Text to accompany:

Open-File Report 78-057

1978

COAL RESOURCE OCCURRENCE MAPS OF THE FERRIS LAKE QUADRANGLE, CARBON COUNTY, WYOMING

(Report includes 4 plates)

Prepared for:

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

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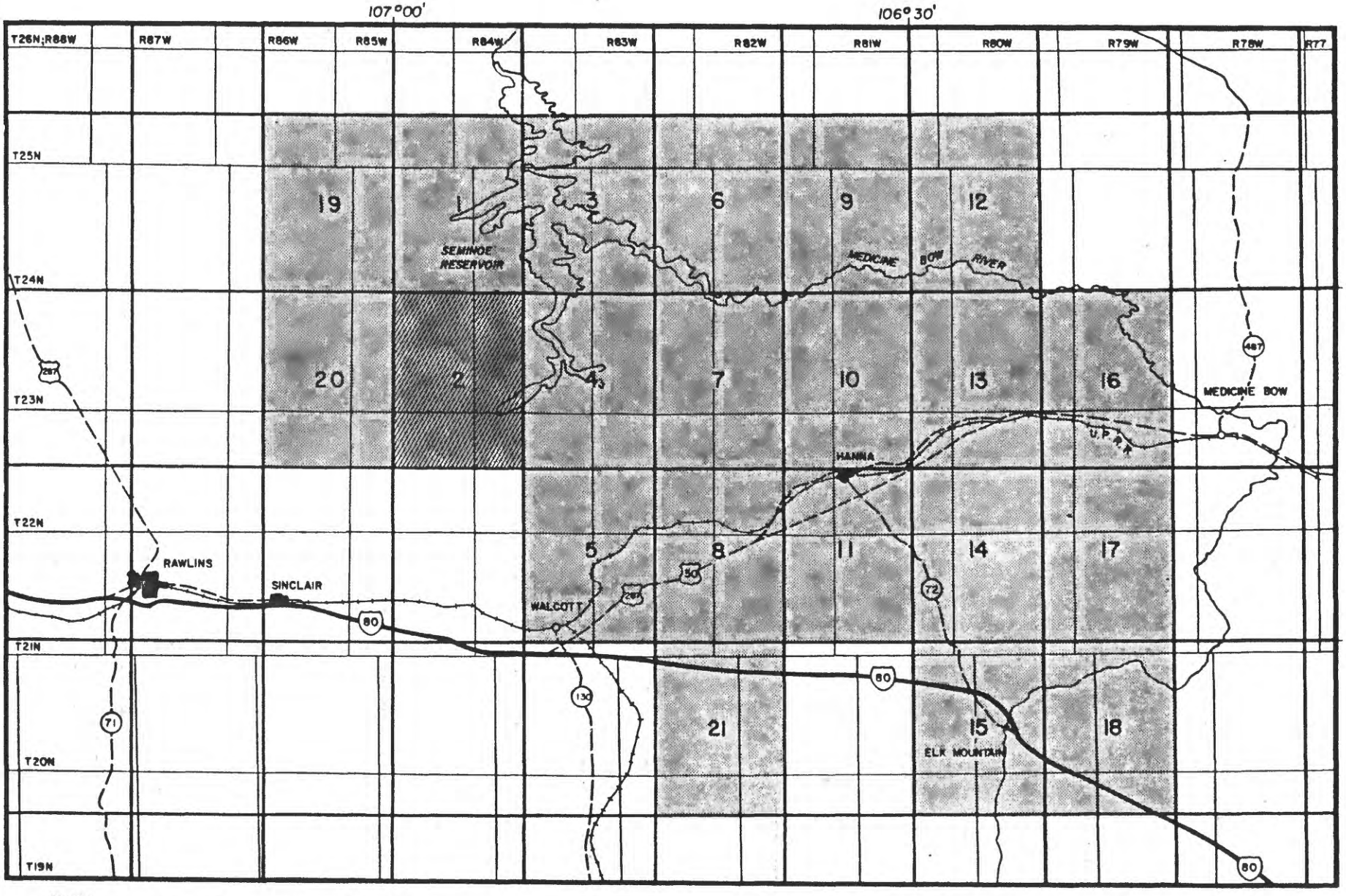

