CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING
ENGINEERING AND CONSTRUCTION DIVISION

GEOTECHNICAL INVESTIGATION
WATER LINE REPLACEMENT IN
FAIRLAWN AREA
WBS NO. S-000035-0186-4
CITY OF HOUSTON, TEXAS

PROJECT NO. 14-319E

TO

QUADRANT CONSULTANTS, INC.
HOUSTON, TEXAS

BY

GEOTECH ENGINEERING AND TESTING

SERVICING

TEXAS, LOUISIANA, NEW MEXICO, OKLAHOMA

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TEXAS BOARD OF PROFESSIONAL ENGINEERS
REGISTRATION NUMBER F-001183

Quadrant Consultants, Inc.
7322 Southwest Freeway, Suite 470
Houston, Texas 77074

Project No. 14-319E
Report No. 1
Report Type: 24/32
November 12, 2014

Attention: Mr. Peter R. Jordan, P.E.
Vice President

GEOTECHNICAL INVESTIGATION
WATER LINE REPLACEMENT IN
FAIRLAWN AREA
WBS NO. S-000035-0186-4
CITY OF HOUSTON, TEXAS

Gentlemen:

Submitted here is Geotech Engineering and Testing (GET) geotechnical study of subsurface condition for the above referenced project. The planned facilities were discussed in detail with Mr. Peter R. Jordan, P.E. in order to plan a study that would provide the necessary design and construction recommendations. This study was conducted in general accordance with GET Proposal No. P14-108, Revision III, dated May 07, 2014. Authorization to Proceed with this study was received through a Professional Services Agreement between Quadrant Consultants, Inc. and GET on May 08, 2014.

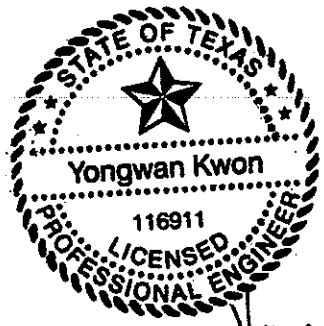
This report presents the results of our desktop geologic fault study, geotechnical field exploration and laboratory testing together with recommendations for the design and construction of the proposed water line replacement project. Our recommendations are in general accordance with the City of Houston Standard Construction Specifications for Wastewater Collection Systems, Water Lines and Storm Drainage, dated July 2012.

We appreciate the opportunity to be of service. Should you have any questions or need additional assistance, please call.

Very truly yours,

GEOTECH ENGINEERING AND TESTING
TEXAS BOARD OF PROFESSIONAL ENGINEERS
REGISTRATION NUMBER F-001183

Yongwan (Alex) Kwon, P.E.
Project Manager



Yongwan (Alex) Kwon
12-12-14

AK/MT/DAE/ak

Copies Submitted: (1) Hard Copy – Quadrant Consultants, Inc. – Mr. Peter R. Jordan, P.E.
(1) PDF Copy Email – Mr. Peter R. Jordan, P.E.

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1.0 EXECUTIVE SUMMARY

It is planned to reconstruct approximately 32,030 linear feet of water lines in Fairlawn Area in the City of Houston, Texas. The specific project information is as follows:

Project	Remarks
Water Line Replacement in Fairlawn Area	We understand that six, eight and twelve-inch diameter water lines will be constructed along various streets in Fairlawn Area, City of Houston, Texas. The total length of the water lines will be about 32, 030 linear feet. The invert depth of the water lines range from 5- to 12-ft below the existing grade. We understand that the construction technique will be trenchless method.

This report presents the results of our desktop geologic fault study, geotechnical field exploration and laboratory testing together with recommendations for the design and construction of the proposed water lines.

Our review of fault map indicates that there are no major active faults located at the project area. The closest known fault to the project alignment is Mikawa Salt Dome located approximately 2.5 miles to south of the project alignments. No special study of movement rates for any of this fault was attempted.

The subsoils and groundwater conditions were evaluated by conducting forty nine (49) soil test borings (B-1 through B-49) along the project alignments to depths ranging from 10- to 17-ft below the existing grade. Furthermore, at the request of the City of Houston (COH), we included six (6) borings (B-1*, B-23*, B-37* through B-39* andB-59*), previously conducted by Geotech Engineering and Testing (GET Report No. 05-869E, Dated April 06, 2006) in this report. Results of our field investigation and engineering analyses are summarized below:

1. In general, based on our field exploration and laboratory testing data, the soils along the project alignments appear to be variable. The soil stratigraphy along the alignments are summarized as follows:

   Heiser Street Area (Borings B-1 through B-15)

Stratum No.	Range of Depth, ft.	Soil Type
		ASPHALT PAVEMENT (2.0- to 10-inch in Thickness)
		CONCRETE PAVEMENT (6.0-inch in thickness)
I	0.2 – 2	SILTY SAND (SM)
II	0.2 – 2	LEAN CLAY (CL)
III	0.2 – 17	FAT CLAY (CH)
IV	12 – 14	LEAN CLAY (CL)

Tucker Street and Netherfield Area (Borings B-1*, B-23*, B-37* through B-39* andB-59*)

Stratum No.	Range of Depth, ft.	Soil Type
		ASPHALT PAVEMENT (1.3- to 8.9-inch in thickness)
		CONCRETE PAVEMENT (1.0- to 8.3-inch in thickness)
I	0.5 – 2	FILL: FAT CLAY (CH); In Boring B-37* only
II	0.6 – 15	LEAN CLAY (CL)
III	0.3 – 16	FAT CLAY (CH)
IV	16 – 25	SILTY SAND (SM); In Boring B-1* only

* Previously conducted by Geotech Engineering and Testing (GET Report No. 05-869E, Dated April 06, 2006)

Fairlawn, Northdale, Cherrydale and Nunn Streets (Borings B-16 through B-29)

Stratum No.	Range of Depth, ft.	Soil Type
		ASPHALT PAVEMENT (2.0- to 12-inch in thickness)
		CONCRETE PAVEMENT (3.0- to 8.3-inch in thickness)
I	0.8 – 2	SILTY SAND (SM)
II	0.8 – 17	LEAN CLAY (CL)
III	0.4 – 10	FAT CLAY (CH)

Roxbury, Plainview, Kingsway and Cherrydale Streets (Borings B-30 through B-40)

Stratum No.	Range of Depth, ft.	Soil Type
		ASPHALT PAVEMENT (2.5- to 6.7-inch in thickness)
		CONCRETE PAVEMENT (4.0- to 6.5-inch in thickness)
I	0.6 – 4	FAT CLAY WITH SAND (CH)
II	0.6 – 16	FAT CLAY (CH)
III	4 – 12	LEAN CLAY WITH SAND (CL)
IV	6 – 10	LEAN CLAY (CL)

Walnut, Richwood, Andwood and Chaffin (Borings B-41 through B-49)

Stratum No.	Range of Depth, ft.	Soil Type
		ASPHALT PAVEMENT (2.0- to 10.0-inch in thickness)
		CONCRETE PAVEMENT (4.6- to 6.5-inch in thickness)
I	0.5 – 10	FAT CLAY WITH SAND (CH)
II	0.6 – 15	FAT CLAY (CH)
III	4 – 10	LEAN CLAY (CL)

2. Depth to groundwater will be important for design and construction of the proposed water lines. Water level observations were made during and after about 0.5-hour of drilling. Our short-term field exploration indicates that groundwater was encountered at depths ranging from 12- to 17-ft during drilling in Borings B-17 and B-44. Groundwater level rose to depths ranging from 10- to 15-ft after about 0.5-hour of drilling. However, no groundwater was encountered in the remaining borings (Borings B-1 through B-16, B-18 through 43 and B-45 through B-49).

3. Borings B-2, B-17 and B-37 were converted to Piezometers PZ-1 through PZ-3, respectively, after completion of drilling. The water reading at Piezometers PZ-1, PZ-2 and PZ-3 indicated that stabilized groundwater level existed at a depth of about 11.5-to 14.5-ft below the existing ground surface.

4. We understand that the water lines will be installed by trenchless construction techniques for this project. Trenchless techniques should be conducted in accordance with the City of Houston Standard Specifications, Section 02447 – Augering Pipe and Conduit.

5. In order to prevent intolerable movement and overstressing of the pipe, suitable thrust restraint should be provided. Use of restrained joints or thrust blocks is the typical methods of providing reaction for the thrust restraint.

6. The bedding and backfill for the auger pits should be conducted in accordance with the City of Houston Standard Specifications, Section 02317 – Excavation and Backfill for Utilities and Section 02447 – Augering Pipe and Conduit, respectively. Furthermore, the City of Houston Standard Specifications, Drawings No. 02447-01 should be used when backfilling the water lines, auger pits and auger holes.

2.0 INTRODUCTION

It is planned to reconstruct approximately 32,030 linear feet of water lines in Fairlawn Area in the City of Houston, Texas. A site vicinity map is presented on Plate 1. The specific project information is as follows:

Project	Remarks
Water Line Replacement in Fairlawn Area	We understand that six, eight and twelve-inch diameter water lines will be constructed along various streets in Fairlawn Area, City of Houston, Texas. The total length of the water lines will be about 32,030 linear feet. The invert depth of the water lines range from 5- to 12-ft below the existing grade. We understand that the construction technique will be trenchless method.

The scope of our work consisted of conducting a desktop geologic fault study and a geotechnical study for the project areas and developing recommendations with respect to design and construction of the water lines. Our recommendations are in general accordance with the City of Houston Standard Construction Specification for Wastewater Collection Systems, Water Lines and Storm Drainage, dated July 2012 (Ref. 1). This study was conducted in general accordance with City of Houston Department of Public Works & Engineering, Chapter 11, Geotechnical and Environmental Guidelines, dated July 2012.

This report briefly describes the field exploration and laboratory testing followed by our engineering analyses and recommendations.

3.0 DESKTOP GEOLOGIC FAULT STUDY

Many faults have been observed within the Gulf Coast Region of Texas. In general, faults are caused by groundwater and oil removal from the underlying surface. Faults originate several thousand feet below the ground surface and can often cause displacement of the ground surface, causing broken pavement, ruptured utility lines, and damage to residential and commercial structures. A geologic fault map of the area is presented on Plate 2.

Our review of fault map (Ref. 2) indicates that there are no major active faults located along the project alignments. However, faults may be present that are absent from the published maps. In general, some faults are currently active. The closest known faults to the project alignments are Mikawa Salt Dome located approximately 2.5 miles to south of the project alignments. No special study of movement rates for any of this fault was attempted. A Phase I Geologic Fault study was not conducted.

4.0 FIELD EXPLORATION

4.1 Pavement Coring

Forty nine (49) pavement corings were conducted prior to drilling and sampling in Borings B-1 through B-49. The results of pavement coring show that the existing pavement generally consists of either concrete or asphalt pavement. The pavement thicknesses are shown on Plate 3. The pavement core locations were patched with ready mix grout.

4.2 Drilling and Sampling

At the request of the client, the soil conditions were explored by conducting forty nine (49) soil test borings (B-1 through B-49) located approximately as shown on Plates 4 through 6. Furthermore, at the request of the City of Houston (COH), we included six (6) borings (B-1*, B-23*, B-37* through B-39* and B-59*), previously conducted by Geotech Engineering and Testing (GET Report No. 05-869E, Dated April 06, 2006) in this report. Locations of the borings were based on the discussion with Mr. Peter R. Jordan, P.E. of Quadrant Consultants, Inc. Summary of boring locations information is presented on Plates 7 and 8. The borings schedule is as follows:

Facility	Boring(s) No.	Boring Depth, ft.
Water Lines	B-3 through B-5, B-7, B-11, B-12, B-14 through B-16, B-18 through B-30, B-32, B-33, B-35, B-36, B-38, B-39, B-41 through B-43 and B-45 through B-49	10
	B-31, B-40 and B-44	15
	B-1, B-2^{+}, B-6, B-8, B-10, B-13, B-34 and B-37^{+}	16
	B-9 and B-17^{+}	17

$^{+}$ Borings B-2, B-17 and B-37 were converted to Piezometers PZ-1 through PZ-3, respectfully.

Soil samples were obtained continuously at each boring location from the ground surface to the completion depths of borings ranging from 10- to 17-ft. The cohesive soils were sampled in general accordance with ASTM D 1587.

Soil samples were examined and classified in the field, and cohesive soil strengths were estimated using a calibrated hand penetrometer. This data, together with a classification of the soils encountered and strata limits, is presented on the soil stratigraphy profiles, Plates 9 through 20. The logs of borings are presented on Plates A-1 through A-49 in Appendix A. The logs of borings previously drilled by GET are shown on Plates A-50 through A-55 in Appendix A. A key to log terms and symbols is shown on Plate A-56 in Appendix A.

Depth to groundwater will be important for design and construction of the proposed water lines. For this reason, borings were drilled dry and the depth at which groundwater was first encountered was recorded. Water level observations made during and 0.5-hr after drilling in the borehole are indicated at the bottom portion of the individual logs. The boreholes not converted to piezometers were grouted using tremie method after the completion of drilling.

4.3 Piezometer Installation and Abandonment

Piezometers PZ-1 through PZ-3 were installed to the depths ranging from 16- to 17-ft in Borings B-2, B-17 and B-37, respectively, after completion of the field work. The piezometers consisted of two-inch diameter PVC riser pipe connected to a 5-ft long section of 0.01-inch slotted well screen. The riser pipe extends to the ground surface and is capped at the top with water tight flush mounted locking cap. After the borings were drilled, the riser pipe and well screen assembly were installed in the boreholes, filter sand was placed in the bottom of the boreholes and in the annulus between the borehole wall and the PVC pipe/screen, and subsequently the boreholes were sealed with bentonite from the top of the filter sand to 2-ft below the existing ground surface and with cement to remaining top 2-ft. The piezometers were developed by using a bailer to purge several volumes of water from the piezometer riser pipe. Water levels were periodically measured to evaluate the stabilized groundwater table. The piezometer installation diagram is shown on Plate 21. A summary of the piezometer readings is presented in the "Piezometer Reading Table" on Plate 22. The piezometers were abandoned in accordance with the TDLR (Chapter 76 of TAC), the City of Houston Design Manual, Item 11.14 - Site Restoration. The piezometer installation and abandonment reports are presented in Appendix B.

5.0 LABORATORY TESTS

5.1 General

Soil classifications and shear strengths were further evaluated by laboratory tests on representative samples of the major strata. The laboratory tests were performed in general accordance with ASTM Standards. Specifically, ASTM D 2487 is used for classification of soils for engineering purposes. Furthermore, summaries of test results are presented on Plate A-57 through A-63 in Appendix A.

5.2 Classification Tests

As an aid to visual soil classifications, physical properties of the soils were evaluated by classification tests. The tests were conducted in general accordance with ASTM Standards. These tests consisted of natural moisture content tests (ASTM D 2216 and ASTM D 4643), percent passing No. 200 sieve tests (ASTM D 1140), dry unit weights and Atterberg limit determinations (ASTM D 4318, Method A). Plastic limit test was conducted on all Atterberg limit test samples. Similarity of these properties is indicative of uniform strength and compressibility characteristics for soils of essentially the same geological origin. Results of these tests are tabulated on the boring logs at respective sample depths.

5.3 Strength Tests

Undrained shear strengths of the cohesive soils, measured in the field, were verified by calibrated hand penetrometer, unconfined compressive strength tests (ASTM D 2166) and torvane tests. The test results are also presented on the boring logs.

5.4 Soil Sample Storage

Soil samples tested or not tested in the laboratory will be stored for a period of fourteen days subsequent to submittal of the final report. The samples will be discarded after this period, unless we are instructed otherwise.

6.0 GENERAL SOILS AND DESIGN CONDITIONS

6.1 Site Conditions

The project alignments are generally flat and exhibit a topographic variation of less than three-ft. Currently, most of the project alignments are along the paved roadways. In general, residential and commercial structures are located along the project alignments. Pictures of the project areas were taken during our site visit. These pictures are presented on Appendix C.

6.2 Soil Stratigraphy

Field and laboratory test data indicate that soil stratigraphy along the project alignments are variable. Details of subsoil conditions at each boring location are presented on the respective boring logs. In general, the soil stratigraphy for the proposed water lines is shown in the following report sections.

6.2.1 Heiser Street Area (Borings B-1 through B-15)

Based on Borings B-1 through B-15, the soils can be grouped into two (2) major strata with depth limits and characteristics as follows:

Stratum No.	Range of Depth, ft.	Soil Description*
		ASPHALT PAVEMENT (2.0- to 10-inch in Thickness)
		CONCRETE PAVEMENT (6.0-inch in Thickness)
I	0.2 – 17	FAT CLAY (CH), soft to very stiff, light gray, gray, dark gray, light brown, brown, reddish brown, dark brown, with ferrous and calcareous nodules, moist; In Boring B-3, Silty Sand (SM) 0.2 to 2-ft and In Boring B-11, Lean Clay (CL) 0.2 to 2-ft
II	12 – 14	LEAN CLAY (CL), stiff, light gray, light brown, with ferrous and calcareous nodules, sands, moist; In Boring B-9 only

6.2.2 Tucker Street and Netherfield Area (Borings B-1*, B-23*, B-37* through B-39* andB-59*)

Based on Borings B-1*, B-23*, B-37* through B-39* andB-59*), previously drilled by GET, the soils can be grouped into three (3) major strata with depth limits and characteristics as follows:

Stratum No.	Range of Depth, ft.	Soil Description*
		ASPHALT PAVEMENT (1.3- to 8.9-inch in thickness)
		CONCRETE PAVEMENT (1.0- to 8.3-inch in thickness)
I	0.6 – 15	LEAN CLAY (CL), firm to very stiff, light gray, gray, brown, with root fibers to 6', ferrous and calcareous nodules, shells, moist
II	0.3 – 16	FAT CLAY (CH), soft to hard, light gray, olive gray, light brown, brown, with root fibers to 8, ferrous and calcareous nodules, silt seams, moist; In Boring B-37*, Fat Clay fill (CH) 0.5 to 2-ft
III	16 – 25	SILTY SAND (SM); medium dense, light gray, light brown, with clay pockets, moist to wet; In Boring B-1* only

6.2.3 Fairlawn, Northdale, Cherrydale and Nunn Streets (Borings B-16 through B-29)

Based on Borings B-16 through B-29, the soils can be grouped into two (2) major strata with depth limits and characteristics as follows:

Stratum No.	Range of Depth, ft.	Soil Description*
		ASHPHALT PAVEMENT (2.0- to 12-inch in thickness)
		CONCRETE PAVEMENT (3.0" to 8.3" in thickness)
I	0.8 – 17	LEAN CLAY (CL), firm to hard, light gray, gray, dark gray, light brown, brown, reddish brown, with root fibers, ferrous and calcareous nodules, sands, moist; In Borings B-21 and B-23, Silty Sand (SM) 0.8 to 2-ft
II	0.4 – 10	FAT CLAY (CH), soft to hard, light gray, gray, dark gray, light brown, reddish brown, dark brown, with root fibers to 4'

6.2.4 Roxbury, Plainview, Kingsway and Cherrydale Streets (Borings B-30 through B-40)

Based on Borings B-30 through B-40, the soils can be grouped into three (3) major strata with depth limits and characteristics as follows:

Stratum No.	Range of Depth, ft.	Soil Description*
		ASPHALT PAVEMENT (2.5- to 6.7-inch in thickness)
		CONCRETE PAVEMENT (4.0- to 6.5-inch in thickness)
I	0.6 – 16	FAT CLAY (CH), firm to hard, light gray, gray, dark gray, light brown, brown, reddish brown, with root fibers to 4', ferrous and calcareous nodules, moist; In Borings B-34 and B-35, Fat Clay with Sand (CH), 0.6 to 4-ft
II	4 – 12	LEAN CLAY (CL), stiff to very stiff, light gray, light brown, reddish brown, with ferrous and calcareous nodules, sands, moist
III	6 – 10	LEAN CLAY WITH SAND (CL), very stiff, light gray, reddish brown, with ferrous and calcareous nodules, sands, moist

6.2.5 Walnut, Richwod, Andwood and Chaffin Streets (Borings B-41 through B-49)

Based on Borings B-41 through B-49, the soils can be grouped into three (3) major strata with depth limits and characteristics as follows:

Stratum No.	Range of Depth, ft.	Soil Description*
		ASPHALT PAVEMENT (2.0- to 10.0-inch in thickness)
		CONCRETE PAVEMENT (4.6- to 6.5-inch in thickness)
I	0.5 – 10	FAT CLAY WITH SAND (CH), firm to very stiff, light gray, gray, dark gray, brown, reddish brown, with ferrous and calcareous nodules, moist
II	0.6 – 15	FAT CLAY (CH), stiff to hard, light gray, gray, dark gray, light brown, brown, reddish brown, with root fibers to 2', ferrous and calcareous nodules, moist
III	4 – 10	LEAN CLAY (CL), stiff to hard, light gray, gray, brown, reddish brown, with ferrous and calcareous nodules, sands, moist

* Classification in general accordance with the modified Unified Soil Classification System (ASTM D 2487)

6.3 Soil Properties

6.3.1 Heiser Street Area (Borings B-1 through B-15)

Based on Borings B-1 through B-15, soil strength and index properties and how they relate to the water lines installation along the project alignments are summarized below:

Stratum No.	Soil Type	PI(s)	Soil Expansivity	Soil Strength, tsf
I	Fat Clay (CH)	34 – 58	Expansive to Highly Expansive	0.23 – 1.50
	Silty Sand (SM)	–	Non-Expansive	–
	Lean Clay (CL)	30	Moderately Expansive	0.69 – 1.50
II	Lean Clay (CL)	24	Moderately Expansive	0.57

6.3.2 Tucker Street and Netherfield Area (Borings B-1*, B-23*, B-37* through B-39* and B-59*)

Based on Borings B-1*, B-23*, B-37* through B-39* and B-59* previously drilled by GET, soil strength and index properties and how they relate to the water lines installation along the project alignments are summarized below:

Stratum No.	Soil Type	PI(s)	SPT	Soil Expansivity	Soil Strength, tsf
I	Lean Clay (CL)	26	–	Moderately Expansive	0.48 – 1.50
II	Fat Clay (CH)	33 – 54	–	Expansive to Highly Expansive	0.23 – 1.92
	Fill: Fat Clay (CH)	–	–	Expansive	1.50
III	Silty Sand (SM)	–	18	Non-Expansive	–

6.3.3 Fairlawn, Northdale, Cherrydale and Nunn Streets (Borings B-16 through B-29)

Based on Borings B-16 through B-29, soil strength and index properties and how they relate to the water lines installation along the project alignments are summarized below:

Stratum No.	Soil Type	PI(s)	Soil Expansivity	Soil Strength, tsf
I	Lean Clay (CL)	13 – 30	Non-to Moderately Expansive	0.31 – 2.33
	Sitly Sand (SM)	–	Non-Expansive	–
II	Fat Clay (CH)	31 – 50	Expansive	0.15 – 2.18

6.3.4 Roxbury, Plainview, Kingsway and Cherrydale Streets (Borings B-30 through B-40)

Based on Borings B-30 through B-40, soil strength and index properties and how they relate to the water lines installation along the project alignments are summarized below:

Stratum No.	Soil Type	PI(s)	Soil Expansivity	Soil Strength, tsf
I	Fat Clay (CH)	33 – 44	Expansive	0.39 – 3.26
	Fat Clay with Sand (CH)	–	Expansive	1.01 – 1.50
II	Lean Clay (CL)	28 – 30	Moderately Expansive	0.62 – 1.74
III	Lean Clay with Sand (CL)	–	Moderately Expansive	1.24 – 1.50

6.3.5 Walnut, Richwod, Andwood and Chaffin Streets (Borings B-41 through B-49)

Based on Borings B-41 through B-49, soil strength and index properties and how they relate to the water lines installation along the project alignments are summarized below:

Stratum No.	Soil Type	PI(s)	Soil Expansivity	Soil Strength, tsf
I	Fat Clay with Sand (CH)	32 – 37	Expansive	0.46 – 1.50
II	Fat Clay (CH)	33 – 35	Expansive	0.69 – 3.53
III	Lean Clay (CL)	24 – 25	Moderately Expansive	0.62 – 2.38

Legend: PI = Plasticity Index
SPT = Standard Penetration Tests

6.4 Water-Level Measurements

The soil borings were first drilled dry to evaluate the presence of perched or free-water conditions. The levels where free water was encountered in the open boreholes during and about 0.5-hour after drilling are shown on the boring logs. Our groundwater measurements are summarized below:

Boring No.	Groundwater Depth, ft. at the Time of Drilling	Groundwater Depth, ft. at about 0.5 Hour Later
B-1 through B-16, B-18 through B-43 and B-45 through B-49	Dry	Dry
B-17	17	15
B-44	12	10

Fluctuations in groundwater generally occur as a function of seasonal moisture variation, temperature, groundwater withdrawal and future construction activities that may alter the surface drainage and subdrainage characteristics of this site.

An accurate evaluation of the hydrostatic water table in the relatively impermeable clays and low permeable sands/silts requires long term observation of monitoring wells and/or piezometers. It is not possible to accurately predict the pressure and/or level of groundwater that might occur based upon short-term site exploration. In view of this, Borings B-2, B-17 and B-37 were converted to Piezometers PZ-1 through PZ-3, respectively, after the completion of the field work. The piezometer readings are presented on Plate 22.

We recommend that GET be immediately notified if a noticeable change in groundwater occurs from that mentioned in our report. We would be pleased to evaluate the effect of any groundwater changes on our design and construction sections of this report.

7.0 WATER LINES

7.1 General

We understand that the invert depths of water lines will be ranging from 5- to 12-ft below the existing grade. Furthermore, trenchless method will be used for the water lines installations. Soil Borings B-1 through B-49 were drilled along the alignments of the water lines to the depths ranging from 10- to 17-ft below the existing grade. The borings schedule is presented in the "Field Exploration" in Section 4.0 of this report. The appropriate boring locations are shown on Plates 4 through 6. We understand that the proposed water lines will be constructed according to the City of Houston Specifications, Section 02447 – Augering Pipe and Conduit.

7.2 Trenchless and Trenchless Pits Method

We understand that trenchless method will be used for this project. The trenchless method should be conducted in accordance with the City of Houston Standard Specifications, Section 02447 – Augering Pipe and Conduit.

Trenchless method should be started from approved pit locations. Excavation for pits and shoring installation should conform to the aforementioned City of Houston Standard Specifications, Section 02317 – Excavation and Backfill for Utilities. The designing, constructing and maintaining safe excavations are the responsibility of the contractor. Detailed guidelines for trenchless pit excavations are presented in "Excavation" in Section 8.5 of this report.

If the trenchless zone is within the cohesionless soils or caving soils, install casing as required by the City of Houston Standard Specifications, Section 02447 – Augering Pipe and Conduit. The augering near existing structures or utility lines should be conducted in accordance with the City of Houston Standard Specification. Diameter of auger hole should not exceed pipe bell diameter plus 2-inch. The receiving pit distance should conform to the aforementioned City of Houston Standard Specifications. A minimum spacing of 6-inch should be provided between the pipe and walls of bore pit. The maximum allowable width of pit shall be 5-ft unless approved by the engineer. Width of pit at surface shall not be less than the pit width at the bottom.

7.3 Groundwater Control

Our short-term field exploration indicates that groundwater was encountered at depths ranging from 12- to 17-ft during drilling in Borings B-17 and B-44. Groundwater level rose to depths ranging from 10- to 15-ft after about 0.5-hour of drilling. However, no groundwater was encountered in the remaining borings. Furthermore, the results of Piezometers PZ-1, PZ-2 and PZ-3 indicated that stabilized groundwater level exist at a depth of about 11.5-to 14.5-ft below the ground surface. Therefore, groundwater dewatering may be required. A detailed groundwater control recommendations are presented in "Groundwater Control" in Section 8.3 of this report.

7.4 Loads Imposed on Buried Pipes

7.4.1 General

The loads on an underground pipe depend principally upon the weight of overburden soils, roadway and loads due to surcharges. For design of concrete pressure pipe, linear load due to overburden can be determined based on the design tables and charts presented in the "AWWA Manual of Water Supply Practices Concrete Pressure Pipe (AWWA M9)" developed by the American Concrete Pipe Association. Overburden pressure for the buried pipes at the project alignments are estimated by using the soil density (γ) and the height of the soil over the pipe (H).

7.4.2 Loads Due to Overburden Pressure

Overburden or prism load for buried pipes is given by the following equation:

$$P = \gamma H$$

Where: P = Load due to weight of soils at depth, psf
γ = Total Unit weight of soil, 125 pcf
H = Height of the soil over the pipe, ft

Loadings per linear foot of pipe:

$$W_e = C_d \gamma (B_d)^2 \text{ (Marston Equation)}$$

$$C_d = \frac{1 - e^{-2ku'\left(\frac{H}{B_d}\right)}}{2ku'}$$

Where: W_e = Load, pounds per linear foot (lb/ft)
B_d = Trench width (ft)
C_d = Load Coefficient
k = Friction angle between backfill and soil
u' = Coefficient of friction between fill material and sides of trench
ku' = for sand = 0.165
for clay = 0.130
for saturated clay = 0.110

7.4.3 Piping System Thrust Restraint

Fittings on underground pipes are subject to thrust forces inherited from the fluid pressure in the pipe and are directly proportional to the fluid pressure. Unbalance thrust forces will be developed in pressure pipelines due to changes in direction, cross-sectional areas, or when the pipe is terminated. These forces may cause joints to disengage if not adequately restrained. There will be a slight loss of head due to turbulence friction in bends of the pipes. This loss will cause a pressure change across the bend, but it is usually small enough to be neglected.

The thrust force may require more reaction than is available just from the pipe bearing against the backfill. In order to prevent intolerable movement and overstressing of the pipe, suitable buttressing should be provided. In general, thrust blocks, restrained joints and tie rods are common methods of providing reaction for the thrust restraint design. The thrust restraint design provisions described in this section are based on the American Water Works Association Manual M9 (1996)-Concrete Pressure Pipe.

The force diagram shown on Plate 23 illustrates the thrust force generated by flow at a bend in the pipe. The equations for computing this thrust force are also given on this plate. The values of thrust force for a surge pressure of 50 psi were computed for a bend angle of 90 degrees. Results are presented on Plate 23. Once the size of the thrust is determined, a thrust block size can be calculated based on the bearing capacity of the soil. The area of block required is equal to the thrust force (lb) divided by the safe bearing value of the soil (psf). In cohesive soils, the safe bearing value is equal to 2/3 of the average shear strength of the soil adjacent to the block which includes a factor of safety of 3. We believe that a factor of safety of 3 is appropriate in order to limit deflections required to mobilize the passive resistance within tolerable values.

For granular soil encountered at this site, a safe bearing value for thrust blocks can be taken as 90% of the effective overburden pressure at the mid height of the thrust block which includes a factor of safety of 3. The effective overburden pressure can be calculated based on the effective unit weight of the soil above the mid-height of the thrust block.

Geotechnical design parameters for designing the necessary buttressing are as follows:

γ : = Wet unit weight of soil − above water level : 125 pcf
Submerged unit weight of soil − below water level : 60 pcf
c : = Cohesion = 1000 psf (for clay)
ϕ : = Angle of internal friction = 30 degrees (for sand)

7.5 Backfilling for Trenchless Pits and Trenchless Holes

Sand used in backfill sections should be free of clay lumps, organic materials, or other deleterious substances, and should have a PI less than 7, and not more than 15% passing the No. 200 sieve.

