Assuring Quality in Geotechnical Reporting Documents

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16. Abstract

This document presents information intended to assist users with effectively incorporating Quality Assurance (QA) into the preparation of Geotechnical Reporting Documents (GRDs), which includes reports and other documents that communicate geotechnical data, analysis and recommendations. This document draws extensively from Department of Transportation (DOT) experience across the United States. Interviews from several state DOTs were used as a basis for developing QA guidance and applying it to alternative contracting methods (ACM). This manual discusses the distinction between Quality Control (QC) and QA, and guidance is provided on the interactive process they play in the development of GRDs. The use of checklists and QA documentation is discussed in this document, and FHWA-ED-88-053 is referenced as a basis for developing agency/owner specific checklists.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards		0.765	m^3
		cubic meters NOTE: volumes		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
^{o}F	Fahrenheit		5 (F-	^{o}C
		32)/9	Celsius	
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
^{o}C	Celsius	1.8C+32	Fahrenheit	^{o}F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inc h	lbf/in^2

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

PREFACE

The documents used to communicate geotechnical site conditions, design and construction recommendations to bridge and roadway design, and construction engineers, and contractors bidding projects, are geotechnical reporting documents.

The purpose of this document is to provide a comprehensive guide for State DOTs and other transportation agencies to apply quality assurance procedures in the preparation and review of geotechnical reporting documents (GRDs). This includes communication procedures and suggested roles and responsibilities of the owner agency, consultants, and contractors, for a variety of GRDs, as well as different project delivery and contracting methods.

The distinction between Quality Control (QC) and Quality Assurance (QA) is discussed, and guidance is provided on the interactive process they play in the development of GRDs. This document does not include the application of a QA program to the preparation of contract plans or to construction activities, but it does discuss the importance of interaction and communication between design and construction staff, including the project geotechnical specialist during construction.

This guidance includes procedures for development of a QA plan for geotechnical reporting documents, which includes strategies for the review of geotechnical information for QA completeness.

This document considers Alternative Contracting Methods (ACMs) such as Design-Build (DB), and Construction Manager/General Contractor (CM/GC) that are being used, in addition to the standard Design-Bid-Build (DBB) method. It also takes into consideration that owner control of, and involvement in, a project varies with the project delivery method and contracting method used. Depending on the delivery method and contracting method used, QA can be the responsibility of the owner agency, the contractor, or a third-party agency and is often shared between the parties.

This document discusses the required and appropriate types and levels of communication between the owner agency and the entity preparing geotechnical reporting documents based on the contracting method and project delivery method. It also discusses appropriate content, organization, quality assurance and roles and responsibilities for the multiple types of contracting and project delivery methods and types of GRDs.

Finally, the use of checklists and QA documentation is discussed, including existing checklists, development of additional checklists for new technologies, the use of ACMs, and Alternative Delivery Methods (ADMs). These can be used by State DOTs and other transportation agencies in QA reviews of GRDs and serve as useful aides for agencies in efficient review and in assuring quality of GRDs. It is envisioned that these checklists may also be useful to anyone responsible for performing QC and QA reviews of GRDs.

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CHAPTER 1 – INTRODUCTION

1.1 OVERVIEW AND PURPOSE

This Guidance Document is intended to provide assistance to effectively incorporate Quality Assurance (QA) into the preparation of ***Geotechnical Reporting Documents (GRDs)***, which includes reports and other documents that communicate geotechnical data, analyses and recommendations. It addresses the quality of subsurface investigations, data summary and analysis of that information, the use of appropriate design analyses and the quality of those analyses, the incorporation of performance requirements and consideration of constructability in the development and implementation of design and construction documents. As part of this Guidance Document development, the current FHWA publications and their associated checklists have been reviewed, as well as more recent technical advances. Relevant and applicable considerations from these documents have been incorporated throughout.

Verification of QA of construction plans, while a critical component of an overarching QA plan, is beyond the scope of this document. Additionally, QA during construction, which is also critical to the successful completion of a project, is beyond the scope of this document. The importance of continued coordination between design and construction staff during plan development and construction is clearly acknowledged and considered important, particularly when subsurface conditions vary from those anticipated in design, or performance and monitoring requirements are included in construction documents.

GRDs can be of many types and formats. These can include, for example, Geotechnical Data Reports, Geotechnical Baseline Reports, Foundation Reports, Geotechnical Design Memos, as well as others that may be defined by owner agencies. Email specific to one or more design elements on a project and sufficiently thorough in their content may be suitable and acceptable under specific circumstances that are discussed in subsequent sections of this document. Regardless of the format used and who is preparing a GRD, appropriate Quality Control (QC) and Quality Assurance procedures must be followed.

Multiple GRDs can be necessary and required by the owner for many reasons, including, but not limited to, the owner's practices, program development and project phasing, modifications to the project scope and the use of alternative contracting or alternative delivery methods.

In 1979, the publication of "A Guide for In-house Review of Proposals and [Geotechnical] Reports" by the Association of Soil and Foundation Engineers (ASFE, 1979) was self-described as "The guideline materials prepared in support of the ASFE Report/Proposal Review Program are suitable for use by individual firms for in-house analysis of their own reports and proposals." This is believed to be one of the first significant efforts to bring an organized QA program to geotechnical investigations and reports. Quality Control and Quality Assurance have since become a more significant factor and an integral part of a QA program for work by other disciplines (roadway, structures, drainage, etc.), as well as for individuals involved in development of designs and construction documents.

It is important to understand the distinction between QC and QA in this process. There are many definitions that can be found in the related literature, as well as in the manuals of practice for Quality Management developed by transportation agencies. A broad definition of QC for GRDs could include checking of all subsurface information, analyses, specifications, details and special requirements for accuracy and their ability to meet the requirements provided by the owner or by the standards of practice, if not included in the owner's standards. These are discussed in Chapter 2 and elsewhere in this document. A broad definition of QA and QA Reviews for GRDs is the process by which QC is verified for those documents.

Often, an Independent Technical Review (ITR) may be performed for a specific design element on a project by an independent geotechnical specialist (GS) using the information available and the results compared with those developed by the project GS. ITRs of GRDs are not within the scope of this document; however, an ITR can be a valuable tool in the project QA program.

The publication by the FHWA in 1985 entitled "Checklists and Guidelines for Review of Geotechnical Reports and Preliminary Plans and Specifications," which was revised in 2003 (FHWA, 2003), carefully addresses the quality in Geotechnical Reporting Documents (GRDs), as well as the incorporation of that information into construction documents. That document incorporated eight checklists for specific geotechnical features as stated in the introduction.

The review checklists and technical guidelines can be classified as a component of the Quality Assurance process since they are provided to verify that the information in the GRD is accurate and adequate to meet or exceed project requirements and assist the highway and structural engineers in:

- Reviewing both geotechnical reports and plan, specification and estimate (PS&E) packages
- Recognizing cost saving opportunities
- Identifying deficiencies or potential contract dispute issues due to inadequate geotechnical investigation, analysis or design
- Recognizing when to request additional technical assistance from a geotechnical specialist

Since these checklists were introduced by FHWA, they have been widely used and, in some states, are still in use. According to various state DOT interviews conducted (see Appendix D), some DOTs have modified the FHWA checklists or developed their own requirements to be met, which are often specific to their conditions and needs.

For this document, geotechnical specialists (GS) are defined as “those individuals responsible for the geotechnical aspects of project design, construction and monitoring of geotechnical features for project design elements (structure foundations, earth retaining structures, ground improvement, earthworks, etc.).” These individuals could include geotechnical engineers, geologists and engineering geologists experienced working with the necessary project design elements. Those developing and responsible for the GRDs should be registered professionals in accordance with the requirements of the states in which a project is located.

The more recent development and increased use of ACMs and the phased design development process by different parties (ADMs), along with the associated demanding project schedules create a much more complex interaction between owners and their designers, as well as contractors. Further complicating the situation, these services are often being performed and/or modified in one area of a project as construction is underway on another component of work. The current direction of the transportation industry to more heavily rely on ACMs requires heightened focus on Quality Assurance by all parties involved in developing and delivering the project.

The key components, tasks and objectives of this document include, as a minimum:

- Development of an outline of the work elements/tasks and parties involved in the various ADMs and ACMs including their relationships, roles and responsibilities from the project development phase to completion of documents for construction, with a focus on geotechnical reporting documents (GRDs)

- Completion of a specific review and summary of the owner agency’s role in preparing bidding documents that assures quality of geotechnical features throughout the entire process from project development to construction

- Incorporation of considerations associated with the owner agency’s need to assure quality in geotechnical reporting documents when using all forms of ADMs and ACMs, including Alternative Technical Concepts (ATCs) and other similar contracting tools

- Discussion and guidance on types and levels of communication between owner agencies and the entity preparing the GRDs

- Discussion of the appropriate content and organization, quality assurance, roles and responsibilities for the various ACMs and the types of GRDs

- Guidance for development of checklists that can be used by State DOTs and other transportation agencies in reviewing GRDs

QC and QA during construction (implementation of the plans and specifications) are not addressed within this document.

1.2 DEFINITIONS AND KEY TERMINOLOGY

Alternative Contracting Methods (ACMs) – Methods used by owner agencies to contract for design and construction of highway projects. Methods include, but may not be limited to, Design-Bid-Build (DBB), Design-Build (DB), and Construction Manager/General Contractor (CM/GC).

Alternative Delivery Methods (ADMs) – Methods used to perform geotechnical engineering work and provide Geotechnical Reporting Documents (GRD) for highway projects. This could include, for example, in-house work by owner agency geotechnical staff, in-house work by geotechnical staff from a full-service Architectural/Engineering (A/E) firm, or work subcontracted to consultants specializing in geotechnical engineering.

Construction Plan Development – The project development phase which includes preparation of Plans, Specifications and Estimates for construction of a project.

Construction Manager/General Contractor (CM/GC) – The CM/GC ACM consists of two phases: design and construction. The owner contracts with a design engineer and a contractor and provides coordination during design. The contractor acts as the construction manager during the design process and offers constructability and pricing feedback on design options, as well as identification of risks based on the contractor's established means and methods. This process also allows the owner to be an active participant during the design process and make informed decisions on design options. When the owner considers the design to be complete, the contractor then has an opportunity to bid on the project based on the completed design and schedule. If the owner, designer and independent cost estimator agree that the contractor has submitted a fair price, the owner issues a construction contract, and the construction manager then becomes the general contractor. An alternative for the owner would be for the contract to be bid based on the plans developed.

Design-Bid-Build (DBB) – This is the traditional contracting method in which the project design for all project elements is taken to the 100% level resulting in plans and specifications for construction that are used for bidding. The geotechnical investigation is taken to the 100% level and one or more GRDs are developed to provide final recommendations for all design elements. Contractors are invited to offer bids for the project, and the owner typically awards the contract to the lowest bidder qualified to execute the work. Construction begins after award. Allowance is often made for offers of Alternative Technical Concepts (ATCs) by the contractor on some design element with the intent of providing a cost savings to the owner while still meeting the objectives of the project design. Value Engineering (VE) proposals are also generally accepted during the bid phase, as well as during the Construction Phase, with an objective similar to the ATC and a sharing of cost savings provided with the proposal, if accepted.

Design-Build (DB) – With this ACM, the project design is taken to about the 30% level, which may also be called Preliminary Design, after which selected contractors are invited to prepare price proposals for the projects based on the preliminary plans and the project requirements outlined in the contract documents provided. The scope of the geotechnical investigation performed for the Bid Phase varies based on owner approach and may be to the level required for Preliminary Design or Final Design. Results are provided in a Geotechnical Data Report (GDR) or possibly a Geotechnical Baseline Report (GBR). The bidding contractors select an engineering team to develop the design to an adequate level that allows submission of their bid based on available information carried forward during the Bid Phase. Selection of a successful proposal may be based on low price or the Best Value rating system that considers the price as well as qualifications of the contractor and the design engineer, as well as other factors. Final Design and construction are completed by the successful bidder after selection. Projects may use a Public-Private-Partnership (P3) as a method to finance a DB project. P3 projects routinely include a combination of public and private funding, a concession and operations component, preservation requirements and warranties. A P3 is not considered an ACM within this document.

Design Consultant – Individual or firm who is under contract to provide engineering services to owner agencies, other consultants or contractors.

Geotechnical Baseline Report (GBR) (ASCE, 1997) – An interpretative report of geotechnical conditions for a project that is included in contract documents. Its primary purpose is to establish a contractual statement of the geotechnical conditions anticipated to be encountered during project construction. Risks associated with conditions consistent with or less adverse than the baseline are allocated to the contractor, and those significantly more adverse than the baseline are accepted by the owner. An additional purpose of the GBR is that it presents the geotechnical and construction conditions that form the basis for design.

Geotechnical Data Report (GDR) (ASCE, 1997) – A report which summarizes factual geotechnical information obtained for a project and is included in the contract documents. The document includes, but is not limited to, a summary of desk study research, field investigations, laboratory testing and other information obtained for the project without providing design or construction recommendations. This document can also be provided in other formats, including a memorandum.

Geotechnical Features (FHWA, 1997) – Structure foundations, retaining walls, bridge approach embankments, landslides, ground improvement techniques, material sites (borrow sources, quarries).

Geotechnical Report (GR) (FHWA, 2003) – A tool used to communicate the site conditions and design and construction recommendations to the roadway design, bridge design and construction personnel.

Geotechnical Reporting Documents (GRD) – Documents used to communicate geotechnical site conditions, design and construction recommendations to the engineers designing project elements including bridges, roadways, drainage, etc., and construction engineers, and the contractors bidding the work, are geotechnical reporting documents. These documents take many forms, including: Geotechnical Data Reports, Geotechnical Engineering Reports, Foundation Investigation Reports, Geotechnical Baseline Reports, Foundation Reports and Geotechnical Design Memos, emails, among others. Quality Assurance must be incorporated into the preparation of all geotechnical reporting documents.

Geotechnical Specialist (GS) – The individual responsible for the geotechnical aspects of project design, construction and monitoring of geotechnical features for project design elements (structure foundations, earth retaining structures, ground improvement, earthworks, etc.). The GS could include geotechnical engineers, geologists and engineering geologists experienced with the necessary project design elements. Typically, the GS who develops the GRD is required to be registered in the project state if the owner is a Department of Transportation.

Owner Agencies – State Departments of Transportation and other transportation agencies responsible for coordination and control of contracts to design and construct highway projects.

Project Design Development – All engineering work associated with development of designs for highway projects including, but not limited to, conceptual studies, preliminary design, and final design resulting in the completion of plans and specifications for construction. Each of these components could be characterized as part of the design phase of project development.

Quality Assurance – All planned and systematic activities implemented within the quality system that verifies a product or service fulfills quality requirements.

Quality Assurance Audits – Reviews by Geotechnical Specialists or trained specialists in Quality Assurance procedures that verify the Quality Assurance Reviews have been completed.

Quality Assurance Reviews – The process of reviewing Quality Control documentation to verify those activities have been performed.

Quality Control – The operational techniques and activities used to verify requirements for quality.

Special Service Consultants – Individuals or engineering firms that specialize in specific project elements utilized in highway construction including, but not limited to, earthworks, foundations, retaining walls, ground improvement and geotechnical aspects of pavements (drainage, subgrades and unbound pavement courses). This would also include, for example, corrosion, seismic and constructability specialists.

1.3 DOCUMENT ORGANIZATION

This document is organized as follows:

Chapter 1 – Introduction, This chapter is an introduction to the objectives of this document, including the background and history leading to the current means and methods being used to design and construct transportation projects. It also addresses the history of incorporating Quality Assurance into transportation projects, focusing particularly on geotechnical reporting documents developed in this process. This chapter provides definitions of key terminology used in the document.

Chapter 2 – Content and Quality Assurance of Geotechnical Reporting Documents, This chapter describes the types of GRDs and their content, as well as the Quality Assurance process.

Chapter 3 – Considerations in Development of Geotechnical Reporting Documents, This chapter includes a discussion of factors considered in the document and introduces ACMs as a key change to traditional practice. Principal methods in use are defined and described, including the project design development process and the geotechnical reporting documents relative to the ACMs. Flow charts are utilized to illustrate the relationships.

Chapter 4 – Implementation of Quality Assurance for Geotechnical Reporting Documents, This chapter introduces the development and use of checklists as part of the Quality Assurance process including those available from the FHWA, their use, their timing in the project schedule, communications involved and the responsibilities of the parties involved. This chapter also introduces results of surveys conducted with a number of State DOTs regarding their Quality Assurance practices and procedures for GRDs including considerations related to procedures for ACMs. This chapter discusses relevant aspects of interviews with State DOTs regarding this document's objectives and their practices.

CHAPTER 2 – CONTENT AND QUALITY ASSURANCE OF GEOTECHNICAL REPORTING DOCUMENTS

2.1 INTRODUCTION

This chapter discusses the content, organization, and types of GRDs that would be generated using the Alternative Contracting Methods (ACM) discussed in this document. This discussion includes the scope and methods of associated investigations, analyses and the recommendations that are developed, as well as their incorporation within construction documents. This includes discussion of quality assurance in the development and use of GRDs.

The content and formats for GRDs can vary depending on many factors, including the project scope, project schedule and the ACM used. The intent is to document and communicate information from the Geotechnical Specialist (GS) to others involved in delivery of a project. The information can vary from a summary of purely factual data and observations to one which includes analyses and design recommendations based on the data. Each GRD is created for one or more purposes and, therefore, is intended for a specific audience.

The purposes of GRDs are, as a minimum, to:

- Provide information used during project programming to establish the scope of work for projects with significant geotechnical features (e.g., landside mitigation)
- Provide project management personnel and owners an adequate pre-construction understanding of impacts that geotechnical considerations will/may have on cost and schedule, as well as other project considerations such as environmental, traffic and constructability
- Provide design disciplines with the geotechnical information they need to develop their designs, as well as construction plans and specifications
- Provide contractors with the information they need to develop a complete and competitive bid with an acceptable level of risk that is also cost effective for the owner
- Provide information that will allow project construction staff to recognize and understand site subsurface conditions at the time of design development prior to construction
- Provide owners with information that the contractor has met minimum accepted levels of investigations and design requirements (code requirements), as well as provide information for future design elements, improvements, new construction, and maintenance

GRDs can take many forms and have many titles, particularly given the various ACMs in use and the design development processes. GRDs can vary from comprehensive reports to a single-page document, a memorandum or even an email. Examples with suggested applications include:

- Comprehensive Geotechnical Reports (GRs) with results of all office studies, site investigations, laboratory test results, analyses of conditions relevant to multiple design elements (e.g., structures, roadway, drainage, etc.) and recommendations for design and construction. This format would be common for Design-Bid-Build (DBB) projects.

