

GEOLOGIC HAZARDS HOTCHKISS-PAONIA RESERVOIR AREA DELTA AND GUNNISON COUNTIES, COLORADO

Colorado Geological Survey
Department of Natural Resources
State of Colorado
John W. Roid, Director

by WALTER R. JUNGE
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GENERAL DESCRIPTION

The valley along the North Fork Gunnison River from Hotchkiss to Paonia Reservoir is likely to experience in the near future a rapid population growth caused by increased coal mining. To aid planning for this anticipated growth, geologic conditions in the area were studied and mapped in accordance with House Bill 1041 (C.R.S. 1973, 24-65.1-101, et seq.) to determine areas of geologic hazard that could cause an economic loss or affect the safety of the citizens of Colorado. The mapped units used in this study conform to the terms and definitions given in Colorado House Bill 1041 and in the Colorado Geological Survey's "Guidelines and Criteria for Identification and Mineral Resource Areas" (Rogers and others, 1974). As defined in House Bill 1041, a 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 and safety or to property." These geologic hazards, which are normal dynamic processes, may be intensified or lessened by human activity. Regardless of the intensity, the hazards should be recognized and considered prior to any land-use changes.

SUGGESTIONS TO MAP USERS

Potentially hazardous geologic conditions are mapped at 1:24,000 in six contiguous 7.5-minute quadrangles, including Hotchkiss, Gray Reservoir, Bowie, Paonia, Somerset, and Paonia Reservoir. These maps show only the most severe geologic hazard in a specific area. Additional geologic conditions, which may affect a certain land use, may be present locally.

The accompanying Explanation of Map Units and the Geologic Hazards Assessment for Common Land Uses should be consulted when using these maps. The Explanation of Map Units is a description of the process that affects a certain area and the Geologic Hazards Assessment for Common Land Uses is an estimation of the degree of hazard for a specific land use and description of conditions affecting the hazards. The degree of hazard will vary depending on the particular land use. Landslides, for example, may be a serious constraint to high-density residential development, whereas recreational areas may be only slightly affected. The geologic hazard maps and accompanying descriptions and explanations are not intended as a detailed analysis of a particular site or land use, and should not be used in place of detailed field investigations of specific areas. We recommend that these maps serve as a basis for further, detailed investigations such that the safety and feasibility of specific projects can be adequately evaluated.

EXPLANATION OF MAP UNITS

- ls₁** **ls₂** **ls₃** **Landslide Area:** an area formed by and susceptible to the moderate to rapid downward and outward movement of rock and/or soil where there is a surface of rupture or zone of weakness that separates the landslide mass from more stable underlying material. These landslide areas include earthflows, translational slides, rotational slides, and debris slides. Man-caused disturbance of the landslide areas could initiate additional instability and mass movement of part or all of the slide mass. This mass movement could damage or destroy structures and could affect adjacent downslope areas. Relative age of the landslide areas is indicated by subscripts (1 is the youngest).
- mf** **Mudflow Area:** an area subject to the rapid downslope movement of wet, viscous masses of fine-grained material following mobilization of the material by intense rainfall or snowmelt runoff. Mobilization usually includes the erosion and transport of poorly consolidated surficial materials that have accumulated in a drainage basin and its channels. Mudflows are a potential danger for most development activities.
- da** **Debris Avalanche Area:** an elongate chute-like area susceptible to the very rapid sliding and flow of unsorted mixtures of soil and rock material down relatively steep slopes. Debris avalanche areas form during periods of intense rainfall and may cover gentle slopes below the steep source areas. Debris avalanches are very hazardous for many land uses.
- rf** **Rockfall Area:** an area subject to rapid, intermittent, nearly unpredictable rolling sliding, or free-falling of detached bedrock of any size from a cliff or very steep slope. Rockfall areas most commonly occur on sparsely vegetated slopes with jointed bedrock cliffs. Rockfalls may adversely affect residential or commercial development.
- df₁** **df₂** **Debris Flow Area:** a triangular-shaped area resulting from the accumulation of water-transported rock, soil, and vegetation debris usually at the confluence of a tributary stream with a larger drainage. Debris movement and accumulation generally is associated with rapid flows that are caused by intense rainfall. Relative age of the debris flows are indicated by subscripts (1 is the youngest). The youngest debris flow areas (Qdf) usually are very hazardous locations for the works of man.

