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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE SULPHUR CREEK RESERVOIR QUADRANGLE, UINTA COUNTY, WYOMING

[Report includes 9 plates]

Prepared for

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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This report has not been edited for conformity with U.S. Geological Survey editorial standards or stratigraphic nomenclature.

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INTRODUCTION

Purpose

This text is to be used in conjunction with Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) Maps of the Sulphur Creek Reservoir quadrangle, Uinta County, Wyoming. This report was compiled to support the land planning work of the Bureau of Land Management to provide a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA's) in the western United States. This investigation was undertaken by Dames & Moore, Denver, Colorado, at the request of the U.S. Geological Survey under contract number 14-08-0001-17104. The resource information gathered for this report is in response to the Federal Coal Leasing Amendments Act of 1976 (P.L. 94-377). Published and unpublished public information available through May, 1978, was used as the data base for this study. No new drilling or field mapping was performed, nor was any confidential data used.

Location

The Sulphur Creek Reservoir quadrangle is located in southwestern Uinta County, Wyoming approximately 5 airline miles (8 km) southeast of the town of Evanston and 18 airline miles (29 km) west of the town of Robertson, Wyoming. Aspen and Altamont, former Union Pacific Railroad stations, are located on the railway in the east-central part of the quadrangle. The former townsites of Beartown and Hilliard are located in the southwestern part of the quadrangle near Sulphur Creek Reservoir. A few houses and buildings are scattered along Sulphur Creek valley and on Hilliard Flat.

Accessibility

Wyoming Highway 150, connecting the Wasatch National Forest to the south in Utah with Evanston, Wyoming, crosses the southwestern corner of the quadrangle. Interstate Highway 80 passes through Evanston to the northwest and through the Guild Hollow quadrangle to the north. An improved light-duty road crosses Hilliard Flat and the southern part of the quadrangle connecting Wyoming Highway 150 and the townsite of Piedmont east of the quadrangle boundary. A second improved light-duty road parallels the Union Pacific Railroad through the central and eastern parts of the quadrangle connecting Wyoming Highway 150 and Interstate Highway 80 to the northeast of the quadrangle boundary. Numerous unimproved dirt roads and trails provide access for the remainder of the quadrangle. The historical Emigrant Trail (California or Mormon Trail) crosses east-west through the central part of the quadrangle (U.S. Bureau of Land Management, 1977; Wyoming State Highway Commission, 1978).

The main east-west line of the Union Pacific Railroad crosses through the central part of the quadrangle. This line provides railway service across southern Wyoming, connecting Ogden, Utah, to the west, with Omaha, Nebraska, to the east (U.S. Bureau of Land Management, 1978).

Physiography

The Sulphur Creek Reservoir quadrangle lies in the southeastern part of the Wyoming Overthrust Belt. The landscape within the quadrangle is characterized by steep ridges, numerous canyons and ravines, and large flat valleys. Hilliard Flats, a wide flat-lying valley, covers the southwestern part of the quadrangle and the valley formed by Sulphur Creek and the Bear River lies on the west-central edge of the quadrangle. Oyster Shell Ridge, bordering the northern and eastern sides of Sulphur Creek Reservoir in the south-central part of the quadrangle, rises approximately 400 feet (122 m) above Hilliard Flat. Knight Ridge, in the center of the quadrangle, rises to an elevation of 7,941 feet (2,420 m) above sea level. Altitudes in the quadrangle range from less than 6,960 feet (2,121 m) on the Bear River along the west-central edge of the quadrangle to over 8,100 feet (2,469 m) on Aspen Mountain in the east-central part of the quadrangle.

Albert Creek, which flows north into Little Muddy Creek and the Green River drainage system, drains the northeastern quarter of the quadrangle. Sulphur Creek and its tributaries drain the southern third of the quadrangle while Stowe Creek and its tributaries drain the central and northwestern parts of the quadrangle. Both flow westward into the Bear River and the Great Basin drainage system. Numerous springs occur throughout the quadrangle and there are several small lakes or reservoirs along the southeastern edge of the quadrangle. Sulphur Creek Reservoir lies in the south-central part of the quadrangle on the northern edge of Hilliard Flat (U.S. Bureau of Land Management, 1971 and 1978).

Climate and Vegetation

The climate of southwestern Wyoming is semiarid, characterized by low precipitation, rapid evaporation, and large daily temperature variations. Summers are usually dry and mild, and winters are cold. The annual precipitation averages approximately 10 inches (25 cm) and is fairly evenly distributed throughout the year (Wyoming Natural Resources Board, 1966).

The average annual temperature of the area is 39° F (4° C). The temperature during January averages 17° F (-8° C) and typically ranges from 4° F (-16° C) to 30° F (-1° C). During July, the average temperature is 62° F (17° C), and the temperature typically ranges from 43° F (6° C) to 82° F (28° C) (Wyoming Natural Resources Board, 1966; U.S. Bureau of Land Management, 1978).

Winds are usually from the west and west-southwest with an average annual velocity of approximately 15 miles per hour (24 km per hr) (U.S. Bureau of Land Management, 1978).

Principal types of vegetation in the quadrangle include grasses, saltbush, sagebrush, mountain mahogany, rabbitbrush, and serviceberry. The Sulphur Creek valley and Hilliard Flat are utilized as cropland (U.S. Bureau of Land Management, 1978).