Backfill should be placed in accordance with the City of Houston Specifications, Section 02317 – Excavation and Backfill for Utilities. City of Houston Standard Specifications Drawing No. 02447-01 should be followed when backfilling the auger pits. The annular space between the pipe and the auger hole should be backfilled to a minimum of 12-inch on both sides beyond the auger pit as indicated in the City of Houston Standard Specifications Drawing No. 02447-01.

8.0 CONSTRUCTION CONSIDERATIONS

8.1 Site Preparation

If needed, site preparation for the proposed water lines construction should be conducted in accordance with the City of Houston Standard Specifications, Section 02221 – Removing Existing Pavements and Structures and Section 02233 – Clearing and Grubbing. In general, subgrade preparation, if needed, should be as follows:

1. The requirement for removal of any existing paving, and subsoil materials will depend on final grades and other alignment information. In general, remove all vegetation, tree roots, organic topsoil, existing foundations, paved areas and any undesirable materials from the construction area. Tree trunks under the construction areas should be removed to a root size of less than 0.5-inch. We recommend that the stripping depth be evaluated at the time of construction by a soil technician.

2. The subgrade areas should then be proofrolled with a loaded dump truck or similar pneumatic-tired equipment with loads ranging from 25- to 50-tons. The proofrolling serves to compact surficial soils and to detect any soft or loose zones. The proofrolling should be conducted in accordance with TxDOT Standard Specification Item 216. Any soils deflecting excessively under moving loads should be undercut to firm soils and recompacted. Any subgrade stabilization should be conducted after site proofrolling is completed and approved by the geotechnical engineer. The proofrolling operations should be observed by an experienced geotechnician.

3. The surficial soils near Borings B-3, B-21 and B-23 are moisture sensitive, compressible and are difficult to compact in a wet condition (they may pump). These soils can be modified, using 5% to 10% Fly-ash. The Fly-ash stabilization should be in accordance with the City of Houston Standard Specifications, Section 02337 – Lime/Fly Ash Stabilized Subgrade.

4. Off-site borrow for structural fill should consist of lean clays with a liquid limit not exceeding 45 and a PI between 8 and 20. These soils should be placed in loose lifts not exceeding eight-inch and compacted to at least 95% of maximum standard density (ASTM D 698) at a moisture content between optimum and 3%. Bank sands should not be used as select structural fill. On-site soils with a liquid limit not exceeding 45 and a PI between 8 and 20, free of organics, (with the exception of sands and silts) are also suitable for use as structural fill. Off-site borrow should be in accordance with the City of Houston Standard Specifications, Section 02319 – Borrow.

5. In cut areas, the soil should be excavated to grade and the surficial soil proofrolled and scarified to a minimum depth of six-inch and recompacted to the previously mentioned density and moisture content.

6. Positive site drainage should be developed at the beginning of the project to limit construction difficulties with wet surface soils.

8.2 Suitability of On-Site Soils for Use as Fill

8.2.1 General

Fill requirements should be in accordance with the City of Houston Standard Specifications Section 02316 –Excavation and Backfill for Structures, Section 02317 – Excavation and Backfill for Utilities and Section 02320 – Utility Backfill Materials. The on-site soils can be used as fill materials as described in the following report sections.

8.2.2 Select Backfill

This is the type of fill that can be used for the structures or utilities. These soils should consist of lean clays with plasticity indices between 8 and 20 and amount of passing No. 200 sieve greater than 50 percent.

8.2.3 Random Backfill

This type of fill does not meet the Atterberg limit requirements for select structural fill. This fill should consist of lean clays or fat clays. They can be used for the structures or utilities after treatment.

8.2.4 General Fill

This type of fill could consist of silts, sands, clays or organic clays. However, the silts and sands are moisture sensitive and are difficult to compact in a wet condition (they may pump). Furthermore, these soils can erode easily. Their use is not recommended as backfill materials. They can be used for site grading and in unimproved areas.

8.2.5 On-Site Fill Soil Classification

8.2.5.1 Heiser Street Area (Borings B-1 through B-15)

Based on Borings B-1 through B-15, the on-site soils can be used as fill materials as described below:

Stratum No.[1]	Soil Type	Use as Fill: Select Structural Fill	Use as Fill: Structural Fill	Use as Fill: General Fill	Notes
I	Silty Sand (SM)	–	–	✓	2, 3
	Lean Clay (CL)	–	✓	✓	2, 4
	Fat Clay (CH)	–	✓	✓	2, 5
II	Lean Clay (CL)	–	✓	✓	2, 4

8.2.5.2 Tucker Street and Netherfield Area (Borings B-1*, B-23*, B-37* through B-39* andB-59*)

Based on Borings B-1*, B-23*, B-37* through B-39* andB-59*, the on-site soils can be used as fill materials as described below:

Stratum No.[1]	Soil Type	Use as Fill: Select Structural Fill	Use as Fill: Structural Fill	Use as Fill: General Fill	Notes
I	Lean Clay (CL)	–	✓	✓	2, 4
II	Fat Clay (CH)	–	✓	✓	2, 5
	Fill: Fat Clay (CH)	–	✓	✓	2, 6
III	Silty Sand (SM)	–	–	✓	2, 3

8.2.5.3 Fairlawn, Northdale, Cherrydale and Nunn Streets (Borings B-16 through B-29)

Based on Borings B-6 through B-29, the on-site soils can be used as fill materials as described below:

Stratum No.[1]	Soil Type	Use as Fill: Select Structural Fill	Use as Fill: Structural Fill	Use as Fill: General Fill	Notes
I	Lean Clay (CL)	–	✓	✓	2, 4
	Silty Sand (SM)	–	–	✓	2, 3
II	Fat Clay (CH)	–	✓	✓	2, 5

8.2.5.4 Roxbury, Plainview, Kingsway and Cherrydale Streets (Borings B-30 through B-40)

Based on Borings B-30 through B-40, the on-site soils can be used as fill materials as described below:

Stratum No.[1]	Soil Type	Use as Fill: Select Structural Fill	Use as Fill: Structural Fill	Use as Fill: General Fill	Notes
I	Fat Clay (CH)	–	✓	✓	2, 5
	Fat Clay with Sand (CH)	–	✓	✓	2, 5
II	Lean Clay (CL)	–	✓	✓	2, 4
III	Lean Clay with Sand (CL)	–	✓	✓	2, 4

8.2.5.5 Walnut, Richwood, Andwood and Chaffin Streets (Borings B-41 through B-49)

Based on Borings B-41 through B-49, the on-site soils can be used as fill materials as described below:

Stratum No.[1]	Soil Type	Use as Fill: Select Structural Fill	Use as Fill: Structural Fill	Use as Fill: General Fill	Notes
I	Fat Clay with Sand (CH)	–	✓	✓	2, 5
II	Fat Clay (CH)	–	✓	✓	2, 6
III	Lean Clay (CL)	–	✓	✓	2, 4

Notes:
1. See soil stratigraphy and design conditions sections of this report for strata description.
2. All fill soils should be free of organics, roots, etc.
3. The on-site cohesionless soils are moisture sensitive and erode easily. These soils will pump when they get wet. Compaction difficulties will occur in these soils in a wet condition.
4. Some of these soils, once lime modified (4% by dry weight), can be used as select structural fill.
5. These soils, once lime modified (6% by dry weight), can be used as select structural fill.
6. These soils, once lime modified (5% by dry weight), can be used as select structural fill.

8.3 Groundwater Control

8.3.1 General

We understand that the invert of the proposed water lines will be founded at depths ranging from 5- to 12-ft below the existing grade. Our short-term field exploration indicates that groundwater was encountered at depths ranging from 12- to 17-ft during drilling in Borings B-17 and B-44. Groundwater level rose to depths ranging from 10- to 15-ft after about 0.5-hour of drilling. However, no groundwater was encountered in the remaining borings. Furthermore, the results of Piezometers PZ-1, PZ-2 and PZ-3 indicated that stabilized groundwater level exist at a depth of 11.5-to 14.5-ft below the ground surface. Therefore, groundwater dewatering may be required. Therefore, groundwater dewatering system may be required.

Fluctuations in groundwater can occur as a function of seasonal moisture variation. Groundwater control recommendations are presented in the following report sections.

8.3.2 Dewatering Technique

In the event that groundwater is encountered during construction, it is our opinion that groundwater should be lowered to a depth of at least three-ft below the deepest excavation grade in order to provide dry working conditions and firm bedding. Any minor water inflow in cohesive soil layers can probably be removed using a sump-pump or trench sump-pump. Wellpoint system can be used in the area where silty sand soils are present.

Design of a dewatering system should consider the amount of groundwater to be lowered and the permeability of the affected soils. The selection and proper implementation of an effective groundwater control system is the responsibility of the contractor. The design of dewatering system for groundwater and surface water control should be in accordance with the City of Houston Specifications, Section 01578 − Control of Ground Water and Surface Water.

8.4 OSHA Soil Classifications

The subsoils can be classified in accordance with Occupational Safety and Health Administration (OSHA) Standards, dated October 31, 1989 of the Federal Register. OSHA classification system categorizes the soil and rock in four types based on shear strength and stability. The description of four (4) types in classification system is summarized in the Appendix D.

Based on our geotechnical exploration and laboratory test results, details of soil classifications at each boring are summarized in the OSHA Soil Classification, presented in Appendix D. Furthermore, a letter for trench safety recommendation is provided separately.

8.5 Excavations

If open excavation or trench, five-ft or deeper is needed, each side of the excavation or trench must be protected by sheeting/bracing shoring or sloped. Based on soil strength data and OSHA soil classifications, temporary (less than 24 hours) open-trenched, non-surcharged, and unsupported excavations should be made on slopes of about 1.5(h):1(v). Vertical cuts can be constructed, provided shoring and bracing are used for the excavation wall stability. Benched excavation can also be used with average slopes of about 1(h):1(v) and steps should not be higher than five-ft. In all cases, excavations should conform to OSHA guidelines. Flatter slopes may have to be used if large amounts of sand need to be excavated for deep utility installations. Specifications should require that no water be allowed to pond in the excavations. The surface slopes should be protected from deterioration and weathering if they are to be left open for more than 24 hours. It is our opinion that the method, means and sequence of construction excavation should be the responsibility of the contractor.

Excavations should be performed with equipment capable of providing a relatively clean bearing area. Excavation equipment should not disturb the soil beneath the design excavation bottom and should not leave large amounts of loose soil in the excavation.

8.6 Lateral Earth Pressures

In the event that open excavations are not used, the proposed water lines can be installed using trench sheeting. The sheeting can be constructed in the form of cantilever sheeting or with bracing. Lateral earth pressures for each method used are summarized on Plate 24. The trenching and shoring operations should follow OSHA Standards. We recommend a geotechnical engineer monitor all phases of trench excavation and bracing to assure trench safety.

8.7 Surface Water Drainage

In order to minimize ponding of surface water, site drainage should be established early in project construction so that this condition will be controlled.

8.8 Earthwork

8.8.1 General

Difficult access and workability problems can occur in the surficial soils due to poor site drainage, wet season, or site geohydrology. Based on the laboratory test results, the subsurface soils at the project site consists of lean clay (CL), fat clay (CH) and silty sand (SM) soils. Considering the soils stratigraphy, the construction of this project is recommended to be done during the dry season to avoid major earthwork problems. Our recommendations for earthwork activity for areas with cohesive and cohessionless soils are provided separately.

8.8.2 Earthwork for Cohesive Soils

Difficult access and workability problems can occur in the surficial clay soils due to poor site drainage, wet season, or site geohydrology. Should this condition develop, drying of the soils for support of pavement may be improved by the addition of 6% lime by dry weight. The application rate corresponding to this additive amount would be approximately 27 pounds per square yard for each six-inch of compacted thickness.

City of Houston Standard Specifications, Section 02336 – Lime Stabilized Subgrade, shall be used as procedural guides for placing, mixing, and compacting lime stabilizer and the soils.

Our recommendations on subgrade stabilization are preliminary. The actual depth and type of stabilization should be determined in the field at the time of construction just after site stripping and proofrolling. The required amount of lime for stabilization should be determined by ASTM C 977 Method. Furthermore, the type and amount of the stabilizer may vary depending on the final grade elevation and the soil type encountered.

Provided the site work is performed during dry weather and/or project schedules permit aeration of wet soils, the subgrade will be suitable for floor slab and pavement support.

8.8.3 Earthwork for Cohesionless Soils

In the event the subgrade soils become wet and experience pumping problems, they can be (a) improving drainage, (b) opened up to dry up, (c) removed and replaced with dry cohesive soils or (d) chemically modified or stabilized. These alternatives are discussed in the following report sections.

8.8.3.1 Improving Drainage

The project site drainage in the pumping soils can be accomplished by placing several shallow ditches (about 18-inches ±) in the surficial cohesionless soils. These ditches should be directed to a low area, such as a hole or another ditch in the lowest elevation area of the site. This will allow the surficial soils to drain the water and make the drying process faster. The hole/low area should not be under the building areas. The excess water can be pumped out of the hole and moved off-site.

8.8.3.2 Subgrade Drying

The on-site wet soils can be opened up so that it would dry up. However, opening up the surficial cohesionless soils for drying purposes may not be practical, due to cyclic rainfall in the Gulf-Coast area.

8.8.3.3 Removal and Replacement

The subgrade cohesionless soils encountered in borings B-3, B-21 and B-23 can be removed and replaced with select structural fill. The actual depth of removal and replacement should be evaluated in the field, but it can be whole thickness of surficial cohesionless soils. This procedure will include removal of the surficial cohesionless soils, proofrolling and compacting the subgrade cohesive soils to a minimum of 95 percent standard Proctor density (ASTM D 698). The site can then be backfilled with select structural fill, compacted to a minimum of 95 percent of standard Proctor density. The proofrolling should be in accordance with the site preparation section of this report. All of the fill soils should be placed and tested in accordance with the site preparation section of this report.

8.8.3.4 Modification/Stabilization

We recommend that the on-site cohesionless soils be modified (to dry up), using 5 to 10 percent fly ash by dry weight. The fly ash stabilization should be in accordance to City of Houston Standard Specification, 02337 – Lime/Fly Ash Stabilized Subgrade. The estimated amounts of fly ash per depth of modification are as follows:

Modification Depth, in.	Fly Ash Weight Range, lbs. per Square Yard
6	23 − 45
12	46 − 90
18	69 − 135
24	92 − 180

We recommend that five percent fly ash be used if the surficial soils are relatively moist at the time of application. Higher levels (10 percent) of fly ash should be used if wet and soggy subgrade soils are encountered.

The subgrade soils should be removed to a depth of 24-inch (or more) below existing grade. These soils should be stockpiled. The soils below a depth of 24-inch should be modified to a depth of 12-inch. These soils should be compacted to a minimum of 95 percent of standard Proctor density (ASTM D 698). The stockpiled soils should then be modified and replaced in six-inch lifts and compacted to 95 percent of maximum dry density as determined by ASTM D 698 at moisture contents within ±2 percent of optimum.

Due to poor drainage and the depth of the cohesionless soils, the depth of stabilization may be as deep as depth of cohesionless soils. A test section can be implemented for this purpose. The subgrade soils should be modified in six-inch lifts and compacted within four hours of mixing and placement. All of the subgrade soils should be compacted to a minimum of 95 percent of the standard Proctor density at the moisture content with optimum. The degree of compaction for the lifts, below a depth of 24-inch can be relaxed to 90 percent of maximum dry density to ease the construction procedures.

The subcontractor who will be doing the subgrade modification or stabilization should be experienced with stabilization procedures and methods. Furthermore, all of the earthwork at this project should be monitored by our geotechnician to assure compliance with the project specifications.

Once the subgrade is constructed, the soils at the top of subgrade should be slicked and the subgrade needs to be crowned such that the all surface water would drain away. No low areas should be left within the subgrade areas, since these areas would hold water and destroy the subgrade structure.

8.9 Construction Surveillance

Construction surveillance and quality control tests should be planned to verify materials and placement in accordance with the specifications. The recommendations presented in this report were based on a discrete number of soil test borings. Soil type and properties may vary across the site. As a part of quality control, if this condition is noted during the construction, we can then evaluate and revise the design and construction to minimize construction delays and cost overruns. We recommend the following quality control procedures be followed by a qualified engineer or technician during the construction of the facilities:

- Monitor all phases of trench safety (if trench is used).
- Observe the site stripping and proofrolling.
- Verify the type, depth and amount of stabilizer.
- Verify the compaction of subgrade soils and backfill soils.
- Evaluate the quality of fill and monitor the fill compaction for all lifts.
- Observe the foundation make-up prior to concrete placement.
- Monitor and test the excavations for strength, cleanness, depth, size, etc.
- Observe all excavation operations.
- Monitor concrete placement, conduct slump tests and make concrete cylinders

It is the responsibility of the client to notify GET when each phase of the construction is taking place so that proper quality control and procedures are implemented.

9.0 RECOMMENDED ADDITIONAL STUDIES

This report has been based on assumed conditions/characteristics of the proposed development where specific information was not available. It is recommended that civil engineer along with any other design professionals involved in this project carefully review these assumptions to ensure they are consistent with the actual planned development. When discrepancies exist, they should be brought to our attention to ensure they do not affect the conclusions and recommendations provided herein. We recommend that GET be retained to review the plans and specifications to ensure that the geotechnical related conclusions and recommendations provided herein have been correctly interpreted as intended.

10.0 STANDARD OF CARE

The recommendations described herein were conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the geotechnical engineering profession practicing contemporaneously under similar conditions in the locality of the project. No other warranty or guarantee, expressed or implied, is made other than the work was performed in a proper and workmanlike manner.

11.0 REPORT DISTRIBUTION

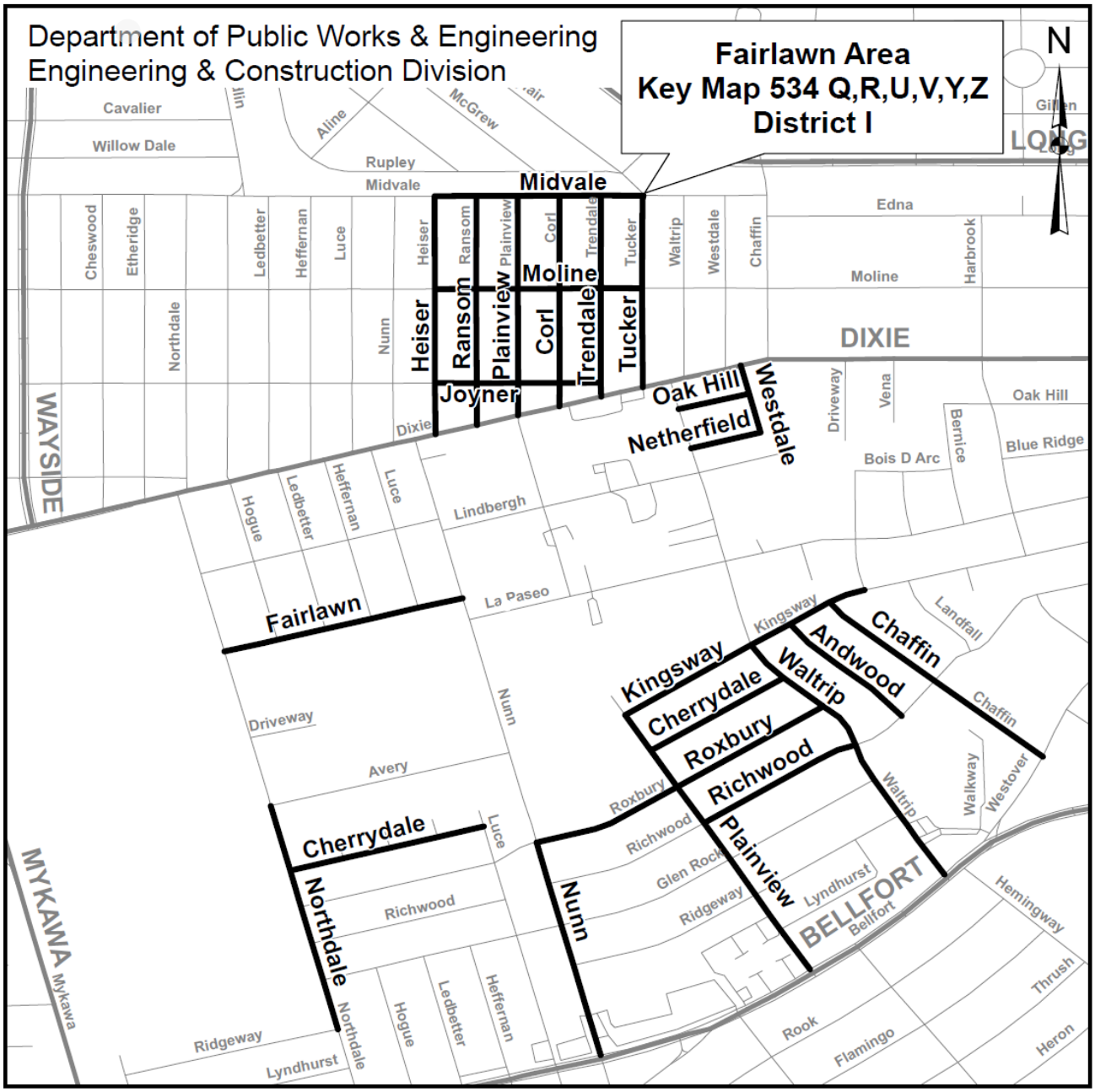
This report was prepared for the sole and exclusive use by our client (Quadrant Consultants, Inc.) and owner (City of Houston), based on specific and limited objectives. All reports, boring logs, field data, laboratory test results, maps and other documents prepared by GET as instruments of service shall remain the property of GET. GET assumes no responsibility or obligation for the unauthorized use of this report by other parties and for purposes beyond the stated project objectives and work limitations.

12.0 REFERENCES

1. "Standard Construction Specifications for Wastewater Collection Systems, Water Lines, Storm Drainage, Street Paving and Traffic", Department of Public Works and Engineering, City of Houston, July 2012.

2. Harris County Flood Control District, 2006. Principal Active Faults in Harris County, Texas.

Water Line Replacement in Fairlawn Area
WBS No. S-000035-0186-4

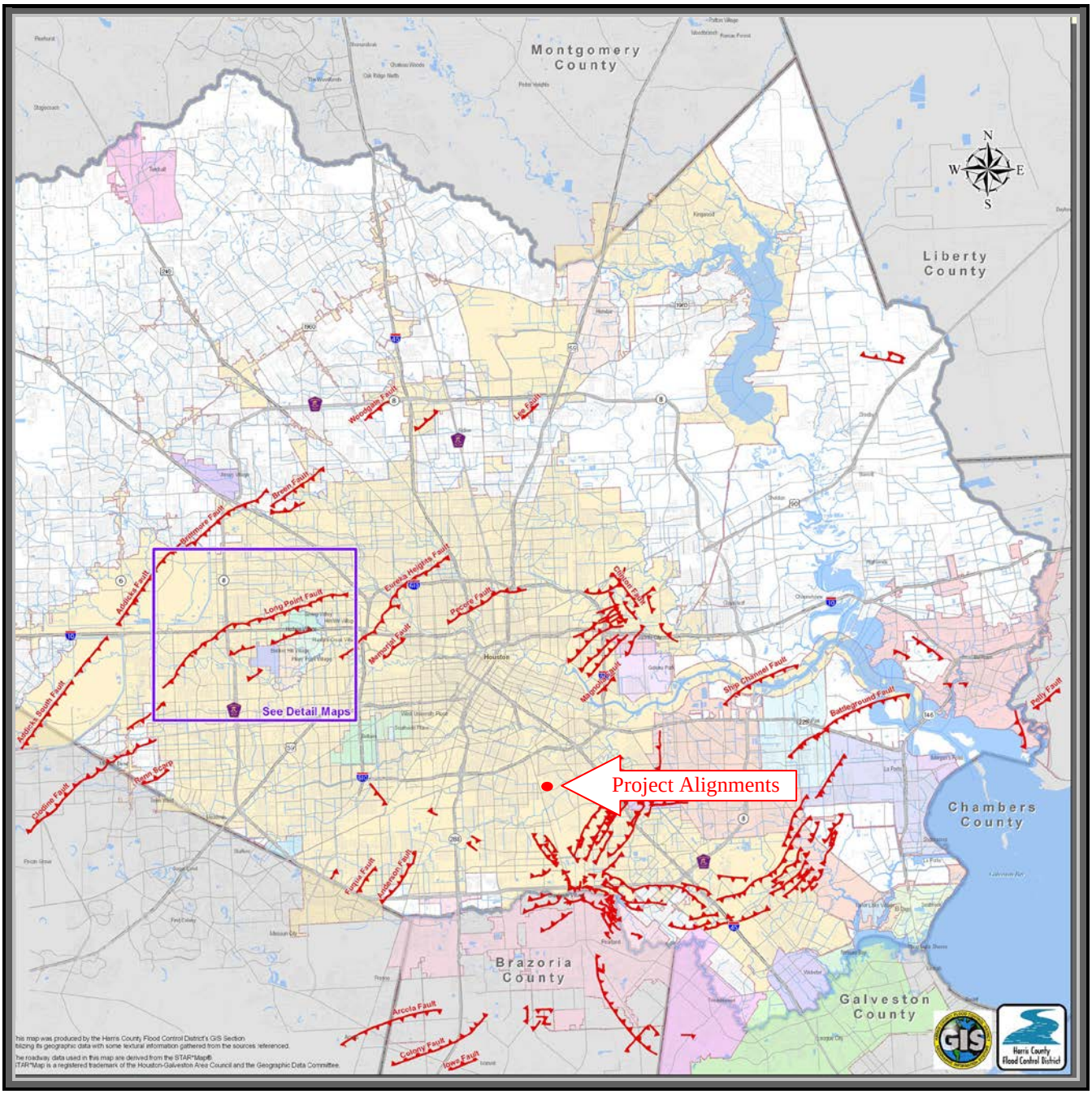


SITE VICINITY MAP

NORTH

PROJECT: Geotechnical Study, Proposed Water Lines Replacement in Fairlawn Area
WBS No. S-000035-0186-4, City of Houston, Texas

SCALE: 1'=500-ft	DATE: NOVEMBER 2014	PROJECT NO.: 14-319E



FAULTS IN THE HARRIS COUNTY AREA (Project alignment location is approximate)

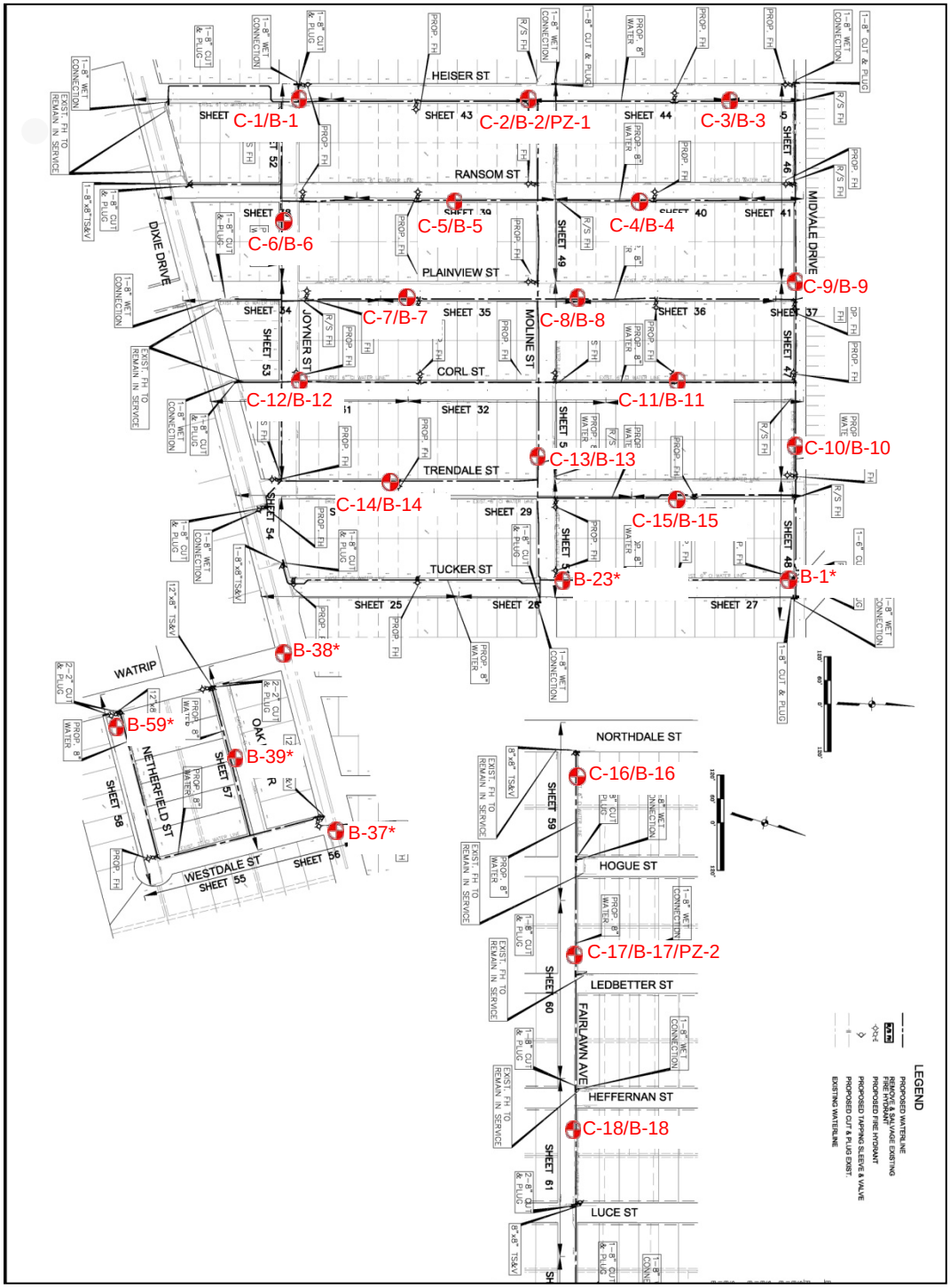
NORTH

PROJECT: Geotechnical Study, Proposed Water Lines Replacement in Fairlawn Area
WBS No. S-000035-0186-4, City of Houston, Texas

SCALE: NOT TO SCALE	DATE: NOVEMBER 2014	PROJECT NO.: 14-319E

EXISTING PAVEMENT THICKNESS

Location	Pavement Thickness, inches		Location	Pavement Thickness, inches	
	Asphalt	Concrete		Asphalt	Concrete
C-1/B-1	3.6	–	C-26/B-26	3.0	6.0
C-2/B-2	2.0	–	C-27/B-27	2.3	6.4
C-3/B-3	2.3	–	C-28/B-28	3.0	5.8
C-4/B-4	2.0	6.0	C-29/B-29	3.0	8.3
C-5/B-5	10.0	–	C-30/B-30	3.0	6.0
C-6/B-6	9.0	–	C-31/B-31	6.7	–
C-7/B-7	9.0	–	C-32/B-32	2.5	6.0
C-8/B-8	2.5	–	C-33/B-33	2.8	6.5
C-9/B-9	2.0	6.0	C-34/B-34	2.5	5.0
C-10/B-10	2.0	6.0	C-35/B-35	3.0	5.0
C-11/B-11	2.5	–	C-36/B-36	2.8	4.6
C-12/B-12	2.5	–	C-37/B-37	2.5	4.0
C-13/B-13	2.5	–	C-38/B-38	3.0	5.0
C-14/B-14	2.5	–	C-39/B-39	3.0	5.0
C-15/B-15	2.5	–	C-40/B-40	3.0	5.0
C-16/B-16	3.4	5.6	C-41/B-41	3.0	5.0
C-17/B-17	2.0	6.5	C-42/B-42	2.2	5.0
C-18/B-18	4.7	3.0	C-43/B-43	2.0	5.0
C-19/B-19	12.0	–	C-44/B-44	3.0	4.6
C-20/B-20	10.5	–	C-45/B-45	3.0	5.0
C-21/B-21	9.5	–	C-46/B-46	10.0	–
C-22/B-22	11.2	–	C-47/B-47	3.3	4.8
C-23/B-23	10.5	–	C-48/B-48	–	6.0
C-24/B-24	–	5.3	C-49/B-49	–	6.5
C-25/B-25	–	5.2			



