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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This Chapter presents the responsibilities of the Geotechnical Design Squads (GDSs) within the South Carolina Department of Transportation (SCDOT). The GDSs are responsible for providing geotechnical engineering expertise in the areas of planning, design, construction, and maintenance for South Carolina’s bridges, roadways, and other transportation related structures and facilities. Geotechnical engineering is defined as the investigation and engineering evaluation of earth materials including soil, rock, groundwater, and man-made materials and their interaction with structural foundations, earth retaining structures, and other civil engineering works. General guidance is provided in this Chapter with reference to the geotechnical engineering services that the GDSs provide the SCDOT. Chapter 2 describes the geotechnical project coordination process within the Preconstruction phase of project development. Together, Chapters 1 and 2 provide the reader with an understanding of the necessary interaction among the various Units in coordinating the geotechnical involvement in typical road and bridge projects.

The GDSs perform design related services including development of field explorations and construction support. For design, the GDSs coordinate with the Office of Materials and Research in obtaining field and laboratory tests. In addition, the GDSs prepare bridge and roadway geotechnical reports for use by the Structural and Road Design Groups. Further, the GDSs review reports prepared by Consultants for technical content, and compliance with this Manual. The GDSs also review plans prepared by both the Structural and Road Design Groups as well as plans prepared by Consultants to assure that the geotechnical information provided has been properly interpreted. The GDSs also provide support to the Construction Office in review and acceptance of Contractor geotechnical submittals.

The following sections describe the geotechnical engineering services that the GDSs provide to the Preconstruction Division, SCDOT Units external to the Preconstruction Division, and to agencies outside of SCDOT.

1.2 PRECONSTRUCTION DIVISION

The Preconstruction Division is divided into 7 subdivisions. Four Regional Production Groups, a Preconstruction Support Group, the Right-of-Way Office, and the Surveys Office. The GDSs are part of the Structural Design Groups within the Regional Production Groups (RPGs). In addition, a GDS is also located within the Preconstruction Support Group (PCS/GDS). During the development of road and bridge design projects, the GDSs will coordinate the geotechnical subsurface investigation and then issue geotechnical reports with design recommendations to the Structural and Road Design Groups within each RPG.
1.2.1 **Regional Production Groups**

The RPGs provide engineering and project management for projects located within specific geographic areas of South Carolina. Figure 1-1 provides the geographic boundary of each RPG.

Each RPG consists of Program Development, Road, Structural, Hydraulic and Utilities Engineering Groups. The Road, Structural, Hydraulic and Utilities Engineering Groups report to the Design Manager, the Design Manager has overall responsibility for coordinating project designs. The GDS is part of the Structural Design Group, which is also comprised of Bridge and Roadway Structures Design personnel. The geotechnical services that the GDS provides the other squads within each RPG are described below.

1.2.1.1 **Program Development**

The GDS will work closely with Program Development and C Projects (non Federal-Aid) by being included in the Project Development Team on all projects that may require geotechnical design. The GDSs primary responsibility as part of the Project Development Team is to provide geotechnical expertise in all phases of the project development process. As part of the Project Development Team, the GDS coordinates the geotechnical subsurface investigation and provides geotechnical guidance and geotechnical designs with respect to:
The GDS provides its input by attending pre-design meetings, Project Development Team meetings, and participating in Design Field Reviews (DFR). In addition to these meetings, the GDS prepares two Preliminary Geotechnical Engineering Reports (PGER), one for the road and one for the bridge, Roadway Geotechnical Engineering Reports (RGER), and Bridge Geotechnical Engineering Reports (BGER), and geotechnical memoranda as needed.

1.2.1.2 Road Design

The GDS is responsible for developing a soil exploration program and preparing a PGER and RGER. The PGER provides general geotechnical recommendations based on limited soils information obtained from existing soil information and the preliminary subsurface investigation. The general geotechnical recommendations, from the PGER, are used to evaluate the DFR plans. After the DFR has been conducted, a detailed subsurface soil exploration program is conducted based on the required structures defined during the DFR. The RGER provides design recommendations for roadway earthwork and roadway structures. Roadway earthworks such as cut excavations and fill embankments are evaluated for stability and performance. Earthworks are designed under static and seismic loading conditions to meet the geotechnical design criteria presented in this Manual. The RGER is provided to the Road Design Group for inclusion of the GDS recommendations in the plans and specifications. The GDS provides stability (global, bearing capacity, sliding, etc.) and settlement analysis for fill embankments and cut sections. A detailed discussion of what should be included in a PGER and RGER is provided in Chapter 21. In addition to these geotechnical reports, the GDS may develop or assist in development of specifications and special provisions (Chapter 23) pertaining to soils, rock, ground improvement methods, earth retaining structures, and foundation systems.

