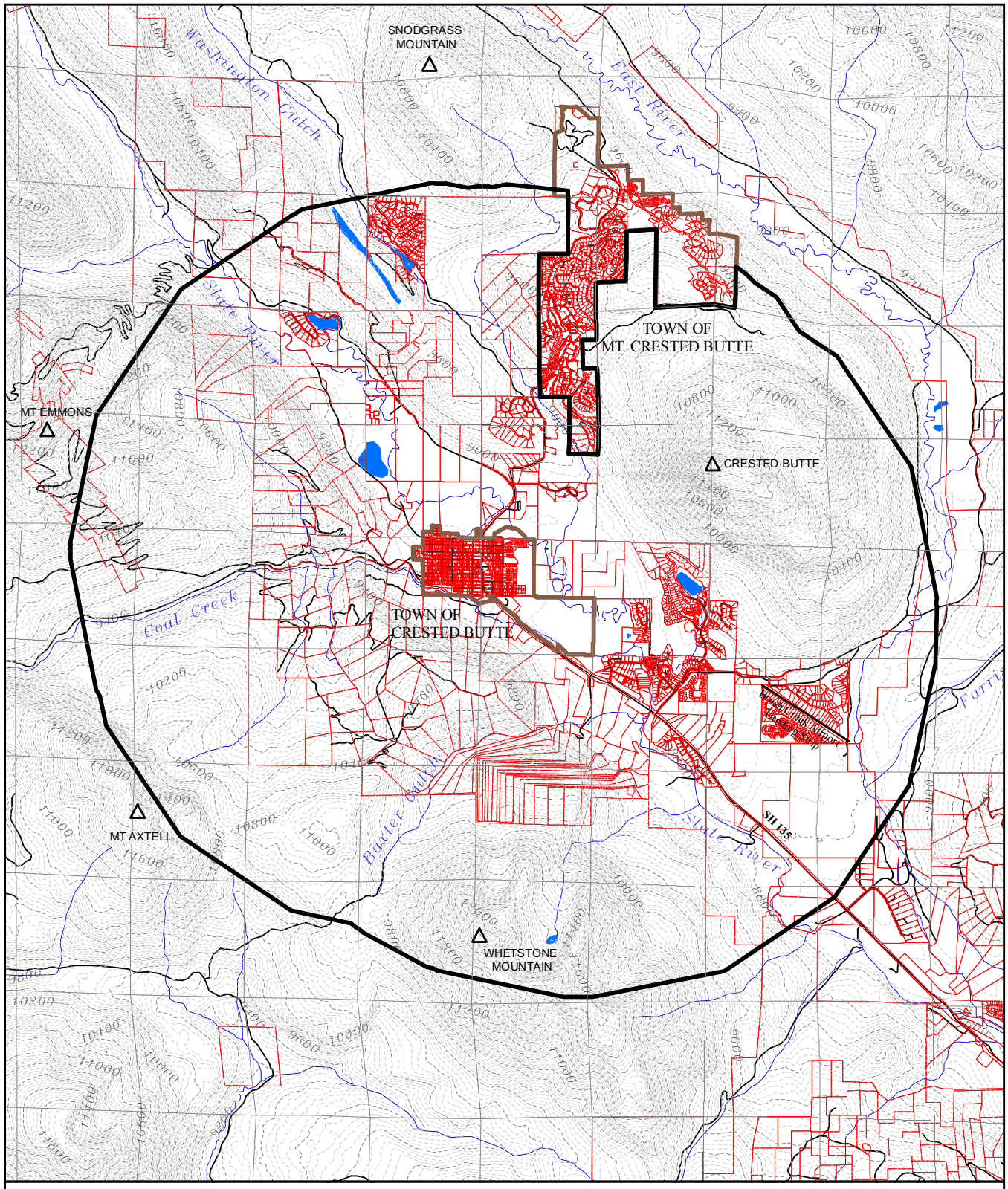


Property Boundaries

- 3 Mile Boundary - Middle Slate River Valley (MSRV)
- Town Boundary
- Streams
- Lakes
- Roads
- Parcel Boundaries
- Section Lines

40' Topographic Contours

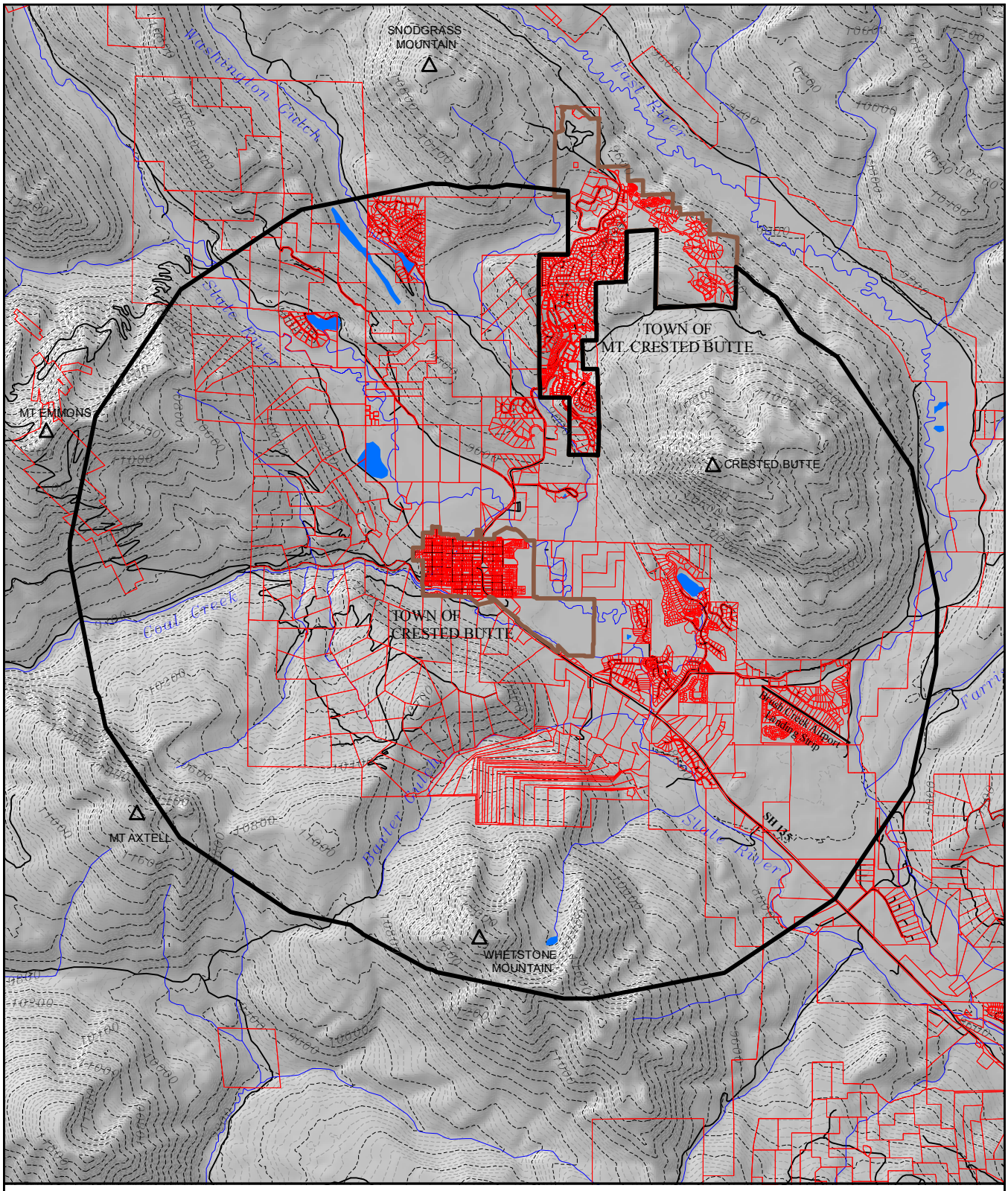
- index
- interval

N W E S

0 0.5 1 2 3 Miles

CRESTED BUTTE, COLORADO · A National Historic District

Drawn by: Hilary Mayes
Date: May 4, 2005
Filename: C:/project/areaplan/property.mxd



Property Boundaries

- 3 Mile Boundary - Middle Slate River Valley (MSRV)
- Town Boundary
- Streams
- Lakes
- Roads
- Parcel Boundaries
- Section Lines

40' Topographic Contours

- index
- interval

N W E S

0 0.5 1 2 3 Miles

CRESTED BUTTE, COLORADO · A National Historic District

Drawn by: Hilary Mayes
Date: April 26, 2005
Filename: C:/project/areaplan/shaded relief.mxd

Part 2, DESCRIPTION OF THE ISSUES

PUBLIC PARTICIPATION

In 1990, the Towns of Crested Butte and Mt. Crested Butte surveyed post office box holders and the landowners between the towns about development in the valley. The two towns also conducted neighborhood meetings about the corridor between the two towns. In November 1991, the Gunnison Basin Community Forum steering committee organized the Successful Communities Workshop. In 1995 and in 2004, additional post office box land use surveys were conducted by Crested Butte.

A summary of the results of these meetings and surveys is found below.

Table PP 1
Number of respondents, by community,
2004 Land Use Survey

Crested Butte……	323
Mt. Crested Butte……...	58
Crested Butte South area……	62
Meridian Lake Park Subdivision……	13
Skyland……..	16
Other valley residents……	55

Table PP 2
Number of Returned Surveys

	Surveys Returned	**Return Rate**
1990	147 of 1,200	12.3%
1995	336	
2004	513 of 2,929	17.5%

The table and information on the following page presents the results of three general questions in the 2004 boxholders survey. When comparisons can be made, boxholder responses to similar questions in earlier surveys are also presented. The results of other more detailed questions will be discussed in the sections of the plan addressing the applicable subject matter.

Respondents have consistently most valued the healthy, natural, mountain environment, and recreational opportunities of the Crested Butte area and the upper East River valley. Those features that are least valued include economic opportunities, cultural activities, and a place to raise children. Valued features, from a list of 22 options, receiving more than an eighty percent (80%) response in any of the surveys, are listed below.

