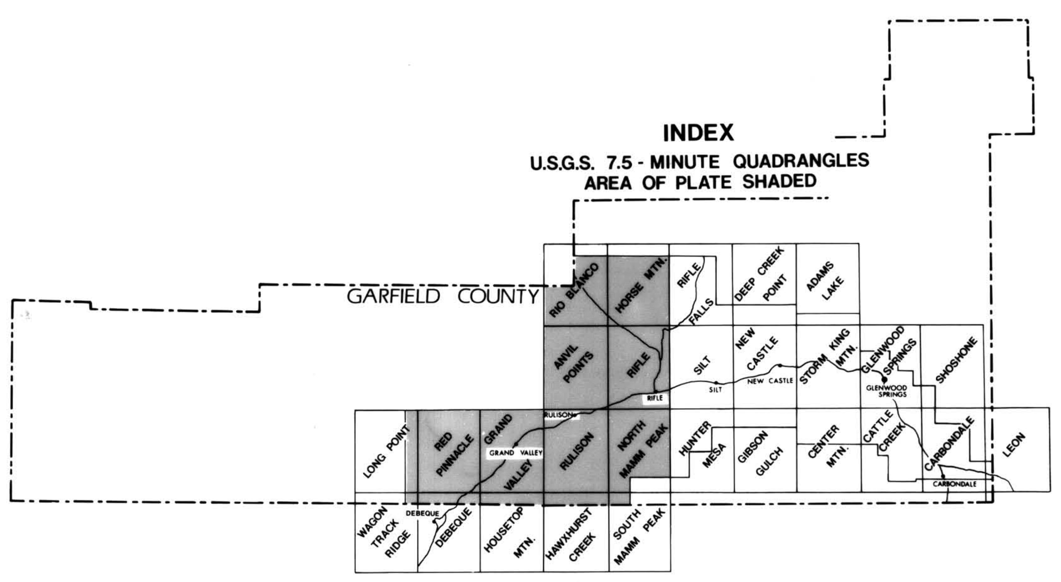
Open-File Report 85-1
Plate 1A
1985
Colorado Geological Survey
Department of Natural Resources
John W. Rold, Director

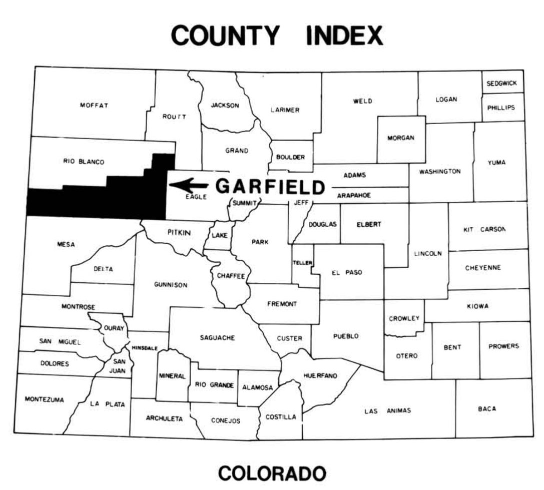
See Plate 1C, 2C, 4C for Explanation

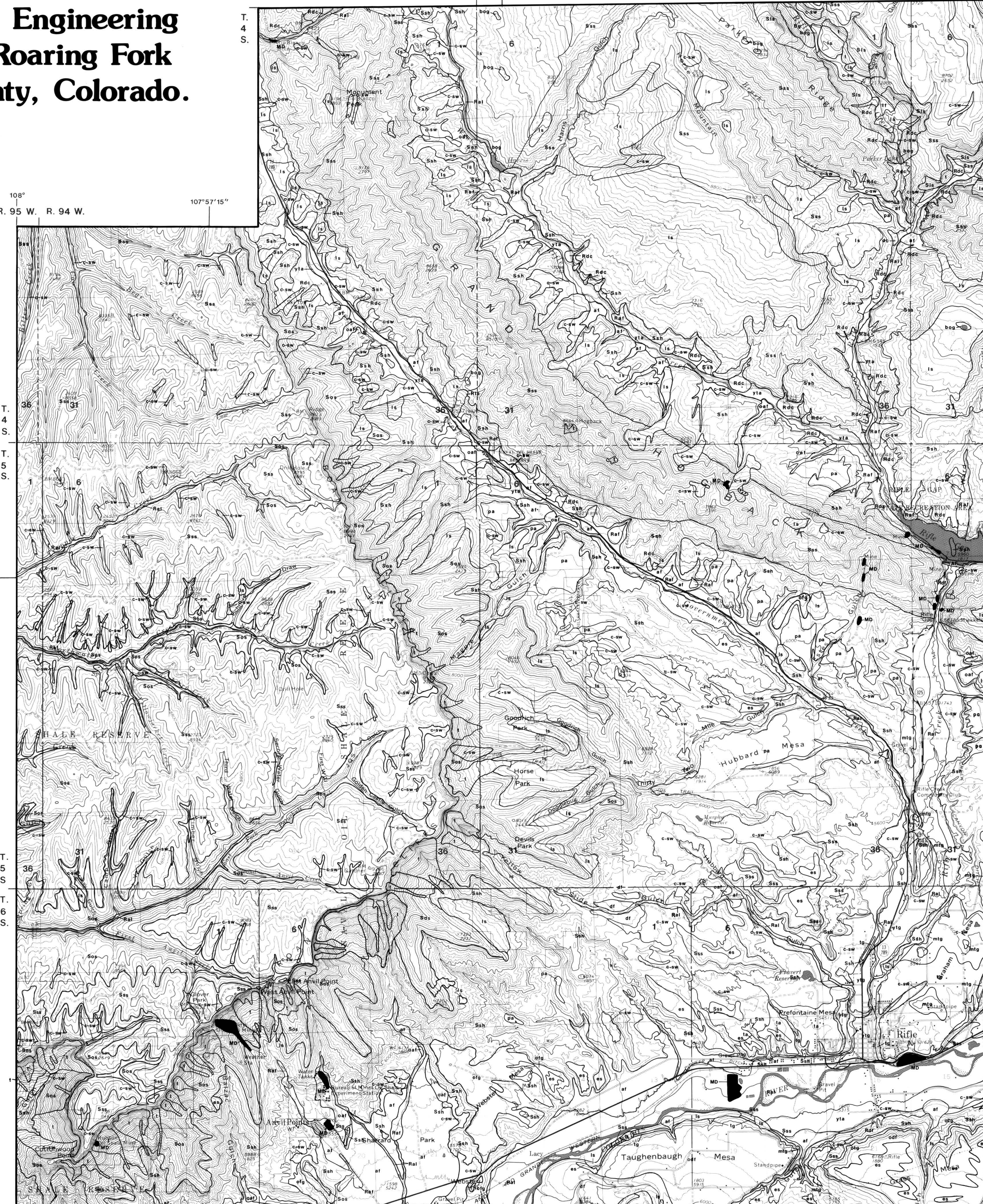
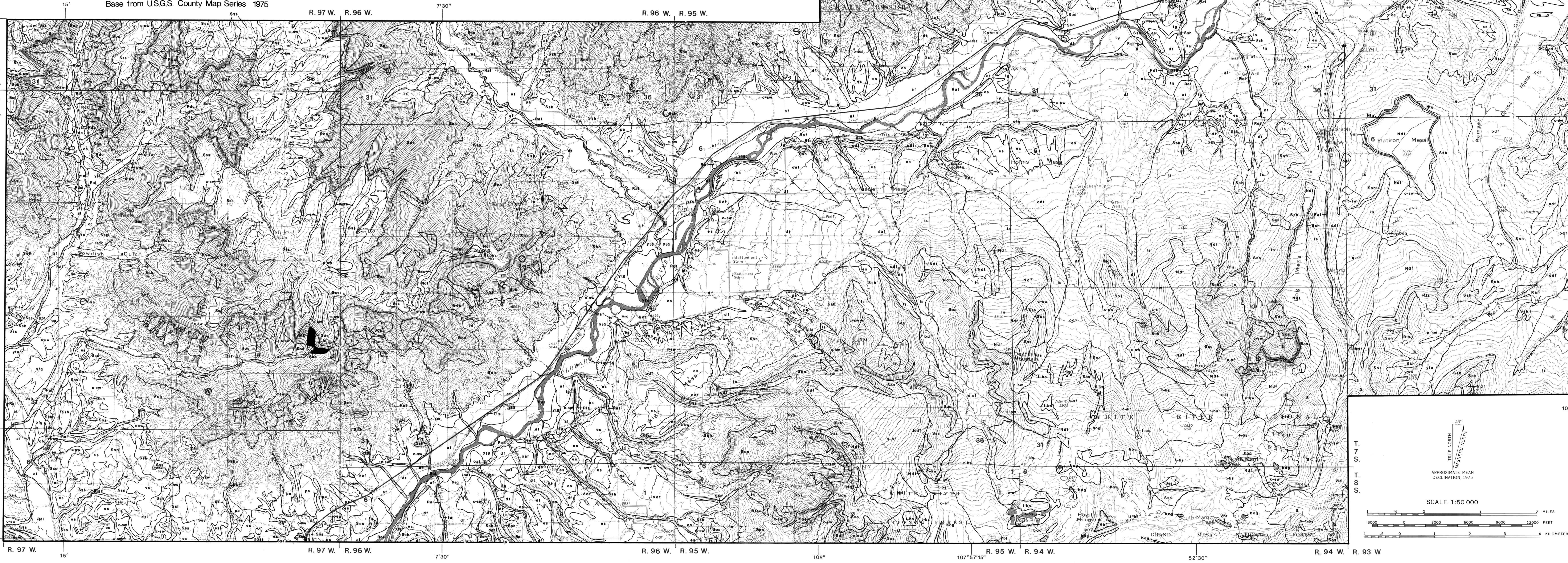
Surficial Geology, Geomorphology, and General Engineering Geology of Parts of the Colorado River Valley, Roaring Fork River Valley, and Adjacent Areas, Garfield County, Colorado.

SURFICIAL - GEOLOGIC MAP

BY B.K. STOVER AND J.M. SOULE





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SURFICIAL - GEOLOGIC MAP EXPLANATION

All surficial deposits are Pleistocene or Holocene unless indicated otherwise.

Alluvial and other water-laid deposits

Ral Recent Floodplain Alluvium -- Gravels composed of clay, silt, sand, and cobble-to-boulder-size clasts in the modern, active floodplains of streams. These alluviums are composed typically of sound, slightly weathered materials whose composition is controlled by the extent of the drainage basin of the stream(s) containing them. Areas underlain by them are subject to episodic water flooding and rapid water transport of solids and seasonally high ground water tables.

ytg Younger Terrace Gravels and Alluvium -- Alluvium composed predominantly of stream gravels in terraces immediately adjacent to and typically 5 to 20 ft above modern-stream floodplains. Except for position these materials closely resemble recent floodplain alluvium. Young terraces usually show little dissection by modern streams, have poorly developed or immature soils on them, and are composed of virtually unweathered clasts.

tg Terrace Gravels and Alluvium -- These deposits are similar in all respects to younger terrace gravels and alluvium except that they typically lie 20 to 100 ft above modern floodplains and clasts are slightly more weathered owing to greater time since deposition. Surface soils on these deposits are better developed than those on ytg.

mtg Middle Terrace Gravel -- This gravel is mapped approximately 350 ft above the modern Colorado River. This gravel is distinguishable from those in lower terraces by elevation, degree of weathering of clasts, and better developed, older soils on terrace surfaces.

ta Terrace Alluvium -- Deposits of fine overbank-flooding-derived silts, sands, and clays with occasional sand and cobble lenses in terraces. These deposits are widely dispersed in terraces and can be seen to cap gravel deposits of mtg or tg in many places.

yta Younger Terrace Alluvium -- Younger terrace alluvium has the same character as terrace alluvium except that it usually occurs in the youngest terraces of major tributary streams to the Colorado River excepting the Roaring Fork River at Glenwood Springs. Includes some areas of dissected arroyo fill of smaller tributaries.

otg Old High Level Colorado River Terrace Gravels -- These are deposits that are 300 ft or more above the modern Colorado River. These gravels are greatly weathered with an abundance of calcium-carbonate-coated rotted clasts. Only very resistant lithologies, i.e. quartzites, remain sound.

