UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

TEXT TO ACCOMPANY:

COAL RESOURCE OCCURRENCE

AND

COAL DEVELOPMENT POTENTIAL

MAPS

OF THE

BOGIE DRAW QUADRANGLE,

CAMPBELL COUNTY, WYOMING

BY

INTRASEARCH INC.

DENVER, COLORADO

OPEN FILE REPORT 79-050
1979

This report is preliminary, and has not been edited or reviewed for conformity with United States Geological Survey standards or stratigraphic nomenclature.

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CONVERSION TABLE

TO CONVERT	MULTIPLY BY	TO OBTAIN
inches	2.54	centimeters (cm)
feet	0.3048	meters (m)
miles	1.609	kilometers (km)
acres	0.40469	hectares (ha)
tons (short)	0.9072	metric tons (t)
cubic yards/ton	0.8428	cubic meters per metric tons
acre feet	0.12335	hectare-meters
Btu/lb	2.326	kilojoules/kilogram (kJ/kg)
Btu/lb	0.55556	kilocalories/kilogram (kcal/kg)
Fahrenheit	5/9 (F-32)	Celsius

I. Introduction

This report and accompanying maps set forth the Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) of coal beds within the Bogie Draw Quadrangle, Campbell County, Wyoming. This CRO and CDP map series (U. S. Geological Survey Open-File Report 79-050) includes 35 plates. The project is compiled by IntraSearch Inc., 5351 South Roslyn Street, Englewood, Colorado, under KRCRA Eastern Powder River Basin, Wyoming Contract Number 14-08-0001-17180. This contract is part of a program to provide an inventory of unleased federal coal in Known Recoverable Coal Resource Areas (KRCRAs) in the western United States.

The Bogie Draw Quadrangle is located in Campbell County, in northeastern Wyoming. It encompasses all or parts of Townships 47 and 48 North, Ranges 75 and 76 West, and covers the area: 44°00' to 44°07'30" north latitude; 105°52'30" to 106°00' west longitude.

Main access to the Bogie Draw Quadrangle is provided by a maintained gravel road (Napier Road) extending northwest to southeast across the northeast quarter. Another gravel road extends east to west across the southern part of the quadrangle. Both roads are accessible from Wyoming State Highway 59 to the east. Minor roads and trails that branch from these gravel roads provide additional access to the more remote areas. The closest railroad is the Burlington Northern trackage, which lies 17 miles (27 km) to the northeast near Gillette, Wyoming.

Significant drainage of the fairly rugged terrain is provided by westward-flowing Beaver Creek that meanders through the central portion of the quadrangle. Beaver Creek eventually drains into the Powder River to the west. Bogie Draw, Bridge Draw, and numerous, intermittent streams supplement the drainage throughout the quadrangle and are also a part of the Powder River drainage system. Elevations attain heights of 4972 feet (1515 m) above sea level in the southern half of the quadrangle, 600 to 700 feet (183 to 213 m) above the valley floors to the north.

The 13 to 14 inches (33 to 36 cm) of annual precipitation falling in this semi-arid region accrue principally in the springtime. Summer and fall precipitation usually originates from thunderstorms, and infrequent snowfalls of 6 inches (15 cm) or less generally characterize winter precipitation. Although temperatures ranging from less than -25°F (-32°C) to more than 100°F (38°C) have been recorded near Gillette, Wyoming, average wintertime minimums and summertime maximums range from +5° to +°15F (-15° to -9°C) and 75° to 90°F (24° to 32°C), respectively.

Surface ownership is divided among fee, state, and federal categories with the state and federal surface generally leased to ranchers for grazing purposes. Details of surface ownership are available at the Campbell County Courthouse in Gillette, Wyoming. Details of mineral ownership on federal lands are available from the U. S. Bureau of Land Management in Cheyenne, Wyoming. Federal coal ownership is shown on Plate 2 of the Coal Resource Occurrence maps. The non-federal coal ownership comprises both fee and state coal resources.

