

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Text to accompany:

Open-File Report 80-042

1980

COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS
OF THE PINE TREE QUADRANGLE, CAMPBELL COUNTY, WYOMING

[Report includes 16 plates]

By

John M. Wunder

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

CONTENTS

	Page
Introduction.....	1
Purpose.....	1
Location.....	1
Accessibility.....	1
Physiography.....	2
Climate.....	2
Land Status.....	2
Methods of Investigation.....	3
Acknowledgments.....	4
General Geology.....	4
Previous Investigations.....	4
Stratigraphy.....	4
Regional Structure.....	5
Coal Geology.....	5
Felix Coal Bed.....	6
Smith Coal Bed.....	7
Wyodak Coal Bed.....	8
"Wildcat" Coal Zone.....	9
Coal Resources.....	10
Coal Development Potential.....	15
Coal Development Potential for Surface-Mining Methods.....	15
Coal Development Potential for Underground-Mining Methods.....	16
Coal Development Potential for In-situ Gasification.....	17
References Cited.....	18

ILLUSTRATIONS

(Plates are separate)

Plates 1-16. Coal resource occurrence and coal development potential maps:

1. Coal-data map
2. Boundary and coal resource data map
3. Coal data sheet
4. Isopach and mining-ratio map of the Felix coal bed
5. Structure-contour map of the Felix coal bed
6. Overburden-isopach map of the Felix coal bed
7. Areal distribution and tonnage map of identified
resources of the Felix coal bed
8. Isopach map of the Wyodak coal bed
9. Structure-contour map of the Wyodak coal bed
10. Overburden-isopach map of the Wyodak coal bed
11. Areal distribution and tonnage map of identified
resources of the Wyodak coal bed
12. Isopach map of the "Wildcat" coal zone
13. Structure-contour map of the "Wildcat" coal zone
14. Overburden-isopach map of the "Wildcat" coal zone
15. Areal distribution and tonnage map of identified
resources of the "Wildcat" coal zone
16. Coal development potential for surface-mining methods

TABLES

Page

Table 1.	Coal Reserve Base for surface-mining methods and underground-mining methods for Federal coal lands in the Pine Tree quadrangle, Campbell County, Wyoming.....	12
2.	Estimated Reserve Base by coal development potential for surface-mining methods for Federal coal lands in the Pine Tree quadrangle, Campbell County, Wyoming.....	13
3.	Estimated Reserve Base by coal development potential for underground-mining methods for Federal coal lands in the Pine Tree quadrangle, Campbell County, Wyoming.....	13
4.	Estimated Reserve Base by coal development potential for in-situ gasification methods for Federal coal lands in the Pine Tree quadrangle, Campbell County, Wyoming.....	14

CONVERSION TABLE

<u>TO CONVERT</u>	<u>MULTIPLY BY</u>	<u>TO OBTAIN</u>
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)
But/lb	0.55556	kilocalories/kilogram (kcal/kg)
Fahrenheit	5/9 (F-32)	Celsius

INTRODUCTION

Purpose

This text and accompanying plates describe the Federal coal resources in the Pine Tree 7.5-minute quadrangle, Campbell County, Wyoming (U.S. Geological Survey Open-File Report 80-042). This report is intended to support land-use planning and coal leasing activities for the U.S. Bureau of Land Management, and to provide information for a systematic coal resource inventory of Federal coal land in Known Recoverable Coal Resource Areas (KRCRA's) in the western United States.

This report contains an evaluation of all federally owned coal beds in the quadrangle which are 5 feet (1.5 m) or more in thickness and occur at depths down to 3,000 feet (914.4 m). Coal resources were not computed for leased Federal coal, State-owned coal, privately owned coal, or Federal coal land encumbered by coal prospecting permits or preference-right lease applications.

Location

The Pine Tree quadrangle is located 56 miles (90 km) south-southwest of the city of Gillette, in southern Campbell County, Wyoming. The quadrangle occupies approximately 54 mi^2 (140 km^2), and covers the area $43^\circ 30'$ to $43^\circ 37' 30''$ north latitude, to $105^\circ 45'$ to $105^\circ 52' 30''$ west longitude. It encompasses parts of Townships 41 and 42 North, and Ranges 74 and 75 West.

