COLORADO
Oil & Gas Conservation Commission
Department of Natural Resources

COGCC Operator Guidance

Rule 304.b.(7).I. GEOLOGIC HAZARD MAP/304.c.(21) GEOLOGIC HAZARD PLAN

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304.b.(7).I. Geologic Hazard Map. A map identifying any Geologic Hazards within a 1 mile radius of the proposed Working Pad Surface. For any identified Geologic Hazard that extends beyond the 1 mile radius, a second map scaled to show the extent of that Hazard in relation to the proposed Oil and Gas Location.

304.c.(21) Geologic Hazard Plan. If the Operator identifies any Geologic Hazards pursuant to Rule 304.b.(7).I, the Operator will submit a Geologic Hazard plan describing proposed mitigation measures.

Geologic Hazard is defined in § 24-65.1-103(8), C.R.S.

Purpose of Attachments

The purpose of the Geologic Hazard Map and the Geologic Hazard Plan is to protect public health, safety, welfare, the environment, and wildlife resources by:

1. Identifying the existence (or confirming the non-existence) of Geologic Hazards proximate to a proposed Oil and Gas Location;
2. Considering those hazards and the risks they may pose to a proposed Oil and Gas Location and the surrounding landscape;
3. Determining ways to avoid, minimize, and/or mitigate the hazards to ensure any related risk to all proposed operations is minimal or nonexistent;
4. Demonstrating that Oil and Gas operations at the proposed Oil and Gas Location will not be impacted by Geologic Hazards; and
5. Demonstrating that Oil and Gas operations at the proposed Oil and Gas Location are sufficiently protective of public health, safety, welfare, the environment, and wildlife resources despite the existence of a known Geologic Hazard.

A Geologic Hazard Map is required to be attached to a Form 2A, Oil and Gas Location Assessment (Form 2A), pursuant to Rule 304.b.(7).I.

A Geologic Hazard Plan is required to be attached to a Form 2A by Rule 304.c.(21) ***only if*** potential Geologic Hazards are identified through the preparation of the Geologic Hazard Map. If no hazards have been identified through the preparation of the Map, the Plan is not required.

Operators may also submit a Geologic Hazard Map or Plan as requested by the Director, or to seek approval to update an existing map or plan, via the Form 4, Sundry Notice (Form 4).

Operators who wish to request a Lesser Impact Area exemption from the Director should refer to the Rule 304.d Lesser Impact Area Guidance document. ***Any Lesser Impact Area Exemption Request for the Geologic Hazard Map or the Geologic Hazard Plan MUST be certified by a Professional Geologist*** (see item "L" in General Notes below).

Requirements

Geologic Hazard Map:
The Geologic Hazard Map will be a portable data file (PDF) attachment that may have multiple pages. The Map attachment will include one or more maps, a list of sources used during the Geologic Hazard review process, and a certifying statement from a Professional Geologist ("PG") (see General Notes and Definitions below).

1. The Geologic Hazard Map will include a topographic map or current aerial photo, scaled to optimize the visibility of the Oil and Gas Location and the surrounding landscape out to a 1-mile radius. The Map will include:
    a. An outline of the Working Pad Surface ("WPS") of the Oil and Gas Location;
    b. A 1-mile radius around the WPS;
    c. All Geologic Hazards identified within the 1-mile radius (see General Notes and Definitions below);
    d. A scale bar;
    e. A north arrow;
    f. A legend of all symbols to identify pertinent features and identified Geologic Hazards; and
    g. A title block that identifies the Operator's name, Oil and Gas Location name, location identification (quarter/quarter, section, township, range, principal meridian, county), and any other relevant Location information.
2. For any identified Geologic Hazard that extends beyond the one mile radius, a second map is required, scaled to show the extent of that hazard in relation to the proposed Oil and Gas Location.
    a. If the Geologic Hazard is of a scope so large (ex: a floodplain continues upstream and downstream for many miles, etc.) that the scale of the corresponding map causes the Location to become effectively "lost" on the map, the entire Geologic Hazard should not be shown. Select a reasonable map area that displays the Location and surrounding area beyond the 1-mile radius, and indicate the direction(s) that the hazard continues off the map;
    b. This second map will be included as an additional page in the overall Map attachment; do not submit two separate attachments.
3. If Geologic Hazards are identified but are determined to pose minimal or no risk to the proposed Oil and Gas Operations or Location:

a. Include all of the identified Geologic Hazards on the map(s) along with a clarifying statement that the hazard poses minimal or no risk to the proposed Oil and Gas Operations or Location and that the Operator will either submit a Geologic Hazards Plan or request a Lesser Impact Area exemption;
b. Provide a self-certification statement describing how this determination was made (see item #5.a.i in this list, below);