Ferris Lake quadrangle (2)

Scale: 1:446,000

Figure 1. - Map of Hanna and Carbon Basins study area

INTRODUCTION

Purpose

This text is to be used along with the accompanying Coal Resource Occurrence (CRO) Maps of the Ferris Lake quadrangle, Carbon County, Wyoming (4 plates; U.S. Geol. Survey Open-File Report 78-057), prepared by Texas Instruments Incorporated under contract to the U.S. Geological Survey. This report was prepared to support the land planning work of the U.S. Bureau of Land Management's Energy Minerals Activities Recommendation System (EMARS) program, and to contribute to a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA's) in the western United States. The Coal Resource Occurrence maps for this quadrangle cover part of the western portion of the KRCRA of the Hanna coal field. The lack of correlatable coal of Reserve Base thickness in this quadrangle, as indicated on the CRO maps, preclude the construction of Coal Development Potential (CDP) maps which normally accompany this type of report.

Acknowledgment

Texas Instruments Incorporated acknowledges the cooperation of the Rocky Mountain Energy Company, a wholly owned subsidiary of the Union Pacific Railroad Company, in supplying copies of survey sheets, drillers reports, electric logs, and coal analyses from the Union Pacific coal inventory program.

The Hanna and Carbon coal basins were studied as part of the Union Pacific coal inventory program and test drilling was conducted in 1970-1971. More than 650 Union Pacific coal drill holes have been evaluated as part of this contract study of 21 quadrangles in Carbon County, Wyoming, and the results of 230 coal analyses have been incorporated into these reports.

Location

The Ferris Lake 7 ½-minute quadrangle is in the northwestern part of Carbon County, Wyoming. The center of the quadrangle is approximately 19 miles (30 km) northeast of Rawlins and 20 miles (32 km) northwest of Hanna, Wyoming (Figure 1).

Accessibility

Seminoe Road, classified as a secondary highway, passes through the extreme northwest part of the quadrangle and connects with State Highway 220 to the north and State Highway 487 to the northeast. To the south, it connects with Interstate Highway 80 at Sinclair, Wyoming. Several local unimproved dirt roads, south of Seminoe Road, provide access to the rest of the quadrangle.

The main east-west track of the Union Pacific Railroad is 11 miles (18 km) south of the center of quadrangle and passes through the towns of Hanna, Sinclair, and Rawlins.

Physiography

The quadrangle is on the western edge of the Hanna structural basin which, in this area, is bounded on the west by the Haystack Mountains. The topography is typical of high plains grasslands with undulating hills and a relief of less than 500 feet (152 m). The major drainage is the North Platte River which enters the quadrangle in the southwest corner and flows east-northeast into an arm of Seminoe Reservoir. Tributary streams dissect the upland areas as they flow to the river and reservoir. Elevations within the quadrangle range from 6,358 feet (1,938 m) at the Seminoe Reservoir shoreline to over 6,840 feet (2,085 m) in sec. 23, T. 23 N., R. 85 W. at the crest of a fairly prominent south-southeasterly trending ridge.

Climate

The climate is semiarid with a mean annual temperature of 43°F (6°C) and extremes ranging from 98°F to -31°F (37°C to -35°C) as recorded at the Seminoe Dam Weather Substation (U.S. Dept. of Interior, 1975). Average annual precipitation at that location is 12 inches (30 cm). Forty-two percent of the precipitation falls as rain in April, May, and June, with the major portion of the remainder falling as snow in the winter months. High winds commonly occur throughout most of the year. The average growing season is generally 60 to 70 days, from late April to early June. High temperatures and lack of precipitation restrict vegetative growth in late summer and frosts occur from September through April.

Land Status

The quadrangle is in the extreme western part of the Hanna and Carbon Basins Known Recoverable Coal Resource Area. The Federal Government owns slightly less than 50 percent of the coal rights in the quadrangle; the remaining 50 percent is privately owned. Approximately 20 percent of the area of the quadrangle is included in the KRCRA, and within this region about 45 percent of the land is federally owned. There are no known active leases, permits or licenses, and no known active mining operations. Plate 2 of the CRO maps illustrates the ownership status of land in the quadrangle and the boundary of the KRCRA.

