Resource Series 36

Availability of Coal Resources in Colorado: Somerset Quadrangle, West-Central Colorado

By Wynn Eakins*, Carol M. Tremain Ambrose*,
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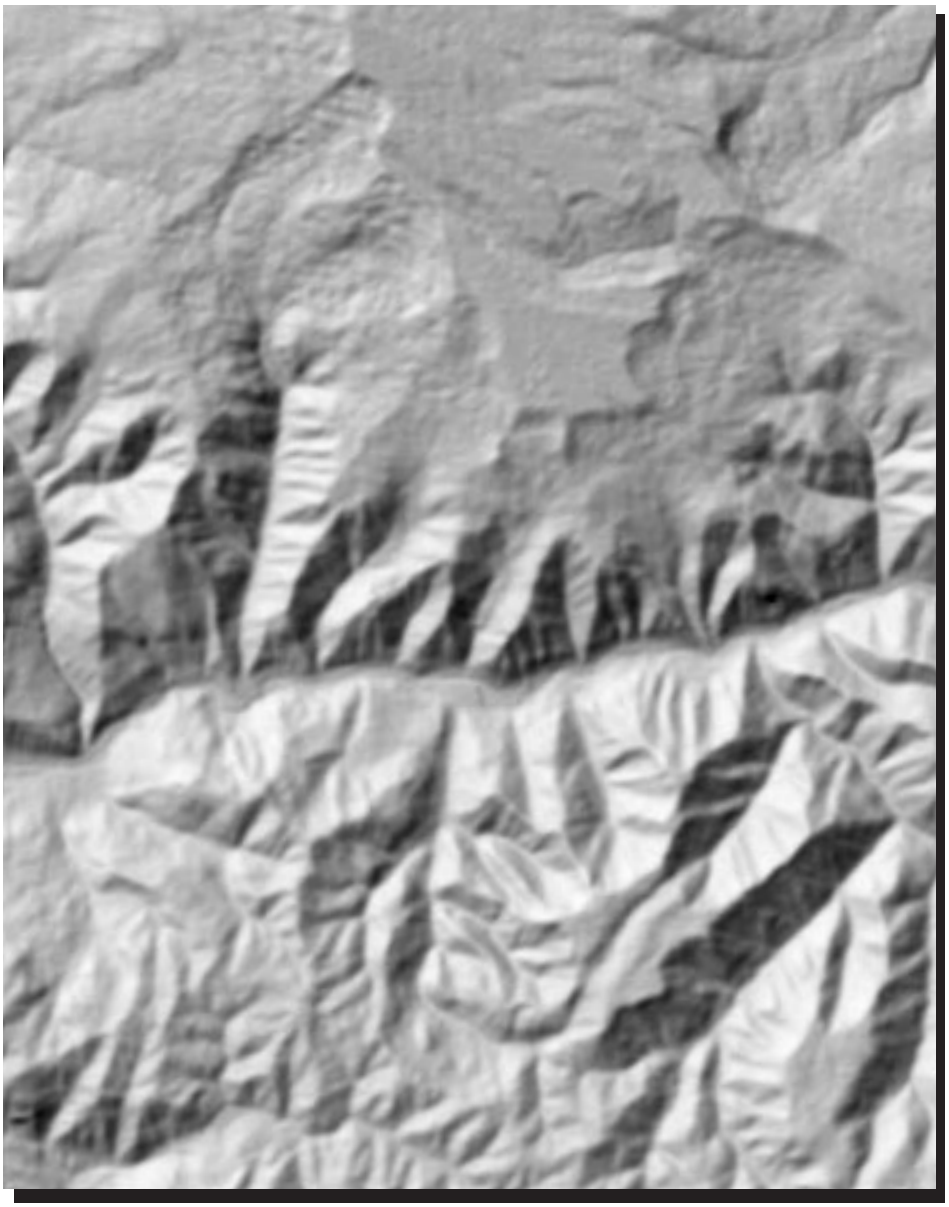

Colorado Geological Survey
Department of Natural Resources
Denver, Colorado
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Coal Availablity Reports

The format of these Coal Availability reports were used as guidance:

- Kentucky Geological Survey Information Circular 47 (Salyersville South Quadrangle), 1994
- Indiana Geological Survey Open-File Report 95-2 (Center Point Quadrangle), 1995
- Illinois State Geological Survey Minerals 114 (Mt. Carmel Quadrangle), 1996
- U.S. Geological Survey Open-File Report 97-469 (Hilite Quadrangle, WY), 1997

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ABSTRACT

The Colorado Geological Survey, in cooperation with the U.S. Geological Survey, has produced an estimate of the amount of available coal in an area of historical and active mining in west-central Colorado. Available coal is the quantity of the total coal resource that is accessible for mine development under current regulatory, land-use, and technologic constraints. This coal availability study of the Somerset quadrangle indicates that approximately 75 percent (2,326 million short tons) of the total 3,088 million tons of original coal in-place in the quadrangle is available for development. Approximately 75 million tons of coal within the quadrangle have been mined through 1997, with a total of about 275 million tons lost in mining. Coal lost in mining includes coal unavailable to be mined due to previous mining of adjacent beds or mining of coal within the same bed. All tonnage measurements in this report are in short tons.

Considerations for coal development in the quadrangle include railroads, highways, rivers and lakes, cemeteries, towns, critical habitat for threatened and endangered species, bald or golden eagle nests, and alluvial valley floors. Some of these considerations could be mitigated so that coal mining could proceed. Other considerations could not be mitigated and would prevent mining in their vicinity. Technologic constraints that affect the availability of coal include mined-out areas, overburden thickness, thin interbeds, and thin coal beds.

BACKGROUND AND PURPOSE

Land-use, environmental, regulatory, technologic and economic restrictions to coal resource recoverability have not been included in traditional Federal coal resource estimates. Many planners have thus overestimated the future supply of the Nation's coal. In 1986, a pilot study was undertaken by the Kentucky Geological Survey and the U.S. Geological Survey (USGS) to develop and test a methodology for determining the quantity of coal resources available for mining under current mining conditions (Carter and Gardner, 1989, 1994; Eggleston and others, 1990). The concern for identifying the restrictions affecting the mining of coal has resulted in a collaborative program between the USGS and state geological surveys. The data generated during the coal availability studies is shared with the USGS for use in their coal recoverability studies and coal assessment activities. In recoverability studies, recovery and cost factors are applied to the estimated coal resources, resulting in calculations of economically recoverable coal that are usually far less than the amount available for development (Rohrbacher and others, 1994; Molnia and others, 1997).

The first coal availability studies were conducted in the eastern United States, in the Appalachian region. The studies expanded into the Illinois Basin and more recently into the western United States in the Powder River Basin of Wyoming (Molnia and others, 1997) and Montana, the San Juan Basin of New Mexico, and the Wasatch Plateau of Utah. This study of coal availability in the Somerset quadrangle is the first coal availability study in Colorado.

The effect of land-use and technologic factors on the availability of the remaining coal in Colorado's coal fields is not well known. Therefore, it is important to calculate the amount of the remaining coal resources available to mining in order to aid the decision-makers addressing issues of future coal development in Colorado.

LOCATION AND PHYSIOGRAPHIC SETTING

The Somerset 7.5-minute quadrangle is located in west-central Colorado, in the southeastern part of the Uinta Coal Region's Piceance Creek Basin (Figure 1). The quadrangle is within the Somerset coal field in the northwestern part of Gunnison County. The town of Somerset, located in the west-central part of the quadrangle, is the only population center. A single major highway, a section of Colorado Highway 133 between the towns of Carbondale and Paonia, crosses the quadrangle.

The steep narrow canyon of the North Fork of the Gunnison River separates mesas in the southern part of the Somerset quadrangle from those in the northern part of the quadrangle: the North Fork flows generally from east to west, nearly bisecting the quadrangle (Figure 2).

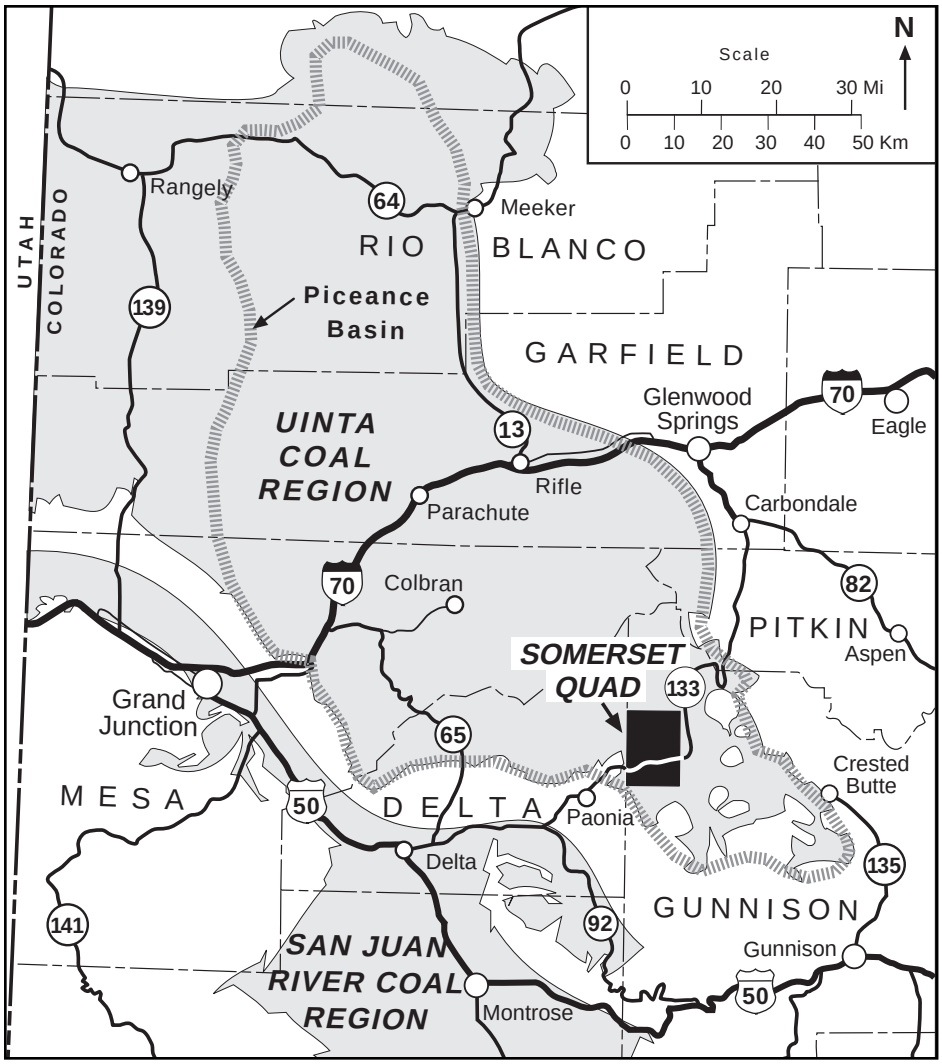

Figure 1. Map showing location of the Uinta Coal Region and the Somerset 7.5-minute quadrangle.

Tributaries of the North Fork have dissected these mesas. Elevations within the quadrangle range from about 5,900 to 9,836 feet above sea level. The lowest elevation is along the river at the western boundary of the quadrangle, while the highest elevation is in the north-central portion of the quadrangle. Mt. Gunnison, at 12,719 feet, is about 4 miles south-southeast of the quadrangle.

Land use in the Somerset quadrangle includes surface facilities for two relatively large operating underground mines; the town of Somerset; and a few dwellings along the North Fork valley. Over half the quadrangle is within the Gunnison National Forest and the U.S. Bureau of Land Management (BLM) administers a large part of the remainder. Coal mining, logging and ranching are the primary industries within the quadrangle.

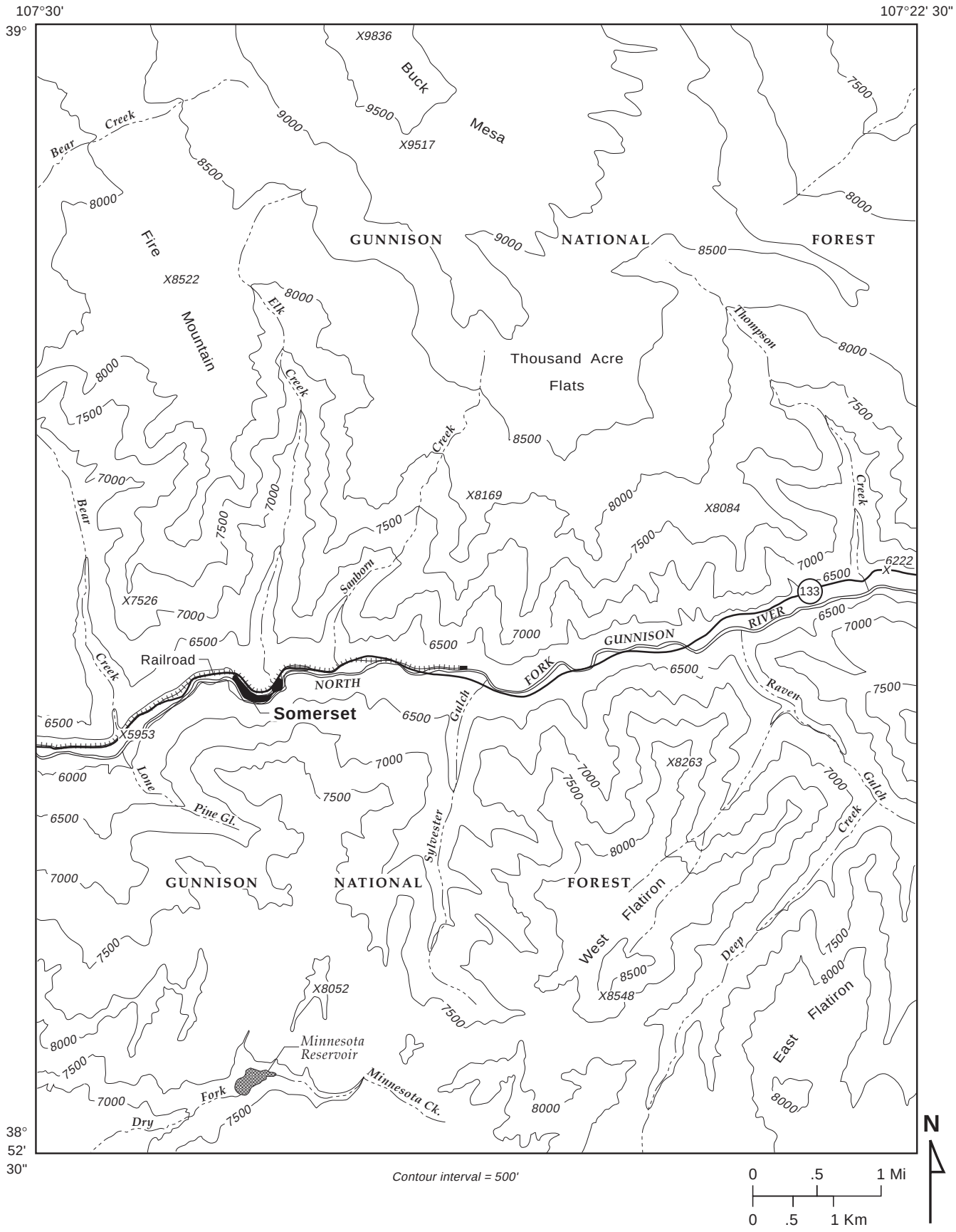

Figure 2. Simplified topographic map of the Somerset quadrangle.

GENERAL GEOLOGY OF THE SOMERSET QUADRANGLE AND VICINITY

REGIONAL GEOLOGY

The Somerset quadrangle is within the Uinta Coal Region. Approximately one-half of the Uinta Region lies in west-central Colorado; the remainder is the main coal-bearing region of eastern Utah. Most of the Colorado portion of the Uinta Region coincides with the Piceance Creek structural basin of Laramide age and is located in the eastern part of the Colorado Plateau physiographic province. The Uinta Region in Colorado is bounded by the Grand Hogback monocline to the east, the Axial Basin uplift to the north, the Utah state line to the west, Grand Valley and the Colorado River to the southwest and the North Fork Valley and Gunnison uplift to the south and southeast (Tremain and others, 1996).

The Piceance Creek Basin is the largest structural basin in western Colorado, covering an area exceeding 7,200 square miles as defined by the base of the Upper Cretaceous Mesaverde Group. The basin is asymmetric in shape, with the steep flank on the east and its long axis trending northwest. This is one of the deepest basins in the Rocky Mountain region, with an estimated 25,000-plus feet of sediments at the north end of the basin in Rio Blanco County.

The southeastern part of the region, in Gunnison and Pitkin counties, is marked by the Elk and West Elk Mountains igneous intrusive complexes of Tertiary-age sills, laccoliths, dikes and associated folds and faults. The high geothermal heat flow characteristic of this part of the region has increased the rank of much of the coal, producing large resources of coking coal. Original in-place identified coking coal resources in Colorado have been estimated at more than 4.2 billion tons. The Uinta Region contains an estimated 0.5 billion tons of coking-coal resources (Goolsby and others, 1979). The southeastern third of the Uinta Region has produced the most desirable coke-oven feedstock in Colorado; however, depth of overburden and relatively high methane content of the coals have tended to retard development of the resource in this area.

SOMERSET COAL FIELD

The Somerset coal field in Delta and Gunnison Counties lies in and near a valley cut by the North Fork of the Gunnison River and its tributaries. The coals in this area occur in the lower Williams Fork Formation (Figures 2 and 3) are high-volatile B and C bituminous, and reach up to 25 feet or more in thickness. The eastern part of the field, near the town of Somerset, contains coking coal of relatively good quality, which contains fairly high levels of methane (Tremain and others, 1996).

The West Elk Mountains are a group of peaks formed from intrusive and volcanic rocks that intrude into or cover sedimentary rocks of Cretaceous and Tertiary age in the Somerset coal field. The intrusive rocks have diverse and locally complex relationships with the sedimentary rocks. The magma that formed the intrusive rocks of the West Elk Mountains was injected into the strata at a relatively low temperature (Johnson, 1948a), so contact metamorphism is not extensive. Coal seams are either partially intruded or replaced by intrusives, and locally may be upgraded in rank.

Strata dip generally to the north-northeast at an average of about 3 to 5 degrees. Six major coal beds have been identified in the Mesaverde Formation (Johnson, 1948a). The geology of these coal beds, designated A through F, and their associated strata, is discussed below.

GEOLOGY OF THE SOMERSET QUADRANGLE

Surficial Geology

Surficial geology is depicted on a geologic map at

Figure 3. Simplified geologic map of the Somerset quadrangle. (After Dunrud, 1989)

a scale of 1:50,000 (Dunrud, 1989). The units described by Dunrud include Holocene alluvium along the North Fork of the Gunnison River and alluvium/colluvium along all drainages in the southern half of the quadrangle, two types of Pleistocene unconsolidated deposits, Pleistocene

alluvial surfaces, and Holocene and Pleistocene landslide deposits.

Bedrock Geology

Subsurface geologic information is available from 93 drill holes within the quadrangle and a 3-mile surrounding zone, which enables inferred resources to be evaluated. Forty-eight of the drill holes are within the quadrangle itself. The deepest drill holes, which are located to the northeast of the quadrangle, are oil and gas test holes. Surficial deposits are not shown on the bedrock geologic map (Figure 3), which was adapted from a USGS map (Dunrud, 1989).

Bedrock units exposed within the Somerset quadrangle range from the Cretaceous Mancos Shale to the Tertiary Wasatch Formation. Each formation, and members where applicable, is briefly described in order from oldest to youngest.

The **Mancos Shale** is the oldest exposed formation in the study area. As reported by numerous workers in the area, the Mancos Shale is composed of gray calcareous shale with sandy or carbonaceous intervals. The depositional environment was interpreted by Wellborn (1982a) as offshore marine and a prodelta facies of a delta system. The total thickness is about 5,000 feet (Young, 1982). The Mancos Shale is exposed in the west-central part of the quadrangle along the North Fork and in the extreme southwestern part.

The **Mesaverde Formation** has been subdivided into four members by many of the geologists who have worked in the area—the Rollins Sandstone Member, the Bowie Shale (or Lower Coal) Member, the Paonia Shale (or Upper Coal) Member, and the Barren Member (Figure 4). Johnson and May (1980) and Dunrud (1989) include a fifth member, the Ohio Creek Member. The significant coals in the Somerset quadrangle are within the Bowie Shale and Paonia Shale Members, or Lower Coal and Upper Coal Members (Dunrud, 1989), of the Mesaverde Formation. These two members are mapped as a single unit in Figure 3. The Mesaverde Formation was deposited as part of a delta system that prograded to the southeast into the Late Cretaceous Western Interior seaway (Wellborn, 1982a).

1) The **Rollins Sandstone Member** of the Mesaverde Formation is a cliff-forming, white to buff sandstone that is present throughout the region. It was interpreted by Wellborn (1982a) as a delta-front facies. The top of the Rollins Sandstone represents the lower boundary of the Bowie Shale Member.
2) The **Bowie Shale Member**, or the Lower Coal Member, of the Mesaverde Formation is defined as the part of the formation above the Rollins Sandstone upward through a distinct series of sandstones. This unit ranges from about 220 to 330 feet in thickness within the quadrangle and consists of intervals of fine-grained sandstone, shale, carbonaceous shale and coal representing lower delta-plain deposits (Wellborn, 1982a). The sediments were deposited in brackish- to fresh-water marshes and swamps, fresh-water lakes, occasional marine bays, and distributary channel systems. The coal-forming materials were deposited in interdistributary areas where water table levels were close to sea level and where conditions favored thick vegetation and little sediment inflow. The thickest and most extensive coals in the Lower Coal Member have been designated the A, B and C beds. In most of the eastern part of the quadrangle and several other smaller areas, a major split of the B bed has been identified. Nowak (1990) identified that the thickest beds in the lower part of the Bowie Member are parallel to the paleoshoreline, and are aligned in a north-south trend. The uppermost part of the member is an interval with several sandstone units from a distributary channel system (Wellborn, 1982) with total thicknesses of about 110 to 190 feet in the quadrangle.
3) The **Paonia Shale Member**, also known as the Upper Coal Member of the Mesaverde Formation, is defined as the part of the formation from the top of the uppermost sandstone unit of the Bowie Shale Member to the top of the F coal bed. This unit is composed of shale, minor carbonaceous shale, siltstone, and sandstone and ranges in thickness from about 210 to 310 feet within the quadrangle. The sediments originate from an interdistributary upper delta plain environment similar to that of the Bowie Shale Member, but influenced

more by fluvial processes, with an increase in channel and splay deposits (Wellborn, 1982a). Nowak (1990) observes that the thickest coal beds in the Paonia Shale Member are thinner than those in the Bowie Shale Member, and are generally not as areally extensive. Distributary channel sandstones are also thinner and less extensive than those of the lower delta-plain setting. The D, E, and F beds are within this unit. A major split of the D bed occurs in most of the quadrangle.

4) The base of the **Barren Member** is defined as the top of the F bed (Nowak, 1990). The Barren Member consists of alternating sandstone, shale, and siltstone beds without continuous coal beds of commercial thickness (Wellborn, 1982a). There are few coals within 100 feet of the F bed. This interval is primarily composed of coarse- to fine-grained sandstones (Nowak, 1990).
5) The **Ohio Creek Member** consists of interbedded sandstone, mudstone, and shale which total about 500 to 900 feet in thickness (Dunrud, 1989). Most geologists working in the area prior to 1980 defined the Ohio Creek as a conglomeratic sandstone of Tertiary age (Wellborn, 1982a). Johnson and May (1980) redefined the Ohio Creek as a member of the Mesaverde Formation.

The Tertiary **Wasatch Formation** is the uppermost rock unit (youngest age) in the quadrangle. It consists of varicolored claystone and mudstone with local lenses of sandstone, thin coal beds, and basal conglomerate (Dunrud, 1989).

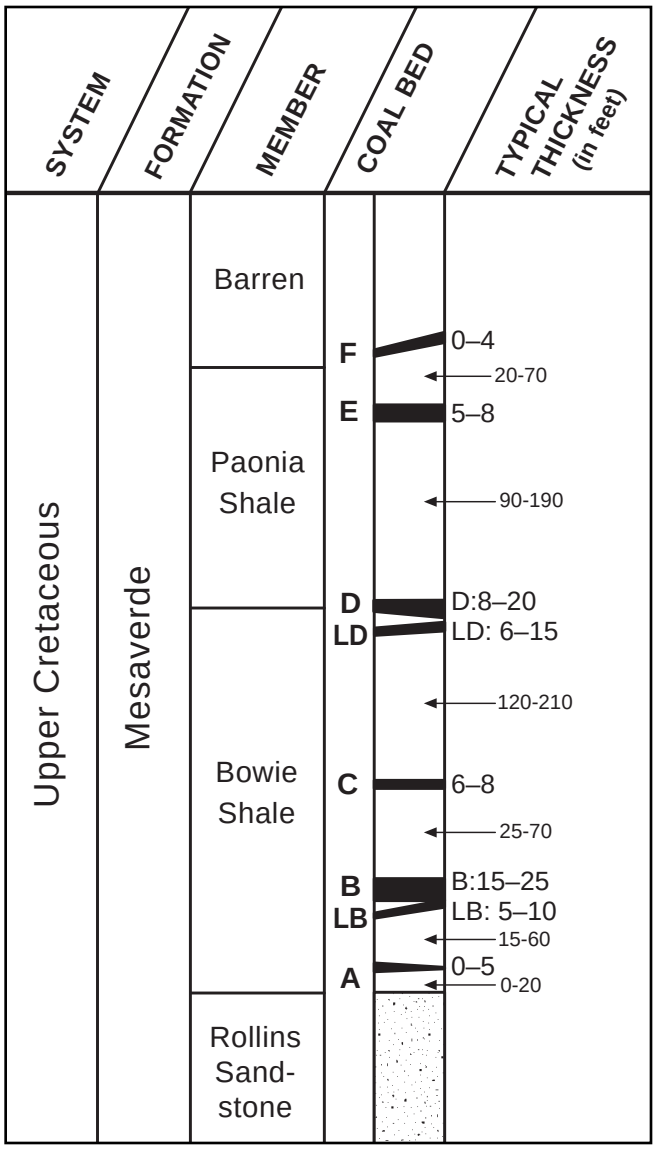

Figure 4. Generalized composite stratigraphic section showing coal beds and adjacent strata of the Somerset quadrangle.

Table 1. Bed names and thickness ranges of principal coal beds, Somerset quadrangle.

Bed Name (Letter Designation)	**Lower B**	**B**	**C**	**Lower D**	**D**	**E**
Common names and alternative names of beds used in this report	B-1	Somerset B-1/ B-2	Bear	Lower Oliver D-1	Oliver Upper Oliver D–2	Hawksnest
Thickness ranges (ft)	1.6– 20	1.2–29	0–16	2.6–21	0–25	0–15
Typical thickness (ft)	5–10	15–25	6–8	6–15	8–20	5–8

Principal Coal Beds

The principal coal beds of the Somerset quadrangle, those beds designated with letters or names, are, in order from bottom to top, the A through F beds. These beds are primarily continuous, but they may have significant splits or areas of nondeposition. Thinner coals between the principal beds and beds A and F are not of minable thickness within the quadrangle. The B, C, D, and E beds have all been mined. Significant areas of unmined coal remain in these beds. Portions of the lower splits of the B and D beds are also minable. Mapping and resource calculations have been done for these six beds or bed splits. The bed designated by the West Elk Mine as the F bed correlates to the E bed of this report. Table 1 provides commonly used and alternative bed names used in this report as well as overall and typical thickness ranges of the principal coal beds in the quadrangle. Typical thicknesses are also shown in Figure 4.

