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# CUMULATIVE HYDROLOGIC IMPACT ASSESSMENT

Kaiser Coal Corporation
Sunnyside Mines
ACT/007/007, Carbon County, Utah

November 7, 1985

## I. Introduction

The purpose of this report is to provide a Cumulative Hydrologic Impact Assessment (CHIA) for Kaiser Coal Corporation's Sunnyside Mines located in Carbon County, Utah. The assessment encompasses the probable cumulative impacts of all anticipated coal mining in the general area on the hydrologic balance and whether the operations proposed under the application have been designed to prevent damage to the hydrologic balance outside the proposed mine plan area. This report complies with federal legislation passed under the Surface Mining Control and Reclamation Act (SMCRA) and subsequent Utah and federal regulatory programs under UMC 786.19(c) and 30 CFR 784.14(f), respectively.

Kaiser Coal Corporation's Sunnyside Mines are located within the Book Cliffs Coal Field approximately 25 miles east of Price, Utah (Figure 1). The Book Cliffs form a rugged, southerly facing escarpment that delineates the Uinta Basin to the north from the San Rafael Swell to the south. Elevations along the Book Cliffs range from approximately 5,000 to 9,000 feet.

Outcropping rocks of the Book Cliffs range from Upper Cretaceous to Quaternary in age. The rock record reflects an overall regressive sequence from marine (Mancos Shale) through littoral and lagoonal (Blackhawk Formation) to fluvial (Castlegate Sandstone, Price River Formation and North Horn Formation) and lacustrine (Flagstaff Formation and Green River Formation) depositional environments. Oscillating depositional environments within the overall regressive trend are represented by members of the Blackhawk Formation and the Colton Formation. The major coal-bearing unit within the Book Cliffs Coal Field is the Blackhawk Formation.

Precipitation varies from 20 inches at higher elevations to 5 inches at lower elevations. The Book Cliffs area may be classified as mid-latitude steppe to desert.

Vegetation varies from the sagebrush/grass community type at lower elevations to the Douglas fir/aspen community at higher elevations. Other vegetative communities include mountain brush, pinyon-juniper, pinyon-juniper/sagebrush and riparian. These communities are primarily used for wildlife habitat and livestock grazing.

