GEOTECHNICAL INVESTIGATION
PLEASANTVILLE DRAINAGE AND PAVING
(SUB PROJECT 1A)
WBS NO. M-000286-001A-3
HOUSTON, TEXAS

REPORT NO. 1140186903

Reported to:

HALFF ASSOCIATES, INC.

Houston, Texas

Submitted by:

GEOTEST ENGINEERING, INC.

Houston, Texas

January 9, 2015

Key Map Nos. 495 U & Q

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Report No. 1140186903
January 9, 2015

Mr. Mike Voinis, P.E.
Halff Associates, Inc.
14800 St Mary's Lane, Ste 160
Houston, Texas 77079

Reference: Geotechnical Investigation
Pleasantville Drainage and Paving (Sub Project 1A)
WBS No. M-000286-001A-3
Houston, Texas

Dear Mr. Voinis:

Presented herein is our final geotechnical investigation report for the referenced project. A draft report was submitted to you on October 13, 2014. This final report supersedes all previously submitted reports, transmittals, etc. for the referenced project. This study was authorized by Notice to Proceed email dated July 9, 2014 by accepting our proposal No. 1140338299 dated June 24, 2014.

We appreciate this opportunity to be of service to you. If you have any questions regarding the report, or if we can be of further service to you, please call us.

Sincerely,
GEOTEST ENGINEERING, INC.
TBPE Registration No. F-410

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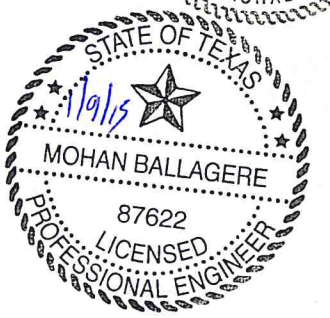

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EXECUTIVE SUMMARY

A geotechnical investigation was performed for the design and construction of the proposed Pleasantville Drainage and Paving (Sub Project 1A). The project includes construction of new water line and storm sewer line along Turning Basin, Industrial and Maxine Street. The proposed water line is about 8 to 16 inches in size and placed at depths ranging 6 to 10 feet. The proposed storm sewer size ranges from 24 inches to 54 inches and 10' x 10' RC box and placed at depths ranging from 8 to 22 feet. The utilities will be installed by open cut method except a portion of 10' x 10' RC box at the existing rail road crossing along Industrial Drive, where it will be installed by trenchless method of construction. Also, the existing pavement will be replaced with new concrete pavement.

The investigation for Pleasantville Drainage and Paving (Sub Project 1A) included drilling and sampling eight (8) borings each to a depth of 25 feet, installing piezometers in two (2) existing borings, performing laboratory tests on soil samples recovered from the borings, performing engineering analyses and developing geotechnical recommendations and preparing a geotechnical report. Borings GB-15 through GB-20 performed for previous study were also utilized for this study.

The principal findings and conclusions developed from this investigation are as follows:

- The subsurface soil beneath pavement and existing ground surface as encountered in borings GB-21 through GB-28 from this study and borings GB-15 through GB-20 from previous study consists of predominantly cohesive soils to the explored depths of 25 to 35 feet except in borings GB-17 and GB-24. In borings GB-17 and GB-24 the subsurface soil beneath pavement and existing ground surface consists of cohesive with intermittent cohesionless soil or cohesive underlain by cohesionless soils to the explored boring depths of 25 to 35 feet. The cohesive soils consist of soft to hard gray, brown, yellowish brown and reddish brown sandy lean clay, lean clay with sand, lean clay, fat clay with sand and fat clay. The cohesionless soil consists of loose to medium dense brown and gray fine sand w/silt and silty sand. Fill material consisting of medium stiff to very stiff brown and gray and reddish brown and gray lean clay with sand, fat clay with sand and fat clay was

encountered in borings GB-18, GB-20, GB-22, GB-24 and GB-25 through GB-28 to depths of 2 feet to 12 feet.

- Based on the Phase I Geological fault study performed for the project, Fidelity Fault crosses Turning Basin Drive near Station No. 46+90 and a fault hazard zone was identified from Stations 45+90 to 47+90 along Turning Basin Drive. The detailed fault study was submitted under a separate cover.

- Groundwater was encountered in borings GB-21, GB-22, GB-23, GB-24, GB-26 through GB-28 to depths ranging from 16 to 25 feet during drilling. The groundwater level, measured 15 minutes after water was first encountered, ranged from 4 to 20.6 feet in these borings. In piezometer borings GB-22P and GB-25P, the water level measured after 30days ranged from 5.3 to 8.2 feet on August 22, 2014.

- The existing paving as obtained in the soil borings GB-21, GB-23 through GB-27 consists of 7.5 to 8 inches of concrete except in boring GB-22 and GB-28. In boring GB-22, the existing pavement consists of 8 inches of concrete underlain by 2 inches of stabilized sand and in boring GB-28 the existing pavement consists of 16.5 inches of concrete.

- All excavation operations should be carried out in accordance with OSHA standards and the City of Houston Standard Specifications.

- The bedding and backfill for storm sewer should be in accordance with City of Houston Standard Specification Section 02317 and Drawing No. 02317-03.

- The excavation and backfill for the RCB should be in accordance with City of Houston Standard Specification Section 02316, Excavation and Backfill for Structures.

- The recommended pavement sections for Pleasantville Area are given below:

Street/ Location	**Pavement Course**	**Thickness, inches**
Turning Basin	Reinforced Concrete	9
	6% Lime-stabilized subgrade	8
Maxine Street	Reinforced Concrete	8
	6% Lime-stabilized subgrade	8

- The details of pavement section are provided in Section 5.4 of this report.

1.0 INTRODUCTION

1.1 General

The City of Houston selected Halff Associates, Inc. to perform engineering services for design and construction of Pleasantville Drainage and Paving (Sub Project 1A) in Houston, Texas. Halff Associates, Inc. retained Geotest Engineering, Inc. as part of the design team to perform geotechnical investigation for the above project.

1.2 Authorization

This study was authorized by Notice to Proceed email dated July 09, 2014 by accepting our Proposal No. 1140338299 dated June 24, 2014.

1.3 Location and Description of Project

The project is located in Pleasantville Area in east Houston, Texas. The project is bounded by Pearl Street to the west, Guinevere Street to the north, IH-610 to the east and Tite Street to the south, within the Key Map Page and Grid 495 Q & U.

The project includes construction of new water line and storm sewer line along Turning Basin, Industrial and Maxine Street. The proposed water line is about 8 to 16 inches in size and placed at depths ranging 6 to 10 feet. The proposed storm sewer size ranges from 24 inches to 54 inches and 10' x 10' RC box and placed at depths ranging from 8 to 22 feet. The utilities will be installed by open cut method except a portion of 10' x 10' RC box at the existing rail road crossing along Industrial Drive, where it will be installed by trenchless method of construction. Also, the existing pavement will be replaced with new concrete pavement. The vicinity map of the project area is shown on Figure 1.

1.4 Purpose and Scope

The purposes of this study were to evaluate soil and groundwater conditions and to provide geotechnical recommendations for the design and construction of the proposed drainage improvements in Pleasantville Area, Sub Project 1A. The scope of this investigation for Pleasantville project area consisted of the following:

- Utilized six (6) borings from previous study.
- Performed concrete coring at eight (8) boring locations for borings access.
- Drilled and sampled eight (8) borings each to a depth of 25 feet.
- Converted two (2) borings into piezometers to monitor long term ground water level.
- Performed appropriate laboratory tests in accordance with ASTM methods on selected samples to develop engineering properties of the soil.
- Performed engineering analyses in accordance with the City of Houston Design Manual (July 2012) to develop geotechnical recommendations for the design and construction of the proposed drainage and paving improvements in Pleasantville Drainage and Paving (Sub Project 1A).
- Prepared a geotechnical report that will include all field data, laboratory test data and geotechnical recommendations.
- Prepared a separate soil type report for trench (open cut) excavation.

2.0 FIELD INVESTIGATION

2.1 General

After obtaining the utilities clearance of proposed eight (8) marked borings in the field, existing concrete pavement was cored at all boring locations for boring access and the borings were drilled to the explored depths utilizing a truck mounted drilling rig. Traffic control devices and personnel were utilized during coring and drilling to maintain safety of drill crew and people driving in the streets. All the drilling and sampling were performed in accordance with appropriate ASTM procedures.

2.2 Geotechnical Borings

Subsurface conditions for Pleasantville project area were explored by drilling and sampling eight (8) soil borings (designated as GB-21 through GB-28) each to a depth of 25 feet. The borings GB-1 through GB-20 were drilled for the previous study. The approximate boring locations are shown on Figures 2.1 through 2.5, Plan of Borings. Survey information (Northing and Easting coordinates and ground surface elevation) of completed borings were provided to us by Halff Associates, Inc. The survey information of completed borings is summarized in Table 1.

In general, samples were obtained continuously to the depth of 20 feet, and intermittent sampling at 5 foot interval to the termination depths of the borings. Cohesive soils were obtained with a 3-inch thin-walled tube sampler in general accordance with ASTM Method D 1587. Granular samples were obtained with a 2-inch split spoon barrel in accordance with ASTM Method D 1586. Each sample was removed from the sampler in the field, carefully examined and then logged by an experienced soils technician. Suitable portions of each sample were sealed and packaged for transportation to Geotest's Laboratory. The shear strength of cohesive soil samples was estimated using a pocket penetrometer in the field. Driving resistances for the split-barrel sampler in granular soils, recorded in the field as "blows per foot," are indicated on the boring logs. All the borings, except the ones converted to piezometers, were grouted with cement-bentonite grout after completion of drilling and obtaining water level measurements.

Detailed descriptions of the soils encountered in the borings are given on the boring logs presented on Figures A-1 through A-8 in Appendix A. A key to symbols and terms used on boring logs is given on Figure A-9 in Appendix A. The borings from previous study are presented in Appendix C.

2.3 Piezometer Installation

During the field investigation, piezometers were installed in the open borehole of borings GB-22 and GB-25. The location of the piezometers, designated as GB-22P and GB-25P, are shown on Figures 2.3 and 2.5. The piezometer installation report showing the details of the construction of the piezometers are provided on Figures A-10 and A-11 in Appendix A.

The piezometers were abandoned after taking the final water level reading. The piezometer installation and abandonment reports were submitted to Texas Department of Licensing and Regulations (TDLR). The TDLR piezometer installation and abandonment reports are presented in Appendix D.

3.0 LABORATORY TESTING

The laboratory testing program was designed to evaluate the pertinent physical properties and shear strength characteristics of the subsurface soils. Classification tests were performed on selected samples to aid in soil classification. All the tests were performed in accordance with ASTM Standards.

Undrained shear strengths of selected cohesive samples were measured by unconsolidated undrained (UU) triaxial compression tests (ASTM D2850). Results of the unconsolidated undrained triaxial tests are plotted as solid squares. The shear strength of cohesive samples was measured in the field with a calibrated pocket penetrometer and also in the laboratory with a hand held Torvane. The shear strength values obtained from the penetrometer and Torvane are plotted on the boring log as open circles and triangles, respectively.

Measurements of moisture content and dry unit weight were taken for each unconsolidated undrained (UU) triaxial test sample. Moisture content measurements (ASTM D2216) were also made on other samples to define the moisture profile at the boring locations. Atterberg limits tests (ASTM D4318) and percent passing No. 200 sieve tests (ASTM D1140) were performed on selected cohesive soil samples. Sieve analysis tests (ASTM D422) were also performed on selected cohesionless soil samples to evaluate grain size distribution. The results of most of the laboratory tests are plotted or summarized on the boring logs. The result of all tests are tabulated or summarized on the boring logs presented on Figures A-1 through A-8 in Appendix A.

The summary of laboratory test results is also presented in a tabular form on Figures B-1 through B-8 in Appendix B. Grain size distribution curves are presented on Figure B-9 in Appendix B.

4.0 SUBSURFACE CONDITIONS

4.1 Geology

The project area lies in the Beaumont Formation. The clays and sands of the Beaumont Formation are over-consolidated as a result of desiccation from frequent rising and lowering of the sea level and the groundwater table. Consequently, clays of this formation have moderate to high shear strength and relatively low compressibility. The sands of the Beaumont Formation are typically very fine and often silty. Further, there is occasional evidence in the Houston area of the occurrence of cemented material (sandstone and siltstone) deposits within the Beaumont Formation.

4.2 General Fault Information

A review of information in the Geotest library, relating to known surface and subsurface geologic faults in the general area of the project alignments, was undertaken. The available information consisted of U.S. Geological and NASA maps, open file reports and information contained in our files relating to geologic faults in the project area.

Based on the Phase I Geological fault study performed for the project, Fidelity Fault crosses Turning Basin Drive near Station No. 46+90 and a fault hazard zone was identified from Stations 45+90 to 47+90 along Turning Basin Drive. The detailed fault study was submitted under a separate cover.

4.3 Existing Paving

The existing paving as obtained in the soil borings GB-21, GB-23 through GB-27 consists of 7.5 to 8 inches of concrete except in boring GB-22 and GB-28. In boring GB-22, the existing pavement consists of 8 inches of concrete underlain by 2 inches of stabilized sand and in boring GB-28 the existing pavement consists of 16.5 inches of concrete.

The details of the existing pavement thickness at each of the boring locations for Pleasantville Project, Sub Project 1A area are summarized below:

Boring Nos.	**Concrete Thickness (in.)**	**Base Thickness (in.)**	**Total (in.)**
GB-21	8.0	--	8.0
GB-22 (GB-22P)	8.0	2.0	10.0
GB-23	8.0	--	8.0
GB-24	8.0	--	8.0
GB-25 (GB-25P)	8.0	--	8.0
GB-26	7.5	--	7.5
GB-27	8.0	--	8.0
GB-28	16.5	--	16.5

Note: 1. The base includes stabilized sand.

4.4 Soils Stratigraphy

Based on the subsurface soils encountered in the boreholes, three (3) boring log profiles were developed and are presented on Figures 3.1 through 3.4. To the left of each boring shown on the profile is an indication of the consistency of each stratum. More than one consistency for an individual stratum indicates that the consistency is different at different depths within the stratum. For cohesive soils, consistency is related to the undrained shear strength of the soil. For cohesionless soils, the relative density of soil is measured by standard penetration test blows of the soil. To the right of each boring shown on the profile is the overall classification of the soil contained within each stratum. The symbols and abbreviations used on the boring log profile are given on Figure 4. The soil classification is based on ASTM Standards.

The subsurface soils beneath pavement as encountered in borings GB-21 through GB-28 from this study and borings GB-15 through GB-20 from previous study as shown in boring log profiles 3.1 through 3.4 along various streets in the Pleasantville project, Sub Project 1A area are summarized below:

Maxine Street:

Boring No.	Location/Street	Depth (ft)	Soil Description
GB-15 through GB-17 and GB-21 (Boring Log Profile Figure 3.1)	Maxine Street	0-35	Soft to hard gray, brown, yellowish brown and reddish brown Fat Clay, Fat Clay with sand, Lean Clay, Lean Clay w/sand and Silty Clay. Loose to very dense brown and gray Silty Sand and Fine Sand with silt was encountered between the depths of 12 feet and 33 feet in boring GB-17.

The Fat Clay and Fat Clay with sand are of high to very high plasticity with liquid limits ranging from 51 to 82 and plasticity indices ranging from 30 to 53. The Lean Clay, Lean Clay with sand, Silty Clay and Sandy Lean Clay are of low to medium plasticity with liquid limits ranging from 23 to 31 and plasticity indices ranging from 7 to 15. The fines content (percent passing No. 200 sieve) of Fat Clay and Fat Clay with sand ranges from 79 to 95 percent. The fines content of Lean Clay, Lean Clay w/sand and Silty Clay ranges from 73 to 96 percent. The fines content of silty sand is about 20 percent and of the percent fines of fine sand with silt is about 5 percent.

Loop 610 Connector and Turning Basin:

Boring No.	**Location/Street**	**Depth (ft)**	**Soil Description**
GB-20, GB-22 through GB-28 (Boring Log Profiles, Figures 3.2 and 3.3)	Loop 610 Connector and Turning Basin	0-35	Soft to hard gray, brown, yellowish brown and reddish brown Fat Clay, Fat clay with sand, Lean Clay, Lean Clay with sand and Sandy Lean Clay. Fill material consisting of stiff to very stiff brown and gray fat clay, fat clay with sand, lean clay with sand was encountered to depths ranging from 2 to 12 feet in borings GB-22 and GB-24 through GB-28. Dense to very dense brown and gray Silty Sand and Fine Sand with silt was encountered between the depths of 6 to 7 feet and 16 to 25 feet in boring GB-24.

The Fat Clay and Fat Clay with sand is of high to very high plasticity with liquid limits ranging from 51 to 92 and plasticity indices ranging from 29 to 60. The Lean Clay and Lean Clay w/sand is of medium to high plasticity with liquid limits ranging from 31 to 46 and plasticity indices ranging from 15 to 26. The fines content of Fat Clay and Fat Clay with sand ranges from 81 to 99 percent. The fines

content of Lean Clay and Lean Clay w/sand ranges from 71 to 99 percent. The fines content of Sandy Lean Clay ranges from 55 to 65 percent. The fines content of Silty Sand is about 19 percent and the fines content of fine sand with silt is about 11 percent.

Industrial Drive:

Boring No.	**Location/Street**	**Depth (ft)**	**Soil Description**
GB-18 and GB-19 (Boring Log Profile, Figure 3.4)	Industrial	0-35	Medium stiff to hard gray, yellowish brown and reddish brown Fat Clay, Lean Clay with sand and Sandy Lean Clay. Fill material consisting of medium stiff to stiff yellowish brown fat clay was encountered to a depth of 8 feet in boring GB-18.

The Fat Clay is of high plasticity with liquid limits ranging from 51 to 63 and plasticity indices ranging from 30 to 39. The Lean Clay w/sand and Sandy Lean Clay is of high plasticity with liquid limits ranging from 39 to 40 and plasticity indices ranging from 21 to 22. The percent fines of Fat Clay ranges from 85 to 95 percent. The percent fines of Lean Clay w/sand is about 81 percent and the percent fines of Sandy Lean Clay is about 67 percent.

4.5 Unsatisfactory Soil Conditions

In boring GB-17, loose silty sand was encountered between the depths of 12 and 16 feet (near the pipe invert depth), hence care should be taken during the utility installation near this location.

4.6 Water Levels

Groundwater was encountered in borings GB-21, GB-22, GB-23, GB-24, GB-26 through GB-28 to depths ranging from 16 to 25 feet during drilling. The groundwater level, measured 15 minutes after water was first encountered, ranged from 4 to 20.6 feet in these borings. In piezometer borings GB-22P and GB-25P, the water level measured after 30 days ranged from 5.3 to 8.2 feet on August 22, 2014.

Boring No.	Groundwater Depth During Drilling (ft)	Groundwater Depth 15 minutes after Drilling (ft)	Groundwater Depth 30 Days After Drilling (ft)
GB-21	16.0	4.0	N/A
GB-22 (GB-22P)	21.0	8.1	5.3 (8-22-14)
GB-23	16.0	4.2	N/A
GB-24	16.0	6.0	N/A
GB-25 (GB-25P)	Dry	N/A	8.2 (08-22-14)
GB-26	25.0	20.6	N/A
GB-27	25.0	19.3	N/A
GB-28	18.0	11.7	N/A
GB-15	9.0	N/A	N/A
GB-16	9.3	N/A	N/A
GB-17 (GB-17P)	4.8	4.6	3.4 (08-02-12)
GB-18	31.3	N/A	N/A
GB-19	Dry	N/A	N/A
GB-20	8.0	N/A	N/A

However, it should be noted that various environmental and man-made factors such as amount of precipitation, nearby subsurface construction activities, and change in area drainage can substantially influence the groundwater level.

4.7 Environmental Concerns

No environmental concerns were observed or noticed in any of the borings (GB-21 through GB-28) drilled for this study. However, Geotest performed the Phase I and Phase II (Previous Study) Environmental Site Assessments for the related environmental concerns and were presented under separate cover.

5.0 ENGINEERING ANALYSES AND RECOMMENDATIONS

5.1 General

The project includes construction of new water line and storm sewer line along Turning Basin, Industrial and Maxine Street. The proposed water line is about 8 to 16 inches in size and placed at depths ranging 6 to 10 feet. The proposed storm sewer size ranges from 24 inches to 54 inches and 10' x 10' RC box and placed at depths ranging from 8 to 22 feet. The utilities will be installed by open cut method except a portion of 10' x 10' RC box at the existing rail road crossing along Industrial Drive, where it will be installed by trenchless method of construction. Also, the existing pavement will be replaced with new concrete pavement.

5.2 Trench Excavation

Based on the information provided by Halff Associates, Inc., it is understood that the utilities will be installed by open cut method of construction except near the existing rail road crossing along Industrial Drive, where the proposed utilities will be installed by trenchless method of construction. The following subsections provide information for the design and construction of the storm sewers and water line open cut method of excavations.

5.2.1 Geotechnical Parameters. Based on the soil conditions revealed by the borings GB-21 through GB-28 from this study and GB-15 through GB-20 from previous study, geotechnical parameters were developed for the design of open cut construction for storm sewers and water line installation. The design parameters are provided in Table 2. For design, the groundwater level should be assumed to exist at the ground surface, since the conditions may exist after or heavy rain or flooding.

5.2.2 Excavation Stability. The open excavation may be shored or laid back to a stable slope or supported by some other equivalent means used to provide safety for workers and adjacent structures, if any. The excavating operations should be in accordance with OSHA Standards, OSHA 2207, Subpart P, latest revision and the City of Houston Standard Specification.

- Excavation Shallower Than 5 Feet - Excavations that are less than 5 feet deep **(critical height)** should be effectively protected when an indication of dangerous ground movement is anticipated.

- Excavations Deeper Than 5 Feet - Excavations that are deeper than 5 feet should be sloped, shored, sheeted, braced or laid back to a stable slope or supported by some other equivalent means or protection such that workers are not exposed to moving ground or cave-ins. The slopes and shoring should be in accordance with the trench safety requirements as per OSHA Standards. The following items provide design criteria for excavation stability.

  (i) OSHA Soil Type. Based on the soil conditions revealed by borings drilled for this study and assumed groundwater level at surface, OSHA soil type "C" should be used for determination of allowable maximum slope and/or the design of shoring along the alignment for full proposed depth of open excavation. For shoring deeper than 20 feet (if needed), an engineering evaluation is required and deeper soil borings will be needed.

  (ii) Excavation Support Earth Pressure. Based on the subsurface conditions indicated by our field investigation and laboratory testing results, excavation support earth pressure diagrams were developed and are presented on Figures 5.1 and 5.2. These pressure diagrams can be used for the design of temporary trench bracing. For a trench box, a lateral earth pressure resulting from an equivalent fluid with a unit weight of 94 pcf can be used. The effects of any surcharge loads at the ground surface should be added to the computed lateral earth pressures. A surcharge load, q, will typically result in a lateral load equal to 0.5 q. The above value of equivalent fluid pressure is based on assumption that the groundwater level is near the ground surface, since these conditions may exist after a heavy rain or flooding.