Table PP 3
Features of Crested Butte Valued by Respondents

Features	2004		1995		1990	
	#	%	#	%	#	%
Beautiful scenery	494	96%	325	96%	142	97%
Clean air	486	95%	329	97%	120	82%
Clean water in lakes and streams	475	93%	314	93%	103	70%
Living in the mountains	464	90%	312	92%		
Abundance and variety of wildflowers	455	89%	302	89%	118	80%
Low crime rate	451	88%	321	95%	118	80%
Summer outdoor recreation opportunities	454	89%	299	88%	131	89%
Winter outdoor recreational opportunities	439	86%	285	84%	101	67%
Nearby designated wilderness areas	439	86%	293	86%		
Vistas (unobstructed views)	432	84%	301	89%	124	84%
Abundance and variety of wildlife	424	83%	286	84%	113	77%
Large expanses of open space with development in isolated areas	410	80%	272	80%		
Open space between developments in the valley	409	80%	272	80%	107	73%
Ability to get around without a car	402	78%	296	87%		
Small population	390	76%	298	88%	122	83%

At least seventy-five (75%) of respondents in 2004, and a higher percentage for every item listed in 1995, identified the following when asked which features, from a list of 16, should be preserved or remain undeveloped when a parcel of land is developed:

- Natural creeks and rivers
- Air quality
- Natural ponds or lakes
- Water quality
- Wetlands
- Wildlife movement corridors
- Wildlife habitat
- Open space
- Top of ridgelines

The last general question about development asked respondents to identify what should be provided as part of a development proposal from another list of 16 items. At least seventy-five (75%) of the respondents in 1995 or 2004 identified the following:

2004	**1995**	
82%	85%	Public access to public lands
80%	84%	Open space
77%	79%	Lake and river access
70%	78%	Affordable housing

Other surveys had similar results. The 2003 branding study, conducted by the Gunnison-Crested Butte Tourism Association to help determine what draws people to the County, found that the majority of responses centered on the county's natural landscape and rural flavor. Respondents

are quoted as saying they enjoyed the "hiking…bird watching…remoteness…laid back lifestyle and unspoiled natural beauty" in Crested Butte. [1]

In 2002 Gunnison County sponsored a community survey to gauge a wide range of opinions from citizens of the County. "The highest components that residents valued include scenery, clean air, open space, rural lifestyle, vistas, and view sheds." [2]

Respondents to a 2004 winter tourism and land development survey also valued natural attributes very highly. Given a choice of 21 attributes, "mountain views" was ranked the highest. "Snow quality" and "friendly people" ranked second and third. "Affordable lodging" and "general affordability" were next most important, but, "forested landscapes," "valley views" and "wildlife viewing" all ranked higher than the remaining tourism infrastructure attributes (such as "high quality restaurants" and "high quality lodging") and all the social/cultural attributes except "solitude and lack of crowds." The respondents spent an average of $1,550 per trip in Gunnison County, plus travel expenses between their front door and Gunnison County. Ninety-seven percent (97%) of the respondents indicated that their choice of Gunnison County for their winter recreation experience was "highly sensitive" to the county's current, relatively undeveloped and open rural and agricultural characteristics. [3]

The Successful Communities Workshop was held in November, 1991. Over 100 participants met in Crested Butte and Gunnison to discuss what people value about the Gunnison Basin, their visions for the Basin, and what to do to achieve those visions. In 1991, people valued the following that apply to the Middle Slate River Valley:

- clean environment
- incredible beauty
- solitude and isolation
- vast public lands
- variety of the landscape
- animals and wildlife
- the three major legs of the Gunnison basin economy (education, ranching and recreation)
- both rich and poor can live in our community
- the many public benefits of ranching
- the moderate growth rate
- the affordability of housing
- the income from second home owners who demand less service than full time residents
- the mining, ranching, skiing and mountain biking heritage of the valley
- old buildings and the National Historic District in Crested Butte
- skiing
- summer recreation opportunities
- close to home recreational opportunities
- small towns
- bicycle and foot transportation that can get us to our destinations in the towns in reasonable time
- excellent cultural benefits
- good restaurants and sufficient shopping
- recycling
- stimulating politics
- the people of the Gunnison Basin:
    - fun, friendly, caring

- lifestyle of choice
- tolerance
- genuine, “Real Thing”
- relaxed slow paced lifestyle
- united in our battle to protect our water
- environmentally conscious
- diversity of people

(1) “Shatter the Model,” Crested Butte News, 10 September 2004, p. 20.
(2) Focus Group Review Draft of the Gunnison County Comprehensive Plan, Crested Butte/Gunnison corridor, January, 2004, Page 4.
(3) Adam Orens and Andrew Seidl, “Winter Tourism and Land Development in Gunnison, Colorado,” 2004, (Economic Development Report for the Department of Agricultural and Resource Economics, Colorado State University, Fort Collins, CO) p. 8-13.

NATURAL HAZARDS TO DEVELOPMENT

AVALANCHE HAZARDS

Most of the information that follows is taken from the Slate River avalanche study for the Gunnison County Planning Office, and the Environmental Impact Statement for the Mt. Emmons Mine, 1981.

Thousands of avalanches occur throughout the Colorado mountains each year. The majority of these avalanches occur in remote regions. As with all other hazards, avalanches are usually not a problem for people, unless they have built structures in the path of a wildfire.

An avalanche path refers to the specific area in which an avalanche moves. Most paths are made up of three parts: the starting zone, the track, and the runout zone. Within the starting zone, the unstable snow breaks loose and accelerates. This zone typically consists of slopes between 60% and 100% (30 to 45 degrees). Slopes steeper than 100% are too steep to permit snow to adhere, thus small sluffs, rather than large avalanches, are common.

In the track, avalanches reach and maintain maximum velocity as the snow released from the starting zone moves down slope. Avalanche tracts may be confined by gullies or may be open slopes as wide, or wider, than the starting zone.

Avalanches decelerate and stop in runout zones. Runout zone slopes are more gentle than track slopes, and are sometimes flat. In some cases, the runout zone may extend partway up a slope of a reversed gradient. It is in this runout zone that the avalanche hazard may sometimes encounter man and his works.

After releasing, there are three forms of avalanche motion depending upon snow types and avalanche tracks: powder avalanche, flowing avalanche, and mixed avalanche.

Powder avalanches travel the longest distance in the runout zone and this must be considered when planning development. Powder avalanches can be predicted in a given path when steepness and irregularity of terrain causes sufficient velocity or fluidization of the avalanche.

Flowing avalanches refer to all avalanche types that move close to the ground. Dry flowing avalanches are 10 to 100 times denser than powder avalanches, but move more slowly and, as a result, tend to follow terrain features more closely. In spite of lower velocities, they are capable of higher impact pressures. Wet flowing avalanches are similar, forming heavy, wet snow with high densities and low velocities.

Mixed avalanches are a combination of dry flowing and powder avalanches, occurring when a portion of the mass of a dry flowing avalanche is whirled into turbulent suspension as a dust cloud.

Snow avalanche areas in the Middle Slate River Valley which may affect areas of existing or potential use by people are shown on the Avalanche Hazard map on page 8. Avalanche areas near the proposed Amax molybdenum mine in the Coal Creek drainage and in the Mt. Axtel area are also mapped. Other avalanche areas in the three mile area have not been mapped except in and near the Town of Mt. Crested Butte.

Avalanches in the Middle Slate River Valley are widespread. Most of the avalanche paths studied occur on open, unforested slopes. This enables single avalanche releases to extend for long distances because slab fractures in the snowpack would not necessarily be limited in length by ridges. Portions of paths north and south of Oh-be-joyful Creek can produce low density powder avalanches so large and fast-moving that they can travel completely across the valley and impact the opposite valley wall.

A very large avalanche, of the type described above, occurred in 1976 on the slopes south of Oh-Be-Joyful Creek. The avalanche released from an elevation of about 11,200 feet and dislodged and incorporated more than 60 acres of snow from the northeast facing slope. This slope averages more than 35 degrees. The released snowslab quickly developed into a mixed dry flowing and powder avalanche, and reached the valley bottom at a very high velocity, probably in excess of 170 miles per hour. After reaching the flat valley floor, the dense lower layer of the avalanche traveled approximately 1,000 feet before coming to rest against the northeast side of the Slate River. The less dense powder avalanche did not stop there. It destroyed about one acre of mature pine trees and ran an additional 700 feet. The mature trees were more than 100 years old. The "air blast" managed to carry small pieces of pine tree limbs about 600 feet further, depositing some of them as much as 150 feet above the Slate River. Including the air blast zone, the total runout zone length was about 2,300 feet.

In 1996 another large avalanche occurred on the south side of Mt. Emmons. This avalanche began in Red Lady Bowl and came down through the Kebler Pass Trail head across the Keystone Mine, Kebler Pass, and Trapper's Crossing at Wildcat roads. It picked up many parked snowmobiles and carried them across Coal Creek. The avalanche ran down Mt. Emmons to Coal Creek at the bottom of the valley and the runout zone rose about 50 feet above the creek on the opposite side of the valley.

Most of the avalanche zones mapped along the Slate River in the Middle Slate River Valley are high hazard zones. Avalanches within this zone have return periods of 25 years or less and will produce impact pressures of 600 pounds per square foot or more. The high hazard zone is characterized by either high frequency, high impact pressure, or both.

The bottoms of the avalanche zones in the Slate River area are labeled moderate hazard zone. Avalanches within these zones will occur at return periods in excess of 25 years and will have impact pressures of less than 600 pounds per square foot. Avalanche frequency and impact pressures decrease toward the outer limits of these zones. When large avalanches occur and run to the outer boundaries of these zones they can be very destructive in spite of their reduced probability and pressures.

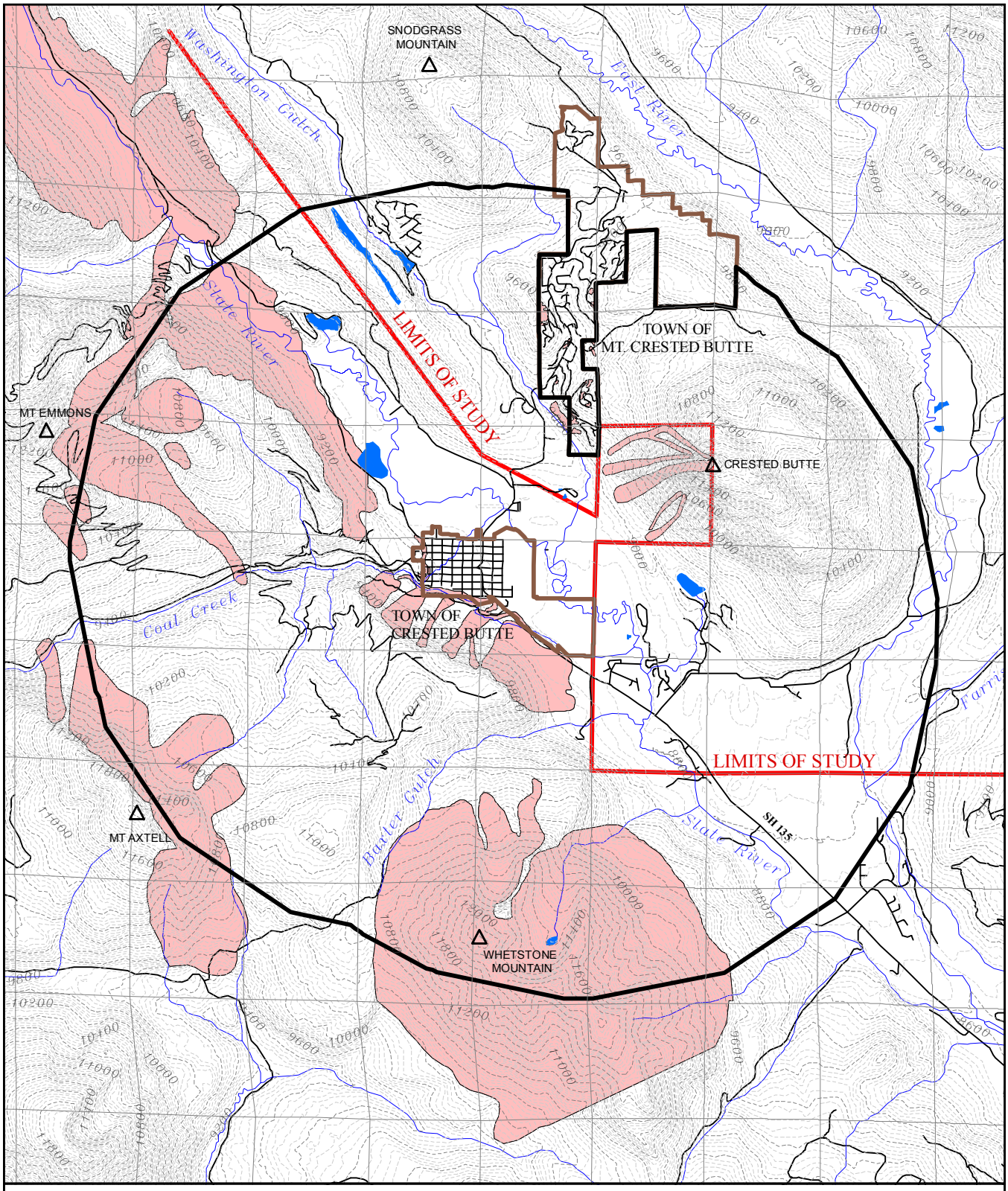
Avalanches are one of many imperfectly understood natural phenomena. The large, infrequent avalanches of interest for planning purposes have seldom been observed and have almost never been monitored to determine velocities, densities and impact pressures. In view of the uncertainties inherent in avalanche analysis and in the obvious consequences of inadequate design of structures, it is strongly recommended that an especially conservative approach be taken to design and planning within or adjacent to these areas.