GENERAL GEOLOGY

Previous Work

Dobbin, Bowen, and Hoots (1929) mapped the Ferris Lake quadrangle as part of their study of the geology and coal and oil resources of the Hanna and Carbon Basins. Berta (1951) reviewed the general stratigraphy and structure of the Hanna coal field. Weitz and Love (1952) compiled a geological map of Carbon County which incorporates available data, published and unpublished, to that date. The geology of the quadrangles adjoining on the west, north, and east has been mapped more recently by Merewether (1973), Merewether (1972), and Blanchard and Comstock (1976), respectively.

Stratigraphy

Rocks exposed in the quadrangle range in age from Late Cretaceous to Quaternary. Coal beds occur in the lower part of the Medicine Bow Formation of Late Cretaceous age. Coal is also found in the subsurface in the upper part of the Mesaverde Group, also of Late Cretaceous age. The oldest rocks are exposed in the southwest corner on the upthrown, or south side of the Cedar Ridge fault. Dobbin, Bowen, and Hoots (1929) allocated these rocks to the Upper Cretaceous Mesaverde Formation. Gill, Merewether, and Cobban (1970, p. 5) elevated the Mesaverde to group status and defined four formations within this group. By comparing the geology along the common border between the Ferris Lake quadrangle and the Lone Haystack Mountain quadrangle to the west it is seen that the Mesaverde Formation rocks mapped by Dobbin, Bowen, and Hoots (1929) comprise parts of the Almond Formation and

the Pine Ridge Sandstone of the Mesaverde Group rocks mapped by Merewether (1973). The Pine Ridge Sandstone unit in this area is 140 feet (43 m) thick, is nonmarine, and consists of dark-gray carbonaceous partly silty shale, medium- to dark-gray carbonaceous sandy siltstone, and light- to medium-gray very fine grained carbonaceous silty sandstone. The unit contains coal but no coal beds are exposed in the Ferris Lake quadrangle. The Almond Formation conformably overlies the Pine Ridge Sandstone, in this area is 565 feet (172 m) thick, and consists of medium- to dark-gray partly carbonaceous silty shale, light- to medium-gray sandy siltstone, and light- to medium-gray fine-grained partly silty sandstone. Coal occurs in the Almond Formation; no coal beds are exposed in the Ferris Lake quadrangle but one coal bed in the subsurface was intersected by a well (Plate 3A). The depositional environment of the Almond sediments varies from fluviatile at the base, through brackish-water, to nearshore marine at the top, representing a transition from the underlying nonmarine sediments to the overlying marine Lewis Shale.

The Upper Cretaceous Lewis Shale crops out along the western margin of the Ferris Lake quadrangle. The formation is entirely marine and conformably overlies and intertongues with the Almond Formation. Immediately to the west in the adjoining quadrangle Merewether (1973) reports a thickness of 2,210 feet (674 m) of Lewis Shale. The well drilled in this quadrangle in the northeast of sec. 22, T. 23 N., R. 85 W. intersected 2,750 feet (838 m) of Lewis Shale. The formation consists of medium- to dark-gray silty shale, gray sandy siltstone, and light-gray to dusky-yellow fine-grained silty sandstone.

The Fox Hills Formation overlies the Lewis Shale with a conformable and gradational contact. Dobbin, Bowen, and Hoots (1929) did not map the formation in this quadrangle but they state (1929, p. 23) that "the Fox Hills sandstone of eastern Wyoming is almost certainly represented in the uppermost part of the Lewis Shale." In the adjoining quadrangle to the west Merewether (1973) mapped a thickness of more than 600 feet (183 m) for the formation; in the Seminoe Dam SW quadrangle to the northwest, Merewether (1972) measured a thickness of 470 feet (143 m); in this quadrangle the well drilled in the northeast of sec. 22, T. 23 N., R. 85 W. intersected 814 feet (248 m). The Fox Hills Formation consists of light- to medium-gray very

fine grained to fine-grained partly silty sandstone, medium- to dark-gray partly silty shale, and gray sandy siltstone. Thin beds of impure coal occur in the formation elsewhere but are not exposed in this quadrangle, nor were any intersected in the subsurface. The formation is of Late Cretaceous age and its sediments reflect a transitional depositional environment between the deep water marine environment of the Lewis Shale and a lagoonal and continental environment as the Cretaceous sea withdrew from the area of southern Wyoming.