Accessibility

The area is accessible by Wyoming State Route 387, which passes east-west through the quadrangle. State Route 50 connects with State Route 387 at Pine Tree. Several unimproved dirt roads and trails provide access to much of the area.

Physiography

The landscape in the Pine Tree quadrangle is dominated by rolling, grass-covered prairie. Elevations range from 5,530 feet (1,685.5 m) in the southwestern part of the quadrangle, to approximately 5,060 feet (1,542.3 m) in the southeastern part of the quadrangle.

Cottonwood Creek, whose northward-flowing upper tributaries drain the northwestern part of the study area, is part of the Powder River drainage system. The South Prong of the Belle Fourche River drains the northeastern portion of the quadrangle. Southeastward-flowing Ninemile Creek and Bates Creek drain the remainder of the quadrangle to the east, and are part of the Cheyenne River drainage system.

Climate

The climate in the Pine Tree quadrangle is temperate and semiarid. The area receives approximately 10 to 14 inches (25.4 to 35.6 cm) of annual precipitation, with most of the precipitation occurring between March and August (Breckenridge and others, 1974). The prevailing winds are from the northwest. The annual range in temperature is more than 90°F to less than 0°F (32°C to -18°C).

Land Status

Surface ownership of the land within the quadrangle is divided among private, State, and Federal categories. Details of the surface ownership are available at the Campbell County Courthouse in Gillette, Wyoming.

The Federal Government owns most of the mineral rights within the study area. Information regarding federally owned mineral rights can be obtained from the U.S. Bureau of Land Management in Cheyenne, Wyoming. Records of State-

owned mineral rights are maintained by the Wyoming State Board of Land Commissioners in Cheyenne. Information pertaining to privately owned mineral rights are available from the Campbell County Clerk's office in Gillette.

Methods of Investigation

A thorough review of published reports and maps was initiated to determine the presence of coal beds which crop out within the quadrangle. Coal beds were identified in the subsurface through the interpretation of geophysical logs from oil and gas test wells. These interpretations relied primarily on gamma-ray, resistivity, and conductivity logs. Coal beds were correlated from well to well by comparing the thickness, structural elevation, and stratigraphic sequence of the coal beds and intervening rock units. A set of Coal-isopach, Structure-contour, Overburden-isopach maps, and an Areal Distribution and Tonnage map of Identified Resources was prepared for the Felix coal bed (pls. 4-7), the Wyodak coal bed (pls. 8-11), and the Lower "Wildcat" and Middle "Wildcat" coal beds which were combined and mapped together as the "Wildcat" coal zone (pls. 12-14). Mining-ratio contours were also drawn for the Felix coal bed (pl. 4). A planimeter was used to measure the area, in acres, for each section of land which falls within the various coal resource categories described in U.S. Geological Survey Bulletin 1450-B (1976, p. 6-7). Tonnage estimates were then computed by multiplying the average coal bed thickness within each resource category by the area of each resource category. Coal tonnage was calculated using an assumed average weight of 1,770 short tons/acre-feet (13,018 metric tons/hectare-meter) for subbituminous coal.

Acknowledgments

The author wishes to gratefully acknowledge the assistance of Mary Salisbury and Chris Cordova for typing the manuscript and rechecking the tonnage figures, and to the members of the Coal Classification Section for providing many helpful suggestions.

GENERAL GEOLOGY

Previous Investigations

Dobbin and Barnett (1927) conducted early studies of coal beds in the area. Portions of the study area were investigated by Love (1952), Troyer and others (1954), and Sharp and Gibbons (1964), but with emphasis placed on the geology of uranium deposits. Breckenridge and others (1974) compiled a geologic map atlas and summarized the land, water, and mineral resources of Campbell County. Denson and others (1978a, 1978b) studied coal beds in the Reno Junction-Antelope Creek area of Wyoming. IntraSearch (1979a, 1979b, 1979c, 1979d, 1979e, 1979f, 1979g, 1979h) evaluated the Federal coal resources in the quadrangles adjacent to the Pine Tree quadrangle.

Stratigraphy

All of the rocks which crop out in the Pine Tree quadrangle belong to the Wasatch Formation of Eocene age. This unit is about 1,000 feet (304.8 m) thick in the quadrangle and consists predominately of fine- to coarse-grained arkosic sandstone, with interbeds of siltstone, shale, and thin coal beds.