The areas that contain split beds, either the B and Lower B or the D and Lower D beds, are located where the parting thickness exceeds either coal thickness. For example, if the B bed consists of 12 feet of coal, 5 feet of shale parting, and 6 feet of coal, the bed is considered to be unsplit, with a thickness of 18 feet. The beds would, however, be considered split if the 12 feet interval of coal is underlain by 6 feet of parting and 5 feet of coal: the B bed is 12 feet thick and the Lower B bed is 5 feet thick. Coal quality and mining of the principal beds are discussed in separate sections.

Structure

The Somerset quadrangle is on the south flank of the Piceance Creek Basin. Dips are typically about 200 to 300 feet per mile to the north-northeast, based on structure maps derived from stratigraphic data used in this evaluation. Faults are steeply dipping, primarily west-northwest trending, and exhibit several feet of stratigraphic separation where they offset coal beds in the Somerset Mine (Dunrud, 1976). No faults with more than 25 feet of separation were identified by structure mapping in the Somerset quadrangle, so the faulting is not reflected in depth-to-coal mapping. Faults exceeding 25 feet of separation have been identified in coal mines west of the quadrangle.

Table 2. Historic coal mines in Somerset coal field producing more than 100,000 tons.

Mine Name (Alternate Name)	Map No.	Dates of Operation	Production (tons)*	Bed(s) Mined	Reference/Comments**
Bear (Bear No. 1)	1	1932–1982	See Bear No. 3	C	Production combined with Bear No. 3 mine
Bear No. 2	2	1934–1982	See Bear No. 3	C	Production combined with Bear No. 3 mine
Bear No. 3	3	1934–1996	9,107,000	B	
Black Beauty (Hawksnest No. 3)	4	1951–1976	1,400,000	E	Metallurgical coal
Bowie No. 1 (Orchard Valley)		1976–	16,059,000	D	Operating mine in Bowie quadrangle; production through 1997
Bowie No. 2		1997–	49,000	D	First production in October 1997; production exceeded 100,000 tons by February 1998; Bowie quadrangle
Farmers (Paonia Farmers, Emmons)		1909–1966	255,000	C	Bowie quadrangle
Hawksnest East (Hawksnest No. 2)	5	1975–1982	1,992,000	F (E)	Kelso and others, 1981; Rushworth and others, 1984; changed to E bed in Boreck and Murray, 1979
Hawksnest No. 1	6	1931–1970	946,000	E	
Hawksnest West	7	1970–1982	1,940,000	E	Kelso and others, 1981; Rushworth and others, 1984
King		1903–1974	2,996,000	A, B	Production primarily from B bed
Lone Pine (Edwards)	8	1934–1965	505,000	B, C	Just west of Bear Mine entries
Mt. Gunnison No. 1	9	1982–1991	4,872,000	F (E)	Rushworth and others, 1984/ Correlated as E bed in this report
Oliver No. 1	10	1923–1960	1,300,000	E	
Oliver No. 2	11	1945–1954	760,000	E (D)	Correlated as D bed in this report
Oliver No. 3	12	1923–1960	See Oliver No. 1	D	Production combined with Oliver No. 1
Sanborn Creek	13	1992–	6,200,000	B, C	Zook and Tremain, 1997/ Currently mining only the B bed; production is through 1997
Somerset	14	1903–1985	31,170,000	B, C	Mine operated in Delta and Gunnison Counties (in Somerset and Bowie quadrangles)
West Elk	15	1992–	30,580,000	B	Zook and Tremain, 1997/ Operating mine; production is through 1997

*Production through 1997 unless otherwise noted, rounded to nearest thousand tons.
**Reference is Boreck and Murray, 1979 unless otherwise cited. Post-1989 production from Colorado Division of Minerals and Geology files.

COAL MINING HISTORY

Since the late 1880s, the Uinta Coal Region in Colorado has produced nearly 230 million tons of coal from 300 mines. This production constitutes 26 percent of the total coal produced in Colorado. More than 15 million tons of coal were produced in the Uinta Region in 1997, or 55 percent of the state's total output.

Approximately 7.5 percent of Colorado's cumulative production through 1997 has come from the Somerset quadrangle. The two operating mines in the quadrangle, the Sanborn Creek and West Elk Mines, produced 27 percent of the state's coal in 1997: these two mines produced a combined 7,322,766 tons of coal, all from the B seam. The West Elk Mine is a longwall operation and the Sanborn Creek Mine is doing development work to support a planned longwall operation.

Historical production from mines in the Somerset coal field with total production exceeding 100,000 tons is shown on Table 2. For each mine, the dates of operation, total production, bed or beds mined, and references are provided. All mines operating in the coal field have been underground mines. Thirty-seven coal mines operated in the Somerset coal field during the period from 1903 to the present (Boreck and Murray, 1979). Of the eighteen mines which produced more than 100,000 tons, fifteen are in the Somerset quadrangle (Table 2). Map numbers on figures 9a through 9f can be used to locate the mines within the Somerset quadrangle.

Total production for the Somerset quadrangle is approximately 75 million tons through 1997. Historic production records attribute all the coal mined from the Somerset Mine to Gunnison County (or the Somerset quadrangle) because the mine portal is in Gunnison County. Approximately half of the roughly 31 million tons mined from the Somerset Mine represents Delta County production. About 80 percent of the coal mined from the Somerset quadrangle was produced from either the B or C seam. The remainder came from the D and E seams.

Table 3. Range of analyses of Somerset coal field coals, as received basis. (Source: Tremain Ambrose and others, 1998, in press. For additional analytical data, see references.)

Coal Field/ Bed	Moisture (%)	Volatile Matter (%)	Ash[1] (%)	Sulfur[1] (%)	Heating Value[1] (Btu/lb)	Ash Fusion Temperature (° F)	FSI[2]
Somerset Coal Field (5 beds)	1.8–16.3	30.9–40.0	2.2–25.4	0.2–2.3	10,040–13,900	2120–2800	0–4.5
			Somerset Quadrangle				
E[3]	4.8–8.3	30.9–40.0	2.2–25.4 5–15	0.2–1.3 0.4–0.6	10,200–13,900 11,000–13,000	2120–2800	0–2.5
D	5.1–8.5	34.4–38.2	4.2–17.7 6–12	0.4–0.9 0.5–0.7	10,300–13,000 11,500–13,000	2800	0–4.0
C	4.5–7.8	36.0–39.2	4.9–12.5 6–10	0.4–0.9 0.4–0.6	11,300–13,500 12,200–13,500	2090–2675	1.5–4.5
B	4.4–8.2	33.4–36.4	5.7–13.0 8–12	0.3–1.0 0.4–0.6	11,200–13,400 11,500–13,000	2595–2800	0–0.5
A	1.8	36.8	9.5–23.1 10–15	0.6–2.3 0.8–1.5	11,200–12,000 11,200–12,000	2800	3.5

[1]For Somerset quadrangle, overall range is shown on first line and typical range on second line

[2]Free swelling index

[3]Iincludes F bed analyses

COAL QUALITY

Although the quality of coal is an important factor in determining the market demand for coal from specific coal deposits, coal quality is not assessed in this study. The distribution of coal quality parameters across the quadrangle is not well understood and additional analytical data would be needed in order to map quality parameters with a reasonable level of certainty. Coal quality data is presented in Table 3 as range of analyses for all beds in the Somerset coal field and for individual beds in the Somerset quadrangle.

Available coal quality data for the Somerset coal field was transferred into a single database. The area covered by the database includes T. 13–15 S. and R. 89–93 W. A total of approximately 520 individual analyses at 68 locations were available for the Somerset coal field. Analyses for 24 locations are within the Somerset quadrangle.

The coal quality database (Tremain Ambrose and others, 1998, in press) contains point identifying numbers; sample dates; mine or corehole names; bed and coal zone names; coal rank; ash and sulfur percentages; Btu; million Btu per short ton; pounds of sulfur per million Btu; latitude, longitude, and sections, townships and ranges of sample locations; and source database names. However, not all of the samples contain all of the above, as certain analyses were not run on every sample.

Sources of coal quality data include 1) USGS coal analysis database [USALYT], [USGS, National Coal Resources Data System (NCRDS), unpublished data], 2) two databases with data on mine samples—one originally developed by the U.S. Bureau of Mines (USBM) and the Energy Information Administration (EIA) [BMALYT] (USGS, NCRDS, unpub. data) and one digitized by the CGS from USBM technical paper 574 (U.S. Bureau of Mines, 1937), 3) a database containing petrographic analyses of coal cores taken by the CGS as part of a late 1970s to early 1980s coalbed methane desorption program [COPET] (USGS, NCRDS, unpub. data), and 4) the USCHEM trace element database of mixed core and mine samples published by the USGS in open file report 94-205 (USGS, 1994). All the coal quality data was converted, if necessary, to an as-received basis.

Table 4. List of possible restrictions to coal mining.

(Printed in **bold** if applicable to the Somerset quadrangle. *Italicized* items are those considered to have possibly been applicable. Potential technologic restrictions would be evaluated for a specific development project. In some cases the potential restriction might be mitigated.)

A. Coal-leasing unsuitability criteria from the Federal Coal Management Regulations (43CFR 3461.5)

1. Federal land systems
2. Rights of way and easements [i.e., railroad]
3. Dwellings, roads, cemeteries, and public buildings
4. Wilderness Study Areas
5. Lands with outstanding scenic quality
6. Lands used for scientific study
7. Historic lands and sites
8. Natural Areas
9. Critical habitat for threatened or endangered species
10. State listed threatened or endangered species
11. Bald or golden eagle nests
12. Bald and golden eagle roost and concentraion areas
13. Federal lands containing active falcon cliff nesting site
14. Habitat for migratory bird species
15. Fish and wildlife habitat for resident species
16. Floodplains
17. Municipal watersheds
18. National Resource Waters
19. Alluvial valley floors
20. State or Indian tribe criteria

B. Other applicable land-use restrictions

1. Towns
2. Pipelines
3. Powerlines
4. Archaeological areas
5. Surface and coal ownership issues
6. Wetlands
7. Streams, lakes, and reservoirs

C. Technologic restrictions

1. Coal quality
2. Coal depth (<100 feet overburden for underground mining)
3. Mined-out areas
4. Limit of coal (including areas of burned coal)
5. Subsidence over abandoned mines
6. Subsidence is projected to cause material damage
7. Active mines
8. Abandoned mines
9. Coal beds too close together (<40 feet)
10. Coal beds too thin
11. Coal bed discontinuities
12. Roof or floor problems
13. Barrier pillars
14. Oil and gas development
15. Steep slopes
16. Steeply dipping beds
17. Proximity to intrusives or faults
18. Block size

RESTRICTIONS ON COAL AVAILABILITY IN THE STUDY AREA

FACTORS AFFECTING AVAILABILITY OF COAL RESOURCES

The availability of coal for future mining in the Somerset quadrangle is limited by several factors. These were identified through interviews with mining engineers and geologists with four coal companies that have mines currently operating within the quadrangle or in geologic and physiographic settings similar to those found in the quadrangle. Staff members from the Colorado Division of Minerals and Geology (CDMG), the state agency responsible for permitting and inspecting mines, were also interviewed. The information from these interviews was used to develop restriction criteria for defining available coal in the quadrangle.

Availablity of coal must be evaluated based on the mining method that will most likely be used to recover the coal. In the Somerset coal field, all historic mining has been by underground methods. In the last several years, plans for expansion within existing mines and plans for new mines have involved longwall mining exclusively.

CONSIDERATIONS FOR RESTRICTIONS

There are many factors that could affect the availability of coal for mining. The three general groups of factors to consider for coal development are legal unsuitability criteria, potential land-use restrictions, and technologic factors. Table 4 provides a complete listing of all factors considered within these three groups. Many of the factors considered are either not applicable to the Somerset quadrangle or after analysis were determined to be non-restrictive. Applicability of restrictions was evaluated based on input from mining engineers from coal companies that have mines in and near the Somerset quadrangle, staff members of the CDMG, and individuals with the USGS who are familiar with other coal availability studies.

A hierarchy was established for land-use and technologic restrictions to prevent double-counting of restrictions when they overlap. The hierarchy for resolving overlapping applicable land-use restrictions was 1) streams, 2) highways, and 3) railroads. Technologic restrictions were considered in this order: 1) mined-out areas, 2) coalbed thickness, and 3) proximity to another bed.

UNSUITABILITY CRITERIA DETERMINATIONS

Coal unsuitability criteria are listed in the Federal Regulations, Title 43, Subpart 3461 (43 CFR 3461). These 20 specific legal criteria are used to determine if an area can be mined by surface mining methods. Underground mining on Federal lands can be exempted from these criteria, except where the mining will include surface operations and have surface impacts on Federal lands that cannot be otherwise exempted (43 CFR 3461.1).

Unsuitability Criteria That Are Restrictions to Mining

The unsuitability criteria that were evaluated to be restrictions to mining in the Somerset quadrangle are rights of way and easements (applicable to the railroad), roads (applicable to Colorado Highway 133) and cemeteries (the miner's cemetery north of Somerset) (Figure 5). Dwellings and public buildings within the town of Somerset are also restrictions, although the entire town of Somerset is restricted under other land-use restrictions.

It is conceivable that the cemetery, highway and railroad could be relocated, if necessary, to allow mining to proceed, once the necessary agreements and permits were acquired. For the

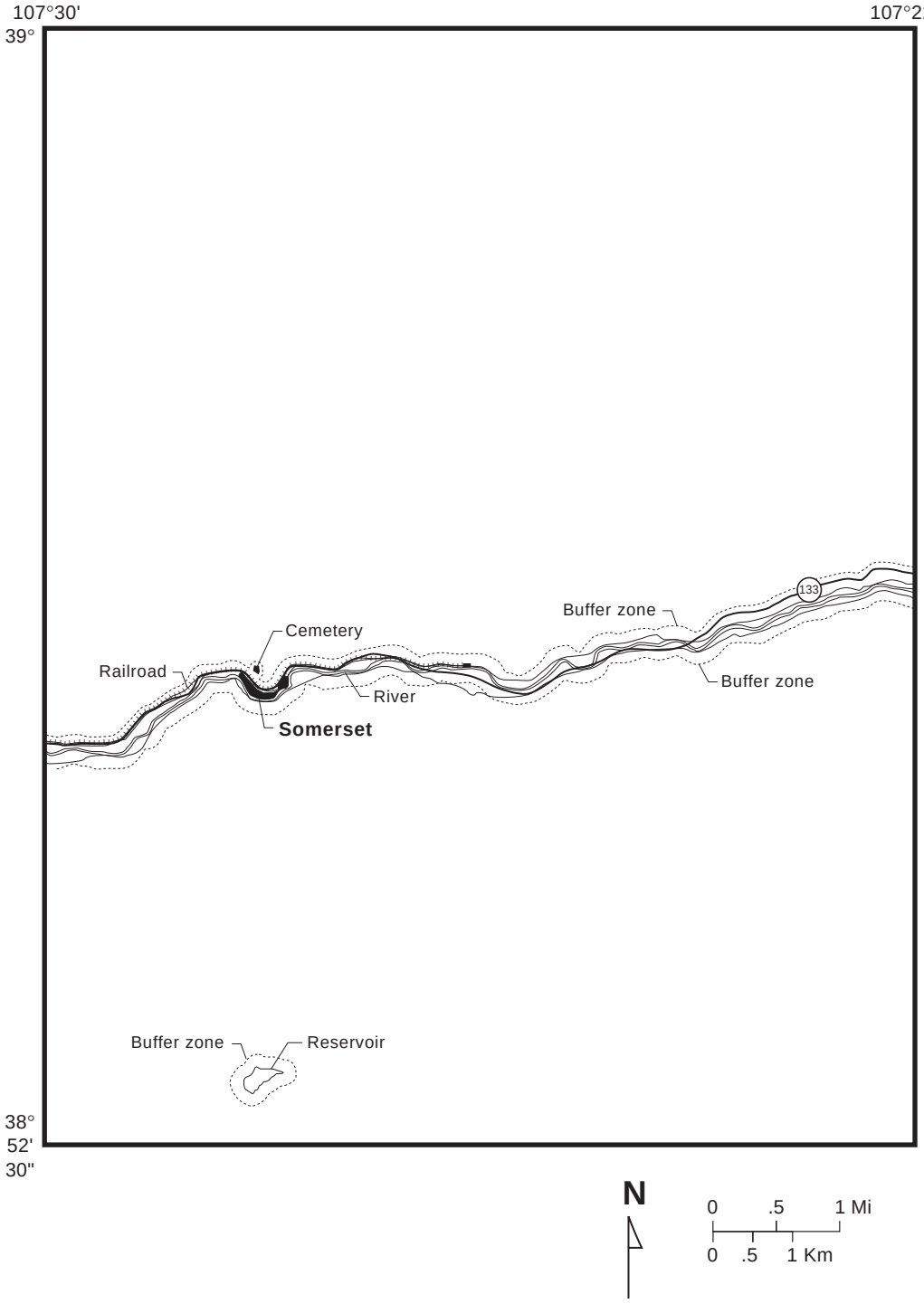

Figure 5. Map of land-use restrictions in the Somerset quadrangle.

purposes of this study, however, they are considered restrictions to mining. No restriction was applied to highways for coal more than 200 feet below the surface.

Unsuitability Criteria That Are Considerations in Mine Planning

Other unsuitability criteria that are potential restrictions in the quadrangle are critical habitat

for threatened or endangered species, bald or golden eagle nests, and alluvial valley floors. The Colorado Division of Wildlife has not identified any bald eagle nests within the quadrangle. Underground mining may be permitted beneath alluvial valley floors (Figure 6) in some cases; therefore alluvial valley floors were not considered a restriction.

These criteria could cause areas to be declared unsuitable for coal mining. Detailed studies, to determine unsuitability or proposing mitigation measures, would be made if an expression of interest for coal development was submitted to the government.

OTHER LAND-USE ISSUES

Coal beneath the town of Somerset is considered restricted. Streams, lakes and reservoirs are also restrictions to coal mining. The North Fork of the Gunnison River and Minnesota Reservoir are both considered land-use restrictions; however, no restriction was applied to streams for coal more than 200 feet below the surface.

Other potential land-use restrictions were considered; however, none were evaluated to be applicable to the Somerset quadrangle. There are no major powerlines or pipelines that transect the quadrangle and no significant archaeological sites have been identified by the Colorado Historical Society. Small, isolated wetlands have been identified within areas permitted for coal mining; however, mining has not been restricted under these areas. Surface and coal ownership issues (Figures 7 and 8) are potential restrictions, but coal has not been restricted for this reason.

TECHNOLOGIC FACTORS

Technologic factors which were evaluated to be restrictions to mining are coal depth, areas of no coal (mined-out areas, both active and abandoned mines, and areas beyond the limit of coal), thin interburden, thin coal beds, and areas of burned coal.

Overburden of less than 100 feet, interburden of less than 40 feet to the overlying bed, and bed thickness of less than 2.3 feet (28 inches) were considered technologic restrictions to underground mining. Figures 9a through 9f show the areas for which each of the six principal beds or splits are technologically restricted.

Other technologic factors may apply to at least portions of the quadrangle, but were not evaluated to be restrictions to mining. There is insufficient data to evaluate some of these factors. For some factors, the basis of what would constitute a restriction is difficult to establish.

No oil and gas development has taken place within the quadrangle. A single test hole, drilled in 1981, was not completed as a well. Coal quality is not considered to be a restriction to mining, although it could influence the specific areas of a bed that are selected to be mined. It is likely that subsidence over abandoned mines may preclude mining in some areas. Data to identify areas affected by such subsidence is not readily available. Areas with roof or floor problems that would preclude mining, steep slopes and intrusives and faults have also not been identified. Block size will be evaluated in the ensuing coal recoverability study of the Somerset quadrangle.

The CGS, with assistance from the USGS, established a digital database of the mined-out areas for the Somerset coal field. Information on the extent of mining was obtained from individual mine maps or previously-compiled 1:24,000 scale maps available at the CGS, from maps within mine permit documents at the CDMG, or from mine operators. Boundaries of active mines were updated to January 1, 1998, in part based on mine plans through the end of 1997.

Depleted reserves consist of the coal tonnage that was originally present in areas that have been mined. These reserves have been extracted by mining or left as pillars within underground mines. The reserves from the entire coal zone were depleted based on mining from an individual bed within the zone. Coal that has been left in place as barrier pillars within 50 feet of mines has been excluded from resources. Colorado law requires that a barrier pillar at least 500 feet wide be left around active mines; however, once a mine becomes inactive, mining may be permitted within 50 feet of abandoned workings. The Mine Safety and Health Administration requires that a 50-foot barrier be left between mines.

The Colorado Surface Coal Mining Reclamation Act also includes a number of potential exclusions or restrictions to underground coal mining, within Title 34, Article 33 as indicated in Table 5. Many of these overlap with Federal restrictions to mining. All were considered for inclusion in the factors affecting availability of coal.

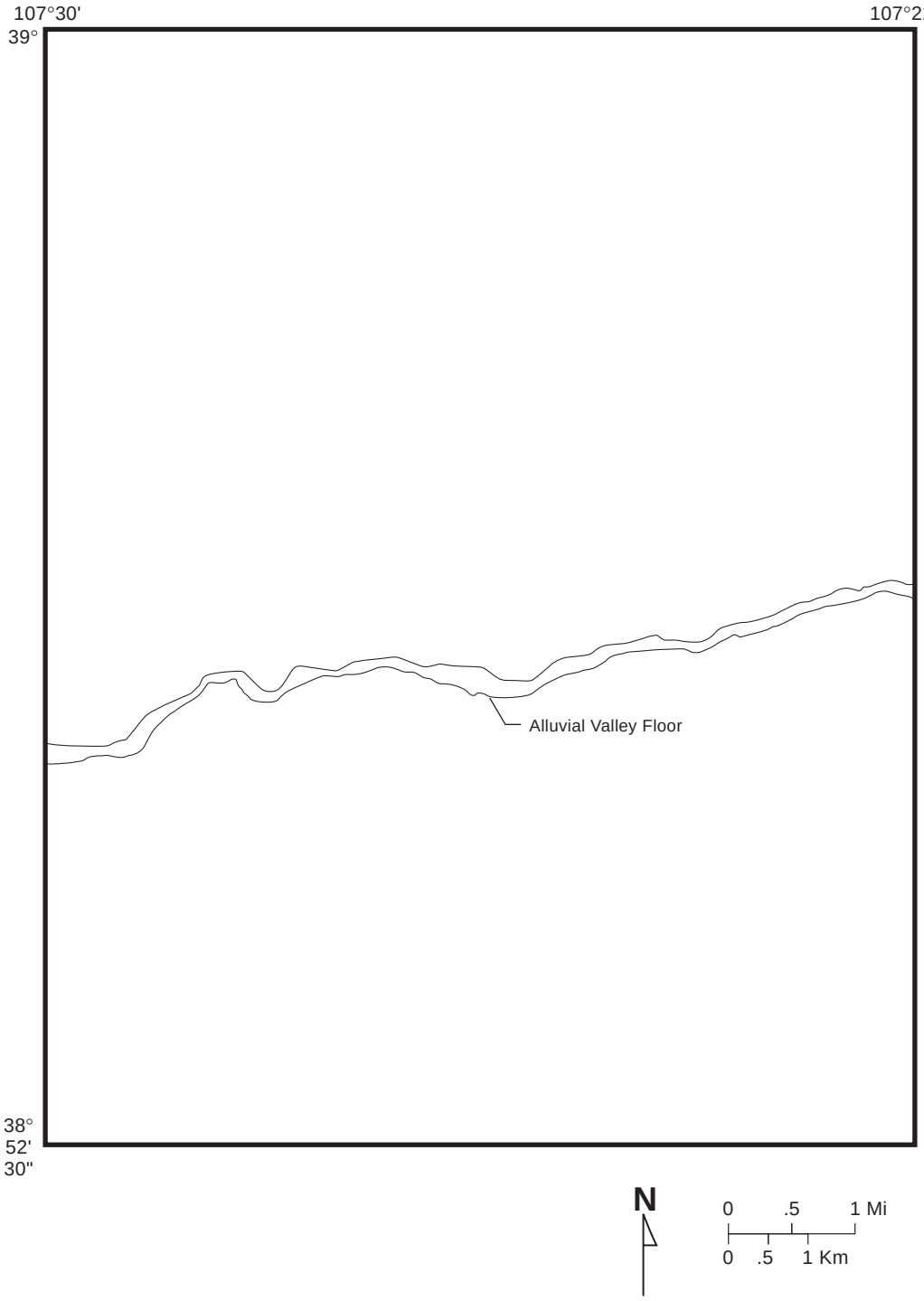

Figure 6. Map of alluvial valley floors in the Somerset quadrangle.

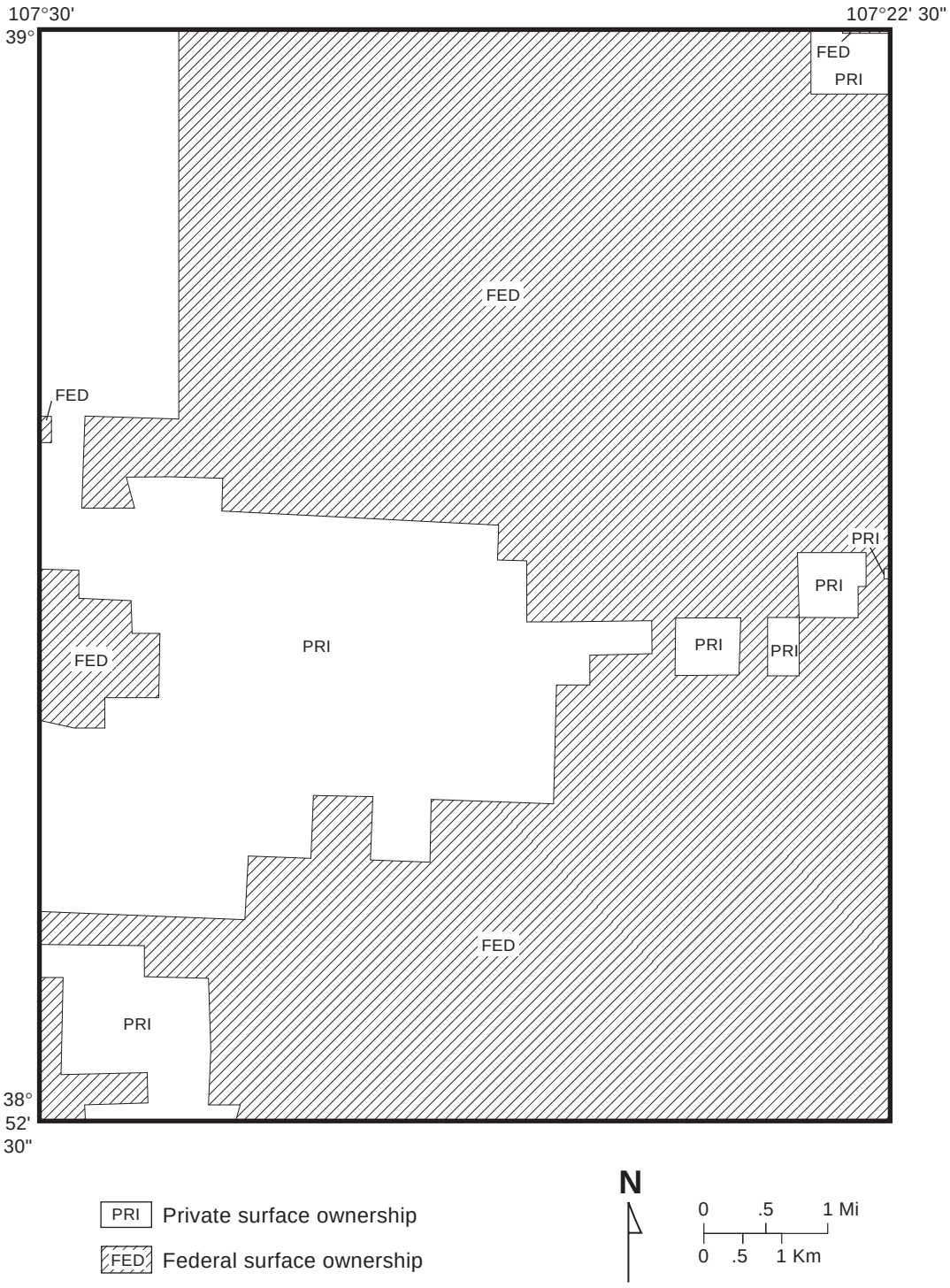

Figure 7. Map of surface ownership in the Somerset quadrangle.

