

## APPENDIX E

### SUBSURFACE INVESTIGATION REQUIREMENTS FOR WATER AND SEWER DESIGN AND CONSTRUCTION

#### a. Soil Borings.

- 1) Washington Suburban Sanitary Commission (WSSC) normally determines the number and location of the soil borings. Locate borings for water mains 16-inch and larger with the concurrence of WSSC. The requirements for tunnel construction and subsurface tunnel investigations are specified in Part Three, Section 26 (Tunnel Design Criteria) and Appendix "F" (Soil Investigation Required for Soft Ground Tunnel Projects).
- 2) Boring depths and testing requirements.
  - a) For general water and sewer pipeline construction, all borings are to be carried to a depth of three feet below the proposed pipe invert, or to auger refusal. Space borings a maximum of three hundred (300) feet apart along all pipelines and locate additional borings at fittings, valves, etc. that require special thrust blocking design and at structure locations, such as valve vaults, manholes, etc. Extend the depth of these additional borings to ten (10) feet below the invert of the pipe. Where two pipelines are designed to be approximately parallel and separated by thirty five (35) feet or less, they may be considered as one pipeline when determining the number and spacing of borings, however, the depth of the borings will be determined by the invert elevation of the deeper pipeline. A minimum of two (2) borings per contract site is required.
  - b) Soil borings may be performed by hand or mechanical equipment or a combination thereof. The minimum boring diameter is 3-1/2-inch when using flight or hand augers and 2-1/2-inch inside diameter using casing or hollow stem augers. Standard penetration tests are to be performed at two and one half (2-1/2) foot intervals for the upper ten (10) feet of the boring, at each five (5) feet thereafter, at a change of material and at the bottom of the boring. Standard penetration tests are to be made using a 2-inch OD, split-spoon sampler (ASTM D 1586) driven by a 140-pound hammer falling freely 30-inch. The number of blows required to drive the sampler a total of 18-inch in 6-inch intervals shall be recorded as the penetration resistance.
  - c) When auger refusal is encountered before reaching the required boring depth, indicating the presence of rock, additional borings are required at one hundred (100) foot intervals in both directions along the proposed pipeline until a boring can be carried to three (3) feet below the pipe invert or the end of the pipeline is reached.
- 3) Sampling.
  - a) Provide jar samples of soil from each split spoon penetration. Provide screw on top, wide mouth glass jars or bottles at least 3-1/2-inch high and approximately 1-3/4-inch diameter at the mouth and the inside diameter of the jar should be no more than 1/4-inch larger than the mouth. Metal screw caps should contain a rubber or waxed paper gasket. Label each jar with the contract number, boring number, depth of the sample and penetration resistance in blows per 6-inch.
  - b) Collect a bag sample at the proposed pipe depth of sufficient quantity to perform soil resistivity testing if ferrous pipe materials will be used for the project and at least one bag sample of each soil type for compaction testing as specified under Laboratory Testing, in this section.



- 4) Groundwater observations. Measure and record the groundwater level of these intervals:
  - a) When first encountered during boring.
  - b) One half (1/2) hour after all augers, sampling equipment or casings have been removed from the boring.
  - c) Twenty four (24) hours after the boring completion.
- 5) Field testing for ferrous pipe materials. When required by the Corrosion Control Guidelines, Part Three, Section 28 (Corrosion Control), perform the following in-situ soil and groundwater testing for ferrous pipe materials:
  - a) Redox potential (ASTM D 1498) of soil at the proposed pipe depth.
  - b) Water-soluble chloride content (ASTM D 512) of soil at the proposed pipe depth. Chloride ion extraction using accepted industry methodology will be necessary prior to testing.
  - c) Carbon Dioxide (CO<sub>2</sub>) content (ASTM D 513) of groundwater, if present.

**b. Laboratory Testing.**

- 1) Determine the natural moisture content of all jar samples and report this information either on the boring logs or a separate sheet.
- 2) Perform the following:
  - a) Gradation analysis, liquid limit, plastic limit and shrinkage limit on at least one jar sample of each soil type (ASTM D 2487) encountered in the borings for each contract. Plot the gradation analysis on the WSSC or computer generated Gradation Curve Chart. Also report Atterberg Limits on this form.
  - b) Moisture-density relationship (ASTM D 698) on at least one bag sample of each soil type encountered in the borings for each contract. Plot the moisture-density relationship on the WSSC or computer generated Moisture Density Curve Chart.
- 3) If ferrous pipe materials are to be used, perform the following and provide this information on the boring logs or a separate sheet.
  - a) pH measurements (ASTM G 51) on the jar sample collected nearest the proposed pipe depth.
  - b) Soil resistivity measurements (ASTM G 57) on the bag samples collected at the proposed pipe depth.
- 4) Due to the common use of computer generated boring logs, gradation curves, etc., the lab has the option of using computer generated forms, provided that the format of the forms has been pre-approved by WSSC.



**c. Boring Logs.**

- 1) The logs for each boring must be completed in full, typed and contain the following information:
  - a) Penetration resistance of each split spoon sample.
  - b) Existing surface elevation.
  - c) Elevation and depth from surface to each soil stratum.
  - d) Elevation and depth of bottom of split spoon sampler at start of penetration test.
  - e) Depth and elevation of bottom of boring.
  - f) Visual description of each soil encountered, including: color, consistency/relative density, and soil description, including ASTM D 2488 designation.
  - g) Groundwater information.
  - h) Any bag samples, special observations, auger refusal or other pertinent remarks.
  - i) Coordinate values of boring location based on WSSC and Maryland coordinate systems.

**d. Submittals.**

- 1) Submit the soil data on unbound (except for staples or paper clips) white bond paper to:

WSSC (project manager and office), 14501 Sweitzer Lane, Laurel, Maryland 20707
- 2) Submittals for the soil data must be clean, legible and reproducible, submittals that do not meet these requirements will not be accepted.
- 3) Submittal requirements:
  - a) Submit three (3) copies of the boring logs, WSSC gradation curves, field moisture contents, if not included on boring logs and moisture density curves.
  - b) Map of boring locations or a copy of the construction plans with boring locations marked.
  - c) Soil resistivity and pH values if ferrous pipe materials are to be used. In-situ redox potential, chloride content of soil and carbon dioxide content of groundwater when required by Part Three, Section 28 (Corrosion Control).
  - d) Observation well readings.
- 4) A professional engineer registered in the State of Maryland must certify all data. The certification will state that the boring locations given on the boring log(s) are accurate within  $\pm 2.0$  feet, the surface elevation on the boring log(s) is accurate within  $\pm 0.5$  feet and the soil descriptions on each boring log were made after careful review of field boring data, visual inspection of the soil samples obtained therefrom and correlation with all laboratory test results.