The Coal Resource Occurrence and Coal Development Potential program pertains to unleased federal coal and focuses upon the delineation of lignite, subbituminous coal, bituminous coal, and anthracite at the surface, and in the subsurface. In addition, the program identifies total tons of coal in place, as well as recoverable tons. These coal tonnages are then categorized into units of measured, indicated, and inferred reserves and resources, and hypothetical resources. Finally, recommendations are made regarding the potential for surface mining, underground mining, and in-situ gasification of the coal beds. This report evaluates the coal resources of all unleased federal coal beds in the quadrangle which are 5 feet (1.5 m) or greater in thickness and occur at depths down to 3000 feet (914 m). No resources or reserves are computed for leased federal coal, state coal, fee coal, or lands encompassed by coal prospecting permits and preference-right lease applications.

Surface and subsurface geological and engineering extrapolations drawn from the current data base suggest the occurrence of approximately 10.7 billion tons (9.7 billion metric tons) of unleased federal coal resources in the Bogie Draw Quadrangle.

The suite of maps that accompany this report sets forth and portrays the coal resource and reserve occurrence in considerable detail. For the most part, this report supplements the cartographically displayed information with minimum verbal duplication of the CRO-CDP map data.

II. Geology

Regional. The thick, economic coal deposits of the Powder River Basin in northeastern Wyoming occur mostly in the Tongue River Member of the Fort Union Formation, and in the lower part of the Wasatch Formation. Approximately 3000 feet (914 m) of the Fort Union Formation, including the Tongue River, Lebo, and Tullock Members of Paleocene age, are unconformably overlain by approximately 700 feet (213 m) of the Wasatch Formation of Eocene age. These Tertiary formations lie in a structural basin flanked on the east by the Black Hills uplift, on the south by the Hartville and Casper Mountain uplifts, and on the west by the Casper Arch and the Big Horn Mountain uplift. The structural configuration of the Powder River Basin originated in Late Cretaceous time, with episodic uplift thereafter. The Cretaceous Cordillera was the dominant positive land form throughout the Rocky Mountain area at the close of Mesozoic time.

Outcrops of the Wasatch Formation and the Tongue River Member of the Fort Union Formation cover most of the areas of major coal resource occurrence in the Powder River Basin. The Tongue River Member is composed of very fine-grained sandstones, siltstones, claystones, shales, carbonaceous shales, and numerous coal beds. The Lebo Member of the Fort Union Formation consists of light- to dark-gray very fine-grained to conglomeratic sandstone with interbedded siltstone, claystone, carbonaceous shale and thin coal beds. Thin bedded calcareous ironstone concretions interbedded with massive white sandstone and slightly bentonitic shale occur throughout the unit. The Lebo Member is mapped at the surface northeast of Recluse, Wyoming. Here, the Lebo Member is east of the principal coal outcrops and associated clinkers (McKay, 1974), and it presumably projects into the subsurface beneath much of the basin. One of the principal characteristics for separating the Lebo and Tullock Members (collectively referred to as the Ludlow Member east of Miles City, Montana) from the overlying Tongue River Member is the color differential between the lighter-colored upper portion and the somewhat darker lower portion (Brown, 1958). Although geologists are trying to develop criteria for subsurface recognition of the Lebo-Tullock and Tongue River-Lebo contacts through the use of subsurface data from geophysical logs, no definitive guidelines are known to have been published. Hence, for subsurface mapping purposes, the Fort Union Formation is not divided into its members for this study.

During the Paleocene epoch, the Powder River Basin tropical to subtropical depositional environment included broad, inland flood basins with extensive swamps, marshes, freshwater lakes, and a sluggish, but active, northeastward-discharging drainage system. These features were superimposed on an emerging sea floor, near base level. Much of the vast area where organic debris collected was within a reducing depositional environment. Localized uplifts began to disturb the near sea-level terrain of northeastern Wyoming following retreat of the Cretaceous seas. However, the extremely fine-grained characteristics of the Tongue River Member clastics suggest that areas of recurring uplift peripheral to the Powder River Basin were subdued during major coal deposit formation.

