

Section 25 - Geologic and Geotechnical

(orig. 7-12-05)

A. Standards

The following standards were adopted to protect lots, tracts and structures from geologic hazards, including, but not limited to, Dipping Bedrock, Rockfall, Potentially Unstable Slopes, Swelling Soils, and Subsidence. (orig. 10-25-05)

1. Buildable areas within lots, tracts, and areas designated for streets/roads and drainage improvements shall be: (am. 10-25-05)
 - a. Reasonably free from geologic hazards or adequately mitigated from geologic hazards. (orig. 10-25-05)
 - b. Free of adverse soil conditions, constructed away from adverse soil conditions, or constructed in areas where adverse soil conditions have been abated. (orig. 10-25-05)
2. All areas which fall within the Dipping Bedrock Overlay District shall be subject to the restrictions in the Dipping Bedrock Overlay District of the Jefferson County Zoning Resolution. (am. 10-25-05)

B. Geologic Report

1. Preparation
 - a. The Geologic Report shall be prepared and signed by a qualified professional geologist (as defined in 34-1-201 C.R.S, as amended) and shall be in substantial conformance with the content requirements of this section. If the development in the Dipping Bedrock Overlay District, the geologist shall have extensive first hand knowledge of and experience with the geology of eastern Jefferson County. (reloc. 7-12-05; am. 10-25-05)
 - b. The Geologic Report and the Geotechnical Report may be combined in a single report, or may be two separate Reports. (orig. 10-25-05)
2. Content
 - a. Bedrock Geology
 - (1) Rock types present, including formation names and ages, if possible. (reloc. 7-12-05)
 - (2) Bedrock characteristics including, but not limited to the following: (reloc. 7-12-05)
 - (a) Degree of weathering, including depth of weathering, presence of expansive claystones. (reloc. 7-12-05)
 - (b) Erodibility, including the range of normal angles of slopes. (reloc. 7-12-05)
 - (c) Aquifer characteristics, including moisture content and permeability. (reloc. 7-12-05)
 - (d) Shrink-swell potential, potential differential heave and range of swelling pressures. (reloc. 7-12-05)
 - (e) Potential response to seismic activity. (reloc. 7-12-05)
 - (f) Radioactivity (naturally occurring and man-made). (reloc. 7-12-05)
 - (g) Slope stability in natural and excavated states, including mudflows, rockfall, creep, subsidence, settlement and slumping. (reloc. 7-12-05)

- (h) Strike and dip of bedding planes, foliation, joints and faults and the frequency and distribution of any such features. (reloc. 7-12-05)
 - (i) Well and Individual Sewage Disposal System suitability. (reloc. 7-12-05; am. 10-25-05)
 - (j) Detailed description of the bedrock surface topography. (reloc. 7-12-05)
- (3) The following items may be required if any portion of the proposed development is located in the Dipping Bedrock Overlay District, and the plans do not conform to the provisions of the Dipping Bedrock Section of the Jefferson County Zoning Resolution: (am. 7-12-05; am. 10-25-05)
- (a) Trenching or other test methods to determine attitudes of bedding planes, depth to bedrock, detailed bedrock stratigraphy and to determine the interface between weathered claystone and clay. Where claystone or weathered claystone is present, the evaluation shall include a detailed description of discrete or zones of highly expansive claystone and/or bentonite beds and a detailed description of filled or open fractures. (reloc. 7-12-05)
 - (b) Cross-sections, which show subsurface bedrock relationships including depth to bedrock, dip of beds and detailed stratigraphy of the bedrock may be required. Frequency and distribution of joints and faults should be noted on the cross-sections using drawings or written descriptions. (reloc. 7-12-05)
- b. Surficial Geology
- (1) Location and description of all surficial materials present, including artificial fill, utilizing unit names and ages, if possible. (reloc. 7-12-05)
 - (2) A discussion of the thickness and distribution of surficial materials. (reloc. 7-12-05)
 - (3) Surficial material characteristics including, but not limited to the following: (reloc. 7-12-05)
 - (a) Erodibility. (reloc. 7-12-05)
 - (b) Degree of weathering, including types of clay minerals. (reloc. 7-12-05)
 - (c) Aquifer characteristics, including permeability and soil moisture. (reloc. 7-12-05)
 - (d) Shrink-swell potential and the potential for differential heave. (reloc. 7-12-05)
 - (e) Potential response to all seismic activity. (reloc. 7-12-05)
 - (f) Radioactivity (naturally occurring and man-made). (reloc. 7-12-05)
 - (g) Slope stability in natural and excavated states, including mudflows, rockfall, creep, subsidence, settlement and slumping. (reloc. 7-12-05)
 - (h) Well and Individual Sewage Disposal System suitability. (reloc. 7-12-05; am. 10-25-05)
 - (i) Discussion and evaluation of the suitability of structure foundations. (reloc. 7-12-05)
 - (j) If any portion of the proposed development is within the Dipping Bedrock Overlay District, a description and map of the general condition and performance of existing roads and structures. Descriptions shall include degree of driveway, flatwork and road damage and/or repair, and any other evidence of ground deformation or movement such as linear heave trends. Areas of investigation shall include the site plus an outlying adjoining area of at least 1/2-mile from the site boundaries in the direction of regional strike and perpendicular to the strike. The map of the area outside the proposed development may be a separate map at a scale of one (1) inch equals 1,000 feet. (reloc. 7-12-05; am. 10-

