UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

TEXT TO ACCOMPANY:

COAL RESOURCE OCCURRENCE

AND

COAL DEVELOPMENT POTENTIAL

MAPS

OF THE

COAL BANK DRAW QUADRANGLE,

CONVERSE AND CAMPBELL COUNTIES, WYOMING

BY

INTRASEARCH INC.

DENVER, COLORADO

OPEN FILE REPORT 79-320

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 Coal Bank Draw Quadrangle, Converse and Campbell Counties, Wyoming. This CRO and CDP map series includes 19 plates (U. S. Geological Survey Open-File Report 79-320. The project is compiled by IntraSearch Inc., 1600 Ogden Street, Denver, Colorado, under KRCRA Northeastern Powder River Basin, Wyoming Contract Number 14-08-0001-17180. This contract is a part of a program to provide an inventory of unleased federal coal in Known Recoverable Coal Resource Areas (KRCRA's) in the western United States.

The Coal Bank Draw Quadrangle is located in Converse and Campbell Counties, in eastern Wyoming. It encompasses parts of Townships 39, 40 and 41 North, Ranges 69 and 70 West, and covers the area: 43° 22' 30" to 43° 30' north latitude; 105° 07' 30" to 105° 15' west longitude.

Main access to the Coal Bank Draw Quadrangle is provided by the Irwin Road, a maintained gravel road which parallels Antelope Creek in the northwestern portion of the study area. Minor roads and trails provide additional access to the quadrangle. The closest railroad is the Burlington Northern trackage to the Black Thunder coal mine, approximately 10 miles (16 km) to the north. This railroad is under construction southward, and will be located 3 miles (5 km) west of the quadrangle boundary when completed.

The Dry Fork of the Cheyenne River drains the southeastern portion of the quadrangle, and Antelope Creek provides the major drainage for the northern half of the study area. These creeks flow eastward

into the Cheyenne River. A maximum elevation of 5060 feet (1542 m) above sea level is located in the west-central part of the quadrangle. Minimum elevations of 4380 feet (1335 m) above sea level occur in the valley floor of Antelope Creek at the eastern quadrangle boundary. The somber grays, yellows and browns of outcropping shales and siltstones contrast strikingly with the brilliant reds, oranges and purples of "clinker" and deep greens of the juniper and pine tree growth.

The ten to twelve inches (25 to 30 cm) of annual precipitation that falls in this semi-arid region accrues principally in the springtime. Summer and fall precipitation usually originates from thunderstorms, and infrequent snowfalls of six 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 approach +5° to +15°F (-15°F and -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 Converse and Campbell County Courthouses in Douglas and Gillette, Wyoming, respectively. Details of mineral ownership on federal lands are available for 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: 1) the delineation of

lignite, subbituminous coal, bituminous coal and anthracite at the surface and in the subsurface on federal land; 2) the identification of total tons in place as well as recoverable tons; 3) categorization of these tonnages into measured, indicated and inferred reserves and resources, and hypothetical resources, and 4) recommendations 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, or fee coal.

Surface and subsurface geological and engineering extrapolations drawn from the current data base suggest the occurrence of approximately 426 million tons (386 million metric tons) of unleased federal coal resources in the Coal Bank Draw Quadrangle.

The suite of maps that accompany this report set forth and portray 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, that includes 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 Lebo Member of the Fort Union Formation is mapped at the surface northeast of Recluse, Wyoming, east of the principal coal outcrops and associated clinkers (McKay, 1974), and 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 working with subsurface data, principally geophysical logs, in the basin are trying to develop criteria for subsurface recognition of the Lebo-Tullock and Tongue River-Lebo contacts, no definitive guidelines are known to have been published. Hence, for subsurface mapping purposes, the Fort Union Formation is not divided into its member subdivisions for this study.