Avalanches become a problem when buildings or infrastructure are constructed in the lower parts of avalanche paths that are reached by avalanches only rarely. The difficulty is determining how far this rare avalanche will go and its destructive force. Since avalanches reach their potential limit at infrequent, irregular intervals and man's direct observational record in most areas is short, it is unlikely that an extreme event will have been observed.

Land threatened by avalanche danger can be used so it will not conflict with the hazard. Examples of such uses include agriculture and open space summer uses which avoid avalanche complications. If dwellings are to be built within areas of potential avalanche hazard, then the degree of hazard must be defined much more precisely. This information should be presented on a detailed map (scale 1:2,000 or larger) showing the topographic details of the avalanche track, the runout zone where the most serious problem usually exists, and especially the part of the runout zone which is seldom reached by avalanches. The runout zone is of great practical importance in land use considerations because, on casual examination, such land appears most suitable for development.

Structures can be engineered to withstand the maximum pressure any avalanche can produce but the derivation of pressure zones through assumption of a dynamic model is an inexact procedure. For this reason, proposed development in or near the hazard areas must be accompanied by detailed avalanche studies conducted by qualified experts, providing information about:

- area extent of the runout zone,
- impact pressure distribution within runout zone,
- avalanche frequency,
- avalanche discharge, and
- avalanche flow depth.



Avalanche Hazard

- 3 Mile Boundary (MSRV)
- Town Boundary
- Streams
- Lakes
- Roads
- Section Lines
- Avalanche Hazard

40' Topographic Contours

- index
- interval

0 0.5 1 2 3 Miles

N W E S

CRESTED BUTTE, COLORADO
A National Historic District

SOURCE: Gunnison County Planning Dept.
Mt. Emmons Mining Project E.I.S., 1981
Mears, Art, 1980, Avalanch Hazards in the Mt. Emmons Project Area.
Mears, Art, 1987, snow Avalanche Hazard Analysis, Gibson Ridge Area, Crested Butte.
Town of Crested Butte Archives.
Town of Mt. Crested Butte

Drawn by: Hilary Mayes Date: June 22, 2005
Filename: C:/project/areaplan/2011/avalanche.mxd

FLOOD HAZARDS

Information for the floodplain map for the Crested Butte Three Mile Plan was taken from:

- the Flood Insurance Rate Map produced for the National Flood Insurance Program, Gunnison County, Colorado, 1989,
- the Floodplain Information Report for Coal Creek, Crested Butte, Colorado, 1992,
- information provided to the Town during review of the Kapushion Annexation, and
- information provided to the Town during review of the Verzuh Annexation.

The Flood Insurance Rate Map does not identify all areas subject to flooding, particularly from small local drainage sources. Most of the information that follows has been taken from Nature's Building Codes, Geology and Construction in Colorado, 1979.

Characteristics

Flooding is the overflowing of water onto land that is normally dry. Flooding occurs when soils become saturated from prolonged rains and/or snowmelt. If runoff or rain continue, water begins to accumulate faster than it can be absorbed or carried away in stream channels. Stream levels begin to rise and eventually overflow the normal stream channel. The gradual rise in water levels may take a few hours or a few days. The Slate and East Rivers experience floods like this each spring.

Tributaries and the larger rivers in the Middle Slate River Valley can also experience flash flooding which happens so fast that little warning can be given.

The mainstream of a flood (floodway) is swift and destructive. The overflow onto the floodplain is less forceful but still destructive. Flood waters are loaded with sediment and debris which become agents of destruction in addition to the water itself. Streams may also change their course during a flood, cutting a new channel within the floodplain.

Consequences

Flood damage is caused by the force of the water itself, the saturation of land and property, the erosive nature of the water and deposition of mud and debris. The whirling waters, their erosive capability increased by sediments and debris, undermine bridges, buildings, and other improvements. Homes, trailers, trees, signs, and other items swept away by the flood waters can jam against bridges, fences, buildings, utility poles, and other structures, resulting in "backwater" damage. Sewer and water lines may be ruptured and utility lines downed. The loss of human and animal life is a possibility in any flood. As the flood waters recede, sediment and debris covers the inundated areas.

The frequency, extent, and degree of damage from flooding are directly related to land use. As natural features such as open land, trees and grasses are replaced with paving, buildings and other improvements, there is a resulting increase in the amount and rate of runoff because the natural areas can no longer absorb the water. A variety of structures including homes erected in floodplains are not designed to withstand floods, and not only may be damaged or destroyed, but often become debris and an aggravating factor in increasing damage to other property.

Flooding is a natural process which only becomes a hazard to people when they build and develop in flood-prone areas. People can also create new and enlarged floodplains. As communities grow, storm runoff from new development can be channeled through older areas. The additional water that is generated cannot be handled in the historic manner and flooding of

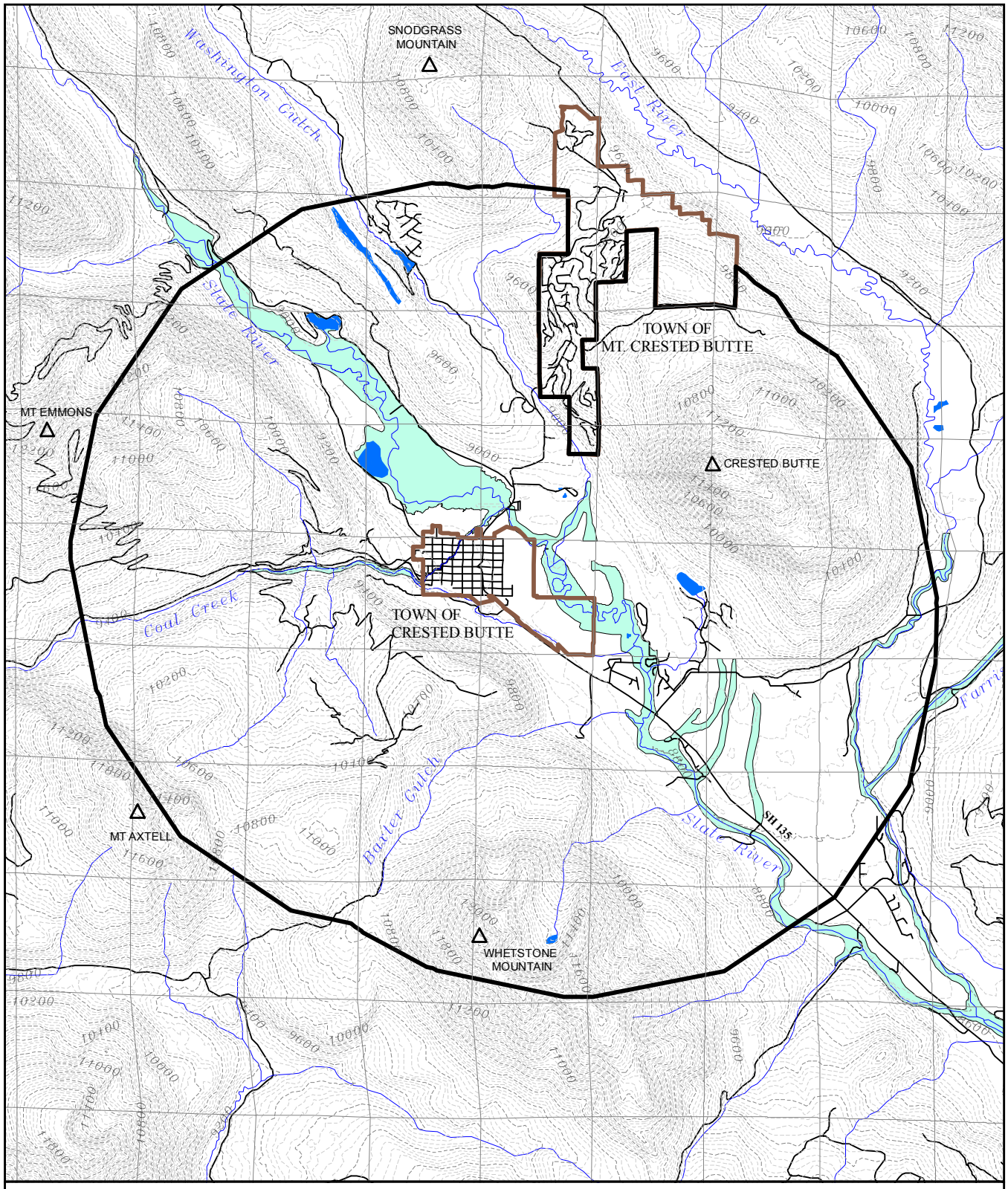
previous flood free areas results. In the Middle Slate River Valley, older developed areas such as Riverbend may be affected in this way if development is allowed upstream.

Mitigation

The least costly way of minimizing flood damage is to avoid intense development on floodplains. Essential improvements such as highways, bridges and utility lines can be designed to withstand floods. Farming, livestock grazing, woodlands, and sand and gravel mining are appropriate uses of floodplains. Fringes of drainageways can double as hiking and bicycle paths and garden areas.

Preservation of natural drainageways as open space in developed areas permits land to serve more than one beneficial use. In developing areas, detention basins can effectively store and slow down the velocity of high water, lessening the likelihood of flood damage. Detention basins are bowl shaped holding areas where runoff waters can accumulate and drain off later through normal channels at lower volumes and velocities. Parks, playgrounds and parking areas can be useful in this way and they can be cleaned up relatively easily after a flood. Keeping natural and manmade drainageways open and free of debris and keeping low lying areas undeveloped helps minimize the damage from high water.

Storm sewers, drop structures, channelization, and irrigation ditches can be used to dissipate floodwater energy and to direct high water away from or through developed areas to another location. Floods usually subject several governmental jurisdictions to a natural, though man-aggravated, hazard. Consequently, flood control, drainage and land use programs and policies must be on a regional or river basin basis if damage from floods is to be minimized. Otherwise, one area might be protected at the expense of another.



Flood Hazards

- 3 Mile Boundary (MSRV)
- Town Boundary
- Streams
- Lakes
- Roads
- Section Lines

40' Topographic Contours

- index
- interval
- 100 Year Floodplain

0 0.5 1 2 3 Miles

N W E S

CRESTED BUTTE, COLORADO
A National Historic District

SOURCE: Flood Insurance Rate Map, Crested Butte, CO 9/04/85; Flood Insurance Rate Map, Gunnison County 09/29/89; Del-Mont Consultants, Inc. 11/03/94; Schmueser Gordon Meyer, Inc. 07/16/01

Drawn by: Hilary Mayes Date: June 22, 2005
Filename: C:/project/areaplan/2011/floodpl.mxd

GEOLOGIC HAZARDS

Geologic hazards were mapped for most of Gunnison County, including the Middle Slate River Valley, by James M. Soule of the Colorado Geologic Survey (CGS) in 1975. In 1974 and 1979 the Colorado Geological Survey published two documents designed to guide development in geologically hazardous areas. The publications are: Guidelines and Criteria for Identification and Land-Use Controls of Geologic Hazard and Mineral Resource Areas and Nature's Building Codes, Geology and Construction in Colorado. Most of what follows summarizes information in these three publications.

