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I. Introduction

Purpose and Scope

The goal of this report is to summarize the known coal resources on the Grand Mesa, Uncompahgre, and Gunnison National Forests (GMUG), and to assess the geographic areas where potential coal resource development may occur between about 2006 and 2021 in support of the GMUG Forest Plan revision process. Throughout the preparation of the Forest Plan revision, the GMUG interacted with mining and minerals specialists from the Bureau of Land Management (BLM) who provided input on coal resource data and activity forecasts. The BLM – Colorado State and Uncompahgre Field Offices reviewed provided input to the 2004 version of this report (Attachment A). This 2006 version has been revised using this collective input from BLM.

This report includes current information on the geologic units that contain coal, current coal quality data, reserve estimates, current production data, as well as identifying areas on the GMUG with coal development potential for the time period indicated above.

Acknowledgments


II. Geologic Units

Coal resources on the GMUG are primarily from the Upper Cretaceous Dakota Formation, Fruitland Formation, and the Mesaverde Formation/Group. These rock units were deposited in continental and nearshore marine settings along the western margin of an ancient interior seaway. Although the Dakota Sandstone has a wide distribution throughout the GMUG, the Mesaverde Formation and Mesaverde Group are confined to areas where the Gunnison and Grand Mesa National Forests extend across the Piceance Basin (Fig. 1), and the Fruitland Formation is confined to an isolated area in the Uncompahgre National Forest (Fig. 2). Table 1 provides information on stratigraphic position, thickness, and a brief description of coal bearing rock units within GMUG.
The Dakota Formation consists of conglomerate, sandstone, mudstone, carbonaceous shale, and coal deposited in alluvial and coastal plain settings during the initial incursion of the Western Interior seaway during the Cenomanian Stage of the Cretaceous Period (98 Ma – 93 Ma). The Dakota Formation is about 30–200 ft thick (Young, 1960) and is overlain by the Mancos Shale. The Mancos Shale consists of about 4,000–5,000 ft of material deposited in an offshore marine environment that persisted from the Cenomanian through Campanian in the study area (98 Ma – 71 Ma), when the shoreline was located in Utah. As the shoreline moved back into the area during the late Campanian (83 Ma – 71 Ma), strata were deposited in a complex system of continental, coastal plain, and shoreface environments.

In the Uncompahgre National Forest about 200 ft of Upper Cretaceous coal-bearing strata is assigned to the Fruitland Formation (Dickinson 1987a, 1987b, 1988; and Hornbaker and others, 1976)(Fig. 2).

In the southern part of the Piceance Basin, about 2,100–5,600 ft of strata has been assigned to the Mesaverde Group and Mesaverde Formation. The Mesaverde has been assigned group status in the Book Cliffs, Grand Hogback, and Carbondale coal fields, but is considered a formation in the Crested Butte and Grand Mesa coal fields. In the Book Cliffs coal field, the Mesaverde Group was divided into (in ascending order) the Castlegate Sandstone, Sego Sandstone, Mount Garfield Formation, and Hunter Canyon Formation (Erdmann, 1934; Fisher and others, 1960). In the Grand Hogback and Carbondale coal fields, the Mesaverde Group was divided into (in ascending order) the Iles and Williams Fork Formations (Collins, 1976).
Figure 1. Location of major geologic structural features. GMUG boundaries are shown in red dashed lines (Hettinger, et al., 2004).
Figure 2. Areas in the GMUG underlain by coal bearing geologic formations (Hettinger, et al., 2004).
TABLE 1. Summary of Cretaceous strata in the GMUG (Hettinger et al., 2004).

<table>
<thead>
<tr>
<th>Age</th>
<th>Group or Formation</th>
<th>Thickness (ft)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late Cretaceous</td>
<td>Late Cretaceous Mesaverde Group and Mesaverde Formation</td>
<td>2,100-5,600</td>
<td>Sandstone, mudrock, carbonaceous shale, and coal. Sandstone is very fine grained to medium grained, and locally coarse grained. Upper part is fine grained to coarse grained and conglomeratic. Lower part intertongues with Mancos Shale. The Mesaverde Group/Formation underlies the Grand Mesa and Gunnison National Forests and is exposed in the Book Cliffs, Carbondale, Crested Butte, Grand Hogback, Grand Mesa, and Somerset coal fields. In the Book Cliffs coal field, the Mesaverde Group is divided into the Castlegate Sandstone, Sego Sandstone, Mount Garfield Formation, and Hunter Canyon Formation. In the Grand Hogback and Carbondale coal fields, the Mesaverde Group is divided into the Iles and Williams Fork Formations. Coeval strata are assigned to the Mancos Shale and Mesaverde Formation in the Grand Mesa and Crested Butte coal fields.</td>
</tr>
<tr>
<td></td>
<td>Fruitland Formation</td>
<td>200</td>
<td>The Fruitland Formation underlies areas in the Uncompahgre National Forest, and it is exposed in the Tongue Mesa coal field.</td>
</tr>
<tr>
<td></td>
<td>Mancos Shale</td>
<td>4,000-5,000</td>
<td>Dark-gray shale with minor sandstone and siltstone; includes thin lenses of limestone, sandy limestone, and limy shale. The Mancos intertongues with the lower part of the Mesaverde Group and Mesaverde Formation.</td>
</tr>
<tr>
<td></td>
<td>Dakota Sandstone</td>
<td>30-200</td>
<td>Light-gray and tan, fine- to coarse-grained sandstone or quartzite; minor interbeds of dark-gray shale, shaly sandstone, conglomeratic sandstone, and thin and lenticular beds of coal.</td>
</tr>
</tbody>
</table>

III. Coal Fields

The GMUG contains lands located within or adjacent to several coal fields of western Colorado (Fig. 3). The coal field boundaries have been defined by Landis (1959), Hornbaker and others (1976), and Tremain and others (1996).

The Grand Mesa National Forest extends across part of the Grand Mesa coal field and lies in close proximity to the Book Cliffs and Somerset coal fields. The northwestern part of the Gunnison National Forest extends across the Carbondale, Crested Butte, and Somerset coal fields. Farther south, parts of the Uncompahgre National Forest lie within the Tongue Mesa coal field and adjacent to the Nucla-Naturita coal field.

Listed below are generalized data for each individual coal field. This information was extracted from Kirschbaum and Biewick (2000), and others as referenced.
Carbondale Coal Field

Stratigraphy
Williams Fork Formation, Iles Formation, Mancos Shale

Coals are located in 3 zones within the Williams Fork Formation, all separated by 100-200 ft of section. These zones, in ascending order are the Cameo-Wheeler, South Canyon, and Coal Ridge. Individual beds within these zones are up to 25 ft thick.

Quality
(Hettinger and others (2000), Hornbaker and others (1976), Murray and others (1977))

<table>
<thead>
<tr>
<th>Ash Content (%)</th>
<th>Sulfur Content (%)</th>
<th>Heating Value (Btu/lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.9-16.2</td>
<td>0.3-2.1</td>
<td>10,160-15,190</td>
</tr>
</tbody>
</table>

In the northern part of the field, the coals are high-volatile B bituminous and non-coking, whereas in the southern part of the field, the coals are metamorphosed by igneous intrusions to high-volatile A bituminous, medium-volatile bituminous, and locally to semianthracite and anthracite and strongly coking (Hornbaker and others, 1976). The coal contains high methane levels, ranging from 1,000–4000 cubic ft gas per ton (Murray and others, 1977).