4. The Geologic Hazard Map will include a list of specific sources and reference materials used to identify, review, and prepare the Geologic Hazard Map.
    a. If field work, unmanned aerial drone work, or other physical reconnaissance occured, provide the date of the work, the name of the person who conducted the work, and a brief summary of any transects or observations that were made;
    b. If electronic information was reviewed, provide the web address and the date accessed.
5. The Geologic Hazard Map will be prepared, or endorsed, and self-certified by a Professional Geologist ("PG") as defined by C.R.S. 23-41-208 (b) (see General Notes and Definitions below). The Map will include one of the following certification statements from the PG:
    a. OPTION 1 - NO SIGNIFICANT HAZARDS IDENTIFIED: "I certify that I am a Professional Geologist, having met the educational requirements and professional work experience required by C.R.S. § 23-41-208(b). I have reviewed information pertaining to this Oil and Gas Location and the surrounding area, and have identified no Geologic Hazards within a one mile radius";
        i. If a hazard was identified but was determined to pose no risk to the Location or its Operations, the PG will use this certifying statement. The use of this statement will also certify the supplemental information required by item #3 in this list (above).
        ii. Written information may be included directly on the map page, or included as subsequent pages in the attachment; it may also include photos, cross-sections, or other maps if helpful to aid in the review.
    b. OPTION 2 - SIGNIFICANT HAZARDS IDENTIFIED: "I certify that I am a Professional Geologist, having met the educational requirements and professional work experience required by C.R.S. § 23-41-208(b). I have reviewed information pertaining to this Oil and Gas Location and the surrounding area, and have identified the following Geologic Hazards:" (enter list of Hazards);
    c. The self-certification statement will be signed and dated by the PG;
    d. The PG's title will be included in the signature;
    e. The self-certification statement does not require a PG stamp or seal for endorsement. The PG may provide professional credentials including a resume, curriculum vitae, PG registration or licensure in another state as evidence of qualifications for the minimum work experience requirement listed in Colorado statutes. Colorado currently does not license or register PGs. A PG licensed or registered in another state should not stamp or seal the geologic hazards map since it is outside applicable jurisdiction.

Rule 304.b.(7).I and Rule 304.c.(21) GUIDANCE

Geologic Hazard Plan:
If Geologic Hazards are identified during the review and preparation of the Geologic Hazard Map (Rule 304.b.(7).I.), the Operator will submit a Geologic Hazard Plan pursuant to Rule 304.c.(21). The Geologic Hazard Plan will include the following components:

1. For each Geologic Hazard identified, provide the following information:
    a. A description of what the hazard is (include the approximate areal extent, any identified surface features, recent geologic history of hazard occurrence, and whether the geologic hazard is considered active or inactive, etc.);
    b. Any additional maps, photos, or information to help illustrate the Geologic Hazard and it's spatial relationship to the proposed Oil and Gas Location;
    c. A detailed assessment describing any impacts that may occur at the Oil and Gas Location or interruptions to the Operations performed at that Location due to the identified geologic hazards;
    d. A statement describing how these potential impacts were assessed or how the risk determination was made;
    e. A simple estimate of the level of risk associated with the hazard, in terms of ***very low, low, moderate, high, or very high*** (ex: a mapped shallow subsurface fault directly under the Location that has had no historic recorded measurable seismic activity may be low risk, whereas steeply-dipping topography with multiple recent rock falls or landslides immediately adjacent to the Location may be very high risk);
    f. A detailed assessment and description of the Operator's intent and ability to avoid, minimize, and/or mitigate the Geologic Hazard during every phase of operations. This should not simply be a list of best management practices ("BMPs"); this should be a thoughtful and scientifically-based assessment demonstrating how various technologies, practices, measures, or other means undertaken by the Operator will address any potential impacts, minimize risk, and reduce the likelihood that the Geologic Hazard will threaten public health, safety, welfare, the environment, or wildlife resources as related to the proposed Oil and Gas Location and any Operations that may occur there; and
    g. A detailed contingency plan that describes the Operator's response if the Geologic Hazard does impact the Oil and Gas Location.
2. The Geologic Hazard Plan will include a list of specific sources and reference materials used to prepare the Plan.
    a. If field work, unmanned aerial drone work, or other physical reconnaissance occured, provide the date of the work, the name of the person who conducted the work, and a brief summary of any transects or observations that were made;
    b. If electronic information was reviewed, provide the web address and the date accessed.
3. The Geologic Hazard Plan will include a list of site-specific BMPs to address how the Operator plans to minimize or mitigate identified Geologic Hazard(s).