The uplift of areas surrounding the Powder River Basin created a structural basin of asymmetric character, with the steep west flank located on the eastern edge of the Big Horn Mountains. The axis of the Powder River Basin is difficult to specifically define, but it is thought to be located in the western part of the Basin and to display a north-south configuration some 15 to 20 miles (24 to 32 km) east of Sheridan, Wyoming. Thus, the sedimentary section described in this report lies on the east flank of the Powder River Basin, with gentle dips of two degrees or less disrupted by surface structure thought to relate to tectonic adjustment and differential compaction.

Some coal beds in the Powder River Basin exceed 200 feet (61 m) in thickness. Deposition of these thick, in-situ coal beds requires a delicate balance between subsidence of the earth's crust and in-filling by trememdous volumes of organic debris. These conditions in concert with a favorable ground water table, non-oxidizing clear water, and a climate amenable to the luxuriant growth of vegetation produce a stabilized swamp critical to the deposition of coal beds.

Deposition of the unusually thick coal beds of the Powder River Basin may be partially attributable to short-distance water transportation of organic detritus into areas of crustal subsidence. Variations in coal bed thickness throughout the basin relate to changes in the depositional environment. Drill hole data that indicate either the complete absence or extreme attenuation of a thick coal bed probably relate to location of the drill holes within the ancient stream channel system draining this lowland area in Early Cenozoic time. Where thick coal beds thin rapidly from the depocenter of a favorable depositional environment, it is not unusual to encounter a synclinal structure over the maximum coal thickness due to the differential compaction between organic debris in the coal depocenter and fine-grained clastics in the adjacent areas.

The Wasatch Formation of Eocene age crops out over most of the central part of the Powder River Basin and exhibits a disconformable contact with the underlying Fort Union Formation. The contact has been placed at various horizons by different workers; however, for the purpose of this report, the contact is positioned near the top of the Roland coal bed as mapped by Olive (1957) in northwestern Campbell County, Wyoming. It is considered to descend disconformably in the stratigraphic column to the top of the Wyodak-Anderson coal bed (Roland coal bed of Taff, 1909) along the eastern boundary of the coal measures. No attempt was made to differentiate the Wasatch and Fort Union Formations on geophysical logs or in the subsurface mapping program for this project.

Although Wasatch and Fort Union lithologies are too similar to allow differentiation in some areas, most of the thicker coal beds occur in the Fort Union section on the east flank of the Powder River Basin. Furthermore, orogenic movements peripheral to the basin apparently increased in magnitude during Wasatch time causing the deposition of friable, coarse-grained to gritty, arkosic sandstones, fine- to very fine-grained sandstones, siltstones, mudstones, claystones, brown-to-black carbonaceous shales, and coal beds. These sediments are noticeably to imperceptibly coarser than the underlying Fort Union clastics.

The Bogie Draw Quadrangle is located in an area where surface rocks are classified within the Wasatch Formation. Olive (1957) correlated coal beds in the Spotted Horse coal field with coal beds in the Sheridan coal field (Baker, 1929) and Gillette coal field (Dobbin and Barnett, 1927), Wyoming, and with coal beds in the Ashland coal field (Bass, 1932) in southeastern Montana. This report utilizes, where possible, the coal bed nomenclature used in previous reports. The Felix coal bed was named by Stone and Lupton (1910). The Smith coal bed was named by Taff (1910). Baker (1929) assigned names to the Anderson, Canyon, and Wall coal beds. The Cook coal bed was named by Bass (1932), and the Pawnee coal bed was named by Warren (1959).

