UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

TEXT TO ACCOMPANY:

COAL RESOURCE OCCURRENCE

AND

COAL DEVELOPMENT POTENTIAL

MAPS

OF THE

SOMERVILLE FLATS WEST QUADRANGLE,

JOHNSON COUNTY, WOMING

BY

INTRASEARCH INC.

ENGLEWOOD, COLORADO

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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/ metric ton
acre-feet	0.12335	hectare-meters
British thermal units/pound (Btu/lb)	2.326	kilojoules/kilogram (kj/kg)
British thermal units/pound (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 Somerville Flats West Quadrangle, Johnson County, Wyoming. This CRO and CDP map series includes 40 plates (U. S. Geological Survey Open-File Report 79-172). 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 a 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 Somerville Flats West Quadrangle is located in Johnson County, in northeastern Wyoming. It encompasses all or parts of Townships 49, 50 and 51 North, Ranges 77 and 78 West, and covers the area: 44°15' to 44°22'30" north latitude; 106°07'30" to 106°15' west longitude.

Main access to the Somerville Flats West Quadrangle is provided by a maintained light-duty road, which extends north to south across the eastern portion of the quadrangle in the Powder River valley. Minor roads and trails branch from the maintained road providing access to the more remote areas. The closest railroad is the Burlington Northern trackage approximately 14 miles (23 km) to the northeast near Echeta, Wyoming.

Drainage is provided by the northward-flowing Powder River which meanders northward throughout the eastern third of the quadrangle.

Flying E Creek, Dry Creek, Coal Gulch, and Deer Gulch flow eastward into the Powder River and drain the rugged terrain of the quadrangle. The terrain attains elevations of 4,620 feet (1,408 m) above sea level in the northwest portion of the quadrangle, where hills rise 750 to 800 feet (229 to 244 m) above the valley floor.

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 Arvada, Wyoming, average wintertime minimums and summertime maximums range from +5° to +15°F (-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 Johnson County Courthouse in Buffalo, 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 (resources), as well as recoverable tons (reserves). These coal tonnages are then categorized in measured, indicated, and inferred parts of identified 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 3,000 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 11.8 billion tons (10.7 billion metric tons) of total, unleased federal coal-in-place resources in the Somerville Flats West Quadrangle.

The suite of maps that accompanies 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 overlying Wasatch Formation. Approximately 3,000 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 the 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. 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 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 member subdivisions 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 2 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 and in-filling of these areas by tremendous 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 of 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 servicing 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 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 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 noticably to imperceptibly coarser than the underlying Fort Union clastics.

The Somerville Flats West Quadrangle is located in an area where surface rocks classified within the Wasatch Formation. Although the Wasatch Formation is reportedly up to 1,800 feet (549 m) thick (Denson and Horn, 1975), Olive (1957) mapped 700 to 800 feet (213 to 244 m). Only 750 to 800 feet (229 to 244 m) of Wasatch Formation are exposed in the quadrangle. Olive (1957) correlated coal beds in the Spotted Horse coal field with coal beds in the northward extension of the Sheridan coal field, Montana (Baker, 1929), and Gillette coal field, Wyoming (Dobbin and Barnett, 1927), 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 Dry Creek and Healy coal beds were named by Gale and Wegemann (1910). The Felix coal bed was named by Stone and Lupton (1910). Taff (1909) named the Smith coal bed, and the Cook coal bed was named by Bass (1932). The Anderson, Canyon, and Wall coal bed were named by Baker (1929). The Pawnee coal bed was named by Warren (1959). IntraSearch informally assigned names to the Wildcat and Oedekoven coal beds (1978b, 1978a).

IntraSearch's correlation of the 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 and Canyon coal beds (Baker, 1929), and all, or part, of the Cook (Bass, 1932) and the Wall coal bed to the north and west of Gillette, Wyoming. Due to problematic correlations outside of the Gillette area, the Wyodak has been informally used by previous authors to represent coal beds in the area surrounding the Wyodak coal mine. The Anderson, Canyon, and Cook coal beds in the Somerville Flats West Quadrangle correlate with the Wyodak coal zone to the south in Juniper Draw Quadrangle.

Local. The Somerville Flats West 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 directly underlies the Wasatch Formation, and is composed of very fine-grained sandstones, siltstones, claystones, shales, carbonaceous shales, and numerous coal bed.

The dominant structural feature within the quadrangle is a northwest-plunging anticline in the eastern half of the quadrangle. Structure contours in the western half of the quadrangle depict regional westward dip.

III. Data Sources

Areal geology of the coal outcrops is derived from the Barber coal field report (Wegemann, 1913). The coal bed outcrops are adjusted to the current topographic maps in the area. The Walters and Healy beds crop out above the Dry Creek coal bed, however, they are not mapped due to insufficient thickness and areal extent.

