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COAL RESOURCE OCCURRENCE MAPS AND COAL DEVELOPMENT POTENTIAL OF THE WILLOW SPRINGS QUADRANGLE, LINCOLN COUNTY, WYOMING

[Report includes 2 plates]

Prepared for

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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INTRODUCTION

Purpose

This text is to be used in conjunction with the Coal Resource Occurrence Maps of the Willow Springs quadrangle, Lincoln County, Wyoming. This report was compiled to support the land planning work of the Bureau of Land Management (BLM) 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 Published and unpublished public information available through April, 1978, was used as the data base for this study.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 Willow Springs quadrangle is located in central Lincoln County, Wyoming, approximately 2 airline miles (3.2 km) east of the town of Kemmerer, Wyoming. Several houses or buildings are present along Hams Fork valley in the southern part of the quadragle and at Willow Springs in the northwestern corner of the quadrangle.

Accessibility

U.S. Highway 30N, a paved heavy-duty road, parallels the Hams Fork valley across the southern part of the quadrangle connecting the town of Kemmerer to the west of the quadrangle boundary with the town of Granger, Wyoming, and Interstate Highway 80 to the southeast. U.S. Highway 189, a paved heavy-duty road connecting Kemmerer and the town of La Barge to the northeast, crosses the northwestern corner of the quadrangle. An improved light-duty road extends north from U.S. Highway 30N in the southwest corner of the quadrangle to Alkali Creek in the west-central part of the quadrangle. Numerous unimproved dirt road and

trails provide access through the remainder of the quadrangle (U.S. Bureau of Land Management, 1971; Wyoming State Highway Commission, 1978).

The Oregon Short Line Railroad, a branch of the Union Pacific Railroad, crosses east-west along the Hams Fork valley in the southern part of the quadrangle. It is a major shipping route connecting Pocatello, Idaho, to the west with the Union Pacific Railroad main east-west line at Granger (U.S. Bureau of Land Management, 1978).

Physiography

The Willow Springs quadrangle lies on the eastern edge of the Wyoming Overthrust Belt and on the western edge of the Green River Basin. The landscape within the quadrangle is characterized by several long north-south-trending ridges, chiefly in the western half of the quadrangle. The flat-lying Hams Fork valley crosses the southern part of the quadrangle, and Oyster Ridge is prominent along the western quadrangle boundary. Altitudes range from less than 6,700 feet (2,042 m) on the Hams Fork to over 7,960 feet (2,426 m) on Oyster Ridge.

Hams Fork, a tributary to the Green River that lies east of the quadrangle, flows easterly across the southern part of the quadrangle. Alkali Creek flows southerly through the central part of the quadrangle and drains the majority of the quadrangle. Craven Creek flows easterly and drains the northeastern corner of the quadrangle. Both are tributaries of Hams Fork. The Craven Creek (Franklin) Reservoir lies in the northeastern corner of the quadrangle. There are numerous springs located throughout the quadrangle. Streams in the quadrangle, with the exception of Hams Fork, are intermittent and flow mainly in response to snowmelt in the spring (U.S. Bureau of Land Management, 1971; Wyoming State Highway Commission, 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 12 miles per hour (19 km per hr) (U.S. Bureau of Land Management, 1978).

Principal types of vegetation in the quadrangle include grasses, sagebrush, rabbitbrush, willow, and cottonwood. Land along the Hams Fork valley in the southern part of the quadrangle is utilized as cropland (U.S. Bureau of Land Management, 1978).

Land Status

The Willow Springs quadrangle lies on the northeastern edge of the Kemmerer Known Recoverable Coal Resources Area (KRCRA). Approximately one tenth of the quadrangle's total area lies within the KRCRA boundary, with the Federal government owning the coal rights to approximately 95 percent of this area, as shown on plate 2. No outstanding Federal coal leases, prospecting permits, or licenses occur within the KRCRA boundary.