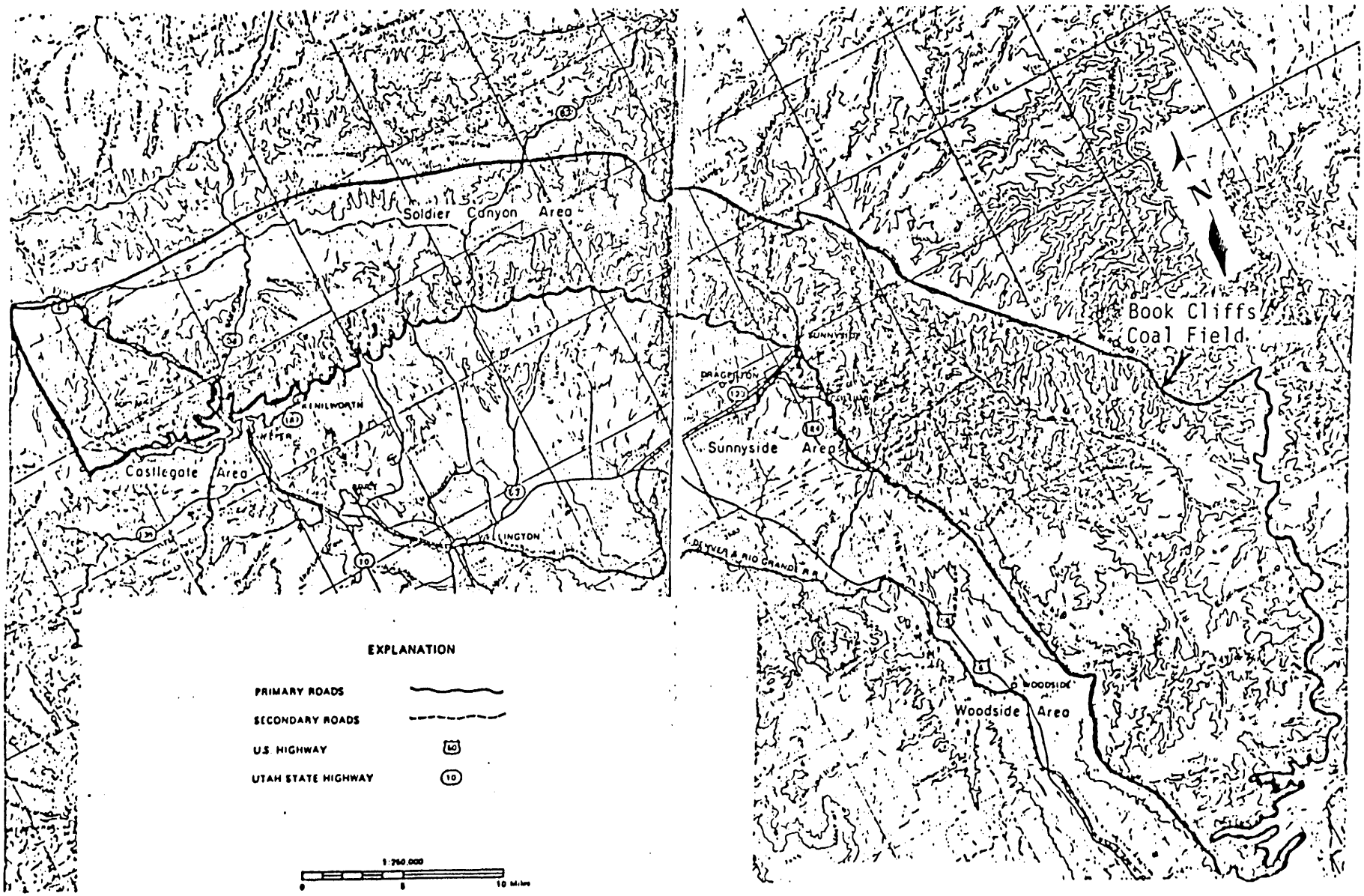


Figure 1. Book Cliffs Coal Field.

From: Doelling 1972.

Surface runoff from the Book Cliffs area flows into the Price River drainage basin of east-central Utah. The Price River originates near Scofield Reservoir and flows southeasterly into the Green River, north of the town of Green River, Utah. Water quality is good in the mountainous headwater tributaries, but deteriorates rapidly as flow traverses the Mancos Shale. The shale lithology typically has low permeability, is easily eroded and contains large quantities of soluble salts that are a major contributor to poor water quality. Depending upon the duration of contact, water quality degrades downstream to where total dissolved solids (TDS) levels of 3,000 milligrams per liter (mg/l) are not uncommon. The predominant ion leached from the Mancos Shale is sulfate ($SO_4$) with values over 1,000 mg/l common in the lower reaches of the Price River.

## II. Cumulative Impact Area (CIA)

Figure 2 delineates the CIA for current and projected Sunnyside Mine operations. The CIA includes the Whitmore Canyon drainage basin, intermittent drainages south of the divide separating Rock Canyon and Bear Canyon and the upper drainage basin of the North Fork Horse Canyon. The western boundary is designated by 110° 30' W longitude, whereas the southern boundary is limited by the Kaiser-U. S. Steel property line and its westward extension to 110° 30' W longitude. The CIA encompasses approximately 64,000 acres.

## III. Scope of Mining

Mining at the Sunnyside properties was initiated during the late 1890's. Total coal production has exceeded 55 million tons. Kaiser Steel Corporation acquired the Sunnyside properties in 1950 and operated the mines until April 1985. Since that time, the mine has been operated by Kaiser Coal Corporation.