  (iii) Bottom Stability. In braced cuts, if tight sheeting is terminated at the base of the cut, the bottom of the excavation can become unstable. The parameters that govern the

stability of the excavation base are the soil shear strength and the differential hydrostatic head between the groundwater level within the retained soils and the groundwater level at the interior of the trench excavation. For cut in cohesive soils as predominantly encountered for the proposed excavation depths in most of the borings, the bottom stability can be evaluated as outlined on Figure 7. However, at locations near boring GB-24 where cohesionless soils (such as fine sand w/silt) were encountered between depths of 6 and 7 feet (at the invert or within 3 feet of bottom of excavation), dewatering will be necessary to avoid bottom stability problems. It should be noted that due to the presence of very thin layer of sand (about 1 feet) in boring GB-24, the excavation can be done after installing a sheetpile cut off wall (if dewatering cannot be effectively lower the ground water) to avoid bottom stability problems.

5.2.3 Groundwater Control. Excavations for the storm sewers may encounter groundwater seepage to varying degrees depending upon the groundwater conditions at the time of construction and the location and depth of the trench. Based on the soil conditions identified in the borings for the proposed storm sewers and water line installation, all the excavations will be in cohesive soils except at boring GB-24 where storm sewer will be in cohesionless soils.

In general for cohesive soils as predominantly encountered for most of the borings for the excavation depths, the groundwater if encountered may be managed by collection in excavation bottom sumps for pumped disposal. However, in boring GB-24 where cohesionless soils (such as fine sand w/silt) were encountered at the invert (about 6 feet) of the excavation; dewatering will be required. Dewatering such as eductor well system may be required to lower the groundwater level to at least 5 feet below the bottom of the excavation. If the dewatering cannot be achieved, the ground water may be controlled by installing continuous interlock (water tight) sheet piling with trench bottom sumps for pumped disposal. It is recommended that the actual groundwater conditions should be verified by the contractor at the time of construction and that groundwater control should be performed in general accordance with the City of Houston Standard Specifications, Section 01578. The cohesionless soils encountered in borings are given below.

Street	Boring	Depth of Cohesionless Soils Encountered (ft)		Type of Soil
		From	To	
Maxine	GB-17 (GB-17P)	12	33	Silty Sand and Fine Sand w/silt
Turning Basin	GB-24	6	7	Fine Sand w/silt
		16	25	Silty Sand

5.2.4 Access Shaft for Tunneling. The access shaft should be constructed as per the City of Houston Standard Specifications, Section 02400, "Tunnel Shafts." The access shafts may be constructed by retained excavations or can be installed by sunken caisson. These methods are described below:

- Retained Excavation. Retained excavations generally require less ground surface area than open-cut excavation with laid back slopes. The retention system can consist of driven sheetpile, liner plates, solider pile/lagging, driven planking, or ring beams and timber lagging. The items pertaining to design criteria for retained excavation stability should be in accordance with guidelines as outlined in section 5.2.2.

- Sunken Caisson Installation. The caisson procedure eliminates the need for a temporary retention system. Caisson units can, however, experience problems with alignment and termination at the proper design depth. Stability considerations of the excavation bottom are similar to those for retained excavation techniques.

5.2.5 Access Shaft Backfill. The excavated shaft should be backfilled per the City of Houston Standard Specification, Section 02400, “Tunnel Shafts,” Subsection 3.04.

5.2.6 Bedding and Backfill for Storm Sewers. Bedding and backfill for utilities should be in accordance with City of Houston Standard Specification Section 02312 and Drawing No. 02317-03.

5.3 Trenchless Installation

It is understood that the proposed water line and the 10' x 10' RC Box along Industrial Drive near railroad crossing will be installed by trenchless method of construction. The water line will be installed by auger method of construction and RC Box will be installed by tunneling method.

5.3.1 Geotechnical Parameters. Based on the soil conditions revealed by soil boring and laboratory test data, geotechnical design parameters were developed for cohesive soils and are provided in Table 3. The cohesive soils include fat clays and lean clays. For design conditions, the groundwater levels should be assumed to exist at the ground surface, since these conditions may exist after heavy rain or flooding.

5.3.2 Earth Pressure on Auger Casing and Tunnel Liner. The earth pressures on the auger casing should be determined from Figure 7. Equations to calculate the tunnel liner loads are also shown in Figure 7. For crossing under the major roads, the stress due to traffic loads should be considered.

5.3.3 Live Loads on Pipeline Due to Traffic. Loads on the pipe due to traffic should be considered. A graph providing calculated vertical stress on pipe due to traffic loads and railroad traffic is given on Figures 8 and 9, respectively.

5.3.4 Carrier Pipe Design Parameters. Carrier pipe must be sufficiently strong to withstand anticipated long-term ground loads and must not be subject to deterioration by substance either in the ground or in the auger casing. The carrier pipe design should include consideration of not only the loads applied to the pipe but also factors other than soil loading. These factors could include minimum structural code requirements, loading from pipe jacking operations and other construction loads. The drained geotechnical design parameters given in Table 3 should be used in analyzing the soil structure interaction of the carrier pipe.

5.3.5 Influence of Trenchless Operation on Adjacent Structures. Surface and near-surface structures near the pipe and casing augering primarily consist of residential buildings, city streets and public utilities.

Ground movement, in terms of loss of ground or ground lost, is commonly associated with soft ground augering. If such ground movement is excessive, it may cause damage to the structures, roads and services located above the auger casing. While ground movement cannot be eliminated, it can be controlled within certain limits by the use of proper construction techniques and good quality workmanship. These include, but are not limited to, prevention of excessive ground loss during trenchless operation with the use of grouting and filling the annular space between the pipe or casing and the surrounding soil and prevention of undue loss of fines through dewatering.

The selection and execution of trenchless methods that are best suited to anticipated ground conditions along the proposed auger casing are, in fact, the contractor's primary contribution to successful completion of the proposed auger casing. Review of the boring logs (GB-18 and GB-19) revealed that the ground conditions for augering and tunneling (excavation face) will be primarily through fill material consisting of fat clay with sand and cohesive soils consisting of stiff to very stiff lean clay and fat clay. The cohesive soils within this fill matrix as well as natural soils are stiff to very stiff in consistency and the ground in this area may be expected to behave as squeezing to raveling ground near the invert.

The proposed auger casing is parallel with or crosses beneath a number of water, gas, power, telephone and storm and sanitary sewer lines. The largest potential problems from utilities may result from:

- Leaking water pipes
- Gas pipe breakage leading to a potential explosion
- Breakage of storm or sanitary sewers

In general, it is the contractor's responsibility to investigate these and other possible third party interactions along the proposed water line alignment and to accommodate all of these interactions with the use of good construction methods.

5.3.6 Groundwater Control. The ground water control should be performed in accordance with Section 5.2.3 of this report.

5.4 Structures

5.4.1 Description. The structure associated with this project will be new manholes and 24 inch RC Boxes. The new manholes for storm sewers will be placed at depths ranging from 10 to 15 feet and the RC boxes will be placed at a depth of about 10 feet.

5.4.2 Foundation Conditions. Based on the soil conditions revealed by the borings GB-21 through GB-28, GB-15 through GB-20, the manholes and RCB bottom will be in medium stiff to very stiff lean clay, fat clay, sandy lean clay except at boring GB-24 where the manholes and RCB will be in fine sand w/silt or interface of fine sand with silt and stiff to very stiff lean clay.

5.4.3 Foundation Design Recommendations. The following items provide recommendations and design criteria for construction of the new manholes and RC Boxes.

- Allowable Bearing Pressures. An allowable (net) bearing pressure 2,500 psf may be used for the design of storm sewer manholes and RC Boxes placed at a depth of 10 to 24 feet (into medium stiff to very stiff lean clay, fat clay, sandy lean clay and fine sand with silt). The allowable bearing pressures include a safety factor of 2.0. The above recommendations assume that the final bearing surfaces consist of undisturbed natural soils and that underlying semi-transmissive zones are properly pressure-relieved and stable undisturbed bearing surfaces are attained.

- Bottom Stability. The bottom stability is described in Section 5.2.2 of this report.

- Lateral Earth Pressure. The pressure diagram presented on Figures 5.1 and 5.2 can be used for the design of braced excavation. The lateral earth pressure diagrams presented on Figures 10.1 and 10.2 are applicable for the design of the permanent walls.

- Hydrostatic Uplift Resistance. Structures extending below the groundwater level should be designed to resist uplift pressure resulting from excess piezometric head. Design uplift pressures should be computed based on the assumption that the water table is at ground surface. To resist the hydrostatic uplift at the bottom of the structure, one of the following sources of resistance can be utilized in each of the designs.

    a. Dead weight of structure,
    b. Weight of soil above base extensions plus weight of structure, or
    c. Soil-wall friction plus dead weight of structure.

    The uplift force and resistance to uplift should be computed as detailed on Figure 11. In determining the configuration and dimensions of the structure using one of the approaches presented on Figure 11, the following factors of safety are recommended.

    a. Dead weight of concrete structure, $S_{f1} = 1.10$,
    b. Weight of soil (backfill) above base extension, $S_{f2} = 1.5$, and
    c. Soil-wall friction, $S_{f3} = 3.0$.

    Friction resistance should be discounted for the upper 5 feet, since this zone is affected by seasonal moisture changes.

5.4.4 Protection of Below Grade Structures. The design of the proper means for protection of below grade structures will depend upon the potential of the aggressivity or corrosivity of soil and groundwater properties. The aggressivity testing was not within the scope of this study. The design of the protection of below grade structures is beyond the scope of services for this study.

5.4.5 Groundwater Control During Construction. Groundwater control should be followed in accordance with Section 5.2.3 of this report.

The contractor should verify the groundwater level at the time of construction and should provide an adequate dewatering system, where required.

5.4.6 Structure Backfill. Excavations for the proposed structures should be backfilled in accordance with the City of Houston Standard Specifications, Section 02316, "Excavation and Backfill for Structures."

5.5 Pavement Structure Design

It is understood that the existing roadway consists of rigid paving. The new pavement will consists of concrete pavement section. The streets include Loop 610 Connector, Turning Basin and Maxine Streets. The pavement design presented below was developed in accordance with "AASHTO Guide for Design of Pavement Structures," 1993 Edition.

5.5.1 Design Parameters

Subgrade Soil Properties. Based on the laboratory test data obtained from the natural subgrade soils, the effective roadbed soil resilient modulus (M_R) is estimated to be about 1,941 psi. Based on an estimated resilient modulus of the 8-inch lime-stabilized subgrade, the effective modulus of subgrade reaction (k) is estimated to be about 49 pci.

Traffic Data. No traffic study was performed for this project, hence, no traffic data was available for the project. Based on Houston Regional Traffic Counts Map and City of Houston GIMS traffic counts data, the traffic data is assumed for Pleasantville Area. The details were given below.

A traffic data of 5.4×10^6 – 18 kips ESAL (W_{18}) over a 20 year design period was utilized for the pavement design of Loop 610 Connector and Turning Basin. This traffic volume is based on assumed traffic distribution of average daily traffic (ADT) volume of 1,500 vehicles, with a distribution of 80% passenger cars, 20% heavy trucks.

A Traffic Data of 1.7×10^6 – 18 kips ESAL over a 20-year design period was utilized for the pavement design of Maxine Street. This traffic volume is based on

assumed traffic distribution of ADT volume of 1,800 vehicles with a distribution of 95% passenger cars, 3% light trucks and 2% heavy trucks.

Other Design Parameters. Other design parameters used in the development of rigid pavement thickness are given below:

Material Properties of Concrete:

Modulus of Elasticity of Concrete (E_c): 3,372,165 psi

Mean value of Modulus of Rupture of Concrete after 28 days (S'_c): 600 psi (based on compressive strength of 3,500 psi)

Load Transfer coefficient (J): 3.2

Drainage coefficient (C_d): 1.2

Overall Standard Deviation (S_o): 0.35

Reliability Level (R): 95%

Serviceability Index

Initial (P_o): 4.5

Terminal (P_t): 2.25

Reinforcement Variables

Allowable Working Stress (f_s): 45,000 psi (grade 60 steel)

Friction Factor (F): 1.8

5.5.2 Recommended Pavement Section

Based on the design parameters described above and the AASHTO design procedures, the thickness of rigid pavement was determined. The recommended pavement section is given below:

Street	**Pavement Course**	**Thickness, inches**
Loop 610 Connector and Turning Basin	Reinforced Concrete	9
	6% Lime-stabilized subgrade	8
Maxine Street	Reinforced Concrete	8
	6% Lime-stabilized subgrade	8

Based on the reinforcement variables and recommended pavement section, the required longitudinal and transverse reinforcing steel (No. 4, Grade 60 Steel) can be determined for 8-inch and 9-inch concrete pavement as per Table 1 of City of Houston Drawing No. 02751-01 (Revised July 1, 2009).

5.5.3 Preparation of Pavement Subgrade

Based on the field and laboratory test data, the subgrade soils at the finished grade of the project site consists of fat clay of high to very high plasticity. These soils have a high volume change potential. Hence, lime stabilization of the clay subgrade will be required to reduce the swell potential of clay subgrade due to volume changes and to accelerate the construction and provide a stable subgrade on which to construct the pavement section. The subgrade soils should be stabilized with approximately 6 percent lime to a depth of at least 6 to 8 inches. This corresponds to approximately 37 pounds of hydrated lime per square yard for 8-inch based upon a soil dry unit weight of 103 pcf. It should be noted that quantity of lime was calculated based on the dry unit weight determined from specific boring locations only.

Subgrade preparation for the proposed pavement after removing the existing pavement should consist of stripping, proof-rolling, and stabilization. The following procedures for subgrade preparation are recommended:

1. Strip the surficial soils to a suitable depth to remove all surficial vegetation and achieve grade. In isolated areas where soft, compressible, or very loose soils are encountered, additional stripping may be required. Stripping should extend to a minimum of 2 feet in the adjacent open (unpaved) area, where it exists beyond the edge of the proposed pavement.

2. After stripping, the exposed surface should be proof-rolled with a minimum of 3 passes of a 30-ton pneumatic-tired roller or a partially loaded truck utilizing a tire pressure of approximately 90 psi. If rutting develops, the tire pressure should be reduced. The purpose of the proof-rolling operation is to identify any underlying zones or pockets of soft soils so these weak materials can be removed and replaced.

3. Lime stabilization of cohesive subgrade (fat clay) should be performed in accordance with City of Houston Standard Specification No. 02336, "Lime-Stabilized Subgrade."

6.0 CONSTRUCTION CONSIDERATIONS

Excavations for the storm sewers may encounter groundwater seepage to varying degrees depending upon the groundwater conditions at the time of construction and the location and depth of the trench. Based on the soil conditions identified in the borings for the proposed storm sewers and water line installation, all the excavations will be in cohesive soils except at boring GB-24 where storm sewer will be in cohesionless soils.

In general for cohesive soils as predominantly encountered for most of the borings for the excavation depths, the groundwater if encountered may be managed by collection in excavation bottom sumps for pumped disposal. However, in boring GB-24 where cohesionless soils (such as fine sand w/silt) were encountered at the invert (about 6 feet) of the excavation; dewatering will be required. Dewatering such as eductor well system may be required to lower the groundwater level to at least 5 feet below the bottom of the excavation. If the dewatering cannot be achieved, the ground water may be controlled by installing continuous interlock (water tight) sheet piling with trench bottom sumps for pumped disposal. It is recommended that the actual groundwater conditions should be verified by the contractor at the time of construction and that groundwater control should be performed in general accordance with the City of Houston Standard Specifications, Section 01578. The cohesionless soils encountered in borings are given below.

7.0 LIMITATIONS

The description of subsurface conditions and the design information contained in this report are based on the soil borings made at the time of drilling at specific locations. However, some variation in soil conditions may occur between soil borings. Should any subsurface conditions other than those described in our boring logs be encountered, Geotest should be immediately notified so that further investigation and supplemental recommendations can be provided. The depth of the groundwater level may vary with changes in environmental conditions such as frequency and magnitude of rainfall. The stratification lines on the log of borings represent the approximate boundaries between soil types, however, the transition between soil types may be more gradual than depicted.

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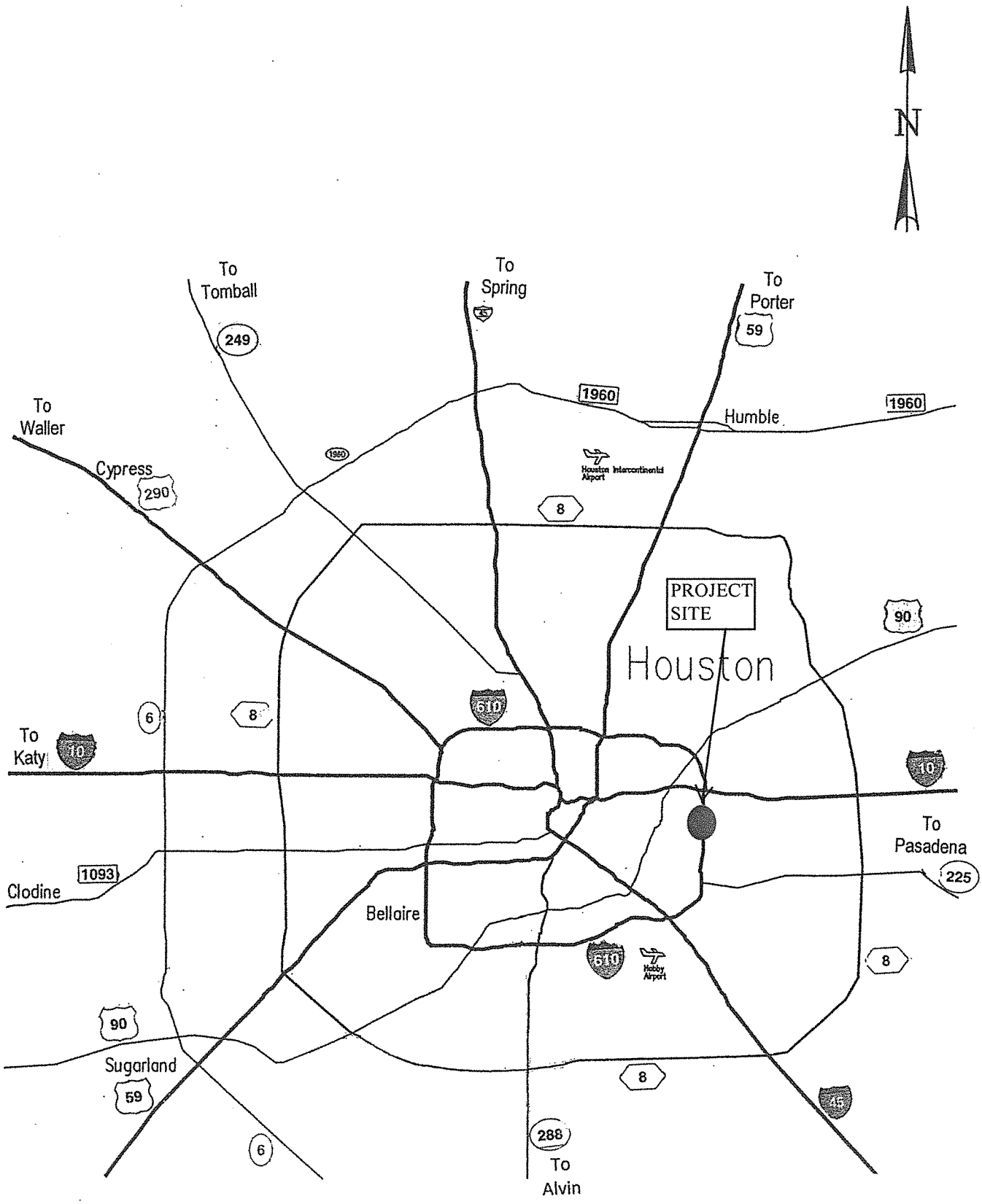
ILLUSTRATIONS

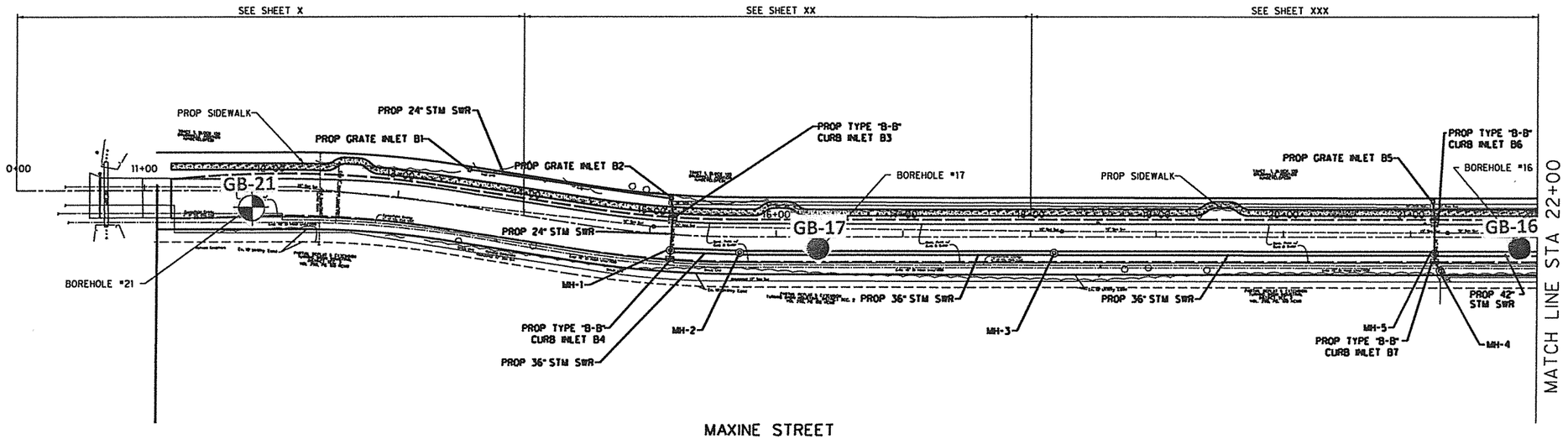
Job No. 1140186903



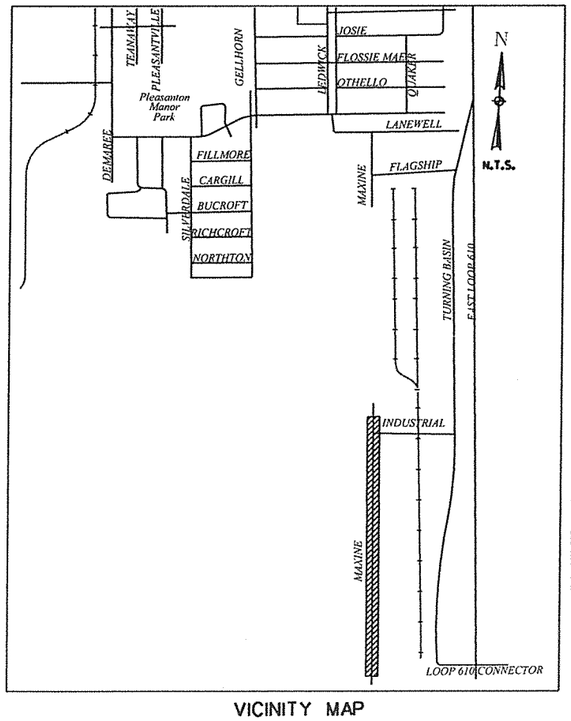
VICINITY MAP

(NOT TO SCALE)

Job No. 1140186903



MAXINE STREET



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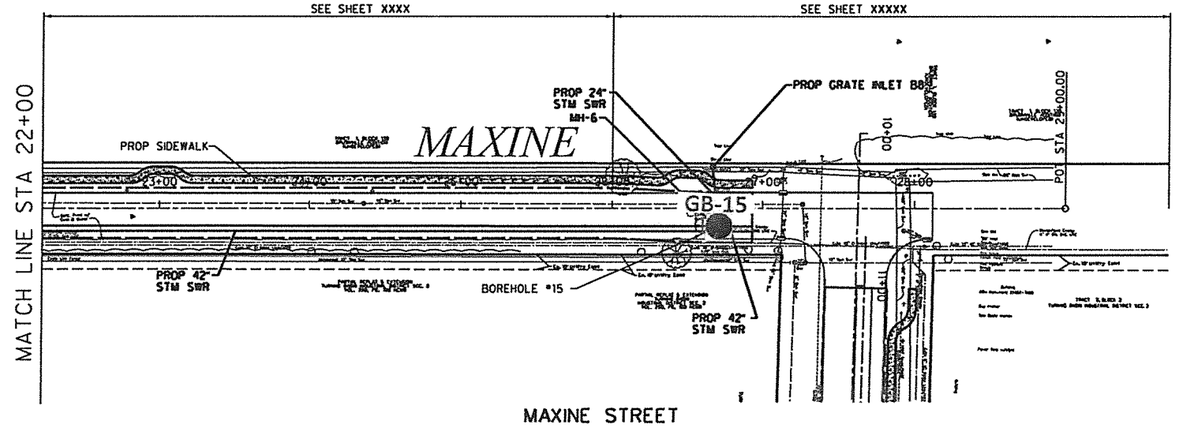

MAXINE STREET

LEGEND

- Borings from Previous Study
- Boring
- Boring w/Piezometer

PLAN OF BORINGS

N

0 25 50 100

1" = 50'

No.	Date	Revisions	App.