IntraSearch's correlation of thick coal beds from the Spotted Horse coal field to Gillette points out that the Wyodak coal bed, named the "D" coal bed by Dobbin and Barnett (1927), is equivalent to the Anderson, Canyon, and all, or part, of the Cook coal beds to the north and west of Gillette, Wyoming. Correlation of this suite of coal beds with the Wyodak coal bed south and southwest of Gillette suggests that the Anderson and Canyon coal beds equate with the upper 10 to 25 percent of the thick Wyodak coal bed, and the Cook and Wall, or Upper Wall, coal beds are equivalent to the major part of the Wyodak coal bed. Due to problematic correlations outside of the Gillette area, the name Wyodak has been informally used by many previous authors to represent the coal beds in the area surrounding the Wyodak coal mine. The Anderson-Canyon-Cook nomenclature is used in the Bogie Draw Quadrangle, to the north in the adjacent Morgan

Draw Quadrangle, and to the east in the adjacent Double Tanks Quadrangle. In the Fats Draw Quadrangle directly south of the Bogie Draw Quadrangle the name Wyodak is used. The Wildcat, Moyer, and Oedekoven coal beds were informally named by IntraSearch (1978b, 1979, and 1978a).

Local. The Bogie Draw Quadrangle lies on the eastern flank of the Powder River Basin where the strata dip gently westward. The Wasatch Formation crops out over the entire quadrangle and is composed of friable, coarse-grained to gritty, arkosic sandstones, fine- to very fine-grained sandstones, siltstones, mudstones, claystones, brown-to-black carbonaceous shales, and coal beds. The Fort Union Formation underlies the Wasatch Formation and is composed of fine-grained sandstones, siltstones, claystones, shales, carbonaceous shales, and numerous coal beds.

III. Data Sources

No significant coal outcrops or associated clinker are mapped in any publications known to IntraSearch at the time of this report. It is presumed, and highly possible, that no significant coal outcrops exist at the surface in the Bogie Draw Quadrangle.

Geophysical logs from oil and gas test bores and producing wells comprise the source of subsurface control. Some geophysical logs are not applicable to this study, for the logs relate only to the deep, potentially productive oil and gas zones. More than 80 percent of the logs include resistivity, conductivity, and self-potential curves. Occasionally the suite of geophysical logs includes gamma, density, and sonic curves. These logs are available from several commercial sources.

All geophysical logs available in the quadrangle are scanned to select those with data applicable to Coal Resource Occurrence mapping. Paper copies of the logs are obtained and interpreted, and coal intervals are annotated. Maximum accuracy of coal bed indentification is accomplished where gamma, density, and resistivity curves are available. Coal bed tops and bottoms are picked on the logs at the midpoint between the minimum and maximum curve deflections. The correlation of coal beds within and between quadrangles is achieved utilizing a fence diagram to associate local correlations with regional coal occurrences.

The reliability of correlations, set forth by IntraSearch in this report, varies depending on: the density and quality of lithologic and geophysical logs; the detail, thoroughness, and accuracy of published and unpublished surface geological maps; and interpretative proficiency. There is no intent on the part of IntraSearch to refute nomenclature established in the literature or used locally by workers in the area. IntraSearch's nomenclature focuses upon the suggestion of regional coal bed names applicable throughout the eastern Powder River Basin. It is expected, and entirely reasonable, that some differences of opinion regarding correlations, as suggested by IntraSearch, exist. Additional drilling for coal, oil, gas, water, and uranium, coupled with expanded mapping of coal bed outcrops and associated clinkers will broaden the data base for coal bed correlations and allow continued improvement in the understanding of coal bed occurrences in the eastern Powder River Basin.

The topographic map of the Bogie Draw Quadrangle is published by the U. S. Geological Survey, compilation date 1971. Land network and mineral ownership data are compiled from land plats available from the U. S. Bureau of Land Management in Cheyenne, Wyoming. This information is current to October 13, 1977.

