

GEOTECHNICAL REPORT OUTLINE

SUMMARY

The summary presents the major conclusions and their basis. This section should be included in all lengthy or complex reports.

1.0 INTRODUCTION

The Introduction sets the stage for the entire report and should contain the following sections:

1.1 OVERVIEW

- Present the formal project name used throughout the report and state the location.
- Briefly describe current or previous work used to form the basis for the conclusions and recommendations contained in the report.

1.2 BACKGROUND

- Provide a description of the project's history if it is important to understanding why the study was performed.
- List other reports completed for the site or adjacent sites and note whether any environmental site assessments or other environmental work has been completed for the site.
- Provide a general description and give dimensions of the project including the general nature of the proposed development, including grading, retaining walls, structures, construction materials, and utilities. Also, include proposed finish floor elevations, maximum depth of cut or fill, foundation and floor loads, etc.
- Describe all other details of the project which were assumed or relied upon in developing the conclusions and recommendations contained in the report.

1.3 PURPOSE AND SCOPE OF SERVICES

- State succinctly the primary purpose for the geotechnical engineering services.
- Summarize the scope of geotechnical engineering services which form the basis for the conclusions and recommendations contained in the report.
- Indicate any limitations to the scope of geotechnical engineering services provided, particularly if the scope represents a departure from services typically provided on similar projects

1.4 INVESTIGATION SUMMARY

- Describe the dates, general nature, and extent of the geotechnical investigation. This section should include data research, borings, test pits, geophysics, physical laboratory testing, chemical testing, field instrumentation or testing, etc.
- If the investigation was complex, present a complete and detailed explanation and results in the form of an appendix.

1.5 REPORT OVERVIEW

- Introduce and describe other sections of the report, directing the reader to critical sections, if appropriate.
- Identify and describe all attachments and appendices.

2.0 SITE CONDITIONS

The Site Conditions shall describe all site features relevant to the study and the geotechnical engineering conclusions and recommendations. Terminology should be clear and consistent, and continue to be consistent through the entire report.

2.1 LOCATION AND SURFACE CONDITIONS

- Present the project's specific address, location and cross streets.
- Generally describe the site and adjoining properties, and indicate their current use.
- Describe surface elevation, topography, elevation, and drainage.
- Identify all current structures, subsurface utilities, wells, manmade fills, and other surface features.
- Describe vegetation, topsoil, paving, and other surface coverings.
- Describe any indications of historic geological processes or hazards on or near the site (i.e., slope instability, landslides, liquefaction, flooding, etc).
- Describe any indications of surface releases or other contamination, or potential contamination sources.
- Describe any planned changes to the surface conditions described above which will take place after the investigation.

2.2 GEOLOGIC SETTING

Provide an overview of regional geology, local stratigraphy, groundwater occurrence, etc.

2.3 SUBSURFACE SOIL CONDITIONS

- Describe each soil or geologic unit encountered by their classification and group units with respect to the properties that are most relevant to the conclusions and recommendations. Give each unit group a unique, clear, common title and consistently refer to this unit by its given title throughout the report.
- Provide important results of the laboratory physical property testing and its indications about soil behavior.
- Avoid detailed descriptions of the sequence of units found in individual borings. Refer the reader to the exploration logs for details.
- Describe any expected changes in subsurface conditions that may occur with time after the investigation.

2.4 GROUNDWATER CONDITIONS

- Describe the nature and occurrence of groundwater.
- Provide an opinion on likely seasonal variations in groundwater levels or flows, and the possibility for changes from those encountered at the time of exploration.
- Show groundwater levels on soil logs.

3.0 DISCUSSION AND CONCLUSIONS

The Discussion and Conclusions should set out major geotechnical issues and alternatives for the project, along with the Geotechnical Engineer's conclusions, in a succinct and clear manner. This section shall clearly describe the logic and reasoning supporting the recommended approach, or alternative

approaches. Specific recommendations should be very limited in this section; they should be presented in the following Recommendations section. Discussions and conclusions should:

- Build on information described in the previous sections.
- Use consistent terminology to describe project features, soils, and construction materials
- Explain any apparent inconsistencies in the data or investigation.
- Clearly describe any limitations or restrictions to the conclusions and recommendations.