Ntg Neogene Terrace Gravels -- Clasts found in colluvium and float that are interpreted as the remains of ancient stream gravels found up to 2000 ft above the modern Colorado River valley. Gravels are preserved only where buried by Neogene debris flow deposits (Ndf). Only the most resistant lithologies are seen, original sedimentary structures are obscured or destroyed by weathering and mass wasting, and exposures of these gravel consist mostly of rounded, transported pebbles and cobbles admixed with colluvium derived from other deposits. These rounded pebbles and cobbles can be traced upslope to an abrupt band of pebble-rich colluvium which marks the level of the terrace deposit.

oal Old Alluvial Deposits -- These are stream-derived deposits in high ancient stranded drainages out of the modern drainage regime. Weathering and erosion of these alluviums has typically destroyed their geomorphic expression and they are usually seen as rounded clasts as "float" in colluvium and slope wash. Includes old alluvium in older valleys west of Silt.

Raf Recent Alluvial-fan Deposits -- Deposits formed by activity on modern alluvial fans during flash-flood events usually occurring during heavy summer rainstorms. These deposits consist of clay, sand, silt, subangular gravels, and boulders of rock types derived from the drainage basin of the associated stream. These materials accumulate as triangular or fan-shaped landforms at the confluence of steep, confining side canyons with larger stream valleys.

af Alluvial-fan Deposits -- These deposits are essentially identical to recent alluvial-fan deposits except that their associated alluvial fan exhibits dissection by its master stream. This entrenched stream does not indicate an inactive fan surface, but merely one where smaller flood and debris-flow events and movement of debris probably will be confined to an established stream channel. Larger debris-flow or water- and debris-flood events can result in water and debris escaping the channel at the debris-fan head or further down fan. Then movement out onto the fan surface can result in unconfined deposition of these deposits on part or all of the alluvial fan.

oaf Old Alluvial-fan Gravel -- Deposits of older alluvium that are remnants of ancient alluvial fans whose morphology has been modified by subsequent stream down cutting and erosion. Some of the original fan morphology may be preserved. These deposits have been isolated above the modern stream regime by stream down cutting.

ofg Older Fan Gravels and Alluvium -- Gravel deposits that are highly dissected or buried by other materials and do not exhibit alluvial-fan morphology. These deposits are distinguished by clasts derived from an associated, identifiable drainage basin and an elevated position with respect to younger deposits of similar origin.

pa Pediment Alluvium -- Deposits consisting of clay, sand, silt, and subrounded to angular cobbles and fragments of underlying bedrock that are found on gently sloping upland surfaces planated by lateral corrosion of the underlying bedrock. This alluvium typically ranges from 5 to 25 ft thick and is commonly veneered with thin deposits of eolian sand and silt mixed with fine grained sheetwash deposits. These deposits may grade laterally into thicker alluvial-fan gravels.

lf Lakefill Deposits -- Interbedded, locally derived sand and clay deposits filling small lake basins formed by glacial processes or landslide dams.

bog Bog and Peat Deposits -- Soft, organic-rich deposits in poorly drained areas, depressions, and sag-pond areas. This unit also includes areas of locally high seasonal ground water tables where organic matter may accumulate.

Colluvial and related deposits

t Talus and Scree Deposits -- Coarse, angular, unconsolidated debris derived from bedrock outcrops and/or exposures; found at the base of steep cliffs, in steep chutes, and mantling steep side slopes and gullies.

t-bs Boulder Streams and Fields -- Course, angular and blocky unconsolidated basalt boulders derived from disintegration and mass wasting of basalt flows. Includes extensive areas strewn with basalt boulders and rubble, rock glaciers and toreva blocks of basalt peripheral to Battlement Mesa.

Rtc Active Talus Cone -- A steeply sloping cone shaped deposit of loose rock rubble usually located on steep valley side slopes below bedrock cliffs from which the rock rubble is derived. Rockfall activity is occurring on the deposits and steep slopes.

ls Landslide or Slump Deposits -- Slope failure deposits, including some areas of soil creep or earth flowage, that are formed by rotational or translational movement downslope of residium and/or rock.

Rls Active Landslide -- Landslide deposits that can be demonstrated to be moving episodically or continuously at the present time.

dc Debris Cone -- Small, steep cone-shaped deposits of poorly sorted debris derived from multiple downslope flows of loose rock, soil debris, and boulders on steep valley side slopes and in gullies. Distinguished from talus cones by presence of fine-grained, matrix-supported clasts in the deposits, and from debris fans by size, position on side slopes, and slope angle.

Rdc Active Debris Cone -- The same type of deposit as debris cone but one that is continuing to form presently.

Rdf Recent or Active Debris Fans -- Active debris fans are those that are an element of the modern stream regime and episodically are undergoing deposition of mud and debris on them. They are distinguished from recent alluvial fans by composition, grading, and surface texture of the debris deposits. Most of these features are located where small tributary drainages in steeply sloping areas join floodplains and terraces of major drainages. The deposit is visually triangular-shaped in plan, commonly has large boulders strewn on it, and may show evidence, such as damaged vegetation, of activity during the last few years.

df Debris-flow Deposit -- Pleistocene material of debris-flow origin forming larger weakly dissected debris fans located on terrace of larger modern streams. These deposits closely resemble Rdf except for being slightly more weathered. The associated debris-fan-forming stream commonly is depositing the newest debris on the smaller debris fan whereas the larger df is out of the direct influence of the modern stream channel.

odf Ancient Debris-flow Deposits -- These deposits are cut off from modern streams and drainage, are cross-cut by younger debris flows and other deposits and are isolated at least 400 ft above the modern Colorado River Valley floor. The diagnostic matrix-supported-clast texture of these deposits is preserved and observable in stream and road cuts. However, the debris-fan morphology that presumably these deposits once had has been greatly modified by subsequent mass wasting and erosion, and the deposits themselves exhibit considerable weathering and, depending on the lithology of clasts, variable rotting of them.

Ndf Neogene Debris-flow and Colluvial Deposits -- Deposits interpreted to be remnants of the oldest debris fans that were part of the pre-Quaternary landscape in the study area. The debris-fan morphology has been almost totally obliterated; the most observable evidence for the origin of these deposits is sedimentary structure, position in the modern landscape, and stratigraphic relationships to younger, identifiable debris flows.

c-sf Colluvial Slope Failure Complex -- Thick deposits of material that has undergone or is undergoing major mass movements. Most of these deposits are located at high elevations and/or on the high slopes of Battlement Mesa. No mass-wasting process appears to be predominant and these deposits consist of a mixture of landslides, slump blocks, boulder fields, and solifluction deposits. These deposits are usually over 50 ft thick ranging upward to 150 ft in a few places. This material is commonly the source material for the older large debris flows and may grade downslope to debris-flow deposits. Probably a major percentage of these deposits is undergoing slow movement presently. Distinguished from colluvium and slopewash deposits (c-sw) by their thickness and morphology.

c-sw Colluvium and Slopewash Deposits -- Pebble to cobble-size rock fragments in a sandy or clayey matrix deposited after downslope transport and sheetwash deposition of material from adjacent side slopes. Deposits over three feet thick in small valleys and swales and upland surfaces are mapped as this unit. In some areas these deposits are subject to hydrocompaction.

gc-s Gypsiferous Colluvial Material -- Colluvium composed of sand-to-clay-size fines that contain some gypsum and evaporite. These deposits are almost always subject to hydrocompaction.

Other Natural Deposits

es Wind-deposited Sand and Silt -- Reddish-brown loess usually found on the leeward sides of low hills, in stable dunes, and as a thin veneer on many upland surfaces. Mapped where greater than 3 ft thick but thinner deposits and deposits highly variable in thickness are widespread and necessitate a generalized map pattern for this unit in most places. Frequently modified by or obscured by agricultural beneficiation and non-native plants.

r Residuum -- Soil and surficial materials derived from weathering and pedogenesis of underlying bedrock. No discernable transport of them is apparent.

gd Glacial Drift -- Gravels composing mostly lateral, end, and ground moraines. Also includes related deposits and ice-contact landforms, such as eskers, fill terraces, and kame terraces.

go Glacial Outwash -- Gravels deposited by glacial melt waters. These gravels are essentially unweathered and clean and contain abundant igneous and metamorphic lithologies from the White River Uplift to the north of the studied area.

tuf Tufa and Tufa-cemented Gravel -- Calcium-carbonate-cemented gravels and deposits of calcium carbonate considered to be precipitated from ground water.

Man-Made Deposits

MD Mine Dump -- Deposits of waste-rock debris from mining operations. Includes coal-waste, spoils, uranium-mill tailings, spent-oil-shale dumps, and quarry pit and spoil.

Af Artificial Fill -- Man-made fill that includes dumps, trash, landfill areas, and larger earth dams. Fills for railroad grades and roads are not mapped.

Cr Clinkered Surface -- Red-to-orange burned and fractured soil, rock, and debris over coal-seam and coal-mine fires. The ground surface in these areas is usually unstable and prone to subside. Commonly these areas are pocked with subsidence craters.

Exposed Bedrock
(less than 4 ft of other deposits masking exposures)

S Bedded sedimentary rocks, undifferentiated.

Sss Bedded sedimentary rocks, sandstones predominate.

Ssh Bedded sedimentary rocks, shales predominate.

Sls Bedded sedimentary rocks, carbonate rocks predominate.

Sos Bedded sedimentary rocks, marlstones (oil shale) predominate.

Sco Bedded sedimentary rocks, pebble and cobble conglomerates predominate.

Sgr Sedimentary rocks, gypsiferous rocks and evaporites dominant Sinkholes in areas underlain by these rocks are indicated by the symbol

Landslide deposit. This unusual feature consists of sandstone and shale bedrock that apparently moved as a large bedrock slump. Exposures exhibit no preferred bedding orientation and the age of the causal event is unknown.

V Volcanic and intrusive igneous rocks, undifferentiated.

Vbsf Basalt lava flows.

Vis Intrusive rock.

Vip Intrusive plug or neck.

B Precambrian basement rocks, undifferentiated.

Bm Precambrian basement rocks, metamorphic rocks predominate.

Bg Precambrian basement rocks, granitic rocks predominate.

Symbols

Contact

Fault, bar and ball on downthrown side; dashed where inferred; dotted where concealed.

Sink hole.

GEOMORPHIC - FEATURES MAP EXPLANATION

Fluvial

TF Terraces and Floodplains -- Alluvial plains or nearly flat and level surfaces adjacent to principal streams. Includes modern flood plains, younger terraces immediately adjacent to streams, and higher, presumably older surfaces composed of floodplain alluvium unquestionably derived from an associated stream.

F Alluvial Fans and Aprons -- Deposits, commonly nearly triangular-shaped in plan, of stream-transported material usually consisting of silt-to-boulder-size clasts derived from the drainage basin of the stream that transported them. Individual alluvial fans may coalesce to form alluvial aprons. Alluvial fans mapped as Raf and parts of those mapped as af on the surficial geologic maps are active alluvium-deposition areas.