25-05)

- (4) A description of the surficial geomorphology. (reloc. 7-12-05)
 - (5) Cross-sections which show bedrock/surficial material relationships may be required in order to illustrate the depth to bedrock and any structural features such as faulting. (reloc. 7-12-05)
- c. Hydrology
- (1) Depth to groundwater, utilizing isopach map. (reloc. 7-12-05)
 - (2) Perched water tables, including existing conditions and potential post-development perched water table conditions. (reloc. 7-12-05)
 - (3) Expected seasonal variations in groundwater. (reloc. 7-12-05)
 - (4) A description of the possible effects of surface water on structure performance, including the potential for erosion and flooding. (reloc. 7-12-05)
- d. Mineral Resources
- (1) Amount and quality of any mineral resources, including, but not limited to sand and gravel, quarry aggregate, coal, limestone, mineral fuels (e.g., oil, gas, uranium), metallic resources (e.g., gold, copper), and nonmetallic resources (e.g., clay). (reloc. 7-12-05)
 - (2) Existing mining site or prospects. (reloc. 7-12-05)
- e. Geologic Map
- (1) Preparation
The Geologic Map shall be legible at a suitable scale not greater than 1:24,000.(reloc. 7-12-05; am. 10-25-05)
 - (2) Content
 - (a) The boundaries of the proposed developmentl, including lots, tracts and street/road alignments or the area to be rezoned. (reloc. 7-12-05; am. 10-25-05)
 - (b) The natural and proposed final topography as shown by contour lines. (reloc. 7-12-05)
 - (c) Location of borings, pits, trenches, seismic traverses, etc. (reloc. 7-12-05)
 - (d) Bedrock geology conditions, including the following where applicable: (am. 7-12-05; am. 10-25-05)
 - (d-1)Test holes, trenches or test pits used in the investigation. (am. 7-12-05; am. 10-25-05)
 - (d-2)Sites of special geologic interest (e.g., fossil beds or unusual mineral formations). (reloc. 7-12-05)
 - (d-3)Geologic Hazard Overlay Zone. (reloc. 7-12-05)
 - (e) Surficial geology conditions. (am. 7-12-05; am. 10-25-05)
 - (f) Groundwater hydrology conditions. (am. 7-12-05)
 - (g) Mineral resource conditions. (am. 7-12-05; am. 10-25-05)
 - (h) Formation contacts. (reloc. 7-12-05; am. 10-25-05)