Geophysical logs from oil and gas test bores and producing wells compose 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 and its 3-mile perimeter area were scanned to select those with data applicable to Coal Resource Occurrence mapping. Paper copies of the logs were obtained and interpreted, and coal intervals were annotated. Maximum accuracy of coal bed identification was accomplished where gamma, density and resistivity curves were available. Coal bed tops and bottoms were identified on the logs at the midpoint between the minimum and maximum curve deflections. The correlation of coal beds within and between quadrangles was 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 details, 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 Somerville Flats West Quadrangle is published by the U. S. Geological Survey, compilation date 1972. 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

The Wasatch Formation and Fort Union Formation coal beds that are present in all or part of the Somerville Flats West Quadrangle include, in descending stratigraphic order: the Walters, Healy, Dry Creek, Local, Felix, Smith, Anderson, Canyon, Cook, Wall, Pawnee, Wildcat, Moyer, Oedekoven, Local 1, and Local 2 coal beds. The Smith coal beds and the Pawnee coal beds are mapped as coal zones. The Oedekoven, Local 1, and Local 2 coal beds are mapped as a coal bed composite. A suite of maps composed of: coal isopach and mining ratio, where appropriate; structure; overburden isopach; areal distribution of identified resources; identified resources and hypothetical resources, where applicable, was prepared for each of these coal beds or coal zones. Mining ratios are presented on the isopach maps of the Local, Dry Creek, and Felix coal beds.

No physical or chemical analyses are known to have been published regarding coal beds from the Somerville Flats West Quadrangle. For Campbell and northern Johnson County coal beds, the "as received" proximate analysis; the Btu value computed on a moist, mineral-matter-free basis;* and the coal rank are as follows:

COAL BED NAME		DATA SOURCE IDENTIFICATION	AS RECEIVED BASIS: ASH %	AS RECEIVED BASIS: FIXED CARBON %	AS RECEIVED BASIS: MOISTURE %	AS RECEIVED BASIS: VOLATILES %	AS RECEIVED BASIS: SULFUR %	AS RECEIVED BASIS: BTU/LB	MOIST, M-M-F BTU/LB	COAL RANK
Felix	(U)	Hole 7335	7.4	33.8	26.2	32.7	0.80	8538	9279	Subbtm. C
Smith	(U)	Hole 7340	3.5	38.0	30.0	28.5	0.31	8371	8700	Subbtm. C
Anderson	(U)	Hole 7334	5.5	34.6	29.2	30.8	0.4~~5~~6	8049	8551	Subbtm. C *
Canyon-Cook	(U)	Hole 7334	5.1	34.9	29.4	30.5	0.28	8329	8814	Subbtm. C
Wall	(U)	Hole 7426	9.5	29.3	32.2	29.0	0.50	7279	8112	Lignite A
Pawnee	(U)	Hole 7424	7.9	31.0	31.9	29.2	0.39	7344	8025	Lignite A

* The moist, mineral-matter-free Btu values are calculated in the manner stipulated in the publications by American Society for Testing and Materials (1971).

** Stone and Lupton (1910).

(1) Winchester (1912).

(U) U. S. Geological Survey and Montana Bureau of Mines and Geology (1974 and 1976).

The proximate analyses presented above are from core hole or outcrop locations in excess of 20 miles (32 km) from this quadrangle. For the purpose of tonnage computations, all coal beds in the Somerville Flats West Quadrangle are tentatively classified as subbituminous C rank.

The Coal Data sheet, plate 3, shows the down-hole identification of coal beds within the quadrangle as interpreted from U. S. Geological Survey and Montana Bureau of Mines and Geology drill holes and geophysical logs from oil and gas test bores and from producing sites. 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 coal bed underlies the entire quadrangle, it is designated as datum for the correlation diagram. The Anderson and Canyon-Cook coal beds show the thickest coal bed occurrence throughout the study area. The Dry Creek, Local, Felix, Smith, Wall, Wildcat, Oedekoven, Local 1, and Local 2 coal beds are relatively thin throughout the Somerville Flats West Quadrangle.

The Dry Creek coal bed is eroded or less than 5 feet (1.5 m) thick for approximately 95 percent of the Somerville Flats West Quadrangle. The Dry Creek coal bed ranges in thickness from 0 to 6 feet (0 to 1.8 m) in the valley of Flying E Creek (figure 1). An insufficient data line is drawn north of Flying E Creek due to inadequate subsurface and surface control. Structure contours drawn on the top of the Dry Creek coal bed depict a gentle, westward dip. The Dry Creek coal bed lies 0 to 350 feet (0 to 107 m) beneath the surface (figure 2).