   a. A Professional Engineer with a background in geological engineering should design these BMPs, but a stamp or seal from the Engineer is not necessary;
   b. BMPs will be copied/pasted into the associated Form 2A (or Form 4) by OGLA staff during technical review.
4. The Geologic Hazard Plan will include a summary that presents the PG's opinion as to whether or not the oil and gas Location can be safely developed. This summary should include a discussion whether the Geologic Hazard(s) can be sufficiently minimized or mitigated to allow for development, or if the Location should not be developed.
5. The Geologic Hazard Plan will be prepared or endorsed by a PG as defined by C.R.S. 23-41-208 (b). The PG must review the final Plan and provide the signed self-certification statement as an endorsement. The Plan will include the following self-certification statement from the PG:
   a. "I certify that I am a Professional Geologist, having met the educational requirements and professional work experience required by C.R.S. § 23-41-208(b). I certify that the Geologic Hazard Plan described herein is, to the best of my knowledge, accurate and complete."
   b. The endorsement certification statement will be signed and dated by the PG;
   c. The PG's title will be included in the signature;
   d. The self-certification statement endorsement does not require a PG stamp or seal. The PG may provide professional credentials including a resume, curriculum vitae, or reference PG licensure or registration in another state as evidence that they meet the minimum work experience criteria in the Colorado statute. Colorado does not currently license or register PGs. A PG licensed or registered in another state should not stamp or seal the geologic hazards plan since it is outside applicable jurisdiction.

General Notes

The following notes are provided to assist Operators in the development of the Geologic Hazard Map and Plan. This is not a comprehensive list of action items to follow, rather, it is intended to give additional support for the process, and clarify some key points of both documents.

A. The COGCC GIS Online Interactive Map provides non-exhaustive information that can be used to identify Geologic Hazards in the vicinity of potential Oil and Gas Locations. These map layers should not be the sole source of information reviewed for the purposes of creating either the Geologic Hazard Map or Plan, but can be a good place to start. Access the interactive map at http://cogcc/maps.html#/gisonline. Center the map on the proposed Location and click on the following layers for preliminary review of Geologic Hazards:
   - Geology - Find the Geology folder near the bottom of the layers list in the left sidebar. Select either the 250K Geology Map or 500K Geology Map (Tweto 1979) to assess Geologic units in the vicinity of the Oil and Gas Location. The 250K Geology Map also shows the presence of mapped faults and folds which may help

in identifying potential Geologic Hazards. Additionally, an Earthquakes (1973-Present) layer, a Colorado Geological Survey ("CGS") Landslides layer, and a 250K Geology Map Index are also presented in this folder, and should be reviewed for these Geologic Hazards in the vicinity of potential Oil and Gas Locations. Geology Map Legends are found on the COGCC home page under "Help" on the right hand margin of the page.

- Topography - The Topography folder is located below the Geology folder, and can aid in identifying steep slopes and other topographic features that may indicate the presence of Geologic Hazards that may adversely impact development of Oil and Gas Locations.
- Mining - The Mining folder is located above the Geology folder, and has various data from the Colorado Division of Reclamation, Mining and Safety ("DRMS"), CGS, and other mining features throughout the state.

B. In addition to the Geology and Topography layers on the COGCC GIS Online Interactive Map, other Geographical Information System (GIS) data, including digital geologic maps published by the USGS, CGS, or other sources may be helpful in identifying Geologic Hazards near proposed Oil and Gas Locations.
C. Review soil surveys prepared by the Natural Resources Conservation Service (NRCS) and soil map unit description for information about hydric, erodible, expansive, collapsible soils (hydrocompaction) that may affect construction, or corrosive soils that may affect steel or concrete. Corrosive soils have implications for cathodic protection requirements on well casings, cement, flowlines, pipelines, footings, or subsurface structures.
D. Evaluate areas for potential flooding, flash floods, slope failure, and debris flows. A Flood Shut-In Plan consistent with Rule 304.c.(9) and the requirements of Rule 421.b.(1) is required for these areas. Areas with less potential for flooding may still require permanent stormwater controls such as diversion ditches. Drainage pipes may be required for slopes covered with unconsolidated materials.
E. Evaluate areas for bedrock faults, seismic activity, and earthquakes. The potential for seismicity or induced seismicity should be evaluated for proposed Oil and Gas Locations and specific placement of Facilities. If faults are identified, the Geologic Hazard Map and Plan should indicate if they are considered active or inactive, estimate of when faults were last active, whether the fault trace is visible at the surface, the dip angle, the relative fault displacement (i.e. upthrown block, downthrown block, or arrows showing direction of movement), and lateral displacement distance.
F. For areas with steep slopes, potential for rockfall or landslides, or steeply dipping bedrock, include strike and dip measurements for bedrock outcrops on the map, or include the percent grade of the natural slope.
G. Evaluate any potential for naturally occurring radioactive materials (NORM) and technologically-enhanced naturally occurring radioactive materials (TENORM) to be present at the proposed Location, and discuss the implications for E&P Waste generation and disposal. Radon levels may need to be considered for Locations that will have structures occupied by Operator personnel or contractors, or potential exposures to public health, safety, welfare, the environment, and wildlife.