DF Debris Fans (small, young) -- Steep, cone-shaped deposits of debris-flow and/or mudflow-transported material usually found at the mouths of steep, narrow gullies where steep-gradient, first-order tributary drainages reach a stream confluence, floodplain, or terrace adjacent to a master, larger stream.

OFR Old Fan Remnants -- Areas underlain by surficial deposits of older, weathered alluvial-fan-derived sands and gravels that cap sloping, higher, and usually poorly dissected surfaces above and probably unrelated to modern drainages. The resulting landforms bear little resemblance, except for gross macroscopic composition and texture of the deposits themselves, to their probable original form. Only larger remnants are shown. Frequently covered by a veneer of loess up to 4 ft thick.

OTR Old Terrace Remnants -- Areas underlain by surficial deposits of older, weathered, stream-derived sands and gravels that are found high above modern streams. These are the remains of ancient floodplains that have been isolated above the modern stream regimen. As with old fan remnants, macroscopic composition and texture of the deposits themselves are their most diagnostic properties. Frequently covered by a veneer of loess up to 4 ft thick.

Colluvial

LDF Debris Fans (large, old) -- The "mesas" or relatively high, sub-horizontal to gently sloping surfaces and their contiguous sideslopes above the valley of the Colorado River. These surfaces are remnants of very large, presumably composite debris and alluvial fans that were formed by massive debris sliding and flowage during the Neogene and Quaternary. Subsequent erosion and slope failure along the sides of the surfaces, deposition of loess and eolian sand on them, lateral down wearing of originally rough surfaces, and local pedimentation and erosional modification have subsequently smoothed and altered the original form of these surfaces in most places. Also includes deposits of similar geologic materials without the distinctive form of LDF described above.

Ls Earthflows, Transitional Landslides, and Complex Slope-movement Features -- areas that have undergone mass slope movements during the Quaternary and/or that are undergoing such movements at the present time. These areas have distinctive hummocky topography, closed, poorly drained depressions, fresh or healed landslide scarps, and disrupted drainage. In the case of active slope failures, movement of man-made structures or cultural effects may be evident.

T Talus apron -- Larger accumulations of rock rubble below steep bedrock cliffs that are formed by repeated rockfalls and rock slides. Shown only in a generalized fashion in most areas. Only larger areas are shown.

Co Colluvial Aprons and Wedges -- Accumulations of material on or below moderate to steep slopes that have formed as the result of mass wasting of loose, poorly consolidated slope-derived debris from up-slope areas.

Erosional

E Sheet-Erosion Areas -- Areas subject to overland or sheet flooding of typically fine-grained alluvial and colluvial materials. Usually distinguished by absence of a well-defined drainage net and absence or disruption of climax vegetation. May be accelerated or greatly affected by modern overgrazing or high-intensity human land uses that damage or remove vegetation cover or disrupt surface drainage.

P Pediments -- Sub-horizontal to gently sloping, nearly flat surfaces planated on bedrock by lateral corrosion of weakly developed or weakly incised drainages lying out of the established, strongly developed drainage net of modern streams. Pediments are usually slightly concave surfaces of near-erosional equilibrium extending from the modern perennial-stream regime to higher retreating monadnocks, cuestas and/or mountain fronts. These bedrock exposures are the remains of pre-existing bedrock highs and extend gradually to higher mountainous areas. Pediments are usually covered with a thin veneer of alluvial gravel whose provenance is the underlying or nearby bedrock.

PR Pediment Remnants -- Relatively small areas, compared to active modern pediments, that are correlative and accordant in position (elevation). They are the remains of formerly extensive pediments. These areas are seen as sub-horizontal to gently sloping gravel-capped surfaces usually at some consistent elevation above younger pediment remnants and/or a modern pediment.

B Badlands -- Areas where modern stream, rill, and sheet erosion of soft, weakly resistant bedrock results in distinctive rounded and fluted low hills and cliffs. These areas are almost exclusively associated with the Wasatch Formation outcrop in places where erosional processes are rapid enough to degrade the bedrock outcrop. The products of erosion in these areas are usually deposited in or near badlands.

Bedrock

H Hogbacks -- Gently to steeply dipping bedrock exposures that form ridges adjacent to the White River Uplift. In the mapped area, hogbacks are the Grand Hogback and lower, less resistant exposures of sedimentary rocks. In places, owing to erosion-resistance variation in bedrock units and drainage development, these hogbacks may include badlands or other types of features.

Fl Volcanic Landforms -- Areas where extensive exposures or near-surface outcrops of extrusive volcanic rocks are the principal determinant of the shape of the land surface. Such areas are characterized by a nearly level to gently sloping land surface with bedrock at or near the surface, poorly incised to deranged drainage owing to the porous characteristics of underlying bedrock, and occasionally by blocky, rubbly bedrock exposures of volcanic rocks.

I Intrusive bodies -- Includes dikes, sills, and stocks. These are exposures of igneous rocks whose shape determines that of the land surface.

Br Undivided Bedrock Exposures -- Bedrock exposures whose form is not distinctive enough to fall in some other landform class.

Glacial

Gl Glacial landforms -- Undivided Glacial Landforms. Moraines, drift, and outwash deposits in Canyon Creek Valley and nearby areas.

Symbols

Contact

CONSTRUCTION - MATERIALS MAP EXPLANATION

Landform Classification

F Floodplain Deposits -- Sand and gravel of the active floodplains of modern streams. These materials are essentially unweathered and contain few large boulders.

T Stream-terrace Deposits -- Sand and gravel of stream terraces of modern streams. Most of these deposits are only lightly weathered and contain few large boulders. They are presently the most heavily exploited resource in the study area.

V Valley Fill -- Sand and gravel as F and T above combined for smaller streams.

U Upland deposits -- Predominantly pediment gravels composed of materials essentially the same as the underlying bedrock. Usually these deposits are thin, highly weathered, and because of the predominantly sandstone and shale bedrock in the region, are a low grade resource.

A Alluvial-fan deposits - Unsorted, ungraded cobble-to-boulder gravels with angular clasts derived from within drainage basins of usually small intermittent stream tributaries to major ancient or modern streams. These gravels usually contain a high percentage of fines, exhibit varying degrees of weathering depending on age of, activity on, and size of the associated alluvial fan. Clast lithologies can vary greatly from place to place depending on bedrock types present in a given drainage basin.

G Glacial Deposits -- Cobble-to-boulder gravels found in or near areas occupied by Pleistocene glaciers. Because of their relatively young geologic age, these deposits are essentially unweathered. Not heavily exploited at present, they are an excellent gravel resource in most places. Poor sorting of some tills containing large boulders may necessitate more crushing and processing of them than other deposits.

Resource Classification

1 Gravel--Relatively clean and sound.

2 Gravel--Significant fines, decomposed clasts, calcium carbonate or poorly rounded clasts.

3 Sand--Quality unevaluated.

4 Gravel--Unevaluated resource, significant properties as (2) above; may be a potential aggregate resource.

Quarry-Aggregate Resources

L Limestone--Quality unevaluated.

B Basalt--Quality of resource varies because of variable internal structures.

S Sliderock, Talus, and Boulder Fields-- comprises a potential rip-rap or aggregate resource of limestone or basalt.

Symbols

Contact--Depth of burial is not determined. Dashed contact indicates a buried or uncertain extent of deposit.

QUARRY Quarry

Gravel pit

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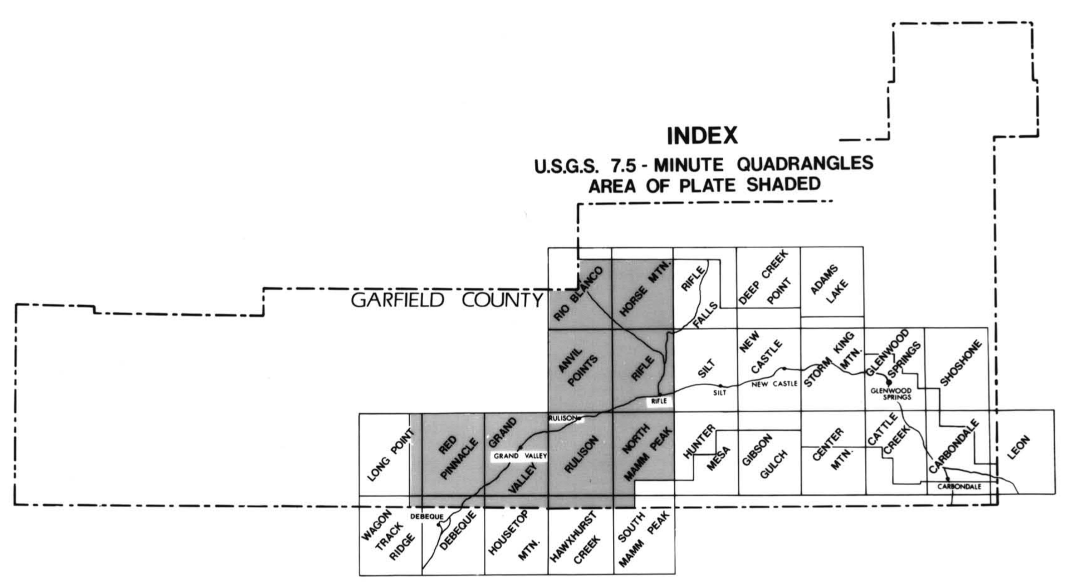

