Geology and Soil Suitability Reports

Engineering Geology Report Guidelines

REVIEW REQUIREMENTS

Counties are required to send subdivision applications to CGS for review. Applications must include reports about soil suitability and geologic conditions. Cities and counties can adopt more stringent requirements. Please contact your city or county for more information on local rules. (CRS 30-28-136)

GEOLOGY REPORTS

All reports must be prepared by a Professional Geologist as defined by Colorado law. Geologists must have special education and experience. (CRS 34-1-201)

SOIL SUITABILITY REPORTS

Engineers preparing soil suitability reports must have specialized knowledge and experience in mitigation of natural hazards and must consult with geologists, planners, and other professionals. See http://www.dora.state.co.us/aes/Policies-PEPLS.pdf

The guidelines that follow are a general outline what should be included in an engineering geology or soil suitability report. Each report should be site-specific, and identify all known or potential geologic hazards or soil conditions that may affect the property, proposed land uses, and public safety.

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This is a general list of information commonly required in geologic and soil investigations for a land use application. Report authors and applicants should be thoroughly familiar with all federal, state, and local land-use codes, policies, and regulations, especially those pertaining to geologic hazards and soil suitability. These vary widely across Colorado and it is the responsibility of each geologist, engineer, and applicant to become familiar with all applicable codes, policies, and regulations.

Basic Information

PROJECT DESCRIPTION

- Describe present zoning, land-use proposed and structure(s) anticipated.
- Indicate size and relationship of the project to the surrounding area.

LOCATION

- Specify the project location in terms of section, township and range, and county.
- Depict the project location on an index map of appropriate scale like USGS 7.5-minute quadrangle map.

PURPOSE

- Clearly state the uses for which the report was prepared. Indicate the commissioning person or organization.

SCOPE

- State the objective(s) and level of investigation for the study.
- Cite previous published or unpublished geologic and geotechnical reports in the subject area and indicate the author(s), firm, and dates of each report.
- List all the methods of investigation as well as professional firm(s) and individuals who participated.

Basic Data

REGIONAL SETTING

- Describe the general physiographic setting of the project and its relationship to local topographic features.
- Describe the general geologic setting of the project and indicate any lithologic, seismotectonic, geomorphic, or soils problems specific to the area. Include the size, frequency, duration and location of historic earthquakes.

SUBSURFACE TESTING FREQUENCY

Subsurface testing is often done during a soil suitability study. Testing and sampling must be done at a frequency that provides a clear indication of soil and bedrock properties. Some cities and counties have specific standards that must be followed. A good example of subsurface testing standards is found in the Jefferson County Land Development Regulations. (http://www.jeffco.us/jeffco/planning_uploads/regulations/ldr/25.pdf)

HOW MANY REPORTS ARE REQUIRED?

Land-use applications should contain both a geology report and a soil suitability report. They can be combined or submitted as two separate reports. Geology reports or sections of a report must be done by a Professional Geologist.

- Describe the general surface and ground water conditions and their relationship to the project area.
- Describe the mineral resources in the general and project area.

Evaluation Techniques

TOPOGRAPHIC MAPPING

- State the extent and method of surface and subsurface geologic studies.
- Indicate the type and accuracy of topographic maps; include the date of the topographic survey and who conducted the survey.

GEOLOGIC MAPPING

- Prepare geologic map(s) on the project topographic map to show important details commensurate with the purpose of the investigation.
- Show the abundance and distribution of earth materials and structural elements exposed or inferred in the subject area. Observed and inferred features or relationships should be so designated on the geologic map.
- Depict significant three dimensional relationships on appropriately positioned cross sections.
- Portray all geologic information at the same scale as the project plans.
- Indicate the geologic base map used, date, and significant additions and modifications to previous work.

REMOTE-SENSING IMAGES

- Describe type(s) of photographs or images including instrumentation, processing techniques, and final product.
- Describe the source, date and scale of photographs or imagery used in the investigation.
- Indicate general relationships observed on the images.

GEOPHYSICAL INVESTIGATIONS

- State type, techniques and objectives of any geophysical investigation(s), quality of the data, and limitations of the geophysical techniques.
- Describe the information used to correlate the geophysical data and known geologic conditions.
- Display the geophysical data on the topographic/geologic maps and cross sections and show cultural features which affect the data.

DRILL-HOLE DATA

- State the specific investigative methods, tests conducted, drilling equipment, and date of investigation.
- Show the location of all borings on the topographic and geologic map.
- Show boring logs, geophysical logs, or profiles obtained in the investigation.
- On boring logs, show depths, type of samples; soil descriptions according to the unified soil classification; lithologic descriptions using standard geologic terminology; critical soil or geologic contacts; and ground-water levels.

TEST PITS AND TRENCHES

- Describe the location and general dimensions of all pits and trenches and date of investigation.
- Indicate the location of all excavations on topographic and geologic maps.
- Provide a large scale descriptive log with sufficient detail commensurate with the features observed.
- Show sample locations and depths if laboratory tests were conducted.

FIELD AND LABORATORY TESTS

- Describe the type and objectives of any tests conducted in the field or laboratory.
- Describe the sample method and test procedures. Show the test results on boring log, data work sheets and in summary tables.
- Describe the type, objectives, and location of all monitoring programs in the subject area

WHAT IS A GEOLOGIC HAZARD?

Colorado statutes define geologic hazards as a "geologic phenomenon which is so adverse to past, current, or foreseeable construction or land use as to constitute a significant hazard to public health and safety or to property." (CRS 24-65.1-101)

Geologic and natural hazards include:

- Avalanches
- Landslides
- Rockfalls
- Mudflows & Debris Fans
- Unstable Slopes
- Potentially Unstable Slopes
- Seismic Effects
- Radioactivity
- Ground Subsidence
- Expansive Soil and Rock
- Corrosive Soil
- Floodplains
- Wildland Fire
- Siltation
- Dry Wash Channels

- State the monitoring period and frequency, and who is responsible for monitoring and collection of data.