General Geology

Previous Work

The geology and economic resources of a large part of Lincoln and Uinta counties located in southwestern Wyoming, including most of the Willow Springs quadrangle, were described by Veatch in 1907. Schultz (1914) investigated the geology and coal resources in the northern part of the Kemmerer coal field. Andrews (1944) described the coal and mapped the geology of the northeast quarter of the Kemmerer 15-minute quadrangle to the northwest. Hunter described the Kemmerer coal field in 1950. The stratigraphy of the coal-bearing Frontier Formation was described by Cobban and Reeside (1952) and Hale (1960). Oriel and Tracey (1970) described the stratigraphy of the uppermost Cretaceous and Tertiary formations in the Kemmerer area, and the geology of the adjacent Kemmerer 15-minute quadrangle was mapped by Rubey and others (1975). Glass (1977) described the coal-bearing formations and reported chemical analyses of the coal beds present in the Hams Fork coal region. The geology and coal resources of the Hams Fork coal region, including the Kemmerer coal field, were also described by Roehler and others (1977). Myers (1977) made a detailed study of the stratigraphy of the Frontier Formation in the Kemmerer area.

Stratigraphy

The formations cropping out in the Willow Springs quadrangle range in age from Jurassic to Eocene. The lower two thirds of the coal-bearing Frontier Formation crops out on the western edge of the quadrangle. A generalized columnar section is shown in figure 1.

Jurassic formations, including the Preuss Red Beds and the Stump Sandstone, crop out in the central part of the quadrangle. They are unconformably overlain by the Wasatch and Green River Formations of Eocene age in the eastern part of the quadrangle.

The Gannett Group of Early Cretaceous age crops out through the central part of the quadrangle and consists of alternating limestone, mudstone, siltstone, and claystone, with a basal conglomerate unit.