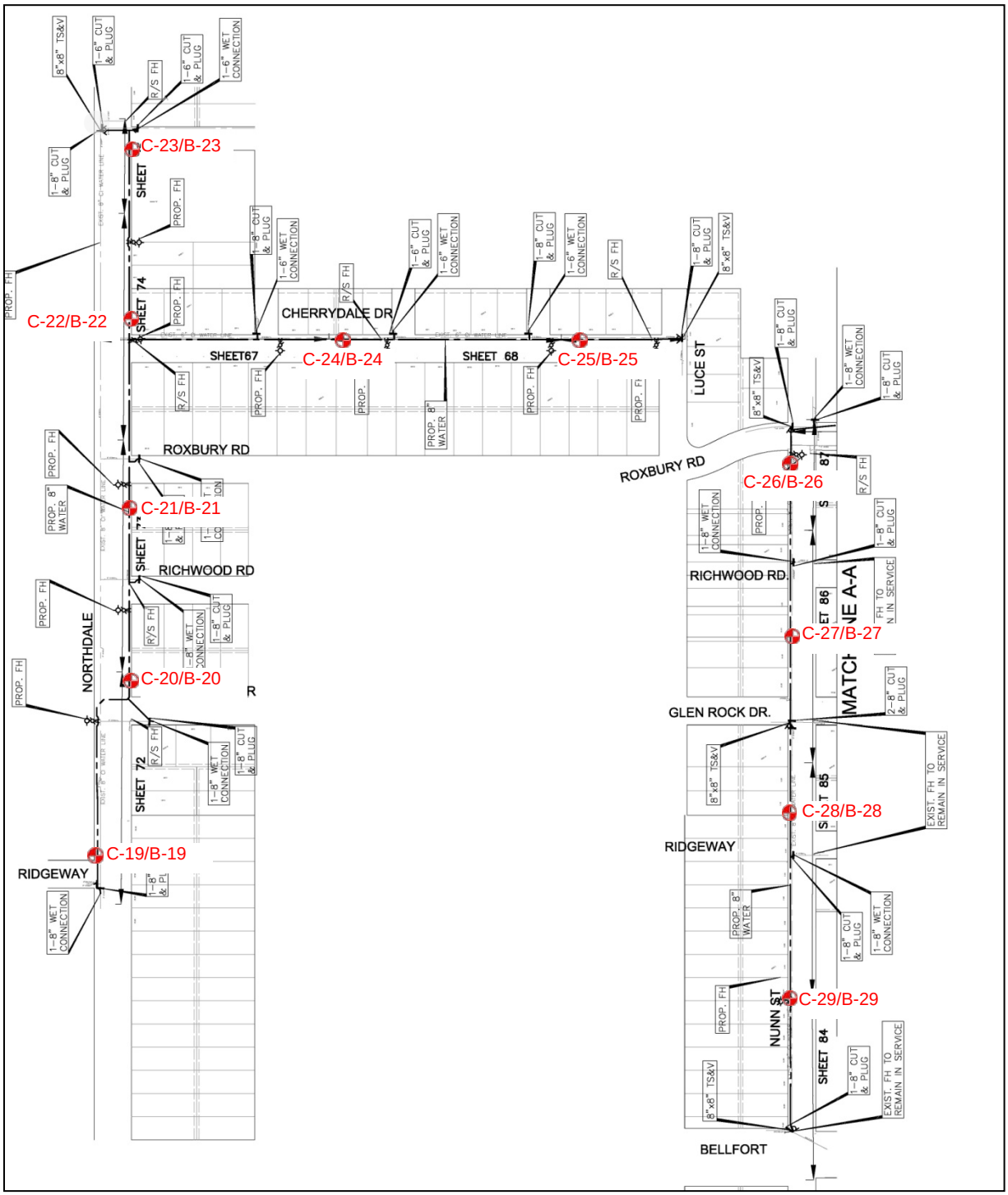
Legend: C-1: Coring C-1
B-1: Boring B-1
PZ-1: Piezometer PZ-1
B-1*: Boring B-1*, B-23*, B-37*, B-38*, B-39* and B-59* were previously drilled by GET (GET Report No. 05-869E, Dated April 06, 2006)

PLAN OF BORINGS (borings locations are approximate)

NORTH

PROJECT: Geotechnical Study, Proposed Water Line Replacement in Fairlawn Area
WBS No. S-000035-0186-4, City of Houston, Texas

SCALE: 1" = 420-FT	DATE: NOVEMBER 2014	PROJECT NO.: 14-319E



Legend:

C-19: Coring C-19

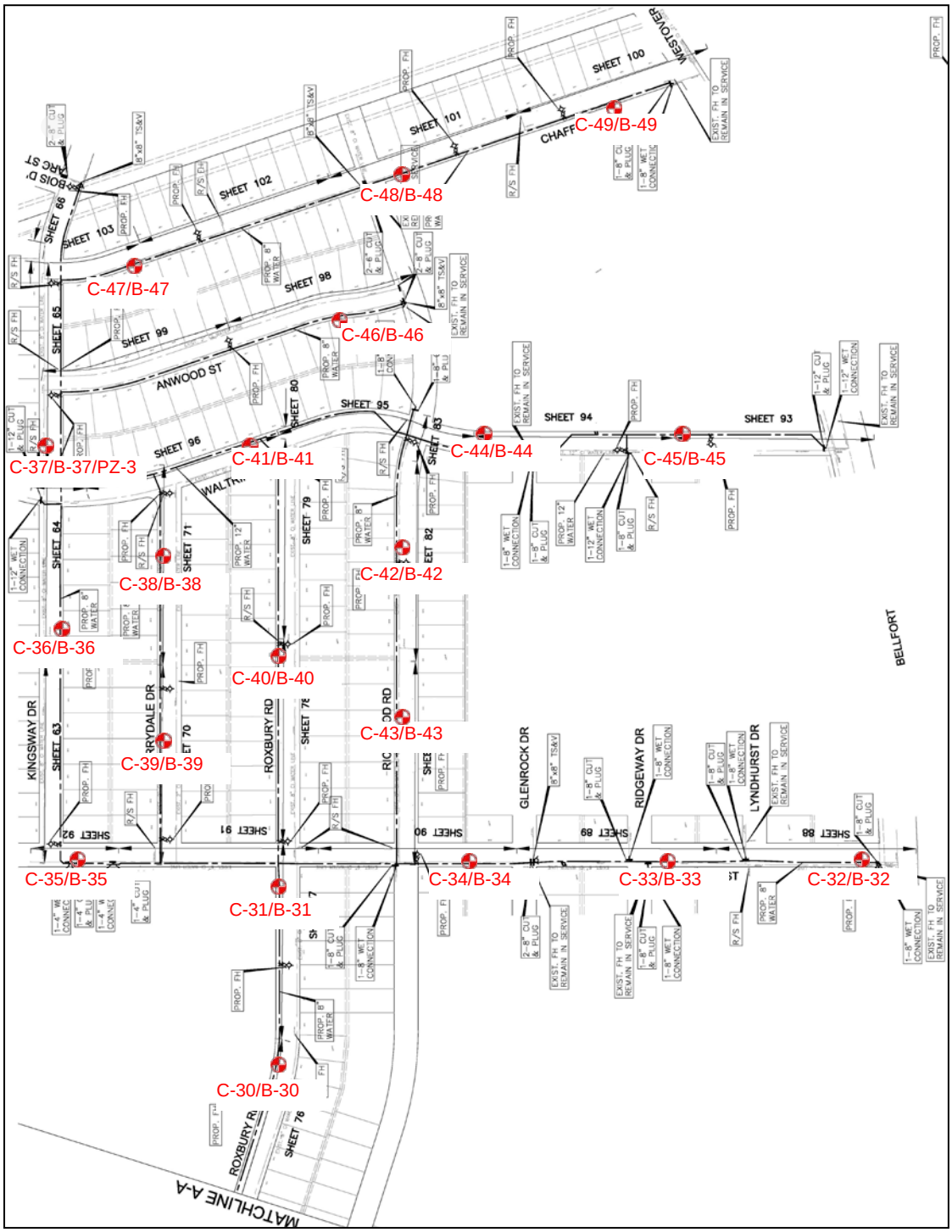
B-19: Boring B-19

PLAN OF BORINGS (borings locations are approximate)

NORTH

PROJECT: Geotechnical Study, Proposed Water Line Replacement in Fairlawn Area
WBS No. S-000035-0186-4, City of Houston, Texas

SCALE: 1" = 350-FT	DATE: NOVEMBER 2014	PROJECT NO.: 14-319E



Legend:

C-30: Coring C-30
B-30: Boring B-30
PZ-3: Piezometer PZ-3

PLAN OF BORINGS (borings locations are approximate)

NORTH

PROJECT: Geotechnical Study, Proposed Water Line Replacement in Fairlawn Area
WBS No. S-000035-0186-4, City of Houston, Texas

SCALE: 1"=420-FT	DATE: NOVEMBER 2014	PROJECT NO.: 14-319E

SUMMARY OF BORING INFORMATION

Geotechnical Study, Proposed Water Lines Replacement in Fairlawn Area,
WBS No. S-000035-0186-4, City of Houston, Texas

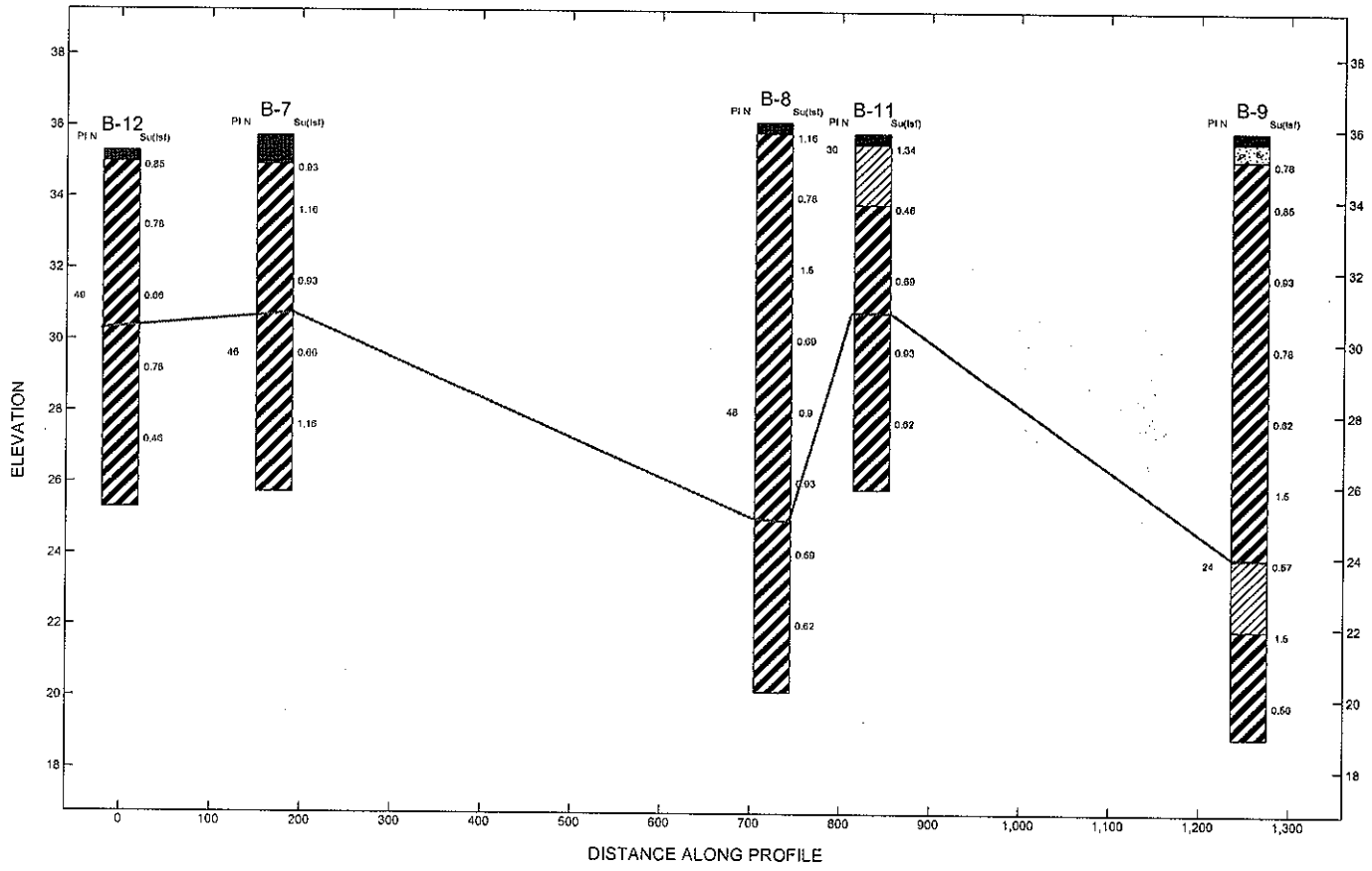
BORE HOLE TABLE									
POINT #	DESCRIPTION	STATION	OFFSET L=-, R=+	BASELINE	SURFACE NORTHING	SURFACE EASTING	GRID NORTHING	GRID EASTING	ELEVATION
20019	BH 1	6+45.80	10.55R	A	13815367.21	3139744.21	13813758.88	3139378.69	36.16'
20020	BH 2	10+19.93	13.73R	A	13815741.24	3139734.88	13814132.87	3139369.36	36.30'
20021	BH 3	16+46.00	12.86R	A	13816366.93	3139713.08	13814758.48	3139347.57	35.62'
20015	BH 4	14+56.91	11.37L	B	13816250.20	3139942.89	13814641.77	3139577.35	35.72'
20016	BH 5	8+75.27	9.26L	B	13815668.95	3139964.43	13814060.59	3139598.89	35.90'
20027	BH 6	4+44.34	11.09L	I	13815236.28	3140057.55	13813627.97	3139691.99	35.58'
20012	BH 7	5+78.52	6.18R	C	13815440.95	3140237.64	13813832.61	3139872.07	35.73'
20011	BH 8	11+43.90	3.75R	C	13816005.94	3140216.32	13814397.53	3139850.75	36.15'
20002	BH 9	5+35.41	7.73L	G	13816525.25	3140105.56	13814916.79	3139740.00	35.92'
20003	BH 10	10+30.15	9.86L	G	13816543.92	3140599.96	13814935.45	3140234.34	35.95'
20001	BH 11	12+34.11	7.82L	D	13816173.76	3140449.27	13814565.34	3140083.67	35.85'
20024	BH 12	3+86.32	9.49R	D	13815327.03	3140494.91	13813718.70	3140129.30	35.29'
20006	BH 13	10+42.95	8.98L	H	13815903.81	3140634.16	13814295.42	3140268.54	35.71'
20007	BH 14	5+04.07	7.98L	E	13815517.19	3140721.20	13813908.84	3140355.57	35.85'
20008	BH 15	12+11.08	5.69L	E	13816223.88	3140699.87	13814615.45	3140334.24	36.09'
70012	BH 16	2+36.45	7.39R	M	13813336.42	3138631.40	13811728.33	3138266.01	35.77'
70011	BH 17	6+47.96	8.34R	M	13813451.61	3139026.45	13811843.50	3138661.02	36.26'
70010	BH 18	11+22.54	7.88R	M	13813585.95	3139481.62	13811977.83	3139116.13	35.60'
70001	BH 19	-1+98.97	3.35L	N	13810369.46	3139395.56	13808761.71	3139030.09	37.86'
70002	BH 20	6+95.00	5.33R	N	13811229.52	3139151.54	13809621.68	3138786.10	37.88'

SUMMARY OF BORING INFORMATION

Geotechnical Study, Proposed Water Lines Replacement in Fairlawn Area,
WBS No. S-000035-0186-4, City of Houston, Texas

BORE HOLE TABLE									
POINT #	DESCRIPTION	STATION	OFFSET L=-, R=+	BASELINE	SURFACE NORTHING	SURFACE EASTING	GRID NORTHING	GRID EASTING	ELEVATION
70003	BH 21	9+57.27	3.95R	N	13811480.73	3139076.18	13809872.85	3138710.74	36.86'
70004	BH 22	14+07.29	2.57R	N	13811912.06	3138947.83	13810304.14	3138582.40	37.36'
70005	BH 23	18+23.54	3.39R	N	13812311.62	3138831.10	13810703.65	3138465.69	37.46'
70006	BH 24	6+02.75	7.29L	O	13811955.81	3139420.46	13810347.88	3139054.98	34.65'
70007	BH 25	11+08.87	5.72L	O	13812098.05	3139906.18	13810490.10	3139540.65	34.80'
70018	BH 26	16+11.34	8.18R	P	13811971.16	3140482.53	13810363.22	3140116.93	35.24'
70017	BH 27	12+78.75	7.19R	P	13811651.98	3140576.05	13810044.08	3140210.44	35.47'
70016	BH 28	9+12.01	7.69L	P	13811296.11	3140665.95	13809688.26	3140300.32	35.85'
70020	BH 29	4+29.02	12.30L	P	13810831.70	3140798.70	13809223.90	3140433.06	35.46'
70015	BH 29	4+28.92	12.30L	P	13810831.61	3140798.73	13809223.81	3140433.09	35.46'
70028	BH 30	4+59.63	5.59L	X	13812156.22	3140768.19	13810548.27	3140402.56	35.44'
70027	BH 31	9+91.75	5.78L	X	13812430.28	3141219.81	13810822.29	3140854.13	34.44'
70031	BH 32	2+84.85	10.31L	Q	13811315.05	3142053.83	13809707.19	3141688.05	33.82'
70030	BH 33	6+71.96	6.75L	Q	13811637.70	3141839.90	13810029.81	3141474.14	34.38'
70029	BH 34	14+98.24	7.50L	Q	13812321.57	3141376.16	13810713.59	3141010.45	34.84'
70026	BH 35	21+47.19	6.73L	Q	13812859.20	3141012.71	13811251.16	3140647.05	35.08'
70035	BH 36	5+86.84	8.08R	U	13813210.35	3141340.68	13811602.27	3140974.98	34.56'
70036	BH 37	11+75.31	5.90L	U	13813551.90	3141820.09	13811943.78	3141454.34	34.07'
70040	BH 38	9+28.46	3.89L	V	13813166.95	3141782.62	13811558.88	3141416.87	34.82'
70041	BH 39	4+68.01	6.00L	V	13812910.37	3141400.28	13811302.33	3141034.57	34.57'

BORE HOLE TABLE									
POINT #	DESCRIPTION	STATION	OFFSET L=-, R=+	BASELINE	SURFACE NORTHING	SURFACE EASTING	GRID NORTHING	GRID EASTING	ELEVATION
70032	BH 40	15+08.04	5.47L	X	13812719.64	3141647.39	13811111.62	3141281.65	34.93'
70039	BH 41	16+87.65	5.25R	R1	13813131.81	3142050.77	13811523.74	3141684.99	34.81'
20039	BH 42	10+08.45	4.99L	W	13812722.54	3142180.13	13811114.51	3141814.33	33.28'
20040	BH 43	3+33.19	6.00L	W	13812344.53	3141620.59	13810736.56	3141254.85	34.24'
20038	BH 44	10+38.32	5.72R	R1	13812625.87	3142428.67	13811017.86	3142062.84	34.27'
20043	BH 45	6+17.11	6.22R	R1	13812277.29	3142665.11	13810669.32	3142299.26	33.14'
20035	BH 46	4+11.97	5.25R	S	13813204.76	3142417.20	13811596.68	3142051.38	33.56'
20030	BH 47	15+34.25	5.29R	T	13813602.25	3142356.74	13811994.13	3141990.92	34.20'
20031	BH 48	8+43.23	5.74L	T	13813175.65	3142900.46	13811567.57	3142534.58	32.76'
20032	BH 49	3+25.02	5.01L	T	13812862.89	3143313.65	13811254.85	3142947.72	32.81'



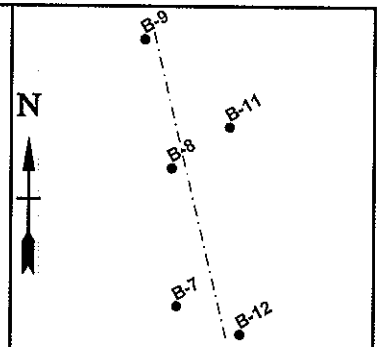
Lithology Graphics

Asphalt

Lean Clay (CL)

Fat Clay (CH)

Concrete



Site Map Scale 1 inch equals 735 feet

Explanation

B-11 — Borehole Number

Borehole Lithology

Water Level Reading at time of drilling.

Water Level Reading after drilling.

0 200

Horizontal Scale

Vertical Exaggeration: 40x

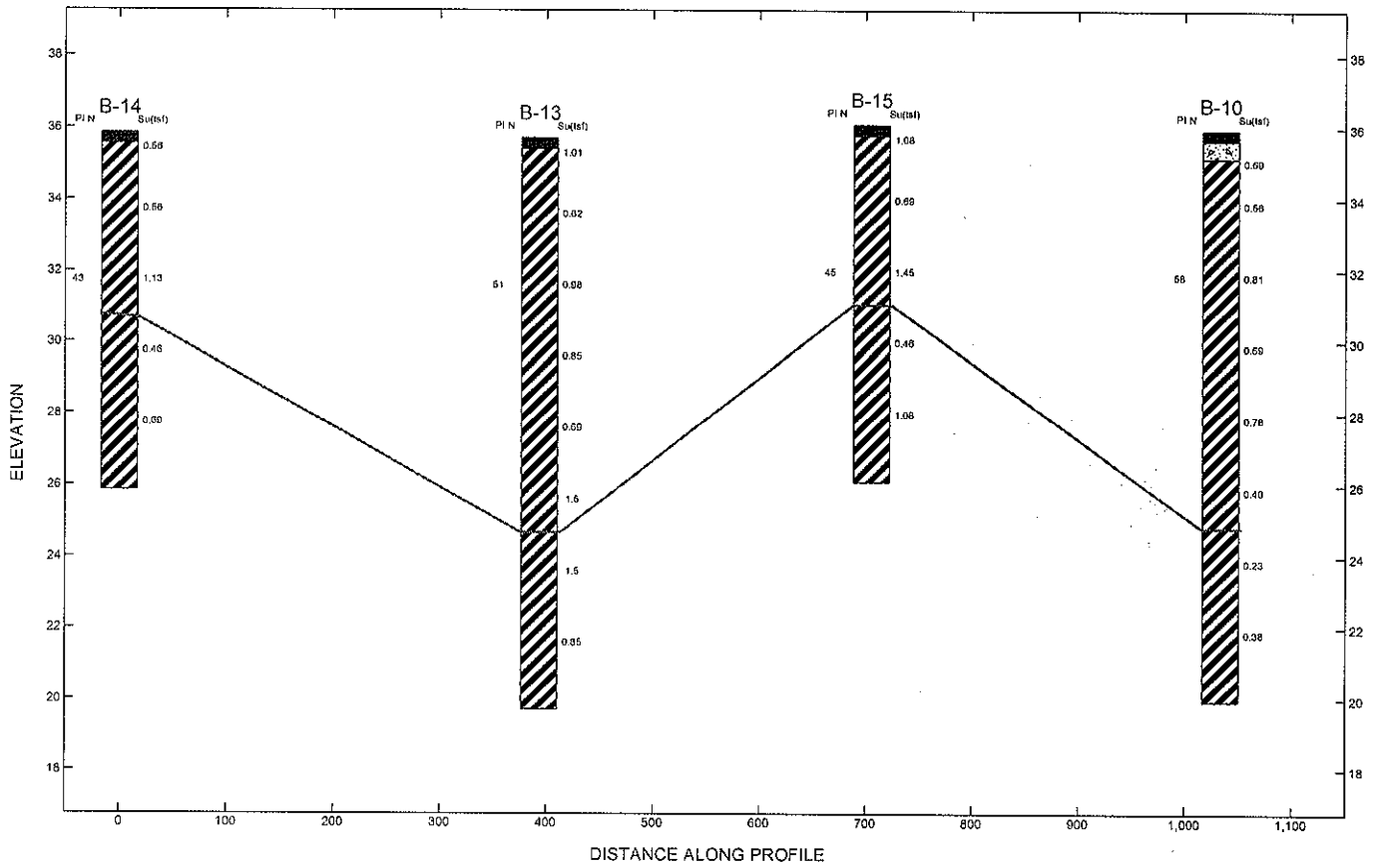
Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022

Proposed Water Line Replacement in Fairlawn Area

City of Houston, Texas

JOB NUMBER	PLATE NUMBER
S-000035-0186-4	Plate 10

BERNARD 14-319E.GPJ FANWNL01.GDT 10/14/14

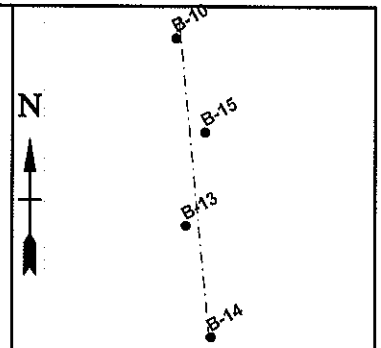


Lithology Graphics

Asphalt

Concrete

Fat Clay (CH)



Site Map Scale 1 inch equals 620 feet

Explanation

B-10 — Borehole Number

Borehole Lithology

Water Level Reading at time of drilling.

Water Level Reading after drilling.

0 169

Horizontal Scale

Vertical Exaggeration: 34x

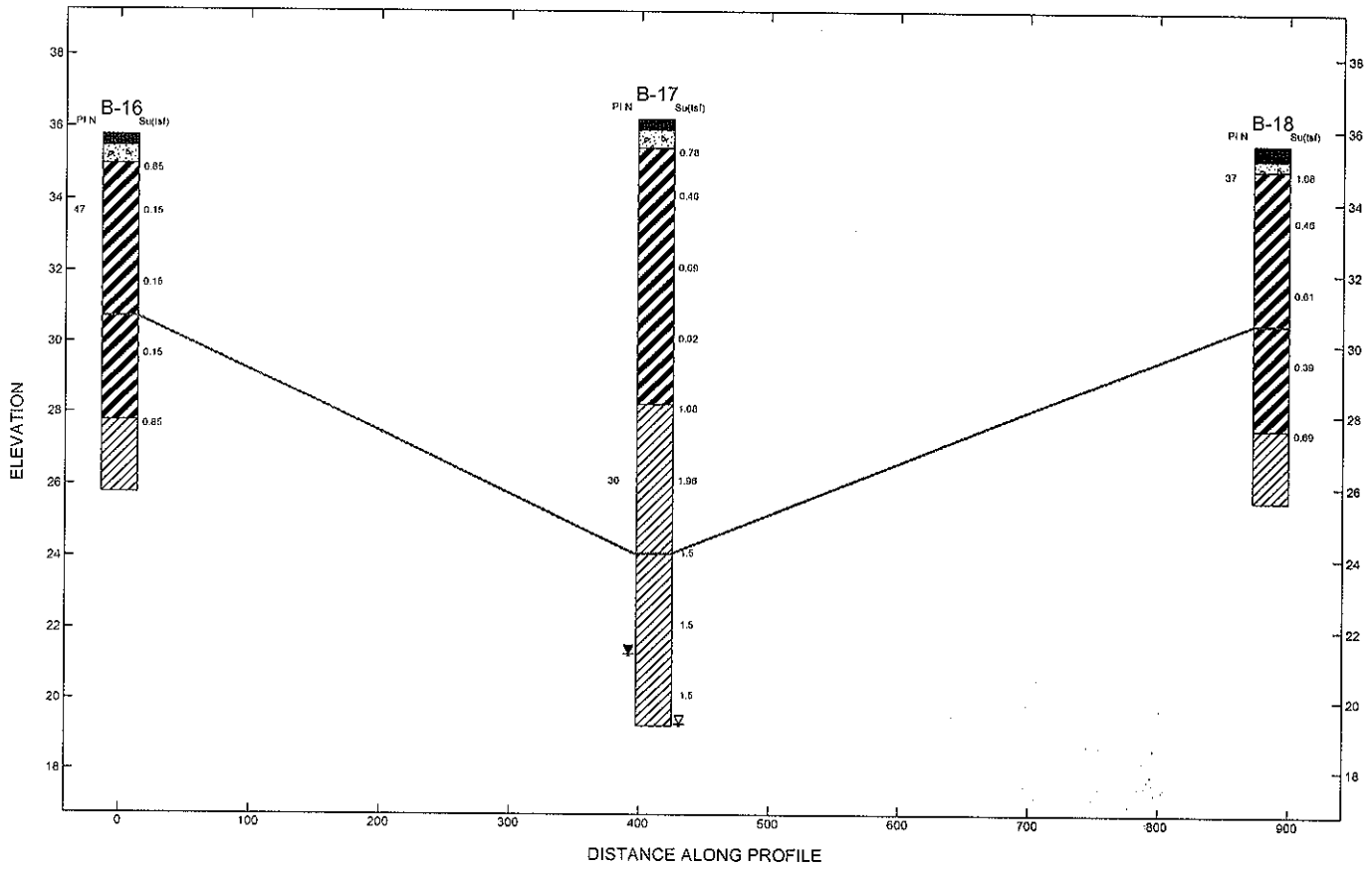
Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022

Proposed Water Line Replacement in Fairlawn Area

City of Houston, Texas

JOB NUMBER	PLATE NUMBER
S-000035-0186-4	Plate 11

BERNARD 14-319E.GPJ FANWNL01.GDT 10/14/14



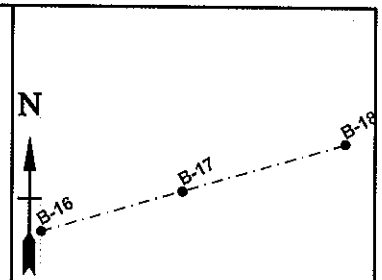
Lithology Graphics

Asphalt

Concrete

Fat Clay (CH)

Lean Clay (CL)



Site Map Scale 1 inch equals 510 feet

Explanation

B-16 — Borehole Number

Borehole Lithology

Water Level Reading at time of drilling.

Water Level Reading after drilling.

