



GEOTECHNICAL INVESTIGATION PAVEMENT THICKNESS RECOMMENDATIONS

**Fitzhugh Road
Austin, Texas**

Report For:

Brohn Homes
6720 Vaught Ranch Road Suite 200
Austin, Texas 78730

November 2017

Engineer's Job # 17101100.075

MLA LABS, INC. TBPE Firm # F-2684
**Geotechnical Engineering and
Construction Materials Testing**
"put us to the test"

Christopher P. Elliott
Senior Project Manager

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GEOTECHNICAL INVESTIGATION PAVEMENT THICKNESS RECOMMENDATIONS

**Fitzhugh Road
Austin, Texas**

BACKGROUND

The purpose of this investigation was to determine subsurface conditions relative to the establishment and design of pavement thickness sections for *Fitzhugh Road* located in Austin, Texas. Authorization to perform this exploration and analysis was by Agreement for Engineering Services signed by Mr. Adam B. Boenig of Brohn Homes on October 24, 2017.

More specifically, the purposes of this investigation were to determine the soil profile, the engineering characteristics of the foundation soil and to provide criteria for use by the design engineers in preparing the pavement thickness designs for the subdivision streets. The scope included a review of geologic literature, a reconnaissance of the immediate site, the subsurface exploration, field and laboratory testing, and an engineering analysis and evaluation of the foundation materials.

Index and engineering properties of the different soil types encountered on this project were determined and used as a basis for assigning parameters for pavement thickness designs. Pavement thicknesses were then designed using the computerized procedure adopted by the City of Austin, March 24, 1988, "Municipal Pavement Structural Design and Life Cycle Cost Analysis System, MFPS".⁽¹⁾ Input data and assumptions as well as results are listed in later sections of this report. Output from the computer analysis is enclosed in **Appendix C**.

The exploration and analysis of the subsurface conditions reported herein is considered in sufficient detail and scope to form a reasonable basis for the preliminary pavement thickness designs. The recommendations submitted are based on the available soil information and the assumed preliminary design for the proposed streets. Any revision in the plans for the proposed

street system from those stated in this report should be brought to the attention of the geotechnical engineer so that he may determine if changes in the recommendations are required.

MLA Labs, Inc. should be retained to monitor site work and construction so that these preliminary recommendations may be finalized, and so that deviations from expected conditions can be properly evaluated.

This report has been prepared for the exclusive use of the client and their design professionals for specific application to the proposed project in accordance with generally accepted soils and pavement engineering practice. This report is not intended to be used as a specification or construction contract document, but as a guide and information source to those qualified professionals who prepare such documents.

FIELD AND LABORATORY INVESTIGATION

Two borings were drilled and sixteen test pits were excavated to various depths spaced at locations as shown on the enclosed Logs of Boring and Test Pits and Plan of Borings and Test Pits using a B-53 drilling rig and a backhoe. Water was not introduced into the borings or test pits. The field investigation included completing the soil borings and test pits, performing field tests, and recovering samples. Pocket penetrometer tests were performed on specimens during sampling. Representative soil samples were selected for laboratory index tests including Atterberg Limits and moisture content tests. The results of these tests and stratigraphy are presented on the Logs of Boring and Test Pits found in **Appendix A**. A key to the Soil Classification and symbols is located behind the last Log of Boring. See **Appendix B** for details of field and laboratory procedures, as applicable.

SITE TOPOGRAPHY, DRAINAGE AND VEGETATION

The site is situated on variably sloping topography with natural slopes ranging from approximately 3 to 12 percent. The vegetation at this site consists of primarily of wild grasses and mature trees. Regionally this site drains in all directions.

SUBSURFACE CONDITIONS AND LOCAL GEOLOGY

Soil Profiles

The soil profile revealed in the borings and test pits consists of a layer of dark brown high plasticity clay (CH) underlain by light yellowish tan low plasticity clay (CL). The surface clay is underlain by intact limestone. The high plasticity soils at this site have the potential for volume change with respect to varying soil moisture contents. This potential is taken into consideration for the foundation recommendations.

Geology

Geologic maps indicate the Fredericksburg Group, *Kfr*, and the Upper Glen Rose Formation, *Kgr(u)*, beneath the subject site^(2,3). A description of each geology follows.

The Fredericksburg Group, *Kfr*, is from the Lower Cretaceous Period and is composed of a series of limestone and marl formations. These include the Edwards Limestone, the Comanche Peak Limestone, the Cedar Park Limestone, the Bee Cave Marl, the Keys Valley Marl, and the Walnut Formation. Each of these geologic formations bears unique characteristics. Descriptions of these formations follows:

The Edwards Formation is the primary member of the Fredericksburg Group and forms a cap on most of the Edwards Plateau. Full sections of the Edwards in Central Texas are about 300 feet thick. Locally, the Edwards limestone is known to contain extremely hard strata, along with occasional marl or clay seams. In some zones, the limestone is dolomitic and contains some quartz and chert deposits. Soil weathering profiles are generally thin and usually include reddish

brown high plasticity clay. Iron stained reddish earth is sometimes found throughout the section and is a result of solution weathering.

The Comanche Peak Formation is one of the youngest members of the Fredericksburg Group. It can range up to 80 feet thick in the Travis-Williamson County area, but the unit thins gradually to the south and east. The Comanche Peak Formation is fine to very fine grained, fairly hard and weathers white in color. This formation typically provides excellent support for residential foundations.

The Cedar Park Limestone is similar to the Comanche Peak but ranges up to 40 feet thick in the Travis-Williamson County area. South of the Travis-Williamson county line the upper portion of this limestone formation is blended with the Edward Limestone and the lower portion of the Cedar Park is mapped with the Bee Cave Marl. This formation is fine to very fine grained, fairly hard in the upper portion, and weathers white in color.

The Bee Cave Marl, the Keys Valley Marl, and the Walnut Formation are very similar. These marl are characteristically soft, white to pale yellow in color and outcrop locally in thicknesses up to 50 feet. Typical indicator fossils are the *Exogyra texana*, with a greater abundance of these occurring in the Bee Cave Marl. Excavations in these marl are often managed with ordinary power equipment. These marl provide generally acceptable support conditions for lightly loaded slabs on ground.

The Upper Glen Rose Formation, *Kgr(u)*, is the youngest formation of the Trinity Group from Lower Cretaceous Period and its outcrop forms a narrow prairie in the Austin area from Mt. Bonnell northwest to Burnet. Its outcrop is characterized by steep canyons and terraced or "staircase" topography on hillsides.

The Glen Rose is predominantly a limestone formation, typically consisting of thin to massively bedded, hard limestone strata alternating with clay, argillaceous limestone and thin sandstone strata. The formation was deposited under neritic or near shore conditions and the various strata represent different depositional environments such as mud flats, lagoons, beaches

and shallow water reefs. The alternating hard and soft layers cause the characteristic staircase topography of the Glen Rose.

The hard, massive limestone can be generally characterized as offering excellent foundation support for the proposed structures, but will present difficulty as far as excavation for utility lines and other site work. The softer argillaceous limestones again offer good foundation support and for the most part can be excavated with less difficulty.

Ground Water

Ground water was encountered in Boring B-19 during this investigation. However, this formation is capable of producing varying quantities of ground water depending upon the antecedent rainfall conditions.

MFPS ANALYSIS AND DESIGN

Pavement thickness sections were developed using the computerized pavement analysis software called "*Municipal Pavement Structural Design and Life Cycle Cost Analysis*" also known as MFPS⁽¹⁾. This program accepts a number of input variables and predicts the performance of the pavement section including the number and type of overlays required for the specified pavement design life. The different sections are ranked on total cost, overlay cost, user cost, routine maintenance cost, and salvage value.

In the absence of project specific data, the City of Austin guidelines for estimating material costs, civil design information and traffic data were used. An estimate of anticipated traffic usage was made from the street classification inferred from the subdivision plat. Minimum layer thicknesses used Table 3-11 of the City of Austin's *Transportation Criteria Manual* ⁽⁴⁾. Pavement layer properties and costs used are shown in **Appendix C** in the program output.

Flexible pavement thickness sections developed from MFPS were cross-checked with recognized minimum pavement thickness analysis to ensure that an adequate ultimate load carrying capacity was provided. The MFPS results are included in **Appendix C**.

We assume that the pavements will be built at or near the existing grade and that the typical road cut will be on the order of 0 feet to 2 feet or less. Pavement options for the expected subgrade conditions are presented in the following table. Final pavement sections should be evaluated in the field by the Geotechnical Engineer.

RECOMMENDATIONS - PAVEMENT THICKNESS SECTIONS

Street Classification	Subgrade Material	Hot Mix Asphaltic Concrete, in	Crushed Limestone Base, in
Local Streets	Less than 2 feet of expansive subgrade PI > 25*	2.0	8

Notes:

1. * - After the streets are rough cut, any high PI clay (PI>20) existing in the subgrade should be removed and replaced with low PI material (PI<20). Where the high PI clay subgrade exceeds 18 inches in depth after street rough cut, remove only 18 inches of existing clay and replace with low PI material.
2. Any expansive fill (PI > 25) placed in the subgrade shall be considered expansive subgrade.
3. These pavement thickness designs are intended to transfer the load from the anticipated traffic conditions.
4. The responsibility of assigning street classification to the streets in this project is left to the civil engineer.
5. If pavement design other than those listed above are desired, please contact MLA Labs, Inc.

CONSTRUCTION CONSIDERATIONS

Ground water

Should ground water become a problem during excavation, or if surface water accumulates during a rainy period, saturated soil should be dried out and/or removed and replaced with crushed limestone base.

Pavement

1. Subgrade and Foundation Soil Preparation
 - a. Strip and remove from construction area any top soil, organics and vegetation to a minimum depth of 6 inches below the existing natural ground surface.
 - b. Fill sections may be composed of on-site material excluding top soil, vegetation, and organics. Fills should be compacted in lifts not exceeding 8 inches after compaction and meet the City of Austin's current "Standard Specifications" Item No.'s 132 and 201 as applicable.⁽⁵⁾
 - c. Compaction of cut areas, on-grade areas, and fill sections should be to 95 percent of TxDOT TEX-114-E. Compaction should be performed with the moisture content of the soil adjusted to within 3 percent of optimum moisture content unless exposed limestone is encountered or suspected. If exposed limestone is suspected the geotechnical engineer should be notified to provide a field confirmation.
2. Base Course
 - a. Base material shall meet the specifications outlined by Item 210 of the City of Austin's "Standard Specifications."
 - b. Thickness of the base course should be as shown on the enclosed ***Recommendations - Pavement Thickness Sections.***
 - c. Base course compaction shall be 100 percent of TxDOT TEX-113-E using 13.26 ft. lbs./cu.in. compaction effort. The moisture content during compaction

shall be maintained within 3 percent of optimum moisture content. Density control by means of field density determination shall be exercised.

- d. After compaction, testing, and curing of the base material, the surface shall be primed using an Asphalt Emulsified Petroleum (AE-P) primer or other acceptable priming material as per Item 306 of the of the current City of Austin's "Standard Specifications."
- e. A full thickness of the base course and subgrade improvement should be extended 3 feet beyond the back of curb line for expansive subgrades.

3. Surface Course Options

- a. The recommended surfacing option consists of hot-mix asphalt. This surfacing shall consist of a hot-mix asphaltic concrete (HMAC) meeting the requirement of Item 340, Type "D" of the current City of Austin's "Standard Specifications." Thickness should be as shown on the included ***Recommendations - Pavement Thickness Sections***.

4. General Conditions

- a. Should at any stage in the construction of the street pavements a non-stable or weaving condition of the subgrade or base course be noted under loads of construction equipment, such areas should be delineated and the Geotechnical Engineer consulted for remedial action before completing the pavement section.
- b. Seepage areas or unusual subgrade soil conditions should be similarly brought to the Geotechnical Engineer's attention before proceeding with pavement completion.
- c. Where pavements are trenched for utilities, a thickness of compacted flexible sub-base should be placed below the new crushed stone base. The sub-base should be meet the specifications outlined by Item 210 of the City of Austin's "Standard Specifications." This sub-base should be compacted in 8 inch lifts to

95 percent of TEX-113-E and be a minimum of 18 inches thick or twice the design base thickness (if greater).

- d. Trenches beneath structures should be strategically backfilled with borrow or suitable material excavated from the trench and free of stone or rock over 8 inches in diameter. The backfill should be compacted to 95 percent of the maximum dry density when determined by TxDOT test method Tex-114-E. The moisture content should be within 2 percent of the optimum moisture content at the time of compaction. If stormwater trenches are backfilled with freely draining materials such as crushed stone, pea gravel or sand, the trench must be sloped a minimum of 0.5 percent to provide positive drainage to daylight.
- e. If ground water or seepage is encountered at the time of construction, French drains may be required to drain or intercept the flow of water from the subsurface pavement materials. These drains should be sloped a minimum of 0.5 percent to provide positive drainage to daylight. French drains should be constructed in general accordance with ASTM D 2321 "Standard Practice for Underground Installation of Thermoplastic Pipe of Sewer and Other Gravity Flow Applications".⁽⁶⁾ The French drain design should be reviewed by the geotechnical engineer prior to installation.
- f. All pavements should be constructed with a curb and gutter system on all sides.

QUALITY ASSURANCE CONSIDERATIONS

Type of Work	Item	Sample Frequency	Sample Size	Minimum Testing
General Earthwork and Fill Material	Soil	1 per Soil Type	110 lbs.	◆ Sieve ◆ P.I. ◆ Moisture Density Relationship
Base Course	Compaction	1 per 5000 ft ² per lift (min. of 3 per lift)	300 lbs.	◆ Field Density Test ◆ Proof rolling w/25 ton pneumatic roller
Subgrade	Compaction	-----		
Concrete or HMAC	Mix Design	1 per concrete class		◆ Review & approval with confirmatory cylinders/cores ◆ Plant & materials approval, testing, if questionable
	Aggregates (coarse & fine)	1 per 500 cu. Yd. Min. 1 per job	30 lbs.	Sieve, organic impurities, specific gravity
HMAC Surface Course	HMAC	1 per 500 tons or each days laydown		◆ 3 cores for density ◆ Extraction/gradation tests ◆ Stability tests ◆ Thickness ◆ Temperature

REFERENCES

1. "Municipal Pavement Structural Design and Life Cycle Cost Analysis", City of Austin, Austin, Texas, December 1992.
2. Local geologic maps published by The Bureau of Economic Geology. Austin, Texas including:
 - "Geologic Atlas of Texas" 15-minute quadrangles. March 9, 2004 geospatial data.
 - "Geologic Map of the Austin Area, Texas 1992" Geology of Austin Area Plate VII.
 - "Geologic Map of the West Half of Taylor Texas, 30 x 60 min quad. 2005. misc. map 43
 - "Geologic Map of the New Braunfels, Texas 30 x 60 min quad" 2000. misc. map 39
3. "The Geology of Texas, Volume I, Stratigraphy", The University of Texas Bulletin No. 3232: August 22, 1932, The University of Texas, Austin, Texas, 1981.
4. "Transportation Criteria Manual", City of Austin, January 1998.
5. "City of Austin Standard Specifications", Latest Adopted Revision.
6. "ASTM D-2321-89 Standard Practice for Underground Installation of Thermoplastic Pipe Sewers and Other Gravity Flow Applications", ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, Pennsylvania, USA 19428-2959.