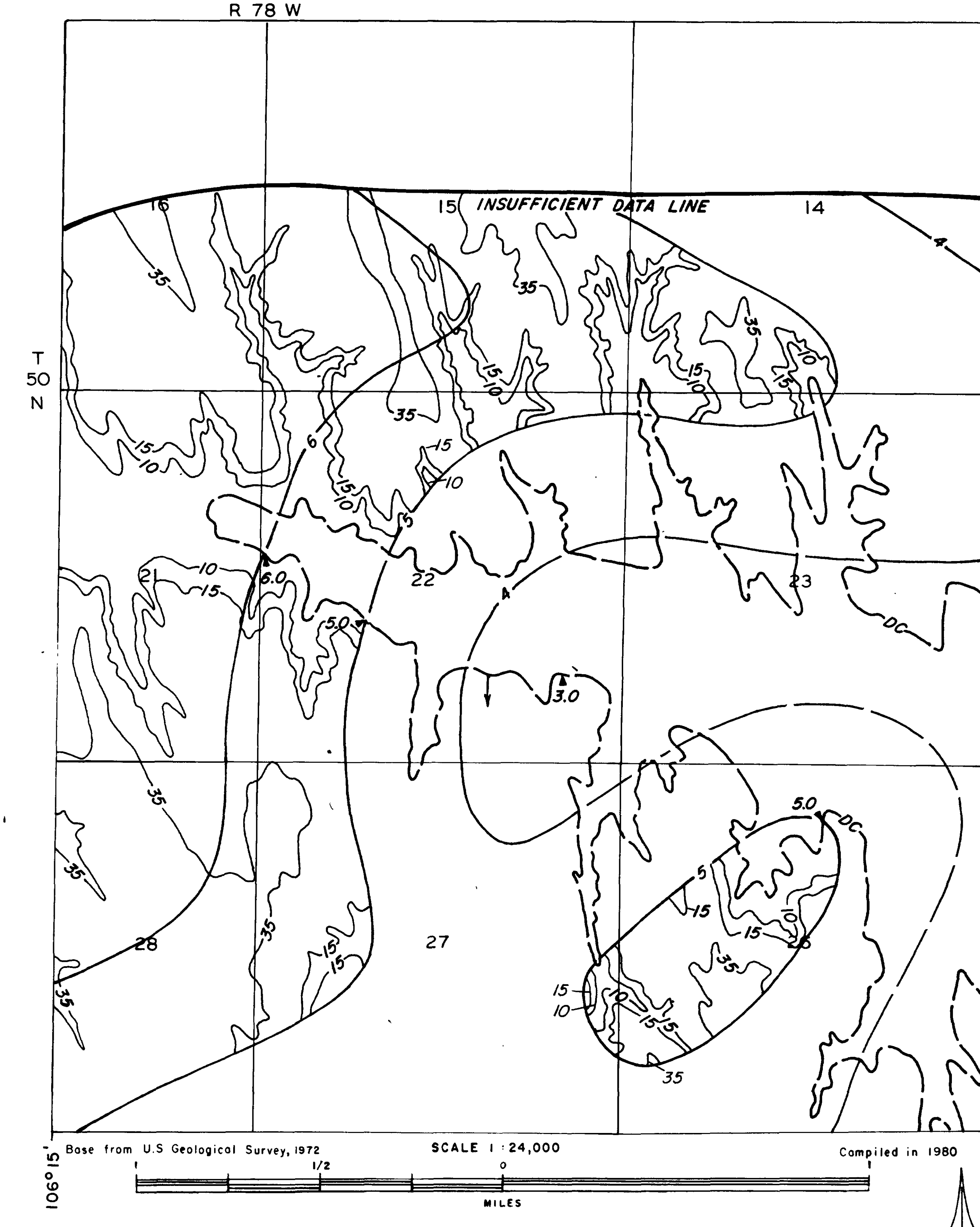
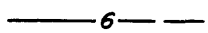
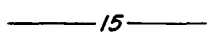


FIGURE 1
ISOPACH AND MINING-RATIO MAP
OF DRY CREEK COAL BED IN
SOMERVILLE FLATS WEST QUADRANGLE,
JOHNSON COUNTY, WYOMING
(See following page for Explanation)

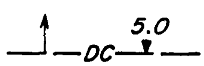
EXPLANATION FOR FIGURE 1



ISOPACH OF COAL BED-Showing thickness in feet. Isopach interval 2 feet, with an intermediate 5 foot contour. Dashed where coal is burned or eroded.



MINING RATIO CONTOUR-Number indicates cubic yards of overburden per ton of recoverable coal by surface mining methods. Contours shown only in area suitable for surface mining within the stripping limit.



TRACE OF COAL BED OUTCROP-Showing coal thickness, in feet, measured at triangle. Arrow points toward the coal-bearing area. Coal bed dashed where inferred or projected.

To convert feet to meters, multiply feet by 0.3048.