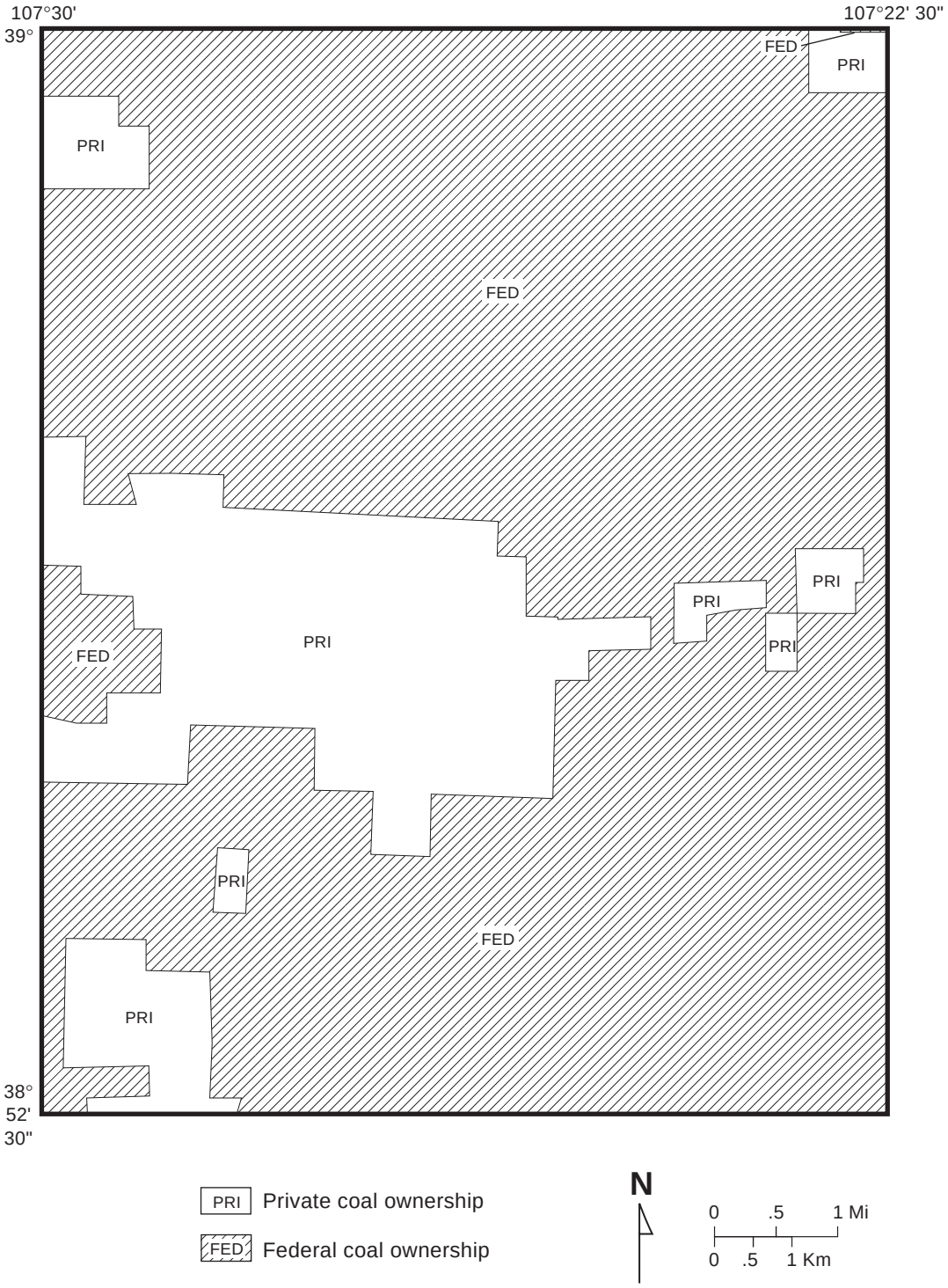

Figure 8. Map of coal ownership in the Somerset quadrangle.

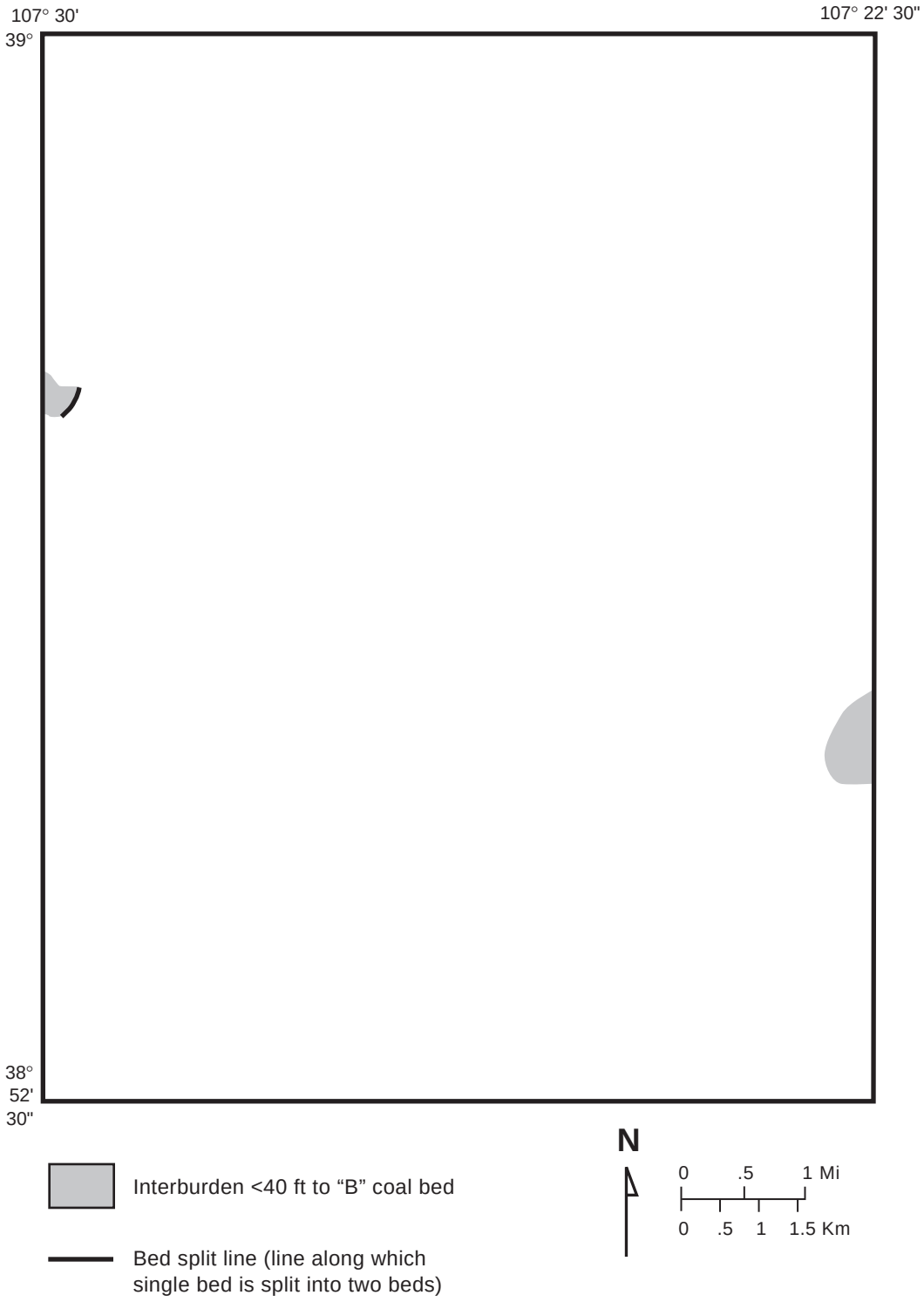

Figure 9a. Map of technologic restrictions of the "Lower B" coal bed, Somerset quadrangle.

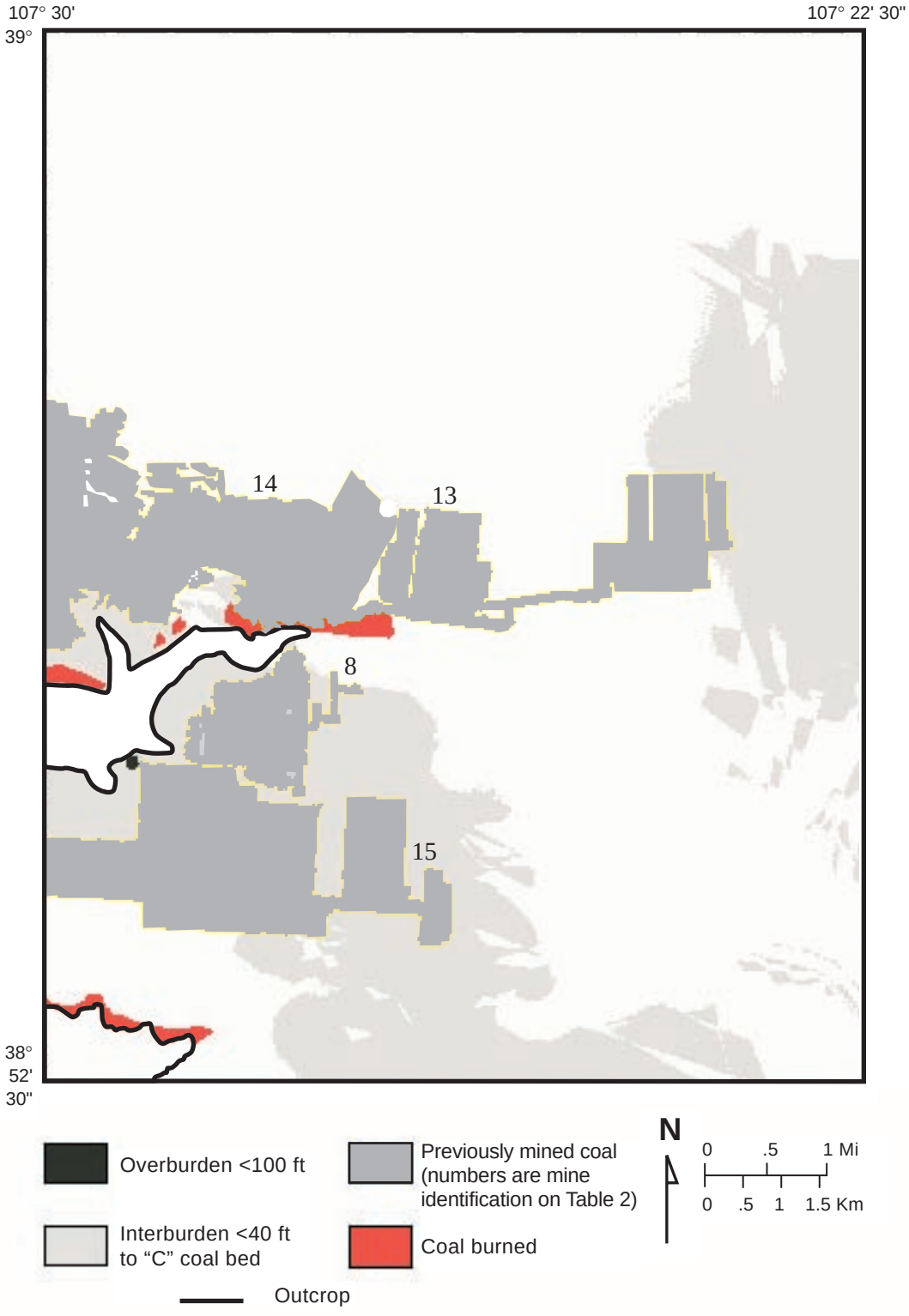

Figure 9b. Map of technologic restrictions of the "B" coal bed, Somerset quadrangle.

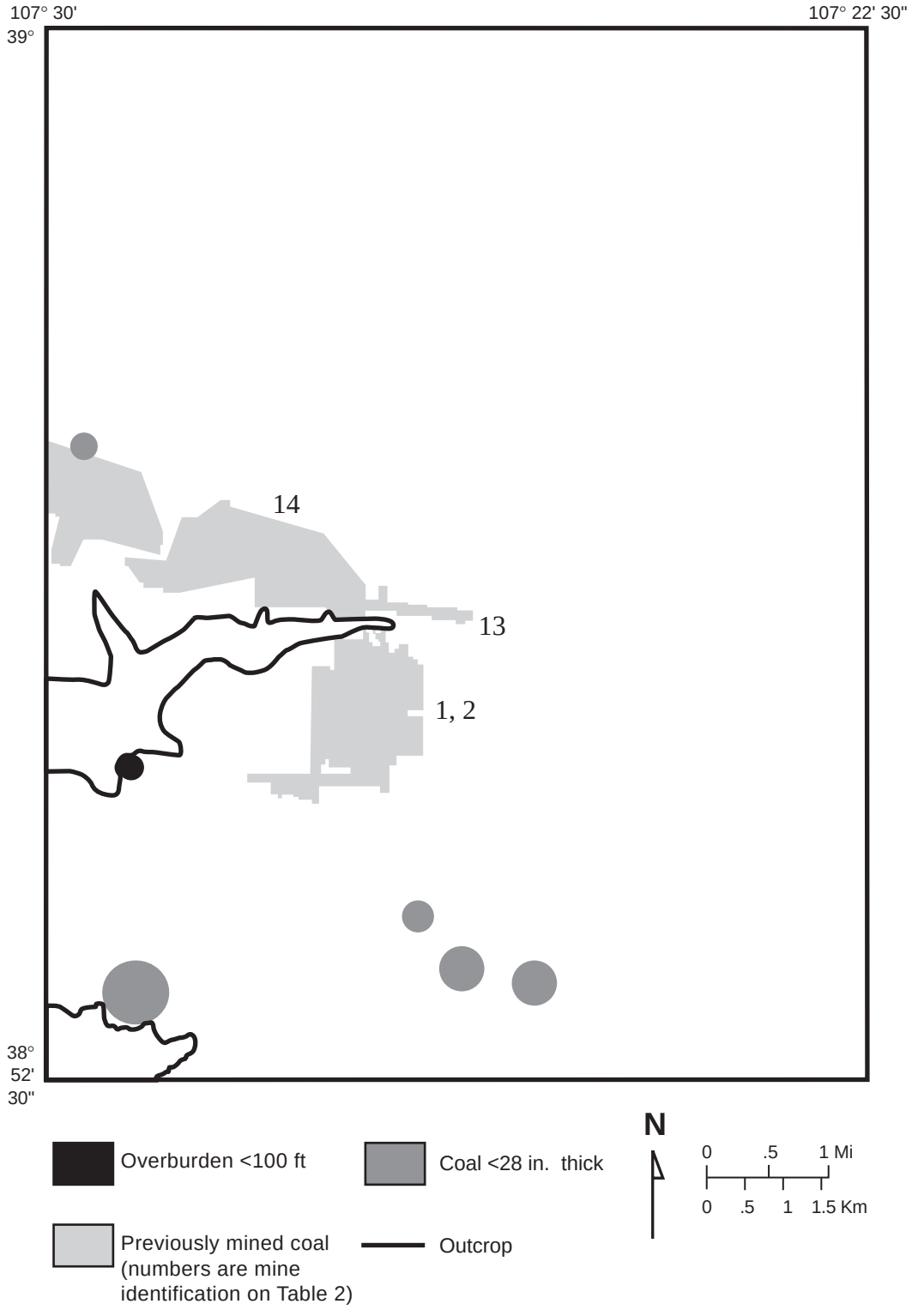

Figure 9c. Map of technologic restrictions of the "C" coal bed, Somerset quadrangle.

Figure 9d. Map of technologic restrictions of the "Lower D" coal bed, Somerset quadrangle.

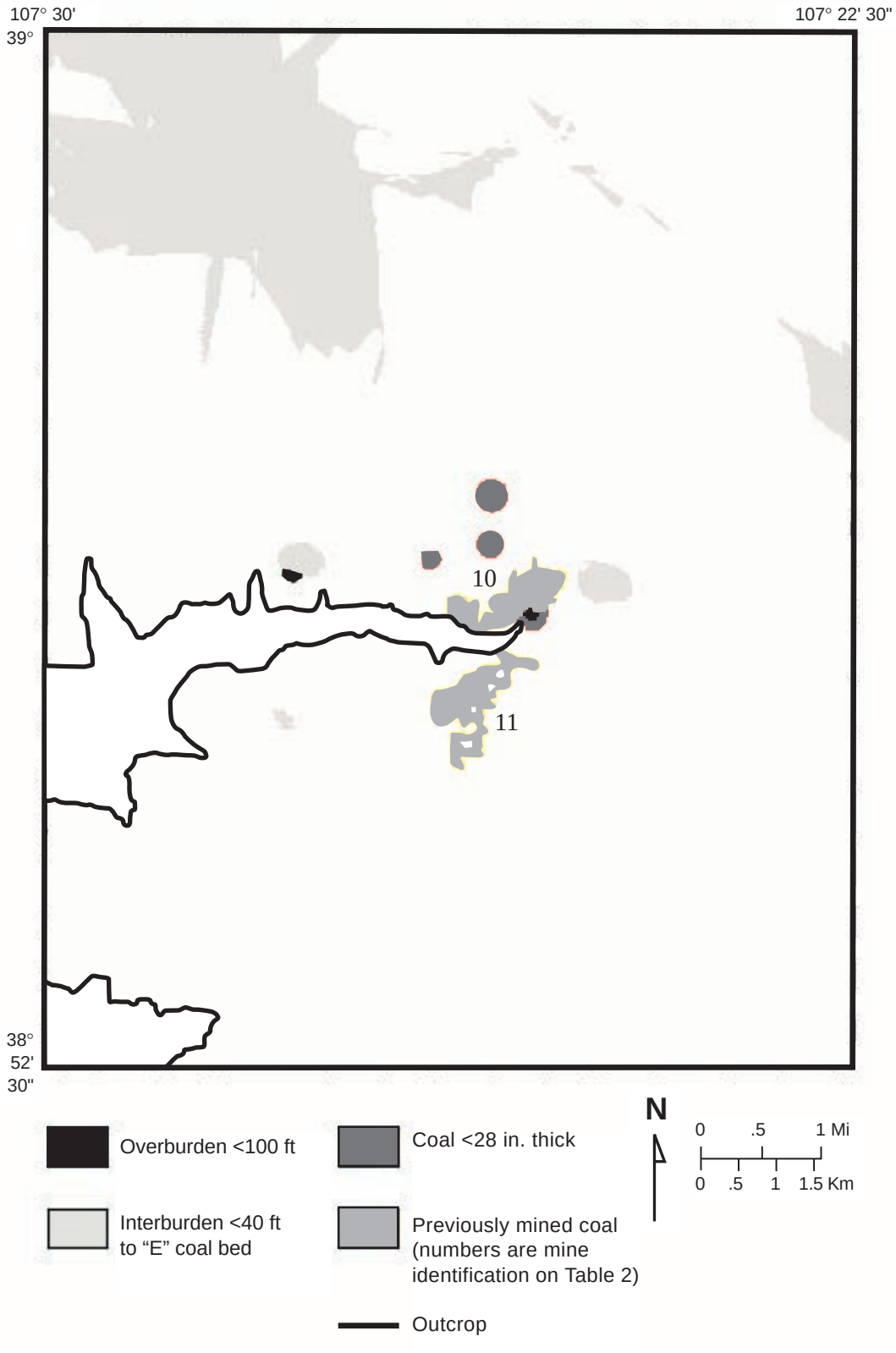

Figure 9e. Map of technologic restrictions of the "D" coal bed, Somerset quadrangle.

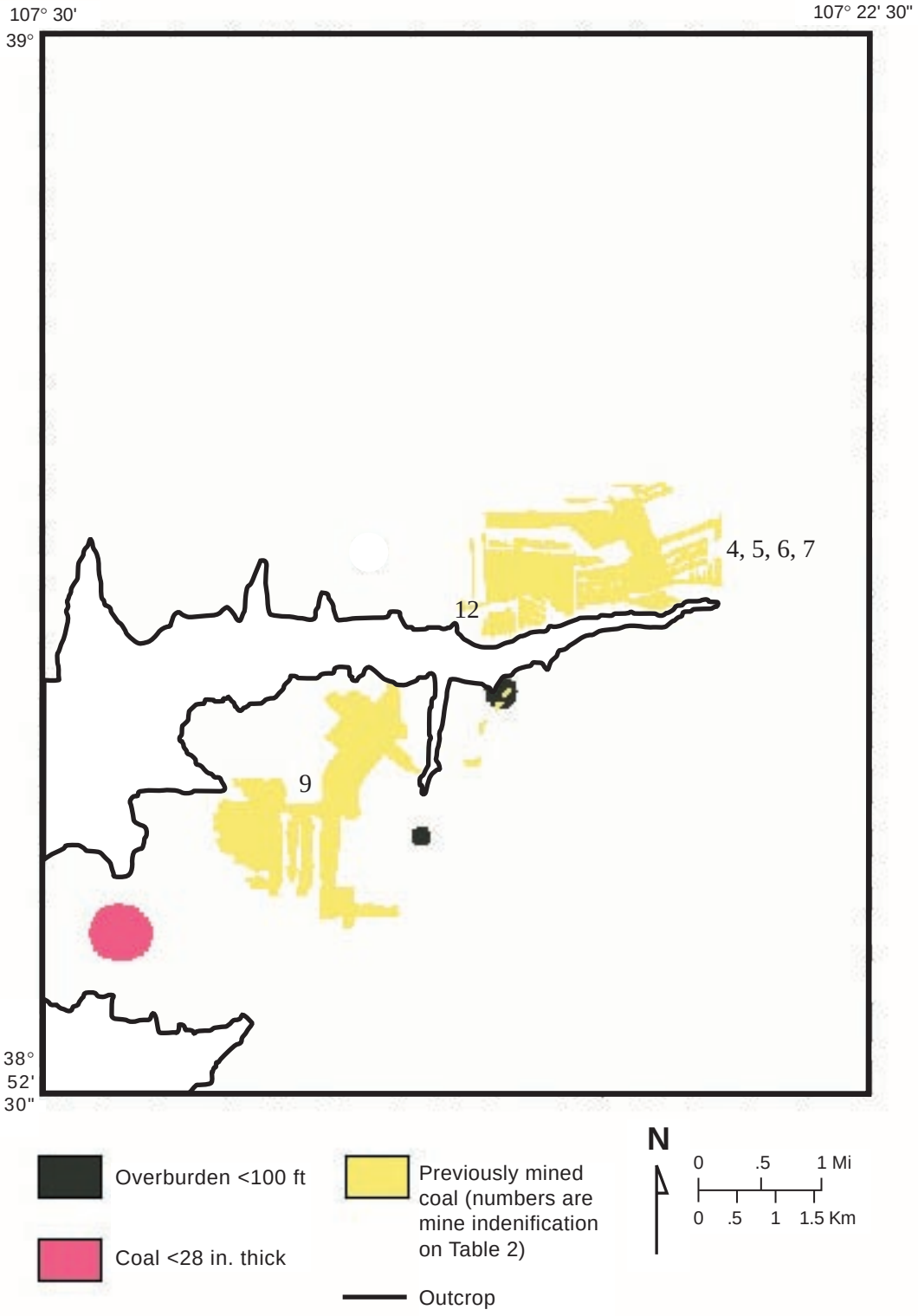

Figure 9f. Map of technologic restrictions of the "E" coal bed, Somerset quadrangle.

Table 5. Exclusions/Restrictions to Mining, Colorado Revised Statutes 34-33-101 and following sections.

Restriction/ Exclusion	Explanation of Restriction or Exclusion	Rule No.
E	Lands within national park system, national wildlife refuges, national system of trails, national wilderness preservation system, wild and scenic rivers, and national recreation areas	2.07.6(2)(d)(iii)(A)
E	Within 300 ft of public building (school, church, hospital, courthouse, government building ...) community or institutional building or any public park	2.07.6(2)(d)(iii)(B)
E	Within 100 ft of a cemetery	2.07.6(2)(d)(iii)(©)
E	Lands designated unsuitable for mining [DMG comment: None have been designated in Colorado.]	2.07.6(2)(d)(i)
E	Operations which affect the continued existence of threatened and endangered species	2.07.6(2)(n)
R	Mining on steep slopes (has to meet specific performance standards)	2.06.4
R	Lands within national forest	2.07.6(2)(d)(iii)(D)
R	Will not adversely affect publicly owned park or place eligible to be included in the National Register of Historic Places	2.07.6(2)(e)(i)
R	Within 100 ft of public road right of way	2.07.6(2)(d)(iv)
R	Within 300 ft of an occupied dwelling (unless owner waives)	2.07.6(2)(d)(v)
R	500 ft, measured horizontally, from active or abandoned underground mines	4.19(1)
R	Beneath or adjacent to any perennial stream, or impoundment or other body of water >20 acre-ft	4.20.4
R	Mining in alluvial valley floors and prime farm land [DMG comment: AVFs are identified during permitting process.]	2.07.6(2)(K)
R	Operations where subsidence is projected to cause material damage [DMG comment: Essentially must avoid or leave support pillars to protect aquifers, agricultural land and occupied residential dwellings and noncommercial buildings.]	2.05.6(6)(b)(iii) 4.20
R	Blasting within 1000 ft of schools, churches, hospitals and nursing facilities and within 500 ft of wells, pipelines and storage tanks for oil, gas or water	4.08.4(7)
R	Surface disturbance within 100 ft of perennial streams with biological communities in them	4.05.18

E—exclusion R—restriction

PREPARATION OF DATA FOR RESOURCE CALCULATIONS

COLLECTION OF STRATIGRAPHIC DATA

Stratigraphic data sources used in determining coal resource quantities include drilling logs, core descriptions, and geophysical logs. Drill hole data was obtained from published sources, USGS databases, BLM files, Mountain Coal Company, and permit documents at the CDMG. The drill holes used, which represent all publicly available data within three miles of the quadrangle, are shown in Figure 10.

Proprietary data were not used in this study. Where other published data were not available, coal bed thicknesses were scaled from cross sections published by the USGS.

The CGS requested that Mountain Coal Company release selected drill hole data to fill in areas where drill holes were spaced more than 1.5 miles apart, to attempt increasing the amount of measured resources. Data, including geophysical logs and core logs, were released on 14 drill holes. Logs of two additional drill holes were obtained from cross sections within permit documents filed with the CDMG.

CORRELATION OF COAL BEDS

Cretaceous coal beds of Colorado are highly lenticular and their minable thicknesses frequently extend laterally relatively short distances. Because of this lenticularity, correlation of coal beds is difficult.

Proprietary data were not available for use in this study; however, coal bed correlations in the USGS databases were influenced by a relatively large amount of closely spaced proprietary data in some areas. Correlations of previous geologists were used to a large extent; however, correlations in this report did not benefit directly from the proprietary data used by some of the geologists previously working in the area. Previous coal bed correlation work for either side of the North Fork valley has generally been done independently, so correlations are not made across the river from north to south. Several previous studies, particularly Johnson (1948) and Dunrud (1989), have covered a relatively large area, including areas both north and south of the river. Their correlations do not agree in some instances.

In this report, as in Dunrud (1989), the Hawksnest bed is correlated as the E bed both north and south of the river. The bed designated as the F bed by Mountain Coal, and mined in the Mt. Gunnison Mine, is designated as the E bed in this report.