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FB NO. P-5871

CITY OF HOUSTON

DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

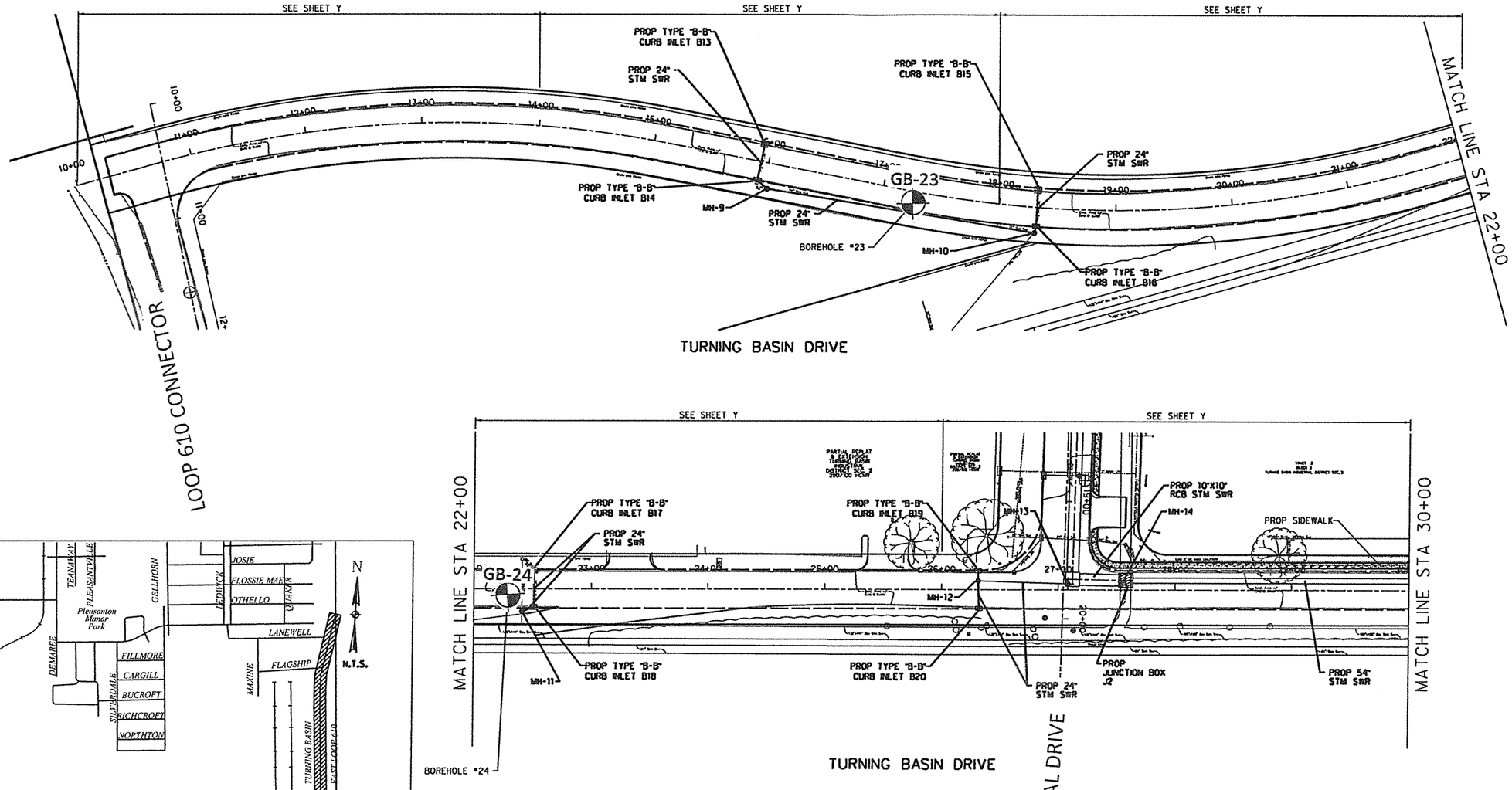
CITY OF HOUSTON
PLEASANTVILLE
DRAINAGE AND PAVING
(SUB-PROJECT 1A)

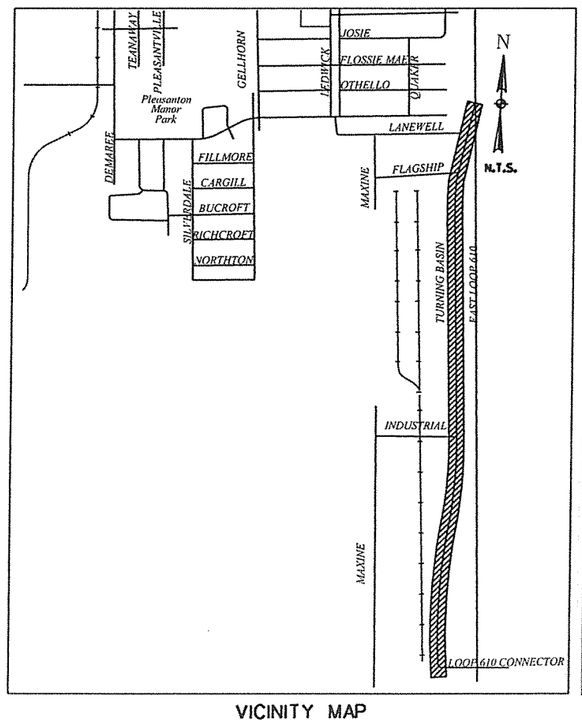
STORM SEWER AND PAVING LAYOUT

WBS NUMBER	M-000286-0001-4
DRAWING SCALE	HORIZ:1"=50'
CITY OF HOUSTON PM	JEFFREY T. HALL, P.E.
SHEET NO. XX OF XX	

FIGURE 2.1

Job No. 1140186903





VICINITY MAP

LEGEND
- Borings from Previous Study
- Boring
- Boring w/Piezometer

PLAN OF BORINGS

No.	Date	Revisions	Appr.

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SHEET NO. XX OF XX	FIGURE 2.2

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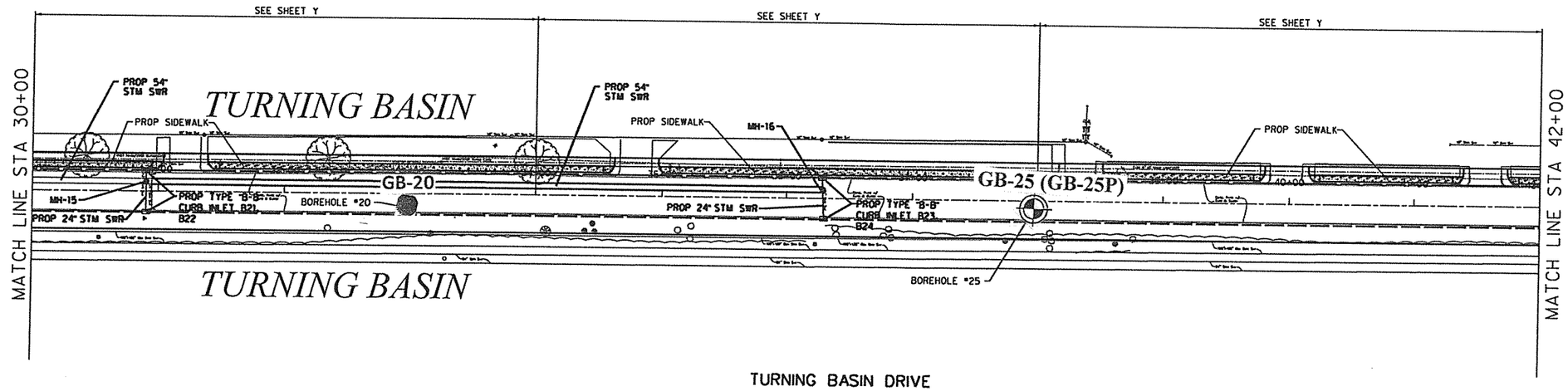
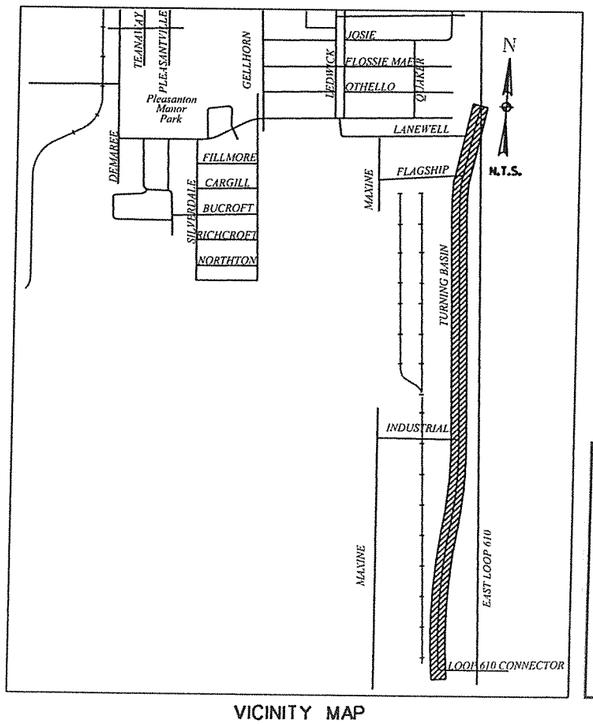


TURNING BASIN DRIVE



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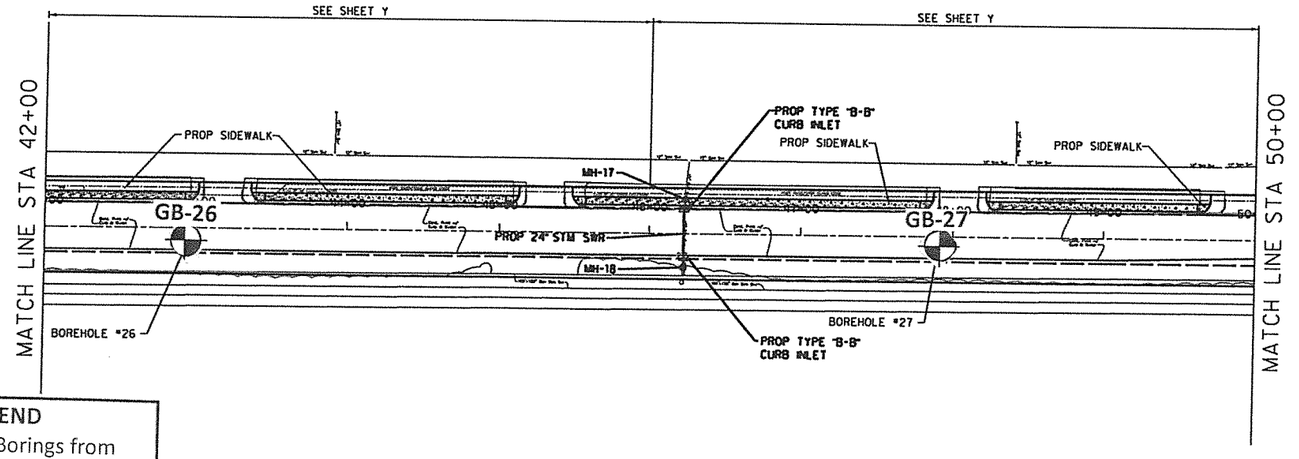

TURNING BASIN DRIVE

LEGEND

- Borings from Previous Study
- Boring
- Boring w/Piezometer

PLAN OF BORINGS

No.	Date	Revisions	App.

N

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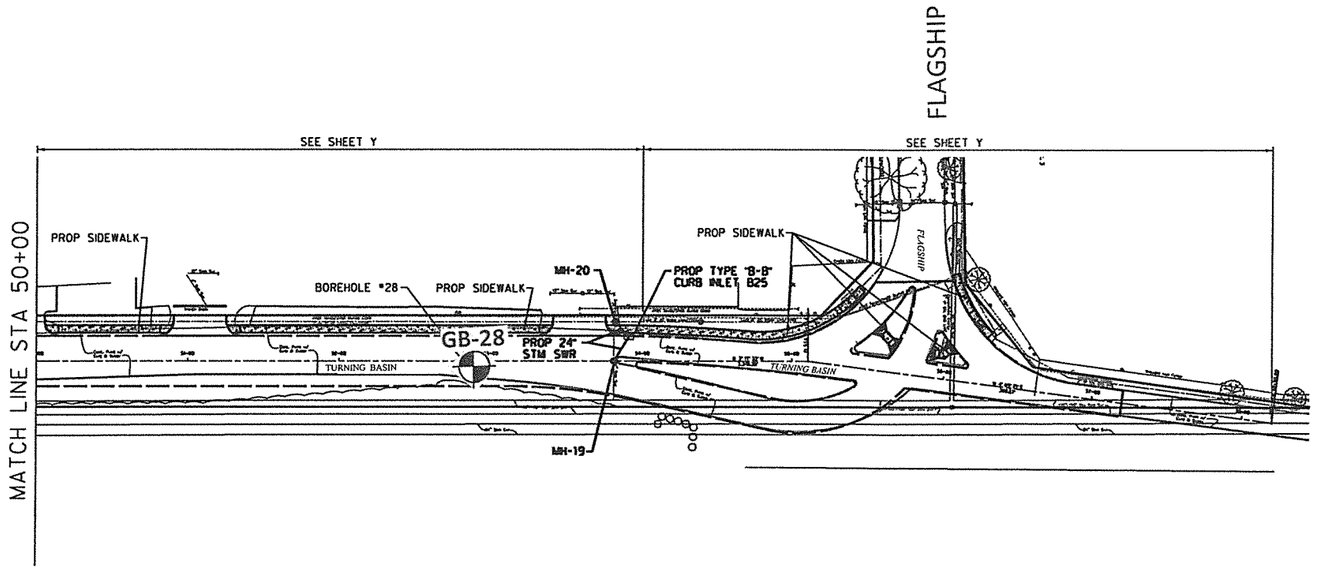
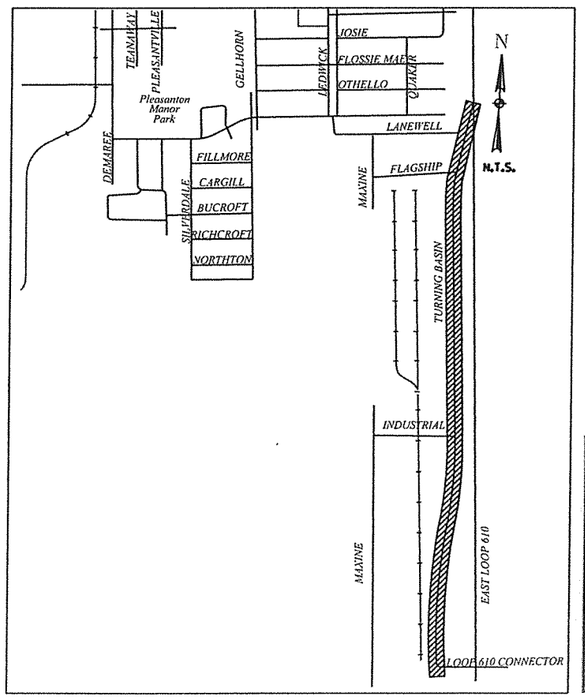
CITY OF HOUSTON PM	JEFFREY T. HALL, P.E.
SHEET NO. XX OF XX	FIGURE 2.3

Job No. 1140186903



TURNING BASIN DRIVE



VICINITY MAP

LEGEND

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- Boring w/Piezometer

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No.	Date	Revisions	App.

N

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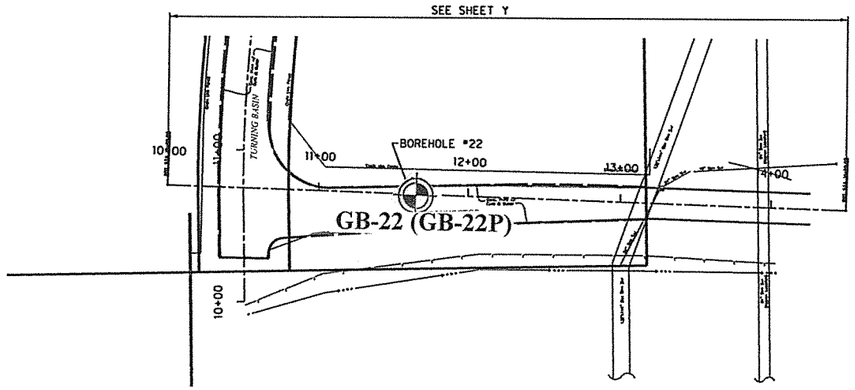
DRAWING SCALE	
HORIZ:1"=50'	
CITY OF HOUSTON PM	
JEFFREY T. HALL, P.E.	
SHEET NO. XX OF XX	FIGURE 2.4

Job No. 1140186903

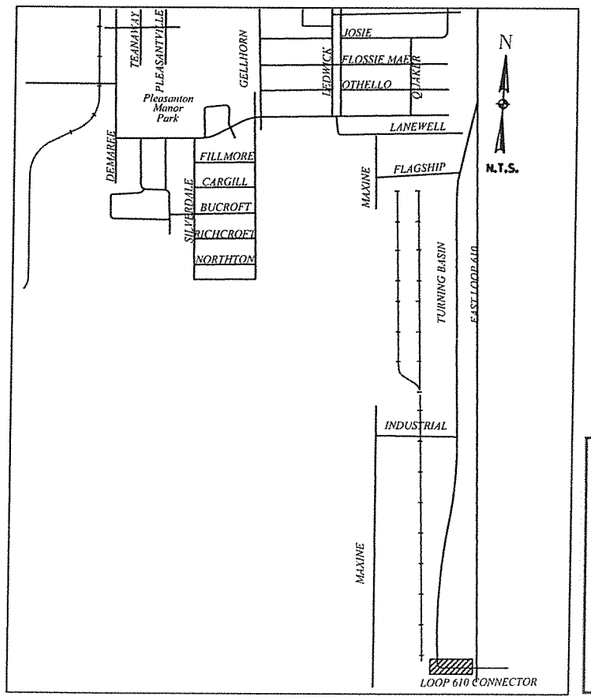
TURNING BASIN

SEE SHEET Y



LOOP 610 CONNECTOR

•NO PROPOSED UNTILITIES



VICINITY MAP

LEGEND

- Borings from Previous Study
- Boring
- Boring w/Piezometer

N

0 25 50 100

1" - 50'

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(SUB-PROJECT 1A)