- Geotechnical Reports (GRs) focused on one phase of the design, (e.g., preliminary, intermediate, final).

- Geotechnical Reports (GRs) focused on one design element, such as a bridge or retaining wall, a drainage culvert or a stormwater retention pond. This format could be used on DBB projects having limited, specific scope. It may also be used on DB projects for a specific design element to allow development of final design and plans for that element so construction can begin on that element while the remainder of the project is being investigated and designed for construction. It could also be used with the CM/GC ACM for specific portions or elements of a project as they are evaluated and summarized.

- Geotechnical Data Reports (GDRs) containing factual information and data from an office and field investigation and laboratory testing program for design elements of a project. These are typically developed by, or for, the owner and are used for Design-Build (DB) contracts. They are provided to proposal teams as a basis for developing designs and costs for the pursuit phase of the project. Owner agencies typically indicate any supplemental investigations required are the responsibility of the contractor.

- Geotechnical Baseline Reports (GBRs) containing factual information and data with interpretative baseline conditions to be used as a basis for design development and as a contractual statement. GBRs can be used for DB projects and most often for projects with complex geotechnical features such as a tunnel.

- As indicated previously, GRDs can also be developed as memos or even emails, which are expeditious formats for covering a single design element or the modification of an element covered in a previous GRD. This format can be especially useful for DB projects where modifications may occur as work progresses and rapid documentation of evaluations and modifications is required (e.g., a Request for Information and Design Change requests).

The definition of a geotechnical report, referred to herein as a Geotechnical Reporting Document or GRD, is borrowed from the FHWA publication “Checklist and Guidelines for Review of Geotechnical Reports and Preliminary Plans and Specifications” (FHWA, 2003). The definition within that reference states, “The geotechnical report is the tool used to communicate the site conditions and design and construction recommendations to the roadway design, bridge design and construction personnel." One of the more important words in this definition is "communicate," which means something much more than "summarize."

The FHWA reference also indicates there is basic information that the GRD should provide, including:

- A summary of all subsurface exploration data, including a subsurface soil and/or rock profile, exploratory logs, laboratory or in-situ test results and groundwater information (FHWA, 2002)
- Interpretation and analysis of subsurface data
- Specific engineering recommendations for design
- Discussion of conditions for solution of anticipated problems
- Recommended geotechnical special provisions (and details)

As noted previously, the term GRD would include reports having many specific titles depending on topics covered and terminology an owner agency may choose to use, for example, Geotechnical Report for …Roadways, …Bridge Foundations, …Landslide Remediation, etc. In addition, it may be titled a Preliminary Geotechnical Report, an Interim Geotechnical Report, a Final Geotechnical Report, a Foundation Report, or in some other way. In some cases, a Technical Memorandum may be a suitable title, particularly for an intermediate GRD or relatively brief report that summarizes and documents a study of a specific design element during design development on a project using any of the ACMs discussed in this document, but especially for the DB and CM/GC Contracting Methods. For small projects or when final design is incremental for design elements, the GRD may be a memorandum or even an email. Regardless of the format used for a GRD, the QC and QA process should be followed and include the project title, the design element(s) covered, dates and names of the GS preparing it, as well as the QC reviewer. As indicated elsewhere in this document, related documentation, details and supporting analyses should be available and included with the GRD. In the case of memos or emails, this information may not be conveyed with the initial GRD submission, but should have been completed and can be made part of the final GRD which follows.

In addition, a Geotechnical Data Report (GDR) is typically developed for use on Design-Build projects. The GDR is a GRD, except that it is a factual report typically containing a summary of all subsurface exploration data obtained for use of DB proposal teams, including a subsurface soil and/or rock profile, exploratory logs, laboratory or in-situ test results and groundwater information (FHWA, 2002), without analyses or design recommendations.

Analyses and recommendations for relatively minor or localized modifications to a previously submitted GRD could also be incorporated as an Addendum to that GRD. This could allow the modification to be included in the final document and not require duplication of background information contained in the initial GRD.

A suggested format for GRDs (but not GDRs) derived from the FHWA Technical Guidelines Manual (FHWA, 2007), which could be modified depending on the size and content of the report includes:

- Title Page
- Table of Contents
- Executive Summary
- Introduction
- Procedures and Results
    - Field Investigations
    - Laboratory Testing
- Summary of Analyses
- Discussion (of subsurface conditions and design considerations, including geology, seismicity and geologic hazards)
- Recommendations (for design and construction of project elements)
- Construction Recommendations (including construction observations, testing and instrumentation)
- Figures (e.g., Location Map, Drawings, etc.)
- Appendices
    - A - Boring and Test Pit logs, etc.
    - B - In-situ Test Results
    - C - Laboratory Test Results
    - Other Appendices as necessary: photos, instrumentation data, analyses, etc.

The report should include a summary of limit states (strength, service and extreme), as well as loading conditions (compression, tension, lateral) for strength, service and extreme limit states and performance requirements (post-construction deformations and phase construction or sequencing). This information should be obtained from, and developed in coordination with, structural and other engineers preparing designs.

Regarding borings and other subsurface investigation methods used for a project, it is very important that a suitable standard of practice is used to obtain and present that information since it forms the basis of designs and recommendations, as well as construction methods. Many owner agencies may have their own requirements, in addition to the following:

- References for the location of borings and other explorations using the project coordinate system or accurate offsets from an established project baseline and determining their elevations using the reference system used for the project design plans. Ground survey and/or GPS methods can be used for this, which will allow accurate plotting of boring locations on plans and subsurface profiles. The same system can be used to accurately locate field observations, such as wet areas, depressions, historical instabilities and sinkholes.

- Accurate measurement of sample depths in borings, soundings and in-situ tests.

- Use of AASHTO, ASTM or other standards of practice methods for Standard Penetration Tests (SPT), Cone Penetrometer Tests (CPT), undisturbed sampling, rock coring and other procedures, as well as logging methods such as soil and rock classification, determining Rock Quality Designation (RQD), etc.

- Groundwater information, including prevention of skewed information influenced by drilling methods (e.g., hollow stem augers, casing advancer with water, rock coring, etc.).

- Field observations during drilling, including communications with drillers, which could include obstructions or difficult drilling or other features that might influence design and construction.

Borings logs and other field information that are reported and used in evaluations should include names or initials of those generating the information, as well as the responsible individual for QC checking of the information that will be used in evaluations and submitted with the GRD. Other field information could include the location and logging of rock exposures, landslides, sinkholes, seepage areas, and other relevant geotechnical features observed.

Similarly, laboratory testing should be performed by an AASHTO R18-accredited laboratory using AASHTO, ASTM or other suitable standard testing methods, which are referenced on the report forms along with the recommended test data from the referenced standard. The report should indicate who performed the tests, as well as verification that a QC review was performed on the test procedures, interpretation (completed by a GS representing the geotechnical engineer of record), and results by the appropriate GS.

A summary of the geo-material parameter interpretation, methods and procedures used, analyses, computations and results should be included with the report, particularly pertinent information which supports a conclusion and/or recommendation. A complete set of analyses and computations should be prepared for documentation, but may not necessarily be included in the GRD. However, documentation in the GRD should indicate that calculations have been prepared, checked and are available upon request. This information could include stability analyses, computations for settlement and lateral deformations, deep foundation nominal resistances, shallow foundation nominal resistances, etc. Analyses should follow procedures designated by the owners' manuals or, if not specified, procedures in AASHTO or FHWA publications or references. In particular, analyses and computations that are in support of conclusions and recommendations should be developed by, and checked by, an individual experienced with that analysis method as part of the QC procedures. This checking would, for example, include a close review for accuracy and reasonableness of the data used for the analyses, computations, any models, parameters, and output from computer software.

The definitions of QC and QA used by agencies may vary to some degree, and two are included here as examples:

DOT-A

Quality Control – The on-going comprehensive, independent checking and verification of activities leading to a final product that meets or exceeds project requirements.

Quality Assurance – The actions necessary to create confidence that the Quality Control process has occurred.

DOT-B

Quality Control – The process performed to ensure conformance with valid requirements.

Quality Assurance – Planned, coordinated and continued activities performed to measure processes against predetermined critical requirements.

Key elements in the definitions for Quality Control are believed to be "independent checking" … "to ensure" … "a final product meets or exceeds project requirements." Note that these QC requirements would also be a component of QA.

Finally, an important and related item which may not be typically viewed as part of the GRD content, but which can create problematic situations, is how the report is intended to be used. It is critical, and cannot be overstated, that the GRD must be reviewed with the design engineers for various disciplines on a project. Clearly communicating the relevant findings, conclusions and any recommendations affecting the work product of each technical discipline is a must for project success. It is also important that the final plans and specifications for the project or any element of the project be reviewed by the project geotechnical specialist prior to acceptance by the owner agency for construction to verify that the recommendations have been properly incorporated. The guidance provided above is vital to the successful implementation of Assuring Quality in Geotechnical Reporting Documents and should be clearly addressed as part of a GRD QA review program.

Quality Assurance and Quality Control considerations are addressed in many FHWA references, including FHWA ED-88-053, 2003 (FHWA, 2003), FHWA Geotechnical Technical Guidance Manual (FHWA, 2007), the various FHWA Technical Manuals available and the SHRP2-GeoTechTools website (www.geotechtools.org). The QA/QC content varies in scope and content with some related to quality during the Design Development phase of the project and others related to quality during the Construction Phase. To differentiate, the objectives of this document solely address QC and QA during the Design Development Phase of the project. To expand further, it is intended that the QA would focus on the technical content of the GRD and on development of plans (including details) and specifications (PS&E) that will result in successful construction and performance as planned. Quality Control and Quality Assurance during construction (implementation of the plans and specifications) are not addressed within this document.

Additional discussion and recommendations for implementation of QA in GRDs is provided in Chapter 4. This includes the use of checklists and other actions, all of which are focused on achieving project success.

Many owner agencies have developed their own requirements, standards and manuals for geotechnical investigations, including spacing and depth of borings, type and frequency of sampling and testing in soil and rock, and the use of alternate field investigation methods (e.g., CPT). There may be requirements for analysis and evaluations as well, and these would be typically tied to AASHTO requirements. There may be other specifics that have been developed and included in their “manual” based on local experience and common issues in their area. Their directives can also include the format and content of the GRDs and specifications, along with details specifically developed for construction and monitoring during construction. These directives can, and often do, offer a system about which the Quality Assurance program for that owner agency is developed.

2.2 APPLICATIONS TO ALTERNATIVE CONSTRUCTION METHODS

As will be discussed in Chapter 3, GRDs during the project phases associated with the three ACMs considered could include:

<u>Design-Bid-Build</u>

- Planning
- Preliminary Design
- Intermediate Design
- Final Structure/Bridge Design
- Final Design or Final Roadway Design, if separate Structure /Bridge Report prepared
- Report for Alternative Technical Concept (ATC) or Value Engineering Study (VE)

Design-Build

- Planning
- Preliminary Design
- Geotechnical Data Report (GDR)
- Intermediate GRDs for project elements or parts of project
- Final Structure/Bridge Design summarizing all structures/bridges
- Final Roadway Design summarizing all roadway elements

Construction Manager/General Contractor

- Planning
- Preliminary Design
- Intermediate GRDs for project elements or parts of project
- Final Structure/Bridge Design summarizing all structures/bridges
- Final Roadway Design summarizing all roadway elements

Chapter 3 discusses who may prepare these GRDs for each ACM based on the delivery method used, but in each case the owner agency should institute procedures that will be followed by the project geotechnical specialist for geotechnical investigations whether utilizing procedures in their own manual or by reference to other applicable and acceptable procedures (e.g., AASHTO, FHWA, etc.). Required Quality Control and Quality Assurance procedures should also be developed by the owner agency and be in place also as discussed in Chapter 3.

Quality assurance for technical features of the investigations can be based on checklists and documents discussed in 2.1. Verification that the procedures were completed would be based on the delivery method, but a Quality Assurance Audit by the owner agency would verify that the QA review had been completed.

CHAPTER 3 – CONSIDERATIONS IN DEVELOPMENT OF GEOTECHNICAL REPORTING DOCUMENTS

3.1 INTRODUCTION

The introduction of Alternative Contracting Methods (ACM) into the transportation industry has had a significant impact on owner agencies, consultants and contractors. While many projects are still being delivered using the traditional Design-Bid-Build (DBB) ACM, the use of Design-Build (DB) ACM has become more popular - in part, due to its ability to reduce the time required to deliver fully-completed projects (design through construction) and, in the case of Public-Private-Partnerships (P3s), the method and timing for financing those projects.

Use of the Construction Manager/General Contractor (CM/GC) method is not as common as DB, in part because it does not offer the same reduction in the time for project completion; however, it is being used and does offer close coordination between the design and construction elements, both of whom are contracted with, and under the full direction of, the owner agency. This ACM is intended to develop a cost-effective constructible design that can still include the use of innovative and new technologies while allowing the owner to control the project direction, work directly with the design consultant and better understand and potentially mitigate risks. This ACM may be especially advantageous on some projects that are complex and very sensitive to budget constraints.

Appendix A contains schematic flowcharts (Figures A-1, A-2 and A-3) intended to illustrate the design development process for each ACM presented in the following sections. As noted, the project development process can extend into the bid phase of a project and even overlap with construction, which can introduce challenging situations into a quality assurance program. The flowcharts also show common GRDs to illustrate the process, though their titles and specific intent can vary based on the agency definitions, requirements and the project scope. The discussion of Quality Assurance in this document is relative to the preparation and use of GRDs during the Project Development process (excluding PS&E) and does not include the implementation of Quality Assurance (QA) controls during construction.

Within each respective ACM, there exists multiple Alternative Delivery Methods (ADMs) that highlight the relationship between the developer of a specific GRD and the subsequent parties involved with the overarching Quality Assurance process (of which Quality Control is part of). GRDs for the various stages in design development, which could include planning, preliminary design, final structure design and final roadway design with the contracting method, could be delivered by one of, or a combination of, several Alternative Delivery Methods (ADMs). This could include in-house staff from the owner agency (e.g., DOT Geotechnical Staff), in-house staff of a design consultant under contract directly to the owner agency or by a sub-consultant/consultant under contract to either the design consultant or the owner agency, respectively.

Appendix B, in addition to illustrating the GRD development and Quality Assurance process, presents the various ADMs for DBB, DB, and CM/GC and the relationship between document production and the QA process. Specifically, Figure B-1 is intended to illustrate the ADMs that can be used with the DBB, preliminary design DB, and CM/GC ACMs (ADMs 1 through 4) to develop GRDs and provide QA. The ADMs for DBB, preliminary design DB, and CM/GC are:

- Method 1: All efforts are completed by the owner agency using their staff Geotechnical Specialist (GS)
- Method 2: Owner contracts with a consultant (with in-house GS)
- Method 3: Owner contracts with a consultant (using a GS subconsultant)
- Method 4: Owner contracts directly with a GS consultant

Figure B-2 illustrates the ADMs for DB ACMs. The ADMs for DB final design, in addition to the four listed above for preliminary design, include:

- Method 5: Contractor contracts with a consultant (with in-house GS)
- Method 6: Contractor contracts with a consultant (using a GS subconsultant)
- Method 7: Contractor contracts directly with a GS consultant

Keeping in mind the definitions of QC and QA presented in Section 1.1 and 1.2, for each of the seven ADMs shown, there are four components and generally four roles in the steps of the process for each GRD, including:

- Individual who is responsible for preparing the GRD
- Individual who performs the QC of the GRD
- Individual who is responsible for QA review of the GRD
- Individual who is responsible for QA audit of the project

Depending in part on the size and scope of the project, these four individuals should generally all be different people (however, that is not always the case), and those performing the QA audits are not required to be a GS.

It will be important that a system is in place to assure that the GRDs have been developed for the project design elements, consistent with requirements of the contract and applicable standards, whether they are developed by the owner, AASHTO, FHWA or other standards of the industry. Also, it is critical that the geotechnical recommendations are properly incorporated in the plans and specifications. With this in mind, it is important to understand the difference in skill-sets between an individual responsible for QC and one responsible for QA.

A QC reviewer must understand the technical details of the calculations, exploration logs, laboratory test results, etc., and confirm the accuracy of these undertakings through a system of checking, updating, and confirming noted deficiencies have been resolved. A QA reviewer (and auditor) must maintain a much broader picture of the full project and understand how the detailed analyses and recommendations will impact development of the construction documents, including how this information is communicated from a risk management standpoint. In short, QC reviewers confirm and document the accuracy of the technical efforts required to support project development, where as QA reviewers confirm and document the appropriate QC has been completed.

The following sections discuss these three principal ACMs in use for design and construction of transportation projects. With respect to the development and use of the GRDs and their QA, topics that are addressed include:

- General form and content of GRDs prepared during the course of a project for each of these contracting methods
- Alternative Delivery Methods (ADMs) that are used to provide the GRDs and their QA
- Roles and responsibilities of owner agencies, consultants and contractors
- Communications that should occur during the course of the program between the participants

Portions of the QA program for geotechnical reporting documents vary by contracting method and can be the responsibility of the owner agency, the consultant, the contractor or other parties involved in the project. It may - and often does - include an independent, project-wide auditing system to verify that QA reviews are being conducted for work by all disciplines involved in the project development phase.

3.2 DESIGN-BID-BUILD

3.2.1 Geotechnical Reporting Documents

Early in the project development process, a planning study illustrated in Figure A-1 may be conducted to evaluate alternative alignments and roadway grades, bridge and culvert locations, as well as other design elements so as to examine the impacts of a project, develop planning level cost estimates and select an alignment. A GRD may be developed for this stage and, if so, it might be based on existing, available geotechnical information, a field reconnaissance and possibly a very limited subsurface investigation.