General coal bed correlations in the Somerset quadrangle are depicted in two coal correlation diagrams, the locations of which are shown on Figure 10. Diagram A–A', on 110, runs east-west just north of the river. Figure 12 contains a north-south coal correlation diagram, B–B'. These correlation diagrams illustrate the variability of bed thickness, splits, and bed position in relatively short distances, which makes correlation of beds difficult. Splitting of the B and D beds, with a defined Lower B or Lower D bed occurring in some drill holes, is also depicted.

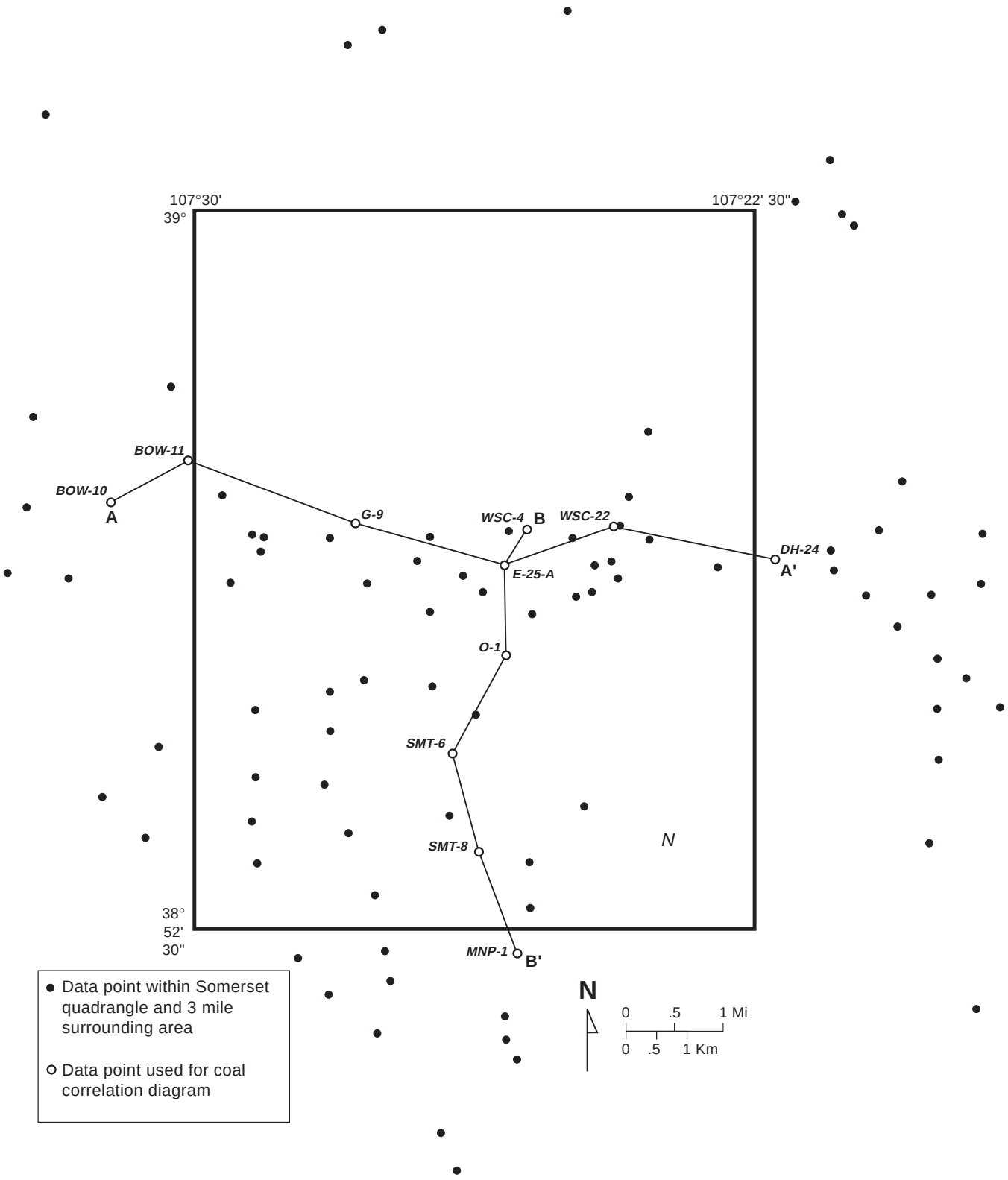

Figure 10. Map of data points and location of coal correlation diagrams used for the Somerset quadrangle.

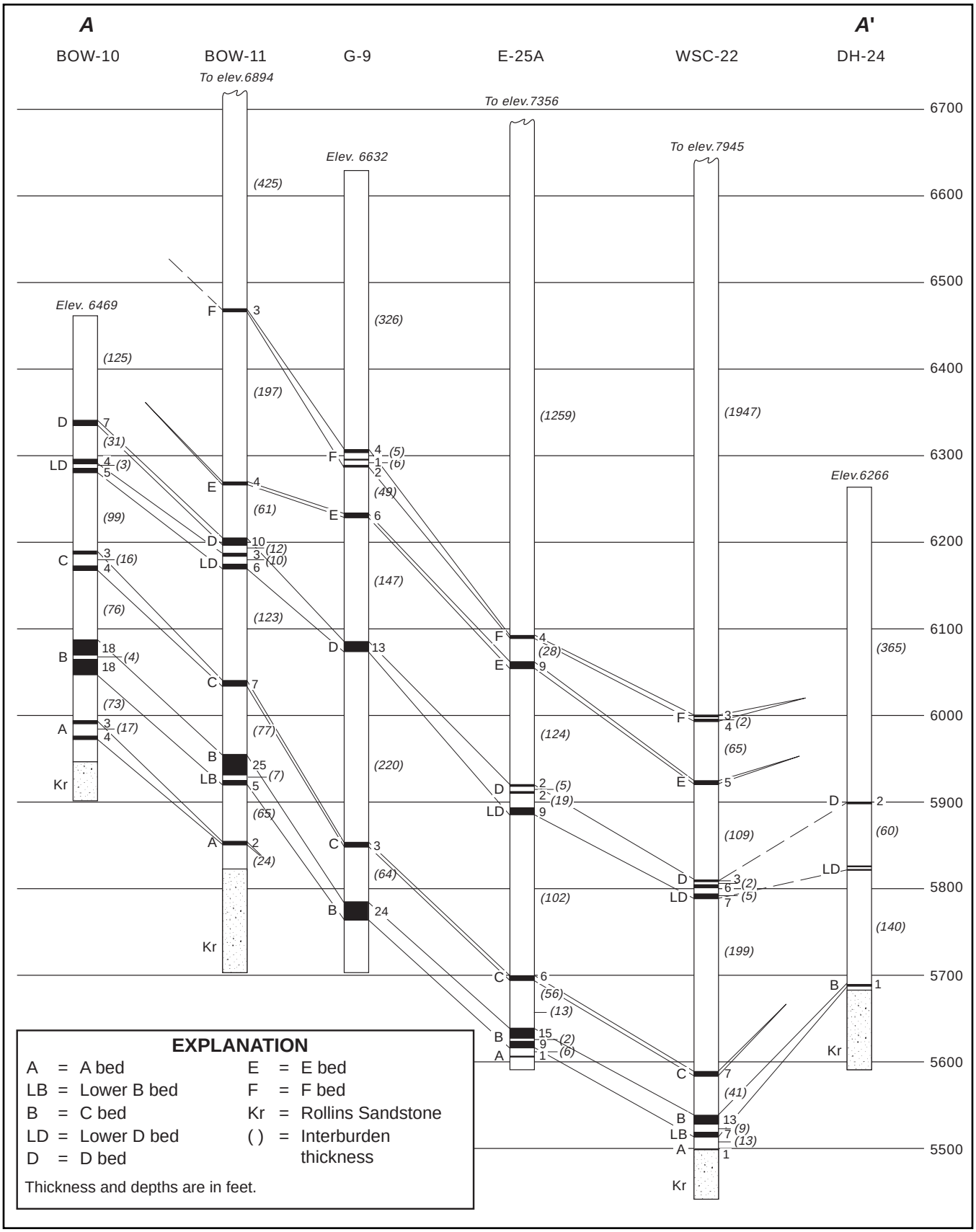

Figure 11. Coal Correlation Diagram A—A'.

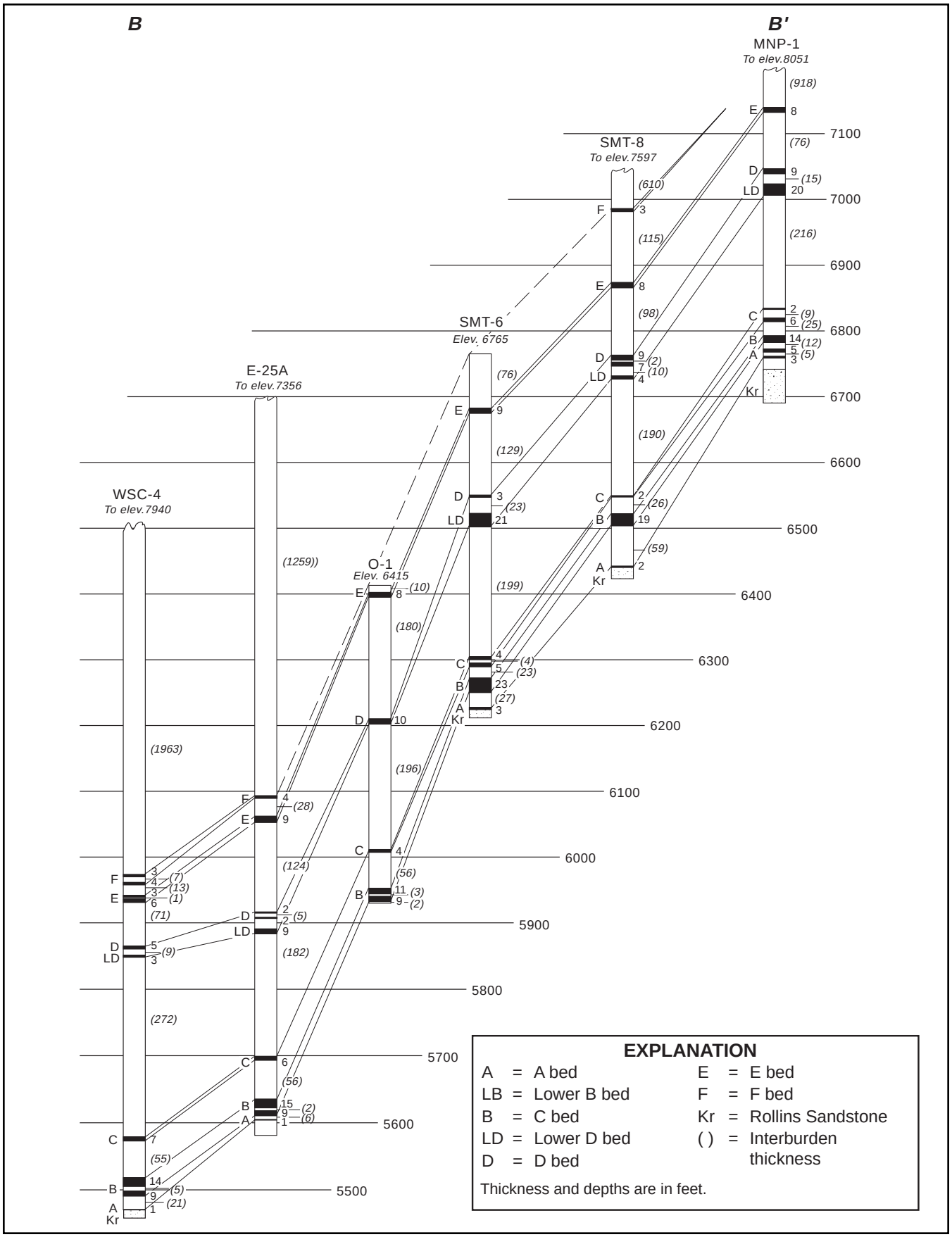

Figure 12. Coal Correlation Diagram B—B'.

COMPUTER TECHNIQUES

Stratifact™ was used to assemble and manipulate the stratigraphic data. Correlations were made or modified in Stratifact, then data were transferred into Access (a Microsoft database program), where individual bed files were established. Geographic Information Systems (GIS) coverages were digitized in ArcInfo:

- Drill hole locations were mapped and digitized.
- Land-use restrictions were digitized, or existing digital coverages were used where possible.
- Mine maps were assembled and digitized to produce a map of mined-out areas for each coal bed.
- Bed outcrops were constructed based on project data, geologic mapping (Dunrud, 1989), and topographic mapping and then digitized.
- Split lines for the B and Lower B beds and the D and Lower D beds were defined, mapped, and digitized.
- Burn areas shown on the geologic map by Dunrud (1989) were digitized. The part of Dunrud's geologic map in the vicinity of the Somerset quadrangle was modified to show bedrock geology, then digitized.
- Existing coverages of surface and mineral ownership were obtained from the BLM and modified in the GIS for use in this project.

DST & Associates was responsible for producing most of the maps and all coal resource tables. The stratigraphic and GIS data generated by the CGS was transferred electronically to DST. The GRASS (Geographical Resource Analysis Support System) program was used by DST to produce maps of coal thickness, areas of reliability, and coal depth (Figures 13 a,b, c through 18 a,b,c); technologic restrictions (Figures 9a through 9f) and the required resource calculations (Tables A1 a,b,c through A7 a,b,c). The maps generated from GRASS contain some irregular lines resulting from GRASS being raster based. "Bullets" shown on some of the maps are caused by GRASS honoring every data point.

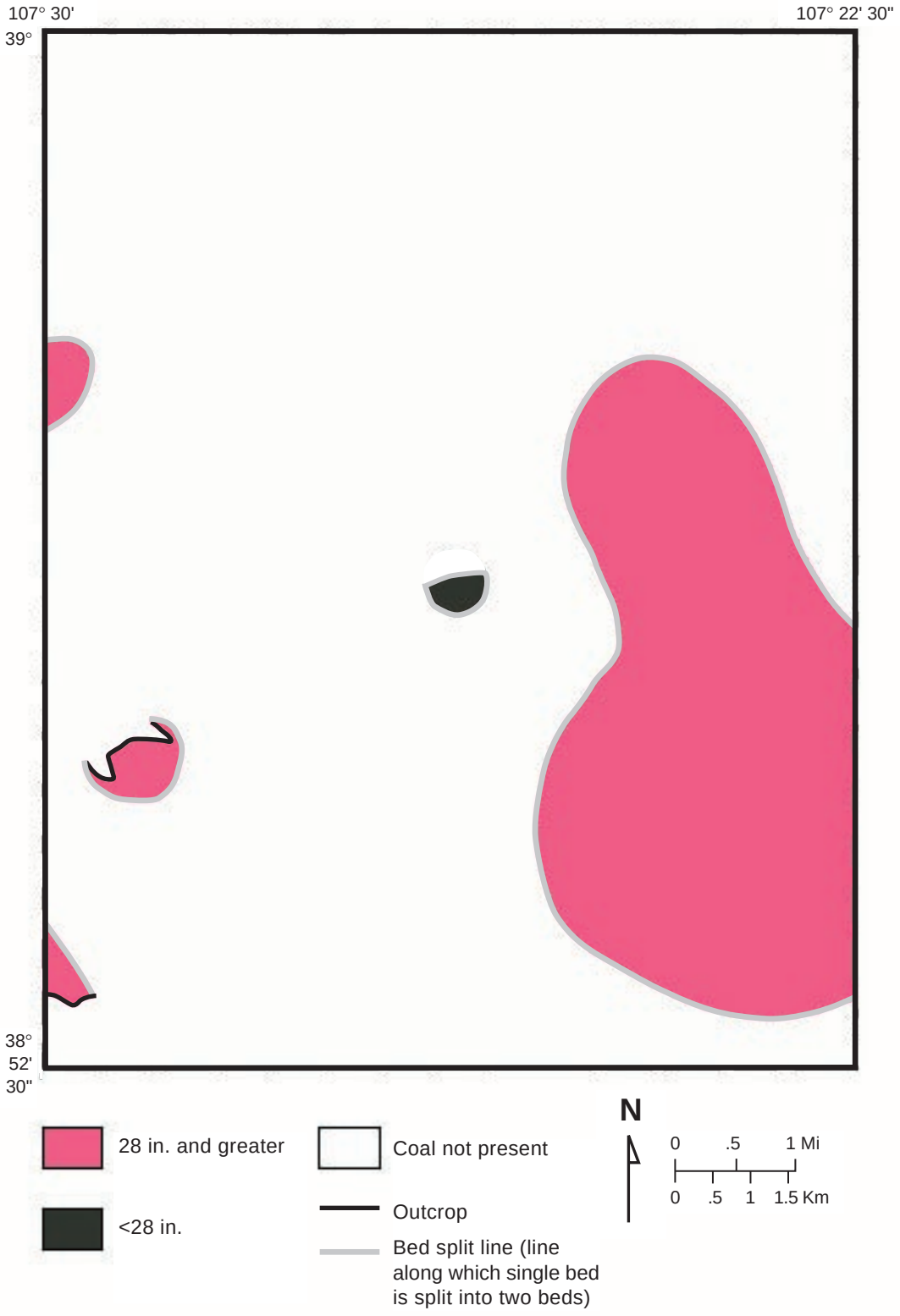

Figure 13a. Bed thickness (coal isopach) map of the "Lower B" coal bed, Somerset quadrangle.

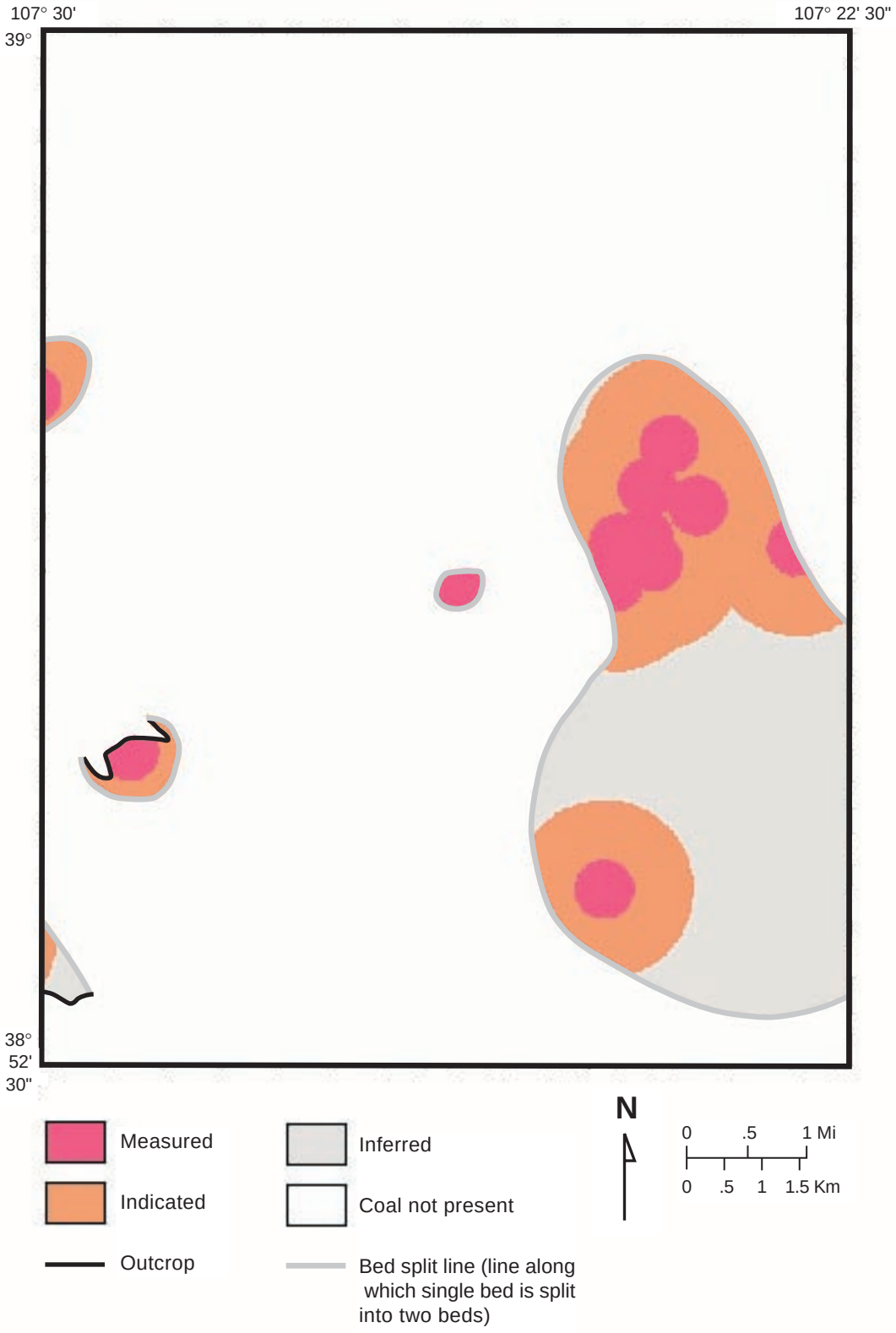

Figure 13b. Map showing areas of reliability of the "Lower B" coal bed, Somerset quadrangle.

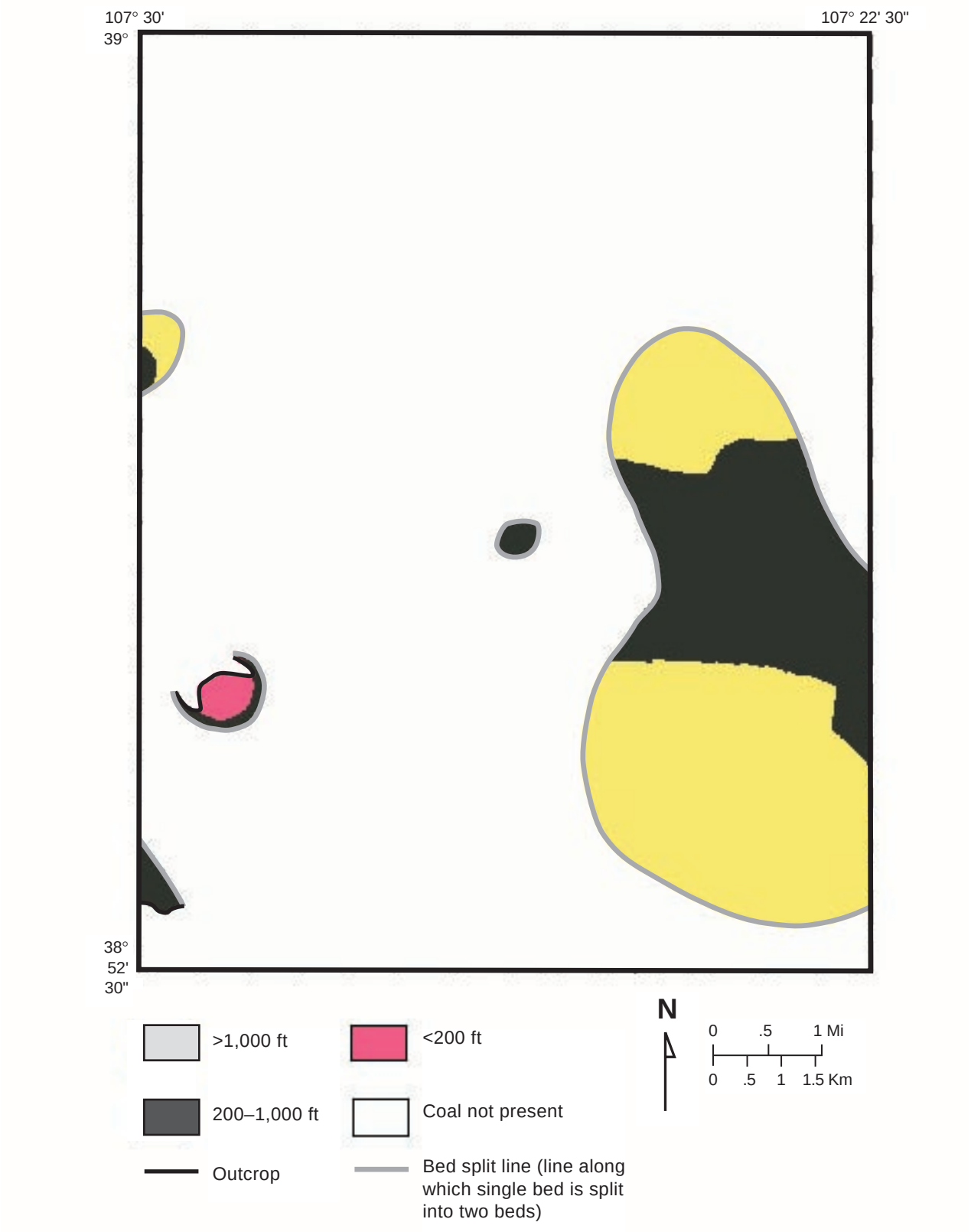

Figure 13c. Depth to coal (overburden isopach) map of the "Lower B" coal bed, Somerset quadrangle.

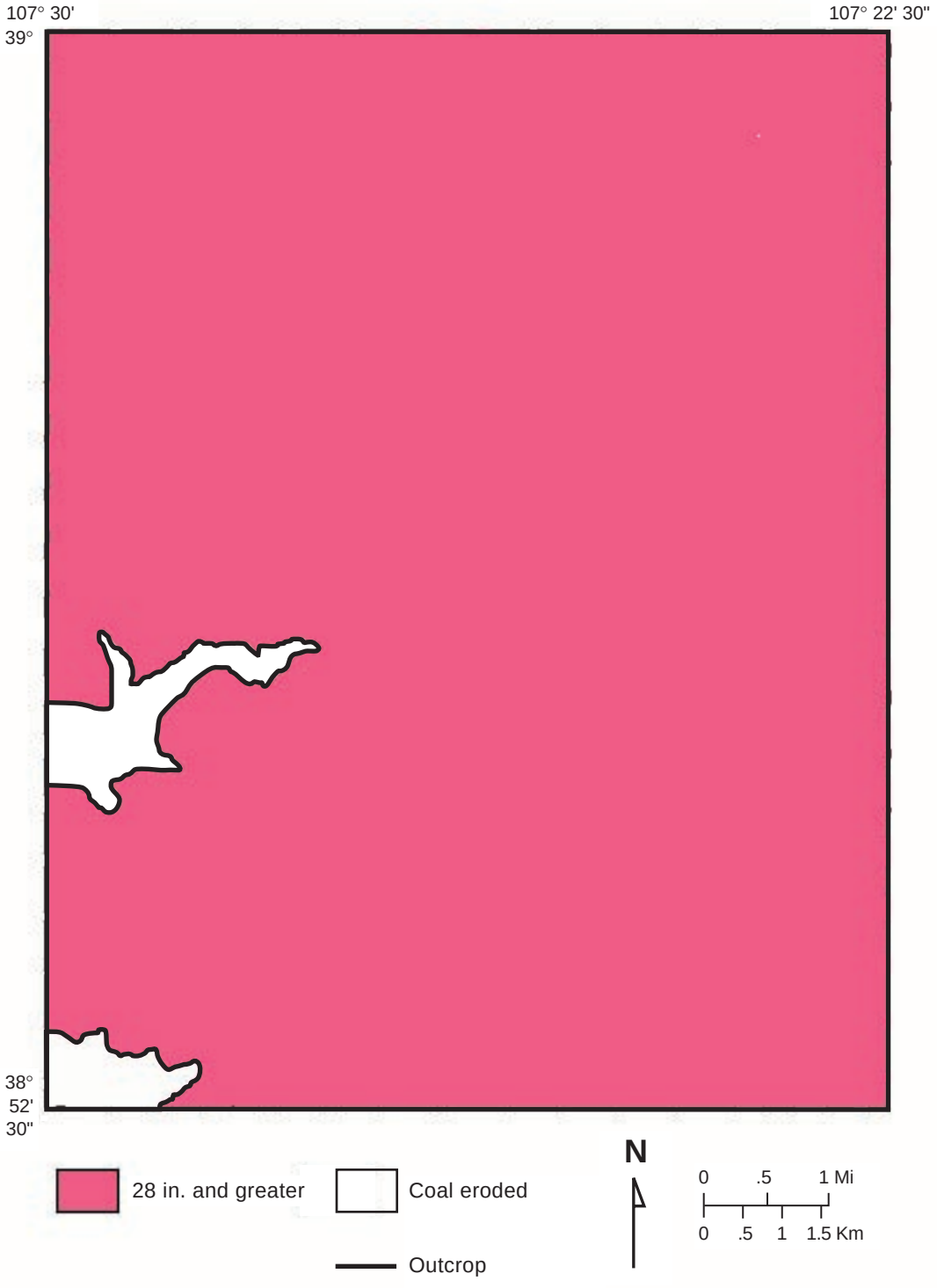

Figure 14a. Bed thickness (coal isopach) map of the "B" coal bed, Somerset quadrangle.