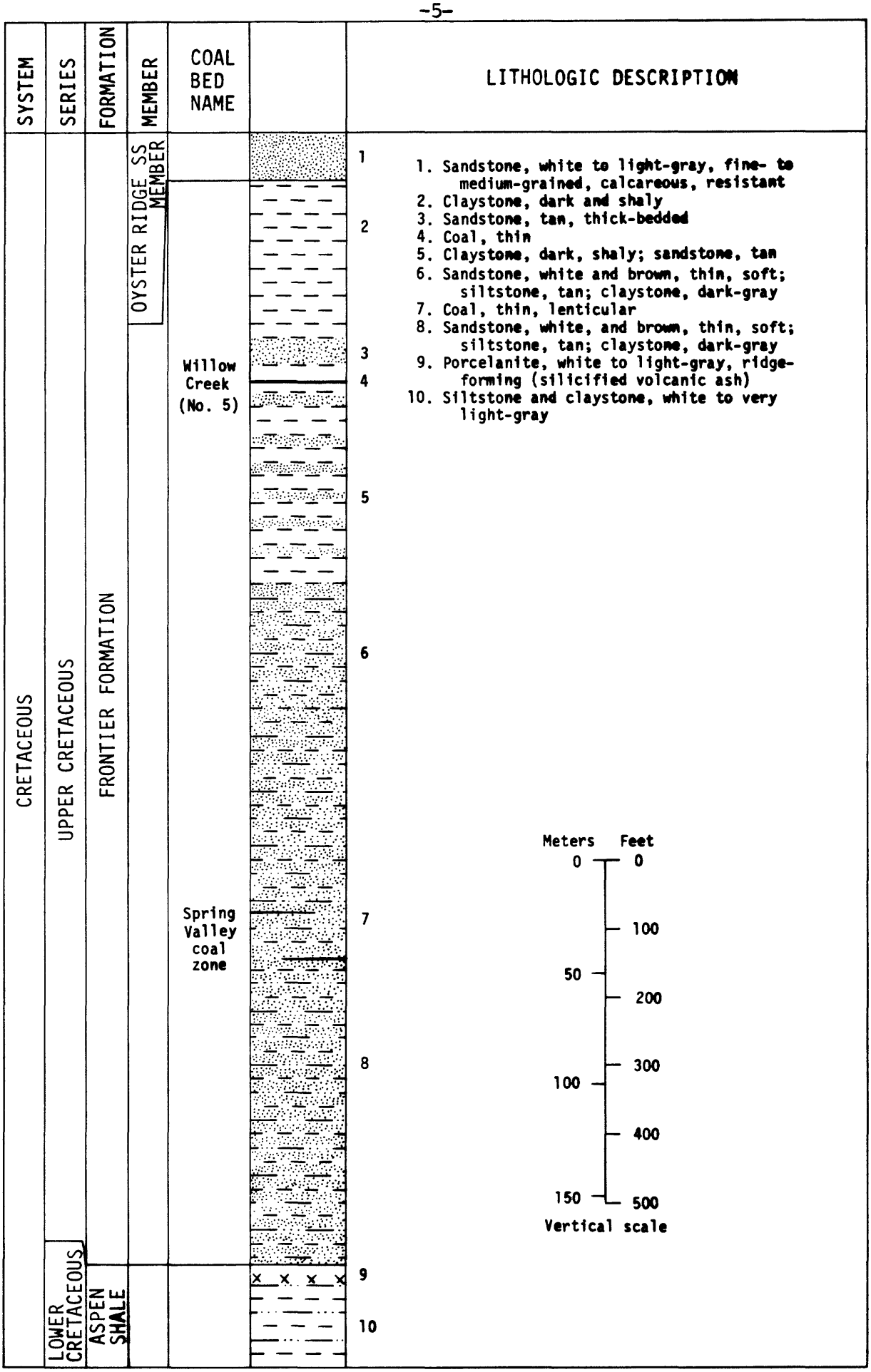


FIGURE 1. — Composite columnar section.

The Gannett Group thickens to the north from approximately 625 to 700 feet (191 to 213 m) (Rubey and others, 1975).

The Bear River Formation of Early Cretaceous age unconformably overlies the Gannett Group and crops out in a narrow band in the central part of the quadrangle. This formation is approximately 1,400 feet (427 m) thick and consists of interbedded dark-gray to black fissile claystone, tan to olive-brown fine-grained sandstone, and fossiliferous limestone (Rubey and others, 1975).

Conformably overlying the Bear River Formation, the Aspen Shale of late Early Cretaceous age crops out in a wide band in the western part of the quadrangle. It consists of approximately 825 to 1,025 feet (251 to 312 m) of light-gray shale, siltstone, claystone, gray quartzitic sandstone, and numerous porcelanite and bentonite beds. The porcelanite beds in the lower part of the Aspen Shale form vegetation-bare silver-gray ridges and hogbacks (Rubey and others, 1975).

The Frontier Formation of early Late Cretaceous age conformably overlies the Aspen Shale. Rubey and others (1975) mapped this formation as three informal units (not shown in figure 1). The basal and middle units of the Frontier Formation crop out along the western edge of the Willow Springs quadrangle and the upper unit crops out in the adjacent southeast quarter of the Kemmerer 15-minute quadrangle. The basal section of the Frontier Formation is composed of thin white and brown sandstone beds, tan siltstone, dark-gray claystone, thin beds of gray, pink and white porcelanite, and the Spring Valley coal zone. The basal unit is approximately 1,000 feet (305 m) thick, thinning to the south. The middle unit of the formation, approximately 675 feet (206 m) thick, consists of tan sandstone, dark shaly claystone, the Willow Creek coal zone, and is capped by the prominent hogback-forming Oyster Ridge Sandstone Member. The Oyster Ridge Sandstone Member consists of approximately 130 feet (40 m) of white to light-gray, thick-bedded resistant sandstone (Rubey and others, 1975).

The Wasatch Formation of Eocene age crops out in the eastern part of the quadrangle, and unconformably overlies Jurassic and Cretaceous formations. It consists of red, maroon, tan, and green variegated mudstone, white and tan sandstone and siltstone, conglomerate, and limestone (Oriel, 1969), and is not known to contain coal in this quadrangle.

The Green River Formation of Eocene age intertongues with and overlies the Wasatch Formation in the eastern part of the quadrangle. It consists of thinly laminated light-gray to white limestone, light-gray marlstone, buff-colored sandstone, light-gray mudstone, siltstone, oil shale, and tuffaceous ash beds (Oriel, 1969), and does not contain any coal beds in this quadrangle.