Land Status

The Sulphur Creek Reservoir quadrangle lies on the southwestern tip of the Kemmerer Known Recoverable Coal Resource Area (KRCRA). Approximately 40 percent of the quadrangle lies within the KRCRA boundary, with the Federal government owning the coal rights for less than half of this land, as shown on plate 2. No outstanding Federal coal leases, prospecting permits, or licenses occur within the KRCRA boundary.

GENERAL GEOLOGY

Previous Work

Veatch (1907) mapped the geology and economic resources of a large part of Lincoln and Uinta counties in southwestern Wyoming, including the Sulphur Creek Reservoir quadrangle. Cobban and Reeside (1952) and Hale (1960) described the stratigraphy of the Frontier Formation. Oriel and Tracey (1970) described the stratigraphy of the Evanston and Wasatch Formations present in the Fossil Basin including this quadrangle. Glass (1975) included coal analyses and measured sections in a description of Adaville Formation coals from the Elkol and Sorenson mines located near the towns of Elkol and Kemmerer to the north. The geology of the Kemmerer and Sage 15-minute quadrangles to the north was mapped by Rubey and others (1975). Roehler and others described the geology and coal resources of the Hams Fork coal region in 1977. Myers (1977) reported on the stratigraphy of the Frontier Formation in the Kemmerer area. Glass (1977) described the coal-bearing formations and coal beds (including coal analyses) present in the Hams Fork coal region. Cook (1977) described the structural geology and stratigraphy of the Aspen Tunnel area located in the eastern half of this quadrangle. Schroeder mapped the surface geology and coal resources of the Ragan (1976a) and the Meadow Draw (1976b) quadrangles to the northeast, the eastern half of the Guild Hollow (1977a) quadrangle to the north, and the Sulphur Creek Reservoir (1977b) quadrangle. Unpublished data from Rocky Mountain Energy Company (RMEC) provided coal thickness and coal outcrop information.

Stratigraphy

The formations cropping out in the Sulphur Creek Reservoir quadrangle range in age from Jurassic to Eocene. The Frontier and Adaville Formations are coal-bearing.

The oldest formations cropping out within the quadrangle have been mapped as a single unit by Schroeder (1977b) and include the Late Jurassic-age Preuss Red Beds, the Stump Sandstone, and the Early Cretaceous-age Gannett Group. This unit is approximately 1,200 feet (366 m) thick in the Meadow Draw quadrangle to the northeast (Schroeder, 1976b). It crops out in a northeasterly-trending band across the central part of the quadrangle adjacent to the trace of the Absaroka thrust fault (Cook, 1977; Schroeder, 1977b).

The Preuss Red Beds consist of dull-reddish- to purplish-gray sandstone, sandy siltstone, and silty claystone. The Stump Sandstone contains alternating gray to greenish-gray glauconitic fine-grained sandstone, limestone, silstone, and claystone (Furer, 1970; Rubey and others, 1975).

The basal part of the Gannett Group, the Ephraim Conglomerate, contains brick-red to dull-maroon mudstone, sandy siltstone, muddy claystone, and interbedded light-gray, red and brown sandstone with red to brown chert-bearing conglomerate lenses. The upper part of the formation consists of alternating gray limestone, red siltstone, mudstone, and claystone (Eyer, 1969; Furer, 1970; Rubey and others, 1975).

The Bear River Formation of Early Cretaceous age conformably overlies the Gannett Group and crops out in a narrow band in the southwestern quarter of the quadrangle. It is covered by the Eocene-age Wasatch formation in the north-central part and in the southeastern corner of the quadrangle (Cook, 1977; Schroeder, 1977b). It consists of interbedded dark-gray to black shale and claystone, olive to tan-weathering fine-grained sandstone, and thin beds of fossiliferous limestone. It is approximately 500 to 600 feet (152 to 183 m) thick in the Meadow Draw quadrangle to the northeast (Rubey and others, 1975; Schroeder, 1976b).

The Aspen Shale of latest Early Cretaceous age conformably overlies the Bear River Formation. It crops out west of Knight Ridge in the west-central part of the quadrangle and in the southeastern part of the quadrangle. The Aspen Shale is unconformably overlain by the Wasatch

Formation in the north-central part of the quadrangle (Cook, 1977; Schroeder, 1977b). The Aspen Shale is approximately 900 to 1,000 feet (274 to 305 m) thick in the Meadow Draw quadrangle to the northeast and is composed of light- to dark-gray siltstone and shale, gray quartzitic sandstone and porcelanite. The porcelanite forms vegetation-base silver-gray ridges in the lower part of the formation (Rubey and others, 1975; Schroeder, 1976b).