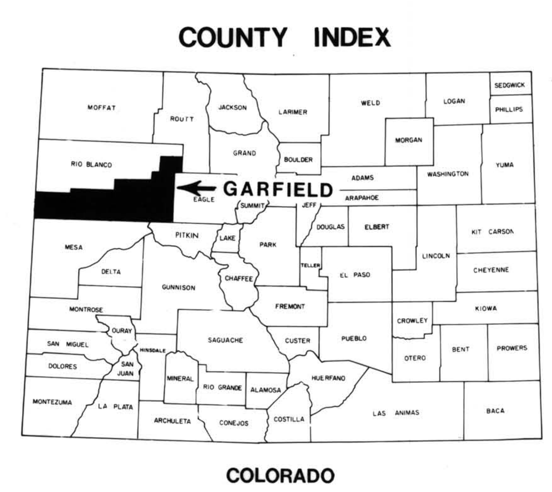

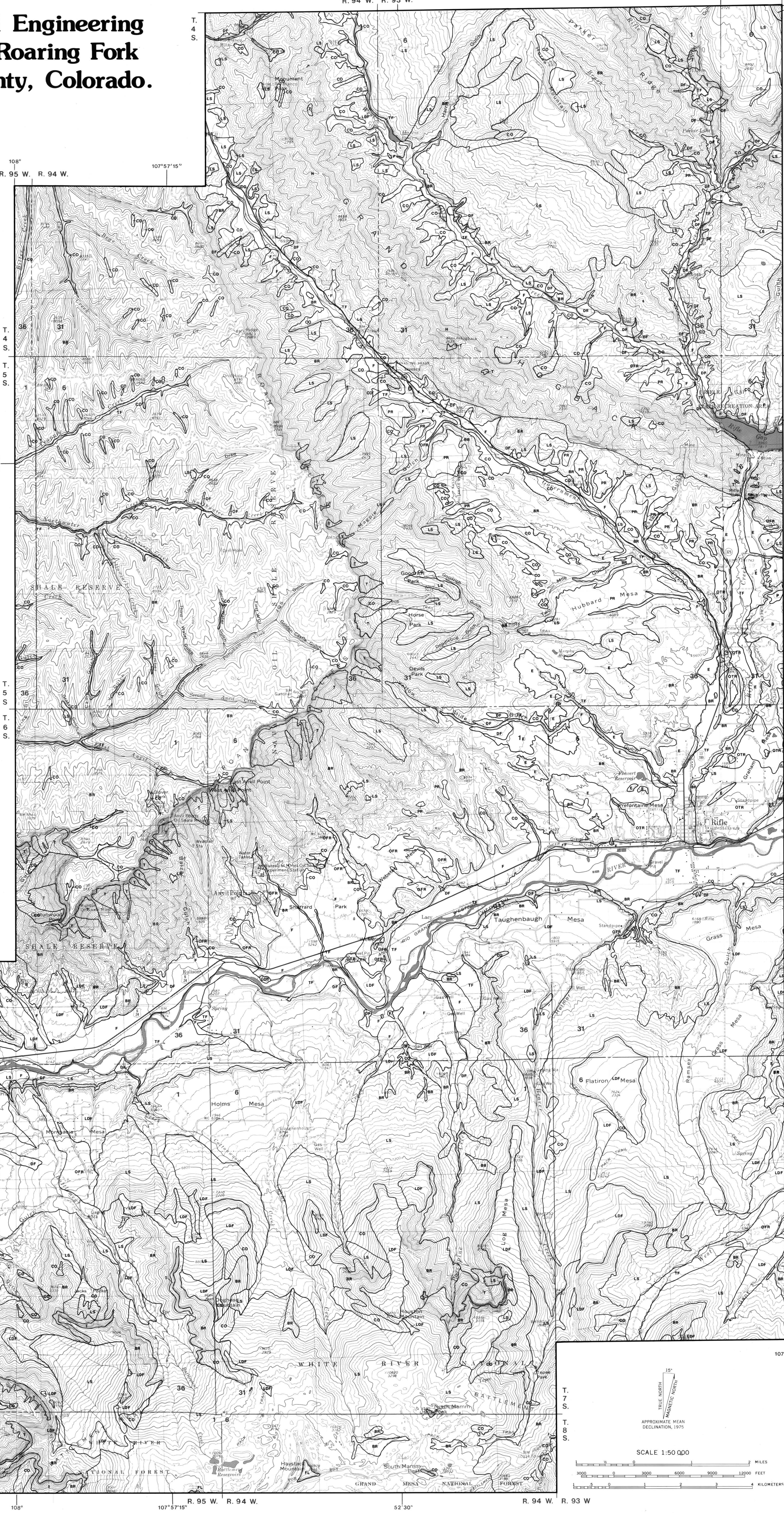
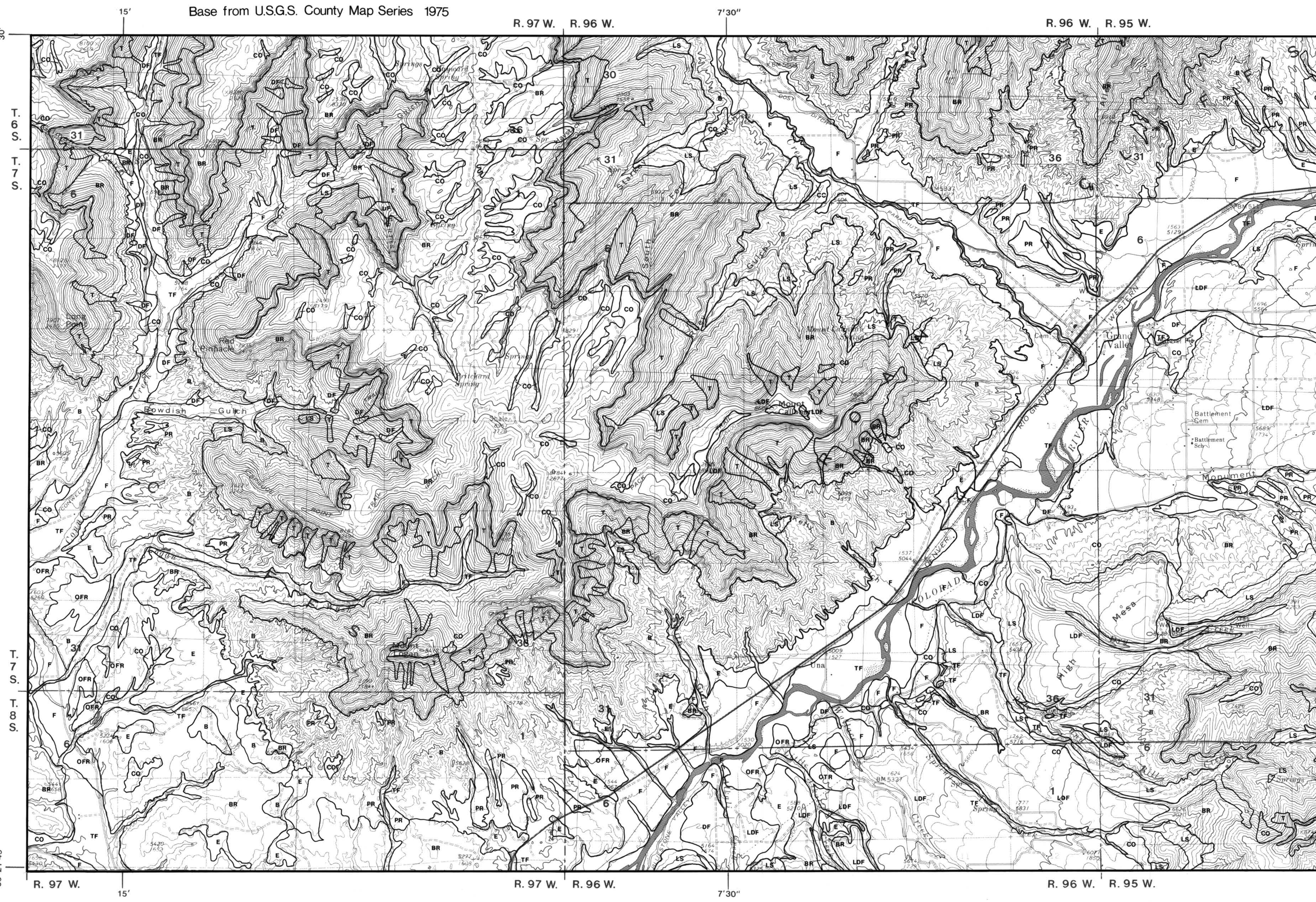

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GEOLOGIC-HAZARDS MAP

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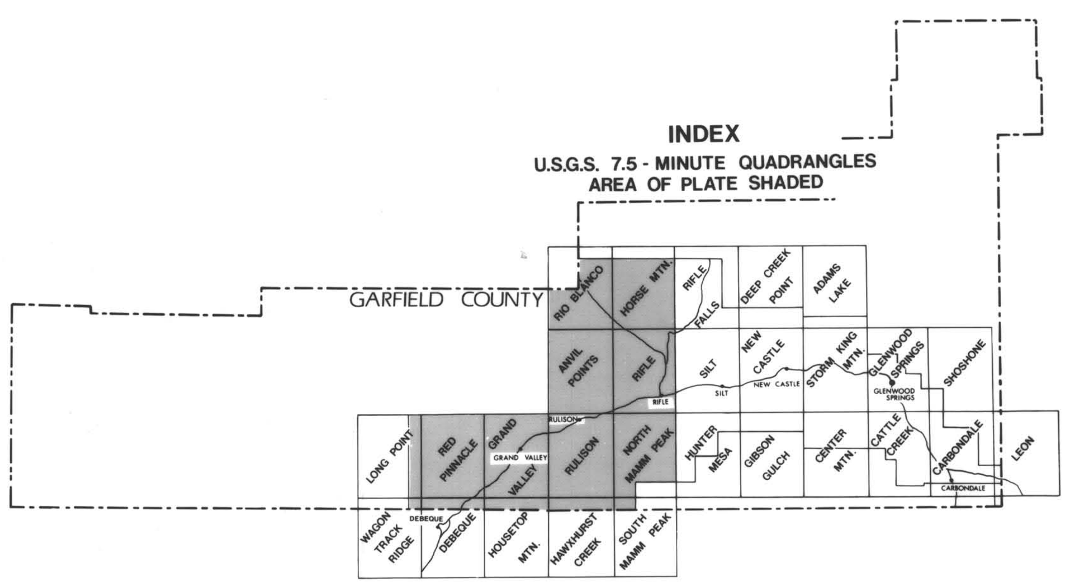
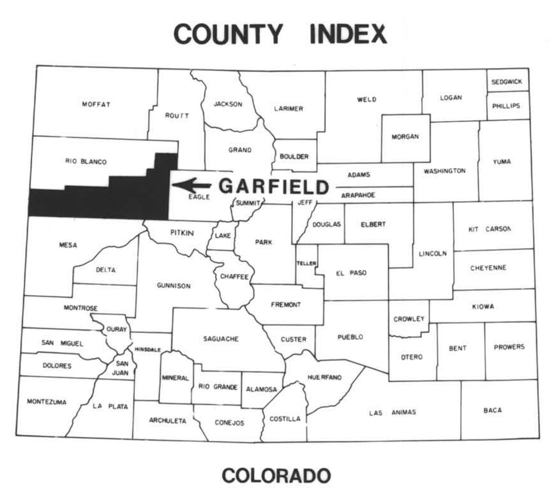
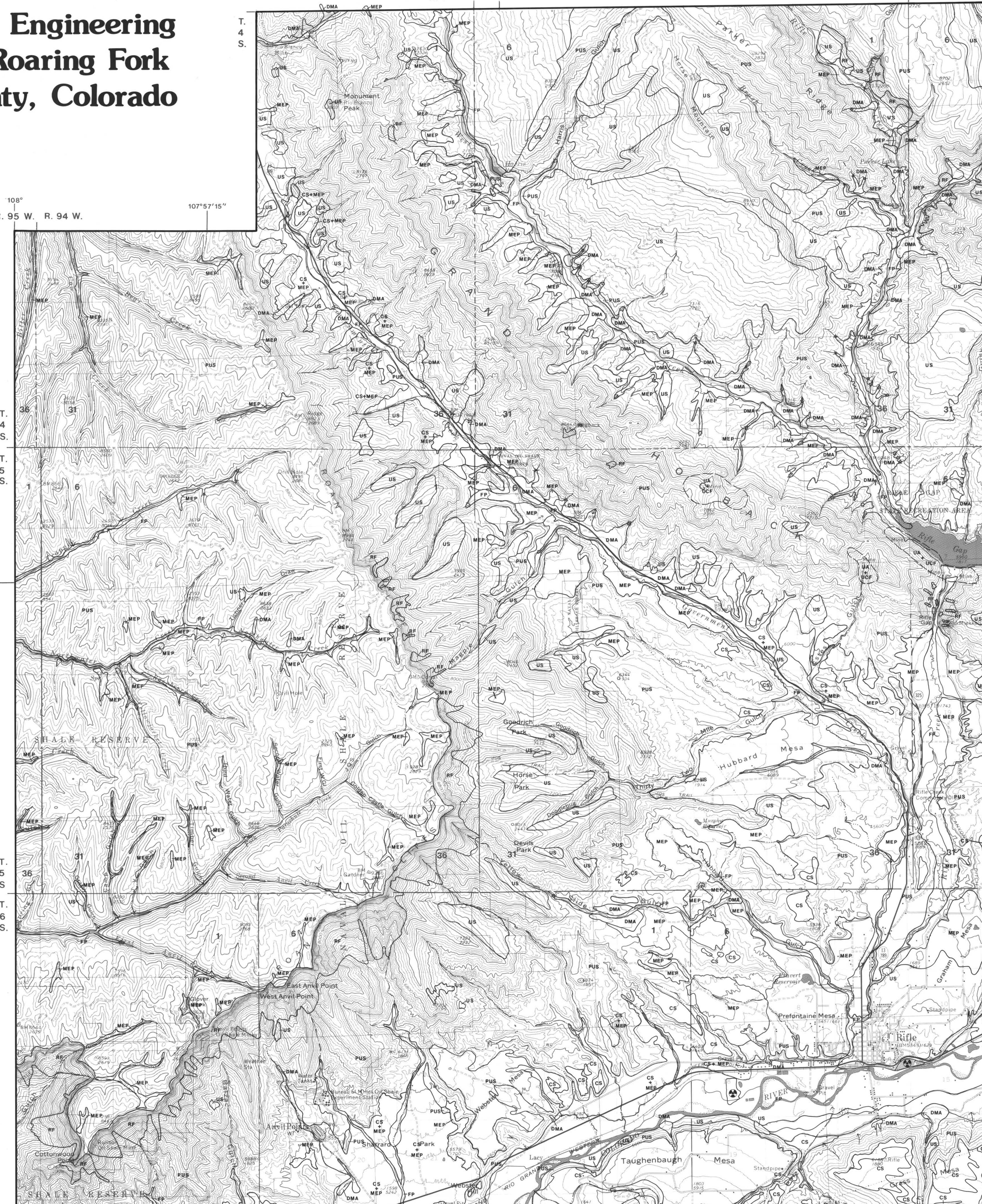
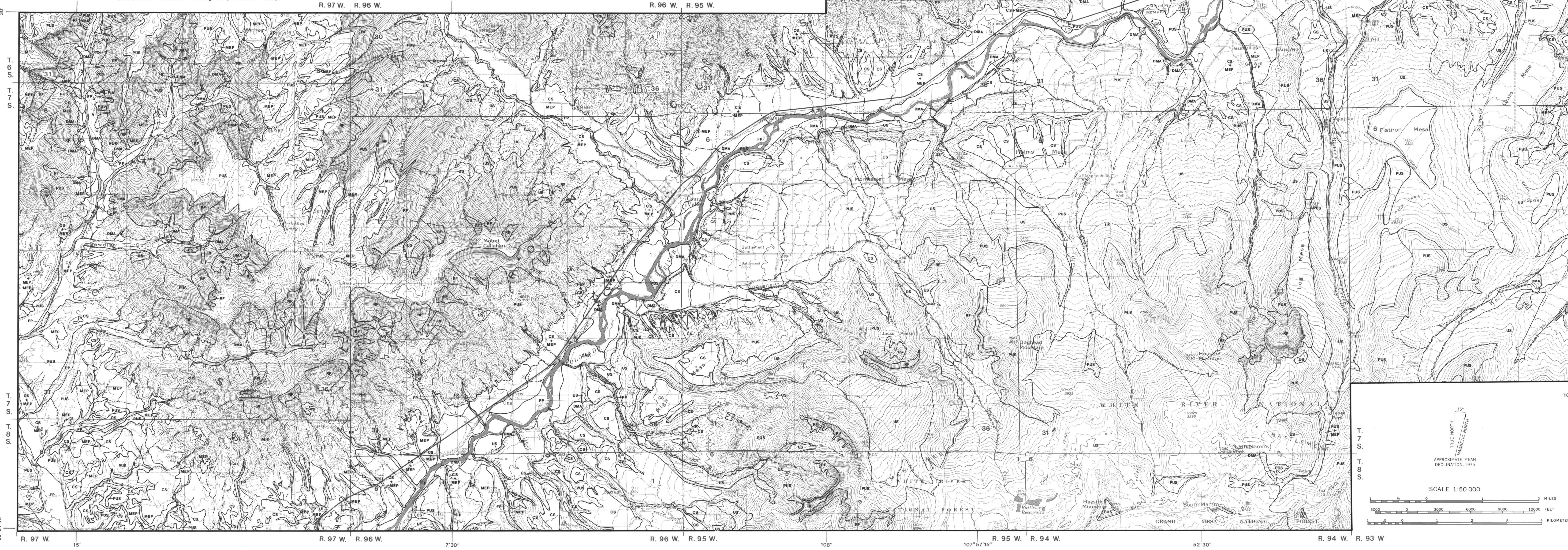
for Explanation