The Wasatch Formation unconformably overlies the Fort Union Formation of Paleocene age. The Fort Union Formation consists predominately of shale and claystone, with interbeds of siltstone, fine- to coarse-grained sandstone and numerous coal beds. The total thickness of the Fort Union Formation is about 3,000 feet (914.4 m) in the Powder River Basin of Wyoming.

The contact between the Wasatch Formation and the underlying Fort Union Formation is arbitrarily placed by most authors at the top, or slightly above, the Wyodak coal bed.

Deposition of the coal beds probably occurred in large, continuous swamps adjacent to fluvial channels in a structurally stable basin. These environmental conditions must have persisted for a long time to promote the development of thick coal beds such as the Wyodak bed.

Regional Structure

The Pine Tree quadrangle is located near the approximate axis of the north-south trending Powder River Basin. The rocks have a gentle regional dip of less than 2 degrees to the northwest. No faults are known by this author to be present in the study area, although Denson and others (1978b) mapped northwest-southeast trending lineaments which may represent the surface expression of subsurface displacement.

COAL GEOLOGY

Several coal beds were identified on the surface or in the subsurface, or were projected into this quadrangle from adjacent quadrangles. These coal beds are shown in the composite stratigraphic section on plate 3. Of the identified coal beds, four coal beds are thick enough and have a large enough areal extent to be mapped and included in estimates of Reserve Base tonnage. Two of these four coal beds were mapped together as the "Wildcat" coal zone.

The uppermost coal bed is the Felix. This coal bed is successively underlain by: a noncoal interval about 570 feet (173.7 m) thick; the Smith coal bed; a noncoal interval about 300 feet (91.4 m) thick; the Wyodak coal bed; a noncoal interval about 5 to 50 feet (1.5 to 15.2 m) thick; an unnamed local coal bed of limited areal extent identified in only two drill holes; a noncoal interval

about 600 feet (182.9 m) thick; and the Middle "Wildcat" and Lower "Wildcat" coal beds ("Wildcat" coal zone) separated by a noncoal interval of about 67 feet (20.4 m).

No chemical analyses are known by this writer to have been published for the coal beds from this quadrangle. However, analyses of the coal beds from other locations in the Powder River Basin in Wyoming indicate that the coal is generally subbituminous C in rank (Glass, 1975, p. 18-21).

Felix Coal Bed
(plates 4-7)

The stratigraphically highest coal bed in the quadrangle is the Felix. This coal bed is present in the middle part of the Wasatch Formation of Eocene age. The Felix coal bed was named by Stone and Lupton (1910, p. 123) for exposures near the head of Wildhorse Creek at Felix, Wyoming.

The trace of the outcrop of the Felix coal bed in the Pine Tree quadrangle was obtained from Sharp and Gibbons (1964, pl. 1), and modified slightly by the present author to conform to the modern topographic map. In the quadrangle to the east of the Pine Tree quadrangle, IntraSearch (1979f) obtained the outcrop pattern of the Felix coal bed from Dobbin and Barnett (1927). As a result of using different data sources, the Felix outcrop of this report does not tie precisely with the Felix outcrop shown by IntraSearch (1979f).

The Felix coal bed in this quadrangle ranges in thickness from 0 feet (0 m) to slightly more than 5 feet (1.5 m) (pl. 4). The pinchout line and 5-foot (1.5-m) coal isopach of the Felix coal bed shown on plate 4 were projected from mapping in adjacent quadrangles by IntraSearch (1979d, 1979f). The Felix coal bed dips less than 2 degrees to the northwest and has approximately 200 feet (61.0 m) of structural relief in this quadrangle (pl. 5). The overburden overlying

the coal bed ranges in thickness from 0 feet (0 m) at the outcrop to slightly over 300 feet (91.4 m) in the northeast corner of the quadrangle (pl. 6). The total Reserve Base tonnage of the Felix coal bed is estimated to be 1.10 million short tons (1.00 million metric tons) (pl. 7).