Geologic hazards in the Middle Slate River Valley are natural conditions and processes that, if unrecognized or inadequately planned for, can result in damage to structures and costly maintenance (especially for homes, other buildings, roads and utilities) or loss of life.

In 1979, the CGS estimated that Americans sustain more than $1 billion in damages annually from landslides, mud flows, ground subsidence, avalanches and other common earth movements. Earthquakes are not included in this annual figure. In addition, there can be loss of life. While no specific figures have been compiled for Colorado annually, the price tag is in the millions of dollars. It has been estimated that losses "could be reduced 90 percent or more by a combination of measures involving adequate geologic interpretations, good engineering practice, and effective enforcement of legal restraints on land use and disturbance." (1) This section describes identified, potential, geologic hazards in a three mile area surrounding Crested Butte.

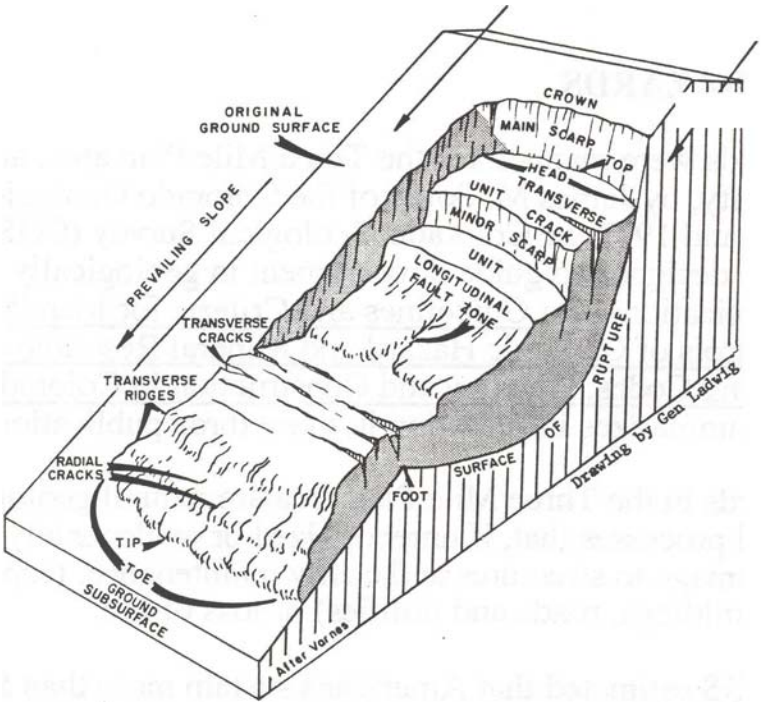
The geologic hazards mapped in the area by Soule include landslides, unstable slopes, potentially unstable slopes, and mud flow and/or debris fans. All of these mapped hazards indicate places where slow to rapid movement of earth materials downslope is occurring, has occurred in the past, or can be expected to occur under certain man-caused or natural conditions. Seismic faults were added to the Crested Butte Three Mile Plan Geologic Hazards Map by Crested Butte Town Staff using information from U.S.G.S. quadrangle maps of the surface geology in the area. (2) Other geologic hazards such as collapsing soils, and subsidence are not mapped in the Middle Slate River Valley because they do not occur here. A summary of the issues involving each mapped geologic hazard follows:

Landslides

A landslide is a mass movement of natural material where there is a distinct surface of rupture, or zone of weakness, which separates the slide material from more stable underlying material.

Landslides are widespread, naturally-occurring geologic events throughout the Middle Slate River Valley. They usually involve a mass which moves as one unit downward and outward. Landslides are usually characterized as dry rock surface material in contrast to mud flows which include movement of a cohesive and sticky fluid material with high water content. Mud flows also lack a distinct surface of separation.

A landslide can occur in several different ways. It may be rapid and of short duration, or it may consist of intermittent periods of active movement separated by relatively inactive periods. It may involve slow, continuous movement over a considerable period of time and may involve isolated, smaller slides occurring within the body of a large slide.



Diagramatic drawing of a rotational landslide

Reprinted from "Guidelines and Criteria for identification and Land-Use Controls of Geologic Hazard and Mineral Resource Areas"

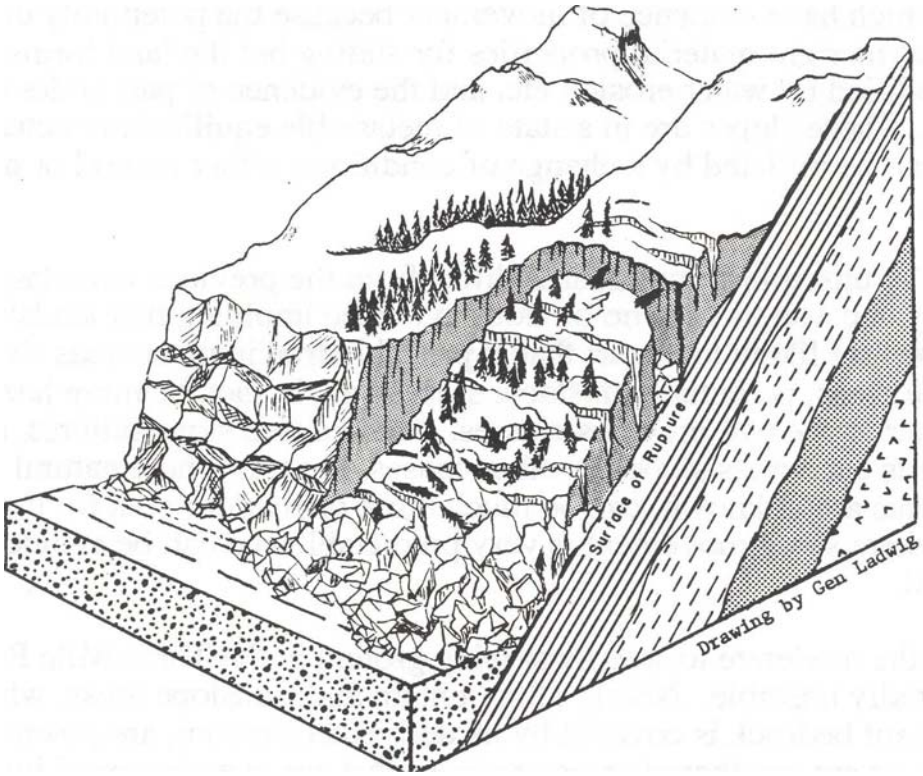
Selected Rotational Slide Terminology

Main Scarp:	steep undisturbed ground surface above the highest part of the slide, resulting from downward movement of slide material
Crown:	in-place material just above the main scarp
Head:	uppermost part of slide material along the contact between the main scarp and the slide material
Radial cracks:	tension cracks resulting from lateral spreading of unconfined slide material
Surface of rupture:	projection of main scarp surface beneath the slide mass

For most moderate to high intensity land uses prevalent in the Crested Butte area, landslides and/or earthflows are serious hazards. These areas are usually high-cost, difficult areas for most developments. Development practices that result in undercutting, wetting, overloading or oversteepening of slopes can cause accelerated slope movements and result in even greater problems that may be impossible to rectify. Lower intensity uses such as utility lines and ski trails are generally possible, but more intensive uses such as buildings, heavy structures and roads are usually feasible only with careful planning and engineering. Maintenance of structures in active slide areas can be costly and, in many cases, may equal or exceed the price of the structures prior to expiration of their useful life.

Unstable and Potentially Unstable Slopes

An unstable or potentially unstable slope is an area susceptible to a landslide, a mud flow, a rockfall, or accelerated creep of a slope-forming material.



Diagramatic drawing of a translational landslide

Reprinted from *"Guidelines and Criteria for identification and Land-Use Controls of Geologic Hazard and Mineral Resource Areas"*

Unstable slopes are common under both natural and modified conditions. Natural factors contributing to instability include weathering, erosion, hydrologic changes, earthquakes, and slow natural deterioration of strength in slope-forming materials. Artificial factors include redistribution of mass by cut and fill operations, alteration of surface drainage, blasting, or heavy vehicular traffic.

Unstable slope areas are places with landforms characteristic of landslides and earthflows, but where current or very recent activity of these slope failure processes is non-existent or uncertain. The distinguishing characteristic is that active landslide/earthflow areas show obvious evidence of current movement, whereas unstable slopes do not. However, all of the areas mapped as unstable slope have undergone slope movement in the recent geologic past.

Hazards in unstable slope areas differ from landslide/earthflow areas. In the case of the latter, an active process is taking place, and in the case of the former, a slope failure process can be initiated by the activities of man.

Many of the unstable slopes in the Middle Slate River Valley are suitable for low to moderate land uses if the nature of the hazard is well-understood and considered seriously in development plans and in subsequent construction. Construction of roads, benching and deep cuts for building foundations can be especially problematical in these areas.

Potentially unstable slopes are more widespread. They differ from unstable active areas of landslide, mudflow and rockfall in that, rather than being an ongoing process, it is an imminent one. Such slopes may be composed of natural rock, soil, artificial fill, or combinations of these materials. They are in a state of metastable equilibrium and actual slope failure can be initiated by a change of conditions; either natural or man induced.

Potentially unstable slope hazards differ from the previous two classes primarily because there is no obvious evidence implying that landslides and earthflows are likely to occur. That is probably true in most areas so mapped. For some areas, potentially unstable slopes can be more hazardous than either of the two previous classes. Man-caused slope failures resulting from roads cut across slopes or other causes in areas where natural slope movements are unknown, can be much more difficult to plan for than in places where slope movement is predictable and can be avoided or mitigated.

Most of the moderate to steep slopes in the Middle Slate River Valley are potentially unstable. Nearly all mountain and sideslope areas, where weak nonresistant bedrock is covered by its derived colluvium, are potentially unstable. Weathered areas or slopes that are oversteepened by erosion, or for other reasons are excessively steep, can also be potentially unstable.

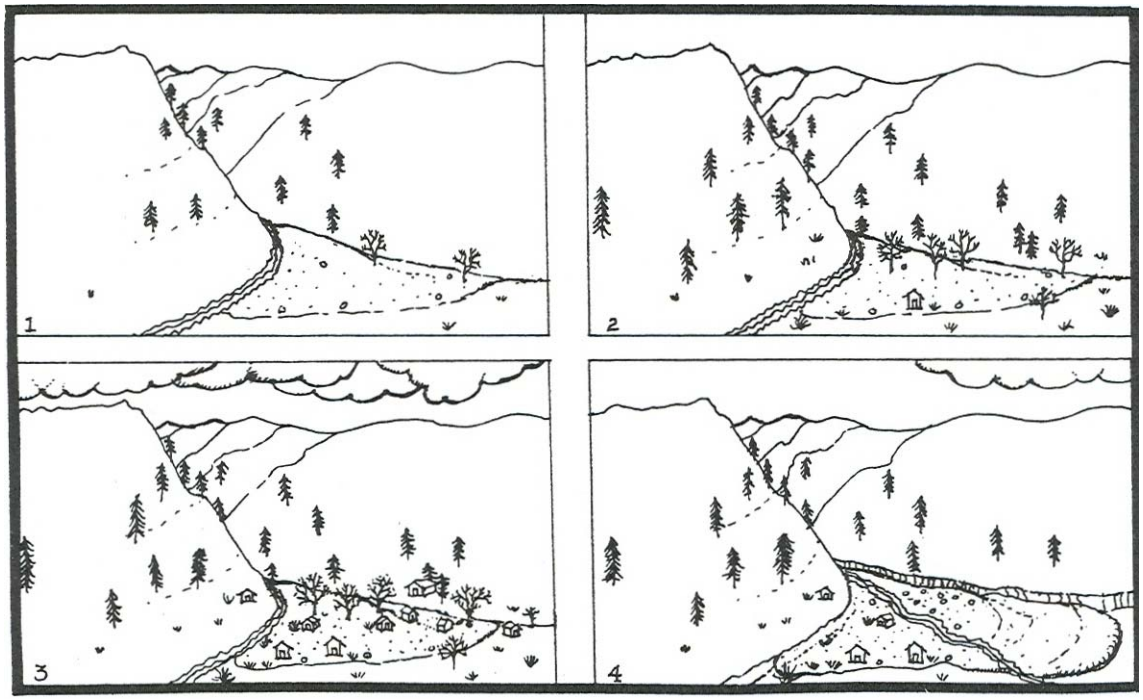
Problems resulting from these slopes depend on the rate of movement and the cost or difficulty of repairing and replacing man-made structures. Generally, as construction costs rise, or the complexity of the structure increases, repair costs and the time to repair also increase after slopes have moved. As the rate of movement increases, the damage also increases. Where movement is slow, structures such as roads, walkways and powerlines can be repaired or re-aligned and the expense tolerated.