Surficial Geology, Geomorphology, and General Engineering Geology of Parts of the Colorado River Valley, Roaring Fork River Valley, and Adjacent Areas, Garfield County, Colorado.

Open-File Report 85-1
Plate 3B
1985
Colorado Geological Survey
Department of Natural Resources
John W. Rold, Director

GEOLOGIC - HAZARDS MAP

BY J.M. SOULE AND B.K. STOVER

See Plate 3C for Explanation

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GEOLOGIC-HAZARD MAP EXPLANATION

BY J.M. SOULE AND B.K. STOVER

Explanation of Map Units

DMA Debris-flow/mudflow-Flooding Area--Debris fans, alluvial fans, and drainage channels subject to potentially destructive inundation by rapid downslope flowage of wet, commonly fluid-like masses of fine-to-coarse debris and water derived from contiguous side slope usually during periods of heavy rainfall and/or snowmelt runoff. Map unit includes only those areas subject to this process in modern times.

PUS Potentially Unstable Slope--Areas subject to slope failure(s) if natural conditions, especially those related to slope, ground moisture, vegetation cover, and drainage, are disrupted. Areas so mapped include those in proximity to or otherwise associated with areas subject to natural slope movements. Does not include steep stream and gully banks, virtually all of which are subject to slope failure during periods of heavy runoff.

US Unstable Slope--Areas subject to natural translational or rotational landslides and/or earthflows. Evidence includes: distinctive landslide and earthflow morphology, proximity to actively failing areas composed of the same or similar geologic units, slope aspect and inclination, vegetation cover conducive to slope failure, and disrupted cultural or structural effects.

RF Rockfall Area--Area subject to free falling, toppling, bounding, or rolling of rock fragments including large cobbles, boulders, and blocks capable of damaging or destroying most types of structures. Areas so mapped include rock source areas(s) and estimated runout zones below cliffs were mobilized rocks come to rest. The exact extent of the runout zone is typically difficult or impossible to predict or map precisely without site-specific studies because of the varying effects of ground-surface texture, size and shapes of mobile rock fragments, and localized vegetation, ground moisture, and slope variations.

UA Mine-Subsidence Area--Area overlying abandoned underground coal mine(s) that could be subject to potentially destructive surface subsidence and ground failure. Areas so mapped are zones broad enough to indicate where precise extent of undermining and its surface effects might cause problems for activities on the land surface. Detailed investigations, including drilling, may in some cases be necessary to precisely delineate the hazard area.

UCF Underground Coal-free Area--Area presently underlain by smoldering or burning underground coal-mine workings or seams, and subject to subsidence effects, fires, and toxic fumes and gases.

PCF Potential Underground Coal-Fire Area--Area adjacent to active underground coal fire(s) that could be subject to future coal-fire effects as fires migrate along coal seams.

CS Collapsing Soils--Low density, mechanically weak soils subject to hydrocompaction associated with excessive wetting and loading. These soils are usually associated with bedrock units containing water-soluble compounds, especially gypsum, their derived colluvium, alluvium, and residuum, and places where wind-blown or rapidly water-laid deposits are the predominant parent material for the soil.

Flash-Flood-Prone Drainageway or Gully--Drainage channels or gullies subject to rapidly rising and flowing flood water during heavy snow-melt and/or rainfall runoff. Areas so mapped indicate only the channel area. In some places adjacent areas, especially where stream banks are only a few feet high may be subject to overbank sheet flooding with flood waters, at most, a few feet in depth. Bank erosion during flash floods can be a serious problem and involves areas above flood elevation depending on bank material and channel configuration.

FP Physiographic Flood Plain--Area subject to overbank flooding underlain by modern flooding-derived deposits. Shown only for major drainages. Areas mapped as this unit are subject to flooding but no statistically definable recurrence of flooding is implied. Additionally, the effect of man-made structures on movement of flood water is not considered in the definition of this map unit.

Radiation Area--Area subject to elevated levels of natural or man-made radioactivity. Includes natural occurrences of radioactive minerals, natural concentrations of radioactive materials in sedimentary rocks, radioactive mine-waste dumps, and radioactive mill tailings.

HEP High Erosion-Potential Area--Area presently undergoing rapid headward erosion, gullying, and/or sheet erosion exhibiting a high potential for continued erosion (generalized).

MEP Moderate Erosion-Potential Area--Area undergoing moderate gullying, headward erosion, and exhibiting a moderate potential for continued erosion (generalized).

Symbols

Contact

Potentially active fault. Seismic risk unevaluated. Bar and ball on downthrown side.

Zone -- Dashed line indicates a high level of uncertainty about extent of mapped area. Precise determination of extent of mapped area will require detailed field and/or subsurface investigation in virtually all cases.

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Suggestions to Users of the Diagram Below

This diagram, which is a matrix that is intended to be used only with the accompanying geologic-hazards map, is designed to enable the map user to predict generally the kinds of engineering-geology-related situations that are apt to arise if the specified land use takes place in the indicated geologic-hazard area. The scenarios that result can be used in several ways. For example:

1.) To enable land-use planners, land owners, land developers, and others to anticipate well in advance of land use changes the kinds of problems that might arise if the land use changes do, in fact, take place.

2.) To indicate to public officials and others responsible for public safety those areas where geologic conditions are so adverse for some land uses as to be directly life and property threatening.

3.) As a basis for indicating the kinds of problems that should be addressed in detailed, site-specific engineering-geologic studies for specific projects. Designs, engineering, and construction can then take the problems into account adequately.

4.) To enable land owners, real-estate appraisers, and financiers to consider generally geologic conditions when evaluating property.

In no instance are the recommendations or advice that can be assembled for the specific cases to be used as a replacement for detailed geotechnical investigations. The intention is rather that this information be used to focus such studies such that only relevant ones are made or required.