- (i) Outcrops. (reloc. 7-12-05)
 - (j) Isopach map showing the thickness and distribution of surficial materials (unconsolidated natural soils and artificial fill). (reloc. 7-12-05)
 - (k) An elevation contour map of the top of the bedrock surface for areas of the proposed development which fall within the Dipping Bedrock Overlay District. For areas which contain claystone, the top of the weathered claystone shall be considered as the top of the bedrock. (reloc. 7-12-05; am. 10-25-05)
- f. The date of all fieldwork performed and a list of references and other supportive data used. (orig. 10-25-05)

3. Approval

The Geologic Report shall be approved by the County Engineering Geologist prior to the proposed development's approval. (orig. 10-25-05)

C. Geologic Plans

1. Preparation

- a. The Geologic Plan(s) (excluding plans for engineered structures) shall be prepared and signed by a qualified professional geologist (as defined in 34-1-201 C.R.S, as amended). If the proposed development is in the Dipping Bedrock Overlay District, the geologist shall have extensive first hand knowledge of and experience with the geology of eastern Jefferson County. (reloc. 7-12-05; am. 10-25-05)
- b. Plans for engineered structures shall be prepared and signed by a professional engineer, registered in the State of Colorado, and qualified in the field of civil engineering. (reloc. 7-12-05)
- c. Geologic Plan(s) shall assure that geologic factors affecting the planning, design, construction, operation, and maintenance of engineered structures are recognized, adequately interpreted, and presented for use in engineering practice. (am. 7-12-05; am. 10-25-05)

2. Content

- a. The geologic processes, constraints, and hazards which will or could affect proposed structures or the intended uses of the site. Recommendations for additional site exploration, testing, development which are necessary to assure adequate performance of mitigation methods. (reloc. 7-12-05)
- b. Methods to mitigate adverse geologic conditions on proposed structures. (reloc. 7-12-05)
- c. Mineral resource recovery, if applicable, in accordance with the Jefferson County Mineral Extraction Policy Plan. (reloc. 7-12-05)
- d. The entity/entities that will implement the mitigation recommendations, construct required improvements, and be responsible for the maintenance of the improvements and appropriate easements, if any. (reloc. 7-12-05)

3. Approval

- a. The Geologic Plans shall be approved by County Engineering Geologist prior to the proposed development's approval. (reloc. 7-12-05; am. 10-25-05)
- b. Plans for engineered structures shall be approved by Planning and Zoning prior to the proposed development's approval. (reloc. 7-12-05; am. 10-25-05)