Resources
Hornbaker and others (1976) estimated 5.2 billion short tons of coal resource lying under 6,000 ft of overburden.

Crested Butte Coal Field

Stratigraphy
Mesaverde Formation and Mancos Shale

Coal is located in 4 major coal beds as thick as 25 ft with numerous thin beds (Gaskill and others, 1986).

Quality
(Hettinger and others (2000), Hornbaker and others (1976), Murray and others (1977))

<table>
<thead>
<tr>
<th>Ash Content (%)</th>
<th>Sulfur Content (%)</th>
<th>Heating Value (Btu/lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2-9.1</td>
<td>0.4-1.9</td>
<td>11,080-14,140</td>
</tr>
</tbody>
</table>

The coal is reported as high volatile bituminous C through anthracite and is of coking quality (Gaskill and others, 1986).

Resources
Hornbaker and other (1976) estimated 1.5 billion short tons of coal resource underlying up to 6,000 ft of overburden.
Figure 3. Location of coal fields in the GMUG greater study area (Hettinger, et al., 2004).
**Grand Mesa Coal Field**

**Stratigraphy**
Mesaverde Formation and Mancos Shale

Coal present around 200 ft above the Rollins Sandstone member. Coals are named A through F and only a couple of the seams are of mineable thickness at any one place.

**Quality**
(Hettinger and others (2000), Hornbaker and others (1976), Murray and others (1977), Tremain and others (1996), and R.H. Affolter (written commun., 1998))

<table>
<thead>
<tr>
<th>Ash Content (%)</th>
<th>Sulfur Content (%)</th>
<th>Heating Value (Btu/lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1-23.3</td>
<td>0.4-2.2</td>
<td>8,300-13,490</td>
</tr>
</tbody>
</table>

**Resources**
Hornbaker and other (1976) estimated 8.6 billion short tons of coal resource in beds greater than 5 ft. thick and underlying up to 6,000 ft of overburden.

**Somerset Coal Field**

**Stratigraphy**
Mesaverde Formation and Mancos Shale

Coals from Bowie Shale member of Mesaverde are mined from beds ranging in thickness between 8.5 and 18 ft (Hornbaker and others, 1976). Coals from the Paonia Shale member of the Mesaverde range in thickness from 12 to 13 ft. Individual beds reach a maximum thickness of 25 and 30 ft (Murray, 1980).

**Quality**

<table>
<thead>
<tr>
<th>Ash Content (%)</th>
<th>Sulfur Content (%)</th>
<th>Heating Value (Btu/lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.4-29.9</td>
<td>0.3-3.2</td>
<td>8,160-14,380</td>
</tr>
</tbody>
</table>

The coals in the Somerset area are of good coking quality and are reported to be of marginal to premium high-volatile A and B bituminous (Goolsby and others, 1979).

**Resources**
8 billion short tons of coal estimated to underlie up to overburden of 6,000 ft.
Tongue Mesa Coal Field

Stratigraphy
Kirtland Shale, Fruitland Formation, Pictured Cliffs Sandstone

Fruitland contains one extensive coal bed that ranges in thickness from 20 to 40 ft and the formation contains additional coal beds that are about 5 to 13 ft thick.

Quality
(Hornbaker and others, 1976)

<table>
<thead>
<tr>
<th>Ash Content (%)</th>
<th>Sulfur Content (%)</th>
<th>Heating Value (Btu/lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.7-8.4</td>
<td>0.5-0.9</td>
<td>9,350-10,200</td>
</tr>
</tbody>
</table>


Resources
Hornbaker and others, 1976, estimated as high as 4,000 million short tons.

IV. Coal Characteristics by Rock Unit and Forest

Dakota Sandstone

The Dakota Sandstone underlies all of the Grand Mesa National Forest and is present within parts of the Uncompahgre and Gunnison National Forests (Fig. 2). The Dakota is gently dipping where it is exposed along the flanks of the Uncompahgre uplift; it abuts the San Juan volcanic field to the south and is locally disrupted by Tertiary intrusions in the Gunnison area. Coal beds in the Dakota are generally thin and discontinuous, and they contain numerous partings of carbonaceous and coaly shale. Coal beds as thick as 7.7 ft are found locally in the study area, but they also contain many partings (Eakins, 1986).

Grand Mesa National Forest The Dakota Sandstone does not crop out within the Grand Mesa National Forest, but it is widespread in the subsurface (Fig. 2). Most of the Dakota is buried at depths greater than 4,000 ft, based on its stratigraphic position below younger units within the forest. Dakota coals crop out 6–10 mi south and west of the forest, between the towns of Grand Junction and Delta, Colo. These coals were measured by Woodruff (1912) and Lee (1912). The thickest single bench of coal measured was 20 in. thick; at another locality 6 ft of coal was described within 11 ft of coal-bearing strata (Woodruff, 1912). The poor quality and thin discontinuous nature of the coal precluded development in the area (Woodruff, 1912). The presence of Dakota coal within the forest
is unknown, but any coal that might be present is likely to be of similar poor quality, quantity, and character.

**Gunnison National Forest** Although the Dakota Sandstone is widely distributed in the Gunnison National Forest (Fig. 2), data by Gaskill and Godwin (1966a, 1966b), Gaskill and others (1967, 1986, 1987), and Godwin (1968) suggest that the Dakota lacks coal in the eastern and southern parts of the Forest.

**Uncompahgre National Forest** The Dakota Sandstone crops out in the Uncompahgre National Forest; however, it is generally poorly exposed, concealed by thick vegetation, or covered by Quaternary land-slide deposits. No published reports list precise thicknesses of Dakota coal in the forest; however, a 2.1-ft thick coal bed was measured in the forest about 12 mi northeast of the town of Nucla (W.W. Boyer, USGS, unpub. data, 1926). Landis (1959) evaluated the Dakota coal and his generalized maps and descriptions indicate that Dakota coal beds in the forest are likely to be thin, impure, and discontinuous. However, minable reserves might be found locally.

**Fruitland Formation**

**Uncompahgre National Forest** Approximately 200 ft of coal-bearing strata is present in a small part of the Uncompahgre National Forest at the Tongue Mesa coal field (Figs. 2,3). The coal-bearing rocks were assigned to the Fruitland Formation by Hornbaker and others (1976) and Dickinson (1987a, 1987b, 1988), and they are part of a 1,000-ft thick interval that was originally thought to be equivalent to the Mesaverde Formation by Landis (1959). Both Landis (1959) and Dickinson (1987a, 1987b, 1988) described the coal-bearing interval as being concealed by heavy vegetation, landslides, talus, and glacial deposits. Dickinson (1987a, 1987b, 1988) mapped the Fruitland cropping out at only a few small and widely spaced localities, and depth to the top of the formation ranges from 0 to 2,500 ft within the forest. The Fruitland contains one laterally extensive coal bed that is about 20–40 ft thick, and three to five coal beds that are about 5–13 ft thick. The beds of coal are gently inclined and disrupted by numerous faults; however, the precise location and displacement of the faults cannot be determined from surface mapping because the area is extensively covered by landslide debris.