IV. Coal Bed Occurrence

Wasatch and Fort Union Formation coal beds that are present in all or part of the Bogie Draw Quadrangle include, in descending stratigraphic order: the Felix, Smith, local, Anderson, Canyon, Cook, Wall, local, Pawnee, Wildcat, Moyer, and Oedekoven. A complete suite of maps (coal isopach, mining ratio, structure, overburden/interburden isopach, areal distribution of identified resources and identified resources) is prepared for the Smith, Lower Wall, and Pawnee coal beds, and for the Felix, Anderson-Canyon-Cook-Upper Wall, and Wildcat-Moyer-Oedekoven coal zones. Insufficient thickness and areal extent preclude any detailed mapping for the local coal beds.

No physical and chemical analyses are known to have been published regarding the coal beds in the Bogie Draw Quadrangle. However, the proximate analysis performed on an "as received" basis for Campbell and Converse County coal beds are as follows:

COAL BED NAME		ASH %	FIXED CARBON %	MOISTURE %	VOLATILES %	SULFUR %	BTU/LB
Felix (U)	Hole 7324	6.993	35.200	25.010	32.788	0.629	8544
Smith (U)	Hole 7340	3.505	38.036	29.980	28.474	0.309	8371
Anderson-Canyon-Cook (U)	Hole 7310	5.852	33.938	29.060	31.150	0.435	8172
Upper Wall (U)	Hole 7426	9.542	29.322	32.150	28.985	0.500	7279
Pawnee (U)	Hole 7424	7.880	31.029	31.910	29.183	0.386	7344
"Wildcat" (*)	Hole 11447	4.3	29.4	27.8	29.4	0.27	8410

(*) - Winchester, 1912
(U) - U. S. Geological Survey and Montana Bureau of Mines and Geology - 1974 & 1976

The Coal Data Sheet, Plate 3, shows the downhole identification of coal beds within the quadrangle as interpreted from geophysical logs from oil and gas test bores and producing sites. A datum coal bed is utilized to position columnar sections on Plate 3. This portrayal is schematic by design; hence, no structural or coal thickness implications are suggested by the dashed correlation lines projected through no record (NR) intervals. Inasmuch as the Anderson-Canyon-Cook coal zone underlies the entire quadrangle, it is designated as datum for the correlation diagram.

The Felix coal zone lies 80 to 660 feet (24 to 201 m) beneath the surface of the quadrangle and is comprised of two thin coal beds. The combined coal zone thickness ranges from 3 to 20 feet (0.9 to 6 m) with maximum thicknesses occurring in the northeast corner and minimum thicknesses in the northwest, southwest, and southeast corners. The clastic interval separating the Felix coal beds varies from 105 to 182 feet (32 to 55 m). The thin Upper Felix coal bed is somewhat lenticular and is absent from the southeast and southwest corners of the study area. Structure contours drawn on top of the Upper Felix coal bed indicate a gentle, regional, northwest dip showing minor anticlinal and synclinal features. The thickness of overburden above the Felix coal zone varies from less than 100 feet (30 m) to more than 500 feet (152 m).

The Smith coal bed occurs 325 to 422 feet (99 to 129 m) below the Felix coal zone and locally includes an Upper and Lower member. The total coal bed thickness ranges from 5 to 15 feet (1.5 to 5 m) with the thickest occurrences having a northwest to southeast trend across the central portion of the quadrangle. The non-coal interval separating the thin, lenticular lower coal bed from the thin, rather uniform upper coal bed varies from 6 to 15 feet (1.8 to 4.6 m). Structure contours drawn on top of the Smith coal bed indicate a westward-plunging anticline along the northern boundary and another northwest-plunging anticline in the southwest quarter of the quadrangle. A complex synclinal feature dominates the central portion of the study area. The Smith coal bed occurs at depths ranging from less than 750 feet (229 m) to more than 1000 feet (305 m) beneath the surface.