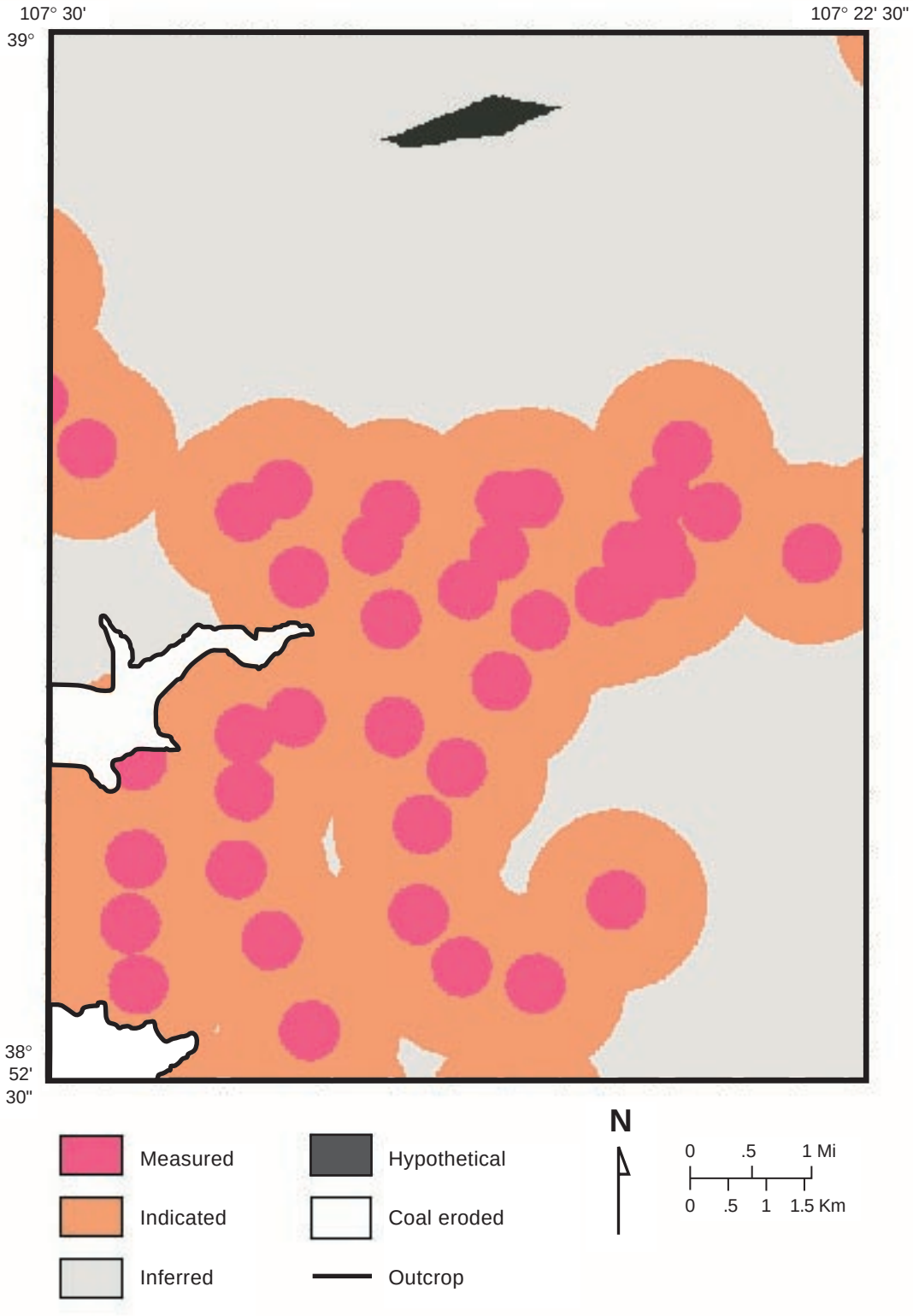

Figure 14b. Map showing areas of reliability of the "B" coal bed, Somerset quadrangle.

Figure 14c. Depth to coal (overburden isopach) map of the "B" coal bed, Somerset quadrangle.

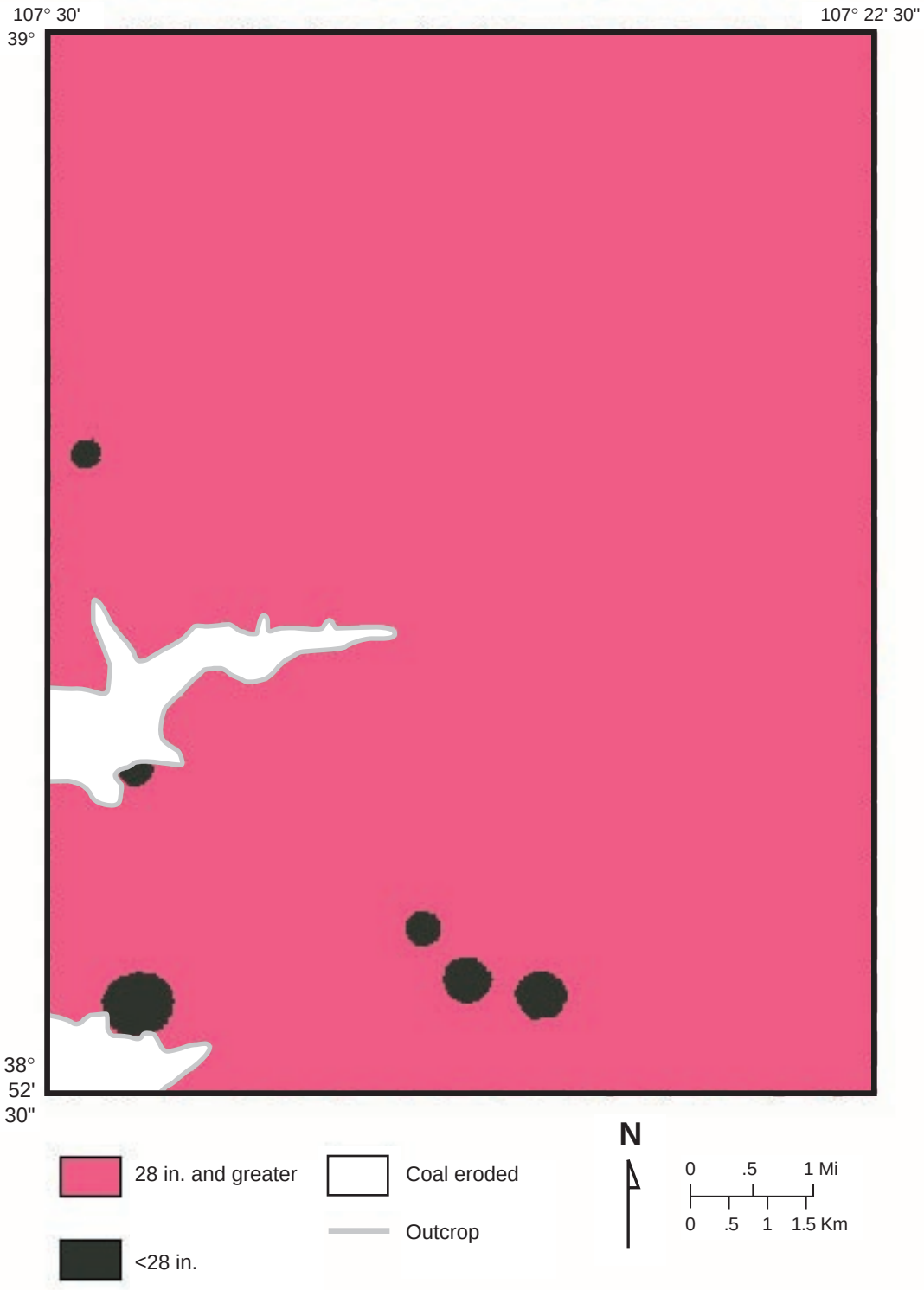

Figure 15a. Bed thickness (coal isopach) map of the "C" coal bed, Somerset quadrangle.

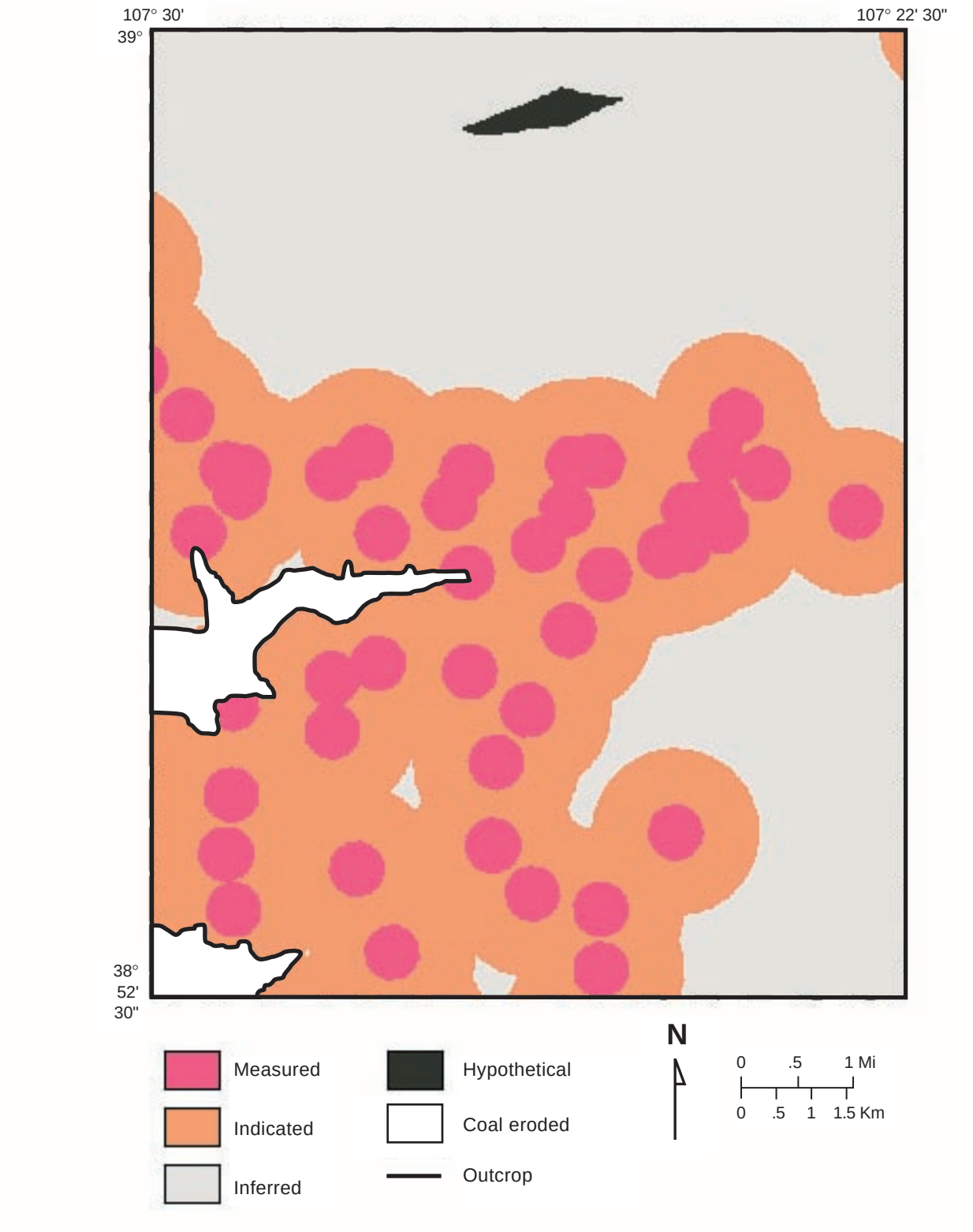

Figure 15b. Map showing areas of reliability of the "C" coal bed, Somerset quadrangle.

Figure 15c. Depth to coal (overburden isopach) map of the "C" coal bed, Somerset quadrangle.

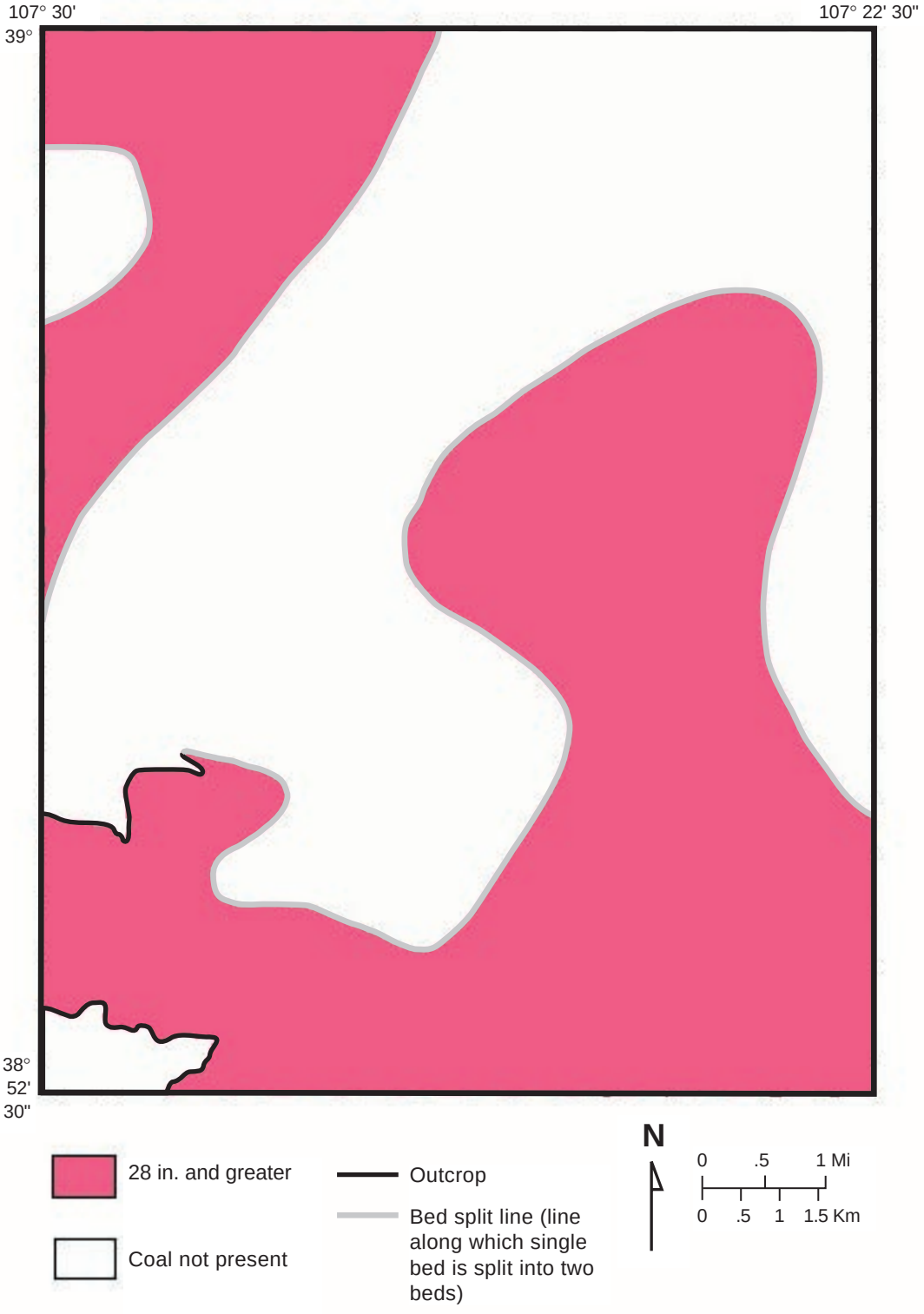

Figure 16a. Bed thickness (coal isopach) map of the "Lower D" coal bed, Somerset quadrangle.

Figure 16b. Map showing areas of reliability of the "Lower D" coal bed, Somerset quadrangle.

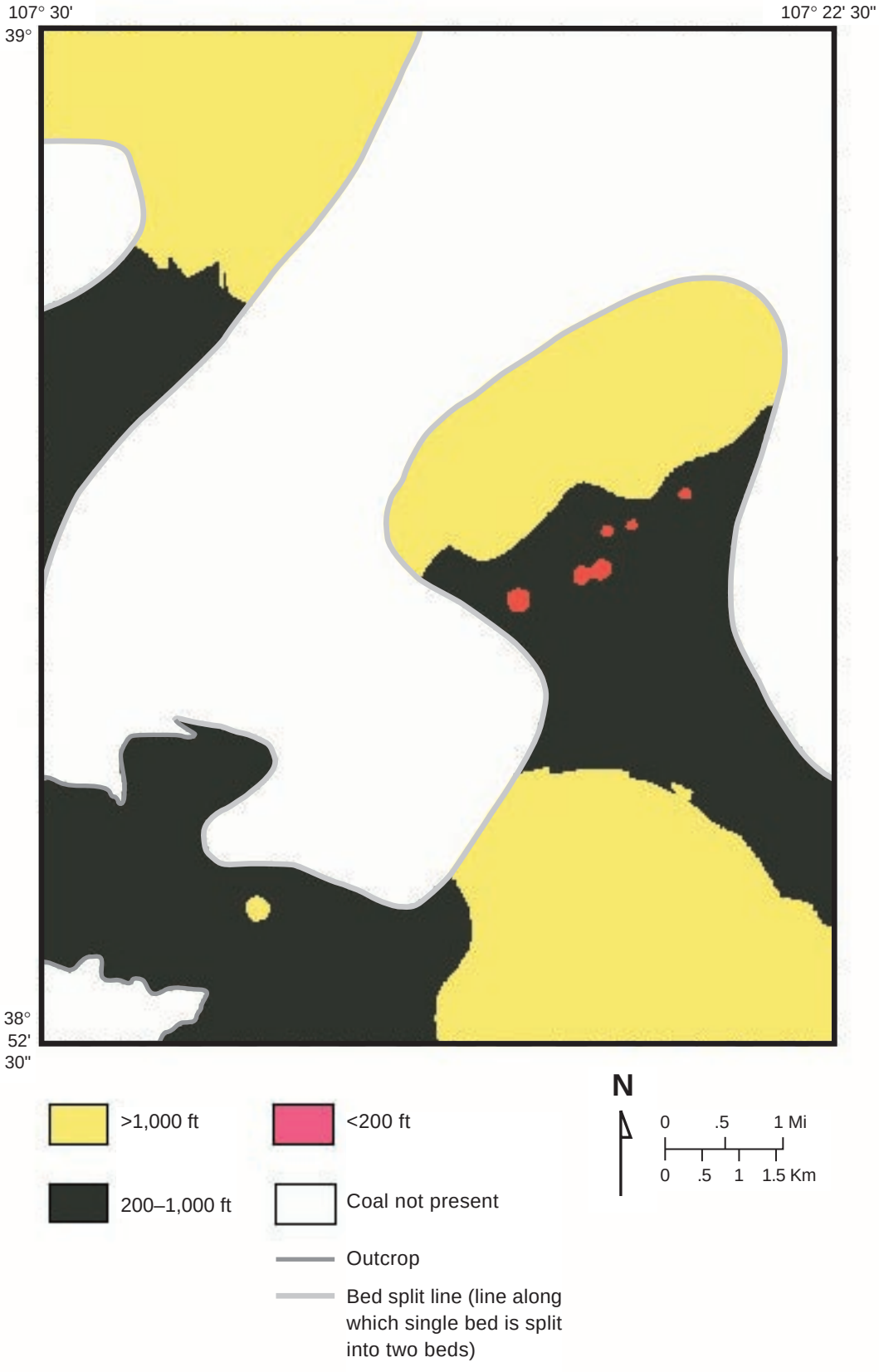

Figure 16c. Depth to coal (overburden isopach) map of the "Lower D" coal bed, Somerset quadrangle.

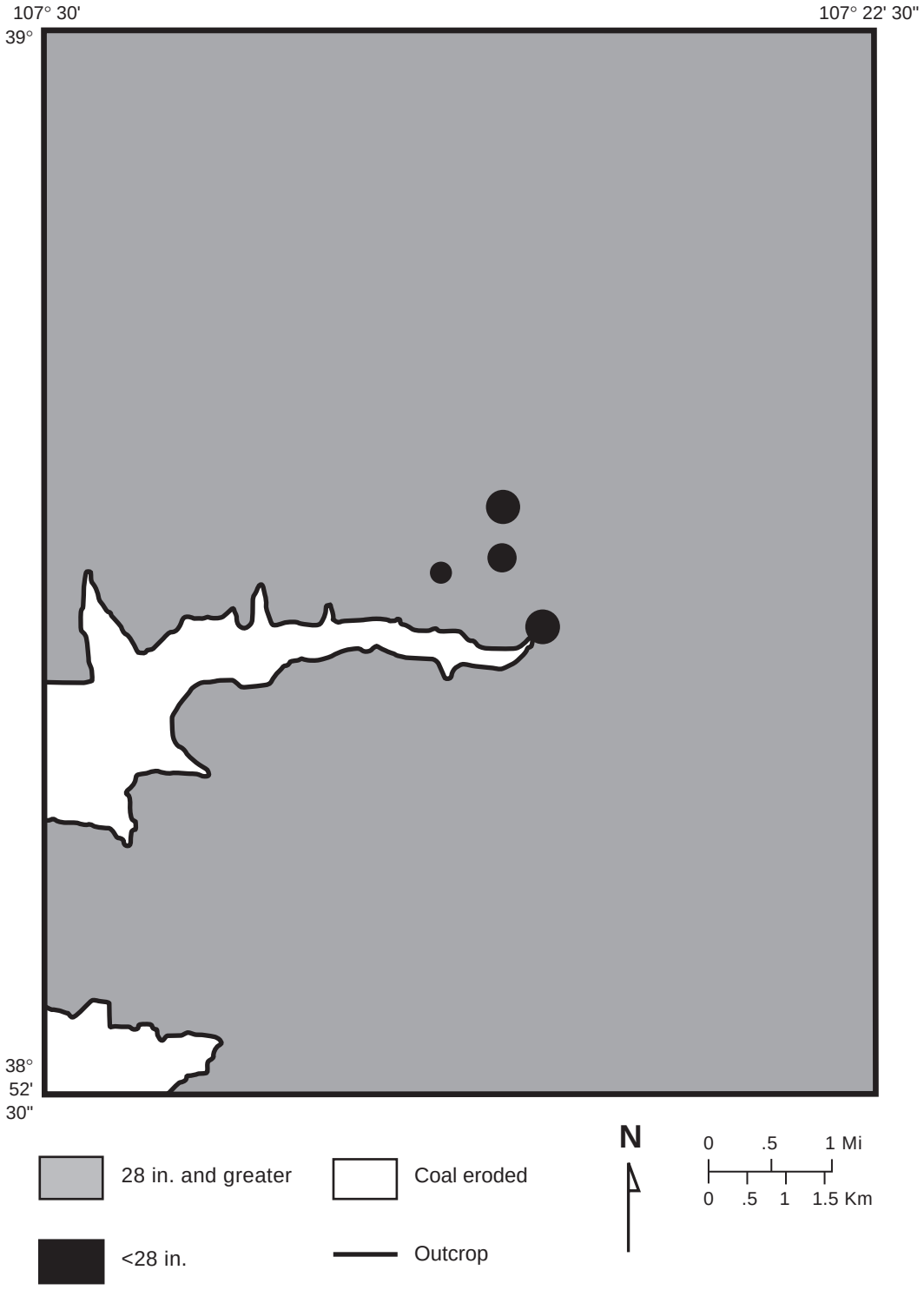

Figure 17a. Bed thickness (coal isopach) map of the "D" coal bed, Somerset quadrangle.

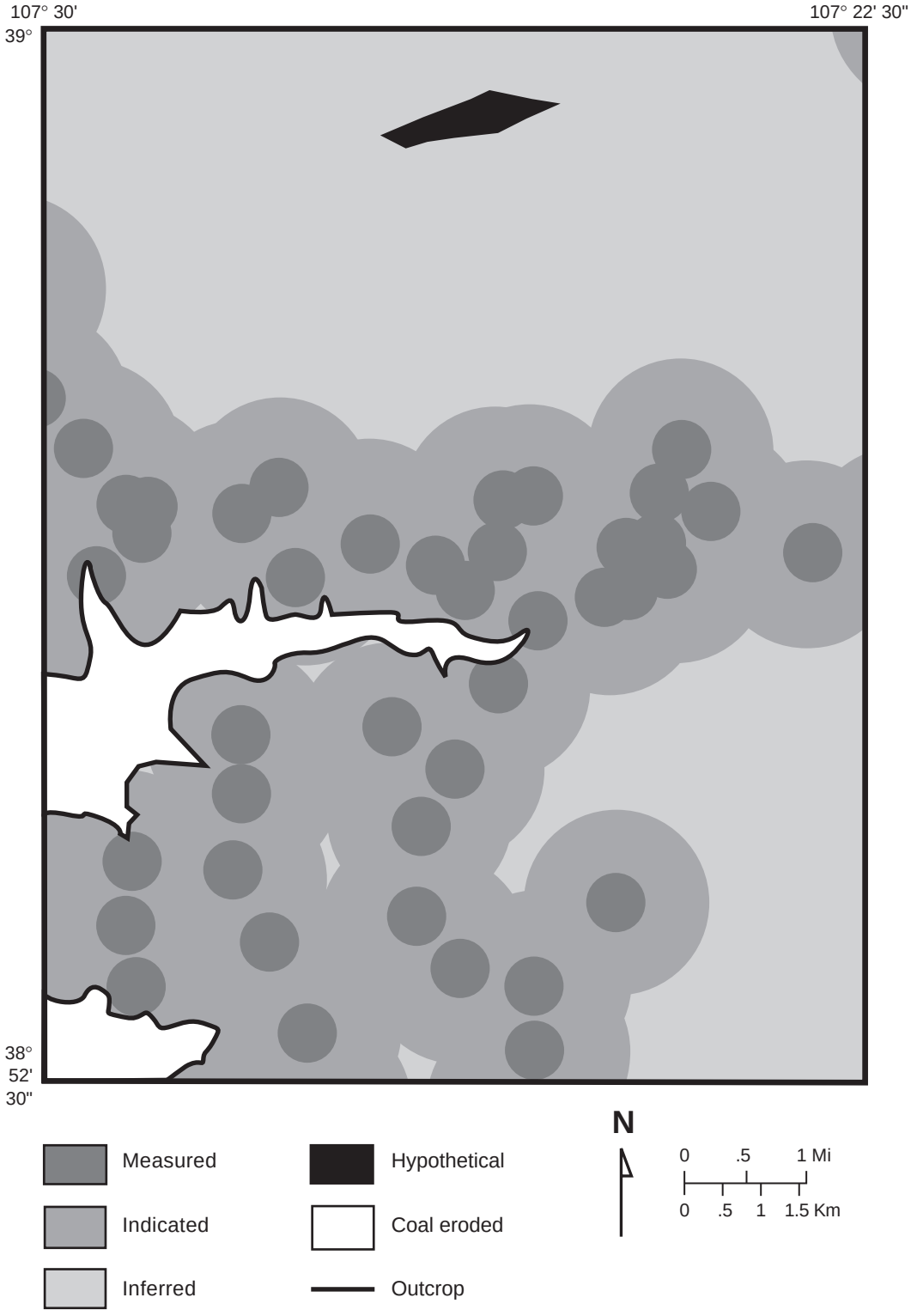

Figure 17b. Map showing areas of reliability of the "D" coal bed, Somerset quadrangle.