Generalized Geologic-Hazard Scenarios for Common Land Uses

Land-Use Activity

Hazards - Map Units	AGRICULTURE (FARMING AND RANCHING)	HIGHWAY AND RAILROAD CONSTRUCTION AND MAINTENANCE	UTILITY LINES (ABOVE GROUND)	PIPELINES AND UNDERGROUND UTILITIES	LOW-DENSITY SINGLE-FAMILY RESIDENTIAL DEVELOPMENT (1 D.U./5 ACRES)
DMA	1 FG Permanent buildings or high-value improvements should not be located in these areas.	2 BCFGHS These areas should be avoided, if possible, to minimize maintenance costs.	2 FGNT Occasional replacement or repair of facilities may be necessary.	2 DFGKRS Occasional replacement of or repair of facilities may be necessary. Corrosive soils will be a serious problem in some areas.	3 FGIKMNS In most cases careful siting of structures will be the only feasible mitigation measure. Corrosive soils will be a serious problem in some areas.
PUS	0 P Drainage changes and irrigation of some of these areas can cause landsliding.	2 ABCDEIKLN Careful engineering and minimal drainage changes can usually minimize hazard.	1 BDK With reasonable precaution hazards in these areas are usually minimal.	2 CDKNRU Construction practices that are mindful of potential slope instability can minimize hazards.	2 ABCDFK Depending on the interre-lationship(s) of the conditions indicated above this use may be unsafe or economically infeasible.
US	2 CDFNP Permanent buildings or high value improvements should not be located in these areas.	3 BCFIKLMNRS High maintenance costs are likely in all of these areas.	3 CFMN Occasional replacement of or movement of towers may be necessary.	4 BFIKMNRS Usually this use is advisable only if no other alinement is feasible.	4 ABCDFIKNOS Even for large lots and high value improvements, costs of mitigating these hazards are usually prohibitive.
RF	1 BDFGKMQRSV Permanent buildings or other high value improvements should not be located in these areas.	2 BCDFKMRV Maintenance costs will be high in most cases. Alternative alinements should be used if possible.	1 DFGV Slightly increased maintenance costs should be anticipated.	2 BDFGKRV Hazards are to personnel and equipment during construction, the costs of which will be substantially increased. Alternative alinements should be used if possible.	4 BDFGKMRSV Construction costs and hazard-mitigation measures are commonly so expensive that this land use will be economically infeasible.
UA	0 JOQ Permanent buildings or other high value improvements should not be located in these areas.	2 JLMOQ Maintenance costs are apt to be high. Alternative alinements should be used if possible.	1 JO Minor maintenance problems should be anticipated.	3 JMO Liklihood and magnitude of subsidence potential must be precisely determined before an adequate hazard assessment can be made.	3 JMOS Adequate hazard mitigation for this use may make it uneconomic.
UCF	2 OQ Fissures, subsidence pits, and noxious gases may in a few areas make this use practically impossible.	2 IJKLMOQ Specialized design engineering for this use will be necessary in virtually all cases.	2 IMO Alternative alinements will be less costly than mitigating the hazard in many cases.	3 IMO Alternative alinements will be less costly than mitigating the hazard in virtually all cases.	5 OS This use is almost always prohibitively dangerous.
PCF	0 Q This use presents little problem.	2 ILQS Facilities that can be located out of these areas probably should be, to minimize the potential for future problems.	2 Facilities that can be located out of these areas probably should be, to minimize the potential for future problems.	3 JKLM Facilities that can be located out of these areas probably should be, to reduce costs and minimize the potential for future problems.	4 JQS Usually this use is unsafe in the long term.
CS	1 NU Damage to irrigation ditches and pipes will occur frequently.	3 AEILNU Pre-wetting of these soils may minimize the amount of remedial work necessary.	1 U Ponding of water around support structures should be avoided.	2 KLNU Water should be kept away from construction trenches and facilities as much as possible. Shoring of trenches may be necessary for construction-personnel safety.	2 AEKMNPU Higher than ordinary construction and maintenance costs should be anticipated.
	1 CDFGKNPT Some damage to crops and low value improvements can be considerable. Permanent high value improvements should not be sited in these areas.	2 CDFGHKOPT Most problems can be adequately addressed with properly designed drainage-control structures.	2 DFGHT Do not place supports for towers or other similar structures in channels.	2 DFGHKN Pipelines should be elevated above ground or buried deeply where they cross channels.	4 CDFGHKMNOPT All high-value improvements should be kept out of drainage channels with adequate setbacks so that stream-bank erosion cannot affect them.
FP	1 FKPSTX High-value improvements should be defended or not located, if economically possible, in these areas.	2 FKLMPTX Occasional high facility-replacement or maintenance costs should be anticipated in some places.	1 FKTX Occasional extraordinary maintenance should be anticipated.	2 FKLMNTX Occasional facility replacement or extraordinary maintenance costs should be anticipated.	3 AFKLNTX Drainage control may reduce hazard to near nil in many places.
	5 LS This use is prohibitively dangerous.	3 KLS These areas should be avoided and alternative alinements used wherever possible.	2 K Health hazards to construction and maintenance personnel will be considerable. Alternative alinements should be used wherever possible.	2 K Health hazards to construction and maintenance personnel will be considerable. Alternative alinements should be used wherever possible.	5 S This use is prohibitively dangerous. Benefication of the site would make this use uneconomic.
HEP	2 ABCDINP Considerable surface damage rendering the land useless for agriculture is possible in these areas.	3 BCIKMNP Relatively low cost remedial drainage engineering can usually reduce problems to a satisfactory level.	2 DKN Some regrading and/or remedial drainage engineering may be necessary to protect facilities.	3 BCKNP Some regrading and/or remedial drainage engineering may be necessary to protect facilities.	3 ABCDKMP Regrading and/or remedial drainage engineering will be necessary to protect facilities in virtually all cases.
MEP	2 CDKN Agricultural uses in these areas should not exceed the carrying capacity of the land. Good range-management practices should minimize problems.	2 BCEIKLNU Careful design and engineering, especially for drainage control, should minimize problems.	2 DEKNU Foundations for towers and similar structures may require specialized designs and concrete types. Disruption of natural drainage should be minimized.	3 DEKNU Cuts and fills should be revegetated and restored to original surface contour as soon as possible after construction.	2 ABCDEKLNPU Careful design and engineering, especially for drainage control, should minimize problems.

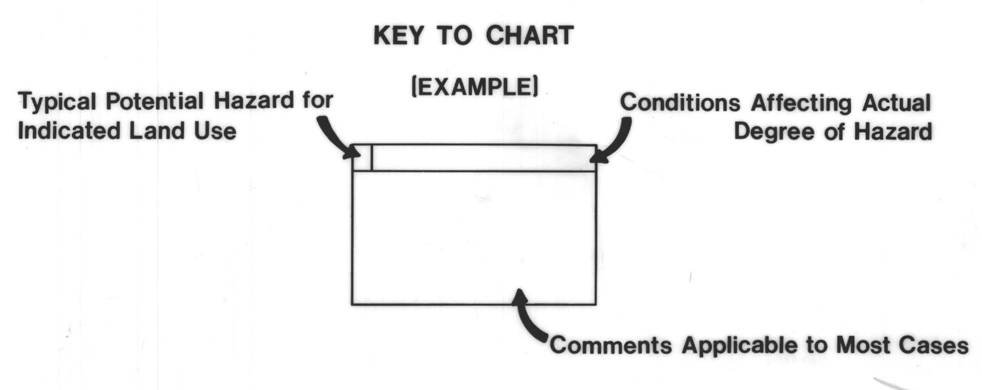
Hazards - Map Units	MEDIUM DENSITY SINGLE-FAMILY RESIDENTIAL DEVELOPMENT (1 D.U./5 ACRES to 1 D.U. ACRE)	HIGH DENSITY SINGLE-FAMILY RESIDENTIAL DEVELOPMENT (1 D.U./ACRE)	MULTI-FAMILY RESIDENTIAL DEVELOPMENT (APARTMENTS AND TOWN HOUSES)	COMMERCIAL DEVELOPMENT (SHOPPING AND SERVICE FACILITIES)	INDUSTRIAL DEVELOPMENT (LOW DENSITY OFFICE PARKS, ETC.)
DMA	4 AFGMR In a few instances this use can be safe. Corrosive soils will be a serious problem in some areas.	5 AFGOR This use is almost always prohibitively dangerous.	5 AFGOR This use is almost always prohibitively dangerous.	4 FGIMR Pre-construction planning and well engineered structural design based in part on detailed engineering-geologic studies may make this use feasible and safe	4 FGIMR Pre-construction planning and well engineered structural designs based in part on detailed engineering-geologic studies may make this use feasible and safe.
PUS	3 ABCDFIKMNRS This use is usually unsafe or economically infeasible.	4 ABCDFINPR This use is usually unsafe and is frequently economically infeasible.	4 ABCDFINPR Depending on property values and availability of alternative sites, this use may be economically feasible.	4 ABCDFIKMNPR Depending on property values and availability of alternative sites, this use may be economically feasible.	3 ABCDFIKMNPR In many cases, despite adverse conditions, this use will be economically feasible.
US	4 ABCDFIKNOS Costs of mitigating these hazards are almost always prohibitive.	5 OQS This use is almost always prohibitively dangerous.	5 OQS This use is almost always prohibitively dangerous.	4 ABCDFMNRS In some instances the value of these improvements will justify costly hazard-mitigation measures.	4 ABCDFMNRS In some instances the value of these improvements will justify costly hazard-mitigation measures.
RF	5 BFGKMQRSV This land use is usually prohibitively dangerous.	5 BFGKMQRSV This land use is usually prohibitively dangerous.	5 BFGKMQRSV This land use is usually prohibitively dangerous.	5 BFGKMQRSV This land use is usually prohibitively dangerous.	4 BFGIKMQRSV In some instances construction costs and hazard-mitigation measures will be so expensive to make this land use economically infeasible.
UA	4 JMOS Adequate hazard mitigation for this use probably will make it uneconomic.	5 JOS Adequate hazard mitigation for this use may make it impossible.	5 JOS Adequate hazard mitigation for this use probably will make it impossible.	5 JOS Adequate hazard mitigation for this use may make it impossible.	3 JMOS Liklihood and magnitude of subsidence potential must be precisely determined before an adequate hazard assessment can be made.
UCF	5 OQS This use is almost always prohibitively dangerous.	5 OQS This use is always prohibitively dangerous.	5 OQS This use is always prohibitively dangerous.	5 OQS This use is always prohibitively dangerous.	4 OQS This use, if practical at all, will necessitate specialized designs and construction techniques.
PCF	4 JQ This use is always unsafe in the long term.	5 JQS This use is always unsafe in the long term.	5 JQS This use is always unsafe in the long term.	5 JQS This use is always unsafe in the long term.	4 JQS Usually this use is unsafe in the long term.
CS	3 AEKMNPU Higher than ordinary construction and maintenance costs should be anticipated. Drainage and erosion control will be critical.	3 AEKMNPU Higher than ordinary construction and maintenance cost should be anticipated. Drainage and erosion control will be critical.	4 AEKMNPU Higher than ordinary construction and maintenance costs should be anticipated. Drainage and erosion control will be critical.	3 AEKMNPU Higher than ordinary construction and maintenance costs should be anticipated. Drainage and erosion control will be critical.	3 AEKMNPU Higher than ordinary construction and maintenance costs should be anticipated. Drainage and erosion control will be critical.
	5 CDFGHKNOPT Increased runoff from impervious areas and flooding in natural channels will necessitate elaborate drainage-control measures which are apt to make this use uneconomic.	5 CDFGHKNOPT Increased runoff from impervious areas and flooding in natural channels will necessitate elaborate drainage-control measures which are apt to make this use uneconomic.	5 CDFGHKNOPT This use is usually prohibitively dangerous.	4 DFGHKMNPT Considering the value of improvements mitigating the hazard may prove to be economic.	3 DFGHKMNPT Considering the value of improvements mitigating the hazard may prove to be economic.
FP	4 AFHIKLMNPSTX In many instances the hazard created will involve excessive risk. In others, detailed hydrologic investigations will indicate that this use is safe.	5 AFHIKLMNPSTX In most instances the hazard created will involve excessive risk. In a few others detailed hydrologic investigations will indicate that this use is safe.	5 AFHIKLMNPSTX In most instances the hazard created will in-volve excessive risk. In a few others economically justifiable site improve-ments based on detailed hydrologic investigations will indicate that this use is safe.	3 FIKMNPTX In most cases economically justifiable site improvements based on detailed hydrologic investigations will reduce risk to an acceptable level.	3 FIKMNPX In most cases economically justifiable site improvements based on detailed hydrologic investigations will reduce risk to an acceptable level.
	5 S This use is prohibitively dangerous. Benefication of the site would make this use uneconomic.	5 S This use is prohibitively dangerous. Benefication of the site would make this use uneconomic.	5 S This use is prohibitively dangerous. Benefication of the site would make this use uneconomic.	5 S This use is prohibitively dangerous unless radio-active materials are removed and the site beneficated. Benefication might make this use uneconomic.	5 S This use is prohibitively dangerous unless radio-active materials are removed and the site beneficated. Beneficiation might make this use uneconomic.
HEP	3 ABCDKMP Regrading and/or remedial drainage engineering will be necessary to protect facilities and prevent increased erosion.	4 ABCDKMP Costly regrading and drainage-engineering schemes will be necessary to protect facilities adequately for the long term.	4 ABCDKMP Costly regrading and drainage-engineering schemes will be necessary to protect facilities adequately for the long term.	3 ABCIKLMNP Potential for increased erosion in off-site areas must be addressed in development plans.	3 ABCIKLMNP Potential for increased erosion in off-site areas must be addressed in development plans.
MEP	3 ABCDEHIKLNPU Careful design and engineering, especially for drainage control, will be absolutely necessary.	3 ABCDEHIKLNPU Careful design and engineering, especially for drainage control, will be absolutely necessary. Drainage-control plans should consider runoff effects on adjacent properties.	3 ABCDEHIKLNPU Careful design and engineering, especially for drainage control, will be absolutely necessary. Runoff effects on adjacent properties can be very adverse in some instances.	3 ABCDEHIKLNPU Careful design and engineering, especially for drainage control, will be absolutely necessary. Uncontrolled runoff can cause severe damage to adjacent properties.	3 ABCDEHIKLNPU Careful design and engineering, especially for drainage control, will be absolutely necessary. Uncontrolled runoff can cause severe damage to adjacent properties.