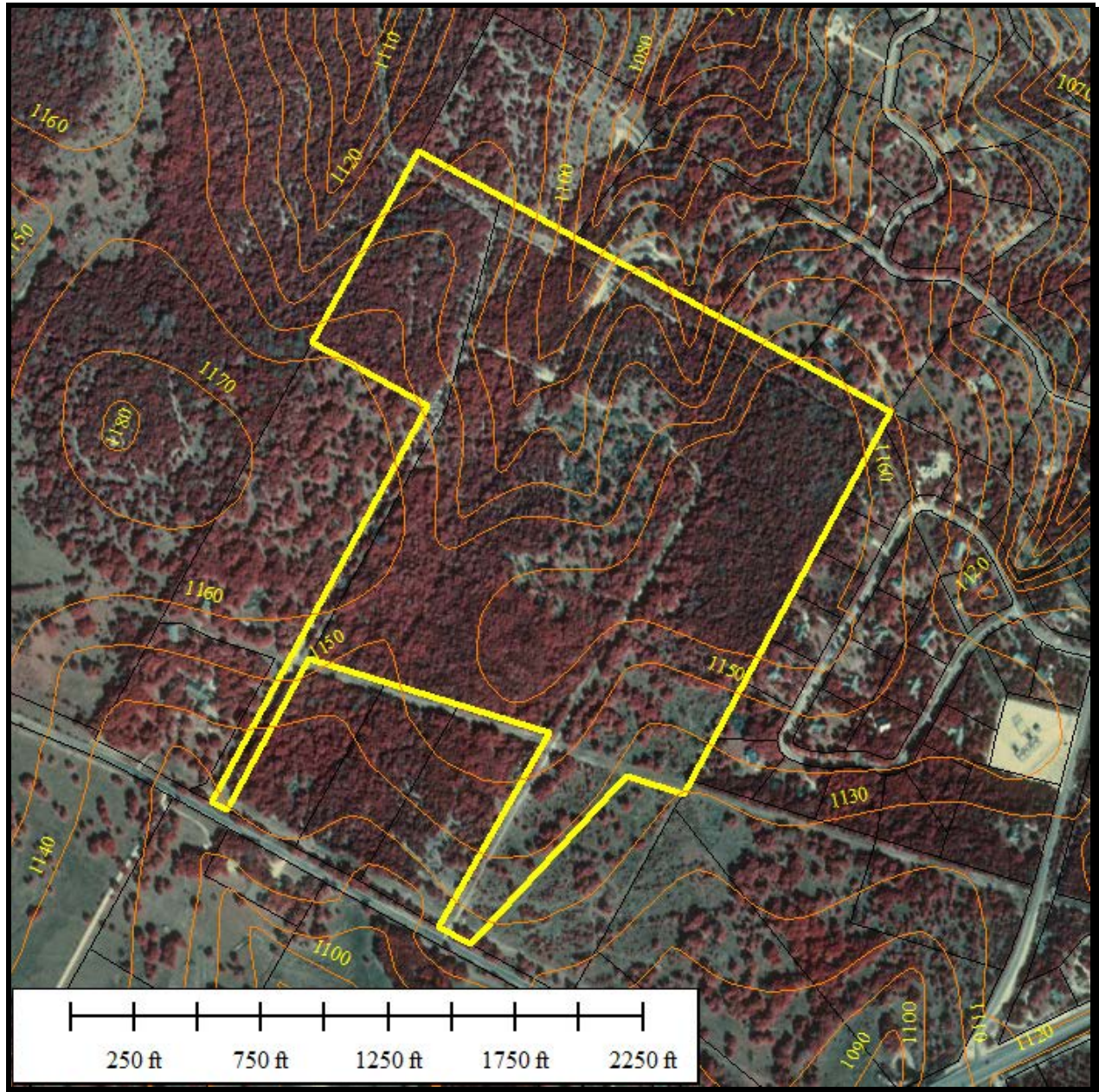
LIMITATION OF REPORT

Conditions of the site at locations other than the boring and test pit locations are not expressed or implied, and conditions may be different at different times from the time of this investigation. Contractors or others desiring more complete information are advised to secure their own supplemental borings or test pits. The analysis and recommendations contained herein are based on the available data as shown in this report and the writer's professional expertise, experience and training, and no other warranty is expressed or implied concerning the satisfactory use of these recommendations or data.

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APPENDIX A

GEOTECHNICAL DATA

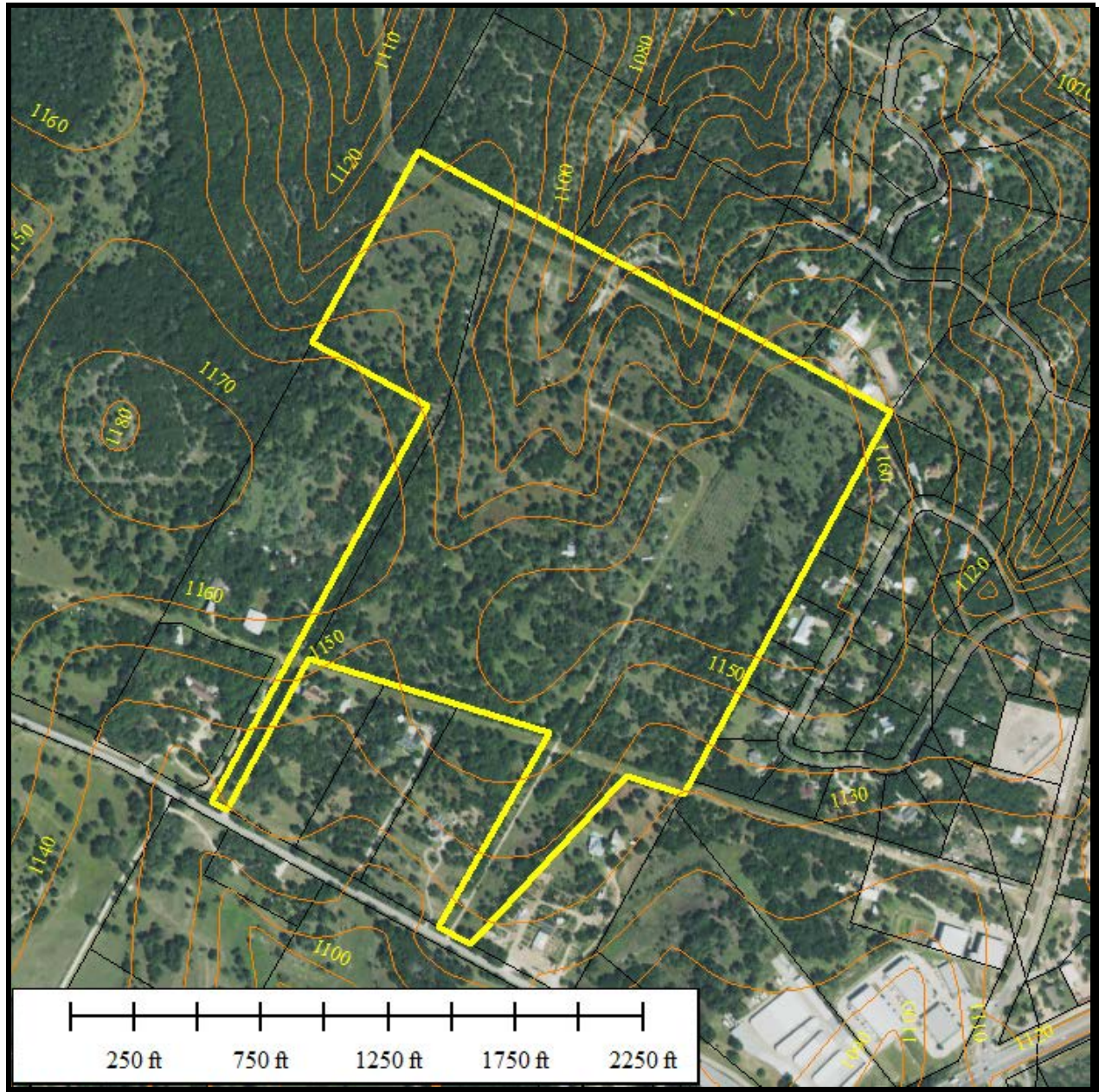


**Approximate location of site in yellow
CAPCOG contours (2008) in orange
TCAD parcels (2015) in black**

NAPP Aerial Photograph of Site – 1995

Source: TEXAS NATURAL RESOURCES INFORMATION SYSTEM
3.75-minute DOQQ. 1-meter ground resolution. apx. date 1995-6
(<http://www.tnris.state.tx.us/digital.htm>)



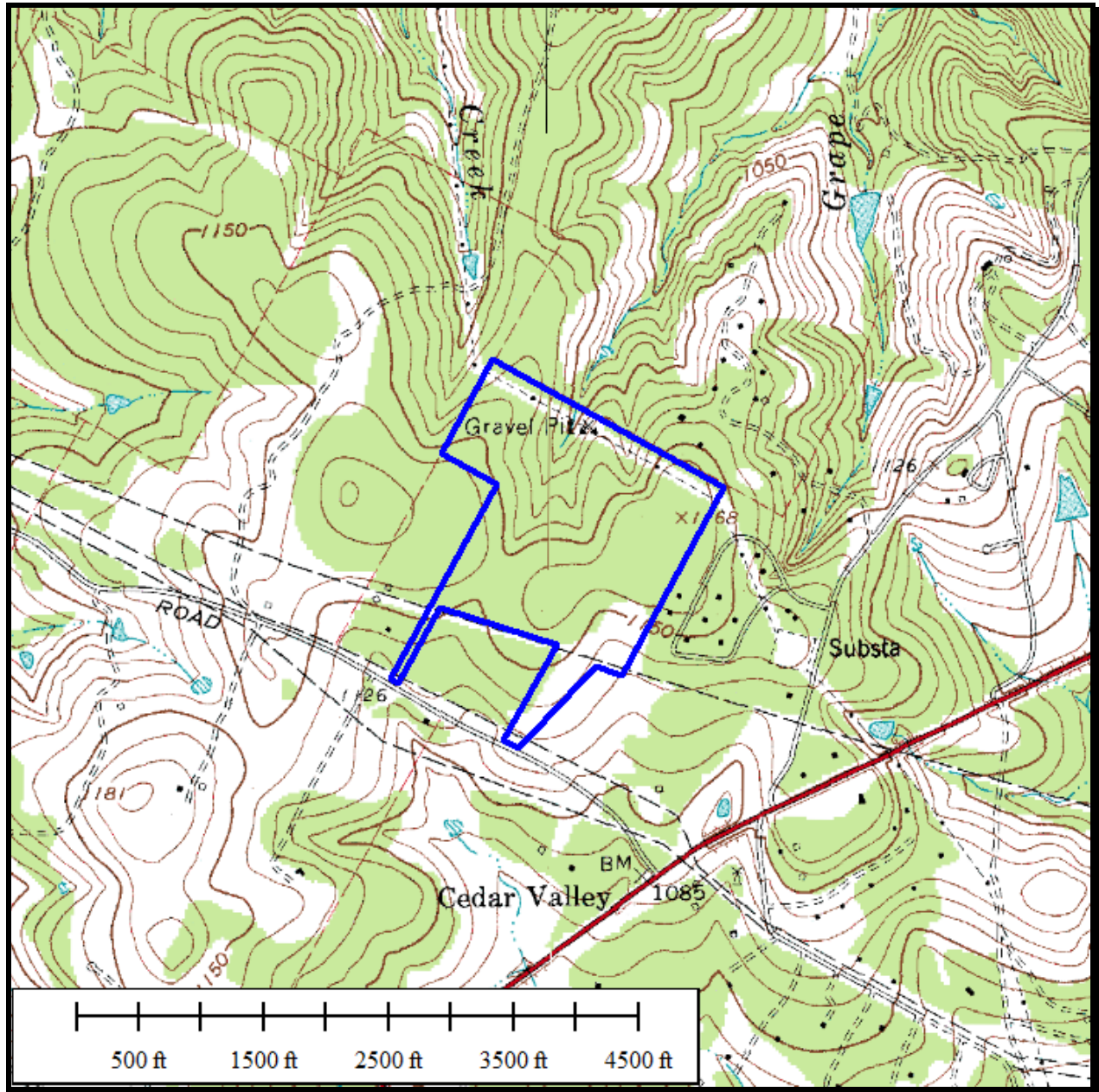


**Approximate location of site in yellow
CAPCOG contours (2008) in orange
TCAD parcels (2015) in black**

Aerial Photograph of Site – 2016

Source: TEXAS NATURAL RESOURCES INFORMATION SYSTEM
Apx. Date - 2016
(www.tnris.org)





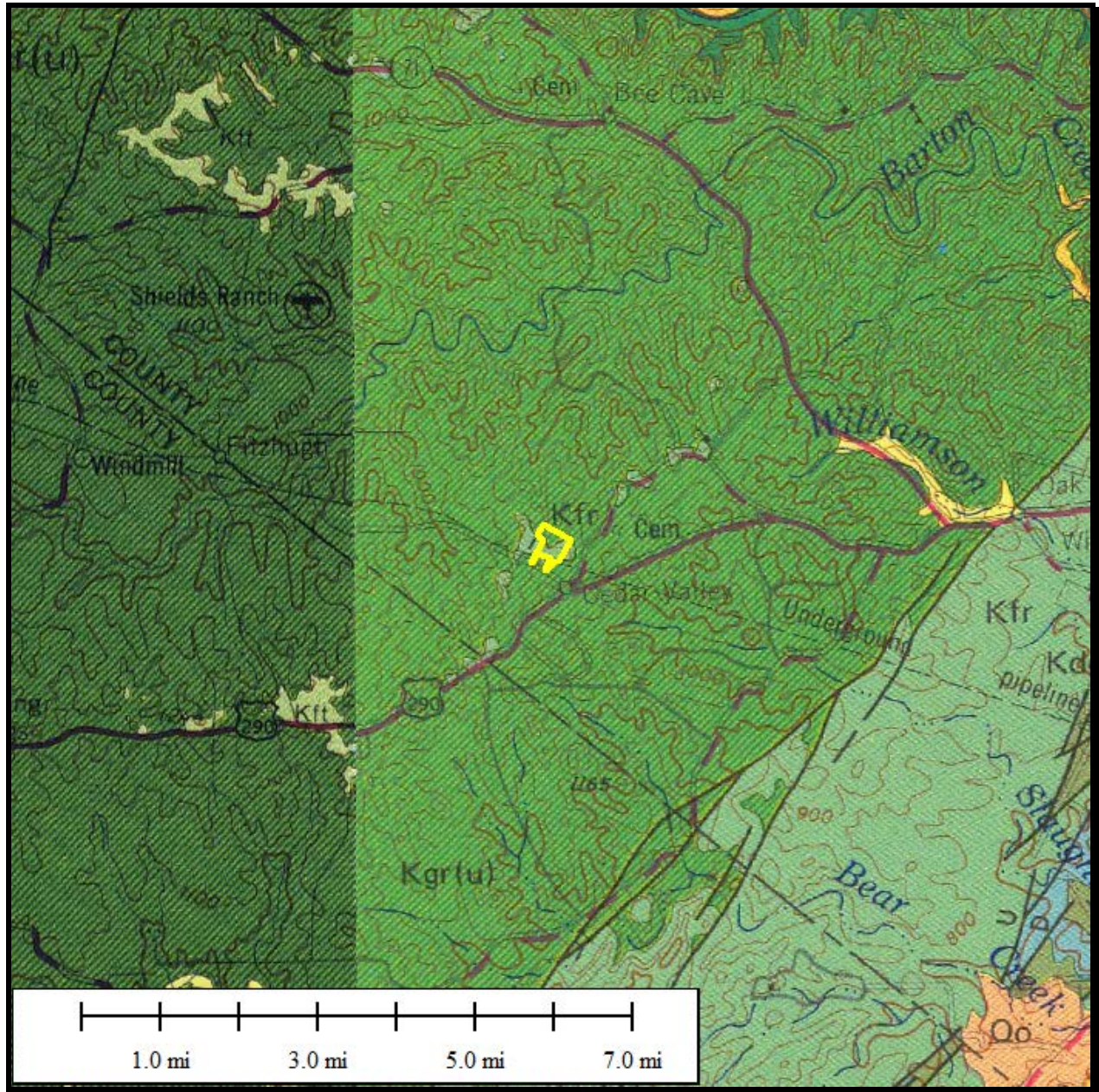
Approximate location of site in blue

**U.S. 7.5 Minute Series Topographic Map
Signal Hill Quadrangle, Texas**

Contour Interval = 20 feet

Source: TEXAS NATURAL RESOURCES INFORMATION SYSTEM
(<http://www.tnris.state.tx.us/digital.htm>)