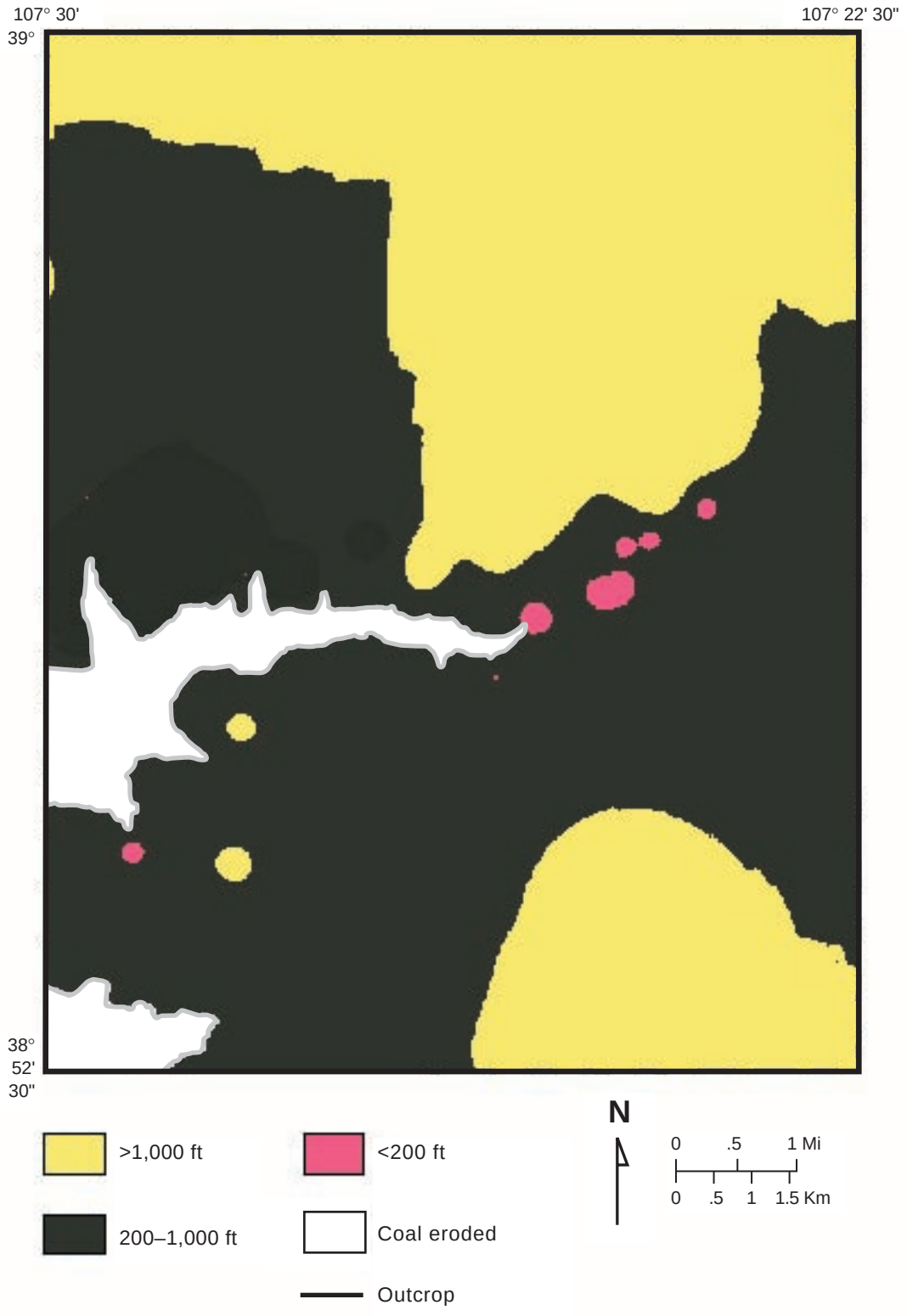

Figure 17c. Depth to coal (overburden isopach) map of the "D" coal bed, Somerset quadrangle.

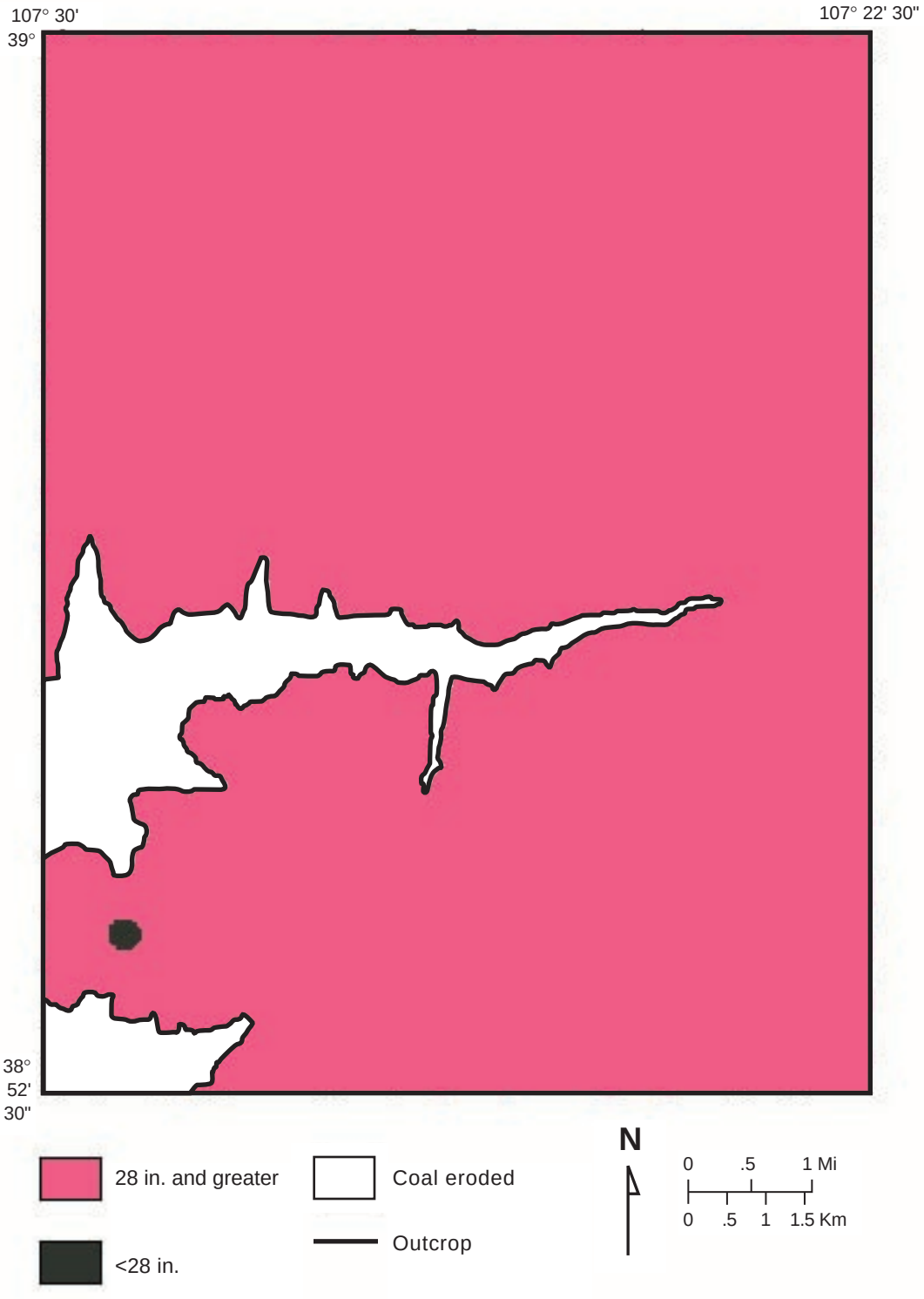

Figure 18a. Bed thickness (coal isopach) map of the "E" coal bed, Somerset quadrangle.

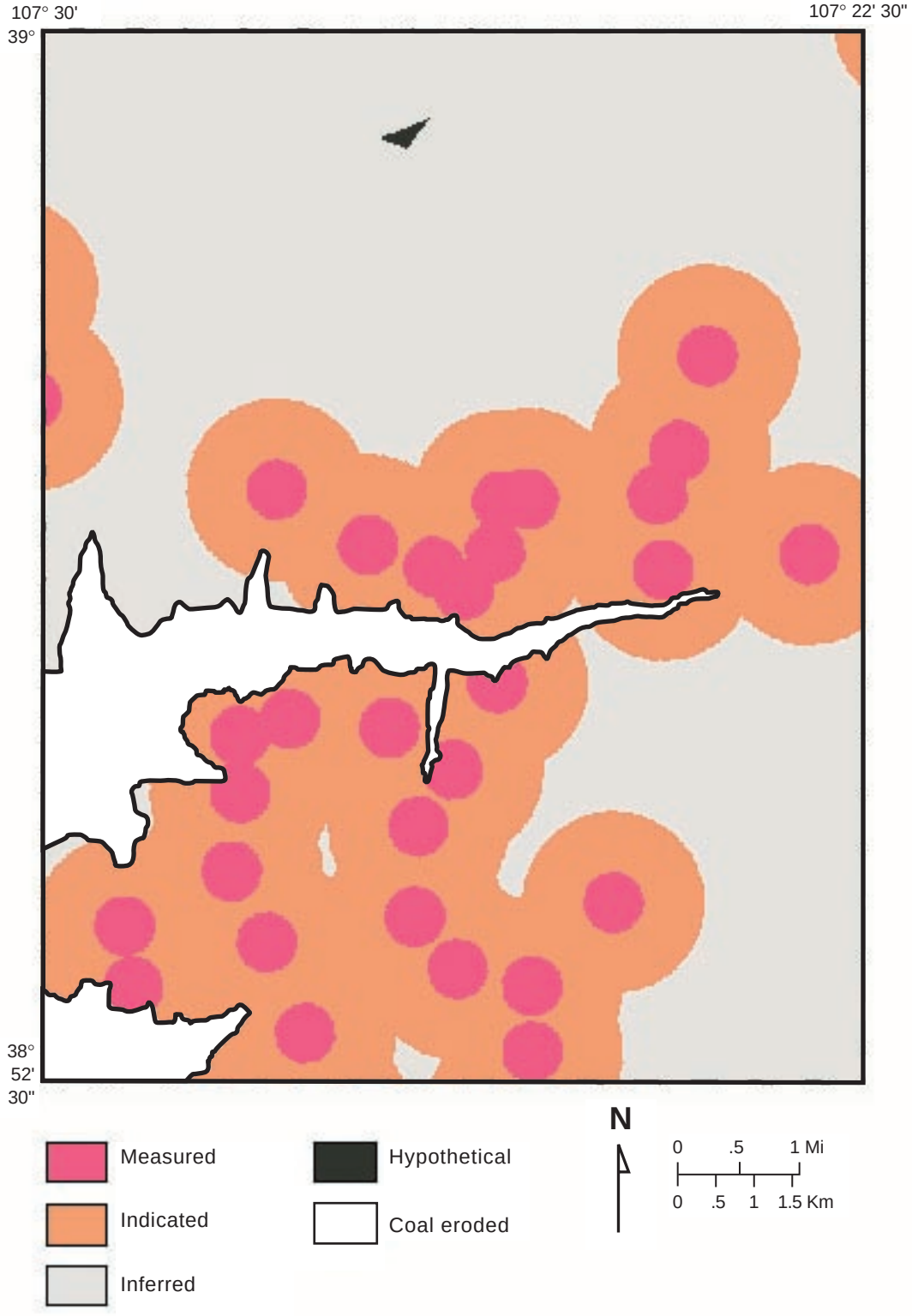

Figure 18b. Map showing areas of reliability of the "E" coal bed, Somerset quadrangle.

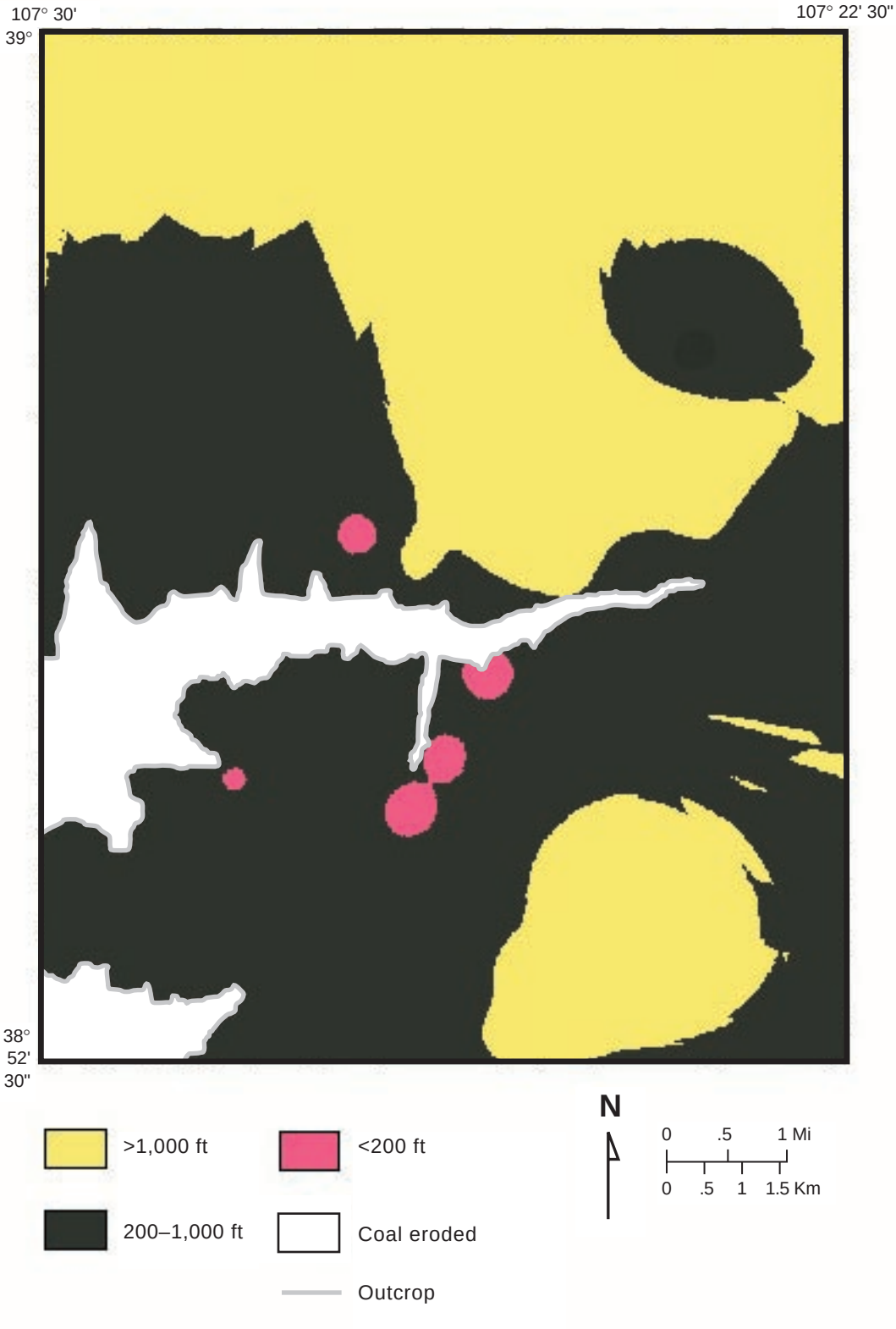

Figure 18c. Depth to coal (overburden isopach) map of the "E" coal bed, Somerset quadrangle.

RESULTS: COAL RESOURCES AND AVAILABLE COAL IN THE SOMERSET QUADRANGLE

The Somerset quadrangle contains almost 3.1 billion tons of total original resources. Approximately 275 million tons have been removed by mining or lost in the mining process, leaving about 2.8 billion tons of remaining resources. Because of land-use and technologic restrictions, about 2.3 billion tons (75 percent of the original resources) are available for mining. The coal resources of the Somerset quadrangle are summarized in Tables 6 and 7. Tables A1 a,b,c through A6 a,b,c provide detailed information on the coal resources of each of the six major beds and Tables A7 a,b,c provide resource information for all the coal beds combined.

OVERVIEW—RESOURCE CATEGORIES

Original, remaining, and available coal resources were calculated for the Somerset quadrangle and are presented in tables in the appendix. Original resources represent the amount of coal resources in the ground before production (Wood and others, 1983). Remaining resources are the coal resources in the ground after coal mined and lost-in-mining has been subtracted from the original resources (Carter and Gardner, 1989). Available resources are the resources that are available for development after coal restricted by land-use or technologic restrictions has been subtracted from the remaining resource (Carter and Gardner, 1989).

Resource estimates are subdivided into categories of overburden thickness (depth), coal thickness, and reliability of estimate. Overburden categories used were: 0–200 feet, 200–1000 feet, and >1000 feet. Two coal thickness categories were used: 1.2–2.3 feet (14–28 inches) and >2.3 feet (>28 inches). Reliability categories used were measured (coal within 0.25 mile of a data point); indicated (coal ranging from 0.25 to 0.75 mile from a data point); inferred (coal ranging from 0.75 to 3 miles from a data point); and hypothetical (coal more than 3 miles from a data point).

Figures 19 and 20 illustrate the distribution of original and available resources of the quadrangle by bed.

ORIGINAL RESOURCES

More than 1.2 billion tons, or approximately 39 percent of the original resource of 3.1 billion tons

Table 6. Summary of original, restricted, and available coal resources of the Somerset quadrangle by bed (millions of short tons).

Resource Category	Lower B	B	C	Lower D	D	E	Total
Original resources	95.2	1,202.5	417.6	280.7	666.4	425.4	3,087.8
Mined or lost in mining	0	222.6	25.6	0	5.3	21.9	275.4
Remaining	95.2	979.9	392.0	280.7	661.1	403.5	2,812.4
Land-use restrictions	0	0.1	0.2	0.9	0.4	0.3	1.9
Technologic restrictions	36.4	198.2	0.9	175.9	72.8	0.3	486.3
Available	58.8	781.6	390.9	103.9	587.9	402.9	2,326.0

Table 7. Summary of restricted coal resources of the Somerset quadrangle by bed (thousands of short tons). All restricted tonnages, regardless of whether they overlap with other restrictions, are presented. Figures do not necessarily coincide with those in Table 6 because adjustments have been made for overlapping restrictions in the overall summary totals presented in Table 6.

Resource Category	Lower B	B	C	Lower D	D	E	Total
Land-Use Restrictions							
Railroads	0	20	61	0	0	0	81
Streams	0	50	157	950	430	275	1,862
Roads	0	8	51	132	90	0	281
Total land-use restrictions	0	78	269	1,082	520	275	2,224
Technologic Restrictions							
Interburden < 40 ft	36,351	193,844	0	175,855	72,564	0	478,614
Burn	0	6,533	0	0	0	0	6,533
Too thin (<28 in.)	230	0	1,102	0	268	317	1,917
Total technologic restrictions	36,581	200,377	1,102	175,855	72,832	317	487,064

in the quadrangle, is B bed coal. The D bed contains about 660 million tons, 22 percent of the original resource. The C and E beds each have more than 400 million tons, which represents about 14 percent of the resource for the E bed and 13 percent for the C bed.

Approximately 55 percent of the original resource for all beds is less than 1000 feet below the surface. Almost all of the original resource is greater than 2.3 feet thick. Less than 0.05 percent of the original resource for all beds represents coal between 1.2 and 2.3 feet thick. More than 99 percent of the coal in this thickness category is from the B bed.

Almost all the original coal resource falls within a reliability category of either measured, indicated, or inferred. Less than 0.5 percent of the original coal is farther than 3 miles from a data point and, therefore, falls within the hypothetical reliability category. The measured category contains 13 percent of the original resource, 38 percent of the original coal is within the indicated category, and 48 percent is in the inferred category.

MINED-OUT AND REMAINING RESOURCES

The B, C, D, and E beds have been mined within the quadrangle. Detailed information on mines is located in the Coal Mining History section.

Of the approximately 275 million tons of coal mined or lost in mining, 81 percent is from the B bed, about 9 percent from the C bed, 8 percent from the E bed, and about 2 percent from the D bed. Coal lost in mining includes coal unavailable to be mined due to previous mining of adjacent beds or mining of coal within the same bed. The amount of coal resource mined or lost-in-mining represents about 9 percent of the original resource of 3.1 billion tons. Remaining resources are, therefore, about 91 percent of the original resource, or 2.8 billion tons.

RESTRICTIONS AND AVAILABLE RESOURCES

Land-use restrictions limit the availability of only 198 million tons of coal, or much less than 0.1 per

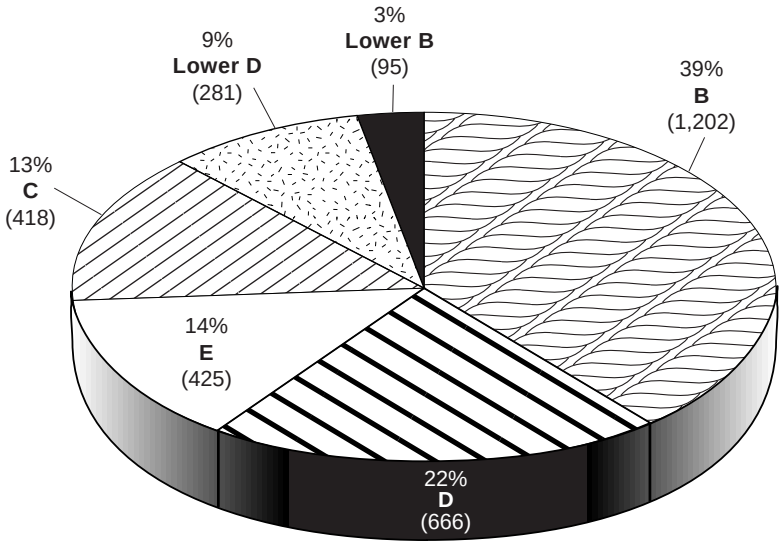

Figure 19. Chart showing total original resources in the Somerset quadrangle (numbers in parenthesis are in millions of tons).

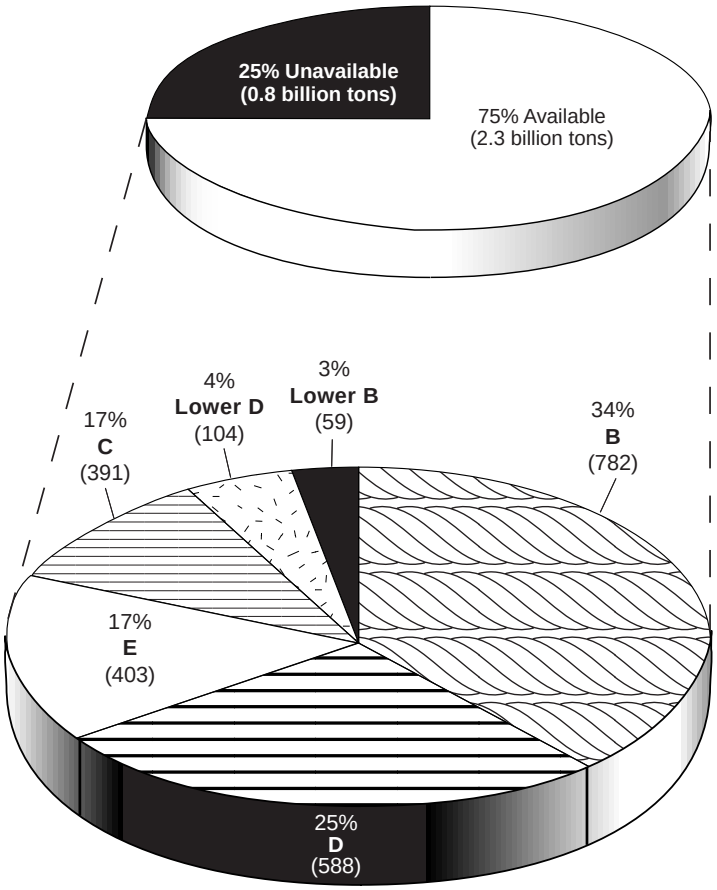

Figure 20. Chart showing proportions of the six coal beds that make up the available coal in the Somerset quadrangle (numbers in parenthesis are in millions of tons).

cent of the original resource. Technologic restrictions, however, limit the availability by almost 500 million tons, almost 16 percent of the original resource. In cases where both land-use and technologic restrictions might apply, the technologic restrictions have been applied, based on the established hierarchy. The primary technologic restriction that has been applied is too thin interburden thickness. This restriction does not impact the E bed because it has no overlying bed, or the C bed, which has no areas of thin interburden to the overlying bed. The entire technologic restriction for the E bed, about 300,000 short tons, and for the C bed, about 550,000 short tons, are due to the thinness of the coal beds. Thin beds account for about 0.3 percent of the total technologic restrictions for all beds.

The B bed has burned near the outcrop in the west-central and southwest parts of the quadrangle, as shown in Figure 9b. The lateral distance of the burned areas is not well known. This technologic restriction applies to an estimated 6.5 million tons or about 3 percent of the total technologic restrictions for the B bed.

More than 780 million tons, or approximately 34 percent of the available resource of 2.3 billion tons in the quadrangle, is coal from the B bed. The D bed contains almost 590 million tons, 28 percent of the available resource. The E bed has more than 400 million tons of available coal, or 17 percent of the total. The C bed contains almost 400 million tons, also about 17 percent of the total. The other two beds account for about 7 percent of the available resource, distributed as follows: Lower D bed (4 percent), and Lower B bed (3 percent).

Approximately 51 percent of the available resource for all beds is less than 1000 feet below the surface. Almost all the available coal resource falls within a reliability category of either measured, indicated, or inferred. Less than 0.5 percent of the original coal is farther than 3 miles from a data point and, therefore, falls within the hypothetical reliability category. The measured category contains 10 percent of the available resource, 35 percent of the available resource is within the indicated category, and 54 percent is in the inferred category.

COMPARISON WITH OTHER COAL AVAILABLILITY STUDIES

This coal availability study indicates that about 75 percent of the original coal resources in the quadrangle is available for mining. Studies in the Appalachian coal region indicate that approximately 50 percent of the original coal resource in that region is available for development (Carter and Gardner, 1994). The major differences between Appalachian and Uinta Basin coal development include land and mineral ownership patterns, environmental regulations, mining methods, topography and land-management policies.

USGS and former USBM coal recoverability studies of the Appalachian region have shown that less than 10 percent of the original resource can be mined and marketed at a profit (Rohrbacher and other, 1994). The coal recoverability study of the Somerset quadrangle will be conducted by the USGS to determine what percent of available coal is economically recoverable, through design of theoretical mine plans for the quadrangle. These mine plans will consider the restricted resources of the quadrangle and mining practices of the Somerset coal field.

COMPARISON WITH PREVIOUS COAL RESOURCE CALCULATIONS

The coal resources exclusively of the Somerset quadrangle have not been previously calculated. In-place coal resources to a depth of 6,000 feet in a 320-square-mile area of the Somerset coal field (in both Delta and Gunnison Counties) have been estimated at more than 8 billion tons (Landis, 1959). The estimate of a 210 square mile area of coal up to 3,000 feet deep is 5.5 billion tons.