- sfc₁** **sfc₂** **sfc₃** **Slope Failure Complex Area:** an area formed by various types of mass-wasting processes such as landslides, mudflows, rockfalls, and soil creep. These areas generally are unstable and the advisability of their development should be determined only after detailed geotechnical studies. The age of movement within these areas usually varies; however, the general age of this unit is indicated by subscripts (1 is the youngest).
- us** **Unstable Slope:** a slope where mass movement may have occurred and where recent movement is not apparent or is uncertain. These slopes generally are characterized by landslide or soil-creep physiography and may be susceptible to landslide, earthflow, mudflow, or accelerated-creep processes, especially if disturbed. Construction on these slopes should be carefully evaluated prior to any development.
- pus** **Potentially Unstable Slope:** a slope which currently is in equilibrium and where past or present mass movement of the soil or rock is not apparent. Physical attributes, such as composition of surficial and bedrock materials or slope inclination and aspect, are similar to nearby areas that have failed. Accordingly, these slopes may be susceptible to mass-movement failures if they are disturbed.
- pfp** **Physiographic Flood Plain Area:** a flat, relatively smooth area adjacent to and formed by a river in its present regimen. The flood plain may be covered by water during flood stages and is susceptible to the adverse affects of erosion and sedimentation; e.g., undercutting, slumping, scour, and infilling. Any construction within the flood plain could raise the level of flood waters and should be very carefully evaluated to determine if flood waters will adversely affect the construction site or adjacent areas. Flash flood areas have not been shown on the map; however, all major drainages in the area are prone to water and debris flooding as well as attendant erosion and sedimentation.
- sf** **Sheet-Flow Flooding and Erosion Area:** an area subject to the overland flow of runoff that spreads as a relatively thin, continuous, uniform sheet of water over a relatively large, nearly planar area. Sheet flows cause erosion and deposition of fine-grained materials and commonly occur on terraces, alluvial fans, and in valley-fill areas. Proper construction techniques usually can minimize or abate any potentially adverse affects.
- ph** **Potential Hydrocompaction Area:** an area which may be subject to the downward displacement of the ground surface by collapse of certain low-density, weak soils after wetting. Excessive wetting from irrigation, broken water lines, surface ponding, or drainage diversions can cause hydrocompaction. A soils foundation investigation should be made to determine the severity of this hazard and ascertain construction design parameters.
- es** **Expansive (Swelling) Soil or Rock Area:** an area containing clays that expand significantly upon wetting and shrink upon drying. The Mancos Shale and surficial deposits derived from it are especially prone to such changes in volume. Expansive soil or rock may cause structural damage to buildings, roads, and pipelines and should be evaluated by a soils and foundation engineering investigation.