The Anderson-Canyon-Cook-Upper Wall coal zone occurs 315 to 534 feet (96 to 163 m) beneath the Smith coal bed and is comprised primarily of two thick coal beds. The total coal zone thickness ranges from 80 to 160 feet (24 to 49 m) with the thickest occurrences in the southeast quarter and western half of the quadrangle. The total thickness of the zone is attenuated locally, possibly due to channel deposits. A clastic interval separating the various coal beds comprising the coal zone varies from 0 to 333 feet (0 to 101 m) with no separation along the west-central border of the area. Structure contours drawn on top of the Anderson-Canyon-Cook-Upper Wall coal zone indicate a northwest-plunging anticline extending across the northern half of the quadrangle and another northwest-plunging anticline occurring in the southwest quarter of the study area. A narrow synclinal trough extends east to west across the southern half of the quadrangle, separating the two anticlines. The overburden above the Anderson-Canyon Cook-Upper Wall coal zone varies in thickness from less than 1000 feet (305 m) to more than 1500 feet (457 m).

The Lower Wall coal bed is located 94 to 253 feet (29 to 77 m) below the Anderson-Canyon-Cook-Upper Wall coal zone. The coal bed thickness ranges from 0 to 28 feet (0 to 9 m) with maximum thicknesses occurring along the northern edge of the quadrangle. The coal bed thins to the southwest and is absent from most of the southern half of the study area. Structure contours drawn on top of the Lower Wall coal bed indicate a gentle, regional, westward dip showing only minor structural variations. The Lower Wall coal bed lies at depths ranging from less than 1500 feet (457 m) to more than 1750 feet (533 m) below the surface.

The Pawnee coal bed lies 229 to 280 feet (70 to 85 m) below the Lower Wall coal bed and is comprised of a thin, locally separated coal bed. The coal bed thickness ranges from 0 to 24 feet (0 to 7 m) with thickest occurrences located in the extreme west-central part of the quadrangle. The coal bed thins to the east and is absent from the northeast and southeast corners of the study area. The clastic interval within the coal bed varies from 0 to 26 feet (0 to 8 m). Structure contours drawn on top of the Pawnee coal bed indicate a west-to-northwest dip showing numerous minor structural variances. The thickness of overburden above the Pawnee coal bed varies from less than 1750 feet (533 m) to more than 2250 feet (686 m).

The Wildcat-Moyer-Oedekoven coal zone occurs 193 to 364 feet (59 to 111 m) beneath the Pawnee coal bed, and is comprised primarily of three coal beds. The total coal zone thickness ranges from 20 to 57 feet (6 to 17 m) with maximum thicknesses occurring in the northern half of the quadrangle. Intervals of clastic debris ranging from 0 to 248 feet (0 to 76 m) thick separate the three primary coal beds into at least seven thin coal beds. Thickest total interburden appears to occur along the southern border of the quadrangle. Structure contours drawn on top of the Wildcat coal bed indicate a regional northwest dip with two minor northwest-plunging anticlines occurring in the western half of the quadrangle. The Wildcat-Moyer-Oedekoven coal zone lies at depths ranging from less than 2000 feet (610 m) to more than 2500 feet (762 m) beneath the surface.

V. Geological and Engineering Mapping Parameters

The correct horizontal location and elevation of drill holes utilized in subsurface mapping are critical to map accuracy. IntraSearch Inc., plots the horizontal location of the drill hole as described on the geophysical log heading. Occasionally this location is superimposed on or near to a drillsite shown on the topographic map, and the topographic map, horizontal location is utilized. If the ground elevation on the geophysical log does not agree with the topographic elevation of the drillsite, the geophysical log ground elevation is adjusted to conformance. If there is no indication of a drillsite on the topographic map, the "quarter, quarter, quarter" heading location is shifted within a small area until the ground elevation on the heading agrees with the topographic map elevation. If no elevation agreement can be reached, the well heading or data sheet is rechecked for footage measurements and ground elevation accuracy. Inquiries to the companies who provided the oil and gas geophysical logs frequently reveal that corrections have been made in the original survey. If all horizontal location data sources have been checked and the information accepted as the best available data, the drillsite elevation on the geophysical log is modified to agree with the topographic map elevation. IntraSearch Inc., considers this agreement mandatory for the proper construction of most subsurface maps, but in particular, the overburden isopach, the mining ratio, and Coal Development Potential maps.