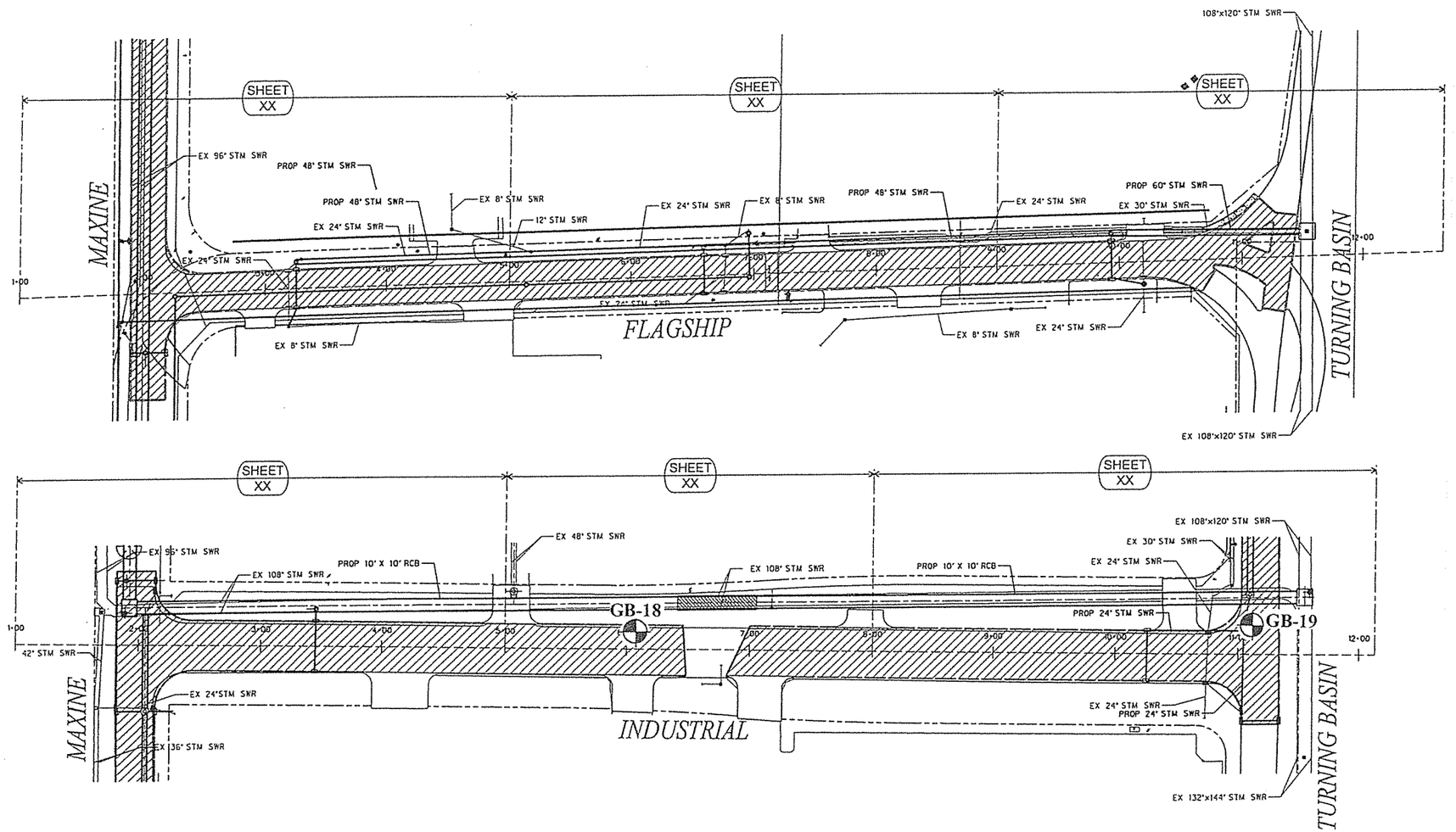
STORM SEWER AND
PAVING LAYOUT

WBS NUMBER	M-000286-0001-4
DRAWING SCALE	HORIZ:1"=50'
CITY OF HOUSTON PM	JEFFREY T. HALL, P.E.
SHEET NO. XX OF XX	

PLAN OF BORINGS

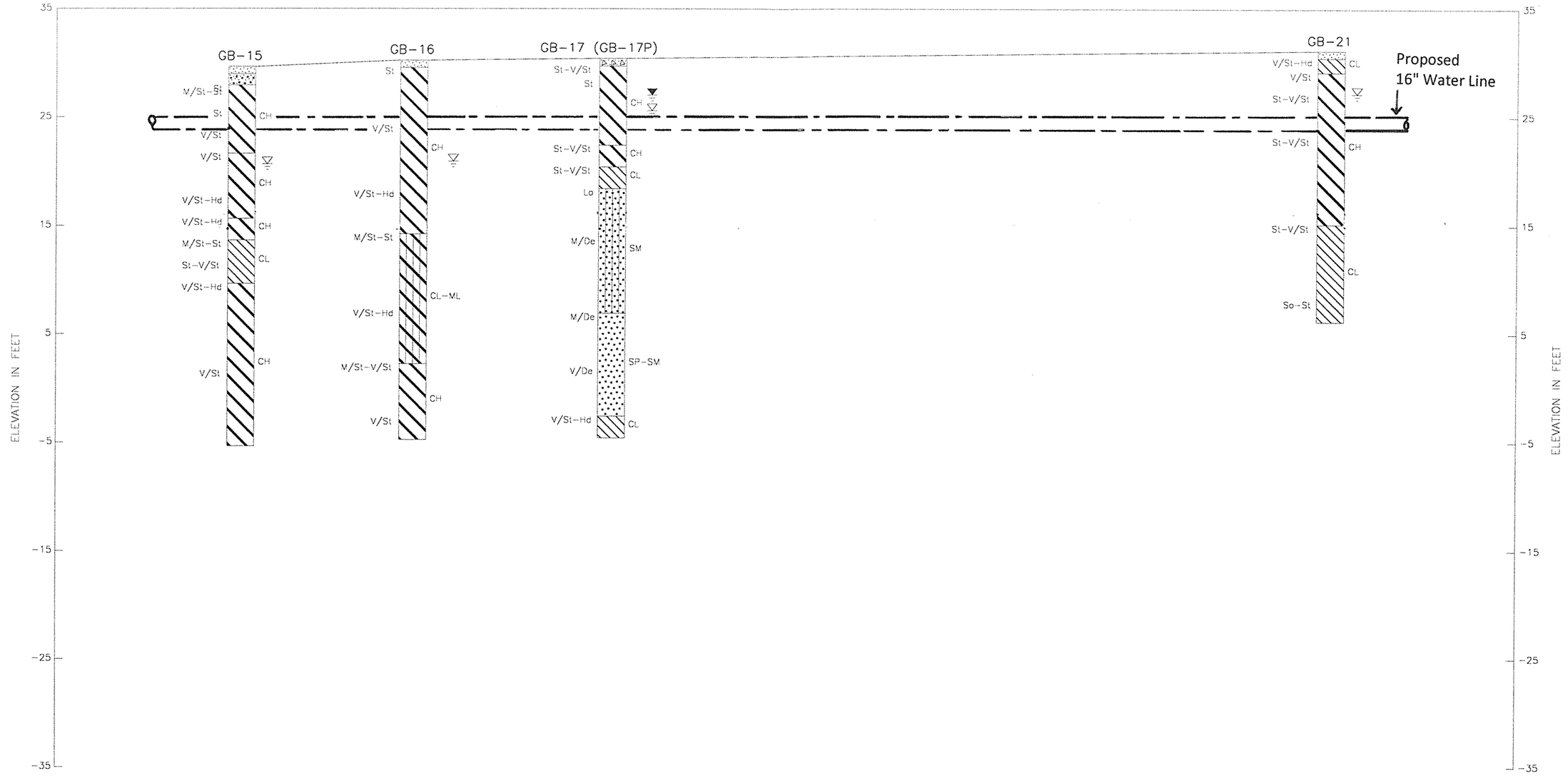
FIGURE 2.5

Job No. 1140186903



Legend	Geotest Engineering, Inc	1140186901
BORING BORING WITH PIEZOMETER	PLEASANTVILLE AND GLENDALE AREA DRAINAGE IMPROVEMENT PROJECT SUB PROJECT 1 WBS NO. M-000286-0001-3 HOUSTON, TEXAS **PLAN OF BORINGS** 0 50 100 150 200 SCALE IN FEET	

FIGURE 2.6



GENERAL NOTES:

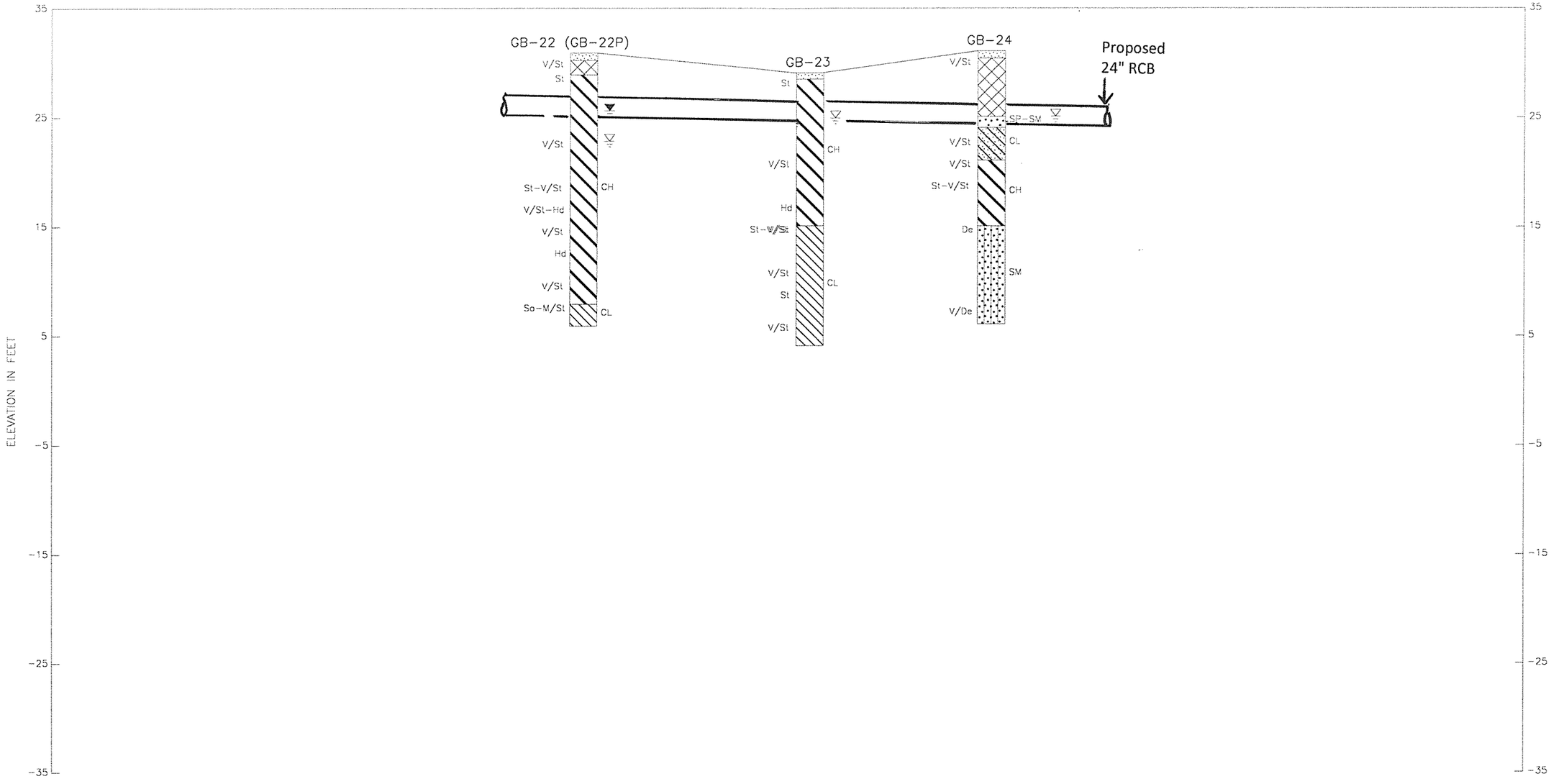
1. See Figure 2.1 for approximate location of borings and profile section.
2. Data concerning subsurface conditions have been obtained at boring locations only. Actual conditions between borings may differ from the profile shown here.
3. See logs of boring for detailed description of soils encountered in each borehole.
4. See Figure 4 for symbols and abbreviations used on this profile.
5. Ground surface elevation at each boring location was based on survey data provided to us by Haliff Associates, Inc.

BORING LOG PROFILE

Maxine Street

0 150 300 450 600

HORIZONTAL SCALE IN FEET



GENERAL NOTES:

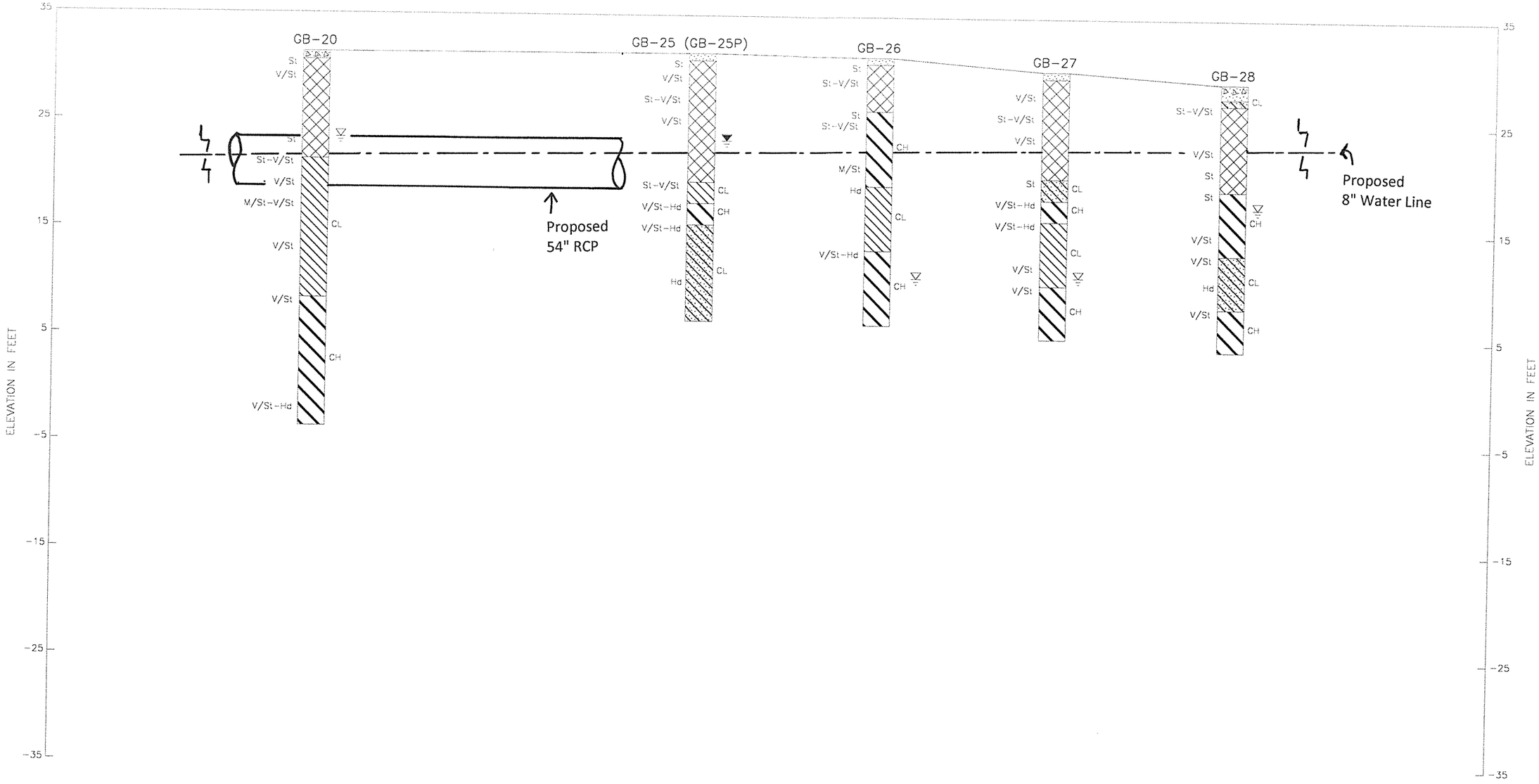
1. See Figures 2.2 & 2.5 for approximate location of borings and profile section.
2. Data concerning subsurface conditions have been obtained at boring locations only. Actual conditions between borings may differ from the profile shown here.
3. See logs of boring for detailed description of soils encountered in each borehole.
4. See Figure 4 for symbols and abbreviations used on this profile.
5. Ground surface elevation at each boring location was based on survey data provided to us by Turning Basin

BORING LOG PROFILE

Loop 610 Connector & Turning Basin

0 150 300 450 600

HORIZONTAL SCALE IN FEET



GENERAL NOTES:

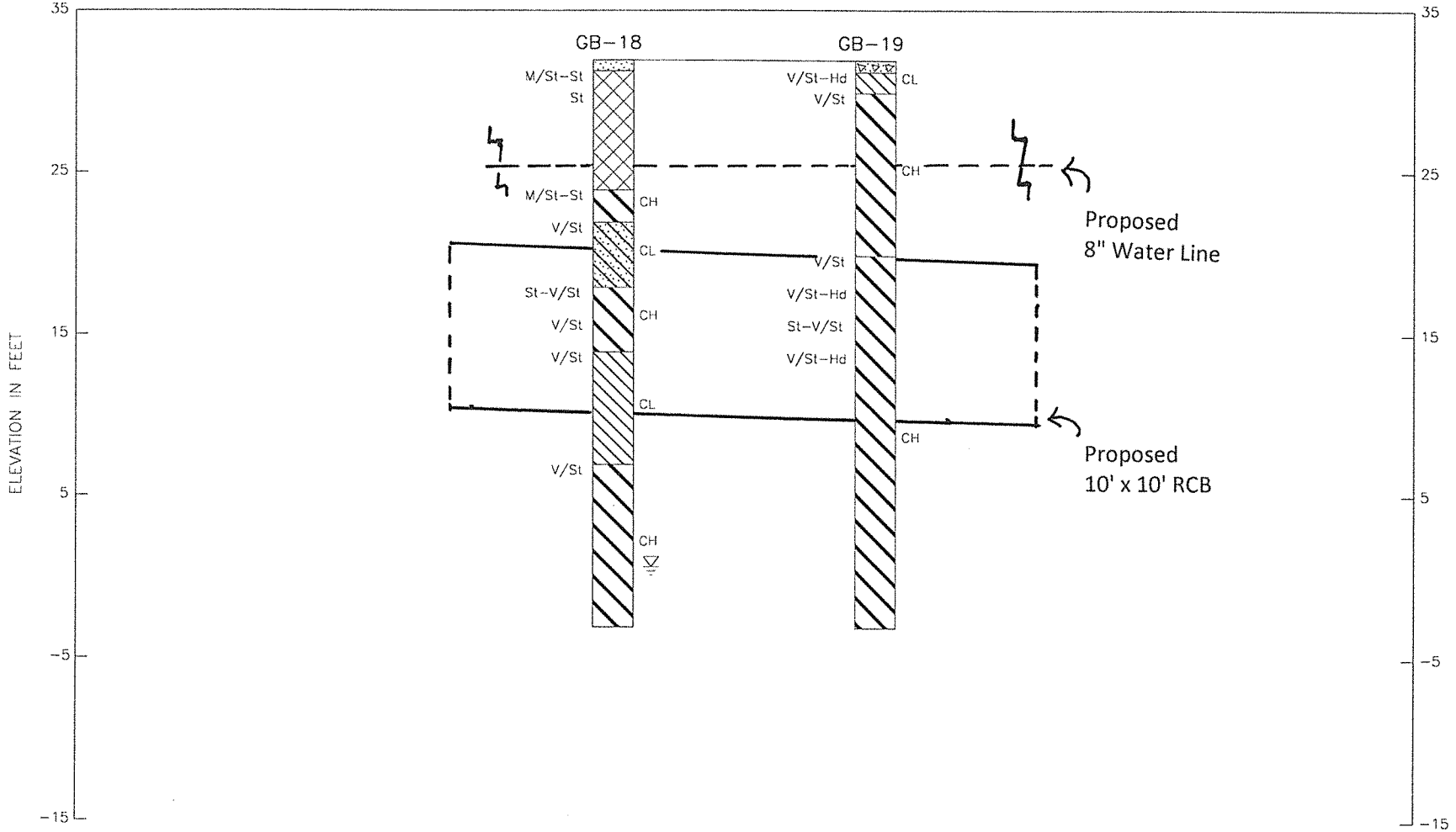
1. See Figures 2.3 & 2.4 for approximate location of borings and profile section.
2. Data concerning subsurface conditions have been obtained at boring locations only. Actual conditions between borings may differ from the profile shown here.
3. See logs of boring for detailed description of soils encountered in each borehole.
4. See Figure 4 for symbols and abbreviations used on this profile.
5. Ground surface elevation at each boring location was based on survey data provided to us by Halff Associates, Inc.

BORING LOG PROFILE
Turning Basin

0 150 300 450 600

HORIZONTAL SCALE IN FEET

Job No. 114018690



GENERAL NOTES:

1. See Figure 2.6 for approximate location of borings and profile section.
2. Data concerning subsurface conditions have been obtained at boring locations only. Actual conditions between borings may differ from the profile shown here.
3. See logs of boring for detailed description of soils encountered in each borehole.
4. See Figure 4 for symbols and abbreviations used on this profile.
5. Ground surface elevation at each boring location was based on survey data provided to us by Halff Associates, Inc.

BORING LOG PROFILE

Industrial Drive

0 150 300 450 600

HORIZONTAL SCALE IN FEET

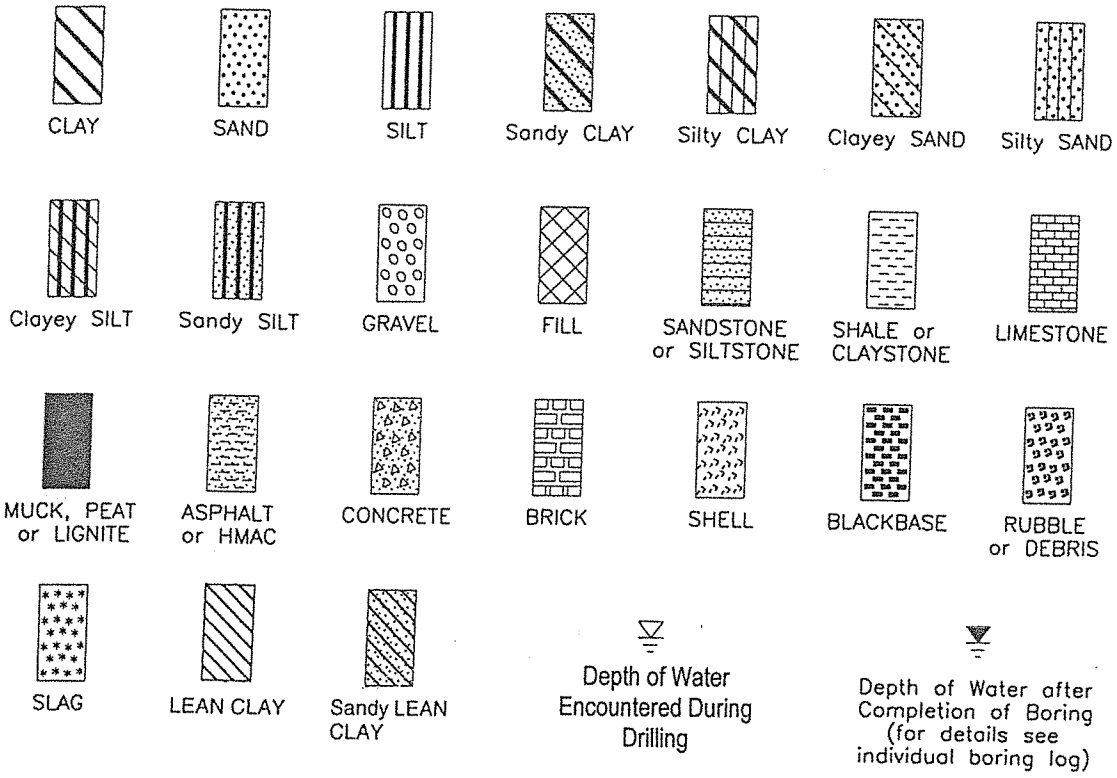
Geotest Engineering, Inc.

