

**DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA**

**GEOTECHNICAL ENGINEERING BUREAU
SOIL SURVEY DRILLING AND SAMPLING GUIDELINES**

Drilling, Sampling and Special Notes

A. Introduction

The subsurface exploration for a proposed roadway identifies subsurface soils and features that will affect the construction and performance of the roadway. It is the intent of these guidelines to provide accurate and sufficient information to provide the Georgia Department of Transportation with an approved Soil Survey Summary. To provide such information, perform visual inspection of the entire roadway alignment and sampling.

Visual observations and tests shall include probing of wetlands and ditch lines, with all findings noted in a field book. Photos are also a good record of visual inspection. Perform sampling as described in these Guidelines.

Prior to developing a subsurface exploration plan, the Geotechnical engineer in charge of the project should have some idea of what they are looking for in the exploration. A good way to learn about an area is to examine the available data concerning the site. These sources of information may include:

- Topographic maps
- Aerial photos
- Existing boring data
- Examine roadway cuts in the area
- Geologic reports of the area
- Experience with soils in the area by DOT Geotechnical Engineers

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While looking at this information, the geotechnical engineer in charge of the project needs to answer the following questions:

- Do you anticipate encountering rock?
- Is the area in a Karst formation?
- Do you anticipate slope stability issues?
- Do you anticipate corrosive soils?
- Do you anticipate very soft, compressible soils?
- What variations in soil types do you anticipate?

This information will assist the geotechnical engineer in charge of the project in defining the type and intensity of drilling and sampling that will be required in the subsurface investigation plan. While different types of sampling can be performed, 60% of the samples should be taken as GDOT's 810.2 samples, as they are vital in determining what soils should be removed or wasted. While SPT borings are required for deep fills, the 810.2 samples also give the continuation and indication of poor soils along the whole project. They also indicate if the soils will need to be undercut, wasted or removed, and determine in the handling of the soils. The 810.2 samples are required both in cut sections and in fill sections.

The Georgia DOT has developed these drilling and sampling guidelines. Their drill crews have followed them for over 30 years. In some cases, these guidelines are very conservative, and, in some cases, the guidelines do not fully address the geotechnical engineer's need for adequate information. Note that the drill crews were using these guidelines without the direct assistance of a Geotechnical engineer. In view of this, these are general guidelines for the Geotechnical engineer's exploration plan. Some deviation from the guidelines based on the geology and consistency of the subsurface materials may be necessary.

B. Cut Sections

1. Drilling and Sampling Locations

- a. On four-lane projects on new alignment, take samples at the center of each direction of travel along the project alignment.
- b. On four-lane undivided projects, in areas of the state where soils are relatively consistent (especially in the Coastal Plain), the geotechnical engineer in charge of the project may determine that samples on the centerline may be taken, along with samples of the cut slopes. Please see Sampling Requirement (2a) below.

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- c. On two-lane projects on new alignment, take samples on the centerline. For road widening projects, take a sample in the center of the new lane(s).
- d. Drill to a depth of 5 feet below the proposed grade line. However, on projects that have side ditches in the Piedmont and Valley & Ridge Regions, where rock may be present in cuts, drill 5 feet below the ditchline(s). Note the presence of any standing or flowing water in the ditchline(s).
- e. When deep cuts are required to lay the slopes back, a boring every 300 feet is required. The sample locations should include one prior to the slope, and one after the slope. If slopes are on both sides of the alignment, then samples are required for both locations.
- f. When encountering rock, drill borings at 100-foot intervals in a grid pattern. If the rock elevation is relatively uniform, continue with this interval, to determine the extent of the rock. If rock elevations are not uniform, drilling at 50-foot intervals may be required. Contact the geotechnical engineer in charge of the project for further instructions.
- g. When observing rock, note the following characteristics in the field notes:
 - 1. layered or weathered
 - 2. boulders or rock outcrops
 - 3. drilling is hard or easy through the rock
 - 4. Mechanical refusal occurs.
- h. Estimate what will remove the rock - a bulldozer, ripper, light blasting or heavy blasting and note this in the field book.
- i. If large quantities of rock exist above grade on large areas of the project, notify the geotechnical engineer in charge of the project immediately. (The project designer may consider raising the grade under certain conditions.) To determine if slopes can be steeper than 2:1, rock cores are necessary. In general, rock should be cored with 5- or 10-foot runs. Note the orientation of the sample in relation to the slope on the rock core. If recommending steeper slope(s), note the strike and dip of the rock or provide oriented cores. Contact the geotechnical engineer in charge of the project for further instructions.