**Mesaverde Group and Mesaverde Formation**

**Grand Mesa and Northwestern Part of the Gunnison National Forest** Coal-bearing strata in the Mesaverde Group and Mesaverde Formation underlie approximately 620 mi² of the Gunnison National Forest and 520 mi² of the Grand Mesa National Forest (Fig. 2). The coal-bearing Mesaverde Group and Mesaverde Formation extend throughout the subsurface of the Piceance Basin and are exposed in the Book Cliffs, Carbondale, Crested Butte, Grand Hogback, Grand Mesa, and Somerset coal fields (Fig. 3). Numerous mines have produced from these coal fields since the late 1800’s. Some of the coal is also considered to be an important source for natural gas (Johnson, 1989).
In order to better delineate the coal resources on the GMUG, Figure 4 shows the boundaries of Area 1, an area with a high probability of coal occurrence.

The coal resources within the Mesaverde Group are broken down into two groups. These groups are the Black Diamond Coal Group and the Cameo-Fairfield coal group. The boundaries between these groups are stratigraphically controlled. The Black Diamond coal group represents coal resources below the Rollins Sandstone Member of the Mesaverde Group (Fig. 5). Whereas the Cameo-Fairfield coal group contains all the coal resources within the Mesaverde Group above the Rollins Sandstone.

**Black Diamond Coal Group**  The Black Diamond coal group is located stratigraphically below the Rollins Sandstone Member, and contains (in ascending order) the Anchor, Palisade, and Chesterfield coal zones. Individual beds of coal are generally less than 6 ft thick where they are exposed in the Book Cliffs and Grand Hogback coal fields, and they pinch out southeast of those localities. Drill hole data show that the coal group lies 3,500–10,500 ft deep and has less than 6 ft of net coal in those areas.

*Resources were not estimated for the Black Diamond coal group because the coal beds are too thin and too deep to be economically significant.*

**Cameo-Fairfield Coal Group**  The Cameo-Fairfield coal group overlies the Rollins Sandstone Member and contains the thickest and most extensively mined coals in the Piceance Basin. The coal group is about 1,000 ft thick in the northeastern part of the Area 1, and it is less than 200 ft thick in the southwestern and southeastern parts of Area 1 (Fig. 4). The Cameo-Fairfield extends throughout most of the subsurface of Area 1, and it is exposed near the forest boundaries in the Carbondale, Crested Butte, Grand Mesa, and Somerset coal fields (Fig. 3). Following the nomenclature of Hettinger and others (2000), the Cameo-Fairfield group contains (in ascending order) the Cameo-Wheeler, South Canyon, and Coal Ridge coal zones in areas located west of long 107°15’ W. (Fig. 5). East of long 107°15’ W., the Cameo-Fairfield group is simply divided into the lower, middle, and upper coal zones (Fig. 5). Coal zone nomenclature was not extended across long 107°15’ W., owing to structural and stratigraphic complexities, and a paucity of data east of the longitudinal line.

Net coal in the Cameo-Fairfield coal group ranges from about 50 to 97 ft in a 20- to 30-mi wide belt that extends north to south across the central part of Area 1 (Fig. 6). Net coal decreases to less than 50 ft in the remaining parts of Area 1. Coal distribution in the Cameo-Wheeler, South Canyon, and Coal Ridge coal zones is shown in a series of net coal isopach maps in Figs.7,8,9, respectively.
Figure 4. Location of Area 1 within the GMUG. This area is between lat 37°45' and 39°30' N. and long 106° and 109° W (Hettinger, et al., 2004).
Figure 5. Stratigraphic section used for the Mesaverde group and Mesaverde formation in the southern part of the Piceance Basin (modified from Hettinger et al., 2000).
In the vicinity of Somerset, CO the historic references label the coal beds as 6 major units. These beds are labeled A through F, with A being the lowest (oldest) bed in the stratigraphic section and F being the highest (youngest). The A through F seams are within the Cameo-Fairfield coal group, and are located within the Bowie Shale member and the Paonia Shale member of the Mesaverde Formation (Fig. 5).

Because coal beds in Colorado are highly lenticular and their mineable thicknesses vary over a relatively short distance it is difficult to group the 6 identified coal beds into the coal zones within the Cameo-Fairfield Coal Group (Cameo-Wheeler, South Canyon, and Coal Ridge, see Fig. 5, and text below).

By examining cross-sections developed from drill holes throughout the region a rough correlation can be made.

A, B, C seam = Cameo-Wheeler Coal Zone
D, E seam = South Canyon Coal Zone
F = Coal Ridge Coal Zone

Once again, it’s important to stress that coal seam and interburden thickness can vary dramatically over a relatively short lateral extent. These correlations are the best match when comparing available non-proprietary data.

**Cameo-Wheeler Coal Zone, or A,B, and C seams (West of Long 107°15’ W.)** The Cameo-Wheeler coal zone (Fig. 5) underlies a 925 mi² area that includes all parts of Area 1 west of long 107°15’ W. This coal zone overlies the Rollins Sandstone Member and is about 100–400 ft thick. The Cameo-Wheeler coal zone has approximately 5–80 ft of net coal, and net coal exceeds 50 ft throughout the central part of Area 1 (Fig. 7). Near the southern boundary, in the Grand Mesa and Somerset coal fields, the Cameo-Wheeler has 10–70 ft of net coal in as many as 15 beds that are 1–30 ft thick. Near the eastern boundary of Area 1, in the Carbondale coal field, the Cameo-Wheeler contains about 7–27 ft of net coal in one to three beds that are 3–18 ft thick.

**South Canyon Coal Zone, or D and E seams (West of Long 107°15’ W.)** The South Canyon coal zone underlies a 530 mi² region in Area 1 (Fig. 8). This coal zone overlies and intertongues with the middle sandstone of the Bowie Shale Member of the Williams Fork Formation (Fig. 5). The coal zone is 1–200 ft thick and contains 1–30 ft of net coal. Net coal exceeds 20 ft along a 5- to 10-mi wide belt that trends N. 20° W. throughout the central part of Area 1. In the Somerset coal field, the South Canyon has 15–35 ft of net coal in two to five beds that are 1–25 ft thick. In the southern part of the Carbondale field, at Coal Basin, the South Canyon contains the 3–20 ft thick Dutch Creek coal bed (Collins, 1976; Dunrud, 1989a).
Figure 6. Isopach map of net coal in the Cameo-Fairfield coal group. Net coal represents all beds > 1 ft thick (Hettinger, et al., 2004).
**Coal Ridge Coal Zone, or F seam (West of Long 107°15' W.)**  The Coal Ridge coal zone overlies and intertongues with the upper sandstone in the Bowie Shale Member of the Williams Fork Formation (Fig. 5), and the coal zone occupies the same area as the underlying South Canyon coal zone. The Coal Ridge is 100–400 ft thick near the line of long 107°15’ W., is less than 100 ft thick throughout most of its west half, and pinches out near the same line as the underlying South Canyon coal zone (Fig. 9). The Coal Ridge generally has less than 10 ft of net coal, although a small area with about 20 ft of net coal is located near the Somerset coal field (Figs. 3,9). In the Somerset coal field, the Coal Ridge coal zone contains 10–26 ft of net coal in two to seven beds that are 1–10 ft thick. In the southern part of the Carbondale coal field, the Coal Ridge coal zone has 2–10 beds of coal that are 1–23 ft thick.