The Upper Cretaceous Medicine Bow Formation is exposed over two-thirds of the Ferris Lake quadrangle as a broad belt of continental-type sediments trending north and northwest and dipping toward the east. Bowen (1918) named and described the formation from exposures along the North Platte River about 10 miles (16 km) north-northeast of the center of this quadrangle, and at that locality the formation is about 6,200 feet (1,890 m) thick. A similar thickness is present in this quadrangle; Dobbin, Bowen, and Hoots (1929) mapped a 4½-mile-wide belt of sediments at the center of the quadrangle with an average dip about 16° easterly. The lower part of the formation consists of brown massive to cross-bedded sandstones which are overlain by an intermediate group of gray to gray-black carbonaceous silty shales, brown fine-grained thin-bedded sandstones, and white massive sandstones. The top part of the formation consists of light-gray coarse-grained massive friable sandstones interbedded with thick beds of dark-gray shale. In the lower part of the formation, 19 coal beds and numerous local coal lenses have been mapped at outcrops or intersected in the subsurface by drill holes (Plates 1 and 3).

The lower part of the Ferris Formation of Late Cretaceous-Early Paleocene age is exposed along the eastern margin of the quadrangle. The formation was named and measured by Bowen (1918) from exposures between the old Ferris Ranch on North Platte River (northwest sec. 33, T. 23 N., R. 84 W., covered by the waters of Seminoe Reservoir) and a hilltop to the east in the adjoining Pats Bottom quadrangle (sec. 28, T. 23 N., R. 83 W.). Whereas the total thickness of the formation is about 6,500 feet (1,981 m), only the lower 2,200 feet (671 m) of sediments are exposed in the Ferris Lake quadrangle. The formation is conformable with the underlying Medicine Bow Formation and consists of a thick sequence of continental sediments that can be

divided into two parts. The lower unit is of Late Cretaceous age, about 1,100 feet (335 m) thick, and includes buff to yellow coarse-grained friable massive sandstones and dark-gray shales, interbedded with conglomerates that occur as pockets, lenses, and thin irregular beds. The upper unit is of Early Paleocene age, 5,400 feet (1,646 m) thick, conformable with the lower unit, and consists of gray, brown and yellow sandstones interstratified with numerous thick beds of coal. The basal 1,100 feet (335 m) of the upper unit is exposed in the Ferris Lake quadrangle. The coal beds occur higher in the succession, in the Pats Bottom quadrangle to the east.

The North Park Formation crops out in the south-central part of the Ferris Lake quadrangle. Dobbin, Bowen, and Hoots (1929) tentatively classified the formation as Miocene age but McGrew (1951), on the basis of mammalian fauna, assigns an early Pliocene age. In this quadrangle the formation is only a few hundred feet thick, rests unconformably on older formations, and consists of unconsolidated white fine sands, sandy clays and marls, with occasional interbedded gray thin-bedded limestones.

Quaternary terrace gravels occur along the banks of the North Platte River, as much as 300 feet (91 m) above the present level of the river. Quaternary alluvium occurs in North Platte River valley and as scattered deposits in the tributary drainage channels.

Structure

The Ferris Lake quadrangle is located on the western edge of the intermontane Hanna Basin. This basin is comparatively small in areal extent, but very deep. The basin extends about 40 miles (64 km) east-west, 25 miles (40 km) north-south, and in its deepest portion in the southeastern part of T. 24 N., R. 82 W. contains approximately 30,000-35,000 feet (9,140-10,670 m) of sediments overlying crystalline basement. Data from outcrop mapping and oil well drilling within the basin indicate that there are 10,000 feet (3,048 m) of sediments overlying Precambrian rocks at the northwest margin of the Ferris Lake quadrangle and more than 20,000 feet (6,096 m) at the eastern margin.