A preliminary study may be conducted to advance a project to a design level that would include more detailed studies leading to selection of a of semi-final alignment and grade, as well as alternative structure arrangements, preliminary culvert types and sizes and preliminary right-of-way impacts. Preliminary slope designs may be developed during this stage to evaluate potential property impacts. A GRD at this stage may include borings and testing at specific locations, geotechnical evaluations and preliminary recommendations for roadways, as well as structures and other design elements.

Subsequent to the preliminary study and its associated GRD, a final design geotechnical investigation and GRD would typically be conducted and be specific enough to allow final design of all elements other than bridge structures including cut and fill slopes, earthwork evaluations, settlement, stability, ground improvement, monitoring systems, retaining walls, culverts, and other specific elements including, but not limited to, subgrade and pavement section designs. Investigations and GRDs for final design of each or all of the bridge structures may be developed separately at this stage. All of these GRDs for final design should include reference to existing special details and specifications or develop new details and specifications for the design elements. In some cases, constructability and risk management studies or workshops may be conducted between preliminary design and the completion of final design.

It is possible that during the bid phase of a project the contractor could be allowed to submit an Alternative Technical Concept (ATC) or a Value Engineering (VE) proposal for consideration by the owner agency. It is also possible that the owner agency could allow submission and consideration of a VE proposal after award as well. In these cases, a GRD specific to the design elements may be required to support the ATC or VE.

3.2.2 Alternative Delivery Methods

GRDs for the various stages in design development could include planning, preliminary design, and Interim GRDs on specific design elements. A Final GRD should be generated at the completion of design to summarize the geotechnical investigations, analyses and final recommendations. This could be delivered entirely by in-house staff from the owner agency (e.g., DOT Geotechnical Staff), by the in-house geotechnical staff of a design consultant under contract directly to the owner agency or by a sub-consultant geotechnical specialist under contract to either the design consultant or the owner agency.

Figure B-1 in Appendix B is intended to illustrate the ADMs that can be used with the DBB ACM to develop GRDs and provide QA.

3.2.3 Roles and Responsibilities of Owner Agencies, Consultants and Contractors

For projects using the DBB contracting method, the roles and responsibilities of these parties relative to development of GRDs and their implementation into project design plans and specifications are summarized as follows:

Owner Agencies - It is the owner’s role and responsibility to:

- Provide the minimum requirements for the geotechnical investigation and methodologies to be used either directly or by reference.
- Provide relevant design standards, geotechnical performance requirements, including specifications.

- Provide QA requirements to be fulfilled for the project and verify that they have been completed through their QA audits. This would apply to not only geotechnical documents, but documents for all disciplines.
- Possibly provide some or all of the services included under consultant's role.

Consultants - The role and responsibility of consultants if they are performing geotechnical investigations and developing GRDs is to:

- Review and understand the scope of the project and the geotechnical needs.
- Perform the investigation and analyses consistent with owner requirements and/or industry standards (e.g., AASHTO, FHWA, etc.).
- Develop recommendations, including existing or new details and specifications necessary to implement recommendations.
- Verify that recommendations, including details and specifications, have been properly included in the plans and specifications.
- Perform and document Quality Control and Quality Assurance reviews of the GRDs.

Contractors - The primary role and responsibility of the contractor is to:

- Familiarize themselves with the GRDs and develop an understanding of the geotechnical conditions on the project prior to developing a bid.
- Construct the intended work elements per the plans and specifications.
- Notify the owner agency if there are variations in any conditions from those anticipated that may require modification of construction plans.

3.2.4 Communications

Communications with respect to development of GRDs using this contracting method should include the following:

- A scoping meeting to establish the level of geotechnical effort for the project, identify geotechnical risks, and other items that all parties should be aware of.
- A pattern of periodic meetings between the owner, the project designer and the geotechnical specialist responsible for developing the GRDs during each phase of design through completion of plans and specifications (PS&E). These meetings should discuss the status of design, as well as the geotechnical investigation, including any modifications to the design elements or conditions encountered during investigations or analyses that could impact design of project elements. Minutes should be developed to document discussions and allow

implementation of the conclusions and any planned actions developed at the meetings.

- Review of GRDs by the owner agency representatives and the design engineers followed by coordination meetings to discuss questions and issues that affect the GRD results and use of any recommendations.

3.3 DESIGN-BUILD

3.3.1 Geotechnical Reporting Documents

As illustrated in Figure A-2 in Appendix A, some GRDs using this ACM may be similar to those for the DBB method, while others are different. Although this contracting method is intended to allow the use of innovative construction methods by the DB Team, the most prominent reason for its use is to reduce the time required to move through final design and construction by starting construction on items right after preliminary plans are approved for construction.

There may be an early planning study of the alignment alternates. For example, as described for the DBB ACM, a GRD could be developed using the same methods and procedures used for DBB projects.

The geotechnical investigation and GRD for the preliminary design, which is typically used to generate plans for price proposals for the shortlisted Contractor Teams, would typically be presented as a Geotechnical Data Report (GDR), which is defined in Section 1.2 and discussed in Section 2.1. The GDR, prepared by the owner agency or a consultant to the owner agency, generally contains boring logs, geotechnical profiles and cross sections, laboratory tests and other site-specific information that is related to the preliminary design scheme, but with no specific recommendations. The scope and amount of information from a subsurface investigation provided in the GDR varies, but may be greater than typical for this stage of design because additional information may reduce the real or perceived risk of variations in subsurface conditions. This could cause either conservative pricing of proposals to cover unknown or assumed risk or result in a potential for claims, if allowed, for unforeseen conditions encountered when final design investigations are conducted by the DB Team's geotechnical specialist.

A Geotechnical Baseline Report (GBR), which is also defined in Section 1.2 and discussed in Section 2.1, has been frequently used for tunnel projects, but has not been commonly used for other transportation projects. The GBR includes information that would be included in the GDR, but it also includes an interpretation of geotechnical conditions for the project that is incorporated into the contract documents. This then establishes a contractual statement or "baseline" of the anticipated geotechnical conditions to be encountered with the intent of helping to manage the distribution of risk between the owner and the contractor. Risks associated with conditions that are consistent with or less adverse than the baseline are allocated to the contractor, and those that are more adverse than the baseline are accepted by the owner. Some investigations may be allowed or completed during the bid or proposal phase of the project, and ATCs may be allowed, but the investigations for final design are typically conducted by the GS for the successful DB Team after selection. In these cases, the GS is contracted with the contractor and, while it may be required that GRDs are consistent with those for the DBB process (e.g., Structure GRDs, Final Design Roadway GRD, etc.), investigations can follow many formats based on the contractor's construction schedule.

One of the many challenges for the geotechnical specialist with this contracting method is the potentially aggressive schedule for conducting the investigation and completing the Final Design GRDs. In some cases, Interim GRDs may be developed to provide final design recommendations for one portion of an alignment or a specific bridge on the alignment so that construction may begin while the remainder of the alignment and design elements are investigated. Ultimately, these Interim GRDs could be assembled to provide the Final GRD required by the owner's standards and technical provisions. This presents challenges to QA in GRDs, not only for the content of the GRD, but for the incorporation of recommendations into the plans and specifications.

For DB projects, the level of design development by the DB Team during the price proposal (bid) phase typically varies depending in large part on the complexity of the subsurface conditions and the project. However, design at this stage must be developed to a level that will allow the Design Team to develop a justifiable price (bid) proposal, which will be based on information provided in the GDR and any supplemental information obtained during the bid phase.

The Request for Qualifications (RFQ) and Request for Proposals (RFP) must clearly indicate the proposal ranking factors (low price or best value and, if best value will be used, how that will be determined). The RFQ and RFP must also clearly indicate what guidance must be followed, what technologies and materials are acceptable and those which are not allowed. Finally, the QA procedures to be followed must be specifically addressed. QA requirements would address submittal content and schedule, review periods and tracking system for disposition of comments.

3.3.2 Alternative Delivery Methods

Figure B-2 in Appendix B refers to the same four ADMs shown on Figure B-1 for preliminary design with the DB ACM. For final design, there are three unique ADMs for DB shown in Figure B-2. Note in Figure B-2 that Steps 1 through 3 during final design involve work by the GS directly or indirectly under contract with the contractor. These methods would be used for any final design GRDs after selection and are especially important due to the challenges described in Section 3.3.1. For this reason, the QA process must be well organized and efficiently completed.

3.3.3 Roles and Responsibilities of Owner Agencies, Consultants and Contractors

Under the DB Contracting Method, the Roles and Responsibilities of the owner agency, the consultant and the DB Team differ from other ACMs.

Owner Agency

- Provide the minimum requirements for the geotechnical investigation and methodologies that must be used either directly or by reference.

- Provide technical provisions, including relevant design standards and specifications including any special geotechnical requirements and performance limits (e.g., maximum amount or time for settlement) or control design features and construction methods (e.g., pile types, wall types, etc.) used.

- Provide a GDR (Geotechnical Data Report) that will be used as a basis for development of price proposals and will minimize risks of contract disputes for unforeseen conditions. The GDR will also minimize the risk of conservative price proposals to account for variations of conditions, provide sufficient information for evaluation of cost effective designs by the Contractor DB Team and facilitate the use of innovative designs. Quality Assurance of the GDR and any previous GRDs (e.g., Planning Phase) prepared in advance of the GDR would be the responsibility of whomever prepares those documents, whether it is prepared by the owner's in-house staff or their consultant. A project audit would then verify that a QA review was conducted. This process would use an ADM shown in Figure B-1.

- Provide Quality Assurance requirements to be fulfilled for preparation of the GRDs developed during final design of the project and establish a process for verification. This would apply not only to geotechnical documents, but documents for all disciplines. This is illustrated by ADM 5, 6 or 7 in Figure B-2 except for GRDs prepared during the bid phase.

- Incorporate "over-the-shoulder" reviews into the project schedule. These are regular meetings held between the owner's representatives and the contractor's team to discuss the status of design and any technical or contractual questions that may arise during final design.

Consultant (includes design consultant and the project GS from in-house staff or sub-consultant performing geotechnical investigations during developing of GRDs)

- Review and understand the project scope and the geotechnical needs.

- Project GS reviews available information including the GDR to develop bid-phase design recommendations, which should be documented in a GRD (e.g., bid phase Geotechnical Report). In this case, Steps 1 through 3 of the QA process shown in Figure B-2 would be completed, but Step 4 may be completed later (during final design, if selected).

- If selected, the project GS performs a final design investigation and analyses consistent with owner requirements and/or industry standards (e.g., AASHTO, FHWA, etc.).

- Develop final design recommendations, including necessary details and specifications and document within a GRD. As described, this process could involve several GRDs for portions of, or specific design elements on, the project.

- If not specified by the owner's documents or the contractor, develop a QA plan addressing the process of developing the GRDs and addressing geotechnical recommendations within the plans for construction using all 4 steps in the process.

Contractor

- During the bid phase for the project, coordinate with the design consultant - at regular intervals and as often as necessary - to reach agreement on the design elements and construction requirements. This includes interpretation of conditions by the project geotechnical specialist and the development of bid phase recommendations.

- If selected, coordinate with the design consultant on scope and schedule for design and construction, allowing for supplemental geotechnical investigations and analyses, if necessary, to meet the project requirements and allow development of geotechnical recommendations.

- Require a GRD or multiple GRDs that address all design elements and provide recommendations with details and specifications that are understood and agreed upon before construction of the elements begins.

- Implement a QA plan, if not developed and required by others involved, with necessary documentation, beginning at the bid-phase of the project.

- Notify the design consultant and the project geotechnical specialist if there are variations in any conditions from those anticipated so that effects on the design performance can be considered, and modifications can be made, if necessary.

3.3.4 Communications

Communications with respect to development of GRDs using this ACM should include the following:

- The RFP should clearly communicate geotechnical expectations, both of the investigation and design of project geotechnical features and performance requirements (e.g., maximum settlement for a bridge abutment).

- During Preliminary Design, the owner agency should conduct periodic meetings with the designer (owner agency or consultant) and the project geotechnical specialist responsible for developing the GBR and/or the GDR. The level of the investigation should be reviewed based on the items noted in Section 3.3.1, if it is not already described in the owner's standards and procedures for investigations on projects using this contracting method.

- During Pre-Final Design (Bid-Phase), the owner agency should conduct meetings with proposers (bidders) to explain the project, technical provisions and requirements and significant items related to bid development design and final design, if selected. This would include questions related to development of final geotechnical recommendations.

- During Final Design, the owner should provide a contact for questions and consider holding periodic meetings with the DB Team representatives to discuss design status and any questions, including those related to GRD development and implementation.

- During Construction, maintain communications with contractor and Design Team to verify status of work, verify related plans and specifications are being implemented properly and discuss any questions related to completion of design and construction consistent with project requirements.

3.4 CONSTRUCTION MANAGER/GENERAL CONTRACTOR

3.4.1 Geotechnical Reporting Documents

Early in the design development process, a planning study illustrated in Figure A-3 may be conducted to evaluate alternate alignments and roadway grades, bridge and culvert locations, as well as other design elements so as to examine the impacts of a project, develop planning-level cost estimates and select an alignment. A GRD may be developed for this stage and, if so, it might be based on existing, available geotechnical information, a field reconnaissance and possibly a very limited subsurface investigation.

A preliminary study may then be conducted, and it would include more detailed studies leading to selection of a semi-final alignment and grade, as well as alternate structure arrangements and preliminary culvert types and sizes and preliminary right-of-way impacts. Preliminary slope designs may be developed during this stage to evaluate potential property impacts. A GRD at this stage would likely report the results of borings and testing at specific locations, geotechnical evaluations and preliminary recommendations for roadways, as well as structures and other design elements.

Subsequent to the preliminary study and the associated GRD, a contractor would be engaged by the owner to review the preliminary plans and offer comments, including recommendations to continue with final design without changes or incorporate modifications that would improve constructability and/or reduce construction costs. These recommendations could affect any part of the preliminary design. As a result of these proposed recommendations, the design engineer would modify the preliminary plans, and the GS would perform supplemental investigations and analyses with associated recommendations. The results of this work would be summarized in a GRD, which could be an intermediate report rather than a final GRD. These intermediate

GRDs for final design can be used to develop the Final GRD, including reference to existing special details and specifications or develop new details and specifications for the design elements.

The QA program is very similar to the one used for the DBB contracting method since the GRDs could be developed by the owner's geotechnical staff or by a consultant under contract to the owner. The content of the GRDs might vary depending on the reviews and interaction between the three parties involved in the final design development process.

3.4.2 Alternative Delivery Methods

GRDs for the various stages in design development could include planning, preliminary design, and Interim GRDs on specific design elements evaluated in conjunction with contractor recommendations during interactions, and with approval of the owner. A Final GRD should be generated at the completion of design to summarize the geotechnical investigations, analyses and final recommendations. This could be delivered entirely by in-house staff from the owner agency (e.g., DOT Geotechnical Staff), by the in-house geotechnical staff of a design consultant under contract directly to the owner agency or by a sub-consultant geotechnical specialist under contract to either the design consultant or the owner agency.

Figure B-1 in Appendix B is intended to illustrate the ADMs that can be used with the CM/GC ACM to develop GRDs and complete the QA review. Note that the ADMs are essentially the same as those for the DBB ACM, as well as the preliminary design phase of DB.

3.4.3 Roles and Responsibilities of Owner Agencies, Consultants and Contractors

For projects using the CM/GC contracting method, the roles and responsibilities of these parties relative to development of GRDs and their integration into project design plans and specifications are summarized as follows:

Owner Agency

- Provide minimum requirements for the geotechnical investigation and methodologies to be used either directly or by reference.
- Provide relevant design standards, geotechnical performance requirements including specifications.
- Provide QA requirements to be fulfilled for the project, and verify that they have been completed through QA audits. This would apply to not only geotechnical documents, but documents for all disciplines.

Consultants (performing geotechnical investigations and developing GRDs)

- Review and understand the scope of the project and the geotechnical needs.

- Perform the investigation and analyses consistent with owner requirements and/or industry standards (e.g., AASHTO, FHWA, etc.).

- At each stage of study during design, perform investigations and analyses and develop recommendations, including details and specifications necessary to implement recommendations.

- Document geotechnical investigations during design in GRDs, including Interim GRDs addressing interactive studies of contractor-proposed schemes.

- Perform and document QC and QA reviews of the GRDs.

Contractor

- Review and discuss proposed project objectives and preliminary design, including geotechnical information and recommendations in the GRD.

- Provide alternate schemes/treatments for selected design elements and review with owner and design consultants, including the project GS.

- Review designs for alternates with owner and design team, including details and specifications.

- If selected for construction phase, construct the intended work elements per the plans and specifications.

- Notify the owner agency if there are variations in any conditions from those anticipated that may require modification of construction plans.

3.4.4 Communications

Communications during design with respect to development of GRDs and final plans using this contracting method are essentially the same as for the DBB contracting method described in Section 3.2.4, except that the contractor should be part of the Team meetings after being brought into the project.

CHAPTER 4 – IMPLEMENTATION OF QUALITY ASSURANCE FOR GEOTECHNICAL REPORTING DOCUMENTS

4.1 INTRODUCTION

This chapter focuses on implementation of a Quality Assurance (QA) program for Geotechnical Reporting Documents (GRDs). While the value of a QA program for GRDs is generally recognized, its content and procedures used may vary. Based on interviews with a representative sample of owner agencies (DOTs) across the country, it appears that checklists are not a consistent part of the QA process, but when used, they have often been derived from the FHWA Checklists publication (FHWA, 2003), and are commonly adapted to the owner agency's process and requirements for developing GRDs. It also appears that QA program requirements for GRDs developed for project design elements are essentially the same for all of the Alternative Contracting Methods (ACMs) and the Alternative Delivery Methods (ADMs), with a few exceptions.

This chapter also includes discussion and examples to illustrate the value provided by a QA program for GRDs and its link to Quality Control (QC). This includes the development and use of checklists, which are a subset of the QA process, and the process used by GRD reviewers in the documentation for a QA program. It also discusses considerations for ACMs and ADMs.

4.2 OWNER AGENCY QUALITY ASSURANCE PROGRAMS FOR GRDS

An examination was made of related manuals or handbooks established by several owner agencies, and some observations are offered to illustrate the content of some QA programs. Current versions of these manuals or handbooks are typically available free of charge for digital download. To avoid the potential for broken or non-existent links in the future, the reader may locate the downloadable documents by completing an internet search using the information contained in the *References* section of this document.