Geologic Descriptions

BEDROCK

- Describe and map sedimentary, igneous, and metamorphic rock types and units.
- Describe and map rock types bedding orientation.
- Describe age of and correlation with recognized formations.
- Describe and map dimensional characteristics such as thickness and extent.
- Describe and show on logs distribution and extent of the weathered zone.
- Describe physical and chemical characteristics.
- Describe response of bedrock materials to natural processes and proposed land uses.
- Describe and map mineral occurrences.

SURFICIAL DEPOSITS

- Describe and map fluvial, colluvial, glacial, eolian, mass wasting, and man-made deposits
- Identify, describe and map material types and sources
- Describe and map dimensional characteristics such as thickness and extent
- Describe surface expression and relationships with present topography
- Describe physical and chemical characteristics
- Describe and map altered zones
- Describe response of surficial materials to natural processes and proposed land uses.
- Describe and map mineral occurrences

GEOMORPHIC FEATURES

- Describe and map landslides, earthflows, debris flows, mudflows, rockfalls, debris avalanches, fault scarps, soil creep, erosion scarps, avalanche paths, and subsidence phenomenon.
- Describe dimensional characteristics
- Describe and map age of feature and history of activity
- Describe recurrence interval for geomorphic process
- Describe physical characteristics including depth, flow velocities, and impact pressures

STRUCTURAL FEATURES

- Describe and map joints, faults, shear zones, folds, schistocity, and foliation
- Describe occurrence, distribution, and proximity to site.
- Describe dimensional and displacement characteristics of faults
- Describe orientation and changes in orientation of all structural features
- Describe and map physical characteristics such as brecciation, slickensides, gouge zones, sand boils, sag ponds, spring alignment, disrupted drainages, or ground water barriers
- Describe and map nature of offset(s) and timing of movement(s)
- Describe absolute or relative age of latest movement
- Describe and map location of seismic events, including size, frequency, duration and their association with faults or fault systems

SURFACE WATER

- Describe and map rivers, streams, ditches, dams, ponds, canals, creeks, wetlands, and draws
- Describe relation to topography (drainage patterns)
- Describe relation to geologic features
- Describe source, permanence, and variation in amount of surface water
- Describe and map earlier occurrence of water at localities now dry
- Estimate peak flows and physiographic flood plain of drainages
- Describe and map probable maximum or 100-year flood limits, including flash and debris floods
- Describe water use and quality

MINERAL RESOURCES

In many counties, Colorado law requires CGS to review subdivision plans for potential land use conflicts with extraction of commercial mineral deposits. (CRS 34-1-304, as amended)

ENGINEERED STRUCTURES

Plans for mitigation involving engineered structures shall be prepared and signed by a professional engineer, registered in the State of Colorado, and qualified in the field of natural hazard mitigation. Plans should assure that soil and geologic factors affecting the planning, design, construction, operation, and maintenance of structures are recognized, adequately interpreted, and presented for use in engineering practice.

GROUND WATER

- Describe and map hydraulic gradients, and aquifer characteristics for confined and unconfined aquifers
- Describe and map saturated zones, depth to ground water, and seasonal fluctuations
- Describe relation to geomorphology, geologic features, recharge and discharge areas
- Describe and map potential for perched ground-water and where the chemical content of water poses engineering concerns
- Describe how on-site sewage disposal impacts water quality and quantity, and geologic hazards

MINERAL RESOURCES

- Describe and map mineral resources, especially commercial mineral deposits.
- Describe past and current mineral production, mineral rights and agreements
- Describe how past and current mineral production impacts existing and proposed land uses and geologic hazards

Geologic Interpretation

GEOLOGIC HAZARDS

- Describe and map landslides, avalanches, rockfall, mudflows, debris flows, radioactivity, expansive soil or rock, potentially unstable slopes, unstable slopes, soil creep, hydrocompaction, shallow bedrock, erosion and siltation.
- Describe and map earthquake hazards, including the potential for surface rupture (sense and amount of displacement); estimated ground motion, duration, and response variability; potential subsidence or uplift from regional tectonic deformation
- Describe and map potential secondary hazards associated with earthquake or wildland fire induced landslides, liquefaction, rockfall, flooding, mudlfows, or debris flows.
- Describe and map soil, geologic, geomorphic, structural and man-induced hazards near or in project area
- Describe and map age and activity of hazards and correlation with formations and land uses.
- Describe how natural and man-induced features and processes affect hazards.
- Describe potential impact and risk of hazards to project area, existing and proposed land use and to public safety.
- Describe amenability of adverse conditions and hazards for adequate mitigation
- Describe long-term lateral and vertical stability of earth and man-made materials

Recommendations

- State whether the proposed land uses are compatible with existing or potential geologic hazards and if mitigation measures are needed
- Discuss critical planning and construction aspects including waste disposal, the stability of earth materials, grading plans, avoidance of hazards, static and dynamic parameters for the design of structures, the extraction of mineral resources, allowable and excluded land uses
- Clearly state the basis for all recommendations and conclusions
- Discuss mitigation measures and procedures needed to mitigate or abate geologic hazards, adverse conditions, or mineral resource conflicts, Each hazard, adverse condition, or mineral resource conflict must be addressed.
- Provide detailed construction and maintenance plans for each mitigation measure.
- Include recommendations for any additional hazard studies or mitigation plans
- All recommendations, mitigation measures, and plans must ensure the long-term stability and adequate performance of the project, protect public safety, and be compatible with existing and proposed land use.