The Late Cretaceous-age Frontier Formation conformably overlies the Aspen Shale and crops out in an arc (Oyster Shell Ridge) around Hilliard Flat in the southern part of the quadrangle, and in a north-easterly-trending band across the central and northeastern parts of the quadrangle (Cook, 1977; Schroeder, 1977b). Schroeder (1977b) has subdivided the formation into lower and upper units (not shown on plate 3). The lower unit, approximately 1,000 feet (305 m) thick in the Meadow Draw quadrangle to the northeast, consists of dark-gray shale, tan siltstone, and brown sandstone, which is less resistant than the remainder of the formation. The Spring Valley coal zone is in the lower part of the unit. The upper unit consists of approximately 1,200 feet (366 m) of shale and gray sandstone. The middle part of the upper unit, the Oyster Ridge Sandstone Member, is a prominent hogback-forming white to light-gray-weathering, oyster-bearing sandstone approximately 85 to 100 feet (26 to 30 m) thick (Schroeder, oral communication, 1979). This member is characterized by the presence of Ostrea soleniscus, a long, slender oyster (Bozzuto, 1977). It is underlain by a thick shale interval and overlain by shale and thin beds of gray sandstone containing the Kemmerer coal zone near the top (Rubey and others, 1975; Schroeder, 1976b).

The Frontier Formation is conformably overlain by the Hilliard Shale of early Late Cretaceous age. It crops out in the southern part of the quadrangle (forming Hilliard Flat) and in a narrow northeasterly-trending band across the central part of the quadrangle quadrangle (Cook, 1975; Schroeder, 1977b). The Hilliard Shale consists of a very thick sequence of dark-gray to dark-brown marine shale, siltstone, and sandy shale. A few conspicuous light-gray to light-tan fine-grained resistant sandstone beds occur in the upper part of the formation. This formation is approximately 6,000 feet (1,829 m) thick in the Meadow Draw quadrangle to the northeast (Rubey and others, 1975; Schroeder, 1976b).

The Adaville Formation of Late Cretaceous age conformably overlies the Hilliard Shale and crops out in several small areas on Hilliard Flat near the south-central border of the quadrangle and in areas around the Miller Mine in sec. 20, T. 14 N., R. 118 W. (Schroeder, 1977b). It consists of an unknown thickness of gray-brown-weathering carbonaceous shale and mudstone containing yellowish-brown to reddish-brown sandstone and siltstone and coal beds. The Lazeart Sandstone Member comprises the lower 200 to 400 feet (61 to 122 m) of the formation. This prominent ledge- and cliff-forming unit is composed of light-gray to white, fine- to coarse-grained sandstone (Rubey and others, 1975; Schroeder, 1976b).

The Wasatch Formation of Eocene age unconformably overlies part of all of the formations cropping out in the quadrangle. It crops out over a large area in the northwest quarter and along the eastern edge of the quadrangle (Schroeder, 1977b). The Wasatch Formation consists of as much as 2,000 feet (610 m) of red, maroon, yellow, and gray mudstone; yellow, brown, and gray fine- to coarse-grained sandstone; and some stream-channel conglomerates (Schroeder, 1976b).

Holocene deposits of alluvium cover the stream valleys of Sulphur Creek and La Chapelle Creek, and terrace gravel deposits cap hills bordering Sulphur Creek. Colluvium and landslide deposits occur in several areas of the quadrangle (Schroeder, 1977b).

The Preuss Red Beds and Stump Sandstone are shallow-marine in origin. The Gannett Group sediments accumulated in fluvial and lacustrine environments (Eyer, 1969; Furer, 1970).

The Cretaceous formations in the Sulphur Creek quadrangle indicate the transgressions and regressions of a broad, shallow north-south seaway that extended across central North America. Sediments accumulated near the western edge of the Cretaceous sea and reflect the location of the shoreline (Weimer, 1960 and 1961).

The interbedded claystones, sandstones, and limestones of the Bear River Formation were deposited in a predominantly marine environment (Eyer, 1969). According to Roehler and others (1977), the formation thickens to the north, where it was deposited in mixed fluvial, paludal, and marine environments.

Deposition of the Aspen Shale marked a westward or landward movement of the sea. According to Hale (1960), the marine shales and sandstones of the Aspen Shale were deposited in water depths up to 120 feet (37 m).

Sediments of the Frontier Formation were deposited during two major transgressions and regressions of the sea. The coal beds in the upper and lower parts of the formation were deposited in coastal swamps during periods when the sea retreated eastward. The Oyster Ridge Sandstone Member is a littoral or beach deposit marking the retreat of the Cretaceous sea from the area (Hale, 1960; Myers, 1977; Roehler and others, 1977).

The marine sequence of shales and sandstones of the Hilliard Shale were deposited during a transgression of the Cretaceous sea and indicate the fluctuations of the shoreline (Roehler and others, 1977).

The Lazeart Sandstone Member at the base of the Adaville Formation is a beach deposit marking a transition from the marine deposition of the Hilliard Shale to the continental coastal plain deposition of the Adaville Formation. The sediments of the Adaville Formation were deposited in flood plains and swamps along the coastal plain (Roehler and others, 1977).

The Wasatch Formation is composed of continental sediments. The bright-colored mudstones were probably deposited on a flood plain and then cut by stream channels now filled with well-sorted conglomerate (Oriel and Tracey, 1970).

Structure

The Sulphur Creek Reservoir quadrangle lies on the southeastern edge of the structurally complex Wyoming Overthrust Belt. Folded Paleozoic and Mesozoic rocks are thrust eastward over folded older-Cretaceous rocks with younger Cretaceous and Tertiary rocks resting unconformably on top of the older rocks. Coal-bearing strata crop out in eroded limbs of folds as long narrow belts bounded on the west by major thrust faults (Roehler and others, 1977). Because of the complexity of the geologic structure in this quadrangle the attitudes of the strata range from nearly horizontal to overturned.