During the Paleocene epoch, the Powder River Basin tropic to subtropic depositional environment included broad, inland flood basins with extensive swamps, marshes, freshwater lakes, and a sluggish but active northeastward discharging drainage system, superimposed on a near

base level, emerging sea floor. Much of the vast areas 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 characteristic, 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 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 discrete 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 low land 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, and is considered to disconformably descend 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 is made to differentiate the Wasatch and Fort Union Formations on geophysical logs or in the subsurface mapping program that is a part of this CRO-CDP 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 Coal Bank Draw Quadrangle is located in an area where surface rocks are classified into the Fort Union Formation. From 600 to 700 feet (183 to 213 m) of this formation are exposed in this area. 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.

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 ten to twenty-five 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 Wildcat coal bed was informally named by IntraSearch (1978).

Local. The Coal Bank Draw Quadrangle lies on the eastern flank of the Powder River Basin, where the strata dip gently westward. The Fort Union Formation crops out over the entire area, and is composed of very fine-grained sandstones, siltstones, claystones, shales, carbonaceous shales, and numerous coal beds.

A shallow, west-northwest plunging syncline is present in the southern portion of the Coal Bank Draw Quadrangle. Other structural configurations portray gentle westward dip.

III. Data Sources

Areal geology of the coal outcrops and associated clinker is derived from the Preliminary Coal Resource Occurrence Map of the Coal Bank Draw Quadrangle, Converse and Campbell Counties, Wyoming (Lingley, 1976).

The major sources of subsurface control, particularly on deep coal beds, is the geophysical logs from oil and gas test bores and producing wells. 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 eighty percent of the logs include resistivity, conductivity, and self-potential curves. Occasionally the logs include 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, interpreted, and coal intervals

annotated. Maximum accuracy of coal bed identification 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, vary 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 Coal Bank 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

Fort Union Formation coal beds that are present in all or part of the Coal Bank Draw Quadrangle include, in descending stratigraphic order, the Lower Wyodak, Local, Upper Wildcat, Local, Middle Wildcat, Local, and Lower Wildcat coal beds. A complete suite of maps (structure, isopach, mining ratio, overburden/interburden, identified resources, and areal distribution of identified resources) is prepared for the Lower Wyodak, Upper Wildcat and Middle Wildcat coal beds, and the Local-Lower Wildcat coal zone. The two stratigraphically highest local coal beds are not mapped due to the paucity of subsurface data.

No physical and chemical analyses are known to have been published regarding the coal beds in the Coal Bank Draw Quadrangle. However, the general "as received" basis proximate analyses for central and southern Campbell County coal beds are as follows:

COAL BED NAME		ASH	FIXED CARBON	MOISTURE	VOLATILES	SULFUR	BTU/LB
Upper Wyodak (U)	Hole 7544	4.501	32.688	24.332	38.450	0.201	8953
Wyodak (1)		4.760	35.000	28.360	31.880	0.330	8605

(U) - U. S. Geological Survey and Montana Bureau of Mines and Geology - 1976.

