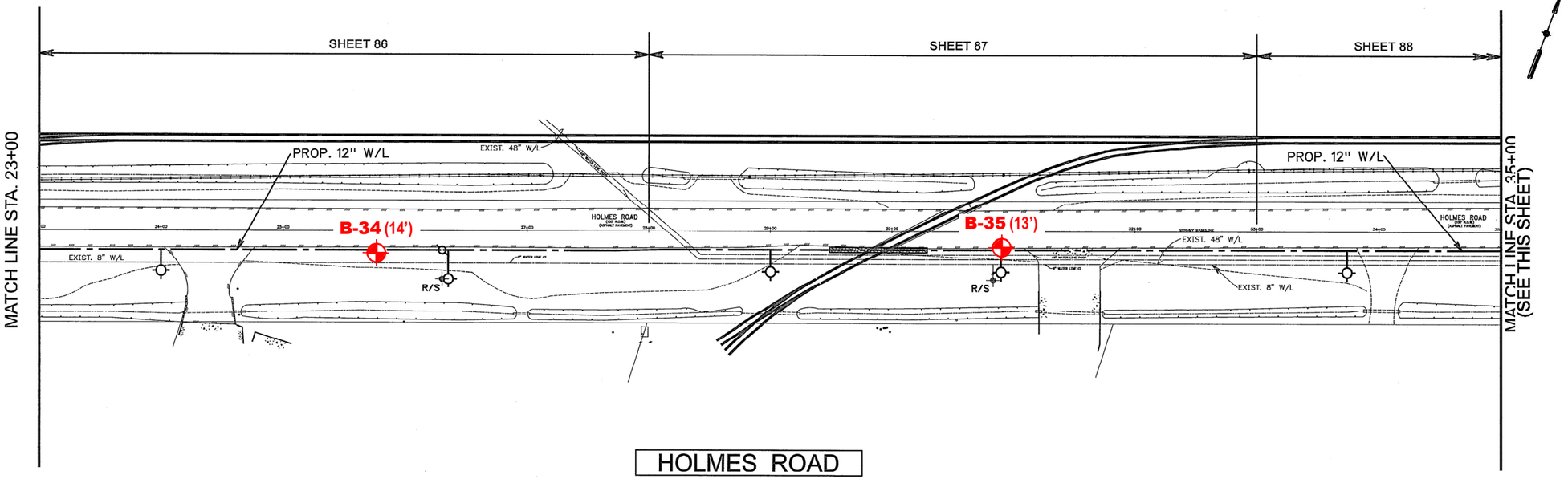
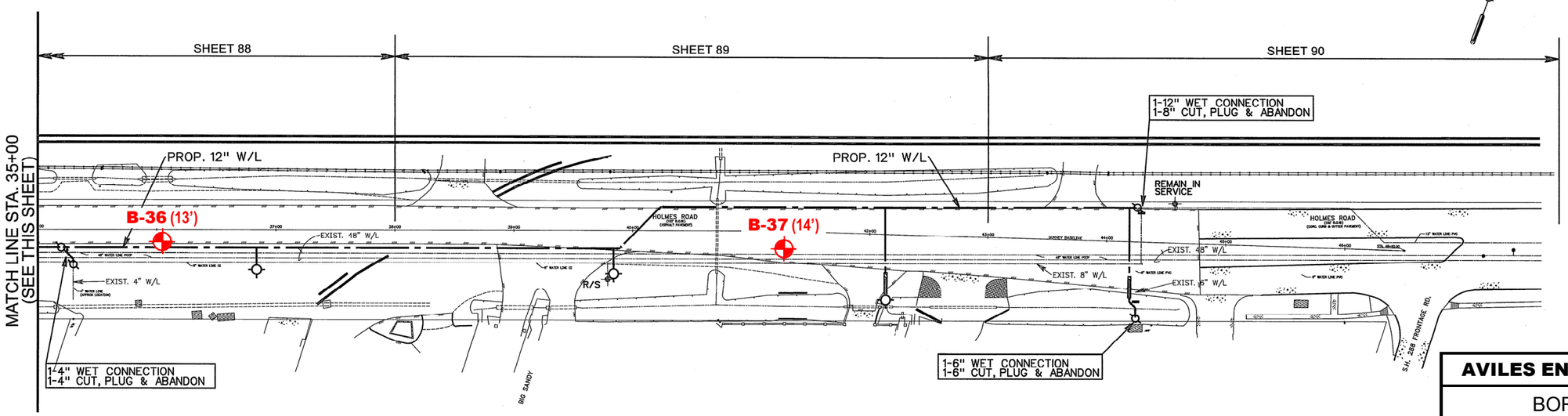
APPROX. SCALE:	DRAFTED BY:	PLATE NO.:
1" = 100'	BpJ	PLATE A-2d



HOLMES ROAD



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CITY OF HOUSTON

DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

WATER LINE REPLACEMENT IN COMMERCE AREA

AREA 2

AVILES ENGINEERING CORPORATION

BORING LOCATION PLAN

WATER LINE REPLACEMENT IN COMMERCE AREA
AND ALONG HOLMES ROAD, COH WBS NO. S-000035-0153-4
HOUSTON, TEXAS

AEC PROJECT NO.:	DATE:	SOURCE DRAWING PROVIDED BY:
G159-13	02-25-14	SANDER ENG. CORP.
APPROX. SCALE:	DRAFTED BY:	PLATE NO.:
1" = 100'	BpJ	PLATE A-2e

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4** BORING **B-1**

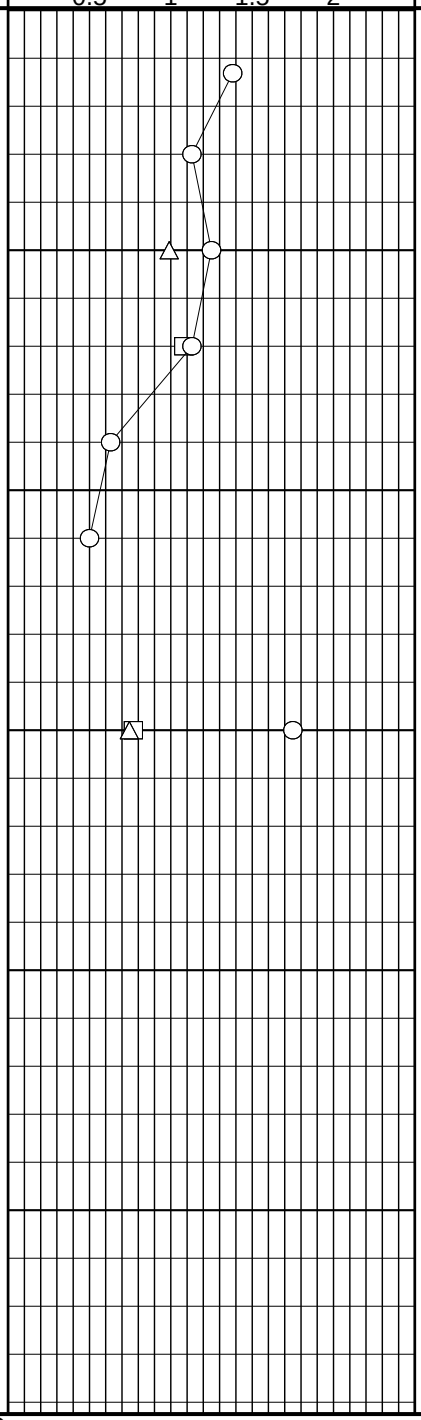
DATE **10/1/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DESCRIPTION

Texas State Plane Coordinates (feet):
Easting: 3128719.95
Northing: 13843060.62
Elevation: 33.52

SHEAR STRENGTH, TSF: △ Confined Compression; ● Unconfined Compression; ○ Pocket Penetrometer; □ Torvane

DEPTH IN FEET	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 2.5" Asphalt							
	Base: 5" sand and crushed limestone							
	Fill: stiff to very stiff, gray and tan Sandy Lean Clay (CL), with ferrous nodules		18					
	-with gravel 1'-2'		16		66	43	13	30
4	-with fat clay pockets 2'-6' and siltstone fragments 2'-4'							
	-with shell 4'-6'		19	109				
	-tan and light gray 6'-10'		16		66	37	12	25
8			14					
	Medium dense, light gray Clayey Sand (SC)		13					
12		15	18					
			17	117	40	26	15	11
	-borehole cave-in at 15.3'							
16		11	21					
	Termination depth = 18 feet.							
20								
24								
28								



BORING DRILLED TO **18** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **16** FEET WHILE DRILLING
WATER LEVEL AT **15.3** FEET AFTER **1/4 HR**
DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

BORING **B-2**

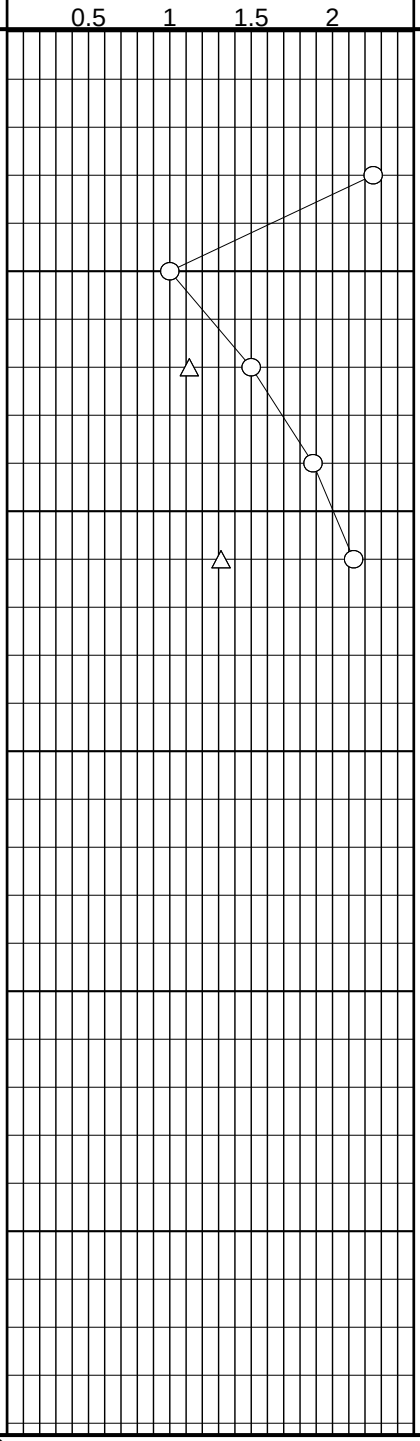
DATE **10/1/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 8" Asphalt							
	Base: 10" sand and crushed limestone							
	Fill: stiff to hard, light gray Sandy Lean Clay (CL)		16					
	-with sand seams 2'-6' and gravel 2'-4'		7					
4	-light gray and tan		12					
	Very stiff to hard, gray and light gray Lean Clay w/Sand (CL), with sand pockets and ferrous nodules		15	114	81	45	13	32
8	-with sand seams 6'-8'							
	-gray and tan 8'-12'		16					
	-with sand seams and siltstone fragments 10'- 12'		17	115				
12	Loose to medium dense, light gray Clayey Sand (SC)		10					
		14	15		42			
16	-wet at 16', borehole caved in at 16.6', with clay seams 16'-22'	10	20					
		14	19		43			
20		14	19					
	Termination depth = 22 feet.							
24								
28								

Texas State Plane Coordinates (feet):
Easting: 3129115.42
Northing: 13842776.16
Elevation: 36.18

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID

WATER ENCOUNTERED AT **16** FEET WHILE DRILLING

WATER LEVEL AT **16** FEET AFTER **1/4 HR**

DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

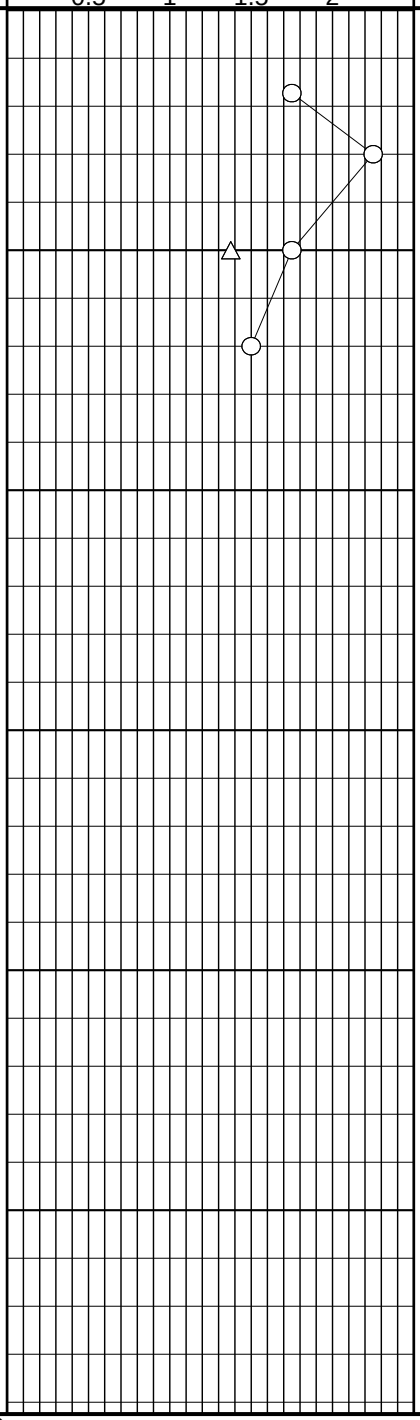
AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4** BORING **B-3**

DATE **10/1/13** TYPE **4" Dry Auger/Wet Rotary** LOCATION **See Boring Location Plan**

Texas State Plane Coordinates (feet):
Easting: 3130192.61
Northing: 13841917.40
Elevation: 37.56

SHEAR STRENGTH, TSF: △ Confined Compression; ● Unconfined Compression; ○ Pocket Penetrometer; □ Torvane



DEPTH IN FEET	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 4" Asphalt							
	Base: 13.5" sand and gravel							
	Very stiff to hard, gray and tan Sandy Fat Clay (CH), with ferrous nodules		20		69	51	15	36
	-with siltstone fragments and calcareous nodules		21					
4			17	118				
	-with sand pockets 6'-8'		15					
8	Medium dense, light gray Clayey Sand (SC)				36			
	-with silty sand seams 8'-14'	23	12					
	-tan and light gray 10'-12'	20	18					
12	-borehole cave-in at 12.2'				31			
		18	21					
	-tan and red 14'-16'		23					
16		22	19					
	Very stiff to hard, tan Silty Clay (CL-ML)				89	23	18	5
		40	19					
20	-with silt seams 20'-22'		23					
	-tan and red, with calcareous nodules and siltstone fragments 22'-24'	23	24					
24	Termination depth = 24 feet.							
28								

BORING DRILLED TO **18** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **12** FEET WHILE DRILLING
WATER LEVEL AT **12.2** FEET AFTER **1/4 HR**
DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4** BORING **B-4**

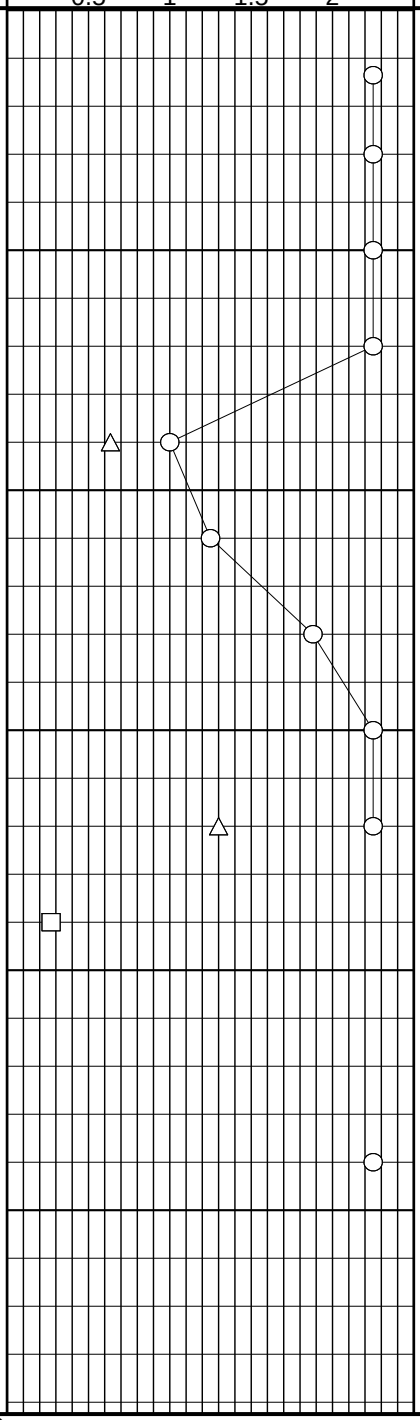
DATE **10/3/13** TYPE **4" Dry Auger/Wet Rotary** LOCATION **See Boring Location Plan**

DEPTH IN FEET	DESCRIPTION	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 1.5" Asphalt + 7" Concrete						
	Stiff to hard, tan, red, and light gray Lean Clay w/Sand (CL), with ferrous nodules	16					
	-tan and light gray 2'-10', with calcareous nodules 2'-4' and siltstone fragments 2'-8'	15					
4		14		80	41	13	28
	-with abundant calcareous nodules and fat clay seams 6'-8'	21					
8	-with silt partings 8'-10'	21	104				
	Very stiff to hard, red, brown, and light gray Fat Clay (CH), with slickensides	27					
12	-with calcareous nodules, siltstone fragments, and silty clay seams 10'-12'	24		99	62	21	41
	-with siltstone fragments and calcareous nodules 14'-18'	24					
16	-borehole cave-in at 16.8'	22	107				
	Soft to hard, red, light gray, and tan Sandy Lean Clay (CL), wet	23		61	26	17	9
20	-with siltstone fragments and calcareous nodules 18'-20'						
24	-light gray and tan, with ferrous nodules	17					
	Termination depth = 25 feet.						
28							

Texas State Plane Coordinates (feet):
Easting: 3128477.41
Northing: 13842703.40
Elevation: 36.68

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **20** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **18** FEET WHILE DRILLING
WATER LEVEL AT **13.3** FEET AFTER **24 HRS**
DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

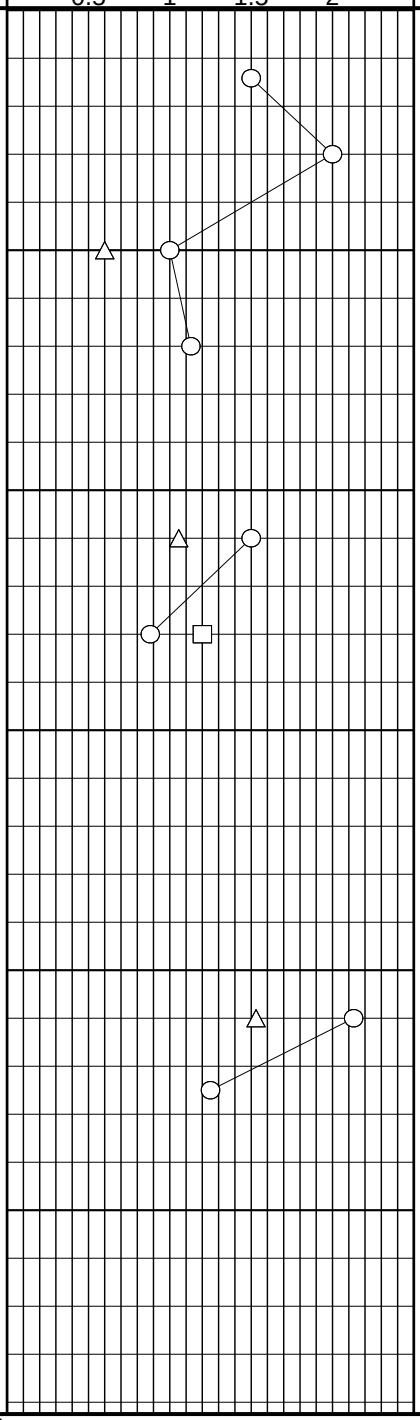
PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4** BORING **B-5**

DATE **10/3/13** TYPE **4" Dry Auger/Wet Rotary** LOCATION **See Boring Location Plan**

DEPTH IN FEET	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 2" Asphalt + 8" Concrete							
	Stiff to hard, tan and gray Sandy Lean Clay (CL)		18					
	-with ferrous nodules 1'-6'		14		53	35	13	22
4	-with silt partings 4'-6' and sand seams 4'-8'		13	115				
			16					
8	Medium dense, light gray and tan Clayey Sand (SC), with silt pockets	13	17		31	33	12	21
	Stiff to very stiff, tan and light gray Sandy Silty Clay (CL-ML), with silt pockets		15	121				
12			17		56	23	16	7
	Medium dense to dense, light gray Silty Sand (SM), with clay pockets	28	18					
16		31	19		31	21	19	2
		14	24					
20	Very stiff to hard, light gray and tan Fat Clay (CH)		18	113				
	-with sand partings 20'-22'		20					
	Termination depth = 23 feet.							
24								
28								

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **16** FEET WITHOUT DRILLING FLUID

WATER ENCOUNTERED AT **14** FEET WHILE DRILLING

WATER LEVEL AT **9.8** FEET AFTER **1/4 HR**

DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

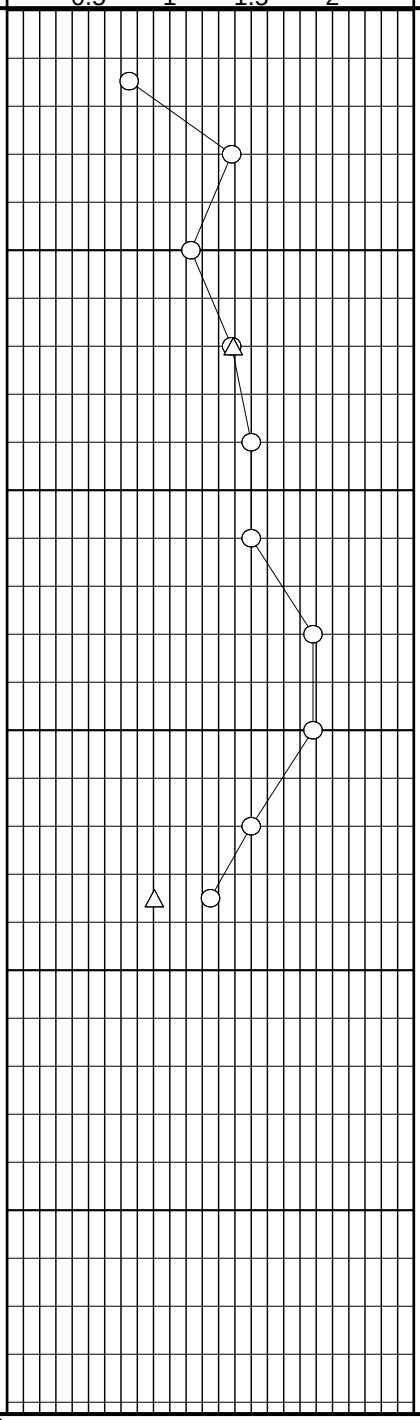
BORING **B-6**

DATE **10/3/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Pavement: 4" Asphalt + 7.5" Concrete							
			Fill: stiff, dark gray Fat Clay (CH), with wood and glass pieces, and gravel		20					
			Very stiff, dark gray and tan Fat Clay (CH) -with ferrous nodules 2'-10'		18					
4			-gray and tan 4'-6'		24					
			-tan and light gray 6'-8', with siltstone fragments and calcareous nodules 6'-16'		23	113				
8			-red, brown, and light gray 8'-16'		23		91	55	18	37
			-with silty clay pockets 10'-12'		19					
12			-with silt pockets 12'-14'		24					
					26					
16			Stiff to very stiff, tan and light gray Lean Clay w/Sand (CL), with ferrous nodules		16		83	29	14	15
			-borehole cave-in at 17.8'		16	118				
			Termination depth = 19 feet.							
20										
24										
28										

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID

WATER ENCOUNTERED AT **17.8** FEET WHILE DRILLING

WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**

DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

AVILES ENGINEERING CORP.
GEOTECHNICAL ENGINEERS

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4** BORING **B-7**

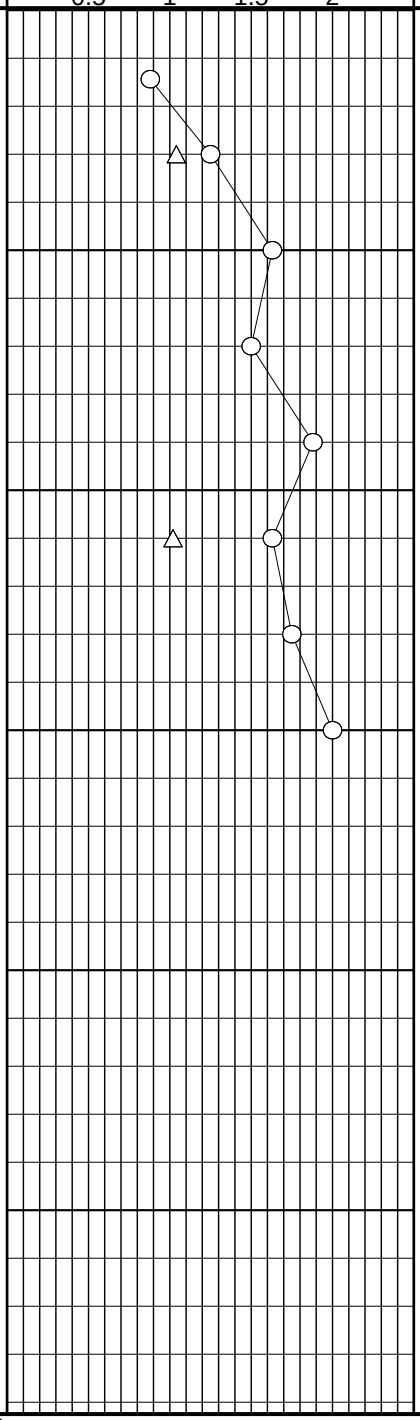
DATE **10/4/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Pavement: 3.5" Asphalt + 7" Concrete							
			Stiff to very stiff, dark gray Fat Clay (CH), with slickensides		22					
			-tan and gray 2'-6', with calcareous nodules and siltstone fragments 2'-12'		22	107				
4					21					
			-red, brown, and light gray, with ferrous nodules 6'-12'		23		96	60	17	43
8					22					
			-with sand partings 10'-12'		23	107				
12			Very stiff to hard, light gray and tan Sandy Lean Clay (CL)		16					
			-with silt partings 12'-14'							
			-with ferrous nodules 14'-16'							
			-borehole cave-in at 15 feet.	▽	15					
16			Termination depth = 16 feet.							
20										
24										
28										

Texas State Plane Coordinates (feet):
Easting: 3128029.64
Northing: 13842569.47
Elevation: 42.38

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **15** FEET WHILE DRILLING ▽
WATER LEVEL AT **N/A** FEET AFTER **COMPLETE** ▼
DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

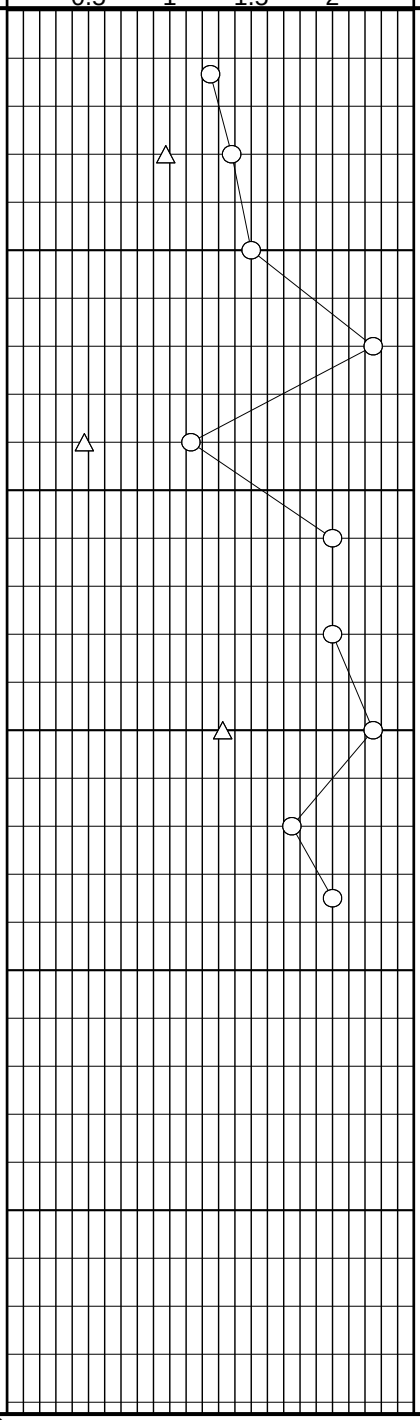
BORING **B-8**

DATE **10/4/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Pavement: 2" Asphalt + 6" Concrete							
			Stiff to hard, dark gray and tan Fat Clay (CH), with ferrous nodules		24					
			-tan 2'-4'		24	102				
4			-brown, light gray, and tan 4'-6', with calcareous nodules and siltstone fragments 4'-8'		23					
			-red, brown, and light gray 6'-8'		20		91	55	16	39
8			Firm to hard, light gray and tan Lean Clay w/ Sand (CL), with ferrous nodules		19	111				
			-with silt seams 8'-10'		15		83	32	13	19
12			-with calcareous nodules and siltstone fragments 12'-16'		18					
			-red and light gray 14'-16'		21	106				
16			Very stiff to hard, red, brown, and light gray Fat Clay (CH), with calcareous nodules and siltstone fragments		28		95	76	28	48
			-with ferrous nodules 16'-18' -with sandy clay pockets 18'-19'		28					
20			Termination depth = 19 feet.							
24										
28										

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



Texas State Plane Coordinates (feet):
Easting: 3128180.42
Northing: 13842232.49
Elevation: 40.49

BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING
WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**
DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4** BORING **B-9**

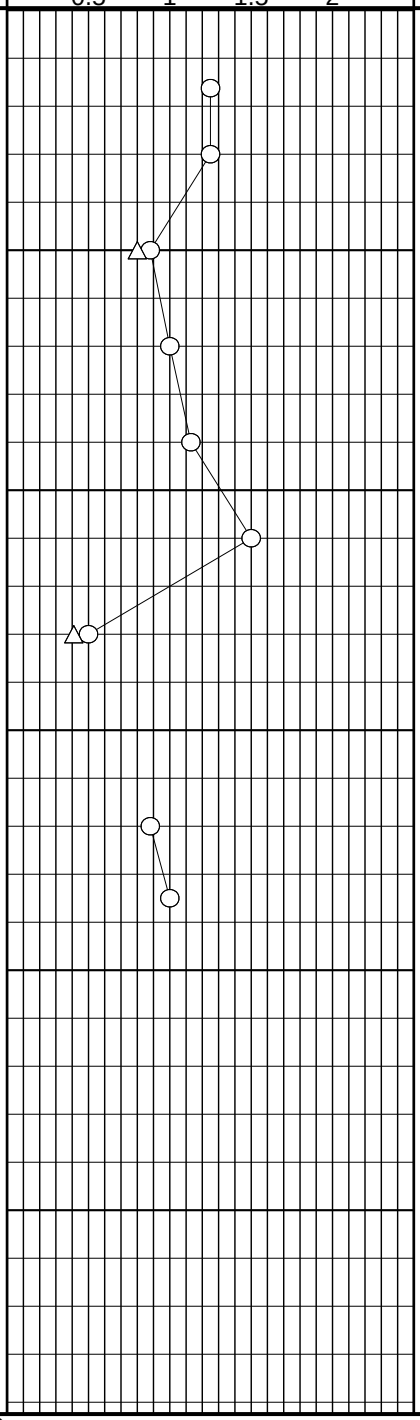
DATE **10/1/13** TYPE **4" Dry Auger/Wet Rotary** LOCATION **See Boring Location Plan**

DEPTH IN FEET	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 4" Asphalt							
	Base: 11" sand, gravel, and crushed limestone		23					
	Fill: very stiff, dark gray Fat Clay (CH) -with sand and shell pockets 2'-4'		22					
4	Firm to very stiff, dark gray, light gray, and tan Fat Clay (CH)		25	99				
	-light gray and tan 6'-14', with siltstone fragments 6'-12' and calcareous nodules 6'-8'		24					
8			24		88	58	16	42
	-with sand partings 10'-14'		21					
12	-with silt partings 12'-14'		18	111				
	-borehole cave-in at 13.2'							
	Medium dense, light gray Silty Sand (SM)	13	19		37			
16	Stiff to very stiff, light gray and tan Lean Clay (CL)		18					
	-with sand partings 16'-18' -with silt partings and fat clay pockets 18'- 19'		20		91	26	15	11
	Termination depth = 19 feet.							
20								
24								
28								

Texas State Plane Coordinates (feet):
Easting: 3128571.37
Northing: 13842260.26
Elevation: 37.47

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **14** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **14** FEET WHILE DRILLING
WATER LEVEL AT **11.5** FEET AFTER **1/4 HR**
DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

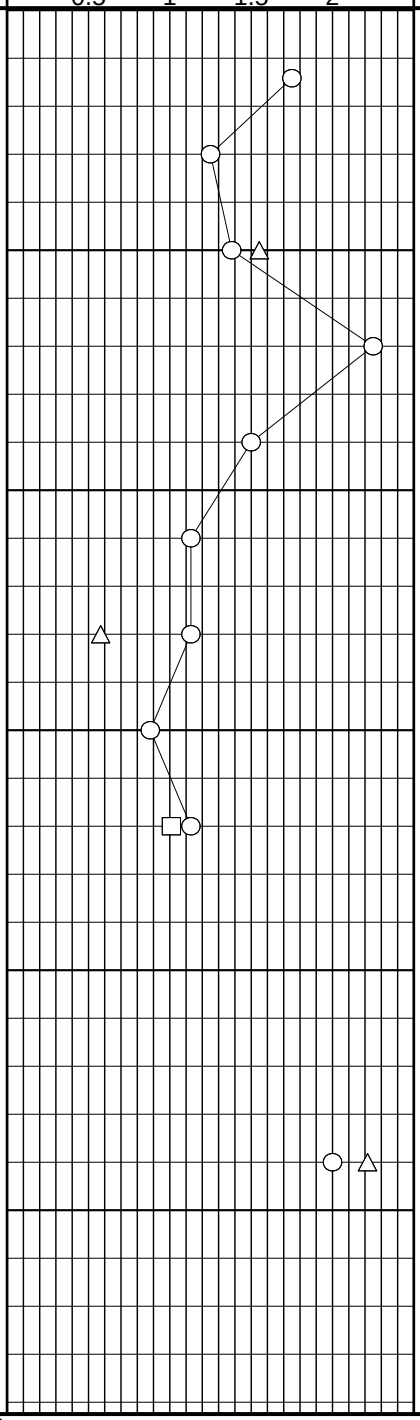
AVILES ENGINEERING CORP.
GEOTECHNICAL ENGINEERS

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4** BORING **B-10**

DATE **10/3/13** TYPE **4" Dry Auger/Wet Rotary** LOCATION **See Boring Location Plan**

Texas State Plane Coordinates (feet):
Easting: 3128957.07
Northing: 13841941.27
Elevation: 35.06

SHEAR STRENGTH, TSF: △ Confined Compression; ● Unconfined Compression; ○ Pocket Penetrometer; □ Torvane



DEPTH IN FEET	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 3.5" Asphalt + 6.5" Concrete							
	Very stiff to hard, dark gray Lean Clay w/ Sand (CL), with ferrous nodules		21					
	-with fat clay seams 1'-4'		21					
4	-light gray and tan 4'-12'		15	120				
			16					
8			15		71	28	16	12
	-with silt pockets 10'-12'		21					
12	Stiff to very stiff, light gray and tan Fat Clay (CH), with silt partings and seams		22	105				
	-borehole cave-in at 14.8'		24					
16	-red, brown, and light gray 16'-18'		40		91	50	16	34
	Dense, tan Silty Sand (SM), wet	32	22					
20	Hard, light gray and tan Sandy Lean Clay (CL), with ferrous nodules							
24			16	120				
	Termination depth = 25 feet.							
28								

BORING DRILLED TO **18** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **18** FEET WHILE DRILLING
WATER LEVEL AT **12.5** FEET AFTER **1/4 HR**
DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

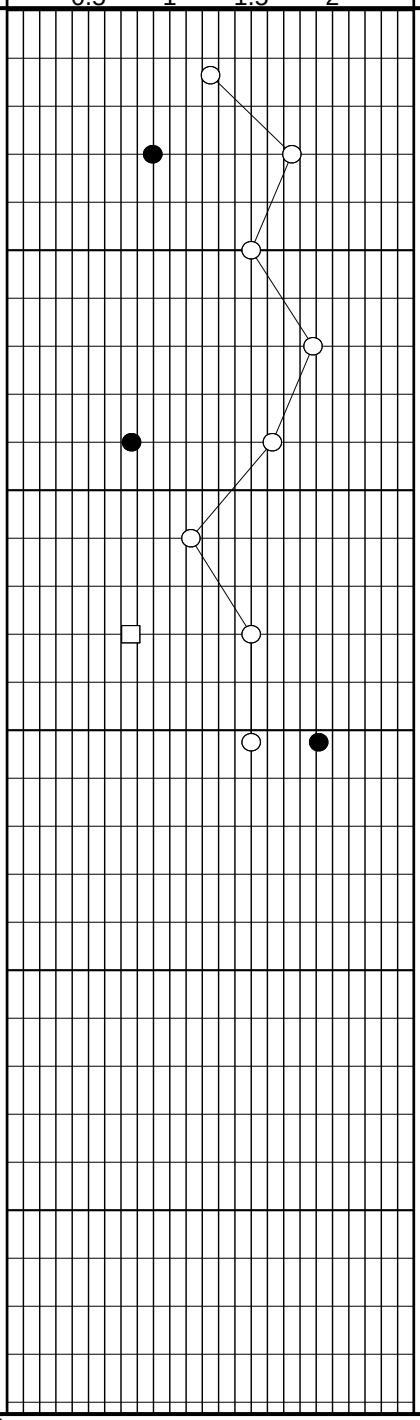
BORING **B-11**

DATE **10/3/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Pavement: 3" Asphalt + 5.5" Concrete							
			Stiff to very stiff, gray and tan Sandy Lean Clay (CL), with ferrous nodules -with roots 1'-2'		20					
					18	111				
4			-with abundant calcareous nodules and siltstone fragments 4'-8'				64	49	17	32
					18					
					18					
8										
					14	117				
					19					
12			Medium dense, gray and tan Clayey Sand (SC) -borehole cave-in at 13'				44	21	11	10
					17					
				19	17	118				
16			Termination depth = 16 feet.							
20										
24										
28										

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID

WATER ENCOUNTERED AT **14** FEET WHILE DRILLING ▽

WATER LEVEL AT **10.7** FEET AFTER **1/4 HR** ▼

DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

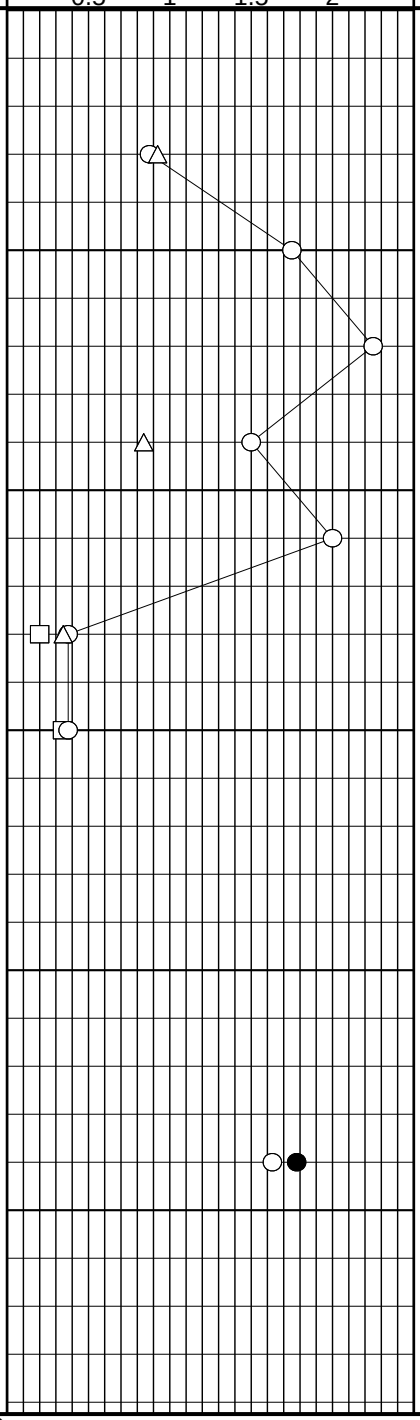
PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4** BORING **B-12**