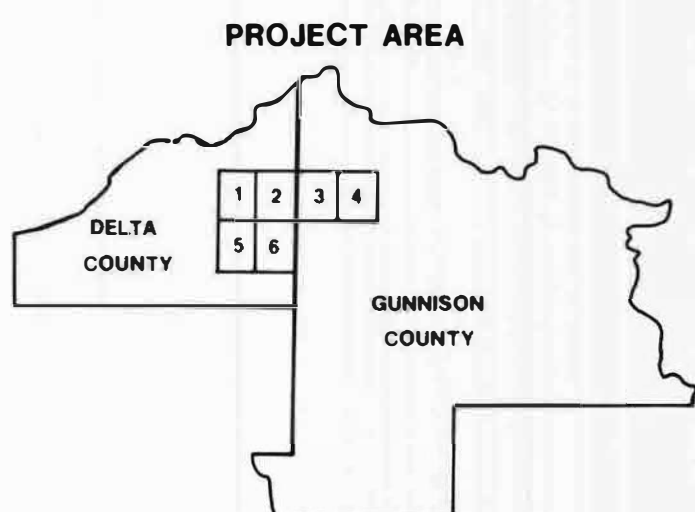
MAP SYMBOLS

- Map unit contact
- Debris avalanche (Qda): may correspond with snow avalanche track in mountainous areas.
- Recent landslide scarp: hachures point in the direction of landslide movement.
- Potential Mine Subsidence Area: an area susceptible to ground-surface displacement caused by collapse of underground mining voids. The maps show only those areas undermined before 1978. Subsidence effects could extend outward from these areas in the future from increased coal mining. Construction should be undertaken only after a geotechnical investigation determines the possible extent of mining and the potential for future ground movement.

REFERENCES

- Dunrud, C. R., 1976, Some engineering geologic factors controlling coal mine subsidence in Utah and Colorado: U.S. Geol. Survey Prof. Paper 969, 39 p.
- Junge, W.R., 1978, Surficial and bedrock geology, Hotchkiss-Paonia Reservoir area, Delta and Gunnison Counties, Colorado: Colo. Geol. Survey open-file rept. 78-4.
- Rogers, W.P., et al, 1974, Guidelines and criteria for identification and land-use controls of geologic hazard and mineral resource areas: Colo. Geol. Survey Spec. Pub. 6, 146 p.
- Soule, J.M., 1976, Geologic hazards in the Crested Butte-Gunnison area, Gunnison County, Colorado: Colo. Geol. Survey Info. Series 5, 34p.