0 — 138

Horizontal Scale

Vertical Exaggeration: 27.5x

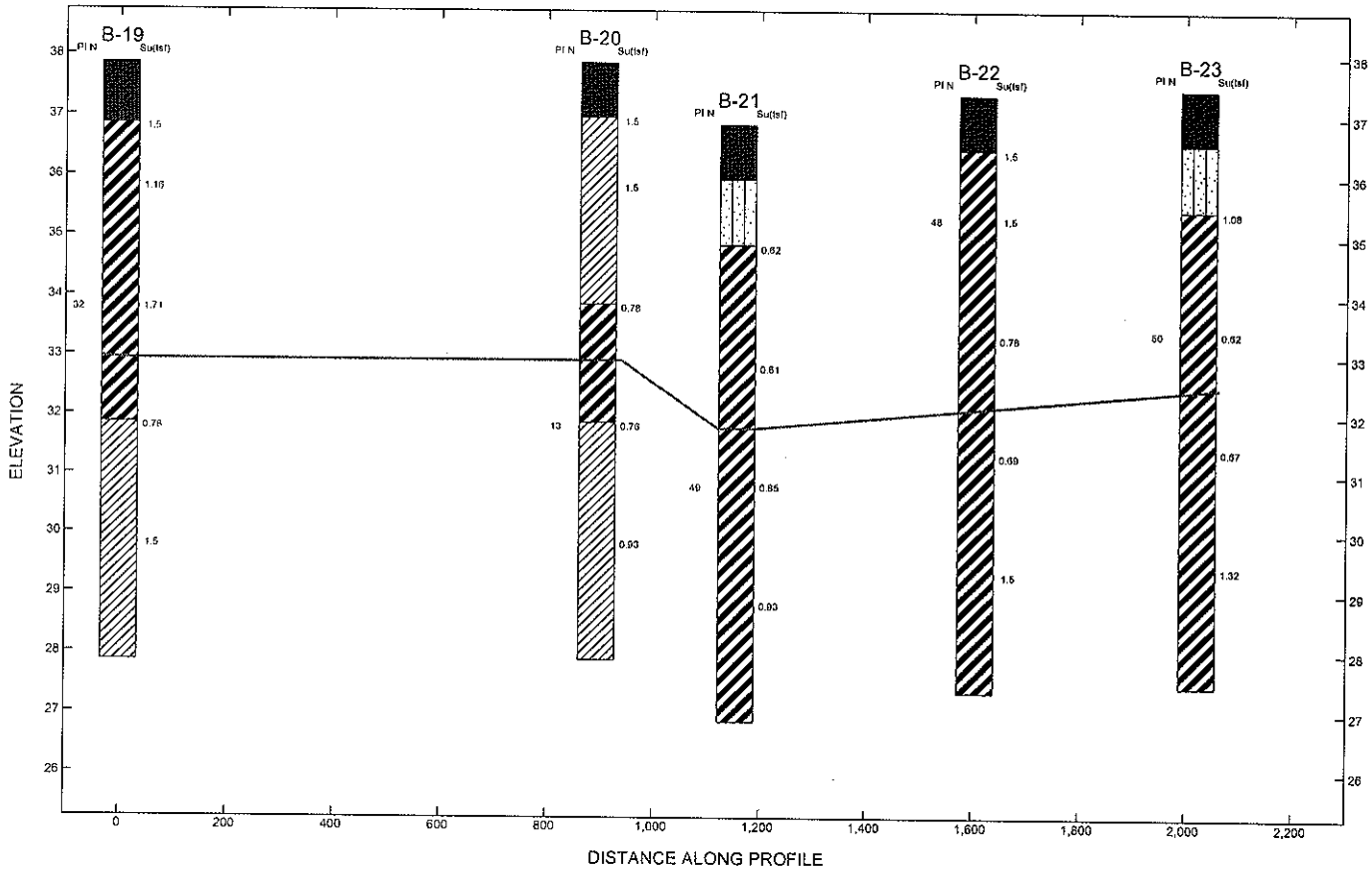
Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022

Proposed Water Line Replacement in Fairlawn Area

City of Houston, Texas

JOB NUMBER	PLATE NUMBER
S-000035-0186-4	Plate 12

BERNARD 14-319E.GPJ FANWNL01.GDT 10/14/14



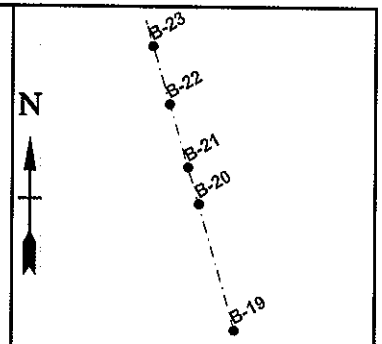
Lithology Graphics

Asphalt

Fat Clay (CH)

Lean Clay (CL)

Silty Sand (SM)



Site Map Scale 1 inch equals 1,240 feet

Explanation

B-19 — Borehole Number

Borehole Lithology

Water Level Reading at time of drilling.

Water Level Reading after drilling.

0 — 338

Horizontal Scale

Vertical Exaggeration: 113x

Geotech Engineering and Testing
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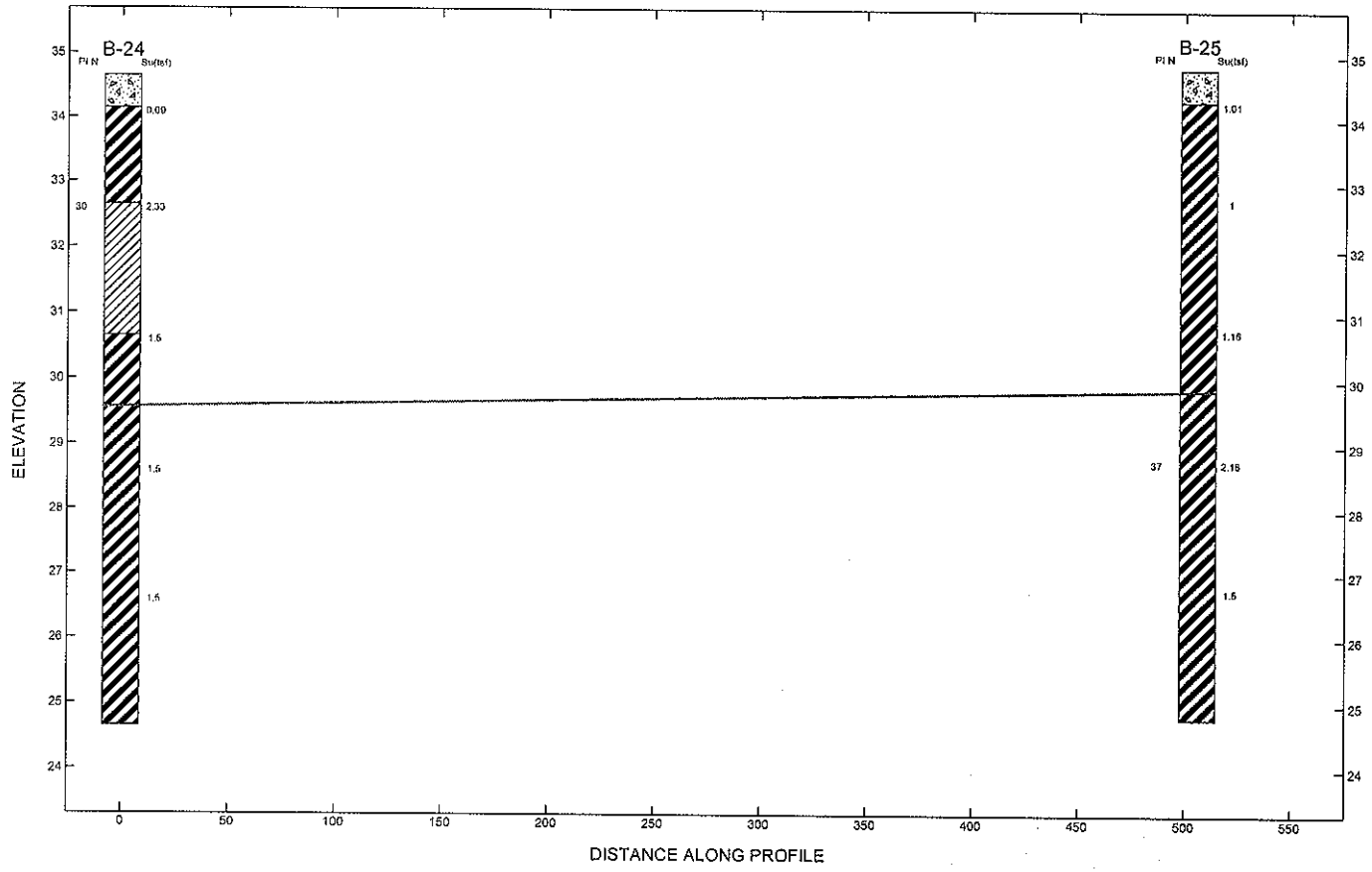
Houston, Texas 77022

Proposed Water Line Replacement in Fairlawn Area

City of Houston, Texas

JOB NUMBER	PLATE NUMBER
S-000035-0186-4	Plate 13

BERNARD 14-319E.GPJ FANWNL01.GDT 10/14/14

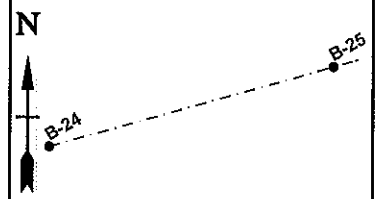


Lithology Graphics

Concrete

Fat Clay (CH)

Lean Clay (CL)



Site Map Scale 1 inch equals 310 feet

Explanation

B-24 — Borehole Number

Borehole Lithology

Water Level Reading at time of drilling.

Water Level Reading after drilling.

0 — 85

Horizontal Scale

Vertical Exaggeration: 31x

Geotech Engineering and Testing
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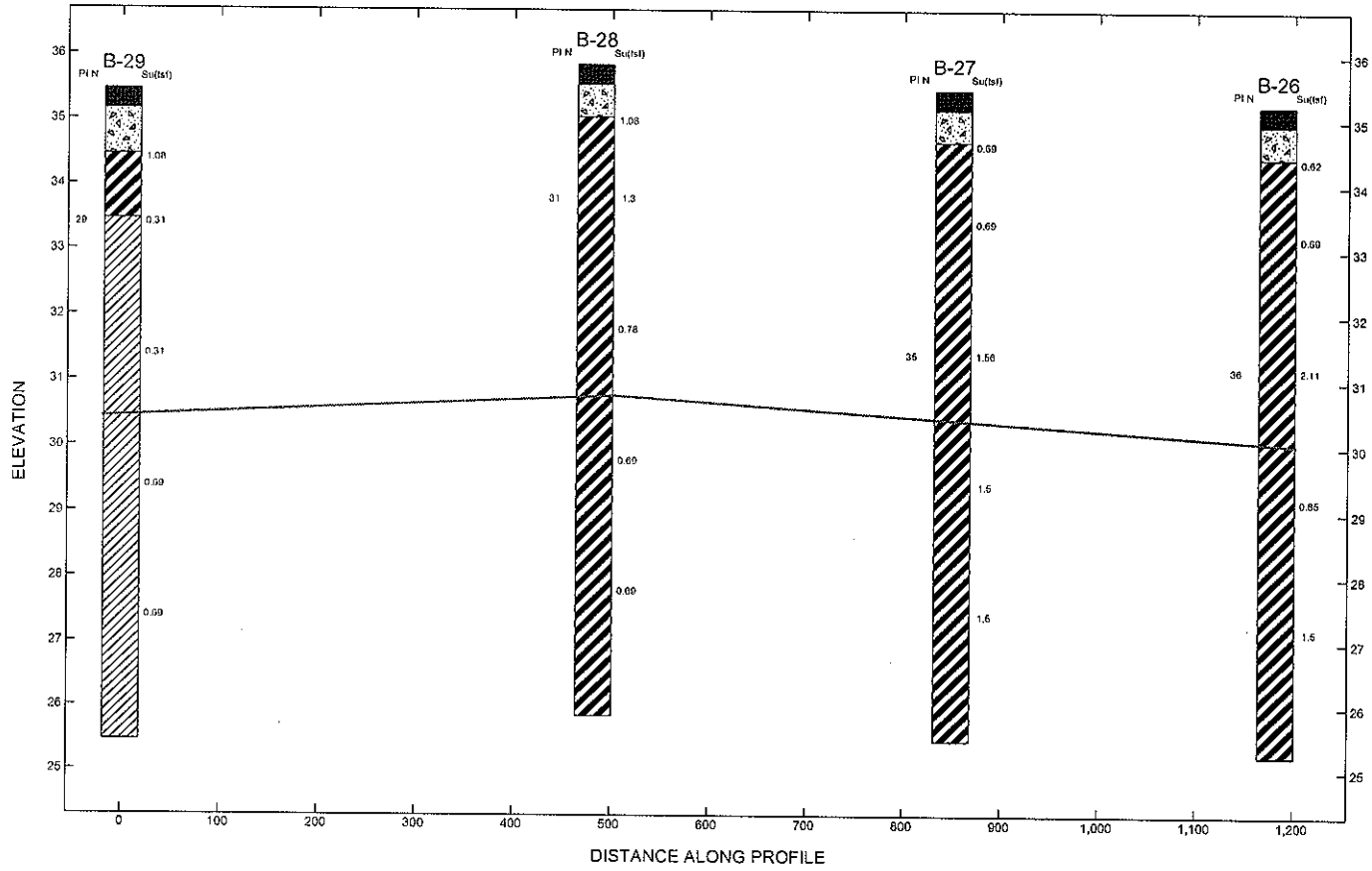
Houston, Texas 77022

Proposed Water Line Replacement in Fairlawn Area

City of Houston, Texas

JOB NUMBER	PLATE NUMBER
S-000035-0156-4	Plate 14

BERNARD 14-319E.GPJ FANWNL01.GDT 10/14/14



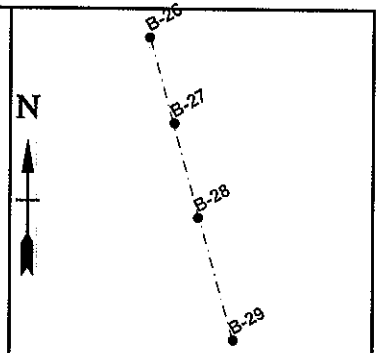
Lithology Graphics

Asphalt

Concrete

Fat Clay (CH)

Lean Clay (CL)



Site Map Scale 1 inch equals 675 feet

Explanation

B-26 — Borehole Number

Borehole Lithology

Water Level Reading at time of drilling.

Water Level Reading after drilling.

0 185

Horizontal Scale

Vertical Exaggeration: 67x

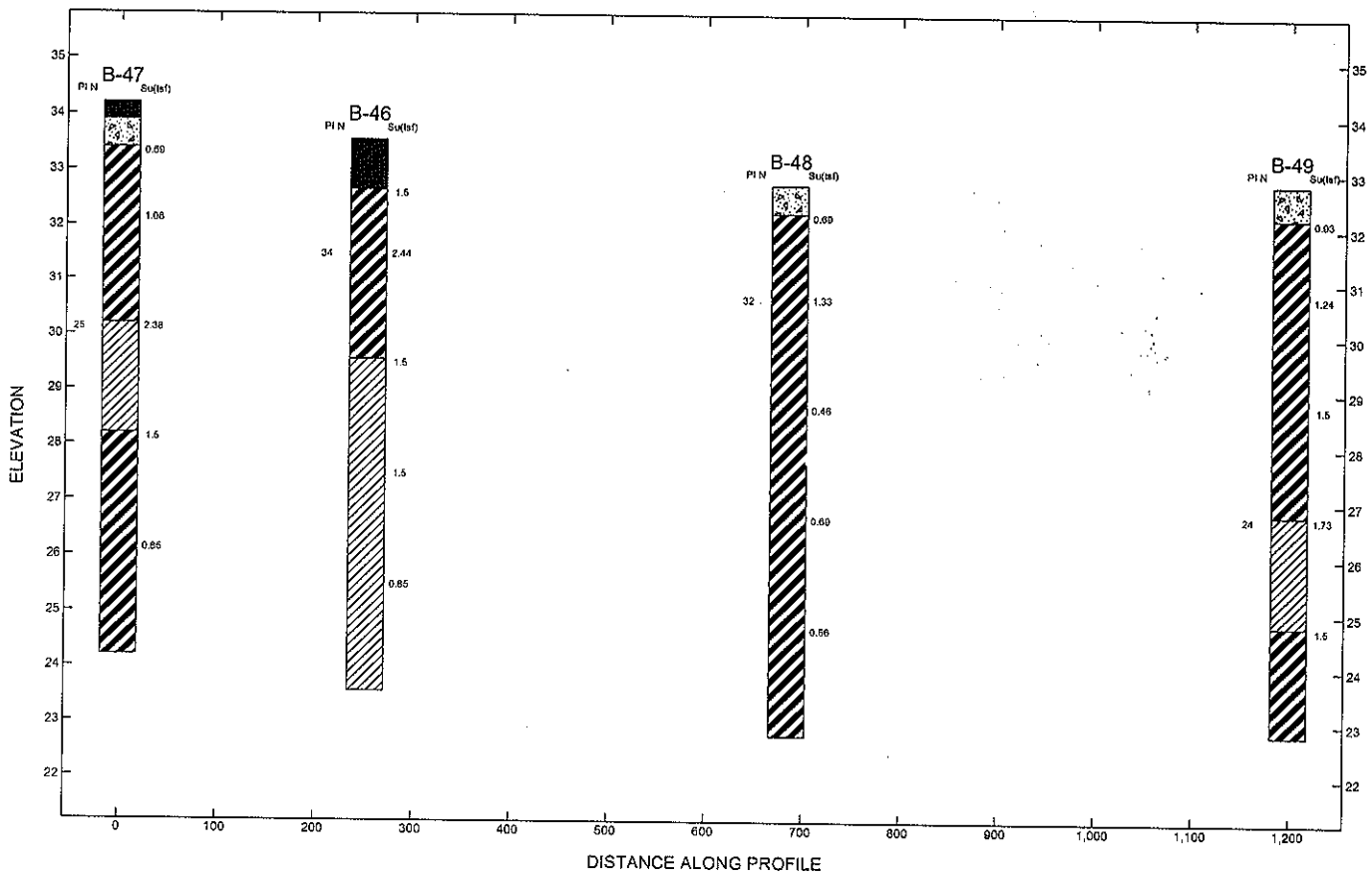
Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022

Proposed Water Line Replacement in Fairlawn Area

City of Houston, Texas

JOB NUMBER	PLATE NUMBER
S-000035-0186-4	Plate 15

BERNARD 14-319E.GPJ FANWNL01.GDT 10/14/14



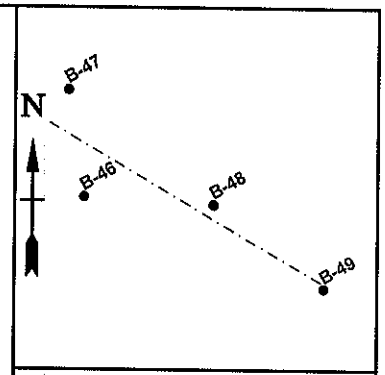
Lithology Graphics

Asphalt

Fat Clay (CH)

Lean Clay (CL)

Concrete



Site Map Scale 1 inch equals 675 feet

Explanation

B-46 — Borehole Number

Borehole Lithology

Water Level Reading at time of drilling.

Water Level Reading after drilling.

0 185

Horizontal Scale

Vertical Exaggeration: 57x

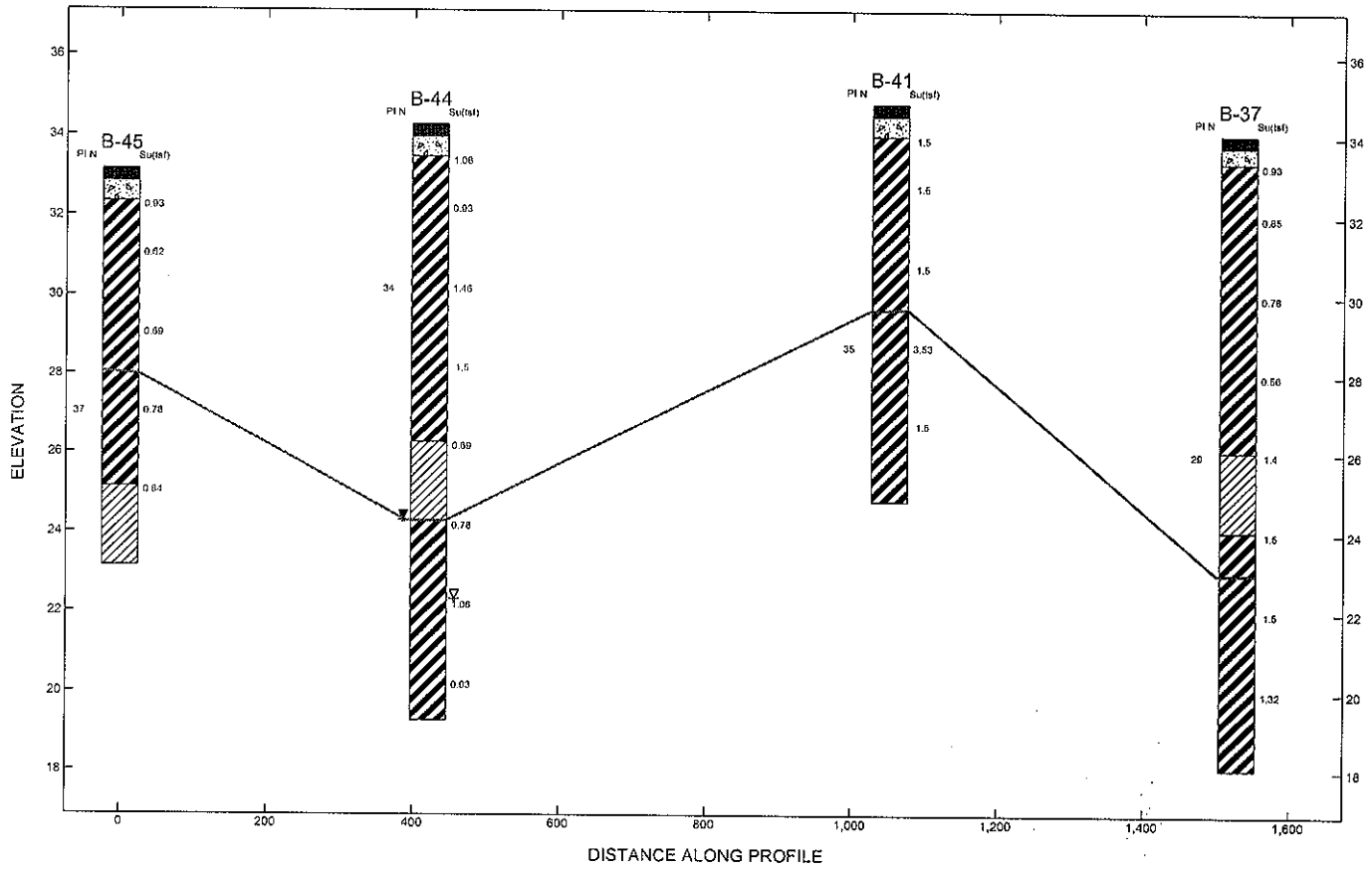
Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022

Proposed Water Line Replacement in Fairlawn Area

City of Houston, Texas

JOB NUMBER	PLATE NUMBER
S-000035-0186-4	Plate 16

BERNARD 14-319E.GPJ FANWNL01.GDT 11/6/14



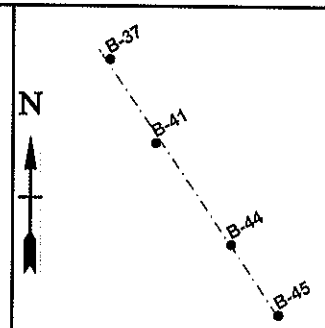
Lithology Graphics

Asphalt

Concrete

Fat Clay (CH)

Lean Clay (CL)



Site Map Scale 1 inch equals 905 feet

Explanation

B-37 — Borehole Number

Borehole Lithology

Water Level Reading at time of drilling.

Water Level Reading after drilling.

0 246

Horizontal Scale

Vertical Exaggeration: 54.5x

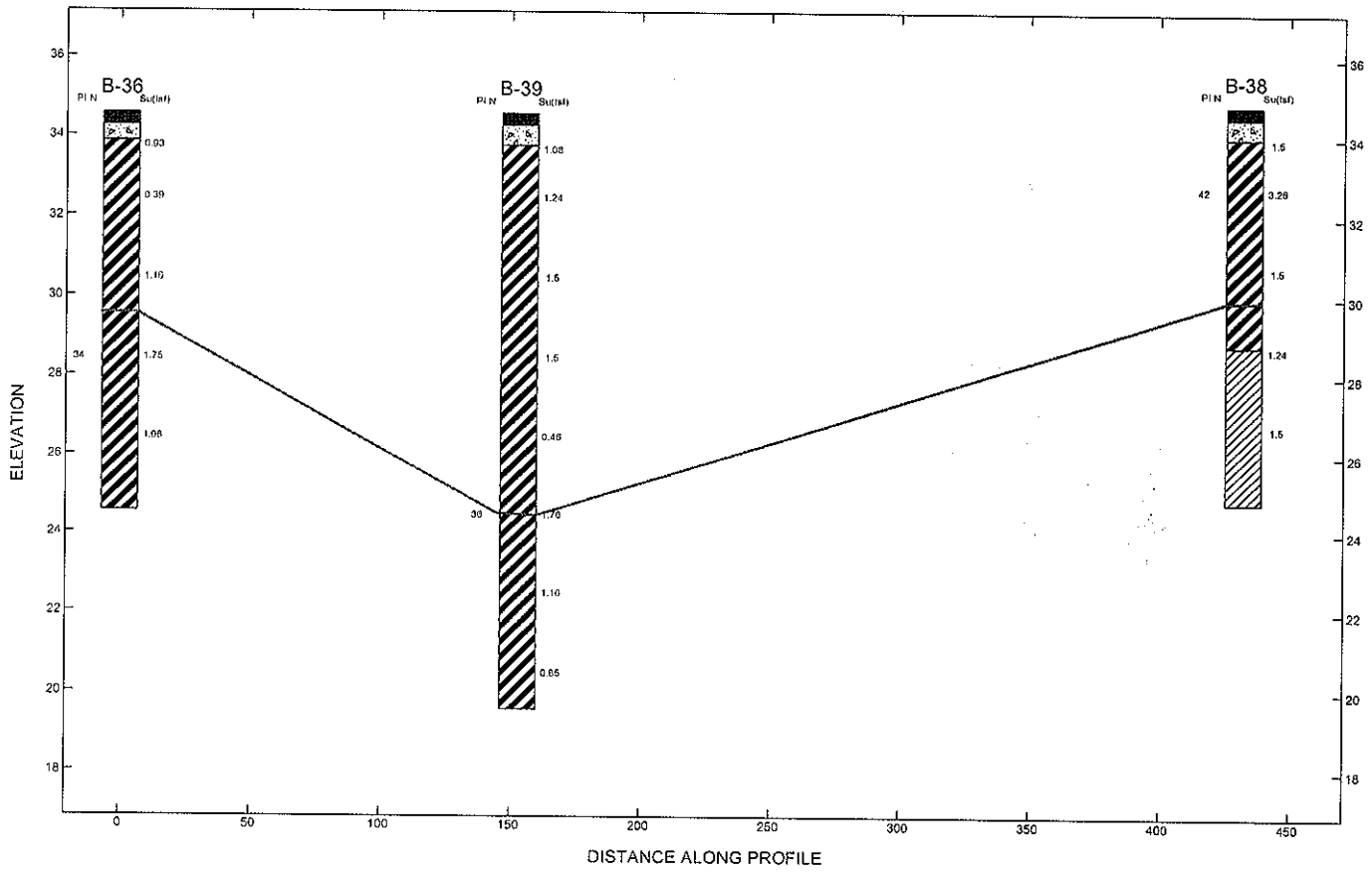
Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022

Proposed Water Line Replacement in Fairlawn Area

City of Houston, Texas

JOB NUMBER	PLATE NUMBER
S-000035-0166-4	Plate 17

BERNARD 14-319E.GPJ FANWNL01.GDT 10/14/14



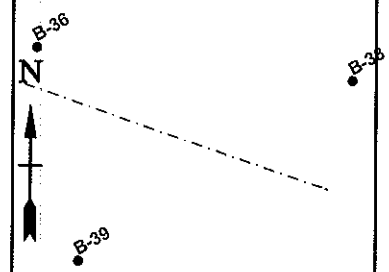
Lithology Graphics

Asphalt

Concrete

Fat Clay (CH)

Lean Clay (CL)



Site Map Scale 1 inch equals 255 feet

Explanation

B-36 — Borehole Number

Borehole Lithology

Water Level Reading at time of drilling.

Water Level Reading after drilling.

0 — 69

Horizontal Scale

Vertical Exaggeration: 15.5x

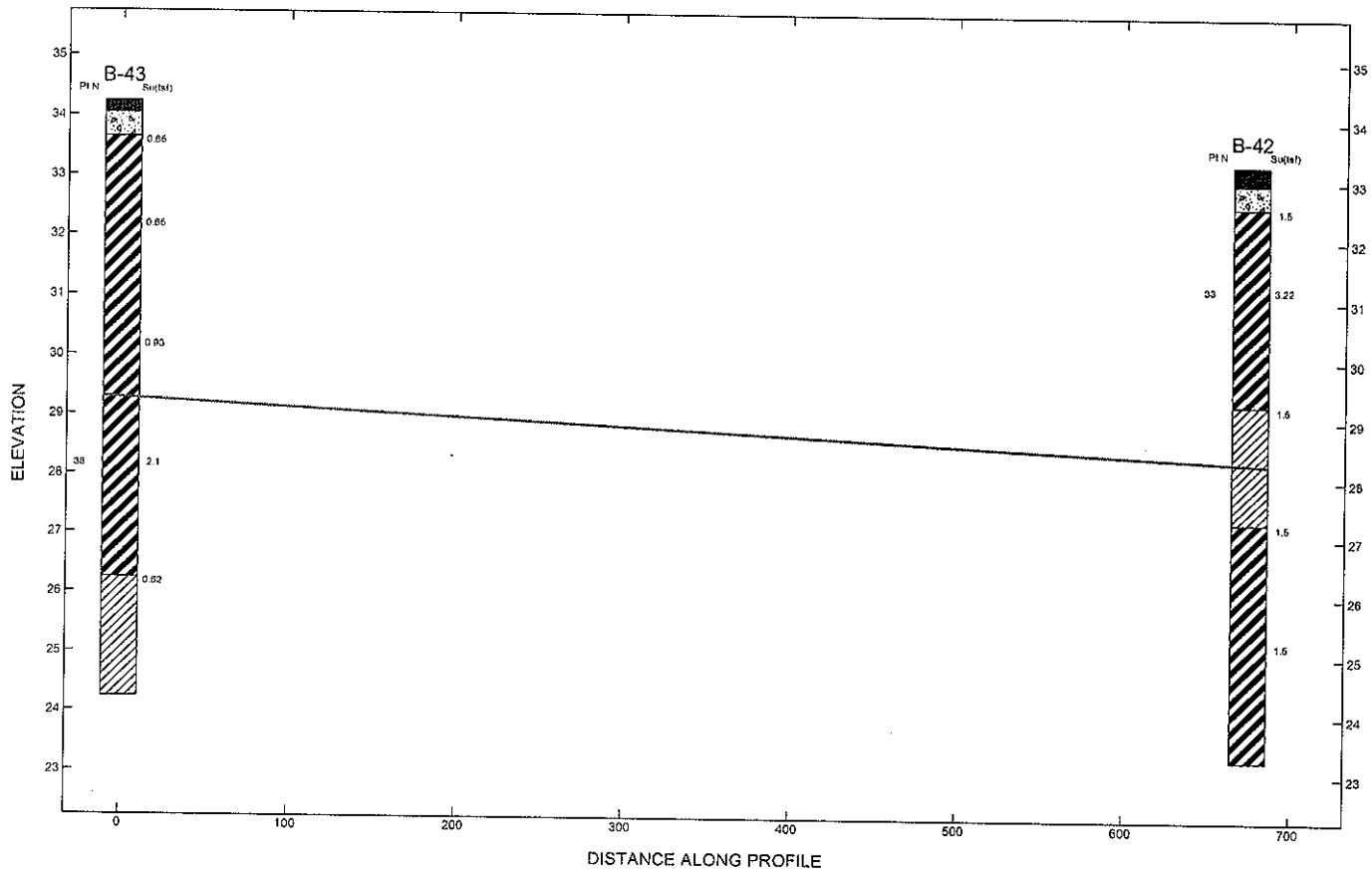
Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022

Proposed Water Line Replacement in Fairlawn Area

City of Houston, Texas

JOB NUMBER	PLATE NUMBER
S-000035-0186-4	Plate 18

BERNARD 14-319E.GPJ FANWNL01.GDT 10/14/14



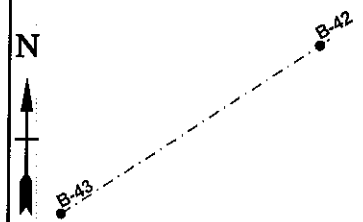
Lithology Graphics

Asphalt

Concrete

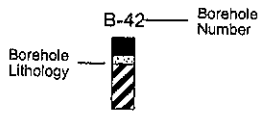
Fat Clay (CH)

Lean Clay (CL)



Site Map Scale 1 inch equals 395 feet

Explanation



Water Level Reading at time of drilling.