DATE **9/27/13** TYPE **4" Dry Auger/Wet Rotary** LOCATION **See Boring Location Plan**

DEPTH IN FEET	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 5.5" Asphalt		1					
	Base: 5.5" stabilized sand with shell and gravel		26		69	58	15	43
	Fill: gray and tan Sandy Fat Clay (CH) -sand and gravel layer, and wood pieces 0.9'-1.3'		21	105				
4	Stiff to very stiff, gray Lean Clay w/Sand (CL) -with sand pockets and partings 2'-4' -greenish gray, with calcareous and ferrous nodules 4'-6'		17		72	47	13	34
	Very stiff to hard, gray Sandy Lean Clay (CL), with ferrous stains		15					
8			16	115	56	32	13	19
	-with sand pockets and partings 10'-12' -borehole caved in at 11.5'		17					
12	Light gray and tan Silty Clayey Sand (SC-SM), moist		18	114				
	-wet at 14'		21		35	24	18	6
16	Medium dense, light gray Silty Sand (SM), with clayey sand seams, wet	13	20					
	-gray and tan, with gravel 18'-20'	17	23		24			
20								
	Very stiff, gray and light tan Fat Clay (CH)							
24			15	119				
	Termination depth = 25 feet.							
28								

Texas State Plane Coordinates (feet):
Easting: 3129865.22
Northing: 13841403.21
Elevation: 36.39

SHEAR STRENGTH, TSF



BORING DRILLED TO **16** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **14** FEET WHILE DRILLING
WATER LEVEL AT **10.2** FEET AFTER **1/4 HR**
DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

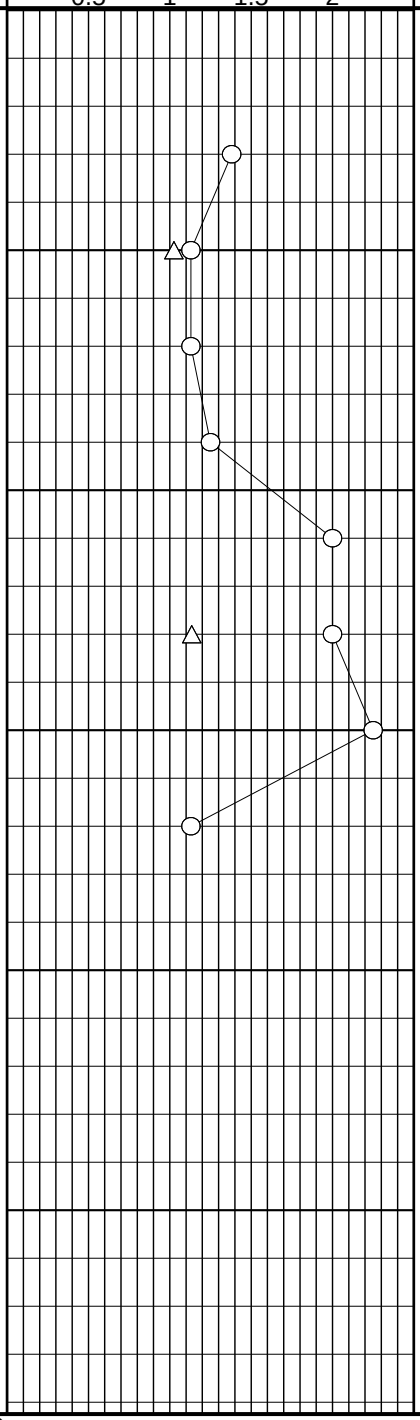
PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4** BORING **B-13**

DATE **10/4/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DESCRIPTION

Texas State Plane Coordinates (feet):
Easting: 3127124.54
Northing: 13842440.10
Elevation: 44.19

SHEAR STRENGTH, TSF: △ Confined Compression; ● Unconfined Compression; ○ Pocket Penetrometer; □ Torvane



DEPTH IN FEET	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 7" Asphalt							
	Fill: dark gray and tan gravel, sand, limestone fragments, and clay pockets		12					
	Very stiff, dark gray Fat Clay (CH), with ferrous nodules		25					
4			24	104				
	-tan and gray, with calcareous nodules 6'-12'		27		91	67	19	48
8	-with siltstone fragments 8'-12'		24					
	-red and brown 10'-12'		23					
12	Very stiff to hard, red, brown, and light gray Lean Clay (CL) -with sand and silt partings, siltstone fragments, and calcareous nodules 12'-14'		19	109	99	47	18	29
			23					
16	-with silt partings 16'-18'		16					
	Termination depth = 18 feet.							
20								
24								
28								

BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING
WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**
DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

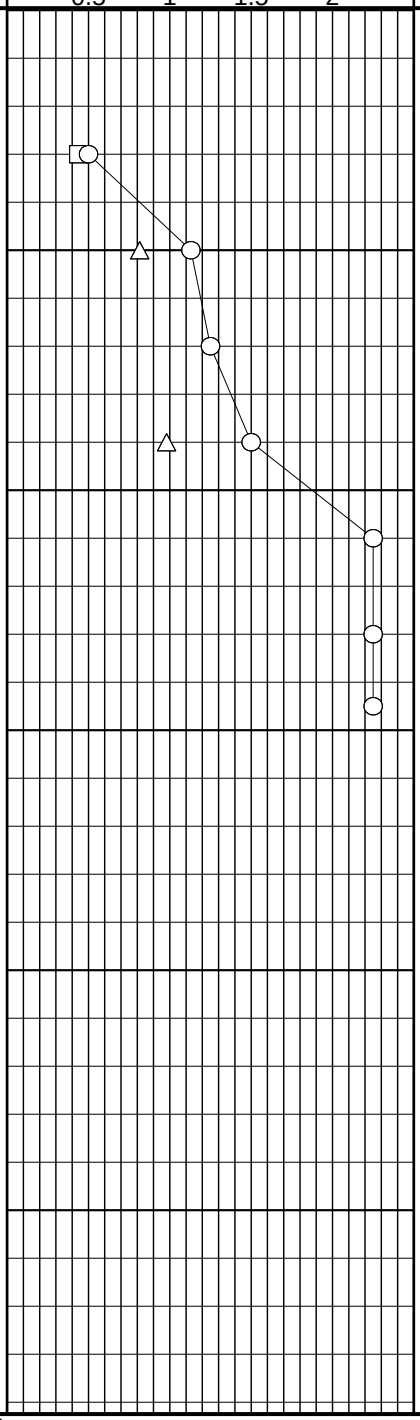
BORING **B-14**

DATE **10/7/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Pavement: 3.5" Asphalt + 5" Concrete							
			Base: 6" sand							
			Fill: firm to very stiff, dark gray and tan Lean Clay w/Sand (CL), with sand seams		19		70	41	13	28
			-dark gray 2'-4'		27					
4					25	94				
			Stiff to hard, gray and tan Fat Clay (CH), with slickensides		26					
8			-with calcareous nodules and siltstone framgents 6'-14', and ferrous nodules 6'-10'							
			-red and gray 8'-10'		23	104				
			-red, brown, and light gray 10'-14'		23		93	58	16	42
12			-with sand partings 12'-15'		21					
			-with ferrous nodules 14'-15'		16					
			Termination depth = 15 feet.							
16										
20										
24										
28										

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID

WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING

WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**

DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

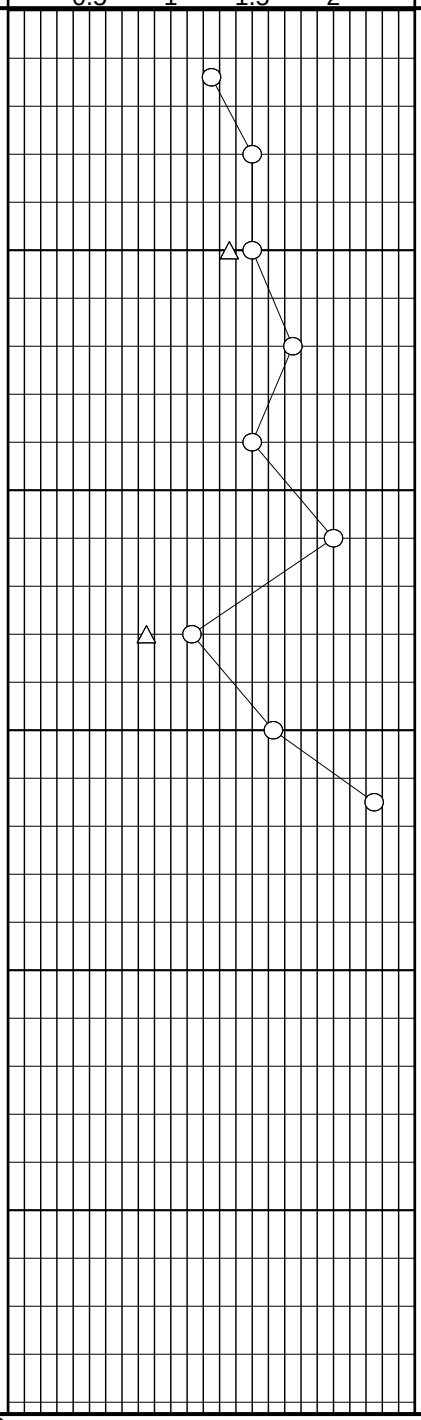
PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4** BORING **B-15**

DATE **10/4/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Pavement: 3.5" Asphalt + 6" Concrete							
			Fill: very stiff, dark gray Fat Clay (CH), with ferrous nodules, and sand and gravel seams		20					
			Very stiff, tan and gray Fat clay (CH), with ferrous and calcareous nodules		19		88	54	15	39
4					20	111				
			-red, brown, and light gray, with siltstone fragments 6'-8'		24					
8			Stiff to hard, red, brown, and light gray Lean Clay w/Sand (CL), with ferrous nodules -with silt partings, abundant calcareous nodules, and siltstone fragment 8'-12'		24					
					23					
12			-tan and light gray, with sand partings 12'-17' and silt partings 12'-14'		17	118	80	30	13	17
					15					
16					19					
			Termination depth = 17 feet.							
20										
24										
28										

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



Texas State Plane Coordinates (feet):
Easting: 3127919.83
Northing: 13841842.33
Elevation: 43.15

BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING
WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**
DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

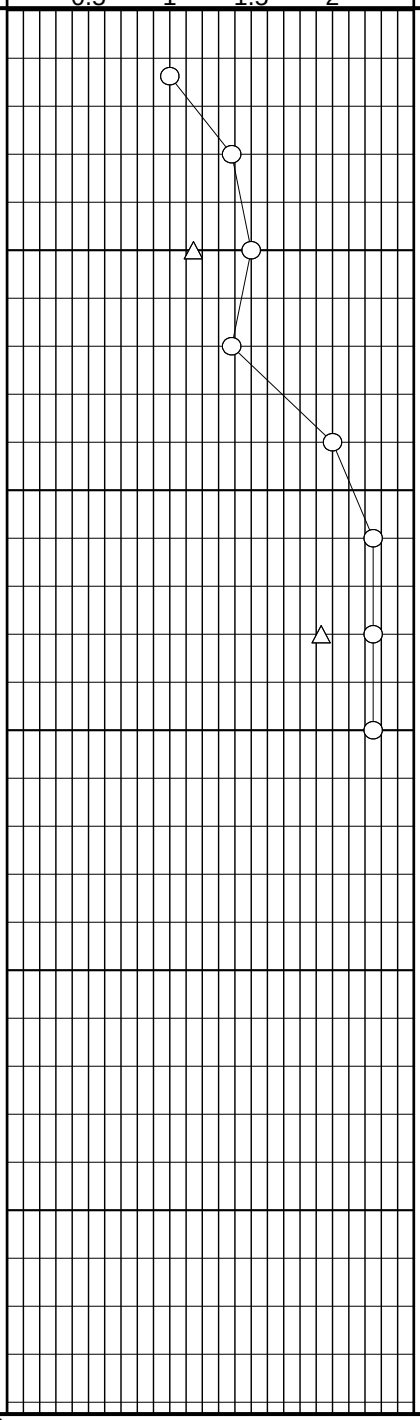
BORING **B-16**

DATE **10/2/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Pavement: 4.5" Asphalt							
			Base: 4.5" stabilized sand and gravel							
			Fill: stiff to very stiff, dark gray Fat Clay (CH), with shell and gravel		22					
			Very stiff, dark gray Fat Clay (CH)		20					
4			-dark gray and tan 4'-6', with calcareous nodules and siltstone fragments 4'-8'		19	111				
					23		92	58	16	38
8			Very stiff to hard, light gray and tan Fat Clay w/Sand (CH), with ferrous nodules -with calcareous nodules 8'-10'		16					
					15					
12			-red, light gray, and tan 12'-16'		18	115	80	51	16	35
					22					
16			Termination depth = 16 feet.							
20										
24										
28										

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID

WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING

WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**

DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4** BORING **B-17**

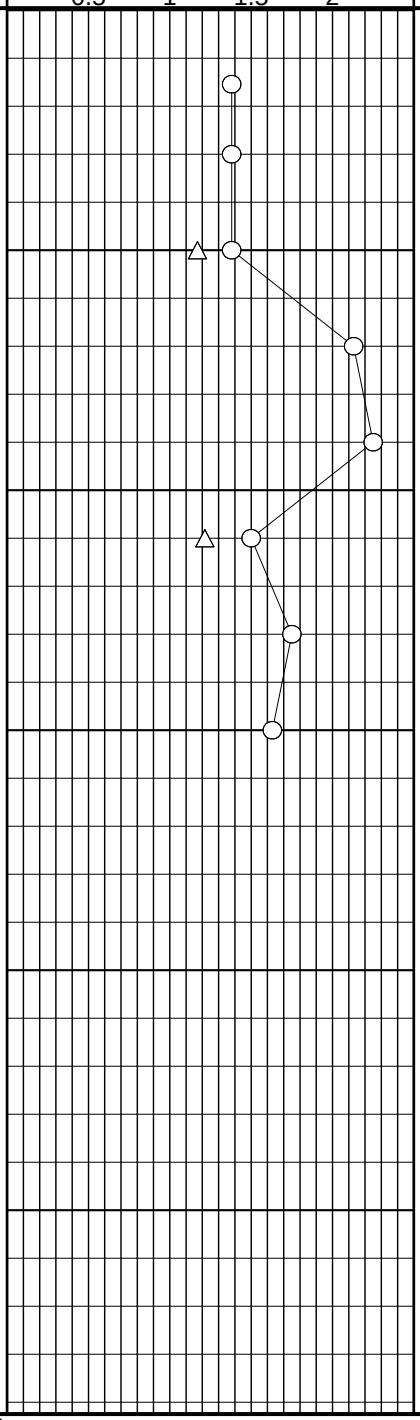
DATE **10/2/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DESCRIPTION

Texas State Plane Coordinates (feet):
Easting: 3128822.87
Northing: 13841254.88
Elevation: 41.72

SHEAR STRENGTH, TSF: △ Confined Compression; ● Unconfined Compression; ○ Pocket Penetrometer; □ Torvane

DEPTH IN FEET	DESCRIPTION	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 7" Asphalt						
	Base: 4" stabilized sand and gravel						
	Very stiff to hard, olive gray Fat Clay (CH), with slickensides and calcareous nodules	21					
		19					
4	-with ferrous nodules 4'-8'						
		22	105				
	-red and tan 6'-10'			96	57	19	38
		23					
8							
		21					
	-gray and tan, with silty sand pockets 10'-12'						
		17	113				
12	Very stiff, gray and tan Lean Clay w/Sand (CL), with silty sand partings			83	33	11	22
		14					
	-gray 14'-16'						
		20					
16	-gray, red, and brown, with vertical silty sand seams 16'-17'	23					
	Termination depth = 17 feet.						
20							
24							
28							



BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING
WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**
DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

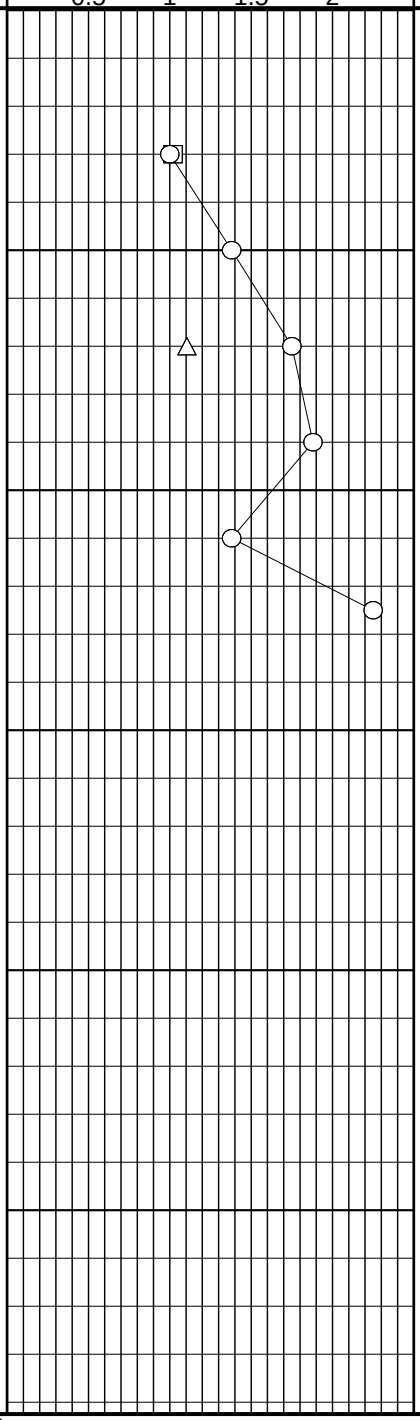
BORING **B-18**

DATE **10/4/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Pavement: 2" Asphalt + 8" Concrete							
			Base: 2" shell, sand, and gravel							
			Fill: stiff to very stiff, dark gray Fat Clay w/ Sand (CH)		22					
			-with sand pockets and shell 1'-2'		21		79	54	15	39
4			Very stiff, tan and gray Fat Clay (CH), with slickensides, calcareous and ferrous nodules, and siltstone fragments		21					
			-red and light gray 6'-10'		24	102				
8					26					
			Very stiff to hard, light gray and tan Lean Clay w/Sand (CL)		17		80	38	14	24
12					18					
			Termination depth = 13 feet.							
16										
20										
24										
28										

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID

WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING

WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**

DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

AVILES ENGINEERING CORP.
GEOTECHNICAL ENGINEERS

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4** BORING **B-19**

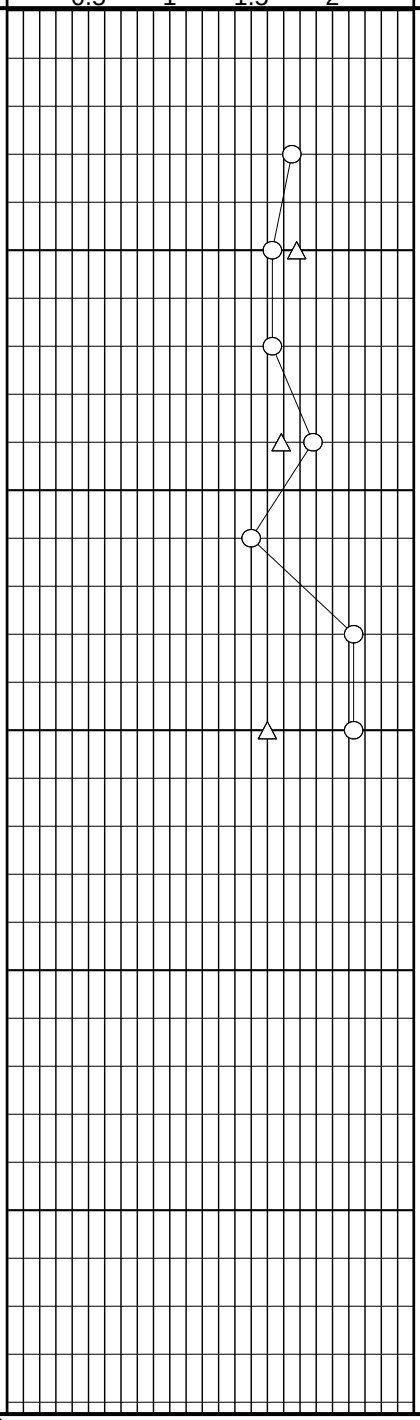
DATE **9/27/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 7.5" Asphalt							
	Base: 9.5" stabilized sand with gravel and shell		1					
	Fill: shell with sand		3					
	Very stiff, gray Fat Clay (CH)		21					
4	-with ferrous nodules 2'-4'							
	-olive gray 4'-6', with calcareous nodules 4'-10'		20	107				
	-tan 6'-8'		19		93	57	15	42
8	-tan and gray 8'-10'		17	112				
	-greenish gray, with sand pockets 10'-12'		16					
12	Very stiff to hard, gray and tan Sandy Fat Clay (CH), with sand seams and ferrous nodules 12'-14'		18					
			16	110	67	50	15	35
16	Termination depth = 16 feet.							
20								
24								
28								

SYMBOL

SAMPLE INTERVAL

SHEAR STRENGTH, TSF



△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane

BORING DRILLED TO **16** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING
WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**
DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

BORING **B-20**

DATE **9/27/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DESCRIPTION

Texas State Plane Coordinates (feet):
Easting: 3129091.84
Northing: 13840741.24
Elevation: 41.29

SHEAR STRENGTH, TSF: △ Confined Compression; ● Unconfined Compression; ○ Pocket Penetrometer; □ Torvane

DEPTH IN FEET	DESCRIPTION	MOISTURE CONTENT, %	DRY DENSITY, PCF	SHEAR STRENGTH, TSF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 4.5" Asphalt							
	Base: 6.5" stabilized sand and gravel	5						
	Hard, dark brown Fat Clay (CH), with slickensides and ferrous stains	15						
		17	114	3.9	88	54	13	41
4	-dark gray 4'-6', with calcareous nodules 4'-12'	16						
	-reddish brown and tan 6'-12'	19	111	4.0				
8		18			90	59	15	44
		19						
12	-with silty sand partings 12'-13'	8	125	5.6				
	Termination depth = 13 feet.							
16								
20								
24								
28								

BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID

WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING

WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**

DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

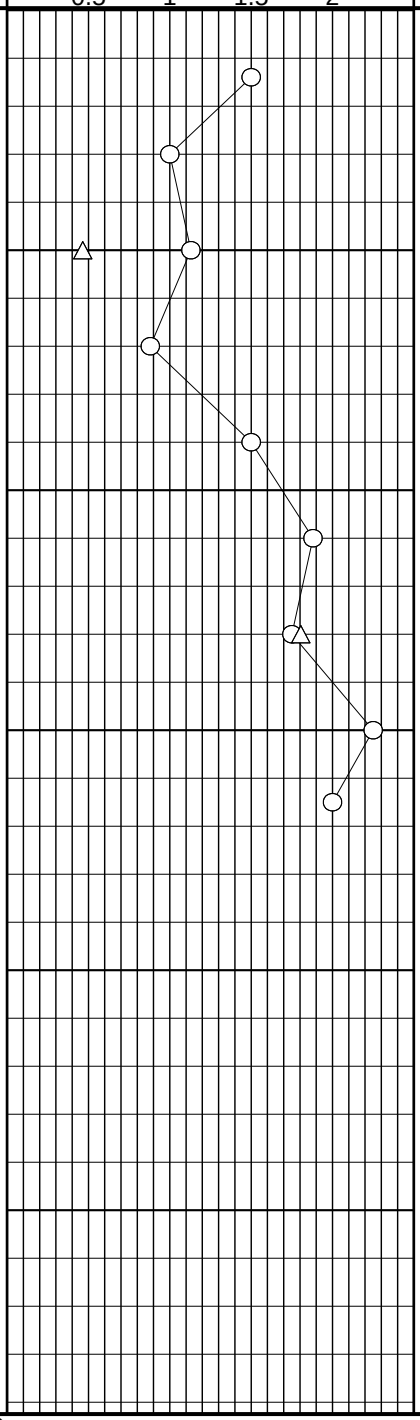
BORING **B-21**

DATE **10/4/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Pavement: 3.5" Asphalt + 6" Concrete							
			Firm to very stiff, dark gray Fat Clay (CH), with slickensides -with ferrous nodules 1'-2' -tan, with sand pockets 2'-4'		22 20					
4			-tan and light gray 4'-6'		30	92				
			-red and light gray, with calcareous and ferrous nodules, and siltstone fragments 6' 8'		25		94	63	17	46
8			Very stiff to hard, tan and light gray Lean Clay (CL), with ferrous nodules and sand partings -with siltstone fragments 8'-12' -red, tan, and light gray 10'-17'		24 25					
12					17	114	87	41	14	27
					18					
16					15					
			Termination depth = 17 feet.							
20										
24										
28										

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



Texas State Plane Coordinates (feet):
Easting: 3127623.73
Northing: 13841433.87
Elevation: 41.59

BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING
WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**
DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

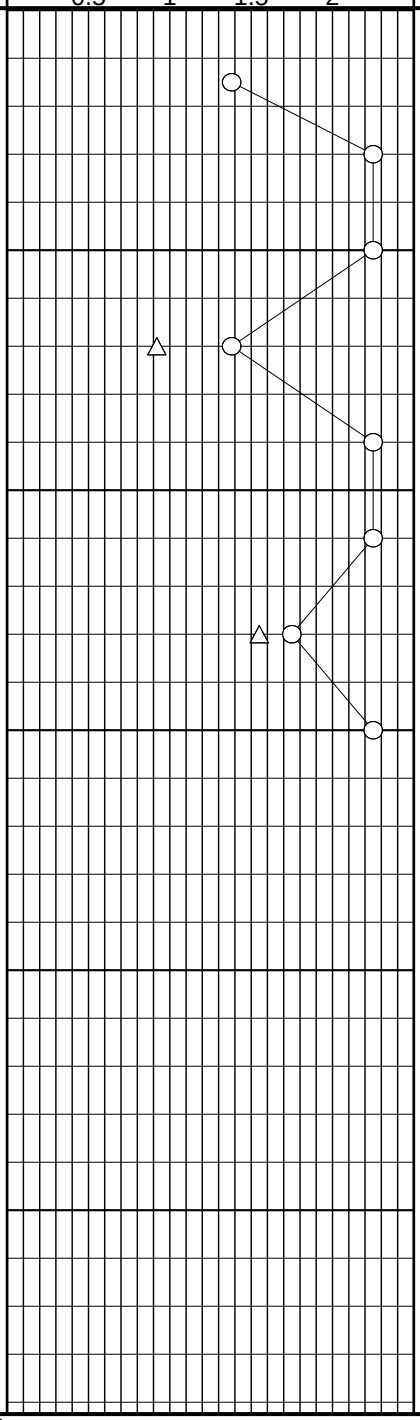
PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4** BORING **B-22**

DATE **10/2/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Pavement: 9" Asphalt							
			Base: 3" stabilized sand and gravel							
			Stiff to hard, dark brown Fat Clay (CH), with slickensides		28					
			-dark gray 2'-4'		21					
4			-olive brown 4'-6', with calcareous nodules 4'-12' and ferrous nodules 4'-8'		18		90	64	16	48
			-red and tan 6'-10'		23	104				
8					22					
			-tan and gray 10'-12'		19					
12			Very stiff to hard, gray and tan Lean Clay w/ Sand (CL), with ferrous nodules		14	117	77	35	14	21
					14					
16			Termination depth = 16 feet.							
20										
24										
28										

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



Texas State Plane Coordinates (feet):
Easting: 3128018.06
Northing: 13841024.92
Elevation: 42.87

BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING
WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**
DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

BORING **B-23**

DATE **9/21/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DESCRIPTION

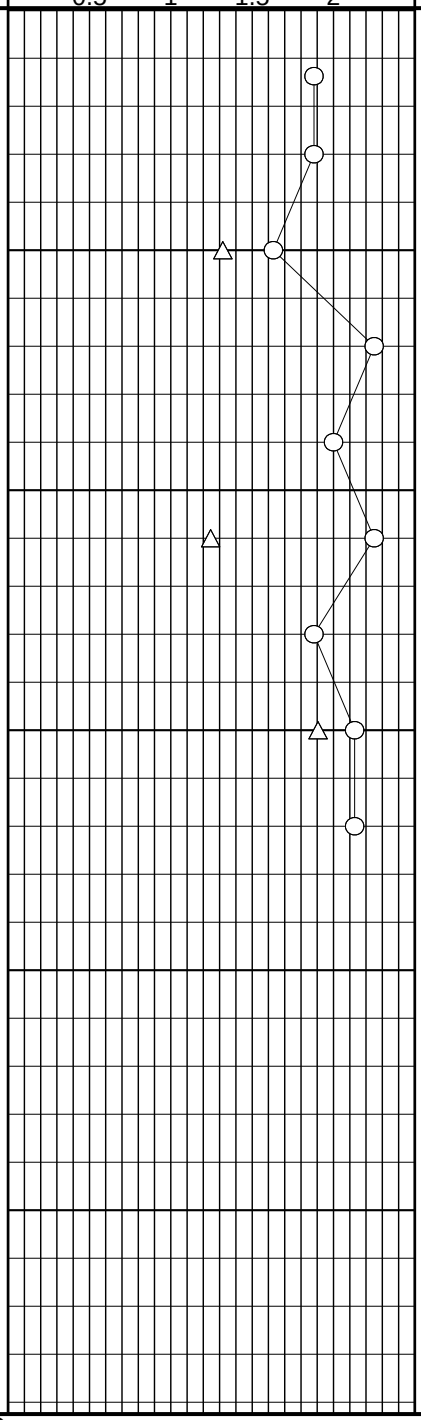
Texas State Plane Coordinates (feet):
Easting: 3128453.26
Northing: 13840740.08
Elevation: 41.75

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane

0.5 1 1.5 2

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Pavement: 4" Asphalt		1					
			Base: 5" stabilized crushed limestone		19					
			Very stiff to hard, dark gray Fat Clay (CH), with slickensides				86	54	14	40
			-with ferrous nodules 2'-6'		19					
4			-dark gray and tan 4'-6', with calcareous nodules 4'-12'		21	109				
			-gray, tan, and brown 6'-10'		23					
8					21		94	60	18	42
			-with sand partings 11'-12'		18	110				
12			Very stiff to hard, tan and light gray Lean Clay w/Sand (CL)		18					
			-with sand partings and calcareous nodules 14'-16'		16	119	83	43	12	31
16			-reddish brown and light gray 16'-18'		25					
			Termination depth = 18 feet.							
20										
24										
28										



BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING
WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**
DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

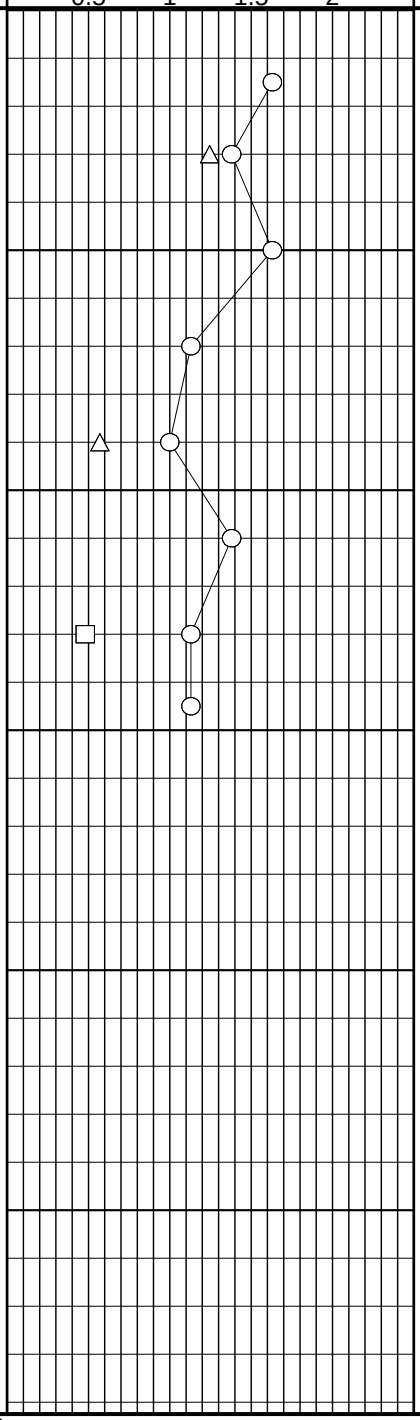
BORING **B-24**

DATE **10/2/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Pavement: 6" Asphalt							
			Base: 6" stabilized sand and gravel							
			Stiff to very stiff, dark brown Fat Clay (CH), with slickensides		21					
			-dark gray 2'-6'		22	104				
4							91	56	17	39
					21					
			-tan and gray, with ferrous nodules 6'-10'							
					23					
8			-with calcareous nodules 8'-12'							
					28	96				
			-red, brown, and gray 10'-12'							
					24					
12			Firm to very stiff, light tan Lean Clay w/Sand (CL)				73	46	17	29
			-with silty sand and fat clay seams 12'-14'		19					
			-tan and gray, with ferrous nodules 14'-15'		15					
			Termination depth = 15 feet.							
16										
20										
24										
28										

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID

WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING

WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**

DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4** BORING **B-25**

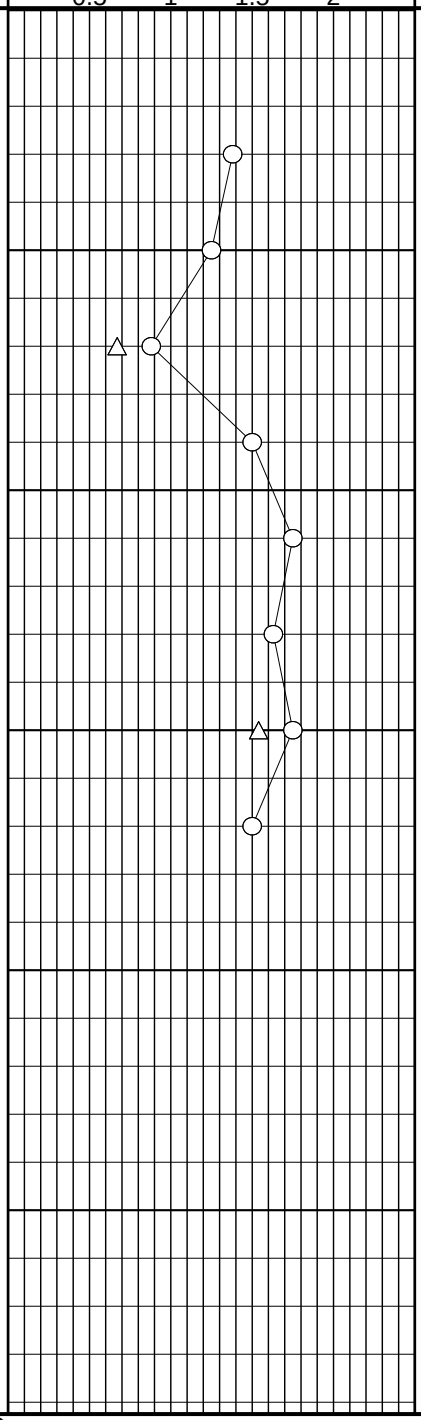
DATE **10/2/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DESCRIPTION

Texas State Plane Coordinates (feet):
Easting: 3128901.87
Northing: 13840383.60
Elevation: 41.27

SHEAR STRENGTH, TSF: △ Confined Compression; ● Unconfined Compression; ○ Pocket Penetrometer; □ Torvane

DEPTH IN FEET	DESCRIPTION	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 5" Asphalt						
	Base: 6" stabilized sand and gravel						
	Fill: very stiff, dark gray Fat Clay (CH)	23					
	-with shell and sand seams, and ferrous nodules 2'-4'	25					
4	Stiff to very stiff, gray and tan Fat Clay (CH), with ferrous nodules	24		90	65	18	47
	-with siltstone fragments 6'-8'	28	97				
8	-red and gray 8'-12', with silt pockets 8'-10'	24					
	-with calcareous nodules 10'-12'	22					
12	Very stiff, brown and gray Lean Clay (CL)			90	49	17	32
	-with silt pocket, calcareous nodules, and siltstone fragments 12'-14'	21					
	-light gray and tan 14'-16', with sand partings 14'-18'	15	116				
16	-with calcareous nodules, siltstone fragments, and sand pockets 16'-18'	19					
	Termination depth = 18 feet.						
20							
24							
28							



BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING
WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**
DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

BORING **B-26**

DATE **9/27/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

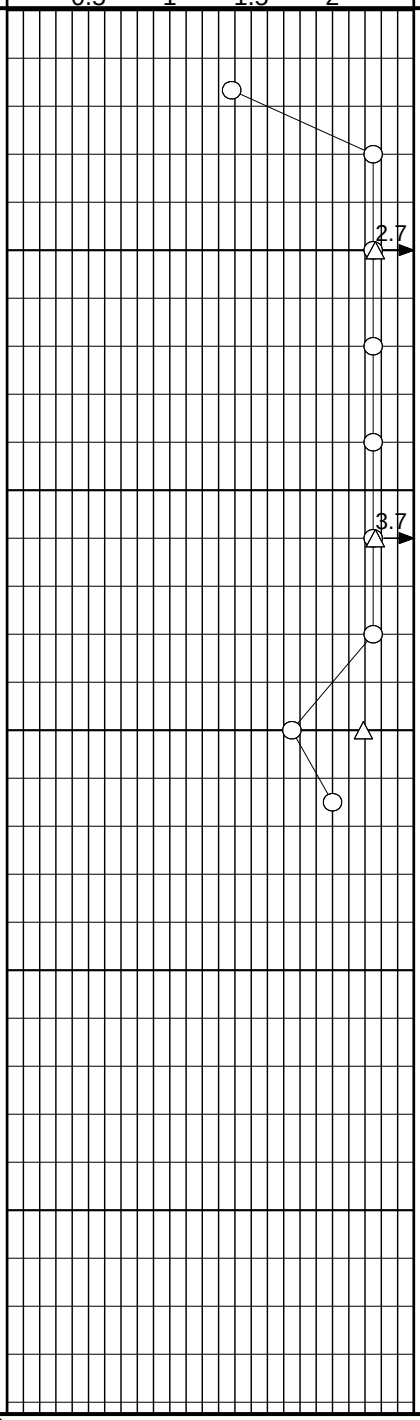
DESCRIPTION

Texas State Plane Coordinates (feet):
Easting: 3129185.80
Northing: 13840291.56
Elevation: 40.50

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane

DEPTH IN FEET	DESCRIPTION	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 6" Asphalt						
	Base: 10" stabilized sand with gravel	5					
	Fill: very stiff, gray and tan Fat Clay (CH), with ferrous nodules	18					
	Hard, tan and gray Fat Clay (CH), with slickensides and calcareous nodules	16					
4	-with ferrous nodules 2'-8'						
	-tan and light gray 4'-6'	19	113				
	-reddish brown and light gray 6'-12'			94	72	18	54
		22					
8							
		22					
	-with siltstone fragments and sandy clay pockets 10'-12'	20	112				
12	Very stiff to hard, light gray and tan Lean Clay w/Sand (CL), with ferrous stains			76	34	12	22
	-with calcareous nodules 12'-14'	14					
	-with sand partings 14'-16', and sand pockets 14'-17'	17	114				
16		15					
	Termination depth = 17 feet.						
20							
24							
28							



BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING
WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**
DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