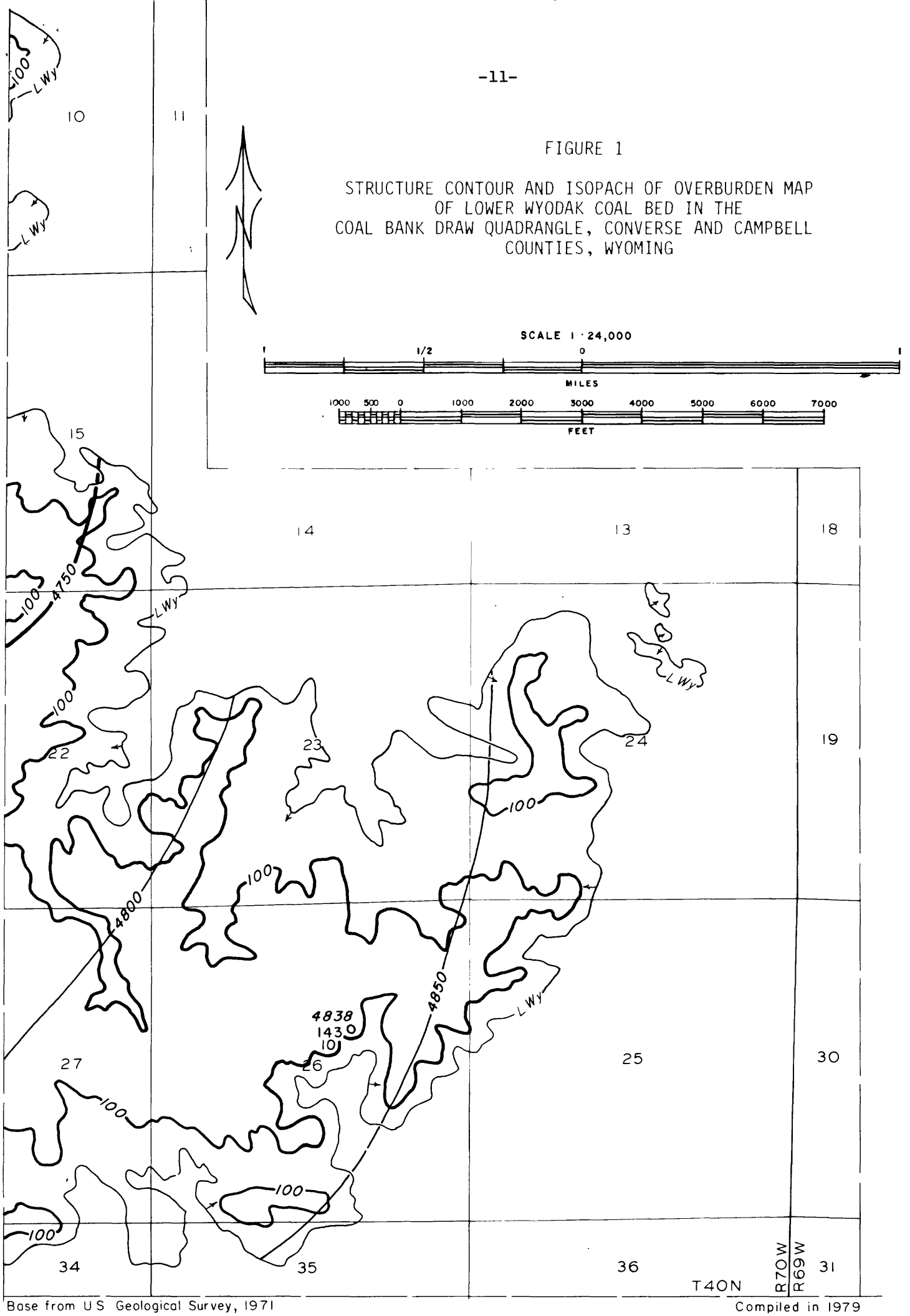
(1) - U. S. Department of the Interior, Draft Environmental Statement for the Development of Coal Resources in the Eastern Powder River Coal Basin of Wyoming - 1974.

All analyses except for BTU/LB are expressed as a percentage.

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. Inasmuch as the Upper Wildcat coal bed underlies the largest portion of the quadrangle, it is designated as datum for the correlation diagram.

FIGURE 1

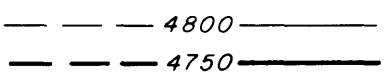
STRUCTURE CONTOUR AND ISOPACH OF OVERBURDEN MAP
OF LOWER WYODAK COAL BED IN THE
COAL BANK DRAW QUADRANGLE, CONVERSE AND CAMPBELL
COUNTIES, WYOMING



Base from U S Geological Survey, 1971

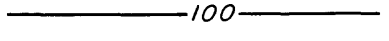
Compiled in 1979

EXPLANATION FOR FIGURE 1

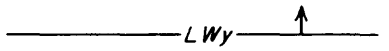


STRUCTURE CONTOURS- Drawn on top of coal bed. Contour interval 50 feet. Datum is mean sea level. Contour dashed where coal is burned or eroded.

DRILL HOLE-Slanted number showing elevation at top of coal bed; top vertical number showing thickness of overburden from the surface to the top of coal bed, bottom vertical number showing interburden thickness between upper and lower splits of the coal bed. Measurements in feet.



OVERBURDEN ISOPACH- Showing thickness of overburden, in feet, from the surface to the top of the coal bed. Isopach interval 100 feet.