Subsurface mapping is based on geologic data within, and adjacent, to the Bogie Draw Quadrangle area. Data from geophysical logs are used to correlate coal beds and control contour lines for the coal thickness, structure, and overburden maps. Structure contour maps are constructed on the tops of the main coal beds.

In preparing overburden isopach maps, no attempt is made to identify coal beds that occur in the overburden above a particular coal bed under study. Mining ratio maps for this quadrangle are constructed utilizing a 95 percent recovery factor. Contours of these maps identify the ratio of cubic yards of overburden to tons of recoverable coal. Where ratio control points are sparse, interpolated points are computed at the intersections of coal bed and overburden isopach contours using coal structure, coal isopach, and topographic control. On the Areal Distribution of Identified Resources Map (ADIR), coal bed reserves are not calculated where the coal is less than 5 feet (1.5 m) thick, where the coal occurs at a depth greater than 500 feet (152 m), where non-federal coal exists, or where federal coal leases, preference-right lease applications, and coal prospecting permits exist.

Coal tonnage calculations involve the planimetering of areas of measured, indicated, inferred reserves and resources, and hypothetical resources to determine their areal extent in acres. An Insufficient Data Line is drawn to delineate areas where surface and subsurface data are too sparse for CRO map construction. Various categories of resources are calculated in the unmapped areas by utilizing coal bed thicknesses mapped in the geologically controlled area adjacent to the insufficient data line. Acres are multiplied by the average coal bed thickness and 1750, or 1770--the number of tons of lignite A or subbituminous C coal per acre-foot, respectively (12,874 or 13,018 metric tons per hectare-meter, respectively), to determine total tons in place. Recoverable tonnage is calculated at 95 percent of the total tons in place. Where tonnages are computed for the CRO-CDP map series, resources and reserves are expressed in millions of tons. Frequently the planimetering of coal resources on a sectionized basis involves complexly curvilinear lines (coal bed outcrop and 500-foot stripping limit designations) in relationship with linear section boundaries and circular resource category boundaries. Where these relationships occur, generalizations of complexly curvilinear lines are discretely utilized, and resources and/or reserves are calculated within an estimated 2 to 3 percent, plus or minus, accuracy.

VI. Coal Development Potential

Strippable Coal Development Potential. Areas where coal beds are 5 feet (1.5 m) or more in thickness and are overlain by 500 feet (152 m) or less of overburden are considered to have potential for surface mining and are 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 subbituminous coal is as follows:

$$MR = \frac{to\ (0.911)^*}{tc\ (rf)}$$

where MR = mining ratio
to = thickness of overburden
tc = thickness of coal
rf = recovery factor
0.911* = conversion factor (cu. yds./ton)

*A conversion factor of 0.922 is used for lignite.

A surface mining development potential map (Plate 34) was prepared utilizing the following mining ratio criteria for coal beds 5 to 40 feet (1.5 to 12 m) thick:

1. Low development potential = 15:1 and greater ratio.
2. Moderate development potential = 10:1 to 15:1 ratio.
3. High development potential = 0 to 10:1 ratio.

The following mining ratio criteria are utilized for coal beds greater than 40 feet (12 m) thick:

1. Low development potential = 7:1 and greater ratio.
2. Moderate development potential = 5:1 to 7:1 ratio.
3. High development potential = 0 to 5:1 ratio.