BORING **B-27**

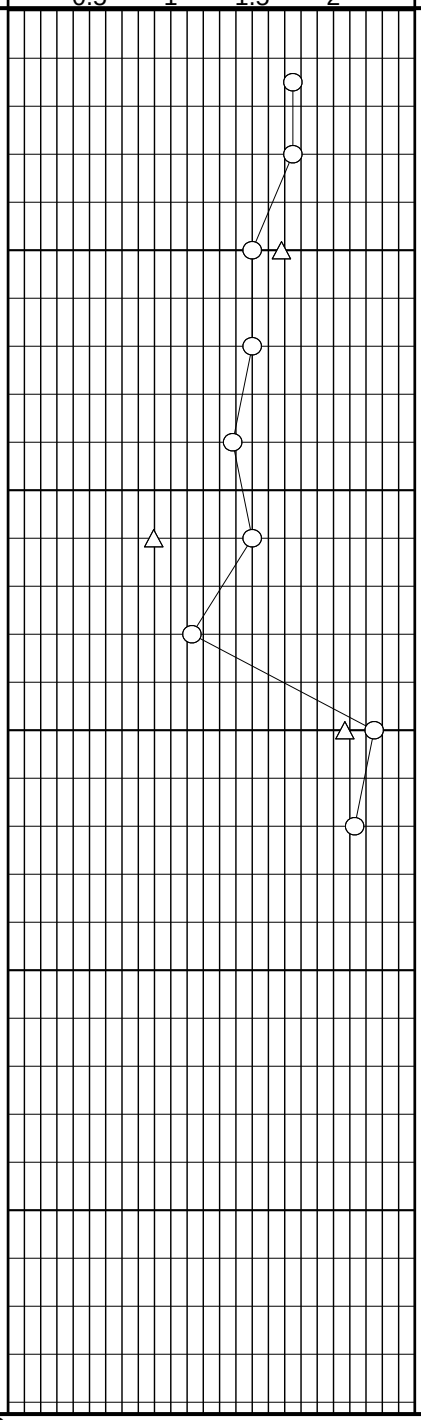
DATE **10/2/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DESCRIPTION

Texas State Plane Coordinates (feet):
Easting: 3128374.38
Northing: 13840420.82
Elevation: 41.81

SHEAR STRENGTH, TSF: △ Confined Compression; ● Unconfined Compression; ○ Pocket Penetrometer; □ Torvane

DEPTH IN FEET	DESCRIPTION	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Pavement: 5" Asphalt						
	Base: 7" stabilized sand and gravel						
	Stiff to very stiff, dark gray Fat Clay (CH), with slickensides	18					
		20					
4	-dark gray and tan 4'-6'	19	111				
	-tan and gray 6'-8', with calcareous nodules and siltstone fragments 6'-12'	24		91	66	19	47
8	-red, tan, and gray, with ferrous nodules 8'-10'	28					
	-red, brown, and gray, with silt seams 10'-12'	26	103				
12	Very stiff to hard, red, brown, and gray Lean Clay w/Sand (CL)	17					
	-with silt seams, siltstone fragments, and calcareous nodules 12'-14'			75	38	13	25
	-tan and gray, with ferrous nodules 14'-18'	14	120				
16		18					
	Termination depth = 18 feet.						
20							
24							
28							



BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID

WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING

WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**

DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

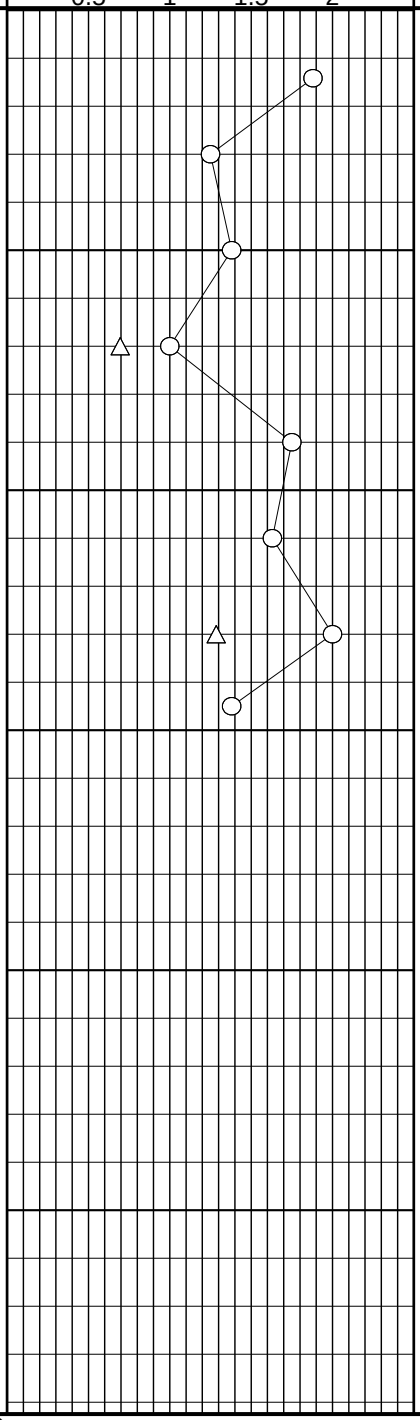
BORING **B-28**

DATE **10/2/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			*Texas State Plane Coordinates (feet):* *Easting: 3128941.73* *Northing: 13839967.23* *Elevation: 41.52*							
			Pavement: 4" Asphalt							
			Base: 6" stabilized sand and gravel							
			Fill: very stiff, dark gray Fat Clay (CH), with sand and shell seams		19					
			Stiff to very stiff, dark gray Fat Clay (CH)		19					
4			-gray and tan 4'-8'				88	54	15	39
					20					
					28	97				
8			-red, brown, and gray 8'-12'							
					26					
			-with calcareous and ferrous nodules, and siltstone fragments 10'-15'		20		98	62	19	43
12			-tan and light gray, with sand partings 12'- 15'							
					15	119				
					16					
16			Termination depth = 15 feet.							
20										
24										
28										

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID

WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING

WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**

DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

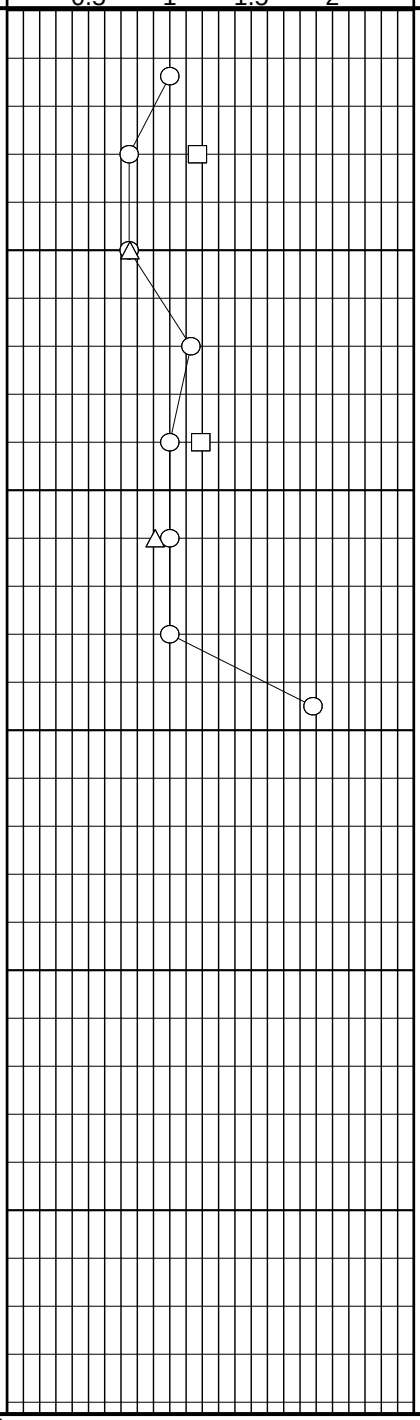
BORING **B-29**

DATE **10/4/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Pavement: 9" Concrete							
			Fill: stiff to very stiff, dark gray Fat Clay (CH) -lime stabilized 1'-2' -with ferrous nodules 2'-4'		26 30					
4			-with sand pockets 4'-6'		30	92				
			Stiff to very stiff, gray Fat Clay (CH), with slickensides -with ferrous nodules 6'-14' -gray and tan 8'-10'		29 28		90	73	21	52
8										
			-red, light gray, and tan 10'-15', with calcareous nodules and siltstone fragments 10'-14'		25 25 28	100				
12										
			Termination depth = 15 feet.							
16										
20										
24										
28										

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID

WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING

WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**

DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

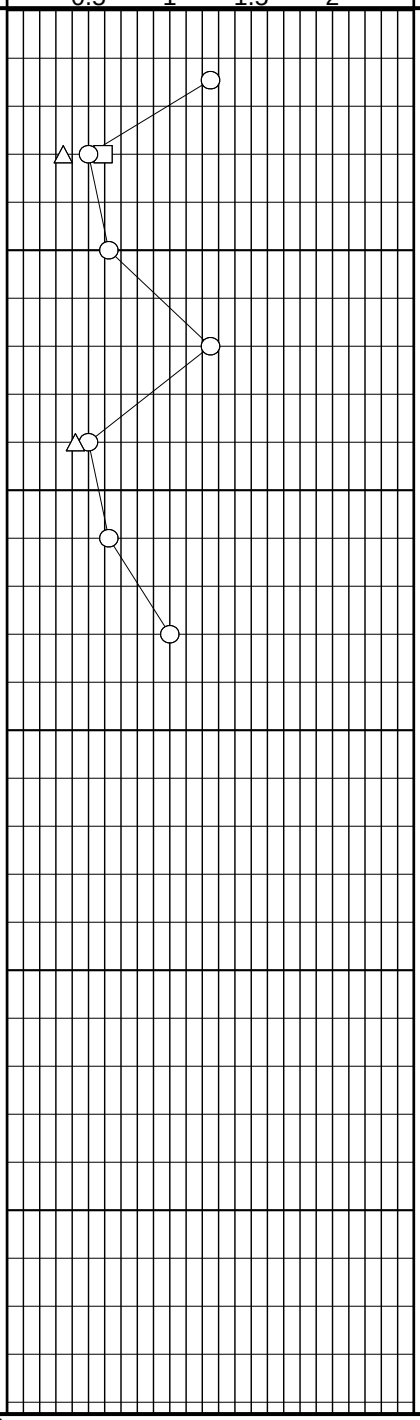
BORING **B-30**

DATE **9/30/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Pavement: 3" Asphalt							
			Base: 8" stabilized sand, gravel and crushed shell		26					
			Fill: firm to very stiff, dark gray and tan Fat Clay (CH), with ferrous stains		32	92				
4			-[hydrocarbon odor 4'-6']		30		88	72	18	54
			Firm to very stiff, gray and tan Fat Clay (CH), with ferrous stains		29					
8			-with calcareous nodules 8'-12'		33	92				
			-reddish brown, light gray and tan, with abundant calcareous nodules 10'-12'		35					
12			-brown and light gray, with silt partings and seams 12'-14'		23					
			Termination depth = 14 feet.							
16										
20										
24										
28										

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID

WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING

WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**

DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

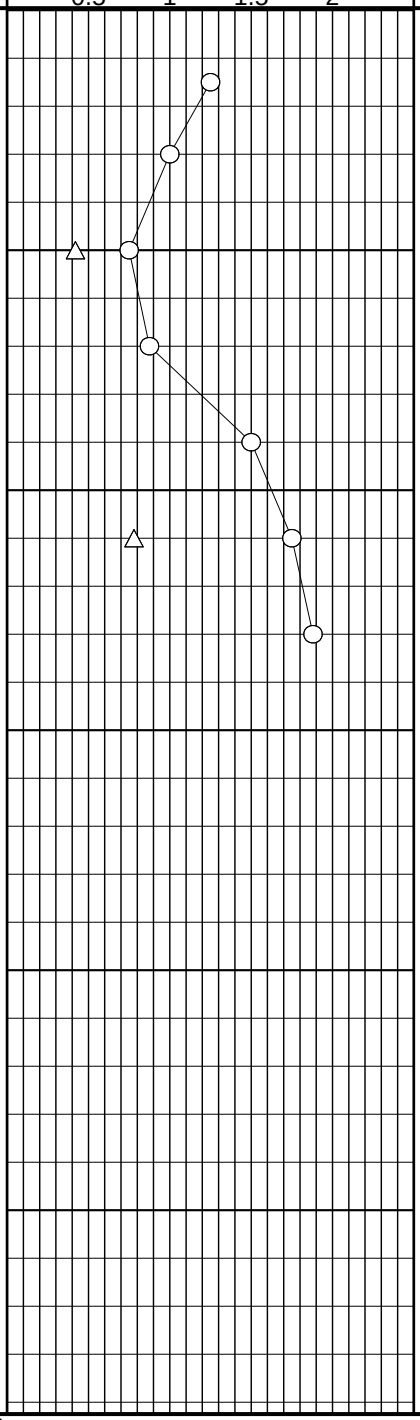
BORING **B-31**

DATE **9/30/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Fill: 8.5" gravel and sand							
			Fill: firm to very stiff, dark gray and tan Fat Clay w/Sand (CH), with ferrous stains -with sand pockets and gravel 2'-4'		25 26					
4			-dark gray and gray, with shell 4'-6' -[hydrocarbon odor 4'-6']		30	91				
			-dark gray 6'-8'		27		84	74	17	57
8			Stiff to very stiff, tan, brown, and light gray Fat Clay (CH), with slickensides -with abundant calcareous nodules 8'-10' -reddish brown and light gray 10'-14'		26 26	99				
12					26					
			Termination depth = 14 feet.							
16										
20										
24										
28										

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **14** FEET WITHOUT DRILLING FLUID

WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING

WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**

DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

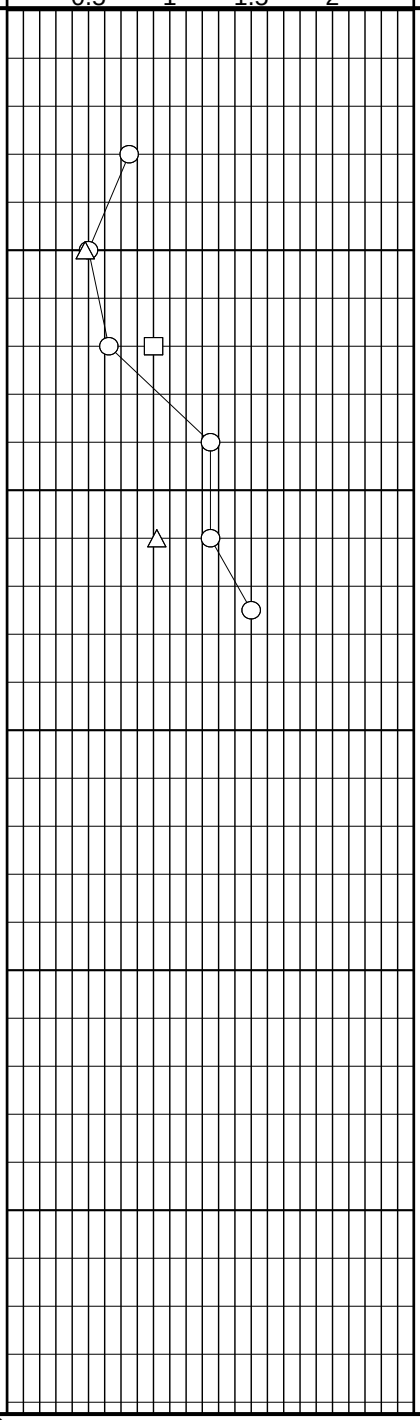
BORING **B-32**

DATE **9/30/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Fill: 6" sand and gravel							
			Fill: firm to stiff, dark gray Fat Clay w/Sand (CH), with gravel and ferrous stains		17					
			-with shell and calcareous nodules 2'-4'		29					
4					29	92				
			-with sandy clay seams 6'-8'		29		78	57	16	41
8			Stiff to very stiff, tan and light gray Fat Clay (CH), with slickensides and calcareous nodules		27					
			-red, brown, and light gray 10'-13', with ferrous nodules 10'-12'		26	100				
12					30					
			Termination depth = 13 feet.							
16										
20										
24										
28										

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID

WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING

WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**

DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

BORING **B-33**

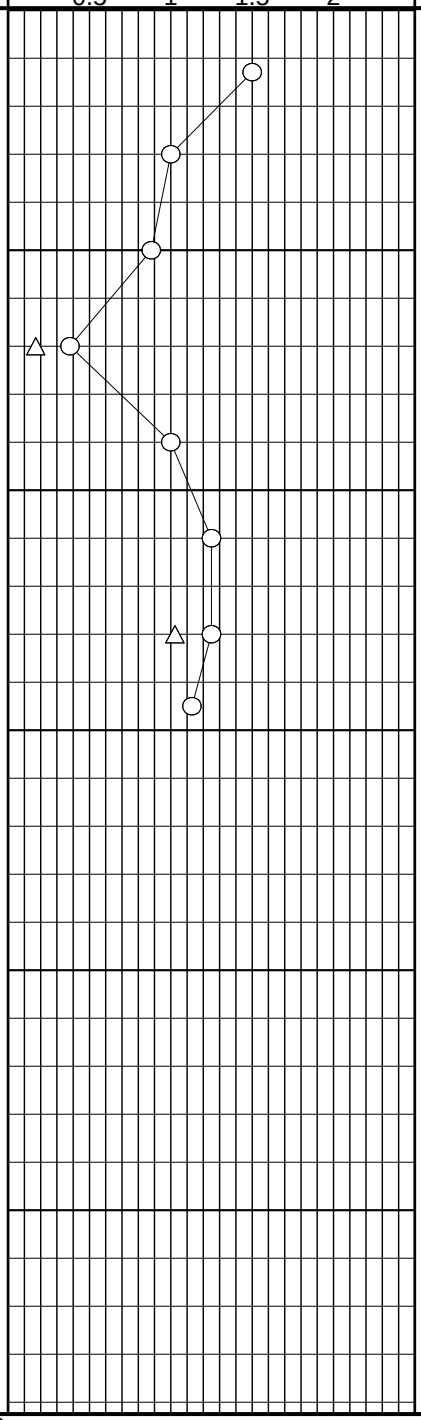
DATE **9/30/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DESCRIPTION

Texas State Plane Coordinates (feet):
Easting: 3114961.18
Northing: 13811339.20
Elevation: 47.82

SHEAR STRENGTH, TSF: △ Confined Compression; ● Unconfined Compression; ○ Pocket Penetrometer; □ Torvane

DEPTH IN FEET	DESCRIPTION	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0	Fill: 7" sand and gravel						
	Fill: soft to very stiff, dark gray Fat Clay (CH), with ferrous stains	23					
	-dark gray and tan 2'-4'	27					
4		28		86	63	18	45
	-with gasoline odor 6'-8'	35	84				
8	Stiff to very stiff, light gray and tan Fat Clay (CH), with slickensides and calcareous nodules	27					
	-with ferrous nodules 8'-14' and siltstone fragments 8'-12'	26		89	59	18	41
12	-red and light gray 12'-14'	25	102				
	-red, brown, and light gray 14'-15'	26					
	Termination depth = 15 feet.						
16							
20							
24							
28							



BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID

WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING

WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**

DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

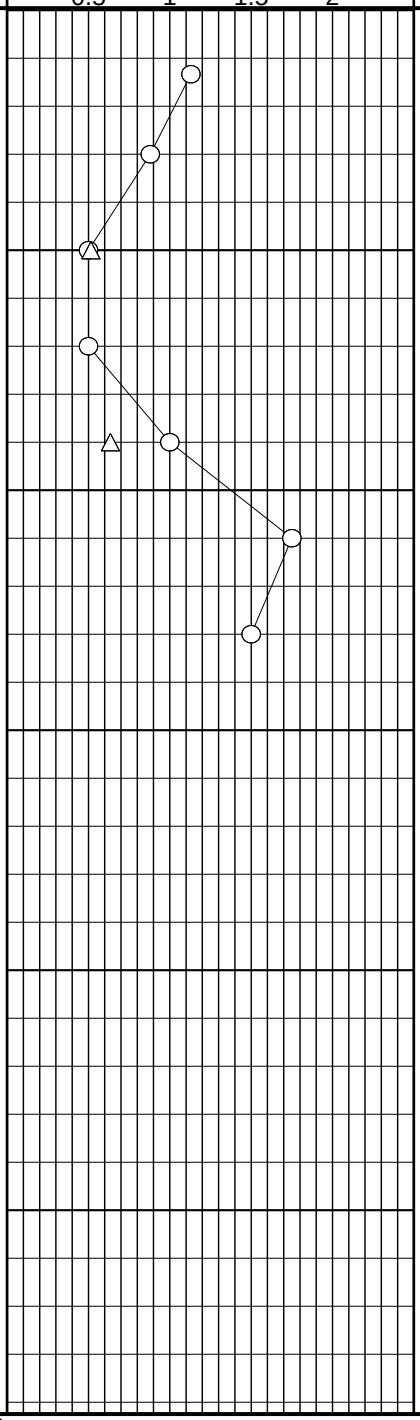
BORING **B-34**

DATE **9/30/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Base: 8" clay with sand and gravel							
			Fill: firm to very stiff, dark gray Fat Clay w/ Sand (CH)		22					
			-with ferrous nodules and shell 1'-8' and calcareous nodules 1'-2'		24					
4			-with gasoline odor 6'-10'		25	96				
					29		77	57	16	41
8			Stiff to very stiff, dark gray and tan Fat Clay (CH)		24	111				
			-with calcareous nodules 8'-10'							
			-red, brown, and light gray 10'-14'		24					
12					29					
			Termination depth = 14 feet.							
16										
20										
24										
28										

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID

WATER ENCOUNTERED AT **13** FEET WHILE DRILLING

WATER LEVEL AT **11.3** FEET AFTER **1/4 HRS**

DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

BORING **B-35**

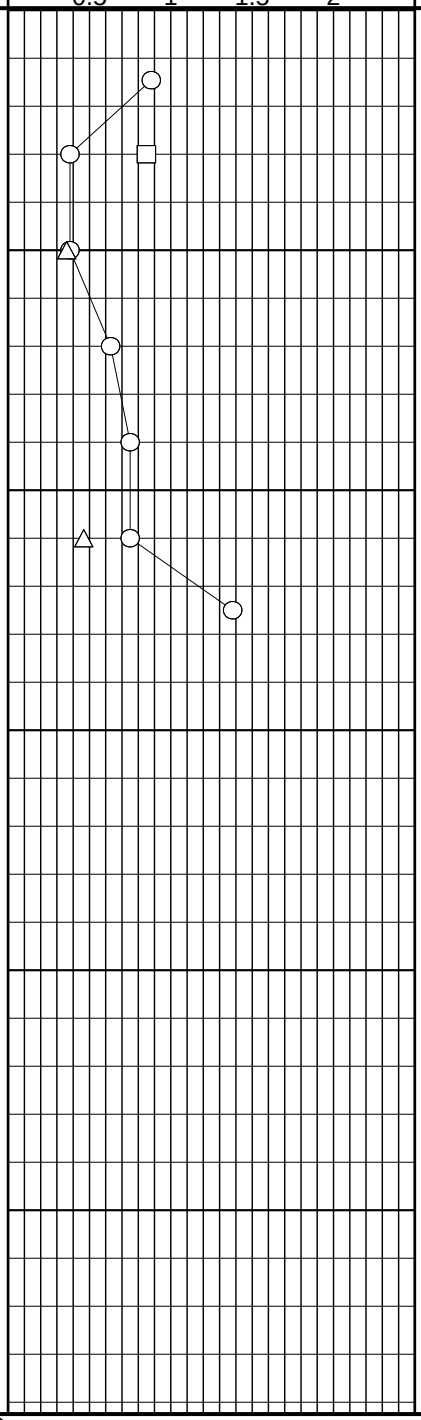
DATE **9/30/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DESCRIPTION

Texas State Plane Coordinates (feet):
Easting: 3115920.71
Northing: 13811700.41
Elevation: 47.52

SHEAR STRENGTH, TSF: △ Confined Compression; ● Unconfined Compression; ○ Pocket Penetrometer; □ Torvane

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Base: 11" clay with shell and gravel							
			Fill: firm to stiff, dark gray and tan Fat Clay w/ Sand (CH), with gravel, shell, and ferrous nodules		30		76	56	18	38
			-with calcareous nodules 1'-2'		27					
4					30	106				
			Firm to very stiff, gray and tan Fat Clay (CH) -with calcareous nodules and siltstone fragments 6'-12' and ferrous nodules 6'-8'		25					
8					28					
			-red, brown, and light gray 10'-13'		25	105				
12					20					
			Termination depth = 13 feet.							
16										
20										
24										
28										



BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID

WATER ENCOUNTERED AT **13** FEET WHILE DRILLING

WATER LEVEL AT **12.6** FEET AFTER **1/4 HRS**

DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

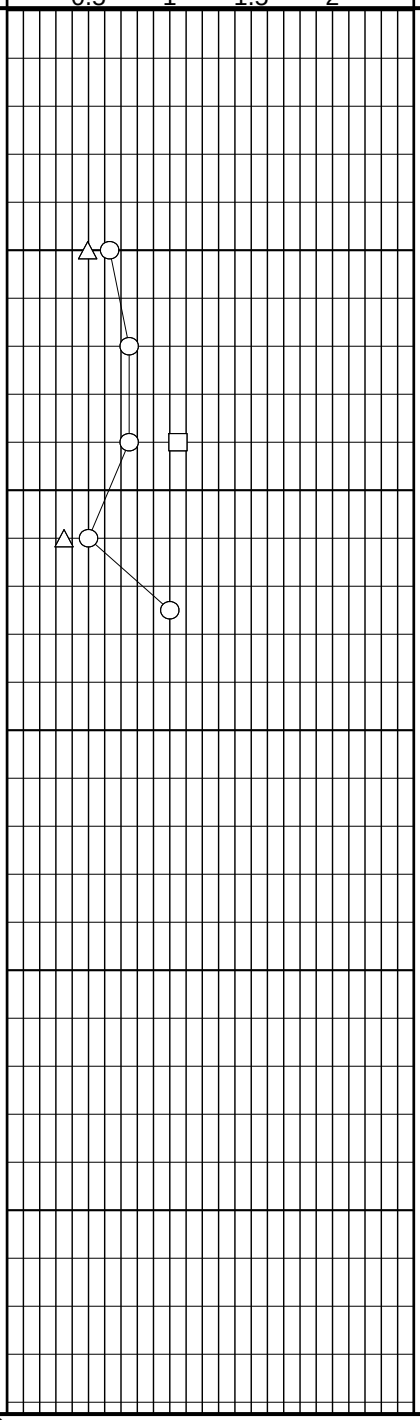
BORING **B-36**

DATE **9/30/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			*Texas State Plane Coordinates (feet):* *Easting: 3116406.52* *Northing: 13811884.31* *Elevation: 47.66* .							
			Fill: lime-stabilized clayey sand (SC), with crush shell and gravel		22					
					7					
4			Fill: firm to stiff, dark gray Sandy Lean Clay (CL), with shell, gravel, and ferrous nodules -with sand seams and calcareous nodules 4'-6'		24	105	57	45	17	28
					24					
8			Firm to very stiff, light gray and tan Lean Clay w/Sand (CL), with calcareous nodules -with siltstone fragments and ferrous nodules 8'-10'		23		84	43	15	28
					34	101				
12			-red, brown, and light gray 12'-13'		29					
			Termination depth = 13 feet.							
16										
20										
24										
28										

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID

WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING

WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**

DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

PROJECT: **WL Rpmt in Commerce Area S-000035-0153-4**

AVILES ENGINEERING CORP. GEOTECHNICAL ENGINEERS

BORING **B-37**

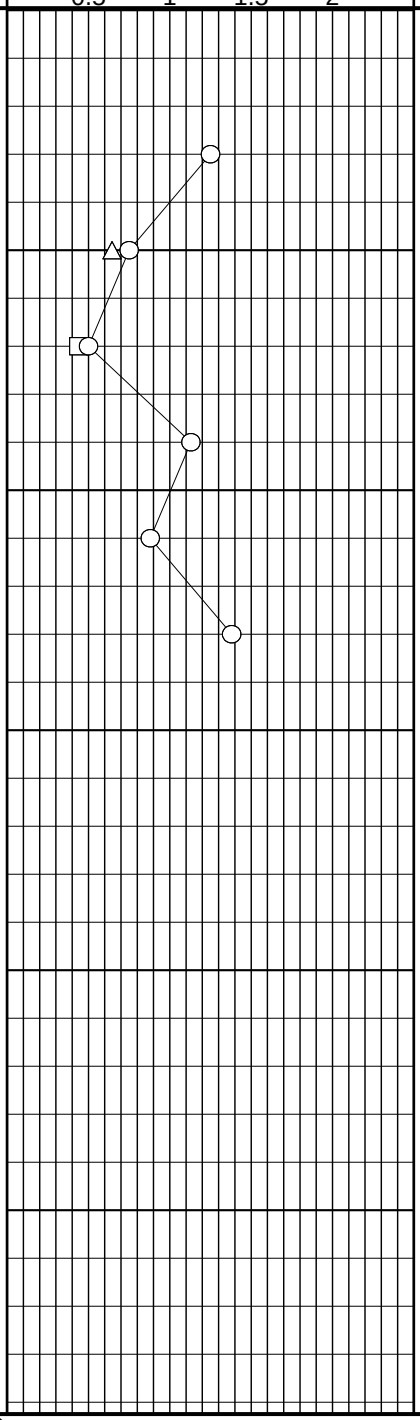
DATE **9/30/13** TYPE **4" Dry Auger** LOCATION **See Boring Location Plan**

DEPTH IN FEET	SYMBOL	SAMPLE INTERVAL	DESCRIPTION	S.P.T. BLOWS / FT.	MOISTURE CONTENT, %	DRY DENSITY, PCF	-200 MESH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
0			Fill: 10" sand and gravel							
			Fill: firm to very stiff, dark gray Fat Clay w/ Sand (CH), with shell, gravel, and ferrous nodules		22					
			-dark gray and light gray 2'-4'		21					
4					21	101				
					34		80	55	18	37
8			Stiff to very stiff, tan and light gray Fat Clay (CH), with calcareous nodules		28					
			-with siltstone fragments 10'-12'		25					
12					24					
			Termination depth = 14 feet.							
16										
20										
24										
28										

Texas State Plane Coordinates (feet):
Easting: 3116899.89
Northing: 13812056.06
Elevation: 46.84

SHEAR STRENGTH, TSF

△ Confined Compression
● Unconfined Compression
○ Pocket Penetrometer
□ Torvane



BORING DRILLED TO **N/A** FEET WITHOUT DRILLING FLUID
WATER ENCOUNTERED AT **N/A** FEET WHILE DRILLING
WATER LEVEL AT **N/A** FEET AFTER **COMPLETE**
DRILLED BY **V&S** CHECKED BY **CHL** LOGGED BY **RJM**

KEY TO SYMBOLS

Symbol	Description
Strata symbols	
	Paving
	Fill
	Clayey sand
	Low plasticity clay
	High plasticity clay
	Silty low plasticity clay
	Silty sand
	Poorly graded clayey silty sand
Misc. Symbols	
	Water table depth during drilling
	Subsequent water table depth
	Torvane
	Pocket Penetrometer
	Confined Compression
	Unconfined Compression

Symbol	Description
Soil Samplers	
	Auger
	Undisturbed thin wall Shelby tube
	Standard penetration test
	Rock core

AYLES ENGINEERING CORP.

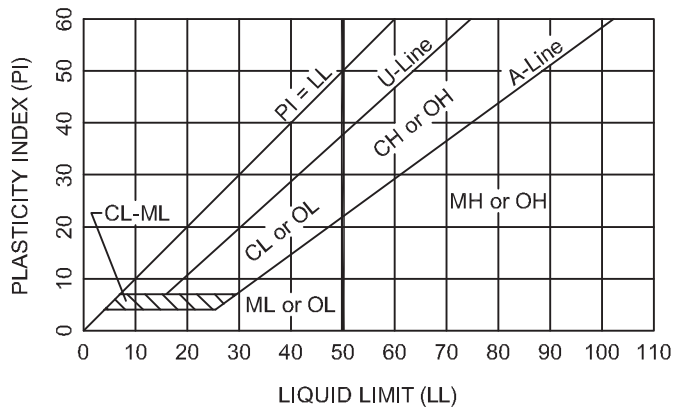
CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

ASTM Designation D-2487

MAJOR DIVISIONS				GROUP SYMBOL	TYPICAL NAMES
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (Less than 50% of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)		GW	Well-graded gravel, well-graded gravel with sand
				GP	Poorly-graded gravel, poorly-graded gravel with sand
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart	GM	Silty gravel, silty gravel with sand
			Limits plot above "A" line & hatched zone on plasticity chart	GC	Clayey gravel, clayey gravel with sand
	SANDS (50% or more of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 sieve)		SW	Well-graded sand, well-graded sand with gravel
				SP	Poorly-graded sand, poorly-graded sand with gravel
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart	SM	Silty sand, silty sand with gravel
			Limits plot above "A" line & hatched zone on plasticity chart	SC	Clayey sand, clayey sand with gravel
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)		SILTS AND CLAYS (Liquid Limit Less Than 50%)		ML	Silt, silt with sand, silt with gravel, sandy silt, gravelly silt
				CL	Lean clay, lean clay with sand, lean clay with gravel, sandy lean clay, gravelly lean clay
				OL	Organic clay, organic clay with sand, sandy organic clay, organic silt, sandy organic silt
		SILTS AND CLAYS (Liquid Limit 50% or More)		MH	Elastic silt, elastic silt with sand, sandy elastic silt, gravelly elastic silt
				CH	Fat clay, fat clay with sand, fat clay with gravel, sandy fat clay, gravelly fat clay
				OH	Organic clay, organic clay with sand, sandy organic clay, organic silt, sandy organic silt

NOTE: Coarse soils between 5% and 12% passing the No. 200 sieve and fine-grained soils with limits plotting in the hatched zone of the plasticity chart are to have dual symbols.

PLASTICITY CHART



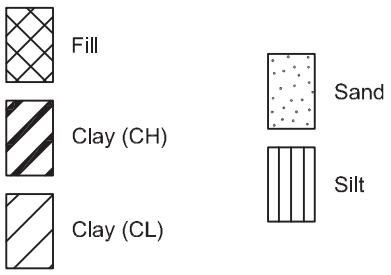
Equation of A-Line: Horizontal at PI=4 to LL=25.5, then PI=0.73(LL-20)

Equation of U-Line: Vertical at LL=16 to PI=7, then PI=0.9(LL-8)

DEGREE OF PLASTICITY OF COHESIVE SOILS

Degree of Plasticity	Plasticity Index
None	0 - 4
Slight	5 - 10
Medium	11 - 20
High	21 - 40
Very High	>40

SOIL SYMBOLS



AYLES ENGINEERING CORP.

TERMS USED ON BORING LOGS

SOIL GRAIN SIZE

U.S. STANDARD SIEVE

6"	3"	3/4"	#4	#10	#40	#200		
BOULDERS	COBBLES	GRAVEL		SAND			SILT	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		
152	76.2	19.1	4.76	2.00	0.420	0.074	0.002	

SOIL GRAIN SIZE IN MILLIMETERS

STRENGTH OF COHESIVE SOILS

Consistency	Undrained Shear Strength, Kips per Sq. ft.
Very Soft	less than 0.25
Soft	0.25 to 0.50
Firm	0.50 to 1.00
Stiff	1.00 to 2.00
Very Stiff	2.00 to 4.00
Hard	greater than 4.00

RELATIVE DENSITY OF COHESIONLESS SOILS FROM STANDARD PENETRATION TEST

Very Loose	<4 bpf
Loose	5-10 bpf
Medium Dense	11-30 bpf
Dense	31-50 bpf
Very Dense	>50 bpf

SPLIT-BARREL SAMPLER DRIVING RECORD

Blows per Foot	Description
25	25 blows driving sampler 12 inches, after initial 6 inches of seating.
50/7"	50 blows driving sampler 7 inches, after initial 6 inches of seating.
Ref/3"	50 blows driving sampler 3 inches, during initial 6-inches seating interval.

NOTE: To avoid change to sampling tools, driving is limited to 50 blows during or after seating interval.

DRY STRENGTH ASTM D2488

None	Dry specimen crumbles into powder with mere pressure of handling
Low	Dry specimen crumbles into powder with some finger pressure
Medium	Dry specimen breaks into pieces or crumbles with considerable pressure
High	Dry specimen cannot be broken with finger pressure, it can be broken between thumb and hard surface
Very High	Dry specimen cannot be broken between thumb and hard surface

MOISTURE CONDITION ASTM D2488

Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water

SOIL STRUCTURE

Slickensided	Having planes of weakness that appear slick and glossy. The degree of slickensidedness depends upon the spacing of slickensides and the easiness of breaking along these planes.
Fissured	Containing shrinkage or relief cracks, often filled with fine sand or silt; usually more or less vertical.
Pocket	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	Inclusion less than 1/8 inch thick extending through the sample.
Seam	Inclusion 1/8 inch to 3 inches thick extending through the sample.
Layer	Inclusion greater than 3 inches thick extending through the sample.
Laminated	Soil sample composed of alternating partings or seams of different soil types.
Interlayered	Soil sample composed of alternating layers of different soil types.
Intermixed	Soil sample composed of pockets of different soil types and layered or laminated structure is not evident.
Calcareous	Having appreciable quantities of calcium material.

AVILES ENGINEERING CORP.