The Florida DOT's Soils and Foundation Handbook (FDOT, 2016) includes detailed procedures and guidelines for:

- Subsurface investigations of highways and related structures, as well as other design elements
- Laboratory Testing
- Materials (Soil and Rock) Descriptions, Classification and Logging
- Field Instrumentation
- Analyses and Design
- Presentation of Geotechnical Information (i.e., GRDs)
- Construction and Post-Construction

A section in the handbook addresses procedures and responsibilities for Design-Build Projects with the three typical phases of these projects, including:

- Planning and Development Phase
- Technical Proposals and Bidding Phase
- Design/Construction Phase

The Utah DOT (UDOT), which has utilized the CM/GC Contracting Method on several projects, has a Manual of Instruction [UDOT, 2014 (1)] that outlines and defines Geotechnical Report Requirements. They also have a document entitled Project Delivery Network Geotechnical Design QC Checklists [UDOT, 2014 (2)], which is designated to be used as *"… a tool to assist the project team in verifying all work is produced with due diligence, using acceptable industry standard techniques, available resources and data, and reasonable decisions by competent professionals."* It continues, *"The checklist is a tool and cannot replace the sound judgment and experience of competent professionals."* And, *"It is the Design Team's responsibility to verify the quality of project documents **before** distribution."* (Note: Highlight of "before" is within the document.)

The North Carolina DOT's Guidelines & Procedures Manual for Subsurface Investigations (NCDOT, 2011) defines requirements for geotechnical investigations and includes Geotechnical Review Checklists and Technical Guidelines that are patterned after the FHWA, 2003 document, but include reference to the Design-Build Contracting Method, which is frequently used by the NCDOT. The following comments (included in the introduction to these guidelines) stress the importance of providing a quality GRD: "*The importance of preparing adequate geotechnical documents cannot be overstressed. The information contained in the documents is referred to often during the design period, construction period, and frequently after completion of the project (resolving claims)*." The document also contains an Appendix which references Standard Special Provisions for Roadways, Structures and Geotechnical features that are considered relevant to the GRDs.

These state agencies (and most all that were interviewed) have manuals that define the geotechnical investigations required by them for projects, including GRDs. Their QA programs do vary. Refer to Appendix D for a summary of comments from interviewed DOT representatives.

4.3 QA CHECKLISTS AND DOCUMENTATION

Use of a documentation process by owner agencies for QA of GRDs may be more important than ever due to the complexity of project requirements, site conditions and schedules, particularly using the DB ACM and due to the number of individuals involved in the process, many of whom are external to the owner agency. This section discusses checklists that exist or can be developed to document the QA process for technical features, as well as the plan development process.

The **General Information Form** (GIF) included and used with examples in Appendix C is offered for use with QA reviews of all GRDs or as a guide for development of a similar summary form by others. The two-page GIF is intended to serve as a cover for the QA review of any GRD and identifies the ACM, as well as the ADM, used. The form has been developed to document basic information for any GRD review including:

- Project Title
- Project Contracting Method (DBB, DB, CM/GC, other)
- QA Reviewer and Firm/Agency Affiliation
- GRD Title
- GRD Type (e.g., GR, GDR, GBR, Memorandum, Email)
- GRD Author and Firm
- GRD Author/Firm Client (Owner, Contractor, Other)
- Project Component(s) Covered (Roadway, Structure, Other) Project Design Development Stage (Planning, Preliminary, Final)
- QA Review Level (Discipline Level Review; Project Level Audit)

It allows for the attachment of review comments to specifically communicate any items in need of discussion or clarification. Those comments could be shown on a copy of the GRD itself, summarized in a memorandum or email, or be included in a cover letter summarizing the QA review. Checklists such as those developed by the FHWA (FHWA, 2003) or developed by agencies can also be attached to provide an indication that the GRD meets the QA review requirements or is being returned for modification and resubmission. The reviewer is identified, and the QA Review Level is indicated as well (Refer to Figures B-1 and B-2).

The second sheet of the GIF allows for an indication of specific checklists that are attached and of related general comments. The General Information Form would identify and verify the GRD content and presentation, as well as the technical project design elements. A blank copy of the GIF is included in Appendix C (Exhibit C-7) for use with or without modifications.

It is noted again that the QA review of construction plans and specifications is not and would not be included in the checklists being discussed since the plans are not a GRD. It is important, however, that a QA review of the plans be performed to verify geotechnical recommendations from the GRDs are properly incorporated.

The related FHWA checklists (FHWA, 2003) focus on the site investigation, the geotechnical features on the project (e.g., embankments and cuts, landslides, retaining structures, structure foundations, ground improvement technologies), and the development and content of the GRD. The checklists can be used directly by an owner agency or adapted to the Manual of Practice of an owner agency.

Some newer technologies and materials, as well as the ACMs and ADMs in use, are not specifically included in the available FHWA checklists. Examples include the DB ACM, one for Geotechnical Data Reports (GDRs) and a checklist for micropile foundations.

Since there have been advances in existing technologies and development of new technologies since the FHWA 2003 document was published, additional checklists can also be developed and added. An example would be for micropile foundations that are not mentioned in FHWA 2003, but are currently accepted and used in practice, including their incorporation into AASHTO Bridge Design Specifications several years after FHWA 2003. In this case, a new checklist can be added to the library available for use in QA reviews.

There are also many manuals and references developed by FHWA and others which summarize design, construction and monitoring methods for traditional and new materials and technologies. This guidance should be utilized in reviews and evaluations, where applicable, including development of checklists. The FHWA documents can be accessed by visiting the FHWA website:

http://www.fhwa.dot.gov/

or, for more specific information:

http://www.fhwa.dot.gov/engineering/geotech/index.cfm

In addition, there are valuable and useful, relevant resources at the interactive TRB SHRP2 website ***GeoTechTools.org***, which includes up-to-date guidance on over 50 technologies:

http://www.geotechtools.org/

This website includes technical information for each technology in the following areas:

- Geotechnical Design Process
- Catalog of Technologies
- Technology Selection, which includes (for each technology):
  - Technology Fact Sheets
  - Photos
  - Case Histories
  - Design Guidelines
  - QC/QA Procedures
  - Specifications
  - Bibliographies

The GeoTechTools website includes information on many traditional and new technologies and materials, for example: Aggregate Columns, Deep Dynamic Compaction, Compaction Grouting, Jet Grouting, MSE Walls, Vibrocompaction, and many others. Micropiles are the only conventional structural deep foundation support system included. The subsection within the website which contains “Technology Information,” includes information on QC/QA for the specific element, but it focuses on construction procedures and documentation. However, it can serve as a very useful tool for QC and, therefore, QA in GRDs by guiding the GS through the development of appropriate checklists that will verify the design approach and assumptions. As mentioned earlier, other sources of information which can be useful for development of checklists are the FHWA Geotechnical Engineering Circulars (GECs), as well as other technical publications which are available through the FHWA website.

In addition to incorporating technical features for new and existing technologies into the development of checklists, some other features that should be incorporated into the checklists for the QC/QA review of GRDs would include:

- Documentation of the assumptions made during analyses and the preparation of recommendations. This includes, for example, loads and load combinations for strength, service and extreme limit states and performance requirements.

- Documentation of calculations and analyses performed that support recommendations with verification that they have been checked by the GS of record or a qualified representative GS. Note that it is recommended there should be a requirement that these calculations and analyses be provided to the owner agency within the GRD or as a separate document.

- Documentation that subsurface exploration logs (borings, CPT, etc.) have been prepared in accordance with owner’s required procedures and that the information has been checked by the GS of record or their qualified representative GS.

- Verification that the GRD includes a provision indicating the limitations associated with its use. This would include allowing the GS of record an opportunity to review the plans and specifications to verify recommendations have been properly incorporated and that there have been no changes in the design elements for which the GRD has been developed.

4.4 THE QA DOCUMENTATION PROCESS – EXAMPLE PROJECTS

The QA process is illustrated with an example project constructed using two ACMs (Case 1 DBB and Case 2 DB) with QA of the GRDs using different ADMs. Appendix C contains a series of exhibits that illustrate how the General Information Form, supplemented by checklists, could be used to document the QA process for a project using the different ACMs and ADMs. For these examples, the FHWA checklists have been used; however, each agency should develop their own checklists using those from the FHWA or those developed by their staff based on information from FHWA, AASHTO, industry standards or their own practices. This includes checklists for design elements that are not in the referenced FHWA checklist because they were not developed at the time of that publication (FHWA, 2003). Examples include micropile foundations, soil nailing and continuous flight augercast piles. In addition, checklists have not been developed for use with GDRs prepared for use with the DB ACM.

For simplicity, the example project is assumed to contain the following design elements:

- Roadway grading, including embankments and cuts in soil and rock
- One bridge structure supported by drilled shaft foundations

Case 1 illustrates the QA process for the DBB ACM with reviews developed for:

- Preliminary Design GRD – See Exhibit C-1
- Final Roadway Design GRD – See Exhibit C-2
- Final Structure Design GRD – See Exhibit C-3

Case 2 illustrates the process if the DB ACM were used and QA reviews were developed for the following GRDs, although there could be others added on an actual project.

- Preliminary Design GRD (Same as DBB) – See Exhibit C-1
- Geotechnical Data Report (GDR) – See Exhibit C-4
- Final Roadway Design GRD – See Exhibit C-5
- Final Structure Design GRD – See Exhibit C-6

Note that the Preliminary Design GRD for the DBB, Exhibit C-1, has been included in Case 2 to illustrate that the Preliminary Design for a DB project would be performed using the same process as a DBB project. In addition, a Geotechnical Data Report (GDR) is typically generated and provided to DB teams for use in developing proposals, as well as in final design by the selected firm.

As shown in Figures B-1 and B-2, these examples illustrate Step 3 of the QA review process conducted by a geotechnical specialist (GS). Although not shown in the example, a project or program level audit (Step 4) could also be conducted to verify that the Step 3 QA has been completed. This could be a project or program representative who is responsible for auditing QA reviews of multiple disciplines that contribute to the PS&E development, thereby verifying communication and coordination between disciplines during completion of design and development of the PS&E.

4.5 CLOSING COMMENTS ON IMPLEMENTATION OF QA PROGRAMS FOR GRDS

The importance of a Quality Assurance program for GRDs cannot be over emphasized, and its use with DB and CM/GC is especially important since the interaction between the owner agency, the engineering consultant, the geotechnical specialist and the contractor is more complicated and schedule driven than the more traditional DBB contracting method. It also introduces the use of ADMs. While use of the CM/GC contracting method allows the owner agency to maintain full control of the design and construction schedule, this ACM also includes the simultaneous coordination between the owner agency, the design consultant, the GS and the contractor. The need for ongoing communication and coordination between the parties involved is heightened and relies even more heavily on the implementation of a strong QA program than the traditional DBB ACM.

A system for QA of the GRDs is discussed in this document. It is intended that this document will assist in obtaining that objective and providing a successful project.

REFERENCES

ASCE (1997). “Geotechnical Baseline Reports for Underground Construction - Guidelines and Practices,” The Technical Committee on Geotechnical Reports of the Underground Technical Research Council, American Society of Civil Engineering and American Institute of Mining, Metallurgical and Petroleum Engineers.

FDOT (2016). Florida DOT, Soils and Foundation Handbook.

FHWA (1979). “A Guide for In-house Review of Proposals and Reports” by The Association of Soil and Foundation Engineers.

FHWA (1997). “Training Course in Geotechnical and Foundation Engineering,” NHI Course 13231- Module 1 (FHWA HI-97-021 Subsurface Investigations).

FHWA (2002). Subsurface Investigation – Geotechnical Site Characterization Reference Manual, FHWA –NHI-01-031.

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FHWA (2007). FHWA Technical Guidelines Manual.

NCDOT (2011). North Carolina DOT, Guidelines & Procedures Manual for Subsurface Investigations.

NCHRP (2008). “Quality-Assurance in Design-Build Projects, A Synthesis of Highway Practice” NCHRP Synthesis 376 by D. Gransberg, J. Datin and K. Molenaar.

UDOT(1) (2014). Utah DOT Geotechnical Manual of Instruction.

UDOT(2) (2014). Utah DOT, Project Delivery Network - Geotechnical Design QC Checklists.

Appendix A

Design Process with Construction Phase Relation
for
Alternative Contracting Methods

Alternative Contracting Method
Design-Bid-Build (DBB)

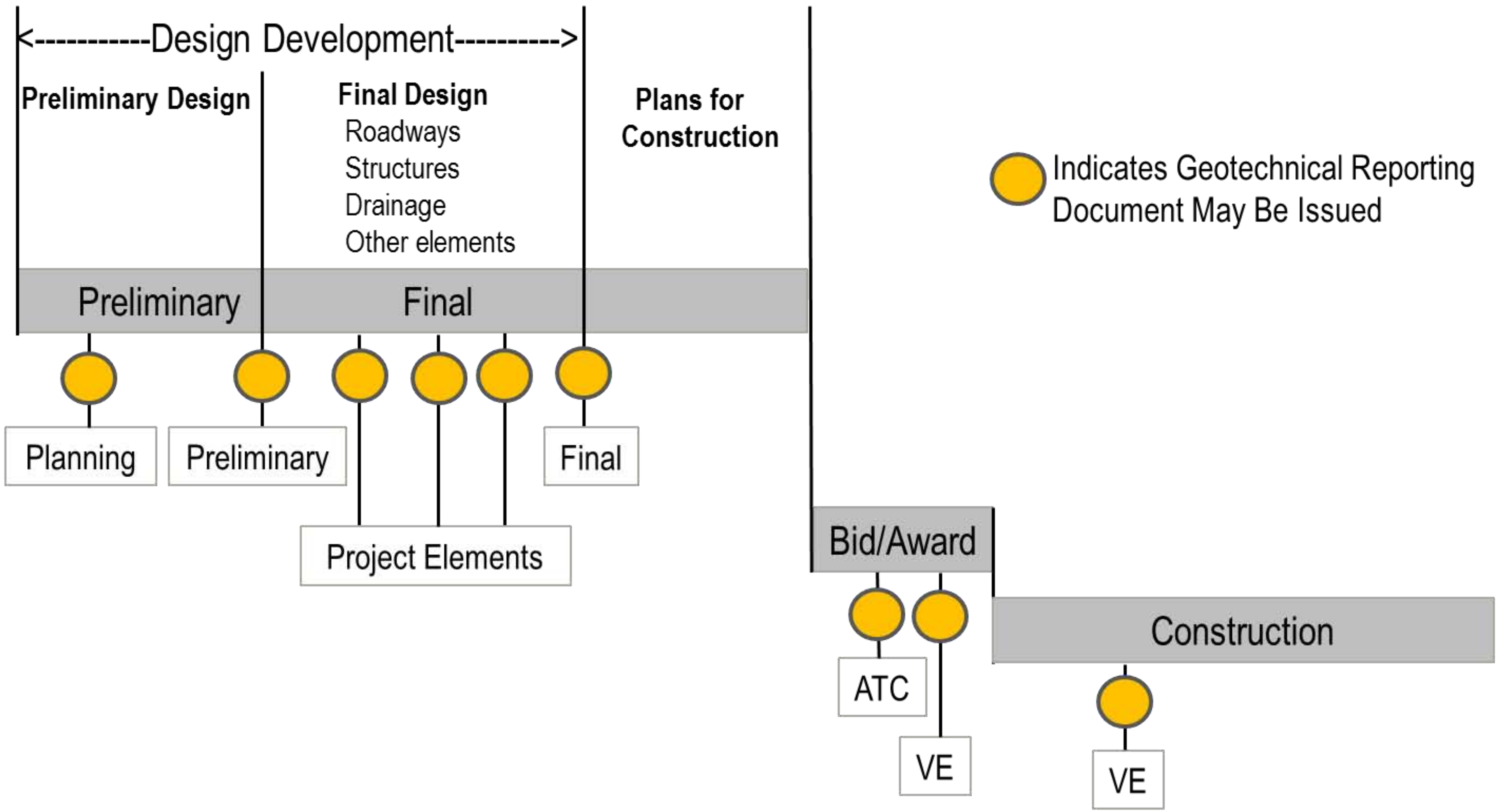


Figure A-1: Graphic Illustrating the Design-Bid-Build Contracting Method

Alternative Contracting Method
Design-Build (DB)

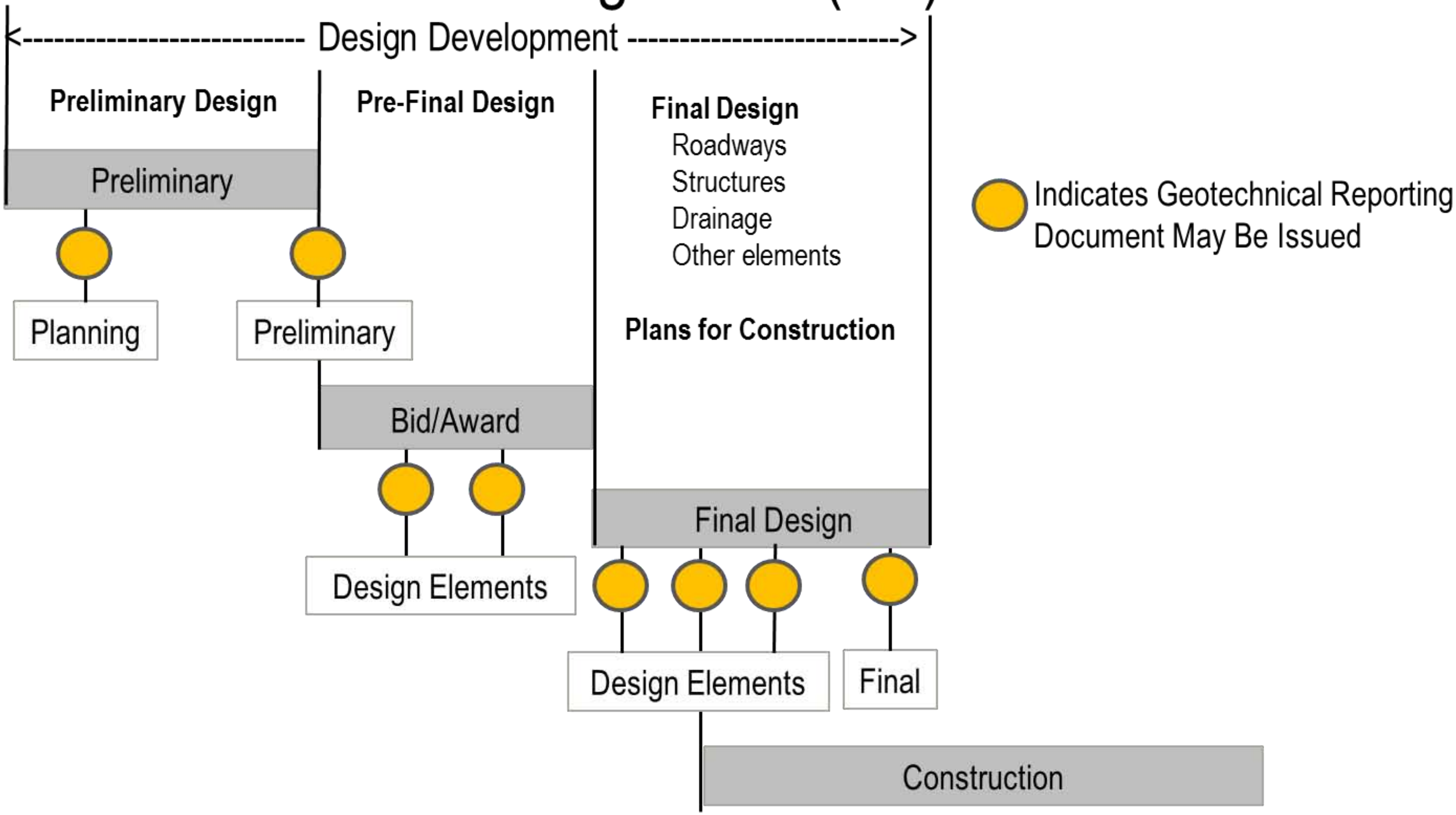


Figure A-2: Graphic Illustrating the Design-Build Contracting Method

Alternative Contracting Method
Construction Manager/General Contractor (CM/GC)