FIGURE 3.4

Job No. 1140186903

SYMBOLS AND ABBREVIATIONS USED ON BORING LOG PROFILE

LEGEND



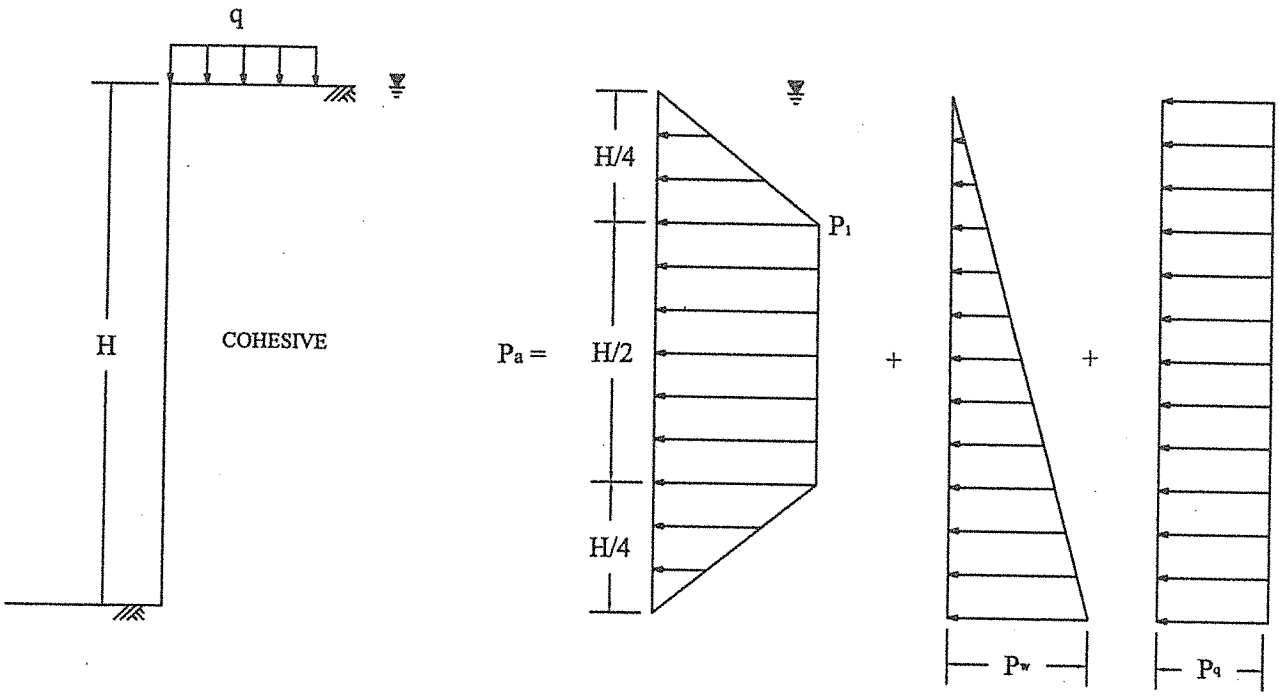
ABBREVIATIONS USED FOR CONSISTENCY/DENSITY

COHESIVE SOILS

V/So	:	Very Soft
So	:	Soft
Fm	:	Firm
M/St	:	Medium Stiff
St	:	Stiff
V/St	:	Very Stiff
Hd	:	Hard
V/Hd	:	Very Hard

COHESIONLESS SOILS

V/Lo	:	Very Loose
Lo	:	Loose
S/Co	:	Slightly Compact
Co	:	Compact
M/De	:	Medium Dense
De	:	Dense
V/De	:	Very Dense



TYPICAL SOIL PARAMETERS

See Table 2 for typical values of soil parameters

BRACED WALL

For $\gamma H/c \leq 4$

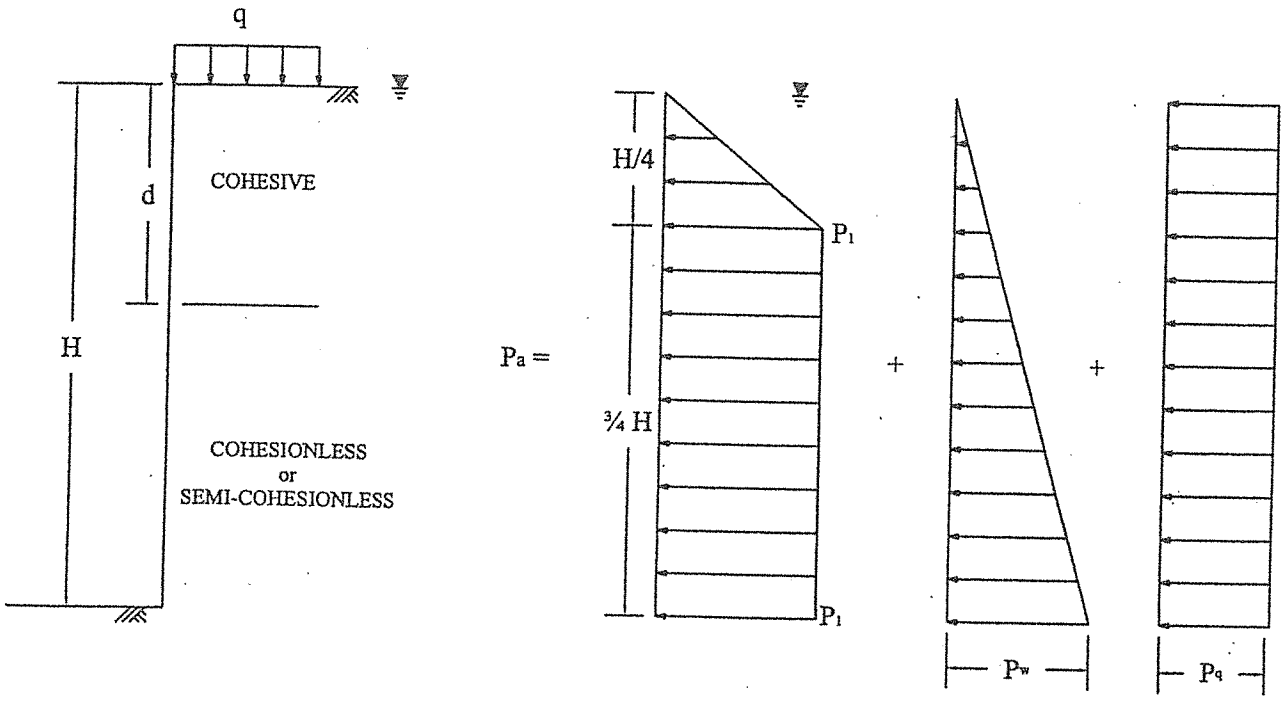
$P_1 = 0.3\ \gamma_c' H$
$P_w = \gamma_w H = 62.4\ H$
$P_q = 0.5\ q$

Where:

γ_c' = Submerged unit weight of cohesive soil, pcf;
γ_w = Unit weight of water, pcf;
q = Surcharge load at surface, psf;
P_a = Lateral pressure, psf;
P_1 = Active earth pressure, psf;
P_q = Horizontal pressure due to surcharge, psf;
P_w = Hydrostatic pressure due to groundwater, psf;
H = Depth of braced excavation, feet
c = Shear strength of cohesion soil, psf;

TRENCH SUPPORT EARTH PRESSURE

SUBMERGED COHESIVE SOIL



TYPICAL SOIL PARAMETERS

BRACED WALL

See Table 2 for typical values of soil parameters

$$\gamma'_{avg} = \frac{\gamma_c' \, d + \gamma_s' \, (H-d)}{H}$$

$P_1 = 0.3 \, \gamma'_{avg} \, H$
$P_w = 62.4 \, H$
$P_q = 0.5 \, q$

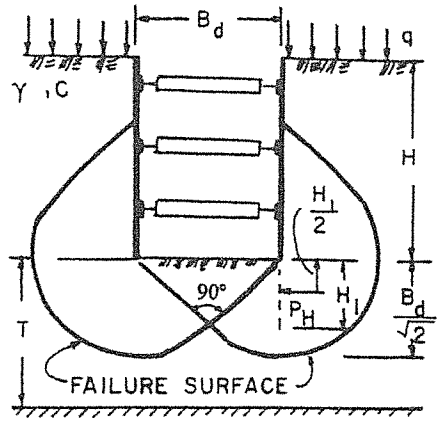
Where:

γ_c' = Submerged unit weight of cohesive soil, pcf;
γ_s' = Submerged unit weight of cohesionless soil, pcf;
γ'_{avg} = Average submerged unit weight of soils, pcf;
q = Surcharge load at surface, psf;
P_a = Lateral pressure, psf;
P_1 = Active earth pressure, psf;
P_q = Horizontal pressure due to surcharge, psf;
P_w = Hydrostatic pressure due to groundwater, psf;
H = Depth of braced excavation, feet

TRENCH SUPPORT EARTH PRESSURE

SUBMERGED COHESIVE SOIL OVER
COHESIONLESS OR SEMI-COHESIONLESS SOIL

CUT IN COHESIVE SOIL,
DEPTH OF COHESIVE SOIL UNLIMITED ($T > 0.7\ B_d$)
L = LENGTH OF CUT



If sheeting terminates at base of cut:

$$\text{Safety factor, } F_S = \frac{N_C C}{\gamma H + q}$$

N_C = Bearing capacity factor, which depends on dimensions of the excavation : B_d , L and H (use N_c from graph below)

C = Undrained shear strength of clay in failure zone beneath and surrounding base of cut

γ = Wet unit weight of soil (see Table 2)

q = Surface surcharge (assumed q = 500 psf)

If safety factor is less than 1.5, sheeting or soldier piles must be carried below the base of cut to insure stability - (see note)

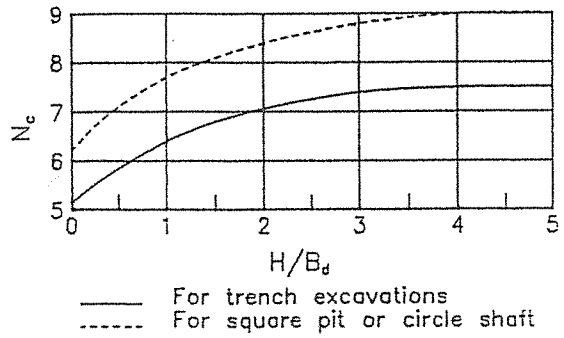
H_1 = Buried length = $\frac{B_d}{2} \geq 5$ feet

Note : If soldier piles are used, the center to center spacing should not exceed 3 times the width or diameter of soldier pile .

Force on buried length, P_H:

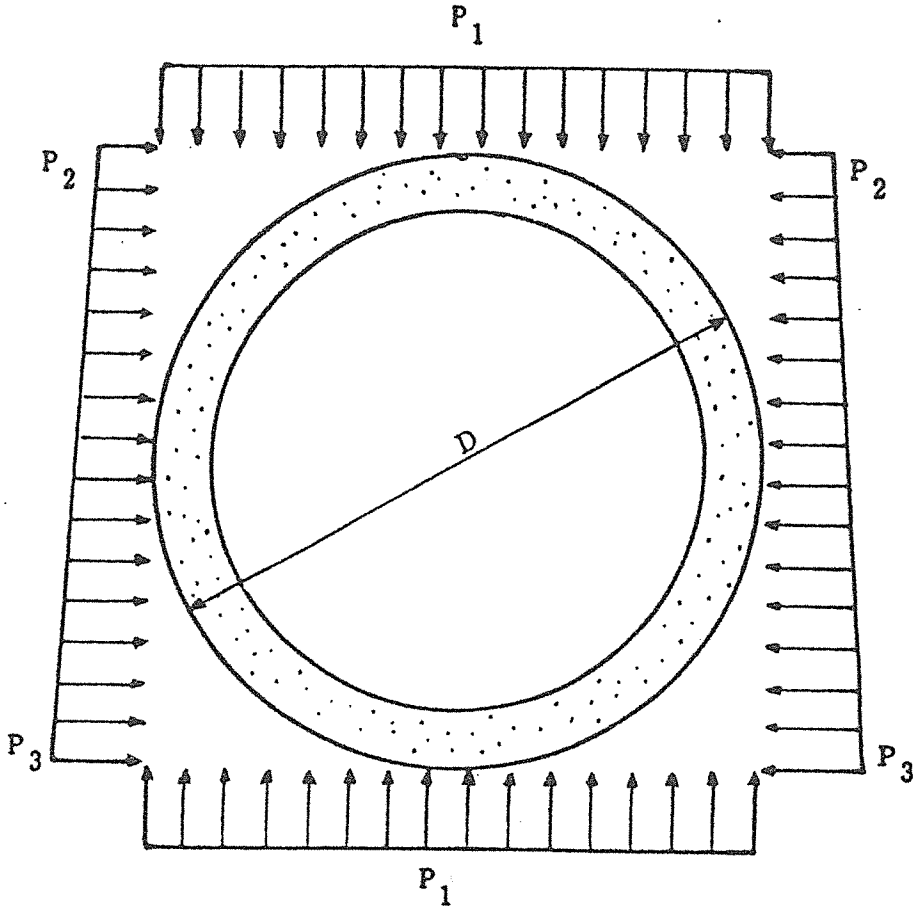
If $H_1 > \frac{2}{3}\frac{B_d}{\sqrt{2}}$, $P_H = 0.7\ (\gamma\ HB_d - 1.4CH - \pi CB_d)$ in lbs/ linear foot

If $H_1 < \frac{2}{3}\frac{B_d}{\sqrt{2}}$, $P_H = 1.5H_1\ (\gamma\ H - \frac{1.4CH}{B_d} - \pi C)$ in lbs/ linear foot



STABILITY OF BOTTOM
FOR
BRACED CUT

Job No. 1140186903



$$P_1 = [(H + \frac{D}{2}) \times (\gamma - \gamma_w) + D_w \times \gamma_w] + q_s \text{ , for } D_w < H + \frac{D}{2}$$

$$P_1 = [(H + \frac{D}{2}) \times \gamma] + q_s \text{ , for } D_w \geq H + \frac{D}{2}$$

$$P_2 = (H \times \gamma) + q_s$$

$$P_3 = [(H + D) \times \gamma] + q_s$$

Where: P_1, P_2, P_3 = Tunnel liner load, psf.

D = Tunnel outside diameter, ft.

H = Depth to top of tunnel; ft.

D_w = Depth to ground water level; ft.

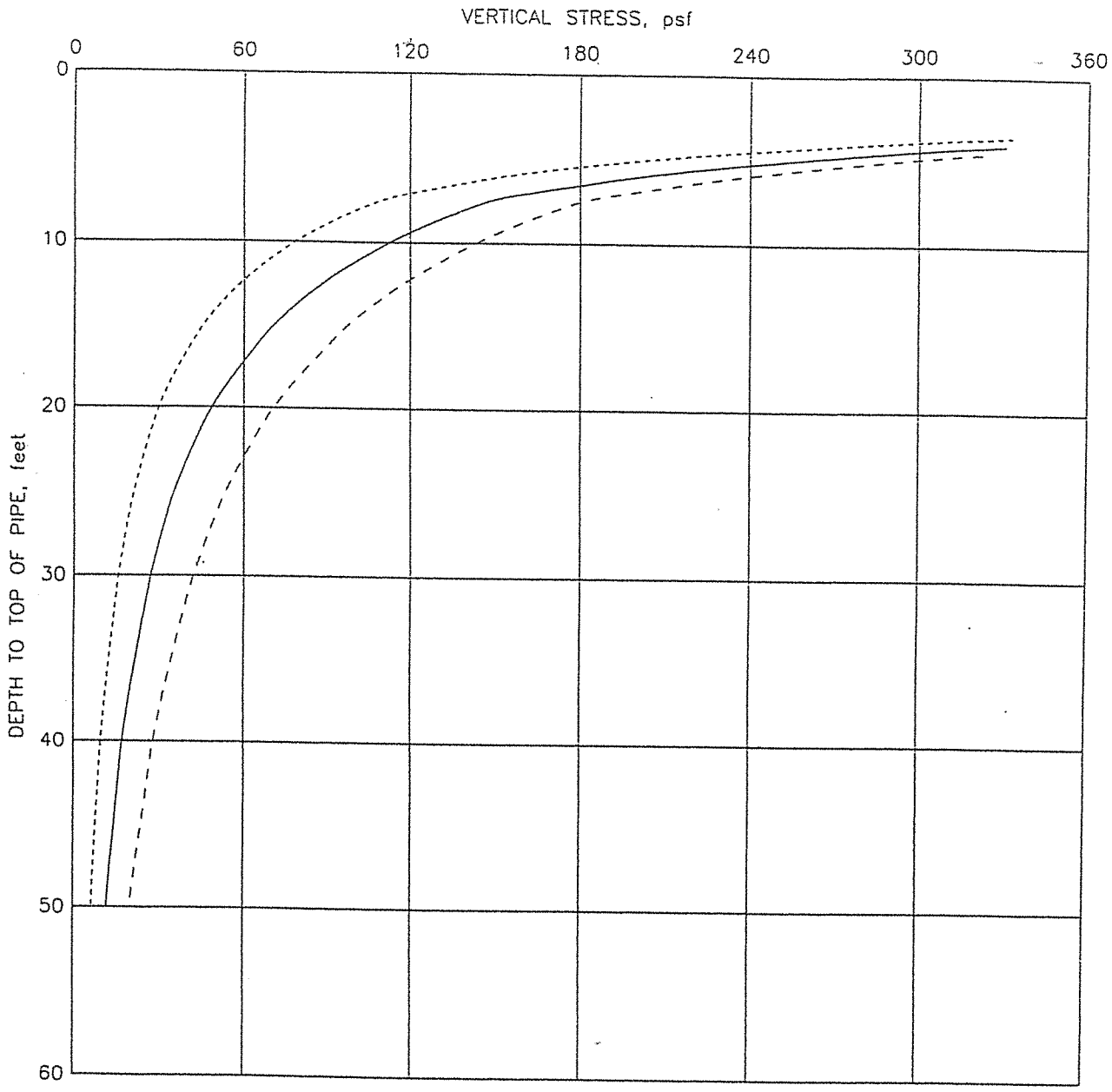
γ = Wet unit weight of soil, pcf (see Table 3)

γ_w = Unit weight of water, 62.4 pcf

q_s = Surcharge load, psf.

EARTH PRESSURE ON PIPE AND CASING AUGERING

Job No. 1140186903



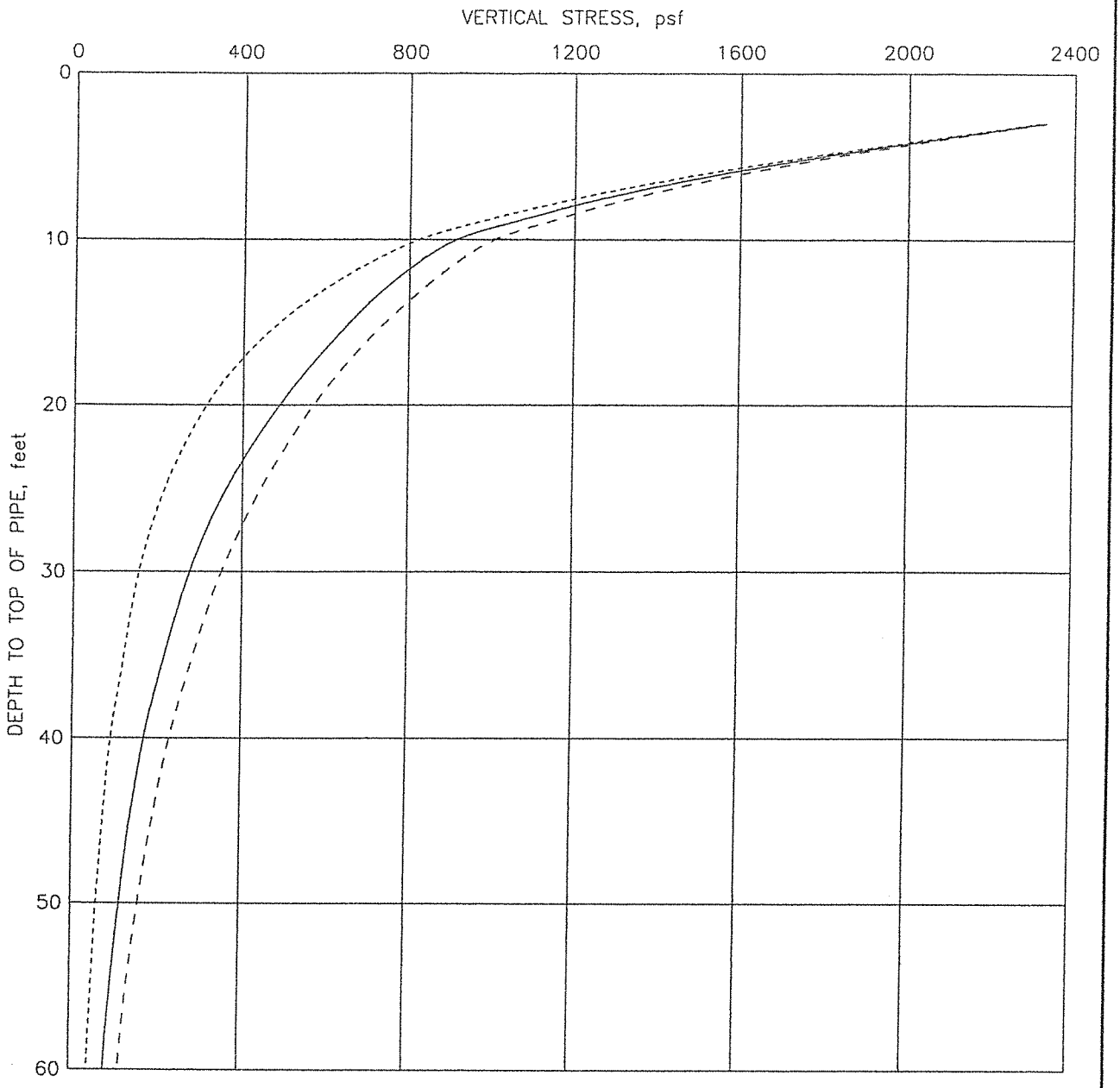
Legend:

------ One passing truck
——— Two passing trucks
– – – Four passing trucks

Notes: 1. The vertical stress was estimated using AASHTO H20 or HS20 truck axle loadings on paved surfaces.
2. Impact factor was included in the vertical stress.