No physical or chemical analyses are known to have been published for the Felix coal bed in the Pine Tree quadrangle. However, Glass (1978, p. 28) reports a range of analyses and their averages from 42 cores of the Felix coal bed in Campbell County, Wyoming, which were obtained by the U.S. Geological Survey and Montana Bureau of Mines and Geology (1973, 1974). These analyses, reported on an as-received basis, are given as follows:

<u>As-Received Basis</u>	<u>Range</u>	<u>Average</u>
Moisture	17.8-33.5%	28.0%
Volatile Matter	29.1-36.4%	31.7%
Fixed Carbon	28.4-39.4%	32.5%
Ash	4.5-14.9%	7.8%
Sulfur	0.32-3.26%	0.89%
Btu/pound	7,180-9,535	8,053

It is assumed by the author of this report that the Felix coal bed is subbituminous C in rank in this quadrangle.

Smith Coal Bed

The Smith coal bed was named for the operator of a local coal mine who mined the coal bed approximately 1 mile (1.6 km) southeast of Dietz, Wyoming. Taff (1907) was the first author to use the name of the Smith coal bed in publication.

The reader is advised that the Smith coal bed was not mapped and that coal resource estimates were not calculated in this quadrangle, although IntraSearch (1979f, 1979h) mapped the coal bed in adjacent quadrangles. IntraSearch's mapping projects a 5-foot (1.5-m) isopach of the Smith into the extreme south-

eastern corner of the Pine Tree quadrangle. The author of this report did not identify the Smith coal bed in any of the drill holes in this quadrangle, and does not recognize the existence of a 5-foot (1.5-m) thick Smith coal bed in this quadrangle.

Wyodak Coal Bed
(plates 8-11)

The Wyodak coal bed, or the "D" coal bed of Dobbin and Barnett (1927), was named for the coal bed being mined at the Wyodak mine 5 miles (8 km) east of Gillette, Wyoming (Martin, 1977). This coal bed is present at the top of, or in the upper part, of the Fort Union Formation of Paleocene age. The Wyodak coal bed of this report correlates with the Wyodak coal bed mapped by IntraSearch (1979a, 1979b, 1979c, 1979d, 1979e, 1979f) in adjacent quadrangles to the west, north, and east of this quadrangle. In the quadrangles to the southeast and south of the Pine Tree quadrangle, IntraSearch (1979g, 1979h) mapped the Anderson coal bed as being stratigraphically equivalent to the Wyodak coal bed of this report.

The Wyodak coal bed in this quadrangle ranges in thickness from 0 feet (0 m) in the southeast corner to slightly over 90 feet (27.4 m) in the northwest corner (pl. 8). The coal bed is shown to be absent in the southeast corner where an inferred pinchout line is projected into this quadrangle from adjacent quadrangles mapped by IntraSearch (1979f, 1979h). Structural contours drawn on the top of the Wyodak coal bed indicate that the coal bed dips less than 1 degree to the northwest (pl. 9). The Wyodak coal bed has approximately 400 feet (121.9 m) of structural relief in this quadrangle. The overburden overlying the coal bed ranges in thickness from less than 700 feet (213.4 m) in the southeast

corner of the quadrangle to over 1,400 feet (426.7 m) in the northwest quadrant of the quadrangle (pl. 10). The total Reserve Base tonnage of the Wyodak coal bed in this quadrangle is estimated to be 3.44 billion short tons (3.12 billion metric tons) (pl. 11).

No physical or chemical analyses are known to have been published for the Wyodak coal bed in the Pine Tree quadrangle. However, a range of values and their averages for 59 analyses of the Wyodak coal bed from Campbell County, Wyoming, has been compiled and reported as follows (Glass, 1978, p. 34):

<u>As-Received Basis</u>	<u>Range</u>	<u>Average</u>
Moisture	21.1-36.9%	29.8%
Volatile Matter	26.5-35.5%	30.7%
Fixed Carbon	29.6-41.4%	33.5
Ash	3.9-12.2%	6.0%
Sulfur	0.2-1.2%	0.5%
Btu/pound	7,420-9,600	8,244

It is assumed by the author of this report that the Wyodak coal bed is subbituminous C in rank in the Pine Tree quadrangle.

