

GEOTECHNICAL STUDY AND REPORT GUIDELINES

1. Purpose and Intent

The California Geotechnical Engineering Association (CalGeo)¹ prepared this document to aid Authorities Having Jurisdiction (AHJs) in developing or updating their geotechnical report preparation guidelines. CalGeo members have extensive experience working in and with various AHJs across the state. We reviewed several relevant documents prepared by AHJs with the intent of developing best practices for geotechnical guidelines. We incorporated aspects of the reviewed guidelines that helped the Geotechnical Consultants understand the local geologic hazards, the geotechnical review process, and other aspects of concern to the AHJ. The following sections establish common roles, suggestions for AHJ review processes, approaches to data collection and analyses, and suggestions for preparing geotechnical reports. We also provide recommendations for post-design services. This document discusses the general aspects and contents that commonly, as a minimum, will be addressed in AHJ's guidelines. However, the level of detail in each guideline will be determined by the AHJs.

Compared to other design and construction disciplines, geotechnical engineering involves considerable judgment in developing an appropriate scope of services for a given project. CalGeo recognizes that the AHJ may not have sufficient in-house staff with expertise to determine the appropriateness of a geotechnical submittal. Therefore, we recommend the AHJ consider establishing an on-call contract(s) with geotechnical consultant(s) to develop and maintain AHJ geotechnical guidelines and peer review geotechnical submittals in their jurisdiction.

The principal goal of peer review is to ensure that potential geotechnical and geological hazards are recognized and mitigated before they become liabilities to AHJs and/or property owners. A successful peer review program will protect the community, the AHJ, the owner, and the project geotechnical consultant. History shows that peer review of technical reports submitted for development projects will enhance public safety and reduce potential financial losses to public and private entities.

2. Definition of Roles

2.1 Geotechnical Consultant

A "Geotechnical Consultant" can be an individual or firm practicing geotechnical engineering and/or engineering geology services to public and private clients. The Geotechnical Consultant shall:

- Comply with the requirements of California Professional Engineers Act Business and Professions Code §§ 6700 – 6799 and Geologist and Geophysicist Act, Business and Professions Code §§ 7800 – 7887.

¹ CalGeo is comprised of members from various private geotechnical consulting firms and individuals practicing in California focusing on enhancing technical and professional development.

- Hold licenses in the State of California as a professional engineer (PE), professional geologist (PG), geotechnical engineer (GE), and/or certified engineering geologist (CEG).

Note in the following sections that we describe two types of Geotechnical Consultants:

- "Project" Geotechnical Consultant who is working on a particular project submitted to the AHJ and
- "On-call" Geotechnical Consultant retained by the AHJ to develop guidelines and perform peer reviews of the Project Geotechnical Consultant submittal(s).

2.2 Geologist/Engineering Geologist

An Engineering Geologist is a California-registered Certified Engineering Geologist, and a Professional Geologist is a California-registered Professional Geologist with experience in engineering geology.

2.3 Geotechnical Engineer

A Geotechnical Engineer is a California-registered Geotechnical Engineer and/or a California-registered Civil Engineer with experience in geotechnical engineering.

2.4 Level of Professional Responsibility

For a given project, the project Geotechnical Consultant prepares geotechnical, geohazard, and geological report(s). The project Geotechnical Consultant should review the project plans and geotechnical-related specifications and provide geotechnical-related observation and testing during construction. The project Geotechnical Consultant is responsible to the project owner and AHJ for the geotechnical and geological aspects of the project from design through construction.² Once commissioned, the project Geotechnical Consultant remains responsible for the project performance, including the geotechnical and geological impacts of the project on surrounding properties. The responsible project Geotechnical Consultant is typically referred to as the Geotechnical Engineer of Record (GEOR).

3. AHJ Review Process

AHJs have the unique advantage of knowing their locality, experiences, and/or specialized projects. However, the AHJ may not have the expertise to evaluate the adequacy of geotechnical submittals in their jurisdiction. To address the AHJ's strengths and potential weaknesses in developing geotechnical guidelines, we recommend that the AHJ retain an in-house staff and/or develop a qualified geotechnical peer review process. Using this approach, we have outlined suggestions for developing geotechnical resources and review steps in the following sections.

² The Geotechnical Consultant's area of responsibility shall include, but is not limited to, performing geotechnical field explorations, evaluating laboratory test data, performing engineering analyses and applying engineering judgment to provide recommendations in geotechnical and geohazard reports, conducting and/or supervising professional observation and testing including approval of excavation bottoms to receive fills, testing for required compaction, stability of finished slopes, design of buttress fills, subdrain installation, and incorporation of geologic data.