2. Sampling Requirements

- a. Cut samples should be taken every 300 feet. At the first drilling interval station, take a 20-pound bag sample at each different soil strata. Sample one side first, and if the material on the opposite side appears to be visually the same as at the first side, no additional sampling at that drilling interval station will be necessary. Note

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this in the field log. Mark the samples for 810.2 classification. In addition to the 20-pound bag, take a 1-pound bag for in-situ moisture content. See Sample and Labeling instructions below.

In addition, an experienced driller or the geotechnical engineer in charge of the project may determine that soils from subsequent borings are similar enough to the samples previously taken and reduce the number of samples from subsequent locations. The practice of reduction is limited to 1000 feet of continuous alignment. If similar soils to the previous samples, note in the field log. Other sources include geologic maps, previous test data, old reports, etc. Consult these sources before reducing sampling and testing.

- b. For cut slopes greater than 35 feet, the slope should be sampled at the toe of the slope with samples taken every 300 feet.
- c. Take a minimum 40-pound bag sample at intervals of one per 2000 feet on the centerline at a depth of 0 to 2 feet below the proposed grade. Mark the 40-pound samples for testing for Soil Support Value and 810.2
- d. If the project is within any of the following counties, take several (1-pound) soil samples from deeper cut sections, place in plastic bags and mark them for corrosion series testing.

Bartow	Bryan	Camden	Carroll	Chatham	Charlton
Cherokee	Fannin	Gilmer	Glynn	Gordon	Haralson
Heard	Liberty	McIntosh	Paulding	Pickens	Polk

3. Groundwater

- a. Note groundwater encountered during the drilling of all cuts. If none encountered, leave several drill holes unfilled but covered (for safety reasons), and make a 24-hour check of the groundwater table. Make a note what depth the groundwater was encountered and the time checked after drilling, or if no groundwater was found, or if the boring caved and what depth it caved at. After the 24-hour check, fill the hole and cover. Note all observations in the field book.
- b. If water is flowing in side ditches along the roadway in any of the counties noted in section B.2.d, take several (1-liter) samples from different locations and mark them for corrosion series testing.

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C. Fill Sections

1. Drilling and Sampling Intervals

- a. On four-lane projects on new alignment, drill borings between the top of slope and the toe of the slopes on the left and right sides along the project alignment.
- b. If the project is a widening, drill only on the side that has the new construction. If the project is a two-lane road on new alignment, drilling at the centerline will be required unless the fill heights result in a wide enough road footprint that two borings per station may be required.

If the footprint exceeds 100 feet wide, two borings may be required. Discuss with the geotechnical engineer in charge of the project. Also, consult other sources including geologic maps, previous test data, old reports, etc. to help determine whether one or two borings per station will be required. The geotechnical engineer in charge of the project may also provide additional guidelines for these situations. In addition, if there are visible, significant changes in the material type that may cause settlement problems with the roadway, drill at a frequency sufficient to represent the changes in material.

If the project is only a bridge replacement or bridge widening with less than 500 feet of approach fills, take at least two samples on each side of the bridge.

- c. When muck (very soft, organic silty clay or plastic silt) or other areas of very soft soils are encountered, drill or probe with hand tools at 100-foot intervals on the centerline, left and right sides if the depth of the muck is relatively uniform. If not uniform, drill or probe at 50-foot intervals on the centerline, left and right sides.

Notify the engineer of these areas as soon as possible, as Shelby tubes and vane shear or other in-place soil tests may be required. Collect Shelby Tubes in accordance with ASTM D1587. Place all notes in field book, noting the station, location and depth.

- d. If any landfills or trash dumps are present on the proposed alignment, notify the geotechnical engineer in charge of the project immediately.