"Wildcat" Coal Zone
(plates 12-15)

IntraSearch (1978) first used the informal name "Wildcat" coal bed in the Rocky Butte quadrangle, Wyoming. The informal name "Wildcat" is used in this report to facilitate correlation and mapping of this coal zone with the same coal bed/zone mapped as the "Wildcat" in adjacent quadrangles by IntraSearch (1979c, 1979d, 1979e, 1979f, 1979g, 1979h).

In this quadrangle, the "Wildcat" coal zone consists of a "Middle Wildcat" and a "Lower Wildcat" coal bed separated by interburden which is up to 67 feet (20.4 m) in thickness. In the quadrangle to the east of the Pine Tree quadrangle, IntraSearch (1979f) projects an "Upper Wildcat" coal bed and an "Upper Wildcat"

pinchout line into this quadrangle. The author of this report does not recognize the presence of a coal bed in this quadrangle which is stratigraphically equivalent to the "Upper Wildcat" mapped by IntraSearch (1979f).

The total combined coal thickness of the "Wildcat" coal zone ranges from less than 5 feet (1.5 m) in much of the western half of the quadrangle to approximately 20 feet (6.1 m) in the southeast corner of the quadrangle (pl. 12). Structural contours drawn on the top of the coal zone indicate a structural relief of approximately 150 feet (45.7 m) (pl. 13). The coal zone dips less than 2 degrees to the northwest, with a broad synclinal feature plunging to the northwest located in the central part of the quadrangle (pl. 13). The overburden overlying the "Wildcat" coal zone ranges in thickness from slightly less than 2,000 feet (609.6 m) in the southeast corner of the quadrangle to approximately 2,500 feet (762.0 m) in the northwest quadrant of the quadrangle (pl. 14). The total interburden between the "Middle Wildcat" and "Lower Wildcat" coal beds is 67 feet (20.4 m) in the southeast part of the quadrangle (pl. 14). The total Reserve Base tonnage of the "Wildcat" coal zone in this quadrangle is estimated to be 307 million short tons (278 million metric tons) (pl. 15).

No physical or chemical analyses are known to have been published for the "Wildcat" coal zone in the Pine Tree quadrangle, but the coal is assumed to be subbituminous C in rank in this quadrangle.

Coal Resources

Coal resource estimates used in this report are restricted to the Reserve Base portion of Identified Coal Resources. The classification of Reserve Base coal used in this report was modified slightly from U.S. Geological Survey Bulletin 1450-B (1976). The Reserve Base of Identified Coal Resources for

subbituminous coal, as used in this report, is coal 5 feet (1.5 m) or more thick, under less than 3,000 feet (914.4 m) of overburden, and within 3 miles (4.8 km) of a complete measurement of the coal bed.

The Identified Reserve Base coal is subdivided into categories of Measured coal, Indicated coal, and Inferred coal based upon degrees of geologic assurance of its presence according to the distance of the coal bed from a known measurement point. Measured coal is coal found within 0.25 mile (0.40 km) of a measurement point; Indicated coal is coal found between 0.25 mile (0.40 km) and 0.75 mile (1.21 km) of a measurement point; Inferred coal is coal found between 0.75 mile (1.21 km) and 3 miles (4.8 km) of a measurement point.

The total Reserve Base coal for federally owned coal in the Pine Tree quadrangle is estimated to be approximately 3.75 billion short tons (3.40 billion metric tons). Plate 2 shows the total Reserve Base of federally owned coal for each section of land within the quadrangle. Table 1 shows the total Reserve Base coal for surface-mining methods and underground-mining methods for each coal bed and for each Identified Resource category. Reserve Base tonnage estimates in the various coal development potential categories for surface-mining methods, underground-mining methods, and in-situ gasification are shown in tables 2, 3, and 4, respectively.

Coal Reserves are considered to be that part of the Reserve Base tonnage which can be economically recovered upon mining. Reserves are calculated by applying a recovery factor to the economically minable Reserve Base. In this quadrangle, Reserves for surface mining were determined by multiplying the amount of Reserve Base coal under less than 500 feet (152.4 m) (the arbitrarily assigned stripping limit) of overburden by a recovery factor of 95 percent.

Table 1.--Coal Reserve Base for surface-mining methods and underground-mining methods for Federal coal lands in the Pine Tree quadrangle, Campbell County, Wyoming.