INDEX MAP



7-1/2' Quadrangles

1. Gray Reservoir
2. Bowie
3. Somerset
4. Paonia Reservoir
5. Hotchkiss
6. Paonia

Drafting by: Susan Soukup

GEOLOGIC HAZARDS ASSESSMENT FOR COMMON LAND USES

	Land Use						Activity					
	Residential Development		Commercial / Industrial Development		Roads	Utilities	On-Lot Effluent Disposal	Agriculture / Ranching	Open Space / Recreation			
	High Density	Low Density	High Density	Low Density								
Landslide (ls), Slope Failure Complex (sfc)	4 ABCH	4 ABCH	4 ABCH	4 ABCH	4 ABCH	3 ABCH	4 AC	1 CD	2 AD			
	HAZARD MITIGATION WITHOUT CAREFUL PLANNING AND DESIGN; PROHIBITIVELY EXPENSIVE	FEASIBLE ONLY WITH ELABORATE AND EXPENSIVE MITIGATION MEASURES	USUALLY REQUIRES ELABORATE AND EXPENSIVE MITIGATION MEASURES	USUALLY REQUIRES ELABORATE AND EXPENSIVE MITIGATION MEASURES	HAZARD MITIGATION WITHOUT CAREFUL PLANNING AND DESIGN; HIGH MAINTENANCE COSTS	NOT FEASIBLE WITHOUT CAREFUL PLANNING AND DESIGN; VERY HIGH MAINTENANCE COSTS	FEASIBLE; EXPLOSIVE WATER MAY REACTIVATE LANDSLIDE	USUALLY FEASIBLE; PROBLEMS EXCEPT FOR BUILDINGS SHOULD BE CAREFULLY SELECTED	COMMONLY FEASIBLE; BUILDING SITES SHOULD BE CAREFULLY SELECTED			
Unstable Slope (us)	4 ABCH	4 ABCH	4 ABCH	4 ABCH	4 ABCH	3 ABCH	4 AC	1 CD	2 AD			
	HAZARD MITIGATION USUALLY IS NECESSARY AND MAY BE PROHIBITIVELY EXPENSIVE	NOT FEASIBLE WITHOUT CAREFUL PLANNING AND DESIGN	NOT FEASIBLE WITHOUT CAREFUL PLANNING AND DESIGN	NOT FEASIBLE WITHOUT CAREFUL PLANNING AND DESIGN	HAZARD MITIGATION WITHOUT CAREFUL PLANNING AND DESIGN; HIGH MAINTENANCE COSTS	HAZARD MITIGATION WITHOUT CAREFUL PLANNING AND DESIGN	NOT FEASIBLE WITHOUT CAREFUL PLANNING AND DESIGN; LANDSLIDES MAY BE REACTIVATED	USUALLY FEASIBLE; PROBLEMS EXCEPT WHERE DETCH LEAKAGE CAUSES MASS-WASTING	COMMONLY FEASIBLE; MAINTENANCE COSTS LIKELY			
Potentially Unstable Slope (pus)	3 BCEH	3 BCEH	3 BCEH	3 BCEH	2 BCEH	3 AC	1 CDE	1 DE				
	NOT FEASIBLE WITHOUT CAREFUL PLANNING AND DESIGN; MITIGATION MAY BE EXPENSIVE	MAY BE FEASIBLE WITH CAREFUL PLANNING AND DESIGN	USUALLY FEASIBLE WITH CAREFUL PLANNING AND DESIGN	USUALLY FEASIBLE WITH CAREFUL PLANNING AND DESIGN	HAZARD CAN BE MITIGATED WITH CAREFUL PLANNING AND DESIGN	HAZARD CAN BE MITIGATED WITH CAREFUL PLANNING AND DESIGN	MAY BE FEASIBLE WITH CAREFUL PLANNING AND DESIGN	USUALLY FEASIBLE; PROBLEMS EXCEPT IN AREAS OF INTENSE CULTIVATION ON STEEP SLOPES	TYPICALLY NO DIFFICULTIES			
Rockfall (rf), Debris Avalanche (da)	4 ABD	4 ABD	2 ABD	4 AB	3 AB	1	1	3 AD				
	FEASIBLE ONLY WITH ELABORATE AND EXPENSIVE MITIGATION; HIGH MAINTENANCE COSTS	HAZARD MITIGATION IS NECESSARY AND MAY BE PROHIBITIVELY EXPENSIVE	HAZARD MITIGATION IS NECESSARY AND MAY BE EXPENSIVE	HAZARD MITIGATION IS NECESSARY; USUALLY VERY HIGH MAINTENANCE COSTS	USUALLY FEASIBLE; HIGH MAINTENANCE COSTS	USUALLY FEW OR NO PROBLEMS	USUALLY FEW OR NO PROBLEMS	USUALLY FEW OR NO PROBLEMS EXCEPT BUILDING SITES SHOULD BE CAREFULLY SELECTED	COMMONLY FEASIBLE; BUILDING SITES SHOULD BE CAREFULLY SELECTED			