ASTM & TXDOT DESIGNATION FOR SOIL LABORATORY TESTS

NAME OF TEST	ASTM TEST DESIGNATION	TXDOT TEST DESIGNATION
Moisture Content	D 2216	Tex-103-E
Specific Gravity	D 854	Tex-108-E
Sieve Analysis	D 421 D 422	Tex-110-E (Part 1)
Hydrometer Analysis	D 422	Tex-110-E (Part 2)
Minus No. 200 Sieve	D 1140	Tex-111-E
Liquid Limit	D 4318	Tex-104-E
Plastic Limit	D 4318	Tex-105-E
Shrinkage Limit	D 427	Tex-107-E
Standard Proctor Compaction	D 698	Tex-114-E
Modified Proctor Compaction	D 1557	Tex-113-E
Permeability (constant head)	D 2434	-
Consolidation	D 2435	-
Direct Shear	D 3080	-
Unconfined Compression	D 2166	-
Unconsolidated-Undrained Triaxial	D 2850	Tex-118-E
Consolidated-Undrained Triaxial	D 4767	Tex-131-E
Pinhole Test	D 4647	-
California Bearing Ratio	D 1883	-
Unified Soil Classification System	D 2487	Tex-142-E

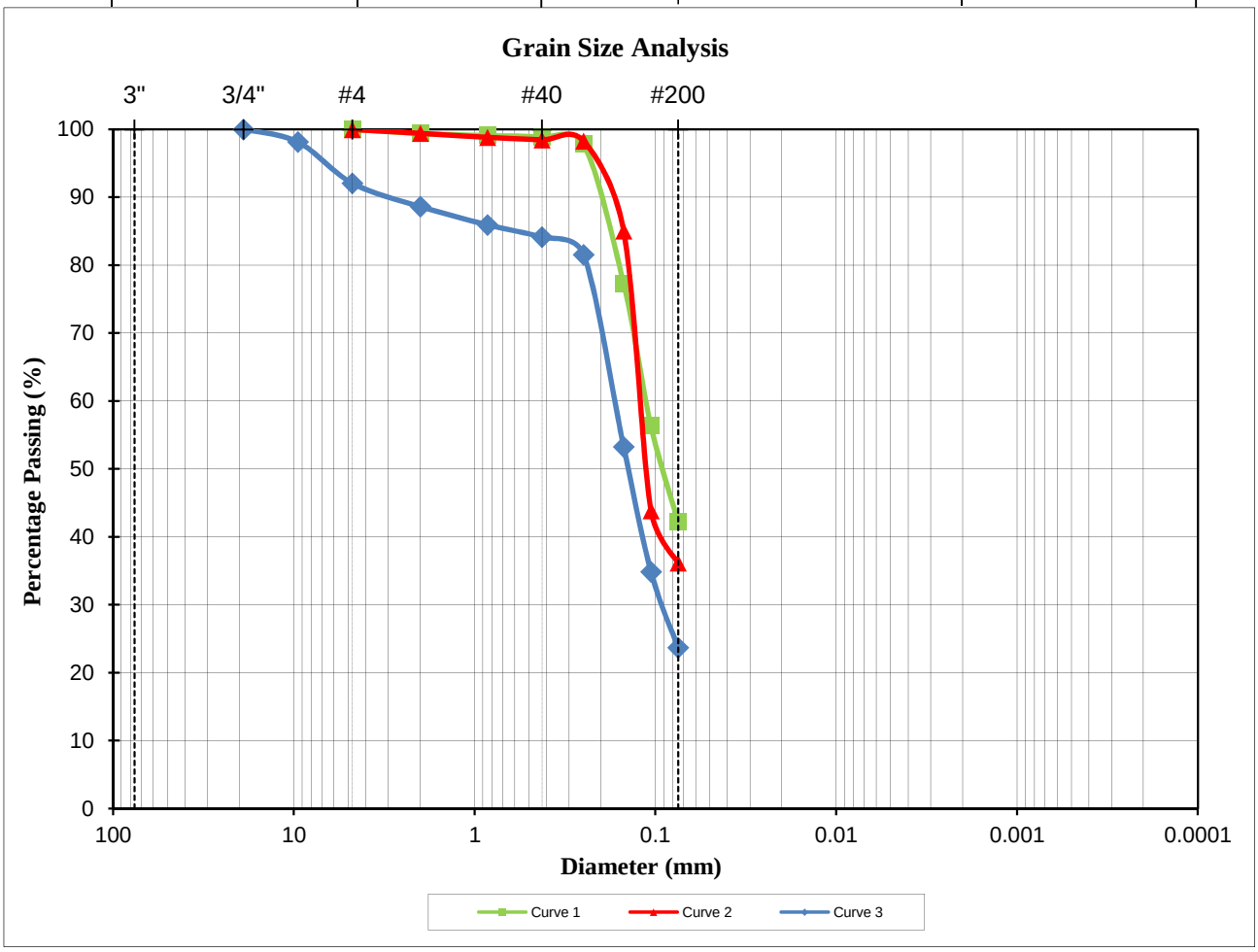
AVILES ENGINEERING CORPORATION

Consulting Engineers - Geotechnical, Construction Materials Testing, Environmental

GRAIN SIZE ANALYSIS - SIEVE

Project : WL Replacement in Commerce Area **Job No.:** G159-13
Location of Project: Houston, Texas **Date of Testing:** 10/3/2013

Gravel	Sand		Silt	Clay
	Coarse to Medium	Fine		



Curve	Boring	Depth (ft)	Soil Description	Cu	Cc
1	B-2	14-16	Clayey Sand (SC)	N/A	N/A
2	B-3	8-10	Clayey Sand (SC)	N/A	N/A
3	B-12	18-20	Silty Sand (SM)	N/A	N/A

SUMMARY OF LABORATORY TEST RESULTS
CITY OF HOUSTON WATER LINE REPLACEMENT IN COMMERCE
HOUSTON, TEXAS
WBS NO. S-000035-0153-4

BORING NO.	SAMPLE NO.	DEPTH (ft) TOP	DEPTH (ft) BOTTOM	TYPE	SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMIT LL (%)	ATTERBERG LIMIT PL (%)	ATTERBERG LIMIT PI (%)	PERCENT PASSING SIEVE NO. 200 (%)	SHEAR STRENGTH (tsf) UNCONFINED COMPRESSION TEST	SHEAR STRENGTH (tsf) UU TEST (confining pressure in psi)	SHEAR STRENGTH (tsf) POCKET PENETRO-METER (TORVANE)	USCS GROUP NAME
B-1	1	0	7.5-in	AG											2.5-in Pavement (AC) +5-in Base
	2	7.5-in	2	UD		18								1.38	Fill: Sandy Lean Clay
	3	2	4	UD		16		43	13	30	66			1.13	Fill: Sandy Lean Clay
	4	4	6	UD		19	109						0.99 (3)	1.25	Fill: Sandy Lean Clay
	5	6	8	UD		16		37	12	25	66			1.13 (1.08)	Fill: Sandy Lean Clay
	6	8	10	UD		14								0.63	Fill: Sandy Lean Clay
	7	10	12	UD		13								0.50	Clayey Sand
	8	12.5	14	SS	15	18									Clayey Sand
	9	14	16	UD		17	117	26	15	11	40		0.75 (6)	1.75 (0.77)	Clayey Sand
	10	16.5	18	SS	11	21									Clayey Sand
B-2	1	0	18-in	AG											8-in Pavement(AC)+10-in Base
	2	18-in	2	AG		16									Fill: Sandy Lean Clay
	3	2	4	UD		7								2.25	Fill: Sandy Lean Clay
	4	4	6	UD		12								1.00	Fill: Sandy Lean Clay
	5	6	8	UD		15	114	45	13	32	81		1.12 (3)	1.50	Lean Clay w/Sand
	6	8	10	UD		16								1.88	Lean Clay w/Sand
	7	10	12	UD		17	115						1.32 (7)	2.13	Lean Clay w/Sand
	8	12	14	UD		10									Clayey Sand
	9	14.5	16	SS	14	15					42				Clayey Sand
	10	16.5	18	SS	10	20									Clayey Sand
	11	18.5	20	SS	14	19					43				Clayey Sand
	12	20.5	22	SS	14	19									Clayey Sand
B-3	1	0	17.5-in	AG											4-in Pavement (AC) +13.5-in Base
	2	17.5-in	2	UD		20								1.75	Sandy Fat Clay
	3	2	4	UD		21		51	15	36	69			2.25	Sandy Fat Clay
	4	4	6	UD		17	118						1.38 (3)	1.75	Sandy Fat Clay
	5	6	8	UD		15								1.50	Sandy Fat Clay
	6	8.5	10	SS	23	12					36				Clayey Sand
	7	10.5	12	SS	20	18									Clayey Sand
	8	12.5	14	SS	18	21					31				Clayey Sand
	9	14	16	UD		23									Clayey Sand
	10	16.5	18	SS	22	19									Clayey Sand
	11	18.5	20	SS	40	19		23	18	5	89				Silty Clay
	12	20.5	22	SS		23									Silty Clay
	13	22.5	24	SS	23	24									Silty Clay
B-4	1	0	0.708	RC											Pavement (1.5-in AC+7-in PCC)
	2	0.708	2	UD		16								2.25	Lean Clay w/Sand
	3	2	4	UD		15								2.25	Lean Clay w/Sand
	4	4	6	UD		14		41	13	28	80			2.25	Lean Clay w/Sand
	5	6	8	UD		21								2.25	Lean Clay w/Sand
	6	8	10	UD		21	104						0.64 (6)	1.00	Lean Clay w/Sand
	7	10	12	UD		27								1.25	Fat Clay
	8	12	14	UD		24		62	21	41	99			1.88	Fat Clay
	9	14	16	UD		24								2.25	Fat Clay
	10	16	18	UD		22	107						1.30 (11)	2.25	Fat Clay
	11	18	20	UD		23		26	17	9	61			(0.27)	Sandy Lean Clay
	12	23	25	UD		17								2.25	Sandy Lean Clay

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SUMMARY OF LABORATORY TEST RESULTS
CITY OF HOUSTON WATER LINE REPLACEMENT IN COMMERCE
HOUSTON, TEXAS
WBS NO. S-000035-0153-4

BORING NO.	SAMPLE NO.	DEPTH (ft) TOP	DEPTH (ft) BOTTOM	TYPE	SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMIT LL (%)	ATTERBERG LIMIT PL (%)	ATTERBERG LIMIT PI (%)	PERCENT PASSING SIEVE NO. 200 (%)	SHEAR STRENGTH (tsf) UNCONFINED COMPRESSION TEST	SHEAR STRENGTH (tsf) UU TEST (confining pressure in psi)	SHEAR STRENGTH (tsf) POCKET PENETRO-METER (TORVANE)	USCS GROUP NAME
B-5	1	0	0.833	RC											Pavement (2-in AC + 8-in PCC)
	2	0.833	2	UD		18								1.50	Sandy Lean Clay
	3	2	4	UD		14		35	13	22	53			2.00	Sandy Lean Clay
	4	4	6	UD		13	115						0.60 (3)	1.00	Sandy Lean Clay
	5	6	8	UD		16								1.13	Sandy Lean Clay
	6	8.5	10	SS	13	17		33	12	21	31				Clayey Sand
	7	10	12	UD		15	121						1.06 (5)	1.50	Sandy Silty Clay
	8	12	14	UD		17		23	16	7	56			0.88	Sandy Silty Clay
	9	14.5	16	SS	28	18									Silty Sand
	10	16.5	18	SS	31	19		21	19	2	31				Silty Sand
	11	18.5	20	SS	14	24									Silty Sand
	12	20	22	UD		18	113						1.53 (9)	2.13	Fat Clay
	13	22	23	UD		20								1.25	Fat Clay
B-6	1	0	0.958	RC											Pavement (4-in AC + 7.5-in PCC)
	2	0.958	2	UD		20								0.75	Fill: Fat Clay
	3	2	4	UD		18								1.38	Fat Clay
	4	4	6	UD		24								1.13	Fat Clay
	5	6	8	UD		23	113						1.39 (5)	1.38	Fat Clay
	6	8	10	UD		23		55	18	37	91			1.50	Fat Clay
	7	10	12	UD		19								1.50	Fat Clay
	8	12	14	UD		24								1.88	Fat Clay
	9	14	16	UD		26								1.88	Fat Clay
	10	16	18	UD		16		29	14	15	83			1.50	Lean Clay w/Sand
	11	18	19	UD		16	118						0.91 (12)	1.25	Lean Clay w/Sand
B-7	1	0	0.875	RC											Pavement (3.5-in AC+ 7-in PCC)
	2	0.875	2	UD		22								0.88	Fat Clay
	3	2	4	UD		22	107						1.04 (2)	1.25	Fat Clay
	4	4	6	UD		21								1.63	Fat Clay
	5	6	8	UD		23		60	17	43	96			1.50	Fat Clay
	6	8	10	UD		22								1.88	Fat Clay
	7	10	12	UD		23	107						1.02 (7)	1.63	Fat Clay
	8	12	14	UD		16								1.75	Sandy Lean Clay
	9	14	16	UD		15								2.00	Sandy Lean Clay
B-8	1	0	0.667	RC											Pavement (2-in AC+6-in PCC)
	2	0.667	2	UD		24								1.25	Fat Clay
	3	2	4	UD		24	102						0.98 (2)	1.38	Fat Clay
	4	4	6	UD		23								1.50	Fat Clay
	5	6	8	UD		20		55	16	39	91			2.25	Fat Clay
	6	8	10	UD		19	111						0.48 (6)	1.13	Lean Clay w/Sand
	7	10	12	UD		15		32	13	19	83			2.00	Lean Clay w/Sand
	8	12	14	UD		18								2.00	Lean Clay w/Sand
	9	14	16	UD		21	106						1.33 (10)	2.25	Lean Clay w/Sand
	10	16	18	UD		28		76	28	48	95			1.75	Fat Clay
	11	18	19	UD		28								2.00	Fat Clay

(Continue on Next Page)

SUMMARY OF LABORATORY TEST RESULTS
CITY OF HOUSTON WATER LINE REPLACEMENT IN COMMERCE
HOUSTON, TEXAS
WBS NO. S-000035-0153-4

BORING NO.	SAMPLE NO.	DEPTH (ft) TOP	DEPTH (ft) BOTTOM	TYPE	SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMIT LL (%)	ATTERBERG LIMIT PL (%)	ATTERBERG LIMIT PI (%)	PERCENT PASSING SIEVE NO. 200 (%)	SHEAR STRENGTH (tsf) UNCONFINED COMPRESSION TEST	SHEAR STRENGTH (tsf) UU TEST (confining pressure in psi)	SHEAR STRENGTH (tsf) POCKET PENETRO-METER (TORVANE)	USCS GROUP NAME
B-9	1	0	1.25	AG											4-in Pavement (AC) + 11-in Base
	2	1.25	2	UD		23								1.25	Fill: Fat Clay
	3	2	4	UD		22								1.25	Fill: Fat Clay
	4	4	6	UD		25	99						0.80 (3)	0.88	Fat Clay
	5	6	8	UD		24								1.00	Fat Clay
	6	8	10	UD		24		58	16	42	88			1.13	Fat Clay
	7	10	12	UD		21								1.50	Fat Clay
	8	12	14	UD		18	111						0.41 (9)	0.50	Fat Clay
	9	14.5	16	SS	13	19					37				Silty Sand
	10	16	18	UD		18								0.88	Lean Clay
	11	18	19	UD		20		26	15	11	91			1.00	Lean Clay
B-10	1	0	0.833	RC											Pavement (3.5-in AC+6.5-in PCC)
	2	0.833	2	UD		21								1.75	Lean Clay w/Sand
	3	2	4	UD		21								1.25	Lean Clay w/Sand
	4	4	6	UD		15	120						1.55 (3)	1.38	Lean Clay w/Sand
	5	6	8	UD		16								2.25	Lean Clay w/Sand
	6	8	10	UD		15		28	16	12	71			1.50	Lean Clay w/Sand
	7	10	12	UD		21								1.13	Lean Clay w/Sand
	8	12	14	UD		22	105						0.58 (8)	1.13	Fat Clay
	9	14	16	UD		24								0.88	Fat Clay
	10	16	18.5	UD		40		50	16	34	91			1.13 (1.01)	Fat Clay
	11	18.5	23	SS	32	22									Silty Sand
	12	23	25	UD		16	120						2.22 (11)	2.00	Sandy Lean Clay
B-11	1	0	0.708	RC											Pavement (3-in AC+5.5-in PCC)
	2	0.708	2	UD		20								1.25	Sandy Lean Clay
	3	2	4	UD		18	111					0.90		1.75	Sandy Lean Clay
	4	4	6	UD		18		49	17	32	64			1.50	Sandy Lean Clay
	5	6	8	UD		18								1.88	Sandy Lean Clay
	6	8	10	UD		14	117					0.77		1.63	Sandy Lean Clay
	7	10	12	UD		19								1.13	Sandy Lean Clay
	8	12	14	UD		17		21	11	10	44			1.50 (0.76)	Clayey Sand
	9	14.5	16	SS	19	17	118					1.92		1.50	Clayey Sand
B-12	1	0	0.917	AG		1									5.5-in Pavement (AC)+5.5-in Base
	2	0.917	2	AG		26		58	15	43	69				Fill: Sandy Fat Clay
	3	2	4	UD		21	105						0.93 (2)	0.88	Lean Clay w/Sand
	4	4	6	UD		17		47	13	34	72			1.75	Lean Clay w/Sand
	5	6	8	UD		15								2.25	Sandy Lean Clay
	6	8	10	UD		16	115	32	13	19	56		0.84 (6)	1.50	Sandy Lean Clay
	7	10	12	UD		17								2.00	Sandy Lean Clay
	8	12	14	UD		18	114						0.35 (8)	0.38 (0.20)	Silty Clayey Sand
	9	14	16	UD		21		24	18	6	35			0.38 (0.34)	Silty Clayey Sand
	10	16.5	18	SS	13	20									Silty Sand
	11	18.5	23	SS	17	23					24				Silty Sand
	12	23	25	UD		15	119					1.78		1.63	Fat Clay

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SUMMARY OF LABORATORY TEST RESULTS
CITY OF HOUSTON WATER LINE REPLACEMENT IN COMMERCE
HOUSTON, TEXAS
WBS NO. S-000035-0153-4

BORING NO.	SAMPLE				SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMIT			PERCENT PASSING SIEVE NO. 200 (%)	SHEAR STRENGTH (tsf)			USCS GROUP NAME
	NO.	DEPTH (ft)		TYPE				LL (%)	PL (%)	PI (%)		UNCONFINED COMPRESSION TEST	UU TEST (confining pressure in psi)	POCKET PENETRO-METER (TORVANE)	
		TOP	BOTTOM												
B-13	1	0	0.583	AG											7-in Pavement (AC)
	2	0.583	2	AG		12									Fill: gravel/sand
	3	2	4	UD		25								1.38	Fat Clay
	4	4	6	UD		24	104						1.03 (3)	1.13	Fat Clay
	5	6	8	UD		27		67	19	48	91			1.13	Fat Clay
	6	8	10	UD		24								1.25	Fat Clay
	7	10	12	UD		23								2.00	Fat Clay
	8	12	14	UD		19	109	47	18	29	99		1.14 (9)	2.00	Lean Clay
	9	14	16	UD		23								2.25	Lean Clay
	10	16	18	UD		16								1.13	Lean Clay
B-14	1	0	1.208	RC											Pavement(3.5-in AC+5-in PCC) +6-in Base
	2	1.208	2	AG		19		41	13	28	70				Fill: Lean Clay w/Sand
	3	2	4	UD		27								0.50 (0.44)	Fill: Lean Clay w/Sand
	4	4	6	UD		25	94						0.82 (3)	1.13	Fill: Lean Clay w/Sand
	5	6	8	UD		26								1.25	Fat Clay
	6	8	10	UD		23	104						0.98 (6)	1.50	Fat Clay
	7	10	12	UD		23		58	16	42	93			2.25	Fat Clay
	8	12	14	UD		21								2.25	Fat Clay
	9	14	15	UD		16								2.25	Fat Clay
B-15	1	0	0.792	RC											Pavement (3.5-in AC+6-in PCC)
	2	0.792	2	UD		20								1.25	Fill: Fat Clay
	3	2	4	UD		19		54	15	39	88			1.50	Fat Clay
	4	4	6	UD		20	111						1.36 (3)	1.50	Fat Clay
	5	6	8	UD		24								1.75	Fat Clay
	6	8	10	UD		24								1.50	Lean Clay w/Sand
	7	10	12	UD		23								2.00	Lean Clay w/Sand
	8	12	14	UD		17	118	30	13	17	80		0.85 (9)	1.13	Lean Clay w/Sand
	9	14	16	UD		15								1.63	Lean Clay w/Sand
	10	16	17	UD		19								2.25	Lean Clay w/Sand
B-16	1	0	0.75	AG											4.5-in Pavement+4.5-in Base
	2	0.75	2	UD		22								1.00	Fill: Fat Clay
	3	2	4	UD		20								1.38	Fat Clay
	4	4	6	UD		19	111						1.15 (3)	1.50	Fat Clay
	5	6	8	UD		23		58	16	38	92			1.38	Fat Clay
	6	8	10	UD		16								2.00	Fat Clay w/Sand
	7	10	12	UD		15								2.25	Fat Clay w/Sand
	8	12	14	UD		18	115	51	16	35	80		1.93 (9)	2.25	Fat Clay w/Sand
	9	14	16	UD		22								2.25	Fat Clay w/Sand

(Continue on Next Page)

SUMMARY OF LABORATORY TEST RESULTS
CITY OF HOUSTON WATER LINE REPLACEMENT IN COMMERCE
HOUSTON, TEXAS
WBS NO. S-000035-0153-4

BORING NO.	SAMPLE				SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMIT			PERCENT PASSING SIEVE NO. 200 (%)	SHEAR STRENGTH (tsf)			USCS GROUP NAME
	NO.	DEPTH (ft) TOP	DEPTH (ft) BOTTOM	TYPE				LL (%)	PL (%)	PI (%)		UNCONFINED COMPRESSION TEST	UU TEST (confining pressure in psi)	POCKET PENETRO-METER (TORVANE)	
B-17	1	0	0.917	AG											7-in Pavement(AC)+4-in Base
	2	0.917	2	UD		21								1.38	Fat Clay
	3	2	4	UD		19								1.38	Fat Clay
	4	4	6	UD		22	105						1.17 (3)	1.38	Fat Clay
	5	6	8	UD		23		57	19	38	96			2.13	Fat Clay
	6	8	10	UD		21								2.25	Fat Clay
	7	10	12	UD		17	113						1.22 (7)	1.50	Fat Clay
	8	12	14	UD		14		33	11	22	83			1.75	Lean Clay w/Sand
	9	14	16	UD		20								1.63	Lean Clay w/Sand
	10	16	17	UD		23									Lean Clay w/Sand
B-18	1	0	1	RC											2-in Pavement(AC)+2-in Base
	2	1	2	AG		22									Fill: Fat Clay w/Sand
	3	2	4	UD		21		54	15	39	79			1.00 (1.02)	Fill: Fat Clay w/Sand
	4	4	6	UD		21								1.38	Fat Clay
	5	6	8	UD		24	102						1.11 (5)	1.75	Fat Clay
	6	8	10	UD		26								1.88	Fat Clay
	7	10	12	UD		17		38	14	24	80			1.38	Lean Clay w/Sand
	8	12	13	UD		18								2.25	Lean Clay w/Sand
B-19	1	0	1.417	AG		1									7.5-in Pavement(AC)+9.5-in Base
	2	1.417	2	AG		3									Fill: shell/sand
	3	2	4	UD		21								1.75	Fat Clay
	4	4	6	UD		20	107						1.78 (3)	1.63	Fat Clay
	5	6	8	UD		19		57	15	42	93			1.63	Fat Clay
	6	8	10	UD		17	112						1.69 (6)	1.88	Fat Clay
	7	10	12	UD		16								1.50	Fat Clay
	8	12	14	UD		18								2.13	Sandy Fat Clay
	9	14	16	UD		16	110	50	15	35	67		1.60 (10)	2.13	Sandy Fat Clay
B-20	1	0	0.916	AG		5									4.5-in Pavement(AC)+6.5-in Base
	2	0.916	2	UD		15								2.25	Fat Clay
	3	2	4	UD		17	114	54	13	41	88		3.90 (2)	2.25	Fat Clay
	4	4	6	UD		16								2.25	Fat Clay
	5	6	8	UD		19	111						4.00 (5)	2.25	Fat Clay
	6	8	10	UD		18		59	15	44	90			2.25	Fat Clay
	7	10	12	UD		19								2.25	Fat Clay
	8	12	13	UD		8	125						5.60 (8)	2.25	Fat Clay
B-21	1	0	0.792	RC											Pavement (3.5-in AC +6-in PCC)
	2	0.792	2	UD		22								1.50	Fat Clay
	3	2	4	UD		20								1.00	Fat Clay
	4	4	6	UD		30	92						0.47 (3)	1.13	Fat Clay
	5	6	8	UD		25		63	17	46	94			0.88	Fat Clay
	6	8	10	UD		24								1.50	Lean Clay
	7	10	12	UD		25								1.88	Lean Clay
	8	12	14	UD		17	114	41	14	27	87		1.81 (9)	1.75	Lean Clay
	9	14	16	UD		18								2.25	Lean Clay
	10	16	17	UD		15								2.00	Lean Clay

(Continue on Next Page)

SUMMARY OF LABORATORY TEST RESULTS
CITY OF HOUSTON WATER LINE REPLACEMENT IN COMMERCE
HOUSTON, TEXAS
WBS NO. S-000035-0153-4

BORING NO.	SAMPLE NO.	DEPTH (ft) TOP	DEPTH (ft) BOTTOM	TYPE	SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMIT LL (%)	ATTERBERG LIMIT PL (%)	ATTERBERG LIMIT PI (%)	PERCENT PASSING SIEVE NO. 200 (%)	SHEAR STRENGTH (tsf) UNCONFINED COMPRESSION TEST	SHEAR STRENGTH (tsf) UU TEST (confining pressure in psi)	SHEAR STRENGTH (tsf) POCKET PENETRO-METER (TORVANE)	USCS GROUP NAME
B-22	1	0	1	AG											9-in Pavement(AC)+3-in Base
	2	1	2	UD		28								1.38	Fat Clay
	3	2	4	UD		21								2.25	Fat Clay
	4	4	6	UD		18		64	16	48	90			2.25	Fat Clay
	5	6	8	UD		23	104						0.92 (6)	1.38	Fat Clay
	6	8	10	UD		22								2.25	Fat Clay
	7	10	12	UD		19								2.25	Fat Clay
	8	12	14	UD		14	117	35	14	21	77		1.55 (9)	1.75	Lean Clay w/Sand
	9	14	16	UD		14								2.25	Lean Clay w/Sand
B-23	1	0	0.75	AG		1									4-in Pavement(AC)+ 5-in Base
	2	0.75	2	UD		19								1.88	Fat Clay
	3	2	4	UD		19		54	14	40	86			1.88	Fat Clay
	4	4	6	UD		21	109						1.32 (3)	1.63	Fat Clay
	5	6	8	UD		23								2.25	Fat Clay
	6	8	10	UD		21		60	18	42	94			2.00	Fat Clay
	7	10	12	UD		18	110						1.25 (7)	2.25	Fat Clay
	8	12	14	UD		18								1.88	Lean Clay w/Sand
	9	14	16	UD		16	119	43	12	31	83		1.91 (10)	2.13	Lean Clay w/Sand
	10	16	18	UD		25								2.13	Lean Clay w/Sand
B-24	1	0	1	AG											6-in Pavement(AC)+6-in Base
	2	1	2	UD		21								1.63	Fat Clay
	3	2	4	UD		22	104						1.25 (2)	1.38	Fat Clay
	4	4	6	UD		21		56	17	39	91			1.63	Fat Clay
	5	6	8	UD		23								1.13	Fat Clay
	6	8	10	UD		28	96						0.57 (6)	1.00	Fat Clay
	7	10	12	UD		24								1.38	Fat Clay
	8	12	14	UD		19		46	17	29	73			1.13 (0.48)	Lean Clay w/Sand
	9	14	15	UD		15								1.13	Lean Clay w/Sand
B-25	1	0	0.916	AG											5-in Pavement(AC)+6-in Base
	2	0.916	2	AG		23									Fill: Fat Clay
	3	2	4	UD		25								1.38	Fill: Fat Clay
	4	4	6	UD		24		65	18	47	90			1.25	Fat Clay
	5	6	8	UD		28	97						0.67 (5)	0.88	Fat Clay
	6	8	10	UD		24								1.50	Fat Clay
	7	10	12	UD		22								1.75	Fat Clay
	8	12	14	UD		21		49	17	32	90			1.63	Lean Clay
	9	14	16	UD		15	116						1.54 (10)	1.75	Lean Clay
	10	16	18	UD		19								1.50	Lean Clay
B-26	1	0	1.333	AG		5									6-in Pavement(AC)+10-in Base
	2	1.333	2	UD		18								1.38	Fill: Fat Clay
	3	2	4	UD		16								2.25	Fat Clay
	4	4	6	UD		19	113						2.70 (3)	2.25	Fat Clay
	5	6	8	UD		22		72	18	54	94			2.25	Fat Clay
	6	8	10	UD		22								2.25	Fat Clay
	7	10	12	UD		20	112						3.70 (7)	2.25	Fat Clay
	8	12	14	UD		14		34	12	22	76			2.25	Lean Clay w/Sand
	9	14	16	UD		17	114						2.19 (10)	1.75	Lean Clay w/Sand
	10	16	17	UD		15								2.00	Lean Clay w/Sand

(Continue on Next Page)

SUMMARY OF LABORATORY TEST RESULTS
CITY OF HOUSTON WATER LINE REPLACEMENT IN COMMERCE
HOUSTON, TEXAS
WBS NO. S-000035-0153-4

BORING NO.	SAMPLE NO.	DEPTH (ft) TOP	DEPTH (ft) BOTTOM	TYPE	SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMIT LL (%)	ATTERBERG LIMIT PL (%)	ATTERBERG LIMIT PI (%)	PERCENT PASSING SIEVE NO. 200 (%)	SHEAR STRENGTH (tsf) UNCONFINED COMPRESSION TEST	SHEAR STRENGTH (tsf) UU TEST (confining pressure in psi)	SHEAR STRENGTH (tsf) POCKET PENETRO-METER (TORVANE)	USCS GROUP NAME
B-27	1	0	1	AG											5-in Pavement(AC)+7-in Base
	2	1	2	UD		18								1.75	Fat Clay
	3	2	4	UD		20								1.75	Fat Clay
	4	4	6	UD		19	111						1.68 (3)	1.50	Fat Clay
	5	6	8	UD		24		66	19	47	91			1.50	Fat Clay
	6	8	10	UD		28								1.38	Fat Clay
	7	10	12	UD		26	103						0.90 (7)	1.50	Fat Clay
	8	12	14	UD		17								1.13	Lean Clay w/Sand
	9	14	16	UD		14	120	38	13	25	75		2.07 (10)	2.25	Lean Clay w/Sand
	10	16	18	UD		18								2.13	Lean Clay w/Sand
B-28	1	0	0.833	AG											4-in Pavement(AC)+6-in Base
	2	0.833	2	UD		19								1.88	Fill: Fat Clay
	3	2	4	UD		19								1.25	Fat Clay
	4	4	6	UD		20		54	15	39	88			1.38	Fat Clay
	5	6	8	UD		28	97						0.70 (5)	1.00	Fat Clay
	6	8	10	UD		26								1.75	Fat Clay
	7	10	12	UD		20		62	19	43	98			1.63	Fat Clay
	8	12	14	UD		15	119						1.29 (9)	2.00	Fat Clay
	9	14	15	UD		16								1.38	Fat Clay
B-29	1	0	0.75	RC											9-in Pavement (PCC)
	2	0.75	2	UD		26								1.00	Fill: Fat Clay
	3	2	4	UD		30								0.75 (1.17)	Fill: Fat Clay
	4	4	6	UD		30	92						0.76 (3)	0.75	Fill: Fat Clay
	5	6	8	UD		29		73	21	52	90			1.13	Fat Clay
	6	8	10	UD		28								1.00 (1.19)	Fat Clay
	7	10	12	UD		25	100						0.91 (7)	1.00	Fat Clay
	8	12	14	UD		25								1.00	Fat Clay
	9	14	15	UD		28								1.88	Fat Clay
B-30	1	0	0.917	AG											3-in Pavement(AC)+8in Base
	2	0.917	2	UD		26								1.25	Fill: Fat Clay
	3	2	4	UD		32	92						0.35 (2)	0.50 (0.59)	Fill: Fat Clay
	4	4	6	UD		30		72	18	54	88			0.63	Fill: Fat Clay
	5	6	8	UD		29								1.25	Fat Clay
	6	8	10	UD		33	92						0.42 (6)	0.50	Fat Clay
	7	10	12	UD		35								0.63	Fat Clay
	8	12	14	UD		23								1.00	Fat Clay
B-31	1	0	0.7083	AG											Fill: sand/gravel
	2	0.7083	1	AG											Fill: Fat Clay w/Sand
	3	1	2	UD		25								1.25	Fill: Fat Clay w/Sand
	4	2	4	UD		26								1.00	Fill: Fat Clay w/Sand
	5	4	6	UD		30	91						0.42 (3)	0.75	Fill: Fat Clay w/Sand
	6	6	8	UD		27		74	17	57	84			0.88	Fill: Fat Clay w/Sand
	7	8	10	UD		26								1.50	Fat Clay
	8	10	12	UD		26	99						0.78 (7)	1.75	Fat Clay
	9	12	14	UD		26								1.88	Fat Clay

(Continue on Next Page)

SUMMARY OF LABORATORY TEST RESULTS
CITY OF HOUSTON WATER LINE REPLACEMENT IN COMMERCE
HOUSTON, TEXAS
WBS NO. S-000035-0153-4

BORING NO.	SAMPLE NO.	DEPTH (ft) TOP	DEPTH (ft) BOTTOM	TYPE	SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMIT LL (%)	ATTERBERG LIMIT PL (%)	ATTERBERG LIMIT PI (%)	PERCENT PASSING SIEVE NO. 200 (%)	SHEAR STRENGTH (tsf) UNCONFINED COMPRESSION TEST	SHEAR STRENGTH (tsf) UU TEST (confining pressure in psi)	SHEAR STRENGTH (tsf) POCKET PENETRO-METER (TORVANE)	USCS GROUP NAME
B-32	1	0	0.5	AG											Fill: sand/gravel
	2	0.5	2	UD		17									Fill: Fat Clay w/Sand
	3	2	4	UD		29								0.75	Fill: Fat Clay w/Sand
	4	4	6	UD		29	92						0.48 (3)	0.50 (0.9)	Fill: Fat Clay w/Sand
	5	6	8	UD		29		57	16	41	78			0.63	Fill: Fat Clay w/Sand
	6	8	10	UD		27								1.25	Fat Clay
	7	10	12	UD		26	100						0.92 (7)	1.25	Fat Clay
	8	12	13	UD		30								1.50	Fat Clay
B-33	1	0	0.583	AG											Fill: sand/gravel
	2	0.583	2	UD		23								1.50	Fill: Fat Clay
	3	2	4	UD		27								1.00	Fill: Fat Clay
	4	4	6	UD		28		63	18	45	86			0.88	Fill: Fat Clay
	5	6	8	UD		35	84						0.17 (5)	0.38	Fill: Fat Clay
	6	8	10	UD		27								1.00	Fat Clay
	7	10	12	UD		26		59	18	41	89			1.25	Fat Clay
	8	12	14	UD		25	102						1.03 (9)	1.25	Fat Clay
	9	14	15	UD		26								1.13	Fat Clay
B-34	1	0	0.667	AG											Base: clay/sand/gravel
	2	0.667	2	UD		22								1.13	Fill: Fat Clay w/Sand
	3	2	4	UD		24								0.88	Fill: Fat Clay w/Sand
	4	4	6	UD		25	96						0.52 (3)	0.50	Fill: Fat Clay w/Sand
	5	6	8	UD		29		57	16	41	77			0.50	Fill: Fat Clay w/Sand
	6	8	10	UD		24	111						0.64 (6)	1.00	Fat Clay
	7	10	12	UD		24								1.75	Fat Clay
	8	12	14	UD		29								1.50	Fat Clay
B-35	1	0	0.917	AG											Fill: shell/gravel
	2	0.917	2	UD		30								0.88	Fill:: Fat Clay w/Sand
	3	2	4	UD		27		56	18	38	76			0.38 (0.85)	Fill:: Fat Clay w/Sand
	4	4	6	UD		30	106						0.36 (3)	0.38	Fill:: Fat Clay w/Sand
	5	6	8	UD		25								0.63	Fat Clay
	6	8	10	UD		28								0.75	Fat Clay
	7	10	12	UD		25	105						0.47 (7)	0.75	Fat Clay
	8	12	13	UD		20								1.38	Fat Clay
B-36	1	0	1.5	AG											Fill: Clayey Sand
	2	1.5	2	UD		22									Fill: Clayey Sand
	3	2	4	UD		7									Fill: Clayey Sand
	4	4	6	UD		24	105	45	17	28	57		0.50 (3)	0.63	Fill: Sandy Lean Clay
	5	6	8	UD		24								0.75	Fill: Sandy Lean Clay
	6	8	10	UD		23		43	15	28	84			0.75 (1.05)	Lean Clay w/Sand
	7	10	12	UD		34	101						0.35 (7)	0.50	Lean Clay w/Sand
	8	12	13	UD		29								1.00	Lean Clay w/Sand

(Continue on Next Page)

SUMMARY OF LABORATORY TEST RESULTS
CITY OF HOUSTON WATER LINE REPLACEMENT IN COMMERCE
HOUSTON, TEXAS
WBS NO. S-000035-0153-4

BORING NO.	SAMPLE				SPT (blows/ft)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMIT			PERCENT PASSING SIEVE NO. 200 (%)	SHEAR STRENGTH (tsf)			USCS GROUP NAME
	NO.	DEPTH (ft)		TYPE				LL (%)	PL (%)	PI (%)		UNCONFINED COMPRESSION TEST	UU TEST (confining pressure in psi)	POCKET PENETRO-METER (TORVANE)	
		TOP	BOTTOM												
B-37	1	0	0.833	AG											Fill: sand/gravel
	2	0.833	2	UD		22									Fill: Fat Clay w/Sand
	3	2	4	UD		21								1.25	Fill: Fat Clay w/Sand
	4	4	6	UD		21	101						0.65 (3)	0.75	Fill: Fat Clay w/Sand
	5	6	8	UD		34		55	18	37	80			0.50 (0.44)	Fill: Fat Clay w/Sand
	6	8	10	UD		28								1.13	Fat Clay
	7	10	12	UD		25								0.88	Fat Clay
	8	12	14	UD		24								1.38	Fat Clay

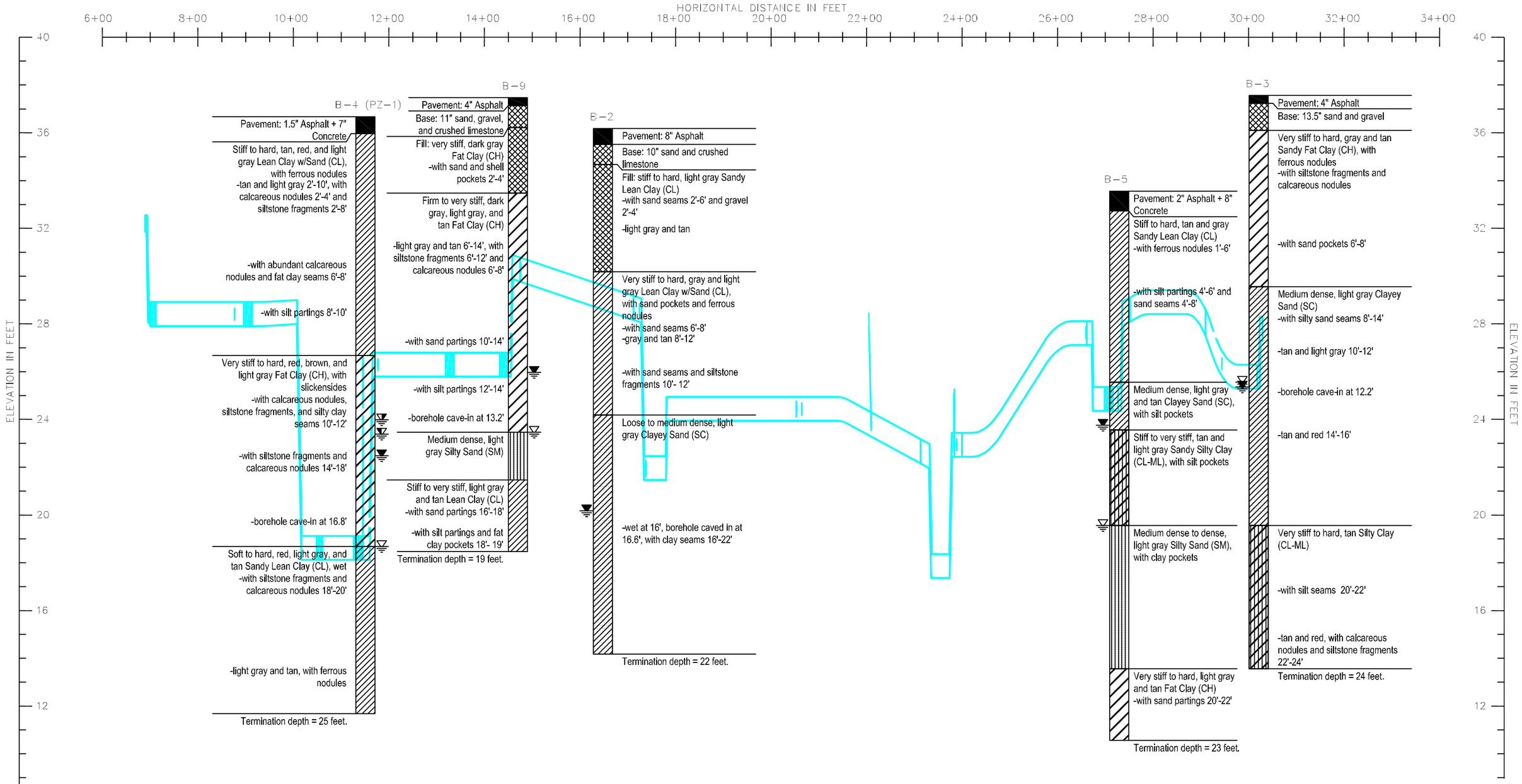
Notes: (1) UD = Undisturbed Sample (Shelby Tube); SS = Split Spoon Sample; AG = Auger Cuttings;
(2) LL = Liquid Limit; PL = Plastic Limit; PI = Plasticity Index; UU = Unconsolidated-Undrained Test
(3) AC = Asphalt Concrete; and PCC = Portland Cement Concrete

APPENDIX B

Plates B-1 to B-7	Generalized Subsurface Profile
Plate B-8	Piezometer Installation Details

GENERALIZED SUBSURFACE SOIL PROFILE

ALONG NAVIGATION



LEGEND:

- Paving
- Fill
- Low plasticity clay
- High plasticity clay
- Poorly graded clayey silty sand
- Silty sand
- Depth of ground-water encountered during drilling
- Clayey sand
- Silty low plasticity clay
- Depth of groundwater approx 15 min. after initial encounter
- Depth of groundwater on 10/04/13 (piezometer)
- Depth of groundwater on 11/11/13 (piezometer)

NOTE:

SOIL STRATIGRAPHY AND SECONDARY SOIL STRUCTURE (SUCH AS SEAMS, LAYERS, OR POCKETS OF SANDS, SILTS, SLICKENSIDES, AND FISSURES) THAT ARE DIFFERENT FROM WHAT WERE IDENTIFIED IN THE ACTUAL BORINGS MAY EXIST AWAY FROM THESE BORINGS.