The confines of the present basin were primarily defined during the Laramide Orogeny. Bordering highlands of the basin were raised and deformed while sediments in the basin accumulated rapidly. The borderlands today are

characterized by complex folding and faulting while, within the basin, mild deformation is expressed by a few broad folds and normal faults. The Late Cretaceous sea made its final withdrawal from the area in Fox Hills time and the depositional environment of basin sediments changed from marine to continental.

In the Ferris Lake quadrangle the exposed rocks display uniform bedding, predominantly north-south strikes, and easterly dips which flatten to the east. The only fold mapped in the quadrangle is in the extreme southwest part where a portion of the east flank of the Cedar Ridge anticline is exposed. This structure is bounded on the northeast flank by the Cedar Ridge fault, a normal fault that has downthrown sediments on its northeast side.

COAL GEOLOGY

Previous Work

The coal deposits of the Hanna and Carbon Basins have been studied by Veatch (1907); Dobbin, Bowen, and Hoots (1929); Berryhill and others (1950); and Glass (1972 and 1975).

Twenty-six coal analyses have been published since 1913 for coal beds of the Mesaverde Group and of the Medicine Bow, Ferris, and Hanna Formations within the Hanna and Carbon Basins (Appendices 1 and 2). Samples collected and analyzed prior to 1913 have not been considered in this report (American Society for Testing and Materials, 1977, p. 218). An average analysis of coal beds in each of these four stratigraphic units has also been calculated for the 230 analyses of the Union Pacific coal inventory program (Appendices 1 and 2). An apparent rank has been calculated from the average analysis for coal in each of the four stratigraphic units. A standard rank determination (ASTM, 1977, p. 216, sec. 6.2.2) cannot be made because: (a) some of the published analyses are from weathered coal samples, and (b) the procedure and quality of sampling for the Union Pacific coal evaluation program are not known.

Glass (1975) and U.S. Department of Interior (1975) published not only proximate coal analyses for 17 samples collected in the Hanna Basin, but also assays for 10 major and minor oxides, 12 major and minor elements, and up to

32 trace elements. Glass (1975, p. 1) stresses that his assay data are insufficient to characterize the chemical and physical properties of any individual coal bed, but that this will be possible at a later date as the study continues. Assay results of the 17 Hanna Basin samples show that these coals contain no significantly greater amounts of trace elements of environmental concern than are found in the 42 samples collected in six other Wyoming coal fields.

General Features

Dobbin, Bowen, and Hoots (1929) mapped 19 coal beds in the Ferris Lake quadrangle (Plate 1). In addition, 23 coal beds have been identified in the subsurface from drill-hole data. All 42 coal beds are shown on the coal data sheets (Plates 3 and 3A). Data from measured outcrops and drill holes indicate that all of the coal beds are very thin; consequently, isopach, structure contour, and other CRO maps were not constructed.

Average analyses and apparent ranks of coal beds in the Hanna and Carbon Basins are shown in Appendices 1 and 2. Analyses of samples from two coal beds in the Medicine Bow Formation are shown in Appendix 3. The samples were taken during the Union Pacific coal inventory program from two drill holes in the Ferris Lake quadrangle.

Mesaverde Coal Beds

No Mesaverde coal beds are exposed in the quadrangle, but one coal bed (bed A) near the top of the Almond Formation was intersected in the subsurface by a well (Plate 3A). Coal bed A is 3 feet (0.9 m) thick in the drill hole.

Medicine Bow Coal Beds

Sixteen coal beds and three local coal lenses which crop out in the western half of the quadrangle, dip eastward into the Hanna Basin at angles ranging from 9^{o} to 22^{o}. These coal outcrops, and 22 additional coal lenses identified in the subsurface, are all in the lower half of the formation. Thicknesses of the coal beds range from 0.8 feet (0.2 m) to 9 feet (2.7 m); most of the thicknesses are less than 3 feet (0.9 m). The 9 foot (2.7 m) thick coal (bed 7) was intersected by drill hole 22 in sec. 9, T. 23 N., R. 85 W.

COAL RESOURCES

Previous Work

Coal reserves of the Hanna and Carbon Basins have been estimated or calculated by Dobbin, Bowen, and Hoots (1929), Berryhill and others (1950), and Glass (1972).