Water Level Reading after drilling.

Vertical Exaggeration: 36x

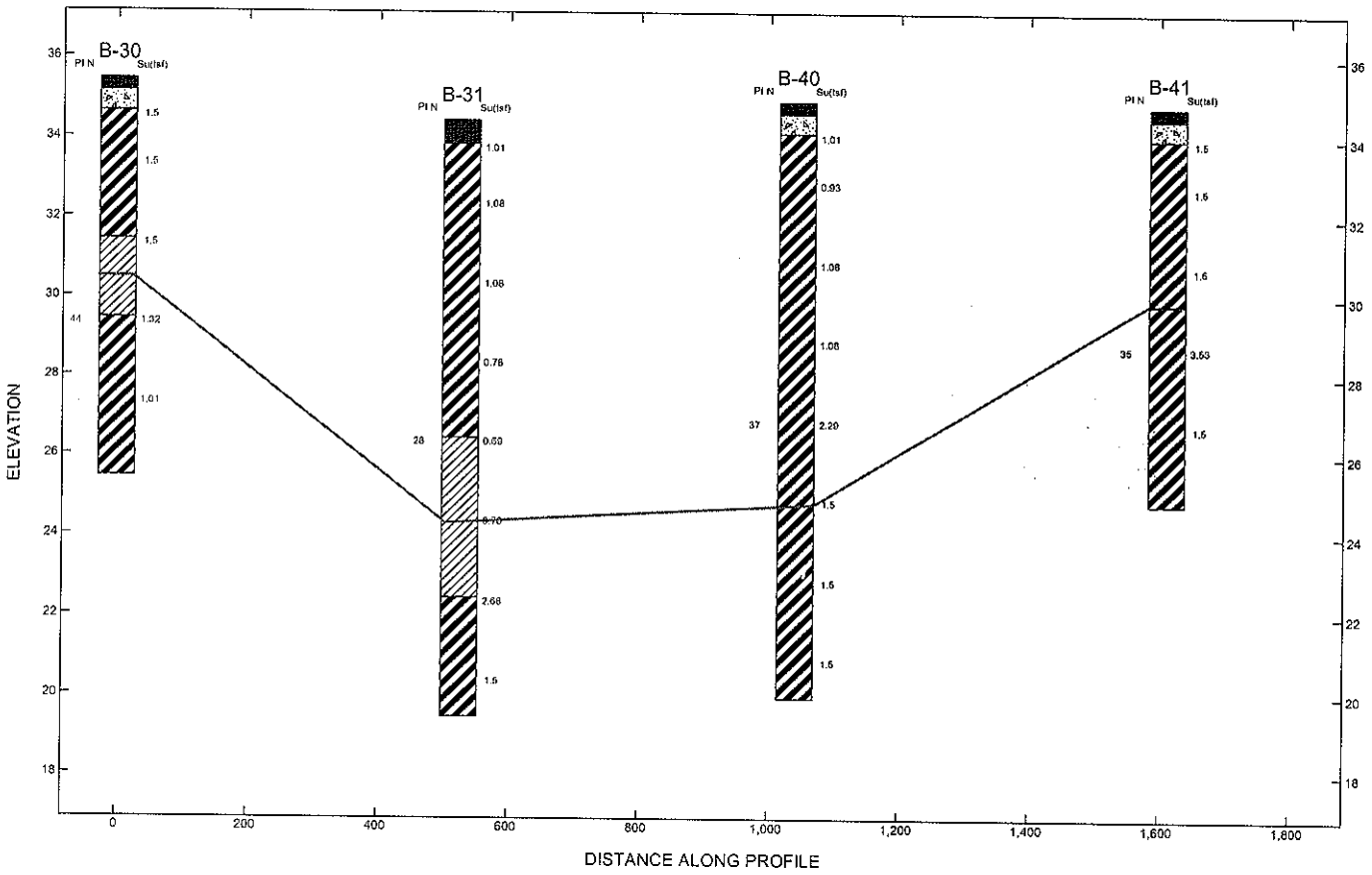
Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022

Proposed Water Line Replacement in Fairlawn Area

City of Houston, Texas

JOB NUMBER	PLATE NUMBER
S-000035-0186-4	Plate 19

BERNARD 14-319E.GPJ FANWNL01.GDT 10/14/14



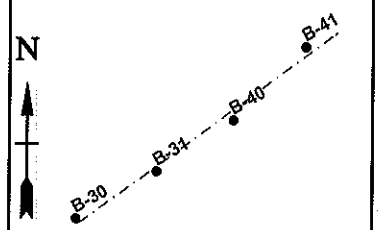
Lithology Graphics

Asphalt

Concrete

Fat Clay (CH)

Lean Clay (CL)



Site Map Scale 1 inch equals 1,015 feet

Explanation

B-30 — Borehole Number

Borehole Lithology

Water Level Reading at time of drilling.

Water Level Reading after drilling.

0 277

Horizontal Scale

Vertical Exaggeration: 61.5x

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022

Proposed Water Line Replacement in Fairlawn Area

City of Houston, Texas

JOB NUMBER	PLATE NUMBER
S-000035-0186-4	Plate 20

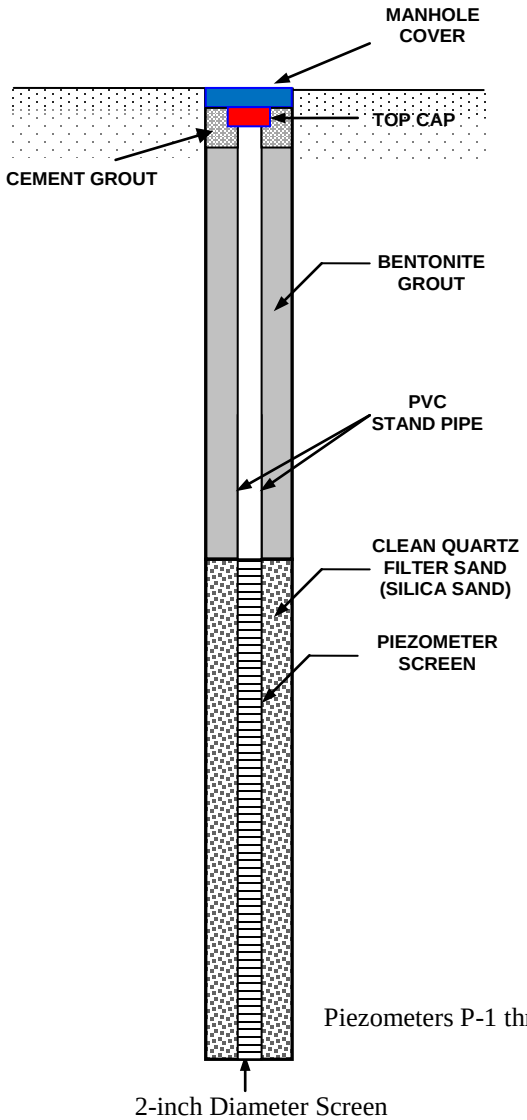
BERNARD 14-319E.GPJ FANWNL01.GDT 10/14/14

PIEZOMETER INSTALLATION REPORT

PROJECT NAME: Water Line Replacement in Fairlawn Area in the City of Houston, Texas
(WBS No. S-000035-0186-4)
PROJECT No.: 14-319E
GEOTECHNICAL CONSULTANT: Geotech Engineering and Testing
DESIGN CONSULTANT: Quadrant Consultants, Inc.

Piezometer No.	Boring No.	Piezometer Tip		Depth to Filter Sand, ft.		Bentonite Grout, ft		Cement Grout	
		Depth, ft.	Screen Length, ft.	Top	Bottom	Top	Bottom	Top	Bottom
PZ-1	B-2	16.00	12.00	4.00	16.00	2.00	4.00	0.00	2.00
PZ-2	B-17	17.00	12.00	5.00	17.00	2.00	5.00	0.00	2.00
PZ-3	B-37	16.00	12.00	4.00	16.00	2.00	4.00	0.00	2.00

Notes: (1) Depth is referenced from existing ground surface.



Note: Drawing is not to scale.

Piezometers P-1 through P-3

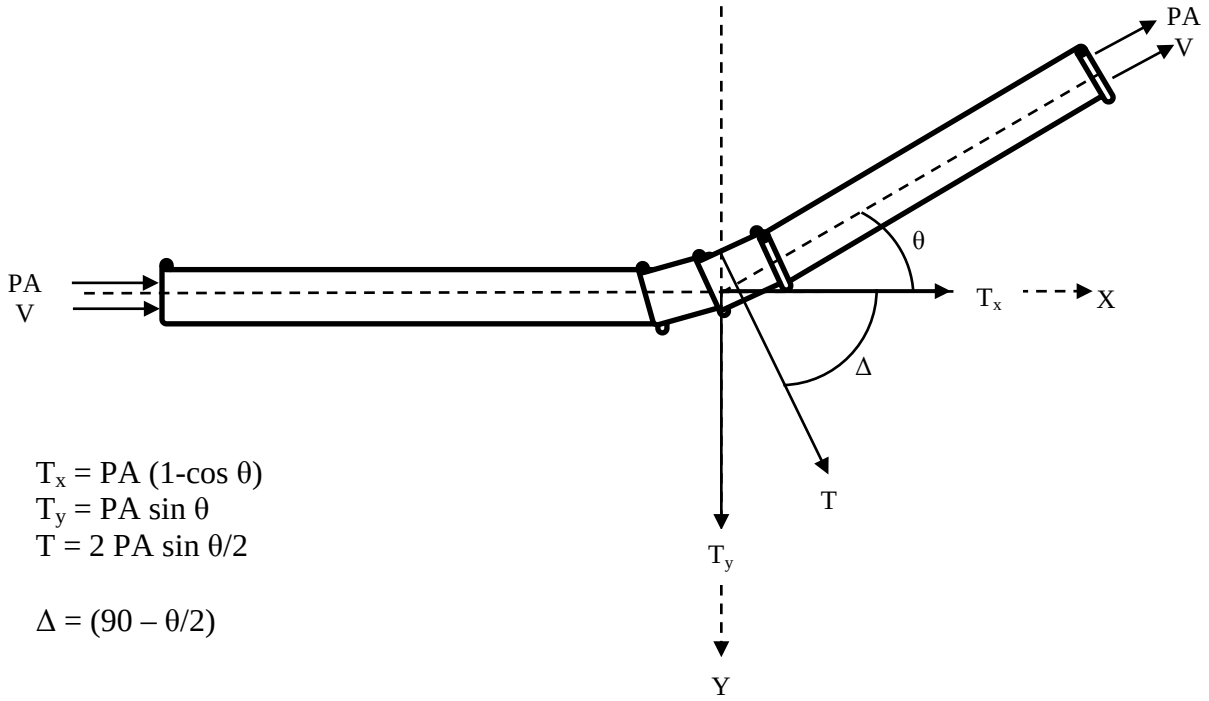
Piezometer No.	Station No.	Northing	Easting	Elevation (ft)
PZ-1	10+19.93	13815741.24	3139734.88	36.30
PZ-2	6+47.96	13813451.61	3139026.45	36.26
PZ-3	11+75.31	13813551.90	3141820.09	34.07

PIEZOMETER READING TABLE

Piezometer No.	Piezometer Groundwater Depths During Drilling from Ground Surface	Groundwater Level in Piezometer					
		July 17, 2014			July 31, 2014		
		Before Bailing	After Bailing		Before Bailing	After Bailing	
PZ-1 (16')	Dry	11′5"	Time (Min.)	Groundwater Depth (ft)	11′5"	Time, (Hr.)	Groundwater Depth (ft)
			1	14.3		24	11′5"
			2	14.0			
			5	13.5			
			10	13.2			
			20	12.6			
			30	12.4			
			60	12.0			11′5"
PZ-2 (17')	Dry	Dry	Time (Min.)	Groundwater Depth (ft)	14′5"	Time, (Hr.)	Groundwater Depth (ft)
			1			24	14′5"
			2				
			5				
			10				
			20				
			30				
			60				14′5"
PZ-3 (16')	Dry	Dry	Time (Min.)	Groundwater Depth (ft)	13′8"	Time, (Hr.)	Groundwater Depth (ft)
			1			24	13′8"
			2				
			5				
			10				
			20				
			30				
			60				13′8"

Note: Borings B-2, B-17 and B-37 were converted to Piezometers PZ-1, PZ-2 and PZ-3, respectively. The piezometer depth is shown in parenthesis.

THRUST FORCES ACTING ON BEND



$T_x = PA\ (1\text{-}\cos\ \theta)$
$T_y = PA \sin \theta$
$T = 2\ PA \sin \theta/2$

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

Where:

T = Resultant Thrust Force on the Bend
T_x = Component of Thrust Force in X-Direction
T_y = Component of Thrust Force in Y-Direction
P = Maximum Sustained Pressure
A = Pipe Cross Sectional Area
θ = Bend Deflection Angle
V = Fluid Velocity

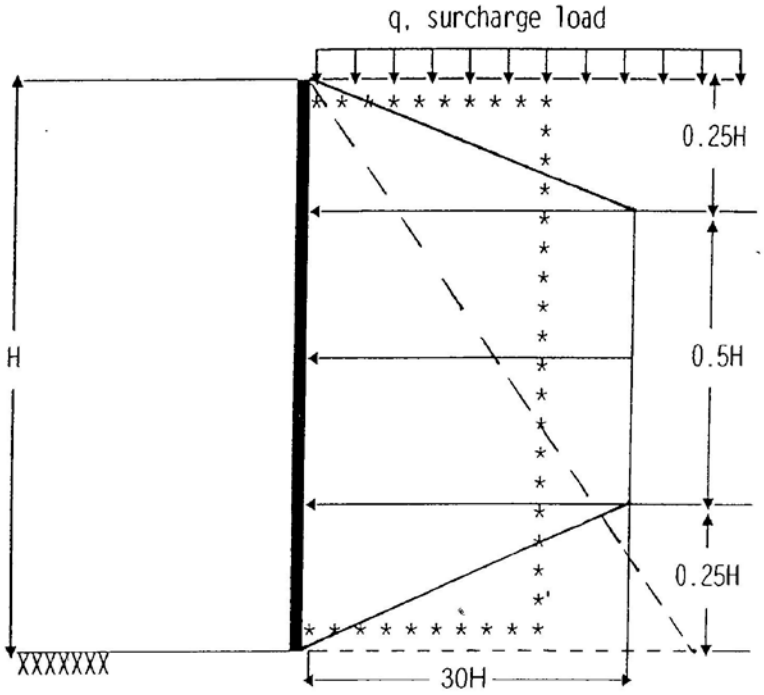
Δ = Angle between T and X-axis
D = Inside Diameter of the Pipe

Sample Calculation:

Given P = 50 psi, D = 12-inch
$A = \pi d^2/4 = 113.1\ in^2$

For θ = 90°
T = 2 PA sin θ/2 = 2 * 50 * 113.1 * sin (90/2) = 7997.4 lb = 7.99 kips
Tx = PA (1 - cos θ) = 50 * 113.1 * (1 – cos 90°) = 5.66 kips
Ty = PA sin θ = 50 * 113.1 * sin 90° = 5.66 kips

LATERAL EARTH PRESSURE DIAGRAM



Legend:

———————— Braced Excavation (stiff clays)
* * * * * * * * * * * * * Braced Excavation (sands)
- - - - - - - - - - - - - - - Cantilivered sheeting

Active Pressure:

(a) Braced Excavation (stiff clays) = 0.5q + 30H + 62.4H
(b) Braced Excavation (sands) = 0.4q + 18H + 62.4H
(c) Cantilivered sheeting = 0.7q + 42H + 62.4H

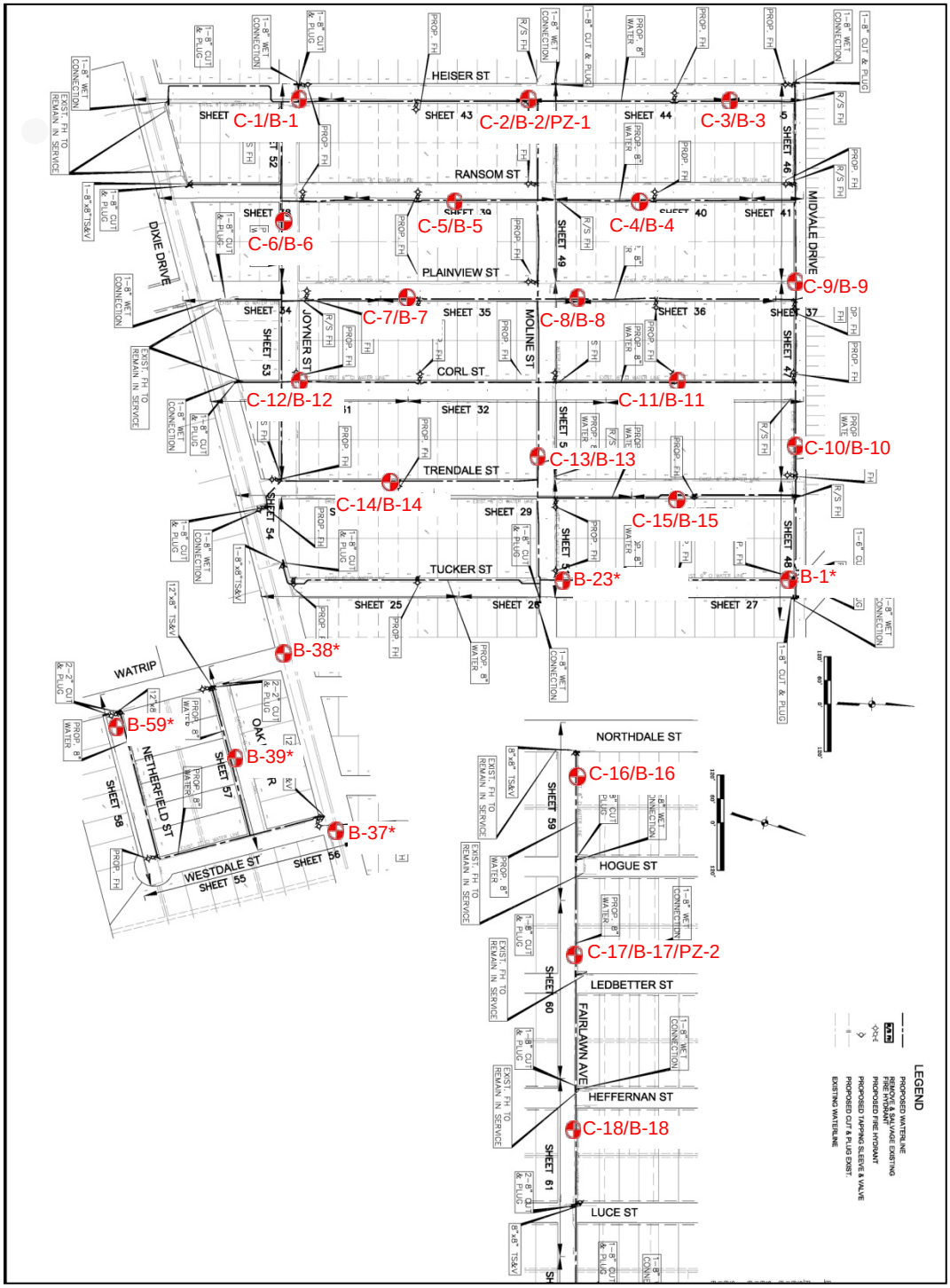
where: q = surcharge load, psf
H = wall height, ft.

Notes:

1. The above Active Pressure Equations account for the groundwater at the surface.
2. The final lateral pressures should be reviewed prior to construction.
3. Trench excavation and construction should be observed by a geotechnical engineer.
4. The means and methods for a safe excavation is the responsibility of the contractor.

APPENDIX A

Plan of Borings
Logs of Borings
Key to Log Terms and Symbols
Summary of Test Results



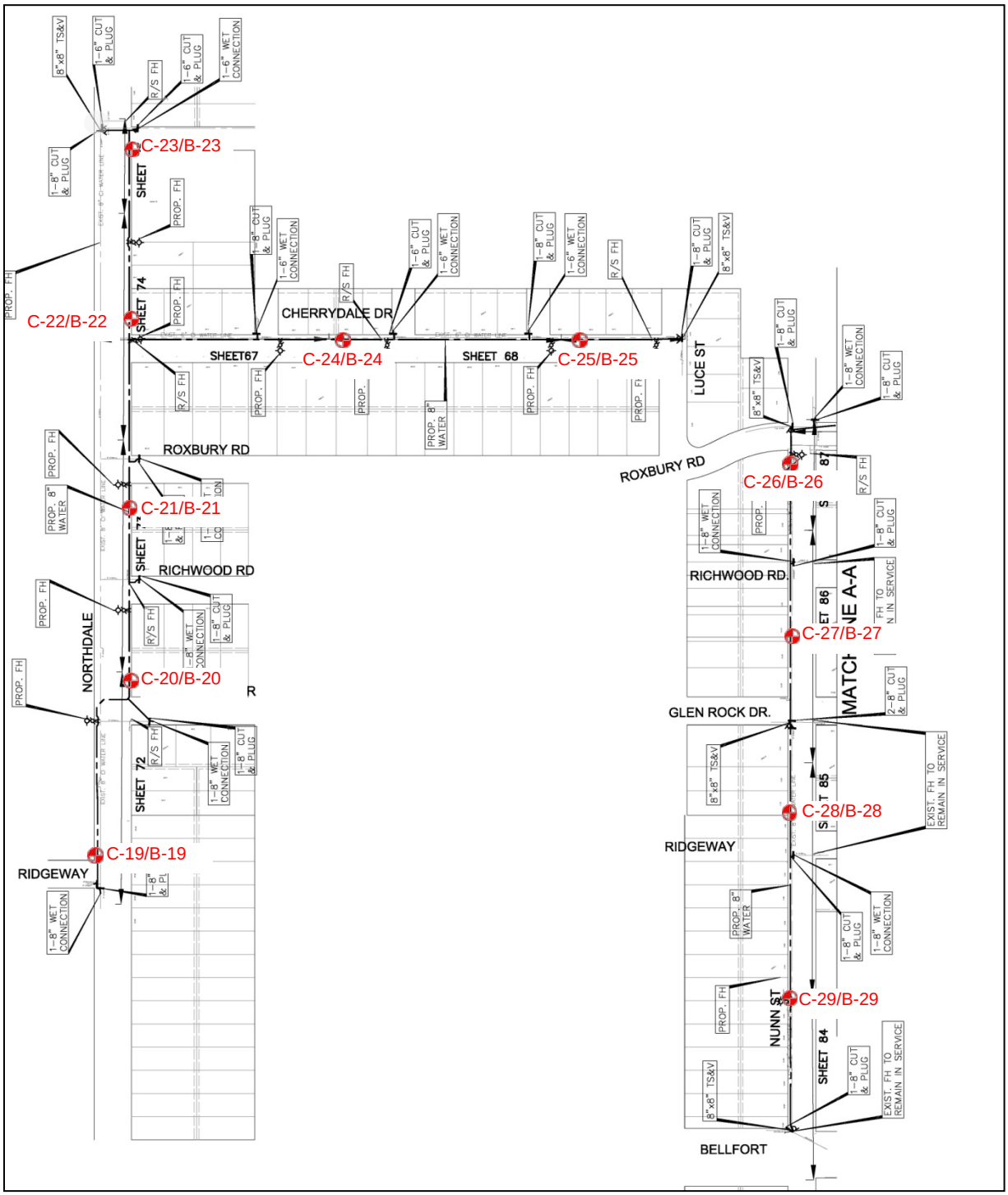
Legend: C-1: Coring C-1
B-1: Boring B-1
PZ-1: Piezometer PZ-1
B-1*: Boring B-1*, B-23*, B-37*, B-38*, B-39* and B-59* were previously drilled by GET (GET Report No. 05-869E, Dated April 06, 2006)

PLAN OF BORINGS (borings locations are approximate)

NORTH

PROJECT: Geotechnical Study, Proposed Water Line Replacement in Fairlawn Area
WBS No. S-000035-0186-4, City of Houston, Texas

SCALE: 1" = 420-FT	DATE: NOVEMBER 2014	PROJECT NO.: 14-319E



Legend:

C-19: Coring C-19

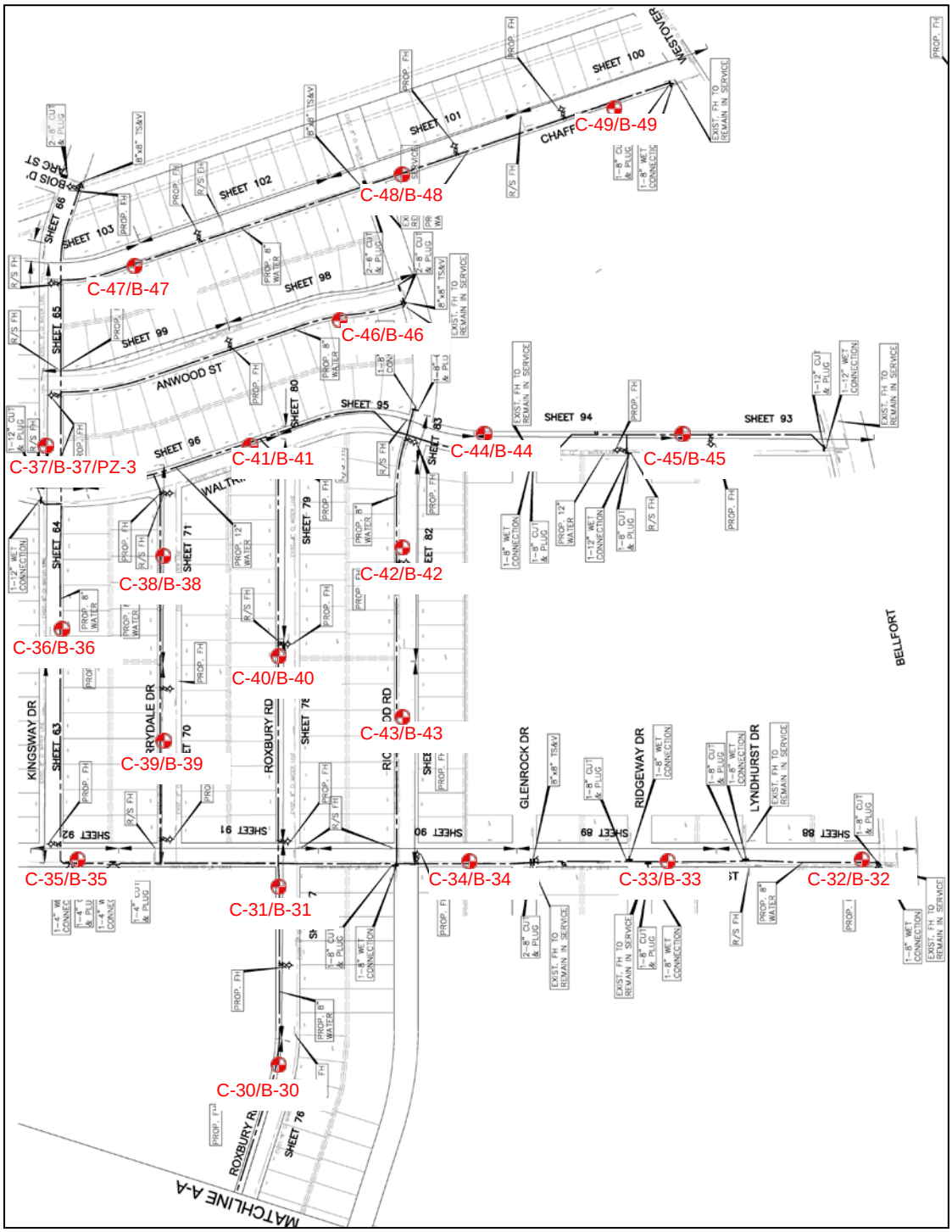
B-19: Boring B-19

PLAN OF BORINGS (borings locations are approximate)

NORTH

PROJECT: Geotechnical Study, Proposed Water Line Replacement in Fairlawn Area
WBS No. S-000035-0186-4, City of Houston, Texas

SCALE: 1" = 350-FT	DATE: NOVEMBER 2014	PROJECT NO.: 14-319E



Legend:

C-30: Coring C-30
B-30: Boring B-30
PZ-3: Piezometer PZ-3

PLAN OF BORINGS (borings locations are approximate)

NORTH

PROJECT: Geotechnical Study, Proposed Water Line Replacement in Fairlawn Area
WBS No. S-000035-0186-4, City of Houston, Texas

SCALE: 1"=420-FT	DATE: NOVEMBER 2014	PROJECT NO.: 14-319E

LOG OF BORING NO. B-1

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 6+45.80

DATE: 6-26-14 COMPLETION DEPTH: 16.0 ft.

ELEVATION: 36.16

DEPTH, ft	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0	ASPHALT PAVEMET (3.6-inches in Thickness)									
	FAT CLAY (CH), firm, dark gray, with ferrous nodules, moist	37	73	22	51			85		
		30								
5		32								
	- stiff 6' to 10'	28				91				
	- light gray, brown, with calcareous nodules 8' to 16'	24								
10	- very stiff 10' to 12'	23								
	- stiff 12' to 14'	22								
	- very stiff 14' to 16'	23								
15										
20										

UNDRAINED SHEAR STRENGTH, tsf

- ▲ HAND PENETROMETER
- ■ TORVANE
- ● UNCONFINED COMPRESSION
- ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 16 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-2

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 10+19.93

DATE: 6-24-14 COMPLETION DEPTH: 16.0 ft.