D. Geotechnical Report

1. Preparation
 - a. Any Geotechnical Report shall be prepared and signed by a qualified professional engineer, registered in the State of Colorado and qualified in the field of geotechnical engineering and shall be in substantial conformance with the content requirements of this section. (orig. 10-25-05)
 - b. The Geologic and Geotechnical Reports may be combined in a single report, or may be two separate Reports. (orig. 10-25-05)
2. Content
 - a. Geotechnical Investigation Standards
 - (1) All sites shall be investigated to evaluate the potential impacts of adverse soil and bedrock conditions on proposed structures, pavements, drainage structures, and utilities. The objectives of this investigation shall be to establish the depth to bedrock across the site with respect to the proposed final grades and foundation elevations of proposed structures and to develop recommendations to mitigate the impacts of adverse soils and bedrock conditions and/or the impacts of steeply dipping bedrock on the proposed development. (reloc. 7-12-05; am. 10-25-05)
 - (2) Dipping Bedrock Overlay District
 - (a) At least one (1) exploratory boring shall be drilled every 250,000 square feet to a minimum depth of 35 feet, or to 25 feet provided bedrock is found. A minimum of 4 borings shall be drilled. (reloc. 7-12-05)
 - (b) If bedrock is not found within 15 feet of anticipated foundation levels (after site grading), the site or portions of the site may be exempted from further requirements for special investigation requirements, such as increased testing upon approval by the Engineering Geologist. In order to qualify for this exemption, the geotechnical engineer shall submit findings to the Engineering Geologist in a letter requesting exemption. The letter shall include a plan showing existing site topography and location of borings, and graphical logs of the borings. If grading plans are available, they shall also be provided. The anticipated cut/fill shall be indicated on the boring logs. The Engineering Geologist shall respond to this request in writing within 14 calendar days. If grading plans are not provided, exemption granted for all or a portion of a site will be subject to review upon review of grading plans by the Engineering Geologist. The Engineering Geologist may refer an exemption request to the Colorado Geological Survey for review and comment. (reloc. 7-12-05; am. 10-25-05)
 - (3) All Other Areas in the Plains: At least one (1) exploratory boring shall be drilled every 250,000 square feet to a minimum depth of 25 feet. A minimum of 4 borings shall be drilled. (reloc. 7-12-05)
 - (4) On comparatively small sites (less than 5 acres) a minimum of 4 borings is required. Boring locations and elevations shall be accurately located and shown on the soils and bedrock map. All borings shall be sampled at approximately 5-foot intervals using a modified California sampler (nominal 2 inch inside diameter) or similar device to obtain relatively undisturbed samples. The minimum depth of all boring shall be 25 feet unless drilling refusal in bedrock is encountered. If deep cuts (in excess of 15 feet) are anticipated during site grading, the borings in cut areas shall extend at least 25 feet below the anticipated cut. The depth of free groundwater shall be measured in each boring at the time of drilling and at least 48 hours after drilling. If rain or snow melt occurs between time of drilling and subsequent measurements, these occurrences shall be noted. (reloc. 7-12-05)
 - (5) Laboratory testing of soil and bedrock shall be conducted to verify field classifications and provide indications of soil and bedrock material properties. Tests shall include the following: (reloc. 7-12-05)

- (a) Moisture content and a dry density profile for all intervals sampled on at least four borings. (reloc. 7-12-05)
 - (b) Atterberg Limits and percent passing the No. 200 sieve on representative samples of each clay or claystone strata. (reloc. 7-12-05)
 - (c) Percent passing the No. 200 sieve from representative samples of each sand or sandstone strata. (reloc. 7-12-05)
 - (d) One dimensional swell-consolidation tests and/or soil suction tests on representative samples of each clay or claystone strata. Swell tests may be performed using a surcharge of 500 psf, 1000 psf, or the anticipated overburden pressure after site grading. Swell tests are not required for non-expansive strata provided other laboratory tests are performed to confirm classification. (reloc. 7-12-05)
- (6) For sites where sub-excavation of bedrock and construction of fill is planned, bulk samples of the cut materials shall be obtained, preferably from exploratory test pits excavated with a backhoe. Standard Proctor tests (ASTM D698) shall be performed on each of the materials. Atterberg Limits and percent passing the No. 200 sieve tests shall be performed for each sample. The proposed fill materials shall be tested for swell using samples compacted to 95 to 98 percent of maximum dry density as determined using ASTM D698 at molding moisture contents of approximately 2 percent below optimum moisture, optimum moisture, 2 percent above optimum moisture, and 4 percent above optimum moisture. These tests shall be performed using a surcharge of 500 psf or 1000 psf. The remolded swell moisture and density data points shall be indicated on the corresponding Proctor Curve. (reloc. 7-12-05)
- (7) Required test frequency per type of material sample is set forth in the following table: (reloc. 7-12-05)

REQUIRED TEST FREQUENCY PER TYPE OF MATERIAL SAMPLED						
Unified Soil Classification or Equivalent Soil Classification	Moisture Content ASTM D2216-80	Dry Density	Atterberg Limits ASTM D424-59 D423-66	Passing #200 Sieve ASTM D1140-54	Hydrometer	One Dimensional Swell/Consolidation or Soil Suction
Sand, clean to silty (SM, SW & SP)	X			X		
Sand, clayey (SC)	X	X	X	X		X
Clay (ML, CL, MH, & CH), Weathered Claystone	X	X	X	X	X	X
Sandstone, clean to silty (SM, SW & SP)	X	(where possible)		X		
Sandstone, clayey (SC)	X	X	X	X		
Claystone (ML, CL, MH, & CH)	X	X	X	X	X	X
Dipping Bedrock Overlay District - A minimum of 2 test series per strata sampled for every 4 borings, except for hydrometer tests which are required at a minimum rate of one (1) test per strata sampled for every 4 borings. All Other Areas In the Plains - A minimum of one (1) test series per strata sampled for every four (4) borings and hydrometer tests are not required. However, in areas of highly expansive clays, additional testing may be required.						