2. Sampling Requirements

- a. Fill samples should be taken every 500 feet. At each drilling interval station, take an 810.2 (20-pound) bag sample. Sample the centerline first, and if the material on the left and right sides appears to be the same as at the centerline, no additional sampling at that interval will be necessary. If the material on the side(s) is significantly different, however, take a sample of it. Mark the samples for 810.2

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- classification. In addition to the 20-pound bag, take a 1-pound bag for in-situ moisture content. See Sample and Labeling instructions below.
- b. Where fill heights are relatively low (less than 15 feet), samples should be taken 5 feet below the existing grade. The 810.2 bag samples may be collected by hand auger or posthole. Probe the area to check for loose/soft soil conditions. Mark the samples for 810.2 classification.
 - c. For fills greater than 15 feet, take SPT samples (either mud rotary or auger) every 5 feet to a depth of approximately 1½ times the maximum fill height at that station. Place them in an appropriate jar. If very soft soils are encountered within 15 feet of the surface, Shelby Tubes should be taken. See labeling requirements in the GDOT Sample Labeling Guidelines. These samples should be marked for Unified Classification and submit the boring logs with the field book. Boring logs should include accurate surveyed ground elevations.
 - d. For fill slopes greater than 35 feet, take 810.2 bag samples at the toe of the existing slope that the new fill will be benched into. In addition, take 810.2 bag samples 5 feet below the station and location of planned top of embankment / maximum height of the fill. Fill samples should be taken every 500 feet.
 - e. However, if soft or unstable soils are present, drill to the bottom of these soils. (See also item C.1.d.). If the project has few or no cut sections, take a minimum 40-pound bag sample at intervals of one per 2000 feet on the centerline (See also item B.2.c.). Mark the samples for testing to obtain a Soil Support Value
 - f. If the project crosses areas of muck or very soft and/or wet soils, take 810.2 bag samples and a 1-pound soil sample for in-situ moisture, store in a sealed plastic bag. Mark the 1-pound soil sample for testing for in-situ moisture content, organic content and Unified Classification

3. Groundwater

If the project crosses a lake, pond, swamp, or other inundated area, probe the bottom of these areas to check for soft material and take several samples of the soils on the bottom of the inundated area. The samples should be tightly stored in a plastic bag. Mark and test these samples for Unified Classification.

Note groundwater encountered during the drilling of all high fills (Fill Heights 15 feet or greater). If none encountered, leave several drill holes unfilled but covered (for safety reasons), and make a 24-hour check of the groundwater table. Make a note what depth the groundwater was encountered, and the time checked after drilling, or

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if no groundwater was found, or if the boring caved and what depth it caved at. After the 24-hour check, fill the hole and cover. Note all observations in the field book.

D. Culvert Drilling Criteria

When performing soil surveys on projects that include culverts, SPT drilling must be performed at the culvert location. The drilling depth depends on the height of culvert and fill above it, and number of borings depend on length of culvert.

Culvert Drilling Depth - drill to a depth of 1.5 times the culvert height plus the maximum fill height above the culvert, if any.

Culvert Boring Frequency:

All culvert extensions with **no new fill or less than 5 feet of new fill** on the culvert -

- a. Perform a minimum of two borings, one at each end of the culvert if the culvert will be extended at both ends.
- b. If the culvert will be extended on one side of the existing culvert only, perform one boring within the footprint of the extension if it is less than 60 ft long, otherwise perform a minimum of two borings within the footprint of the extension.

All culvert extensions with **5 ft of fill or more** on the existing culvert as well as the new culvert extensions –

- a. If the culvert the extension is less than 60 ft long on either side of the existing culvert, at a minimum, perform one boring within 10 feet of the footprint of the existing culvert (do not drill through the existing culvert) and a boring within the footprint of the extension on each side.
- b. If the culvert extension is 60 ft long or more on either side of the existing culvert, at a minimum, perform one boring within 10 feet of the footprint of the existing culvert (do not drill through the existing culvert) and two or more borings within the footprint of the extension on each side. Add one additional boring for every 60 ft of culvert extension.

Note: If culvert extension footprint is not accessible, consult with OMAT for a case-by-case evaluation of the situation.

New location culverts - perform one boring for culverts less than 60 ft long. For culverts 60 ft long or more, perform two borings, one at each end. Add one more boring at the center for every additional 60 ft of culvert.