3.1 SLOPE STABILITY

- Summarize data and analysis used to evaluate slope stability.
- Provide an opinion regarding the risk of instability on the site or adjacent properties currently, during construction, and after the project is completed.
- Describe how design and construction recommendations will reduce or eliminate the risk of instability.
- Discuss any construction or post-construction measures necessary to verify slope stability.

3.2 SEISMIC CONSIDERATIONS

- Provide an opinion on the expected level of ground motion during a major earthquake.
- Describe any seismic risks associated with an earthquake such as liquefaction, lateral spreading, landslides, or flooding.
- Describe how design and construction recommendations will reduce or eliminate the impact of seismic risks.

3.3 SITE WORK

- Describe what is anticipated for site grading and earthwork and provide an opinion on the proper sequence and approach to accomplish the site work.
- Describe key issues which will impact proper earthwork, including short term slope stability, on-site and import fill materials, groundwater and drainage, rainfall and moisture sensitive soils, and erosion.
- Describe how these issues should be addressed during construction, including dewatering, temporary retaining structures, and erosion control.
- Include specific recommendations for on-site erosion control based on erosivity of site soils and presence of groundwater, surface water, and slopes.
- Include statements regarding the importance of construction monitoring by a geotechnical engineering firm.

3.4 RETAINING STRUCTURES

- If temporary retaining systems are necessary, provide an opinion as to the most appropriate type of temporary retaining system or systems.
- Summarize the data and analysis used to evaluate permanent retaining systems
- If permanent retaining systems are necessary, provide an opinion on the most appropriate permanent retaining system or systems and describe their expected performance with respect to stability and deflection.
- If reinforced soil slopes or reinforced soil backfill are to be used, clearly define all limitations on backfill materials, reinforcement, and drainage.
- Emphasize any aspects of site work, particularly with respect to native soil materials, backfill, and drainage, which could impact performance of the retaining structures

- Include statements regarding the importance of construction monitoring by a geotechnical engineering firm.

3.6 FOUNDATION SUPPORT

- Summarize the data and analysis used to evaluate foundation systems.
- Provide an opinion on the most appropriate foundation system and alternatives, along with the expected level of performance with respect to load capacity and settlement.
- Emphasize any aspects of site work which could impact the performance of foundations.
- Includes statements regarding the importance of construction monitoring by a geotechnical engineering firm.

4.0 RECOMMENDATIONS

The Recommendations should present all detailed geotechnical engineering recommendations for design and construction in a clear and logical sequence. For each item covered in the recommendations sections, present the following:

- Design recommendations along with their limitations, factors of safety, minimum dimensions, and effect of expected variations in actual conditions.
- Construction recommendations including definitions, materials, execution, monitoring, testing, or other quality control measures, and any other construction requirements to support the design recommendations.
- Responsibility for seeing that each recommendation is met, such as owner, geotechnical engineer, other design consultants, or contractor.
- The ultimate responsibility is held by the owner of the project. Construction responsibilities are directly related to the contractor.

4.1 SITE GRADING AND EARTHWORK

- Provide design recommendations for 1) depth of stripping, 2) soil excavation limits and slopes, 3) depth and lateral limits of over excavation to remove unsuitable materials, 4) preload fills, 5) location and thickness of particular fill material or compaction requirements, 6) maximum temporary and permanent slopes, and 7) permanent surface and subsurface drainage systems.
- Provide construction recommendations for 1) clearing, 2) on-site and/or import fill materials, 3) excavation and compaction equipment, 4) fill material moisture conditioning, placement, and compaction, 5) proof-rolling, in-place density testing, and other quality control measures, 6) temporary seepage and drainage control measures, 7) permanent surface or subsurface drainage system installation (as appropriate), and 8) temporary slope protection and erosion control measures.

4.2 TEMPORARY SHORING AND RETAINING WALLS

- Provide design recommendations for 1) active and passive earth pressures, 2) surcharge pressures, 3) bearing capacity, 4) minimum or maximum dimensions and depth of penetration, 5) lateral support, 6) wall or backfill drainage systems, and 7) any other appropriate structural details.
- If appropriate, provide design recommendations for tie-back anchors including 1) anchor inclination, 2) no load zones, 3) minimum anchor length, 4) anchor bond zone, 5) anchor adhesions, and 6) corrosion protection.