Kaiser Coal Corporation's Sunnyside operations include, from south to north, the No. 2 Mine, No. 3 Mine and No. 1 Mine (Figure 2). The three mines are adjacent to each other and workings currently encompass the southern three-quarters of the permit area. Future mining is projected to occur towards the northwest and will include separate permits for the B Canyon and C Canyon areas.

Mine workings are approximately 6.5 miles in length and extend a maximum of 2.5 miles down-dip to the east. The first five year permit area encompasses 14,300 acres. Mining, during the first five year permit term, will occur in the Upper Sunnyside coal seam in the No. 3 Mine and Lower Sunnyside coal seam in the No. 1 Mine and No. 2 Mine. Sixty-five to eighty percent of the coal will be produced by longwall mining methods. The remaining production will be from continuous miner entry development and pillaring in areas unsuitable for longwall methods.

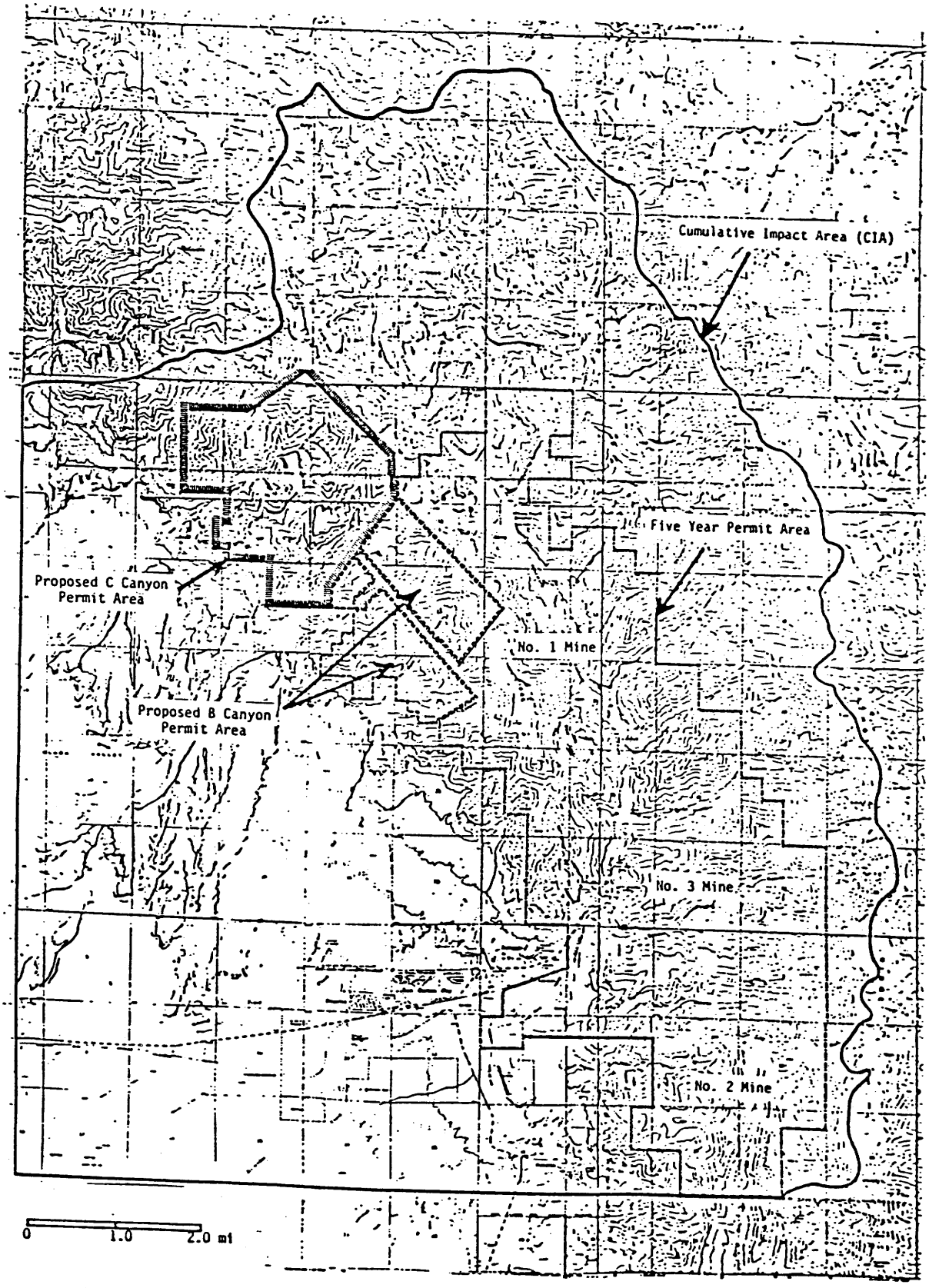


Figure 2. Cumulative Impact Area (CIA)

Production during the five year permit term will occur sequentially as given below.

No. 1 Mine

1985, 19th Left Inside Panel
1986, 19th Left Outside Panel
1987, 20th Left Outside Panel
1988-1989, 21st Outside Panel

No. 3 Mine

1985, 17th Left Panel

No. 2 Mine

1985, 17th Left No. 2 Panel

Overburden thickness ranges from approximately 1,200 feet to 2,000 feet above the panels to be mined.

IV. Study Area

A. Geology

The Sunnyside Mines area is characterized by cliffs, narrow canyons, and pediments. Stratigraphic units outcropping within the area include, from oldest to youngest, the Mancos Shale, Blackhawk Formation, Castlegate Sandstone, Price River Formation, undifferentiated North Horn/Flagstaff formation, Colton Formation, Green River Formation and Quaternary deposits. Lithologic descriptions and unit thicknesses are given in Figure 3.

Rocks in the Sunnyside area generally strike northwest and dip to the northeast at angles of 5 to 12 degrees. The predominant fault trend is northwest-southeast, roughly paralleling strike. Fault displacement is generally less than 100 feet.

Principal coal accumulations occur within the Blackhawk Formation. Five coal seams have been identified and are termed, in ascending order, the Kenilworth, Gilson, Rock Canyon, Lower Sunnyside and Upper Sunnyside beds. The Lower and Upper Sunnyside beds have the greatest economic potential and are the focus of current and future Kaiser extraction operations.