VERTICAL STRESS ON PIPES DUE TO TRAFFIC LOADS

Job No. 1140186903



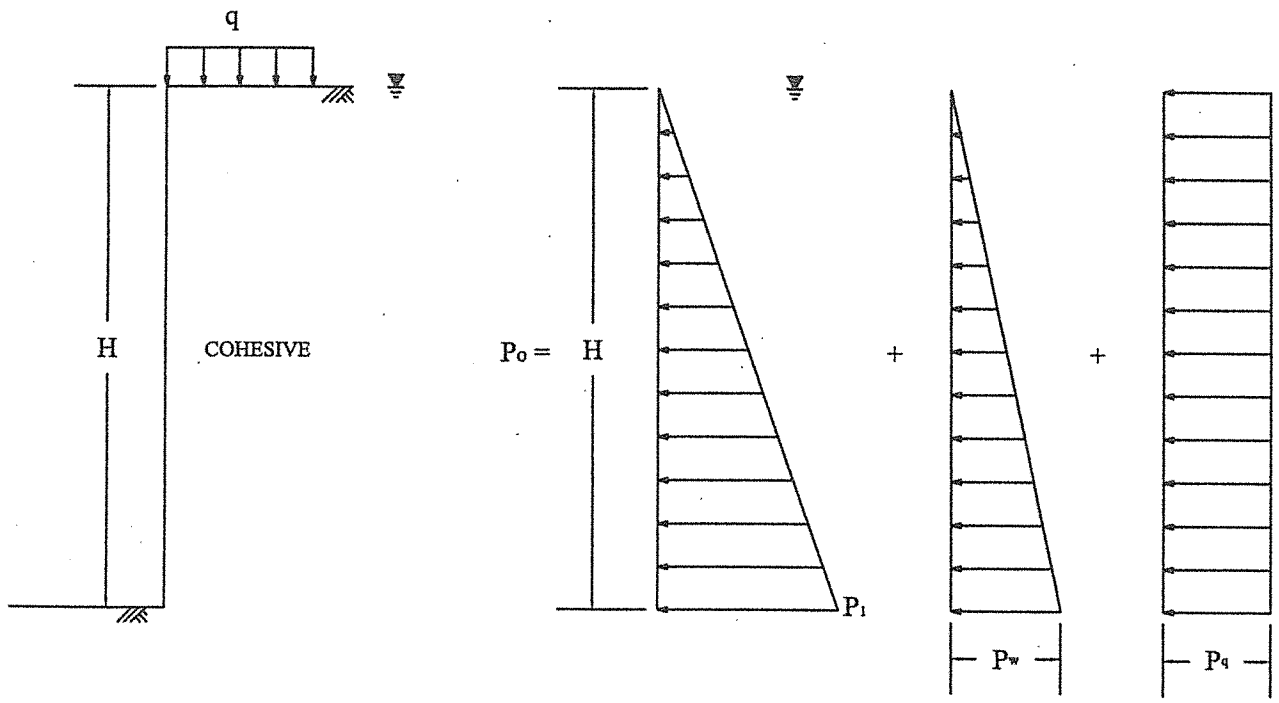
Legend:

------ Single passing track
_____ Two passing tracks
_ _ _ Three passing tracks

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

LIVE LOADS ON PIPE CROSSING UNDER RAILROAD TRACKS

Job No. 1140186903



TYPICAL SOIL PARAMETERS

See Table 2 for typical values of soil parameters

$K_{oc} = 1.0$

PERMANENT WALL

$P_1 = K_{oc}\,\gamma_c'\,H$
$P_w = \gamma_w\,H = 62.4\,H$
$P_q = 0.5\,q$

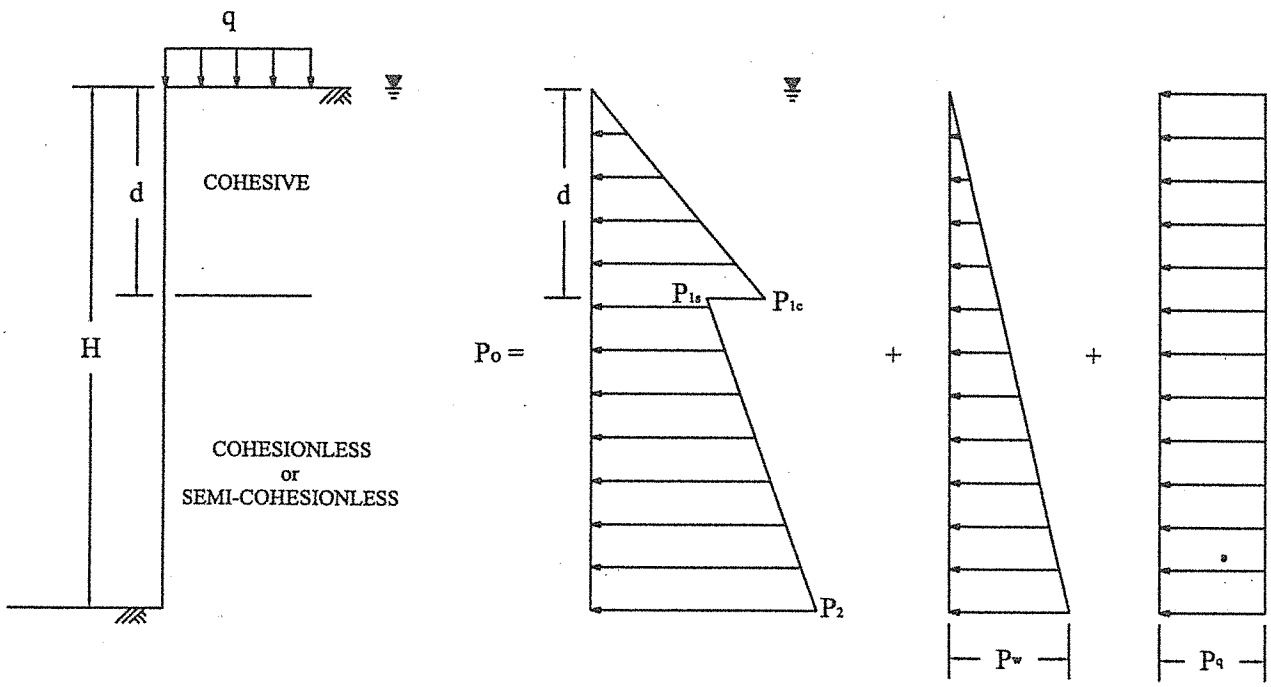
Where:

γ_c' = Submerged unit weight of cohesive soil, pcf;
K_{oc} = Coefficient of at-rest earth pressure in cohesive soil;
γ_w = Unit weight of water, pcf;
q = Surcharge load at surface, psf;
P_o = Lateral pressure, psf;
P_1 = At-rest earth pressure, psf;
P_q = Horizontal pressure due to surcharge, psf;
P_w = Hydrostatic pressure due to groundwater, psf;
H = Depth of excavation, feet

LATERAL EARTH PRESSURE DIAGRAM FOR PERMANENT WALL

SUBMERGED COHESIVE SOIL

Job No. 1140186903



TYPICAL SOIL PARAMETERS

See Table 2 for typical values of soil parameters

$K_{oc} = 1.0$

$K_{os} = 1\text{-}\sin\phi_s$

PERMANANT WALL

$P_{1c} = \gamma_c' \, d \, K_{oc}$

$P_{1s} = \gamma_c' \, d \, K_{os}$

$P_2 = [\gamma_c' \, d + \gamma_s' \, (H-d)] \, K_{os}$

$P_w = \gamma_w \, H = 62.4 \, H$

$P_q = 0.5 \, q$

Where:

γ_c' = Submerged unit weight of cohesive soil, pcf;
γ_s' = Submerged unit weight of cohesionless or semi-cohesionless soil, pcf;
ϕ_s = Internal friction angle of cohesionless or semi-cohesionless soil, degree;
K_{oc} = Coefficient of at-rest earth pressure in cohesive soil;
K_{os} = Coefficient of at-rest earth pressure in cohesionless or semi-cohesionless soil;
γ_w = Unit weight of water, pcf;
q = Surcharge load at surface, psf;
P_o = Lateral pressure, psf;
P_i, P_{ic}, P_{is} = At-rest earth pressure, psf; i = 1, 2;
P_q = Horizontal pressure due to surcharge, psf;
P_w = Hydrostatic pressure due to groundwater, psf;
H = Height of wall, feet

LATERAL EARTH PRESSURE DIAGRAM FOR PERMANENT WALL

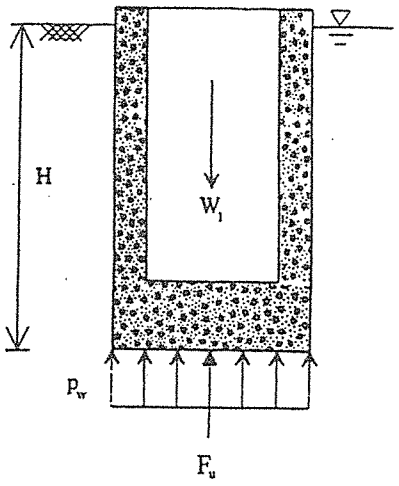
SUBMERGED COHESIVE SOIL OVER COHESIONLESS OR SEMI-COHESIONLESS SOIL

Geotest Engineering, Inc.

FIGURE 10.2

Job No. 1140186903

(a) DEAD WEIGHT OF STRUCTURE

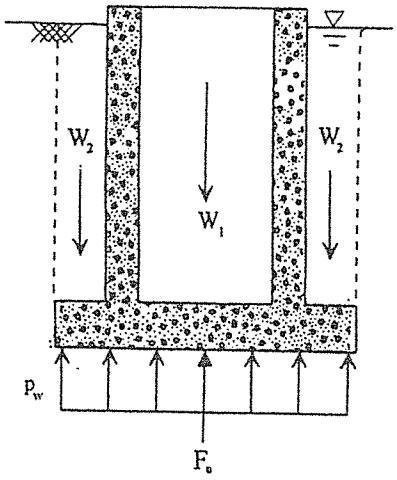


$p_w = H\gamma_w$

$F_u = A_b p_w$

$\frac{W_1}{Sf_1} = F_u$

(b) WEIGHT OF SOIL ABOVE BASE EXTENSION PLUS DEAD WEIGHT OF STRUCTURE

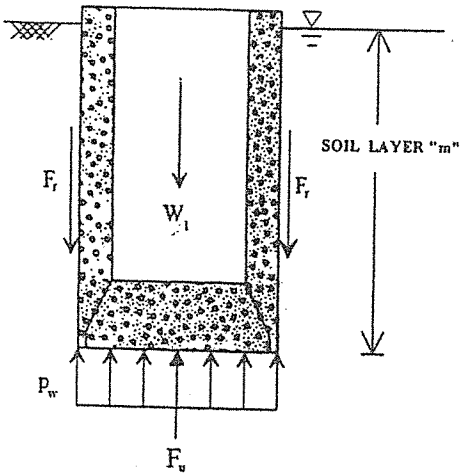


$p_w = H\gamma_w$

$F_u = A_b p_w$

$\frac{W_1}{Sf_1} + \frac{W_2}{Sf_2} = F_u$

(c) SOIL-WALL FRICTION PLUS DEAD WEIGHT OF STRUCTURE



$p_w = H\gamma_w$

$F_u = A_b p_w$

$\frac{W_1}{Sf_1} + \frac{F_r}{Sf_3} = F_u$

Predominantly Cohesive Soils, $F_r = \alpha\, c_m\, A_m$

Predominantly Cohesionless Soils, $F_r = p_m A_m K \tan \delta_m$

See Table 2 for typical values of soil parameters

Where:

A_b	=	area of base, sq. ft.
A_m	=	cylindrical surface area of layer "m" , sq. ft.
c_m	=	undrained cohesion of soil layer "m", psf.
F_u	=	hydrostatic uplift force, lbs.
F_r	=	frictional resistance, lbs.
H	=	height of buried structure, ft.
K	=	coefficient of lateral pressure = 0.5.
p_m	=	average overburden pressure for layer "m," psf.
p_w	=	hydrostatic uplift pressure, psf.
$Sf_{1,\,2,\,3}$	=	factor of safety.
W_1	=	dead weight of concrete structure, lbs.
W_2	=	weight of backfill above base extension, lbs.
α	=	cohesion reduction factor = 0.5.
δ_m	=	friction angle between soil layer "m" and concrete wall, degrees = 0.75 ϕ_m
ϕ_m	=	internal angle of friction of soil layer "m", degrees.
γ_w	=	unit weight of water = 62.4 pcf.

UPLIFT PRESSURE AND RESISTANCE

TABLES

TABLE 1

SUMMARY OF BORING INFORMATION

Boring No.	Depth (feet)	Street	Northing	Easting	Elevation (feet)
GB-21	25	Maxine	13837797.39	3152445.44	31.15
GB-22 (GB-22P)	25	Turning Basin/Loop 610 Connector	13837812.88	3153210.93	30.88
GB-23	25	Turning Basin	13838432.44	3153269.37	29.08
GB-24	25	Turning Basin	13838928.56	3153338.44	31.06
GB-25 (GB-25P)	25	Turning Basin	13840492.23	3153250.21	31.46
GB-26	25	Turning Basin	13840990.09	3153220.64	31.20
GB-27	25	Turning Basin	13841485.47	3153191.84	30.05
GB-28	25	Turning Basin	13841985.45	3153159.51	29.03

Survey information is provided by Halff Associates, Inc.

TABLE 2

GEOTECHNICAL DESIGN PARAMETER SUMMARY
OPEN-CUT EXCAVATION

Alignments	Boring Nos.	Stratigraphic Unit	Range of Depths, ft	Wet Unit Weight, γ, pcf	Submerged Unit Weight, γ', pcf	Undrained Cohesion, psf	Internal Friction Angle, φ, degree
16" Water Line and 15" Sanitary Sewer along Maxine	GB-15 and GB-16	Cohesive	0-6	125	63	1,400	--
			6-14	130	65	2,100	--
			14-16	130	65	1,000	--
			16-20	125	63	500	--
			20-28	130	65	2,500	--
			28-35	130	65	800	--
	GB-17	Cohesive	0-12	125	63	1,000	--
		Cohesionless	12-23.5	105	53	--	28
			23.5-33	100	50	--	30
		Cohesive	33-35	125	63	3,000	--
	GB-21	Cohesive	0-4	126	63	2,000	--
			4-12	128	64	1,600	--
			12-20	125	63	1,500	--
			20-25	125	63	400	--
10' x 10' RCB along Industrial	GB-18 and GB-19	Fill/Cohesive	0-8	125	63	1,000	--
		Cohesive	8-14	120	60	2,000	--
			14-20	125	63	1,800	--
			20-35	120	60	3,000	--
24" Strom Sewer and 8" Water Line along Turning Basin	GB-20	Fill	0-4	120	60	1,600	--
			4-8	125	63	2,500	--
		Cohesive	8-20	125	63	1,000	--
			20-35	130	65	3,000	--
	GB-21 through GB-23	Cohesive	0-4	126	63	1,200	--
			4-12	128	64	1,600	--
			12-20	125	63	1,500	--
			20-25	125	63	400	--
	GB-24	Fill	0-6	125	63	2,000	--
		Cohesionless	6-7	100	50	--	30
		Cohesive	7-16	126	63	1,300	--
		Cohesionless	16-25	110	55	--	30
	GB-25 through GB-28	Fill	0-2	120	60	1,500	--
			2-10	120	60	800	--
		Cohesive	10-12	125	63	500	--
			12-14	128	64	1,000	--
			14-18	128	64	2,100	--
			18-25	130	65	2,000	--

Note: 1) Cohesive soils include Fat Clay, Fat Clay with sand, Lean Clay, Lean Clay with sand, Silty Clay and Sandy Lean Clay.
2) Cohesionless soils include Fine Sand w/silt and Silty Sand.

TABLE 3

GEOTECHNICAL DESIGN PARAMETER SUMMARY
TRENCHLESS INSTALLATION (Boring GB-18 and GB-19)

PROPERTY		COHESIVE SOILS[1]
Wet Unit Weight, γ, pcf	0-8	125
	8-14	120
	14-20	125
	20-35	120
Submerged Unit Weight, γ', pcf	0-8	63
	8-14	60
	14-20	63
	20-35	60
Moisture Content (%)	0-8	18
	8-14	24
	14-20	30
	20-35	18
Undrained Cohesion, C_u, psf	0-8*	1,000
	8-14*	2,000
	14-20*	1,800
	20-28*	3,000
UNDRAINED PROPERTIES		
Angle of Internal Friction, ϕ, degrees	0-8*	--
	8-14*	--
	14-20*	--
	20-28*	--
Elastic Modulus, E, psf	0-8*	300,000
	8-14*	800,000
	14-20*	540,000
	20-28*	1,200,000
Coefficient of Lateral Earth Pressure at Rest, K_o,	0-8*	1.2
	8-14*	1.2
	14-20*	1.2
	20-28*	1.2
Poisson's Ratio, μ		0.45
DRAINED PROPERTIES		
Drained Cohesion, C', psf	0-8*	0
	8-14*	0
	14-20*	0
	20-28*	0
Angle of Internal Friction, ϕ', degrees	0-8*	18
	8-14*	22
	14-20*	18
	20-28*	22
Elastic Modulus, E, psf	0-8*	180,000
	8-14*	480,000
	14-20*	324,000
	20-28*	720,000

APPENDIX A

LOG OF BORING NO. GB-21

PROJECT : Pleasantville Drainage and Paving (Sub Project 1A)
WBS No. M-000286-001A-3
Houston, Texas

PROJECT NO. : 1140186903

LOCATION : N 13837797.39, E 3152445.44
Maxine Street See Plan of Borings (Figure 2.1)

COMPLETION DEPTH : 25.0 FT.

SURFACE ELEVATION : 31.15 FT.

DATE : 07-22-14

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 16.0 FT.
WET ROTARY : 16.0 TO 25.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
31.1	0								
30.5		8" Concrete							
29.1		Very stiff to hard dark gray and brown LEAN CLAY (CL) w/sand seams				13			
		Very stiff dark gray FAT CLAY (CH)				26			
	5	-stiff to very stiff 4'-6'		92	101	27	64	25	39
		-yellowish brown and gray w/ferrous nodules and ferrous stains 7'-16'				28			
		-w/calcareous nodules 8'-10'							
	10	-stiff to very stiff reddish brown and gray 8'-12'				30			
					101	25			
		-hard 14'-16'				24			
	15								
15.1		Stiff to very stiff brown LEAN CLAY (CL) w/silt seams and ferrous stains				23			
				96	112	20	31	16	15
	20					25			
		-soft to stiff 23'-25'							
6.1	25					20			
	30								
	35								

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

0.5 1.0 1.5 2.0 2.5

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 16.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 4.0 FT.
HOLE OPEN TO 25.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-1

LOG OF BORING NO. GB-22 (GB-22P)

PROJECT : Pleasantville Drainage and Paving (Sub Project 1A)
WBS No. M-000286-001A-3
Houston, Texas

PROJECT NO. : 1140186903

LOCATION : N 13837812.88, E 3153210.93
Turning Basin Drive See Plan of Borings (Figure 2.5)

COMPLETION DEPTH : 25.0 FT.

SURFACE ELEVATION : 30.88 FT.

DATE : 07-22-14

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 21.0 FT.
WET ROTARY : 21.0 TO 25.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
30.9	0								
30.2		8" Concrete over 2" Stabilized Sand							
28.9		FILL: very stiff dark gray, gray, and brown fat clay w/shell fragments and gravel		91	89	23 32	87	31	56
	5	Stiff gray FAT CLAY (CH) w/calcareous and ferrous nodules -yellowish brown and gray 6'-12' -very stiff 8'-12'				33 30			
	10					37			
		-stiff to very stiff 12'-14' -reddish brown and gray, slickensided w/ferrous stains 12'-23' -very stiff to hard 14'-16'		99	93	34 29	76	28	48
	15	-very stiff 16'-18'				24			
		-hard 18'-20'				22			
	20	-very stiff 21'-23'				22			
7.9		Soft to medium stiff gray LEAN CLAY (CL) w/sand seams		94		27	66	25	41
5.9	25					17			
		NOTE : See piezometer GB-22P for water level measurements.							
	30								
	35								

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

0.5 1.0 1.5 2.0 2.5

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 21.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 8.1 FT.
▼: WATER DEPTH AT 5.3 FT., HOLE OPEN TO 25.0 FT. ON 08-22-14.

Geotest Engineering, Inc.

FIGURE A-2

LOG OF BORING NO. GB-23

PROJECT : Pleasantville Drainage and Paving (Sub Project 1A)
WBS No. M-000286-001A-3
Houston, Texas

PROJECT NO. : 1140186903

LOCATION : N 13838432.44, E 3153269.37
Turning Basin Drive See Plan of Borings (Figure 2.2)

COMPLETION DEPTH : 25.0 FT.

SURFACE ELEVATION : 29.08 FT.

DATE : 07-22-14

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 16.0 FT.
WET ROTARY : 16.0 TO 25.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
29.1	0	8" Concrete							
28.5		Stiff gray and brown FAT CLAY (CH) w/ferrous nodules and ferrous stains				28			
		-gray and yellowish brown 2'-8'				29			
	5	-w/calcareous nodules 6'-14'				32			
		-very stiff gray and brown 8'-12'		93	93	32	92	32	60
	10					30			
		-hard reddish brown and gray 12'-14'				27			
15.1						21			
	15	Stiff to very stiff reddish brown and gray LEAN CLAY (CL) w/ferrous nodules and ferrous stains				19			
		-very stiff to hard 18'-20'		99	104	22	40	19	21
	20	-stiff 20'-22'				25			
		-w/sand and silt 20'-25'				17			
		-very stiff gray 23'-25'							
4.1	25					17			
	30								
	35								

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

0.5 1.0 1.5 2.0 2.5

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 16.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 4.2 FT.
HOLE OPEN TO 25.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-3

LOG OF BORING NO. GB-24

PROJECT : Pleasantville Drainage and Paving (Sub Project 1A)
WBS No. M-000286-001A-3
Houston, Texas

PROJECT NO. : 1140186903

LOCATION : N 13838928.56, E 3153338.44
Turning Basin Drive See Plan of Borings (Figure 2.2)

COMPLETION DEPTH : 25.0 FT.

SURFACE ELEVATION : 31.06 FT.

DATE : 07-22-14

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 16.0 FT.
WET ROTARY : 16.0 TO 25.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
31.1	0								
30.4		8" Concrete							
		FILL: very stiff brown and gray lean clay w/sand seams, shell fragments and gravel				18			
		-reddish brown and gray 2'-6'				23			
	5								
25.1				83	113	18	43	18	25
24.1		Brown and gray FINE SAND (SP-SM) w/silt		11		13			
		Reddish brown and gray SANDY LEAN CLAY (CL)		59		19	32	15	17
21.1	10	-very stiff 8'-10'				16			
		Very stiff brown and gray FAT CLAY (CH) w/calcareous and ferrous nodules				20			
		-stiff to very stiff 12'-16'		92	100	29	51	22	29
	15								
15.1		Dense brown and gray SILTY SAND (SM)				22			
			30			23			
	20		32	19		23			
		-very dense 23.5'-25'							
6.1	25		85/5.0"			22			
	30								
	35								

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

0.5 1.0 1.5 2.0 2.5

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 16.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 6.0 FT.
HOLE OPEN TO 25.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-4

LOG OF BORING NO. GB-25 (GB-25P)

PROJECT : Pleasantville Drainage and Paving (Sub Project 1A)
WBS No. M-000286-001A-3
Houston, Texas

PROJECT NO. : 1140186903

LOCATION : N 13840492.23, E 3153250.21
Turning Basin Drive See Plan of Borings (Figure 2.3)

COMPLETION DEPTH : 25.0 FT.

SURFACE ELEVATION : 31.46 FT.

DATE : 07-21-14

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

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
31.5	0	8" Concrete							
30.8		FILL: stiff reddish brown and gray fat clay w/calcareous and ferrous nodules and ferrous stains -very stiff 2'-4' -stiff to very stiff 4'-6'				25			
	5					20			
		-very stiff 6'-12'		83	112	18	55	22	33
		-gray and brown 8'-10' -w/silt seams 8'-12'				20			
	10	-gray and brown 10'-12'				19			
19.5		Stiff to very stiff gray and yellowish brown LEAN CLAY (CL) w/sand, ferrous nodules, and ferrous stains				19			
17.5	15			85	107	21	39	18	21
15.5		Very stiff to hard reddish brown and gray FAT CLAY (CH) w/calcareous and ferrous nodules and ferrous stains				22			
	20					14			
		Very stiff to hard gray and brown SANDY LEAN CLAY (CL) w/sand seams and ferrous stains -hard 21'-25'		63	120	14	35	15	20
						16			
6.5	25					16			
	30								
	35								

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

NOTE :
See piezometer GB-25P for water level measurements.

DEPTH TO WATER IN BORING :
NO GROUNDWATER ENCOUNTERED DURING DRILLING.
▼: WATER DEPTH AT 8.2 FT., HOLE OPEN TO 25.0 FT. ON 08-22-14.

Geotest Engineering, Inc.

FIGURE A-5

LOG OF BORING NO. GB-26

PROJECT : Pleasantville Drainage and Paving (Sub Project 1A)
WBS No. M-000286-001A-3
Houston, Texas

PROJECT NO. : 1140186903

LOCATION : N 13840990.09, E 3153220.64
Turning Basin Drive See Plan of Borings (Figure 2.3)

COMPLETION DEPTH : 25.0 FT.

SURFACE ELEVATION : 31.20 FT.