Holocene deposits of alluvium occur in the stream valleys of Hams Fork and Alkali Creek.

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

The Gannett Group was formed in lacustrine and marine environments (Holm and others, 1977).

The sandstone, black claystone, and fresh water limestone of the Bear River Formation were deposited in coastal swamps and flood plains during a regression of the Cretaceous sea (Roehler and others, 1977).

Deposition of the Aspen Shale marked a westward or landward movement of the sea. The marine shale, siltstone and sandstone of the Aspen Shale were deposited in water up to 120 feet (37 m) deep (Hale, 1960).

Sediments in the lower two thirds of the Frontier Formation reflect minor fluctuations of the Cretaceous sea. Depositional environments were

predominantly shallow-water to near-shore marine, coastal swamp, and deltaic (Cobban and Reeside, 1952).

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. Other sediments were deposited in a lacustrine environment (Oriel and Tracey, 1970).

Sediments of the Green River Formation were deposited in a lacustrine environment. Fluctuations in the lake size are recorded by the intertonguing of Green River Formation beds with Wasatch Formation strata around the margin of the basin. Volcanic activity occurred in the area during the deposition of the Green River Formation, as indicated by the thin beds of tuffaceous ash in the formation (Oriel and Tracey, 1970).

Structure

The Willow Springs quadrangle is located on the southeastern edge of the structurally complex Wyoming Overthrust Belt and on the western edge of the Green River Basin. West of the quadrangle, Paleozoic and Mesozoic rocks are thrust eastward over folded Cretaceous formations with younger Cretaceous and Tertiary rocks resting unconformably on top of the older rocks. Cretaceous formations crop out in eroded limbs of folds as long narrow belts bounded on the west by major thrust faults (Roehler and others, 1977).

The axis of the Lazeart Syncline, a major structural feature, trends northeasterly across the northwestern corner of the adjacent southeast quarter of the Kemmerer 15-minute quadrangle. Beds of Cretaceous age dip approximately 30° on the eastern limb of the syncline and 60° on the western limb (Rubey and others, 1975). In the Willow Springs quadrangle, Cretaceous formations are exposed in the eroded eastern limb of the Lazeart Syncline and dip approximately 20° to the west.

The Quealy Fault, a high-angle normal fault with the down-thrown side to the north, trends northeasterly in sec. 29, T. 22 N., R. 115 W. (plate 1).