Mudflow and Debris Fan Areas

Mud flow and debris fan areas are typically made up of the following three elements:

1. a source of mud and debris, usually in the upper reaches of a drainage basin or its contiguous sideslopes
2. a drainage way or other channel down which this mud and debris can move
3. a debris or “alluvial” fan formed by successive episodes of deposition of mud and debris

A mudflow is a mass of water and fine-grained earth materials that flows down a stream, ravine, canyon or gulch. If more than half of the solids in the mass are larger than sand grains (rocks, stones or boulders) the event is called a debris flow. Mud and debris flows are usually initiated by high-intensity summer rainstorms or rapid snowmelt runoff that mobilizes accumulated sediment and debris. This moving material is channeled into a drainage way, and eventually is discharged onto the debris fan where it is deposited.



Debris and mudflow fans frequently offer scenic building sites in mountain valleys. This case illustrates the problems that can occur on such sites.

1. This first box represents a time in the past, shortly after a debris flow that removed many of the trees and left the channel on one side of the fan.
2. Some years later the soil and vegetation have recovered and the fan shows little evidence of past debris flow events.
3. People develop the fan area with housing.
4. An intense cloudburst causes a debris flow which destroys structures and vegetation and moves the channel to a new location until the next event.

Reprinted from *"Nature's Building Codes" Geology and Construction in Colorado*

Debris and mudflows are a combination of fast moving water and a great volume of sediment and debris that surges downslope with tremendous force. The consistency is similar to pancake batter. They are similar to flash floods and can occur suddenly and without adequate warning. When the drainage channel becomes less steep, the liquid mass spreads out and slows down to form a part of a debris fan or a mudflow deposit. In the steep channel itself, erosion is the dominant process as the flow picks up more solid material. A drainage may have several mudflows a year, or none for several years.

A debris fan is a sloping, wedge-shaped deposit of loose rock, earth and vegetative debris near or at the junction of a smaller stream with a larger stream valley, or where the gradient of a stream abruptly decreases. The stream which deposited the fan normally traverses or runs along one of the edges of the fan.

Many stream valleys in the Middle Slate River Valley have debris fans that were built up over the centuries at the mouth of the stream valleys. They appear to offer attractive places for development. Frequently, in an effort to avoid mainstream flooding, debris fans are proposed for

development without the realization that they too are subject to periodic debris flows and flooding.

Usually, the destructive forces of the debris flows decrease as one moves from the narrow, steep apex of the fan to the broader, gentler slopes down gradient. Correspondingly, the size of the material deposited decreases as the debris flow moves across the fan. Debris fans often are vegetated with cottonwood or aspen trees, grasses and shrubs in distinct contrast to adjacent plant growth. Some debris fans are also subject to avalanches.

Structures and improvements on the apex of the fan may be destroyed or badly damaged while improvements farther down on the fan may experience milder water and mud damage. The heavy mass can push in walls, remove buildings from foundations, fill in basements and excavations, and sweep away cars. Boulders and trees, swept along by the muddy mass, can demolish buildings and flatten fences and utility poles. Even lower intensity land uses such as roads and utilities can be seriously jeopardized, resulting in loss of service and high maintenance costs. Erosion and deposition on an active fan by successive debris flows is to be expected. Removal of vegetation on steep slopes, dumping debris and fill in a mud flow path and improper road building or earth moving can contribute to a mudflow. The failure of a dam, irrigation ditch or other water management structure can initiate a mud/debris flow if the escaping water can swiftly accumulate a large volume of soil materials.

Mitigation requires an understanding of the natural processes of a debris fan and locating and constructing improvements accordingly. Measures that can be taken to decrease the hazard include building massive earth structures on the uphill side of houses or other improvements to divert the flow to one side or the other, planting a dense row of trees, erecting retaining walls, and channeling the stream. These measures should be considered only after a complete understanding of the process is obtained because in many instances they could be of little benefit and could even increase the hazard to other developed areas.

To prevent loss of life and property damage, areas subject to mudflows and debris flows should not be developed. Land uses on debris fans should range from open space to low intensity uses.

Seismicity

Geologists recognize that many of the state's mountain ranges and basins are geologically youthful and that the faults associated with them continue to move and have the potential for generating earthquakes. In the last few decades, earth movement has been detected by seismographic instruments. Most of the earthquakes were quite small, but several exceeded Richter magnitude 5 and caused severe ground-shaking locally. Colorado is a moderately active earthquake area and in time larger earthquakes may occur.

Probably the largest quake ever felt in Colorado occurred November 8, 1882. Its intensity has been estimated as high as 6.5 on the Richter scale. It was felt throughout the state and in several adjacent states. Accounts of the quake suggest it was centered north of Denver near present day Broomfield or Louisville.

A powerful earthquake occurred near Crested Butte in 1880. The event occurred near midnight and brought residents out of their homes. Other earthquakes in the area occurred in 1940 and 1941 near Aspen, and 1984 near Carbondale.

More recently, earth movements were felt in the Crested Butte area in 1986. They were centered in the Ruby Range near Paradise Divide. An intense sequence of at least 200 events occurred

between August 12th and September 23rd. Sixteen of the earthquakes were felt locally and ranged from 2.0 to 3.5 on the Richter scale.

Earthquakes are caused by fault movements within the earth that produce vibrational waves which are transmitted through the ground. Interaction of these earthquake vibrations with the nearby surface and with the works of man results in the damage and destruction that often accompanies moderate and larger-sized earthquakes. The adverse effects may include severe ground-shaking in the epicentral region and possible ground rupture and displacement in the fault zone. In cases of adverse conditions, ground failure, such as landslides, soil settlement, soil liquefaction and ground cracking, may occur.

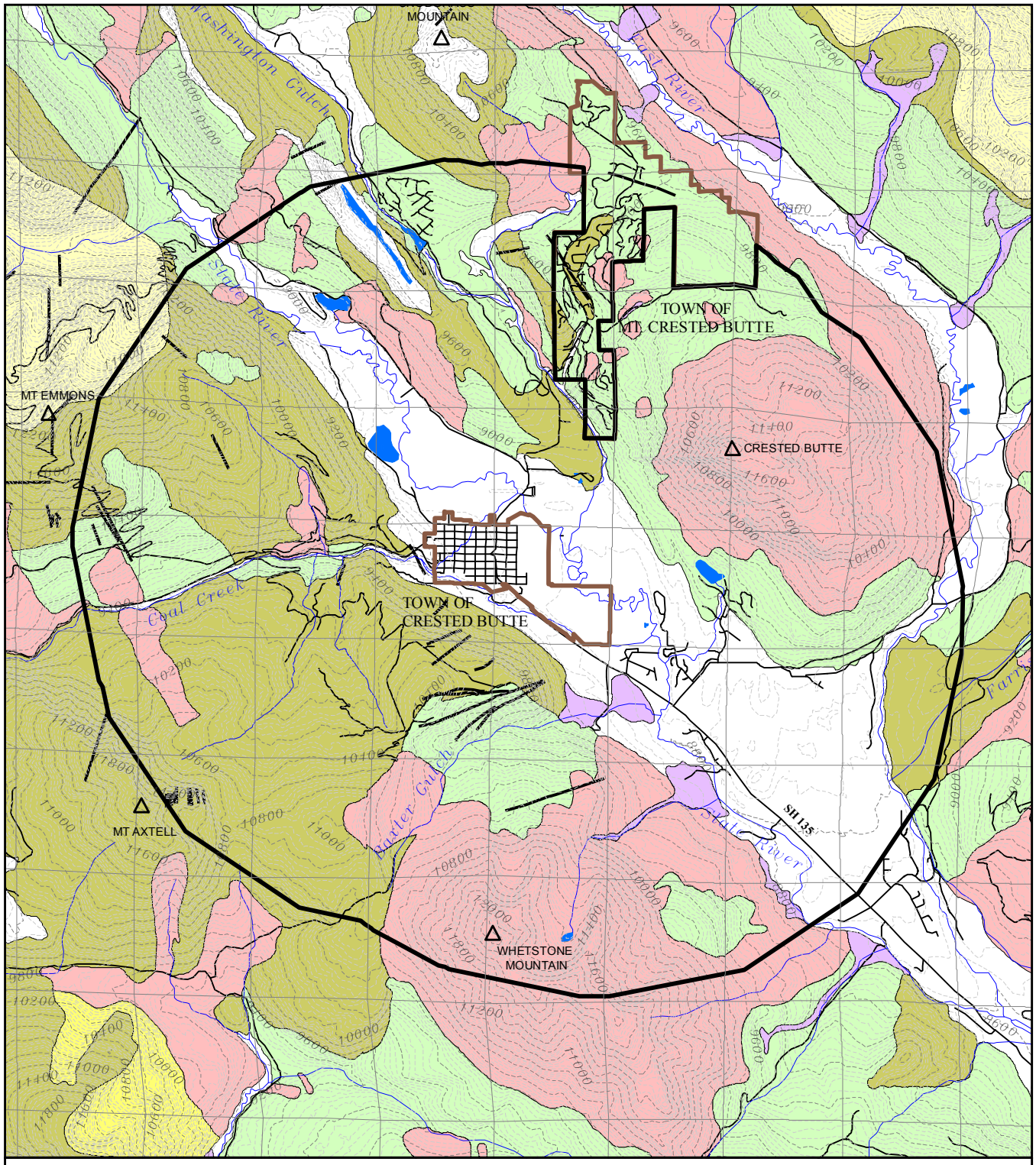
The faults mapped on the Geologic Hazards map are those that are evidenced in the surficial geology (surface geology) of the area. When the location of active faults in an area is well known and surface rupture and displacement are known to accompany earthquakes, building near faults should be avoided completely. Only when there is no alternative should certain transportation and utility corridors be built near faults.

Mitigation of earthquake damage deals primarily with the broader effects of ground-shaking on actual structures. It also deals with preventing associated effects such as landslides, through careful and conservative engineering designs and building codes consistent with the actual seismic hazard.

Development activities and structures that have the potential for severe offsite impacts are a special category of development near faults. Included in this category are large tailings impoundments, large reservoirs, hazardous waste storage, deep fluid disposal wells, and any other activity where a malfunction due to an earthquake could cause serious adverse effects to adjacent lands. Such facilities should receive careful seismic analyses and conservative engineering designs consistent with the earthquake risk of their locations.

(1) Landslides: Analysis and Control, Special Report 176, Robert L. Schuster and Raymond J. Krizek, Editors; National Academy of Sciences, 1978; 234 pages.