DATE : 07-21-14

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

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

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
31.2	0	7.5" Concrete							
30.6		FILL: stiff dark gray fat clay w/calcareous nodules -stiff to very stiff 2'-4'				31			
						23			
26.2	5	Stiff gray and yellowish brown FAT CLAY (CH) w/ferrous nodules and ferrous stains -stiff to very stiff w/calcareous nodules 6'-10' -medium stiff w/crawfish hole 10'-12'				26			
				90	100	26	65	25	40
	10					27			
19.2		Hard gray and yellow LEAN CLAY (CL) w/sand, calcareous nodules, and ferrous stains -w/crawfish hole 12'-13'				35			
				71	119	15	37	15	22
	15					14			
13.2		Very stiff to hard reddish brown and gray FAT CLAY (CH) w/ferrous stains and calcareous nodules -brown and gray slickensided 21'-25'				15			
	20			88		20	61	24	37
6.2	25					19			
	30								
	35								

▽

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 25.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 20.6 FT.
HOLE OPEN TO 25.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-6

LOG OF BORING NO. GB-27

PROJECT : Pleasantville Drainage and Paving (Sub Project 1A)
WBS No. M-000286-001A-3
Houston, Texas

PROJECT NO. : 1140186903

LOCATION : N 13841485.47, E 3153191.84
Turning Basin Drive See Plan of Borings (Figure 2.3)

COMPLETION DEPTH : 25.0 FT.

SURFACE ELEVATION : 30.05 FT.

DATE : 07-21-14

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

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

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
30.0	0	8" Concrete							
29.4		FILL: dark gray and brown fat clay w/calcareous and ferrous nodules and ferrous stains -w/gravel 8"-2' -very stiff 2'-4' -stiff to very stiff 4'-6' -very stiff 6'-10'				27			
						26			
	5			88	107	23	57	23	34
						18			
20.0	10					20			
		Stiff gray and yellowish brown SANDY LEAN CLAY (CL) w/sand seams, calcareous and ferrous nodules, and ferrous stains		55	110	19	37	16	21
18.0									
16.0		Very stiff to hard reddish brown and gray FAT CLAY (CH) w/calcareous and ferrous nodules				20			
	15					16			
		Very stiff gray and yellowish brown LEAN CLAY (CL) w/sand, ferrous nodules, and ferrous stains -very stiff to hard 16'-18' -very stiff to hard gray and brown 19'-20'		73	120	16	32	15	17
						17			
10.0	20					17			
						28			
5.0	25	Very stiff reddish brown and gray FAT CLAY (CH) w/calcareous nodules				24			
	30								
	35								

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 25.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 19.3 FT.
HOLE OPEN TO 25.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-7

LOG OF BORING NO. GB-28

PROJECT : Pleasantville Drainage and Paving (Sub Project 1A)
WBS No. M-000286-001A-3
Houston, Texas

PROJECT NO. : 1140186903

LOCATION : N 13841985.45, E 3153159.51
Turning Basin Drive See Plan of Borings (Figure 2.4)

COMPLETION DEPTH : 25.0 FT.

SURFACE ELEVATION : 29.03 FT.

DATE : 07-21-14

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

ELEVATION, FEET	DEPTH, FEET	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
29.0	0			16.5" Concrete							
27.7				7.5" Lime Stabilized SANDY LEAN CLAY (CL)							
27.0				FILL: stiff to very stiff gray fat clay w/sand seams -w/silt seams and calcareous nodules 4'-10' -very stiff 6'-8' -stiff 8'-10'				20			
	5					81	107	20	57	23	34
								18			
19.0	10							23			
				Stiff yellowish brown and gray FAT CLAY (CH) w/ferrous nodules -w/silt seams 12'-14' -very stiff 14'-16'		91	96	29	66	25	41
								32			
	15							21			
13.0				Very stiff gray SANDY LEAN CLAY (CL) -hard 18.5'-20'		65	119	15	37	16	21
	20				36			20			
8.0				Very stiff reddish brown and gray FAT CLAY (CH) w/sand seams and ferrous stains				36			
4.0	25							32			
	30										
	35										

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

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 18.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 11.7 FT.
HOLE OPEN TO 25.0 FT. AT END OF DRILLING.

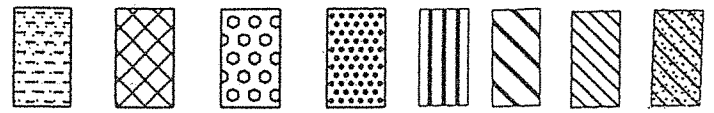
Geotest Engineering, Inc.

FIGURE A-8

Job No. 1140186903

SYMBOLS AND TERMS USED ON BORING LOGS

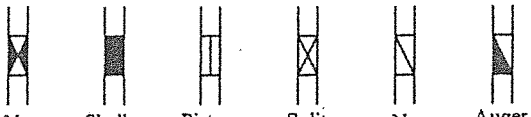
SOIL TYPES
(SHOWN IN SYMBOL COLUMN)



Asphaltic Concrete | Fill | Gravel | Sand | SILT | CLAY | LEAN CLAY | Sandy LEAN CLAY

Predominant type shown heavy

SAMPLER TYPES
(SHOWN IN SAMPLES COLUMN)



Pitcher Barrel | Nx Core | Shelby Tube | Piston | Split Spoon | No Recovery | Auger

TERMS DESCRIBING CONSISTENCY OR CONDITION

Basic Soil Type	Density or Consistency	Standard Penetration Resistance, (1) Blows/ft.	Unconfined Compressive Strength (q_u), (2) Tons/sq. ft.
Cohesionless	Very loose	Less than 4	Not applicable
	Loose	4 to <10	Not applicable
	Medium dense	10 to <30	Not applicable
	Dense	30 to <50	Not applicable
	Very dense	50 or greater	Not applicable
Cohesive	Very soft	Less than 2	Less than 0.25
	Soft	2 to <4	0.25 to <0.5
	Firm/Medium stiff	4 to <8	0.5 to <1.0
	Stiff	8 to <15	1.0 to <2.0
	Very stiff	15 to <30	2.0 to <4.0
	Hard	30 or greater	4 or greater

(1) Number of blows from 140-lb. weight falling 30-in. to drive 2-in. OD, 1-3/8-in. ID, split barrel sampler (ASTM D1586)

(2) q_u may also be approximated using a pocket penetrometer

TERMS CHARACTERIZING SOIL STRUCTURE

Parting: -paper thin in size Seam: -1/8" to 3" thick Layer: -greater than 3"

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 and 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 size missing.
Flocculated	- pertaining to cohesive soils that exhibit a loose knit or flakey structure.

Job No. 1140186903

PIEZOMETER INSTALLATION REPORT

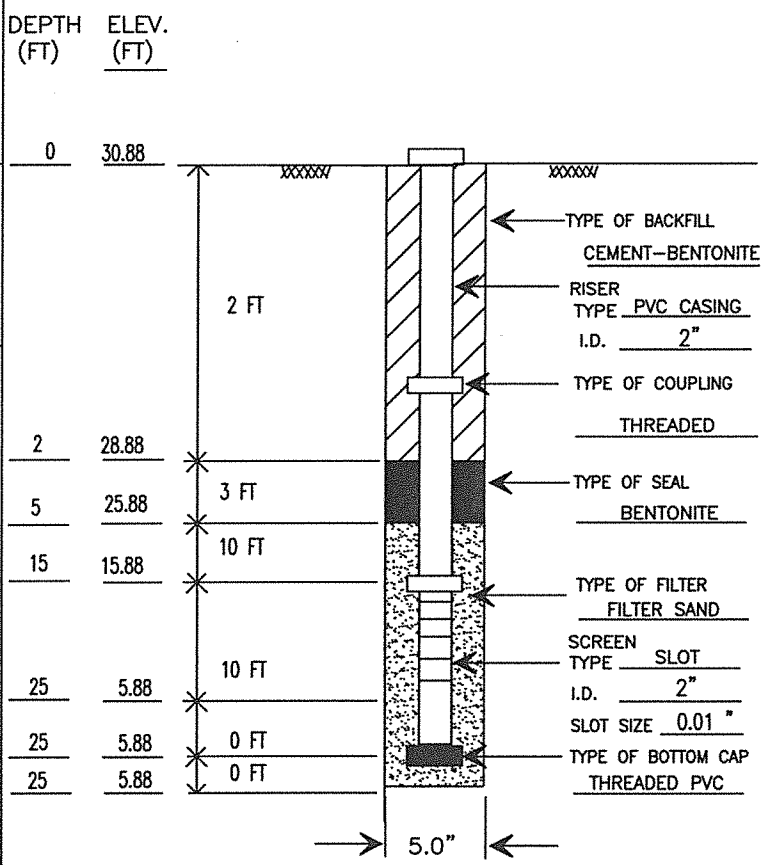
PROJECT NAME: PLEASANTVILLE DRAINAGE AND PAVING (SUB PROJECT 1A) WBS NO. M-000286-001A-3 HOUSTON, TEXAS		PIEZOMETER NUMBER: GB-22P
GEOTECHNICAL CONSULTANT GEOTEST ENGINEERING, INC.	DESIGN CONSULTANT HALFF ASSOCIATES, INC.	HOUSTON, TEXAS

COMPLETION DATE 07-22-14
DRY AUGERED 0 TO 21 FT
WASH BORED 21 TO 25 FT
DRILLING FLUID: WATER

DEVELOPMENT DATE: 07-22-14
METHOD OF DEVELOPMENT: BAILING

WATER LEVEL READINGS:

DATE	DEPTH (TOG)	ELEVATION
07-23-14	5.3	25.6
08-22-14	5.3	25.6



(NOT TO SCALE)

REMARKS:

NOTES:
1. DIMENSIONS NOMINAL UNLESS OTHERWISE NOTED
2. TOG = TOP OF GROUND

DRILLED BY: DG	STARTED: 07-22-14	NORTHING: 13837812.88 EASTING: 3153210.93
LOGGED BY: JG	COMPLETED: 07-22-14	GROUND LEVEL (MSL): 30.88
CHECKED BY: NK	APPROVED BY: MB	SHEET 1 OF 1

Job No. 1140186903

PIEZOMETER INSTALLATION REPORT

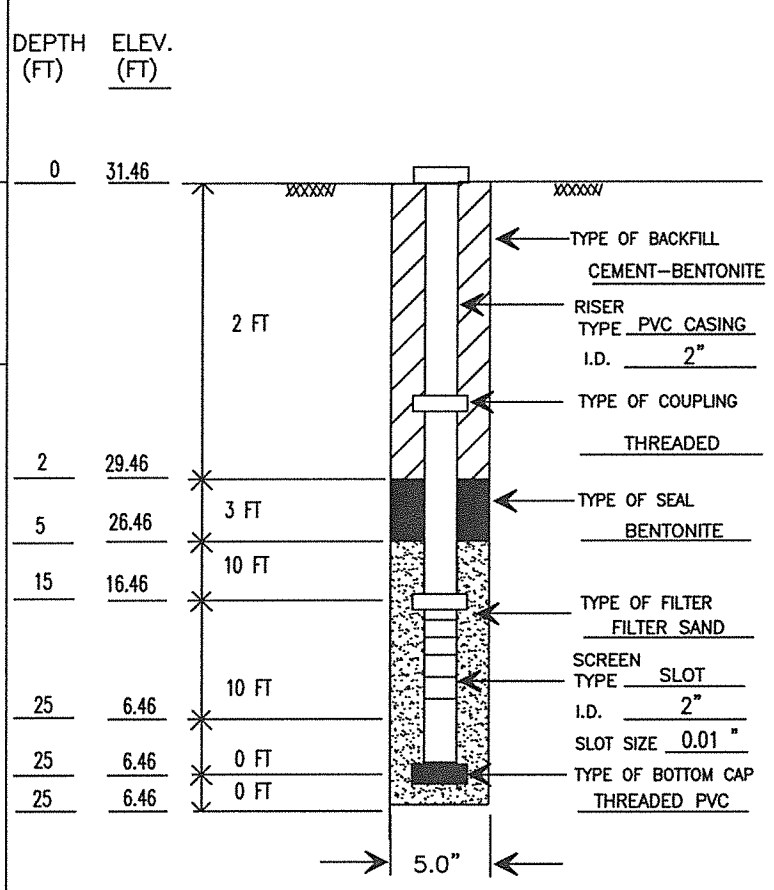
PROJECT NAME: PLEASANTVILLE DRAINAGE AND PAVING (SUB PROJECT 1A) WBS NO. M-000286-001A-3 HOUSTON, TEXAS		PIEZOMETER NUMBER: GB-25P
GEOTECHNICAL CONSULTANT GEOTEST ENGINEERING, INC.	DESIGN CONSULTANT HALFF ASSOCIATES, INC.	HOUSTON, TEXAS

COMPLETION DATE 07-21-14
DRY AUGERED 0 TO 25 FT
WASH BORED -- TO -- FT
DRILLING FLUID: WATER

DEVELOPMENT DATE: 07-21-14
METHOD OF DEVELOPMENT: BAILING

WATER LEVEL READINGS:

DATE	DEPTH (TOG)	ELEVATION
07-22-14	9.2	22.3
08-22-14	8.2	23.3



(NOT TO SCALE)

REMARKS:

NOTES:
1. DIMENSIONS NOMINAL UNLESS OTHERWISE NOTED
2. TOG = TOP OF GROUND

DRILLED BY: DG	STARTED: 07-21-14	NORTHING: 13840492.23 EASTING: 3153250.21
LOGGED BY: JG	COMPLETED: 07-21-14	GROUND LEVEL (MSL): 31.46
CHECKED BY: NK	APPROVED BY: MB	SHEET 1 OF 1

APPENDIX B

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Pleasantville Drainage and Paving (Sub Project 1A)
WBS No. M-000286-001A-3
Houston, Texas
PROJECT NUMBER: 1140186903

BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
GB-21	2	0.7	2.0	UD		13									1.00	2.25	Lean Clay
	3	2.0	4.0	UD		26									1.00	1.00	Fat Clay
	4	4.0	6.0	UD		27	101	64	25	39	92		0.83	0.43	0.88	1.00	Fat Clay
	5	6.0	8.0	UD		28									1.00	1.13	Fat Clay
	6	8.0	10.0	UD		30									1.00	0.75	Fat Clay
	7	10.0	12.0	UD		25	101						0.79	0.86	1.00	1.25	Fat Clay
	8	12.0	14.0	UD		24									1.25	1.50	Fat Clay
	9	14.0	16.0	UD		23									2.00	2.13	Fat Clay
	10	16.0	18.0	UD		20	112	31	16	15	96		0.75	1.30	1.00	1.50	Lean Clay
	11	18.0	20.0	UD		25									0.63	1.25	Lean Clay
	12	23.0	25.0	UD		20									0.20	0.50	Lean Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-1

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Pleasantville Drainage and Paving (Sub Project 1A)
WBS No. M-000286-001A-3
Houston, Texas
PROJECT NUMBER: 1140186903

BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
CB-22 (CB-22P)	2	0.7	2.0	UD		23									1.00	1.00	Fill
	3	2.0	4.0	UD		32	89	87	31	56	91		0.69	0.29	0.85	0.75	Fat Clay
	4	4.0	6.0	UD		33									0.80	0.75	Fat Clay
	5	6.0	8.0	UD		30									0.80	0.88	Fat Clay
	6	8.0	10.0	UD		37									1.00	1.00	Fat Clay
	7	10.0	12.0	UD		34									1.00	1.13	Fat Clay
	8	12.0	14.0	UD		29	93	76	28	48	99		0.86	1.01	1.00	1.38	Fat Clay
	9	14.0	16.0	UD		24									1.75	2.13	Fat Clay
	10	16.0	18.0	UD		22									1.25	1.75	Fat Clay
	11	18.0	20.0	UD		22									2.00	2.00	Fat Clay
	12	21.0	23.0	UD		27		66	25	41	94				1.50	1.50	Fat Clay
	13	23.0	25.0	UD		17									0.20	0.38	Lean Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-2

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Pleasantville Drainage and Paving (Sub Project 1A)
WBS No. M-000286-001A-3
Houston, Texas
PROJECT NUMBER: 1140186903

BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
GB-23	2	0.6	2.0	UD		28									0.85	0.75	Fat Clay
	3	2.0	4.0	UD		29									0.75	0.75	Fat Clay
	4	4.0	6.0	UD		32									0.65	0.75	Fat Clay
	5	6.0	8.0	UD		32	93	92	32	60	93		0.59	0.58	0.90	0.75	Fat Clay
	6	8.0	10.0	UD		30									1.13	1.25	Fat Clay
	7	10.0	12.0	UD		27									1.25	1.25	Fat Clay
	8	12.0	14.0	UD		21									2.50	2.25	Fat Clay
	9	14.0	16.0	UD		19									0.75	1.50	Lean Clay
	10	16.0	18.0	UD		22	104	40	19	21	99		0.78	1.30	1.25	1.38	Lean Clay
	11	18.0	20.0	UD		25									1.50	2.25	Lean Clay
	12	20.0	22.0	UD		17									0.50	0.63	Lean Clay
	13	23.0	25.0	UD		17									1.25	1.63	Lean Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-3

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Pleasantville Drainage and Paving (Sub Project 1A)
WBS No. M-000286-001A-3
Houston, Texas
PROJECT NUMBER: 1140186903

BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
GB-24	2	0.7	2.0	UD		18									1.00	1.25	Fill
	3	2.0	4.0	UD		23									1.00	1.13	Fill
	4	4.0	6.0	UD		18	113	43	18	25	83		1.00	0.43	1.00	1.25	Fill
	5	6.0	7.0	UD		13					11						Sand
	6	7.0	8.0	UD		19		32	15	17	59						Sandy Lean Clay
	7	8.0	10.0	UD		16									0.88	1.25	Sandy Lean Clay
	8	10.0	12.0	UD		20									1.00	1.38	Fat Clay
	9	12.0	14.0	UD		29	100	51	22	29	92		0.71	1.01	0.63	1.25	Fat Clay
	10	14.0	16.0	UD		22									0.63	1.25	Fat Clay
	11	16.5	18.0	SS	30	23											Silty Sand
	12	18.5	20.0	SS	32	23					19						Silty Sand
	13	23.5	25.0	SS	85/5.0"	22											Silty Sand

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-4

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Pleasantville Drainage and Paving (Sub Project 1A)
WBS No. M-000286-001A-3
Houston, Texas
PROJECT NUMBER: 1140186903

BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
GB-25 (GB-25P)	2	0.7	2.0	UD		25									0.70	0.75	Fill
	3	2.0	4.0	UD		20									1.00	1.13	Fill
	4	4.0	6.0	UD		18	112	55	22	33	83		0.88	0.43	1.00	1.00	Fill
	5	6.0	8.0	UD		20									1.00	1.00	Fill
	6	8.0	10.0	UD		19									1.00	1.00	Fill
	7	10.0	12.0	UD		19									1.38	1.63	Fill
	8	12.0	14.0	UD		21	107	39	18	21	85		0.55	1.01	1.00	1.38	Lean Clay
	9	14.0	16.0	UD		22									1.50	2.25	Fat Clay
	10	16.0	18.0	UD		14									1.13	2.13	Sandy Lean Clay
	11	18.0	20.0	UD		14	120	35	15	20	63		1.59	1.44	1.13	2.25	Sandy Lean Clay
	12	21.0	23.0	UD		16									2.25	2.25	Sandy Lean Clay
	13	23.0	25.0	UD		16									2.25	2.25	Sandy Lean Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-5

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Pleasantville Drainage and Paving (Sub Project 1A)
WBS No. M-000286-001A-3
Houston, Texas
PROJECT NUMBER: 1140186903

BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
GB-26	2	0.6	2.0	UD		31									0.45	0.38	Fill
	3	2.0	4.0	UD		23									1.00	0.88	Fill
	4	4.0	6.0	UD		26									0.85	0.75	Fat Clay
	5	6.0	8.0	UD		26	100	65	25	40	90		0.74	0.58	1.00	1.00	Fat Clay
	6	8.0	10.0	UD		27									1.00	0.88	Fat Clay
	7	10.0	12.0	UD		35									0.30	0.25	Fat Clay
	8	12.0	14.0	UD		15	119	37	15	22	71		2.02	1.01	2.13	2.25	Lean Clay
	9	14.0	16.0	UD		14									2.13	2.25	Lean Clay
	10	16.0	18.0	UD		15									2.50	2.25	Lean Clay
	11	18.0	20.0	UD		20		61	24	37	88				1.63	2.00	Fat Clay
	12	23.0	25.0	UD		19									2.13	1.50	Fat Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-6

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Pleasantville Drainage and Paving (Sub Project 1A)
WBS No. M-000286-001A-3
Houston, Texas
PROJECT NUMBER: 1140186903

BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
GB-27	2	0.7	2.0	AG		27											Fill
	3	2.0	4.0	UD		26									1.13	1.25	Fill
	4	4.0	6.0	UD		23	107	57	23	34	88		1.10	0.43	1.00	0.88	Fill
	5	6.0	8.0	UD		18									1.38	1.25	Fill
	6	8.0	10.0	UD		20									1.50	1.25	Fill
	7	10.0	12.0	UD		19	110	37	16	21	55		0.77	0.86	0.75	0.75	Sandy Lean Clay
	8	12.0	14.0	UD		20									1.75	2.13	Fat Clay
	9	14.0	16.0	UD		16									1.25	1.13	Lean Clay
	10	16.0	18.0	UD		16	120	32	15	17	73		1.54	1.30	1.63	2.00	Lean Clay
	11	18.0	19.0	UD		17									1.38	1.75	Lean Clay
	12	19.0	20.0	UD		17									1.50	2.00	Lean Clay
	13	20.0	22.0	UD		28									1.88	1.88	Fat Clay
	14	23.0	25.0	UD		24									1.88	1.88	Fat Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-7

SUMMARY OF LABORATORY TEST RESULTS

GEOTEST ENGINEERING, INC.