The Absaroka thrust fault trends northeasterly through the center of the quadrangle and is well exposed except in the southwestern corner of the quadrangle, where it is covered by Quaternary colluvium and terrace gravels. It is an extensive thrust fault which has been mapped for a linear distance of 205 miles (330 km) in Wyoming and Idaho. Stratigraphic displacement of the Absaroka fault is approximately 10,000 to 15,000 feet (3,048 to 4,572 m), and its lateral displacement is approximately 3 miles (4.8 km). Major movement along the fault occurred very late in Cretaceous time with probable minor movement in the Paleocene (Rubey and others, 1975). A few minor faults occur along the trace of the Absaroka fault (Schroeder, 1977b).

The Oil Springs fault, located to the east and nearly parallel to the Absaroka fault, trends northeasterly through the quadrangle. The Oil Springs fault is a high-angle reverse fault with the up-thrown side on the east (Schroeder, 1977b). A branch of the Oil Springs fault runs south from Aspen Mountain to near the southern boundary of the quadrangle. The Oil Springs fault forms a border around Oyster Shell Ridge and Hilliard Flat in the southern part of the quadrangle.

Near the northeastern corner of the quadrangle, an unnamed reverse fault, trending northwesterly, cuts the Lazeart and the Stowe Creek synclines, and terminates at the Absaroka fault (Schroeder, 1977b).

The Miller Mine fault, an unmapped fault near the Miller mine in the west-central part of the quadrangle, brings the Adaville Formation into contact with the Aspen Shale. The Miller Mine fault is a normal fault with the down-dropped side to the west (Schroeder, oral communication, 1979).

The axial trace of the asymmetric Lazeart syncline trends northeasterly through the south-central and eastern parts of the quadrangle. It is bisected by the Oil Springs fault at Aspen Mountain and by an unnamed reverse fault in the northeastern part of the quadrangle (Schroeder, 1977b).

The Stowe Creek syncline lies between the Absaroka and Oil Springs faults in the central and northeastern parts of the quadrangle. It is bisected by a reverse fault in the northeastern part of the quadrangle. Beds in the Stowe Creek syncline dip steeply to the east and west, north of the reverse fault, but south of the fault the beds are overturned with dips to the east (Schroeder, 1977b).

COAL GEOLOGY

Coal zones in both the Frontier and Adaville Formations have been identified in this quadrangle as shown on plate 1. Two coal zones, the Spring Valley and the Kemmerer, are present in the Frontier Formation. The Willow Creek coal zone of the Frontier Formation, located between the Spring Valley and Kemmerer zones in the northern part of the Kemmerer coal field, has not been mapped in quadrangles as far south as Sulphur Creek Reservoir.

Chemical analyses of coal.--Representative analyses of coal from the Spring Valley, Kemmerer, and Adaville coal zones are listed in table 1. Analyses for the Spring Valley and Kemmerer coal zones are from the Ragan quadrangle and from the southeast quarter of the Kemmerer 15-minute quadrangle to the north, respectively. In general, coals in the Spring Valley and Kemmerer coal zones rank as high-volatile B bituminous and coals from the Adaville zone rank subbituminous B (Glass, 1975). These coals have been ranked on a moist, mineral-matter-free basis according to

ASTM Standard Specification D 388-77 (American Society for Testing and Materials, 1977).

Coal beds that have been isopached in this quadrangle are not formally named and have been given bracketed numbers for identification purposes in this quadrangle only. Where coal beds have been identified at only one location and cannot be correlated with other coal beds, they have been treated as isolated data points (see Isolated Data Points section of this report).

Frontier Formation Coal Zones

The Frontier Formation and its associated coal zones are exposed along both limbs of the Lazeart syncline in the south-central part of the quadrangle and on the overturned limbs of the Stowe Creek syncline in the central part of the quadrangle. The beds trend northeasterly to nearly east-west. Stratigraphically, the Spring Valley coal zone is the lowest coal zone identified in this quadrangle and lies near the base of the Frontier Formation. The Kemmerer coal zone lies near the top of the formation above the prominent Oyster Ridge Sandstone Member.

Spring Valley Coal Zone

The Spring Valley coal zone crops out along the eastern limb of the Lazeart syncline in the southeastern corner of the quadrangle. It was named for Spring Valley Station located in T. 15 N., R. 118 W. (Glass, 1977). Dips of the Spring Valley coal beds, as measured by Schroeder (1977b), are approximately 24° to the west. Coal beds in the Spring Valley zone are normally less than Reserve Base thickness (5 feet or 1.5 meters) in this quadrangle, averaging 3 feet (0.9 m). One exception is the Spring Valley [1] coal bed, which reaches a maximum reported cumulative coal thickness of 6.5 feet (2.0 m) with 0.5 feet (0.2 m) of rock partings in sec. 25, T. 14 N., R. 119 W. The coal bed thins rapidly to the north and south as shown on plate 4. The Spring Valley [1] coal bed is a local bed, and is not correlative with coal beds in other quadrangles.

