

**11.01 INTRODUCTION**

A. This chapter includes minimum geotechnical investigation requirements for design of utilities and streets. Utilities include water lines, wastewater systems, and storm water drainage conduits and open channels. Streets include design of street pavements.

B. This chapter is not intended to address tunnel projects.

**11.02 REFERENCES**

A. AASHTO - American Association of State Highway and Transportation Officials.

B. AREA - American Railroad Engineering Association.

C. ASTM - American Society for Testing and Materials.

D. OSHA - Occupational Safety and Health Administration.

E. TxDOT - Texas Department of Transportation, Foundation Exploration and Design Manual.

F. TNRCC - Texas Natural Resource Conservation Commission.

**11.03 INVESTIGATION REQUIREMENTS**

A. A geotechnical investigation is required prior to design under the conditions listed below. Data from earlier project design activities can be incorporated if sufficient and reliable for the current project. A geotechnical investigation by borings is required for design of:

1. Underground utilities using open cut methods.

2. Underground utilities to be augered beneath existing streets, pipelines, or other obstructions or structures.

3. Street paving.

4. Construction which could affect the integrity of adjacent structures, with the exception of utilities at a depth less than 5 feet, interconnections such as service connections, and meter vault installations.

B. Install piezometer(s) in a water bearing layer.

1. Read water levels 24 hours after initial installation and at 30 days just prior to removal and grouting.

2. Space piezometers no greater than 2500 feet apart.

C. The minimum geotechnical recommendations shall consist of the following:

1. Open cut Trenches: Bedding, backfill, excavation wall and bottom stability, thrust restraint, ground water control requirements at boring locations, dewatering method, and flexible pipe design parameters.

2. Auger Installation: Soil design parameters, ground stability, auger pit excavation stability, dewatering recommendation

3. Appurtenance: Bearing capacity, lateral earth pressures, excavation stability, dewatering

4. Open Channel: Slope angle or slope ratio, setback distance, and erosion protection.

D. All projects requiring a geotechnical investigation shall have a reconnaissance fault study to determine the potential for known active faults to impact the project. If the project is part of a larger tract for which a reconnaissance fault study is available, the results of the study on the larger tract will satisfy this requirement.

E. For privately funded subdivision development in the City or subdivision development in a utility district, when borings have been conducted for a master study of the development and development of an adjacent section has been conducted, subsequent design within sections of the master planned area may not require individual borings or a geotechnical report. The borings and report may not be needed if the project design provides for field verification of encountered conditions by direct supervision of a registered geotechnical engineer and provides for response to unexpected soil conditions encountered during construction and those responses are in accordance with City design standards.

#### **11.04 INVESTIGATION OF GRANULAR AND COHESIVE SOILS**

A. The borehole sampling and testing procedure shall include obtaining undisturbed Shelby Tube samples in cohesive soils and Standard Penetration Test Split Barrel samples in granular soils, if not otherwise required (see paragraph 11.05). Continuous sampling shall be performed to a minimum depth of 10 feet, and at 5 foot intervals below that depth. Additional samples shall be obtained at strata changes encountered within the standard 5-foot sampling intervals.

#### **11.05 INVESTIGATION CRITERIA**

A. Utility Line Projects. The frequency and depth of borings for utility line projects shall not be less than described below unless waived by the City Engineer. Bore an additional 5 feet if the last planned sample is in water bearing sand. Make borings within an offset distance of no more than 20 feet from the centerline alignment of the utility line or at the location of the proposed structure. Soil borings shall be made at a spacing not greater than 500 feet with additional boring at closer spacing to better define areas of inconsistent stratigraphy.

1. Open Cut Construction and Auger Pits:

<b>Table 1.1 REQUIREMENTS FOR BORING DEPTHS</b>		
<b>TRENCH WIDTH</b>	<b>TRENCH DEPTH</b>	<b>BORING DEPTH</b>
Up to 6 feet	All	Trench Depth + 5 feet
Greater than 6 feet and up to 10 feet	Up to 10 feet	Trench Depth + 5 feet
Greater than 6 feet and up to 10 feet	10 to 15 feet	Trench Depth + 10 feet
Greater than 6 feet and up to 10 feet	Greater than 15 feet	Trench Depth + 1.5 times trench width
Greater than 10 feet	All	Trench Depth + 1.5 times trench width

2. Augered Sections: Make boring depth to line depth plus 5 feet for lines up to 10 feet deep. For lines over 10 feet deep, make boring depth to line depth plus 10 feet.

**B. Water Line Projects.**

1. The frequency and depth of borings for water line projects shall conform to those listed in paragraph 1 1.05A, Utility Line Projects.

2. A geotechnical investigation is required for any waterline with nominal bedding depth greater than 5 feet or water line diameter greater than 20 inches.

**C. Wastewater Line Projects.**

I. The frequency and depth of borings for wastewater line projects shall conform to those listed in paragraph I 1.05A Utility Line Projects.

2. In addition, at least one boring must be made within 20 feet of the proposed center of a lift station. For lift stations 30 feet in diameter or larger, make one boring at the center; add borings around the periphery at maximum 50 feet spacing.

a. For City projects, the boring shall extend to:

(1) A depth of B below the bottom of the lift station, or

(2) A depth of 0.75 D below the bottom of the lift station, whichever is greater,

where:

B is the width of diameter of the lift station, and

D is the depth of the lift station or excavation.

b. For projects within the City's extra territorial jurisdiction (ETJ), the boring shall be to a minimum depth of 10 feet below the base of the structure.