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Sampling Requirements

- a. Take SPT samples (either mud rotary or auger) every 5 feet to the appropriate depth as directed above. Place them in an appropriate jar. If very soft soils are encountered within the required drilling depth, Shelby Tubes should be taken. See labeling requirements in the GDOT Sample Labeling Guidelines. Submit the boring logs along with the field notes to the engineer of record. Boring logs should include accurate surveyed ground elevations and GPS coordinates (see more details in Special Notes below).
- b. Take a water sample for corrosion series testing. Use a clean, unused 1-litre bottle with a watertight sealing cap for sample collection. If the creek or stream is dry, then take soil sample for corrosion series testing. Samples should be at least 1-pound and placed in plastic bags that seal and reasonably prevent moisture seeping out.

E. Special Notes for All Projects

1. Include all field notes in the appendices of the Soil Survey report.
2. Make notes on any wells, whether they are on the plans or not. Note the Station number, offset from centerline, size, approximate depth, type of well (drilled, brick-lined, concrete-lined, etc.) and the approximate water level.
3. If any landfills or trash dumps are present on the proposed alignment, notify the geotechnical engineer in charge of the project immediately.
4. Make notes on any springs, streams or other bodies of water, whether they are on the plans or not. Note the Station number, offset from centerline and direction of flow. Note whether the spring appears to flow year round or is a wet-weather spring only.
5. Note if there are any wet-weather ditches, swamps or low wet areas on the project alignment.
6. If fills are located at the bottom of cuts or on existing grade, push Shelby Tubes in these locations for settlement evaluation if soft soils are present. See the GDOT Labeling Requirements.
7. If the project includes the construction of new pavement over existing paved shoulders, take samples (from the subgrade level to two feet below subgrade) below the paved shoulder at every third drilling interval. The samples should be

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- stored in a plastic bag and labeled for in-situ moisture content and Unified Classification testing.
8. Note any heavily forested areas in which large amounts of soil stripping will be required.
 9. Note the location of any trash piles, buildings or building foundations, caves or limesinks.
 10. Note if the project will pass through residential or commercial areas, which have buildings that will be relatively close to new construction, or buildings that are in poor condition. Take water samples (1-liter bottle) on each project at stream crossings or large cross-drain pipes. Mark the samples for corrosion series testing. If the streambeds are dry, take a 1-pound sample and place it in a plastic bag, and mark it for corrosion series testing.
 11. Note the size, type and condition of all cross-drain and other exposed pipes. Note the presence and depth of silt and debris blocking the drains.
 12. Note the type and condition of the pavement, and if there are any industries such as sawmills, truck stops, rock quarries, paper mills, etc. that would have frequent heavy truck traffic.
 13. Note any other problems or additional information that would be helpful in the foundation design or construction of the roadway.
 14. In addition to all drilling and sampling data, all 810.2, soil support, and SPT boring reports and/or logs should contain the project number and county, the date, the location, the driller's name, the type of drill used (i.e. truck-mounted Failing 250, CME 550 on ATV, etc.), the drilling method used (auger, rotary, etc.), the groundwater elevation, GPS coordinates for each sample/boring and all other notes relevant to the subsurface conditions. The GPS coordinates should be in decimal degrees to the precision of at least 5 decimal places and to the accuracy of 10 ft +/- . The driller should also include energy rating data for the hammer.

Note: SPT hammers must be calibrated once every 2 years and calibration data must be submitted as part of the deliverables on every project.

Note: Please refer to Chapter 1.1 of the GDOT Automated Survey Manual for project coordinate datum guidance.

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15. Provide for each project an individual PDF file per boring/sampling location for the SPT boring logs, the 810.2 lab test results and soil support lab test results. These lab test results should be identified by boring/sample number, station number, offset and depth of sampling. These should be considered a separate deliverable from the SPT borings logs, 810.2 and soil support lab test results included in the appendices of any SS report. The consultant report review request may be rejected if this deliverable is not included in the submittal package.