Kemmerer Coal Zone

The Kemmerer coal zone crops out in an arc in the south-central part of the quadrangle, where it is localized by folding associated with the Lazeart syncline. It also crops out in both limbs of the Stowe Creek syncline in the central part of the quadrangle. Kemmerer coal beds dip approximately 35° on the eastern limb of the Lazeart syncline and 62° on the western limb. In the Stowe Creek syncline, the Kemmerer coal beds are overturned to the east with dips averaging 60°.

The Kemmerer coal zone was named for the town of Kemmerer located in T. 21 N., R. 116 W., where it was mined extensively around the turn of the century. This zone has been traced for more than 60 miles (97 km) in the Kemmerer coal field (Glass, 1977) and is approximately 100 feet (30 m) thick.

The Kemmerer [3] coal bed is the only Kemmerer coal bed of Reserve Base thickness (5 feet or 1.5 meters) isopached in this quadrangle (plate 4). It crops out in the overturned limbs of the Stowe syncline. Maximum thickness of the coal bed on the western limb of the syncline is 19 feet (5.8 m), with no partings, where measured at the outcrop in sec. 12, T. 14 N., R. 119 W. On the eastern limb, the coal bed has a maximum recorded thickness of 18 feet (5.5 m), with no partings, in sec. 24, T. 14 N., R. 119 W. The coal bed thins in some areas, but averages approximately 10 feet (3.0 m) thick. The Kemmerer [3] coal bed is not known to correlate with coal beds in other quadrangles.

Two other coal beds in the Kemmerer coal zone, the Kemmerer [1] and [2], have been encountered at only one location and have been treated as isolated data points.

Adaville Coal Zone

Coal beds in the Adaville coal zone crop out in the Lazeart syncline near the southern boundary of the quadrangle and west of Knight Ridge in the west-central part of the quadrangle. Only three isolated measurements of Adaville coal beds, all on non-Federal land, have been reported in this quadrangle. Two of the measurements exceed Reserve Base thickness. An unidentified Adaville coal bed, 22 feet (6.7 m) thick, was measured in the Carlton mine in sec. 4, T. 13 N., R. 119 W. In the Miller mine in sec. 20, T. 14 N., R. 119 W., an Adaville coal bed is reported to be 16 feet (4.9 m) thick..

Isolated Data Points

In instances where isolated, or single, measurements of coal beds exceeding Reserve Base thickness are encountered, the standard criteria for construction of isopach, structure contour, mining ratio, and overburden isopach maps are not available. The lack of data concerning these coal beds limits the extent to which they can be reasonably projected in any direction and usually precludes correlations with other, better known coal beds. For these reasons, isolated data points are included on a separate sheet (in U.S. Geological Survey files) for non-isopached coal beds. Also, where the inferred limit of influence from the isolated data point is entirely within non-Federal land areas or lands already leased for coal mining, isolated data point maps are not constructed for the coal bed. The isolated data points mapped in this quadrangle are listed below.

Source	Location	Coal Bed or Zone	Thickness
RMEC	sec. 13, T. 14 N., R. 119 W.	K[1]	10.5 ft (3.2 m)
Schroeder, 1977b	sec. 35, T. 14 N., R. 119 W.	K[2]	5.2 ft (1.6 m)

COAL RESOURCES

Drill hole and outcrop information from RMEC (no date), and surface mapping and measured sections from Veatch (1907) and Schroeder (1977b) were used to construct outcrop, isopach, and structure contour maps of the coal beds in this quadrangle. The source of each indexed data point shown on plate 1 is listed in table 4.

Coal resources were calculated using data obtained from the coal isopach maps (plate 4). The coal bed acreage (measured by planimeter) multiplied by the average isopached thickness of the coal bed and by a conversion factor of 1,800 short tons of coal per acre-foot (13,238 metric tons per hectare-meter) for bituminous coal, or 1,770 short tons of coal per acre-foot (13,018 metric tons per hectare-meter) for subbituminous coal, yields the coal resources in short tons of coal for each isopached coal bed. Coal beds of Reserve Base thickness (5 feet or 1.5 meters) or greater that lie less than 3,000 feet (914 m) below the ground surface are included. These criteria differs somewhat from those used in calculating Reserve Base and Reserve tonnages as stated in U.S. Geological Survey Bulletin 1450-B which calls for a a minimum thickness of 28 inches (70 cm) for bituminous coal and a maximum depth of 1,000 feet (305 m) for both bituminous and subbituminous coal.

Reserve Base and Reserve tonnages for the isopached beds are shown on plate 7 and are rounded to the nearest 10,000 short tons (9,072 metric tons). Only Reserve Base tonnages (designated as inferred resources) are calculated for areas influenced by isolated points. Coal Reserve Base tonnages per Federal section are shown on plate 2 and total approximately 7,850,000 short tons (7,120,000 metric tons) for the entire quadrangle. This total includes 120,000 short tons (109,000 metric tons) from the isolated data points. Reserve Base tonnages in the various development potential categories for surface and in-situ mining methods are shown in tables 2 and 3.

Dames & Moore has not made any determination of economic recoverability for any of the coal beds described in this report.