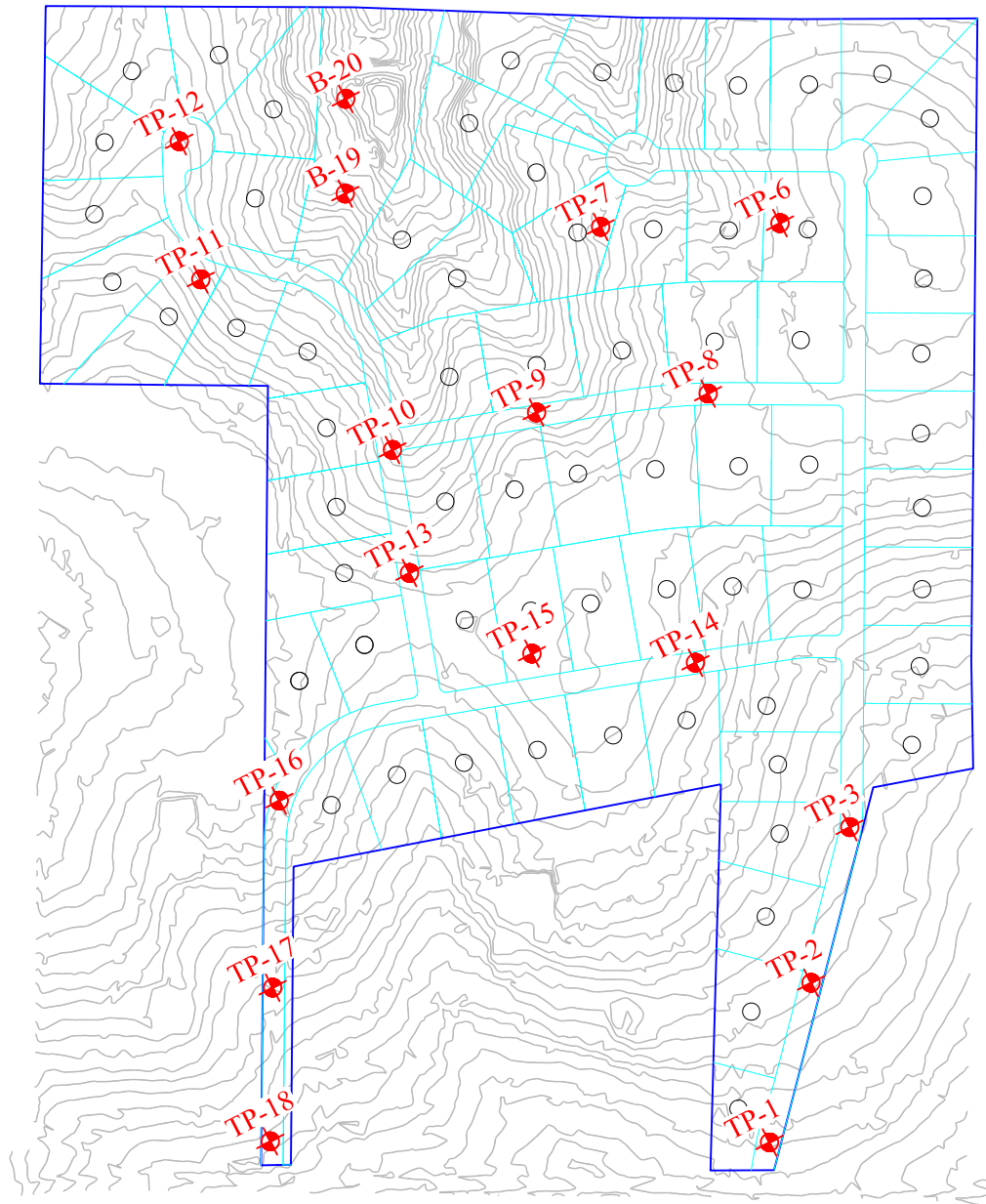


Approximate location of site in yellow

Geologic Setting of Site Geologic Atlas of Texas

Original Source: Bureau of Economic Geology, The University of Texas at Austin, latest version
Digital Source: 15-minute Digital GAT Quads. TCEQ March 9, 2004





SCALE = N.T.S.

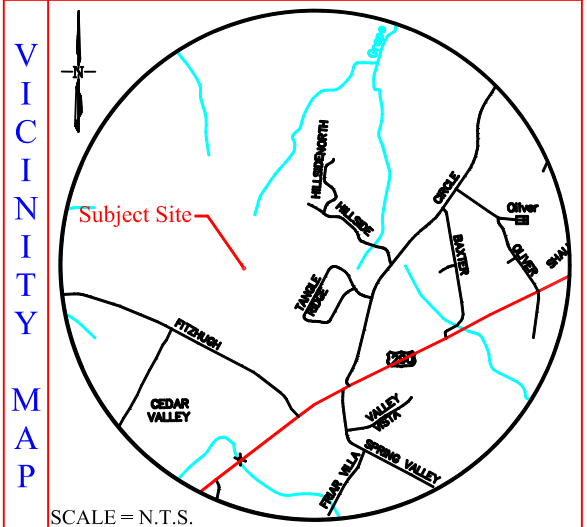
PAGE 1 OF 1

PLAN OF BORINGS & TEST PITS

Fitzhugh Road
Austin, Texas
Job. No.: 17101100.075
Client: Brohn Homes

LEGEND

B-#	Boring Number
TP-#	Test Pit Number
	Approx. Boring/ Test Pit Location



LOG OF TEST PIT

Job Name: Fitzhugh Road

Job Location: Austin, Texas

Engineer's Job #: 17101100.075

Client: Brohn Homes

Test Pit TP-1

PAGE 1 OF 1

Excavation Date: November 7, 2017

Ground Elevation: n/a

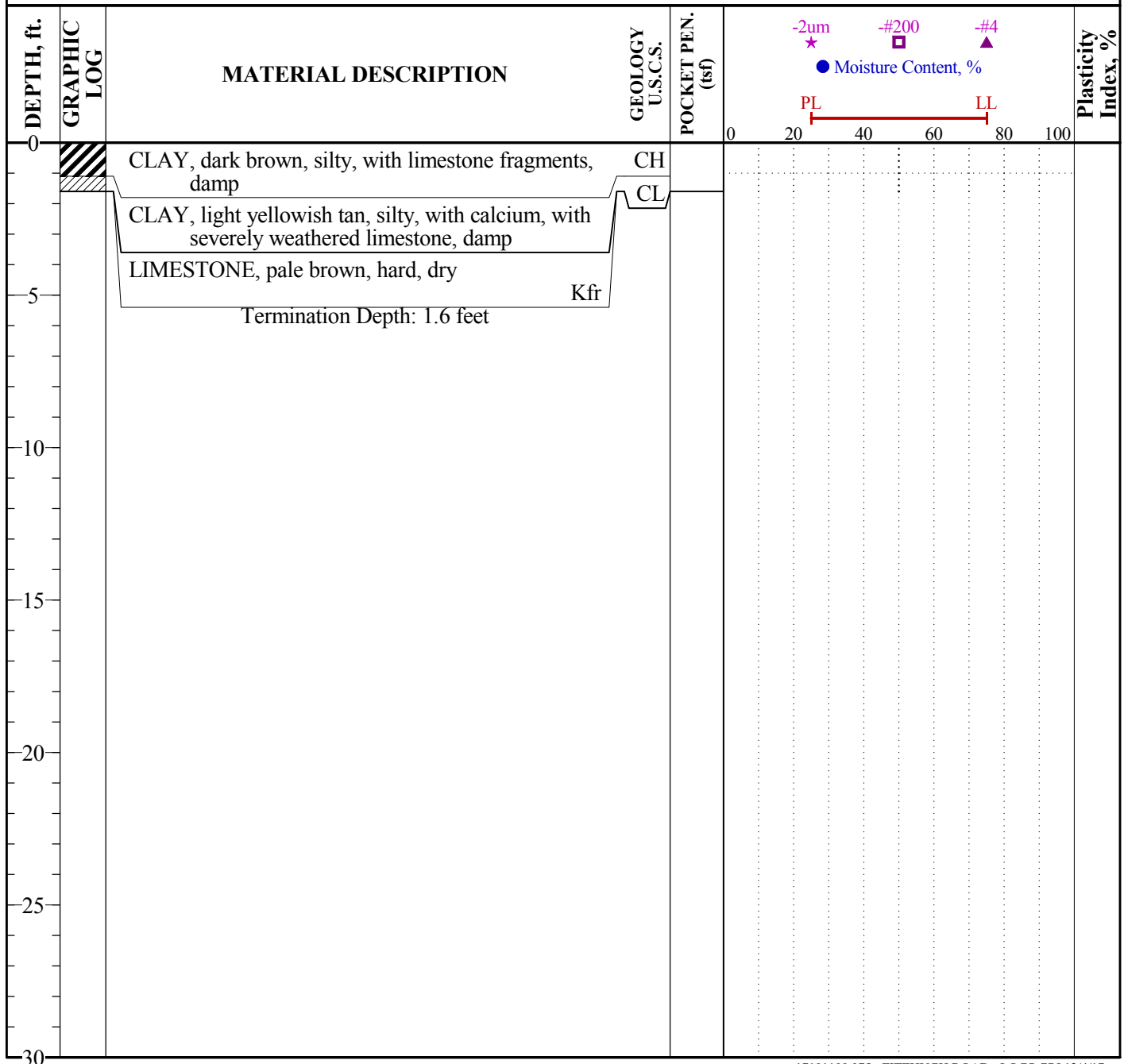
Ground Water Levels:

AT TIME OF EXCAVATION: ---

AT END OF EXCAVATION: ---

AFTER EXCAVATION: ---

Notes:



17101100.075 - FITZHUGH ROAD - LOGS.GPJ 12/4/17

LOG OF TEST PIT

Job Name: Fitzhugh Road

Job Location: Austin, Texas

Engineer's Job #: 17101100.075

Client: Brohn Homes

Test Pit TP-2

PAGE 1 OF 1

Excavation Date: November 7, 2017

Ground Elevation: n/a

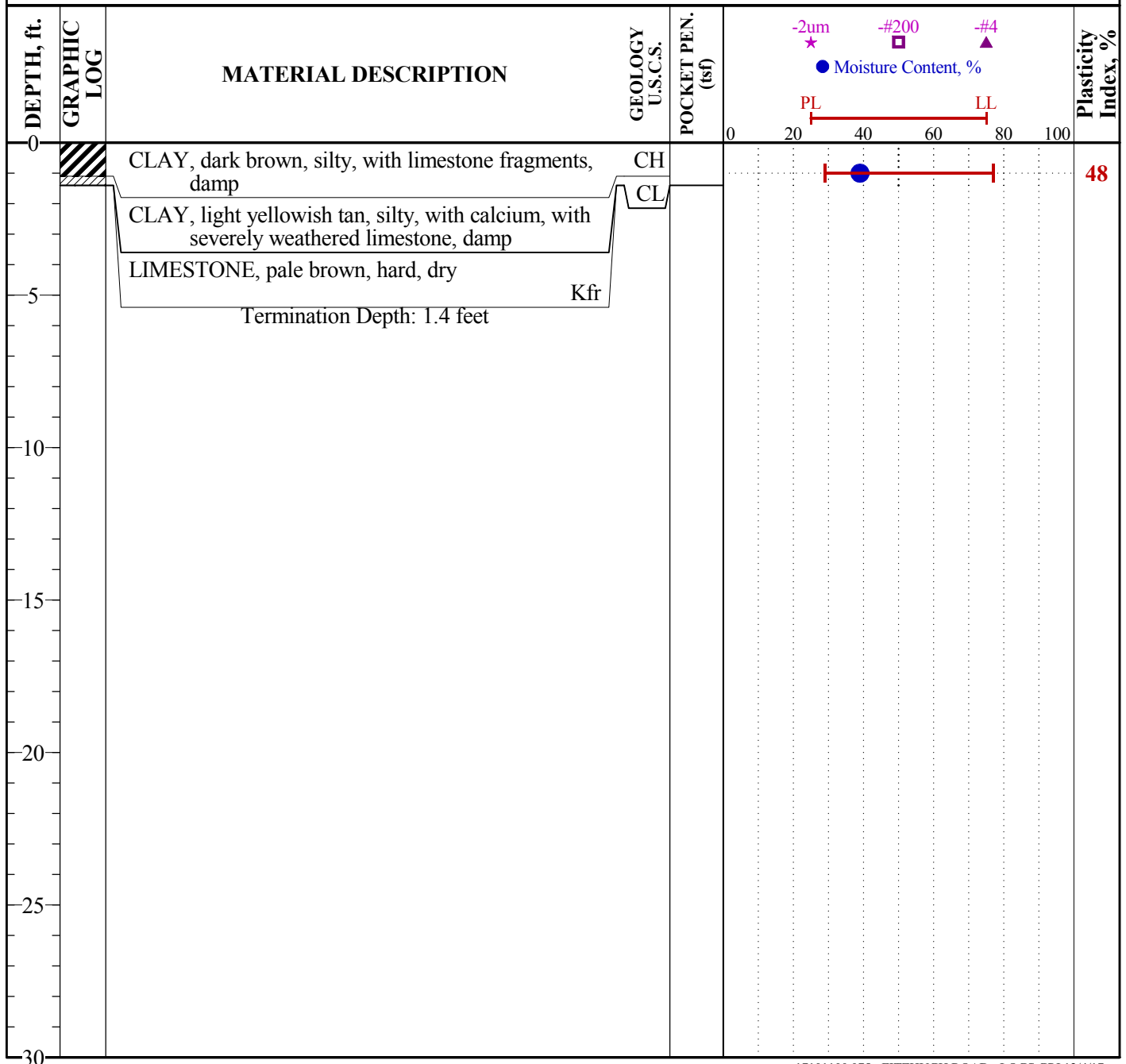
Ground Water Levels:

AT TIME OF EXCAVATION: ---

AT END OF EXCAVATION: ---

AFTER EXCAVATION: ---

Notes:



17101100.075 - FITZHUGH ROAD - LOGS.GPJ 12/4/17

LOG OF TEST PIT

Job Name: Fitzhugh Road
Job Location: Austin, Texas
Engineer's Job #: 17101100.075
Client: Brohn Homes

Test Pit TP-3

PAGE 1 OF 1

Excavation Date: November 7, 2017 **Ground Elevation:** n/a

Ground Water Levels:

AT TIME OF EXCAVATION: ---

AT END OF EXCAVATION: ---

AFTER EXCAVATION: ---

Notes:

DEPTH, ft.	GRAPHIC LOG	MATERIAL DESCRIPTION	GEOLOGY U.S.C.S.	POCKET PEN. (tsf)	-2um -#200 -#4 Moisture Content, % PL LL	Plasticity Index, %
0		CLAY, dark brown, silty, with limestone fragments, damp	CH			
		LIMESTONE, pale brown, hard, dry	Kfr			
		Termination Depth: 1.0 feet				
5						
10						
15						
20						
25						
30						

17101100.075 - FITZHUGH ROAD - LOGS.GPJ 12/4/17

LOG OF TEST PIT

Job Name: Fitzhugh Road
Job Location: Austin, Texas
Engineer's Job #: 17101100.075
Client: Brohn Homes

Test Pit TP-6

PAGE 1 OF 1

Excavation Date: November 7, 2017 **Ground Elevation:** n/a

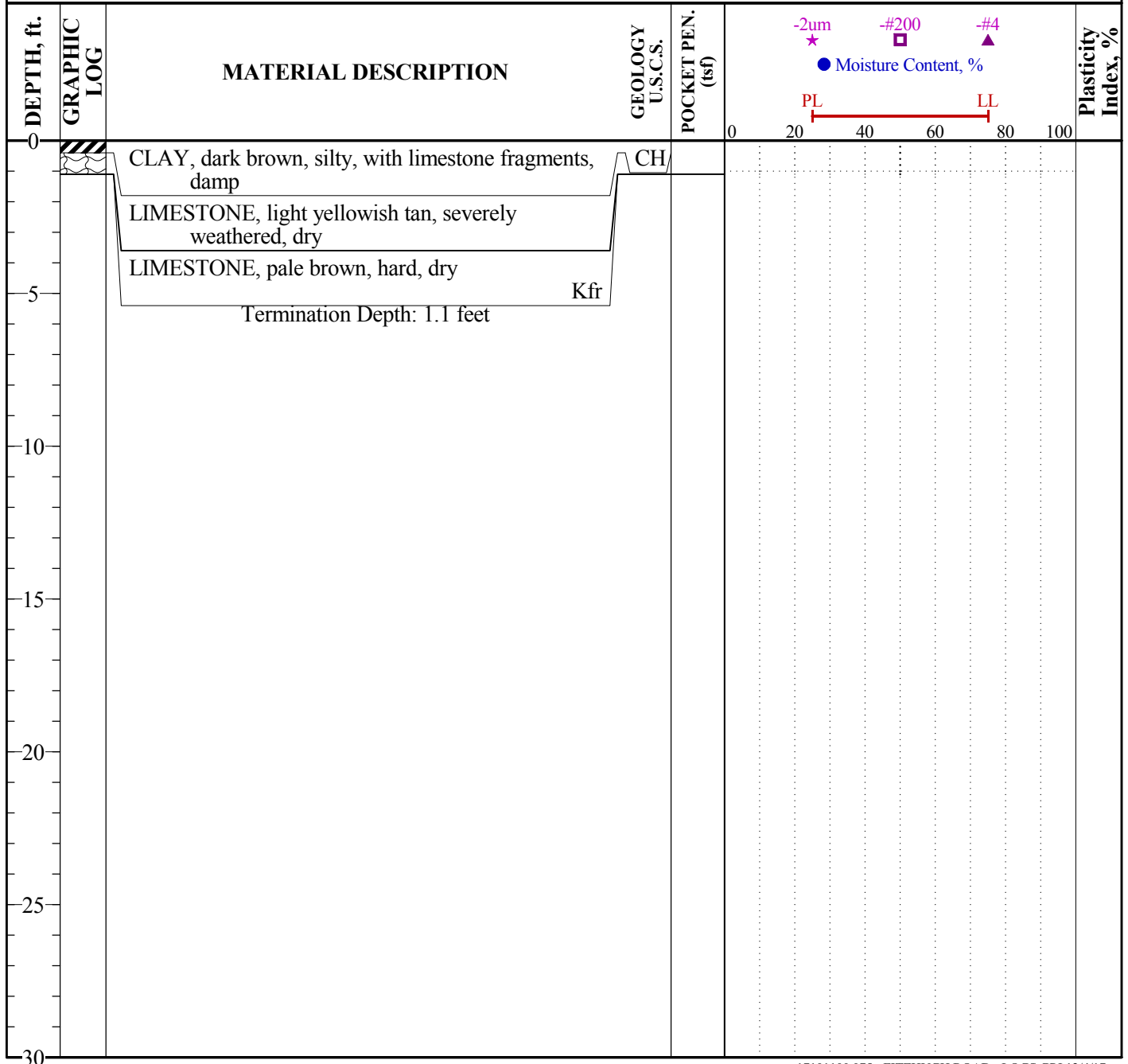
Ground Water Levels:

AT TIME OF EXCAVATION: ---

AT END OF EXCAVATION: ---

AFTER EXCAVATION: ---

Notes:



17101100.075 - FITZHUGH ROAD - LOGS.GPJ 12/4/17

LOG OF TEST PIT

Job Name: Fitzhugh Road
Job Location: Austin, Texas
Engineer's Job #: 17101100.075
Client: Brohn Homes

Test Pit TP-7
 PAGE 1 OF 1

Excavation Date: November 7, 2017 **Ground Elevation:** n/a

Ground Water Levels:

AT TIME OF EXCAVATION: ---
 AT END OF EXCAVATION: ---
 AFTER EXCAVATION: ---

Notes:

DEPTH, ft.	GRAPHIC LOG	MATERIAL DESCRIPTION	GEOLOGY U.S.C.S.	POCKET PEN. (tsf)	-2um ★ -#200 □ -#4 ▲ ● Moisture Content, % PL ————— LL	Plasticity Index, %
0		CLAY, dark brown, silty, with limestone fragments, damp	CH			
		LIMESTONE, pale brown, hard, dry	Kfr			
		Termination Depth: 1.2 feet				
5						
10						
15						
20						
25						
30						

17101100.075 - FITZHUGH ROAD - LOGS.GPJ 12/4/17

LOG OF TEST PIT

Job Name: Fitzhugh Road

Job Location: Austin, Texas

Engineer's Job #: 17101100.075

Client: Brohn Homes

Test Pit TP-8

PAGE 1 OF 1

Excavation Date: November 7, 2017

Ground Elevation: n/a

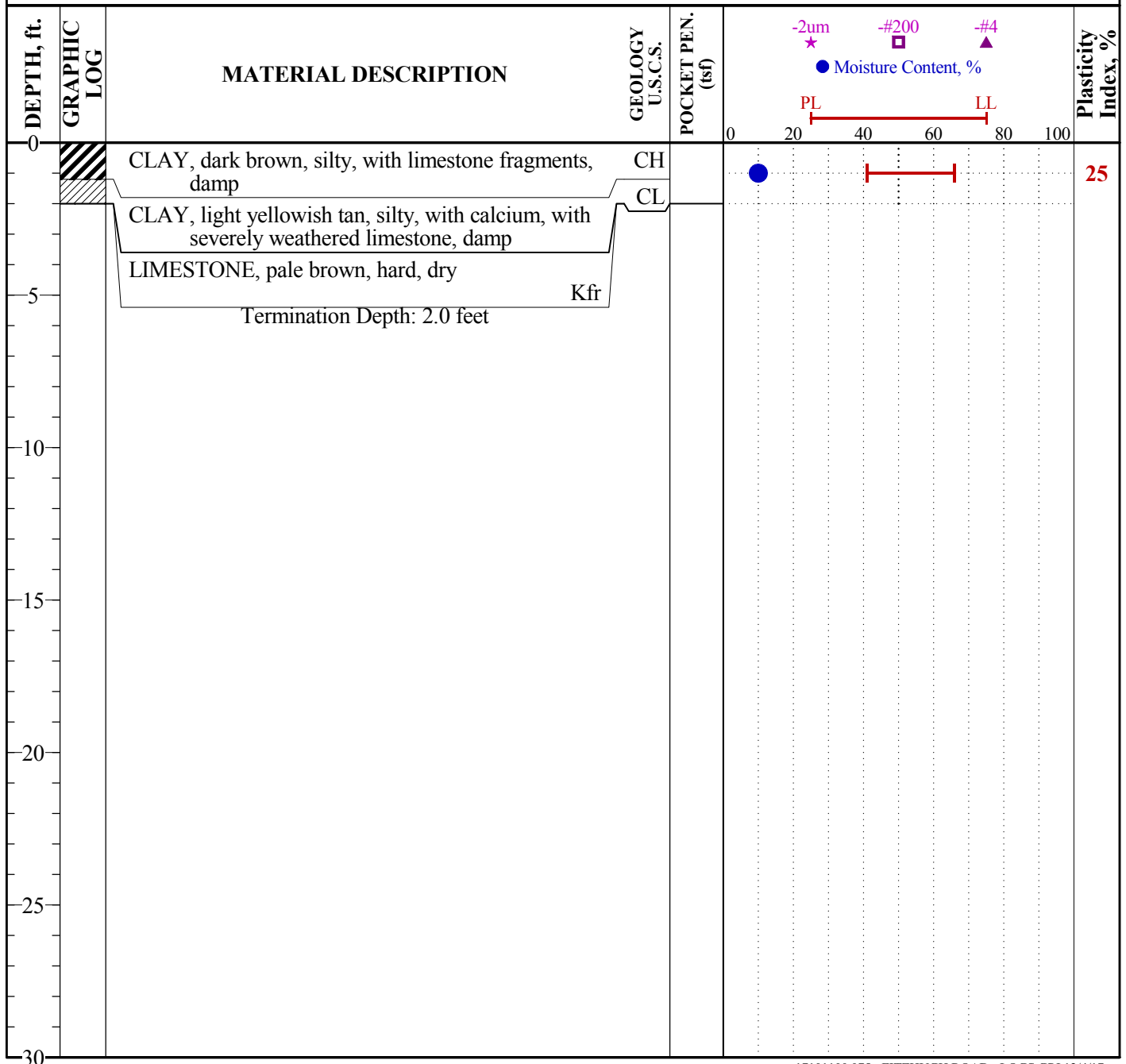
Ground Water Levels:

AT TIME OF EXCAVATION: ---

AT END OF EXCAVATION: ---

AFTER EXCAVATION: ---

Notes:



17101100.075 - FITZHUGH ROAD - LOGS.GPJ 12/4/17

LOG OF TEST PIT

Job Name: Fitzhugh Road
Job Location: Austin, Texas
Engineer's Job #: 17101100.075
Client: Brohn Homes

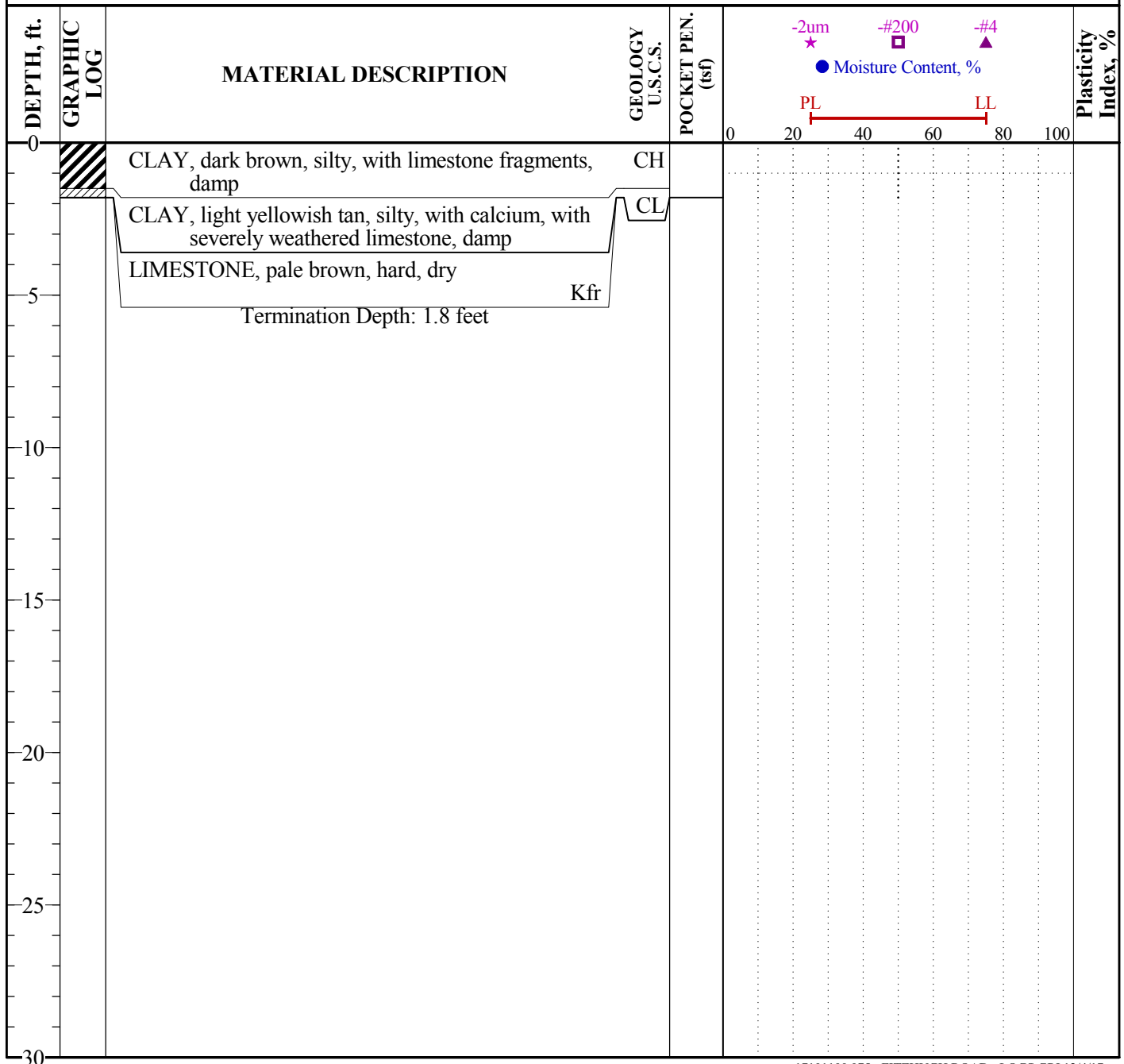
Test Pit TP-9
 PAGE 1 OF 1

Excavation Date: November 7, 2017 **Ground Elevation:** n/a

Ground Water Levels:

AT TIME OF EXCAVATION: ---
 AT END OF EXCAVATION: ---
 AFTER EXCAVATION: ---

Notes:



17101100.075 - FITZHUGH ROAD - LOGS.GPJ 12/4/17

LOG OF TEST PIT

Job Name: Fitzhugh Road
Job Location: Austin, Texas
Engineer's Job #: 17101100.075
Client: Brohn Homes

Test Pit TP-10

PAGE 1 OF 1

Excavation Date: November 7, 2017 **Ground Elevation:** n/a

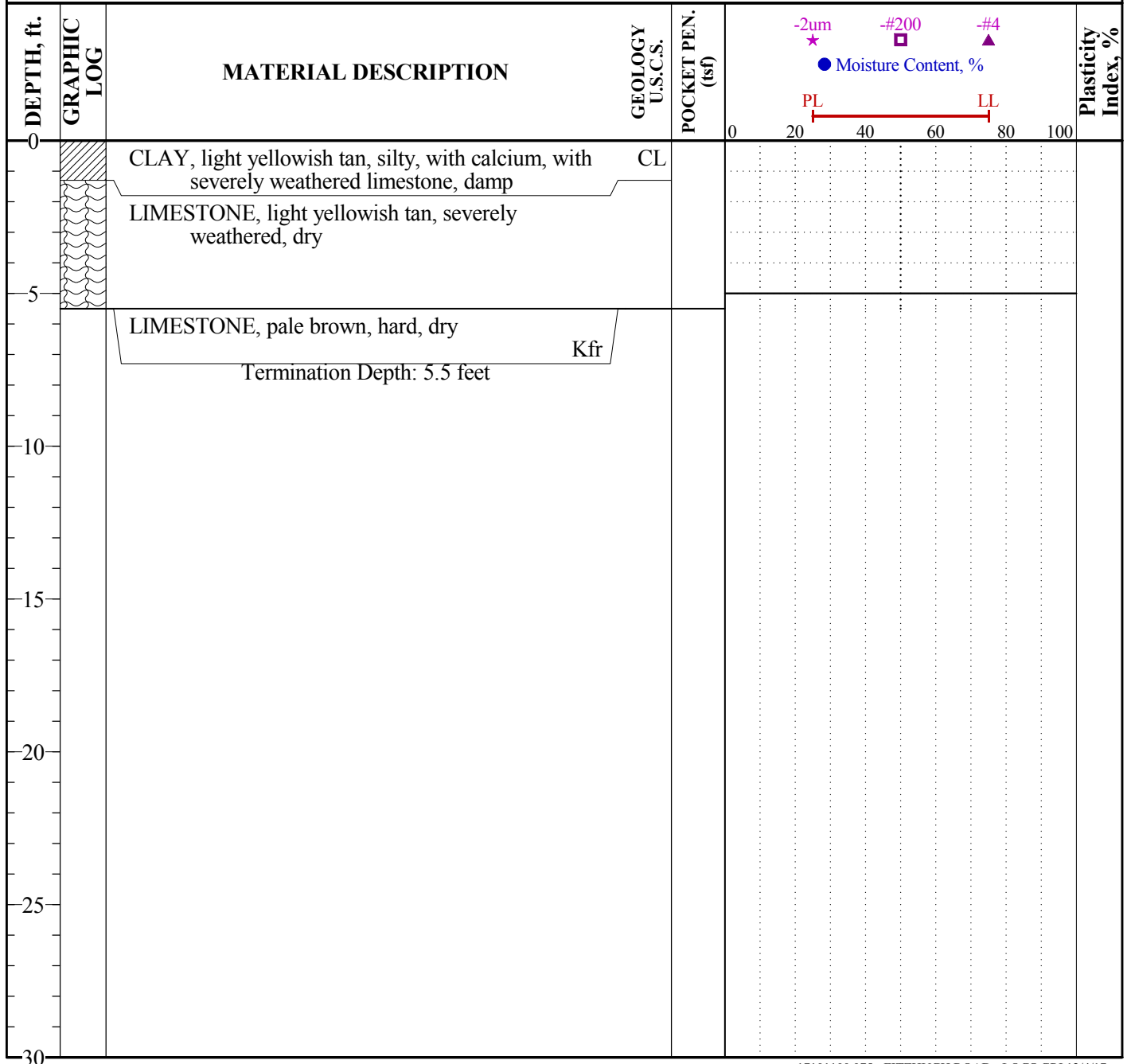
Ground Water Levels:

AT TIME OF EXCAVATION: ---

AT END OF EXCAVATION: ---

AFTER EXCAVATION: ---

Notes:



17101100.075 - FITZHUGH ROAD - LOGS.GPJ 12/4/17

LOG OF TEST PIT

"put us to the test"

Job Name: Fitzhugh Road

Job Location: Austin, Texas

Engineer's Job #: 17101100.075

Client: Brohn Homes

Test Pit TP-11

PAGE 1 OF 1

Excavation Date: November 7, 2017

Ground Elevation: n/a

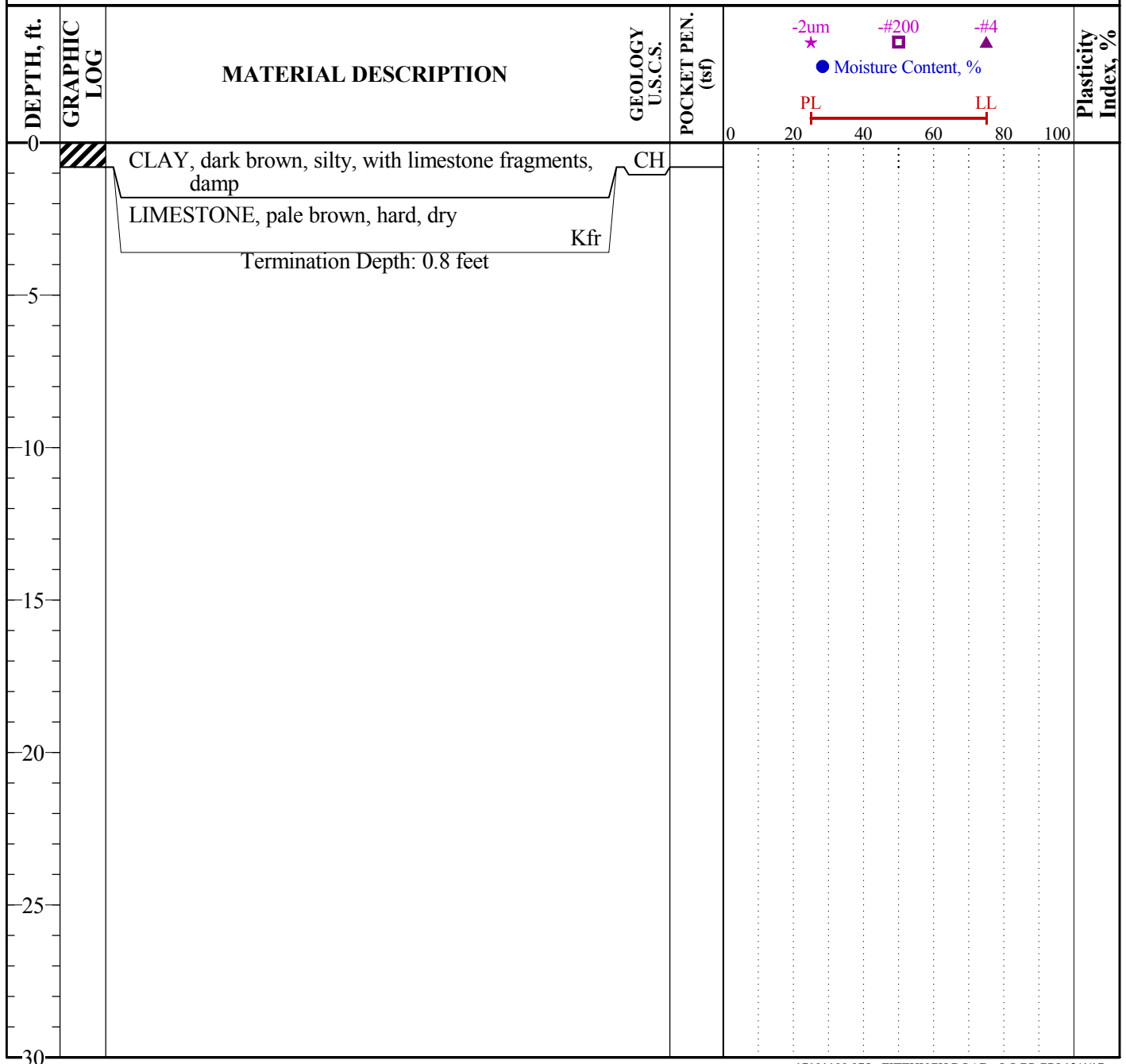
Ground Water Levels:

AT TIME OF EXCAVATION: ---

AT END OF EXCAVATION: ---

AFTER EXCAVATION: ---

Notes:



17101100.075 - FITZHUGH ROAD - LOGS.GPJ 12/4/17

LOG OF TEST PIT

Job Name: Fitzhugh Road
Job Location: Austin, Texas
Engineer's Job #: 17101100.075
Client: Brohn Homes

Test Pit TP-12

PAGE 1 OF 1

Excavation Date: November 7, 2017

Ground Elevation: n/a

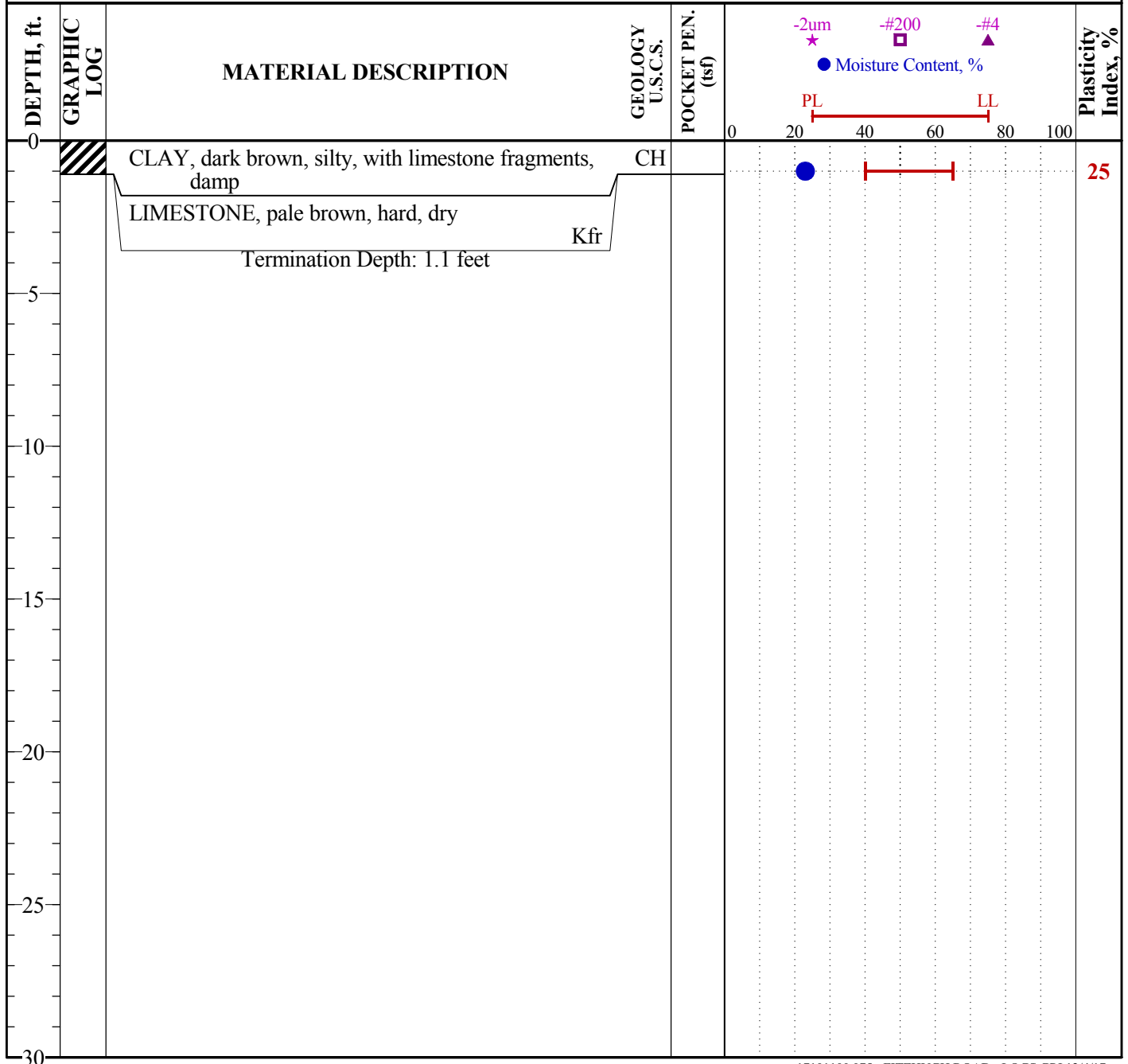
Ground Water Levels:

AT TIME OF EXCAVATION: ---

AT END OF EXCAVATION: ---

AFTER EXCAVATION: ---

Notes:



17101100.075 - FITZHUGH ROAD - LOGS.GPJ 12/4/17

LOG OF TEST PIT

Job Name: Fitzhugh Road
Job Location: Austin, Texas
Engineer's Job #: 17101100.075
Client: Brohn Homes