The GDS also reviews geotechnical engineering calculations and plans prepared by Contractors, Consultants, or Suppliers to ensure conformance with SCDOT design standards and policies.

1.2.1.3 Structural Design

The GDS is responsible for developing a soil exploration program and preparing a PGER and BGER. The PGER provides general geotechnical recommendations based on limited soils information obtained from existing soil information and the preliminary subsurface investigation. The general geotechnical recommendations may be used to recommend foundation types, perform seismic evaluations, and assist in the establishment of tentative bridge lengths. After the DFR has been conducted, a more detailed subsurface soil exploration is conducted based on the bridge spans and anticipated foundation type. The BGER is used to design foundations.
for bridges and bridge related structures. Bridge foundations are designed for static and seismic loadings. Bridge foundation recommendations include foundation type and size, structural design information, and plan notes for construction drawings. Bridge related structures such as wing-walls, abutment walls, MSE walls, etc. are evaluated for stability, performance, and structural design. If stability or performance of these structures does not meet the geotechnical design requirements as presented in this Manual, geotechnical design recommendations are provided to the project manager/bridge designer. Foundation recommendations include foundation type (spread footing or deep foundation), stability (global, bearing capacity, sliding, etc.), and structure performance (settlements, displacements, etc.). Foundation recommendations for roadway structures such as retaining walls (fill walls and cut walls) and culverts (box and 3-sided) are provided by the GDS. Foundation recommendations would include foundation type (spread footing or deep foundation), stability (global, bearing capacity, sliding, etc.), and structure performance (settlements, lateral displacements, etc.). The BGER is provided to the Bridge Design Squad for inclusion of the GDS recommendations in the plans and specifications. The recommendations for roadway structures will be provided in either the BGER or the RGER depending on which set of plans will contain the structure (i.e. is the structure in the Bridge or Road Plans). A detailed discussion of what should be included in a PGER, BGER and/or RGER is provided in Chapter 21. In addition to these geotechnical reports, the GDS may develop or assist in development of specifications and special provisions pertaining to soils, rock, ground improvement methods, earth retaining structures, and foundation systems.

The GDS reviews geotechnical engineering drawings, geotechnical engineering calculations, specifications, and geotechnical engineering reports prepared by Contractors, Consultants, or Suppliers to ensure conformance with SCDOT design standards and policies. When the Contractor is responsible for designing a roadway structure (i.e. MSE wall, soil nailing, etc.) during construction, the Contractor is required to provide a geotechnical report prepared in accordance with the Manual. The report will be reviewed by the GDS for technical content and compliance with this Manual.

1.2.1.4 Hydraulic Engineering

The GDS is responsible for obtaining soil samples within potential scour zones and assigning laboratory testing for use by the Hydraulic Engineering Squad in evaluating the potential and magnitude of scour at bridge and hydraulic structures. In addition, the GSDs:

- Coordinate with Hydraulics and Structural Design Groups for bridge and culvert designs; and,
- Provide input, analysis, design recommendations, and/or review for slope protections in cases of moderate to severe erosion or erodability potential.

The Hydraulic Engineering Group is responsible for performing and/or reviewing hydrologic and hydraulic analyses on all projects for both roadway drainage appurtenances and bridge waterway openings. The responsibilities of the various engineering groups of the RPGs are as follows:

1. **Survey Request.** The Road Design Group is responsible for forwarding the Survey Request to the Hydraulic Engineering Group for its review and approval. This activity
generally occurs after the Program Action Request (PAR) has been prepared and routed to the appropriate personnel by the Design Manager.

2. Hydraulic/Scour Report. Any structures over a waterway require a Hydraulic/Scour Study. Once the general bridge location is known, the Structural Design Group will prepare a hydraulic request to the Hydraulics Engineering Group to conduct the necessary studies and prepare the applicable reports. Based on the hydrologic data collected and the preliminary plan and profile, the Hydraulic Engineering Group will perform the detailed hydraulic analysis for a bridge. The Report will provide the following information to the Structural Design Group:

- The necessary bridge waterway channel bottom width, side slopes, skew angle, and channel centerline station;
- National Pollutant Discharge Elimination System (NPDES) boundary information; and,
- The results of the hydraulic scour analysis.

1.2.1.5 Utilities Engineering

The Utilities Engineering Group is responsible for coordinating with utility companies impacted by highway improvement projects. The Utilities Engineering Group will coordinate between the GDS and local utility companies to resolve conflicts between borings and utility locations. In addition, GDS can provide the following services:

- Trench, temporary shoring, braced excavation design, review;
- Special provisions or Supplemental Specifications; and,
- Design, review, and/or guidance on backfill for pipes, sewers, storm sewers, lift stations, etc.