B. Topography and Precipitation

Topography ranges from less than 5,800 feet to over 10,000 feet in the western and eastern portions of the CIA, respectively.

| System | Series | Stratigraphic Unit | Thickness Feet | Description |
|---|---|---|---|---|
| Quaternary | Holocene<br>Pleistocene | Quaternary deposits | Variable | Surficial stream terrace and channel, alluvial fan, landslide and talus and moraine deposits. |
| Tertiary | Eocene | Green River Formation | 100 | Greenish-gray and white claystone and shale, also contains fine-grained and thin-bedded sandstone. Shales often dark brown containing carbonaceous matter. Full thickness not exposed. |
| | | Colton Formation | 250-1,000 | Brown to dark red lenticular sandstone, shale and siltstone. |
| | Paleocene | Undifferentiated North Horn/Flagstaff Formation | 1,200-1,800 | Flagstaff consists of blue-gray to reddish-brown limestone.<br><br>North Horn predominantely gray to gray-green calcareous and silty shale, tan to yellow-gray fine-grained sandstone and minor conglomerate. |
| Upper Cretaceous | Maestrichtian | Price River Formation: Bluecastle Sandstone Member<br>Lower Unnamed Member | 500 | Yellow-gray to white, medium-grained sandstone and shaley sandstone with gray to olive-green shale. Contains carbonaceous shale with minor coal. |
| | Campanian | Castlegate Sandstone | 180 | White to gray, fine- to medium-grained, argillaceous massive resistant sandstone with subordinate shale. |
| | | Blackhawk Formation: Upper Mudstone Member<br>Sunnyside Member<br>Lower Mudstone Member<br>Kenilworth Member<br>Aberdeen Member | 700 | Cyclical littoral and lagoonal deposits. Littoral deposits mainly thick-bedded to massive cliff-forming yellow-gray fine- to medium-grained sandstone, individual beds separated by gray shale.<br><br>Lagoonal facies consist of thin- to thick-bedded yellow-gray sandstones, shaley sandstones, shale and coal. Coal beds form basis of Book Cliffs coal field. |
| | Santonian<br>Coniacian | Mancos Shale | 4,000 | Gray marine shale, locally heavily charged with carbonaceous material, slightly calcareous and gypsiferous, nonresistant forming flat desert surface and rounded hills and badlands. |