AVILES ENGINEERING CORPORATION

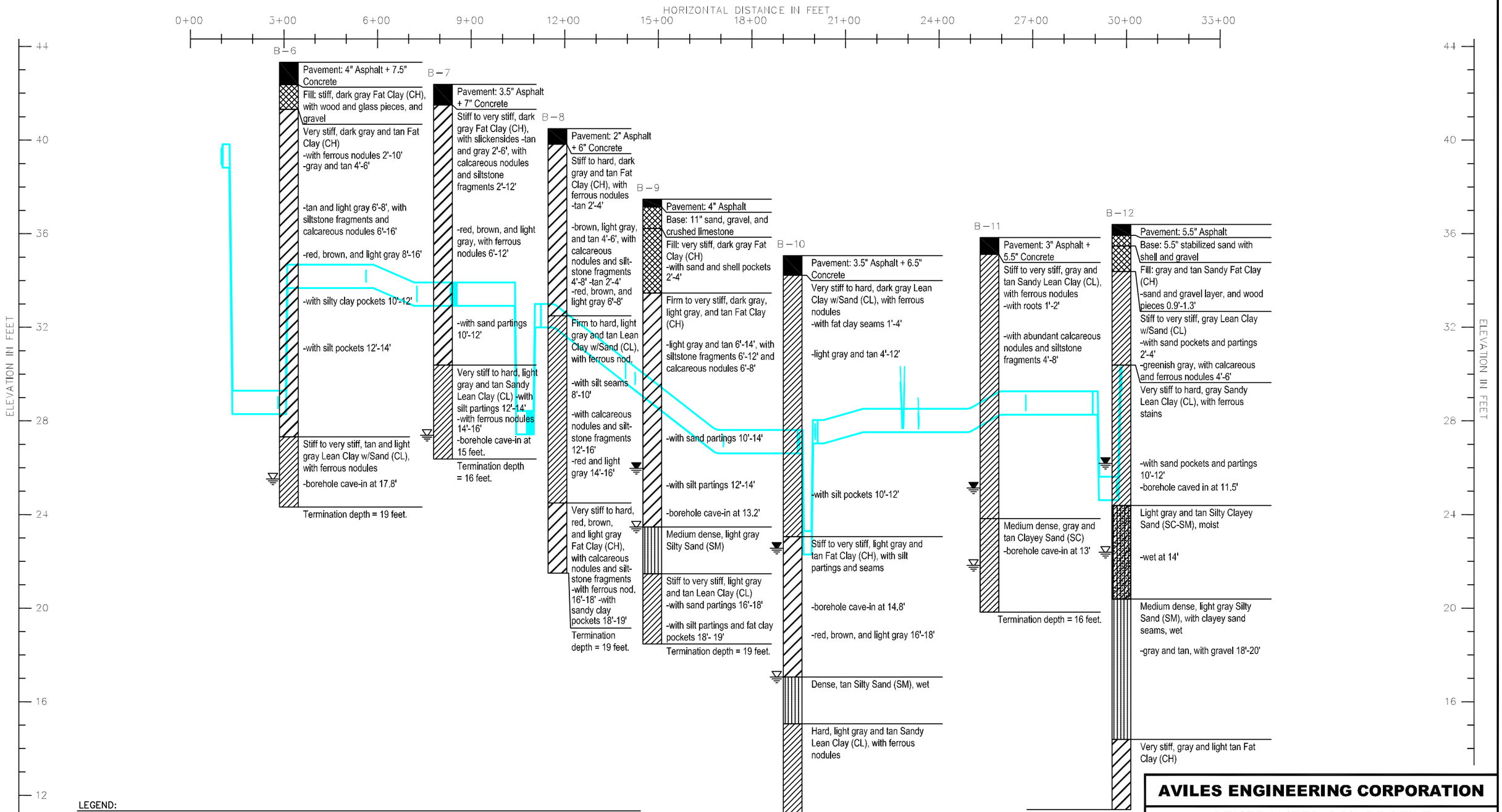
GENERALIZED SOIL PROFILE
WATER LINE REPLACEMENT IN COMMERCE AREA
WBS NO. S-000035-0153-4
HOUSTON, TEXAS

AEC PROJECT NO.: G159-13	DATE: 02-25-14	SOURCE DRAWING PROVIDED BY: AVILES ENGINEERING CORP.
VERTICAL SCALE: 1" = 4' HORIZONTAL SCALE: 1" = 200'	DRAFTED BY: BpJ	PLATE NO.: PLATE B-1

GENERALIZED SUBSURFACE SOIL PROFILE

ALONG CANAL

WEST — EAST



LEGEND:

Paving	High plasticity clay	Depth of ground-water encountered during drilling	Depth of groundwater approx 15 min. after initial encounter
Fill	Poorly graded clayey silty sand	Clayey sand	Depth of groundwater on 10/04/13 (piezometer)
Low plasticity clay	Silty sand	Silty low plasticity clay	Depth of groundwater on 11/11/13 (piezometer)

NOTE:

SOIL STRATIGRAPHY AND SECONDARY SOIL STRUCTURE (SUCH AS SEAMS, LAYERS, OR POCKETS OF SANDS, SILTS, SLICKENSIDES, AND FISSURES) THAT ARE DIFFERENT FROM WHAT WERE IDENTIFIED IN THE ACTUAL BORINGS MAY EXIST AWAY FROM THESE BORINGS.

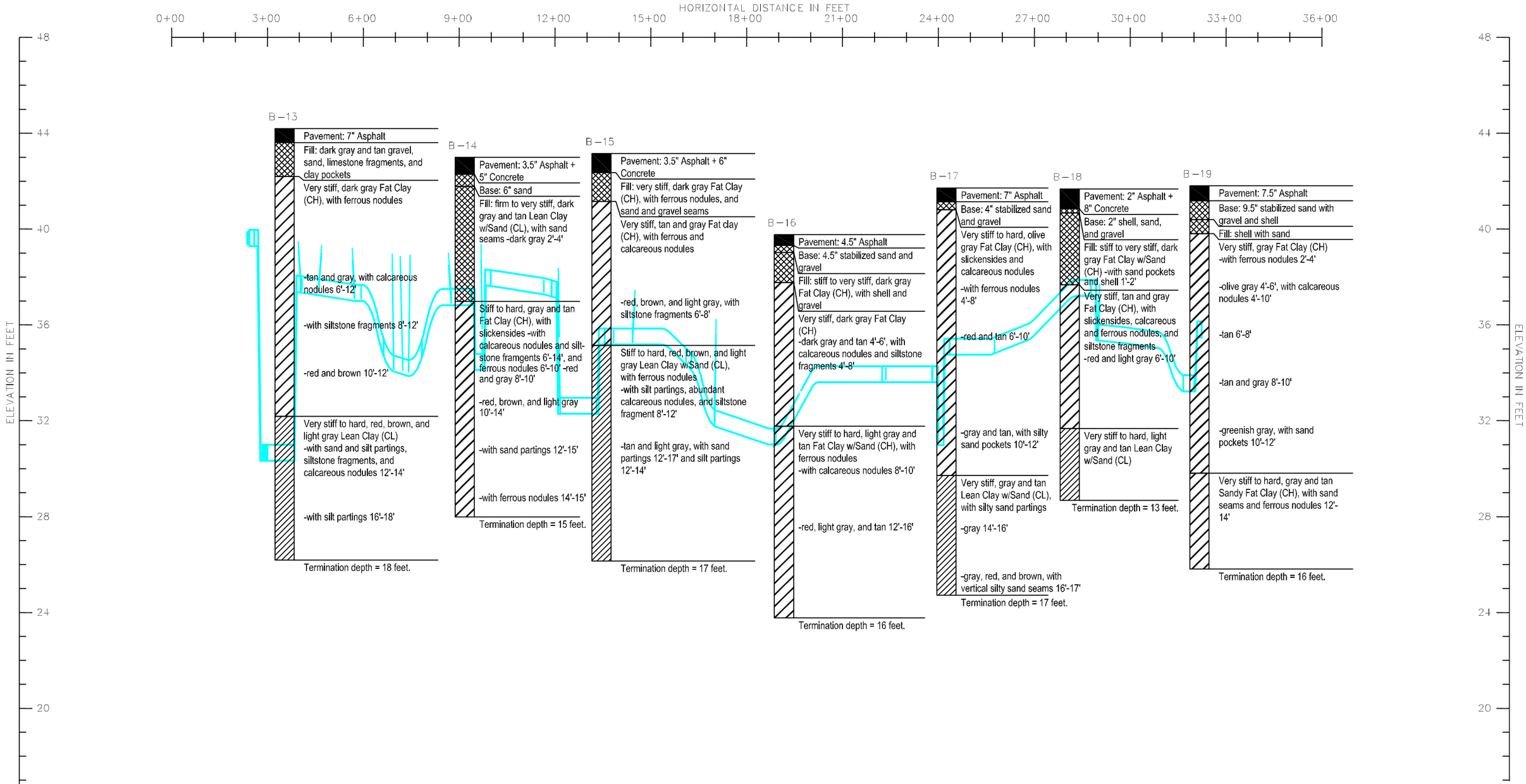
AVILES ENGINEERING CORPORATION

GENERALIZED SOIL PROFILE
WATER LINE REPLACEMENT IN COMMERCE AREA
WBS NO. S-000035-0153-4
HOUSTON, TEXAS

AEC PROJECT NO.: G159-13	DATE: 02-25-14	SOURCE DRAWING PROVIDED BY: AVILES ENGINEERING CORP.
VERTICAL SCALE: 1" = 4' HORIZONTAL SCALE: 1" = 300'	DRAFTED BY: BpJ	PLATE NO.: PLATE B-2

GENERALIZED SUBSURFACE SOIL PROFILE

ALONG COMMERCE



LEGEND:

Paving	High plasticity clay	Depth of ground-water encountered during drilling	Depth of groundwater approx 15 min. after initial encounter
Fill	Poorly graded clayey silty sand	Clayey sand	Depth of groundwater on 10/04/13 (piezometer)
Low plasticity clay	Silty sand	Silty low plasticity clay	Depth of groundwater on 11/11/13 (piezometer)

NOTE:

SOIL STRATIGRAPHY AND SECONDARY SOIL STRUCTURE (SUCH AS SEAMS, LAYERS, OR POCKETS OF SANDS, SILTS, SLICKENSIDES, AND FISSURES) THAT ARE DIFFERENT FROM WHAT WERE IDENTIFIED IN THE ACTUAL BORINGS MAY EXIST AWAY FROM THESE BORINGS.

AVILES ENGINEERING CORPORATION

GENERALIZED SOIL PROFILE
WATER LINE REPLACEMENT IN COMMERCE AREA
WBS NO. S-000035-0153-4
HOUSTON, TEXAS

AEC PROJECT NO.: G159-13	DATE: 02-25-14	SOURCE DRAWING PROVIDED BY: AVILES ENGINEERING CORP.
VERTICAL SCALE: 1" = 4' HORIZONTAL SCALE: 1" = 300'	DRAFTED BY: BpJ	PLATE NO.: PLATE B-3

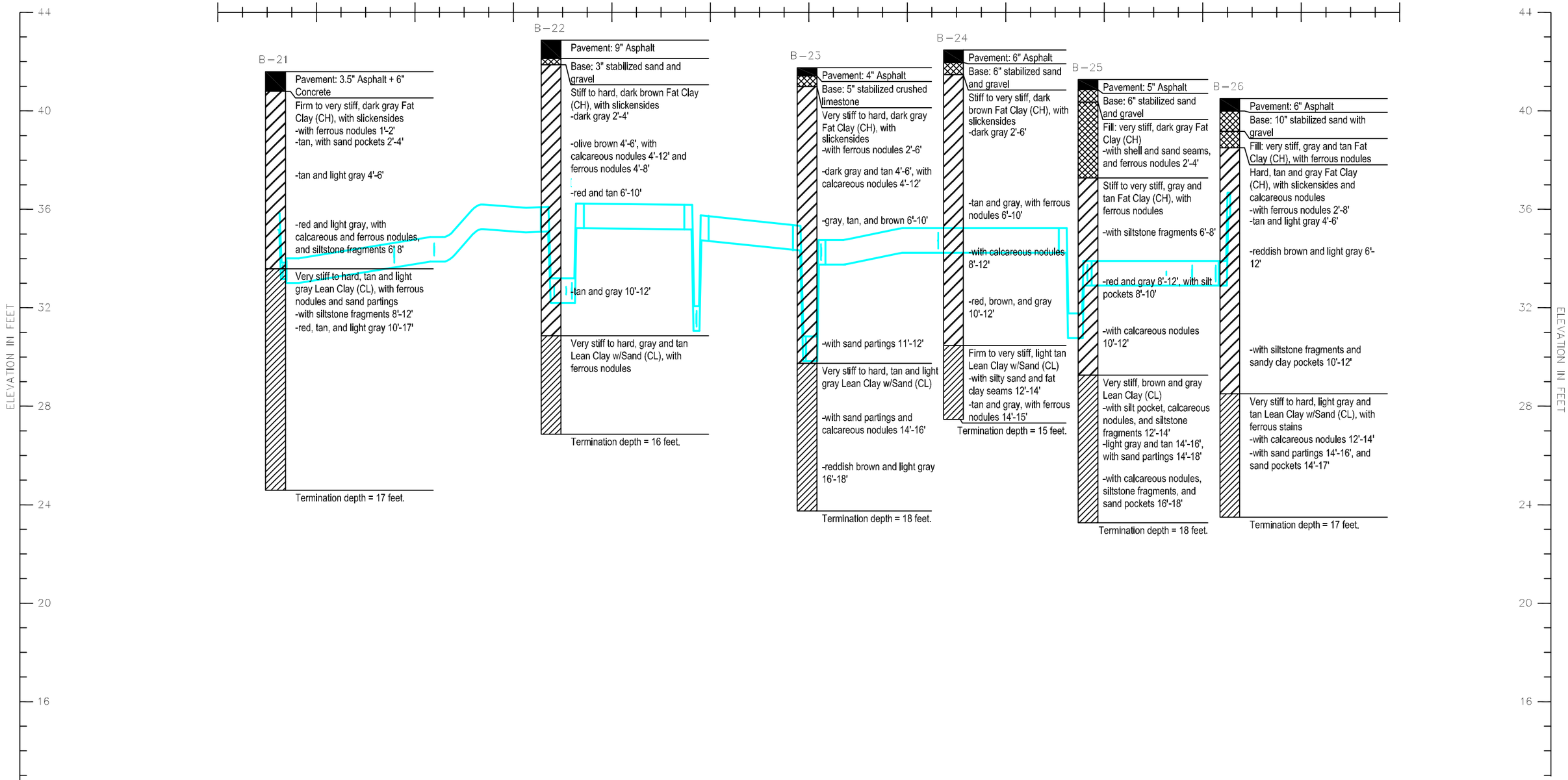
GENERALIZED SUBSURFACE SOIL PROFILE

ALONG GARROW

WEST — EAST

HORIZONTAL DISTANCE IN FEET: 0+00, 2+00, 4+00, 6+00, 8+00, 10+00, 12+00, 14+00, 16+00, 18+00, 20+00, 22+00, 24+00

ELEVATION IN FEET: 44, 40, 36, 32, 28, 24, 20, 16, 12, 8



LEGEND:

- Paving
- Fill
- Low plasticity clay
- High plasticity clay
- Poorly graded clayey silty sand
- Silty sand
- Depth of ground-water encountered during drilling
- Clayey sand
- Silty low plasticity clay
- Depth of groundwater approx 15 min. after initial encounter
- Depth of groundwater on 10/04/13 (piezometer)
- Depth of groundwater on 11/11/13 (piezometer)

NOTE:

SOIL STRATIGRAPHY AND SECONDARY SOIL STRUCTURE (SUCH AS SEAMS, LAYERS, OR POCKETS OF SANDS, SILTS, SLICKENSIDES, AND FISSURES) THAT ARE DIFFERENT FROM WHAT WERE IDENTIFIED IN THE ACTUAL BORINGS MAY EXIST AWAY FROM THESE BORINGS.

AVILES ENGINEERING CORPORATION

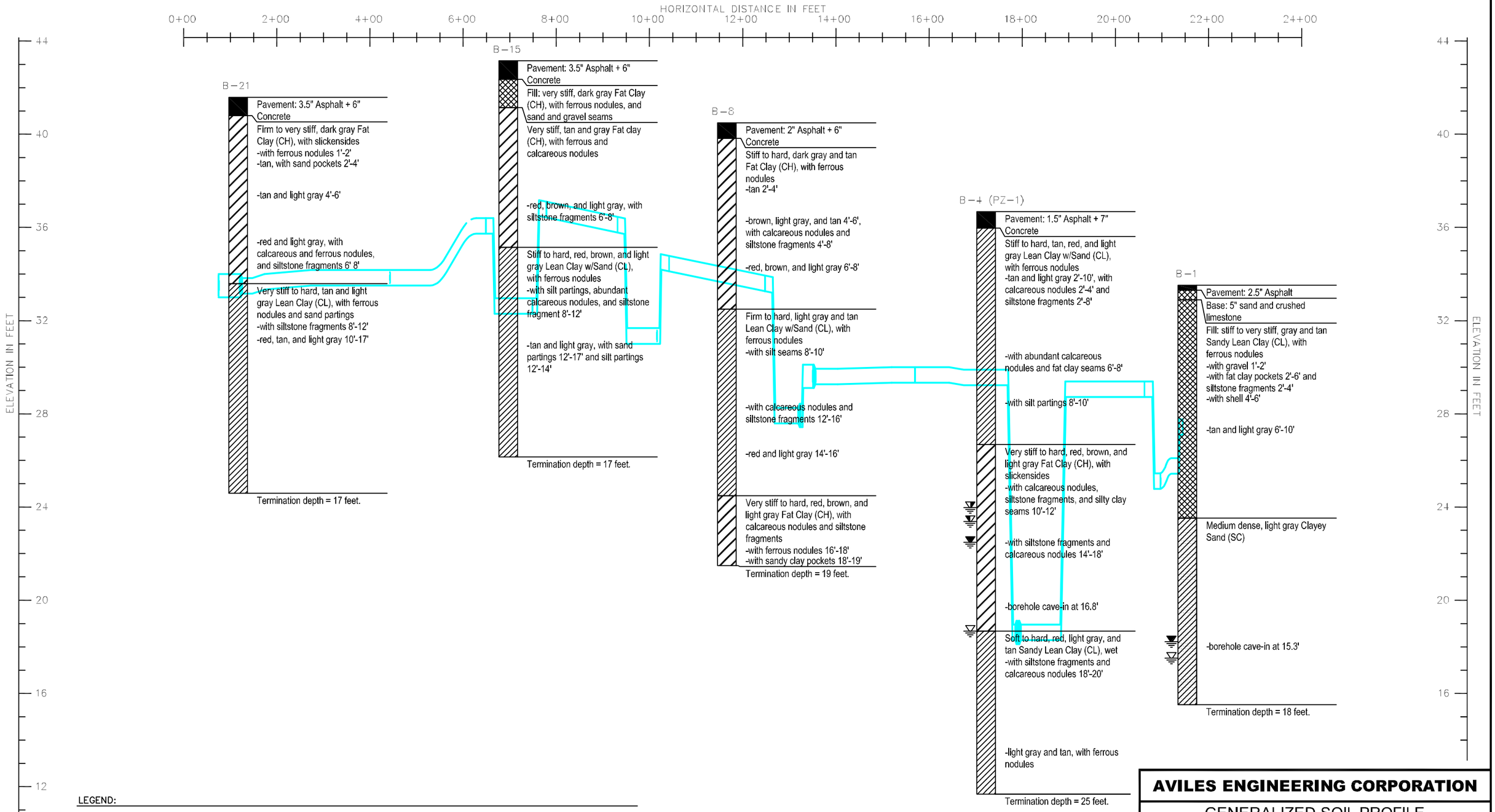
GENERALIZED SOIL PROFILE
WATER LINE REPLACEMENT IN COMMERCE AREA
WBS NO. S-000035-0153-4
HOUSTON, TEXAS

AEC PROJECT NO.: G159-13	DATE: 02-25-14	SOURCE DRAWING PROVIDED BY: AVILES ENGINEERING CORP.
VERTICAL SCALE: 1" = 4' HORIZONTAL SCALE: 1" = 200'	DRAFTED BY: BpJ	PLATE NO.: PLATE B-4

GENERALIZED SUBSURFACE SOIL PROFILE

ALONG ST. CHARLES

SOUTH — NORTH



LEGEND:

- Paving
- Fill
- Low plasticity clay
- High plasticity clay
- Poorly graded clayey silty sand
- Silty sand
- Depth of ground-water encountered during drilling
- Clayey sand
- Silty low plasticity clay
- Depth of groundwater approx 15 min. after initial encounter
- Depth of groundwater on 10/04/13 (piezometer)
- Depth of groundwater on 11/11/13 (piezometer)

NOTE:

SOIL STRATIGRAPHY AND SECONDARY SOIL STRUCTURE (SUCH AS SEAMS, LAYERS, OR POCKETS OF SANDS, SILTS, SLICKENSIDES, AND FISSURES) THAT ARE DIFFERENT FROM WHAT WERE IDENTIFIED IN THE ACTUAL BORINGS MAY EXIST AWAY FROM THESE BORINGS.

AVILES ENGINEERING CORPORATION

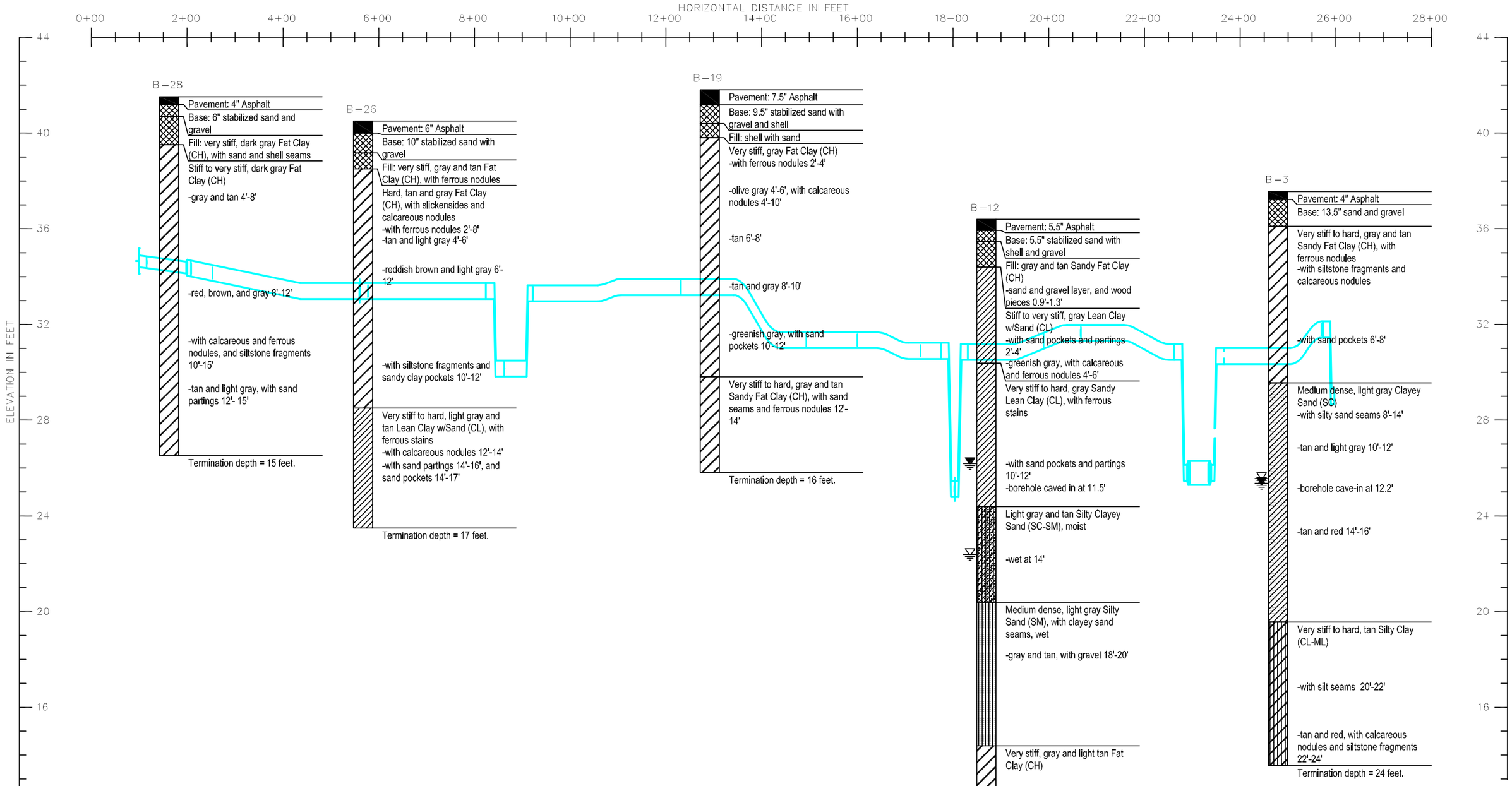
GENERALIZED SOIL PROFILE
WATER LINE REPLACEMENT IN COMMERCE AREA
WBS NO. S-000035-0153-4
HOUSTON, TEXAS

AEC PROJECT NO.: G159-13	DATE: 02-25-14	SOURCE DRAWING PROVIDED BY: AVILES ENGINEERING CORP.
VERTICAL SCALE: 1" = 4' HORIZONTAL SCALE: 1" = 200'	DRAFTED BY: BpJ	PLATE NO.: PLATE B-5

GENERALIZED SUBSURFACE SOIL PROFILE

ALONG PALMER

SOUTH — NORTH



LEGEND:

Paving	High plasticity clay	Depth of ground-water encountered during drilling	Depth of groundwater approx 15 min. after initial encounter
Fill	Poorly graded clayey silty sand	Clayey sand	Depth of groundwater on 10/04/13 (piezometer)
Low plasticity clay	Silty sand	Silty low plasticity clay	Depth of groundwater on 11/11/13 (piezometer)

NOTE:

SOIL STRATIGRAPHY AND SECONDARY SOIL STRUCTURE (SUCH AS SEAMS, LAYERS, OR POCKETS OF SANDS, SILTS, SLICKENSIDES, AND FISSURES) THAT ARE DIFFERENT FROM WHAT WERE IDENTIFIED IN THE ACTUAL BORINGS MAY EXIST AWAY FROM THESE BORINGS.

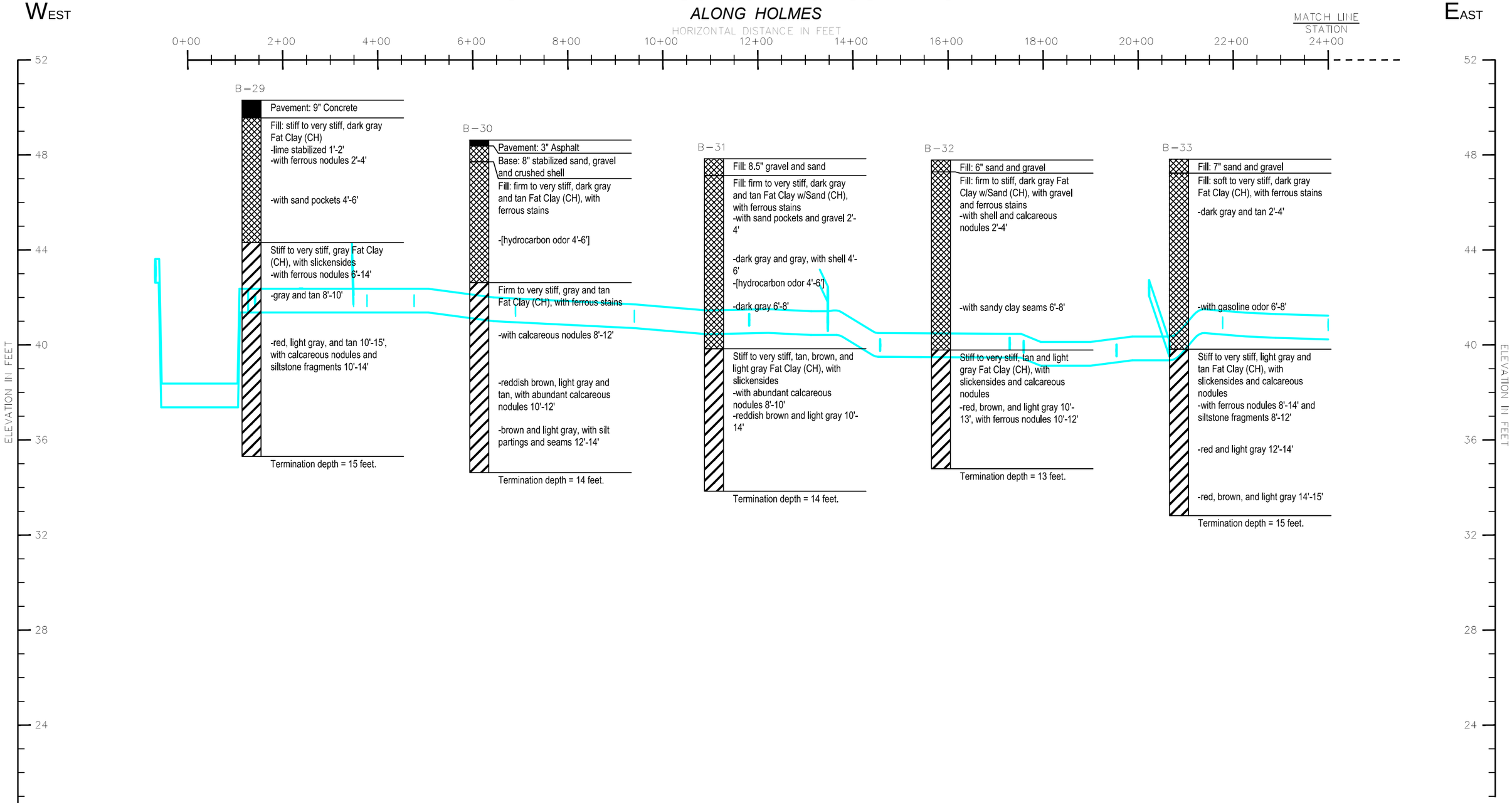
AVILES ENGINEERING CORPORATION

GENERALIZED SOIL PROFILE
WATER LINE REPLACEMENT IN COMMERCE AREA
WBS NO. S-000035-0153-4
HOUSTON, TEXAS

AEC PROJECT NO.: G159-13	DATE: 02-25-14	SOURCE DRAWING PROVIDED BY: AVILES ENGINEERING CORP.
VERTICAL SCALE: 1" = 4' HORIZONTAL SCALE: 1" = 200'	DRAFTED BY: BpJ	PLATE NO.: PLATE B-6

GENERALIZED SUBSURFACE SOIL PROFILE

ALONG HOLMES



LEGEND:

Paving	High plasticity clay	Depth of ground-water encountered during drilling	Depth of groundwater approx 15 min. after initial encounter
Fill	Poorly graded clayey silty sand	Clayey sand	Depth of groundwater on 10/04/13 (piezometer)
Low plasticity clay	Silty sand	Silty low plasticity clay	Depth of groundwater on 11/11/13 (piezometer)

REVISION:

PROPOSED WATER LINE PROFILE UPDATED AS PER S.E.C. DRAWING DATED 3/24/2014.

NOTE:

SOIL STRATIGRAPHY AND SECONDARY SOIL STRUCTURE (SUCH AS SEAMS, LAYERS, OR POCKETS OF SANDS, SILTS, SLICKENSIDES, AND FISSURES) THAT ARE DIFFERENT FROM WHAT WERE IDENTIFIED IN THE ACTUAL BORINGS MAY EXIST AWAY FROM THESE BORINGS.

AVILES ENGINEERING CORPORATION

GENERALIZED SOIL PROFILE

WATER LINE REPLACEMENT IN COMMERCE AREA

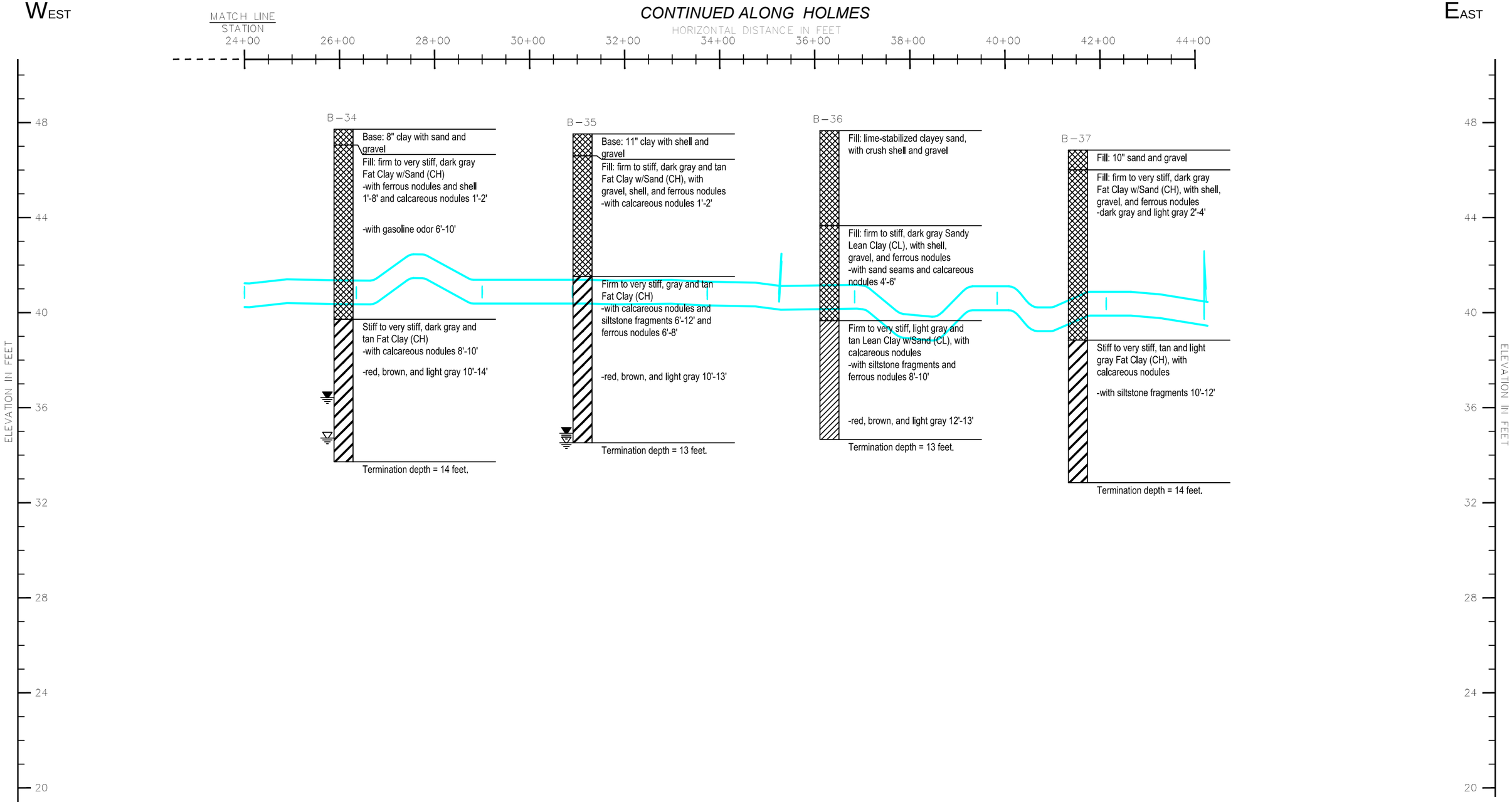
WBS NO. S-000035-0153-4

HOUSTON, TEXAS

AEC PROJECT NO.: G159-13	DATE: 04-02-14	SOURCE DRAWING PROVIDED BY: AVILES ENGINEERING CORP.
VERTICAL SCALE: 1" = 4' HORIZONTAL SCALE: 1" = 200'	DRAFTED BY: BpJ	PLATE NO.: PLATE B-7a

GENERALIZED SUBSURFACE SOIL PROFILE

CONTINUED ALONG HOLMES



LEGEND:

- Paving
- Fill
- Low plasticity clay
- High plasticity clay
- Poorly graded clayey silty sand
- Silty sand
- Depth of ground-water encountered during drilling
- Clayey sand
- Silty low plasticity clay
- Depth of groundwater approx 15 min. after initial encounter
- Depth of groundwater on 10/04/13 (piezometer)
- Depth of groundwater on 11/11/13 (piezometer)

REVISION:

PROPOSED WATER LINE PROFILE UPDATED AS PER S.E.C. DRAWING DATED 3/24/2014.

NOTE:

SOIL STRATIGRAPHY AND SECONDARY SOIL STRUCTURE (SUCH AS SEAMS, LAYERS, OR POCKETS OF SANDS, SILTS, SLICKENSIDES, AND FISSURES) THAT ARE DIFFERENT FROM WHAT WERE IDENTIFIED IN THE ACTUAL BORINGS MAY EXIST AWAY FROM THESE BORINGS.