Test Pit TP-13

PAGE 1 OF 1

Excavation Date: November 7, 2017 **Ground Elevation:** n/a

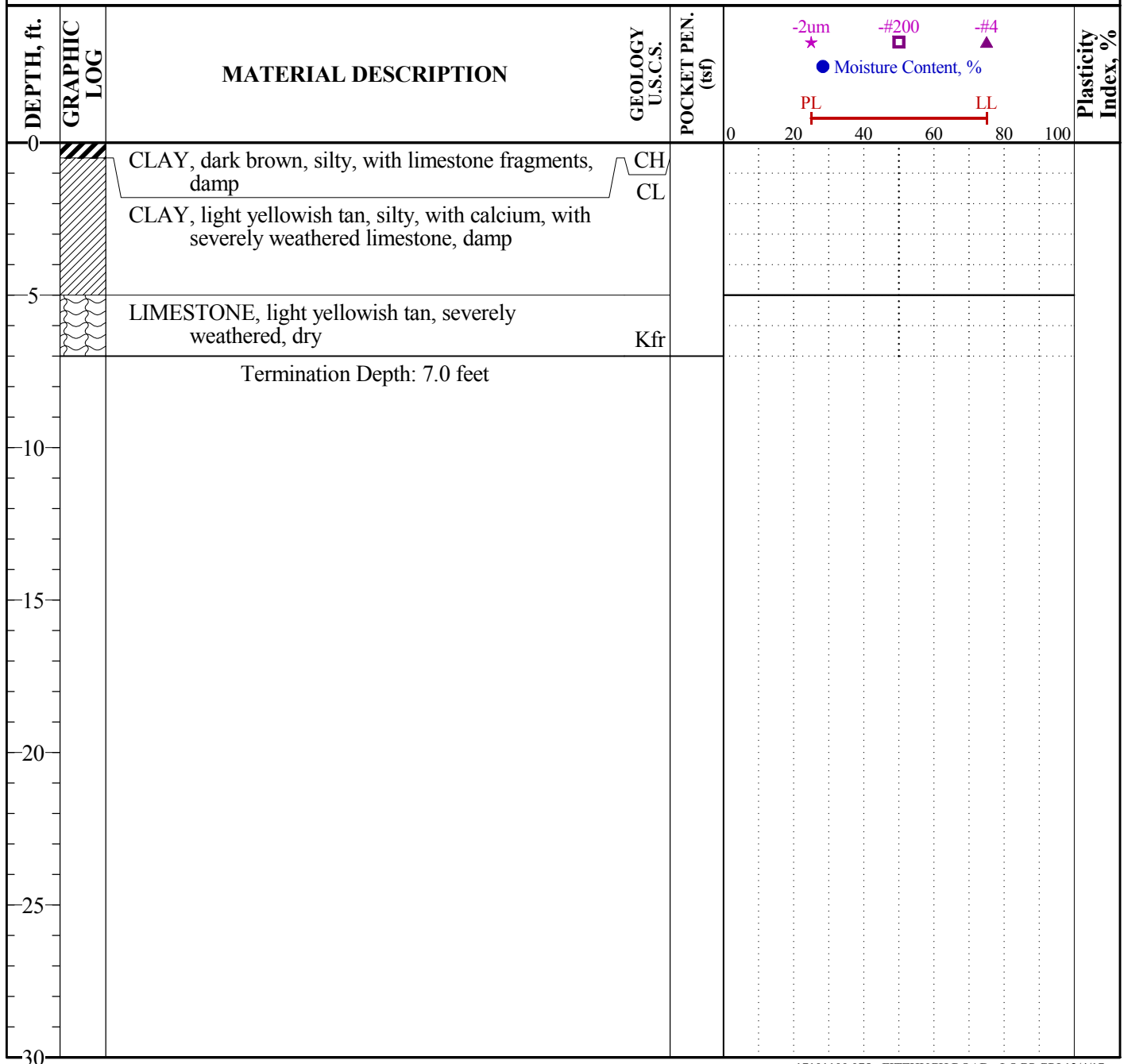
Ground Water Levels:

AT TIME OF EXCAVATION: ---

AT END OF EXCAVATION: ---

AFTER EXCAVATION: ---

Notes:



17101100.075 - FITZHUGH ROAD - LOGS.GPJ 12/4/17

LOG OF TEST PIT

Job Name: Fitzhugh Road

Job Location: Austin, Texas

Engineer's Job #: 17101100.075

Client: Brohn Homes

Test Pit TP-14

PAGE 1 OF 1

Excavation Date: November 7, 2017

Ground Elevation: n/a

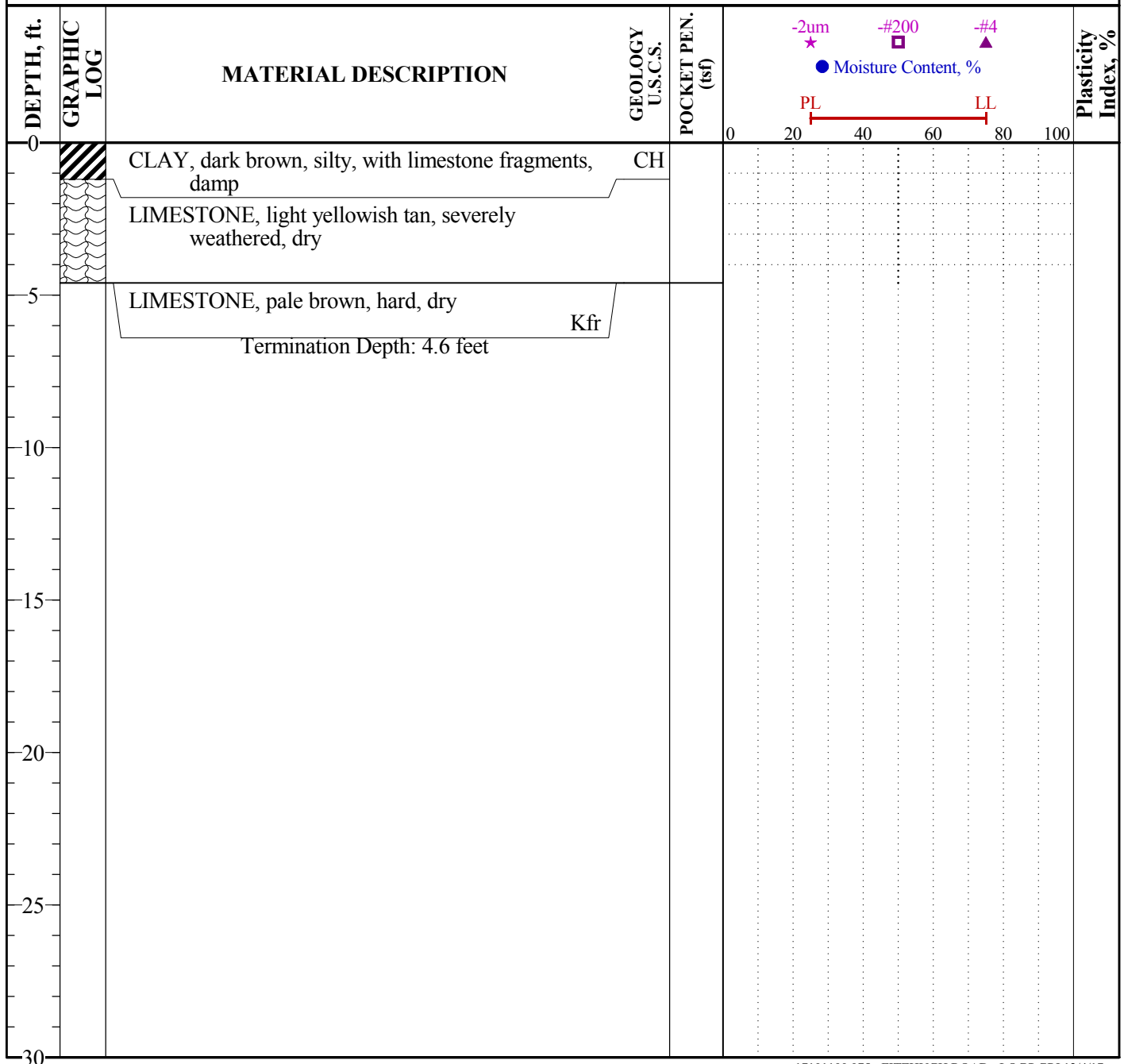
Ground Water Levels:

AT TIME OF EXCAVATION: ---

AT END OF EXCAVATION: ---

AFTER EXCAVATION: ---

Notes:



17101100.075 - FITZHUGH ROAD - LOGS.GPJ 12/4/17

LOG OF TEST PIT

"put us to the test"

Job Name: Fitzhugh Road

Job Location: Austin, Texas

Engineer's Job #: 17101100.075

Client: Brohn Homes

Test Pit TP-15

PAGE 1 OF 1

Excavation Date: November 7, 2017

Ground Elevation: n/a

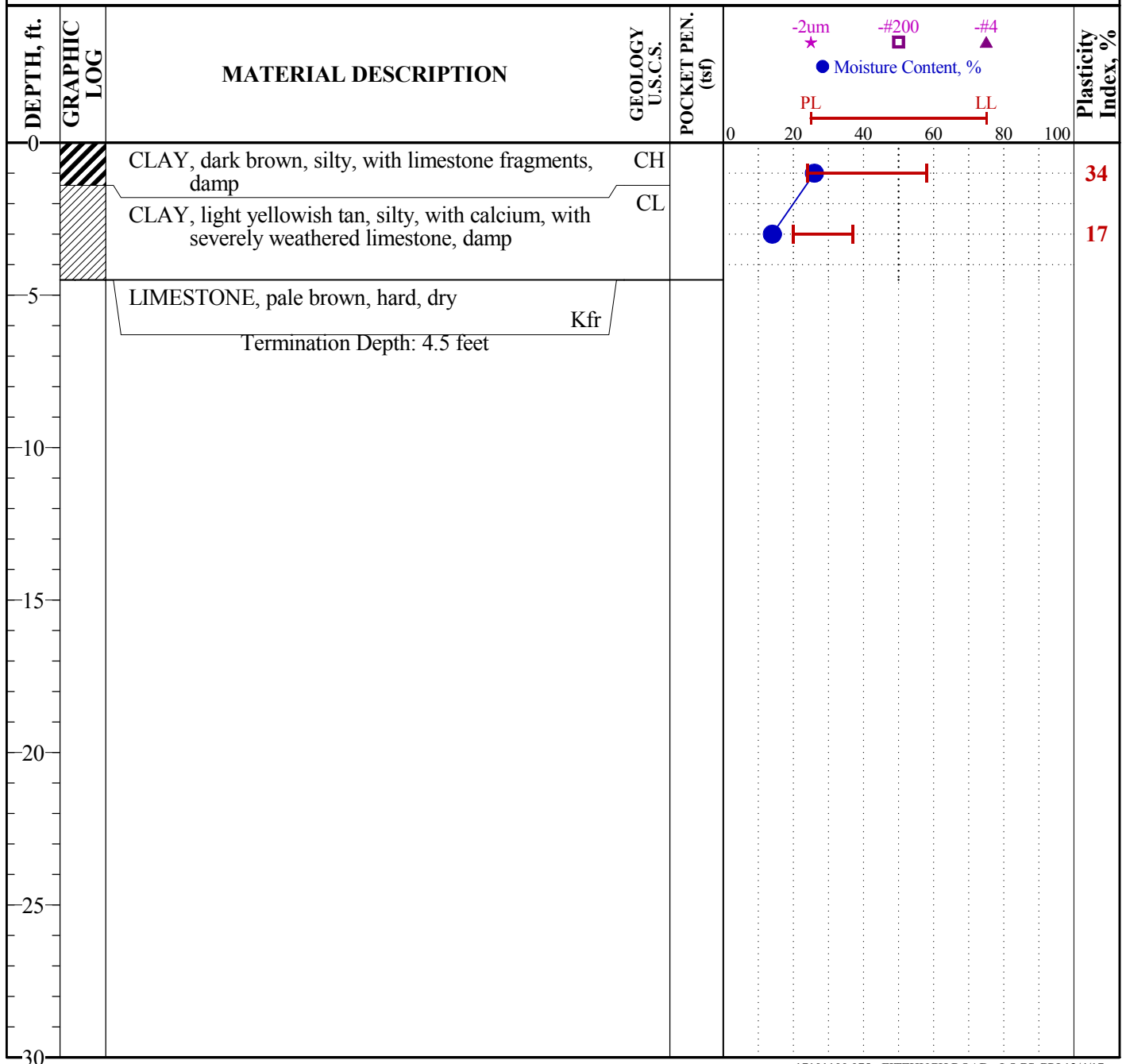
Ground Water Levels:

AT TIME OF EXCAVATION: ---

AT END OF EXCAVATION: ---

AFTER EXCAVATION: ---

Notes:



17101100.075 - FITZHUGH ROAD - LOGS.GPJ 12/4/17

LOG OF TEST PIT

Job Name: Fitzhugh Road
Job Location: Austin, Texas
Engineer's Job #: 17101100.075
Client: Brohn Homes

Test Pit TP-16

PAGE 1 OF 1

Excavation Date: November 7, 2017 **Ground Elevation:** n/a

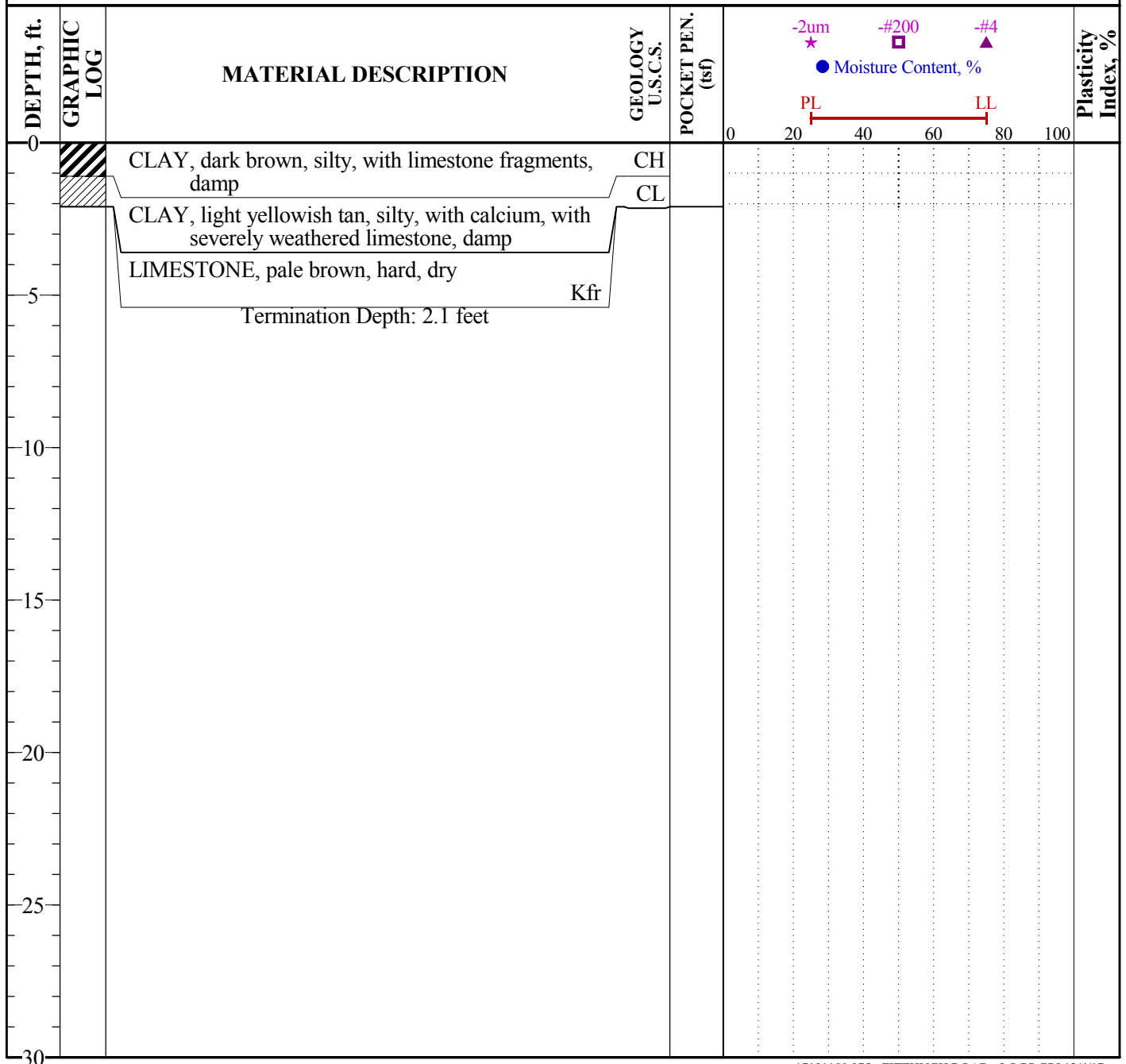
Ground Water Levels:

AT TIME OF EXCAVATION: ---

AT END OF EXCAVATION: ---

AFTER EXCAVATION: ---

Notes:



17101100.075 - FITZHUGH ROAD - LOGS.GPJ 12/4/17

LOG OF TEST PIT

Job Name: Fitzhugh Road

Job Location: Austin, Texas

Engineer's Job #: 17101100.075

Client: Brohn Homes

Test Pit TP-17

PAGE 1 OF 1

Excavation Date: November 7, 2017

Ground Elevation: n/a

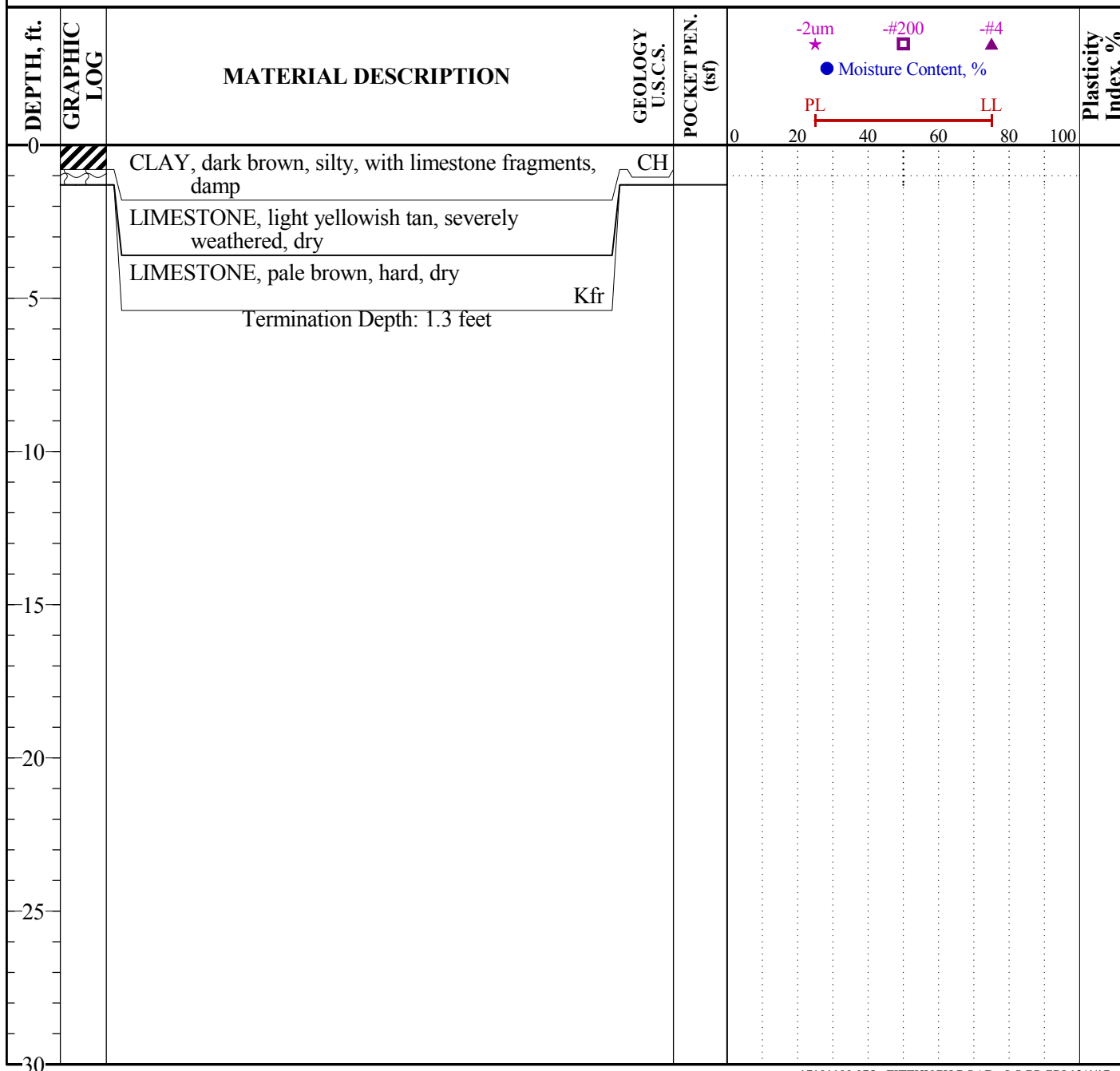
Ground Water Levels:

AT TIME OF EXCAVATION: ---

AT END OF EXCAVATION: ---

AFTER EXCAVATION: ---

Notes:



17101100.075 - FITZHUGH ROAD - LOGS.GPJ 12/4/17

LOG OF TEST PIT

Job Name: Fitzhugh Road
Job Location: Austin, Texas
Engineer's Job #: 17101100.075
Client: Brohn Homes

Test Pit TP-18
 PAGE 1 OF 1

Excavation Date: November 7, 2017 **Ground Elevation:** n/a

Ground Water Levels:

AT TIME OF EXCAVATION: ---

AT END OF EXCAVATION: ---

AFTER EXCAVATION: ---

Notes:

DEPTH, ft.	GRAPHIC LOG	MATERIAL DESCRIPTION	GEOLOGY U.S.C.S.	POCKET PEN. (tsf)	-2um ★ -#200 □ -#4 ▲ ● Moisture Content, % PL ————— LL	Plasticity Index, %
0		CLAY, dark brown, silty, with limestone fragments, damp	CH			
		LIMESTONE, pale brown, hard, dry	Kfr			
		Termination Depth: 0.7 feet				
5						
10						
15						
20						
25						
30						

17101100.075 - FITZHUGH ROAD - LOGS.GPJ 12/4/17

LOG OF BORING

Job Name: Fitzhugh Road
Job Location: Austin, Texas
Engineer's Job #: 17101100.075
Client: Brohn Homes

Boring B-19
PAGE 1 OF 1

Drill Date: November 27, 2017

Ground Elevation: n/a

Ground Water Levels:

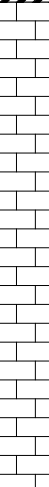
Hole Size: 4.5 in.

AT TIME OF DRILLING: ---

▼ AT END OF DRILLING: 12.9 ft / Elev 0.0 ft

AFTER DRILLING: ---

Notes:

DEPTH, ft.	GRAPHIC LOG	MATERIAL DESCRIPTION	GEOLOGY U.S.C.S.	POCKET PEN. (tsf)	-2um -#200 -#4 Moisture Content, % PL LL	Plasticity Index, %
0		CLAY, dark brown, silty, with limestone fragments, damp	CH	-		
		LIMESTONE, pale brown, medium to hard, dry		-		
5		... clay layer 5.3' to 5.5'		-		
				-		
				-		
10				-		
				-		
				-		
15			Kgr	-		
		Termination Depth: 15.0 feet				
20						
25						
30						

17101100.075 - FITZHUGH ROAD - LOGS.GPJ 12/4/17

LOG OF BORING

Job Name: Fitzhugh Road
Job Location: Austin, Texas
Engineer's Job #: 17101100.075
Client: Brohn Homes

Boring B-20

PAGE 1 OF 1

Drill Date: November 27, 2017

Ground Elevation: n/a

Ground Water Levels:

Hole Size: 4.5 in.

AT TIME OF DRILLING: ---

AT END OF DRILLING: ---

AFTER DRILLING: ---

Notes:

DEPTH, ft.	GRAPHIC LOG	MATERIAL DESCRIPTION	GEOLOGY U.S.C.S.	POCKET PEN. (tsf)	-2um -#200 -#4 Moisture Content, % PL LL	Plasticity Index, %
0		CLAY, light yellowish tan, silty, with calcium, with severely weathered limestone, damp	CL	-		
		LIMESTONE, pale brown, medium to hard, dry		-		
5				-		
				-		
10		... gray below 10.9'		-		
				-		
15			Kgr	-		
		Termination Depth: 15.0 feet				
20						
25						
30						

17101100.075 - FITZHUGH ROAD - LOGS.GPJ 12/4/17

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		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, SILTY CLAYS, LEAN CLAYS	
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	
	CLAYS LIQUID LIMIT GREATER THAN 50		CH	INORGANIC CLAYS OF HIGH PLASTICITY	
	SOILS OF MODERATE PLASTICITY			CL-CH	LOW PI CLAYS WITH APPRECIABLE HIGH PI MOTTLING, CLAY WITH BORDERLINE CLASSIFICATION
	OTHER MATERIALS			FILL	MATERIAL NOT NATURALLY DEPOSITED
			LS	WEATHERED LIMESTONE INTACT LIMESTONE	

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

Key to Terms and Abbreviations

Descriptive Terms Characterizing Soils and Rock	Standard Description Abbreviations and Terms	Symbols and Abbreviations for Test Data
Slickensided – having inclined planes of weakness that are slick and glossy in appearance. Fissured – containing shrinkage cracks frequently filled with fine sand or silt, usually more or less vertical. Laminated – composed of thin layers of varying color or texture. Layers are typically distinct and varying in composition from sand to silt and clay. Varved – see Laminated. Crumbly – cohesive soils which break into small blocks or crumbs on drying. Argillaceous – having appreciable amounts of clay in the soil or rock mass. Used most often in describing limestones, occasionally sandstones. Calcareous – containing appreciable quantities of calcium carbonate. Can be either nodular or “powder.” Mottled – characterized as having multiple colors organized in a marbled pattern. Evaporite – deposits of salts and other soluble compounds. Most commonly calcium carbonate or gypsum. May be in either “powder” or visible crystal form. Ferruginous – having deposits of iron or nodules, typically oxidized and dark red in color.	brn = brown dk = dark lt = light wx = weathered calc = calcareous sw = severely weathered cw = completely weathered n/a = not available b. = below Engineering Units pcf = pounds per cubic foot psf = pounds per square foot tsf = tons per square foot pF = picofarad psi = pounds per square foot ksf = thousand pounds per square foot kips = thousand pounds (force)	LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index (LL-PL) γ_d = 95-Dry Unit Weight SPT = standard penetration test N = blows per foot from SPT SCR = standard core recovery RQD = rock quality designation RQI = see RQD qu = unconfined compressive strength

Terms Describing Consistency of Soil and Rock

COARSE GRAINED MATERIAL		SEDIMENTARY ROCK	
DESCRIPTIVE TERM	BLOWS/FT (SPT)	DESCRIPTIVE TERM	STRENGTH, TSF
very loose	0 – 4	soft	4 – 8
loose	4 – 10	medium	8 – 15
firm (medium)	10 – 30	hard	15 – 50
dense	30 – 50	very hard	over 50
very dense	over 50		

Describing Consistency of Fine Grained Soil

DESCRIPTIVE TERM	BLOWS/FT (SPT)	UNCONFINED COMPRESSION, TSF
very soft	< 2	< 0.25
soft	2 – 4	0.25 – 0.50
medium stiff	4 – 8	0.50 – 1.00
stiff	8 – 15	1.00 – 2.00
very stiff	15 – 30	2.00 – 4.00
hard	over 30	over 4.00

APPENDIX B

STANDARD FIELD AND LABORATORY PROCEDURES

STANDARD FIELD AND LABORATORY PROCEDURES

STANDARD FIELD PROCEDURES

Drilling and Sampling

Borings and test pits are typically staked in the field by the drillers, using simple taping or pacing procedures and locations are assumed to be accurate to within several feet. Unless noted otherwise, ground surface elevations (GSE) when shown on logs are estimated from topographic maps and are assumed to be accurate to within a foot. A Plan of Borings or Plan of Test Pits showing the boring locations and the proposed structures is provided in the Appendix.

A log of each boring or pit is prepared as drilling and sampling progressed. In the laboratory, the driller's classification and description is reviewed by a Geotechnical Engineer. Individual logs of each boring or pit are provided in the Appendix. Descriptive terms and symbols used on the logs are in accordance with the Unified Soil Classification System (ASTM D-2487). A reference key is also provided. The stratification of the subsurface material represents the soil conditions at the actual boring locations, and variations may occur between borings. Lines of demarcation represent the approximate boundary between the different material types, but the transition may be gradual.

A truck-mounted rotary drill rig utilizing rotary wash drilling or continuous flight hollow or solid stem auger procedures is used to advance the borings, unless otherwise noted. A backhoe provided by others is used to place test pits. Test pits are advanced to the required depth, refusal (typically bedrock) or to the limits of the equipment. Samples of soil are obtained from the borings or test pit spoils for subsequent laboratory study. Samples are sealed in plastic bags and marked as to depth and boring/pit locations in the field. Cores are wrapped in a polyethylene wrap to preserve field moisture conditions, placed in core boxes and marked as to depth and core runs. Unless notified to the contrary, samples and cores will be stored for 90 days, then discarded.

Standard Penetration Test and Split-Barrel Sampling of Soils (ASTM D-1586) (SPT)

This sampling method consists of driving a 2 inch outside diameter split barrel sampler using a 140 pound hammer freely falling through a distance of 30 inches. The sampler is first seated 6 inches into the material to be sampled and then driven an additional 12 inches. The number of blows required to drive the sampler the final 12 inches is known as the Standard Penetration Resistance. The results of the SPT is recorded on the boring logs as "N" values.

Thin-Walled Tube Sampling of Soils (ASTM D-1587) (Shelby Tube Sampling)

This method consists of pushing thin walled steel tubes, usually 3 inches in diameter, into the soils to be sampled using hydraulic pressure or other means. Cohesive soils are usually sampled in this manner and relatively undisturbed samples are recovered.

Soil Investigation and Sampling by Auger Borings (ASTM D-1452)

This method consists of auguring a hole and removing representative soil samples from the auger flight or bit at intervals or with each change in the substrata. Disturbed samples are obtained and this method is, therefore, limited to situations where it is satisfactory to determine the approximate subsurface profile and obtain samples suitable for Index Property testing.

Diamond Core Drilling for Site Investigation (ASTM D-2113)

This method consists of advancing a hole into hard strata by rotating a single or double tube core barrel equipped with a cutting bit. Diamond, tungsten carbide, or other cutting agents may be used for the bit. Wash water or air is used to remove the cuttings and to cool the bit. Normally, a 3 inch outside diameter by 2-1/8 inch inside diameter coring bit is used unless otherwise noted. The rock or hard material recovered within the core barrel is examined in the field and in the laboratory and the cores are stored in partitioned boxes. The intactness of all rock core specimens is evaluated in two ways. The first method is the Standard Core Recovery expressed as the length of the total core recovered divided by the length of the core run, expressed as a percentage:

$$\text{SCR} = \frac{\text{total core length recovered}}{\text{length of core run}} \times 100\%$$

This value is exhibited on the boring logs as the Standard Core Recovery (SCR).

The second procedure for evaluating the intactness of the rock cores is by Rock Quality Designation (RQD). The RQD provides an additional qualitative measure of soundness of the rock. This index is determined by measuring the intact recovered core unit which exceed four inches in length divided by the total length of the core run:

$$\text{RQD} = \frac{\text{all core lengths greater than 4''}}{\text{length of core run}} \times 100\%$$

The RQD is also expressed as a percentage and is shown on the boring logs.