3. For City projects, install a piezometer within 20 feet of the center of the lift station. For projects within the ETJ, install a piezometer within 20 feet of the center of each lift station location at which the groundwater level in the boring, measured at least 24 hours after drilling, is above or within 3 feet below the bottom elevation of the lift station. Read the water level again at 30 days after initial installation, then remove the piezometer and gout the hole.

4. Other Structures: A boring program shall be established by the owner and structural engineer in consultation with the geotechnical engineer.

D. Storm Drainage, Box Culverts, and Open Channels.

1. The frequency and depth of borings for storm drainage pipes and box culverts shall conform to those listed in paragraph 11.05A, Utility Line Projects.

2. Open Channels.

a. Soil borings shall be made at a spacing not greater than 500 feet with additional boring at closer spacing to better define areas of inconsistent stratigraphy.

b. Channel depth (D) less than or equal to 10 feet, extend boring D feet below the ditch bottom.

c. For channel depth greater than 10 feet and less than or equal to 20 feet, extend boring 10 feet below the ditch bottom.

d. For channel depth greater than 20 feet establish boring depth to provide sufficient geotechnical information for design.

3. Soils information for culverts in roadside ditches shall be obtained from soil borings made for the paving design, as described in paragraph

E. Street Paving.

1. Soil borings shall be made at a spacing not greater than 500 feet.

2. The depth of borings shall be at least 5 feet below the top of the curb for curb and gutter sections and 5 feet below the crown of the road for open ditch sections, or 3 feet below ditch invert, whichever is greater.

3. Rigid paving.

a. The minimum geotechnical recommendations shall consist of the following: Pavement thickness, including minimum reinforcing and minimum subgrade treatment, as required in Chapter 10, Street Paving Design Requirements.

4. Flexible paving.

a. Design Structural Number (SN), pavement thickness, subgrade treatment, as required in Chapter 10, Street Paving Design Requirements.

5. Rehabilitation recommendations.

#### **11.06 LABORATORY TESTING PROGRAM**

A. Laboratory Tests may include but not be limited to the following:

1. ASTM D 4318 Liquid Limit, Plastic Limits and Plasticity Index of Soils.
2. ASTM D 1140 Amount of Material in Soils Finer Than the No. 200 Sieve.
3. ASTM D 2216 Laboratory Determination of Water Content of Soil, Rock and Soil Aggregate Mixture.
4. ASTM D 422 Particle Size Analysis of Soils.
5. ASTM D 2487 Classification of Soils for Engineering Purposes.
6. ASTM D 2166 Unconfined Compressive Strength of Cohesive Soils.
7. ASTM D 2850 Unconsolidated Undrained Compressive Strength of Cohesive Soils in Triaxial Compression.
8. ASTM D 2435 One Dimensional Consolidation Properties of Soils.
9. ASTM D 698 Laboratory Compaction Characteristics of Soil Using Standard Effort.
10. ASTM D 1883 CBR (California Bearing Ratio) of Laboratory Compacted Soils.

#### **11.07 SURVEY REQUIREMENTS**

A. Within the public domain, the locations and elevations of boreholes and piezometers shall be determined by surveying. Elevation and coordinates shall be shown on boring logs. Station and offset shall be shown on boring logs for street projects and utility line work.

#### **11.08 SITE RESTORATION**

A. Site Cleanup along developed right of way. Clean the boring site by removing cuttings and mud and other debris. Fill ruts or pits in the ground to original conditions and elevation.

B. Abandonment of Borings and Piezometers.

1. Piezometer abandon in accordance with TNRCC Rules, Chapter 238 Well Drillers and Water Well Pump Installers..

2. Borehole: Backfill with cement grout using tremie method. For non paved areas and depths less than or equal to 10 feet, soil backfill tamped into the borehole is acceptable provided that the conditions and methods are in agreement with TNRCC Rules. Boreholes or piezometers installed in known contaminated areas, or in which contamination otherwise has been detected, shall be abandoned in accordance with the applicable provisions of TNRCC Rules, Chapter 238 Well Drillers and Water Well Pump Installers.

C. Restoration of Cores Through Pavement. Boreholes or other cored penetrations of pavements shall be restored with the same or equivalent materials as the existing pavement. Larger penetrations shall be repaired following City of Houston Standard Detail No. 02902 01, Pavement Repair Details. Do not restore the pavement until the borehole grout has taken initial set to allow for any settlement or shrinkage of the grout.

#### **10.09 GEOTECHNICAL REPORT**

A. A sample Table of Contents for a typical geotechnical report follows:

Summary

Field Investigation and Laboratory Testing

1. Introduction

2. Field Investigation

3. Laboratory Testing

Interpretive Report

4. Site Characterization

5. Design Criteria and Recommendations

6. Ground Faults

7. Construction Considerations

8. Monitoring

9. Earthwork Specification and Recommendations

Attachments

B. Geotechnical report for trench safety system shall be provided for all City of Houston projects with excavation over 5 feet deep. Report shall satisfy statutory requirements for contracting for trench safety construction.

**END OF CHAPTER**