(2) Geologic Map of the Crested Butte Quadrangle, Gunnison County, Colorado; D. L. Gaskill, Steven M. Colman, J. E. DeLong, Jr., and Charles H. Robinson; U.S. Geological Survey; 1986.
Geologic Map of the Gothic Quadrangle, Gunnison County, Colorado; David L. Gaskill, Felix E. Mutschler, John A. Thomas, and Stephen G. Zahony; U.S. Geological Survey; 1991.
Geologic Map of the Mt. Axtell Quadrangle, Gunnison County, Colorado; D. L. Gaskill, J. E. DeLong, Jr., and D.M. Cochran; U.S. Geological Survey; 1987.
Geologic Map of the Oh-Be-Joyful Quadrangle, Gunnison County, Colorado; David L. Gaskill, Larry Godwin, and Felix E. Mutschler; U.S. Geological Survey; 1967.



Geologic Hazards

- 3 Mile Boundary (MSRV)
- Town Boundary
- Streams
- Lakes
- Roads
- Section Lines

40' Topographic Contours

- index
- interval
- Faults

Geologic Hazards

- LANDSLIDE-EARTHFLOW AREA
- UNSTABLE SLOPE
- POTENTIALLY UNSTABLE SLOPE
- MUDFLOW-DEBRIS FAN
- ROCKFALL AREA
- UNKNOWN

N W E S

CRESTED BUTTE, COLORADO
A National Historic District

SOURCE: Colorado Geologic Survey, 1975, James A Soule
U.S. Geologic Survey Geologic Quadrange Maps:
Crested Butte (GQ 1580), Gothic (GQ 1689), Mt. Axtell
(GQ 1604) and Oh-Be-Joyful (GQ 578).

0 0.5 1 2 3 Miles

Drawn by: Hilary Mayes Date: May 4, 2005
Filename: C:/project/areaplan/2011/geologic.mxd

WILDFIRE HAZARDS

Wildfire Hazard Map

The Wildfire Hazard map for the Middle Slate River Valley was created by the Gunnison County Long Range Planning Office. Information sources for the Wildfire section and the Wildfire Hazard map include: the U.S. Forest Service, the U.S. Geological Survey (USGS), the Colorado State Forest Service (CSFS) and the Crested Butte Fire Protection District.

What are Wildfires?

Wildfires are natural or human caused events that burn native vegetation and human made improvements. As with all other hazards, wildfires are usually not a problem for people unless they build structures in the path of a wildfire. Wildfires can occur in all seasons of the year. The fuels are more hazardous during certain times of the year and during droughts, when vegetation dries out.

The wildfires of concern are those which, once started, may become disastrous. Disastrous, in this context, means loss of life and destruction of improved property or natural resources. Crown fires that advance through the tops of trees or shrubs, more or less independent of the overall fire, are the type of fire to be most feared because most modern fire fighting methods are ineffective in stopping such a fire. Crown fires burn with a rapidly advancing wall of flame often more than 100 feet high. If conditions remain favorable to such fires, several hundred acres can burn hourly.

The best case scenario presented in the August, 2004 journal "Conservation Biology" predicts a 100% increase in wildfires by the end of the century due to projected changes in climate in western states.(1)

Wildfire Hazard Mapping

The process to map wildfire hazard areas used a rating score for various wildfire factors as shown in Appendix III. The three major criteria when mapping wildfire hazard areas were Fuels, Slope and Aspect. Wildfire mapping also considered Ladder Fuels, Forest Density, and Insects and Disease.

As part of the wildfire mapping analysis, wildfire hazard labels of "Extreme, High, Moderate, Low or None" were applied to all parts of the Middle Slate River Valley on the Wildfire Hazard map. Generalized explanations of these categories are shown below:

Extreme:

Extreme wildfire hazard areas are areas supporting mixed or high-density conifers, heavy deadstanding or down trees, and conifer species with heavy burst understory on steep hillsides. Tree crowns are often touching. The burning characteristics are high intensity, long-burning fires during critical fire weather. Long-range spot fires of more than one-quarter (1/4) mile are common. The rate of spread is slow to very fast and flare-ups are frequent to continuous. Tree crown fires are possible. Just-burned areas are untenable by humans for an hour or more. The fire front is impassable. Extreme wildfire hazard areas are located throughout the Middle Slate River Valley hillsides, especially in the southwest portion.

High:

High wildfire hazard areas are areas that score lower than Extreme areas but are similar. They are generally on steep hillsides but the vegetation may not be as mature, making crown fires less likely. In these areas the fuels may be dense, high brush, 1-1/2 to 10 feet in height. They include dense conifer saplings taller than one foot. Small and scattered patches of conifers or deciduous trees may also grow in these areas. The fuels are continuous or nearly so. Flammability may vary markedly during the year due to changes in fuel moisture and leaf fall. Fire does not usually kill the brush species. They may re-sprout after fires with more numerous thin-stemmed fuels than before. Brush fuels reach maturity sooner than forests and thereby can be expected to burn more frequently than forests.

Moderate:

An example is a medium density conifer stand in which tree crowns are close but not touching. The burning characteristics of this fuel type support medium intensity fires. The rate of spread is slow to fast and flare-ups occur intermittently. Just burned areas are tenable by humans in about one-half (1/2) hour. Moderate fuel types are located throughout the Three Mile Plan, especially in the northeast portion.

Low:

Some examples would be grasses, alpine areas, dryland crops or streamside plants. Where steeper slopes and high grasses occur, and where ranching and wildlife have been displaced, grasses will increase and the grass and brush fire hazard increases.

Consequences of ignoring the Wildfire Hazard threat

Consequences of wildfire include flame fronts that are impassable by humans and wildlife, consumption of flammable vegetation, destruction of improperly designed structures, and sharp decreases in property values. Dangers to humans can vary from minor to fatal. Long-term impacts can include soil erosion, stream siltation, landslides, and loss of reservoir capacity. Another consequence of wildfire is the cost of fire fighting.

In Colorado, counties can participate in the Emergency Fire Fund (EFF). The EFF is a trust fund established by member counties into which they pay annual assessments. It is administered and implemented by CSFS. In the event of a wildfire, a member county may apply to the State Forester for EFF assistance. If approved, EFF will assist in paying for suppression costs. Gunnison County received EFF approval for the Wiley Ridge fire in 2002 and the Oso Creek fire in 2003. The total cost to fight the Wiley fire was $150,000. The Wiley fire was a 1,084 acre forest and sagebrush fire. Approximately three-quarters (¾) of the burned area was sagebrush allowing it to be mopped up quickly. The costs would have been much higher if the entire fire had been timber.

If fire suppression requirements exceed a county's resources and state or federal agencies are asked for assistance, the county, state, and/or Federal Emergency Management Agency (FEMA) must bear the wildfire suppression costs. For example, in Larimer County, a plane crash on private property started a fire that burned 2,400 acres in eight hours. Fire fighting continued for one week and the county was responsible for $250,000 in costs incurred by the state and the United States Forest Service.

Minimizing Wildfire Hazards

In areas where the wildfire hazard is significant, minimum lot size should increase as slope and amount of vegetation increases. Minimum lot sizes should increase and other modifications may be required when development is proposed in areas where slopes are thirty (30) percent or more. An alternative to larger lot sizes is clustered development, with considerable open space on the property. Clustered development can be an effective means to minimize damage to improvements and the increased threat of wildfire due to human occupation of the land.

For planning purposes, developments should be designed with extreme fire weather conditions in mind. These conditions of high winds, low humidity, and high temperatures may occur only once every two or three years. However, when extreme fire weather is present, a disastrous wildfire is very likely to occur. Similar thinking is used in determining safe wind and snow loading specifications for building codes. Design should include wildfire safety zones for temporary public evacuation during fires. Roads should be designed to provide more than one ingress/egress to a subdivision during a fire and all lots should abut public roads so fire fighting equipment has legal access.

Generally, mitigation measures involve reducing fuels and ignition sources and providing fire fighting capability in developing areas. Examples of these measures are described below.

Fuel modification or treatment includes:

- Chip or burn, under safe conditions, all slash materials that are not to be used as poles, posts or firewood.
- Maintain a large strip around all structures that is free of dead grass and dead trees.
- Prune dead branches to a height of at least 10 feet above the ground. This applies to all trees within two tree heights of structures.
- Thin vegetation near structures, thereby creating large spaces between potentially flammable natural fuels and structures.
- Stack firewood uphill of structures.
- Thin forested areas according to the Firewise Publications or CSFS recommendations, or the CBFD. (Firewise is a Colorado State Forest Service program that helps homeowners and builders prepare sites to address wildfire.)

When building roads or structures, the following measures can reduce wildfire hazards:

- Fire spread rates increase with slope. Fire spreads twice as fast on 30% slopes as on flat ground. When the slope reaches 55%, the rate of spread doubles again. Due to this natural uphill phenomena, structures should be restricted from vegetated hillsides until evaluations and recommendations have been completed by the CSFS or the CBFPD.
- Structures should be set back from the top of ridges because as fires move up hillsides, they swirl at the top of a ridge. Structures near the edge are more prone to catch fire than those that have been set back from the edge. The chart below presents the recommended distances structures should be set back from the edge of hillsides:

Table W 1
Recommended Distances
from the Edge of Hillsides to Structures

Hazard Labels	Distance Between Structures and Hillsides (feet)
Moderate	30
High	50
Extreme	100

- Decks and big flat structures extending over the edge of steep hillsides are discouraged. Such structures provide large flat surface areas for exposure to fires.
- Building materials that are less likely to catch fire are encouraged.
- Discourage large soffits because they trap fire under eaves.
- Vents and accesses should have screens with 1/8" openings to prevent embers entering.
- Maintain a large strip around all structures that is free of dead grass, weeds, fallen trees and other debris.
- Prune dead branches to a height of at least 10 feet above the ground. This applies to all trees within two tree heights of structures.
- Single pane windows allow heat to pass through more easily than double or triple pane windows. Curtains and furniture on the inside of windows can spontaneously combust from the heat outside passing through the glass. Double and triple pane windows are encouraged. Curtains made with non-flammable materials are encouraged.
- External fire suppression systems are encouraged since they maximize the use of available water.
- Road design should comply with CBFPD Guidelines, Standards and Fees for the Review of Fire Protection in Proposed Inclusions to the CBFPD and New Subdivisions, P.U.D.'s or any other Buildable Parcel of Land Within the CBFPD, adopted July 20, 2004, as it may be amended, except for exclusions listed elsewhere in this Plan.
- Fire fighters may come from other counties or other states and will not be familiar with an area. Those directing fire crews may ask crews to go to specific roads that will be safe for fire fighters. Clearly mark streets and with reflective signs and clearly mark structures with numbers. Street signs should be constructed of non-combustible materials.
- Protect power supplies so power is available to run pumps.
- Protect pump houses made of non-combustible materials.
- Create evacuation clearings big enough that people can go to them to be safe if they cannot otherwise get away from a fire.