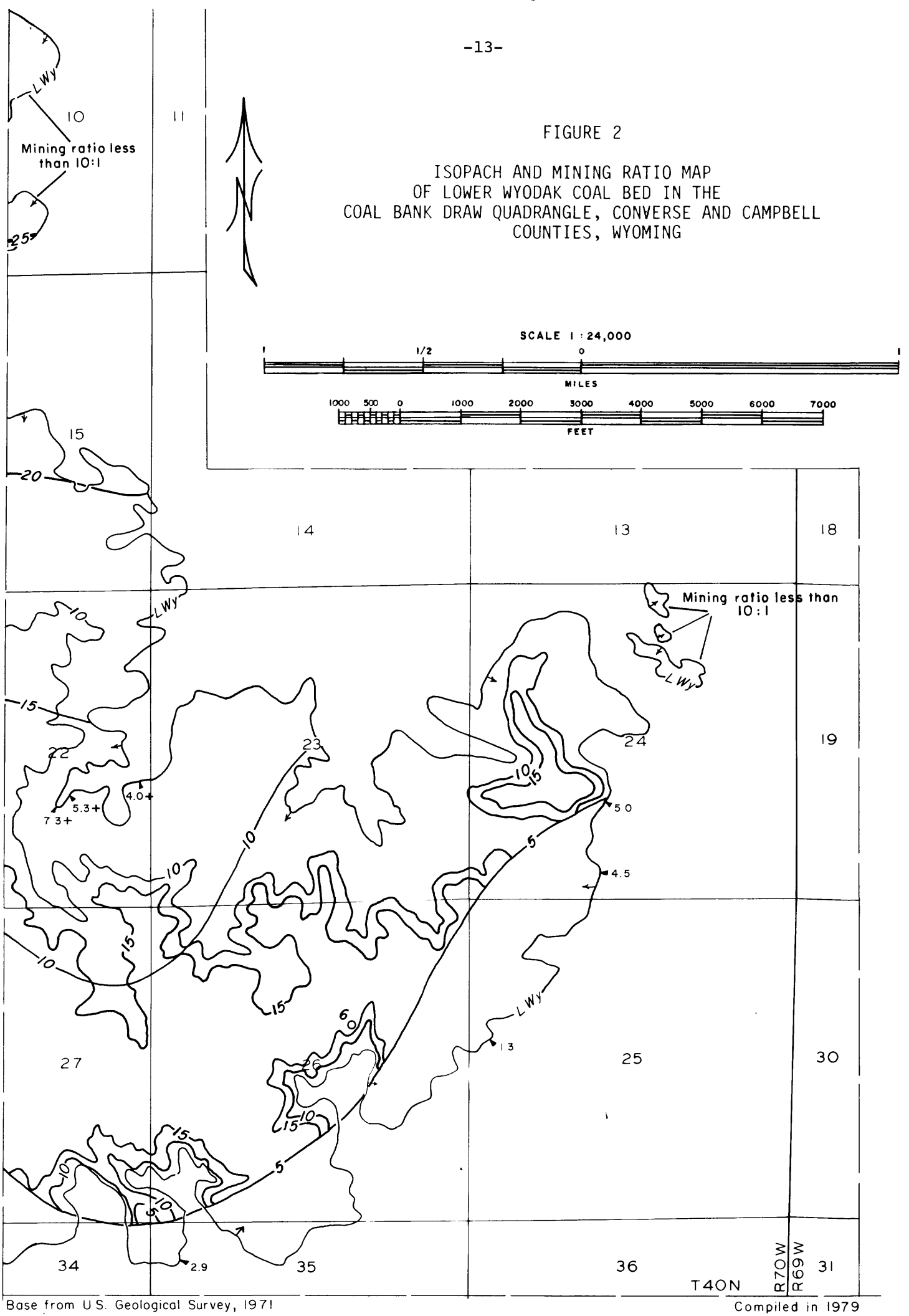


TRACE OF COAL BED OUTCROP- Arrow points toward the coal-bearing area.