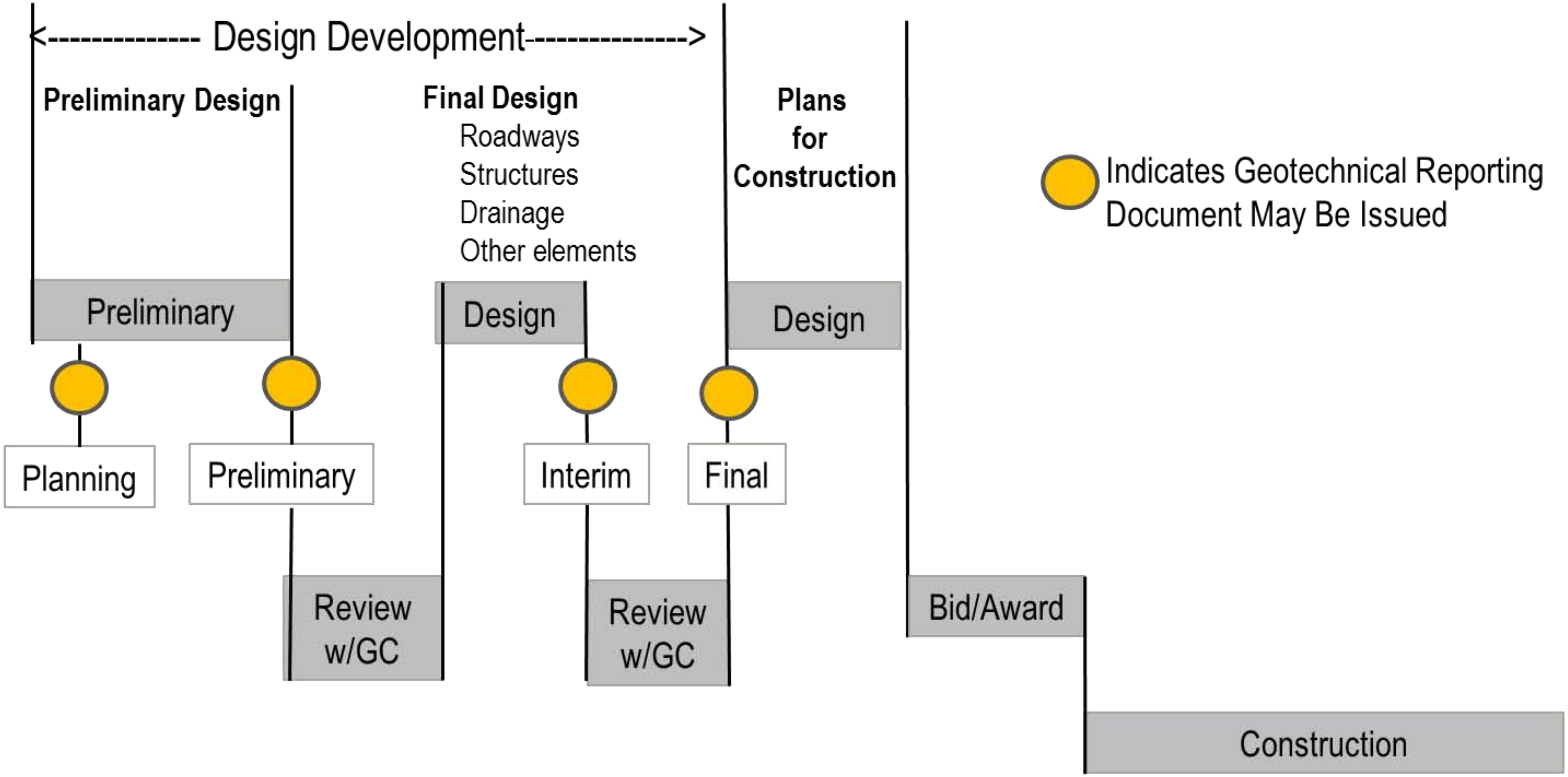
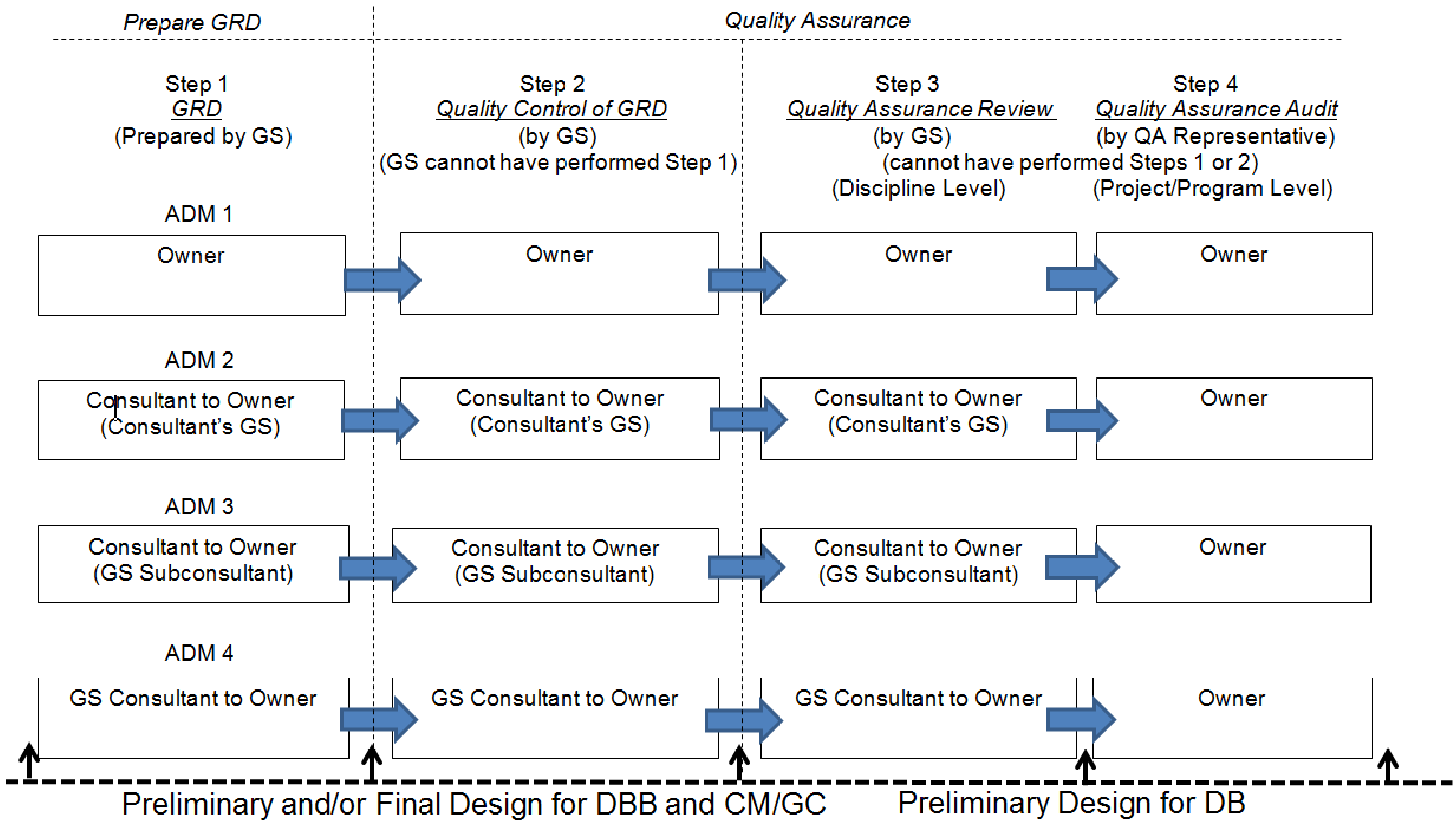


Figure A-3: Graphic Illustrating the Construction Manager/General Contractor Contracting Method

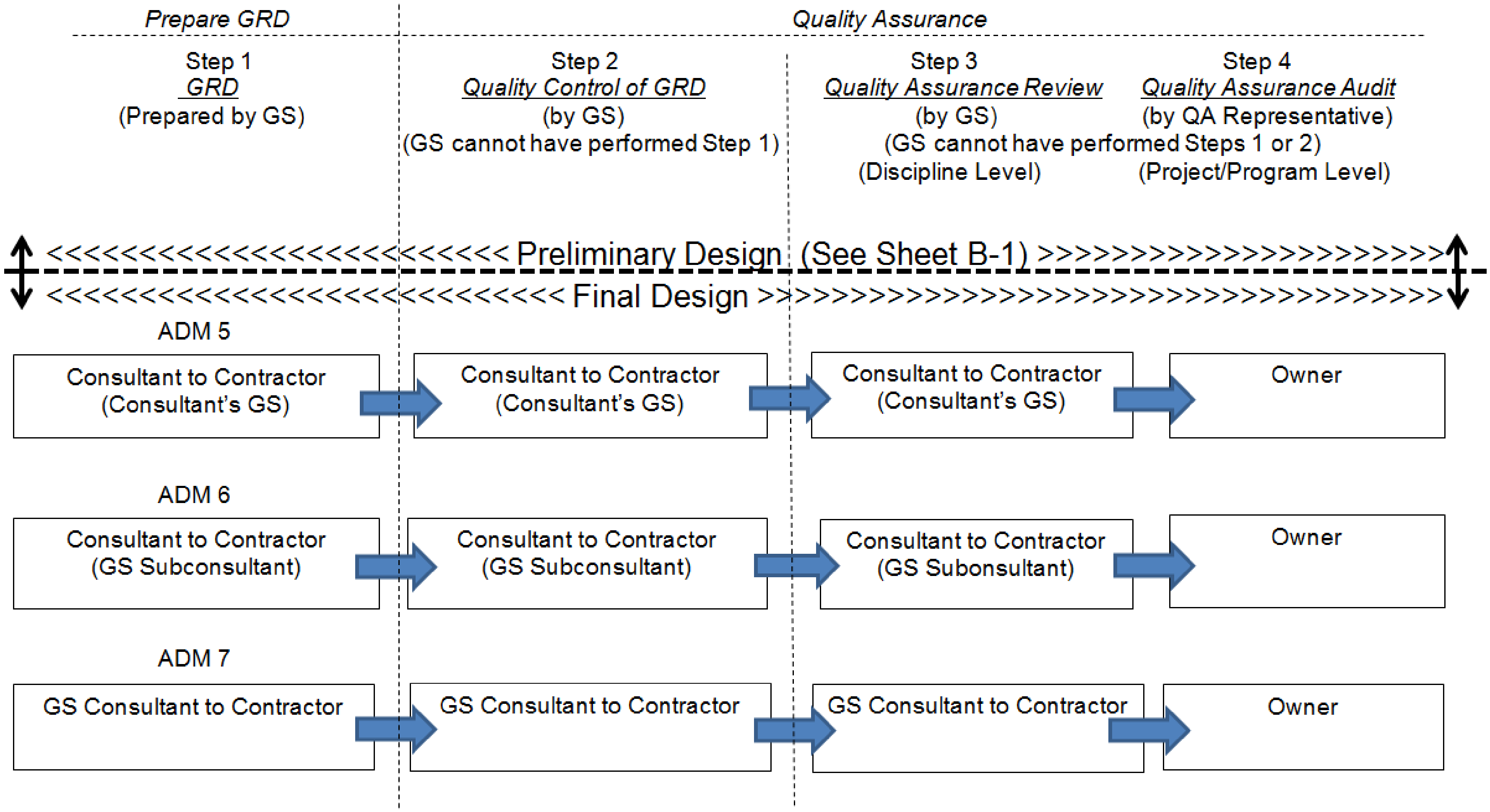
Appendix B

QA Processes for Alternative Delivery Methods



Notes:
Consultant – Design Consultant who may have in-house Geotechnical Specialists (Consultant's GS) or subcontract geotechnical services (GS Subconsultant)
GS Consultant – Firm providing only geotechnical services directly to the owner
Geotechnical Specialist (GS) – Refer to Section 1.2 of Guidance Document. GS in Step 1 must be licensed in project state.
QA Representative – Quality Assurance Representative

Figure B-1 QA of GRDs for Alternative Delivery Methods - DBB, CM/GC and Preliminary DB (ACMs)



Notes:
Consultant – Design Consultant who may have in-house Geotechnical Specialists (Consultant's GS) or subcontract geotechnical services (GS Subconsultant)
GS Consultant – Firm providing only geotechnical services directly to the contractor
Geotechnical Specialist (GS) – Refer to Section 1.2 of Guidance Document. GS in Step 1 must be registered in project state.
QA Representative – Quality Assurance Representative

Figure B-2 QA of GRDs for Alternative Delivery Method with Design-Build (ACM)

Appendix C - QA for Example Projects

<u>Case 1 DBB ACM</u>

C-1 GRD for Preliminary Design
C-2 GRD for Final Design of Roadways
C-3 GRD for Final Design of Structures

<u>Case 2 DB ACM</u>

C-4 Geotechnical Data Report (GDR)
C-5 GRD for Final Design of Roadways
C-6 GRD for Final Design of Structures

C-7 Blank General Information Form

Exhibit C-1

Example Project - Case 1 (DBB ACM)

GRD for Preliminary Design
(Refer to Figure B-1, ADM 2)

Geotechnical Reporting Document (GRD) Quality Assurance Checklist

Part 1 - General Information Form

Project Name: Route 1492 Section 123 ____________________

Project Contracting Method: DBB __X__ DB____ P3 ___ CM/GC ___ Other _____

Note: If other, describe here: ______________________________

QA Reviewer John Johnson, PE Firm/Agency Affiliation: XYZ DOT

GRD Title: Geotechnical Report for Preliminary Design – Route 1492, Section 123

GRD Type (e.g., GR, GDR, GBR, Memo, Email) Geotechnical Report

GRD Author and Firm: Henry Pete, PE; ABC Engineering; 1243 Soil Dr, Siskle, VA 12345

GRD Author/Firm Client: Owner Agency __X__ Contractor _______ Other_______

Note: If other, describe here: ______________________________

Project Component(s) Covered by GRD: Roadway __X__ Structure __X__ Other ______

Note: If other, describe here: ______________________________

Project Development Stage

Planning/Conceptual: _______ Preliminary Design __X__

Final Design: _______

If other than above, describe here: ______________________________

Note: Use appropriate Checklist Form based on Project Information.

Copy of Review Comments Attached: Yes __X__ No ___

Copy of QC Checklists Attached: Yes __X__ No ___

Accepted: Yes __X__ No ____ (If NO, return for modification and resubmission.)

Signature of Reviewer John Johnson, P.E. **Date:** 08/03/2016

QA Review Level: Discipline Level Review __X__ Project/Program Level Audit ____

Part 2 - Checklists Attached (Attach Specific Applicable Checklists)

__X__ A – Site Investigation Information

__X__ B – Centerline Cuts and Embankments

____ C – Embankment over Soft Ground

____ D – Landslide Corrections

____ E – Retaining Structures

____ F – Structure Foundations – Spread Footings

____ G – Structure Foundations – Driven Piles

____ H – Structure Foundations – Drilled Shafts

____ I – Ground Improvement Techniques

____ J – Material Sites

____ K – (add as needed)

____ L – (add as needed)

____ M – (add as needed)

____ N – (add as needed)

Comments:

General: Project is at Preliminary Design. One structure is on the project and foundations will be addressed in final structures geotechnical report. Checklists reference FHWA 2003 unless otherwise noted.

-Items A.5 and A.6a-d, no field test data or photographs were obtained during this investigation. Will be obtained as necessary during Final Design Roadway Investigation.

-Items B.9 and 10, no special usage at this time for excavated soils. Shrink-swell factors will be provided in the GR for Final Roadway Design.

-Items B.13-15, will be addressed and final recommendations provided in the GR for Final Roadway Design.

Example Project: Case 1 – GRD for Preliminary Design

GTR REVIEW CHECKLIST FOR SITE INVESTIGATION

A. Site Investigation Information

Since the most important step in the geotechnical design process is to conduct an adequate site investigation, presentation of the subsurface information in the geotechnical report and on the plans deserves careful attention.