AVILES ENGINEERING CORPORATION

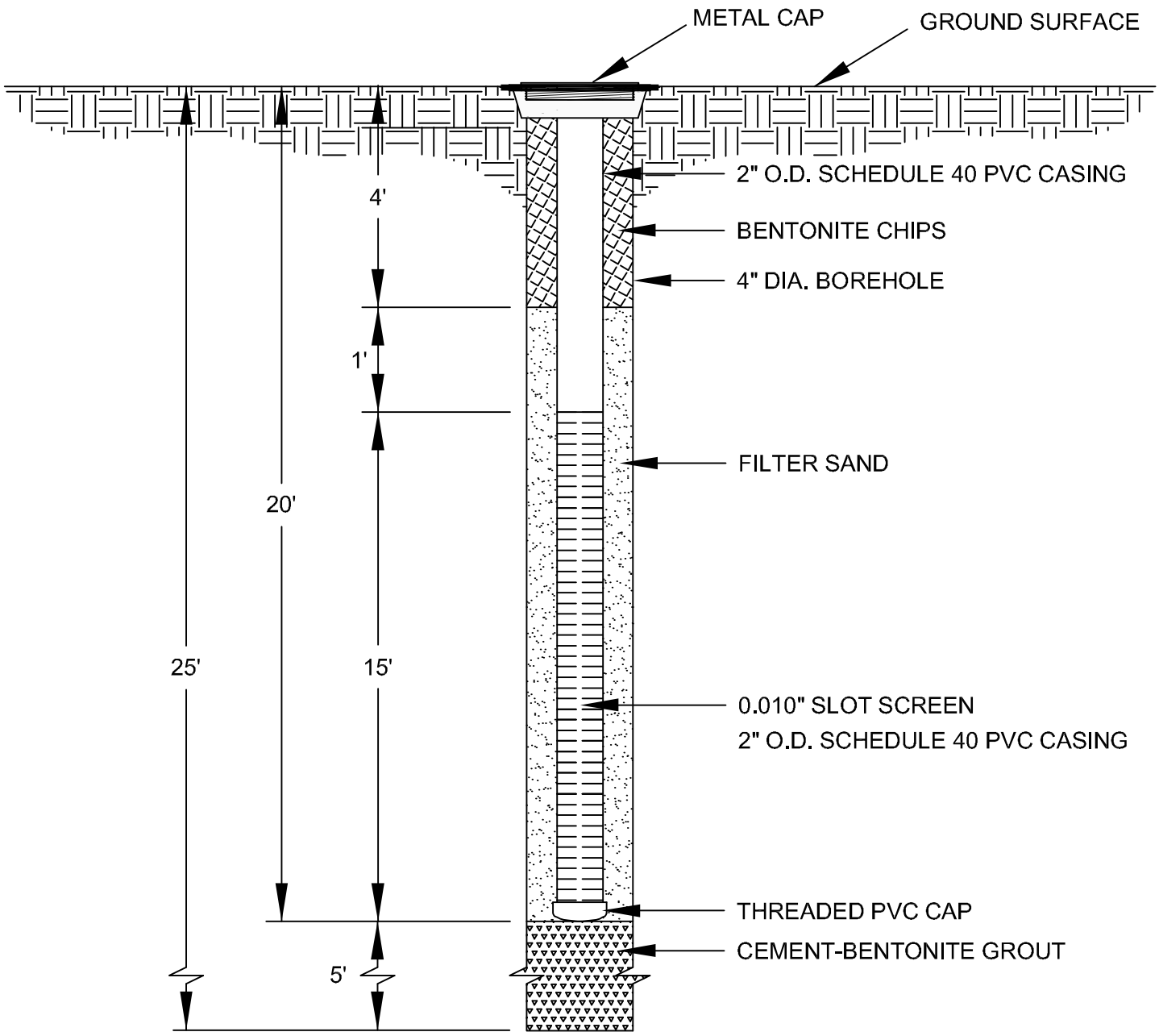
GENERALIZED SOIL PROFILE

WATER LINE REPLACEMENT IN COMMERCE AREA

WBS NO. S-000035-0153-4

HOUSTON, TEXAS

AEC PROJECT NO.: G159-13	DATE: 04-02-14	SOURCE DRAWING PROVIDED BY: AVILES ENGINEERING CORP.
VERTICAL SCALE: 1" = 4' HORIZONTAL SCALE: 1" = 200'	DRAFTED BY: BpJ	PLATE NO.: PLATE B-7b



GROUNDWATER DEPTH FROM SURFACE:	DATE MEASURED:
13.3 ft.	10/4/13
12.7 ft.	11/11/13

AVILES ENGINEERING CORPORATION

PIEZOMETER INSTALLATION DETAILS
BORING B-4 (PZ-1)
WATER LINE REPLACEMENT IN COMMERCE AREA
WBS NO. S-000035-0153-4
HOUSTON, TEXAS

AEC PROJECT NO.:	DATE:	SOURCE DWG. BY:
G159-13	02-25-14	AVILES ENGINEERING CORP.
SCALE: N.T.S.	DRAWN BY: BpJ	PLATE NO.: PLATE B-8

APPENDIX C

Plates C-1a to C-1d	Recommended Geotechnical Design Parameters
Plate C-2	Load Coefficients for Pipe Loading
Plate C-3	Live Loads on Pipe Crossing Under Roadway
Plate C-4	Live Load on Pipe Crossing Under Railroad Track

G159-13 WATERLINE REPLACEMENTS IN COMMERCE AREA, HOUSTON, TEXAS
SOIL PARAMETERS FOR UNDERGROUND UTILITIES

Boring	Depth (ft)	Soil Type	γ (pcf)	γ' (pcf)	E'n	OSHA Type	Short-Term					Long-Term				
							C (psf)	φ (deg)	K_a	K_0	K_p	C' (psf)	φ' (deg)	K_a	K_0	K_p
B-1	0-8	Fill: stiff to very stiff CL	130	68	600	C	2000	0	1.00	1.00	1.00	200	18	0.53	0.69	1.89
	8-10	Fill: stiff CL	130	68	600	C	1200	0	1.00	1.00	1.00	100	18	0.53	0.69	1.89
	10-18	Medium dense SC	137	75	600	C	0	28	0.36	0.53	2.77	0	28	0.36	0.53	2.77
B-2	0-6	Fill: stiff to hard CL	120	58	600	C	2000	0	1.00	1.00	1.00	200	18	0.53	0.69	1.89
	6-12	Very stiff to hard CL	135	73	1000	B	2200	0	1.00	1.00	1.00	200	18	0.53	0.69	1.89
	12-22	Loose to medium dense SC	120	58	600	C (12-20)	0	26	0.39	0.56	2.56	0	26	0.39	0.56	2.56
B-3	0-8	Very stiff CH	138	76	1000	B	2800	0	1.00	1.00	1.00	275	16	0.57	0.72	1.76
	8-18	Medium dense SC	120	58	1000	C	0	30	0.33	0.50	3.00	0	30	0.33	0.50	3.00
	18-24	Very stiff to hard CL-ML	125	63	1000	C (18-20)	0	30	0.33	0.50	3.00	0	30	0.33	0.50	3.00
B-4	0-8	Hard CL	126	64	1000	B	2500	0	1.00	1.00	1.00	250	18	0.53	0.69	1.89
	8-10	Stiff to very stiff CL	126	64	600	B	1200	0	1.00	1.00	1.00	100	18	0.53	0.69	1.89
	10-18	Very stiff to hard CH	131	69	1000	C*	2400	0	1.00	1.00	1.00	250	16	0.57	0.72	1.76
	18-25	Soft to hard CL	120	58	200	C (18-20)	500	0	1.00	1.00	1.00	50	18	0.53	0.69	1.89
B-5	0-4	Very stiff to hard CL	120	58	1000	B	2500	0	1.00	1.00	1.00	250	18	0.53	0.69	1.89
	4-8	Stiff CL	130	68	600	B	1200	0	1.00	1.00	1.00	100	18	0.53	0.69	1.89
	8-10	Medium dense SC	120	58	600	C	0	28	0.36	0.53	2.77	0	28	0.36	0.53	2.77
	10-14	Stiff to very stiff CL-ML	139	77	600	C*	1800	0	1.00	1.00	1.00	175	18	0.53	0.69	1.89
	14-18	Medium dense SM	125	63	1000	C	0	32	0.31	0.47	3.25	0	32	0.31	0.47	3.25
	18-20	Medium dense SM	120	58	600	C	0	28	0.36	0.53	2.77	0	28	0.36	0.53	2.77
	20-23	Very stiff to hard CH	133	71	1000	N/A	3000	0	1.00	1.00	1.00	300	16	0.57	0.72	1.76
B-6	0-2	Fill: stiff CH	120	58	600	C	1500	0	1.00	1.00	1.00	150	16	0.57	0.72	1.76
	2-16	Very stiff CH	139	77	1000	B	2500	0	1.00	1.00	1.00	250	16	0.57	0.72	1.76
	16-19	Stiff to very stiff CL	137	75	600	C*	1800	0	1.00	1.00	1.00	150	18	0.53	0.69	1.89

(Continue on Next Page)

G159-13 WATERLINE REPLACEMENTS IN COMMERCE AREA, HOUSTON, TEXAS
SOIL PARAMETERS FOR UNDERGROUND UTILITIES

Boring	Depth (ft)	Soil Type	γ (pcf)	γ' (pcf)	E'n	OSHA Type	Short-Term					Long-Term				
							C (psf)	φ (deg)	K_a	K_0	K_p	C' (psf)	φ' (deg)	K_a	K_0	K_p
B-7	0-16	Stiff to very stiff CH/CL	132	70	600	B	2000	0	1.00	1.00	1.00	200	16	0.57	0.72	1.76
B-8	0-8	Stiff to hard CH	126	64	600	B	2000	0	1.00	1.00	1.00	200	16	0.57	0.72	1.76
	8-11	Firm to very stiff CL	132	70	300	B	1000	0	1.00	1.00	1.00	100	18	0.53	0.69	1.89
	11-19	Very stiff to hard CL/CH	128	66	1000	B	2600	0	1.00	1.00	1.00	250	18	0.53	0.69	1.89
B-9	0-4	Fill: very stiff CH	120	58	600	C	1800	0	1.00	1.00	1.00	175	16	0.57	0.72	1.76
	4-12	Stiff to very stiff CH	124	62	600	B	1600	0	1.00	1.00	1.00	150	16	0.57	0.72	1.76
	12-14	Firm CH	131	69	300	C*	800	0	1.00	1.00	1.00	75	16	0.57	0.72	1.76
	14-16	Medium dense SM	120	58	600	C	0	28	0.36	0.53	2.77	0	28	0.36	0.53	2.77
	16-19	Stiff to very stiff CL	120	58	600	C*	1800	0	1.00	1.00	1.00	175	18	0.53	0.69	1.89
B-10	0-10	Very stiff to hard CL	138	76	1000	B	2500	0	1.00	1.00	1.00	250	18	0.53	0.69	1.89
	10-18	Stiff to very stiff CL/CH	128	66	600	C*	1200	0	1.00	1.00	1.00	100	16	0.57	0.72	1.76
	18-20	Dense SM	125	63	2000	C	0	32	0.31	0.47	3.25	0	32	0.31	0.47	3.25
	20-25	Hard CL	139	77	1000	N/A	3000	0	1.00	1.00	1.00	300	18	0.53	0.69	1.89
B-11	0-8	Stiff to very stiff CL	131	69	600	B	1800	0	1.00	1.00	1.00	175	18	0.53	0.69	1.89
	8-12	Stiff to very stiff CL	133	71	600	C*	1500	0	1.00	1.00	1.00	150	18	0.53	0.69	1.89
	12-16	Medium SC	138	76	1000	C	0	30	0.33	0.50	3.00	0	30	0.33	0.50	3.00
B-12	0-2	Fill: CH	120	58	200	C	500	0	1.00	1.00	1.00	50	16	0.57	0.72	1.76
	2-10	Stiff to hard CL	133	71	600	B	1800	0	1.00	1.00	1.00	175	18	0.53	0.69	1.89
	10-22	Medium dense SM/SC-SM	120	58	600	C (12-20)	0	28	0.36	0.53	2.77	0	28	0.36	0.53	2.77
	22-25	Very stiff CH	137	75	1000	N/A	3000	0	1.00	1.00	1.00	300	16	0.57	0.72	1.76
B-13	0-2	Fill: sand, gravel, and clay	120	58	300	C	0	26	0.39	0.56	2.56	0	26	0.39	0.56	2.56
	2-18	Very stiff to hard CH/CL	130	68	600	B	2000	0	1.00	1.00	1.00	200	16	0.57	0.72	1.76
B-14	0-4	Fill: firm CL	120	58	300	C	800	0	1.00	1.00	1.00	75	18	0.53	0.69	1.89
	4-6	Fill: stiff to very stiff CL	118	56	600	C	1600	0	1.00	1.00	1.00	150	18	0.53	0.69	1.89
	6-15	Stiff to hard CH	128	66	600	B	2000	0	1.00	1.00	1.00	200	16	0.57	0.72	1.76
B-15	0-2	Fill: very stiff CH	120	58	600	C	2000	0	1.00	1.00	1.00	200	16	0.57	0.72	1.76
	2-8	Very stiff CH	133	71	1000	B	2700	0	1.00	1.00	1.00	250	16	0.57	0.72	1.76
	8-17	Stiff to hard CL	138	76	600	B	1700	0	1.00	1.00	1.00	150	18	0.53	0.69	1.89

(Continue on Next Page)

G159-13 WATERLINE REPLACEMENTS IN COMMERCE AREA, HOUSTON, TEXAS
SOIL PARAMETERS FOR UNDERGROUND UTILITIES

Boring	Depth (ft)	Soil Type	γ (pcf)	γ' (pcf)	E'n	OSHA Type	Short-Term					Long-Term				
							C (psf)	φ (deg)	K_a	K_0	K_p	C' (psf)	φ' (deg)	K_a	K_0	K_p
B-16	0-2	Fill: stiff to very stiff CH	120	58	600	C	2000	0	1.00	1.00	1.00	200	16	0.57	0.72	1.76
	2-8	Very stiff CH	132	70	1000	B	2200	0	1.00	1.00	1.00	200	16	0.57	0.72	1.76
	8-16	Very stiff to hard CH	136	74	1000	B	3000	0	1.00	1.00	1.00	300	16	0.57	0.72	1.76
B-17	0-17	Very stiff to hard CH/CL	132	70	1000	B	2400	0	1.00	1.00	1.00	225	16	0.57	0.72	1.76
B-18	0-4	Fill: stiff to very stiff CH	120	58	600	C	2000	0	1.00	1.00	1.00	200	16	0.57	0.72	1.76
	4-13	Very stiff to hard CH/CL	126	64	1000	B	2200	0	1.00	1.00	1.00	200	16	0.57	0.72	1.76
B-19	0-16	Very stiff to hard CH	131	69	1000	B	3000	0	1.00	1.00	1.00	300	16	0.57	0.72	1.76
B-20	0-13	Hard CH	135	73	1000	B	3000	0	1.00	1.00	1.00	300	16	0.57	0.72	1.76
B-21	0-8	Firm to very stiff CH	120	58	300	B	900	0	1.00	1.00	1.00	75	16	0.57	0.72	1.76
	8-17	Very stiff to hard CL	133	71	1000	B	2800	0	1.00	1.00	1.00	275	18	0.53	0.69	1.89
B-22	0-12	Stiff to hard CH	128	66	600	B	1800	0	1.00	1.00	1.00	175	16	0.57	0.72	1.76
	12-16	Very stiff to hard CL	133	71	1000	B	3000	0	1.00	1.00	1.00	300	18	0.53	0.69	1.89
B-23	0-12	Very stiff to hard CH	132	70	1000	B	2600	0	1.00	1.00	1.00	250	16	0.57	0.72	1.76
	12-18	Very stiff to hard CL	138	76	1000	B	3000	0	1.00	1.00	1.00	300	18	0.53	0.69	1.89
B-24	0-6	Stiff to very stiff CH	127	65	1000	B	2500	0	1.00	1.00	1.00	250	16	0.57	0.72	1.76
	6-15	Firm to very stiff CH/CL	123	61	300	B	1000	0	1.00	1.00	1.00	100	16	0.57	0.72	1.76
B-25	0-4	Fill: very stiff CH	120	58	1000	C	2000	0	1.00	1.00	1.00	200	16	0.57	0.72	1.76
	4-8	Stiff to very stiff CH	124	62	600	B	1400	0	1.00	1.00	1.00	125	16	0.57	0.72	1.76
	8-18	Very stiff CH/CL	133	71	1000	B	3000	0	1.00	1.00	1.00	300	16	0.57	0.72	1.76
B-26	0-2	Fill: very stiff CH	120	58	1000	C	2000	0	1.00	1.00	1.00	200	16	0.57	0.72	1.76
	2-17	Very stiff to hard CH/CL	134	72	1000	B	3000	0	1.00	1.00	1.00	300	16	0.57	0.72	1.76
B-27	0-6	Very stiff CH	132	70	1000	B	3000	0	1.00	1.00	1.00	300	16	0.57	0.72	1.76
	6-12	Stiff to very stiff CH	130	68	600	B	1800	0	1.00	1.00	1.00	175	16	0.57	0.72	1.76
	12-18	Very stiff to hard CL	137	75	1000	B	2000	0	1.00	1.00	1.00	200	18	0.53	0.69	1.89
B-28	0-2	Fill: very stiff CH	120	58	1000	C	2000	0	1.00	1.00	1.00	200	16	0.57	0.72	1.76
	2-10	Stiff to very stiff CH	124	62	600	B	1400	0	1.00	1.00	1.00	125	16	0.57	0.72	1.76
	10-15	Very stiff CH	137	75	1000	B	2600	0	1.00	1.00	1.00	250	16	0.57	0.72	1.76
B-29	0-6	Fill: stiff to very stiff CH	120	58	600	C	1500	0	1.00	1.00	1.00	150	16	0.57	0.72	1.76
	6-15	Stiff to very stiff CH	125	63	600	B	1800	0	1.00	1.00	1.00	175	16	0.57	0.72	1.76
B-30	0-6	Fill: firm to very stiff CH	121	59	300	C	700	0	1.00	1.00	1.00	50	16	0.57	0.72	1.76
	6-14	Firm to very stiff CH	122	60	300	B	800	0	1.00	1.00	1.00	75	16	0.57	0.72	1.76

(Continue on Next Page)

G159-13 WATERLINE REPLACEMENTS IN COMMERCE AREA, HOUSTON, TEXAS
SOIL PARAMETERS FOR UNDERGROUND UTILITIES

Boring	Depth (ft)	Soil Type	γ (pcf)	γ' (pcf)	E'n	OSHA Type	Short-Term					Long-Term				
							C (psf)	φ (deg)	K_a	K_0	K_p	C' (psf)	φ' (deg)	K_a	K_0	K_p
B-31	0-8	Fill: firm to very stiff CH	118	56	300	C	800	0	1.00	1.00	1.00	75	16	0.57	0.72	1.76
B-32	0-8	Fill: firm to stiff CH	119	57	300	C	1000	0	1.00	1.00	1.00	100	16	0.57	0.72	1.76
B-33	0-5	Fill: stiff to very stiff CH	113	51	600	C	1800	0	1.00	1.00	1.00	175	16	0.57	0.72	1.76
	5-8	Fill: soft CH	113	51	200	C	300	0	1.00	1.00	1.00	25	16	0.57	0.72	1.76
	8-15	Stiff to very stiff CH	128	66	600	B	2000	0	1.00	1.00	1.00	200	16	0.57	0.72	1.76
B-34	0-8	Fill: firm to stiff CH	120	58	300	C	1000	0	1.00	1.00	1.00	100	16	0.57	0.72	1.76
	8-14	Stiff to very stiff CH	138	76	600	B	1300	0	1.00	1.00	1.00	125	16	0.57	0.72	1.76
B-35	0-6	Fill: firm to stiff CH	138	76	300	C	700	0	1.00	1.00	1.00	50	16	0.57	0.72	1.76
	6-13	Firm to very stiff CH	131	69	300	B	900	0	1.00	1.00	1.00	75	16	0.57	0.72	1.76
B-36	0-8	Fill: firm to stiff CL	130	68	300	C	1000	0	1.00	1.00	1.00	100	18	0.53	0.69	1.89
	8-13	Firm to very stiff CL	135	73	300	B	700	0	1.00	1.00	1.00	50	18	0.53	0.69	1.89
B-37	0-8	Fill: firm to very stiff CH	122	60	300	C	1000	0	1.00	1.00	1.00	100	16	0.57	0.72	1.76
	8-14	Stiff to very stiff CH	120	58	600	B	1800	0	1.00	1.00	1.00	175	18	0.53	0.69	1.89

(1) γ = Unit weight for soil above water level, γ′ = Buoyant unit weight for soil below water level. E'n = Soil modulus for native soils;

(2) C = Soil ultimate cohesion for short term (upper limit of 3,000 psf for design purposes), φ = Soil friction angle for short term;

(3) C' = Soil ultimate cohesion for long term (upper limit of 300 psf for design purposes), φ' = Soil friction angle for long term;

(4) K_a = Coefficient of active earth pressure, K_0 = Coefficient of at-rest earth pressure, K_p = Coefficient of passive earth pressure;

(5) CL = Lean Clay, CH = Fat Clay, CL-ML = Silty Clay, SC = Clayey Sand, SM = Silty Sand, SC-SM = Silty Clayey Sand;

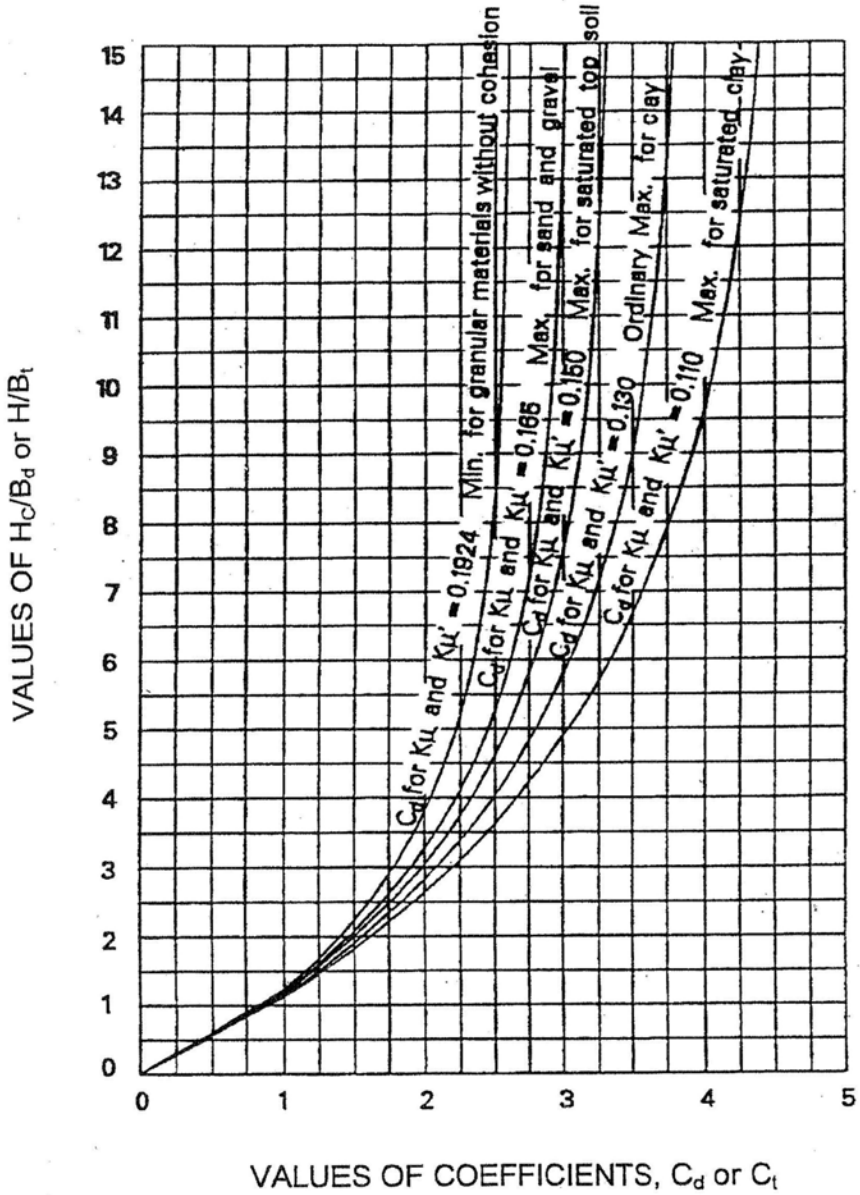
(6) OSHA Soil Types for soils in the top 20 feet below grade:

A: cohesive soils with qu = 1.5 tsf or greater (qu = Unconfined Compressive Strength of the Soil)

B: cohesive soils with qu = 0.5 tsf or greater

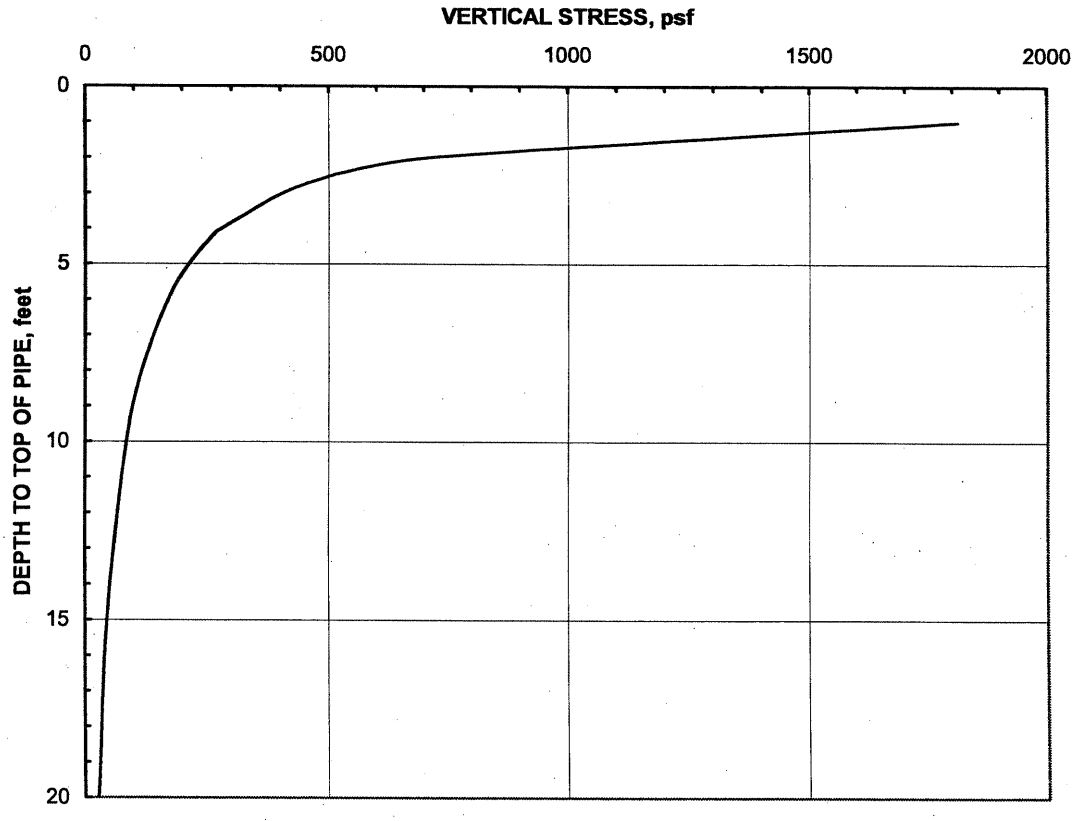
C: cohesive soils with qu = less than 0.5 tsf, fill materials, or granular soil

C*: submerged cohesive soils; dewatered cohesive soils can be considered OSHA Type C.



Reference: US Army Corps of Engineers Engineering Manual, EM 1110-2-2909, Oct. 31, 1997, Figure 2-5.

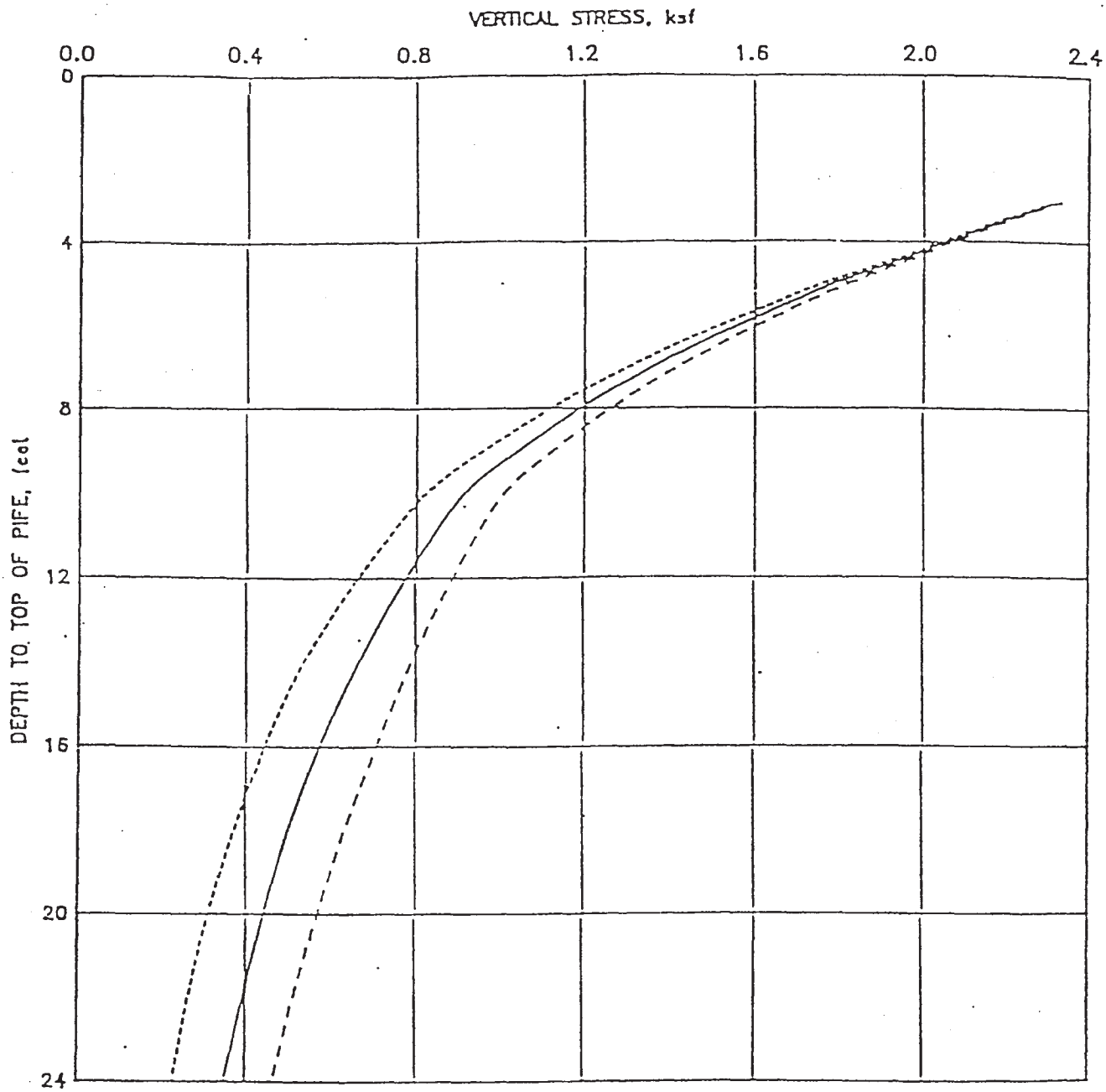
AVILES ENGINEERING CORP.



LIVE LOADS ON PIPE CROSSING UNDER ROADWAY

Note: 1. The vertical stress was estimated using AASHTO HS20 truck axle loadings on paved surfaces (Reference: ASCE 15-98, "Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standandard Installations").
2. Single truck passing.

AVILES ENGINEERING CORP.



Legend:

——— Single passing track
——— Two passing tracks
– – – Three passing tracks

Notes:
1. The vertical stress was estimated using a Cooper E–80 loading.
2. Impact factor was included in the vertical stress.

LIVE LOADS ON PIPE
CROSSING UNDER RAILROAD TRACKS

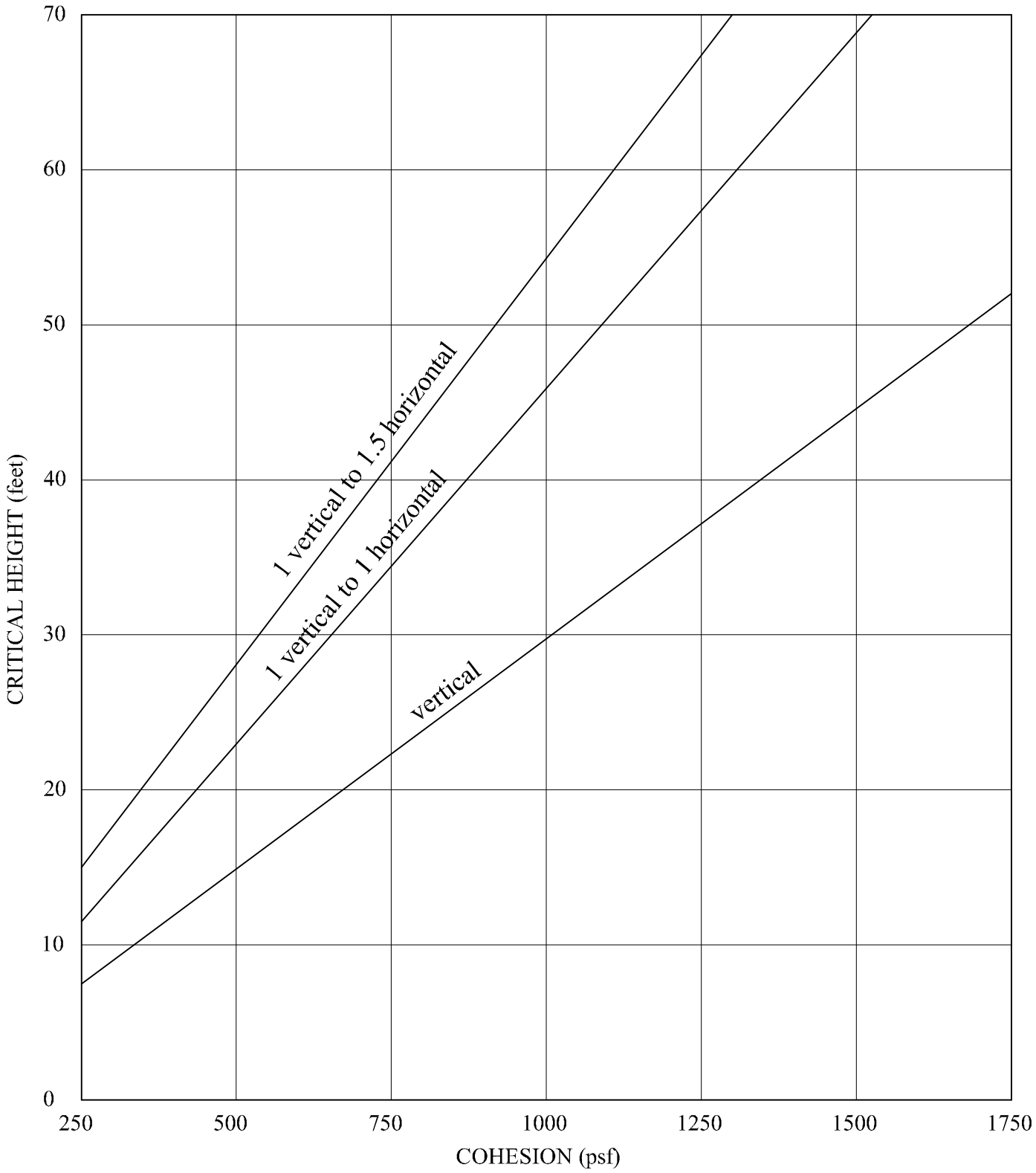
PLATE C-4

APPENDIX D

Plate D-1	Critical Heights of Cuts in Nonfissured Clays
Plate D-2	Maximum Allowable Slopes
Plate D-3	A Combination of Bracing and Open Cut
Plate D-4	Lateral Pressure Diagrams - For Open Cuts in Cohesive Soils - Long Term Conditions
Plate D-5	Lateral Pressure Diagrams - For Open Cuts in Cohesive Soils - Short Term Conditions
Plate D-6	Lateral Pressure Diagrams - For Open Cuts in Sand
Plate D-7	Bottom Stability for Braced Excavation
Plate D-8	Thrust Force Calculation
Plate D-9	Thrust Force Example Calculation
Plate D-10	Design Parameters for Bearing Thrust Block
Plate D-11	Relation between the Width of Surface Depression and Depth of Cavity for Tunnels

AVILES ENGINEERING CORP.

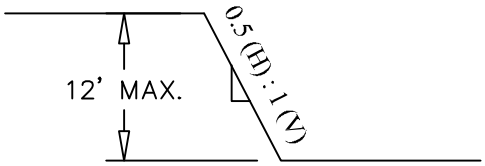
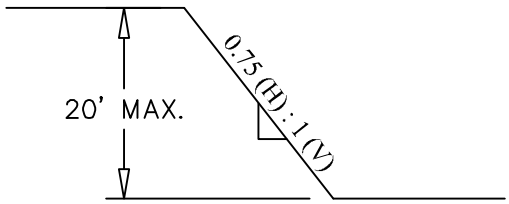
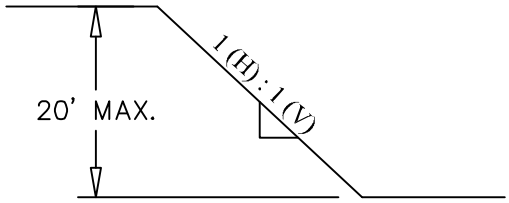
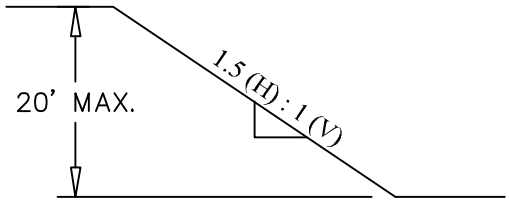
Critical Heights of Cut Slopes in Nonfissured Clays



Note: The charts are calculated based on NAVFAC DM7.1, Page 7.1-319, assuming the critical circles are toe circles, and wet unit weight of soils = 125pcf.

AYLES ENGINEERING CORP.

MAXIMUM ALLOWABLE SLOPES

	SHORT TERM	LONG TERM
TYPE A SOILS		
TYPE B SOILS	N/A	
TYPE C SOILS	N/A	

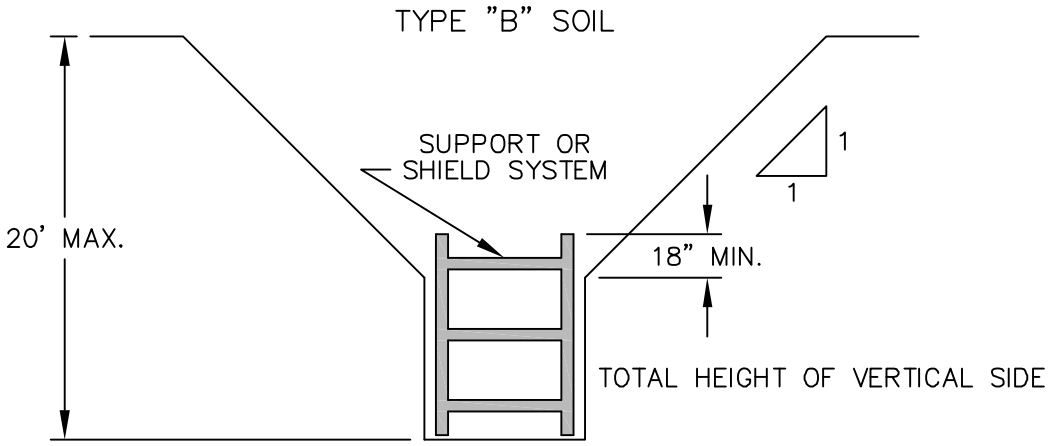
NOTES:

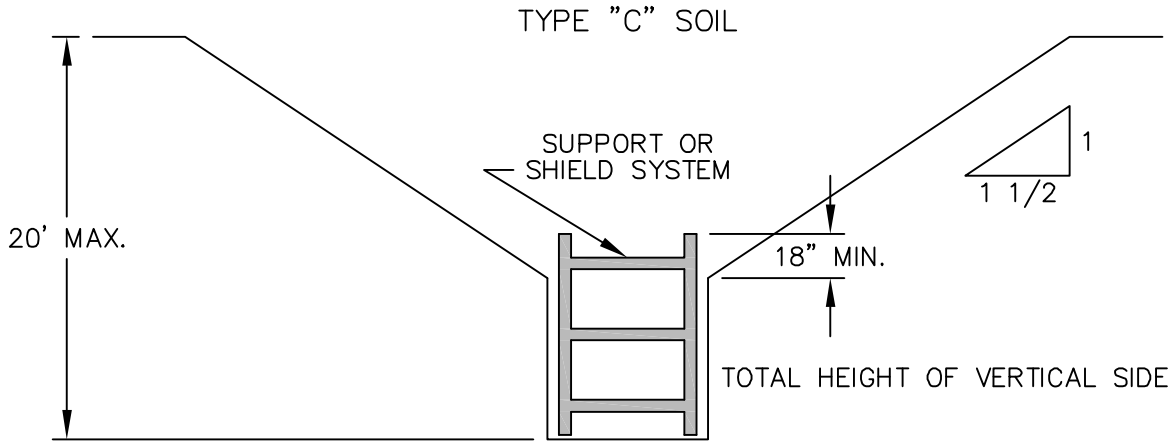
(1) For Type A soils, a short term maximum allowable slope of 0.5 (H) : 1 (V) is allowed in excavations that are 12 feet or less in depth; short term (24 hours or less) maximum allowable slopes for excavations greater than 12 feet in depth shall be 0.75 (H) : 1 (V).

(2) Maximum depth for above slopes is 20 feet. For slopes deeper than 20 feet, trench protection should be designed by the Contractor's professional engineer.