H. For Oil and Gas Locations in historic abandoned coal mining areas, include a description of potential mine subsidence and any known history of the stability, structure, or relevant information about the mine.

I. For proposed Centralized E&P Waste Management Facilities (Rule 907.b.(7).A), the facility design and engineering data should incorporate BMPs, including plans and elevations, design basis, calculations, geologic data including, but not limited to: the type and thickness of unconsolidated sediment and soils; type and thickness of bedrock; if applicable, local and regional Geologic structures; and any Geologic Hazards that may affect the design and operation of the facility. Refer to guidance documents for Centralized E&P Waste Management Facilities for more information.

J. Onsite field studies, geotechnical subsurface investigations, or other surveys may need to be performed on selected Oil and Gas Locations to assess potential Geologic Hazards, or to develop site-specific minimization and mitigation BMPs.

K. Staff encourages Operators to employ a Professional Engineer ("PE") with a background in geological engineering for the development of structural mitigation measures or BMPs within hazardous geologic conditions; however, a PE is not required.

L. Lesser Impact Area Exemption Request - If the PG determines that there are no Geologic Hazards within a 1-mile radius of the Oil and Gas Location, or, determines that Geologic Hazards do not pose a risk, the Operator may request an exemption from the Director under Rule 304.d. for the Geologic Hazards Map.
    - The PG must provide a summary of the materials reviewed, and provide clear evidence that the hazard does not exist, or does not pose a threat. The PG must also include a certifying statement (see above), signature, and date. This summary, evidence, and certification must be submitted as part of the Lesser Impact Area Exemption Request.
    - If the Geologic Hazard Map indicates no hazards exist, or the Lesser Impact Area exemption request is granted for the Map, the Geologic Hazard Plan is NOT REQUIRED per Rule 304.c.(21). Do not request a Lesser Impact Area exemption for the Plan if the Plan is simply not required.
    - If the Geologic Hazard Map indicates Geologic Hazards exist, the Operator may request a Lesser Impact Area exemption for the Geologic Hazard Plan. However, it is important to note that requesting an exemption from the Plan, when Geologic Hazards have been identified, will require extraordinarily well-supported documentation and rationale as provided by the PG, as evidence that any potential impacts due to the hazard will be so minimal as to pose no concern. See Rule 304.d.

M. The Relevant Local Government may have additional or different requirements, standards, qualifications, and definitions that pertain to preparation of Geologic Hazard reports and soil suitability assessments for development. Report authors and applicants should be familiar with all federal, state, and local land use codes, policies, and regulations related to Geologic Hazards or soil suitability reports to ensure compliance.

N. Substantially Equivalent Information - If a Geologic Hazard Map or Plan (or substantially equivalent document) was developed in conjunction with a Relevant Local Government

permit process, the Operator may submit that document as "Substantially Equivalent" pursuant to Rule 304.e.

O. A geologic map may be a useful supplement to either the Geologic Hazard Map or Plan.

Definition

GEOLOGIC HAZARD is defined in § 24-65.1-103(8), C.R.S.:

> Colorado Revised Statute (C.R.S.) 24-65.1-103(8): *"Geologic Hazard means 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, safety, or to property. The term includes, but is not limited to: avalanches, landslides, rockfalls, mudflows, and unstable or potentially unstable slopes; seismic effects; radioactivity; and ground subsidence."*
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> Staff notes that Geologic Hazards may also include debris fans, earthquakes, faults, expansive, collapsible, or corrosive soils, siltation, and floodplains. This definition is not meant to be exclusive, and should consider any potential Geologic Hazard that may adversely impact the proposed development.
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> Staff also notes that geologic features named on this list may not need to be recognized as "Geologic Hazards" if their properties do not constitute a significant hazard to public health, safety, or property.