3.1 Qualified Geotechnical Reviewers

CalGeo believes the best judge of geotechnical submittals to an AHJ are other qualified geotechnical engineers and/or engineering geologists/geologists. There are three options the AHJ should consider for qualified Geotechnical Reviewers:

- Hire qualified in-house geotechnical staff.³
- Retain On-call Geotechnical Consultants (henceforth referred to as Geotechnical Reviewers for clarity) or
- A combination of hiring staff and retaining on-call consultants.

The AHJ should evaluate the best option based on their preferences, frequency of geotechnical reviews, complexity of their geologic environment, budget constraints, and other factors unique to the AHJ. CalGeo members have experience with AHJs employing one of these options with generally positive results for the AHJ and project Geotechnical Consultant. Thus, we believe each of these options has merit and present suggestions for each option as follows.

3.1.1 In-House Geotechnical Staff

The AHJ hires a qualified geotechnical engineer(s) and/or engineering geologist(s)/geologist to develop geotechnical guidelines and perform geotechnical reviews on their behalf. The AHJ should consider the following qualifications for hiring:

- California licensing, consisting of a PE with geotechnical experience or GE
- At least 10 years of geotechnical experience
- Experience working on geotechnical projects in the AHJ area.
- Experience with the geologic hazards in the AHJ area, including mitigation approaches of identified hazards.
- Familiarity with the local project Geotechnical Consultants
- Experience with the AHJ codes and/or established guidelines

3.1.2 On-Call Geotechnical Reviewers

The AHJ retains on-call geotechnical consultants as Geotechnical Reviewers through an on-call process using qualification-based selection (QBS) to retain firms.⁴ Qualifications should include the previous list for the in-house geotechnical staff with a preference for local qualified Geotechnical Consultants. We recommend the AHJ retain three to five on-call Geotechnical Consultants to provide consultation on an as-needed basis and use a task order process to engage the on-call Geotechnical Consultant utilizing a rotating format (i.e., the awarded firm goes to the bottom of the list and other firms advance).

Before engaging the on-call Geotechnical Consultant Reviewer for a task order, the AHJ should request a conflict of interest (COI) statement from the on-call Geotechnical Reviewer and provide up to three examples of similar projects to the solicitation. If the AHJ deems either the

³ We recommend geotechnical qualifications include California licensing (PE with geotechnical experience or GE) and at least 10 years of geotechnical experience.

⁴ For information on the QBS process, we recommend the ACEC California Resource Center: https://www.acec-ca.org/page/QBS_ResourceCenter.

COI or experience with the first on-call Geotechnical Reviewer insufficient, the AHJ should then go to the next firm on their rotating on-call list.

We recommend the on-call Geotechnical Reviewer be retained for a period of three to five years. While the retained firms should be allowed to re-compete for the next on-call cycle, their qualifications should include feedback from the AHJ staff and Geotechnical Consultants who engaged with the on-call Geotechnical Reviewers for their report submittals. For the latter, we suggest a confidential questionnaire be sent to the project Geotechnical Consultant upon completion of their peer review to evaluate the on-call Geotechnical Reviewer. The AHJ should designate an administrator (if no in-house geotechnical staff) to maintain the on-call list and participate in the evaluations and selection process.

3.1.3 Combination of In-House and On-Call Geotechnical Reviewers

The AHJ should consider the combination approach with the in-house staff working in tandem with the on-call Geotechnical Reviewer to complete the required task. The advantages of the combination approach include having the in-house geotechnical staff manage the on-call Geotechnical Reviewer and having the discretion to complete geotechnical reviews in-house or go to the on-call firms.

3.2 AHJ Geotechnical Resources

3.2.1 AHJ Contacts

Conveyance of local knowledge and experience is a valuable asset to both the AHJ and the project Geotechnical Consultant to deliver successful projects in their jurisdiction. The AHJ should:

- Designate an in-house geotechnical staff or administrator of the on-call list within their organization that could be made available to the project Geotechnical Consultant to respond to questions and provide guidance based on their local experience and
- Provide a clear organizational chart so the project Geotechnical Consultant can understand the various AHJ divisions and applicability to their project.

3.2.2 AHJ Archives and References

A clearinghouse⁵ of geotechnical reports, geologic maps, and other published geotechnical data is critical for the project Geotechnical Consultant to understand the local issues. The AHJ should:

- Highlight geologic hazards in their jurisdiction that would alert the project Geotechnical Consultant of potential issues when developing their scope of services.
- Provide local knowledge to communicate to the project Geotechnical Consultant and reduce mistakes due to ignorance of the local conditions.