Figure 3. Stratigraphy of the Sunnyside Mines Area (modified from Doelling 1972 and Osterwald et al 1981).

The western portion of the CIA, from 110°30'W longitude to the crest of West Ridge and south of the drainage divide between Grassy Trail Creek and Icelander Creek above Horse Canyon is characterized by southeast draining ephemeral streams that originate above 8,500 feet and progressively traverse nonmarine and marine Cretaceous rocks and alluvial fan deposits. Precipitation in the western portion of the CIA varies from 20 to less than 8 inches. However, a realistic approximation for average annual precipitation is 10 inches per year. Slopes associated with alluvial fans are approximately three to four percent, whereas slopes along the Book Cliffs escarpment between 7,000 and 8,800 feet average 22 percent.

The eastern portion of the CIA is characterized by a north-south perennial stream system with northeast-southwest trending tributaries. Headwaters originate above 10,000 feet and progressively traverse Tertiary and Cretaceous age rocks. Precipitation is less variable than in the western portion of the CIA and the average annual value is 20 inches or more. Slopes associated with the north-south system of perennial streams are approximately three to four percent below 7,500 feet. Slopes for northeast-southwest trending tributaries are approximately 32 percent above 7,500 feet.

There is a strong north-south slope effect on vegetation because of the narrow canyons. North facing slopes are dominated by Douglas fir or mountainbrush communities while south-facing slopes are typically dominated by pinyon-juniper and sagebrush. These vegetation types are intermixed with grassland vegetation at lower elevations.

Riparian vegetation is located in the moist areas of the narrow canyon floors and along Grassy Trail Creek. This vegetation type is dominated by willows and sagebrush with an overstory of narrowleaf cottonwood and box elder.

## V. Hydrologic Resources

### A. Ground Water

The ground-water regime within the CIA is dependent upon climatic and geologic parameters that establish systems of recharge, movement and discharge.

Snowmelt at higher elevations provides most of the ground-water recharge, particularly where permeable lithologies such as fractured or solution limestone are exposed at the surface. Vertical migration of ground water occurs through permeable rock units and/or along zones of faulting and fracturing. Lateral migration initiates when ground water encounters impermeable rocks and continues until

either the land surface is intersected (and spring discharge occurs) or other permeable lithologies or zones are encountered that allow further vertical flow.

The Kenilworth Member, Sunnyside Member and Upper Mudstone Member of the Blackhawk Formation, Castlegate Sandstone, Bluecastle Sandstone Member of the Price River Formation, undifferentiated North Horn/Flagstaff formation, Colton Formation, Green River Formation and Quaternary deposits are potential reservoirs or conduits for ground water in the CIA. Reservoir lithologies are predominantly sandstone and limestone. Sandstone reservoirs occur as channel and overbank, lenticular and tabular deposits, whereas limestone reservoirs have developed through solution processes and fracturing. Shale, siltstone and cemented sandstone beds act as aquacludes to impede ground-water movement. The Mancos Shale is a regional aquaclude that delimits downward flow within the CIA. Localized aquacludes include the Aberdeen Member and Lower Mudstone Member of the Blackhawk Formation, Lower Unnamed Member of the Price River Formation and relatively thin impermeable lithologies occurring within overlying units.