1.2.2 Preconstruction Support Group

A Geotechnical Design Squad is also located within the Structures Engineering Group of the Preconstruction Support Group (PCS/GDS). The PCS/GDS will be responsible for providing Quality Assurance services for geotechnical engineering products (i.e. reports and letters) that will be used to support engineering and construction projects. In addition, PCS/GDS will also be responsible for preparing and updating this Manual and other documents that will affect geotechnical engineering design procedures. Further, the PCS/GDS will lead training efforts within the various production oriented GDSs. The PCS/GDS will develop, recommend and oversee implementation of geotechnical engineering policies and procedures. The PCS/GDS will further provide technical support to the other GDSs.

1.2.3 Right-of-Way Office

The GDS is responsible for coordinating with the Right-of-Way Office to obtain Access Permission that allows the Department to conduct a geotechnical soil exploration on properties that are currently being acquired by the State. This typically occurs when a highway project is on a new alignment or where widening of a current alignment requires the acquisition of adjacent properties. In addition, the Right-of-Way Office will provide coordination with railroad
companies impacted by highway improvement projects. Railroad coordination must occur as early as practical in the project development process. The Right-of-Way Office will assist in the coordination with railroads to provide access for drilling equipment where the transportation structure crosses or is in conflict with the railroad.

1.2.4 Surveys Office

The Surveys Office is responsible for conducting aerial and field surveys for all Department projects. The Surveys Office will assist in locating all soil test-boring locations in the field both prior to and after completion of field services, if boring locations have been moved with the approval of the GDS. The Surveys Office shall obtain the approximate elevation and coordinates (latitude and longitude) of all testing locations. The Surveys Office shall provide this information to the Materials Geotechnical Engineer in the Office of Materials and Research.

1.3 SCDOT UNITS EXTERNAL TO PRECONSTRUCTION DIVISION

The GDSs also work and coordinate with other divisions of SCDOT. Listed below are the divisions that the GDSs work with:

- Planning
- Environmental Management
- Traffic Engineering Division
- Construction Division
- Maintenance Division
- District Offices

A brief description of the type of geotechnical engineering services that the GDSs provide these Divisions is provided below.

1.3.1 Planning

The Planning Office assesses the scope and cost of project alternatives for the Project Study Report. The Planning Office also works closely with Metropolitan Planning Organizations (MPOs) and Council of Governments (COGs) to develop long-range transportation plans for local areas. In addition, this office also focuses on the wider range of transportation projects, including not only highways, but also ports, railroads, and mass transit efforts. The GDSs interface with this office by providing literature searches of available geotechnical information, field reconnaissance, geologic mapping, and subsurface explorations. In addition, the GDSs may be requested to prepare geologic hazard commentary and data for use in project documents and, on request, address geologic hazard issues at public hearings.

1.3.2 Environmental Management

The Environmental Management Office is within the Planning Division and is responsible for a variety of activities related to environmental impacts and procedures. This includes air, noise, and water quality analyses; biological, archeological, and historical impacts; preparation of environmental documents for SCDOT projects; evaluation and mitigation of hazardous waste sites; and public involvement. In particular, the Environmental Management Office coordinates with the applicable Federal and/or State agencies for processing the permit information and
obtaining the agency approvals. The GDSs and the Environmental Management Office will coordinate to ascertain potential environmental impacts of drilling operations. The impacts include wetland impacts of drill rig access and potentials for soil and groundwater contamination that could be a health or environmental hazard.

1.3.3 Traffic Engineering Division

The Traffic Engineering Division provides a variety of traffic engineering services to other Departmental Units (e.g., traffic control devices, highway capacity analyses, traffic engineering studies). Where a bridge project involves the removal of an existing structure in a specific sequence during construction, the Structural Design Group will assist the Traffic Engineering Division in the development of the proposed Work Zone Traffic Control Plans; otherwise, the Traffic Engineering Division provides the Road Design Group with the required information. The Road Design Group then provides this information to the Structural Design Group when it becomes available. The GDSs will provide geotechnical services related to traffic engineering for Headquarter and District offices by:

- Providing foundation design and/or review for signs, traffic lights, and other structures; and,
- Coordinating traffic control with temporary shoring when necessary.

1.3.4 Construction Division

The Construction Division, in coordination with the District Offices, is responsible for all construction activities on all State maintained roads. This includes the development of specification, inspections and staffing, and approval of construction change orders.

The GDSs provide support to the Construction Division through the Resident Construction Engineer (RCE) during construction of the geotechnical portion of projects and assists in resolving situations resulting from soils and foundation problems. The GDS will also review significant features exposed during construction to compare actual conditions to those anticipated during design, and to make corrective recommendations as necessary. If Foundation Testing is required, coordinate the testing with the RCE. The following summarizes the coordination between the GDSs and the Construction Division:

1. **Shop Plans.** Contractors are responsible for submitting the required Shop Plans (e.g., structural steel, prestressed concrete piles, MSE wall, etc.) to the RCE who then forwards the Shop Plans to the Pre-Construction Support Engineer for distribution, review and approval. See Section 725 of the SCDOT Construction Manual and Chapter 24 – Construction QA/QC for more details on Shop Plans.