⁵ The clearinghouse should be robust, well maintained, and easily accessible. Many AHJs have geographic information systems (GIS) capabilities; the AHJ should consider making maps of geology, geologic hazards, and other local data available through GIS tools that can be easily searched and updated.

- Maintain a list of "geotechnical trouble spots" where historical issues should inform the project Geotechnical Consultant of potential problems⁶.
- Maintain and update their references regularly to keep up with the evolving practice of geotechnical engineering, particularly seismic hazards.⁷
- Make available geotechnical and geological reports previously performed at the project site and immediate vicinity.
- Provide guidance documents from applicable jurisdictions.
- Provide geological (hydrogeological), topographic, and hazard (e.g., seismic, landslide) maps.
- Provide documentation on the performance of existing facilities at the project site, if available.

These tasks should be assigned to the in-house geotechnical staff and/or on-call Geotechnical Reviewer at the AHJ's discretion.

3.3 AHJ Review Steps

3.3.1 Triggers for AHJ Reviews

The AHJ guidelines and review process should:

- Provide clear, concise descriptions of what would trigger an AHJ review of a project.
- Consider different levels of the review process.
- Differentiate between the type of project being proposed (e.g., new high-rise, residential remodel) and the known geologic hazards within the project location (e.g., liquefaction, slope stability), and
- Provide a simple matrix or flowchart describing the triggers and levels of AHJ review to the project owner and project Geotechnical Consultant.

This approach helps the project Geotechnical Consultant establish an appropriate level of scope for the project but also streamlines the AHJ resources required for a particular review level.⁸

3.3.2 Review Steps and Levels

The following are suggested steps the AHJ should consider in their review process.⁹

⁶ As an example, the County of Santa Cruz's guidelines include references to coastal damage from past winter storms, including specific locations within their jurisdiction of past severe hazards such as landslides (County of Santa Cruz, "Guidelines for Geotechnical Investigation Reports," June 7, 2022).

⁷ Where referencing other guidelines from state agencies (e.g., SP 117), we suggest the AHJ reference that agency (e.g., California Geological Survey) instead of the particular document to allow for updates.

⁸ As an example, an addition to a single-family residence on level ground underlain by dense soil or rock should have a different AHJ review process than a new multi-level structure located in steep terrain.

⁹ The steps are based on the collective experiences of our members working in a variety of jurisdictions throughout the state.

- At the earliest engagement, the in-house geotechnical staff and/or on-call Geotechnical Reviewer should review the project type and location to establish the level of AHJ review.¹⁰
- The review process steps should be clearly stated along with the typical schedule and fees.¹¹

3.3.3 Review Fees

The review fees should reflect the average level of effort for the different review processes. These fees should be available at the outset of the review process and subject to escalation if the project duration is longer than anticipated or the project Geotechnical Consultant's recommendations indicate a different level of review based on their data collection. Typically, the AHJ will collect either a Fixed Fee or a Time and Materials (T&M) Fee prior to the review being initiated. Fixed Fees are based on a set fee schedule and depend on the level of project to be reviewed (e.g., new single-family residence, new swimming pool, new septic system, etc.). Fixed Fees usually cover the initial review and a response review. T&M Fee typically applies to larger projects (e.g., large commercial buildings) or projects located in geologically sensitive areas (e.g., liquefaction, landslides, earthquake fault zones, etc.) requiring extensive review and exceeding the Fixed Fees' standard range.

4. Suggestions for Geotechnical Services

The following presents our suggestions for geotechnical services to incorporate into the AHJ guidelines. These suggestions are intended as a first step based on the collective experiences of CalGeo members. The actual checklist for geotechnical services should be developed for the AHJ by the in-house geotechnical staff and/or on-call Geotechnical Reviewer.

4.1 Subsurface Exploration

Prior to subsurface explorations, the Geotechnical Consultant should obtain and review existing information relevant to the project from the AHJ Archives and References described above. In the AHJ guidelines, the in-house geotechnical staff and/or on-call Geotechnical Reviewer should include general requirements for subsurface explorations depending on the complexity of the project and the anticipated subsurface variability. The in-house geotechnical staff and/or on-call Geotechnical Consultant should review the subsurface exploration program and provide commentary on the adequacy for the owner's consideration; however, the project Geotechnical Consultant should determine the final subsurface exploration for the project.