To convert feet to meters multiply feet by 0.3048.

FIGURE 2

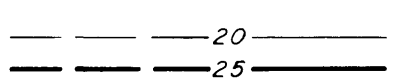
ISOPACH AND MINING RATIO MAP
OF LOWER WYODAK COAL BED IN THE
COAL BANK DRAW QUADRANGLE, CONVERSE AND CAMPBELL
COUNTIES, WYOMING



Base from U.S. Geological Survey, 1971

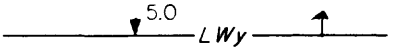
Compiled in 1979

EXPLANATION FOR FIGURE 2

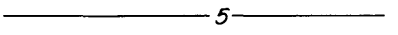


ISOPACHS OF COAL BED- Showing thickness in feet, interval 5 feet. Dashed where coal is burned or eroded.

DRILL HOLE- Showing coal thickness in feet.



TRACE OF COAL BED OUTCROP- Showing coal thickness in feet, measured at triangle. Arrow points toward the coal-bearing area.

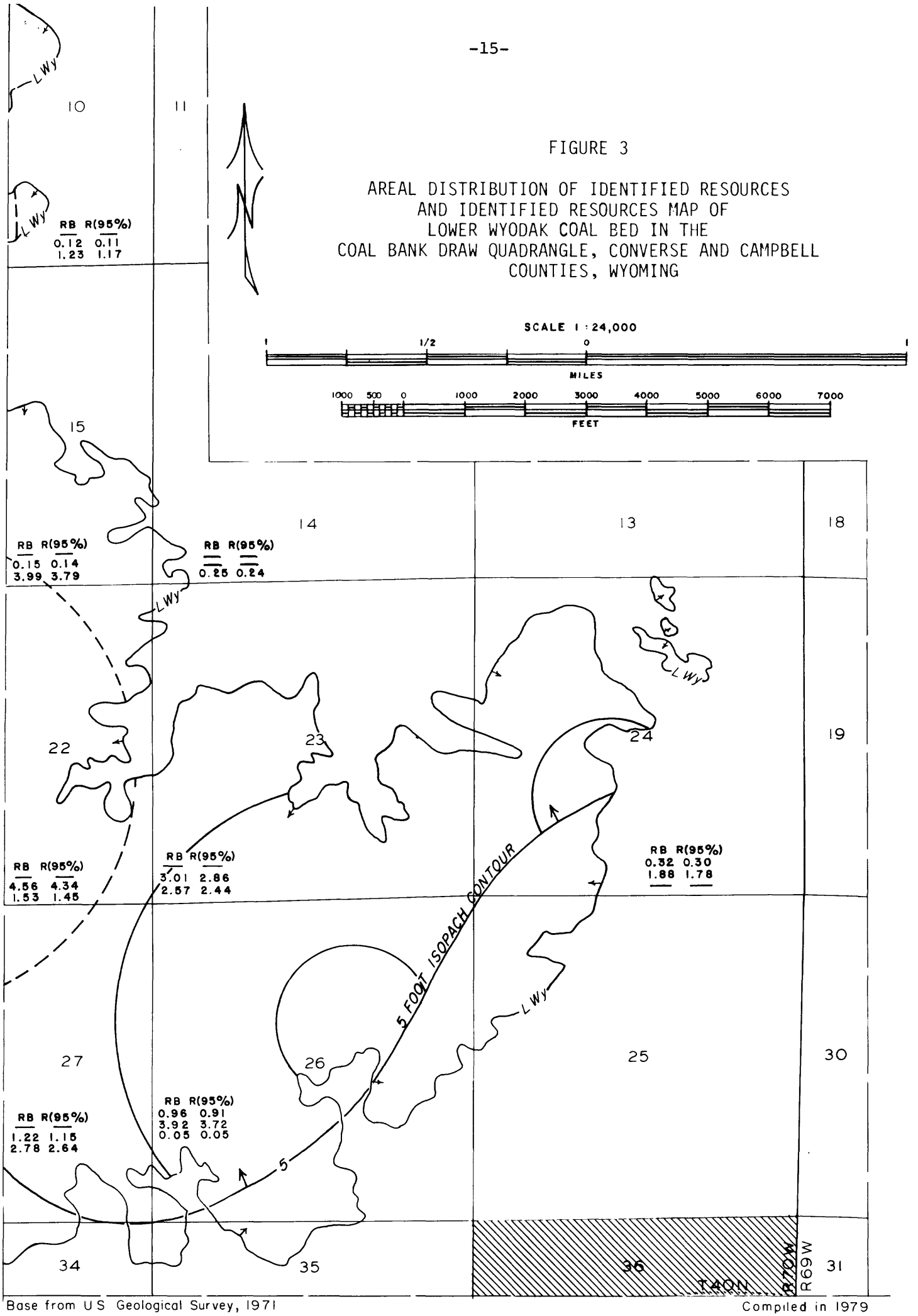


MINING RATIO- Number indicates cubic yards of overburden per ton of recoverable coal by surface mining methods. Ratio shown only in area suitable for surface mining.

To convert feet to meters multiply feet by 0.3048.

FIGURE 3

AREAL DISTRIBUTION OF IDENTIFIED RESOURCES
AND IDENTIFIED RESOURCES MAP OF
LOWER WYODAK COAL BED IN THE
COAL BANK DRAW QUADRANGLE, CONVERSE AND CAMPBELL
COUNTIES, WYOMING

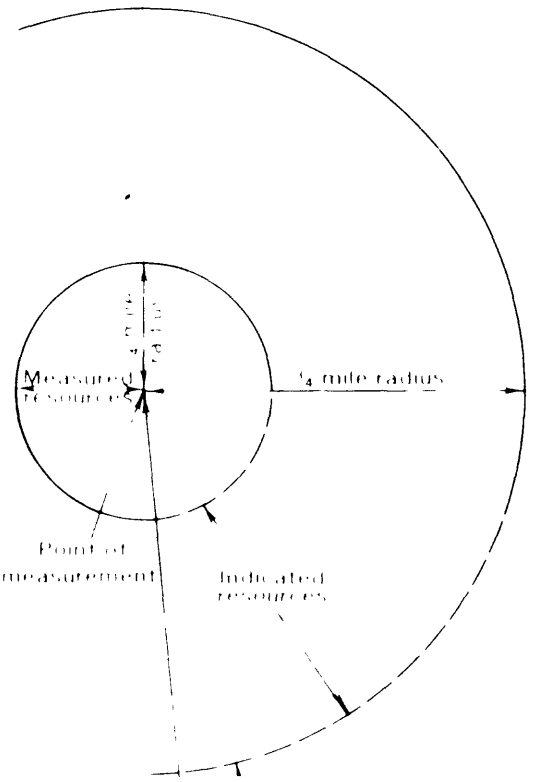


Base from US Geological Survey, 1971

Compiled in 1979

EXPLANATION FOR FIGURE 3

NON-FEDERAL COAL LAND