The surface mining potential is low for most of the Bogie Draw Quadrangle. A minute area in the northeast corner is of moderate development potential. The low and moderate development potential ratings can be attributed to the moderate-to-high, overburden-to-coal ratios for the Felix coal zone. Approximately one-third of the quadrangle is classified as non-federal land or as having no surface mining potential.

Underground Mining Coal Development Potential. Subsurface coal mining potential throughout the Bogie Draw Quadrangle is considered low. Inasmuch as recovery factors have not been established for the underground development of coal beds in this quadrangle, reserves are not calculated for coal beds that occur more than 500 feet (152 m) beneath the surface. Table 2 sets forth the estimated coal resources in tons per coal bed.

In-Situ Gasification Coal Development Potential. The evaluation of subsurface coal deposits for in-situ gasification potential relates to the occurrence of coal beds more than 5 feet (1.5 m) thick buried from 500 to 3000 feet (152 to 914 m) beneath the surface. This categorization is as follows:

1. Low development potential relates to: 1) a total coal section less than 100 feet (30 m) thick that lies 1000 feet (305 m) to 3000 feet (914 m) beneath the surface, or 2) a coal bed or coal zone 5 feet (1.5 m) or more in thickness which lies 500 feet (152 m) to 1000 feet (305 m) beneath the surface.
2. Moderate development potential is assigned to a total coal section from 100 to 200 feet (30 to 61 m) thick and buried from 1000 to 3000 feet (305 to 914 m) beneath the surface.
3. High development potential involves 200 feet (61 m) or more of total coal thickness buried from 1000 to 3000 feet (305 to 914 m).

The coal development potential map for in-situ gasification (Plate 35) is constructed using the above criteria.

The coal development potential for in-situ gasification within the Bogie Draw Quadrangle is moderate for approximately 70 percent of the study area. A high potential rating covers approximately 20 percent of the quadrangle in the northern half, where the total coal thickness below 1000 feet (305 m) in depth exceeds 200 feet (61 m). The low potential rating covers approximately 7 percent of the study area primarily in the northwest quarter. The coal resource tonnage totals for in-situ gasification for low, moderate, and high potential areas are given on Table 3. The remaining area of the quadrangle is classified as non-federal coal land and was not evaluated for in-situ gasification.

Table 1.--Strippable Coal Reserve Base Data (in short tons) for Federal Coal Lands in the Bogie Draw Quadrangle, Campbell County, Wyoming.

Development potentials are based on mining ratios (cubic yards of overburden/ton of recoverable coal).

Coal Bed	High Development Potential (0-10:1 Mining Ratio)	Moderate Development Potential (10:1-15:1 Mining Ratio)	Low Development Potential (15:1 Mining Ratio)	Total
Felix	-	510,000	410,850,000	411,360,000
TOTAL	-	510,000	410,850,000	411,360,000

Table 2.--Coal Resource Base and Data (in short tons) for Undergound Mining Methods for Federal Coal Lands in the Bogie Draw Quadrangle, Campbell County, Wyoming.

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Felix	-	-	43,430,000	43,430,000
Smith	-	-	446,020,000	446,020,000
Anderson-Canyon Cook-Upper Wall	-	-	6,254,180,000	6,254,180,000
Lower Wall	-	-	548,450,000	548,450,000
Pawnee	-	-	616,980,000	616,980,000
Wildcat-Moyer-Oedekoven	-	-	2,378,330,000	2,378,330,000
TOTAL	-	-	10,287,390,000	10,287,390,000

Table 3.--Coal Resource Base Data (in short tons) for In-Situ Gasification for Federal Coal Lands in the Bogie Draw Quadrangle, Campbell County, Wyoming.

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
	2,560,040,000	7,082,050,000	645,300,000	10,287,390,000
TOTAL	2,560,040,000	7,082,050,000	645,300,000	10,287,390,000

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