Geotechnical Report Text (Introduction) (Pgs. 10-1 to 10-4)	Yes	No	Unknown or N/A
1. Is the general location of the investigation described and/or a vicinity map included?	X		
2. Is scope and purpose of the investigation summarized?			
3. Is concise description given of geologic setting and topography of area?	X		
4. Are the field explorations and laboratory tests on which the report is based listed?	X-None		
5. Is the general description of subsurface soil, rock, and groundwater conditions given?			X
*6. Is the following information included with the geotechnical report (typically included in the report appendices):			
a. Test hole logs? (Pgs. 2-24 to 2-32)		X	
b. Field test data?		X	
c. Laboratory test data? (Pgs. 4-22 to 4-23)		X	
d. Photographs (if pertinent)?		X	
Plan and Subsurface Profile (Pgs. 2-19, 3-9 to 3-12, 10-13)			
*7. Is a plan and subsurface profile of the investigation site provided?			X-N/A
8. Are the field explorations located on the plan view?			X-N/A

*A response other than (yes) or (N/A) for any of these checklist questions is cause to contact the appropriate geotechnical engineer for a clarification and/or to discuss the project.

Example Project: Case 1 – GRD for Preliminary Design

GTR REVIEW CHECKLIST FOR CENTERLINE CUTS AND EMBANKMENTS

B. Centerline Cuts and Embankments (Pgs. 2-2 to 2-6)

In addition to the basic information listed in Section A, is the following information provided in the project geotechnical report.

Are station-to-station descriptions included for:	Yes	No	Unknown or N/A
1. Existing surface and subsurface drainage?	X		
2. Evidence of springs and excessively wet areas?	X		
3. Slides, slumps, and faults noted along the alignment?	X		
Are station-to-station recommendations included for the following?			
General Soil Cut or Fill			
4. Specific surface/subsurface drainage recommendations?	X		
5. Excavation limits of unsuitable materials?	X		
*6. Erosion protection measures for back slopes, side slopes, and ditches, including riprap recommendations or special slope treatment.	X		
Soil Cuts (Pgs. 5-23, 5-24)			
*7. Recommended cut slope design?	X		
8. Are clay cut slopes designed for minimum F.S. = 1.50?	X		
9. Special usage of excavated soils?		X	
10. Estimated shrink-swell factors for excavated materials?		X	
11. If answer to 3 is yes, are recommendations provided for design treatment?	X		

Example Project: Case 1 – GRD for Preliminary Design

B.	Centerline Cuts and Embankments (Cont.)	Yes	No	Unknown or N/A
	Fills (Pgs. 5-1 to 5-3)			
12.	Recommended fill slope design?	X		
13.	Will fill slope design provide minimum F.S. = 1.25?		X	
	Rock Slopes			
*14.	Are recommended slope designs and blasting specifications provided?		X	
*15.	Is the need for special rock slope stabilization measures, e.g., rockfall catch ditch, wire mesh slope protection, shotcrete, rock bolts, addressed?		X	
16.	Has the use of "template" designs been avoided (such as designing all rock slopes on 0.25:1 rather than designing based on orientation of major rock jointing)?	X		
*17.	Have effects of blast induced vibrations on adjacent structures been evaluated?	X		

*A response other than (yes) or (N/A) for any of these checklist questions is cause to contact the appropriate geotechnical engineer for a clarification and/or to discuss the project.

Exhibit C-2

Example Project - Case 1 (DBB ACM)

GRD for Final Design of Roadway
(Refer to Figure B-1, ADM 2)

Geotechnical Reporting Document (GRD) Quality Assurance Checklist

Part 1 - General Information Form

Project Name: Route 1492 Section 123

Project Contracting Method: DBB __X__ DB___ P3 ___ CM/GC ___ Other _____

Note: If other, describe here: ________________________

QA Reviewer John Johnson, P.E. Firm/Agency Affiliation: XYZ DOT

GRD Title: Geotechnical Report for Final Design – Route 1492, Section 123

GRD Type (e.g., GR, GDR, GBR, Memo, Email) Geotechnical Report

GRD Author and Firm: Henry Pete, PE; ABC Engineering; 1243 Soil Dr, Siskle, VA 12345

GRD Author/Firm Client: Owner Agency __X__ Contractor _______ Other_______

Note: If other, describe here: ________________________

Project Component(s) Covered by GRD: Roadway __X__ Structure ____ Other ______

Note: If other, describe here: ________________________

Project Development Stage

Planning/Conceptual: _______ Preliminary Design ______

Final Design: ___X___

If other than above, describe here: ________________________

Note: Use appropriate Checklist Form based on Project Information.

Copy of Review Comments Attached: Yes _X_ No ___

Copy of QC Checklists Attached: Yes _X_ No ___

Accepted: Yes __X__ No ____ (If NO, return for modification and resubmission.)

Signature of Reviewer *John Johnson, P.E.* **Date:** 08/03/2016

QA Review Level: Discipline Level Review __X__ Project/Program Level Audit ____

Part 2 - Checklists Attached (Attach Specific Applicable Checklists)

_X_ A – Site Investigation Information

_X_ B – Centerline Cuts and Embankments

____ C – Embankment over Soft Ground

____ D – Landslide Corrections

____ E – Retaining Structures

____ F – Structure Foundations – Spread Footings

____ G – Structure Foundations – Driven Piles

____ H – Structure Foundations – Drilled Shafts

____ I – Ground Improvement Techniques

____ J – Material Sites

____ K – (add as needed)

____ L – (add as needed)

____ M – (add as needed)

____ N – (add as needed)

Comments:

-General: Project is at Final Design for Roadway and other elements except for bridge structure. Final design recommendations for bridge structure will be provided after final design investigation and completion of geotechnical report. Checklists reference FHWA, 2003 unless otherwise noted.

-Item B.9, there was no special usage for excavated soils. All will be disposed of offsite by contractor at an approved waste area.

Example Project: Case 1 – GRD for Final Roadway Design

GTR REVIEW CHECKLIST FOR SITE INVESTIGATION

A. Site Investigation Information

Since the most important step in the geotechnical design process is to conduct an adequate site investigation, presentation of the subsurface information in the geotechnical report and on the plans deserves careful attention.

Geotechnical Report Text (Introduction) (Pgs. 10-1 to 10-4)	Yes	No	Unknown or N/A
1. Is the general location of the investigation described and/or a vicinity map included?	X		
2. Is scope and purpose of the investigation summarized?	X		
3. Is concise description given of geologic setting and topography of area?	X		
4. Are the field explorations and laboratory tests on which the report is based listed?	X		
5. Is the general description of subsurface soil, rock, and groundwater conditions given?	X		
*6. Is the following information included with the geotechnical report (typically included in the report appendices):			
a. Test hole logs? (Pgs. 2-24 to 2-32)	X		
b. Field test data?	X		
c. Laboratory test data? (Pgs. 4-22 to 4-23)	X		
d. Photographs (if pertinent)?	X		
Plan and Subsurface Profile (Pgs. 2-19, 3-9 to 3-12, 10-13)			
*7. Is a plan and subsurface profile of the investigation site provided?	X		
8. Are the field explorations located on the plan view?	X		

*A response other than (yes) or (N/A) for any of these checklist questions is cause to contact the appropriate geotechnical engineer for a clarification and/or to discuss the project.

Example Project: Case 1 – GRD for Final Roadway Design

GTR REVIEW CHECKLIST FOR CENTERLINE CUTS AND EMBANKMENTS

B. Centerline Cuts and Embankments (Pgs. 2-2 to 2-6)

In addition to the basic information listed in Section A, is the following information provided in the project geotechnical report.

Are station-to-station descriptions included for:	Yes	No	Unknown or N/A
1. Existing surface and subsurface drainage?	X		
2. Evidence of springs and excessively wet areas?	X		
3. Slides, slumps, and faults noted along the alignment?	X		

Are station-to-station recommendations included for the following?

General Soil Cut or Fill

	Yes	No	Unknown or N/A
4. Specific surface/subsurface drainage recommendations?	X		
5. Excavation limits of unsuitable materials?	X		
*6. Erosion protection measures for back slopes, side slopes, and ditches, including riprap recommendations or special slope treatment.	X		

Soil Cuts (Pgs. 5-23, 5-24)

	Yes	No	Unknown or N/A
*7. Recommended cut slope design?	X		
8. Are clay cut slopes designed for minimum F.S. = 1.50?	X		
9. Special usage of excavated soils?		X	
10. Estimated shrink-swell factors for excavated materials?	X		
11. If answer to 3 is yes, are recommendations provided for design treatment?	X		

Example Project: Case 1 – GRD for Final Roadway Design

B. Centerline Cuts and Embankments (Cont.)	Yes	No	Unknown or N/A
Fills (Pgs. 5-1 to 5-3)			
12. Recommended fill slope design?	X		
13. Will fill slope design provide minimum F.S. = 1.25?	X		
Rock Slopes			
*14. Are recommended slope designs and blasting specifications provided?	X		
*15. Is the need for special rock slope stabilization measures, e.g., rockfall catch ditch, wire mesh slope protection, shotcrete, rock bolts, addressed?	X		
16. Has the use of "template" designs been avoided (such as designing all rock slopes on 0.25:1 rather than designing based on orientation of major rock jointing)?	X		
*17. Have effects of blast induced vibrations on adjacent structures been evaluated?	X		

*A response other than (yes) or (N/A) for any of these checklist questions is cause to contact the appropriate geotechnical engineer for a clarification and/or to discuss the project.

Exhibit C-3

Example Project - Case 1 (DBB ACM)

GRD for Final Design of Structures
(Refer to Figure B-1, ADM 2)

Geotechnical Reporting Document (GRD) Quality Assurance Checklist

Part 1 - General Information Form

Project Name: Route 1492 Section 123

Project Contracting Method: DBB __X__ DB___ P3 ___ CM/GC ___ Other _____

Note: If other, describe here: ____________________

QA Reviewer John Johnson, P.E. Firm/Agency Affiliation: XYZ DOT

GRD Title: Geotechnical Report for Final Design – Route 1492, Section 123 Bridge

GRD Type (e.g., GR, GDR, GBR, Memo, Email) Geotechnical Report

GRD Author and Firm: Henry Pete, PE; ABC Engineering; 1243 Soil Dr, Siskle, VA 12345

GRD Author/Firm Client: Owner Agency __X__ Contractor _______ Other________

Note: If other, describe here: ____________________

Project Component(s) Covered by GRD: Roadway ____ Structure __X__ Other ______

Note: If other, describe here: ____________________

Project Development Stage

Planning/Conceptual: _______ Preliminary Design ______

Final Design: ___X___

If other than above, describe here: ____________________

Note: Use appropriate Checklist Form based on Project Information.

Copy of Review Comments Attached: Yes _X_ No ___

Copy of QC Checklists Attached: Yes _X_ No ___

Accepted: Yes __X__ No ____ (If NO, return for modification and resubmission.)

Signature of Reviewer John Johnson, P.E. **Date:** 08/03/2016

QA Review Level: Discipline Level Review __X__ Project/Program Level Audit ____

Part 2 - Checklists Attached (Attach Specific Applicable Checklists)

__X__ A – Site Investigation Information

____ B – Centerline Cuts and Embankments

____ C – Embankment over Soft Ground

____ D – Landslide Corrections

____ E – Retaining Structures

____ F – Structure Foundations – Spread Footings

____ G – Structure Foundations – Driven Piles

__X__ H – Structure Foundations – Drilled Shafts

____ I – Ground Improvement Techniques

____ J – Material Sites

____ K – (add as needed)

____ L – (add as needed)

____ M – (add as needed)

____ N – (add as needed)

Comments:

-General: See Geotechnical Report for Final Design of Roadway for related recommendations. Checklists reference FHWA, 2003 unless otherwise noted.

-Item H.4, no static load test is required for this design based on previous experience with drilled shafts in the area.

-Item H.6, shafts are obtaining bearing in rock socket. Casing will be required due to loose sands and high groundwater table. Designers decided to leave casing in place to control risk of caving and possible detrimental impact to rock socket and bearing surface.

-Item H.8, no boulders encountered in explorations.

Example Project Case 1 – GRD for Final Design of Structures

GTR REVIEW CHECKLIST FOR SITE INVESTIGATION

A. Site Investigation Information

Since the most important step in the geotechnical design process is to conduct an adequate site investigation, presentation of the subsurface information in the geotechnical report and on the plans deserves careful attention.

Geotechnical Report Text (Introduction) (Pgs. 10-1 to 10-4)	Yes	No	Unknown or N/A
1. Is the general location of the investigation described and/or a vicinity map included?	X		
2. Is scope and purpose of the investigation summarized?	X		
3. Is concise description given of geologic setting and topography of area?	X		
4. Are the field explorations and laboratory tests on which the report is based listed?	X		
5. Is the general description of subsurface soil, rock, and groundwater conditions given?	X		
*6. Is the following information included with the geotechnical report (typically included in the report appendices):			
a. Test hole logs? (Pgs. 2-24 to 2-32)	X		
b. Field test data?	X		
c. Laboratory test data? (Pgs. 4-22 to 4-23)	X		
d. Photographs (if pertinent)?	X		
Plan and Subsurface Profile (Pgs. 2-19, 3-9 to 3-12, 10-13)			
*7. Is a plan and subsurface profile of the investigation site provided?	X		
8. Are the field explorations located on the plan view?	X		

*A response other than (yes) or (N/A) for any of these checklist questions is cause to contact the appropriate geotechnical engineer for a clarification and/or to discuss the project.

Example Project Case 1 – GRD for Final Design of Structures

GTR REVIEW CHECKLIST FOR DRILLED SHAFTS

H. Structure Foundations – Drilled Shafts (Pgs. 8-23 to 8-29)

In addition to the basic information listed in Section A, if drilled shaft support is recommended or given as an alternative, are conclusion/recommendations provided in the project foundation report for the following:

		Yes	No	Unknown or N/A
*1.	Are recommended shaft diameter(s) and length(s) for allowable design loads based on an analysis using soil parameters for side friction and end bearing?	X		
*2.	Settlement estimated for recommended design loads?	X		
*3.	Where lateral load capacity of shaft is an important design consideration, are p-y (load vs. deflection) curves or soils data provided in geotechnical report that will allow structural engineer to evaluate lateral load capacity of shaft?	X		
4.	Is static load test (to plunging failure) recommended?		X	

Construction Considerations

		Yes	No	Unknown or N/A
5.	Have construction methods been evaluated, i.e., can less expensive dry method or slurry method be used or will casing be required?	X		
6.	If casing will be required, can casing be pulled as shaft is concreted (this can result in significant cost savings on very large diameter shafts)?		X	
7.	If artesian water was encountered in explorations, have design provisions been included to handle it (such as by requiring casing and a tremie seal)?	X		
8.	Will boulders be encountered? (If boulders will be encountered, then the use of shafts should be seriously questioned due to construction installation difficulties and resultant higher cost to boulders can cause.)		X	

*A response other than (yes) or (N/A) for any of these checklist questions is cause to contact the appropriate geotechnical engineer for a clarification and/or to discuss the project.

Exhibit C-4

Example Project - Case 2 (DB ACM)

Geotechnical Data Report (GDR)
(Refer to Figure B-2; Figure B-1, ADM 2)

Geotechnical Reporting Document (GRD) Quality Assurance Checklist

Part 1 - General Information Form

Project Name: Route 1492 Section 123____

Project Contracting Method: DBB _____ DB__X__ P3 ___ CM/GC ___ Other _____

Note: If other, describe here: ____

QA Reviewer Jacob M. Smith, P.E. Firm/Agency Affiliation: _____XYZ DOT_______

GRD Title: __Geotechnical Data Report – Route 1492, Section 123_______________

GRD Type (e.g., GR, GDR, GBR, Memo, Email) _Geotechnical Data Report (GDR)__

GRD Author and Firm: Zeke L. Allen, P.E.; ABC Engineering; 1243 Soil Dr, Siskle, VA 12345

GRD Author/Firm Client: Owner Agency __X__ Contractor _______ Other________

Note: If other, describe here: ____

Project Component(s) Covered by GRD: Roadway __X__ Structure __X__ Other ______

Note: If other, describe here: ____

Project Development Stage

Planning/Conceptual: _______ Preliminary Design ___X___

Final Design: _______

If other than above, describe here: ____

Note: Use appropriate Checklist Form based on Project Information.

Copy of Review Comments Attached: Yes _X_ No ___

Copy of QC Checklists Attached: Yes _X_ No ___

Accepted: Yes __X__ No ____ (If NO, return for modification and resubmission.)

Signature of Reviewer _Jacob M. Smith, P.E._ **Date:** ___08/03/2016___

QA Review Level: Discipline Level Review__X__ Project/Program Level Audit ____

Part 2 - Checklists Attached (Attach Specific Applicable Checklists)

__X[1]__ A – Site Investigation Information (GDR for DB Project)

____ B – Centerline Cuts and Embankments

____ C – Embankment over Soft Ground

____ D – Landslide Corrections

____ E – Retaining Structures

____ F – Structure Foundations – Spread Footings

____ G – Structure Foundations – Driven Piles

____ H – Structure Foundations – Drilled Shafts

____ I – Ground Improvement Techniques

____ J – Material Sites

____ K – (add as needed)

____ L – (add as needed)

____ M – (add as needed)

____ N – (add as needed)

Comments:

-General: Project is in Preliminary Design for a DB ACM. Checklists reference FHWA, 2003 unless otherwise noted.

[1]Checklist not specifically for GDR. Notes are used to supplement as necessary. As no recommendations are contained, Site Investigations checklist is appropriate.

Example Project: Case 2 – GDR for D-B

GTR REVIEW CHECKLIST ~~FOR SITE INVESTIGATION~~ **GDR**

A. Site Investigation Information

Since the most important step in the geotechnical design process is to conduct an adequate site investigation, presentation of the subsurface information in the geotechnical report and on the plans deserves careful attention.

Geotechnical Report Text (Introduction) (Pgs. 10-1 to 10-4)	Yes	No	Unknown or N/A
1. Is the general location of the investigation described and/or a vicinity map included?	X		
2. Is scope and purpose of the investigation summarized?	X		
3. Is concise description given of geologic setting and topography of area?	X		
4. Are the field explorations and laboratory tests on which the report is based listed?	X		
5. Is the general description of subsurface soil, rock, and groundwater conditions given?	X		
*6. Is the following information included with the geotechnical report (typically included in the report appendices):			
a. Test hole logs? (Pgs. 2-24 to 2-32)	X		
b. Field test data?			X-None
c. Laboratory test data? (Pgs. 4-22 to 4-23)	X		
d. Photographs (if pertinent)?	X		
Plan and Subsurface Profile (Pgs. 2-19, 3-9 to 3-12, 10-13)			
*7. Is a plan and subsurface profile of the investigation site provided?	X		
8. Are the field explorations located on the plan view?	X		

*A response other than (yes) or (N/A) for any of these checklist questions is cause to contact the appropriate geotechnical engineer for a clarification and/or to discuss the project.