**Lower, Middle, and Upper Coal Zones (East of Long 107°15’ W.)**  East of long 107°15’ W., the Cameo-Fairfield coal group is divided into the lower, middle, and upper coal zones. The collective coal zones have about 1–30 ft of net coal (Fig. 10) in one to five beds, and individual beds are 1–25 ft thick. The lower coal zone overlies a basal marine sandstone that was considered to be equivalent to the Rollins Sandstone Member by Gaskill and Godwin (1966a, 1966b), Godwin (1968), and Gaskill and others (1967, 1986, 1987). The lower coal zone contains only one or two coal beds that were measured locally along outcrops in the Crested Butte coal field. The only important coal in the lower zone is a 0–4.0 ft thick bed, which is located 7–10 miles south of the town of Crested Butte (Gaskill and others, 1987). The middle coal zone overlies a second marine sandstone that is about 100–200 ft stratigraphically above the Rollins equivalent sandstone. The middle coal zone contains two to six coal beds that range from 1 to 25 ft thick. Included in the middle zone are four beds near the town of Crested Butte.

The upper coal zone is about 300 ft stratigraphically above the Rollins equivalent sandstone, and it contains several lenticular coal beds in the Crested Butte coal field. Important beds include one that is about 5 to 6 ft thick in the Ohio Creek district, and a 3.5–4.5 ft thick anthracite bed that has been mined 7 miles southwest from the town of Crested Butte (Gaskill et al., 1987).
Figure 7. Isopach map of net coal in the Cameo-Wheeler coal zone. Net coal represents all beds > 1 ft thick (Hettinger, et al., 2004).
Figure 8. Isopach map of net coal in the South Canyon coal zone. Net coal represents all beds > 1 ft thick (Hettinger, et al., 2004).
Figure 9. Isopach map of net coal in the Coal Ridge coal zone. Net coal represents all beds > 1 ft thick (Hettinger, et al., 2004).
Figure 10. Isopach map of net coal in the Cameo-Fairfield coal group east of long 107°15'W. Net coal represents all beds > 1 ft thick (Hettinger, et al., 2004).
V. Coal Resource Potential (geologic occurrence)

GMUG is considered to have coal resource potential in areas where underlying strata (1) are likely to have accumulated in a coal-forming environment, and (2) the potential coal-bearing rocks are less than 3,500 ft deep (Fig. 11). As summarized in this report, coal-bearing strata are either known or are likely to be in the Dakota Formation, Fruitland Formation, Mesaverde Formation, or Mesaverde Group. Areas of high coal resource potential have nearby outcrop or drill hole data that substantiate the presence of coal. Areas of moderate coal resource potential do not have drill hole or outcrop data to substantiate the presence of coal; however, data in adjacent areas indicate that coal is likely to be present. Areas of low coal resource potential have no information to substantiate the presence of coal; however, the presence of coal is inferred from regional data.

Methods

Gross coal resources were estimated using a modified methodology based on that of Wood and others (1983), by which, all coal in the ground in beds greater than 1 ft thick and under less than 3,500 ft of overburden are reported. The term “original resource” refers to coal in the ground prior to mining. More deeply buried coal is reported as other occurrences of non-resource coal. This report does not attempt to estimate coal reserves which are that subset of the resource that can be economically produced at the present time. Coal resources were estimated by multiplying the volume of coal by the average density of coal (Wood and others, 1983, p. 36).

For this portion of this report, an average density of 1,800 short tons per acre-ft for bituminous coal is used. Coal tonnages are reported within overburden categories of 0–500, 500–1,000, 1,000–2,000, and 2,000–3,000 ft. Overburden was determined by subtracting elevations at the base of the specified coal interval from surface elevations; the difference therefore represents the maximum overburden on the specified coal interval. Elevations at the base of the Cameo-Fairfield coal group and Cameo-Wheeler coal zone were determined from a structure contour map of the top of the Rollins Sandstone Member (Hettinger and others, 2000). Similarly, elevations at the base of the South Canyon and Coal Ridge coal zones were determined from structure contour maps that represent the base of those respective coal zones. Maximum overburden thicknesses on the Cameo-Wheeler, South Canyon, and Coal Ridge coal zones are shown in Figures 12, 13, 14 respectively, and the maximum overburden thickness on the base of the Cameo-Fairfield coal group east of long 107°15’ W. is shown in Figure 15.
Figure 11. Areas within GMUG showing the potential for coal deposits to exist (Hettinger, et al., 2004).
Figure 12. Isopach map over overburden on base of Cameo-Wheeler coal zone (Hettinger, et al., 2004).
Figure 13. Isopach map over overburden on base of South Canyon coal zone (Hettinger, et al., 2004).
Figure 14. Isopach map over overburden on base of Coal Ridge coal zone (Hettinger, et al., 2004).
Figure 15. Isopach map over overburden on base of Cameo-Fairfield coal group east of long 107°15′W (Hettinger, et al., 2004).
Coal Resource Potential of the Dakota Sandstone

There are two problems in trying to determine the coal resource potential of the Dakota Sandstone. The first problem is that few data are available for Dakota coal in the GMUG. The presence of coal in the Dakota must therefore be inferred from adjacent areas where the Dakota has been described. The second problem is that the Dakota Sandstone and underlying Jurassic strata have been mapped as a single unit at many localities in the Gunnison and Uncompahgre National Forests, and presence of the Dakota is not certain in those areas. Based on published geologic maps, the Dakota is definitely present where mapped separately from the underlying Burro Canyon Formation, and it is likely to be present below areas where younger sedimentary rocks have been mapped at the surface.

The GMUG has either a moderate, low, or no resource potential for coal in the Dakota Sandstone (Fig 11A). The Uncompahgre National Forest has a low to moderate coal resource potential in areas underlain by the Dakota Sandstone. Although few data are available to substantiate the presence of coal in the forest, the occurrence of mineable coals outside of the forest (near the towns of Nucla and Norwood) indicates that isolated deposits of mineable coal might also be in the forest. The Dakota Sandstone has a low coal resource potential in a small part of the Grand Mesa National Forest. The Dakota is 5,000 and 6,000 ft deep in that area, and its low resource potential is based on outcrop data that show the Dakota to contain a few thin coal beds about 10 mi outside the forest along the Gunnison River.