Frequently Asked Questions

1. Why do the Geologic Hazard Map, Plan, and Lesser Impact Area Exemption requests for Geologic Hazards need to be prepared, or approved and certified by a Professional Geologist?
    a. According to C.R.S. § 23-41-208 "Any report required by law or by rule and prepared as a result of or based on a Geologic study or on Geologic data, or which contains information relating to geology and which is to be presented to or is prepared for any state agency, political subdivision of the state, or recognized state or local board or commission, shall be prepared or approved by a Professional Geologist." Therefore, the Geologic Hazard Map and Geologic Hazard Plan must be prepared by a Professional Geologist [C.R.S. 23-41-208(b)].
2. What is the definition of a PG?
    a. Pursuant to C.R.S. 23-41-208(b) : "A Professional Geologist is a person engaged in the practice of geology who is a graduate of an institution of higher education which is accredited by a regional or national accrediting agency, with a minimum of thirty semester (forty-five quarter) hours of undergraduate or graduate work in a field of geology and whose postbaccalaureate training has been in the field

of geology with a specific record of an additional five years of Geological experience to include no more than two years of graduate work."

b. Staff recognizes that the statutory definition of Professional Geologist does not currently imply the requirement for a professional licensure or registration.

General References

Jochim et al, 1988, "OF-03-16 Critical Landslides of Colorado," Colorado Geologic Survey Bulletin 48, 1 plate (1:50,000)

Johnson, J.D., and J.W., Himmelreich, Jr., 1998, "IS-47 Geologic Hazards Avoidance or Mitigation: A Comprehensive Guide to State Statutes, Land Use Issues, and Professional Practice in Colorado," Colorado Geological Survey, p. 186., 8 appendices

Kirkham, R.M., 1978, "OF-78-03 Earthquake Potential in Colorado: A Preliminary Evaluation Colorado," Geological Survey, Digital PDF download.

Muckel, G.B. 2004, "Understanding Soil Risks and Hazards, Using Soil Survey to Identify Areas with Risks and Hazards to Human Life and Property," United States Department of Agriculture, Natural Resources Conservation Service, National Soil Survey Center, Lincoln, Nebraska, p. 94; https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/16/nrcs143_019308.pdf

Noe, D.C., 1997, "SP-45 Heaving-Bedrock Hazards, Mitigation, and Land-Use Policy: Front Range Piedmont, Colorado," Colorado Geological Survey, p. 11, (Reprinted article from Environmental Geosciences, Vol. 4, No. 2)

Nuhfer, E.B., Proctor, R.J., Moser, P.H.,1993, "MI-57 The Citizens' Guide to Geologic Hazards: A Guide to Understanding Geologic Hazards, Including Asbestos, Radon, Swelling Soils, Earthquakes, Volcanoes, Landslides, Subsidence, Floods, and Coastal Hazards," Westminster, CO: The American Institute of Professional Geologists

Rogers, W.P., Ladwig, L.R.,Hornbaker, A.L., Schwochow, S.D., Hart, S.S., Shelton, D.C., Scroggs, D.L., and Soule, J.M.,1979, "SP-06, Guidelines and Criteria for Identification and Land-Use Controls of Geologic Hazard and Mineral Resource Areas," Colorado Geologic Survey, p. 157, 32 Figures, 7 Tables, one Appendix.

Shelton, D.C. and Prouty D., 1979, "SP-12, Nature's Building Codes: Geology and Construction in Colorado," Colorado Geological Survey, p. 72., 8 appendices.

Stover, B.K., 1992, "MS-27 Surficial Geology and Geologic Hazards of the Douglas Pass-Baxter Region, Rio Blanco and Garfield Counties, Colorado," Colorado Geologic Survey, 1 plate (1:24,000) Corresponding Open File Reports, OF-86-02, OF-86-03, and OF-86-04.

Resources

Colorado Division of Homeland Security and Emergency Management, About DHSEM | Division of Homeland Security and Emergency Management (colorado.gov)
Colorado Emergency Management Office Emergency Management Office | Division of Homeland Security and Emergency Management (colorado.gov)
Colorado Geological Survey, Hazards - Colorado Geological Survey
Colorado Geological Survey, HAZUS HAZUS - Colorado Geological Survey
Colorado Geological Survey, Land Use Review Land Use Review - Colorado Geological Survey
United States Geological Survey, Geologic Hazards Science Center (usgs.gov)