BOUNDARY LINES- Enclosing areas of measured and indicated coal resources of the coal bed. Inferred resources beyond 3/4 mile. Dashed where projected from adjacent quadrangles.

RB	R(95%)	
—	—	(Measured)
3.01	2.86	(Indicated)
2.57	2.44	(Inferred)

IDENTIFIED RESOURCES OF COAL BED- In millions of short tons. Dash indicates no resources in that category. Reserve Base (RB) x the recovery factor (95%) = Reserves (R).

LWy

TRACE OF COAL BED OUTCROP- Showing coal thickness in feet, measured at triangle. Arrow points toward the coal-bearing area.

To convert miles to kilometers multiply miles by 1.609.

To convert short tons to metric tons multiply short tons by 0.9072.

The Lower Wyodak coal bed crops out in the west-central portion of the quadrangle, and due to its limited geographic extent, three 8 1/2 x 11 inch (22 x 28 cm) maps are prepared to show the coal resources for the Lower Wyodak coal bed. Thicknesses for the Lower Wyodak coal bed (Figure 2) range from 1.3 to 20 feet (0.4 to 6 m), and average approximately 10 feet (3 m). Structural contours on top of the Lower Wyodak coal bed portray a westward dip of less than one degree (Figure 1). The Lower Wyodak coal bed lies less than 200 feet (61 m) beneath the surface throughout its area of occurrence (Figure 1).