COAL DEVELOPMENT POTENTIAL

Coal development potential areas are drawn to coincide with the boundaries of the smallest legal land subdivisions shown on plate 2. In sections or parts of sections where no land subdivisions have been surveyed by the BLM, approximate 40-acre (16-ha) parcels have been used to show the limits of the high, moderate, or low development potentials. A constraint imposed by the BLM specifies that the highest development potential affecting any part of a 40-acre (16-ha) lot, tract, or parcel be applied to that entire lot, tract, or parcel. For example, if 5 acres (2 ha) within a parcel meet criteria for a high development potential affecting any part of a 40-acre (16-ha) lot, tract, or parcel be applied to that entire lot, tract, or parcel. For example, if 5 acres (2 ha) within a parcel meet criteria for a high development

potential, 25 acres (10 ha) a moderate development potential, and 10 acres (4 ha) a low development potential, then the entire 40 acres (16 ha) are assigned a high development potential.

Development Potential for Surface Mining Methods

Areas where the coal beds of Reserve Base thickness are overlain by 200 feet (61 m) or less of overburden are considered to have potential for surface mining and were assigned a high, moderate, or low development potential based on the mining ratio (cubic yards of overburden per ton of recoverable coal). The formula used to calculate mining ratios for surface mining of coal is shown below:

$$MR = \frac{t_o\,(cf)}{t_c\,(rf)}$$

where MR = mining ratio

t_o = thickness of overburden in feet

t_c = thickness of coal in feet

rf = recovery factor (85 percent for this quadrangle)

cf = conversion factor to yield MR value in terms of cubic yards of overburden per short tons of recoverable coal:
0.911 for subbituminous coal
0.896 for bituminous coal

Note: To convert mining ratio to cubic meters of overburden per metric ton of recoverable coal, multiply MR by 0.8428.

Areas of high, moderate, and low development potential are defined as areas underlain by coal beds having respective mining ratio values of 0 to 10, 10 to 15, and greater than 15. These mining ratio values for each development potential category are based on economic and technological criteria and were provided by the U.S. Geological Survey.

Unknown development potentials have been assigned to those areas where coal data is absent or extremely limited, including those areas influenced by isolated data points. Even though these areas may contain coal thicker than 5 feet (1.5 m), limited knowledge pertaining to the areal distribution, thickness, depth, and attitude of the coal beds prevents accurate evaluation of the development potential in the high, moderate, or low categories. The areas influenced by isolated data points in this quadrangle contain approximately 90,000 short tons (82,000 metric tons) of coal available for surface mining.

The coal development potential for surface mining methods is shown on plate 8. Of the Federal land areas having a known development potential for surface mining methods, 95 percent are rated high and 5 percent are rated moderate. The remaining Federal lands within the KRCRA boundary in this quadrangle are classified as having unknown development potential for surface mining methods.

Development Potential for Subsurface and In-Situ Mining Methods

Areas where the coal beds of Reserve Base thickness lie between 200 and 3,000 feet (61 and 914 m) below the ground surface, having dips of 15° or less, are usually considered to have development potential for conventional subsurface mining methods. In this quadrangle, all known coal beds of Reserve Base thickness have dips greater than 15°. Therefore, all Federal lands have been rated as having an unknown development potential for conventional subsurface mining methods.

Coal beds lying between 200 and 3,000 feet (61 and 914 m) below the ground surface, dipping greater than 15°, are considered to have a development potential for in-situ mining methods. Based on criteria provided by the U.S. Geological Survey, coal beds of Reserve Base thickness dipping between 35° and 90° with a minimum Reserve Base of 70 million short tons (63.5 million metric tons) of subbituminous coal or 50 million short tons (45.4 million metric tons) of bituminous coal have a moderate potential for in-situ development.

Coal beds dipping from 15° to 35°, regardless of tonnage, and coal beds dipping from 35° to 90° with less than 50 million short tons (45.4 million metric tons) of coal have a low development potential for in-situ mining methods. Coal lying between the 200-foot (61-m) overburden line and the outcrop is not included in total coal tonnages available because it is needed for cover and containment in the in-situ process.

The coal development potential for in-situ mining methods is shown on plate 9. All of the Federal land areas having a known development potential for in-situ mining are rated low because only 5,680,000 short tons (5,150,000 metric tons) of coal are believed to be available for this mining method. The remaining Federal land areas that have not already been leased, including those areas influenced by isolated data points, are classified as having an unknown development potential for in-situ mining methods.

Table 1. Chemical analyses of coals in the Sulphur Creek Reservoir quadrangle, Uinta County, Wyoming.

