UTAH GEOLOGICAL AND MINERAL SURVEY

GUIDELINES FOR PREPARING ENGINEERING GEOLOGIC REPORTS IN UTAH

by
The Utah Section of the
Association of Engineering Geologists

These guidelines are intended to be a general aid to professional geologists evaluating site-specific conditions and hazards and to regulatory agencies for review of reports. The guidelines do not include systematic descriptions of all available techniques or topics, nor is it suggested that all techniques or topics be utilized on every project. Variations in site conditions and purposes of investigations may require more or permit less effort than is outlined here. All elements of these guidelines should be considered during the preparation and review of engineering geologic reports.

The guidelines were developed by the Guidelines Committee of the Utah Section of the Association of Engineering Geologists for the purpose of protecting the health, safety, and welfare of the people of Utah. They were modeled after a series of guidelines developed in California during the past 20 years and subsequently published by the California Division of Mines and Geology in the CDMG Note series. In 1984, the California guidelines were published in the Bulletin of the Association of Engineering Geologists (Slosson, 1984), making then readily available to geologists and reviewers in other states.

I. GEOLOGIC MAPPING AND INVESTIGATION

A. Geologic mapping of the subject area should be done at a scale which shows sufficient detail to adequately define the geologic conditions present. For many purposes, available geologic maps are unsuitable to provide a basis for understanding the site conditions and independent geologic mapping is needed. If available geologic maps are used to portray site conditions, they must be updated to reflect geologic or topographic changes which have occurred since map publication. It may be necessary for the geologist to extend mapping into adjacent areas to adequately define geologic conditions significant at the subject area.

B. Mapping should be done on a suitable topographic base at an appropriate scale with satisfactory horizontal and vertical control. The nature, date, and source of the base should be included on each map. In certain cases where topographic base maps at scales larger than 1:24,000 (U.S. Geological Survey 7-1/2 minute quadrangle) are not available, geologic mapping may be done and presented on an aerial photograph base of suitable scale to permit documentation of pertinent features. On small-scale maps, 1 inch commonly equals 2000 feet (1:24,000) or more, whereas on large scale maps 1 inch equals 500 feet (1:6,000) or less.

C. The geologist doing the investigation and preparing the map should pay particular attention to the nature of bedrock and surficial materials, structural features and relationships, and the three-dimensional distribution of earth materials exposed and inferred within the area. A clear distinction should be made between observed and inferred features and relationships.

D. The report should include one or more appropriately positioned and scaled cross sections to show three-dimensional relationships that cannot be adequately described in words alone. Fence or block diagrams may also be appropriate for describing three-dimensional relationships.

E. The locations of test holes (drill holes, test pits, and trenches) should be shown on maps and sections and described in the text of the report. The actual data or processed data upon which interpretations are based should be included in the report to permit technical reviewers to make their own assessments regarding reliability and interpretation.

II. GENERAL INFORMATION

Each report should include sufficient background information to inform the reader of the general site setting, the proposed land use, and the purpose and scope of the geologic investigation. The following items should be addressed:

A. Location and size of subject area, and its general setting with respect to major or regional geographic and geologic features.

B. Name(s) of geologist(s) who did the mapping on which the report is based, and dates when the mapping was done. This is particularly valuable for reports which are not signed by the geologist(s).

C. Purpose and scope of the report and geologic investigation.

D. Topography and drainage within or affecting the subject area.

E. General nature, distribution, and abundance of exposures of earth materials within the subject area.

F. Basis of interpretations and conclusions regarding the geology of the subject area. Nature and source of available subsurface information and geologic reports or maps. Suitable explanations of the available data should provide a technical reviewer with the means of evaluating the reliability. Reference to cited works or field observations should be made to substantiate opinions and conclusions.

G. Disclosure of known or suspected geologic hazards affecting the project area. This should include a statement regarding past performance of existing facilities (such as buildings or utilities) in the immediate vicinity.

III. GEOLOGIC DESCRIPTIONS

The report should contain brief but complete descriptions of all natural materials and structural features recognized or inferred within the subject area. Where interpretations are added to the recording of direct observations, the basis for such interpretations should be clearly stated.

The following checklist may be useful as a general, though not necessarily complete, guide for descriptions:

A. Bedrock

1. Identification of rock type (such as granite, silty sandstone, clay shale.
2; Relative age and, where possible, correlation with named formations (e.g., Wasatch Formation, Navajo Sandstone).
3. Surface expression, areal distribution, and thickness.
4. Pertinent physical characteristics (e.g., color, grain size, nature of stratification, strength, variability of characteristics).
5. Special physical or chemical features (e.g., voids, gypsum veins).
6. Distribution and extent of zones of weathering; significant differences between fresh and weathered rock.
7. Special engineering characteristics or concerns (e.g., factors affecting grading).

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UTAH GEOLOGICAL AND MINERAL SURVEY
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B. Structural features - stratification, faults, fractures, foliation, schistosity, folds.

1. Occurrence, distribution, dimensions, orientation, and variability; projections into subject area.
2. Relative ages, where pertinent.
3. Special features of faults (e.g., topographic expression, zones of gouge and breccia, nature of offsets, timing of movements, youngest faulted unit and oldest unfaulted unit).
4. Special engineering characteristics or concerns.

C. Surficial or unconsolidated deposits - alluvial, colluvial, eolian, glacial, lacustrine, marine, residual, mass movement, volcanic (such as cinders and ash), and man-placed fill.

1. Identification of material, grain size, relative age, degree of activity of originating process.
2. Distribution, dimensional characteristics, variations in thickness, degree of soil development, surface expression.
3. Pertinent physical characteristics (e.g., color, grain size, lithology, compactness, cementation, strength, thickness).
4. Special physical or chemical features (e.g., indications of volume change or instability, such as cracks, clay, gypsum).
5. Special engineering characteristics or concerns.