Exhibit C-5

Example Project - Case 2 (DB ACM)

GRD for Final Design of Roadways
(Refer to Figure B-2, ADM 5)

Geotechnical Reporting Document (GRD) Quality Assurance Checklist

Part 1 - General Information Form

Project Name: Route 1492 Section 123____________________________________

Project Contracting Method: DBB _____ DB_X__ P3 ___ CM/GC ___ Other _____

Note: If other, describe here: ____

QA Reviewer: Alvin L. Zunk, PE____ Firm/Agency Affiliation: LMN Engineering______

GRD Title: Geotechnical Report for Final Design – Route 1492, Section 123_________

GRD Type (e.g., GR, GDR, GBR, Memo, Email) __Geotechnical Report (GR)________

GRD Author and Firm: Jeffery M. Stadler, PE; LMN Engineering; 301 Fines Dr, Turk, PA 21234

GRD Author/Firm Client: Owner Agency ____ Contractor ___X___ Other_______

Note: If other, describe here: ____

Project Component(s) Covered by GRD: Roadway __X_ Structure ____ Other ______

Note: If other, describe here: ____

Project Development Stage

Planning/Conceptual: _______ Preliminary Design ______

Final Design: ___X___

If other than above, describe here: ____

Note: Use appropriate Checklist Form based on Project Information.

Copy of Review Comments Attached: Yes _X_ No ___

Copy of QC Checklists Attached: Yes _X_ No ___

Accepted: Yes _X__ No ____ (If NO, return for modification and resubmission.)

Signature of Reviewer _Alvin L. Zunk, PE_____________ **Date:** 08/03/2016____

QA Review Level: Discipline Level Review _X__ Project/Program Level Audit ____

Part 2 - Checklists Attached (Attach Specific Applicable Checklists)

_X__ A – Site Investigation Information (GDR for DB Project)

_X_ B – Centerline Cuts and Embankments

____ C – Embankment over Soft Ground

____ D – Landslide Corrections

____ E – Retaining Structures

____ F – Structure Foundations – Spread Footings

____ G – Structure Foundations – Driven Piles

____ H – Structure Foundations – Drilled Shafts

____ I – Ground Improvement Techniques

____ J – Material Sites

____ K – (add as needed)

____ L – (add as needed)

____ M – (add as needed)

____ N – (add as needed)

Comments:

General: Project is at Final Design for roadway and other elements except for bridge structure. Final recommendations for bridge structure will be presented in the Structure Geotechnical Engineering Report after Final Design Investigation. Checklists reference FHWA, 2003 unless otherwise noted.

-Item B.9, there is no special use intended for excavated material except as embankment. Waste material will be hauled off by the contractor to an approved waste area.

Example Project: Case 2 – GRD for Final Roadway Design

GTR REVIEW CHECKLIST FOR SITE INVESTIGATION

A. Site Investigation Information

Since the most important step in the geotechnical design process is to conduct an adequate site investigation, presentation of the subsurface information in the geotechnical report and on the plans deserves careful attention.

Geotechnical Report Text (Introduction) (Pgs. 10-1 to 10-4)	Yes	No	Unknown or N/A
1. Is the general location of the investigation described and/or a vicinity map included?	X		
2. Is scope and purpose of the investigation summarized?	X		
3. Is concise description given of geologic setting and topography of area?	X		
4. Are the field explorations and laboratory tests on which the report is based listed?	X		
5. Is the general description of subsurface soil, rock, and groundwater conditions given?	X		
*6. Is the following information included with the geotechnical report (typically included in the report appendices):			
a. Test hole logs? (Pgs. 2-24 to 2-32)	X		
b. Field test data?	X		
c. Laboratory test data? (Pgs. 4-22 to 4-23)	X		
d. Photographs (if pertinent)?	X		
Plan and Subsurface Profile (Pgs. 2-19, 3-9 to 3-12, 10-13)			
*7. Is a plan and subsurface profile of the investigation site provided?	X		
8. Are the field explorations located on the plan view?	X		

*A response other than (yes) or (N/A) for any of these checklist questions is cause to contact the appropriate geotechnical engineer for a clarification and/or to discuss the project.

Example Project: Case 2 – GRD for Final Roadway Design

GTR REVIEW CHECKLIST FOR CENTERLINE CUTS AND EMBANKMENTS

B. Centerline Cuts and Embankments (Pgs. 2-2 to 2-6)

In addition to the basic information listed in Section A, is the following information provided in the project geotechnical report.

Are station-to-station descriptions included for:	Yes	No	Unknown or N/A
1. Existing surface and subsurface drainage?	X		
2. Evidence of springs and excessively wet areas?	X		
3. Slides, slumps, and faults noted along the alignment?	X		

Are station-to-station recommendations included for the following?

General Soil Cut or Fill

	Yes	No	Unknown or N/A
4. Specific surface/subsurface drainage recommendations?	X		
5. Excavation limits of unsuitable materials?	X		
*6. Erosion protection measures for back slopes, side slopes, and ditches, including riprap recommendations or special slope treatment.	X		

Soil Cuts (Pgs. 5-23, 5-24)

	Yes	No	Unknown or N/A
*7. Recommended cut slope design?	X		
8. Are clay cut slopes designed for minimum F.S. = 1.50?	X		
9. Special usage of excavated soils?	X		
10. Estimated shrink-swell factors for excavated materials?	X		
11. If answer to 3 is yes, are recommendations provided for design treatment?	X		

B.	Centerline Cuts and Embankments (Cont.)	Yes	No	Unknown or N/A
	Fills (Pgs. 5-1 to 5-3)			
12.	Recommended fill slope design?	X		
13.	Will fill slope design provide minimum F.S. = 1.25?	X		
	Rock Slopes			
*14.	Are recommended slope designs and blasting specifications provided?	X		
*15.	Is the need for special rock slope stabilization measures, e.g., rockfall catch ditch, wire mesh slope protection, shotcrete, rock bolts, addressed?	X		
16.	Has the use of "template" designs been avoided (such as designing all rock slopes on 0.25:1 rather than designing based on orientation of major rock jointing)?	X		
*17.	Have effects of blast induced vibrations on adjacent structures been evaluated?	X		

*A response other than (yes) or (N/A) for any of these checklist questions is cause to contact the appropriate geotechnical engineer for a clarification and/or to discuss the project.

Exhibit C-6

Example Project - Case 2 (DB ACM)

GRD for Final Design of Structures
(Refer to Figure B-2, ADM 5)

Geotechnical Reporting Document (GRD) Quality Assurance Checklist

Part 1 - General Information Form

Project Name: Route 1492 Section 123

Project Contracting Method: DBB _____ DB X P3 ___ CM/GC ___ Other _____

Note: If other, describe here: ____________________

QA Reviewer Alvin L. Zunk, PE Firm/Agency Affiliation: LMN Engineering

GRD Title: Geotechnical Report for Final Design – Route 1492, Section 123

GRD Type (e.g., GR, GDR, GBR, Memo, Email) Memorandum

GRD Author and Firm: Jeffery M. Stadler, PE; LMN Engineering; 301 Fines Dr, Turk, PA 21234

GRD Author/Firm Client: Owner Agency ____ Contractor X Other_______

Note: If other, describe here: ____________________

Project Component(s) Covered by GRD: Roadway ____ Structure X Other ______

Note: If other, describe here: ____________________

Project Development Stage

Planning/Conceptual: _______ Preliminary Design ______

Final Design: X

If other than above, describe here: ____________________

Note: Use appropriate Checklist Form based on Project Information.

Copy of Review Comments Attached: Yes X No ___

Copy of QC Checklists Attached: Yes X No ___

Accepted: Yes X No ____ (If NO, return for modification and resubmission.)

Signature of Reviewer Alvin L. Zunk, PE **Date:** 08/03/2016

QA Review Level: Discipline Level Review X Project/Program Level Audit ____

Part 2 - Checklists Attached (Attach Specific Applicable Checklists)

__X__ A – Site Investigation Information (GDR for DB Project)

____ B – Centerline Cuts and Embankments

____ C – Embankment over Soft Ground

____ D – Landslide Corrections

____ E – Retaining Structures

____ F – Structure Foundations – Spread Footings

____ G – Structure Foundations – Driven Piles

__X__ H – Structure Foundations – Drilled Shafts

____ I – Ground Improvement Techniques

____ J – Material Sites

____ K – (add as needed)

____ L – (add as needed)

____ M – (add as needed)

____ N – (add as needed)

Comments:

-General: See Geotechnical Report for Final Design of Roadway for related recommendations. Checklists reference FHWA, 2003 unless otherwise noted.

-Item H.4, no static load test is required for this design based on previous experience with drilled shafts in the area.

-Item H.6, shafts are obtaining bearing in rock socket. Casing will be required due to loose sands and high groundwater table. Designers decided to leave casing in place to control risk of caving and possible detrimental impact to rock socket and bearing surface.

-Item H.8, no boulders encountered in explorations.

Example Project Case 2 – GRD for Final Design of Structures

GTR REVIEW CHECKLIST FOR SITE INVESTIGATION

A. Site Investigation Information

Since the most important step in the geotechnical design process is to conduct an adequate site investigation, presentation of the subsurface information in the geotechnical report and on the plans deserves careful attention.

Geotechnical Report Text (Introduction) (Pgs. 10-1 to 10-4)	Yes	No	Unknown or N/A
1. Is the general location of the investigation described and/or a vicinity map included?	X		
2. Is scope and purpose of the investigation summarized?	X		
3. Is concise description given of geologic setting and topography of area?	X		
4. Are the field explorations and laboratory tests on which the report is based listed?	X		
5. Is the general description of subsurface soil, rock, and groundwater conditions given?	X		
*6. Is the following information included with the geotechnical report (typically included in the report appendices):			
a. Test hole logs? (Pgs. 2-24 to 2-32)	X		
b. Field test data?	X		
c. Laboratory test data? (Pgs. 4-22 to 4-23)	X		
d. Photographs (if pertinent)?	X		
Plan and Subsurface Profile (Pgs. 2-19, 3-9 to 3-12, 10-13)			
*7. Is a plan and subsurface profile of the investigation site provided?	X		
8. Are the field explorations located on the plan view?	X		

*A response other than (yes) or (N/A) for any of these checklist questions is cause to contact the appropriate geotechnical engineer for a clarification and/or to discuss the project.

Example Project Case 2 – GRD for Final Design of Structures

GTR REVIEW CHECKLIST FOR DRILLED SHAFTS

H. Structure Foundations – Drilled Shafts (Pgs. 8-23 to 8-29)

In addition to the basic information listed in Section A, if drilled shaft support is recommended or given as an alternative, are conclusion/recommendations provided in the project foundation report for the following:

		Yes	No	Unknown or N/A
*1.	Are recommended shaft diameter(s) and length(s) for allowable design loads based on an analysis using soil parameters for side friction and end bearing?	X		
*2.	Settlement estimated for recommended design loads?	X		
*3.	Where lateral load capacity of shaft is an important design consideration, are p-y (load vs. deflection) curves or soils data provided in geotechnical report that will allow structural engineer to evaluate lateral load capacity of shaft?	X		
4.	Is static load test (to plunging failure) recommended?		X	
	Construction Considerations			
5.	Have construction methods been evaluated, i.e., can less expensive dry method or slurry method be used or will casing be required?	X		
6.	If casing will be required, can casing be pulled as shaft is concreted (this can result in significant cost savings on very large diameter shafts)?		X	
7.	If artesian water was encountered in explorations, have design provisions been included to handle it (such as by requiring casing and a tremie seal)?	X		
8.	Will boulders be encountered? (If boulders will be encountered, then the use of shafts should be seriously questioned due to construction installation difficulties and resultant higher cost to boulders can cause.)		X	

*A response other than (yes) or (N/A) for any of these checklist questions is cause to contact the appropriate geotechnical engineer for a clarification and/or to discuss the project.

Exhibit C-7

Blank General Information Form

Geotechnical Reporting Document (GRD) Quality Assurance Checklist

Part 1 - General Information Form

Project Name: ____

Project Contracting Method: DBB _____ DB____ P3 ___ CM/GC ___ Other _____

Note: If other, describe here: ____

QA Reviewer _________________ Firm/Agency Affiliation: ____________________

GRD Title: ____

GRD Type (e.g., GR, GDR, GBR, Memo, Email) ______________________________

GRD Author and Firm: ____

GRD Author/Firm Client: Owner Agency ____ Contractor _______ Other _______

Note: If other, describe here: ____

Project Component(s) Covered by GRD: Roadway ____ Structure ____ Other ______

Note: If other, describe here: ____

Project Development Stage

Planning/Conceptual: _______ Preliminary Design ______

Final Design: _______

If other than above, describe here: ____

Note: Use appropriate Checklist Form based on Project Information.

Copy of Review Comments Attached: Yes ___ No ___

Copy of QC Checklists Attached: Yes ___ No ___

Accepted: Yes ____ No ____ (If NO, return for modification and resubmission.)

Signature of Reviewer __________________________ **Date:** _______________

QA Review Level: Discipline Level Review____ Project/Program Level Audit ____

Part 2 - Checklists Attached (Attach Specific Applicable Checklists)

_____ A – Site Investigation Information

_____ B – Centerline Cuts and Embankments

_____ C – Embankment over Soft Ground

_____ D – Landslide Corrections

_____ E – Retaining Structures

_____ F – Structure Foundations – Spread Footings

_____ G – Structure Foundations – Driven Piles

_____ H – Structure Foundations – Drilled Shafts

_____ I – Ground Improvement Techniques

_____ J – Material Sites

_____ K – (add as needed)

_____ L – (add as needed)

_____ M – (add as needed)

_____ N – (add as needed)

Checklists reference FHWA 2003 unless otherwise noted.

Comments:

Appendix D

Summary of Interviews with Owner Agencies (DOTs)

Executive Summary

As part of the study to prepare this Guidance Document, several DOT agencies across the United States were contacted and interviews were conducted. The purpose of the interviews was to obtain examples of relevant practices being used by the owner agencies. In each case the same specific questions were used. The states were selected in large part based on their use of alternative contracting methods. While it is recognized there are other transportation agencies that have used these methods as well, and their views would be of equal interest, it was necessary to limit the number of DOTs contacted. In some cases those interviewed offered supplemental commentary. Agencies interviewed included the Colorado DOT, Florida DOT, Maine DOT, Minnesota DOT, North Carolina DOT, South Carolina DOT, Utah DOT and the Virginia DOT.

The following questions were asked:

1 - Do you have a program for QA of GRDs? If yes, who is responsible?

2 - Do you have someone who is responsible for project QA? If yes, who would that be? (Note: This is intended to differentiate between someone who performs QA of GRDs and someone who manages and is responsible for the project QA program, which would track the GRD QA.)

3 - Do you have a QA Guidance Document (w Checklists?) and a tracking system?

4 - How does your QA system account for ACMs and ADMs?

5 - If you have a system, how is performing? Is it being used? Is there something that would make it better?

6 - Are they using the FHWA Pub ED-88-053 August 1988, Rev February 2003 – Checklist and Guidelines for Review of Geotechnical Reports and Preliminary Plans and Reports? Other documents?

7 - Other questions/comments based on discussion?

Based on the interview results, some notable observations are offered:

- Most but not all had a formal QA program for GRDs and several indicated they had used the FHWA, 2003 checklist as a format for their own system. Also that their system was generally based on requirements in the geotechnical manuals of required practices.
- Some states that had an organized program rose to the district offices and others rose to the state office level.
- Most indicated their QA system for GRDs were the same for any of the ACMs or ADMs. In a few cases the size and scope of the project caused the QA reviews to be performed by sub-consultants to the agency.
- Most who had a QA system, were satisfied with the system in place.

A summary of the responses along with HDR's representative and the individuals contacted at the DOTs follows.

Question 1 - Do you have a program for QA of GRDs? If yes, who is responsible?

Colorado DOT (per Jim Starick-HDR Irvine, CA)
- Mr. David Thomas, CPG, PE. Soils and Geotechnical Program Manager, Colorado DOT

Mr. Thomas indicated that CDOT uses a two-tier review process for all geotechnical deliverables. This involves first the review by a licensed PE, and finally the review by a licensed PE and Geologist (or just PE as necessary). There is no specific protocol for who does the QA review, only that they are uninvolved in the project. The Soils and Materials Program Manager has ultimate responsibility for all QA throughout the department, and personally reviews every document that goes out with a PE stamp on it.

Florida DOT (per Jerry DiMaggio, ARA)
- Mr. Larry Jones State Geotechnical Engineer, Central Office Tallahassee
- Mr. Rodrigo Herrera, Assistant State Geotechnical Engineer, Central Office Tallahassee

FDOT does have a formal Quality Assurance program GRDs and has had one for some time. The responsibility for the program resides with the State Geotechnical Engineer in Central Office. Project level reviews are conducted by either the District Geotechnical staff or Central Office depending on the category of project or a specific project feature. Category 2 projects or features (e.g., Bridge) are conducted by Central Office.

The technical requirements for geotechnical features are addressed in depth with the FDOT Soils and Foundations Handbook, FDOT Standard Specifications, and project scope requirements for specific project RFPs.

Some time ago Central Office and Districts developed a series of spreadsheets to conduct project reviews. These spreadsheets involve and are somewhat based on the FHWA checklists. There are common items to the District spreadsheets but local soil and rock conditions and project requirements may be focused, added or omitted based on regional specifics.

Maine DOT (per Aaron Zdinak - HDR Glen Allen, VA)

- Ms. Laura Krusinski, P.E. - Senior Geotechnical Engineer, Maine Department of Transportation (MaineDOT) Bridge Program

MaineDOT geotechnical relies heavily on the MaineDOT Bridge Design Guide (BDG), August 2003 with updates through 2014, which outlines appropriate QA/QC activities, checking guidelines and documentation. There is also a QA/QC checklist for PS&E documents and Preliminary Design Reports (PDRs) are subject to meetings with management and are ultimately approved by the Assistant Program Manager; part of the MaineDOT geotechnical requirements is that “checked” calculations are submitted with the geotechnical reporting document as an appendix.