ELEVATION: 36.3

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)	UNDRAINED SHEAR STRENGTH, tsf
0					ASPHALT PAVEMET (2.0-inches in Thickness)										
					FAT CLAY (CH), very stiff, brown, with ferrous and calcareous nodules, moist	14									
					- firm, dark brown 2' to 6'	15									
5						26	67	21	46			99			
					- stiff 6' to 10' - light gray 6' to 16'	31									
						35									
10					- firm 10' to 12'	29									
					- stiff 12' to 16'	24				86					
15						30									
20															

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
▮ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 16 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Eric

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-3

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 16+46.00

DATE: 6-26-14 COMPLETION DEPTH: 10.0 ft.

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)	UNDRAINED SHEAR STRENGTH, tsf
					ELEVATION: 35.62										▲ HAND PENETROMETER ■ TORVANE ● UNCONFINED COMPRESSION ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0					ASPHALT PAVEMET (2.3-inches in Thickness)										0.5 1.0 1.5 2.0 2.5
					SILTY SAND (SM), stiff, dark gray, with ferrous nodules, moist	19				22					
					FAT CLAY (CH), stiff, dark gray, with ferrous nodules, moist	25									
5						23	55	21	34			98			
					- light gray, light brown 6' to 10'	25									
					- firm 8' to 10'	23									
10															
15															
20															

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-4

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 14+56.91

DATE: 6-26-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 35.72

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT PAVEMET (2.0-inches in Thickness)									
					CONCRETE PAVEMENT (6.0-inches in Thickness)									
					FAT CLAY (CH), firm, dark gray, with ferrous nodules, moist - stiff 2' to 8'	25								
						25								
5					- gray 4' to 10'	25								
						27	60	21	39			104		
						30								
10														
15														
20														

UNDRAINED SHEAR STRENGTH, tsf

▲ HAND PENETROMETER

■ TORVANE

● UNCONFINED COMPRESSION

○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-5

GEOTECH ENGINEERING & TESTING
Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: City of Houston, Texas
PROJECT NO.: S-000035-0186-4 STATION NO.: 8+75.27
DATE: 6-26-14 COMPLETION DEPTH: 10.0 ft.

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
					ELEVATION: 35.9									
0					ASPHALT PAVEMET (10.0-inches in Thickness)									
					FAT CLAY (CH), firm, dark gray, with ferrous nodules, moist									
					- stiff 2' to 4'	33								
						25	65	20	45			97		
5						31								
					- very stiff, light gray 6' to 8'	23				92				
					- stiff, brown 8' to 10'	29								
10														
15														
20														

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
■ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-6

GEOTECH ENGINEERING & TESTING
Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: City of Houston, Texas
PROJECT NO.: S-000035-0186-4 STATION NO.: 4+44.34
DATE: 6-26-14 COMPLETION DEPTH: 16.0 ft.

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
					ELEVATION: 35.58									
0					ASPHALT PAVEMET (9.0-inches in Thickness)									
					FAT CLAY (CH), stiff, dark gray, with ferrous nodules, moist	25								
						29								
					- firm, gray 4' to 6'									
5						27				91				
						28								
					- very stiff 8' to 10'									
						21	57	20	37			106		
10					- reddish brown 10' to 12'									
						19								
					- brown 12' to 16'									
						21								
					- very stiff 14' to 16'									
15						17								
20														

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
■ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 16 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-7

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: City of Houston, Texas
PROJECT NO.: S-000035-0186-4 STATION NO.: 5+78.52
DATE: 6-26-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 35.73

DEPTH, ft	DESCRIPTION
0	ASPHALT PAVEMET (9.0-inches in Thickness)
	FAT CLAY (CH), stiff, dark gray, with ferrous nodules, moist
	- very stiff 2' to 4'
5	
	- light gray, brown, with calcareous nodules 6' to 10'
	- very stiff 8' to 10'
10	
15	
20	

DEPTH, ft	SPT N-VALUE blows per foot	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
22										
21						93				
24										
23		67	21	46				99		
25										

UNDRAINED SHEAR STRENGTH, tsf
- ▲ HAND PENETROMETER
- ■ TORVANE
- ● UNCONFINED COMPRESSION
- ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-8

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 11+43.90

DATE: 6-26-14 COMPLETION DEPTH: 16.0 ft.

ELEVATION: 36.15

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT PAVEMET (2.5-inches in Thickness)									
					FAT CLAY (CH), very stiff, dark gray, with ferrous and calcareous nodules, moist									
					- stiff 2' to 4'	29				86				
						30								
					- light gray, brown 4' to 16'									
5						22								
					- stiff 6' to 16'	29								
						33	70	22	48			90		
10					- light brown 10' to 16'									
						27								
						30								
15						24								
20														

UNDRAINED SHEAR STRENGTH, tsf
- ▲ HAND PENETROMETER
- ▮ TORVANE
- ● UNCONFINED COMPRESSION
- ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 16 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-9

GET GEOTECH ENGINEERING & TESTING
Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: City of Houston, Texas
PROJECT NO.: S-000035-0186-4 STATION NO.: 5+35.41
DATE: 6-26-14 COMPLETION DEPTH: 17.0 ft.

ELEVATION: 35.92

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT PAVEMENT (2.0-inch in Thickness)									
					CONCRETE PAVEMENT (6.0-inch in Thickness)									
					FAT CLAY (CH), stiff, dark gray, with ferrous and calcareous nodules, moist	27								
					- light gray, light brown 4' to 12'	31								
5						28								
						26				85				
						26								
10					- very stiff 10' to 12'									
						26								
					LEAN CLAY (CL), stiff, light gray, light brown, with ferrous and calcareous nodules, sands, moist	27	42	18	24			102		
					FAT CLAY (CH), very stiff, light gray, light brown, with ferrous and calcareous nodules, moist	20								
15					- stiff 16' to 17'									
						22								
20														

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
■ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 17 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-10

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 10+30.15

DATE: 6-27-14 COMPLETION DEPTH: 16.0 ft.

ELEVATION: 35.95

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)	UNDRAINED SHEAR STRENGTH, tsf
0					ASPHALT PAVEMENT (2.0-inch in Thickness)										
					CONCRETE PAVEMENT (6.0-inch in Thickness)										
					FAT CLAY (CH), stiff, gray, dark gray, with ferrous nodules, moist	10									0.5
						22									1.0
					- brown, with calcareous nodules 4' to 16'										1.5
5						21	81	23	58			114			2.0
						15									
						15									
10					- firm 10' to 12'										
						17									
					- soft 12' to 14'										
						14									
					- firm 14' to 16'										
15						18									
20															

UNDRAINED SHEAR STRENGTH, tsf
- ▲ HAND PENETROMETER
- ▮ TORVANE
- ● UNCONFINED COMPRESSION
- ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 16 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-11

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 12+34.11

DATE: 6-27-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 35.85

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)	UNDRAINED SHEAR STRENGTH, tsf
0					ASPHALT PAVEMENT (2.5-inch in Thickness)										
					LEAN CLAY (CL), very stiff, gray, brown, with ferrous nodules, sands, moist	19	49	19	30			102			
					FAT CLAY (CH), firm, gray, light brown, with ferrous nodules, moist	17									
5					- stiff, with calcareous nodules 4' to 10'	21									
						23									
10						16									
15															
20															

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
▮ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/6/14

LOG OF BORING NO. B-12

GEOTECH ENGINEERING & TESTING
Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: City of Houston, Texas
PROJECT NO.: S-000035-0186-4 STATION NO.: 3+86.32
DATE: 6-27-14 COMPLETION DEPTH: 10.0 ft.

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
					ELEVATION: 35.29									
0					ASPHALT PAVEMENT (2.5-inch in Thickness)									
					FAT CLAY (CH), stiff, gray, dark gray, with ferrous nodules, moist	14								
						14								
					- light brown 4' to 10'									
5						16	70	21	49			104		
					- with calcareous nodules 6' to 8'									
						22								
					- firm 8' to 10'									
						23				92				
10														
15														
20														

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
■ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-13

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 10+42.95

DATE: 6-27-14 COMPLETION DEPTH: 16.0 ft.

ELEVATION: 35.71

DEPTH, ft	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0	ASPHALT PAVEMENT (2.5-inch in Thickness)									
	FAT CLAY (CH), very stiff, dark gray, with ferrous and calcareous nodules, moist	23								
	- stiff 2' to 10'	26								
5		27	74	23	51			102		
	- light gray, light brown 6' to 16'	24								
	- reddish brown 8' to 14'	26								
10		18								
		18								
	- stiff 14' to 16'	18								
15										
20										

UNDRAINED SHEAR STRENGTH, tsf

- ▲ HAND PENETROMETER
- ▮ TORVANE
- ● UNCONFINED COMPRESSION
- ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 16 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-14

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 5+04.07

DATE: 6-27-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 35.85

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT PAVEMENT (2.5-inch in Thickness)									
					FAT CLAY (CH), stiff, dark gray, with ferrous nodules, moist									
					- gray 2' to 6'	26				91				
					- very stiff 4' to 6'	27								
5						24	64	21	43			100		
					- firm 6' to 8' - brown 6' to 10'	26								
10						21								
15														
20														

UNDRAINED SHEAR STRENGTH, tsf

▲ HAND PENETROMETER

■ TORVANE

● UNCONFINED COMPRESSION

○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-15

GEOTECH ENGINEERING & TESTING
Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: City of Houston, Texas
PROJECT NO.: S-000035-0186-4 STATION NO.: 12+11.08
DATE: 6-27-14 COMPLETION DEPTH: 10.0 ft.

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)	UNDRAINED SHEAR STRENGTH, tsf
0					ELEVATION: 36.09										
					ASPHALT PAVEMENT (2.5-inch in Thickness)										
					FAT CLAY (CH), very stiff, dark gray, with ferrous and calcareous nodules, shells, moist										
					- stiff 2' to 4'	21									
						25									
					- light gray, light brown 4' to 10'										
5						23	66	21	45			101			
					- firm 6' to 8'	26									
						31				88					
10															
15															
20															

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
■ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ___ TO ___ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-16

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 2+36.45

DATE: 6-27-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 35.77

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT PAVEMENT (3.4-inch in Thickness)									
					CONCRETE PAVEMENT (5.6-inch in Thickness)									
					FAT CLAY (CH), stiff, gray, dark gray, with root fibers to 4, ferrous nodules, moist - soft 2' to 8'	34								
						35	69	22	47			87		
5						34								
						34				89				
					LEAN CLAY (CL), stiff, light gray, reddish brown, with ferrous nodules, sands, moist	19								
10														
15														
20														

UNDRAINED SHEAR STRENGTH, tsf

- ▲ HAND PENETROMETER
- ■ TORVANE
- ● UNCONFINED COMPRESSION
- ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-17

GEOTECH ENGINEERING & TESTING
Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: City of Houston, Texas
PROJECT NO.: S-000035-0186-4 STATION NO.: 6+47.96
DATE: 6-27-14 COMPLETION DEPTH: 17.0 ft.

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
					ELEVATION: 36.26									
0					ASPHALT PAVEMENT (2.0-inch in Thickness)									
					CONCRETE PAVEMENT (6.5-inch in Thickness)									
					FAT CLAY (CH), stiff, dark gray, reddish brown, with ferrous nodules, moist - firm 2' to 4'	38								
						30								
5						25								
						33				95				
					LEAN CLAY (CL), very stiff, light gray, brown, reddish brown, with ferrous and calcareous nodules, sands, moist	21								
10						17	48	18	30			112		
						13								
					- light brown 14' to 17'									
15						15								
						12								
20														

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
▮ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
▽ : WATER ENCOUNTERED AT 17.0 ft. DURING DRILLING
▼ : WATER DEPTH AT 15.0 ft. AFTER 0.5-HOUR

DRY AUGER: 0 TO 17 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-18

GEOTECH ENGINEERING & TESTING
Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: City of Houston, Texas
PROJECT NO.: S-000035-0186-4 STATION NO.: 11+22.54
DATE: 6-27-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 35.6

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT PAVEMENT (4.7-inch in Thickness)									
					CONCRETE PAVEMENT (3.0-inch in Thickness)									
					FAT CLAY (CH), very stiff, dark gray, reddish brown, with ferrous nodules, moist	25	57	20	37					
					- firm, with calcareous nodules 2' to 4'	26								
					- stiff 4' to 6'									
					- light gray 4' to 8'	25				89		96		
5					- firm 6' to 8'	25								
					LEAN CLAY (CL), stiff, light gray, brown, with ferrous nodules, sands, moist	16								
10														
15														
20														

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
■ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-19

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: City of Houston, Texas
PROJECT NO.: S-000035-0186-4 STATION NO.: -1+98.97
DATE: 6-24-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 37.86

DEPTH, ft	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0	ASPHALT PAVEMENT (12-inch in Thickness)									
	FAT CLAY (CH), very stiff, dark brown, with ferrous nodules, moist	11								
		16								
5		18	51	19	32			112		
	LEAN CLAY (CL), stiff, dark gray, reddish brown, with ferrous and calcareous nodules, sands, moist	19								
	- very stiff 8' to 10'	17								
10										
15										
20										

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
▮ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Eric

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-20

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 6+95.00

DATE: 6-24-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 37.88

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT PAVEMENT (10.5-inch in Thickness)									
					LEAN CLAY (CL), very stiff, dark gray, with ferrous nodules, sands, mosit - reddish brown 2' to 4'	12								
						14				87				
5					FAT CLAY (CH), stiff, dark gray, reddish brown, with ferrous nodules, moist	15								
					LEAN CLAY (CL), stiff, light gray, reddish brown, with ferrous nodules, sands, moist	16	28	15	13			110		
						17								
10														
15														
20														

UNDRAINED SHEAR STRENGTH, tsf

▲ HAND PENETROMETER

■ TORVANE

● UNCONFINED COMPRESSION

○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Eric

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-21

GEOTECH ENGINEERING & TESTING
Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: City of Houston, Texas
PROJECT NO.: S-000035-0186-4 STATION NO.: 9+57.27
DATE: 6-24-14 COMPLETION DEPTH: 10.0 ft.

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
					ELEVATION: 36.86									
0					ASPHALT PAVEMENT (9.5-inch in Thickness)									
					SILTY SAND (SM), gray, moist	9								
					FAT CLAY (CH), stiff, gray, reddish brown, with ferrous nodules, moist	28				94				
5						29						93		
					- light gray 6' to 10'	28	71	22	49					
						22								
10														
15														
20														

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
■ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Eric

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-22

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 14+07.29

DATE: 6-24-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 37.36

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)	UNDRAINED SHEAR STRENGTH, tsf
0					ASPHALT PAVEMENT (11.2-inch in Thickness)										
					FAT CLAY (CH), very stiff, dark gray, reddish brown, with ferrous nodules, moist	20									
						23	71	23	48			100			
					- stiff 4' to 8'										
5						26									
					- light gray, with calcareous nodules 6' to 10'										
						29				90					
10						21									
15															
20															

UNDRAINED SHEAR STRENGTH, tsf
- ▲ HAND PENETROMETER
- ■ TORVANE
- ● UNCONFINED COMPRESSION
- ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Eric

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-23

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 18+23.54

DATE: 6-24-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 37.46

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT PAVEMENT (10.5-inch in Thickness)									
					SILTY SAND (SM), brown, with shells, moist	5				26				
					FAT CLAY (CH), very stiff, gray, reddish brown, with ferrous nodules, moist	25								
					- stiff 4' to 8'	29	74	24	50					
5					- light gray 6' to 10'	30						92		
						21								
10														
15														
20														

UNDRAINED SHEAR STRENGTH, tsf

▲ HAND PENETROMETER

■ TORVANE

● UNCONFINED COMPRESSION

○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Eric

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-24

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 6+02.75

DATE: 6-27-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 34.65

DEPTH, ft	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0	CONCRETE PAVEMENT (5.3-inch in Thickness)									
	FAT CLAY (CH), stiff, gray, light brown, with ferrous nodules, moist	25								
	LEAN CLAY (CL), hard, light gray, with ferrous and calcareous nodules, sands, moist	17	48	18	30			114		
5	FAT CLAY (CH), very stiff, light gray, reddish brown, with ferrous and calcareous nodules, moist	18								
		22				89				
10		21								
15										
20										

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
■ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-25

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 11+08.87

DATE: 6-27-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 34.8

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					CONCRETE PAVEMENT (5.2-inch in Thickness)									
					FAT CLAY (CH), very stiff, dark gray, reddish brown, with ferrous nodules, moist									
					- with calcareous nodules 2' to 10'	23								
						19								
5						22								
					- hard 6' to 8'	19	57	20	37			109		
						19								
10														
15														
20														

UNDRAINED SHEAR STRENGTH, tsf

- ▲ HAND PENETROMETER
- ▮ TORVANE
- ● UNCONFINED COMPRESSION
- ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-26

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 16+11.34

DATE: 6-28-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 35.24

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT PAVEMENT (3.0-inch in Thickness)									
					CONCRETE PAVEMENT (6.0-inch in Thickness)									
					FAT CLAY (CH), stiff, dark gray, with ferrous and calcareous nodules, moist	24								
						21								
					- hard 4' to 6'									
5					- light gray, reddish brown 4' to 10'	21	56	20	36			111		
						17								
					- very stiff 8' to 10'									
10						19				86				
15														
20														

UNDRAINED SHEAR STRENGTH, tsf

- ▲ HAND PENETROMETER
- ■ TORVANE
- ● UNCONFINED COMPRESSION
- ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-27

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 12+78.75

DATE: 6-28-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 35.47

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT PAVEMENT (2.3-inch in Thickness)									
					CONCRETE PAVEMENT (6.4-inch in Thickness)									
					FAT CLAY (CH), stiff, gray, dark gray, with ferrous and calcareous nodules, moist	24				88				
						20								
5					- very stiff, light brown 4' to 10'	25	55	20	35			102		
						21								
						22								
10														
15														
20														

UNDRAINED SHEAR STRENGTH, tsf

- ▲ HAND PENETROMETER
- ▮ TORVANE
- ● UNCONFINED COMPRESSION
- ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-28

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 9+12.01

DATE: 6-28-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 35.85

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT PAVEMENT (3.0-inch in Thickness)									
					CONCRETE PAVEMENT (5.8-inch in Thickness)									
					FAT CLAY (CH), very stiff, gray, dark gray, with ferrous and calcareous nodules, moist									
					- stiff, light brown 4' to 10'	15								
						20	51	20	31			108		
5						19								
						17				87				
						11								
10														
15														
20														

UNDRAINED SHEAR STRENGTH, tsf

- ▲ HAND PENETROMETER
- ■ TORVANE
- ● UNCONFINED COMPRESSION
- ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-29

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 4+29.02

DATE: 6-28-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 35.46

DEPTH, ft	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0	ASPHALT PAVEMENT (3.0-inch in Thickness)									
	CONCRETE PAVEMENT (8.3-inch in Thickness)									
	FAT CLAY (CH), very stiff, gray, dark gray, with ferrous and calcareous nodules, moist	19						106		
	LEAN CLAY (CL), firm, gray, dark gray, with ferrous and calcareous nodules, sands, moist	22	47	18	29					
5		18								
	- stiff 6' to 10'	22								
10		23				88				
15										
20										

UNDRAINED SHEAR STRENGTH, tsf

▲ HAND PENETROMETER

■ TORVANE

● UNCONFINED COMPRESSION

○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-30

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 4+59.63

DATE: 6-28-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 35.44

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT PAVEMENT (3.0-inch in Thickness)									
					CONCRETE PAVEMENT (6.0-inch in Thickness)									
					FAT CLAY (CH), very stiff, dark gray, with ferrous nodules, moist - with calcareous nodules 2' to 4'	19								
						19				90				
5					LEAN CLAY (CL), very stiff, light gray, light brown, with ferrous and calcareous nodules, sands, moist	12								
					FAT CLAY (CH), very stiff, gray, light brown, with ferrous and calcareous nodules, moist	22	66	22	44					
10						16								
15														
20														

UNDRAINED SHEAR STRENGTH, tsf

- ▲ HAND PENETROMETER
- ■ TORVANE
- ● UNCONFINED COMPRESSION
- ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-31

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 9+91.75

DATE: 6-28-14 COMPLETION DEPTH: 15.0 ft.

ELEVATION: 34.44

DEPTH, ft	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0	ASPHALT PAVEMENT (6.7-inch in Thickness)									
	FAT CLAY (CH), very stiff, dark gray, with root fibers to 2', ferrous nodules, moist	22								
	- light brown, with calcareous nodules 2' to 8'	21								
5		21				92				
	- stiff 6' to 8'	17								
	LEAN CLAY (CL), stiff, light gray, light brown, with ferrous and calcareous nodules, sands, moist	17	47	19	28					
10		15								
	FAT CLAY (CH), hard, light gray, reddish brown, with ferrous and calcareous nodules, moist	25						101		
	- very stiff 14' to 15'	30								
15										
20										

UNDRAINED SHEAR STRENGTH, tsf
- ▲ HAND PENETROMETER
- ▮ TORVANE
- ● UNCONFINED COMPRESSION
- ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 15 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-32

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 2+84.85

DATE: 6-28-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 33.82

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT PAVEMENT (2.5-inch in Thickness)									
					CONCRETE PAVEMENT (6.0-inch in Thickness)									
					FAT CLAY (CH), very stiff, dark gray, with root fibers, ferrous nodules, moist	18								
					- hard 2' to 4'									
					- gray, light brown, with calcareous nodules 2' to 10'	20	53	20	33			111		
5						20								
					- hard 6' to 8'	22						105		
						22				96				
10														
15														
20														

UNDRAINED SHEAR STRENGTH, tsf

- ▲ HAND PENETROMETER
- ▮ TORVANE
- ● UNCONFINED COMPRESSION
- ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-33

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 6+71.96

DATE: 6-28-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 34.38

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT PAVEMENT (2.8-inch in Thickness)									
					CONCRETE PAVEMENT (6.5-inch in Thickness)									
					FAT CLAY (CH), very stiff, dark gray, with ferrous and calcareous nodules, moist	20								
						17								
5					- gray 4' to 8'	20	56	20	36			108		
						23								
					- stiff 6' to 8'	20				95				
10														
15														
20														

UNDRAINED SHEAR STRENGTH, tsf

- ▲ HAND PENETROMETER
- ■ TORVANE
- ● UNCONFINED COMPRESSION
- ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-34

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 14+98.24

DATE: 6-28-14 COMPLETION DEPTH: 16.0 ft.

ELEVATION: 34.84

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)	UNDRAINED SHEAR STRENGTH, tsf
0					ASPHALT PAVEMENT (2.5-inch in Thickness)										
					CONCRETE PAVEMENT (5.0-inch in Thickness)										
					FAT CLAY WITH SAND (CH), very stiff, dark gray, with ferrous and calcareous nodules, moist	20				83					
5					FAT CLAY (CH), very stiff, reddish brown, with ferrous and calcareous nodules, moist	16									
						18									
						20	52	19	33			112			
10						19									
						20									
						17									
15						19									
20															

UNDRAINED SHEAR STRENGTH, tsf: 0.5, 1.0, 1.5, 2.0, 2.5

▲ HAND PENETROMETER
■ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 16 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-35

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: City of Houston, Texas
PROJECT NO.: S-000035-0186-4 STATION NO.: 21+47.19
DATE: 6-29-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 35.08

DEPTH, ft	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0	ASPHALT PAVEMENT (3.0-inch in Thickness)									
	CONCRETE PAVEMENT (5.0-inch in Thickness)									
	FAT CLAY WITH SAND (CH), very stiff, dark gray, with ferrous and calcareous nodules, moist	22				78				
		19								
5	LEAN CLAY (CL), very stiff, reddish brown, with ferrous and calcareous nodules, sands, moist	18	49	19	30			102		
		16								
	- stiff 8' to 10'	19								
10										
15										
20										

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
■ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/6/14

LOG OF BORING NO. B-36

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: City of Houston, Texas
PROJECT NO.: S-000035-0186-4 STATION NO.: 5+86.84
DATE: 6-29-14 COMPLETION DEPTH: 10.0 ft.

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)	UNDRAINED SHEAR STRENGTH, tsf
0					ELEVATION: 34.56										
0					ASPHALT PAVEMENT (2.8-inch in Thickness)										
					CONCRETE PAVEMENT (4.6-inch in Thickness)										
					FAT CLAY (CH), stiff, dark gray, with ferrous nodules, moist	22				88					
					- firm 2' to 4'	25									
					- very stiff, light gray 4' to 10'	20									
5						18	55	21	34			110			
					- reddish brown 8' to 10'	21									
10															
15															
20															

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
■ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-37

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: City of Houston, Texas
PROJECT NO.: S-000035-0186-4 STATION NO.: 11+75.31
DATE: 6-29-14 COMPLETION DEPTH: 16.0 ft.

ELEVATION: 34.07

DEPTH, ft	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0	ASPHALT PAVEMENT (2.5-inch in Thickness)									
	CONCRETE PAVEMENT (4.0-inch in Thickness)									
	FAT CLAY (CH), stiff, dark gray, with ferrous nodules, moist	20								
		21								
5		22				90				
	- with calcareous nodules 6' to 8'	24								
	LEAN CLAY (CL), very stiff, light gray, light brown, with ferrous and calcareous nodules, sands, moist	20	48	19	29			107		
10	FAT CLAY (CH), very stiff, light gray, reddish brown, with ferrous and calcareous nodules, moist	20								
		21								
15		21								
20										

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
■ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 16 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-38

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 9+28.46

DATE: 6-29-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 34.82

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT PAVEMENT (3.0-inch in Thickness)									
					CONCRETE PAVEMENT (5.0-inch in Thickness)									
					FAT CLAY (CH), very stiff, dark gray, reddish brown, with root fibers to 4, ferrous nodules, moist - hard 2' to 4'	16								
						20	64	22	42			109		
5						16								
					LEAN CLAY WITH SAND (CL), very stiff, light gray, reddish brown, with ferrous and calcareous nodules, sands, moist	17								
						14				81				
10														
15														
20														

UNDRAINED SHEAR STRENGTH, tsf

- ▲ HAND PENETROMETER
- ■ TORVANE
- ● UNCONFINED COMPRESSION
- ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-39

GET GEOTECH ENGINEERING & TESTING
Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: City of Houston, Texas
PROJECT NO.: S-000035-0186-4 STATION NO.: 4+68.01
DATE: 6-29-14 COMPLETION DEPTH: 15.0 ft.

ELEVATION: 34.57

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT PAVEMENT (3.0-inch in Thickness)									
					CONCRETE PAVEMENT (5.0-inch in Thickness)									
					FAT CLAY (CH), very stiff, dark gray, reddsih brown, with ferrous nodules, moist	20								
						19								
					- light gray, with calcareous nodules 4' to 14'									
5						17						92		
						17								
					- firm 8' to 10'									
						24								
10					- brown 10' to 15'									
						19	56	20	36					
						19								
					- stiff 14' to 15'									
15						19								
20														

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
■ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-40

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 15+08.04

DATE: 6-29-14 COMPLETION DEPTH: 15.0 ft.

ELEVATION: 34.93

DEPTH, ft	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0	ASPHALT PAVEMENT (3.0-inch in Thickness)									
	CONCRETE PAVEMENT (5.0-inch in Thickness)									
	FAT CLAY (CH), very stiff, dark gray, with ferrous nodules, moist	20								
	- stiff 2' to 4'	20								
	- light gray 4' to 15'	20				90				
5	- brown 6' to 15'	20								
	- hard 8' to 10'	18	57	20	37			110		
10		16								
		21								
15		21								
20										

UNDRAINED SHEAR STRENGTH, tsf

- ▲ HAND PENETROMETER
- ■ TORVANE
- ● UNCONFINED COMPRESSION
- ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 15 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-41

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: City of Houston, Texas
PROJECT NO.: S-000035-0186-4 STATION NO.: 16+87.65
DATE: 6-29-14 COMPLETION DEPTH: 10.0 ft.

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
					ELEVATION: 34.81									
0					ASPHALT PAVEMENT (3.0-inch in Thickness)									
					CONCRETE PAVEMENT (5.0-inch in Thickness)									
					FAT CLAY (CH), very stiff, dark gray, light brown, with ferrous nodules, moist	15								
					- light gray 4' to 10'	15								
5						16								
					- hard 6' to 8'	20	54	19	35			115		
					- reddish brown, with calcareous nodules 8' to 10'	26								
10														
15														
20														

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
▮ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-42

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 10+08.45

DATE: 6-29-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 33.28

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT PAVEMENT (2.2-inch in Thickness)									
					CONCRETE PAVEMENT (5.0-inch in Thickness)									
					FAT CLAY (CH), very stiff, dark gray, reddish brown, with ferrous nodules, moist - hard 2' to 4'	15								
						14	52	19	33			115		
5					LEAN CLAY (CL), very stiff, light gray, reddish brown, with ferrous nodules, sands, moist	10								
					FAT CLAY (CH), very stiff, light gray, brown, with ferrous and calcareous nodules, sands, moist	15								
10						25								
15														
20														

UNDRAINED SHEAR STRENGTH, tsf

- ▲ HAND PENETROMETER
- ▮ TORVANE
- ● UNCONFINED COMPRESSION
- ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-43

GET GEOTECH ENGINEERING & TESTING
Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: City of Houston, Texas
PROJECT NO.: S-000035-0186-4 STATION NO.: 3+33.19
DATE: 6-29-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 34.24

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT PAVEMENT (2.0-inch in Thickness)									
					CONCRETE PAVEMENT (5.0-inch in Thickness)									
					FAT CLAY (CH), stiff, dark gray, with ferrous nodules, moist	20								
					- light gray, light brown 2' to 8'	18				87				
5						19								
					- hard 6' to 8'	18	58	20	38			109		
					LEAN CLAY (CL), stiff, light gray, brown, with ferrous nodules, sands, moist	22								
10														
15														
20														

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
■ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-44

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 10+38.32

DATE: 6-29-14 COMPLETION DEPTH: 15.0 ft.

ELEVATION: 34.27

DEPTH, ft	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0	ASPHALT PAVEMENT (3.0-inch in Thickness)									
	CONCRETE PAVEMENT (4.6-inch in Thickness)									
	FAT CLAY (CH), very stiff, dark gray, reddish brown, with root fibers to 2', ferrous nodules, moist - stiff 2' to 4'	25								
5		20								
		21	55	21	34			107		
	LEAN CLAY (CL), stiff, light gray, reddish brown, with ferrous nodules, sands, moist	19								
10		19								
	FAT CLAY (CH), stiff, light gray, reddish brown, with ferrous and calcareous nodules, sands, moist - very stiff 12' to 14'	30								
		28								
15		28								
20										

SPT N-VALUE blows per foot | OVM, ppm | SYMBOL | SAMPLES

UNDRAINED SHEAR STRENGTH, tsf
- ▲ HAND PENETROMETER
- ▮ TORVANE
- ● UNCONFINED COMPRESSION
- ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
- ▽ : WATER ENCOUNTERED AT 12.0 ft. DURING DRILLING
- ▼ : WATER DEPTH AT 10.0 ft. AFTER 0.5-HOUR

DRY AUGER: 0 TO 15 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-45

GEOTECH ENGINEERING & TESTING
Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: City of Houston, Texas
PROJECT NO.: S-000035-0186-4 STATION NO.: 6+17.11
DATE: 6-29-14 COMPLETION DEPTH: 10.0 ft.