Method of Calculating Resources

Data from Dobbin, Bowen, and Hoots (1929), oil and gas well logs, and coal drill holes (written communication, Rocky Mountain Energy Company, 1977) were used to construct the Coal Data Map (Plate 1) and the Coal Data Sheets (Plate 3 and 3A) for the Ferris Lake quadrangle. U.S. Geological Survey reviewed these three plates and concluded that no individual coal bed or coal zone on unleased Federal land within the KRCRA was thick enough and extensive enough to be selected for coal reserve evaluation. However, the calculation of coal Reserve Base was requested for the isolated or noncorrelatable data points in the quadrangle.

The information on Plates 1, 3, and 3A served as the basis for estimating coal resources in areas of sparse, isolated coal data, insufficient to construct isopach and structure contour maps. The estimates of coal resources within the KRCRA boundary were made in accordance with the classification system given in U.S. Geological Survey Bulletin 1450-B and by following methods suggested by the U.S. Geological Survey:

- All outcrop measurements and subsurface measurements are considered as one planar unit.
- All coal deeper than 3,000 feet (914 m) is excluded.
- Coal bed thicknesses from surface mapping are true thicknesses; thicknesses from subsurface data are apparent thicknesses. No corrections were made for coal bed thicknesses to compensate for the dip of the containing rocks.
- Coal resources are calculated for a single coal bed at least 5 feet (1.5 m) thick or for an aggregate thickness of multiple coal beds each at least 5 feet (1.5 m) thick.
- Areal subsurface distribution of coal from outcrop data points is determined by constructing an arc with a radius equal to one-half the length of the outcrop within a five-foot or greater thickness limit, and centered on a point midway on the outcrop.

- Areal subsurface distribution for a subsurface data point with a five-foot or greater thickness of coal is defined by a circle with a radius of 0.5 mile (805 m).

- Coal resources at depths of less than 200 feet (61 m) are tabulated separately from coal resources at depths between 200 and 3,000 feet (61 and 914 m).

When estimating coal resources in areas of sparse, isolated data some data require a unique solution. For example:

- Where a coal bed outcrop has data points with a coal thickness less than 5 feet (1.5 m), a 5-foot (1.5 m) cut-off point is interpolated, and the resulting segments with values greater than 5 feet (1.5 m) are used to generate arcs (radii equal to half the partial outcrop length).

- Where areas within outcrop segment arcs and areas within 0.5 mile (805 m) of a drill hole coincide, the areas are combined, and drill hole coal thickness values are averaged with outcrop coal thickness values.

- When evaluating multiple coal beds of an isolated or noncorrelatable data point, the interburden between subsurface coal beds may be too great to allow the aggregate thickness of coal to be considered as one planar unit. In such instances, a conservative judgment is made and the resources for each bed are calculated separately and then totaled.

Results

The coal resource acreage from isolated or noncorrelatable data points was determined by planimetering the areas which occurred in unleased Federal land within the KRCRA boundary. Coal Reserve Base values were obtained by multiplying the coal resource acreage for each section of Federal land by the average thickness of the coal bed, or the average aggregate thickness of multiple coal beds, times a conversion factor of 1,770 short tons (1,606 t) of coal per acre-foot for subbituminous coal. Reserve Base values are shown on Plate 2 and are considered to be in the inferred reliability category of identified coal resources.

The total coal Reserve Base of unleased Federal lands within the KRCRA in the Ferris Lake quadrangle is 0.07 million short tons (0.06 million t) of inferred resources with 0-200 feet (0-61 m) overburden. Coal reserves were not calculated and, therefore, the coal development potential could not be assessed. The coal Reserve Base data are for rough inventory estimates only.

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Appendix 1. — Average analyses of coal samples from the Hanna and Carbon Basins

Source of Data	Number of samples (1)	Total footage Ft	in	Average analyses — as-received basis, Percent: Moisture	Ash	Volatile matter	Fixed carbon	Sulfur	Btu/lb	Calorific Value, Btu/lb, Moist, mineral-matter-free basis (2)	Apparent rank of coal (3)
Published analyses	26	318	6	12.5	7.1	36.2	44.2	0.6	10,553	11,438	sub A or hvCb
Union Pacific coal inventory program	230	1,605	10	12.48	8.74	35.12	43.68	0.82	10.398	11,494	sub A or hvCb

Notes:

(1) Published data from USBM (1931, p. 40-45, sample nos. 2623, 2624, 22800, 22972, 93486, 93488, 93541, A14123, A14124); Glass (1975, p. 16-19, sample nos. 74-23 to 74-34, inclusive); Dept. of Interior (1975, p. 38, sample nos. D169597-99, D169607-08). Union Pacific coal inventory program data from company files, Rocky Mountain Energy Company (1977).