b. Geotechnical Investigation Findings

- (1) A description of the site including existing vegetation, evidence of previous construction, nearby water sources, and the slope of the existing site. (reloc. 7-12-05)
- (2) A description of the proposed construction, including site grading, anticipated maximum cut and fill depths, the types of structures planned, and any anticipated sources of water such as detention or retention ponds, lakes and water features. (reloc. 7-12-05)
- (3) Results of field and laboratory investigations and tests. (reloc. 7-12-05; am. 10-25-05)
- (4) Graphical logs of the exploratory borings. All measurements of moisture content, dry density, Atterberg Limits, percent passing the No. 200 sieve, and measured percent swell of relatively undisturbed samples shall be summarized on the graphical logs. Boring logs shall indicate existing surface elevations, proposed surface elevations, foundation limits and bearing elevation limits of over-excavation if applicable. (reloc. 7-12-05; am. 10-25-05)
- (5) Results of laboratory tests in graphic or tabular form. (reloc. 7-12-05)
- (6) If applicable, discussion of dipping bedrock on the proposed development and the methods recommended to mitigate these impacts. If sub-excavation of bedrock and replacement by compacted fill is recommended, the recommended compaction and moisture contents for the fill shall be in accordance with the Compaction procedures in Excavation and Grading Section. (am. 7-12-05)

c. Geotechnical Map

(1) Preparation

The Geotechnical Map shall be a legible map of the area of investigation, at a suitable scale not greater than 1:24,000. (orig. 10-25-05)

(2) Content

- (a) The proposed development's boundary, including lots, tracts, and street/road alignments. (reloc. 7-12-05; am. 10-25-05)
- (b) The existing site topography based upon a topographic survey performed by a professional land surveyor. (am. 7-12-05; am. 10-25-05)
- (c) The surface elevation of the bedrock beneath the site in the form of a contour map if not already included in the geologic reports. (am. 7-12-05; am. 10-25-05)
- (d) Delineation and designation of soil types present. (reloc. 7-12-05)
- (e) Natural and artificial soil hazard areas. (reloc. 7-12-05)

- d. The date of all fieldwork was performed and a list of references and other supportive data used. (orig. 10-25-05)

3. Approval

The Geotechnical Report shall be approved by the County Engineering Geologist prior to the proposed development's approval. (orig. 10-25-05)

E. Geotechnical Plans

1. Preparation

- a. The Geotechnical Plans shall be prepared and signed by a qualified professional engineer,

registered in the State of Colorado, and qualified in the field of geotechnical engineering. (reloc. 7-12-05; am. 10-25-05)

- b. Plans for engineered structures shall be prepared and signed by a professional engineer, registered in the State of Colorado, and qualified in the field of civil engineering. (reloc. 7-12-05)
- c. Plans shall assure that soil and bedrock factors affecting the planning, design, construction, operation, and maintenance are recognized, adequately interpreted, and presented for use in engineering practice. (am. 7-12-05; am. 10-25-05)

2. Content

- a. Alternative and solutions to abate and/or minimize the adverse soil and bedrock conditions on structures. (reloc. 7-12-05)
- b. The entity/entities that will implement the plan, construct required improvements, and be responsible for the maintenance of the improvements and appropriate easements, if any. (reloc. 7-12-05)

3. Approvals

The Geotechnical Plan(s) shall be approved by the County Engineering Geologist prior to the proposed development's approval. (reloc. 7-12-05; am. 10-25-05)