Hazards - Map Units	HEAVY INDUSTRIAL DEVELOPMENT (OIL-SHALE RETORTS, OIL REFINERIES, PROCESSING AND MANUFACTURING PLANTS, RAILROAD YARDS)	MINING AND QUARRYING AND ATTENDANT FACILITIES	DEVELOPED OPEN SPACE (GOLF COURSES, PARKS, GREENBELTS, RECREATIONAL FACILITIES, ETC.)	SEPTIC SEWAGE DISPOSAL	SOLID-WASTE DISPOSAL (EXCLUDING HAZARDOUS WASTES; INCLUDING MINE TAILINGS)	WATER-RESOURCE DEVELOPMENT (RESERVOIRS, IRRIGATION DITCHES, DAMS)
DMA	3 FGIM The high value of these improvements will make hazard mitigation economically feasible in nearly all cases.	2 FG These areas are not usually associated with economic mineral deposits.	2 FG Occasional repair of or replacement of facilities may be necessary.	3 ADFGNRSU In most cases it will be economically disadvantageous to use these areas for this purpose.	2 BFGJLN Investigations of the effects on surface and ground-water quality should be made in the planning phase of development.	3 FGIKLMN Occasional repair of, replacement of, or costly maintenance of facilities may be necessary. Corrosive soils will be a serious problem in some areas.
PUS	2 ABCDFIKMNPR In many cases, despite adverse conditions, this use will be economically feasible.	2 BDFJKLP Economics of this use will be more affected by resource value than geologic hazards.	2 CDN Low intensity land uses such as parks and golf courses should require little remedial engineering of the slope if drainage is carefully controlled.	3 ADFJR In many places this sewage-disposal method is inadvisable because of inadequate percolation rates or system-engineering problems.	2 CDJKNR Sophisticated site-specific engineering for proper fill compaction and maintenance of ground-water quality will be necessary in essentially all cases.	3 BCDJLKMNPR Reservoir and irrigation-ditch leakage in these areas can result in severe geotechnical problems for these facilities.
US	3 BDFJKLMNPS The value of such industrial improvements combined with critical location requirements will frequently make it economically feasible to control slope movements or accept high maintenance costs.	3 BCDFJNP The value of such industrial improvements combined with critical location requirements will frequently make it economically feasible to control slope movements or accept high maintenance costs.	2 CDFNP Permanent buildings or other high value improvements should not be located in these areas.	4 ADFJO Increasing water content of these near-surface materials will greatly increase the possibility of large-scale, rapid slope failures.	3 BCDFJKN Use of active slope-failure areas as landfill sites may prove to be extraordinarily troublesome and expensive.	4 ABDIJKLMNRS Structures or other improvements should only be located in these areas when alternative locations are not possible.
RF	3 BFGIKMRSV The high value of these improvements may necessitate that specific high-hazard sites be used despite high costs of hazard mitigation.	3 BDEGJKLPV Economics of this land use will be affected both by the resource value and costs of mitigating the geologic hazard.	3 DFGQV It is usually more practical to leave these areas as undeveloped open space.	4 ABDFGIKMQRV The only parts of these areas that may be suitable are lower, more gently sloping rockfall runout zones. Percolation rates and construction costs will most likely be unacceptable in most areas.	4 BDFGIJLNPQRV Preparation of the site to safely receive refuse will render this use uneconomic in most places.	3 FGIKLMRV Hazards will be highly dependent on site-specific details and the improvements planned. Detailed engineering-geologic investigations will be necessary in all instances.
UA	3 JMO High value uses that require these areas may be economic.	1 KLMP Suface mining of previously underground-mined areas would be the most common case.	1 QS It will be advisable to keep permanent high value improvements out of these areas.	3 KMP As this use is usually associated with residential development it is not feasible in most cases.	1 JKP In most places this use will be feasible, but only after detailed site-specific engineering-geologic investigations.	3 JKLMNQ Because of the various types of developments possible, site-specific, detailed engineering-geologic investigations will be necessary for each case.
UCF	3 MOQS It may, in isolated instances, be economic to site heavy industrial development in these areas.	3 MOR In most cases the costs of mitigating the hazard will make this use uneconomic.	3 MOQS In most cases the costs of mitigating this hazard and locations of these areas will make this use impractical.	4 MOQ In most cases the costs of mitigating this hazard and locations of these areas will make this use impractical.	5 LOS In most cases the costs of mitigating this hazard and locations of these areas will make this use impractical.	4 JKLMOQS This use probably will only be practical in places where no alternative location for facilities is possible.
PCF	4 JQS This use is usually inadvisable unless no alternative site(s) are available.	3 JK This use can aggravate or increase the potential for fires.	2 MQS In most cases the costs of mitigating this potential hazard and the locations of these areas will make this use impractical.	2 KQRS In most cases the locations of these areas make this use practically impossible.	3 JKLPQR In most cases the locations of these areas make this use practically impossible.	3 JKLMR Alternative sites for these facilities should be used if possible.
CS	3 AEJKLNPU Some damage to permanent facilities can occur if their design and engineering are inadequate. Remedial engineering costs should be low enough to not affect economics of this use significantly.	0 PU Some damage to permanent facilities can occur if their design and engineering are inadequate.	1 CNU High value improvements should be made with proper engineering precautions.	3 AEKMNU Damage to leach-field lines from settlement can necessitate premature replacement of systems. Percolation rates will be variable, and in some places, unacceptable.	2 CIKLNP Detailed soil engineering and design to prevent leachate contamination of ground-water will be necessary.	3 CEIJKLMNPU In most places this use is possible but increased costs will be considerable.
	3 DFGHKMNPT Considering the value of improvements mitigating the hazard may prove to be economic.	3 DFGHKNPT Occasional serious damage to facilities should be anticipated.	2 CFGHKNPT High value improvements should not be placed in channels.	3 DFGHKNPT If possible, these facilities should not be sited in these areas.	3 CDFGHKNPT This use will necessitate specialized detailed engineering-geologic and hydrologic studies prior to development.	2 FGHKLNPT Higher value improvements probably will justify the cost of hazard mitigation.
FP	2 FIKMNPX In most cases economically justifiable site improvements based on detailed hydrologic investigations will reduce risk to an acceptable level.	1 FKNPTX Sand and gravel pits and mining equipment may incur damage during major floods, but this should be considered to be an acceptable consequence of this use.	1 FN High value improvements should be made only after a detailed hydrologic flood-plain determination.	4 AFJLNTX This use is usually inadvisable because of the high liklihood of serious ground-water contamination.	3 CFJLNTX This use is usually inadvisable because of the high liklihood of serious ground-water contamination.	2 CFHKMNTX Problems related to this use usually can be solved by using appropriately engineered structures.
	5 S This use is prohibitively dangerous unless radioactive materials are removed and the site beneficiated. Beneficiation might make this use uneconomic.	5 S Except for secondary leaching of tailings piles it is inconceivable that this use could be economic.	5 S This use is prohibitively dangerous unless radio-active materials are removed and the site beneficiated. Beneficiation would most likely make this use uneconomic.	5 S Considering constraints on residential development this use would be inconceivable.	5 S Health hazards to construction and maintenance personnel will be considerable. Alternative sites should be used whenever possible.	5 S Health hazards to construction and maintenance personnel will be considerable. Contamination of surface water by radioactive materials is likely.
HEP	2 ABCIKLMNP Potential for increased erosion in off-site areas must be addressed in development plans.	2 KNP Careful regrading after mining can usually minimize problems.	2 CKNP High value improvements should not be located in these areas.	3 ABCDKLMN Usually percolation rates in these areas are unacceptable for conventional systems.	3 CDKNP Alternative sites should be used if possible.	3 ABCDKMP Alternative sites should be used if possible.
MEP	2 ABCDEJKLNPU Usually adequate hazard mitigation will be well within economic limits of economical project cost.	2 DKNP Mine reclamation should restore, as much as possible, the original surface contour, vegetation, and drainage to minimize long-term increased erosion.	2 CDNP High value improvements should be designed and engineered much the same as low density residential development in these areas.	3 ADEIJLMU Problems are usually reduced as overall density (numbers) of septic systems is reduced. Percolation rates will be highly variable from place to place.	3 CDIJKLNP Control of leachates will be difficult in many places. Reclamation should restore, as much as possible, the original surface contour, vegetation, and drainage to minimize long-term increased erosion.	3 BCDEIJKLMNPU In most cases adequate hazard mitigation will be well within economic limits of economical project cost.

Explananation of Chart Symbols

KEY TO CHART

[EXAMPLE]



Degree of Hazard

0 In all cases essentially no geologic hazards will be created - little, if any, hazard.

1 Typically minor problems related to geologic conditions will be experienced - low hazard.

2 In some cases serious problems related to geologic conditions will be experienced - moderate to high hazard.

3 In many cases serious problems related to geologic conditions will be experienced - moderate to high hazard.

4 In most cases serious problems related to geologic conditions will be experienced - high hazard.

5 In essentially all cases serious problems related to geologic conditions will be experienced - very high to extreme (severe) hazard.

Conditions Affecting Hazard

A Surcharging near-surface soils and/or groundwater with sewage effluent or uncontrolled runoff from impervious (developed) areas increases hazard greatly.

B Undercutting slopes increases hazard greatly in most instances.

C Removing natural vegetation by overgrazing or ill-advised construction practices increases hazard greatly.

D Hazard usually increases considerably with increased slope.

E Expansive soils are common and may require specialized designs for structural foundations and drainage control.

F Hazard or likelihood of occurrence of this hazardous process varies seasonally.

G Nearly all of the hazardous events occur rapidly during heavy rainstorms.

H Occasional flash flooding in small tributary drainage channels (not mapped) can be a severe hazard.

I Pre-construction, detailed engineering-geology investigations will be necessary in nearly all cases.

J Detailed engineering-geologic studies, including drilling, are necessary to properly assess hazards in these areas.

K Improperly designed cuts and fills can greatly increase hazards in these areas.