Location	COAL BED NAME	Form of Analysis	Proximate				Ultimate					Heating Value	
			Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu/Lb
Average analysis of 19 samples from Kemmerer area (Glass,1975)	Adaville coal zone	A	20.9	33.8	40.4	4.8	0.6	-	-	-	-	-	9,470
SW¼, NE¼, sec. 12, T. 21 N., R. 116 W., Kemmerer No. 1 Mine (U.S. Bureau of Mines, 1931)	Kemmerer No. 1	A	5.9	37.6	49.0	7.5	1.4	-	-	-	-	-	12,370
		C	0.0	39.9	52.1	8.0	1.5	-	-	-	-	-	13,140
NW¼, sec. 12, T. 15 N., R. 118 W., Richardson Mine (U.S. Bureau of Mines, 1931)	Spring Valley	A	6.9	35.6	43.8	13.7	0.9	-	-	-	-	-	11,350
		C	0.0	38.2	47.1	14.7	1.0	-	-	-	-	-	12,180

Form of Analysis: A, as received
C, moisture free

Note: To convert Btu/pound to kilojoules/kilogram, multiply by 2.326

Table 2. Coal Reserve Base data for surface mining methods for Federal coal lands (in short tons) in the Sulphur Creek Reservoir quadrangle, Uinta County, Wyoming.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Kemmerer {3}	690,000	690,000	690,000	-	2,070,000
Spring Valley {1}	-	10,000	-	-	10,000
Isolated data points	-	-	-	90,000	90,000
Totals	690,000	700,000	690,000	90,000	2,170,000

NOTE: To convert short tons to metric tons, multiply by 0.9072.

Table 3. -- Coal Reserve Base data for in-situ mining methods for Federal coal lands (in short tons) in the Sulphur Creek Reservoir quadrangle, Uinta County, Wyoming.

Coal Bed or Zone	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Kemmerer {3}	-	5,650,000	-	5,650,000
Isolated Data Points	-	-	30,000	30,000
Totals	-	5,650,000	30,000	5,680,000

NOTE: To convert short tons to metric tons, multiply by 0.9072.

Table 4. -- Sources of data used on plate 1

Plate 1 Index Number	Source	Data Base
1	Veatch, 1907, U.S.Geological Survey Professional Paper 56, p. 132	Mine Section (Carlton Mine)
2	Schroeder, 1977b, U.S. Geological Survey, unpublished data	Mine Section No. 9
3	↓	Mine Section No. 8
4	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 130	Measured Section No. 147
5	↓	Measured Section No. 148
6	↓	Measured Section No. 149
7	↓	Measured Section No. 150
8	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 6 line B
9	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 130	Measured Section No. 152
10	↓	Measured Section No. 151
11	↓	Measured Section No. 153
12	↓	Measured Section No. 156
13	Rocky Mountain Energy Co., (no date),	Drill hole No. 1 line A
14	↓	Drill hole No. 2 line A

Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
15	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 130	Measured Section No. 154
16	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 3 line A
17	↓	Drill hole No. 4 line A
18	↓	Drill hole No. 5 line A
19	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 130	Measured Section No. 157
20	↓	Measured Section No. 155
21	↓	Measured Section No. 158
22	↓	Measured Section No. 159
23	↓	Measured Section No. 160
24	Rocky Mountain Energy Co., (no date), unpublished report	Measured Section
25	Schroeder, 1977b, U.S. Geological Survey, unpublished data	Measured Section No. 7
26	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 130	Measured Section. No. 161
27	↓	Mine-Section No. 162
28	↓	Measured Section No. 163

Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
29	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1 line A
30	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 130	Measured Section No. 165
31	↓	Measured Section No. 166
32	Rocky Mountain Energy Co., (no date), unpublished data	Measured Section
33	Schroeder, 1977b, U.S. Geological Survey, unpublished data	Measured Section No. 6
34	Sundance Oil Co.	Oil/gas well No. 1 Federal-Big Piney
35	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 130	Measured Section No. 164
36	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 2 line A
37	↓	Drill hole No. 1 line A
38	Schroeder, 1977b, U.S. Geological Survey, unpublished data	Measured Section No. 2
39	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 130	Measured Section No. 167
40	↓	Measured Section No. 168
41	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 130	Measured Section No. 169
42	Schroeder, 1977b, U.S. Geological Survey, unpublished data	Measured Section No. 5

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Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
43	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 131	Measured Section No. 170
44	Schroeder, 1977b, U.S. Geological Survey, unpublished data	Measured Section No. 4
45	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 131	Measured Section No. 171
46	Rocky Mountain Energy Co., (no date), unpublished data	Measured Section
47	Schroeder, 1977b, U.S. Geological Survey, unpublished data	Measured Section No. 3
48	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 131	Measured Section No. 177
49	Schroeder, 1977b, U.S. Geological Survey, unpublished paper	Measured Section No. 1
50	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1 line A
51		Drill hole No. 2 line A
52		Drill hole No. 3 line A
53		Drill hole No. 4 line A
54		Drill hole No. 1 line A
55		Drill hole No. 2 line A
56		Drill hole No. 3 line A

Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
57	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 4 line A
58	↓	Drill hole No. 5 line A
59	↓	Drill hole No. 6 line A

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REFERENCES

American Society for Testing and Materials, 1977, Standard specification for classification of coals by rank, in Gaseous fuels; coal and coke; atmospheric analysis: ASTM Standard Specification D 388-77, pt. 26, p. 214-218.

Bozzuto, R. T., 1977, Geology of the Skull Point mine area, Lincoln County, Wyoming, in Rocky Mountain and thrust belt geology and resources, Joint Wyoming, Montana and Utah Geological Association Guidebook, 29th Annual Field Conference, 1977: p. 673-678.

Cobban, W. A., and Reeside, J. B., Jr., 1952, Frontier Formation, Wyoming and adjacent areas: American Association of Petroleum Geologists Bulletin, v. 36, no. 10, p. 1913-1961.