(2) Moist, mineral-matter-free Btu/lb calculated from average analyses, as-received basis, using Parr formula (ASTM, 1977, p. 216, sec. 8.2).

(3) Sub A — subbituminous A; hvCb — high volatile C bituminous (ASTM, 1977, p. 215, sec 4.2, and p. 217).

[To convert feet and inches to meters, multiply feet by 0.3048 and inches by 0.0254. To convert Btu/lb to kilojoule/kilogram, multiply by 2.326].

Appendix 2. — Average analyses of coal grouped by coal-bearing formations in the Hanna and Carbon Basins

Source of data	Formation or Group	Number of samples (1)	Total footage Ft	in	Average analyses — as-received basis: Percent Moisture	Ash	Volatile matter	Fixed carbon	Sulfur	Btu/lb	Calorific Value, Btu/lb Moist, mineral-matter-free basis (2)	Apparent rank of coal (3)
Published analyses	Mesaverde	1	4	0	14.1	7.8	36.5	41.6	1.1	10,290	11,251	sub A or hvCb
	Medicine Bow	2	10	1	12.8	3.8	33.3	50.2	0.8	11,050	11,534	hvCb
	Ferris	10	93	1	.13.0	8.3	34.3	44.3	0.4	9,970	10,956	sub A or hvCb
	Hanna	13	211	4	12.0	6.6	38.1	43.3	0.7	11,946	11,797	hvCb
Union Pacific coal inventory program	Mesaverde	13	70	5	9.45	8.41	35.42	46.72	0.77	11,112	12,237	hvCb
	Medicine Bow	16	93	4	13.09	4.03	35.46	47.42	0.80	10,927	11,446	sub A or hvCb
	Ferris	114	863	1	12.69	7.96	34.39	44.97	0.44	10,331	11,309	sub A or hvCb
	Hanna	87	579	0	12.51	10.67	35.96	40.85	1.33	10,280	11,640	hvCb

Notes:

(1) Published data from USBM (1931, p. 40-45, sample nos. 2623, 2624, 22800, 22972, 93486, 93488, 93541, A14123, A14124); Glass (1975, p. 16-19, sample nos. 74-23 to 74-34, inclusive); Dept. of Interior (1975, p. 38, sample nos. D169597-99, D169607-08). Union Pacific coal inventory program data from company files, Rocky Mountain Energy Company (1977).

(2) Moist, mineral-matter-free Btu/lb calculated from average analyses, as-received basis, using Parr formula (ASTM, 1977, p. 216, sec. 8.2).

(3) Sub A — subbituminous A; hvCb — high volatile C bituminous (ASTM, 1977, p. 215, sec. 4.2, and p. 217).

[To convert feet and inches to meters, multiply feet by 0.3048 and inches by 0.0254. To convert Btu/lb to kilojoule/kilogram, multiply by 2.326].

Appendix 3. — Coal analyses, Ferris Lake quadrangle

Drill hole	Location			Coal bed	Sample interval				Sample width		Analyses — as-received basis					
					From		To				Percent					
	Sec.	Twp.	Rge.		Ft	in	Ft	in	Ft	in	Moisture	Ash	Volatile matter	Fixed carbon	Sulfur	Btu/lb
19	15	23N	85W	9	429	8	433	4	3	8	13.51	4.44	33.94	48.11	0.41	10,547
22	9	23N	85W	7	55	2	60	4	5	2	16.99	6.04	32.49	44.48	0.70	9,889

Data from Rocky Mountain Energy Company (1977).

[To convert feet and inches to meters (m), multiply feet by 0.3048 and inches by 0.0254. To convert Btu/lb to kilojoules/kilogram (kJ/kg), multiply by 2.326].