L Engineered fills will be absolutely necessary to minimize hazards in these areas.

M In some instances careful siting of structures after detailed engineering-geologic studies of these areas can reduce hazards to an acceptable level.

N In some cases rerouting drainage or draining slopes can reduce hazards considerably.

O This hazardous process is virtually impossible to halt or mitigate adequately.

P May result in increased erosion in nearby moderate erosion potential areas.

Q Usually slopes in these areas are so steep that this land use is practically impossible.

R Some excavations in these areas may be extraordinarily difficult or expensive.

S Defense structures or adequate hazard-mitigation measures are apt to be extraordinarily expensive.

T Large scale flooding of associated major streams can result in considerable damage.

U Corrosive soils in some places will necessitate use of specialized concrete and protection for some metals that are exposed to soils.

V Winter freeze-thaw cycles can also cause some falls.

X Seasonal shallow ground-water tables may be encountered.

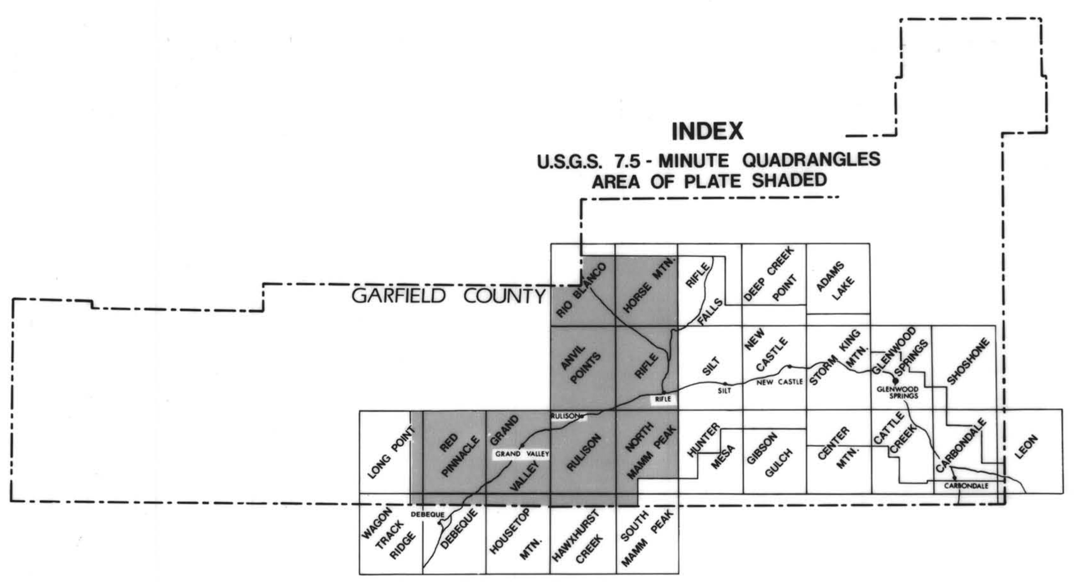
Open-File Report 85-1
Plate 4A
1985
Colorado Geological Survey
Department of Natural Resources
John W. Rold, Director

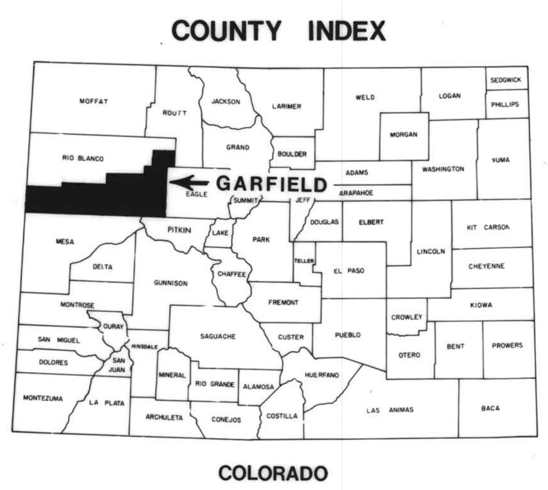
See Plate 1C, 2C, 4C
for Explanation

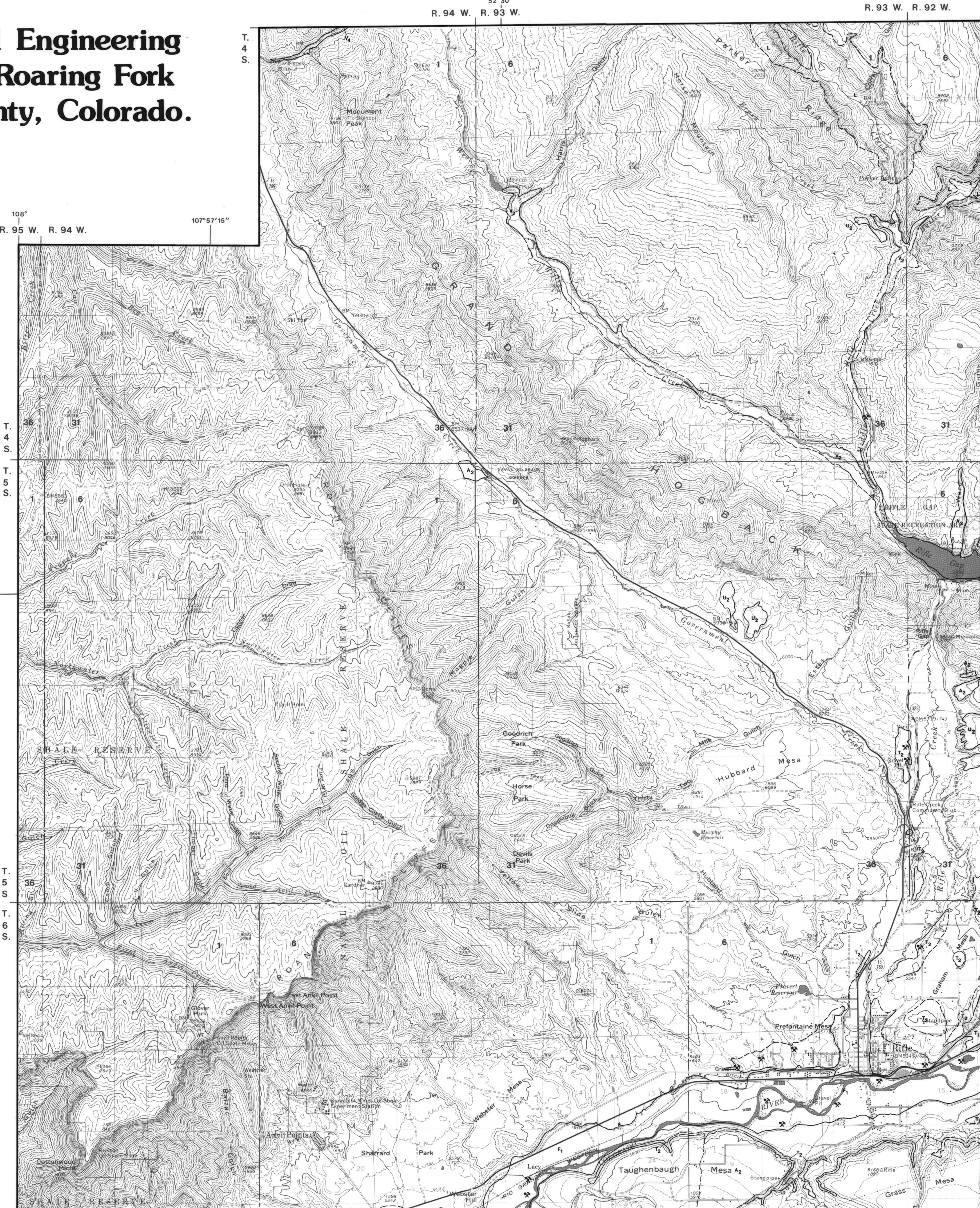
Surficial Geology, Geomorphology, and General Engineering Geology of Parts of the Colorado River Valley, Roaring Fork River Valley, and Adjacent Areas, Garfield County, Colorado.

CONSTRUCTION - MATERIALS MAP

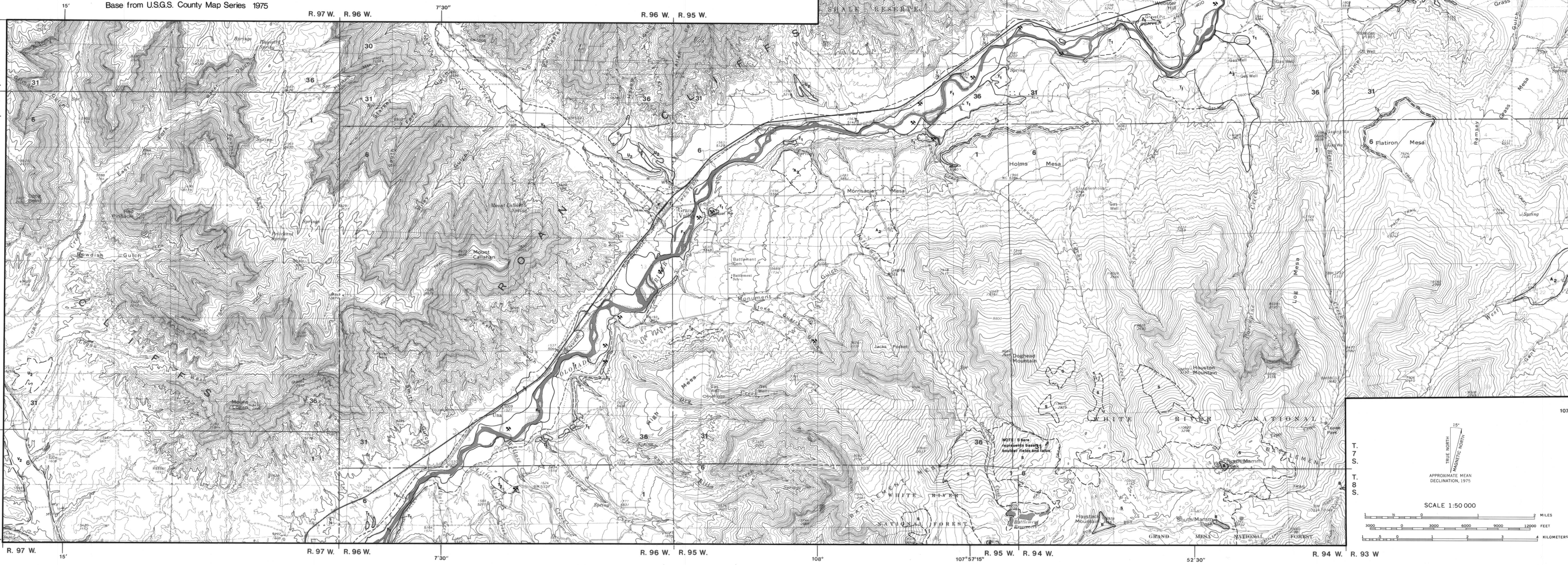
BY B.K. STOVER AND J.M. SOULE







Base from U.S.G.S. County Map Series 1975



Surficial Geology, Geomorphology, and General Engineering Geology of Parts of the Colorado River Valley, Roaring Fork River Valley, and Adjacent Areas, Garfield County, Colorado.

Open-File Report 85-1
Plate 4B
1985
Colorado Geological Survey
Department of Natural Resources
John W. Rold, Director

See Plate 1C, 2C, 4C for Explanation

CONSTRUCTION - MATERIALS MAP

BY B.K. STOVER AND J.M. SOULE

Base from U.S.G.S. County Map Series 1975