Any Dakota coal that might be present in the Grand Mesa National Forest would not have current mining (development) potential because it is at depths that exceed the physical or economic limits of present-day mining techniques. The Dakota Sandstone has no coal resource potential in the remaining part of the Grand Mesa National Forest because it is more than 6,000 ft deep. Available data indicate that the Dakota does not contain coal where it is exposed in the vicinity of the Gunnison National Forest, and therefore this forest is not considered to have resource potential for Dakota coal.

Coal Resource Potential of the Fruitland Formation

The Uncompahgre National Forest has a moderate to high resource potential for coal where it is underlain by the Fruitland Formation in the Tongue Mesa coal field (Fig. 11B). The area is given a high resource potential because it is known to contain thick beds of subbituminous coal; the area is also assigned a moderate resource potential because coal bed continuity could not be determined, owing to poor exposure and structural complexities. Coal beds were mined locally in the Tongue Mesa coal field between the 1890’s and 1940’s (Dickinson, 1987a, 1987b, 1988), and there has been some interest to develop the coal since that time (Hornbaker and others, 1976; Dickinson, 1987a, 1987b, 1988). Although the area has a moderate to high resource potential, Hornbaker and others (1976) thought that the coal in the Tongue Mesa area could not compete with better coal in the Somerset field.
Coal Resource Potential of the Mesaverde Formation

The Grand Mesa and Gunnison National Forests have a high coal resource potential where the Cameo-Fairfield coal group is at depths of less than 3,000 ft (Fig. 11B). This regionally extensive coal group is in the Mesaverde Group and Mesaverde Formation; it contains as much as 97 ft of net coal, and has individual coal beds as thick as 30 ft within the forest areas. Cameo-Fairfield coal has been mined at several coal fields located in and adjacent to the forests. About 150 million short tons have been produced since the late 1800’s.

The area of high coal resource potential in the Grand Mesa and Gunnison National Forests (Fig. 11B) is estimated to contain about 38 billion short tons of coal in the Cameo-Fairfield coal group, as determined for Area 1 (Fig. 4). This large resource figure does not represent mineable reserves, which are a subset of the resource that could be economically produced at the present time (see Section VIII). Coal in the Cameo-Fairfield would have to be mined using underground methods, and technological and geologic restrictions preclude much of the resource from being economically mined. For example, only 37 percent (14 billion short tons) of the coal resource is at depths (less than 3,000 ft) favorable for longwall mining. Some coal would be precluded from mining because the beds are too thin, thick, or steeply inclined. Additional coal would also be restricted from mining because the beds might be discontinuous, left in the ground as pillars for roof support, or bypassed due to mining of adjacent strata.

Coal Resource Breakdown of the Cameo-Fairfield Coal Group (A-F seams)

Based on information from the USGS, Area 1 has an original coal resource of about 14 billion short tons in the Cameo-Fairfield coal group. This total represents coal beds more than 1 ft thick and under less than 3,500 ft of overburden. The resource figure does not include coal folded over the flanks of laccoliths or buried beneath laccoliths. Approximately 20 percent of the resource is in the Grand Mesa National Forest, and 80 percent of the resource is in the Gunnison National Forest.

Area 1 also contains about 58 billion short tons of non-resource coal in the Cameo-Fairfield group that is covered by 3,000–11,500 ft of overburden. Non-resource coal is defined by coal seams which are too thin, or of such quality (low BTU, or high sulfur/mercury), to make them uneconomical to mine. Approximately 76 percent of the non-resource coal is in the Grand Mesa National Forest, and 24 percent is in the Gunnison National Forest. Coal tonnages are reported by reliability and overburden categories for each coal zone in the Cameo-Fairfield group where it is located west of long 107°15’ W. (Tables 2,3,4 respectively), and tonnages are reported for the entire Cameo-Fairfield coal group where it is located east of long 107°15’ W. (Table 5).
Within the Tables below, Identified resources are located less than 3 mi from a coal measurement (data point from an exploration drill-hole), and Hypothetical resources are located more than 3 mi from a coal measurement.

### Table 2. Original Coal Resources (in millions of tons) in the Cameo-Wheeler coal zone (Area 1).

<table>
<thead>
<tr>
<th>Forest</th>
<th>Reliability</th>
<th>Overburden 0-500</th>
<th>500-1,000</th>
<th>1,000-2,000</th>
<th>2,000-3,000</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Mesa</td>
<td>Identified</td>
<td>140</td>
<td>130</td>
<td>420</td>
<td>940</td>
<td>1600</td>
</tr>
<tr>
<td></td>
<td>Hypothetical</td>
<td>78</td>
<td>94</td>
<td>290</td>
<td>440</td>
<td>900</td>
</tr>
<tr>
<td>Grand Mesa Total</td>
<td></td>
<td>210</td>
<td>220</td>
<td>710</td>
<td>1400</td>
<td>2700</td>
</tr>
<tr>
<td>Gunnison</td>
<td>Identified</td>
<td>940</td>
<td>820</td>
<td>2200</td>
<td>2600</td>
<td>6900</td>
</tr>
<tr>
<td></td>
<td>Hypothetical</td>
<td>80</td>
<td>15</td>
<td>0</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>Gunnison Total</td>
<td></td>
<td>1000</td>
<td>830</td>
<td>2200</td>
<td>2800</td>
<td>7100</td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
<td>1200</td>
<td>1100</td>
<td>2900</td>
<td>4100</td>
<td>10000</td>
</tr>
</tbody>
</table>

### Table 3. Original Coal Resources (in millions of tons) in the South Canyon coal zone (Area 1).

<table>
<thead>
<tr>
<th>Forest</th>
<th>Reliability</th>
<th>Overburden 0-500</th>
<th>500-1,000</th>
<th>1,000-2,000</th>
<th>2,000-3,000</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Mesa</td>
<td>Identified</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Hypothetical</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>.47</td>
<td>0.47</td>
</tr>
<tr>
<td>Grand Mesa Total</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>.47</td>
<td>0.47</td>
</tr>
<tr>
<td>Gunnison</td>
<td>Identified</td>
<td>180</td>
<td>350</td>
<td>840</td>
<td>740</td>
<td>2100</td>
</tr>
<tr>
<td></td>
<td>Hypothetical</td>
<td>.2</td>
<td>2.5</td>
<td>20</td>
<td>59</td>
<td>80</td>
</tr>
<tr>
<td>Gunnison Total</td>
<td></td>
<td>180</td>
<td>350</td>
<td>860</td>
<td>790</td>
<td>2200</td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
<td>180</td>
<td>350</td>
<td>860</td>
<td>790</td>
<td>2200</td>
</tr>
</tbody>
</table>