[In millions of short tons. To convert short tons to metric tons, multiply by 0.9072.]

Coal bed/zone	Surface-mining methods [overburden 0-500 feet (0-152.4 m)]			Underground-mining methods [overburden 500-3,000 feet (152.4-914.4 m)]		
	Identified Resource Category:		Total	Identified Resource Category:		Total
	Measured	Indicated		Measured	Indicated	
Felix	-----	-----	1.10	-----	-----	1.10
Wyodak	-----	-----	-----	101.68	680.65	3,440.78
"Wildcat"	-----	-----	-----	6.46	48.52	306.96
Total	-----	-----	1.10	108.14	729.17	3,747.74
						3,748.84

Table 2.--*Estimated Reserve Base by coal development potential for surface-mining methods [0-500 feet (0-152.4 m) overburden] for Federal coal lands in the Pine Tree quadrangle, Campbell County, Wyoming.*

[In millions of short tons. Development potentials are based on mining ratios (cubic yards of overburden/short ton of recoverable coal). To convert short tons to metric tons, multiply by 0.9072; to convert mining ratios in yd³/ton coal to m³/t, multiply by 0.842. To calculate Reserves, multiply the Reserve Base by the recovery factor of 95%.]

Coal bed/zone	High development potential (0-10 mining ratio)	Moderate development potential (10-15 mining ratio)	Low development potential (>15 mining ratio)	Total
Felix	----	0.77	0.33	1.10
Wyodak	----	----	----	----
"Wildcat"	----	----	----	----
Total	----	0.77	0.33	1.10

Table 3.--*Estimated Reserve Base by coal development potential for underground-mining methods [>500 feet (>152.4 m) overburden] for Federal coal lands in the Pine Tree quadrangle, Campbell County, Wyoming.*

[In millions of short tons. To convert short tons to metric tons, multiply by 0.9072.]

Coal bed/zone	High development potential	Moderate development potential	Low development potential	Total
Felix	----	----	----	----
Wyodak	----	----	3,440.78	3,440.78
"Wildcat"	----	----	306.96	306.96
Total	----	----	3,747.74	3,747.74

Table 4.--*Estimated Reserve Base by coal development potential for in-situ gasification methods [>500 feet (>152.4 m) overburden] for Federal coal lands in the Pine Tree quadrangle, Campbell County, Wyoming.*

[In millions of short tons. To convert short tons to metric tons, multiply by 0.9072.]

Coal bed/zone	High development potential	Moderate development potential	Low development potential	Total
Wyodak and Wildcat	----	----	3,747.74	3,747.74
Total	----	----	3,747.74	3,747.74

The Felix is the only coal bed in this quadrangle in which surface-minable Reserve estimates were made (pl. 7). The other coal beds lie deeper than 500 feet (152.4 m) beneath the ground surface and were not considered for underground-minable Reserve tonnage calculations. The Pine Tree quadrangle is estimated to contain 1.05 million short tons (0.95 million metric tons) of surface-minable coal Reserves.

COAL DEVELOPMENT POTENTIAL

Coal Development Potential for Surface-Mining Methods

Areas where the coal beds are 5 feet (1.5 m) or more thick and are overlain by 500 feet (152.4 m) or less of overburden are considered to have potential for surface mining and are assigned a high, moderate, or low coal development potential based upon the mining ratio (cubic yards of overburden per short ton of recoverable coal). The formula used to calculate mining ratios for subbituminous coal is as follows:

$$MR = \frac{(t_o)(0.911)}{(t_c)(rf)}$$

Where: MR = mining ratio
 t_o = thickness of overburden
(in feet)
 t_c = thickness of coal
(in feet)
rf = recovery factor (0.95) for this
quadrangle
0.911 = volume-to-weight conversion
factor for subbituminous coal
(cu. yds./short ton)

Areas which contain coal beds which are 5 feet (1.5 m) to 40 feet (12.2 m) thick and are overlain by 500 feet (152.4 m) or less of overburden were assigned into categories of high, moderate, and low coal development potential for surface-mining methods. These areas of high, moderate, and low coal development potential are defined in this report as areas underlain by coal beds having respective mining-ratio values of 0 to 10, 10 to 15, and greater than 15.