D. Surface and shallow subsurface hydrologic conditions.

1. Distribution, occurrence, and variations (e.g., drainage courses, ponds, swamps, springs, and seeps).
2. Identification and characterization of aquifers; depth to ground water and seasonal fluctuations.
3. Relationships to topographic and geologic features.
4. Evidence for earlier occurrence of water at localities now dry (e.g., vegetation, mineral deposits, historic records).
5. Special engineering characteristics or concerns (such as fluctuating water table.)

E. Seismic considerations.

1. Description of the seismotectonic setting of the subject area (including size, frequency, and location of historic earthquakes).
2. Potential for subject area to be affected by surface rupture (including sense and amount of displacement and width of zone of surface deformation).
3. Probable site response to likely earthquakes (estimated ground motion).
4. Potential for subject area to be affected by earthquake-induced landslides or liquefaction.
5. Potential for subject area to be affected by regional tectonic deformation (subsidence or uplift).

IV. ASSESSMENT OF GEOLOGIC FACTORS

Assessment of geologic factors with respect to intended use constitutes the principal contribution of the report. It involves both 1) the effects of the geologic features upon the proposed grading, construction, and land use, and 2) the effects of these proposed modifications upon future geologic processes in the area.

The following checklist includes the topics that ordinarily should be considered in submitting discussions, conclusions, and recommendations in geologic reports:

A. General suitability of proposed land use to geologic conditions.

1. Areas to be avoided, if any.
2. Topography and slope.
3. Stability of earth minerals.
4. Flood inundation, erosion, and deposition.
5. Problems caused by geologic features or conditions in adjacent properties.
6. Other general problems.

B. Identification and extent of known or suspected geologic hazards (such as flood inundation, shallow ground water, storm surge, surface- and ground-water pollution, snow avalanche, landslide, debris flow, rock fall, expansive soil, collapsible soil, subsidence, erosion, deposition, earthquake shaking, fault rupture, tectonic deformation, liquefaction, seiche, volcanic eruption).

C. Recommendations for site grading.

1. Prediction of what materials and structural features will be encountered in proposed cuts.
2. Prediction of stability based on geologic factors; recommended avoidance or engineering to cope with existing or potential landslide masses.
3. Excavation considerations (hard or massive rock, ground-water flows).
4. General considerations of proposed fill masses in canyons or on sidehills.
5. Suitability of excavated material for use as compacted fill.
6. Recommendations for positioning fill masses, provisions for underdrainage, buttressing, and the need for erosion protection on fill slopes.
7. Other recommendations required by the proposed land use, such as for reorientation of cut slopes, positions of drainage terraces, the need for rock-fall protection on cut slopes, the need for erosion protection on cut slopes.

D. Drainage considerations.

1. Protection from inundation or wave erosion along shorelines.
2. Soil permeability, suitability for septic systems.
3. Protection from sheet flood or gulley erosion and debris flows or mud flows.

E. Recommendations for additional investigations.

1. Borings, test pits, and/or trenches needed for additional geologic information.
2. Percolation tests needed by the engineer for septic system design.
3. Program of subsurface exploration and testing that is most likely to provide data needed by the soils or civil engineer.

V. RECOMMENDED TECHNIQUES/SYSTEMS TO CONSIDER

A. Engineering geology mapping can be done using the Genesis-Lithology-Qualifier (GLQ) system rather than the conventional Time-Rock system. The GLQ system (Keaton, 1984) promotes communication of geology information to non-geologists. The Unified Soil Classification System (U.S. Army Corps of Engineers, 1953, and American Society for Testing and Materials, 1984) has been used in engineering for many years and can be adapted for mapping. It has been incorporated into the GLQ system.

B. The Unified Rock Classification System (Williamson, 1984) provides a systematic and reproducible method of describing rock weathering, strength, discontinuities, and density in a manner directly usable by engineers.

C. Systems for mapping landslide deposits are described by Wieczorek (1984) and by McCalpin (1984).

D. Commonly accepted grading requirements are described in Chapter 70 of the Uniform Building Code.

E. A number of the local governmental agencies have adopted specific ordinances regarding hillside development, siting issues with respect to proximity to fault traces, requirements for septic system designs, waste material disposal requirements, and others. The geologist should check with local agencies regarding such ordinances that might affect specific aspects of the project requirements.

REFERENCES

American Society for Testing and Materials, 1984, Standard practice for description and identification of soils (visual-manual procedure): ASTM Standard D-2488-84, p. 409-423.

Keaton, J.R., 1984, Genesis-lithology-qualifier (GLQ) system of engineering geology mapping symbols: Bulletin of the Association of Engineering Geologists, Vol. XXI, No. 3, p. 355-364.

McCalpin, James, 1984, Preliminary age classification of landslides for inventory mapping: 21st Annual Symposium on Engineering Geology and Soils Engineering, Proceedings, University of Idaho, Moscow, ID, p. 99-111.

Slossen, J.E., 1984, Genesis and evolution of guidelines for geologic reports: Bulletin of the Association of Engineering Geologists, Vol. XXI, No. 3, p. 295-316.

U.S. Army Corps of Engineers, 1953, The Unified Soil Classification System: U.S. Army Technical Memorandum 3-357.

Wieczorek, G.F., 1984, Preparing a detailed landslide-inventory map for hazard evaluation and reduction: Bulletin of the Association of Engineering Geologists, Vol. XXI, No. 3, p. 337-342.

Williamson, D.A., 1984, Unified Rock Classification System: Bulletin of the Association of Engineering Geologists, Vol. XXI, No. 3, p. 345-354.