Reference: OSHA, Safety and Health Regulations for Construction, 1926 Subpart P.

A COMBINATION OF BRACING AND OPEN CUTS

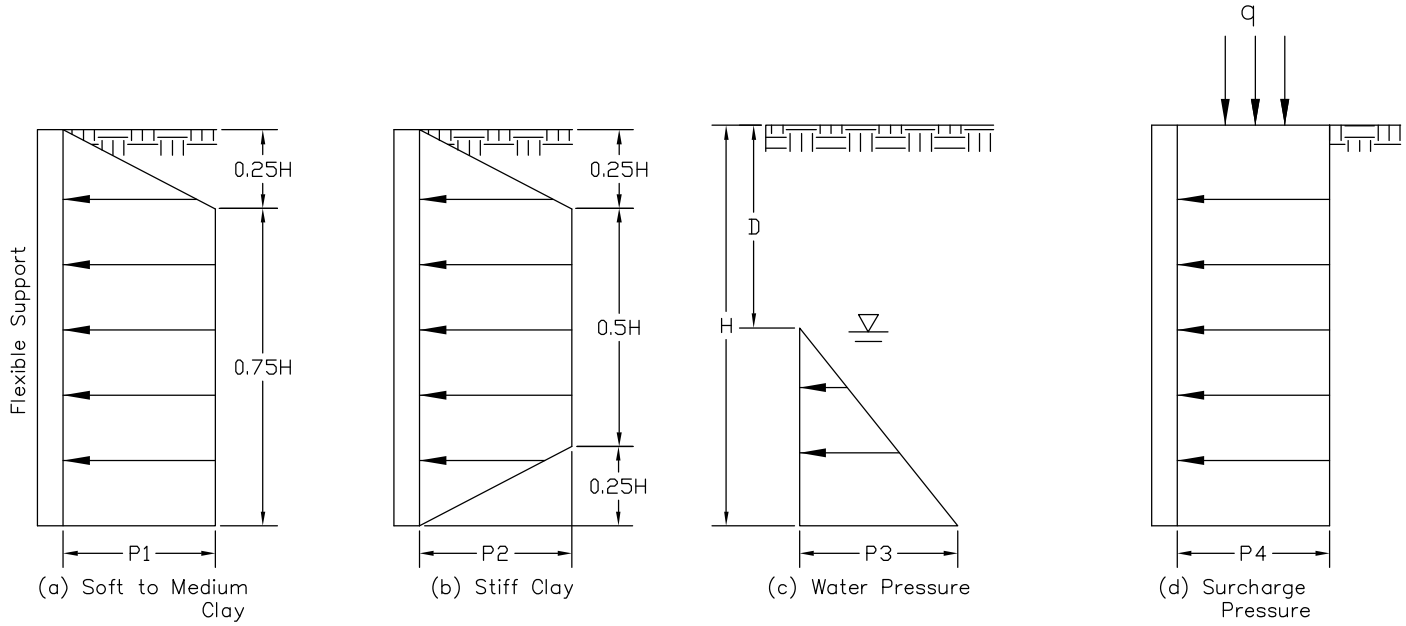




Reference: OSHA, Safety and Health Regulations for Construction, 1926 Subpart P.

AVILES ENGINEERING CORP.

LATERAL PRESSURE DIAGRAMS
FOR OPEN CUTS IN COHESIVE SOIL - LONG TERM CONDITIONS



Empirical Pressure Distributions

Where:
H = Total excavation depth, feet
D = Depth to water table, feet
P1 = Lateral earth pressure = γH-4C, psf
P2 = Lateral earth pressure = 0.4γH, psf
P3 = Water pressure = γ_w (H-D), psf
P4 = Lateral earth pressure caused by surcharge = qK_a, psf
γ = Effective unit weight of soil, pcf
γ_w = Unit weight of water, pcf
C = Drained shear strength or cohesion, psf
K_a = Coefficient of active earth pressure

Notes:
1. All pressures are additive.
2. No safety factors are included.
3. For use only during long term construction.
4. If γH/C < 4, use section (b),
   If 4 < γH/C < 6, use larger of section (a) or (b),
   If γH/C > 6, use section (a).

Reference: Peck, R.B. (1969), "Deep Excavation and Tunneling in soft Ground", 7th ICSMFE, State of art volume, pp. 225-290.

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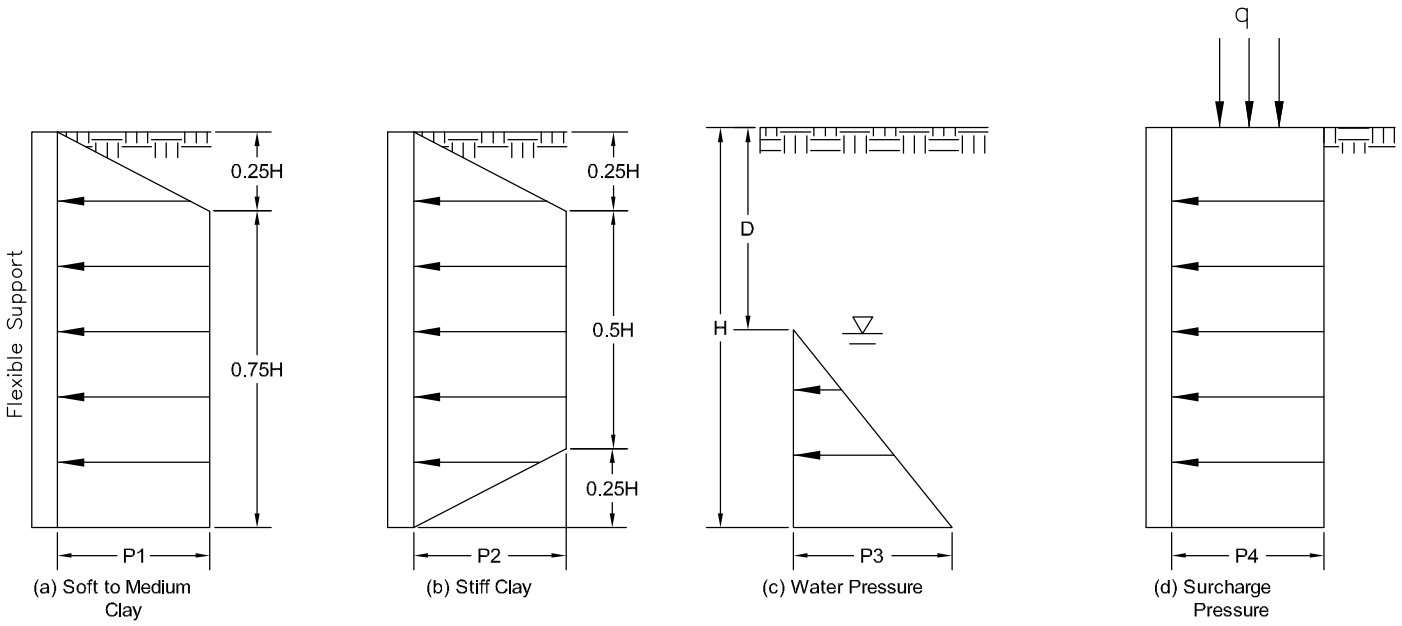
LATERAL PRESSURE DIAGRAMS
FOR OPEN CUTS IN COHESIVE SOIL - SHORT TERM CONDITIONS



Empirical Pressure Distributions

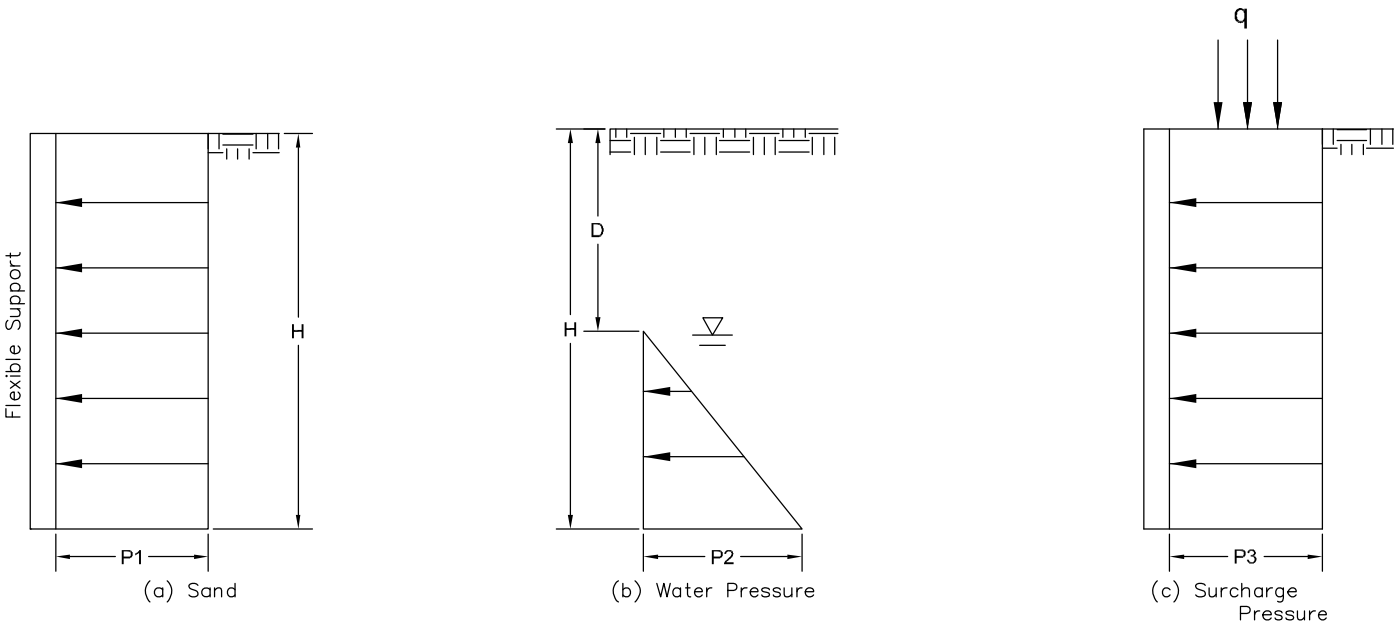
Where:
H = Total excavation depth, feet
D = Depth to water table, feet
P1 = Lateral earth pressure = $\gamma H - 4S_u$, psf
P2 = Lateral earth pressure = $0.2\gamma H$, psf
P3 = Water pressure = γ_w (H-D), psf
P4 = Lateral earth pressure caused by surcharge = qK_a, psf
γ = Effective unit weight of soil, pcf
γ_w = Unit weight of water, pcf
S_u = Undrained shear strength = $q_u/2$, psf
q_u = Unconfined compressive strength, psf
K_a = Coefficient of active earth pressure

Notes:
1. All pressures are additive.
2. No safety factors are included.
3. For use only during short term construction.
4. If $\gamma H/S_u < 4$, use section (b),
   If $4 < \gamma H/S_u < 6$, use larger of section (a) or (b),
   If $\gamma H/S_u > 6$, use section (a).

Reference: Peck, R.B. (1969), "Deep Excavation and Tunneling in soft Ground", 7th ICSMFE, State of art volume, pp. 225-290.

AYLES ENGINEERING CORP.

LATERAL PRESSURE DIAGRAMS
FOR OPEN CUTS IN SAND



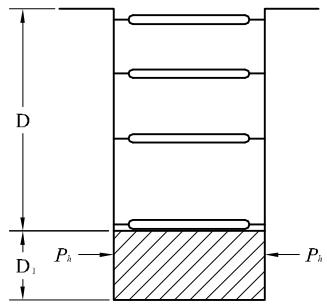
Empirical Pressure Distributions

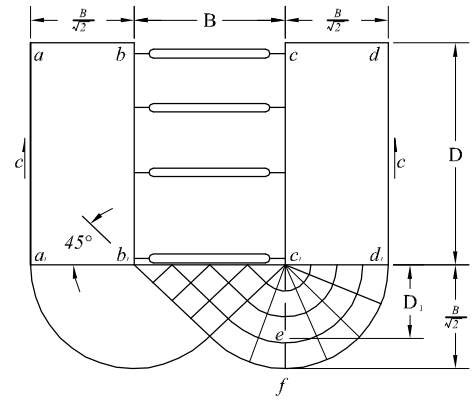
Where:
H = Total excavation depth, feet
D = Depth to water table, feet
P1 = Lateral earth pressure = $0.65*\gamma HK_a$, psf
P2 = Water pressure = γ_w (H-D), psf
P3 = Lateral earth pressure caused by surcharge = qK_a, psf
γ = Effective unit weight of soil, pcf
γ_w = Unit weight of water, pcf
K_a = Coefficient of active earth pressure = $(1-\sin\varphi)/(1+\sin\varphi)$
φ = Drained friction angle

Notes:
1. All pressures are additive.
2. No safety factors are included.

Reference: Peck, R.B. (1969), "Deep Excavation and Tunneling in soft Ground", 7th ICSMFE, State of art volume, pp. 225-290.

BOTTOM STABILITY FOR BRACED EXCAVATION IN CLAY





Factor of Safety against bottom of heave,

$$F.S = \frac{NcC}{(\gamma D + q)}$$

where, Nc = Coefficient depending on the dimension of the excavation (see Figure at the bottom)
C = Undrained shear strength of soil in zone immediately around the bottom of the excavation,
γ = Unit weight of soil,
D = Depth of excavation,
q = Surface surcharge.

If F.S < 1.5, sheeting should be extended further down to achieve stability

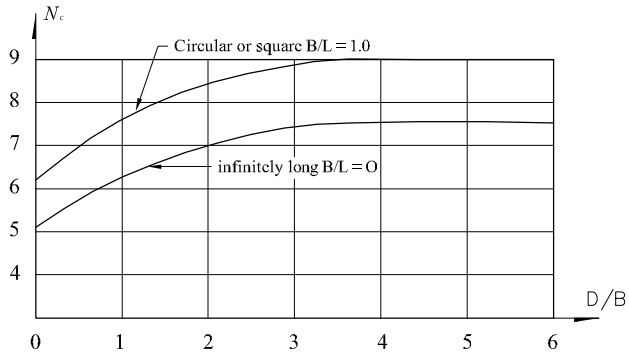
$$\textit{Depth of Buried Length, } (D_1) = \frac{1.5(\gamma D + q) - NcC}{(C/B) - 0.5\gamma} \; ; D_1 \geq 5\ ft.$$

Pressure on buried length, P_h:

For $D_1 < 0.47B$; $P_h = 1.5\ D_1(\gamma D - 1.4\ CD/B - 3.14C)$

For $D_1 > 0.47B$; $P_h = 0.7\ (\gamma DB - 1.4\ CD - 3.14CB)$

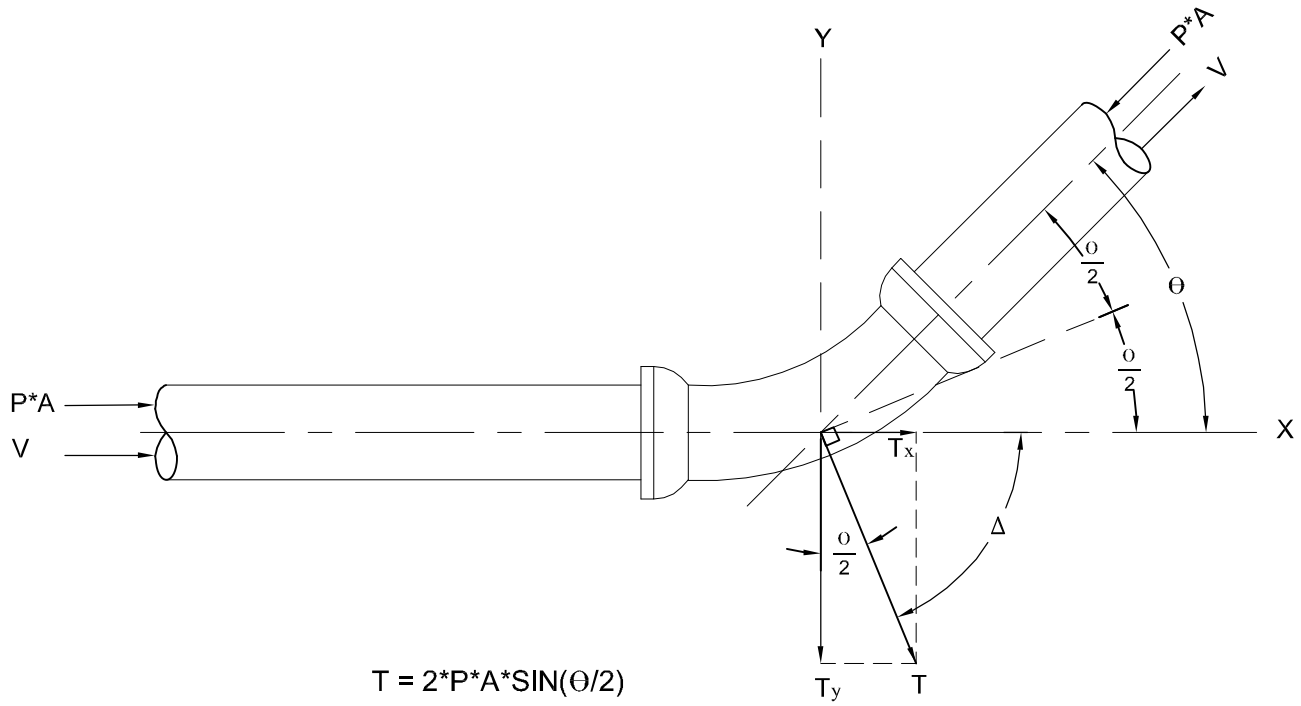
where; B = width of excavation



N_c rectangular = $(0.84 + 0.16B/L)N_c$ square

Reference: Bjerrum, L. and Eide, O., Stability of Strutted Excavations in Clay, Geotechnique, 6, 32-47 (1956).

THRUST FORCE CALCULATION



$T = 2*P*A*SIN(\Theta/2)$

$T_x = P*A*(1-COS\Theta)$

$T_y = P*A*SIN\Theta$

$\Delta = (90-\Theta/2)$

Where:

T = resultant thrust force

T_x= thrust force component along the X axis

T_y= thrust force component along the Y axis

P = maximum sustained pressure

A = cross-sectional area of pipe = $(\pi/4)*(D)^2$

D = inside diameter conduit

Θ = angle of bend

Δ = angle between X axis and T

V = fluid velocity

Reference: American Water Works Association, Manual MA, "Concrete Pressure Pipe".

THRUST FORCE EXAMPLE CALCULATION

Trust Force Example Calculation

$T = 2*P*A*SIN(\Theta/2)$

$T_x = P*A*SIN(1-COS\Theta)$

$T_y = P*A*SIN\ \Theta$

Where:

T = resultant thrust force

T_x = thrust force component along the X axis

T_y = thrust force component along the Y axis

P = maximum sustained pressure

A = cross-section area of pipe = $(\pi/4)*(D)^2$

D = inside diameter of conduit

U = angle of bend

Given: D = 24", P = 200 psi, $\Theta = 60°$

Find: T, T_x and T_y

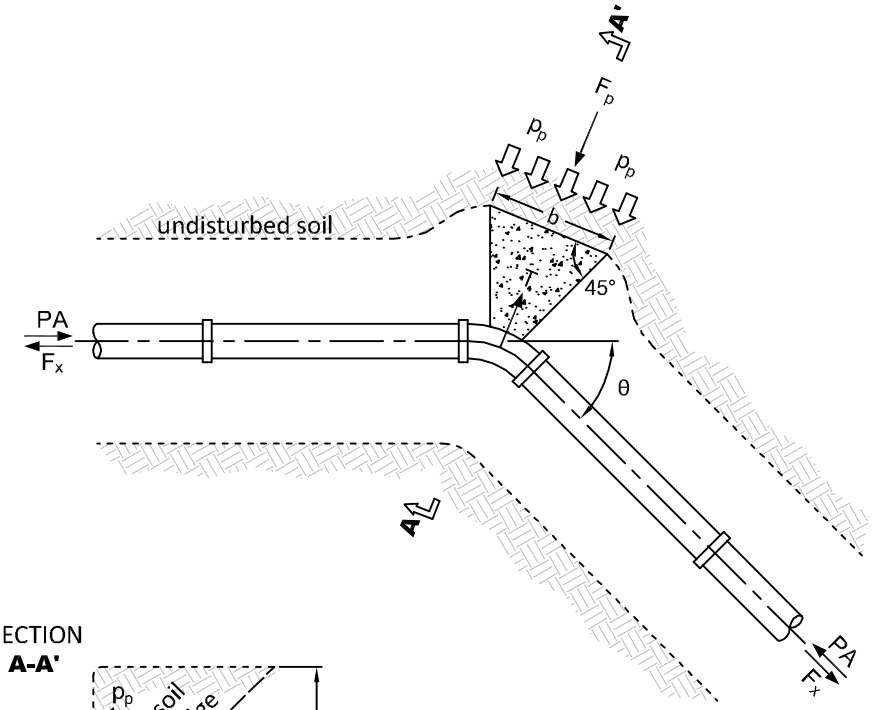
$A = (\pi/4)*(24)^2 = 452.39\ in^2$

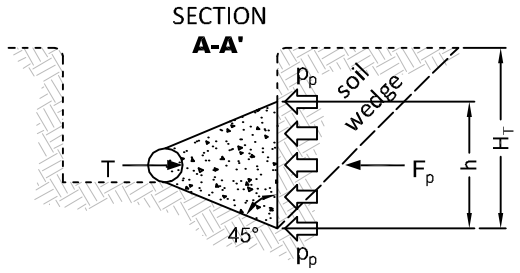
T = 2*200*452.39*SIN(60/2) = 90,478 lb

T_x = 200*452.39*(1-COS60) = 45,239 lb

T_y = 200*452.39*SIN60 = 78,356 lb

DESIGN PARAMETERS FOR BEARING THRUST BLOCK





Required Bearing Area:

$$A_b = hb = \frac{F_s\ 2PA\ \text{Sin}\ \frac{\theta}{2}}{p_p}$$

Required Block Width:

$$b = \frac{2F_s\ PA\ \text{Sin}\ \frac{\theta}{2}}{h\ p_p}$$

Where:

$p_p = \Upsilon H_c K_p + 2C\sqrt{K_p}$

$K_p = \text{Tan}^2\ (45° + \frac{\emptyset}{2})$

Where:

T = resultant thrust force on the bend

F_p = resistance force developed by passive soil pressure

A_b = minimum bearing area of block base

h = height of thrust block

b = width of thrust block

A = pipe cross-sectional area

θ = bend deflection angle

p_p = passive soil pressure

H_T = depth to bottom of block

Υ = soil unit weight

K_p = coefficient of passive earth pressure

$\emptyset$ = soil internal friction angle

C = soil cohesion

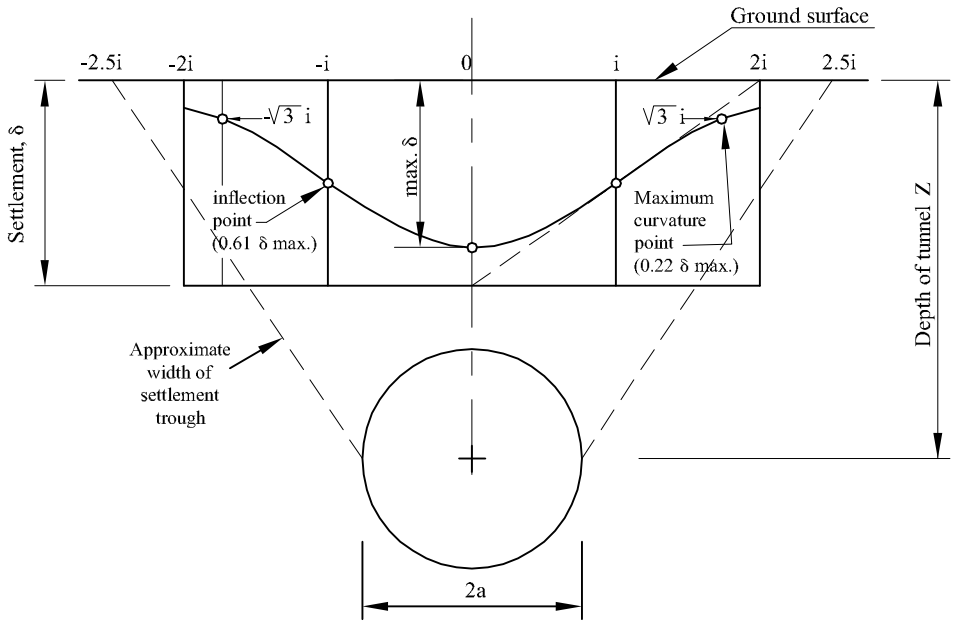
F_s = factor of safety (usually 1.5)

H_c = mean depth from ground surface to the plane of resistance (center of bearing area of a thrust block)

p = maximum sustained pressure

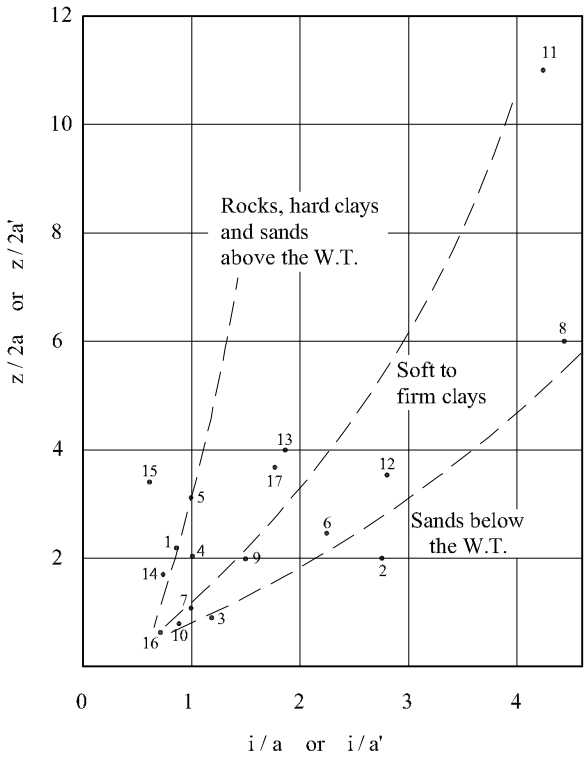
F_x = conduit frictional resistance per unit length

Relation between the Width of the Surface Depression (i/a) and the Depth of the Cavity (z/a) for Tunnels



Volume of depression = 2.5i δ max.

(a)



(b)

Reference: Peck, R. B. (1969) "Deep Excavations and Tunneling in Soft Ground," Proceedings, Seventh International Conference on Soil Mechanics and Foundation Engineering, Mexico City, State of the Art Volume, pp. 225-290.

APPENDIX E

Piezometer Installation and Plugging Reports

STATE OF TEXAS WELL REPORT for Tracking #348070

Owner:	**City of Houston Geotechnical Dept**	Owner Well #:	**PZ-1**
Address:	**611 Walker Floor 14** **Houston , TX 77002**	Grid #:	**65-14-7**
Well Location:	**St Charles** **Houston , TX 77003**	Latitude:	**29° 45' 20" N**
Well County:	**Harris**	Longitude:	**095° 20' 46" W**
Elevation:	**No Data**	GPS Brand Used:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Date:	Started: **10/3/2013** Completed: **10/3/2013**
Diameter of Hole:	Diameter: **4 in From Surface To 20 ft**
Drilling Method:	**Mud Rotary**
Borehole Completion:	Other: **20/40 sand and bentonite**
Annular Seal Data:	1st Interval: **From 0 ft to 6 ft with .5 cement (#sacks and material)** 2nd Interval: **From 6 ft to 8 ft with .5 bentonite (#sacks and material)** 3rd Interval: **No Data** Method Used: **tremmie** Cemented By: **tremmie** Distance to Septic Field or other Concentrated Contamination: **na ft** Distance to Property Line: **na ft** Method of Verification: **na** Approved by Variance: **na**
Surface Completion:	**Surface Sleeve Installed**

Water Level:	Static level: **18' ft. below land surface on 10/3/2013** Artesian flow: **No Data**
Packers:	**20/40 sand 8'-20'**
Plugging Info:	Casing left in well: Cement/Bentonite left in well: From (ft) To (ft) From (ft) To (ft) Cem/Bent Sacks Used **na**
Type Of Pump:	**No Data**
Well Tests:	**No Data**

Water Quality:	Type of Water: **No Data** Depth of Strata: **No Data** Chemical Analysis Made: **No** Did the driller knowingly penetrate any strata which contained undesirable constituents: **No**
Certification Data:	The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the

statements herein are true and correct. The driller understood that failure to complete the required items will result in the log(s) being returned for completion and resubmittal.

Company Information:	**Van and Sons Drilling Service** **319 John Alber** **Houston , TX 77076**
Driller License Number:	**3286**
Licensed Well Driller Signature:	**Mark Thornton**
Registered Driller Apprentice Signature:	**No Data**
Apprentice Registration Number:	**No Data**
Comments:	**No Data**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking number (Tracking #**348070**) on your written request.

Texas Department of Licensing & Regulation
P.O. Box 12157
Austin, TX 78711
(512) 463-7880

DESC. & COLOR OF FORMATION MATERIAL

From (ft)	To (ft)	Description
no data		

CASING, BLANK PIPE & WELL SCREEN DATA

Dia.	New/Used	Type	Setting From/To
2 n		**Sch 40 PVC Riser**	**0'-10'**
2 n		**Sch 40 PVC Screen**	**10'-20'**

STATE OF TEXAS PLUGGING REPORT for Tracking #91286

Owner:	**City of Houston Geotech Dept**	Owner Well #:	**pz-1**
Address:	**611 Walker, Floor 14** **Houston , TX 77002**	Grid #:	**65-14-7**
Well Location:	**St Charles** **Houston , TX 77003**	Latitude:	**29° 45' 20" N**
Well County:	**Harris**	Longitude:	**095° 20' 46" W**
		GPS Brand Used:	**No Data**

Well Type: **Monitor**

HISTORICAL DATA ON WELL TO BE PLUGGED

Original Well Driller:	**Mark Thornton**
Driller's License Number of Original Well Driller:	**3286M**
Date Well Drilled:	**10/3/2013**
Well Report Tracking Number:	**348070**
Diameter of Borehole:	**4 inches**
Total Depth of Borehole:	**20 feet**

Date Well Plugged:	**11/18/2013**
Person Actually Performing Plugging Operation:	**Mark Thornton**
License Number of Plugging Operator:	**3286**
Plugging Method:	**Tremmie pipe cement from bottom to top.**
Plugging Variance #:	**No Data**
Casing Left Data:	1st Interval: **2 inches diameter, From 0 ft to 20 ft** 2nd Interval: **No Data** 3rd Interval: **No Data**
Cement/Bentonite Plugs Placed in	1st Interval: **From 0 ft to 20 ft; Sack(s)/type of cement used: 1.5 cement** 2nd Interval: **No Data**

Well:	3rd Interval: **No Data** 4th Interval: **No Data** 5th Interval: **No Data**

Certification Data:	The plug installer certified that the plug installer plugged this well (or the well was plugged under the plug installer's direct supervision) and that each and all of the statements herein are true and correct. The plug installer understood that failure to complete the required items will result in the log(s) being returned for completion and resubmittal.
Company Information:	**Van and Sons Drilling Service** **319 John Alber** **Houston , TX 77076**
Plug Installer License Number:	**3286**
Licensed Plug Installer Signature:	**Mark Thornton**
Registered Plug Installer Apprentice Signature:	**Elliot Van Antwerp**
Apprentice Registration Number:	**No Data**
Plugging Method Comments:	**No Data**

Please include the plugging report's tracking number (Tracking #**91286**) on your written request.

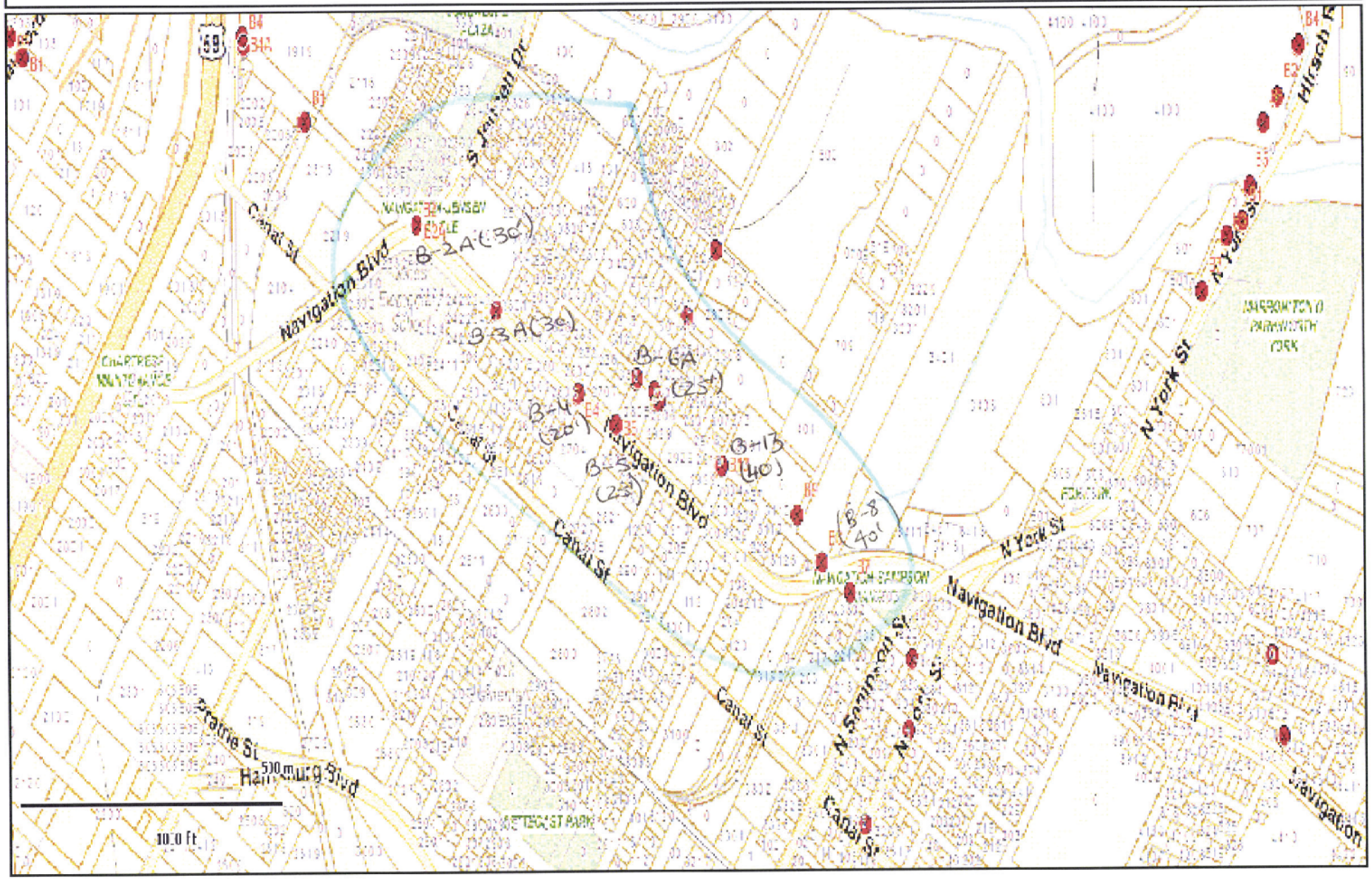
Texas Department of Licensing & Regulation
P.O. Box 12157
Austin, TX 78711
(512) 463-7880

APPENDIX F

Previous Geotechnical Borings Performed by Geotest Engineering, Inc., and HVJ Associates, Inc.

City of Houston

Geo-Environmental Information System

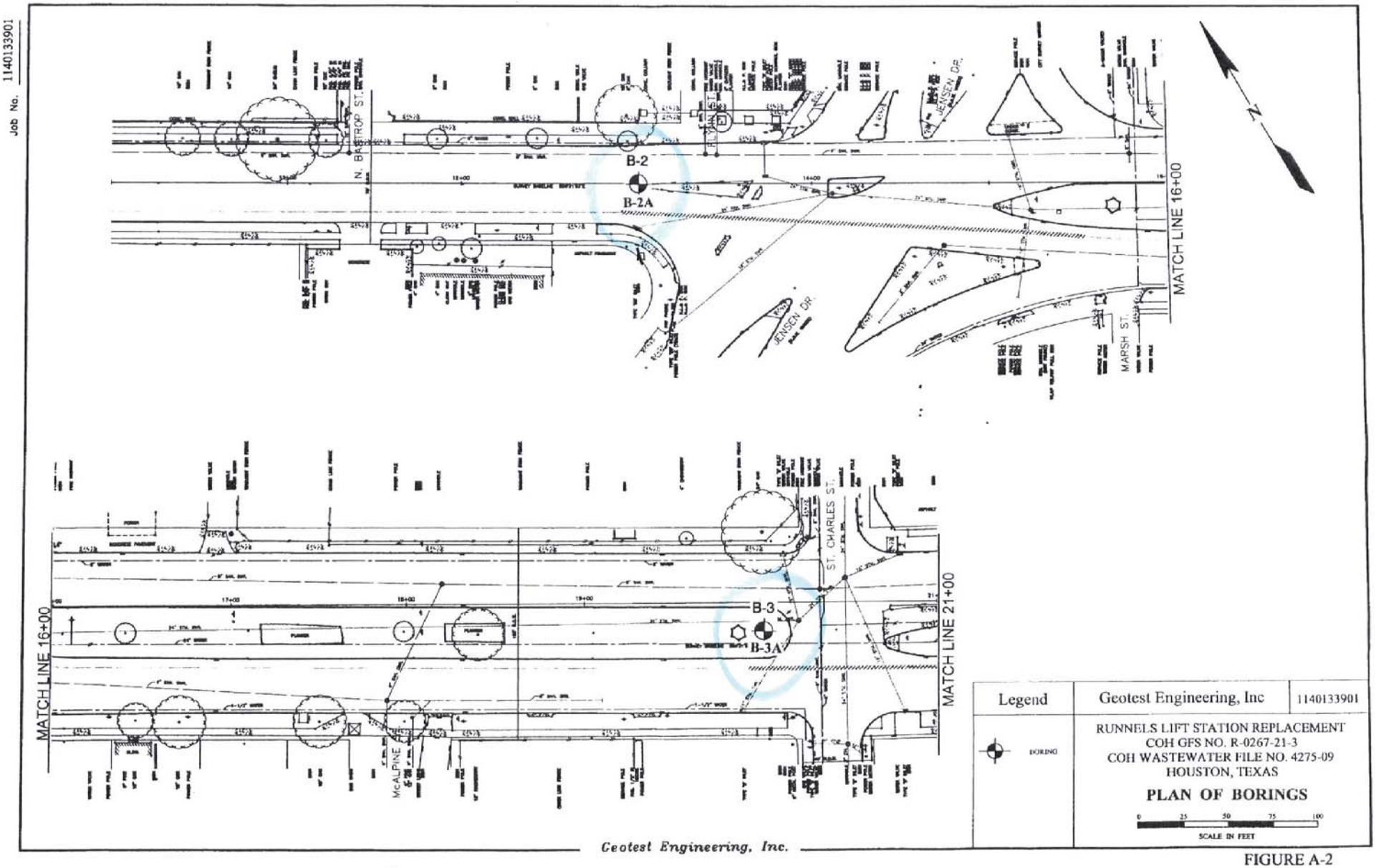


COHGIS data is prepared and made available for general reference purposes only and should not be used, or relied upon for specific applications, without independent verification. The City of Houston neither represents, nor warrants COHGIS data accuracy, or completeness, nor will the City of Houston accept liability of any kind in conjunction with its use.

S-000035-0153-4

Printed on Wed Jul 31 2013 12:15:10 PM.