F. Laboratory Testing

The primary testing of soil survey samples from cut sections is according to the series of tests indicated in Section 810.2 of the Standard Specifications book. These tests include:

- Nos. 60 and 200 sieve analysis
- Maximum dry density
- Volume change (shrinkage and swell)
- Percent clay
- Optimum moisture content

The primary testing of samples from high fill sections should be in accordance with the Unified Soil Classification System (USCS) and includes, but is not limited to, the following:

- Washed gradation over a series of sieves
- Plasticity Index (PI) tests

The geotechnical engineer in charge of the project may require Plasticity Index test run on selected samples from cut sections. Other tests on select disturbed samples include, but are not limited to:

- Organic content
- In-place moisture content
- Corrosion series (pH and resistivity)
- Specific gravity

Depending on the sub-surface conditions and project requirements, some of the following tests may also be required at the discretion of the geotechnical engineer in charge:

- Consolidation
- Triaxial

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- Permeability
- Direct shear
- Rock unconfined compressive strength

Sample Types and Definitions

Bulk Soil Sample Types

Bags for Bulk Soil Samples are to be made of cotton or natural fibers and need to be strong enough to hold 40-pound samples and tightly stitched with closely woven fabric to prevent fine grain soils from leaking through the fabric. The bags should not be air tight, to allow the sample to dry before testing.

- 810.2 – 20 lbs. bulk soil sample to be placed in Cotton bag generally conforming to GDOT Standard Specification 881.2.04.
- Soil support – 40 lbs. bulk soil sample to be placed in Cotton bag generally conforming to GDOT Standard Specification 881.2.04.

Split Spoon (SPT) sample – wide mouth Jar with screw-on sealing lid, 16 oz. jars may be plastic or glass. Fill the sample jar, if not enough sample was recovered, note why on the boring log. Do not put SPT samples in plastic bags for GDOT for testing.

Shelby tube (Thin-walled Tube Sample) – 3-inch OD diameter by 36-inch length, per ASTM D1587, for soft clay or plastic silt. To ensure sufficient sampling, the driller must advance the Shelby tube the full length of the tube into the soil layer. Cap the tube for a watertight seal. Tubes must always be transported vertically and not allowed to tip or lay on their side.

Corrosion series (water) – Samples are to be collected in a new and clean 1-Liter bottle with a watertight sealing cap.

Corrosion series (soil) - If the project is within any of the following Counties, take several 1-pound soil samples from deeper cuts, place in plastic bags and mark them for corrosion series testing.

Bartow	Bryan	Camden	Carroll	Chatham	Charlton
Cherokee	Fannin	Gilmer	Glynn	Gordon	Haralson
Heard	Liberty	McIntosh	Paulding	Pickens	Polk

Samples should be at least 1-pound and placed in plastic bags that seal and reasonably prevent moisture seeping out.

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Moisture content, organic content and Unified classification (soil) - Samples should be at least 1 lb. and be placed in plastic bags which must seal and reasonably prevent moisture seeping in or out.

Rock Core – Perform coring with NQ sized drilling equipment, unless otherwise instructed by the geotechnical engineer in charge of the project. Save all core runs and label the boxes with the project number and county, boring number, depths and date. Label the top and bottom of the core runs with the beginning and ending depths. Do not break core runs to fit into boxes. If long boxes are not readily available and cores must be broken to fit into shorter boxes, note the locations of the breaks on the cores and on the drilling logs.

Water Sample – Samples taken at all stream crossings and culverts are to be submitted in a clean, unused 1-liter bottle with a watertight sealing cap.

GDOT labeling requirements for proper labeling of samples to be turned into GDOT for testing

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Appendix A

Associated Standard Practices

D6151 Standard Practice for Using Hollow Stem Augers for Geotechnical Exploration and Soil Sampling

D2113 Standard Practice for Rock Core Drilling and Sampling of Rock for Site Exploration

AASHTO T206 Standard Method of Test for Penetration Test and Split-Barrel Sampling of Soils

D6169/D6169M Standard Guide for Selection of Soil and Rock Sampling Devices Used with Drill Rigs for Environmental Investigations

D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils

D1452/D1452M Standard Practices for Soil Exploration and Sampling by Auger Borings

D1587/D1587M Standard Practices for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes

D5434 Standard Guides for Field Logging of Subsurface Explorations of Soil and Rock

D4220/D4220M Standard Practices for Preserving and Transporting Soil Samples

D2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)

D6032/D6032M Standard Test Method for Determining Rock Quality Designation (RQD) of Rock Core

The latest editions of the standards above should be followed for any lab tests performed.

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