An unpublished draft report written by Vard Johnson on the geology and coal resources of the Paonia coal area, Delta and Gunnison Counties (Johnson, 1948a) indicates that more than 4.8 billion tons of reserves are within his area of study, of which 1.9 billion tons may be recoverable. The reserves were segregated into measured, indicated, and inferred reserves and also classified as original, remaining and recoverable. There is not good agreement between the Johnson and Landis estimates: for two of the townships Johnson shows considerably more recoverable reserves than Landis indicates for coal resources. Johnson also estimates that 12 million tons of coal in T. 13 S., R. 90 and 91 W. are strippable.

Landis provided resources for the Somerset coal field by county, township and range, overburden thickness and coal thickness. Coal tonnage estimates given for the six townships that occur within the Somerset quadrangle are in Table 8.

These estimates of original resources, which total more than 1.9 billion tons, are for beds greater than 14 inches thick and overburden less than 3,000 feet. They include measured, indicated and inferred resource estimates for each township. The resource calculations for this coal availability evaluation include beds greater than 3,000 feet deep, hypothetical resources, and are based on additional data points.

The Somerset quadrangle does not include any one of these six townships in its entirety. The entire portion of two townships (T. 12 and 13 S., R. 91 W.) that is within Gunnison County is, however, within the quadrangle. Resources for these unique areas have been previously calculated. For the remaining four townships, other methods were used to estimate the original resources of the quadrangle. In cases where drill hole data points used by Landis are skewed toward a particular part of a township, the proportion of the township resources within the quadrangle was estimated accordingly. Where drill hole data points are relatively evenly distributed, the percentage of each township underlain by coal that is within the Somerset quadrangle was estimated. The estimated percentage of the township resource totals was then applied to this portion of the quadrangle. The resource adjustments made are provided in Table 9.

Table 8. Coal resource estimates for townships that include portions of the Somerset quadrangle. (Based on Landis, 1959)

Township	Estimated Coal Resources (Million Short Tons)
T. 12 S., R. 89 W.	24
T. 12 S., R. 90 W.	136
T. 12 S., R. 91 W.	6
T. 13 S., R. 89 W.	458
T. 13 S., R. 90 W.	1,279
T. 13 S., R. 91 W.	27

It is estimated that 1.37 billion tons of original coal resources was calculated by Landis for the area underlying the Somerset quadrangle. This estimate represents about 44 percent of the original coal resources of almost 3.1 billion tons calculated in this coal availability study.

Table 9. Estimated original coal resources, Somerset quadrangle. (Based on Landis, 1959)

Township	Original Resources (Million Short Tons)	Estimated Percentage of Resources in Quadrangle	Estimated Original Resources, Somerset Quadrangle (Million Short Tons)
T. 12 S., R. 89 W.	24	20	5
T. 12 S., R. 90 W.	136	100	136
T. 12 S., R. 91 W.	6	100	6
T. 13 S., R. 89 W.	458	10	46
T. 13 S., R. 90 W.	1,279	90	1,151
T. 13 S., R. 91 W.	27	100	27
Total	1,930	71	1,371

Comparison of resource estimates for the Somerset quadrangle shows the usefulness of periodically recalculating coal resources for an area when there have been significant increases in the availability of data. The coal availability calculation is a further refinement, which indicates the amount of the original coal resource that has already been mined and the amount of coal available for development.

SELECTED REFERENCES

Boreck, D.L., 1980, Geologic factors affecting development at the Hawk's Nest Mines, Somerset, Colorado: Colorado School of Mines MS Thesis T-2649.

Boreck, D.L, and Murray, D.K., 1979, Colorado coal reserves depletion data and coal mine summaries: Colorado Geological Survey Open File Report 79-1, 65 p. and appendix.

Boreck, D.L., and Strever, M., 1980, Conservation of methane from mined/minable coal beds, Colorado: Colorado Geological Survey Open File 80-5, 95p., 1 pl.

Carter, M. D., and Gardner, N.K., 1989, An assessment of coal resources available for development: U.S. Geological Survey Open File Report 89-362, 52 p.

Carter, M.D., and Gardner, N.K., 1994, Coal availability studies—The impact of restrictions on the development potential of coal resources, *in* Chiang, Shiao-Hung, ed., Coal—energy and the environment: 11th Annual International Pittsburgh Coal Conference, 1994, p. 1–4.

Collins, B.A., 1976, Coal deposits of the Carbondale, Grand Hogback, and Southern Danforth Hills coal fields, Eastern Piceance Basin, Colorado: Colorado School of Mines Quarterly, v. 71, no. 1, January, 138 p.

Collins, B.A., 1977, Geology of the Coal Basin area, Pitkin County, Colorado, in Exploration frontiers of the Central and Southern Rockies: Rocky Mountain Association of Geologists Field Conference Guidebook, p. 363–377.

Colorado State Planning Commission, 1939, State planning commission map of the West Elk Mountains coal fields, Somerset to Crested Butte.

Daub, G.J., 1982, Stratigraphy and geology of some coal mines along the North Fork of the Gunnison River, Somerset coal field, Colorado *in* W.R. Averitt, editor, Grand Junction Geological Society—1982 Field Trip Guidebook, Southeastern Piceance Creek Basin, p. 69–77.

Dunrud, C.R., 1976, Some engineering geologic factors controlling coal mine subsidence in Utah and Colorado: U.S. Geological Survey Professional Paper 969, 39 p.

Dunrud, C.R., 1989, Geologic map and coal stratigraphic framework of the Paonia Area, Delta and Gunnison Counties, Colorado: U.S. Geological Survey Coal Investigations Map C-115, 2 pl., scale 1:50,000.

Eggleston, J.R., Carter, M.D., and Cobb, J.C., 1990, Coal resources available for development—a methodology and pilot study: U.S. Geological Survey Circular 1055, 15 p.

Ellis, M.S., Gaskill, D.L., and Dunrud, C.R., 1987, Geologic map of the Paonia and Gunnison area, Delta and Gunnison Counties, Colorado: U.S. Geological Survey Coal Investigations Map C-109, scale 1:100,000.

Ellis, M.S., Freeman, V.L., and Donnell, J.R., 1988, Cross sections showing correlation of coal beds and coal zones in the Mesaverde Formation in the Carbondale 30' x 60' Quadrangle, West-Central Colorado: U.S. Geological Survey Coal Investigations Map C-97-B, 2 pl.

Goolsby, S.M., Reade, N.B.S., and Murray, D.K., 1979, Evaluation of coking coals in Colorado: Colorado Geological Survey, Resources Series 7, 72 p., 3 pl.

Johnson, R.C. and May, F., 1980, A study of the Cretaceous-Tertiary unconformity in the Piceance Creek Basin, Colorado: the underlying Ohio Creek Formation (Upper Cretaceous) redefined as a member of the Hunter Canyon or Mesaverde Formation: U.S. Geological Survey Bulletin 1481-B, 27 p.

Johnson, V.H., Geology and coal resources of the Paonia coal area, Delta and Gunnison Counties, Colorado, unpublished material for planned U.S. Geological Survey bulletin, available at the U.S.G.S. Library.

Johnson, V.H., Geology of the Paonia coal field, Delta and Gunnison Counties, Colorado: U.S. Geological Survey Preliminary Map, scale 1:48,000.

Kelso, B.S., Ladwig, L.R., and Sitowitz, L., 1981, Directory of permitted Colorado coal mines, 1981: Colorado Geological Survey Map Series 15, 130 p.

Landis, E.R., 1959, Coal resources of Colorado: U.S. Geological Survey Bulletin 1071-C, p. 131–232.

Lee, W.T., 1912, Coal fields of Grand Mesa and the West Elk Mountains: U.S. Geological Survey Bulletin 510, 237p., 1 pl.

Molina, C.M. and others, 1997, Coal availability in the Hilight quadrangle, Powder River Basin, Wyoming: a prototype study in a western coal field: U.S. Geological Survey Open File Report 98-469.

Murray, D.K., Fender, H.B., and Jones, D.C., 1977, Coal and methane gas in the southeastern part of the Piceance Creek Basin, Colorado, *in* Exploration frontiers of the Central and Southern Rockies: Rocky Mountain Association of Geologists Field Conference Guidebook, p. 379–405.

Nowak, H.C., 1990, Stratigraphy of the coal bearing part of the Mesaverde Formation, and application to coalbed methane exploration, Southeast Piceance Creek Basin, Colorado: Colorado School of Mines MS Thesis T-3743, 123 p., 4 pl.

Rohrbacher, T.J., Teeters, D.D., Osmondson, L.M., and Plis, M.N., 1994, Coal recoverability and the definition of coal reserves, Central Appalachian Region, 1993: U.S. Bureau of Mines Open File Report 10-94, 36 p.

Rushworth, P., Kelso, B.S., and Ladwig, L.R., 1984, Map, directory, and statistics of permitted Colorado coal mines, 1983: Colorado Geological Survey Map Series 23, scale: 1:1,000,000, 147 p.

Strever, M., 1980, Methane drainage plan using horizontal holes at the Hawk's Nest East Mine, Paonia, Colorado: Colorado Geological Survey, Open File Report 80-7.

Toenges, A.L., Dowd, J.J., Turnbull, L.A., Davis, J.D., Smith, H.L., and Johnson, V.H., 1949, Reserves, petrographic and chemical characteristics, and carbonizing properties of coal occurring south of Dry Fork of Minnesota Creek, Gunnison County, near Paonia, Colorado, and the geology of the area: U.S. Bureau of Mines Technical Paper 721, 48p.

Toenges, A.L., Turnbull, L.A., Davis, J.D., Reynolds, D.A., Parks, B.C., Cooper, H.M., and Abernathy, R.F., 1952, Coal deposit, Coal Creek District, Gunnison County, Colorado: reserves, coking properties, and petrographic and chemical characteristics: U.S. Bureau of Mines Bulletin 501, 83p.

Tremain, C. M., Hornbaker, A.L., Holt, R.D., Murray, D.K. and Ladwig, L.R., 1996; 1995 Summary of coal resources in Colorado: Colorado Geological Survey Special Publication 41, 19 p.

Tremain Ambrose, C.M., Kelso, B.S., Schultz, J.E., and Eakins, W. (compilers), 1998, Colorado coal quality data, Colorado Geological Survey Open File Report (in press), CD-ROM.

Tyler, R. and McMurry, R.G., 1995, Genetic stratigraphy, coal occurrence and regional cross section of the coal-bearing Williams Fork Formation, Mesaverde Group, Piceance Basin, Northwestern Colorado: Colorado Geological Survey Open File Report 95-2, prepared by the Bureau of Economic Geology, University of Texas at Austin, 1pl.; 42 p.

Tyler, R. and others, 1996, Geologic and hydrologic controls critical to coalbed methane producibility and resource assessment: Williams Fork Formation, Piceance Basin, Northwest Colorado: Gas Research Institute Topical Report GRI-95/0532, prepared by the Bureau of Economic Geology, University of Texas at Austin, 398 p.

U.S. Department of the Interior, Office of Surface Mining Reclamation and Enforcement, 1985, Draft reconnaissance maps to assist in identifying alluvial valley floors, West-Central and Northwestern Colorado: OSM/TM-4/85.

U.S. Energy Information Administration, 1997, Coal industry annual, 1996: DOE/EIA-0584(96), 256 p.

U.S. Geological Survey, 1994, Coal quality (COALQUAL) database: Version 1.3: U.S. Geological Survey Open File Report 94-205, CD-ROM.

Wellborn, J.E., 1982a, Stratigraphy of the Mesaverde Formation, Mount Gunnison Coal Property, Gunnison County, Colorado: Colorado School of Mines MS Thesis T-2506.

Wellborn, J.E., 1982b, Stratigraphy of the Mesaverde Formation on the Mount Gunnison Coal Property, Gunnison County, Colorado *in* W.R. Averitt, ed., Grand Junction Geological Society—1982 Field Trip Guidebook, Southeastern Piceance Creek Basin, p. 65–67.

Wood, G.H., Jr., Kehn, T.M., Carter, M.D., and Culbertson, W.C., 1983, Coal resource classification system of the U.S. Geological Survey: U.S. Geological Survey Circular 891, 65 p.

Young, R.G., 1982, Stratigraphy and petroleum geology of the Mesaverde Group, Southern Piceance Creek Basin, Colorado *in* W.R. Averitt, editor, Grand Junction Geological Society—1982 Field Trip Guidebook, Southeastern Piceance Creek Basin, p. 45–54.

Zook, J.M. and Tremain, C.M., 1997, Directory and statistics of Colorado coal mines with distribution and electric generation map, 1995–96: Colorado Geological Survey Resource Series 32, 55p., 1 pl., scale 1:1,000,000.

Appendix A

Tables A1a through A7c

Table A1a. Summary of estimated coal resources of the "Lower B" coal bed in the Somerset 7.5-minute quadrangle, Colorado (in thousands of short tons). Resources are subdivided into categories of overburden thickness (0–200 ft, 200–1000 ft, and >1000 ft), coal thickness (1.2–2.3 ft and >2.3 ft), and reliability of estimate (measured, indicated, inferred, and hypothetical).

		MEASURED			INDICATED			INFERRED			HYPOTHETICAL			TOTAL		
		1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL
ORIGINAL																
	0–200	0	735	735	0	318	318	0	0	0	0	0	0	0	1053	1053
	200–1000	230	5454	5684	0	11704	11704	0	15133	15133	0	0	0	230	32291	32521
	>1000	0	5277	5277	0	22398	22398	0	33930	33930	0	0	0	0	61605	61605
	TOTAL	230	11466	11696	0	34420	34420	0	49063	49063	0	0	0	230	94949	95179
MINED OUT**																
SURFACE	0–200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	200–1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEEP	0–200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	200–1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	>1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0–200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	200–1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	>1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REMAINING																
	0–200	0	735	735	0	318	318	0	0	0	0	0	0	0	1053	1053
	200–1000	230	5454	5684	0	11704	11704	0	15133	15133	0	0	0	230	32291	32521
	>1000	0	5277	5277	0	22398	22398	0	33930	33930	0	0	0	0	61605	61605
	TOTAL	230	11466	11696	0	34420	34420	0	49063	49063	0	0	0	230	94949	95179
RESTRICTIONS																
LAND-USE	0–200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	200–1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	>1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TECHNOLOGIC	0–200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	200–1000	230	5454	5684	0	10416	10416	0	6411	6411	0	0	0	230	22281	22511
	>1000	0	3727	3727	0	8706	8706	0	1410	1410	0	0	0	0	13843	13843
	TOTAL	230	9181	9411	0	19122	19122	0	7821	7821	0	0	0	230	36124	36354
TOTAL	0–200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	200–1000	230	5454	5684	0	10416	10416	0	6411	6411	0	0	0	230	22281	22511
	>1000	0	3727	3727	0	8706	8706	0	1410	1410	0	0	0	0	13843	13843
	TOTAL	230	9181	9411	0	19122	19122	0	7821	7821	0	0	0	230	36124	36354
AVAILABLE																
	0–200	0	735	735	0	318	318	0	0	0	0	0	0	0	1053	1053
	200–1000	0	0	0	0	1288	1288	0	8722	8722	0	0	0	0	10010	10010
	>1000	0	1550	1550	0	13692	13692	0	32520	32520	0	0	0	0	47762	47762
	TOTAL	0	2285	2285	0	15298	15298	0	41242	41242	0	0	0	0	58825	58825

**Mined and lost-in-mining, by surface and deep mining methods.
Note: Totals may not equal sum of components because of independent rounding.

Table A1b. Estimated remaining coal resources of the "Lower B" coal bed unavailable due to land use restrictions in the Somerset 7.5-minute quadrangle, Colorado (in thousands of short tons). Resources are subdivided into categories of overburden thickness (0–200 ft, 200–1000 ft, and >1000 ft),coal thickness (1.2–2.3 ft and >2.3 ft), and reliability of estimate (measured, indicated, inferred, and hypothetical).

		MEASURED			INDICATED			INFERRED			HYPOTHETICAL			TOTAL		
		1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL
0-200 FT																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Streams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200–1000 FT																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Streams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>1000 FT																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Streams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Streams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

**Not necessarily sum. Calculated separately to avoid double counting of overlapping restrictions.
Note: Totals may not equal sum of components because of independent rounding.

Table A1c. Estimated remaining coal resources of the "Lower B" coal bed unavailable due to technologic restrictions in the Somerset 7.5-minute quadrangle, Colorado (in thousands of short tons). Resources are subdivided into categories of overburden thickness (0–200 ft, 200–1000 ft, and >1000 ft), coal thickness (1.2–2.3 ft and >2.3 ft), and reliability of estimate (measured, indicated, inferred, and hypothetical).

		MEASURED			INDICATED			INFERRED			HYPOTHETICAL			TOTAL		
		1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL
0–200 FT																
	Interburden < 40 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	<100 ft overburden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200–1000 FT																
	Interburden < 40 ft	227	5454	5681	0	10416	10416	0	6411	6411	0	0	0	227	22281	22508
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	230	0	230	0	0	0	0	0	0	0	0	0	230	0	230
	TOTAL	457	5454	5911	0	10416	10416	0	6411	6411	0	0	0	457	22281	22738
>1000 FT																
	Interburden < 40 ft	0	3727	3727	0	8706	8706	0	1410	1410	0	0	0	0	13843	13843
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	3727	3727	0	8706	8706	0	1410	1410	0	0	0	0	13843	13843
TOTAL																
	Interburden < 40 ft	227	9181	9408	0	19122	19122	0	7821	7821	0	0	0	227	36124	36351
	<100 ft overburden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	230	0	230	0	0	0	0	0	0	0	0	0	230	0	230
	TOTAL	457	9181	9638	0	19122	19122	0	7821	7821	0	0	0	457	36124	36581

**Not necessarily sum. Calculated separately to avoid double counting of overlapping restrictions.
Note: Totals may not equal sum of components because of independent rounding.

Table A2a. Summary of estimated coal resources of the "B" coal bed in the Somerset 7.5-minute quadrangle, Colorado (in thousands of short tons). Resources are subdivided into categories of overburden thickness (0–200 ft, 200–1000 ft, and >1000 ft), coal thickness (1.2–2.3 ft and >2.3 ft), and reliability of estimate (measured, indicated, inferred, and hypothetical).

		MEASURED			INDICATED			INFERRED			HYPOTHETICAL			TOTAL		
		1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL
ORIGINAL																
	0–200	0	2130	2130	0	0	0	0	0	0	0	0	0	0	2130	2130
	200–1000	0	102285	102285	0	328532	328532	0	191587	191587	0	0	0	0	622404	622404
	>1000	0	50734	50734	0	124515	124515	0	395794	395794	0	6903	6903	0	577946	577946
	TOTAL	0	155149	155149	0	453047	453047	0	587381	587381	0	6903	6903	0	1202480	1202480
MINED OUT**																
SURFACE	0–200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	200–1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEEP	0–200	0	870	870	0	0	0	0	0	0	0	0	0	0	870	870
	200–1000	0	53316	53316	0	107812	107812	0	19490	19490	0	0	0	0	180618	180618
	>1000	0	19404	19404	0	21711	21711	0	0	0	0	0	0	0	41115	41115
	TOTAL	0	73590	73590	0	129523	129523	0	19490	19490	0	0	0	0	222603	222603
TOTAL	0–200	0	870	870	0	0	0	0	0	0	0	0	0	0	870	870
	200–1000	0	53316	53316	0	107812	107812	0	19490	19490	0	0	0	0	180618	180618
	>1000	0	19404	19404	0	21711	21711	0	0	0	0	0	0	0	41115	41115
	TOTAL	0	73590	73590	0	129523	129523	0	19490	19490	0	0	0	0	222603	222603
REMAINING																
	0–200	0	1260	1260	0	0	0	0	0	0	0	0	0	0	1260	1260
	200–1000	0	48969	48969	0	220720	220720	0	172097	172097	0	0	0	0	441786	441786
	>1000	0	31330	31330	0	102804	102804	0	395794	395794	0	6903	6903	0	536831	536831
	TOTAL	0	81559	81559	0	323524	323524	0	567891	567891	0	6903	6903	0	979877	979877
RESTRICTIONS																
LAND-USE	0–200	0	50	50	0	0	0	0	0	0	0	0	0	0	50	50
	200–1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	>1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	50	50	0	0	0	0	0	0	0	0	0	0	50	50
TECHNOLOGIC	0–200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	200–1000	0	17003	17003	0	84697	84697	0	25202	25202	0	0	0	0	126902	126902
	>1000	0	15509	15509	0	26562	26562	0	29228	29228	0	0	0	0	71299	71299
	TOTAL	0	32512	32512	0	111259	111259	0	54430	54430	0	0	0	0	198201	198201
TOTAL	0–200	0	50	50	0	0	0	0	0	0	0	0	0	0	50	50
	200–1000	0	17003	17003	0	84697	84697	0	25202	25202	0	0	0	0	126902	126902
	>1000	0	15509	15509	0	26562	26562	0	29228	29228	0	0	0	0	71299	71299
	TOTAL	0	32562	32562	0	111259	111259	0	54430	54430	0	0	0	0	198251	198251
AVAILABLE																
	0–200	0	1210	1210	0	0	0	0	0	0	0	0	0	0	1210	1210
	200–1000	0	31966	31966	0	136023	136023	0	146895	146895	0	0	0	0	314884	314884
	>1000	0	15821	15821	0	76242	76242	0	366567	366567	0	6903	6903	0	465533	465533
	TOTAL	0	48997	48997	0	212265	212265	0	513462	513462	0	6903	6903	0	781627	781627

**Mined and lost-in-mining, by surface and deep mining methods.
Note: Totals may not equal sum of components because of independent rounding.

Table A2b. Estimated remaining coal resources of the "B" coal bed unavailable due to land use restrictions in the Somerset 7.5-minute quadrangle, Colorado (in thousands of short tons). Resources are subdivided into categories of overburden thickness (0–200 ft, 200–1000 ft, and >1000 ft), coal thickness (1.2–2.3 ft and >2.3 ft), and reliability of estimate (measured, indicated, inferred, and hypothetical).

		MEASURED			INDICATED			INFERRED			HYPOTHETICAL			TOTAL		
		1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL
0–200 FT																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	20	20	0	0	0	0	0	0	0	0	0	0	20	20
	Streams	0	50	50	0	0	0	0	0	0	0	0	0	0	50	50
	Roads	0	8	8	0	0	0	0	0	0	0	0	0	0	8	8
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL**	0	78	78	0	0	0	0	0	0	0	0	0	0	78	78
200–1000 FT																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Streams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>1000 FT																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Streams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	20	20	0	0	0	0	0	0	0	0	0	0	20	20
	Streams	0	50	50	0	0	0	0	0	0	0	0	0	0	50	50
	Roads	0	8	8	0	0	0	0	0	0	0	0	0	0	8	8
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	78	78	0	0	0	0	0	0	0	0	0	0	78	78

**Not necessarily sum. Calculated separately to avoid double counting of overlapping restrictions.
Note: Totals may not equal sum of components because of independent rounding.

Table A2c. Estimated remaining coal resources of the "B" coal bed unavailable due to technologic restrictions in the Somerset 7.5-minute quadrangle, Colorado (in thousands of short tons). Resources are subdivided into categories of overburden thickness (0–200 ft, 200–1000 ft, and >1000 ft), coal thickness (1.2–2.3 ft and >2.3 ft), and reliability of estimate (measured, indicated, inferred, and hypothetical).

		MEASURED			INDICATED			INFERRED			HYPOTHETICAL			TOTAL		
		1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL
0–200 FT																
	Interburden < 40 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	<100 ft overburden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200–1000 FT																
	Interburden < 40 ft	0	16052	16052	0	81434	81434	0	25059	25059	0	0	0	0	122545	122545
	Burn	0	952	952	0	3946	3946	0	1635	1635	0	0	0	0	6533	6533
	Too thin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	17004	17004	0	85380	85380	0	26694	26694	0	0	0	0	129078	129078
>1000 FT																
	Interburden < 40 ft	0	15509	15509	0	26562	26562	0	29228	29228	0	0	0	0	71299	71299
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	15509	15509	0	26562	26562	0	29228	29228	0	0	0	0	71299	71299
TOTAL																
	Interburden < 40 ft	0	31561	31561	0	107996	107996	0	54287	54287	0	0	0	0	193844	193844
	<100 ft overburden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Burn	0	952	952	0	3946	3946	0	1635	1635	0	0	0	0	6533	6533
	Too thin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	32513	32513	0	111942	111942	0	55922	55922	0	0	0	0	200377	200377

**Not necessarily sum. Calculated separately to avoid double counting of overlapping restrictions.
Note: Totals may not equal sum of components because of independent rounding.

Table A3a. Summary of estimated coal resources of the "C" coal bed in the Somerset 7.5-minute quadrangle, Colorado (in thousands of short tons). Resources are subdivided into categories of overburden thickness (0–200 ft, 200–1000 ft, and >1000 ft), coal thickness (1.2–2.3 ft and >2.3 ft), and reliability of estimate (measured, indicated, inferred, and hypothetical).

		MEASURED			INDICATED			INFERRED			HYPOTHETICAL			TOTAL		
		1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL
ORIGINAL																
	0–200	93	1694	1787	0	0	0	0	0	0	0	0	0	93	1694	1787
	200–1000	448	38532	38980	131	120361	120492	0	73733	73733	0	0	0	579	232626	233205
	>1000	552	14153	14705	0	32827	32827	0	132556	132556	0	2515	2515	552	182051	182603
	TOTAL	1093	54379	55472	131	153188	153319	0	206289	206289	0	2515	2515	1224	416371	417595
MINED OUT**																
SURFACE	0–200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	200–1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEEP	0–200	0	597	597	0	0	0	0	0	0	0	0	0	0	597	597
	200–1000	29	6571	6600	0	16616	16616	0	0	0	0	0	0	29	23187	23216
	>1000	0	1588	1588	0	190	190	0	0	0	0	0	0	0	1778	1778
	TOTAL	29	8756	8785	0	16806	16806	0	0	0	0	0	0	29	25562	25591
TOTAL	0–200	0	597	597	0	0	0	0	0	0	0	0	0	0	597	597
	200–1000	29	6571	6600	0	16616	16616	0	0	0	0	0	0	29	23187	23216
	>1000	0	1588	1588	0	190	190	0	0	0	0	0	0	0	1778	1778
	TOTAL	29	8756	8785	0	16806	16806	0	0	0	0	0	0	29	25562	25591
REMAINING																
	0–200	93	1097	1190	0	0	0	0	0	0	0	0	0	93	1097	1190
	200–1000	419	31961	32380	131	103745	103876	0	73733	73733	0	0	0	550	209439	209989
	>1000	552	12565	13117	0	32637	32637	0	132556	132556	0	2515	2515	552	180273	180825
	TOTAL	1064	45623	46687	131	136382	136513	0	206289	206289	0	2515	2515	1195	390809	392004
RESTRICTIONS																
LAND-USE	0–200	0	157	157	0	0	0	0	0	0	0	0	0	0	157	157
	200–1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	>1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	157	157	0	0	0	0	0	0	0	0	0	0	157	157
TECHNOLOGIC	0–200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	200–1000	267	0	267	79	0	79	0	0	0	0	0	0	346	0	346
	>1000	552	0	552	0	0	0	0	0	0	0	0	0	552	0	552
	TOTAL	819	0	819	79	0	79	0	0	0	0	0	0	898	0	898
TOTAL	0–200	0	157	157	0	0	0	0	0	0	0	0	0	0	157	157
	200–1000	267	0	267	79	0	79	0	0	0	0	0	0	346	0	346
	>1000	552	0	552	0	0	0	0	0	0	0	0	0	552	0	552
	TOTAL	819	157	976	79	0	79	0	0	0	0	0	0	898	157	1055
AVAILABLE																
	0–200	93	940	1033	0	0	0	0	0	0	0	0	0	93	940	1033
	200–1000	152	31961	32113	52	103745	103797	0	73733	73733	0	0	0	204	209439	209643
	>1000	0	12565	12565	0	32637	32637	0	132556	132556	0	2515	2515	0	180273	180273
	TOTAL	245	45466	45711	52	136382	136434	0	206289	206289	0	2515	2515	297	390652	390949

**Mined and lost-in-mining, by surface and deep mining methods.
Note: Totals may not equal sum of components because of independent rounding.