Mudflow (mf), Debris Fan (df)	4 CDEFH	4 CDEFH	3 CDEFH	4 CDFH	3 CEFH	1	2 CEF	3 CDEF				
	FEASIBLE ONLY WITH ELABORATE AND EXPENSIVE MITIGATION; HIGH MAINTENANCE COSTS	FEASIBLE ONLY WITH ELABORATE AND EXPENSIVE MITIGATION; HIGH MAINTENANCE COSTS	NOT FEASIBLE WITHOUT CAREFUL PLANNING AND DESIGN; MITIGATION MAY BE EXPENSIVE	FEASIBLE ONLY WITH ELABORATE AND EXPENSIVE MITIGATION; HIGH MAINTENANCE COSTS	HAZARD MITIGATION WITHOUT CAREFUL PLANNING AND DESIGN; HIGH MAINTENANCE COSTS	USUALLY FEW OR NO PROBLEMS	USUALLY FEW OR NO PROBLEMS; BUILDING SITES SHOULD BE CAREFULLY SELECTED	COMMONLY FEASIBLE; MAINTENANCE COSTS				
Physiographic Flood Plain (pfp)	4 FH	4 FH	4 FH	3 FH	3 F	4 C	2 F	3 F				
	SEVERE HAZARD AREA; HYDROLOGIC DETERMINATION NECESSARY	SEVERE HAZARD AREA; HYDROLOGIC DETERMINATION NECESSARY	SEVERE HAZARD AREA; HYDROLOGIC FLOOD PLAIN DETERMINATION NECESSARY	HAZARD MITIGATION DIFFICULT AND EXPENSIVE; ORANGE-PHON AREA	HAZARD MITIGATION DIFFICULT AND EXPENSIVE; DAMAGE-PRONE AREA	COMMONLY NOT FEASIBLE; PRODUCTION OF NEAR-SURFACE GROUND-WATER	COMMONLY FEASIBLE; MAINTENANCE COSTS	COMMONLY FEASIBLE; MAINTENANCE COSTS	COMMONLY FEASIBLE; MAINTENANCE COSTS			
Sheet Flow (sf)	3 DFH	3 DFH	3 DFH	2 DFH	2 DF	4 C	1	1 F				
	HAZARD MITIGATION NOT DIFFICULT; MINIMAL DRAINAGE STUDY NECESSARY	HAZARD MITIGATION NOT DIFFICULT; MINIMAL DRAINAGE STUDY NECESSARY	HAZARD MITIGATION NOT DIFFICULT; MINIMAL DRAINAGE STUDY NECESSARY	COMMONLY FEASIBLE; PERIODIC MAINTENANCE COSTS MINIMAL; LOCAL DRAINAGE STUDY NECESSARY	COMMONLY FEASIBLE; PERIODIC MAINTENANCE COSTS MINIMAL; LOCAL DRAINAGE STUDY NECESSARY	HAZARD MITIGATION WITHOUT CAREFUL PLANNING AND DESIGN	TYPICALLY NO DIFFICULTIES	TYPICALLY NO DIFFICULTIES	TYPICALLY NO DIFFICULTIES			
Expansive Soil (es), Potential Hydrocompaction (ph)	3 CH	3 CH	3 CH	2 CH	2 C	3 C	1	1				
	FEASIBLE WITH SPECIAL CONSTRUCTION TECHNIQUES; SOIL AND FOUNDATION STUDIES NECESSARY	FEASIBLE WITH SPECIAL CONSTRUCTION TECHNIQUES; SOIL AND FOUNDATION STUDIES NECESSARY	FEASIBLE WITH SPECIAL CONSTRUCTION TECHNIQUES; SOIL AND FOUNDATION STUDIES NECESSARY	USUALLY FEASIBLE WITH CAREFUL PLANNING AND DESIGN	COMMONLY FEASIBLE WITH CAREFUL PLANNING AND DESIGN	MAY BE FEASIBLE WITH CAREFUL PLANNING AND DESIGN	TYPICALLY NO DIFFICULTIES	TYPICALLY NO DIFFICULTIES	TYPICALLY NO DIFFICULTIES			
Potential Mine Subsidence (pms)	4 G	4 G	4 G	3 G	4 G	2 G	2 G	1 G				
	MAY NOT BE FEASIBLE; RELATED SURFACE DISRUPTION NEARLY UNPREDICTABLE	MAY NOT BE FEASIBLE; RELATED SURFACE DISRUPTION NEARLY UNPREDICTABLE	MAY NOT BE FEASIBLE; RELATED SURFACE DISRUPTION NEARLY UNPREDICTABLE	SUBSIDENCE RELATED SURFACE DISRUPTION NEARLY UNPREDICTABLE	MAY NOT BE FEASIBLE; RELATED SURFACE DISRUPTION NEARLY UNPREDICTABLE	COMMONLY FEASIBLE; SUBSIDENCE MAY DISRUPT DISPOSAL SYSTEM	COMMONLY FEASIBLE; SUBSIDENCE MAY DISRUPT DISPOSAL SYSTEM	COMMONLY FEASIBLE; SUBSIDENCE MAY DISRUPT DISPOSAL SYSTEM	COMMONLY FEASIBLE; SUBSIDENCE MAY DISRUPT DISPOSAL SYSTEM			