Thirty-six springs or areas of multiple springs occur within the CIA (Figure 4). Three springs are located within the five-year permit area. The majority of springs occur above 8,000 feet and discharge from the Green River Formation or Quaternary alluvium overlying the Green River Formation. Four springs occur in the southwest portion of the CIA and are associated with Quaternary alluvium overlying the Mancos Shale. Average flow is estimated to be less than 10 gpm for each spring.

Total mine inflow is approximately 740 gpm from mine shafts (245 gpm), boreholes (300 gpm), paleochannels (10 gpm) and gobs, faults and fractures (185 gpm). The majority of inflow occurs in the No. 1 Mine and is associated with the Manshaft, Twin Shafts, Pole Canyon Shaft and 18th Left Outside Panel (Figure 4). The Manshaft and Twin Shafts penetrate from the Blackhawk Formation to undifferentiated North Horn/Flagstaff formation and extend through the Castlegate Sandstone and Price River Formation. Flow into Manshaft and Twin Shafts totals 160 gpm and is, most likely, derived from either the Bluecastle Sandstone Member and/or permeable lithologies in the undifferentiated North Horn/Flagstaff formation. The Pole Canyon Shaft penetrates the Blackhawk Formation, Castlegate Sandstone, Price River Formation and Colton Formation. Pole Canyon Shaft inflow exceeds 50 gpm and is probably derived from the Colton Formation. The 18th Left Outside Panel collects flow from previously mined areas up dip. This flow may be attributed to wall weeps, roof drips and fractures and presumably, represents aquifer dewatering within and adjacent to the coal seam (i.e., Kenilworth Member, Sunnyside Member, Upper Mudstone Member).