### Table 4. Original Coal Resources (in millions of tons) in the Coal Ridge coal zone (Area 1).

<table>
<thead>
<tr>
<th>Forest</th>
<th>Reliability</th>
<th>Overburden 0-500</th>
<th>500-1,000</th>
<th>1,000-2,000</th>
<th>2,000-3,000</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Mesa</td>
<td>Identified</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>.27</td>
<td>0.27</td>
</tr>
<tr>
<td></td>
<td>Hypothetical</td>
<td>0</td>
<td>0</td>
<td>.18</td>
<td>5.8</td>
<td>6</td>
</tr>
<tr>
<td>Grand Mesa Total</td>
<td></td>
<td>0</td>
<td>0</td>
<td>.18</td>
<td>6.1</td>
<td>7</td>
</tr>
<tr>
<td>Gunnison</td>
<td>Identified</td>
<td>170</td>
<td>230</td>
<td>670</td>
<td>540</td>
<td>1600</td>
</tr>
<tr>
<td></td>
<td>Hypothetical</td>
<td>.96</td>
<td>.82</td>
<td>.22</td>
<td>38</td>
<td>40</td>
</tr>
<tr>
<td>Gunnison Total</td>
<td></td>
<td>170</td>
<td>230</td>
<td>670</td>
<td>580</td>
<td>1600</td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
<td>170</td>
<td>230</td>
<td>670</td>
<td>586</td>
<td>1607</td>
</tr>
</tbody>
</table>
Table 5. Original Coal Resources (in millions of tons) in the Cameo-Fairfield coal group east of 107°15'W. (Area 1).

<table>
<thead>
<tr>
<th>Reliability</th>
<th>Overburden</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-500</td>
<td>500-1,000</td>
</tr>
<tr>
<td>Identified</td>
<td>160</td>
<td>160</td>
</tr>
<tr>
<td>Hypothetical</td>
<td>160</td>
<td>64</td>
</tr>
<tr>
<td>Grand Total</td>
<td>320</td>
<td>224</td>
</tr>
</tbody>
</table>

The large gross coal resource figures reported for Area 1 must be regarded with caution because it does not reflect economic, land-use, environmental, technological, and geologic restrictions that affect the availability and recoverability of coal. The coal would have to be mined using underground methods, and technological and economical constraints generally limit current longwall mining to (1) depths of less than 3,000 ft, (2) beds more than 3.5 ft thick, and (3) strata inclined by less than 12°; additionally, only about 14 ft of coal can be mined even if the bed is of greater thickness (Timothy J. Rohrbacher, oral commun., 1996).

An estimated 14 billion short tons of coal in Area 1 meets favorable underground mining criteria regarding depth of burial (less than 3,000 ft), and only a fraction of that coal could be mined economically because many beds are either less than 3.5 ft thick or more than 14 ft thick, and because many localities in the vicinity of the Crested Butte and Carbondale coal fields are steeply inclined. Additional coal would also be restricted from mining because it might be in beds that are discontinuous, left in the ground as pillars for roof support, or bypassed due to mining of adjacent strata.

**Area 1 - Cameo-Wheeler Coal Zone, or A,B,and C seams** The Cameo-Wheeler zone has an original coal resource of 10 billion short tons in Area 1 (Table 2) where the coal is covered by less than 3,000 ft of overburden (Fig. 12). Approximately 5.2 billion short tons are under less than 2,000 ft of overburden.

**Area 1 - South Canyon Coal Zone, or D and E seam** The South Canyon zone has an original coal resource of approximately 2.2 billion short tons in Area 1 (Table 3). Approximately 1.4 billion short tons are under less than 2,000 ft of overburden. The South Canyon contains an additional 3.8 billion short tons of non-resource coal in Area 1.

**Area 1 - Coal Ridge Coal Zone, or F seam** The Coal Ridge coal zone has an original coal resource of approximately 1.6 billion short tons in Area 1 (Table 4) where the coal is covered by less than 3,000 ft of overburden (Fig. 14). Approximately 1.1 billion short tons are under less than 2,000 ft of overburden. The Coal Ridge contains an additional 1.8 billion short tons of non-resource coal in Area 1.
Area 1 - Coal Resources of the Cameo-Fairfield Coal Group East of Long 107°15’ W.

Area 1 has an original resource of 918 million short tons of coal in the Cameo-Fairfield coal group where it is located east of long 107°15’ W. (Table 5). The coal resource is distributed across the lower, middle, and upper coal zones. This resource figure is tenuous because of the complex geology and paucity of coal measurements in the area. Additionally, the resource figure does not include coal that is folded over the flanks of laccoliths or that is buried beneath laccoliths in the region. Maximum overburden on the Cameo-Fairfield coal group east of long 107°15’ W. is shown in Figure 15. Approximately 767 million short tons are under less than 2,000 ft of overburden.

VI. Historic Mining and Production

Historic Mining

Historic coal mining on the GMUG occurred within several coalfields; the Carbondale, Somerset, Crested Butte, Baldwin, and Grand Mesa coalfields.

Historic (and recent) underground coal mining occurred in the Carbondale Coalfield. Actual mining occurred in the portion of the Carbondale field that underlies the White River NF, and some exploration activities occurred on the GMUG in upper Muddy Creek Basin. Evidence of abandoned drill roads and drill pads are still visible on the south and western flanks of Huntsman Ridge.

Historic coal mining activity in the Somerset coalfield occurred east of Crawford, along FR 710 near Beaver Reservoir, and in the East Fork of Minnesota Creek, Navajo Creek, Coal Creek, Kauffman Creek, and Cliff Creek drainages. The majority of the coal mining activity has occurred along the North Fork of the Gunnison River between the Towns of Paonia and Somerset. Coal mining has occurred in the North Fork Valley since the late 1800’s. Numerous mines have operated historically in the area including the Hawksnest, Oliver mines, Edwards, US Steel, Bear mines, Blue Ribbon, King, and Farmers.

Coal mining also occurred in the past in the Crested Butte coalfield. According to the BLM, there is anthracite coal west of Ohio Pass. The patent inholdings in the vicinity of the old ghost town Floresta, were initiated by virtue of anthracite coal patents. A small mining town existed there, and apparently mining was fairly extensive. The CGS found evidence of historic abandoned coal operations in Ohio Creek basin at the north end of Anthracite Mesa. The CGS also inventoried abandoned coal operations above the town of Gothic, in Baxter Gulch on the northwest flank of Whetstone Mountain, and in the Baldwin coalfield in Carbon Creek, in Washington Gulch, and in the Owens Creek drainage.

Historic underground coal mining also occurred in the Grand Mesa coalfield on lands within the GMUG in the early 1900s. The Colorado Geological Survey (CGS) reported two abandoned coal mines in the Kannah Creek basin on the western flank of Grand Mesa. The CGS reported little remains of the mining operations in 1996.
The CGS also found a small coal mine in the Dakota sandstone in the Bilk Creek drainage in the San Miguel basin.

**Historic Production**

Coal has been produced from the southern part of the Piceance Basin since the late 1800’s, and about 110 mines have operated at various times along the margin of the study area. Historic production compiled by the Colorado Geological Survey (Eakins and Coates, 1998) indicate that about 176 million short tons of coal have been mined from Gunnison (99), Pitkin (30), Delta (21), Mesa (18), and Garfield (8) Counties. These production figures reflect the cumulative coal mined from the southern part of the Piceance Basin because no significant amounts of coal have been mined elsewhere in the counties.