Explanation of Chart Symbols

Degree of Hazard	Conditions Affecting Hazard
4 HIGH: DETAILED GEOTECHNICAL STUDIES NECESSARY TO DETERMINE IF AREA IS COMPATIBLE WITH PROPOSED LAND USE	A HAZARD ESPECIALLY SEVERE ON STEEP SLOPES
3 MODERATE: DETAILED GEOTECHNICAL STUDIES NECESSARY DURING PLANNING STAGES	B OVERSTEEPENING OR CUTTING OF SLOPES CAN INCREASE HAZARD
2 LOW: GEOTECHNICAL STUDIES MAY BE NECESSARY DURING PLANNING STAGES	C ARTIFICIAL OR NATURAL INCREASE IN GROUND MOISTURE CAN INCREASE HAZARD
1 VERY LOW: GEOTECHNICAL STUDIES COMMONLY NOT NECESSARY	D REMOVAL OF NATURAL VEGETATION CAN INCREASE HAZARD
	E HAZARD MAY DECREASE AS SLOPE INCREASES
	F HAZARD RELATED DIRECTLY TO METEOROLOGICAL EVENTS
	G HAZARD RELATED TO COAL EXTRACTION
	H DISTURBANCE OF NATURAL DRAINAGE SYSTEM CAN INCREASE HAZARD