Table A3b. Estimated remaining coal resources of the "C" coal bed unavailable due to land use restrictions in the Somerset 7.5-minute quadrangle, Colorado (in thousands of short tons). Resources are subdivided into categories of overburden thickness (0–200 ft, 200–1000 ft, and >1000 ft), coal thickness (1.2–2.3 ft and >2.3 ft), and reliability of estimate (measured, indicated, inferred, and hypothetical).

		MEASURED			INDICATED			INFERRED			HYPOTHETICAL			TOTAL		
		1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL
0–200 FT																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	61	61	0	0	0	0	0	0	0	0	0	0	61	61
	Streams	0	157	157	0	0	0	0	0	0	0	0	0	0	157	157
	Roads	0	51	51	0	0	0	0	0	0	0	0	0	0	51	51
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL**	0	269	269	0	0	0	0	0	0	0	0	0	0	269	269
200–1000 FT																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Streams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>1000 FT																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Streams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	61	61	0	0	0	0	0	0	0	0	0	0	61	61
	Streams	0	157	157	0	0	0	0	0	0	0	0	0	0	157	157
	Roads	0	51	51	0	0	0	0	0	0	0	0	0	0	51	51
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	269	269	0	0	0	0	0	0	0	0	0	0	269	269

**Not necessarily sum. Calculated separately to avoid double counting of overlapping restrictions.
Note: Totals may not equal sum of components because of independent rounding.

Table A3c. Estimated remaining coal resources of the "C" coal bed unavailable due to technologic restrictions in the Somerset 7.5-minute quadrangle, Colorado (in thousands of short tons). Resources are subdivided into categories of overburden thickness (0–200 ft, 200–1000 ft, and >1000 ft), coal thickness (1.2–2.3 ft and >2.3 ft), and reliability of estimate (measured, indicated, inferred, and hypothetical).

		MEASURED			INDICATED			INFERRED			HYPOTHETICAL			TOTAL		
		1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL
0–200 FT																
	Interburden < 40 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	<100 ft overburden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200–1000 FT																
	Interburden < 40 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	419	0	419	131	0	131	0	0	0	0	0	0	550	0	550
	TOTAL	419	0	419	131	0	131	0	0	0	0	0	0	550	0	550
>1000 FT																
	Interburden < 40 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	552	0	552	0	0	0	0	0	0	0	0	0	552	0	552
	TOTAL	552	0	552	0	0	0	0	0	0	0	0	0	552	0	552
TOTAL																
	Interburden < 40 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	<100 ft overburden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	971	0	971	131	0	131	0	0	0	0	0	0	1102	0	1102
	TOTAL	971	0	971	131	0	131	0	0	0	0	0	0	1102	0	1102

**Not necessarily sum. Calculated separately to avoid double counting of overlapping restrictions.
Note: Totals may not equal sum of components because of independent rounding.

Table A4a. Summary of estimated coal resources of the "Lower D" coal bed in the Somerset 7.5-minute quadrangle, Colorado (in thousands of short tons). Resources are subdivided into categories of overburden thickness (0–200 ft, 200–1000 ft, and >1000 ft), coal thickness (1.2–2.3 ft and >2.3 ft), and reliability of estimate (measured, indicated, inferred, and hypothetical).

		MEASURED			INDICATED			INFERRED			HYPOTHETICAL			TOTAL		
		1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL
ORIGINAL																
	0–200	0	1880	1880	0	0	0	0	0	0	0	0	0	0	1880	1880
	200–1000	0	27474	27474	0	69567	69567	0	49755	49755	0	0	0	0	146796	146796
	>1000	0	12241	12241	0	40597	40597	0	78384	78384	0	795	795	0	132017	132017
	TOTAL	0	41595	41595	0	110164	110164	0	128139	128139	0	795	795	0	280693	280693
MINED OUT**																
SURFACE	0–200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	200–1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEEP	0–200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	200–1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	>1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0–200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	200–1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	>1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REMAINING																
	0–200	0	1880	1880	0	0	0	0	0	0	0	0	0	0	1880	1880
	200–1000	0	27474	27474	0	69567	69567	0	49755	49755	0	0	0	0	146796	146796
	>1000	0	12241	12241	0	40597	40597	0	78384	78384	0	795	795	0	132017	132017
	TOTAL	0	41595	41595	0	110164	110164	0	128139	128139	0	795	795	0	280693	280693
RESTRICTIONS																
LAND-USE	0–200	0	950	950	0	0	0	0	0	0	0	0	0	0	950	950
	200–1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	>1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	950	950	0	0	0	0	0	0	0	0	0	0	950	950
TECHNOLOGIC	0–200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	200–1000	0	16640	16640	0	56281	56281	0	28615	28615	0	0	0	0	101536	101536
	>1000	0	11962	11962	0	33664	33664	0	28692	28692	0	0	0	0	74318	74318
	TOTAL	0	28602	28602	0	89945	89945	0	57307	57307	0	0	0	0	175854	175854
TOTAL	0–200	0	950	950	0	0	0	0	0	0	0	0	0	0	950	950
	200–1000	0	16640	16640	0	56281	56281	0	28615	28615	0	0	0	0	101536	101536
	>1000	0	11962	11962	0	33664	33664	0	28692	28692	0	0	0	0	74318	74318
	TOTAL	0	29552	29552	0	89945	89945	0	57307	57307	0	0	0	0	176804	176804
AVAILABLE																
	0–200	0	930	930	0	0	0	0	0	0	0	0	0	0	930	930
	200–1000	0	10834	10834	0	13286	13286	0	21140	21140	0	0	0	0	45260	45260
	>1000	0	279	279	0	6933	6933	0	49692	49692	0	795	795	0	57699	57699
	TOTAL	0	12043	12043	0	20219	20219	0	70832	70832	0	795	795	0	103889	103889

**Mined and lost-in-mining, by surface and deep mining methods.
Note: Totals may not equal sum of components because of independent rounding.

Table A4b. Estimated remaining coal resources of the "Lower D" coal bed unavailable due to land use restrictions in the Somerset 7.5-minute quadrangle, Colorado (in thousands of short tons). Resources are subdivided into categories of overburden thickness (0–200 ft, 200–1000 ft, and >1000 ft), coal thickness (1.2–2.3 ft and >2.3 ft), and reliability of estimate (measured, indicated, inferred, and hypothetical).

		MEASURED			INDICATED			INFERRED			HYPOTHETICAL			TOTAL		
		1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL
0–200 FT																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Streams	0	950	950	0	0	0	0	0	0	0	0	0	0	950	950
	Roads	0	132	132	0	0	0	0	0	0	0	0	0	0	132	132
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL**	0	1082	1082	0	0	0	0	0	0	0	0	0	0	1082	1082
200–1000 FT																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Streams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>1000 FT																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Streams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Streams	0	950	950	0	0	0	0	0	0	0	0	0	0	950	950
	Roads	0	132	132	0	0	0	0	0	0	0	0	0	0	132	132
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	1082	1082	0	0	0	0	0	0	0	0	0	0	1082	1082

**Not necessarily sum. Calculated separately to avoid double counting of overlapping restrictions.
Note: Totals may not equal sum of components because of independent rounding.

Table A4c. Estimated remaining coal resources of the "Lower D" coal bed unavailable due to technologic restrictions in the Somerset 7.5-minute quadrangle, Colorado (in thousands of short tons). Resources are subdivided into categories of overburden thickness (0–200 ft, 200–1000 ft, and >1000 ft), coal thickness (1.2–2.3 ft and >2.3 ft), and reliability of estimate (measured, indicated, inferred, and hypothetical).

		MEASURED			INDICATED			INFERRED			HYPOTHETICAL			TOTAL		
		1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL
0–200 FT																
	Interburden < 40 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	<100 ft overburden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200–1000 FT																
	Interburden < 40 ft	0	16641	16641	0	56281	56281	0	28615	28615	0	0	0	0	101537	101537
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	16641	16641	0	56281	56281	0	28615	28615	0	0	0	0	101537	101537
>1000 FT																
	Interburden < 40 ft	0	11962	11962	0	33664	33664	0	28692	28692	0	0	0	0	74318	74318
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	11962	11962	0	33664	33664	0	28692	28692	0	0	0	0	74318	74318
TOTAL																
	Interburden < 40 ft	0	28603	28603	0	89945	89945	0	57307	57307	0	0	0	0	175855	175855
	<100 ft overburden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	28603	28603	0	89945	89945	0	57307	57307	0	0	0	0	175855	175855

**Not necessarily sum. Calculated separately to avoid double counting of overlapping restrictions.
Note: Totals may not equal sum of components because of independent rounding.

Table A5a. Summary of estimated coal resources of the "D" coal bed in the Somerset 7.5-minute quadrangle, Colorado (in thousands of short tons). Resources are subdivided into categories of overburden thickness (0–200 ft, 200–1000 ft, and >1000 ft), coal thickness (1.2–2.3 ft and >2.3 ft), and reliability of estimate (measured, indicated, inferred, and hypothetical).

		MEASURED			INDICATED			INFERRED			HYPOTHETICAL			TOTAL		
		1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL
ORIGINAL																
	0–200	108	16623	16731	0	24483	24483	0	94	94	0	0	0	108	41200	41308
	200–1000	30	59059	59089	0	203777	203777	0	130506	130506	0	0	0	30	393342	393372
	>1000	268	16339	16607	0	47558	47558	0	165212	165212	0	2362	2362	268	231471	231739
	TOTAL	406	92021	92427	0	275818	275818	0	295812	295812	0	2362	2362	406	666013	666419
MINED OUT**																
SURFACE	0–200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	200–1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEEP	0–200	48	14	62	0	0	0	0	0	0	0	0	0	48	14	62
	200–1000	29	2368	2397	0	2872	2872	0	0	0	0	0	0	29	5240	5269
	>1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	77	2382	2459	0	2872	2872	0	0	0	0	0	0	77	5254	5331
TOTAL	0–200	48	14	62	0	0	0	0	0	0	0	0	0	48	14	62
	200–1000	29	2368	2397	0	2872	2872	0	0	0	0	0	0	29	5240	5269
	>1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	77	2382	2459	0	2872	2872	0	0	0	0	0	0	77	5254	5331
REMAINING																
	0–200	60	16609	16669	0	24483	24483	0	94	94	0	0	0	60	41186	41246
	200–1000	1	56691	56692	0	200905	200905	0	130506	130506	0	0	0	1	388102	388103
	>1000	268	16339	16607	0	47558	47558	0	165212	165212	0	2362	2362	268	231471	231739
	TOTAL	329	89639	89968	0	272946	272946	0	295812	295812	0	2362	2362	329	660759	661088
RESTRICTIONS																
LAND-USE	0–200	61	370	431	0	0	0	0	0	0	0	0	0	61	370	431
	200–1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	>1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	61	370	431	0	0	0	0	0	0	0	0	0	61	370	431
TECHNOLOGIC	0–200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	200–1000	0	376	376	0	723	723	0	44357	44357	0	0	0	0	45456	45456
	>1000	268	0	268	0	27067	27067	0	41	41	0	0	0	268	27108	27376
	TOTAL	268	376	644	0	27790	27790	0	44398	44398	0	0	0	268	72564	72832
TOTAL	0–200	61	370	431	0	0	0	0	0	0	0	0	0	61	370	431
	200–1000	0	376	376	0	723	723	0	44357	44357	0	0	0	0	45456	45456
	>1000	268	0	268	0	27067	27067	0	41	41	0	0	0	268	27108	27376
	TOTAL	329	746	1075	0	27790	27790	0	44398	44398	0	0	0	329	72934	73263
AVAILABLE																
	0–200	0	16239	16239	0	24483	24483	0	94	94	0	0	0	0	40816	40816
	200–1000	0	56315	56315	0	200182	200182	0	86149	86149	0	0	0	0	342646	342646
	>1000	0	16339	16339	0	20491	20491	0	165171	165171	0	2362	2362	0	204363	204363
	TOTAL	0	88893	88893	0	245156	245156	0	251414	251414	0	2362	2362	0	587825	587825

**Mined and lost-in-mining, by surface and deep mining methods.
Note: Totals may not equal sum of components because of independent rounding.

Table A5b. Estimated remaining coal resources of the "D" coal bed unavailable due to land use restrictions in the Somerset 7.5-minute quadrangle, Colorado (in thousands of short tons). Resources are subdivided into categories of overburden thickness (0–200 ft, 200–1000 ft, and >1000 ft), coal thickness (1.2–2.3 ft and >2.3 ft), and reliability of estimate (measured, indicated, inferred, and hypothetical).

		MEASURED			INDICATED			INFERRED			HYPOTHETICAL			TOTAL		
		1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL
0–200 FT																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Streams	61	369	430	0	0	0	0	0	0	0	0	0	61	369	430
	Roads	29	61	90	0	0	0	0	0	0	0	0	0	29	61	90
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL**	90	430	520	0	0	0	0	0	0	0	0	0	90	430	520
200–1000 FT																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Streams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>1000 FT																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Streams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Streams	61	369	430	0	0	0	0	0	0	0	0	0	61	369	430
	Roads	29	61	90	0	0	0	0	0	0	0	0	0	29	61	90
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	90	430	520	0	0	0	0	0	0	0	0	0	90	430	520

**Not necessarily sum. Calculated separately to avoid double counting of overlapping restrictions.
Note: Totals may not equal sum of components because of independent rounding.

Table A5c. Estimated remaining coal resources of the "D" coal bed unavailable due to technologic restrictions in the Somerset 7.5-minute quadrangle, Colorado (in thousands of short tons). Resources are subdivided into categories of overburden thickness (0–200 ft, 200–1000 ft, and >1000 ft), coal thickness (1.2–2.3 ft and >2.3 ft), and reliability of estimate (measured, indicated, inferred, and hypothetical).

		MEASURED			INDICATED			INFERRED			HYPOTHETICAL			TOTAL		
		1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL
0–200 FT																
	Interburden < 40 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	<100 ft overburden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200–1000 FT																
	Interburden < 40 ft	0	376	376	0	723	723	0	44357	44357	0	0	0	0	45456	45456
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	376	376	0	723	723	0	44357	44357	0	0	0	0	45456	45456
>1000 FT																
	Interburden < 40 ft	0	0	0	0	0	0	0	27067	27067	0	41	41	0	27108	27108
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	268	0	268	0	0	0	0	0	0	0	0	0	268	0	268
	TOTAL	268	0	268	0	0	0	0	27067	27067	0	41	41	268	27108	27376
TOTAL																
	Interburden < 40 ft	0	376	376	0	723	723	0	71424	71424	0	41	41	0	72564	72564
	<100 ft overburden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	268	0	268	0	0	0	0	0	0	0	0	0	268	0	268
	TOTAL	268	376	644	0	723	723	0	71424	71424	0	41	41	268	72564	72832

**Not necessarily sum. Calculated separately to avoid double counting of overlapping restrictions.
Note: Totals may not equal sum of components because of independent rounding.

Table A6a. Summary of estimated coal resources of the "E" coal bed in the Somerset 7.5-minute quadrangle, Colorado (in thousands of short tons). Resources are subdivided into categories of overburden thickness (0–200 ft, 200–1000 ft, and >1000 ft), coal thickness (1.2–2.3 ft and >2.3 ft), and reliability of estimate (measured, indicated, inferred, and hypothetical).

		MEASURED			INDICATED			INFERRED			HYPOTHETICAL			TOTAL		
		1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL
ORIGINAL																
	0–200	0	4619	4619	0	37	37	0	0	0	0	0	0	0	4656	4656
	200–1000	270	25239	25509	47	111801	111848	0	91754	91754	0	0	0	317	228794	229111
	>1000	0	13617	13617	0	41869	41869	0	135839	135839	0	323	323	0	191648	191648
	TOTAL	270	43475	43745	47	153707	153754	0	227593	227593	0	323	323	317	425098	425415
MINED OUT**																
SURFACE	0–200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	200–1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEEP	0–200	0	247	247	0	0	0	0	0	0	0	0	0	0	247	247
	200–1000	0	4328	4328	0	9389	9389	0	263	263	0	0	0	0	13980	13980
	>1000	0	2365	2365	0	5275	5275	0	18	18	0	0	0	0	7658	7658
	TOTAL	0	6940	6940	0	14664	14664	0	281	281	0	0	0	0	21885	21885
TOTAL	0–200	0	247	247	0	0	0	0	0	0	0	0	0	0	247	247
	200–1000	0	4328	4328	0	9389	9389	0	263	263	0	0	0	0	13980	13980
	>1000	0	2365	2365	0	5275	5275	0	18	18	0	0	0	0	7658	7658
	TOTAL	0	6940	6940	0	14664	14664	0	281	281	0	0	0	0	21885	21885
REMAINING																
	0–200	0	4372	4372	0	37	37	0	0	0	0	0	0	0	4409	4409
	200–1000	270	20911	21181	47	102412	102459	0	91491	91491	0	0	0	317	214814	215131
	>1000	0	11252	11252	0	36594	36594	0	135821	135821	0	323	323	0	183990	183990
	TOTAL	270	36535	36805	47	139043	139090	0	227312	227312	0	323	323	317	403213	403530
RESTRICTIONS																
LAND-USE	0–200	0	275	275	0	0	0	0	0	0	0	0	0	0	275	275
	200–1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	>1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	275	275	0	0	0	0	0	0	0	0	0	0	275	275
TECHNOLOGIC	0–200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	200–1000	270	0	270	47	0	47	0	0	0	0	0	0	317	0	317
	>1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	270	0	270	47	0	47	0	0	0	0	0	0	317	0	317
TOTAL	0–200	0	275	275	0	0	0	0	0	0	0	0	0	0	275	275
	200–1000	270	0	270	47	0	47	0	0	0	0	0	0	317	0	317
	>1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	270	275	545	47	0	47	0	0	0	0	0	0	317	275	592
AVAILABLE																
	0–200	0	4097	4097	0	37	37	0	0	0	0	0	0	0	4134	4134
	200–1000	0	20911	20911	0	102412	102412	0	91491	91491	0	0	0	0	214814	214814
	>1000	0	11252	11252	0	36594	36594	0	135821	135821	0	323	323	0	183990	183990
	TOTAL	0	36260	36260	0	139043	139043	0	227312	227312	0	323	323	0	402938	402938

**Mined and lost-in-mining, by surface and deep mining methods.

Note: Totals may not equal sum of components because of independent rounding.

Table A6b. Estimated remaining coal resources of the "E" coal bed unavailable due to land use restrictions in the Somerset 7.5-minute quadrangle, Colorado (in thousands of short tons). Resources are subdivided into categories of overburden thickness (0–200 ft, 200–1000 ft, and >1000 ft), coal thickness (1.2–2.3 ft and >2.3 ft), and reliability of estimate (measured, indicated, inferred, and hypothetical).

		MEASURED			INDICATED			INFERRED			HYPOTHETICAL			TOTAL		
		1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL
0–200 FT																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Streams	0	275	275	0	0	0	0	0	0	0	0	0	0	275	275
	Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL**	0	275	275	0	0	0	0	0	0	0	0	0	0	275	275
200–1000 FT																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Streams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>1000 FT																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Streams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Streams	0	275	275	0	0	0	0	0	0	0	0	0	0	275	275
	Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	275	275	0	0	0	0	0	0	0	0	0	0	275	275

**Not necessarily sum. Calculated separately to avoid double counting of overlapping restrictions.
Note: Totals may not equal sum of components because of independent rounding.

Table A6c. Estimated remaining coal resources of the "E" coal bed unavailable due to technologic restrictions in the Somerset 7.5-minute quadrangle, Colorado (in thousands of short tons). Resources are subdivided into categories of overburden thickness (0–200 ft, 200–1000 ft, and >1000 ft), coal thickness (1.2–2.3 ft and >2.3 ft), and reliability of estimate (measured, indicated, inferred, and hypothetical).

		MEASURED			INDICATED			INFERRED			HYPOTHETICAL			TOTAL		
		1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL
0–200 FT																
	Interburden < 40 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	<100 ft overburden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200–1000 FT																
	Interburden < 40 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	270	0	270	47	0	47	0	0	0	0	0	0	317	0	317
	TOTAL	270	0	270	47	0	47	0	0	0	0	0	0	317	0	317
>1000 FT																
	Interburden < 40 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL																
	Interburden < 40 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	<100 ft overburden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	270	0	270	47	0	47	0	0	0	0	0	0	317	0	317
	TOTAL	270	0	270	47	0	47	0	0	0	0	0	0	317	0	317

**Not necessarily sum. Calculated separately to avoid double counting of overlapping restrictions.
Note: Totals may not equal sum of components because of independent rounding.

Table A7a. Summary of estimated coal resources of all coal in the Somerset 7.5-minute quadrangle, Colorado (in thousands of short tons). Resources are subdivided into categories of overburden thickness (0–200 ft, 200–1000 ft, and >1000 ft), coal thickness (1.2–2.3 ft and >2.3 ft), and reliability of estimate (measured, indicated, inferred, and hypothetical).*

		MEASURED			INDICATED			INFERRED			HYPOTHETICAL			TOTAL		
		1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL
ORIGINAL																
	0–200	201	27681	27882	0	24838	24838	0	94	94	0	0	0	201	52613	52814
	200–1000	978	258043	259021	178	845742	845920	0	552468	552468	0	0	0	1156	1656253	1657409
	>1000	820	112361	113181	0	309764	309764	0	941715	941715	0	12898	12898	820	1376738	1377558
	TOTAL	1999	398085	400084	178	1180344	1180522	0	1494277	1494277	0	12898	12898	2177	3085604	3087781
MINED OUT**																
SURFACE	0–200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	200–1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEEP	0–200	48	1728	1776	0	0	0	0	0	0	0	0	0	48	1728	1776
	200–1000	58	66583	66641	0	136689	136689	0	19753	19753	0	0	0	58	223025	223083
	>1000	0	23357	23357	0	27176	27176	0	18	18	0	0	0	0	50551	50551
	TOTAL	106	91668	91774	0	163865	163865	0	19771	19771	0	0	0	106	275304	275410
TOTAL	0–200	48	1728	1776	0	0	0	0	0	0	0	0	0	48	1728	1776
	200–1000	58	66583	66641	0	136689	136689	0	19753	19753	0	0	0	58	223025	223083
	>1000	0	23357	23357	0	27176	27176	0	18	18	0	0	0	0	50551	50551
	TOTAL	106	91668	91774	0	163865	163865	0	19771	19771	0	0	0	106	275304	275410
REMAINING																
	0–200	153	25953	26106	0	24838	24838	0	94	94	0	0	0	153	50885	51038
	200–1000	920	191460	192380	178	709053	709231	0	532715	532715	0	0	0	1098	1433228	1434326
	>1000	820	89004	89824	0	282588	282588	0	941697	941697	0	12898	12898	820	1326187	1327007
	TOTAL	1893	306417	308310	178	1016479	1016657	0	1474506	1474506	0	12898	12898	2071	2810300	2812371
RESTRICTIONS																
LAND-USE	0–200	61	1802	1863	0	0	0	0	0	0	0	0	0	61	1802	1863
	200–1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	>1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	61	1802	1863	0	0	0	0	0	0	0	0	0	61	1802	1863
TECHNOLOGIC	0–200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	200–1000	767	39473	40240	126	152117	152243	0	104585	104585	0	0	0	893	296175	297068
	>1000	820	31198	32018	0	95999	95999	0	59371	59371	0	0	0	820	186568	187388
	TOTAL	1587	70671	72258	126	248116	248242	0	163956	163956	0	0	0	1713	482743	484456
TOTAL	0–200	61	1802	1863	0	0	0	0	0	0	0	0	0	61	1802	1863
	200–1000	767	39473	40240	126	152117	152243	0	104585	104585	0	0	0	893	296175	297068
	>1000	820	31198	32018	0	95999	95999	0	59371	59371	0	0	0	820	186568	187388
	TOTAL	1648	72473	74121	126	248116	248242	0	163956	163956	0	0	0	1774	484545	486319
AVAILABLE																
	0–200	92	24151	24243	0	24838	24838	0	94	94	0	0	0	92	49083	49175
	200–1000	153	151987	152140	52	556936	556988	0	428130	428130	0	0	0	205	1137053	1137258
	>1000	0	57806	57806	0	186589	186589	0	882327	882327	0	12898	12898	0	1139620	1139620
	TOTAL	245	233944	234189	52	768363	768415	0	1310551	1310551	0	12898	12898	297	2325756	2326053

*All coal in these six beds: Lower B, B, C, Lower D, D, and E.
**Mined and lost-in-mining, by surface and deep mining methods.

Table A7b. Estimated remaining coal resources of all coal* unavailable due to land use restrictions in the Somerset 7.5-minute quadrangle, Colorado (in thousands of short tons). Resources are subdivided into categories of overburden thickness (0–200 ft, 200–1000 ft, and >1000 ft), coal thickness (1.2–2.3 ft and >2.3 ft), and reliability of estimate (measured, indicated, inferred, and hypothetical).

		MEASURED			INDICATED			INFERRED			HYPOTHETICAL			TOTAL		
		1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL
0–200 FT																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	20	20	0	0	0	0	0	0	0	0	0	0	20	20
	Streams	61	1644	1705	0	0	0	0	0	0	0	0	0	61	1644	1705
	Roads	29	201	230	0	0	0	0	0	0	0	0	0	29	201	230
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	90	1865	1955	0	0	0	0	0	0	0	0	0	90	1865	1955
200–1000 FT																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Streams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>1000 FT																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Streams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Roads	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL																
	Cemeteries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Railroads	0	20	20	0	0	0	0	0	0	0	0	0	0	20	20
	Streams	61	1644	1705	0	0	0	0	0	0	0	0	0	61	1644	1705
	Roads	29	201	230	0	0	0	0	0	0	0	0	0	29	201	230
	Lakes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Towns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	90	1865	1955	0	0	0	0	0	0	0	0	0	90	1865	1955

*All coal in these beds: Lower B, B, C, Lower D, D, and E.

Table A7c. Estimated remaining coal resources of all coal* unavailable due to technologic restrictions in the Somerset 7.5-minute quadrangle, Colorado (in thousands of short tons). Resources are subdivided into categories of overburden thickness (0–200 ft, 200–1000 ft, and >1000 ft), coal thickness (1.2–2.3 ft and >2.3 ft), and reliability of estimate (measured, indicated, inferred, and hypothetical).

		MEASURED			INDICATED			INFERRED			HYPOTHETICAL			TOTAL		
		1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL	1.2–2.3ft	>2.3ft	TOTAL
0–200 FT																
	Interburden < 40 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	<100 ft overburden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200–1000FT																
	Interburden < 40 ft	227	38523	38750	0	148854	148854	0	104442	104442	0	0	0	227	291819	292046
	Burn	0	952	952	0	3946	3946	0	1635	1635	0	0	0	0	6533	6533
	Too thin	919	0	919	178	0	178	0	0	0	0	0	0	1097	0	1097
	TOTAL	1146	39475	40621	178	152800	152978	0	106077	106077	0	0	0	1324	298352	299676
>1000 FT																
	Interburden < 40 ft	0	31198	31198	0	68932	68932	0	86397	86397	0	41	41	0	186568	186568
	Burn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Too thin	820	0	820	0	0	0	0	0	0	0	0	0	820	0	820
	TOTAL	820	31198	32018	0	68932	68932	0	86397	86397	0	41	41	820	186568	187388
TOTAL																
	Interburden < 40 ft	227	69721	69948	0	217786	217786	0	190839	190839	0	41	41	227	478387	478614
	<100 ft overburden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Burn	0	952	952	0	3946	3946	0	1635	1635	0	0	0	0	6533	6533
	Too thin	1739	0	1739	178	0	178	0	0	0	0	0	0	1917	0	1917
	TOTAL	1966	70673	72639	178	221732	221910	0	192474	192474	0	41	41	2144	484920	487064

*All coal in these beds: Lower B, B, C, Lower D, D, and E