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
					ELEVATION: 33.14									
0					ASPHALT PAVEMENT (3.0-inch in Thickness)									
					CONCRETE PAVEMENT (5.0-inch in Thickness)									
					FAT CLAY WITH SAND (CH), stiff, dark gray, brown, with ferrous nodules, moist	25								
					- with calcareous nodules 2' to 4'	21				81				
5					- light gray 6' to 8'	24								
						22	58	21	37					
					LEAN CLAY (CL), stiff, light gray, reddish brown, with ferrous nodules, sands, moist	21						103		
10														
15														
20														

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
■ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-46

GEOTECH ENGINEERING & TESTING
Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: City of Houston, Texas
PROJECT NO.: S-000035-0186-4 STATION NO.: 4+11.97
DATE: 7-1-14 COMPLETION DEPTH: 10.0 ft.

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
					ELEVATION: 33.56									
0					ASPHALT PAVEMENT (10.0-inch in Thickness)									
					FAT CLAY (CH), very stiff, gray, reddish brown, with ferrous and calcareous nodules, moist - hard 2' to 4'	26								
						18	54	20	34			112		
5					LEAN CLAY (CL), very stiff, light gray, with ferrous and calcareous nodules, sands, moist	7								
					- reddish brown 6' to 10'	19				88				
					- stiff 8' to 10'	23								
10														
15														
20														

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
▮ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-47

GEOTECH ENGINEERING & TESTING
Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: City of Houston, Texas
PROJECT NO.: S-000035-0186-4 STATION NO.: 15+34.25
DATE: 7-1-14 COMPLETION DEPTH: 10.0 ft.

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
					ELEVATION: 34.2									
0					ASPHALT PAVEMENT (3.3-inch in Thickness)									
					CONCRETE PAVEMENT (4.8-inch in Thickness)									
					FAT CLAY (CH), stiff, gray, with ferrous and calcareous nodules, moist - very stiff 2' to 4'	21				85				
						17								
5					LEAN CLAY (CL), hard, gray, with ferrous and calcareous nodules, sands, moist	14	43	18	25			116		
					FAT CLAY (CH), very stiff, reddish brown, with ferrous and calcareous nodules, moist	18								
					- stiff 8' to 10'	19								
10														
15														
20														

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
▮ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0,5 1,0 1,5 2,0 2,5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-48

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 8+43.23

DATE: 7-1-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 32.76

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					CONCRETE PAVEMENT (6.0-inch in Thickness)									
					FAT CLAY WITH SAND (CH), stiff, gray, with ferrous and calcareous nodules, moist - very stiff 2' to 4'	23								
						18	51	19	32			110		
5					- firm 4' to 6'	21								
					- reddish brown 6' to 10'	17				82				
10						17								
15														
20														

UNDRAINED SHEAR STRENGTH, tsf

- ▲ HAND PENETROMETER
- ▮ TORVANE
- ● UNCONFINED COMPRESSION
- ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-49

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: City of Houston, Texas

PROJECT NO.: S-000035-0186-4 STATION NO.: 3+25.02

DATE: 7-1-14 COMPLETION DEPTH: 10.0 ft.

ELEVATION: 32.81

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					CONCRETE PAVEMENT (6.5-inch in Thickness)									
					FAT CLAY WITH SAND (CH), stiff, gray, with ferrous and calcareous nodules, moist - very stiff 2' to 6'	19								
						15				84				
5						15								
					LEAN CLAY (CL), very stiff, reddish brown, with ferrous and calcareous nodules, sands, moist	16	42	18	24			113		
					FAT CLAY (CH), very stiff, reddish brown, with ferrous and calcareous nodules, moist	21								
10														
15														
20														

UNDRAINED SHEAR STRENGTH, tsf
- ▲ HAND PENETROMETER
- ▮ TORVANE
- ● UNCONFINED COMPRESSION
- ○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: GET (T)
LOGGED BY: Shawn

OVM2 14-319E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-1*

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: Houston, Texas
PROJECT NO.: 14-319E STATION NO.:
DATE: 1-5-06 COMPLETION DEPTH: 25.0 ft.

ELEVATION: Existing Grade

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT (1.3") CONCRETE (8.3") LEAN CLAY (CL), very stiff, gray, light gray, with root fibers to 6', ferrous nodules, moist - stiff 2' to 4'	20	44	18	26					
5					- firm 4' to 8' - with calcareous nodules 4' to 6'	29						97		
10					FAT CLAY (CH), very stiff, light gray, brown, with ferrous and calcareous nodules, moist	25	64	21	43			102		
15					SILTY SAND (SM), light gray, light brown, with clay pockets, moist to wet									
20														
25	18				- medium dense 23' to 25'	23				31				

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
▮ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
▽ : WATER ENCOUNTERED AT 18.0 ft. DURING DRILLING
▼ : WATER DEPTH AT 11.0 ft. AFTER 24-HOUR

DRY AUGER: 0 TO 25 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: Orion
LOGGED BY: Ricky

OVM2 05-869E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-23*

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area

LOCATION: Houston, Texas

PROJECT NO.: 14-319E STATION NO.:

DATE: 1-3-06 COMPLETION DEPTH: 10.0 ft.

ELEVATION: Existing Grade

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0					ASPHALT (2.0") CONCRETE (1.0") FAT CLAY (CH), very stiff, light gray, brown, with root fibers to 2', ferrous and calcareous nodules, moist - stiff 2' to 6'									
						28	69	22	47					
5						22	65	21	44			102		
						20						113		
10														
15														
20														
25														

UNDRAINED SHEAR STRENGTH, tsf

▲ HAND PENETROMETER

■ TORVANE

● UNCONFINED COMPRESSION

○ UNCONSOLIDATED-UNDRAINED TRIAXIAL

0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ___ TO ___ ft.

DRILLED BY: Orion
LOGGED BY: Ricky

OVM2 05-869E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-37*

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: Houston, Texas
PROJECT NO.: 14-319E STATION NO.:
DATE: 1-11-06 COMPLETION DEPTH: 10.0 ft.

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
					ELEVATION: Existing Grade									
0					ASPHALT (3.3") CONCRETE (2.5") FILL: FAT CLAY (CH), very stiff, with ferrous and calcareous nodules, moist									
					FAT CLAY (CH), firm, olive gray, light brown, with ferrous and calcareous nodules, moist	21	52	19	33					
5					- stiff 4' to 6'									
					- very stiff 6' to 10'	20	61	21	40			108		
10						15						115		
15														
20														
25														

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
■ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: Orion
LOGGED BY: Ricky

OVM2 05-869E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-38*

GEOTECH ENGINEERING & TESTING
Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: Houston, Texas
PROJECT NO.: 14-319E STATION NO.:
DATE: 1-11-06 COMPLETION DEPTH: 10.0 ft.

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
					ELEVATION: Existing Grade									
0					ASPHALT (2.6") / CONCRETE (5.7") / LEAN CLAY (CL), stiff, light gray, with ferrous nodules, shell fragments, moist									
					FAT CLAY (CH), stiff, light gray, olive gray, brown, with root fibers to 8', ferrous nodules, moist	28						97		
5					- very stiff 6' to 10'	28	69	22	47					
					- with calcareous nodules 8' to 10'	21						109		
10														
15														
20														
25														

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
■ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 10 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: Orion
LOGGED BY: Ricky

OVM2 05-869E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-39*

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: Houston, Texas
PROJECT NO.: 14-319E STATION NO.:
DATE: 1-9-06 COMPLETION DEPTH: 15.0 ft.

DEPTH, ft	SPT N-VALUE blows per foot	OVM, ppm	SYMBOL	SAMPLES	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
					ELEVATION: Existing Grade									
0					ASPHALT (8.9")									
					FAT CLAY (CH), stiff, light gray, olive gray, brown, with root fibers to 8', ferrous and calcareous nodules, moist	29	77	23	54					
5					- hard 6' to 8'	18	54	19	35			110		
					LEAN CLAY (CL), stiff, light gray, brown, with ferrous and calcareous nodules, moist	15						114		
10					- very stiff 13' to 15'									
15														
20														
25														

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
▮ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 15 ft.
WET ROTARY: ___ TO ___ ft.

DRILLED BY: Orion
LOGGED BY: Ricky

OVM2 05-869E.GPJ OVM.GDT 11/5/14

LOG OF BORING NO. B-59*

Geotech Engineering and Testing
800 Victoria Drive
Houston, Texas 77022
Phone: 713-699-4000 Fax: 713-699-9200

PROJECT: Proposed Water Line Replacement in Fairlawn Area
LOCATION: Houston, Texas
PROJECT NO.: 14-319E STATION NO.:
DATE: 1-10-06 COMPLETION DEPTH: 15.0 ft.

ELEVATION: Existing Grade

DEPTH, ft	DESCRIPTION	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SUCTION (pF)	DRY UNIT WEIGHT, pcf	PERCENT COMPACTION	PASSING/FAILING (P/F)
0	ASPHALT (3.5") CONCRETE (5.3") FAT CLAY (CH), soft, dark gray, light gray, brown, with root fibers to 4', ferrous and calcareous nodules, moist - very stiff 2' to 6'									
5	- stiff 6' to 8'									
	- very stiff, with silt seams 8' to 10'	21	55	20	35			104		
10										
	- stiff 13' to 15'									
15										
20										
25										

UNDRAINED SHEAR STRENGTH, tsf
▲ HAND PENETROMETER
■ TORVANE
● UNCONFINED COMPRESSION
○ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

DRY AUGER: 0 TO 15 ft.
WET ROTARY: ____ TO ____ ft.

DRILLED BY: Orion
LOGGED BY: Ricky

OVM2 05-869E.GPJ OVM.GDT 11/5/14

KEY TO LOG TERMS AND SYMBOLS

UNIFIED SOIL CLASSIFICATIONS

Symbol		Material Descriptions
GW		WELL GRADED-GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
GP		POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
GM		SILTY GRAVELS, GRAVEL-SAND SILT MIXTURES
GC		CLAY GRAVELS, GRAVEL-SAND CLAY MIXTURES
SW		WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SP		POORLY GRADED SANDS, OR GRAVELLY SANDS, LITTLE OR NO FINES
SM		SILTY SANDS, SAND-SILT MIXTURES a
SC		CLAYEY SANDS, SAND-SILT MIXTURES b
ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
CL		INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, LEAN CLAYS
OL		ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MH		INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
OH		ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
PT		PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENT
		FILL SOILS

TERMS CHARACTERIZING SOIL STRUCTURE

Slickensided	-	Having incline planes of weakness that are slick and glossy in appearance.
Fissured	-	Containing shrinkage cracks frequently filled with fine sand or silt: usually vertical.
Laminated	-	Composed of thin layers of varying colors and soil sample texture.
Interbedded	-	Composed of alternate layers of different soil types.
Calcareous	-	Containing appreciable quantities of calcium carbonate.
Well Graded	-	Having wide range in grain sizes and substantial amounts of all intermediate particle sizes.
Poorly Graded	-	Predominantly of one grain size, or having a range of sizes with some intermediate sizes missing.
Pocket	-	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	-	Inclusion less than ⅛-inch thick extending through the sample.
Seam	-	Inclusion ⅛- to 3-inch thick extending through the sample.
Layer	-	Inclusion greater than 3-inch thick extending through the sample.
Interlayered	-	Soils sample composed of alternating layers of different soil types.
Intermixed	-	Soil samples composed of pockets of different soil type and layered or laminated structure is not evident.

COARSE GRAINED SOILS (major portion retained on No. 200 Sieve): Includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Conditions rated according to standard penetration test (SPT)* as performed in the field.

Descriptive Terms	Blows Per Foot*
Very Loose	0 – 4
Loose	5 – 10
Medium Dense	11 – 30
Dense	31 – 50
Very Dense	over 50

* 140 pound weight having a free fall of 30-inch

FINE GRAINED SOILS (major portion passing No. 200 Sieve): Include (1) inorganic or organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength as indicated by hand penetrometer readings or by unconfined compression tests.

Descriptive Term	Undrained Shear Strength Ton/Sq. Ft.
Very Soft	Less than 0.13
Soft	0.13 to 0.25
Firm	0.25 to 0.50
Stiff	0.50 to 1.00
Very Stiff	1.00 to 2.00
Hard	2.00 or higher

NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above because of weakness or cracks in the soil. The consistency ratings of such soils are based on hand penetrometer readings.

SOIL SAMPLERS

- SHELBY TUBE SAMPLER
- STANDARD PENETRATION TEST
- AUGER SAMPLING

TERMS CHARACTERIZING ROCK PROPERTIES

VERY SOFT OR PLASTIC	Can be remolded in hand: corresponds in consistency up to very stiff in soils.
SOFT	Can be scratched with fingernail.
MODERATELY HARD	Can be scratched easily with knife; cannot be scratched with fingernail. Difficult to scratch with knife.
VERY HARD	Cannot be scratched with knife.
POORLY CEMENTED OR FRIABLE	Easily crumbled.
CEMENTED	Bounded Together by chemically precipitated materials.
UNWEATHERED	Rock in its natural state before being exposed to atmospheric agents.
SLIGHTLY WEATHERED	Noted predominantly by color change with no disintegrated zones.
WEATHERED	Complete color change with zones of slightly decomposed rock.
EXTREMELY WEATHERED	Complete color change with consistency, texture, and general appearance or soil.

Summary of Laboratory Tests

Project: Proposed Water Line Replacement in Fairlawn Area, WBS No. S-000035-0186-4
Location: City of Houston, Texas

Boring No.	Sample Depth (ft) From	To	Soil Classification	Moisture Content (%)	Atterberg Limits (%) LL	PL	PI	No. 200 Sieve (%)	Dry Density (pcf)	Undrained Shear Strength H.P (tsf)	Torvane (tsf)	U.C. (tsf)
B-1	0	0.3	Asphalt Pavement									
	0.3	2	Fat Clay (CH)	37	73	22			85	0.39	0.5	0.47
	2	4	Fat Clay (CH)	30						0.46	0.5	
	4	6	Fat Clay (CH)	32						0.46	0.5	
	6	8	Fat Clay (CH)	28				91		0.69	0.75	
	8	10	Fat Clay (CH)	24						0.85	0.9	
	10	12	Fat Clay (CH)	23						1.08	1.12	
	12	14	Fat Clay (CH)	22						0.93	1	
	14	16	Fat Clay (CH)	23						1.5	1.5	
B-2	0	0.3	Asphalt Pavement									
	0.3	2	Fat Clay (CH)	14						1.5	1.5	
	2	4	Fat Clay (CH)	15						0.39	0.5	
	4	6	Fat Clay (CH)	26	67	21			99	0.78	0.88	1.07
	6	8	Fat Clay (CH)	31						0.56	0.62	
	8	10	Fat Clay (CH)	35						0.78	0.88	
	10	12	Fat Clay (CH)	29						0.31	0.38	
	12	14	Fat Clay (CH)	24				86		0.78	0.88	
	14	16	Fat Clay (CH)	30						0.93	1	
B-3	0	0.3	Asphalt Pavement									
	0.3	2	Silty Sand (SM)	19				22				
	2	4	Fat Clay (CH)	25						0.69	0.75	
	4	6	Fat Clay (CH)	23	55	21			98	0.62	0.75	0.76
	6	8	Fat Clay (CH)	25						0.78	0.88	
	8	10	Fat Clay (CH)	23						0.46	0.5	
B-4	0	0.3	Asphalt Pavement									
	0.3	0.8	Concrete Pavement									
	0.8	2	Fat Clay (CH)	25						0.31	0.38	
	2	4	Fat Clay (CH)	25						0.85	0.88	
	4	6	Fat Clay (CH)	25						0.78	0.88	
	6	8	Fat Clay (CH)	27	60	21			104	0.62	0.75	0.96
	8	10	Fat Clay (CH)	30						0.46	0.5	
B-5	0	0.9	Asphalt Pavement									
	0.9	2	Fat Clay (CH)	33						0.39	0.5	
	2	4	Fat Clay (CH)	25	65	20			97	0.46	0.5	0.85
	4	6	Fat Clay (CH)	31						0.38	0.5	
	6	8	Fat Clay (CH)	23				92		1.01	1.12	
	8	10	Fat Clay (CH)	29						0.69	0.75	
B-6	0	0.8	Asphalt Pavement									
	0.8	2	Fat Clay (CH)	25						0.69	0.75	
	2	4	Fat Clay (CH)	29						0.69	0.75	
	4	6	Fat Clay (CH)	27				91		0.46	0.5	
	6	8	Fat Clay (CH)	28						0.56	0.62	
	8	10	Fat Clay (CH)	21	57	20			106	0.93	1	1.11
	10	12	Fat Clay (CH)	19						0.93	1	
	12	14	Fat Clay (CH)	21						0.93	1	
	14	16	Fat Clay (CH)	17						1.5	1.5	
B-7	0	0.8	Asphalt Pavement									
	0.8	1.2	Fat Clay (CH)	22						0.93	1	
	2	2	Fat Clay (CH)	21				93		1.16	1.25	
	4	2	Fat Clay (CH)	24						0.93	1	
	6	2	Fat Clay (CH)	23	67	21			99	0.69	0.75	0.66
	8	2	Fat Clay (CH)	25						1.16	1.25	
B-8	0	0.3	Asphalt Pavement									
	0.3	2	Fat Clay (CH)	29				86		1.16	1.25	
	2	4	Fat Clay (CH)	30						0.78	0.88	
	4	6	Fat Clay (CH)	22						1.5	1.5	
	6	8	Fat Clay (CH)	29						0.69	0.75	
	8	10	Fat Clay (CH)	33	70	22			90	1.08	1.12	0.9
	10	12	Fat Clay (CH)	27						0.93	1	
	12	14	Fat Clay (CH)	30						0.69	0.75	
	14	16	Fat Clay (CH)	24						0.62	0.75	

PLATE A-60

Summary of Laboratory Tests

Project: Proposed Water Line Replacement in Fairlawn Area, WBS No. S-000035-0186-4
Location: City of Houston, Texas

Boring No.	Sample Depth (ft) From	To	Soil Classification	Moisture Content (%)	Atterberg Limits (%) LL	PL	PI	No. 200 Sieve (%)	Dry Density (pcf)	Undrained Shear Strength H.P (tsf)	Torvane (tsf)	U.C. (tsf)
B-9	0	0.3	Asphalt Pavement									
	0.3	0.8	Concrete Pavement									
	0.8	2	Fat Clay (CH)	27						0.78	0.88	
	2	4	Fat Clay (CH)	31						0.85	1	
	4	6	Fat Clay (CH)	28						0.93	1.12	
	6	8	Lean Clay (CL)	26				85		0.78	1	
	8	10	Fat Clay (CH)	26						0.62	0.75	
	10	12	Fat Clay (CH)	26						1.5	1.5	
	12	14	Fat Clay (CH)	27	42	18			102	1.5	1.5	0.57
	14	16	Fat Clay (CH)	20						1.5	1.5	
	16	17	Fat Clay (CH)	22						0.56	0.62	
B-10	0	0.3	Asphalt Pavement									
	0.3	0.8	Concrete Pavement									
	0.8	2	Lean Clay (CL)	10						0.69	0.75	
	2	4	Fat Clay (CH)	22						0.56	0.62	
	4	6	Fat Clay (CH)	21	81	23			114	0.62	0.75	0.81
	6	8	Fat Clay (CH)	15						0.69	0.75	
	8	10	Fat Clay (CH)	15						0.78	0.88	
	10	12	Fat Clay (CH)	17						0.46	0.5	
	12	14	Fat Clay (CH)	14						0.23	0.25	
	14	16	Fat Clay (CH)	18						0.38	0.5	
B-11	0	0.3	Asphalt Pavement									
	0.3	2	Lean Clay (CL)	19	49	19			101	1.5	1.5	1.34
	2	4	Fat Clay (CH)	17						0.46	0.5	
	4	6	Fat Clay (CH)	21						0.69	0.75	
	6	8	Fat Clay (CH)	23						0.93	1	
	8	10	Fat Clay (CH)	16						0.62	0.75	
B-12	0	0.3	Asphalt Pavement									
	0.3	2	Fat Clay (CH)	14						0.85	0.88	
	2	4	Fat Clay (CH)	14						0.78	0.88	
	4	6	Fat Clay (CH)	16	70	21			104	0.62	0.75	0.66
	6	8	Fat Clay (CH)	22						0.78	0.88	
	8	10	Fat Clay (CH)	23				92		0.46	0.5	
B-13	0	0.3	Asphalt Pavement									
	0.3	2	Fat Clay (CH)	23						1.01	1.12	
	2	4	Fat Clay (CH)	26						0.62	0.69	
	4	6	Fat Clay (CH)	27	74	23			102	0.69	0.75	0.98
	6	8	Fat Clay (CH)	24						0.85	0.9	
	8	10	Fat Clay (CH)	26						0.69	0.75	
	10	12	Fat Clay (CH)	18						1.5	1.5	
	12	14	Fat Clay (CH)	18						1.5	1.5	
	14	16	Fat Clay (CH)	18						0.85	0.88	
B-14	0	0.3	Asphalt Pavement									
	0.3	2	Fat Clay (CH)	26			91			0.56	0.62	
	2	4	Fat Clay (CH)	27						0.56	0.62	
	4	6	Fat Clay (CH)	24	64	21		100		0.62	0.75	1.13
	6	8	Fat Clay (CH)	26						0.46	0.5	
	8	10	Fat Clay (CH)	21						0.69	0.75	
B-15	0	0.3	Asphalt Pavement									
	0.3	1.7	Fat Clay (CH)	21						1.08	1.12	
	2	2	Fat Clay (CH)	25						0.69	0.75	
	4	2	Fat Clay (CH)	23	66	21			101	1.24	1.25	1.45
	6	2	Fat Clay (CH)	26						0.46	0.5	
	8	2	Fat Clay (CH)	31				88		1.08	1.12	

PLATE A-61

Summary of Laboratory Tests

Project: Proposed Water Line Replacement in Fairlawn Area, WBS No. S-000035-0186-4
Location: City of Houston, Texas

Boring No.	Sample Depth (ft) From	To	Soil Classification	Moisture Content (%)	Atterberg Limits (%) LL	PL	PI	No. 200 Sieve (%)	Dry Density (pcf)	Undrained Shear Strength H.P (tsf)	Torvane (tsf)	U.C. (tsf)
B-16	0	0.3	Asphalt Pavement									
	0.3	0.8	Concrete Pavement									
	0.8	2	Lean Clay (CL)	34						0.85	0.88	
	2	4	Fat Clay (CH)	35	69	22			87	0.15	0.25	0.15
	4	6	Fat Clay (CH)	34						0.15	0.25	
	6	8	Fat Clay (CH)	34				89		0.15	0.25	
	8	10	Lean Clay (CL)	19						0.85	0.88	
B-17	0	0.3	Asphalt Pavement									
	0.3	0.8	Concrete Pavement									
	0.8	2	Lean Clay (CL)	38						0.78	0.88	
	2	4	Fat Clay (CH)	30						0.46	0.5	
	4	6	Fat Clay (CH)	25						0.69	0.75	
	6	8	Fat Clay (CH)	33				95		0.62	0.75	
	8	10	Lean Clay (CL)	21						1.08	1.12	
	10	12	Lean Clay (CL)	17	48	18			112	1.5	1.5	1.96
	12	14	Lean Clay (CL)	13						1.5	1.5	
	14	16	Lean Clay (CL)	15						1.5	1.5	
	16	17	Lean Clay (CL)	12						1.5	1.5	
B-18	0	0.4	Asphalt Pavement									
	0.4	0.7	Concrete Pavement									
	0.7	2	Fat Clay (CH)	25	57	20				1.08	1.12	
	2	4	Fat Clay (CH)	26						0.46	0.5	
	4	6	Fat Clay (CH)	25				89	96	0.39	0.5	0.61
	6	8	Fat Clay (CH)	25						0.39	0.5	
	8	10	Lean Clay (CL)	16						0.69	0.75	
B-19	0	1	Asphalt Pavement									
	1	2	Fat Clay (CH)	11						1.5	1.5	
	2	4	Fat Clay (CH)	16						1.16	1.25	
	4	6	Fat Clay (CH)	18	51	19			112	0.69	0.75	1.71
	6	8	Lean Clay (CL)	19						0.78	0.88	
	8	10	Lean Clay (CL)	17						1.5	1.5	
B-20	0	0.9	Asphalt Pavement									
	0.9	2	Lean Clay (CL)	12						1.5	1.5	
	2	4	Lean Clay (CL)	14				87		1.5	1.5	
	4	6	Fat Clay (CH)	15						0.78	0.88	
	6	8	Lean Clay (CL)	16	28	15			110	0.93	0.95	0.76
	8	10	Lean Clay (CL)	17						0.93	0.95	
B-21	0	0.9	Asphalt Pavement									
	0.9	2	Silty Sand (SM)	9								
	2	4	Fat Clay (CH)	28				94		0.62	0.75	
	4	6	Fat Clay (CH)	29					93	0.46	0.5	0.81
	6	8	Fat Clay (CH)	28	71	22				0.85	0.88	
	8	10	Fat Clay (CH)	22						0.93	1	
B-22	0	0.9	Asphalt Pavement									
	0.9	2	Fat Clay (CH)	20						1.5	1.5	
	2	4	Fat Clay (CH)	23	71	23			100	0.93	1	1.5
	4	6	Fat Clay (CH)	26						0.78	0.85	
	6	8	Fat Clay (CH)	29				90		0.69	0.85	
	8	10	Fat Clay (CH)	21						1.5	1.5	

PLATE A-62

Summary of Laboratory Tests

Project: Proposed Water Line Replacement in Fairlawn Area, WBS No. S-000035-0186-4
Location: City of Houston, Texas

Boring No.	Sample Depth (ft) From	To	Soil Classification	Moisture Content (%)	Atterberg Limits (%) LL	PL	PI	No. 200 Sieve (%)	Dry Density (pcf)	Undrained Shear Strength H.P (tsf)	Torvane (tsf)	U.C. (tsf)
B-23	0	0.9	Asphalt Pavement									
	0.9	2	Silty Sand (SM)	5				26				
	2	4	Fat Clay (CH)	25						1.08	1.12	
	4	6	Fat Clay (CH)	29	74	24				0.62	0.75	
	6	8	Fat Clay (CH)	30					92	0.46	0.5	0.67
	8	10	Fat Clay (CH)	21						1.32	1.5	
B-24	0	0.5	Concrete Pavement									
	0.5	2	Fat Clay (CH)	25						0.69	0.75	
	2	4	Lean Clay (CL)	17	48	18			114	1.5	1.5	2.33
	4	6	Fat Clay (CH)	18						1.5	1.5	
	6	8	Fat Clay (CH)	22				89		1.5	1.5	
	8	10	Fat Clay (CH)	21						1.5	1.5	
B-25	0	0.5	Concrete Pavement									
	0.5	2	Fat Clay (CH)	23						1.01	1.12	
	2	4	Fat Clay (CH)	19						1	1.25	
	4	6	Fat Clay (CH)	22						1.16	1.25	
	6	8	Fat Clay (CH)	19	57	20			109	1.5	1.5	2.18
	8	10	Fat Clay (CH)	19						1.5	1.5	
B-26	0	0.3	Asphalt Pavement									
	0.3	0.8	Concrete Pavement									
	0.8	2	Fat Clay (CH)	24						0.62	0.75	
	2	4	Fat Clay (CH)	21						0.69	0.75	
	4	6	Fat Clay (CH)	21	56	20			111	1.24	1.25	2.11
	6	8	Fat Clay (CH)	17						0.85	0.88	
	8	10	Fat Clay (CH)	19				86		1.5	1.5	
B-27	0	0.3	Asphalt Pavement									
	0.3	0.8	Concrete Pavement									
	0.8	2	Fat Clay (CH)	24				88		0.69	0.75	
	2	4	Fat Clay (CH)	20						0.69	0.75	
	4	6	Fat Clay (CH)	25	55	20			102	0.93	1	1.56
	6	8	Fat Clay (CH)	21						1.5	1.5	
	8	10	Fat Clay (CH)	22						1.5	1.5	
B-28	0	0.3	Asphalt Pavement									
	0.3	0.8	Concrete Pavement	15						1.08	1.12	
	0.8	2	Fat Clay (CH)	20	51	20			108	0.78	0.88	1.3
	2	4	Fat Clay (CH)	19						0.78	0.88	
	4	6	Fat Clay (CH)	17				87		0.69	0.88	
	6	8	Fat Clay (CH)	11						0.69	0.88	
	8	10	Fat Clay (CH)									
B-29	0	0.3	Asphalt Pavement									
	0.3	1	Concrete Pavement									
	1	2	Fat Clay (CH)	19					106	1.01	1.12	1.08
	2	4	Lean Clay (CL)	22	47	18				0.31	0.38	
	4	6	Lean Clay (CL)	18						0.31	0.38	
	6	8	Lean Clay (CL)	22						0.69	0.75	
	8	10	Lean Clay (CL)	23				88		0.69	0.75	
B-30	0	0.3	Asphalt Pavement									
	0.3	0.8	Concrete Pavement									
	0.8	2	Fat Clay (CH)	19						1.5	1.5	
	2	4	Fat Clay (CH)	19				90		1.5	1.5	
	4	6	Lean Clay (CL)	12						1.5	1.5	
	6	8	Fat Clay (CH)	22	66	22				1.32	1.5	
	8	10	Fat Clay (CH)	16						1.01	1.12	

Summary of Laboratory Tests

Project: Proposed Water Line Replacement in Fairlawn Area, WBS No. S-000035-0186-4
Location: City of Houston, Texas

Boring No.	Sample Depth (ft) From	To	Soil Classification	Moisture Content (%)	Atterberg Limits (%) LL	PL	PI	No. 200 Sieve (%)	Dry Density (pcf)	Undrained Shear Strength H.P (tsf)	Torvane (tsf)	U.C. (tsf)
B-31	0	0.6	Asphalt Pavement									
	0.6	2	Fat Clay (CH)	22						1.01	1.12	
	2	4	Fat Clay (CH)	21						1.08	1.12	
	4	6	Fat Clay (CH)	21				92		1.08	1.12	
	6	8	Fat Clay (CH)	17						0.78	0.88	
	8	10	Lean Clay (CL)	17	47	19				0.69	0.75	
	10	12	Lean Clay (CL)	15						0.78	0.88	
	12	14	Fat Clay (CH)	25					101	1.5	1.5	2.68
	14	15	Fat Clay (CH)	30						1.5	1.5	
B-32	0	0.3	Asphalt Pavement									
	0.3	0.8	Concrete Pavement									
	0.8	2	Fat Clay (CH)	18						1.5	1.5	
	2	4	Fat Clay (CH)	20	53	20			111	1.32	1.5	2.46
	4	6	Fat Clay (CH)	20						1.24	1.25	
	6	8	Fat Clay (CH)	22					105	1.5	1.5	2.32
	8	10	Fat Clay (CH)	22				96		1.5	1.5	
B-33	0	0.3	Asphalt Pavement									
	0.3	0.9	Concrete Pavement									
	0.9	2	Fat Clay (CH)	20						1.5	1.5	
	2	4	Fat Clay (CH)	17						1.5	1.5	
	4	6	Fat Clay (CH)	20	56	20			108	1.01	1.12	1.34
	6	8	Fat Clay (CH)	23						0.78	0.88	
	8	10	Fat Clay (CH)	20				95		1.5	1.5	
B-34	0	0.3	Asphalt Pavement									
	0.3	0.8	Concrete Pavement									
	0.8	2	Fat Clay With Sand (CH)	20						1.5	1.5	
	2	4	Fat Clay With Sand (CH)	16				83		1.5	1.5	
	4	6	Fat Clay (CH)	18						1.08	1.5	
	6	8	Fat Clay (CH)	20	52	19			112	0.69	0.75	1.34
	8	10	Fat Clay (CH)	19						1.5	1.5	
	10	12	Fat Clay (CH)	20						1.5	1.5	
	12	14	Fat Clay (CH)	17						1.5	1.5	
	14	16	Fat Clay (CH)	19						1.5	1.5	
B-35	0	0.3	Asphalt Pavement									
	0.3	0.8	Concrete Pavement									
	0.8	2	Fat Clay With Sand (CH)	22				78		1.01	1.5	
	2	4	Fat Clay With Sand (CH)	19						1.01	1.5	
	4	6	Lean Clay (CL)	18	49	19			102	1.24	1.5	1.74
	6	8	Lean Clay (CL)	16						1.5	1.5	
	8	10	Lean Clay (CL)	19						0.62	0.75	
B-36	0	0.3	Asphalt Pavement									
	0.3	0.7	Concrete Pavement									
	0.7	2	Fat Clay (CH)	22				88		0.93	1	
	2	4	Fat Clay (CH)	25						0.39	0.5	
	4	6	Fat Clay (CH)	20						1.16	1.25	
	6	8	Fat Clay (CH)	18	55	21			110	1.01	1.12	1.75
	8	10	Fat Clay (CH)	21						1.08	1.12	