Cook, W. R., III, 1977, The structural geology of the Aspen Tunnel area, Uinta County, Wyoming, in Rocky Mountain and thrust belt geology and resources, Joint Wyoming, Montana and Utah Geological Association Guidebook, 29th Annual Field Conference, 1977: p. 397-405.

Eyer, J. A., 1969, Gannett Group of western Wyoming and southeastern Idaho: American Association of Petroleum Geologists Bulletin, v. 53, No. 7, p. 1368-1390, 8 figs.

Furer, L. C., 1970, Petrology and stratigraphy of non-marine Upper Jurassic-Lower Cretaceous rocks of western Wyoming and southeastern Idaho: American Association of Petroleum Geologists Bulletin, v. 54, No. 12, p. 2282-2302, 22 figs.

Glass, G. B., 1975, Analyses and measured sections of 54 Wyoming coal samples (collected in 1974): Wyoming Geological Survey, Report of Investigations No. 11, 219 p.

______ 1977, Update on the Hams Fork coal region, in Rocky Mountain and thrust belt geology and resources, Joint Wyoming, Montana, and Utah Geological Association Guidebook, 29th Annual Field Conference, 1977: p. 689-706.

Hale, L. A., 1960, Frontier formation, Coalville, Utah, and nearby areas of Wyoming and Colorado, in Overthrust belt of southwestern Wyoming and adjacent areas, Wyoming Geological Association Guidebook, 15th Annual Field Conference, 1960: p. 136-146.

Myers, R. C., 1977, Stratigraphy of the Frontier Formation (Upper Cretaceous), Kemmerer area, Lincoln County, Wyoming, in Rocky Mountain and thrust belt geology and resources, Joint Wyoming, Montana and Utah Geological Association Guidebook, 29th Annual Field Conference, 1977: p. 271-311.

References--Continued

Oriel, S. S., and Tracey, J. I., Jr., 1970, Uppermost Cretaceous and Tertiary stratigraphy of Fossil Basin, southwestern Wyoming: U.S. Geological Survey Professional Paper 635, 53 p.

Rocky Mountain Energy Company, (no date), Unpublished drill-hole data from the Union Pacific coal inventory of 1968-1969.

Roehler, H. W., Swanson, V. E., and Sanchez, J. D., 1977, Summary report of the geology, mineral resources, engineering geology and environmental geochemistry of the Sweetwater-Kemmerer area, Wyoming, part A, geology and mineral resources: U.S. Geological Survey Open-File Report 77-360, 80 p.

Rubey, W. W., Oriel, S. S., and Tracey, J. I., Jr., 1975, Geology of the Sage and Kemmerer 15-minute quadrangles, Lincoln County, Wyoming: U.S. Geological Survey Professional Paper 855, 18 p.

Schroeder, M. L., 1976a, Preliminary geologic map and coal resources of the Ragan quadrangle, Uinta County, Wyoming: U.S. Geological Survey, unpublished report and map, scale 1:24,000.

______ 1976b, Preliminary geologic map and coal resources of the Meadow Draw quadrangle, Uinta County, Wyoming: U.S. Geological Survey, unpublished report and maps, scale 1:24,000.

______ 1977a, Preliminary geologic map and coal resources of the east half of the Guild Hollow quadrangle, Uinta County, Wyoming: U.S. Geological Survey Open-File Report 77-427, scale 1:24,000.

______ 1977b, Preliminary geologic map and coal resources of the Sulphur Creek Reservoir quadrangle, Uinta County, Wyoming: U.S. Geological Survey, unpublished report and map, scale 1:24,000.

U.S. Bureau of Land Management, 1971, BLM public lands guide, Rock Springs district, Wyoming: Ogden, Utah, scale 1:337,920.

______ 1978, Draft environmental statement, proposed development of coal resources in southwestern Wyoming: U.S. Department of the Interior, v. 1 to 3.

U.S. Bureau of Mines, 1931, Analyses of Wyoming coals: U.S. Bureau of Mines Technical Paper 484, pp. 54-57, 115-121.

U.S. Bureau of Mines and U.S. Geological Survey, 1976, Coal resource classification system of the U.S. Bureau of Mines and U.S. Geological Survey: U.S. Geological Survey Bulletin 1450-B, 7 p.

References--Continued

Veatch, A. C., 1907, Geography and geology of a portion of southwestern Wyoming with special reference to coal and oil: U.S. Geological Survey Professional Paper 56, 178 p.

Weimer, R. J., 1960, Upper Cretaceous stratigraphy, Rocky Mountain area: American Association of Petroleum Geologists Bulletin, v. 44, no. 1, p. 1-20.

______ 1961, Uppermost Cretaceous rocks in central and southern Wyoming, and northwest Colorado, _in_ Symposium on the Late Cretaceous rocks in Wyoming and adjacent areas: Wyoming Geological Association Guidebook, 16th Annual Field Conference, 1961: p. 17-28.

Wyoming Natural Resources Board, 1966, Wyoming weather facts: Cheyenne, p. 30-31.

Wyoming State Highway Commission, 1978, Wyoming official highway map: Cheyenne, Wyoming, approximate scale 1:140,000.