Areas which contain coal beds which are greater than 40 feet (12.2 m) thick and are overlain by 500 feet (152.4 m) or less of overburden were assigned into areas of high, moderate and low coal development potential based on the coal beds having respective mining-ratio values of 0 to 5, 5 to 7, and greater than 7. These mining-ratio values for each coal development potential category are based on generalized economic and technologic criteria developed by the U.S. Geological Survey for use in the Powder River Basin of Wyoming.

With the exception of a small area in the northeast corner of the quadrangle, almost all of the quadrangle is considered to have no coal development potential for surface mining (pl. 16). In the northeast corner of the quadrangle, the Felix coal bed is at least 5 feet (1.5 m) thick and lies within 500 feet (152.4 m) of the ground surface. The Felix coal bed has a low-to-moderate coal development potential in this area. All of the other coal beds present in the quadrangle are deeper than 500 feet (152.4 m) beneath the surface, and are considered to have no coal development potential for surface mining.

In the Pine Tree quadrangle, the amount of Reserve Base coal in the moderate coal development potential category for surface-mining methods is estimated to be 0.77 million short tons (0.70 million metric tons) (table 2). The Reserve Base coal in the low coal development potential category is estimated to be 0.33 million short tons (0.30 million metric tons).

Coal Development Potential for Underground-Mining Methods

The Reserve Base for federally owned coal deeper than 500 feet (152.4 m) beneath the ground surface is estimated to be 3.75 billion short tons (3.40 billion metric tons) (table 3). This coal would be recoverable only by underground mining methods. Because recovery factors have not been established for the underground development of coal beds in this quadrangle, Reserves were not calculated for coal beds deeper than 500 feet (152.4 m) beneath the ground surface. The underground coal development potential for these deep coal beds was not evaluated, and a coal development potential map for underground-mining methods was not prepared.

Coal Development Potential for In-Situ Gasification

Areas where the coal beds are 5 feet (1.5 m) or more thick and are overlain by 500 feet (152.4 m) or more of overburden are considered to have potential for in-situ gasification and are assigned a high, moderate, or low coal development potential based on the following depth and total coal thickness criteria:

<u>Depth from surface</u>	<u>Total coal thickness</u>	<u>Development potential</u>
0-500 feet (0-152.4 m)	5 feet (1.5 m) or more	none
500-1,000 feet (152.4-304.8 m)	5 feet (1.5 m) or more	low
1,000-3,000 feet (304.8-914.4 m)	100 feet (30.5 m) or less	low
	100-200 feet (30.5-61.0 m)	moderate
	200 feet (61.0 m) or more	high

These development potential categories for in-situ gasification are based upon generalized criteria developed by the U.S. Geological Survey for use in the Powder River Basin of Wyoming.

The coal development potential for in-situ gasification within the Pine Tree quadrangle is considered to be low because the total aggregate thickness of the coal at any given point in the quadrangle is less than 100 feet (30.5 m). As a result, a coal development potential map for in-situ gasification was not made for this quadrangle.

The Reserve Base for in-situ gasification on federally owned land within this quadrangle is estimated to be 3.75 million short tons (3.40 million metric tons) (table 4).

REFERENCES CITED

- Breckenridge, R. M., Glass, G. B., Root, F. K., and Wendell, W. G., 1974, Geologic map atlas and summary of land, water and mineral resources of Campbell County, Wyoming: Geological Survey of Wyoming County Resource Series 3, 9 plates.
- Denson, N. M., Dover, J. H., and Osmonson, L. M., 1978a, Lower Tertiary coal bed distribution and coal resources of the Reno Junction-Antelope Creek area, Campbell, Converse, Niobrara, and Weston Counties, Wyoming: U.S. Geological Survey Miscellaneous Field Studies Map MF-960, scale 1:125,000.
- _____ 1978b, Structure contour and isopach maps of the Wyodak-Anderson coal bed in the Reno Junction-Antelope Creek area, Campbell and Converse Counties, Wyoming: U.S. Geological Survey Miscellaneous Field Studies Map MF-961, scale 1:125,000.
- Dobbin, C. E., and Barnett, V. H., 1927 [1928], The Gillette coal field, northeastern Wyoming: U.S. Geological Survey Bulletin 796-A, p. 1-64.
- Glass, G. B., 1975, Analyses and measured sections of 54 Wyoming coal samples (collected in 1974): Geological Survey of Wyoming Report of Investigation 11, 219 p.
- _____ 1978, Wyoming coal fields, 1978: Geological Survey of Wyoming Public Information Circular 9, 91 p.
- IntraSearch, Inc., 1978, Coal resource occurrence and coal development potential maps of the Rocky Butte Quadrangle, Campbell County, Wyoming: U.S. Geological Survey Open-File Report 78-830, 22 p., 24 plates.