PLATE A-64

Summary of Laboratory Tests

Project: Proposed Water Line Replacement in Fairlawn Area, WBS No. S-000035-0186-4
Location: City of Houston, Texas

Boring No.	Sample Depth (ft) From	To	Soil Classification	Moisture Content (%)	Atterberg Limits (%) LL	PL	PI	No. 200 Sieve (%)	Dry Density (pcf)	Undrained Shear Strength H.P (tsf)	Torvane (tsf)	U.C. (tsf)
B-37	0	0.3	Asphalt Pavement									
	0.3	0.7	Concrete Pavement									
	0.7	2	Fat Clay (CH)	20						0.93	1	
	2	4	Fat Clay (CH)	21						0.85	0.88	
	4	6	Fat Clay (CH)	22				90		0.78	0.88	
	6	8	Fat Clay (CH)	24						0.56	0.62	
	8	10	Lean Clay (CL)	20	48	19			107	1.5	1.5	1.4
	10	12	Fat Clay (CH)	20						1.5	1.5	
	12	14	Fat Clay (CH)	21						1.5	1.5	
	14	16	Fat Clay (CH)	21						1.32	1.5	
B-38	0	0.3	Asphalt Pavement									
	0.3	0.8	Concrete Pavement									
	0.8	2	Fat Clay (CH)	16						1.5	1.5	
	2	4	Fat Clay (CH)	20	64	22			109	1.5	1.5	3.26
	4	6	Fat Clay (CH)	16						1.5	1.5	
	6	8	Lean Clay With Sand (CL)	17						1.24	1.25	
	8	10	Lean Clay With Sand (CL)	14				81		1.5	1.5	
B-39	0	0.3	Asphalt Pavement									
	0.3	0.8	Concrete Pavement									
	0.8	2	Fat Clay (CH)	20						1.08	1.12	
	2	4	Fat Clay (CH)	19						1.24	1.25	
	4	6	Fat Clay (CH)	17					92	1.5	1.5	
	6	8	Fat Clay (CH)	17						1.5	1.5	
	8	10	Fat Clay (CH)	24						0.46	0.5	
	10	12	Fat Clay (CH)	19	56	20				1.5	1.5	1.76
	12	14	Fat Clay (CH)	19						1.16	1.25	
	14	15	Fat Clay (CH)	19						0.85	0.88	
B-40	0	0.3	Asphalt Pavement									
	0.3	0.5	Concrete Pavement									
	0.8	1.2	Fat Clay (CH)	20						1.01	1.12	
	2	4	Fat Clay (CH)	20						0.93	1	
	4	6	Fat Clay (CH)	20				90		1.08	1.12	
	6	8	Fat Clay (CH)	20						1.08	1.12	
	8	10	Fat Clay (CH)	18	57	20			110	1.5	1.5	2.29
	10	12	Fat Clay (CH)	16						1.5	1.5	
	12	14	Fat Clay (CH)	21						1.5	1.5	
	14	15	Fat Clay (CH)	21						1.5	1.5	
B-41	0	0.3	Asphalt Pavement									
	0.3	0.8	Concrete Pavement									
	0.8	2	Fat Clay (CH)	15						1.5	1.5	
	2	4	Fat Clay (CH)	15						1.5	1.5	
	4	6	Fat Clay (CH)	16						1.5	1.5	
	6	8	Fat Clay (CH)	20	54	19			115	1.5	1.5	3.53
	8	10	Fat Clay (CH)	26						1.5	1.5	
B-42	0	0.3	Asphalt Pavement									
	0.3	0.7	Concrete Pavement									
	0.7	2	Fat Clay (CH)	15						1.5	1.5.	
	2	4	Fat Clay (CH)	14	52	19			115	1.5	1.5	3.22
	4	6	Lean Clay (CL)	10						1.5	1.5	
	6	8	Fat Clay (CH)	15						1.5	1.5	
	8	10	Fat Clay (CH)	25						1.5	1.5	

PLATE A-65

Summary of Laboratory Tests

Project: Proposed Water Line Replacement in Fairlawn Area, WBS No. S-000035-0186-4
Location: City of Houston, Texas

Boring No.	Sample Depth (ft) From	To	Soil Classification	Moisture Content (%)	Atterberg Limits (%) LL	PL	PI	No. 200 Sieve (%)	Dry Density (pcf)	Undrained Shear Strength H.P (tsf)	Torvane (tsf)	U.C. (tsf)
B-43	0	0.2	Asphalt Pavement									
	0.2	0.6	Concrete Pavement									
	0.6	2	Fat Clay (CH)	20						0.85	0.88	
	2	4	Fat Clay (CH)	18				87		0.85	0.88	
	4	6	Fat Clay (CH)	19						0.93	1	
	6	8	Fat Clay (CH)	18	58	20			109	1.32	1.38	2.1
	8	10	Lean Clay (CL)	22						0.62	0.75	
B-44	0	0.3	Asphalt Pavement									
	0.3	0.8	Concrete Pavement									
	0.8	2	Fat Clay (CH)	25						1.08	1.12	
	2	4	Fat Clay (CH)	20						0.93	1	
	4	6	Fat Clay (CH)	21	55	21			107	0.78	0.88	1.46
	6	8	Fat Clay (CH)	19						1.5	1.5	
	8	10	Lean Clay (CL)	19						0.69	0.75	
	10	12	Fat Clay (CH)	30						0.78	0.88	
	12	14	Fat Clay (CH)	28						1.08	1.12	
	14	15	Fat Clay (CH)	28						0.93	1	
B-45	0	0.3	Asphalt Pavement									
	0.3	0.8	Concrete Pavement									
	0.8	2	Fat Clay With Sand (CH)	25						0.93	1	
	2	4	Fat Clay With Sand (CH)	21				81		0.62	0.75	
	4	6	Fat Clay With Sand (CH)	24						0.69	0.75	
	6	8	Fat Clay With Sand (CH)	22	58	21				0.78	0.88	
	8	10	Lean Clay (CL)	21					103	0.69	0.75	0.84
B-46	0	0.9	Asphalt Pavement									
	0.9	2	Fat Clay (CH)	26						1.5	1.5	
	2	4	Fat Clay (CH)	18	54	20			112	1.5	1.5	2.44
	4	6	Lean Clay (CL)	7						1.5	1.5	
	6	8	Lean Clay (CL)	19				88		1.5	1.5	
	8	10	Lean Clay (CL)	23						0.85	0.88	
B-47	0	0.3	Asphalt Pavement									
	0.3	0.8	Concrete Pavement									
	0.8	2	Fat Clay (CH)	21				85		0.69	0.75	
	2	4	Fat Clay (CH)	17						1.08	1.12	
	4	6	Lean Clay (CL)	14	43	18			116	1.5	1.5	2.38
	6	8	Fat Clay (CH)	18						1.5	1.5	
	8	10	Fat Clay (CH)	19						0.85	0.88	
B-48	0	0.5	Concrete Pavement									
	0.5	2	Fat Clay With Sand (CH)	23						0.69	0.75	
	2	4	Fat Clay With Sand (CH)	18	51	19			110	0.93	1	1.33
	4	6	Fat Clay With Sand (CH)	21						0.46	0.5	
	6	8	Fat Clay With Sand (CH)	17				82		0.69	0.75	
	8	10	Fat Clay With Sand (CH)	17						0.56	0.62	
B-49	0	0.6	Concrete Pavement									
	0.6	2	Fat Clay With Sand (CH)	19						0.93	1	
	2	4	Fat Clay With Sand (CH)	15				84		1.24	1.25	
	4	6	Fat Clay With Sand (CH)	15						1.5	1.5	
	6	8	Lean Clay (CL)	16	42	18			113	1.5	1.5	1.73
	8	10	Fat Clay (CH)	21						1.5	1.5	

PLATE A-66

APPENDIX B

Piezometer Installation and Abandonment Report

STATE OF TEXAS WELL REPORT for Tracking #367966

Owner:	**Geotech Engineering and Testing**	Owner Well #:	**B-2,PZ-1**
Address:	**800 Victoria Dr. Houston , TX 77043**	Grid #:	**65-22-5**
Well Location:	**5710 Heiser RD (Fairlawn Area) Houston , TX**	Latitude:	**29° 40' 57" N**
Well County:	**Harris**	Longitude:	**095° 18' 42" W**
Elevation:	**No Data**	GPS Brand Used:	**Magellan GPS**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Date: Started: **7/3/2014**
Completed: **7/3/2014**

Diameter of Hole: Diameter: **6 in From Surface To 16 ft**

Drilling Method: Other: **flight auger**

Borehole Completion: Other: **20/40 sand**

Annular Seal Data:
1st Interval: **From 16 ft to 4 ft with 6,sand (#sacks and material)**
2nd Interval: **From 4 ft to 2 ft with 1,bent. chip (#sacks and material)**
3rd Interval: **From 2 ft to 0 ft with .5, cement (#sacks and material)**
Method Used: **hand mix**
Cemented By: **MEDI**
Distance to Septic Field or other Concentrated Contamination: **No Data**
Distance to Property Line: **No Data**
Method of Verification: **No Data**
Approved by Variance: **No Data**

Surface Completion: **Surface Slab Installed**

Water Level: Static level: **No Data**
Artesian flow: **No Data**

Packers: **No Data**

Plugging Info: Casing or Cement/Bentonite left in well: **No Data**

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 Data** Did the driller knowingly penetrate any strata which contained undesirable constituents: **No Data**
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:	**Mathers Environmental Drilling, Inc.** **12243 B. FM 529** **Houston , TX 77041**
Driller License Number:	**54308**
Licensed Well Driller Signature:	**Shawn Mathers**
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 #**367966**) on your written request.

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

DESC. & COLOR OF FORMATION CASING, BLANK PIPE & WELL SCREEN

MATERIAL	DATA
From (ft) To (ft) Description	Dia. New/Used Type Setting From/To
0 - 16 clay, brown	**2 new sch. 40 pvc screen 16 - 6 0.010 slot**
	2 new sch. 40 pvc riser 6 - 0

STATE OF TEXAS WELL REPORT for Tracking #367967

Owner:	**Geotech Engineering and Testing**	Owner Well #:	**B-17,PZ-2**
Address:	**800 Victoria Dr. Houston , TX 77043**	Grid #:	**65-22-5**
Well Location:	**6300 Fairlawn (Fairlawn Area) Houston , TX**	Latitude:	**29° 40' 34" N**
Well County:	**Harris**	Longitude:	**095° 18' 51" W**
Elevation:	**No Data**	GPS Brand Used:	**Magellan GPS**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Date: Started: **7/3/2014**
Completed: **7/3/2014**

Diameter of Hole: Diameter: **6 in From Surface To 17 ft**

Drilling Method: Other: **flight auger**

Borehole Completion: Other: **20/40 sand**

Annular Seal Data:
1st Interval: **From 17 ft to 5 ft with 5,sand (#sacks and material)**
2nd Interval: **From 5 ft to 2 ft with 1,bent. chip (#sacks and material)**
3rd Interval: **From 2 ft to 0 ft with .5, cement (#sacks and material)**
Method Used: **hand mix**
Cemented By: **MEDI**
Distance to Septic Field or other Concentrated Contamination: **No Data**
Distance to Property Line: **No Data**
Method of Verification: **No Data**
Approved by Variance: **No Data**

Surface Completion: **Surface Slab Installed**

Water Level: Static level: **No Data**
Artesian flow: **No Data**

Packers: **No Data**

Plugging Info: Casing or Cement/Bentonite left in well: **No Data**

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 Data** Did the driller knowingly penetrate any strata which contained undesirable constituents: **No Data**
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:	**Mathers Environmental Drilling, Inc.** **12243 B. FM 529** **Houston , TX 77041**
Driller License Number:	**54308**
Licensed Well Driller Signature:	**Shawn Mathers**
Registered Driller Apprentice Signature:	**No Data**
Apprentice Registration Number:	**No Data**
Comments:	**No Data**

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

DESC. & COLOR OF FORMATION CASING, BLANK PIPE & WELL SCREEN

MATERIAL	DATA
From (ft) To (ft) Description	Dia. New/Used Type Setting From/To
0 - 17 clay, brown	**2 new sch. 40 pvc screen 17 - 7 0.010 slot**
	2 new sch. 40 pvc riser 7 - 0

STATE OF TEXAS WELL REPORT for Tracking #367968

Owner:	**Geotech Engineering and Testing**	Owner Well #:	**B-37,PZ-3**
Address:	**800 Victoria Dr. Houston , TX 77043**	Grid #:	**65-22-5**
Well Location:	**6300 Fairlawn (Fairlawn Area) Houston , TX**	Latitude:	**29° 40' 34" N**
Well County:	**Harris**	Longitude:	**095° 18' 19" W**
Elevation:	**No Data**	GPS Brand Used:	**Magellan GPS**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Date: Started: **7/3/2014**
Completed: **7/3/2014**

Diameter of Hole: Diameter: **6 in From Surface To 17 ft**

Drilling Method: Other: **flight auger**

Borehole Completion: Other: **20/40 sand**

Annular Seal Data:
1st Interval: **From 17 ft to 5 ft with 5,sand (#sacks and material)**
2nd Interval: **From 5 ft to 2 ft with 1,bent. chip (#sacks and material)**
3rd Interval: **From 2 ft to 0 ft with .5, cement (#sacks and material)**
Method Used: **hand mix**
Cemented By: **MEDI**
Distance to Septic Field or other Concentrated Contamination: **No Data**
Distance to Property Line: **No Data**
Method of Verification: **No Data**
Approved by Variance: **No Data**

Surface Completion: **Surface Slab Installed**

Water Level: Static level: **No Data**
Artesian flow: **No Data**

Packers: **No Data**

Plugging Info: Casing or Cement/Bentonite left in well: **No Data**

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 Data** Did the driller knowingly penetrate any strata which contained undesirable constituents: **No Data**
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:	**Mathers Environmental Drilling, Inc.** **12243 B. FM 529** **Houston , TX 77041**
Driller License Number:	**54308**
Licensed Well Driller Signature:	**Shawn Mathers**
Registered Driller Apprentice Signature:	**No Data**
Apprentice Registration Number:	**No Data**
Comments:	**No Data**

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Please include the report's Tracking number (Tracking #**367968**) on your written request.

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

DESC. & COLOR OF FORMATION CASING, BLANK PIPE & WELL SCREEN

MATERIAL	DATA
From (ft) To (ft) Description	Dia. New/Used Type Setting From/To
0 - 17 clay, brown	**2 new sch. 40 pvc screen 17 - 7 0.010 slot**
	2 new sch. 40 pvc riser 7 - 0

STATE OF TEXAS PLUGGING REPORT for Tracking #96167

Owner:	**Geotech Eng. and Testing**	Owner Well #:	**PZ-1**
Address:	**800 Victoria Dr. Houston , TX**	Grid #:	**65-22-5**
Well Location:	**5710 Heiser RD Houston , TX**	Latitude:	**29° 40' 57" N**
Well County:	**Harris**	Longitude:	**095° 18' 42" W**
		GPS Brand Used:	**Magellan GPS**
Well Type:	**Monitor**		

HISTORICAL DATA ON WELL TO BE PLUGGED

Original Well Driller:	**Shawn Mathers**
Driller's License Number of Original Well Driller:	**54308**
Date Well Drilled:	**7/3/2014**
Well Report Tracking Number:	**367966**
Diameter of Borehole:	**6 inches**
Total Depth of Borehole:	**16 feet**

Date Well Plugged:	**8/7/2014**
Person Actually Performing Plugging Operation:	**Shawn Mathers**
License Number of Plugging Operator:	**54308**
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 0 ft** 2nd Interval: **No Data** 3rd Interval: **No Data**
Cement/Bentonite	1st Interval: **From 16 ft to 0 ft; Sack(s)/type of cement used: 2,cement**

Plugs Placed in Well:	2nd Interval: **No Data** 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:	**Mathers Environmental Drilling, Inc.** **12243 B. FM 529** **Houston , TX 77041**
Plug Installer License Number:	**54308**
Licensed Plug Installer Signature:	**Shawn Mathers**
Registered Plug Installer Apprentice Signature:	**No Data**
Apprentice Registration Number:	**No Data**
Plugging Method Comments:	**No Data**

Please include the plugging report's tracking number (Tracking #**96167**) on your written request.

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

STATE OF TEXAS PLUGGING REPORT for Tracking #96166

Owner:	**Geotech Eng. and Testing**	Owner Well #:	**PZ-2**
Address:	**800 Victoria Dr. Houston , TX**	Grid #:	**65-22-5**
Well Location:	**6300 Fairlawn Houston , TX**	Latitude:	**29° 40' 34" N**
Well County:	**Harris**	Longitude:	**095° 18' 51" W**
		GPS Brand Used:	**Magellan GPS**
Well Type:	**Monitor**		

HISTORICAL DATA ON WELL TO BE PLUGGED

Original Well Driller:	**Shawn Mathers**
Driller's License Number of Original Well Driller:	**54308**
Date Well Drilled:	**7/3/2014**
Well Report Tracking Number:	**367967**
Diameter of Borehole:	**6 inches**
Total Depth of Borehole:	**17 feet**

Date Well Plugged:	**8/7/2014**
Person Actually Performing Plugging Operation:	**Shawn Mathers**
License Number of Plugging Operator:	**54308**
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 0 ft** 2nd Interval: **No Data** 3rd Interval: **No Data**
Cement/Bentonite	1st Interval: **From 17 ft to 0 ft; Sack(s)/type of cement used: 2,cement**

Plugs Placed in Well:	2nd Interval: **No Data** 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:	**Mathers Environmental Drilling, Inc.** **12243 B. FM 529** **Houston , TX 77041**
Plug Installer License Number:	**54308**
Licensed Plug Installer Signature:	**Shawn Mathers**
Registered Plug Installer Apprentice Signature:	**No Data**
Apprentice Registration Number:	**No Data**
Plugging Method Comments:	**No Data**

Please include the plugging report's tracking number (Tracking #**96166**) on your written request.

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

STATE OF TEXAS PLUGGING REPORT for Tracking #96165

Owner:	**Geotech Eng. and Testing**	Owner Well #:	**PZ-3**
Address:	**800 Victoria Dr. Houston , TX**	Grid #:	**65-22-5**
Well Location:	**6300 Fairlawn Houston , TX**	Latitude:	**29° 40' 34" N**
Well County:	**Harris**	Longitude:	**095° 18' 19" W**
		GPS Brand Used:	**Magellan GPS**
Well Type:	**Monitor**		

HISTORICAL DATA ON WELL TO BE PLUGGED

Original Well Driller:	**Shawn Mathers**
Driller's License Number of Original Well Driller:	**54308**
Date Well Drilled:	**7/3/2014**
Well Report Tracking Number:	**367968**
Diameter of Borehole:	**6 inches**
Total Depth of Borehole:	**17 feet**

Date Well Plugged:	**8/7/2014**
Person Actually Performing Plugging Operation:	**Shawn Mathers**
License Number of Plugging Operator:	**54308**
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 0 ft** 2nd Interval: **No Data** 3rd Interval: **No Data**
Cement/Bentonite	1st Interval: **From 17 ft to 0 ft; Sack(s)/type of cement used: 2,cement**

Plugs Placed in Well:	2nd Interval: **No Data** 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:	**Mathers Environmental Drilling, Inc.** **12243 B. FM 529** **Houston , TX 77041**
Plug Installer License Number:	**54308**
Licensed Plug Installer Signature:	**Shawn Mathers**
Registered Plug Installer Apprentice Signature:	**No Data**
Apprentice Registration Number:	**No Data**
Plugging Method Comments:	**No Data**

Please include the plugging report's tracking number (Tracking #**96165**) on your written request.

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

APPENDIX C

Project Pictures

PROJECT PICTURES
Project No. 14-319E

P-1 (A Picture of Project Alignment along Heiser Street)

P-2 (A Picture of Drilling Operation and Traffic Control at Northdale Street)

PROJECT PICTURES
Project No. 14-319E

P-3 (A Picture of Piezometer Installation)

P-4 (A Picture of Grouting using Tremie Method along Northdale Street)

APPENDIX D

OSHA CLASSICIFICATION

OSHA SOIL CLASSIFICATION

General

Occupational Safety and Health Administration (OSHA) has required a trench protective system for trenches deeper than five-ft. Trenches that are deeper than five-ft, should be shored, sheeted, braced or laid back to a stable slope, or some other appropriate means of protection should be provided where workers might be exposed to moving ground or caving. OSHA developed a soil classification system to be used as a guideline in determining protective requirements for trench excavations.

OSHA classification system categorizes the soil and rock in four types based on shear strength and stability. These classifications are summarized in the following report sections.

Stable Rock

Means natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed.

Type A Soil

Means cohesive soils with an unconfined compressive strength of 1.5-ton per square foot (tsf) or greater. Examples of cohesive soils are: clay, silty clay, sandy clay, clay loam, silty clay loam, sandy clay loam, caliche and hardpan. No soil is Type A if:

- The soil is fissured; or
- The soil is subject to vibration from heavy traffic, pile driving or similar effects; or
- The soil has been previously disturbed; or
- The soil is part of a slope, layered system where the layers dip into the excavation on a slope of 4(h): 1(v) or greater; or
- The material is subject to other factors that would require it to be classified as a less stable material.

Type B Soil

- Cohesive soil with an unconfined compressive strength greater than 0.5 tsf but less than 1.5 tsf; or
- Granular cohesionless soils including: angular gravel, silt, silt loam, sandy loam, and in some case, silty clay loam and sandy clay loam; or
- Previously disturbed soils except those which would otherwise be classified as Type C soil; or
- Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration; or

- Dry rock that is not stable; or
- Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than 4(h): 1(v), but only if the material would otherwise be classified as Type B.

Type C Soil

- Cohesive soil with an unconfined compressive strength of 0.5 tsf or less; or
- Granular soils including gravel, sand, and loamy sand; or
- Submerged soil or soil from which water is freely seeping; or
- Submerged rock that is not stable; or
- Materials in a sloped, layered system where the layers dip into the excavation on a slope 4 (h) : 1(v) or steeper.

Under the assumption that appropriate groundwater control measures are carried out, and the groundwater table, if present, is lowered and maintained at least 3 feet below the excavation depths, the stable cohesive soils (CL) & (CH), with unconfined compressive strength greater than 0.5 tsf, are classified as OSHA soil Type "B". The granular soils, which are less stable, are classified as OSHA soil Type "C".

Based on our geotechnical exploration and laboratory test results details of soil classifications at each boring are summarized below:

OSHA SOIL TYPE

Boring No.	Depth Range [(1)], ft	Soil Type	OSHA Soil Classification
B-1	0 – 6	Fat Clay (CH)	C
	6 – 16	Fat Clay (CH)	B
B-2	0 – 2	Fat Clay (CH)	B
	2 – 4	Fat Clay (CH)	C
	4 – 10	Fat Clay (CH)	B
	10 – 12	Fat Clay (CH)	C
	12 – 16	Fat Clay (CH)	B
B-3	0 – 2	Silty Sand (SM)	C
	2 – 8	Fat Clay (CH)	B
	8 – 10	Fat Clay (CH)	C

Boring No.	Depth Range [1], ft	Soil Type	OSHA Soil Classification
B-4	0 – 2	Fat Clay (CH)	C
	2 – 8	Fat Clay (CH)	B
	8 – 10	Fat Clay (CH)	C
B-5	0 – 2	Fat Clay (CH)	C
	2 – 4	Fat Clay (CH)	B
	4 – 6	Fat Clay (CH)	C
	6 – 10	Fat Clay (CH)	B
B-6	0 – 4	Fat Clay (CH)	B
	4 – 6	Fat Clay (CH)	C
	6 – 16	Fat Clay (CH)	B
B-7	0 – 10	Fat Clay (CH)	B
B-8	0 – 16	Fat Clay (CH)	B
B-9	0 – 12	Fat Clay (CH)	B
	12 – 14	Lean Clay (CL)	B
	14 – 17	Fat Clay (CH)	B
B-10	0 – 2	Lean Clay (CL)	B
	2 – 10	Fat Clay (CH)	B
	10 – 16	Fat Clay (CH)	C
B-11	0 – 2	Lean Clay (CL)	B
	2 – 4	Fat Clay (CH)	C
	4 – 10	Fat Clay (CH)	B
B-12	0 – 8	Fat Clay (CH)	B
	8 – 10	Fat Clay (CH)	C
B-13	0 – 16	Fat Clay (CH)	B
B-14	0 – 6	Fat Clay (CH)	B
	6 – 8	Fat Clay (CH)	C
	8 – 10	Fat Clay (CH)	B

Boring No.	Depth Range [1], ft	Soil Type	OSHA Soil Classification
B-15	0 – 6	Fat Clay (CH)	B
	6 – 8	Fat Clay (CH)	C
	8 – 10	Fat Clay (CH)	B
B-16	0 – 2	Lean Clay (CL)	B
	2 – 8	Fat Clay (CH)	C
	8 – 10	Lean Clay (CL)	B
B-17	0 – 2	Lean Clay (CL)	B
	2 – 4	Fat Clay (CH)	C
	4 – 8	Fat Clay (CH)	B
	8 – 15	Lean Clay (CL)	B
	15 – 17	Lean Clay (CL)	C
B-18	0 – 2	Fat Clay (CH)	B
	2 – 4	Fat Clay (CH)	C
	4 – 6	Fat Clay (CH)	B
	6 – 8	Fat Clay (CH)	C
	8 – 10	Lean Clay (CL)	B
B-19	0 – 6	Fat Clay (CH)	B
	6 – 10	Lean Clay (CL)	B
B-20	0 – 4	Lean Clay (CL)	B
	4 – 6	Fat Clay (CH)	B
	6 – 10	Lean Clay (CL)	B
B-21	0 – 2	Silty Sand (SM)	C
	2 – 10	Fat Clay (CH)	B
B-22	0 – 10	Fat Clay (CH)	B
B-23	0 – 2	Silty Sand (SM)	C
	2 – 10	Fat Clay (CH)	B
B-24	0 – 2	Fat Clay (CH)	B
	2 – 4	Lean Clay (CL)	B
	4 – 10	Fat Clay (CH)	B

Boring No.	Depth Range [1], ft	Soil Type	OSHA Soil Classification
B-25	0 – 10	Fat Clay (CH)	B
B-26	0 – 10	Fat Clay (CH)	B
B-27	0 – 10	Fat Clay (CH)	B
B-28	0 – 10	Fat Clay (CH)	B
B-29	0 – 2	Fat Clay (CH)	B
	2 – 6	Lean Clay (CL)	C
	6 – 10	Lean Clay (CL)	B
B-30	0 – 4	Fat Clay (CH)	B
	4 – 6	Lean Clay (CL)	B
	6 – 10	Fat Clay (CH)	B
B-31	0 – 8	Fat Clay (CH)	B
	8 – 12	Lean Clay (CL)	B
	12 – 15	Fat Clay (CH)	B
B-32	0 – 10	Fat Clay (CH)	B
B-33	0 – 10	Fat Clay (CH)	B
B-34	0 – 4	Fat Clay With Sand (CH)	B
	4 – 16	Fat Clay (CH)	B
B-35	0 – 4	Fat Clay With Sand (CH)	B
	4 – 10	Lean Clay (CL)	B
B-36	0 – 2	Fat Clay (CH)	B
	2 – 4	Fat Clay (CH)	C
	4 – 10	Fat Clay (CH)	B
B-37	0 – 8	Fat Clay (CH)	B
	8 – 10	Lean Clay (CL)	B
	10 – 16	Fat Clay (CH)	B
B-38	0 – 6	Fat Clay (CH)	B
	6 – 10	Lean Clay With Sand (CL)	B

Boring No.	Depth Range [1], ft	Soil Type	OSHA Soil Classification
B-39	0 – 8	Fat Clay (CH)	B
	8 – 10	Fat Clay (CH)	C
	10 – 15	Fat Clay (CH)	B
B-40	0 – 15	Fat Clay (CH)	B
B-41	0 – 10	Fat Clay (CH)	B
B-42	0 – 4	Fat Clay (CH)	B
	4 – 6	Lean Clay (CL)	B
	6 – 10	Fat Clay (CH)	B
B-43	0 – 8	Fat Clay (CH)	B
	8 – 10	Lean Clay (CL)	B
B-44	0 – 8	Fat Clay (CH)	B
	8 – 10	Lean Clay (CL)	B
	10 – 15	Fat Clay (CH)	C
B-45	0 – 8	Fat Clay With Sand (CH)	B
	8 – 10	Lean Clay (CL)	B
B-46	0 – 4	Fat Clay (CH)	B
	4 – 10	Lean Clay (CL)	B
B-47	0 – 4	Fat Clay (CH)	B
	4 – 6	Lean Clay (CL)	B
	6 – 10	Fat Clay (CH)	B
B-48	0 – 4	Fat Clay With Sand (CH)	B
	4 – 6	Fat Clay With Sand (CH)	C
	6 – 10	Fat Clay With Sand (CH)	B
B-49	0 – 6	Fat Clay With Sand (CH)	B
	6 – 8	Lean Clay (CL)	B
	8 – 10	Fat Clay (CH)	B

Boring No.	Depth Range [1], ft	Soil Type	OSHA Soil Classification
B-1*	0 – 4	Lean Clay (CL)	B
	4 – 8	Lean Clay (CL)	C
	8 – 11	Fat Clay (CH)	B
	11 – 16	Fat Clay (CH)	C
	16 – 25	Silty Sand (SM)	C
B-23*	0 – 10	Fat Clay (CH)	B
B-37*	0 – 2	Fill: Fat Clay (CH)	B
	2 – 4	Fat Clay (CH)	C
	4 – 10	Fat Clay (CH)	B
B-38*	0 – 2	Lean Clay (CL)	B
	2 – 10	Fat Clay (CH)	B
B-39*	0 – 8	Fat Clay (CH)	B
	8 – 15	Lean Clay (CL)	B
B-59*	0 – 2	Fat Clay (CH)	C
	2 – 15	Fat Clay (CH)	B

Note: 1. Refer to each boring log for soils stratigraphy