COAL GEOLOGY

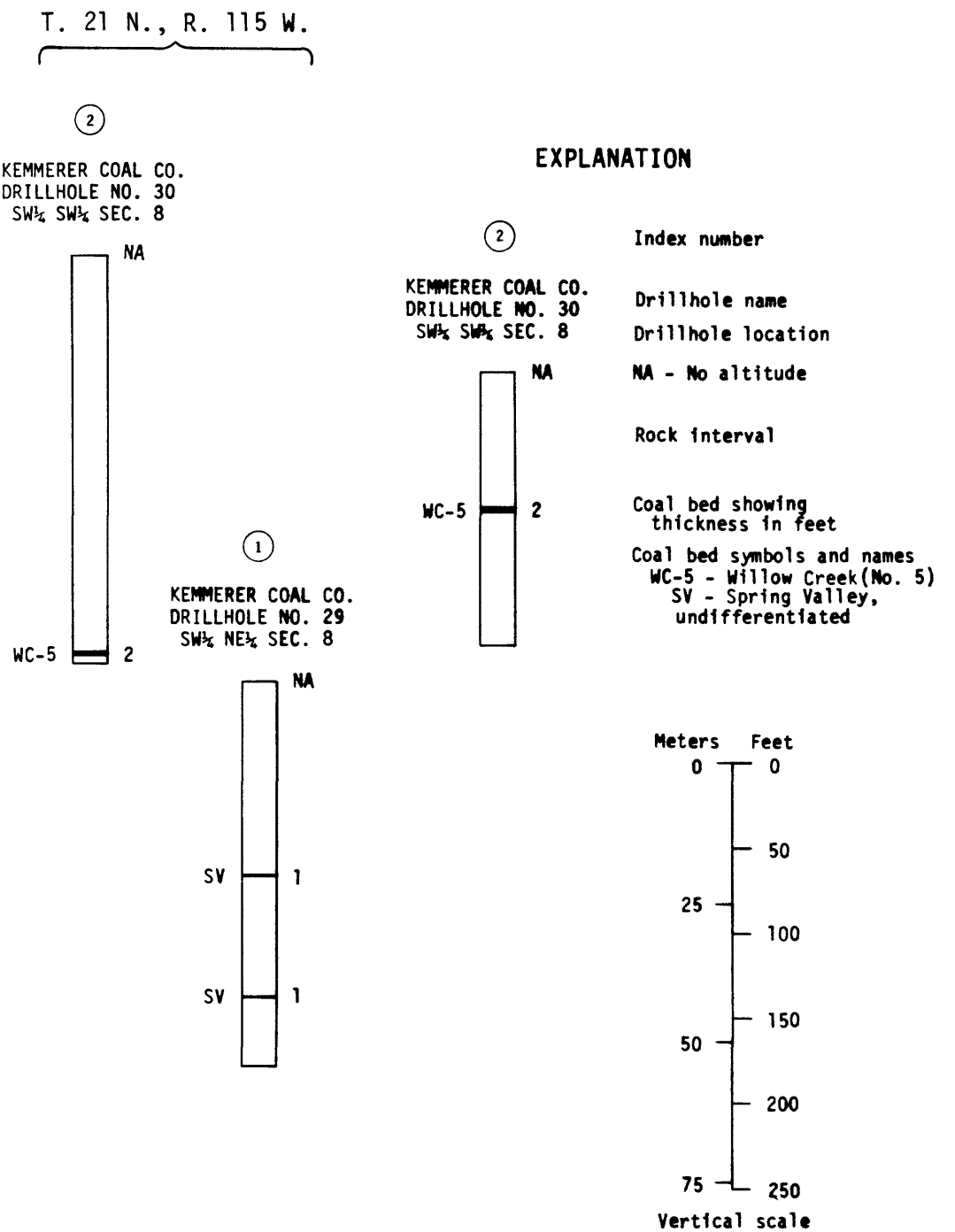
The Frontier Formation is the only formation that is potentially coal-bearing at depths of less than 3,000 feet (914 m) below the ground surface in the Willow Springs quadrangle. Two Frontier Formation coal zones, the Spring Valley coal zone and the Willow Springs coal zone, occur in that part of the Frontier Formation that crops out in this quadrangle.

Chemical analyses of coal.--No chemical analyses of coals were available from the Spring Valley coal zone or the Willow Creek coal zone in this quadrangle. However, the U.S. Bureau of Mines (1931) reported chemical analyses of Spring Valley coal in the Elkol quadrangle to the southwest and of Willow Creek coal in the southeast quarter of the Kemmerer 15-minute quadrangle to the west. Chemical analyses are shown in table 1. In general, coal in the Spring Valley coal zone ranks as high-volatile B bituminous and Willow Creek coals rank as high-volatile A bituminous on a moist, mineral-matter-free basis according to ASTM Standard Specification D 388-77 (American Society for Testing and Materials, 1977).

Coal Beds of the Frontier Formation

Spring Valley Coal Zone

The Spring Valley coal zone is located approximately 450 feet (137 m) above the base of the Frontier Formation (Glass, 1977). Two coal beds in the Spring Valley coal zone were encountered in a drill hole in sec. 8, T. 21 N., R. 115 W. (figure 2), in the Willow Springs quadrangle. The coal beds are both 1 foot (0.3 m) thick and are separated by 70 feet (21.3 m) of rock. Northwest of the Willow Springs quadrangle, in the northeast quarter of the Kemmerer 15-minute quadrangle, one Spring Valley coal bed was reported to have a maximum cumulative coal thickness of 8.7 feet (2.7 m) with a rock parting 2.2 feet (0.7 m) thick. To the



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U.S. Geol. Survey, 1935, Inactive Coal Lease No. EV-08809, Kemmerer Coal Co.