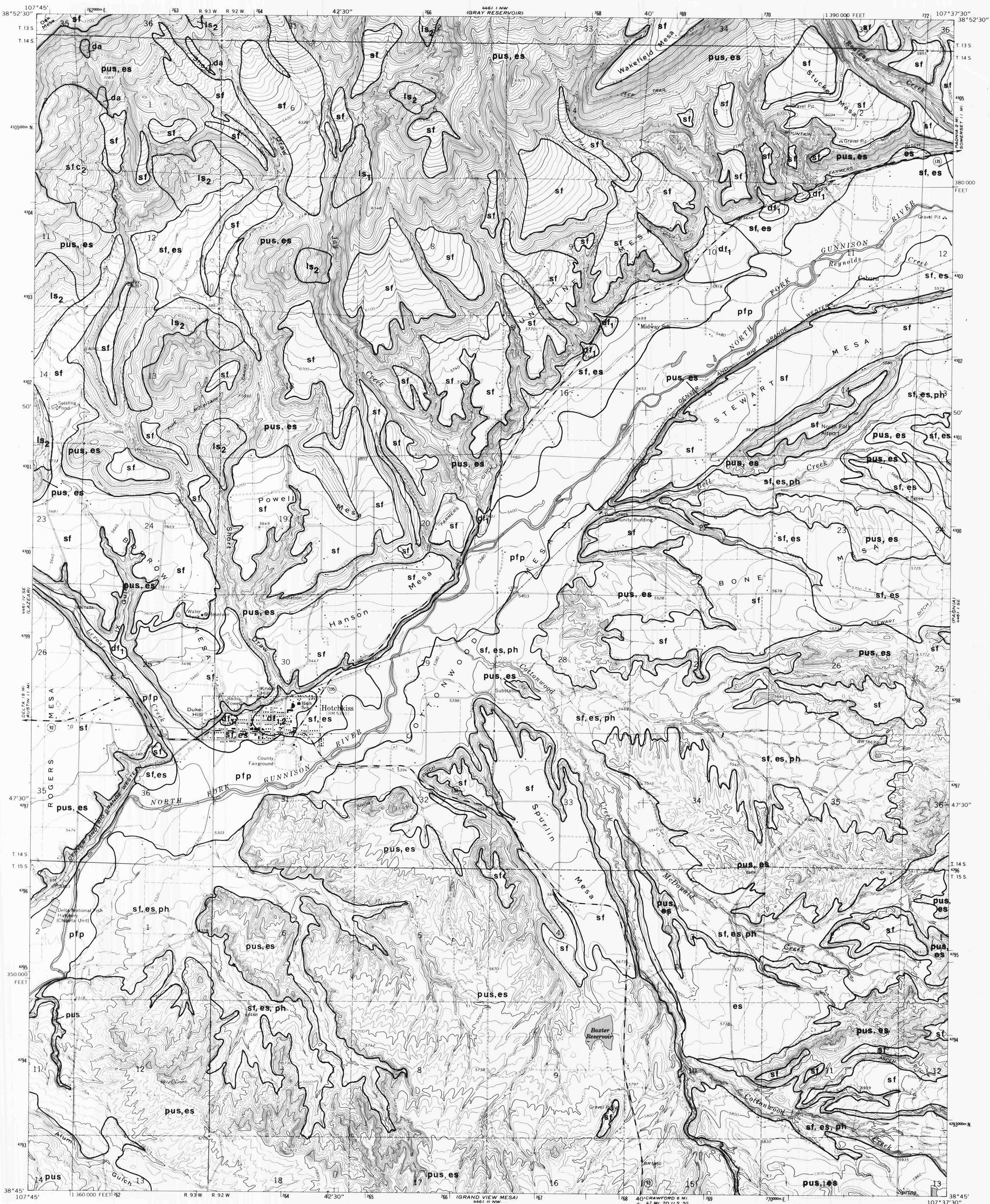


BASE FROM U.S. GEOLOGICAL SURVEY
7½-MINUTE QUADRANGLE.



GEOLOGIC HAZARDS MAP OF THE
PAONIA RESERVOIR QUADRANGLE
BY
WALTER R. JUNGE
1978

CGS OF-78-12
PLATE 4 OF 7
EXPLANATION OF MAP IS PLATE 7



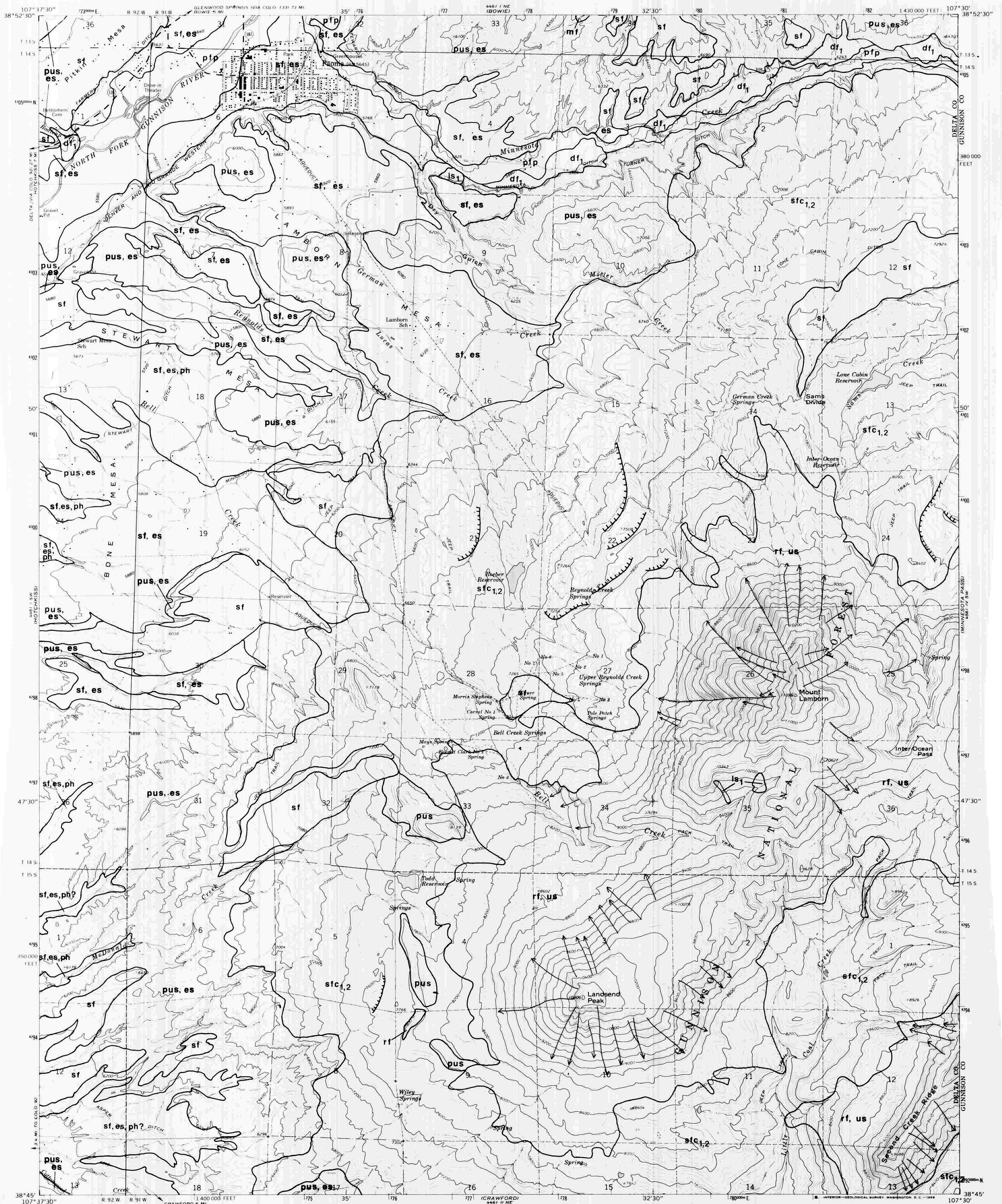
BASE FROM U.S. GEOLOGICAL SURVEY
7½-MINUTE QUADRANGLE.