- _____ 1979a, Coal resource occurrence and coal development potential maps of the NW¼ of the Ross 15' Quadrangle, Converse and Campbell Counties, Wyoming: U.S. Geological Survey Open-File Report 79-315, 18 p., 8 plates.
- _____ 1979b, Coal resource occurrence and coal development potential maps of the Artesian Draw Quadrangle, Campbell County, Wyoming: U.S. Geological Survey Open-File Report 79-308, 19 p., 9 plates.
- _____ 1979c, Coal resource occurrence and coal development potential maps of the Rolling Pin Ranch Quadrangle, Campbell County, Wyoming: U.S. Geological Survey Open-File Report 79-071, 19 p., 19 plates.
- _____ 1979d, Coal resource occurrence and coal development potential maps of the South Butte Quadrangle, Campbell County, Wyoming: U.S. Geological Survey Open-File Report 79-072, 23 p., 25 plates.
- _____ 1979e, Coal resource occurrence and coal development potential maps of the NW¼ of the Turnercrest 15' Quadrangle, Campbell County, Wyoming: U.S. Geological Survey Open-File Report 79-073, 22 p., 25 plates.
- _____ 1979f, Coal resource occurrence and coal development potential maps of the SW¼ of the Turnercrest 15' Quadrangle, Campbell County, Wyoming: U.S. Geological Survey Open-File Report 79-309, 22 p., 24 plates.
- _____ 1979g, Coal resource occurrence and coal development potential maps of the NW¼ of the Coal Draw 15' Quadrangle, Converse and Campbell Counties, Wyoming: U.S. Geological Survey Open-File Report 79-316, 22 p., 24 plates.
- _____ 1979h [1980] Coal resource occurrence and coal development potential of the NE¼ of the Ross 15' Quadrangle, Converse and Campbell Counties, Wyoming: U.S. Geological Survey Open-File Report 79-181 (in press).
- Love, J. D., 1952, Preliminary report on uranium deposits in the Pumpkin Buttes area, Powder River Basin, Wyoming: U.S. Geological Survey Circular 176, 37 p.

- Martin, G. C., 1977, Coal resource occurrence map of the Little Thunder Reservoir Quadrangle, Campbell County, Wyoming: U.S. Geological Survey Open-File Report 77-57, 17 p. 13 plates.
- Sharp, W. N., and Gibbons, A. B., 1964, Geology and uranium deposits of the southern part of the Powder River Basin, Wyoming: U.S. Geological Survey Bulletin 1147-D, 60 p.
- Stone, R. W., and Lupton, C. T., 1910, The Powder River coal field Wyoming, adjacent to the Burlington Railroad: U.S. Geological Survey Bulletin 381-B, p. 115-136.
- Taff, J. A., 1907 [1909], The Sheridan coal field, Wyoming: U.S. Geological Survey Bulletin 341, p. 123-150.
- Troyer, M. L., McKay, E. J., Soister, P. E., and Wallace, S. R., 1954, Summary of investigations of uranium deposits in the Pumpkin Buttes area, Johnson and Campbell Counties, Wyoming: U.S. Geological Survey Circular 338, 17 p.
- 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.
- U.S. Geological Survey and Montana Bureau of Mines and Geology, 1973, Preliminary report of coal drill-hole data and chemical analyses of coal beds in Sheridan and Campbell Counties, Wyoming, and Big Horn County, Montana: U.S. Geological Survey Open-File Report, 51 p.
- _____, 1974, Preliminary report of coal drill-hole data and chemical analyses of coal beds in Campbell County, Wyoming: U.S. Geological Survey Open-File Report 74-97, 241 p.