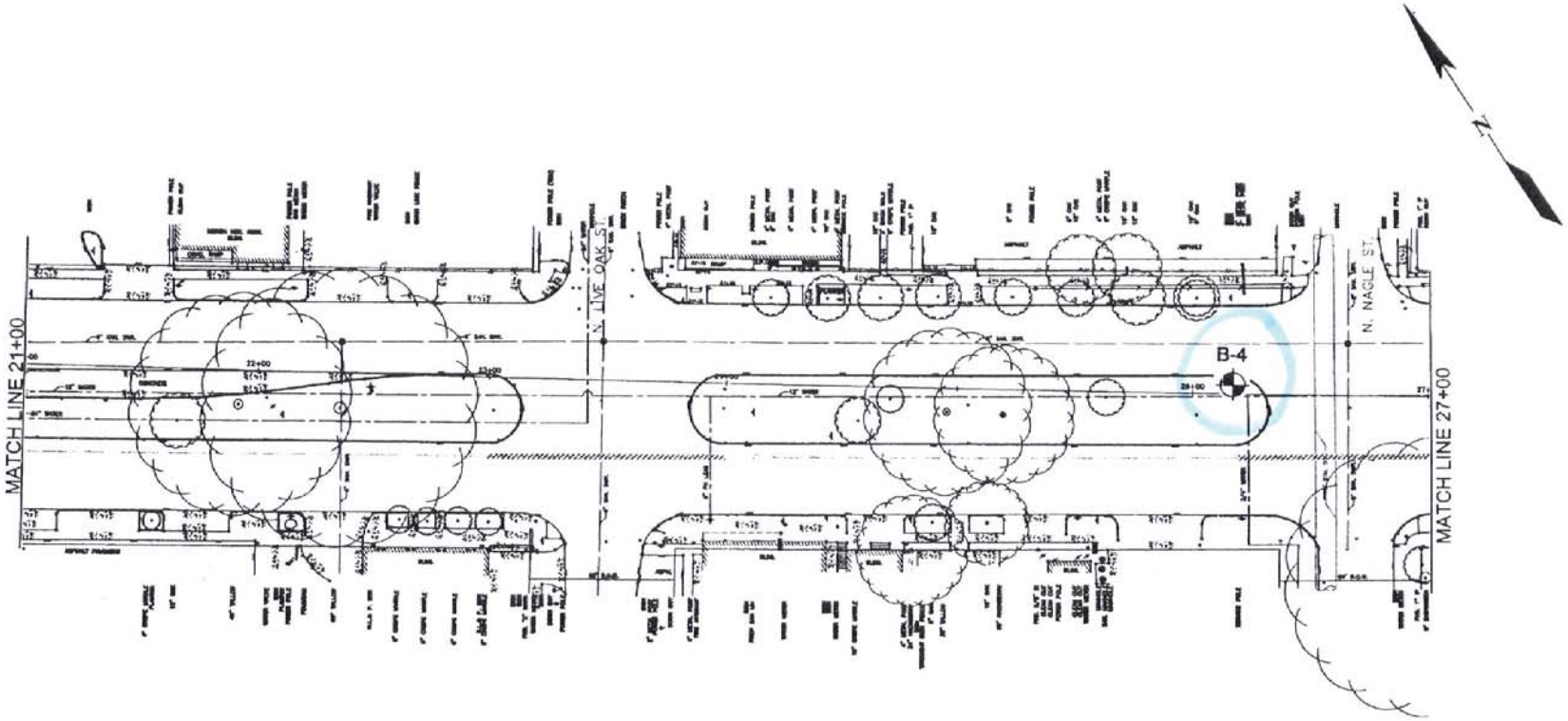
Job No. 1140133901



Geotest Engineering, Inc.

FIGURE A-2

Job No. 1140133901

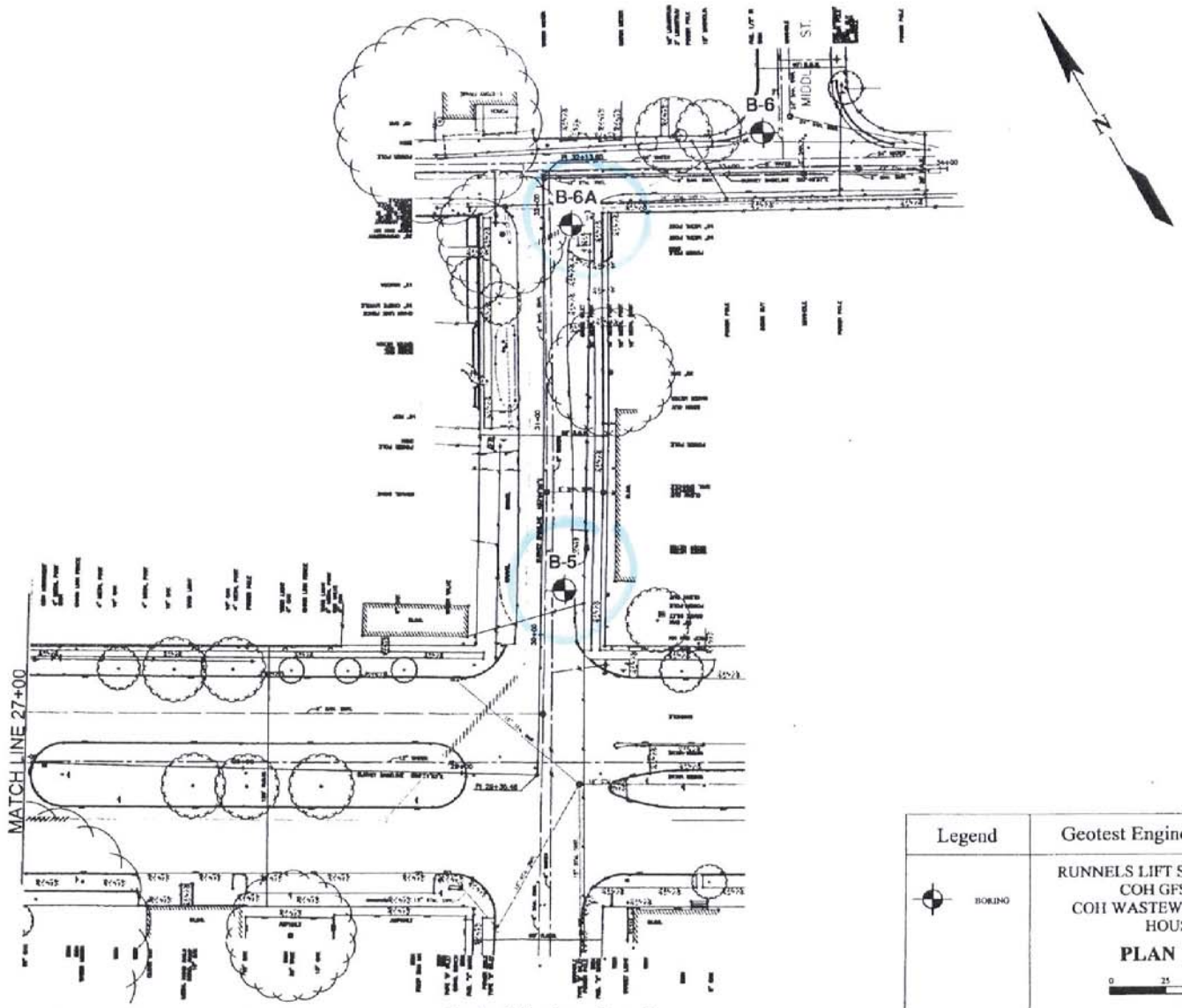


Legend	Geotest Engineering, Inc	1140133901
BORING	RUNNELS LIFT STATION REPLACEMENT COH GFS NO. R-0267-21-3 COH WASTEWATER FILE NO. 4275-09 HOUSTON, TEXAS **PLAN OF BORINGS** 0 25 50 75 100 SCALE IN FEET	

Geotest Engineering, Inc.

FIGURE A-3

Job No. 1140133901



Legend	Geotest Engineering, Inc	1140133901
BORING	RUNNELS LIFT STATION REPLACEMENT COH GFS NO. R-0267-21-3 COH WASTEWATER FILE NO. 4275-09 HOUSTON, TEXAS **PLAN OF BORINGS** 0 25 50 75 100 SCALE IN FEET	

Geotest Engineering, Inc.

FIGURE A-4

LOG OF BORING NO. B-2

PROJECT : Runnels Lift Station Replacement
COH GFS No. R-0267-21-3
COH Wastewater File No. 4275-09

LOCATION : Houston, Texas
Sta 13+00 (approx.), Offset 0.0 (approx.)

SURFACE ELEVATION : 41.0 FT. (Approximate)

PROJECT NO. : 1140133901

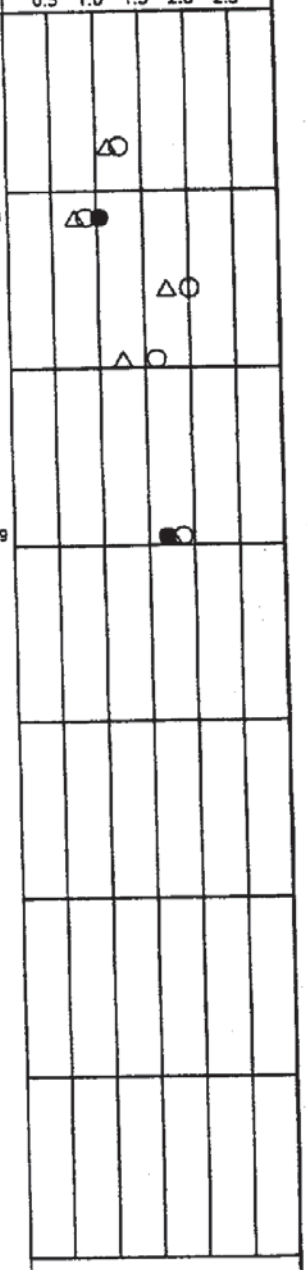
COMPLETION DEPTH : 15.0 FT.

DATE : 11-14-02

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 15.0 FT.
WET ROTARY : -- TO -- FT.

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
41.0	0	2.5" Asphaltic Concrete							
40.8		6.75" Portland Cement Concrete							
40.4		8" lime stablized silty sand, w/shell & gravel base							
39.0		Very stiff brown & gray CLAY (CH)			102	22	55	22	33
37.0	5	Stiff to very stiff gray & brown SILTY CLAY (CL), w/calcareous nodules -very stiff to hard 6'-8'			101	20	35	17	18
						24			
	10					20			
		-very stiff clay layer, w/ferrous stains 13'-15'							
26.0	15				105	21	50	21	29
	20								
	25								
	30								
	35								



DEPTH TO WATER IN BORING :
NO GROUNDWATER ENCOUNTERED DURING DRILLING.

Geotest Engineering, Inc.

FIGURE B-2

LOG OF BORING NO. B-2A

PROJECT : Runnels Lift Station Replacement
COH GFS No. R-0267-21-3
COH Wastewater File No. 4275-09

LOCATION : Houston, Texas
Sta 13+00 (approx.)

SURFACE ELEVATION : 41.0 FT. (Approximate)

PROJECT NO. : 1140133901

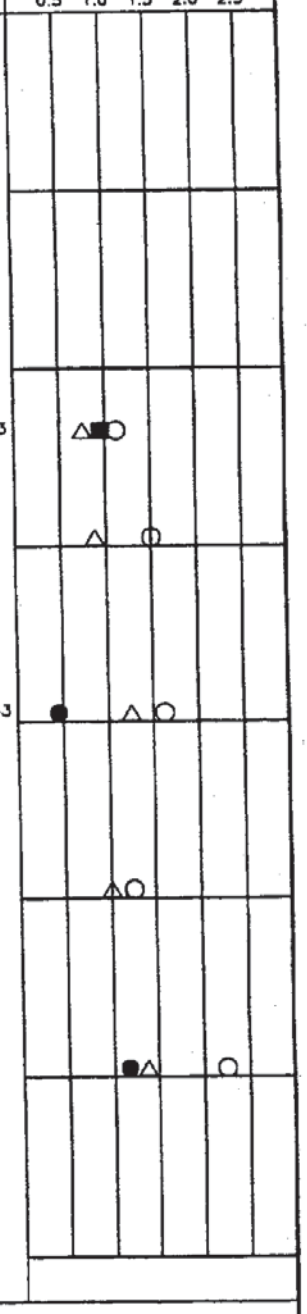
COMPLETION DEPTH : 30.0 FT.

DATE : 6-23-03

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 30.0 FT.
WET ROTARY : -- TO -- FT.

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
41.0	0	See Figure B-2 for 0-10'							
31.0	10	Stiff to very stiff gray SILTY CLAY (CL), w/calcareous & ferrous nodules -w/hydrocarbon odor 10'-12'			113	17	27	14	13
						18			
26.0	15	Very stiff gray & yellow CLAY (CH), w/clacareous nodules -w/silt & sand seams & ferrous nodules 15'-18' -w/ferrous stains 18'-23' -reddish brown & gray, slickensided 18'-30'			98	26	69	26	43
	20	-w/sand seams 23'-28'							
						26			
	25	-very stiff to hard, w/ferrous nodules 28'-30'							
11.0	30				103	22			
	35								



DEPTH TO WATER IN BORING :
NO GROUNDWATER ENCOUNTERED DURING DRILLING.
NO GROUNDWATER ENCOUNTERED, HOLE OPEN TO 30.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE B-2A

LOG OF BORING NO. B-3

PROJECT : Runnels Lift Station Replacement
COH GFS No. R-0267-21-3
COH Wastewater File No. 4275-09

LOCATION : Houston, Texas
Sta 20+05 (approx.), Offset 16.0 RT (approx.)

SURFACE ELEVATION : 38.5 FT. (Approximate)

PROJECT NO. : 1140133901

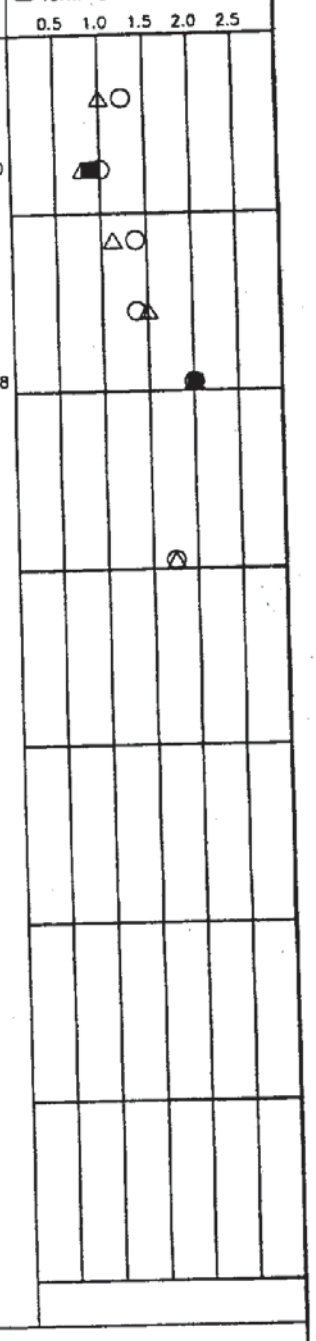
COMPLETION DEPTH : 15.0 FT.

DATE : 11-14-02

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 15.0 FT.
WET ROTARY : -- TO -- FT.

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE

ELEVATION, FEET	DEPTH, FEET	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
38.5	0			Stiff to very stiff gray & brown SILTY CLAY (CL), w/sand seams & ferrous stains				18			
				-w/grass roots 0'-2'			103	19	43	13	30
				-very stiff, gray 2'-8'							
	5			-w/ferrous nodules 2'-15'				18			
								18			
				-very stiff to hard, gray & yellowish brown 8'-15'			108	16	44	16	28
	10										
								16			
23.5	15										
	20										
	25										
	30										
	35										



DEPTH TO WATER IN BORING :
NO GROUNDWATER ENCOUNTERED DURING DRILLING.

Geotest Engineering, Inc.

FIGURE B-3

LOG OF BORING NO. B-3A

PROJECT : Runnels Lift Station Replacement
COH GFS No. R-0267-21-3
COH Wastewater File No. 4275-09

LOCATION : Houston, Texas
Sta 20+05 (approx.)

SURFACE ELEVATION : 38.5 FT. (Approximate)

PROJECT NO. : 1140133901

COMPLETION DEPTH : 30.0 FT.

DATE : 6-26-03

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 18.0 FT.
WET ROTARY : 18.0 TO 30.0 FT.

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
38.5	0	See Figure B-3 for 0-10'							
28.5	10	Stiff to very stiff gray & yellow SILTY CLAY (CL)			111	17	41	14	27
		-w/sand pockets 13'-15' -w/silt seams 13'-18'			103	20	39	14	25
	15	-gray & brown, w/sand seams 15'-18'							
		-w/calcareous nodules 17'-17.5'							
20.5		Medium dense brown & gray SILTY FINE SAND (SM)	17	29		23			
18.5	20	Very stiff to hard gray & yellow SILTY CLAY (CL)				17			
					112	16	46	20	26
	25	-reddish brown & gray, w/calcareous & ferrous nodules 25'-30'							
						22			
8.5	30								
	35								

NOTE :
Hole open to 30.0 ft at end of drilling

DEPTH TO WATER IN BORING :
▽ : FREE WATER 1st ENCOUNTERED AT 18.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 14.3 FT.

Geotest Engineering, Inc.

FIGURE B-3A

LOG OF BORING NO. B-4

PROJECT : Runnels Lift Station Replacement
COH GFS No. R-0267-21-3
COH Wastewater File No. 4275-09

LOCATION : Houston, Texas
Sta 26+17 (approx.), Offset 5.0 LT (approx.)

SURFACE ELEVATION : 38.5 FT. (Approximate)

PROJECT NO. : 1140133901

COMPLETION DEPTH : 20.0 FT.

DATE : 11-14-02

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 16.0 FT.
WET ROTARY : 16.0 TO 20.0 FT.

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
38.5	0	Stiff to very stiff gray SILTY CLAY (CH) -w/roots 0'-2' -yellowish brown & gray, w/ferrous nodules & ferrous stains 2'-6'				17			
						24			
34.5	5	Firm to stiff yellowish brown & gray SANDY CLAY (CL) -w/ferrous nodules 6'-8' -stiff to very stiff, reddish brown & gray, w/ferrrous stains 8'-13'			102	17	25	16	9
						16			
	10				110	16	30	14	16
25.5	15	Medium dense gray & brown SILTY FINE SAND (SM), w/clay seams	14	41		18			
		-yellowish brown & gray 18.5'-20'	16	25		19			
18.5	20	NOTE : Hole open to 20' at end of drilling.							
	25								
	30								
	35								

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 16.0 FT. DURING DRILLING; AFTER 20.0 MIN. AT 13.5 FT.

Geotest Engineering, Inc.

FIGURE B-4

LOG OF BORING NO. B-5

PROJECT : Runnels Lift Station Replacement
COH GFS No. R-0267-21-3
COH Wastewater File No. 4275-09

LOCATION : Houston, Texas
Sta 30+26 (approx.), Offset 10.0 RT (approx.)

SURFACE ELEVATION : 36.0 FT. (Approximate)

PROJECT NO. : 1140133901

COMPLETION DEPTH : 25.0 FT.

DATE : 11-14-02

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 15.0 FT.
WET ROTARY : 15.0 TO 25.0 FT.

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
36.0	0	3" Asphaltic Concrete							
35.8		15" lime stabilized sand, w/shell & gravel base				16			
34.8		Very stiff to hard gray SILTY CLAY (CL), w/ferrous nodules & ferrous stains			105	17	41	18	23
	5	-yellowish brown & gray 4'-8'				16			
						17			
28.0		Firm to stiff yellowish brown & gray SANDY CLAY (CL)			110	17	29	16	13
	10	-w/ferrous stains 8'-13'							
		-very stiff, gray, w/sand seams 13'-15'				18			
21.0	15	Medium dense gray & brown SILTY SAND (SM)							
	20		22			22			
		-dense 23.5'-25'							
11.0	25		35			22			
	30								
	35								

NOTE :
Hole open to 25' at end of drilling.

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 15.0 FT. DURING DRILLING; AFTER 20.0 MIN. AT 10.8 FT.

Geotest Engineering, Inc.

FIGURE B-5

LOG OF BORING NO. B-6A

PROJECT : Runnels Lift Station Replacement
COH GFS No. R-0267-21-3
COH Wastewater File No. 4275-09

LOCATION : Houston, Texas
Sta 31+85 (approx.), Offset 13.0 RT (approx.)

SURFACE ELEVATION : 36.0 FT. (Approximate)

PROJECT NO. : 1140133901

COMPLETION DEPTH : 25.0 FT.

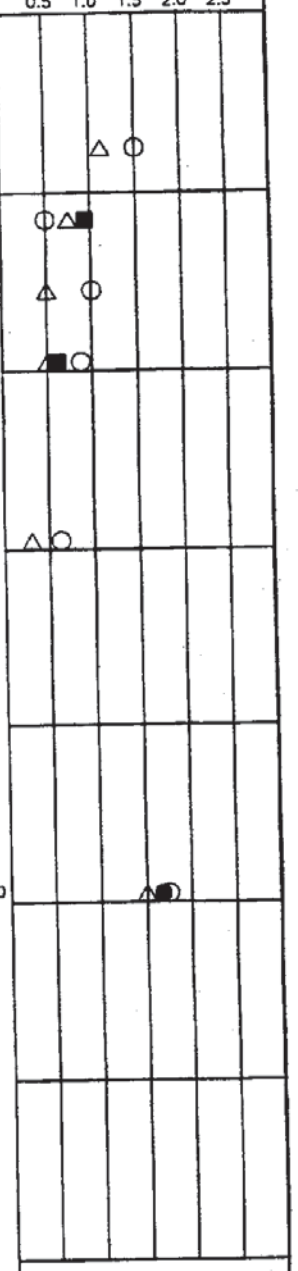
DATE : 11-14-02

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 18.0 FT.
WET ROTARY : 18.0 TO 25.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
36.0	0	4.5" Asphaltic Concrete							
35.6									
34.5		13.5" sand, w/shell & gravel base				15			
		Very stiff brown SANDY CLAY (CL)			112	15	36	16	20
32.0	5	-yellowish brown & gray 2'-4'			113	15	26	17	9
		Stiff to very stiff yellowish brown & gray SILTY CLAY (CL)				15			
28.0		Firm to stiff yellowish brown & gray SANDY CLAY (CL)			109	14	25	14	11
	10								
		-gray, w/clay seams 13'-18'		52		20	30	14	16
	15								
18.0		Medium dense brown & gray SILTY FINE SAND (SM)	18	27		21			
	20								
13.0		Very stiff brown & gray SILTY CLAY (CL), w/ferrous nodules & ferrous stains			114	14	32	12	20
11.0	25								
	30								
	35								

NOTE :
Hole open to 25 ft at end of drilling.

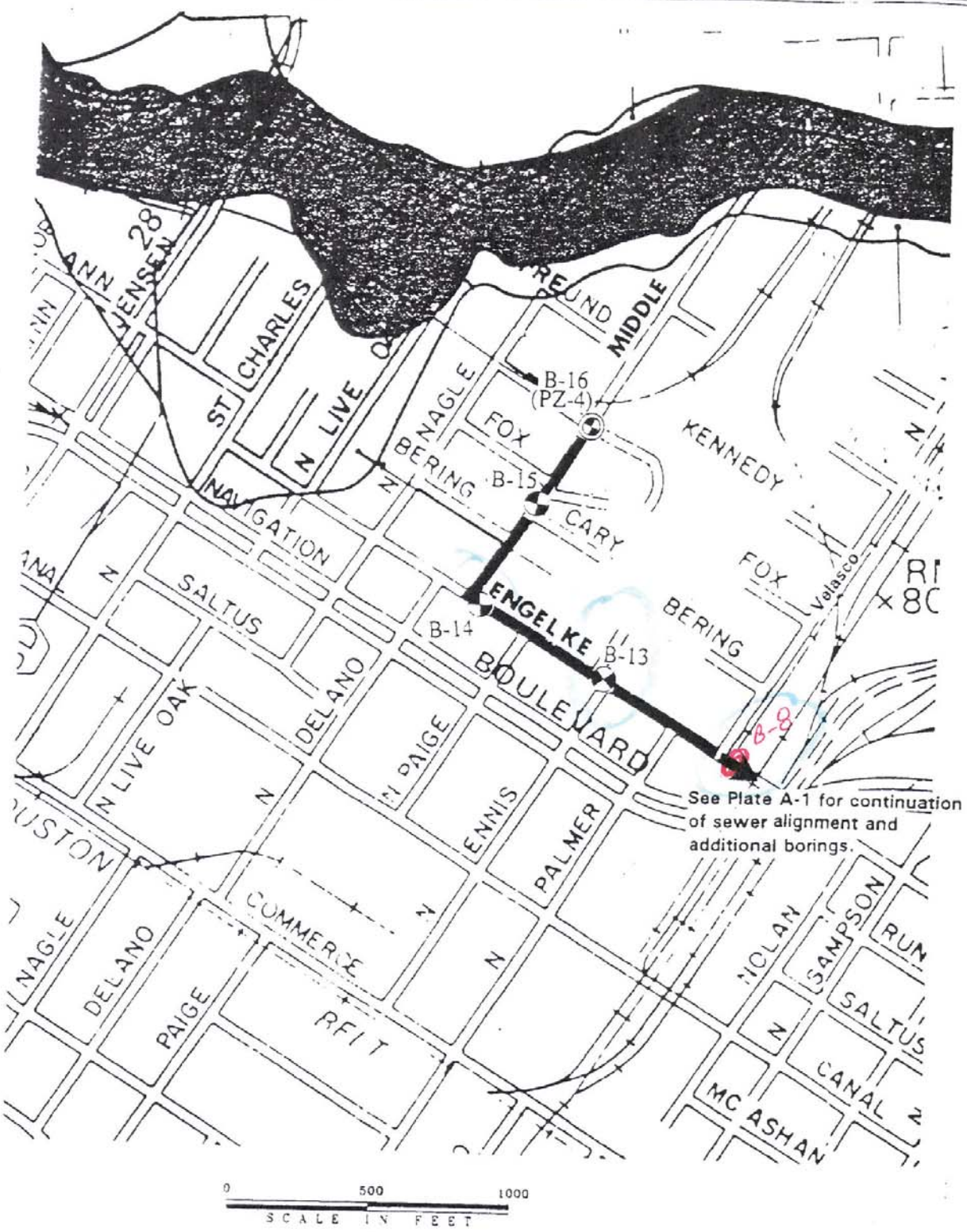
UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE



DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 18.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 13.4 FT.

Geotest Engineering, Inc.

FIGURE B-6A



LEGEND:

- APPROXIMATE BORING LOCATIONS
- APPROXIMATE PIEZOMETER LOCATIONS
- PROPOSED SEWER ALIGNMENT

HVJ ASSOCIATES, INC.
GEOTECHNICAL ENGINEERS

SCALE: 1"=500'	APPROVED BY: CO	PREPARED BY: DY
DATE: 06/17/96		

PLAN OF BORINGS
NORTH YORK RELIEF SEWERS

PROJECT NO.	DRAWING NUMBER:
94-2006-09	PLATE A-2

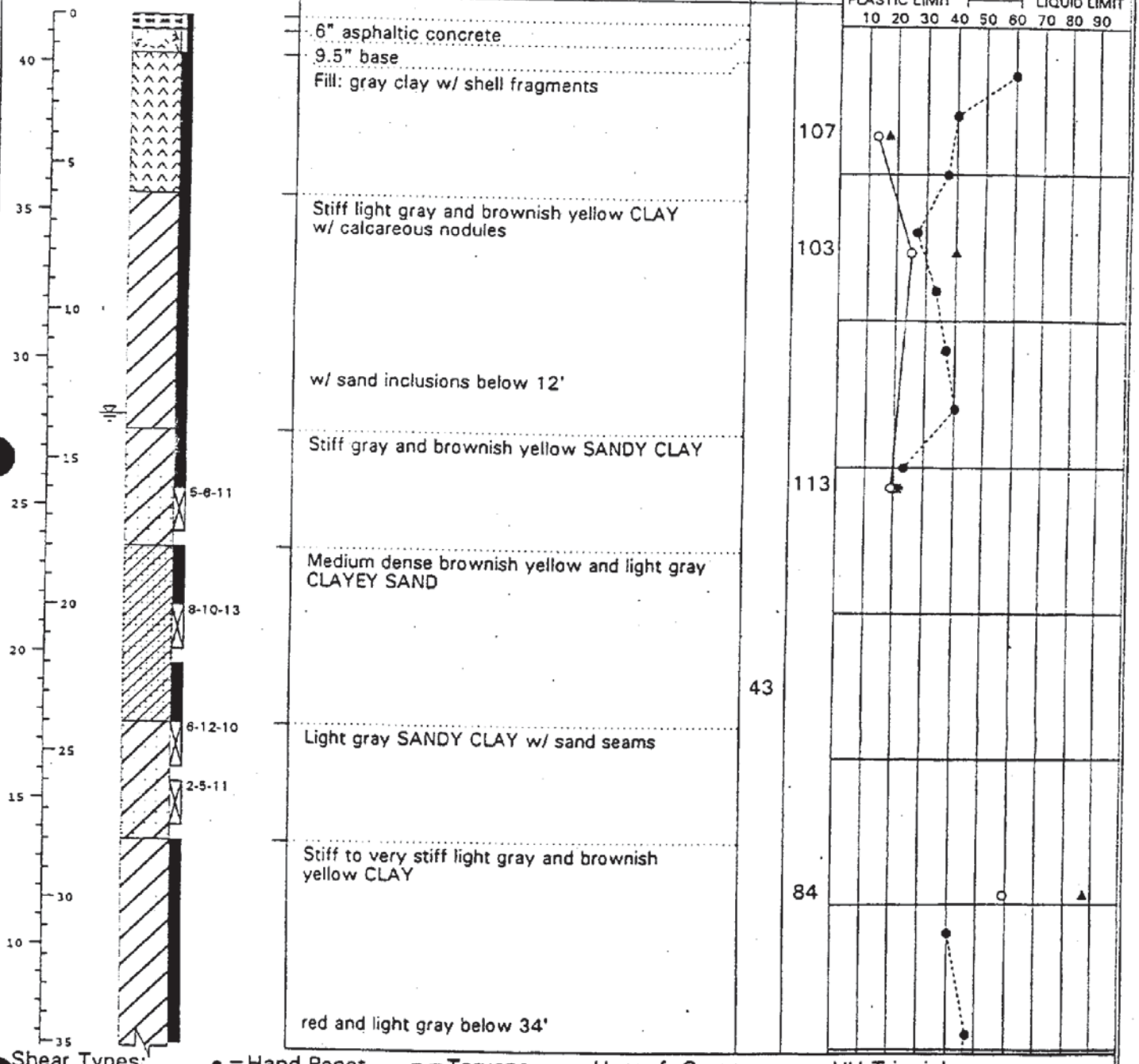
LOG OF SOIL BORING

GHWP Project No. 4458-NS2-1 - Engelke
Boring No.: B-8 Date: 01-26-96
Groundwater during drilling: 13.5 feet

Northing: 716962
Easting: 3161859

Project No. 94-200G-09
Elevation: 41.6 feet
Station: 9+99
Offset: 2.9' RT

ELEV. DEPTH. FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL DESCRIPTION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
		6" asphaltic concrete		
		9.5" base		
		Fill: gray clay w/ shell fragments		107
		Stiff light gray and brownish yellow CLAY w/ calcareous nodules		103
		w/ sand inclusions below 12'		
		Stiff gray and brownish yellow SANDY CLAY		113
	5-6-11			
		Medium dense brownish yellow and light gray CLAYEY SAND		
	8-10-13			
			43	
	6-12-10	Light gray SANDY CLAY w/ sand seams		
	2-5-11			
		Stiff to very stiff light gray and brownish yellow CLAY		84
		red and light gray below 34'		



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ● = UU Triaxial

See Appendix A for boring location.

Plate B-12A

LOG OF SOIL BORING

GHWP Project No. 4458-NS2-1 - Engelke
Boring No.: B-8 Date: 01-26-96
Groundwater during drilling: 13.5 feet

Northing: 716962
Easting: 3161859

Project No. 94-200G-09
Elevation: 41.6 feet
Station: 9+99
Offset: 2.9' RT

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL DESCRIPTION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF	SHEAR STRENGTH, TSF (0.5, 1, 1.5, 2) / MOISTURE CONTENT, % (PLASTIC LIMIT – LIQUID LIMIT; 10 20 30 40 50 60 70 80 90)
5					
40					
0					
45					
-5					
50					
-10					
55					
-15					
60					
-20					
65					
-25					
70					

Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✱ = UU Triaxial

See Appendix A for boring location.

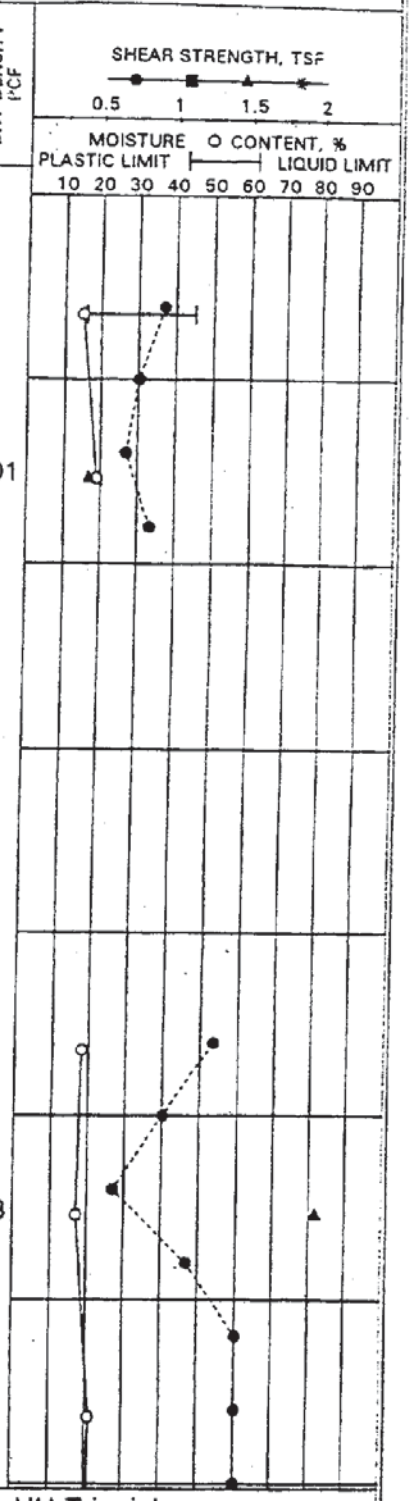
Plate B-128

LOG OF SOIL BORING

GHWP Project No. 458-NS2-1 - Engelke
Boring No.: B-13 Date: 04-08-96
Groundwater during drilling: 8.1 feet Northing:
Easting:

Project No. 94-200G-09
Elevation: 35.5 feet ≈
Station: 17+00 ≈
Offset:

ELEV. DEPTH. FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL DESCRIPTION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
35 / 0		9" asphaltic concrete		
		8" base		
		Firm to stiff gray SANDY CLAY w/ sand inclusions and lenses		
30 / 5		light gray w/ soft silt inclusions at 6'- 8'		101
25 / 10		Brownish yellow SILTY SAND		
	17-20-20	light gray below 12'		
	14-16-20			
20 / 15	14-20-32		45	
	16-22-35			
15 / 20	9-40-50/4	Stiff to very stiff light gray CLAY		
		brownish yellow and light gray w/ sand partings 22'-30'		
10 / 25				113
5 / 30		reddish brown and light gray w/ silt stones and calcareous inclusions 30'-40'		
35				



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ✱ = UU Triaxial

See Appendix A for boring location.

Plate B-16A

LOG OF SOIL BORING

GHWP Project No. 458-NS2-1 - Engelke
Boring No.: B-13 Date: 04-08-96
Groundwater during drilling: 8.1 feet Northing:
Easting:

Project No. 94-200G-09
Elevation: 35.5 feet ≈
Station: 17+00 ≈
Offset:

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL DESCRIPTION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF	SHEAR STRENGTH, TSF (0.5, 1, 1.5, 2) / MOISTURE CONTENT, % (PLASTIC LIMIT – LIQUID LIMIT; 10 20 30 40 50 60 70 80 90)
0					
-5 (40)					
-10 (45)					
-15 (50)					
-20 (55)					
-25 (60)					
-30 (65)					
(70)					

Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ◆ = UU Triaxial

See Appendix A for boring location.

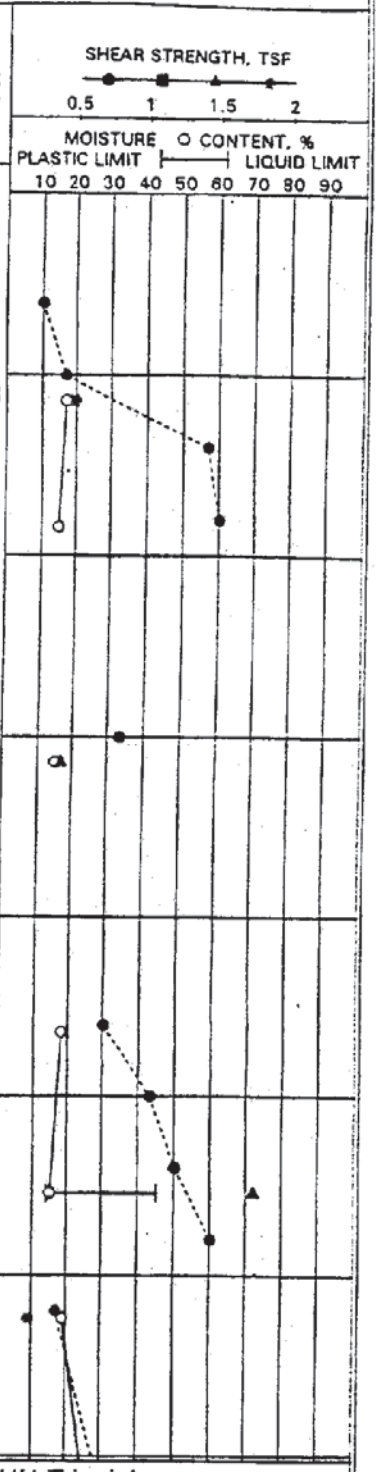
Plate B-16B

LOG OF SOIL BORING

GHWP Project No. 4458-NS2-1 - Engelke
Boring No.: B-14 Date: 04-08-96
Groundwater during drilling: 13.2 feet Northing:
Easting:

Project No. 94-200G-09
Elevation: 36.0 feet ≈
Station: 22+00 ≈
Offset:

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL DESCRIPTION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF
		6" asphaltic concrete		
		12" Portland cement concrete		
		Fill: gray shell intermixed w/ clay and gravel	53	
		Very stiff light gray SANDY CLAY		108
		Gray CLAYEY SAND		
	9-13-20	Dense gray and brownish yellow SAND	45	
		Stiff light gray SANDY CLAY		
	4-14-20	Dense brownish yellow SILTY SAND		118
	8-15-15	Medium dense to dense brownish yellow and light brown SAND		
		Stiff to very stiff light gray CLAY		
		Very stiff light gray and reddish brown SANDY CLAY		117
		Light brown and reddish brown CLAYEY SAND		113
		Medium dense light brown SILTY SAND		
	8-13-15	Reddish brown and light gray CLAY	23	



Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ◆ = UU Triaxial

See Appendix A for boring location.

Plate B-17A

LOG OF SOIL BORING

GHWP Project No. 4458-NS2-1 - Engelke
Boring No.: B-14 Date: 04-08-96
Groundwater during drilling: 13.2 feet Northing:
Easting:

Project No. 94-200G-09
Elevation: 36.0 feet ≈
Station: 22+00 ≈
Offset:

ELEV. DEPTH, FEET	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	SOIL DESCRIPTION	% PASSING NO. 200 SIEVE	DRY DENSITY PCF	SHEAR STRENGTH, TSF (0.5, 1, 1.5, 2) / MOISTURE CONTENT, % (PLASTIC LIMIT – LIQUID LIMIT; 10 20 30 40 50 60 70 80 90)
0					
40					
-5					
45					
-10					
50					
-15					
55					
-20					
60					
-25					
65					
-30					
70					

Shear Types: ● = Hand Penet. ■ = Torvane ▲ = Unconf. Comp. ◆ = UU Triaxial

See Appendix A for boring location.

Plate B-17B

HVJ ASSOCIATES, INC.