Measures which reduce ignition sources include:

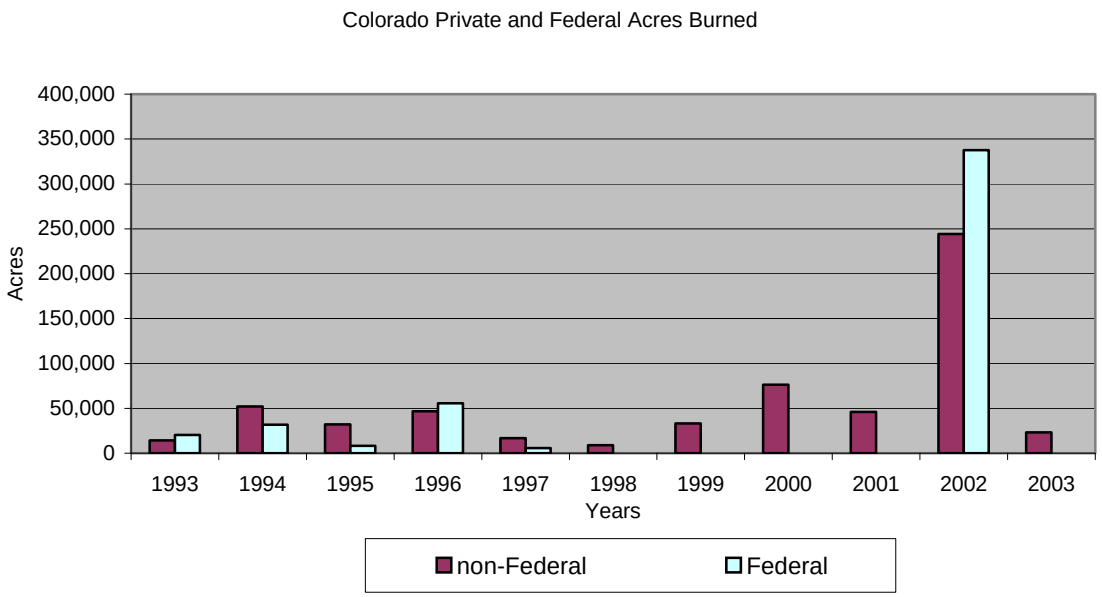
- Equip stacks and chimneys with spark arrestors.
- Ban fireworks in Extreme and High wildfire hazard areas.
- Ban debris and trash burning during periods of high fire danger. (See Gunnison County Burn Ordinance.)
- Use explosion proof pumps and motors in areas close to combustible materials.

Providing adequate fire fighting equipment involves the following:

- Comply with the Crested Butte Fire Protection District standard minimum road specifications for access by fire fighting vehicles.
- Install standard hydrants and/or a cistern water system in developed areas according to NFPA 1141, 1142, 1144 and the International Urban Wildland Interface Code.
- Provide fire stations or substations where developments are planned to be more than five miles from the nearest presently available fire station.

In some cases the economic or environmental costs of mitigation, particularly fuel reduction, may be prohibitive. If, therefore, fuels cannot be modified so the wildfire hazard is acceptable, or if the fuels cannot be modified without creating new environmental problems, then the next most logical mitigation measure is to avoid Extreme, High, and Moderate hazard areas.

Chart W 2

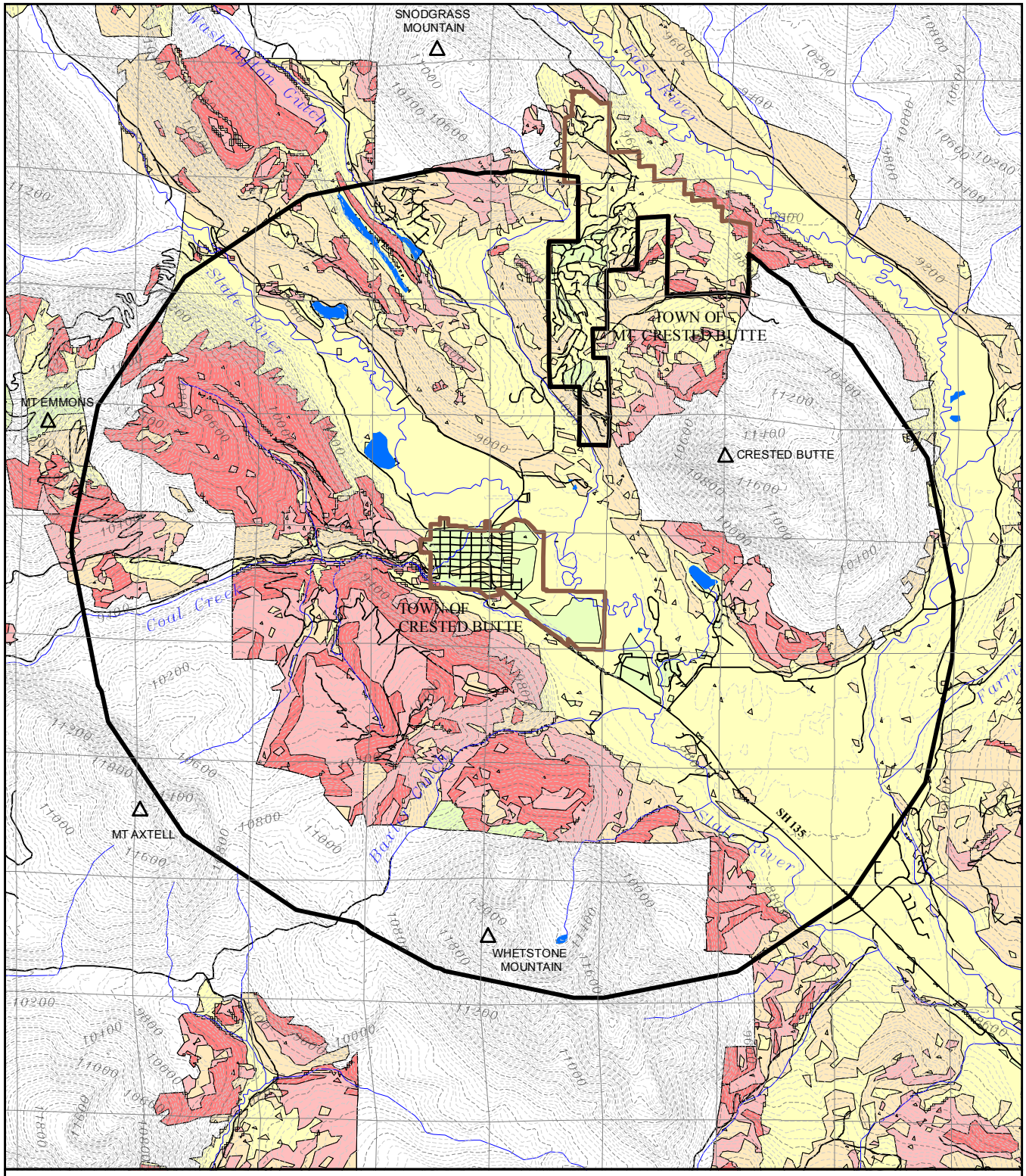


Source: Rocky Mountain Area and Coordination Center, Annual Activity Reports

Table W 3
Private Acres Burned in Gunnison County by Year

Year	Acres
1998	86
1999	11
2000	70
2001	575
2002	530
2003	80
2004	10

(1) "In a warming west, expect more fire", High Country News, September, 27, 2004, p. 5.



Wildfire Hazards

3 Mile Boundary (MSRV)
Town Boundary
Streams
Lakes
Roads
Section Lines

Wildfire Hazard
Extreme hazard
High hazard
Moderate hazard
Low hazard
No hazard

40' Topographic Contours
index
interval

N
W E
S

CRESTED BUTTE, COLORADO
National Historic District

SOURCE: Gunnison County MIS Dept. June, 2004
Colorado State Forest Service, Fort Collins, CO 1993

Miles
0 0.5 1 2 3

Drawn by: Hilary Mayes Date: June 22, 2005
Filename: C:/project/areaplan/2011/wildfire.mxd

SOILS

When soils are analyzed, the top 60 inches or so are assessed. The soils that have been mapped on the Soils map for the Middle Slate River Valley are those that are least suited for development. Generally these soils are hydric soils or those rated poorly for construction by the American Association of State Highway Officials (AASHO).

Hydric soils are so wet that some of the natural vegetation does not need to get oxygen from the soil. Rather, the stems and leaves allow oxygen to go to the roots. Some soils may be hydric because they are irrigated. When development occurs and irrigation stops, they may no longer be hydric.

The AASHO system classifies soils in seven basic groups according to those properties that affect their use in highway construction. The groups range from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. A-1 soils are gravely soils of high bearing strength. At the other extreme are A-7 soils which are clay soils that have low strength when wet.

Information used to determine which areas should be mapped was taken from the "Soil Survey of Gunnison Area, Colorado, Parts of Gunnison, Hinsdale and Saguache Counties, August 1975" and from the "Soil Survey of Taylor River Area, Colorado, June 1977." The soil surveys were conducted by the U.S. Department of Agriculture Forest Service and Soil Conservation Service (SCS), which is now the Natural Resources Conservation Service (NRCS), in cooperation with Colorado Agriculture Experiment Station.

The following soils were mapped:

1. Hydric soils
2. Soils identified as poor for development which received all of the following ratings in the soils studies:
    a. Poor for road fill
    b. Severe for local roads and streets
    c. Severe for dwellings without basements
    d. Moderate or high shrink swell potential
    e. Rated A-6 or A-7 on the AASHO engineering classification system
3. Bedrock outcrops and slide areas were also mapped

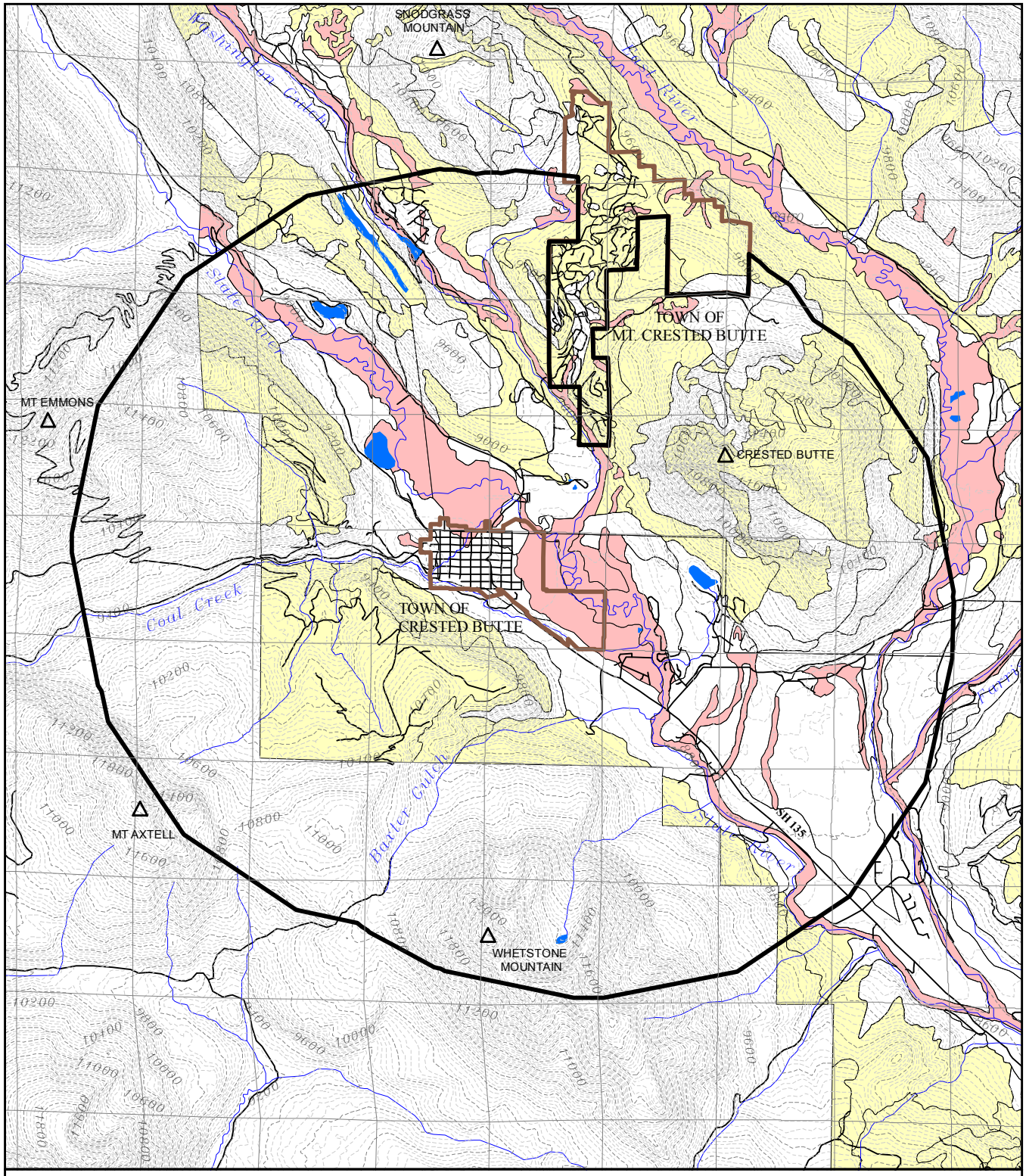
The SCS analyzed many other attributes for each soil type but the above issues are deemed to be most relevant to development. The following list describes each soil mapped and the interpretations by the SCS regarding their suitability for various types of development.