4.2 Laboratory Testing

Laboratory testing is an important element of subsurface exploration. Like other exploration elements, the type and extent of laboratory testing depends on the project's complexity and the subsurface conditions. The common types of laboratory testing are characterization (index)

¹⁰ The review would inform the owner and project Geotechnical Consultant the minimum level of services that the AHJ would expect such that the project Geotechnical Consultant could provide the appropriate scope of services. An allowance for challenges by the project Geotechnical Consultant should be accommodated by the AHJ to allow for differences of opinion in the designated review process.

¹¹ The schedule will inform the project owner to establish sufficient design time for the process and allow the project Geotechnical Consultant to establish a scope and fee to address the AHJ review process.

tests and strength/advanced tests. Characterization tests are typically used for classification purposes and can be performed on disturbed or undisturbed samples. Advanced tests are usually conducted on undisturbed samples and are used to measure parameters that can directly be used in the design. The extent of the laboratory testing program and test type selection is affected by the size of the project, subsurface soil profile, and encountered soil layers and will be determined at the discretion of the project Geotechnical Consultant.

4.3 Geologic Assessment

A geologic assessment should include an evaluation of both on- and off-site areas to assess the potential of the proposed development creating or changing on- or off-site geologic hazards. We suggest the geologic assessment include:

- Review of site history
- Review of regional and site-specific geologic maps, as appropriate
- Description of regional geologic setting (topography, geologic units, stratigraphy, geologic structure, geomorphology, hydrology, and seismicity)
- Review of aerial photos and other remote sensing data
- Developing geologic cross section(s)
- Summary discussion

The Geotechnical Consultant should provide proposed mitigation to the geologic hazards identified during the geologic assessment. Typical Geologic hazards include:

- Seismic ground shaking
- Fault rupture
- Liquefaction and associated effects, such as surface settlement and lateral spreading
- Seismic densification
- Slope stability
- Settlement, expansion, and collapse potentials
- Tsunami or seiche inundation
- Flooding

A statement by the project Geotechnical Consultant shall be included that the proposed development will not create new geologic hazards. The geologic hazard analyses should be consistent with the State and AHJ's requirements. Mitigation of the geologic hazards identified by the project Geotechnical Consultant should be clearly explained in the geotechnical deliverable for review by the AHJ's in-house geotechnical staff and/or on-call Geotechnical Reviewer.

4.4 Geotechnical Deliverable¹²

Geotechnical deliverables should summarize the existing and proposed conditions, local geology, seismic and geologic hazards, subsurface explorations, available reports reviewed,

¹² Different AHJs may have different naming protocols for geotechnical deliverables. For instance, the common type of geotechnical reports for municipalities are usually named as: Pavement Reports, Preliminary Geotechnical and Geohazard Evaluation Report, Limited Geotechnical Report, and Final Geotechnical and Geohazard Evaluation Report, while for more complex projects or different project delivery systems, some agencies require and break down the study process and reports to: Preliminary Geotechnical Report, Geotechnical Data Report, Geotechnical Design Report, Foundation Report, etc.

and subsurface conditions encountered. The following is a minimum list of suggested items to be included in the geotechnical report:

- Description of the existing conditions and a site plan showing the location of borings
- Proposed developments and improvements
- Graphical logs of exploratory borings
- Geologic cross-sections and geological maps
- Discussion of the geologic condition of the site based on the geological assessment (Section 4.3)
- A discussion of the materials encountered in the borings and their engineering properties.
- Laboratory tests results
- Groundwater encountered and historical records.
- Evaluation of seismic-induced hazards, including liquefaction, post-earthquake settlement and lateral spreading, slope failure and landslide, etc., and provide necessary mitigative measures.
- Seismic design parameters per the latest version of the California Building Code (CBC)
- Recommendations for the design and construction of the proposed developments from a geotechnical standpoint, including but not limited to grading, ground improvement, over-excavation, foundation alternatives and their capacity and settlement, utility trench backfilling, temporary excavations, flatwork, post-grading improvements, etc.
- List of references
- Figures and maps
- Engineering analyses backups

The geotechnical report should also note that the project Geotechnical Consultant should observe and document construction activities to continue their services.

5. Change in GEOR

The project Geotechnical Consultant is the geotechnical engineer of record (GEOR) throughout the design and construction of a project. However, changes in the GEOR may happen during design, after design completion, and during the construction phase of projects for various reasons. If a change of project Geotechnical Consultant occurs during any phase of a project, the AHJ should require letters from both the former and proposed/present GEORs to approve the change. The change of GEOR shall follow the procedures established by the AHJ. CalGeo has written a Geotechnical Engineer of Record Policy Recommendation white paper that can be accessed [here](#). The new GEOR possesses ownership of all the reports and works performed by the previous GEOR and accepts full responsibility for the project.