The Upper Wildcat coal bed varies from 0 to 10 feet (0 to 3 m) thick, averages approximately 5 feet (1.5 m) thick (Plate 4), and is absent from the western portion of the study area. An Insufficient Data Line for the Upper Wildcat coal bed extends across the eastern half of the quadrangle delimiting the area to the east where subsurface data does not exist. Structural contours on top of the Upper Wildcat coal bed indicate a westward dip of less than one degree, and a west-plunging synclinal feature in the southern portion of the quadrangle (Plate 5). The Upper Wildcat coal bed lies less than 800 feet (244 m) beneath the surface throughout the Coal Bank Draw Quadrangle (Plate 6).

Occurring 108 to 180 feet (33 to 55 m) below the Upper Wildcat coal bed, the Middle Wildcat coal bed ranges from 0 to 10 feet (0 to 3 m) thick (Plate 9). Absent from the south-central portion of the study area, the Middle Wildcat coal bed averages approximately 5 feet (1.5 m) thick. Structural contours drawn on top of the Middle Wildcat coal bed define a westward dip of less than one degree (Plate 10). The Middle Wildcat coal bed in the Coal Bank Draw Quadrangle is equivalent to the Lower Wildcat coal bed in the Piney Canyon Southwest Quadrangle directly to the

north. In the Piney Canyon Southwest Quadrangle, the Middle Wildcat coal bed is labeled Lower Wildcat coal bed as a result of the presence of only two Wildcat coal beds. The Middle Wildcat coal bed lies less than 900 feet (274 m) beneath the surface throughout the Coal Bank Draw Quadrangle (Plate 11).

From 61 to 110 feet (19 to 34 m) of clastic sediment separates the Local-Lower Wildcat coal zone from the Middle Wildcat coal bed. Thicknesses for the Local-Lower Wildcat coal zone vary from 0 to 11 feet (0 to 3 m) and average 6 feet (1.8 m). Maximum thicknesses of 11 feet (3 m) are located in the central portion of the study area (Plate 14). The Local coal bed is present only in the east-central part of the quadrangle, and the Lower Wildcat coal bed is absent from the northern and southern portions of the study area. Structural contours are drawn on top of the Local coal bed where it is present. Where the Local coal bed is absent, structural contours are drawn on top of the Lower Wildcat coal bed. These structural contours portray a westward dip of less than one degree (Plate 15). The Local coal bed lies less than 600 feet (183 m) beneath the surface throughout its area of occurrence. Less than 950 feet (290 m) of overburden overlies the Lower Wildcat coal bed throughout the Coal Bank Draw Quadrangle (Plate 16).

V. Geological and Engineering Mapping Parameters

The correct horizontal location and elevation of drill holes utilized in subsurface mapping are critical to map accuracy. Intra-Search plots the horizontal location of the drill hole as described on the geophysical log heading. Occasionally this location is superimposed 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 correctness. 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 considers this agreement mandatory for the proper construction of most subsurface maps, but in particular, the overburden isopach, the ratio, and Coal Development Potential maps.

Subsurface mapping is based on geologic data within and adjacent to the Coal Bank 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. Isopach lines are also drawn to honor selected measured sections where there is sparse subsurface control. Where isopach contours do not honor surface measured sections, the surface thicknesses are thought to be attenuated by oxidation and/or erosion, hence not reflective of total coal thickness. Isopach lines extend to the coal bed outcrops, the projections of coal bed outcrops, and the contact between porcellanite (clinker) and unoxidized coal in place. Attenuation of total coal bed thickness is

known to take place near these lines of definition; however, the overestimation of coal bed tonnages that results from this projection of total coal thickness is insignificant to the Coal Development Potential maps. Structure contour maps are constructed on the tops of the main coal beds. Where subsurface data is scarce, supplemental structural control points are selected from the topographic map along coal outcrops.