- Provide construction recommendations for 1) installation, 2) on-site and/or import backfill materials, 4) backfill material moisture conditioning, placement, and compaction, 5) in-place density testing or other quality control measures, and 6) seepage and drainage control.
- If appropriate, provide construction recommendations for tie-back anchors including 1) anchor installation methods, 2) anchor testing, and 3) monitoring.

4.3 REINFORCED SOIL STRUCTURES

- Geogrid or geotextile fabric may be used to reinforce a fill. Reinforcement results in a more stable slope and helps reduce the risk of significant long term maintenance. If reinforced slopes are used, the geotechnical engineer should specify, at a minimum, the fill soil materials, vertical spacing of the reinforcement, the specific type of reinforcement and the distance to which it must extend into the fill, the amount of overlap at reinforcement joints, and the construction sequence. Additional design parameters will be required for each specific site.

4.4 STRUCTURE AND FOUNDATIONS

- Provide seismic design recommendations and Site Class.
- Spread footing foundation: provide design recommendations for 1) bearing soils, 2) bearing capacity, 3) minimum footing depths and widths for both interior and exterior footings, 4) lateral load resistance, and 5) foundation drainage system.
- Mat foundations: provide design recommendations for 1) bearing soils, 2) bearing capacity, 3) modulus of subgrade reaction, 4) minimum dimensions, and 5) lateral load resistance.
- Pile foundations: provide design recommendations for 1) type of pile, 2) means of support (end or friction), 2) minimum dimensions and depths, 3) allowable vertical and uplift capacity, 4) allowable lateral loads and deflections, and 5) group effects and minimum spacing.
- Spread footing or mat foundations: provide construction recommendations for 1) foundation subgrade preparation and protection, 2) verification of bearing capacity, and 3) installation of foundation drainage system.
- Pile foundations: provide construction recommendations for 1) pile driving equipment, 2) pile installation, 3) pile load tests or verification piles, and 4) monitoring and testing during pile installation.

4.5 FLOORS

Slab-on-Grade Floors:

- provide design recommendations for 1) slab base rock thickness, 2) capillary break, 3) vapor barrier, and 4) floor system drainage.
- Supported Wood Floors: provide design recommendations for 1) vapor barrier, and 2) crawl space drainage.
- Slab-on-Grade Floors: provide construction recommendations for 1) subgrade preparation, 2) slab base rock placement and compaction, 3) capillary break and vapor barrier installation, and 4) floor drainage system installation (if appropriate).

4.6 PAVEMENTS

- Provide design recommendations for 1) pavement design section, and 2) pavement drainage.
- Provide construction recommendations for 1) pavement subgrade preparation and verification, and 2) pavement base and subbase materials, placement, and compaction.

4.7 UTILITIES

- Provide construction recommendations for 1) utility excavation, 2) bedding material placement, and 3) backfill material, placement, and compaction.

4.8 DRAINAGE

- Recommend provisions for subsurface drainage at walls, floors, and footings.
- Evaluate permanent and temporary surface and subsurface drainage for both walls and floors if applicable.

4.9 HAZARDS

- Present additional information if natural or man-made hazards exist on the property. Recommendations should be general and further studies may be required.

REPORT FIGURES AND ILLUSTRATIONS

1. VICINITY MAP

The report shall include a Vicinity or Location Map which presents adequate street and/or other physical references to allow clear identification of the project location. This map may be an individual figure or be included on the Site Plan.

2. SITE PLAN

The Site Plan shall include the project boundaries, property lines, existing features and the proposed development and structures. A north arrow and scale should be included along with all subsurface exploration locations. The accuracy of exploration locations should be indicated on the Site Plan or in the report.

3. EXPLORATION LOGS

Include logs of all explorations describing soil units encountered, soil classification, density or stiffness, moisture conditions, groundwater levels, stratigraphic sequence, common geologic unit name, and other descriptive information.

4. LABORATORY TEST DATA

Include figures or tables of laboratory test results if presentation of all the data, in the text, would require more than a simple paragraph to supplement the data provided in the exploration logs.

5. CROSS SECTIONS

Where applicable include cross sections to visually present all but the most simple subsurface conditions.

6. TYPICAL DETAILS

Include figures, graphs, and other visual aids to clearly present detailed recommendations. Provide design details on drawings such as: reinforced earth, interceptor trenches, wall and footing drains, utility backfill, and other details used for a particular design.