FIGURE 2. — Coal beds in drill holes.

southwest in the Elkol quadrangle, a Spring Valley coal bed has a maximum reported thickness of 12.4 feet (3.8 m) with no rock partings, and several other Spring Valley coal beds range in thickness from less than 1 foot (0.3 m) to 7 feet (2.1 m). According to Hunter (1950), two Spring Valley coal beds, separated by 40 to 80 feet (12.2 to 24.4 m) of rock, have been mined in the Elkol quadrangle where the coal beds vary greatly in thickness over a very short distance and thin rapidly to the north. Thickness measurements of Spring Valley coal beds in the adjacent southeast quarter of the Kemmerer 15-minute quadrangle to the west were not available. The dip of the Spring Valley coal beds in the Willow Springs quadrangle is approximately 20° to the west (Rubey and others, 1975).

Willow Creek Coal Zone

The Willow Creek coal zone is located 600 to 800 feet (183 to 244 m) above the Spring Valley coal zone and 200 to 300 feet (61 to 91 m) below the Oyster Ridge Sandstone Member. The Willow Creek (No. 5) coal bed, also called the Middle Willow Creek coal bed, is the thickest and most persistent coal bed in the Willow Creek coal zone (Hunter, 1950; Glass, 1977). In the Willow Springs quadrangle, the Willow Creek (No. 5) coal bed is 2 feet (0.6 m) thick with no rock partings where measured in sec. 8, T. 21 N., R. 115 W. To the west, in the southeast quarter of the Kemmerer 15-minute quadrangle, the Willow Creek (No. 5) coal bed has a maximum measured thickness of 5 feet (1.5 m) with no rock partings. To the northwest in the northeast quarter of the Kemmerer 15-minute quadrangle, this coal bed was reported to have a maximum cumulative thickness of 7.5 feet (2.3 m) with 0.3 feet (0.1 m) of rock partings. According to Hunter (1950), the Willow Creek (No. 5) thins to the south. Usually, there are other thin coal beds above the Willow Creek (No. 5) coal bed, but they were not encountered in this quadrangle (Andrews, 1944; Glass, 1977). The dip of this coal bed in the Willow Springs quadrangle is approximately 20° to the west (Rubey and others, 1975).

COAL DEVELOPMENT POTENTIAL

Areas where coal beds of Reserve Base thickness (5 feet or 1.5 meters) or greater are overlain by 3,000 feet (914 m) of overburden are

considered to have development potential for either surface or subsurface mining methods. In the Willow Springs quadrangle, the available drill-hole and coal-resource data is not sufficient to accurately evaluate coal resources. Since coal beds of Reserve Base thickness (5.0 feet or 1.5 meters) are not known to be present on Federal land in this quadrangle, all Federal lands within the KRCRA boundary have been classified as having an unknown development potential for surface and subsurface mining methods.

The source of each indexed data point shown on plate 1 is listed in table 2.

Table 1. Chemical analyses of coals in the Willow Springs 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
SW¼, NW¼, sec. 19, T. 22 N., R. 115 W., Willow Creek Prospect (U.S. Bureau of Mines, 1931)	Willow Creek	A	4.0	36.2	55.0	4.8	0.8	-	-	-	-	-	13,500
		C	0.0	37.7	57.3	5.0	0.8	-	-	-	-	-	14,060
Sec. 4, T. 20 N., R. 116 W., Fitzpatrick Mine (U.S. Bureau of Mines, 1931)	Spring Valley	A	7.1	35.2	50.8	6.9	0.4	-	-	-	-	-	12,470
		C	0.0	37.9	54.7	7.4	0.5	-	-	-	-	-	13,420

Form of Analysis: A, as received
B, air dried
C, moisture free

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

Table 2. -- Sources of data used on plate 1

Plate 1 Index Number	Source	Data Base
1	U.S. Geological Survey, 1935, Inactive coal lease Evanston-08809, Kemmerer Coal Co.	Drill hole No. 29
2	↓	Drill hole No. 30
3	Union Oil Co. and Carter Oil Co.	Oil/gas well No. 1-Gov't (Unit #1-Waterfall-Heath)

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