A summary of mining activity in the southern Piceance Basin prior to 1977 was compiled by Murray and others (1977). Their study indicates that about 84 million short tons of coal were mined from the southern Piceance Basin from 1864 through 1976. Most of the coal was mined from the Cameo-Fairfield coal group.

A survey of production records indicates about 94.2 million short tons of coal has been produced from 31 mines between January 1977 and December 1997. Production records examined include (1) the September 1998 COALdat database (Resource Data International, Inc., 1998); (2) the Diskette user’s handbook (MSHA, 1996); (3) Keystone Coal Industry Manuals (1978 through 1998); and (4) summaries of mineral industry activities in Colorado (Colorado Division of Mines, 1977 through 1980). These sources indicate that between 1.9 and 8.6 million short tons of coal were produced annually from the southern part of the Piceance Basin during the period from 1/1977 to 12/1997. Only six mines were producing coal at the end of 1997; these include the Bowie No. 1 (Orchard Valley mine), Bowie No. 2 mine, McClane Canyon mine, Roadside North Portal, Sanborn Creek mine, and West Elk (Mt. Gunnison) mine. The Sanborn Creek and West Elk (Mt. Gunnison) mines produced 1.6 million and 5.6 million short tons of coal, respectively, in 1997.

**VII. Current Mining Operations and Production**

Current operations within the GMUG are the Bowie #2 Mine operated by Bowie Resources Ltd., the Elk Creek Mine operated by Oxbow Mining Inc., and the West Elk Mine operated by the Mountain Coal Company, L.L.C (Fig. 16). All of these operations operate within the Somerset Coal Field (Fig. 3). Coals within this field are within the Cameo-Fairfield coal group, and are located within the Bowie Shale member and the Paonia Shale member of the Mesaverde Formation (Fig. 5). Coal beds within these geologic units have been broken down into 6 major beds, A through F (Fig. 17). Because coal beds in Colorado are highly lenticular and their minable thicknesses vary over a relatively short distance it is difficult to group the 6 identified coal beds in Fig. 17 into the coal zones within the Cameo-Fairfield Coal Group (Cameo-Wheeler, South Canyon, and Coal Ridge, see Fig. 5).
Figure 16. Location of active coal mines in GMUG.
Figure 17. Generalized stratigraphic section showing coal beds in the Somerset area (Rohrbacher, et al., 2000).
By examining cross-sections developed from drill holes throughout the region a rough correlation can be made. The coal beds labeled A-F in Fig. 17 match up as follows:

A, B, C seam = Cameo-Wheeler Coal Zone  
D, E seam = South Canyon Coal Zone  
F = Coal Ridge Coal Zone

Once again, it’s important to stress that coal seam and interburden thickness can vary dramatically over a relatively short lateral extent. These correlations are the best match, when comparing available non-proprietary data.

Currently the Bowie #2 mine operates within the B seam and the D seam. The Elk Creek Mine in the past has mined the C, B, and D seams; currently it mines the B seam. The West Elk Mine, previously mined the F seam, however current mining is the B seam. West Elk Mine also has plans for E seam mining.

VIII. Identification of Areas with Potential for Coal Development During Plan Life and Reserve Estimates

This report was prepared to aid in identifying areas with coal development potential on the GMUG in support of the Forest Plan revision underway in 2006. The following development potential estimates are for the plan life of 10 to 15 years beginning in about 2006, and are based on the most current available resource and development information.

Identification of Areas with Potential for Coal Development During Plan Life

For the purposes of defining for the Forest Plan which areas on the GMUG have coal development potential, the evaluation used the following criteria:

   a. areas with high potential for coal resource occurrence,  
   b. existing coal activity is occurring,  
   c. areas where the overburden is 3,500 feet or less  
   d. assumes advances in mining technology could occur  
   e. assumes coal prices and high coal quality will continue the demand for area coal

Based on these criteria, the areas shown on Figure 18 could be carried forward for further consideration for coal leasing in the Forest Plan. This area surrounds the currently active coal operations in the North Fork Valley, in the Somerset Coalfield, and an area to the west of existing operations north of the North fork of the Gunnison River into the grand Mesa Coalfield. The area identified contains known coal resources in the Mesaverde Formation and Group. The boundary as shown in Fig. 18 has an overburden cut-off at 3,500 feet (rather than the 3,000 feet cited by USGS). This increased overburden limit is considered to allow for improvements in technology and mining techniques. As new equipment and techniques are employed, the depths to which longwall operations are safe and manageable are likely to increase.
On the south side of the North Fork of the Gunnison River, the area with potentially developable coal reserves is defined by the river on the north, the West Elk Wilderness boundary to the south, Coal Creek to the east, and the coal outcrop on the west.

The estimated area on the GMUG having a high potential for coal development is 45,280 acres (Fig. 18). This acreage is broken into three separate polygons (A, B, C). The acreage breakdown of the individual polygons is as follows:

<table>
<thead>
<tr>
<th>Polygon ID</th>
<th>Acreage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>24,780</td>
</tr>
<tr>
<td>B</td>
<td>4,675</td>
</tr>
<tr>
<td>C</td>
<td>15,825</td>
</tr>
</tbody>
</table>

Other areas on the GMUG where coal resource potential exists but where additional info is needed:

Snowshoe Mesa in the Somerset Coalfield. This area lies to the east of Coal Creek and south of the North Fork of the Gunnison River in the North Fork. The coal companies currently operating on the GMUG acknowledge the potential for anthracite coal resources in this area. According to BLM, there is uncertainty as to the presence of mineable coal due seam splits and economic viability of mining thinner seams. Viability of these reserves needs further evaluation.

Other areas on the GMUG where coal resource potential exists, but development potential unlikely in planning period (BLM, 2004):

Crested Butte Coalfield. This field was historically developed by small mines servicing a local market. The coal seams were generally five feet and less in thickness. The remaining reserve base of anthracite coal is not believed to be sufficient to support a modern coal mining operation.

Carbondale Coalfield. The Carbondale field produced mainly coking coals. The former Mid-Continent Mine and other historic workings depleted the known reserves. Therefore, no activity is expected in this area.

Grand Mesa Coalfield (west of Leroux Creek). BLM believes that low coal quality in the Grand Mesa coalfield, along with deep overburden and inaccessibility to coal handling and transportation facilities will preclude activity in this area during the life of the Forest Plan.
Figure 18. Map showing Area of with potentially developable coal.
Tongue Mesa coalfield. Coals in the Fruitland formation occur as part of the Tongue Mesa field. Small “dog hole” mines were opened along the coal outcrop. BLM issued a license to mine on private surface with federal minerals in the field that was last used in 1996. The Tongue Mesa field is heavily faulted, is in a remote area with limited access. Therefore, no activity is expected in this area.

Reserve Estimates for Area with Development Potential

Gross Reserve Estimates

The majority of currently active coal operations on the GMUG are within the Somerset quadrangle. In 2000, the USGS published a report on the coal reserves within the Somerset quad (Rohrbacher et al., 2000), this report is summarized below in Table 6. It provides a gross estimate of the coal reserves in the vicinity of the West Elk, Elk Creek, and Bowie #2 mines.