In preparing overburden isopach maps, no attempt is made to identify coal beds that occur in the overburden to a particular coal bed under study. Mining ratio maps for this quadrangle are constructed utilizing a ninety-five 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 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 1770 (the number of tons of subbituminous C coal per acre-foot; 13,018

metric tons per hectare-meter), to determine total tons in place. Recoverable tonnage is calculated at ninety-five 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 complex curvilinear lines are discretely utilized, and resources and/or reserves are calculated within an estimated two to three 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 is as follows:

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

where MR = mining ratio
t_o = thickness of overburden
t_c = 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 potential map (Plate 19) is 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 is 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 high for approximately ten percent of the Coal Bank Draw Quadrangle. High potential areas in the west-central portion of the study area relate to mining ratios of less than 10:1 for the Lower Wyodak coal bed. Areas of high potential in the northeast and southeast sectors are due to Upper Wildcat mining ratios of less than 10:1. Moderate potential areas constitute five percent of the quadrangle. In the west-central part, these moderate potentials relate to Lower Wyodak mining ratios between 10:1 and 15:1. Moderate potential areas in the northeast and southeast portions of the quadrangle are due to Upper Wildcat mining ratios between 10:1 and 15:1. Low development potential areas encompass fifty percent of the Coal Bank Draw Quadrangle. These low development potential areas relate to mining ratios greater than 15:1 for the Upper Wildcat and Middle Wildcat coal beds, and the Local-Lower Wildcat coal zone. The remaining thirty-five percent of the study area is classified either as no development potential for surface mining methods

or non-federal coal land. Areas of no development potential are located where coal beds are less than 5 feet (1.5 m) thick, or overburden thicknesses are greater than 500 feet (152 m). Table 1 sets forth the estimated strippable reserve base and hypothetical resource tonnages per coal bed for the quadrangle.

Underground Mining Coal Development Potential. Subsurface coal mining pontential throughout the Coal Bank 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 500 feet (152 m) to 3000 feet (914 m) beneath the surface, or 2) coal beds 5 feet (1.5 m) or more in thickness that lie 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 for in-situ gasification on the Coal Bank Draw Quadrangle is low, hence no CDP map is generated for this map series. The coal resource tonnage for in-situ gasification with low development potential totals approximately 104 million tons (94 million metric tons) (Table 3). None of the coal beds in the Coal Bank Draw Quadrangle qualify for a moderate or high development potential rating.

Table 1.--Strippable Coal Reserve Base and Hypothetical Resource Data (in short tons) for Federal Coal Lands in the Coal Bank Draw Quadrangle, Converse and Campbell Counties, 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
Reserve Base Tonnage				
Lower Wyodak	14,680,000	5,570,000	6,840,000	27,090,000
Upper Wildcat	10,040,000	5,750,000	82,620,000	98,410,000
Middle Wildcat	-----	4,690,000	58,180,000	62,870,000
Local - Lower Wildcat	-----	-----	105,470,000	105,470,000
TOTAL	24,720,000	16,010,000	253,110,000	293,840,000
Hypothetical Resource Tonnage				
Upper Wildcat	-----	-----	12,910,000	12,910,000
TOTAL	-----	-----	12,910,000	12,910,000
GRAND TOTAL	24,720,000	16,010,000	266,020,000	306,750,000

Table 2.--Coal Resource Base Data (in short tons) for Underground Mining Methods for Federal Coal Lands in the Coal Bank Draw Quadrangle, Converse and Campbell Counties, Wyoming.

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Upper Wildcat	-----	-----	840,000	840,000
Middle Wildcat	-----	-----	57,840,000	57,840,000
Local-Lower Wildcat	-----	-----	45,480,000	45,480,000
TOTAL	-----	-----	104,160,000	104,160,000

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

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Upper Wildcat	-----	-----	840,000	840,000
Middle Wildcat	-----	-----	57,840,000	57,840,000
Local-Lower Wildcat	-----	-----	45,480,000	45,480,000
TOTAL	-----	-----	104,160,000	104,160,000

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