Soil Symbol & Name	AASHO Rating	Shrink Swell Potential	Road Fill Suitability	Local Roads & Streets	Dwellings Without Basements
BaF Bead	A-7	moderate	poor; slope is 10-50%	severe; 10-50% slope; >35% stone fragments	severe; 10-50% slope
BuF Bucklon	A-7	high	poor; depth to bedrock	severe; slope	severe; slope
CoE Cochetopa	A-7	high	poor; plastic clay	severe; 5-30% slope; high shrink swell potential; plastic clay	severe; 5-30% slope high shrink swell potential;
MoE Mord	A-6-7	moderate	poor; low shear strength	severe; 5-30% slope	severe;
NuF Nutras	A-7	moderate	poor; low stability; 25-55% stones	severe; 5-40% slope 25-55% stones	severe; 5-40% slope moderate shrink swell potential
Rl Rockland	too variable to be rated		poor; depth to rock; slope	severe; depth to rock; slope	severe; depth to rock;
Ro Rock outcrop	bedrock		poor; depth to rock	severe; bedrock at surface	severe; bedrock at surface
Rs Rockslides			na	severe; slide area	na
St Stony rock land			na	severe depth to rock	na
Sh Shale rock land	A-7	high	poor; depth to rock; slope	severe; depth to rock; slope	severe; depth to rock;

Soil Symbol & Name	AASHO Rating	Shrink Swell Potential	Road Fill Suitability	Local Roads & Streets	Dwellings Without Basements
TiF Tilton	A-6	moderate	poor; slope	severe; slope	severe; slope
TrF Tongue River	A-6	moderate	poor; sand stone at depth of 20-40" slope 10-50%	severe; bedrock 20-40"	severe; bedrock 20-40"
UtF Uinta	A-6	moderate	poor; 10-50% slope strength	severe; low shear	severe;
WeF Wetterhorn	A-7	moderate	poor; bedrock at depth of 20-40	severe; slope 10-55%	severe; slope 10-55%

The hydric soils that are mapped are as follows:

Aw Alluvial land	BbA, BbB Big Blue	Cr Cryaquolls
Cs Cryaquolls and Histosols	GaA, GaB Gas Creek	IrA, IrB Irim



Soils

- 3 Mile Boundary (MSRV)
- Town Boundary
- Streams
- Lakes
- Roads
- Section Lines

40' Topographic Contours

- index
- interval

Soils

- Hydric
- Other soils that are poor for development

SOURCE: Soil Survey of Gunnison Area, Colorado, 1975
Soil Survey of Taylor River Area, Colorado, 1977
U.S.D.A. Forest Service and Soil Conservation Service in cooperation with Colorado Agricultural Experimental Station.

N W E S

CRESTED BUTTE, COLORADO • A National Historic District •

0 0.5 1 2 3 Miles

Drawn by: Hilary Mayes Date: June 22, 2005
Filename: C:/project/areaplan/2011/soils.mxd

SLOPE

The information that follows was generated for the Gunnison County Planning Office in the mid 1970's, and by the Colorado Geological Survey in Nature's Building Codes, Geology and Construction in Colorado, 1979.

The importance of topography, both natural and man-made, to development in the Middle Slate River Valley cannot be overemphasized. An understanding of rock types, vegetation, drainage, climate, and active earth processes in relationship to topography is one of the keys to successful development.

Some of the planning elements affected directly by topography include:

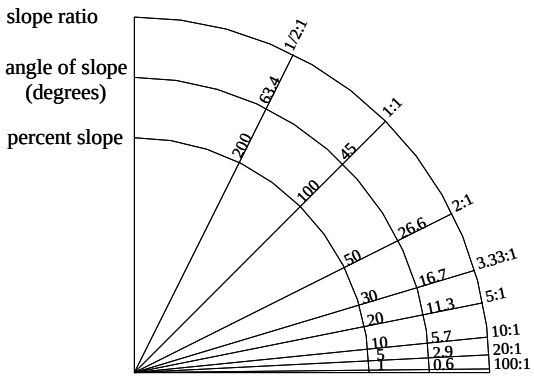
1. road layout
2. access to individual lots
3. need for cut and fill
4. sewage disposal system feasibility
5. surface drainage control and pattern
6. slope stability
7. lot layout
8. density of units
9. location of building envelopes
10. visual impact
11. wildfire hazard

An essential component of any development plan is an adequate topographic map showing the shape and character of the land surface proposed for development. Superimposing the proposed development on a topographic map can reveal unsuspected relationships that are not evident when considered individually. The developer/builder can then take advantage of desirable natural features and avoid problem areas.

When development occurs on land with steep slopes, design characteristics will have to be altered to keep costs down for cut and fill and also to avoid slope failures. Roads should be placed parallel to contours to avoid grading expenses. Abrupt changes in grade may, in some cases, be overcome by switchbacks.

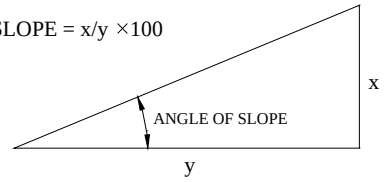
Slopes from one (1) to four (4) percent are usable for all kinds of intensive activity. Slopes between four and ten (10) percent are suitable for informal movement and activity. Slopes over ten (10) percent, make unfavorable roads and can be actively used only for hill sports or freeplay. Gradients above ten (10) percent require noticeable effort to surmount. Streets and roads should never be over eight (8) percent maximum grade. Maximum road gradients should also be reduced in consideration of snow and ice conditions. A fifteen (15) percent slope approaches the limit that an ordinary loaded vehicle can climb for a sustained period. Lawn areas should not exceed twenty-five (25) percent slope as this is the steepest grade recommended for a power mower.

It is difficult to build and maintain structures or roads on slopes of thirty (30) percent or more and these slopes are shown on the Slope 30% and Greater map.



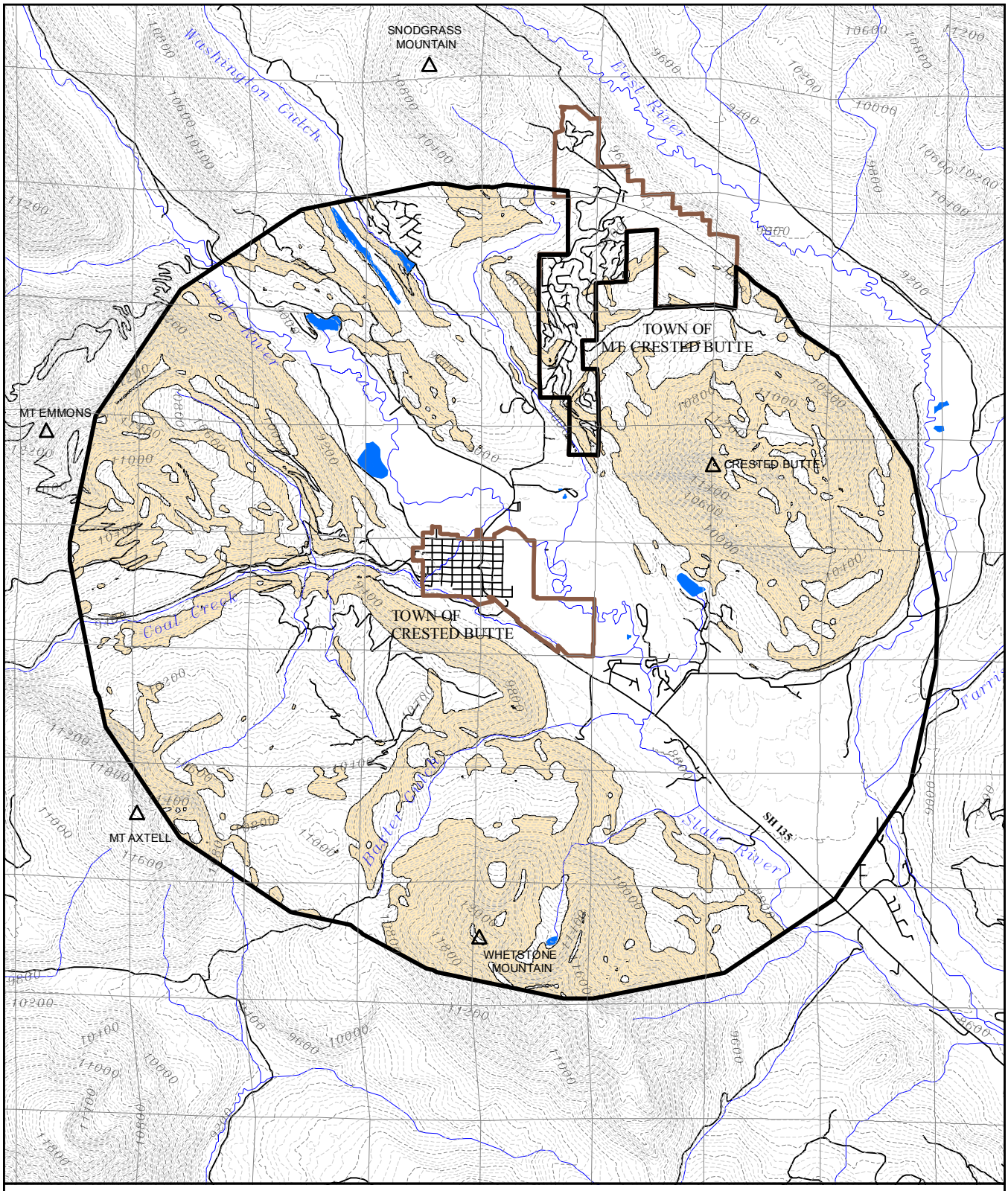
Relationship between percent slope, angle or slope in degrees, and slope ratio.

PERCENT SLOPE = x/y ×100



SLOPE RATIO = y:x

Reprinted from "Nature's Building Codes" Geology and Construction in Colorado



Slope 30% and Greater

- 3 Mile Boundary (MSRV)
- Town Boundary
- Streams
- Lakes
- Roads
- Section Lines

40' Topographic Contours

- index
- interval
- Slope 30% and greated

N W E S

CRESTED BUTTE, COLORADO · A National Historic District

0 0.5 1 2 3 Miles

SOURCE: Gunnison County MIS dept. June, 2004
Town of Crested Butte Planning Department, 2004

Drawn by: Hilary Mayes Date: June 22, 2005
Filename: C:/project/areaplan/2011/slope.mxd