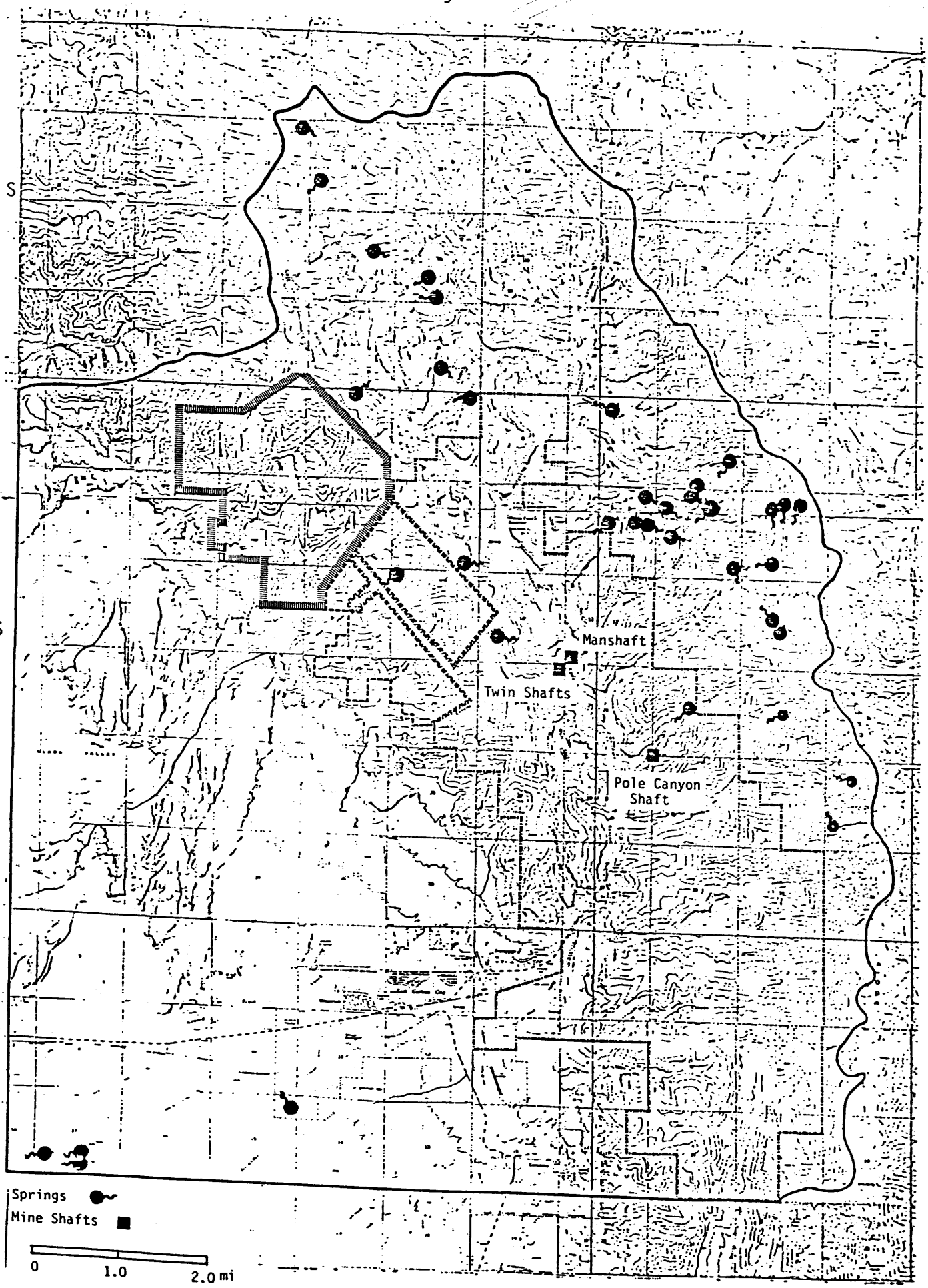


Figure 4. Location of Springs and Significant Mine Shaft Inflows.

B. Surface Water

Four principal drainages occur within the CIA. These drainages are termed Grassy Trail Creek, Price River-Lower Basin Grassy Trail Creek, Icelander Creek and Price River-Lower Basin Horse Canyon (Figure 5). Grassy Trail Creek drainage has been further subdivided into Right and Left Fork Grassy Trail Creek and Whitmore Canyon/Grassy Trail Creek.

Grassy Trail Creek

Right and Left Fork

Right and Left Fork Grassy Trail Creek are characterized by steep gradients, narrow canyons and gravel streambeds with silt and sand where gradients are reduced. Base flow is sustained by springs at approximately 8,500 feet.

Mining will be confined to areas beneath and adjacent to West Ridge. A subsidence barrier has been established to protect Grassy Trail Reservoir and Right and Left Fork Grassy Trail Creek. Excepting the reservoir, surface disturbance is limited to preexisting Class III access roads located along the Right Fork and Left Fork of Whitmore Canyon.

Whitmore Canyon

Grassy Trail Creek, from the permit boundary to the reservoir, is characterized by a low gradient (three to four percent), a relatively broad canyon (30 to 100 yards wide) and a bedrock streambed that is sporadically overlain by boulders, gravel, sand and mud. Grassy Trail Reservoir impounds upper Grassy Trail Creek flow and thus, has reduced the flooding potential associated with thunderstorm events. Flow records since 1979 for Grassy Trail Creek below the reservoir have ranged from 10 cfs to 100 cfs.

Slaughter Canyon, Number Two Canyon, Pasture Canyon, Pole Canyon, Bear Canyon and Water Canyon are tributaries to Grassy Trail Creek. These secondary drainages are characterized by steep gradients (greater than 25 p rcent), narrow canyons and gravel streambeds with sand and silt where gradients are reduced. Tributary flow is intermittent and in response to precipitation events.

Mining has occurred beneath most of Grassy Trail Creek and portions of the six tributaries. During the first five year permit term mining will extend northeast to encompass additional areas beneath Grassy Trail Creek, Number Two Canyon (Left Fork), Bear Canyon and Water Canyon. Future mine development will continue to the north and northeast and progressively encompass additional areas beneath Grassy Trail Creek and the five tributaries entering from the east.