Vane Shear Tests

In-situ vane shear tests may be used to determine the shear strength of soft to medium cohesive soil. This test consists of placing a four-bladed vane in the undisturbed soil and determining the torsional force applied at the ground surface required to cause the cylindrical perimeter surface of the vane to be sheared. The torsional force sufficient to cause shearing is converted to a unit of shearing resistance or cohesion of the soil surrounding the cylindrical surface.

THD Cone Penetrometer Test

The THD Cone Penetrometer Test is a standard field test to determine the relative density or consistency and load carrying capacity of foundation soils. This test is performed in much the same manner as the Standard Penetration Test described above. In this test, a 3 inch diameter penetrometer cone is used in place of a split-spoon sampler. This test calls for a 170-pound weight falling 24 inches. The actual test in hard materials consists of driving the penetrometer cone and accurately recording the inches of penetration for the first and second 50 blows for a total of 100 blows. These results are then correlated using a table of load capacity vs. number of inches penetrated per 100 blows.

Ground Water Observation

Ground moisture observations are made during the operations and are reported on the logs of boring or pit. Moisture condition of cuttings are noted, however, the use of water for circulation precludes direct observation of wet conditions. Water levels after completing the borings or pits are noted. Seasonal variations, temperatures and recent rainfall conditions may influence the levels of the ground water table and water may be present in excavations, even though not indicated on the logs.

STANDARD LABORATORY PROCEDURES

To adequately characterize the subsurface material at this site, some or all of the following laboratory tests are performed. The results of the actual tests performed are shown graphically on the Logs of Boring or Pit.

Moisture Content - ASTM D-2216

Natural moisture contents of the samples (based on dry weight of soil) are determined for selected samples at depths shown on the respective boring logs. These moisture contents are useful in delineating the depth of the zone of moisture change and as a gauge of correlation between the various index properties and the engineering properties of the soil. For example, the relationship between the plasticity index and moisture content is a source of information for the correlation of shear strength data.

Atterberg Limits - ASTM D-4318

The Atterberg Limits are the moisture contents at the time the soil meets certain arbitrarily defined tests. At the moisture content defined as the plastic limit, P_w , the soil is assumed to change from a semi-solid state to a plastic state. By the addition of more moisture, the soil may be brought up to the moisture content defined as the liquid limit, L_w , or that point where the soil changes from a plastic state to a liquid state. A soil existing at a moisture content between these two previously described states is said to be in a plastic state. The difference between the liquid limit, L_w , and the plastic limit, P_w , is termed the plasticity index, I_w . As the plasticity index

increases, the ability of a soil to attract water and remain in a plastic state increases. The Atterberg Limits that were determined are plotted on the appropriate log.

The Atterberg Limits are quite useful in soil exploration as an indexing parameter. Using the Atterberg Limits and grain size analysis, A. Casagrande developed the Unified Soils Classification System (USCS) which is widely used in the geotechnical engineering field. This system related the liquid limit to the plasticity index by dividing a classification chart into various zones according to degrees of plasticity of clays and silts. Although the Atterberg Limits are an indexing parameter, K. Terzaghi has related these limits to various engineering properties of a soil. Some of these relationships are as follows:

1. As the grain size of the soil decreases, the Atterberg Limits increase.
2. As the percent clay in the soil increases, the Atterberg Limits increase.
3. As the shear strength increases, the Atterberg Limits decrease.
4. As the compressibility of a soil increases, the Atterberg Limits increase.

Triaxial Shear Test - ASTM D-2850-70

Triaxial tests may be performed on samples that are approximately 2.83 inches in diameter, unless a smaller diameter sample was necessary to achieve a more favorable length:diameter (L:D) ratio. A minimum length to diameter ratio (L:D) of 2.0 is maintained to reduce end effects.

The triaxial tests are typically unconsolidated-undrained using nitrogen gas for chamber confining pressure. Confining pressures are selected to conform to in-situ hydrostatic pressure considering the earth to be a fluid of 120 pcf. In this test, undisturbed Shelby tube samples are trimmed so that their ends are square and then pressed in a triaxial compression machine. The load at which failure occurs is the compressive strength. The results of the triaxial tests and the correlated hand penetrometer strengths can be utilized to develop soil shear strength values.

Unconfined Compressive Strength of Rock Cores - ASTM D-2938

The unconfined compressive strength is a valuable parameter useful in the design of foundation footings. This value, q_u , is related to the shearing resistance of the rock and thus to the capacity of the rock to support a load. In completing this test it is imperative that the length:diameter ratio of the core specimens are maintained at a minimum of 2:1. This ratio is set so that the shear plane will not extend through either of the end caps. If the ratio is less than 2.0 a correction is applied to the result.

Grain Size Analysis - ASTM D-421 and D-422

Grain size analysis tests are performed to determine the particle size and distribution of the samples tested. The grain size distribution of the soils coarser than the Standard Number 200 sieve is determined by passing the sample through a standard set of nested sieves, and the distribution of sizes smaller than the No. 200 sieve is determined by a sedimentation process,

using a hydrometer. The results are given on the log of Boring/Pit or on Grain Size Distribution semi-log graphs within the report.

Soil Suction Test - ASTM D-5298-94

Soil suction (potential) tests are performed to determine both the matric and total suction values for the samples tested. Soil suction measures the free energy of the pore water in a soil. In a practical sense, soil suction is an indication of the affinity of a given soil sample to retain water. Soil suction provides useful information on a variety of characteristics of the soil that are affected by the soil water including volume change, deformation, and strength.

Soil suction tests are performed using the filter paper method per ASTM D-5298. Results of these tests are shown graphically on the logs of boring and tabulated in summary sheet of laboratory data.

For matric suction values found using this method, it should be noted that when the soil is in a dry state adequate contact between the filter paper and the soil may not be possible. This lack of contact may result in the determination of total suction instead of matric suction.

APPENDIX C

MFPS COMPUTER OUTPUT

MM	MM	FFFFFFFF	PPPPPPPP	SSSSS	11
MMM	MMM	FFFFFFFF	PPPPPPPP	SSSSSSS	111
MMMM	MMMM	FF	PP PP	SS SS	1111
MMMMMMMM		FF	PP PP	SS	11
MM	MM	FFFFFF	PPPPPPPP	SSSSSS	11
MM	M	MM	FFFFFF	PPPPPPPP	SSSSSS
MM	MM	FF	PP	SS	11
MM	MM	FF	PP	SS SS	11
MM	MM	FF	PP	SSSSSSS	111111
MM	MM	FF	PP	SSSSS	111111

MUNICIPAL FLEXIBLE PAVEMENT DESIGN SYSTEM
 VERSION 1.0, SEPTEMBER 1983
 MOVED TO MICROCOMPUTER OCTOBER 1985 (P.J.- BRE)

NOTICE --

THIS COMPUTER PROGRAM REPRESENTS AN ADAPTATION OF THE ORIGINAL TEXAS STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION FLEXIBLE PAVEMENT DESIGN SYSTEM (FPS-11) FOR THE DESIGN AND CONSIDERATION OF LIFE-CYCLE COSTS OF MUNICIPAL STREETS AND THOROUGHFARES IN AUSTIN, TEXAS. THIS PROGRAM WAS DEVELOPED BY ARE, INC (512/327-3520) FOR SOLE USE BY THE CITY OF AUSTIN. BECAUSE OF THE NATURE OF THE DEVELOPMENT OF THE MFPS-1 PROGRAM AND CERTAIN BUILT-IN REGIONAL FACTORS, USE BY ANY OTHER CITY OR AGENCY REQUIRES A THOROUGH UNDERSTANDING OF THE PROGRAM OPERATION AND ITS INHERENT ASSUMPTIONS.

CAUTION IS RECOMMENDED IN APPLYING THIS FIRST VERSION OF THE MUNICIPAL FLEXIBLE PAVEMENT DESIGN SYSTEM. THE USER SHOULD ACCEPT ULTIMATE RESPONSIBILITY FOR THE ACCURACY OF THE INPUTS AND THE VALIDITY OF THE RESULTS.

MFPS-1 MUNICIPAL FLEXIBLE PAVEMENT DESIGN SYSTEM, VERSION 1.0, 8/83
 ADAPTED FROM TEXAS SDHPT FPS-11 PROGRAM FOR CITY OF AUSTIN
 BY ARE INC, CONSULTING ENGINEERS, AUSTIN, TEXAS

PROBLEM TITLE (DESCRIPTION)
 17101100.075 - Fitzhugh Road, Local Streets

***** PAVEMENT *****

TOTAL NUMBER OF LANES IN FACILITY 2
 TOTAL NUMBER OF CURBS IN FACILITY 2
 NUMBER OF LAYERS CONSIDERED IN THIS PROBLEM . . . 2
 LANE WIDTH (FEET) 13.50
 CURB HEIGHT (INCHES). 6.00
 CONCRETE CURB CONSTRUCTION COST (\$/LF). 5.50
 THICKENED EDGE FIXED COST (\$/LF). 00
 THICKENED EDGE INCREMENTAL COST (\$/IN/LF) 00

***** LAYER *****

LAYER NO.	LAYER CODE	LAYER DESCRIPTION	MIN. DEPTH (IN.)	MAX. DEPTH (IN.)	THICK. INCR. (IN.)	COST (\$/CY)	COST (\$/SY)	SALV. VALUE (%)	STIFF. COEF.
1	H	HMAC	2.00	4.00	.50	84.00	.00	30.0	.960
2	F	FLEX. BASE	8.00	18.00	1.00	20.00	.00	20.0	.500

***** SUBGRADE *****

SWELLING PROBABILITY. 1.00
 SWELLING RATE CONSTANT. 18
 POTENTIAL VERTICAL RISE (INCHES). 1.00
 SUBGRADE EXCAVATION COST (\$/CY) 7.50
 SUBGRADE COST (\$/SY). 00
 SUBGRADE STIFFNESS COEFFICIENT. 210

***** AC OVERLAY *****

MINIMUM AC OVERLAY THICKNESS (INCHES) 1.50
 MAXIMUM ACCUMULATED OVERLAY THICKNESS (INCHES). . 3.00
 AVERAGE LEVEL-UP THICKNESS (INCHES) 50
 OVERLAY COST (\$/CY) 55.00
 OVERLAY COST (\$/SY) 00
 OVERLAY SALVAGE VALUE (%) 30.00
 AC OVERLAY STIFFNESS COEFFICIENT. 960
 OVERLAY EDGE TAPERING COST (\$/LF) 00
 OVERLAY EDGE MILLING COST (\$/LF). 3.25
 AC OVERLAY PRODUCTION RATE (CY/HR). 40.0

MFPS-1 MUNICIPAL FLEXIBLE PAVEMENT DESIGN SYSTEM, VERSION 1.0, 8/83
 ADAPTED FROM TEXAS SDHPT FPS-11 PROGRAM FOR CITY OF AUSTIN
 BY ARE INC, CONSULTING ENGINEERS, AUSTIN, TEXAS

PROBLEM TITLE (DESCRIPTION)
 17101100.075 - Fitzhugh Road, Local Streets

***** DESIGN CONSTRAINTS *****

CONFIDENCE LEVEL (%)	90.00
LENGTH OF ANALYSIS PERIOD (YEARS)	20.0
MINIMUM TIME TO FIRST OVERLAY (YEARS)	20.0
MINIMUM TIME BETWEEN OVERLAYS (YEARS)	5.0
MAXIMUM THICKNESS OF INITIAL CONSTR. (INCHES)	22.00
MAXIMUM FUNDS AVAILABLE FOR INITIAL CONSTR. (\$)	50.00
DISCOUNT RATE (%)	5.00

***** PERFORMANCE *****

SERVICEABILITY INDEX AFTER INITIAL CONSTRUCTION	4.20
TERMINAL SERVICEABILITY INDEX	1.00
SERVICEABILITY INDEX AFTER OVERLAY CONSTRUCTION	4.00

***** MAINTENANCE *****

FIRST YEAR COST OF ROUTINE MAINTENANCE	.00
ANNUAL INCREMENTAL INCREASE IN MAINTENANCE COST	150.00

***** TRAFFIC *****

AVERAGE DAILY TRAFFIC GROWTH RATE (%)	3.00
DIRECTIONAL DISTRIBUTION FACTOR (%)	50.00
LANE DISTRIBUTION FACTOR (%)	100.00
PERCENT TRUCKS IN AVERAGE DAILY TRAFFIC	2.00
18-KIP EQUIVALENCY FACTOR FOR STD. CITY TRUCK	.40
INITIAL ADT ON FACILITY (VPD)	500.

***** TRAFFIC DELAY *****

INDEX TO DETOUR MODEL	2
NO. OF OPEN LANES THROUGH OVERLAY ZONE	
IN OVERLAY DIRECTION	1
IN NON-OVERLAY DIRECTION	1
AVERAGE APPROACH SPEED TO OVERLAY ZONE (MPH)	15.
AVERAGE SPEED THROUGH OVERLAY ZONE (MPH)	
IN OVERLAY DIRECTION	15.
IN NON-OVERLAY DIRECTION	15.
DISTANCE OVER WHICH TRAFFIC IS SLOWED (MILES)	
IN OVERLAY DIRECTION	.20
IN NON-OVERLAY DIRECTION	.20
DETOUR DISTANCE (MILES)	1.00
NO. OF HOURS PER DAY OVERLAY CONSTRUCTION OCCURS	7.00
ADT ARRIVING EACH HOUR OF CONSTRUCTION (%)	14.00

MFPS-1 MUNICIPAL FLEXIBLE PAVEMENT DESIGN SYSTEM, VERSION 1.0, 8/83
 ADAPTED FROM TEXAS SDHPT FPS-11 PROGRAM FOR CITY OF AUSTIN
 BY ARE INC, CONSULTING ENGINEERS, AUSTIN, TEXAS

PROBLEM TITLE (DESCRIPTION)
 17101100.075 - Fitzhugh Road, Local Streets

SUMMARY OF THE BEST DESIGN STRATEGIES
 IN ORDER OF INCREASING TOTAL COST

	1	2

MATERIAL ARRANGEMENT	H	HF

SUBGRADE EXC. COST	.83	2.08
CURB CONSTR. COST	3.67	3.67
THICKENED EDGE COST	.00	.00

TAPERING COSTS	.00	.00
MILLING COSTS	.00	.00

INIT. CONST. COST	13.83	14.86
OVERLAY CONST. COST	.00	.00
USER COST	.00	.00
ROUTINE MAINT. COST	1.96	1.96
SALVAGE VALUE	-1.06	-.86

TOTAL COST	14.74	15.96

LAYER DEPTH (INCHES)		
D(1)	4.00	2.00
D(2)	.00	8.00

OVERLAY POLICY(INCH)		
(INCLUDING LEVEL-UP)		

PERF. TIME (YEARS)		
T(1)	25.96	40.00

SWELLING CLAY LOSS		
(SERVICEABILITY)		
SC(1)	.33	.34

THE TOTAL NUMBER OF FEASIBLE DESIGNS ENCOUNTERED WAS 56