MnDOT (per Steve Olson – HDR, Minneapolis, MN)

- Mr. Rich Lamb, PE – Foundation Design-Build Engineer, MnDOT

MnDOT does not have a program or particular person responsible for project QA. However, each specialty group independently performs their own QA. The Geotechnical Group QA process seems to be very simple. There is an originator of the GRD and a separate person to review. The GRD is signed by the Foundation Engineer that may or may not be the reviewer of the original document.

North Carolina DOT (per Brian Keaney - HDR Raleigh, NC)

- Mr. John Pilipchuk, LG, PE, State Geotechnical Engineer for the NCDOT
- Mr. Scott Hidden, PE, Support Service Supervisor of the GEU
- Mr. Kevin Miller, LG, Geotechnical Investigations Supervisor of the GEU

NCDOT GEU does not have a formalized system for review of geotechnical deliverables. They added that there is no specific protocol for who does the QA reviews, but there is a review performed by the Project Geological Engineer and then through the Area Geological Engineer. In certain circumstances, the State Geotechnical Engineer reviews the bridge foundation engineering recommendations. All documents are reviewed by the NCDOT Geotechnical Engineering Unit (GEU), but just not in a formalized manner or documentation process. NCDOT has a rating system that is provided to the Consultant for each geotechnical deliverable. This rating system is currently undergoing changes.

South Carolina DOT (per Brian Keaney – HDR Raleigh, NC)

- Mr. Nick Harman, PE Geotechnical Support Engineer for SCDOT

SCDOT does perform Quality Assurance reviews and they are performed to verify that the documents were produced or were adhered to, in accordance with SCOT's Geotechnical Design Manual (GDM). The reports are read, questions may get asked, and comments are generated in a semi-standardized comment form that goes back to the Consultant.

The individual region's program manager is responsible for performing the QA reviews, which are submitted to the individual region design manager. Depending on workload, the review results may go directly to the support geotechnical engineers in the Central office. Many of the reports go to the Geotechnical Support Engineers for review.

Utah DOT (per Nick LaFronz – HDR Phoenix, AZ)

- Mr. Darin Sjoblom, PE
- Mr. Keith Brown, PE

The UDOT Geotech Section does QA review of all geotechnical consultant reports and provides comments/questions that have to be addressed. The reviewers assure that comments are addressed and, as part of the UDOT Structures Division QA process, the Geotechnical Unit provides a signed form stating that all comments have been addressed.

VDOT (per Aaron Zdinak - HDR Glen Allen/Richmond, VA)

- Mr. J. Michael Hall, PE – VDOT Central Office, Structures and Bridge Geotechnical

VDOT does not necessarily have a formal program, but has a written policy that describes to in-house personnel and consultants what shall be included in GRDs. The policy is the Materials Division Manual of Instruction (MOI), specifically Chapter 3 (Geotechnical) of the MOI. VDOT does not mandate that these documents take on a specific form; no report templates (other than for boring logs) are mandated. Mr. Hall indicated the MOI is managed by Mr. Benson in the CO Materials Division, but it is not his responsibility to “police” the districts and consultants to confirm the MOI is followed.

Question 2 - Do they have someone who is responsible for project QA? If yes, who would that be? (Note: This is intended to differentiate between someone who performs QA of GRDs and someone who manages and is responsible for the project QA program, which would track the GRD QA.)

<u>Colorado DOT</u>

For larger projects, it may vary who is in control of the overall QA process. However, generally there is a Project Manager (PM) who is in charge of monitoring QA throughout all major disciplines including Geotechnical.

<u>Florida DOT</u>

The upper management of FDOT is fully aware and acknowledges the Geotechnical QA process but input and management of the program is fully and completely managed and coordinated by the FDOT Geotechnical staff. There is no direct or indirect involvement from a centrally focused QA manager or program.

<u>Maine DOT</u>

Responsibility for documentation that QC and QA have been completed is generally described in Chapter 1 of the MaineDOT BDG, as summarized in the response to Item 1. For both DOT lead and consultant lead projects, the MaineDOT Bridge Design Guide indicates the QA personnel are expected to perform an appropriate level of check or review, namely an Independent Design Check (for geotechnical components, e.g., piles, spread footings, slopes) or a Design Review (for geotechnical reports). All geotechnical reports are checked and reviewed by experienced QA geotechnical engineers only. Management of the QA program for GRD’s is undifferentiated from, and integrated within, the performance of project QA.

<u>North Carolina DOT</u>

There is no one person responsible for Project QA, it is the specific regional offices that perform the reviews of internal and consultant submitted documents.

South Carolina DOT

There is no one person responsible for Project QA. As mentioned in the response to No. 1, the reports pass through the Program Manager for the region for circulation and assure reviews are in compliance with the SCDOT GDM.

Utah DOT

Each project is assigned to a geotechnical engineer to provide oversight, and the GRD QA responsibility is assigned to this geotechnical oversight engineer. The DOT has a Quality Engineering group that sets policy and audits QA procedures. Mr. Stewart is in charge of this group, but does not track the GRD QA.

VDOT

No. VDOT's geotechnical duties are divided among District Materials, Central Office (CO) Materials, and CO Structure and Bridge personnel. Numerous persons within these groups are involved with preparing or reviewing GRDs. There is the assumption that every GRD is reviewed by someone, but it is not documented in a manner to confirm it occurs. With the different methods in which projects are delivered (P3, D-B, (PPTA)) and the trend to reduce internal staffing, it is possible that some GRDs are not reviewed. No person has been identified as the responsible party.

Question 3 - Do they have a QA Guidance Document (w Checklists?) and a tracking system?

Colorado DOT

CDOT uses a proprietary in-house guidance document with some checklists. This is referred to as a "Manual of Practice" which is in draft form and is not publically available. Mr. Thomas indicated the checklists were not used as a pass-or-fail type review methodology, but only as an outline as to what should be looked for during a review process. Discussion from other questions indicated that this document was inspired by and borrows from the FHWA ED-88-053. A specific tracking system did not exist other than the two-tier protocol mentioned in Question 1.

Florida DOT

There is a guidance document as outlined above. Tracking of all comments and disposition/ resolution is performed through the FDOT Electronic Review System (ERS). In a separate email, Mr. Jones provided links (see below) which provide general information on this system and several other guidance references related to QA. Mr. Jones also agreed to provide an example project review spreadsheet.

It was also mentioned that although the Geotechnical Program Quality Assurance reviews (not performance aspects of geotechnical features), they are addressed in the formal QA process reviews conducted by the Construction and Structures Offices.

http://www.dot.state.fl.us/structures/Manuals/SFH.pdf

http://www.fdot.gov/designsupport/ProjectReview/ERC/default.shtm

Maine DOT

MaineDOT does have a formal checklist for Plans, Specifications, and Estimate (PS&E) submittals and a formal review and “sign-off” of Preliminary Design Reports (PDRs). They are general and intended to document if the project elements have adequately been addressed. The system in use within MaineDOT builds upon the requirement for thorough QC documentation, where the QA confirms that project elements have been appropriately addressed. QA checklists are lacking and would be a beneficial addition to the current system.

MnDOT

MnDOT does not have a QA Guidance Document and generally does not use a checklist. They have a MnDOT Geotechnical Engineering Manual, dated 2013, that contains process and procedures in field exploration, lab testing, reporting, etc. MnDOT does not have a formal QA tracking system.

North Carolina DOT

NCDOT GEU relies on the Project Manager to assure the proper process and procedures have been followed. NCDOT has relied on the FHWA ED-88-053 Checklist in the distant past but much less over time. This FHWA reference may be provided to newer employees as a guidance document in order to assist them to know what should be in a report.

Portions of this checklist are in the current NCDOT Geotechnical Guidelines & Procedures Manual for Subsurface Investigations which is dated from 2004.

South Carolina DOT

SCDOT does not rely on checklists. The guidance document is the GDM. The tracking system is the comment form that is generated by the reviewer and forwarded to the Geotechnical Design Sub-consultant.

Utah DOT

The QA is part of the UDOT Project Delivery System, and includes checklists.

VDOT

The MOI likely qualifies as QA Guidance Document, but VDOT does not have a formalized QA program nor a method for tracking GRDs. The MOI is extensive, but it does not contain a checklist.

Question 4 - How does their QA system account for ACMs and ADMs?

Colorado DOT

The QA system used is the same regardless. Mr. Thomas expanded on this answer by mentioning that the geotechnical department is considered an 'internal consultant', and their review is on a document-by-document basis rather than a project-by-project basis.

Florida DOT

This would be a general or specific discussion depending on the response and practice of the agency. The QA system and approach and involvement by FDOT does not vary much by the by the type of project delivery method (D-B-B, D-B, CM/GC) or PPP projects. FDOT has considerable experience with D-B projects but no experience with CM/GC. FDOT has completed several P3 projects. Although the general approach may not significantly vary, the focus in terms of geotechnical feature performance may vary. For example, long-term deformations may not be as important for P3 projects as compared with D-B since performance long-term would be a responsibility of the P3 team. This approach is reinforced by the strong emphasis which FDOT places on specific technical guidance in their respective technical references and guidance.

On some special projects such as the Port of Miami Tunnel FDOT required that the design team hire a QA reviewer with specific experience and knowledge in tunneling. In addition FDOT also hired an independent QA reviewer who worked directly for the department.

Maine DOT

MaineDOT is a D-B leader in New England with the first successful project completed in the mid-1990s. They have also completed one CM/GC project successfully and a second CM/GC project is in progress. Department reviews of D-B and CM/GC design plans and submittals consist mainly of checks to ensure that contract requirements and design criteria are being followed and that the D-B's design quality management plan is being followed. Formal QC/QA documentation is included with all D-B submittals. Procedures for alternative delivery methods are mentioned in the Division 1-- - Design Build General Conditions. . Checklists, QC/QA documentation and Comment/Resolution Forms have proven to be effective for geotechnical QC and QA reviews for Alternative Contracting Mechanisms, as well as Alternative Delivery Methods.

MnDOT

All projects have some form of GRD, one of the types described in the first bullet above. MnDOT does not have a different process or procedure for specific contract or delivery methods.

North Carolina DOT

The QA system NCDOT has in place, is the same, regardless of the alternative contracting or delivery process.

South Carolina DOT

The QA review system is the same regardless if it is DBB or D-B process. SCDOT may have had one 3P project in the past, and has no experiences with CM/GC.
SCDOT geotechnical reporting documents consist of Data Reports which are added to D-B contracts or a Baseline Report which contains additional information than a data report and provides some indication of what to expect for bridge and roadway foundations.

Other reporting documents in D-B-B, include a Preliminary and Final Design Reports, and a Site-Specific Seismic Response Report.

Utah DOT

It is really not different than on standard D-B-B projects, but sometimes on a large D-B project a geotechnical consultant performs the QC/QA and UDOT act in an oversight role.

VDOT

N/A. Unaware of any specific guidance beyond what is included in the MOI.

Question 5 - **If they have a system, how is performing? Is it being used? Is there something that would make it better?**

Colorado DOT

Question and response are not indicated in Summary Memorandum.

Florida DOT

It is believed that the current system is performing well. The current system is being used on a routine basis. This qualitative assessment of its effectiveness has a very low occurrence of major and repeat issues occurring during construction or related to post construction performance.

In the few cases where repeat occurrences has occurred supplemental guidance has been added to the Soils and Foundations Handbook. The example of punching bearing capacity was mentioned and the Soils and Foundations Handbook currently includes a requirement for this limit state check and a recommended method of analysis.

Maine DOT

The current system is performing well, and was recently reviewed and improved upon. One specific element that has enhanced the current system is the requirement for review “hold points” during project development. Currently, there are two specific points where MaineDOT QA occurs, one at the final Geotechnical Report and one at the Preliminary Design Report. Fields have been added to the Preliminary Design Reports to document the need for additional borings and geotechnical analyses to ensure all AASHTO and FHWA requirements are satisfied in final design. More “hold points” would be expected to provide a greater level of control over the approach and process elements of a project where input may be most beneficial and useful – more collaborative and less strict review. Additionally, having checklists to capture the intent of the additional “hold points” would enable the creation of the “paper trail” for documentation of the process. Currently, this is an area for improvement in the process.

MnDOT

As per other responses, MnDOT does not have a formal QA system. No additional comments were provided.

North Carolina DOT

No response provided.

South Carolina DOT

SCDOT is satisfied with their current process, but sometimes there is so much volume of reporting documents. One thing that SCDOT wants to eliminate is consultants relying on the SCDOT to provide the QC of the geotechnical documents. If GRDs are not in accordance with the Manual then the Geotechnical Consultants will be contacted to discuss.

Utah DOT

UDOT has a QA system, and it seems to be becoming more intense over time. The Structures Division QA system that we are part of is very rigorous.

VDOT

N/A. As mentioned previously, the formality of the system exists in the MOI. Documentation and compliance with specific QA requirements are not tracked in standardized manner.

Question 6 - Are they using the FHWA Pub ED-88-053 August 1988, Rev February 2003 – Checklist and Guidelines for Review of Geotechnical Reports and Preliminary Plans and Reports? Other documents?

Colorado DOT

As mentioned in the response in Question 3, above, CDOT used the FHWA reference in the development of their proprietary internal Manual of Practice. No other documents were noted.

Florida DOT

The FHWA checklists are used routinely as part of the spreadsheets mentioned above.

Maine DOT

Yes, MaineDOT is aware of the FHWA publication and the checklists contained there in. However, the checklists tend to be too general for wide application on their projects and the desire is to have more flexibility. There is an inherent understanding of the value of project specific checklists, but the FHWA sheets are too general to be useful. Having a structured form to allow MaineDOT provide comments on particular project elements would be useful; more narrative for engineer explanation as opposed to checking a “Yes” or “No” box for a general project element. Checklists should include some method to document the QA review comments and how they were resolved.

MnDOT

MnDOT does not use FHWA Publication ED-88-053 guideline or the checklists. Their guideline is the MnDOT Geotechnical Engineering Manual. They do not typically use a documented checklist. However, a conscious effort is made to address site specific issues in each GRD, such as weak compressible soil, potential effects of shallow bedrock, etc. MnDOT commented on FHWA Circulars as beneficial reference manuals.

North Carolina DOT

The current FHWA PUB ED-88-053, Revised Feb 2003 is not being used. The NCDOT would be receptive to using this guidance document but with some of the features mentioned in the previous answer to No. 5.

South Carolina DOT

SCDOT does not use FHWA - ED-88-053, Revised Feb 2003. Much of what controls in their geotechnical design are the seismic aspects and the current checklist is silent on this information.

For some aspects of geotechnical reporting or design which are not in the manual, SCDOT refers to AASHTO Standards for guidance.

Utah DOT

UDOT does not use the publication; however, they have checklists that appear consistent with the publication in our MOI, but not as many and not as detailed.

VDOT

Yes. VDOT is aware of the document, but unaware that it had been revised. Don't believe it is used by the Department for the purpose of QA. VDOT does reference documents in the MOI as guidance. These documents are generated by organizations such as FHWA, USACOE, and other State agencies. Hyperlinks to access these documents are provided with the MOI, and QA/QC requirements of these documents are intended to apply.

Question 7 – Other questions/comments based on discussion?

Colorado DOT

CDOT mentioned that it was beneficial and that they write their own recommendations and reports in addition to reviewing reports and design deliverables from outside consultants. It was also mentioned that as 'internal consultants' they were expected to bid competitively against other consultants, whose work they were also expected to review.

Florida DOT

No other questions or discussion points were addressed.

Maine DOT

Infrequent deficiencies in the quality of GRDs are noted but most of the time they occur when the in-place QA system is circumvented and not executed as intended. In general, having the requirement for calculations to be part of the GRD and having MaineDOT staff review the GRD for reasonableness with some quick calculation review seems to maintain an acceptable level of quality in the GRDs. MaineDOT is turning towards an emphasis of identifying high geotechnical sites (surficial geology maps, landslide hazard areas, historical soils reports, etc.) in order to alert designers to these elements before execution of a geotechnical study. Having a checklist of specific geotechnical hazards to be considered and including it with a preliminary design report would be beneficial in aiding designers to focus efforts on those high risk items. Functionally, because

MaineDOT’s geotechnical program is “fragmented” or decentralized (Highway-, Pavement Design, Bridge, Multimodal, Materials Testing and Exploration), getting a coordinated QA program is difficult.

MnDOT

The primary GRD is the Foundation Analysis and Design Report (FADR). FADR is very similar in style to formal reports typically submitted by consultants (i.e., report style with letterhead, etc.). Another document is Technical Memo (TM) also similar in style to consultant’s TM (i.e., memo format similar to this document). They also have single page Foundation and Other Recommendation document for pile foundation design that include specific recommendations for each structure (abutments, piers, etc.). For Design Build projects they have also provided Geotechnical Data Reports (GDR) which is a factual document without recommendations for use by the design team. The Geotechnical Baseline Report (GBR) is not currently utilized by MnDOT. Finally, the MnDOT Geology Group generates Contact Report pertaining to aggregate pit/rock quarry study and also report of geophysical survey results.

All GRDs have 4 main parts; project description, investigation/lab results, analysis, and recommendations.

An interesting comment was that GRDs are not often included in contract documents when designed in-house.

MnDOT Geotechnical takes pride in accurate location and elevation of borings, with Global Positioning, a check against contour files, and final survey check.

North Carolina DOT

The guidance document as a result of this study should be flexible since adherence to State standards are important; it needs to be able to provide a checklist as to why is the reporting document adequate (or inadequate), why were certain subsurface programs or designs implemented. The document should be in some form of a database.

South Carolina DOT

Mr. Harman noted that they would like to know “what should be in a good geotechnical report.” A guideline for focusing on the design team is important. It should explain the performance requirements so that the team can follow them in the design deliverable, including the geotechnical report documents.

Utah DOT

No response provided.

VDOT

The development and implementation of a QA program might be a good way to overcome some of the challenges of having reduced staff.

Supplemental question and response:

Do you routinely experience deficiencies in GRDs that you have reviewed either prepared by in-house or external consultants? If yes, how might that be improved upon?

Yes, deficiencies are noted. Having a formal and documented QA plan that is implemented would be effective in reducing the deficiencies commonly observed.