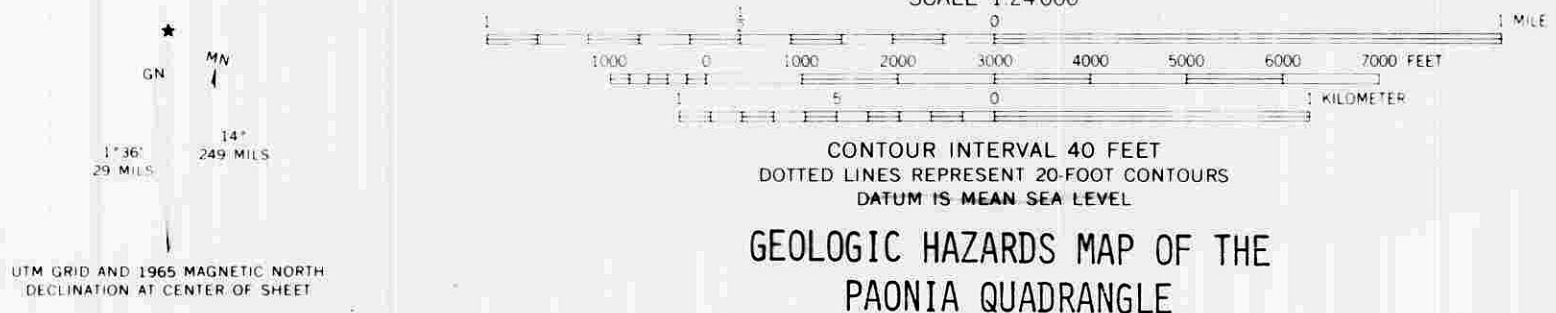
GEOLOGIC HAZARDS MAP OF THE
HOTCHKISS QUADRANGLE

BY
WALTER R. JUNGE
1978

CGS OF-78-12
PLATE 5 OF 7
EXPLANATION OF MAP IS PLATE 7



BASE FROM U.S. GEOLOGICAL SURVEY
7½-MINUTE QUADRANGLE.



GEOLOGIC HAZARDS MAP OF THE
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CGS OF-78-12
PLATE 6 OF 7
EXPLANATION OF MAP IS PLATE 7