Table 6. Summary of original, mined, and available coal resources within the Somerset 7.5’ Quadrangle as of 1998 (Rohrbacher et al., 2000, after Eakins et al., 1998) (numbers in millions of tons)

<table>
<thead>
<tr>
<th>Resource Category</th>
<th>Lower B</th>
<th>B</th>
<th>C</th>
<th>Lower D</th>
<th>D</th>
<th>E</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original coal resource</td>
<td>95.2</td>
<td>1202.5</td>
<td>417.6</td>
<td>280.7</td>
<td>666.4</td>
<td>425.4</td>
<td>3087.8</td>
</tr>
<tr>
<td>Coal Mined or lost during mining</td>
<td>0.0</td>
<td>222.6</td>
<td>25.6</td>
<td>0.0</td>
<td>5.3</td>
<td>21.9</td>
<td>275.4</td>
</tr>
<tr>
<td>Remaining coal</td>
<td>95.2</td>
<td>979.9</td>
<td>392.0</td>
<td>280.7</td>
<td>661.1</td>
<td>403.5</td>
<td>2812.4</td>
</tr>
<tr>
<td>Land-use restrictions</td>
<td>0.0</td>
<td>0.1</td>
<td>0.2</td>
<td>0.9</td>
<td>0.4</td>
<td>0.3</td>
<td>1.9</td>
</tr>
<tr>
<td>Technological restrictions</td>
<td>36.4</td>
<td>198.3</td>
<td>0.9</td>
<td>175.9</td>
<td>72.8</td>
<td>0.3</td>
<td>484.6</td>
</tr>
<tr>
<td>Available coal resource</td>
<td>58.8</td>
<td>781.5</td>
<td>390.9</td>
<td>103.9</td>
<td>587.9</td>
<td>402.9</td>
<td>2325.9</td>
</tr>
</tbody>
</table>

Given that Table 6 reflects data as of 1998 it would be a fair estimate that available coal resources within the Somerset 7.5’ Quadrangle is still over 2.2 billion short tons. However it is important to recognize that these numbers are total for all coal beds greater than 2.3 ft thick. Only a fraction of that coal could be mined economically because many beds are either less than 3.5 ft thick or more than 14 ft thick (range favorable for longwall operations). Additional coal would also be restricted from mining because of discontinuous beds, left in the ground as pillars for roof support, or bypassed due to mining of adjacent strata.

Refined Reserve Estimates

Although the USGS has published many reports calculating the reserves in and around the GMUG, a more refined reserve estimate is needed to reflect the reserves within the area highlighted in Figure 18.

In Hettinger, 2000, the USGS included spreadsheet data containing lithologic logs of explorations hole in the Somerset quadrangle. Also included in this report were GIS
layers showing thickness of net coal and overburden. This coal resource data was “clipped” to the area having a high potential for coal development. Using GIS allowed the summation of coal reserves only for the area with high potential for coal development. When totaled, the amount of coal reserves for all coal beds (any thickness) is approximately 3025 million tons. However, this estimate, due to the fact it contains all coal beds and has no land-use restrictions is not realistic. Since the USGS typically studies large regions with dispersed exploration logs, they typically extrapolate coal bed thickness over large areas. Therefore, their estimates of coal reserves are typically high.

Therefore, an estimation of recoverable and mineable coal reserves for the area identified in Figure 18 will be done using a method accepted by BLM. BLM recommend assuming a thickness of mineable coal for the area to be 20 feet (to account for multiple seams of mineable thickness), a value of 1,830 tons per acre per foot of height. Using these parameters, the area in Figure 18 contains an estimated 1.65 billion tons of mineable coal, equating to 829 million tons of recoverable coal.

IX. Compliant and Super-Compliant Coal Reserves

The existing coal production from mines operating on federal leases within the GMUG produce Clean Air Act ‘compliant’ and ‘super-compliant’ coal, meaning the coal quality meets or exceeds standards of the Act for clean burning coal (i.e. 'compliant' coal contains between 1.0 and 1.2 pound of sulfur dioxide per million Btu, whereas 'super-compliant' coal contains less than 1.0 lbs of sulfur dioxide per million Btu). The Energy Policy Act of 2005 contains provisions (Section 437) for the Secretary of Interior, in consultation with the Secretary of Agriculture to inventory coal resources, including identifying areas where resources of compliant and super-compliant coal exist. As of March 2006, this inventory process had not been formally initiated by the Secretary of Interior.

Recognizing that currently developed coal resources within the GMUG meet Clean Air Act standards, available USGS data was reviewed to generally assess where compliant and super-compliant coal resources may exist on the GMUG.

According to data presented by Affolter (2000), the five coalfields on the GMUG contain the range of non-compliant to super-compliant coals. All of the coalfields contain some reserves that would at least be compliant coal.

X. Production Estimates

In 2005, according to the Colorado Division of Minerals and Geology, the Bowie mines, the Elk Creek Mine, and the West Elk Mine collectively produced a total of 16,221,235 tons of coal, which was over 40% of coal produced from all Colorado coal mines.

According to the Department of Energy’s 2004 Annual Energy Outlook with Projections to 2025, the demand for western low-sulfur coal (like what is found in the Somerset area on the GMUG) is likely to increase annually by 2.2 percent. BLM forecasts that 5 to 10
% of coal reserves in the Somerset coalfield will be recovered over the next 10 to 15 years.

Although demand for coal is projected to increase, yearly production at the mines is likely to remain the close to the existing rate of approximately 16 million tons per year. Production outputs are determined through several factors. One of these factors is the rail-line, a spur off the main-line in Delta, CO, operated by Union Pacific which hauls the coal. This spur-line’s sole purpose is supporting the 3 mines in the Somerset area. At the present time it is unlikely that the rail-line itself, due to train availability, could support an increase in mine production. Other limits include physical bottlenecks at the mine facilities such as conveyor and train load-out capacities. Another factor affecting production is the amount of coal that is allowed to be stockpiled at the individual mine sites.

**XI. Summary**

The Grand Mesa, Uncompahgre, and Gunnison National Forests contains several geologic formations that contain coal, or have a high potential for the geologic occurrence of coal within five currently recognized coalfields; the Carbondale, Crested Butte, Somerset, Grand Mesa, and Tongue Mesa. Based on evaluation completed by the USGS, the lands within the GMUG considered to have coal resource potential are in areas where underlying strata are likely to have accumulated in a coal-forming environment, and the potential coal-bearing rocks are less than 6,000 ft deep. The coal resources on the GMUG occur primarily in the Upper Cretaceous Dakota Formation, Mesaverde Formation and Group, and the Fruitland Formation.

Using input and information from BLM, the GMUG estimates that coal development would occur in an area generally surrounding existing operations in the Somerset coalfield and into eastern portions of the Grand Mesa coalfield in the next 10 to 15 years. This area encompasses about 45,280 acres and contains an estimated 829 million tons of recoverable coal reserves.

Currently the 3 mines in the Somerset area collectively produce ~16 million tons of coal per year. This production rate will likely remain stable and could increase slightly over the next 10 to 15 years.
References Cited