2. **Installation Plans.** Contractors are required to submit installation plans for certain types of construction (e.g. piles, drilled shafts, etc.). The installation plans are submitted to the RCE. The RCE forwards the plans to headquarters. The responsible GDS will review the plan for compliance with the appropriate specification on special provision (see Chapter 24 for more information).
3. **Temporary Structures.** If temporary structures are required on a project, the contractor shall submit design drawings for the temporary structure to the RCE. The RCE will forward the designs to headquarters for review and approval. All temporary designs that involve geomaterials will be reviewed by the responsible GDS for compliance to the specification on special provision (see Chapter 24 for more information).

4. **Value Engineering Proposals.** The Department encourages contractors to submit Value Engineering Proposals. Upon receipt, the RCE will contact the appropriate SCDOT offices to discuss the original design intent and the potential merits and cost savings of accepting the proposal. If approved by the Department, the Value Engineering Proposal will require the creation and proper execution of a Change Order.

5. **Constructability Reviews.** Selected projects may undergo a constructability review to ensure that a project is buildable, cost effective, biddable, and maintainable. A representative from the Central Construction Office is the Team Leader during all constructability reviews; however, the Structural Design Group is responsible for the organization of the review.

### 1.3.4.1 Bridge Construction

The GDSs review all in-house and consultant pile driving and drilled shaft installation plans. Provide assistance with constructability issues relating to bridge foundations, approaches, embankments, and approach slabs.

After the awarding of construction projects, the GDSs also works closely with the Construction Division to provide geotechnical construction support services.

### 1.3.4.2 Road Construction

The GDSs provide assistance with constructability issues relating to subgrade preparation beneath embankments, embankments, retaining walls, culverts, temporary retaining structures, and approach slabs.

After the awarding of construction projects, the GDSs also works closely with the Construction Division to provide geotechnical construction support services.

### 1.3.4.3 Materials and Research

The GDSs maintain an open line of communication with Materials Geotechnical Engineer. When necessary, any subsurface field investigations, requested by the GDSs will be forwarded to the Office of Materials and Research (OMR). The GDSs will:

- Coordinate with OMR to obtain subsurface investigations; and,
- Develop or assist in developing specifications and supplemental specifications pertaining to soils, rock, and/or foundation systems

### 1.3.5 Maintenance Division

The GDSs evaluate chronic, urgent and emergency situations resulting from geotechnical problems, such as landslide repairs, assist in the development of plans, specifications and estimates for projects to correct such conditions. Further the GDSs set the scope of geotechnical studies for the roadway portions of projects done by consultants, work with the
consultant in selecting appropriate analyses and design options, provide ongoing geotechnical review during the consultant’s work, and provide general technical oversight. In addition, the GDSs:

- Provide remedial design in cases of slope or embankment failure (including settlement analysis) and/or landslide;
- Provide input, analysis, design recommendations, and/or review for slope protections in cases of moderate to severe erosion or erodability potential;
- Provide input for subsurface investigation and laboratory soil analysis for maintenance bridge replacement;
- Provide foundation design for maintenance bridges, as required;
- Assist with analysis, design, and emergency action plan input in cases of bridge failure; and,
- Provide assistance with regard to constructability issues associated with bridge foundations, approaches, embankments, and approach slabs.

1.3.6 District Offices

The SCDOT is organized into a Headquarters and 7 Districts. In each District there is a District Engineering Administrator (DEA) that oversees the operations of the District Construction, Maintenance, and Traffic Engineering personnel. The GDSs provide geotechnical engineering support to the District Construction, Maintenance, and Traffic Engineers. The GDSs typically provide geotechnical engineering through the Headquarters coordinator for Construction (Bridge or Road), Maintenance, or Traffic Engineering.

1.4 FEDERAL HIGHWAY ADMINISTRATION

The Federal Highway Administration (FHWA) administers the Federal-aid program, which funds eligible highway improvements nationwide. Its basic responsibility is to ensure that the State DOTs comply with all applicable Federal laws in their expenditure of Federal funds and to ensure that the State DOTs meet the applicable engineering requirements for their proposed highway projects. FHWA maintains a Division Office within each State, and this Office is the primary point of contact for a State DOT.

The GDSs routinely confer with the following FHWA office regarding the following:

- **SC Division Office:** Complex geotechnical designs, geotechnical policies, specifications, supplemental specifications;
- **Office of Bridge Technology – Geotechnical Engineering:** Review of new procedures and completed designs; and
- **Resource Center – Geotechnical and Hydraulic:** Obtain new technologies that could impact projects. The impacts include reducing construction times and saving money.