PROJECT NAME: Pleasantville Drainage and Paving (Sub Project 1A)
WBS No. M-000286-001A-3
Houston, Texas
PROJECT NUMBER: 1140186903

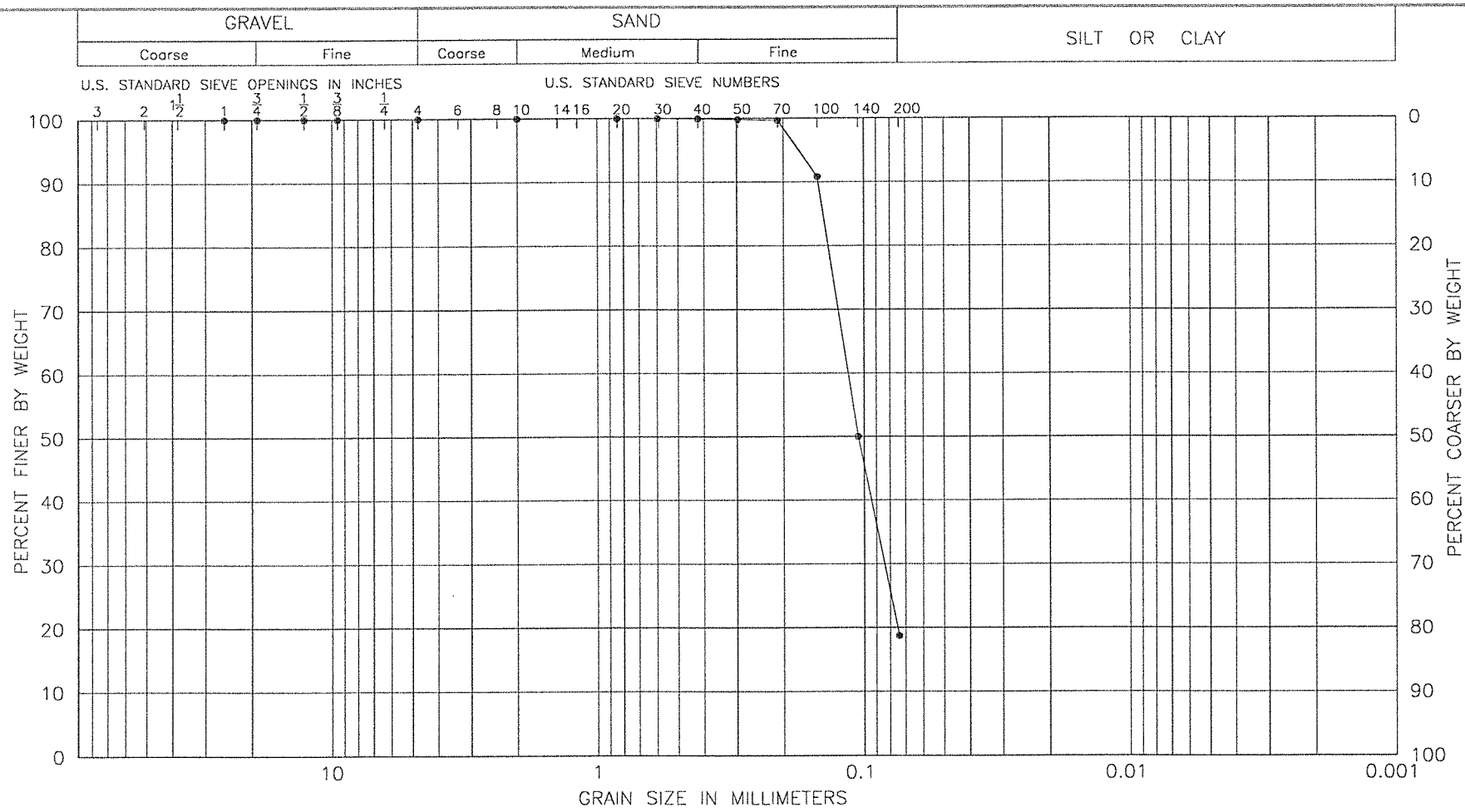
BORING NO.	SAMPLE				SPT (blows/ft.)	WATER CONTENT (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS			PASSING NO. 200 SIEVE (%)	UNCONFINED COMPRESSION TEST	TRIAXIAL COMPRESSION TEST (U-U)		TORVANE	POCKET PENE-TROMETER	TYPE OF MATERIAL
	No.	Depth (ft.) Top	Depth (ft.) Bottom	Type				LL	PL	PI		Shear Strength (tsf)	Shear Strength (tsf)	Conf. Press. (tsf)	Shear Strength (tsf)	Shear Strength (tsf)	
GB-28	3	2.0	4.0	UD		20									0.75	1.00	Fill
	4	4.0	6.0	UD		20	107	57	23	34	81		1.03	0.43	1.00	0.88	Fill
	5	6.0	8.0	UD		18									1.25	1.00	Fill
	6	8.0	10.0	UD		23									0.80	0.88	Fill
	7	10.0	12.0	UD		29	96	66	25	41	91		0.46	0.86	0.85	0.75	Fat Clay
	8	12.0	14.0	UD		32									0.55	0.50	Fat Clay
	9	14.0	16.0	UD		21									1.63	1.50	Fat Clay
	10	16.0	18.0	UD		15	119	37	16	21	65		1.02	1.30	1.38	1.00	Sandy Lean Clay
	11	18.5	20.0	SS	36	20											Sandy Lean Clay
	12	21.0	23.0	UD		36									1.13	1.50	Fat Clay
	13	23.0	25.0	UD		32									1.25	1.25	Fat Clay

LEGEND:
UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD
SS = SPLIT SPOON SAMPLE
AG = AUGER CUTTINGS
PB = PITCHER BARREL SAMPLE
Nx = Nx-DOUBBLE BARREL SAMPLE

SPT = Standard Penetration Test
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

FIGURE B-8

Job No. 1140186903



LEGEND	BORING NO.	SAMPLE NO.	DEPTH FT.	SAMPLE DESCRIPTION
●-●-●-●	GB-24	S-10	8.5-20.0'	Brown and gray silty sand

GRAIN SIZE DISTRIBUTION CURVES

Geotest Engineering, Inc.

FIGURE B-9

APPENDIX C

Log of Borings from Previous Study

LOG OF BORING NO. GB-15

PROJECT : Pleasantville and Glendale Area Drainage Improvements Project, Subproject 1; WBS No. M-000286-0001-3
Houston, Texas

PROJECT NO. : 1140186901

LOCATION : N 13840786.57, E 3152739.83
Maxine; See Plan of Borings (Figure 2.3)

COMPLETION DEPTH : 35.0 FT.

SURFACE ELEVATION : 29.63 FT.

DATE : 06-11-12

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 17.0 FT.
WET ROTARY : 17.0 TO 35.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
29.6	0	8" Concrete							
29.0		12.5" Sand w/sandy clay							
27.9		Stiff gray FAT CLAY (CH) -medium stiff to stiff 2'-4' -stiff 4'-6' -w/ferrous nodules 4'-8'		92		21 27	69	26	43
	5	-very stiff 6'-8'				26			
21.6		Very stiff yellowish brown and gray FAT CLAY (CH) w/sand, calcareous and ferrous nodules				26 24			
	10	-very stiff to hard 12'-14'		79	108	20	60	24	36
15.6						14			
	15	Very stiff to hard reddish brown and gray FAT CLAY (CH) w/calcareous and ferrous nodules				22			
13.6		Medium stiff to stiff yellowish brown and gray LEAN CLAY (CL) w/sand and calcareous nodules -stiff to very stiff 18'-20'		77	114	17	27	17	10
9.6	20					16			
		Very stiff to hard yellowish brown and gray FAT CLAY (CH) w/calcareous and ferrous nodules and sand seams		90	114	19	60	24	36
	25								
		-very stiff 28'-30'							
	30					19			
-5.4	35					19			

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

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 17.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 9.0 FT.
HOLE OPEN TO 35.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-15

LOG OF BORING NO. GB-16

PROJECT : Pleasantville and Glendale Area Drainage Improvements Project, Subproject 1; WBS No. M-000286-0001-3
Houston, Texas

PROJECT NO. : 1140186901

LOCATION : N 13840310.87, E 3152765.97
Maxine; See Plan of Borings (Figure 2.3)

COMPLETION DEPTH : 35.0 FT.

SURFACE ELEVATION : 30.22 FT.

DATE : 06-11-12

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 18.0 FT.
WET ROTARY : 18.0 TO 35.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
30.2	0	8" Concrete							
29.6		Stiff dark gray FAT CLAY (CH) w/calcareous and ferrous nodules -yellowish brown and gray 2'-6'				32			
						24			
	5	-w/sand 6'-10' -very stiff 6'-12' -reddish brown and gray 6'-16'		89	99	23	66	25	41
						18			
	10	-w/silt seams 10'-16'				18			
		-very stiff to hard 12'-16'				21			
						24			
	15					26			
14.2		Medium stiff to stiff yellowish brown and gray SILTY CLAY (CL-ML) w/sand and calcareous and ferrous nodules		73	113	18	23	16	7
	20					17			
		-very stiff to hard 23'-25'							
	25					17			
2.2		Medium stiff to very stiff reddish brown and gray FAT CLAY (CH) w/calcareous and ferrous nodules -slickensided 28'-30'		95	97	27	82	29	53
	30	-very stiff 33'-35'							
-4.8	35					25			

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

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 18.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 9.3 FT.
HOLE OPEN TO 35.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-16

LOG OF BORING NO. GB-17 (GB-17P)

PROJECT : Pleasantville and Glendale Area Drainage Improvements Project, Subproject 1; WBS No. M-000286-0001-3
Houston, Texas

PROJECT NO. : 1140186901

LOCATION : N 13839761.20, E 3152798.01
Maxine; See Plan of Borings (Figure 2.3)

COMPLETION DEPTH : 35.0 FT.

SURFACE ELEVATION : 30.40 FT.

DATE : 06-11-12

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 12.0 FT.
WET ROTARY : 12.0 TO 35.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
30.4	0	8.5" Concrete							
29.7		Stiff to very stiff gray and brown FAT CLAY (CH) w/sand, ferrous nodules, and ferrous stains -stiff 2'-8'				28			
						28			
	5			84	104	22	57	23	34
						23			
22.4		Stiff to very stiff reddish brown and gray FAT CLAY (CH) w/calcareous and ferrous nodules		87	103	23	51	21	30
20.4	10								
18.4		Stiff to very stiff gray and yellowish brown LEAN CLAY (CL) w/sand				20			
		Loose brown and gray SILTY SAND (SM)	8			18			
	15	-medium dense 16.5'-20'	9	20		20			
			27			19			
			23			18			
	20								
6.9		Medium dense gray FINE SAND (SP-SM) w/silt	13	5		22			
	25								
		-very dense 28.5'-30'							
	30		57			21			
-2.6		Very stiff to hard yellowish brown and gray LEAN CLAY (CL) w/sand							
-4.6	35					17			

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

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 12.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 3.8 FT.
▽: WATER DEPTH AT 3.4 FT., HOLE OPEN TO 35.0 FT. ON 08-02-12.

NOTE : See Piezometer GB-17P water level readings.

Geotest Engineering, Inc.

FIGURE A-17

LOG OF BORING NO. GB-18

PROJECT : Pleasantville and Glendale Area Drainage Improvements Project, Subproject 1; WBS No. M-000286-0001-3
Houston, Texas

PROJECT NO. : 1140186901

LOCATION : N 13840914.66, E 3153066.23
Industrial; See Plan of Borings (Figure 2.3)

COMPLETION DEPTH : 35.0 FT.

SURFACE ELEVATION : 31.92 FT.

DATE : 06-11-12

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 32.0 FT.
WET ROTARY : 32.0 TO 35.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
31.9	0	8" Concrete							
31.3		FILL: medium stiff to stiff yellowish brown fat clay w/calcareous and ferrous nodules -stiff 2'-8'		89		18			
	5					24	51	21	30
						24			
						27			
23.9		Medium stiff to stiff reddish brown and gray FAT CLAY (CH) w/ferrous nodules and sand seams		95	93	30	58	23	35
21.9	10								
		Very stiff reddish brown and gray SANDY LEAN CLAY (CL)		67		18	39	18	21
						22			
17.9		Stiff to very stiff reddish brown and gray FAT CLAY (CH), slickensided w/calcareous and ferrous nodules -very stiff 16'-18'		95	105	23	57	23	34
	15					14			
13.9		Very stiff yellowish brown and gray LEAN CLAY (CL) w/sand, calcareous and ferrous nodules		81	115	17	40	18	22
	20								
						16			
6.9	25	Very stiff yellowish brown and gray FAT CLAY (CH) w/calcareous nodules							
				94		18	53	22	31
	30								
						23			
-3.1	35								

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

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 32.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 31.3 FT.
HOLE OPEN TO 35.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-18

LOG OF BORING NO. GB-19

PROJECT : Pleasantville and Glendale Area Drainage Improvements Project, Subproject 1; WBS No. M-000286-0001-3
Houston, Texas

PROJECT NO. : 1140186901

LOCATION : N 13840931.52, E 3153553.50
Industrial; See Plan of Borings (Figure 2.4)

COMPLETION DEPTH : 35.0 FT.

SURFACE ELEVATION : 31.87 FT.

DATE : 06-11-12

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 35.0 FT.
WET ROTARY : -- TO -- FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
31.9	0	8.5" Concrete							
31.2		Very stiff to hard gray LEAN CLAY (CL) w/sand and grass roots				18			
29.9		Very stiff gray FAT CLAY (CH) w/sand, calcareous and ferrous nodules and ferrous stains				21			
	5	-gray and yellowish brown 6'-12'		85	105	19	50	21	29
						21			
	10	-slickensided 10'-12'				26			
19.9		Very stiff reddish brown and gray FAT CLAY (CH), slickensided w/calcareous and ferrous nodules				22			
		-very stiff to hard 14'-16'				24			
	15	-stiff to very stiff 16'-18'				22			
		-very stiff to hard 18'-35'		95	103	24	63	24	39
	20					20			
						20			
	25	-gray and yellowish brown 26'-35'							
						19			
	30								
-3.1	35					22			

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

0.5 1.0 1.5 2.0 2.5

DEPTH TO WATER IN BORING :
NO GROUNDWATER ENCOUNTERED DURING DRILLING.
HOLE OPEN TO 35.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-19

LOG OF BORING NO. GB-20

PROJECT : Pleasantville and Glendale Area Drainage Improvements Project, Subproject 1; WBS No. M-000286-0001-3
Houston, Texas

PROJECT NO. : 1140186901

LOCATION : N 13841512.32, E 3153624.50
Turning Basin; See Plan of Borings (Figure 2.5)

COMPLETION DEPTH : 35.0 FT.

SURFACE ELEVATION : 31.35 FT.

DATE : 06-11-12

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 8.0 FT.
WET ROTARY : 8.0 TO 35.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
31.4	0	8.75" Concrete							
30.6		FILL: stiff reddish brown and gray fat clay w/sand, shell fragments and calcareous nodules				21			
		-very stiff 2'-8'				18			
	5	-dark gray and brown 4'-8'				21			
		-stiff dark gray, brown and gray w/ferrous nodules 8'-10'		83	111	18	54	22	32
21.4	10	-w/silt seams 9'-10'				24			
		Stiff to very stiff gray and brown LEAN CLAY (CL) w/sand and calcareous nodules		76		19	46	20	26
		-very stiff 12'-14'				27			
	15	-medium stiff to very stiff 14'-16'							
		-w/ferrous nodules 16'-23'		71	105	24	38	18	20
		-very stiff 18'-20'				15			
	20					16			
8.4		Very stiff reddish brown and gray FAT CLAY (CH), slickensided w/calcareous and ferrous nodules and ferrous stains		92	105	24	77	28	49
	25	-yellowish brown and gray 27'-33'							
	30					22			
		-very stiff to hard brown and gray 33'-35'							
-3.6	35					20			

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

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 8.0 FT. DURING DRILLING; AFTER 10.0 MIN. AT 8.0 FT.
HOLE OPEN TO 35.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-20

APPENDIX D

TDLR Piezometer Well and Abandonment Reports

STATE OF TEXAS WELL REPORT for Tracking #375035

Owner:	**Geotest Engineering, Inc.**	Owner Well #:	**GB - 22P (1869)**
Address:	**5600 Bintliff Dr. Houston , TX 77036**	Grid #:	**65-22-3**
Well Location:	**Glendal Houston , TX 77029**	Latitude:	**29° 44' 47" N**
Well County:	**Harris**	Longitude:	**095° 15' 57" W**
Elevation:	**No Data**	GPS Brand Used:	**Lowrance XOG**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Date: Started: **7/22/2014**
Completed: **7/22/2014**

Diameter of Hole: Diameter: **5 in From Surface To 25 ft**

Drilling Method: Other: **Auger**

Borehole Completion: **Straight Wall**

Annular Seal Data:
1st Interval: **From 0 ft to 2 ft with 1/2 Portland (#sacks and material)**
2nd Interval: **From 2 ft to 5 ft with 1 Bentonite (#sacks and material)**
3rd Interval: **No Data**
Method Used: **Poured**
Cemented By: **Dempsey Gearen Jr.**
Distance to Septic Field or other Concentrated Contamination: **na ft**
Distance to Property Line: **na ft**
Method of Verification: **No Data**
Approved by Variance: **No Data**

Surface Completion: **Alternative Procedure Used**

Water Level: Static level: **8.08 ft. below land surface on 7/22/2014**
Artesian flow: **No Data**

Packers: **Homemade 5'**

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

Type Of Pump: **Other: none**
Depth to pump bowl: **(No Data) ft**

Well Tests: **Bailer**
Yield: **.25 GPM with (No Data) ft drawdown after (No Data) hours**

Water Quality:
Type of Water: **good**
Depth of Strata: **1 ft.**
Chemical Analysis Made: **No**
Did the driller knowingly penetrate any strata which contained undesirable constituents: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the

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

Company Information:	**Gearen Drilling** **32126 Rochen Rd.** **Waller , TX 77484**
Driller License Number:	**2836**
Licensed Well Driller Signature:	**Dempsey Gearen Jr.**
Registered Driller Apprentice Signature:	**No Data**
Apprentice Registration Number:	**No Data**
Comments:	**Piezometer**

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 #**375035**) on your written request.

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

DESC. & COLOR OF FORMATION MATERIAL

From (ft)	To (ft)	Description
0	**8"**	**Concrete**
8"	**2'**	**Dr G Clay**
2	**21**	**G & Br Clay**
21	**23**	**R Br Clay w Si Sand Seams**
23	**25**	**G Sa Clay**

CASING, BLANK PIPE & WELL SCREEN DATA

Dia.	New/Used	Type	Setting From/To
2	**New**	**PVC Blank**	**0 - 15 Sch 40**
2	**New**	**PVC Slotted**	**15 - 25 .010**

STATE OF TEXAS PLUGGING REPORT for Tracking #97742

Owner:	**Geotest Engineering, Inc.**	Owner Well #:	**GB - 22P (1869)**
Address:	**5600 Bintliff Dr. Houston , TX 77036**	Grid #:	**65-22-3**
Well Location:	**Glendal Houston , TX 77029**	Latitude:	**29° 44' 47" N**
Well County:	**Harris**	Longitude:	**095° 15' 57" W**
		GPS Brand Used:	**Lowrance XOG**

Well Type: **Monitor**

HISTORICAL DATA ON WELL TO BE PLUGGED

Original Well Driller: **Dempsey Gearen Jr.**

Driller's License Number of Original Well Driller: **2836**

Date Well Drilled: **7/22/2014**

Well Report Tracking Number: **375035**

Diameter of Borehole: **5" inches**

Total Depth of Borehole: **25' feet**

Date Well Plugged: **10/16/2014**

Person Actually Performing Plugging Operation: **Dempsey Gearen Jr.**

License Number of Plugging Operator: **2836**

Plugging Method: **Tremmie pipe cement from bottom to top.**

Plugging Variance #: **No Data**

Casing Left Data: 1st Interval: **0 inches diameter, (No Data) ft to (No Data) ft**
2nd Interval: **No Data**
3rd Interval: **No Data**

Cement/Bentonite Plugs Placed in Well: 1st Interval: **From 0 ft to 25 ft; Sack(s)/type of cement used: 1 1/2**
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:	**Gearen Drilling** **32126 Rochen Rd.** **Waller , TX 77484**
Plug Installer License Number:	**2836**
Licensed Plug Installer Signature:	**Dempsey Gearen Jr.**
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 #**97742**) on your written request.

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

STATE OF TEXAS WELL REPORT for Tracking #375036

Owner:	**Geotest Engineering, Inc.**	Owner Well #:	**GB - 25P (1869)**
Address:	**5600 Bintliff Dr.** **Houston , TX 77036**	Grid #:	**65-14-9**
Well Location:	**Glendal** **Houston , TX 77029**	Latitude:	**29° 45' 13" N**
Well County:	**Harris**	Longitude:	**095° 15' 56" W**
Elevation:	**No Data**	GPS Brand Used:	**Lowrance XOG**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Date:
Started: **7/21/2014**
Completed: **7/21/2014**

Diameter of Hole:
Diameter: **5 in From Surface To 25 ft**

Drilling Method:
Other: **Auger**

Borehole Completion:
Straight Wall

Annular Seal Data:
1st Interval: **From 0 ft to 2 ft with 3/4 Portland (#sacks and material)**
2nd Interval: **From 2 ft to 5 ft with 1 Bentonite (#sacks and material)**
3rd Interval: **No Data**
Method Used: **Poured**
Cemented By: **Dempsey Gearen Jr.**
Distance to Septic Field or other Concentrated Contamination: **na ft**
Distance to Property Line: **na ft**
Method of Verification: **No Data**
Approved by Variance: **No Data**

Surface Completion:
Alternative Procedure Used

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

Packers:
Homemade 5'

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

Type Of Pump:
Other: none
Depth to pump bowl: **(No Data) ft**

Well Tests:
Bailer
Yield: **0 GPM with (No Data) ft drawdown after (No Data) hours**

Water Quality:
Type of Water: **na**
Depth of Strata: **No Data**
Chemical Analysis Made: **No**
Did the driller knowingly penetrate any strata which contained undesirable constituents: **No**

Certification Data:
The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the

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

Company Information:	**Gearen Drilling** **32126 Rochen Rd.** **Waller , TX 77484**
Driller License Number:	**2836**
Licensed Well Driller Signature:	**Dempsey Gearen Jr.**
Registered Driller Apprentice Signature:	**No Data**
Apprentice Registration Number:	**No Data**
Comments:	**Piezometer. Water Level: Dry.**

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 #**375036**) on your written request.

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

DESC. & COLOR OF FORMATION MATERIAL

From (ft)	To (ft)	Description
0	**8"**	**Concrete**
8"	**12'**	**G & Br Clay**
12	**16**	**G & Y Si Clay**
16	**21**	**G & Br Sa Clay**
21	**25**	**R & Br & G & Y Clay**

CASING, BLANK PIPE & WELL SCREEN DATA

Dia.	New/Used	Type	Setting From/To
2	**New**	**PVC Blank**	**0 - 15 Sch 40**
2	**New**	**PVC Slotted**	**15 - 25 .010**

STATE OF TEXAS PLUGGING REPORT for Tracking #97743

Owner:	**Geotest Engineering, Inc.**	Owner Well #:	**GB - 25P (1869)**
Address:	**5600 Bintliff Dr. Houston , TX 77036**	Grid #:	**65-14-9**
Well Location:	**Glendal Houston , TX 77029**	Latitude:	**29° 45' 13" N**
Well County:	**Harris**	Longitude:	**095° 15' 56" W**
		GPS Brand Used:	**Lowrance XOG**

Well Type: **Monitor**

HISTORICAL DATA ON WELL TO BE PLUGGED

Original Well Driller:	**Dempsey Gearen Jr.**
Driller's License Number of Original Well Driller:	**2836**
Date Well Drilled:	**7/21/2014**
Well Report Tracking Number:	**375036**
Diameter of Borehole:	**5" inches**
Total Depth of Borehole:	**25' feet**

Date Well Plugged:	**10/16/2014**
Person Actually Performing Plugging Operation:	**Dempsey Gearen Jr.**
License Number of Plugging Operator:	**2836**
Plugging Method:	**Tremmie pipe cement from bottom to top.**
Plugging Variance #:	**No Data**
Casing Left Data:	1st Interval: **0 inches diameter, (No Data) ft to (No Data) ft** 2nd Interval: **No Data** 3rd Interval: **No Data**
Cement/Bentonite Plugs Placed in Well:	1st Interval: **From 0 ft to 25 ft; Sack(s)/type of cement used: 1 3/4** 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:	**Gearen Drilling** **32126 Rochen Rd.** **Waller , TX 77484**
Plug Installer License Number:	**2836**
Licensed Plug Installer Signature:	**Dempsey Gearen Jr.**
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 #**97743**) on your written request.

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