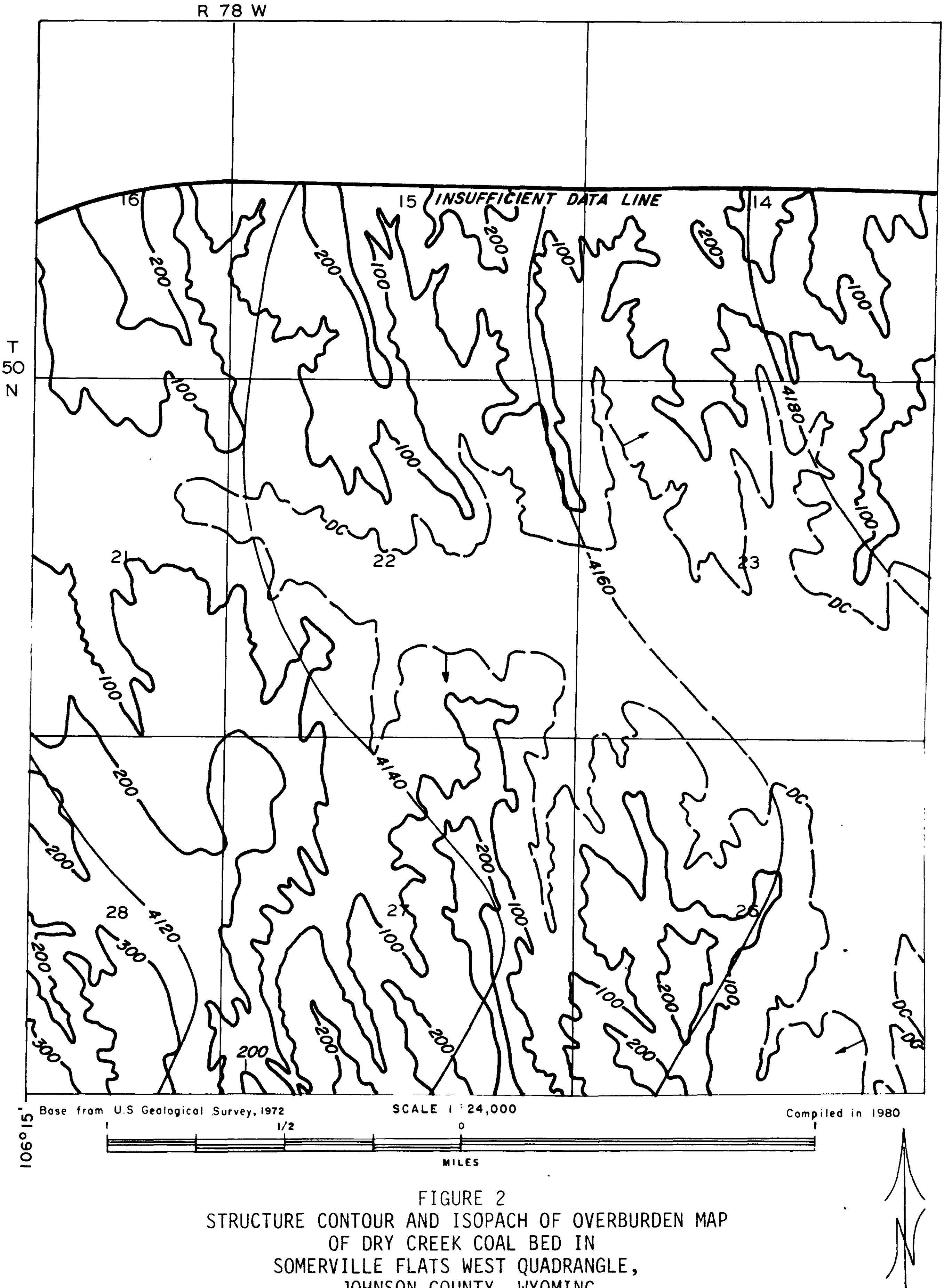


FIGURE 2
STRUCTURE CONTOUR AND ISOPACH OF OVERBURDEN MAP
OF DRY CREEK COAL BED IN
SOMERVILLE FLATS WEST QUADRANGLE,
JOHNSON COUNTY, WYOMING
(See following page for Explanation)

EXPLANATION FOR FIGURE 2

———4160—— ——	STRUCTURE CONTOUR—Drawn on top of coal bed. Contour interval 20 feet. Datum is mean sea level. Dashed where coal is burned or eroded.
———300———	OVERBURDEN ISOPACH-Showing thickness of overburden, in feet, from the surface to the top of the coal bed. Isopach interval 100 feet.
—— —DC—↑—— —	TRACE OF COAL BED OUTCROP-Arrow points toward the coal-bearing area. Coal bed dashed where inferred or projected.

To convert feet to meters, multiply feet by 0.3048.

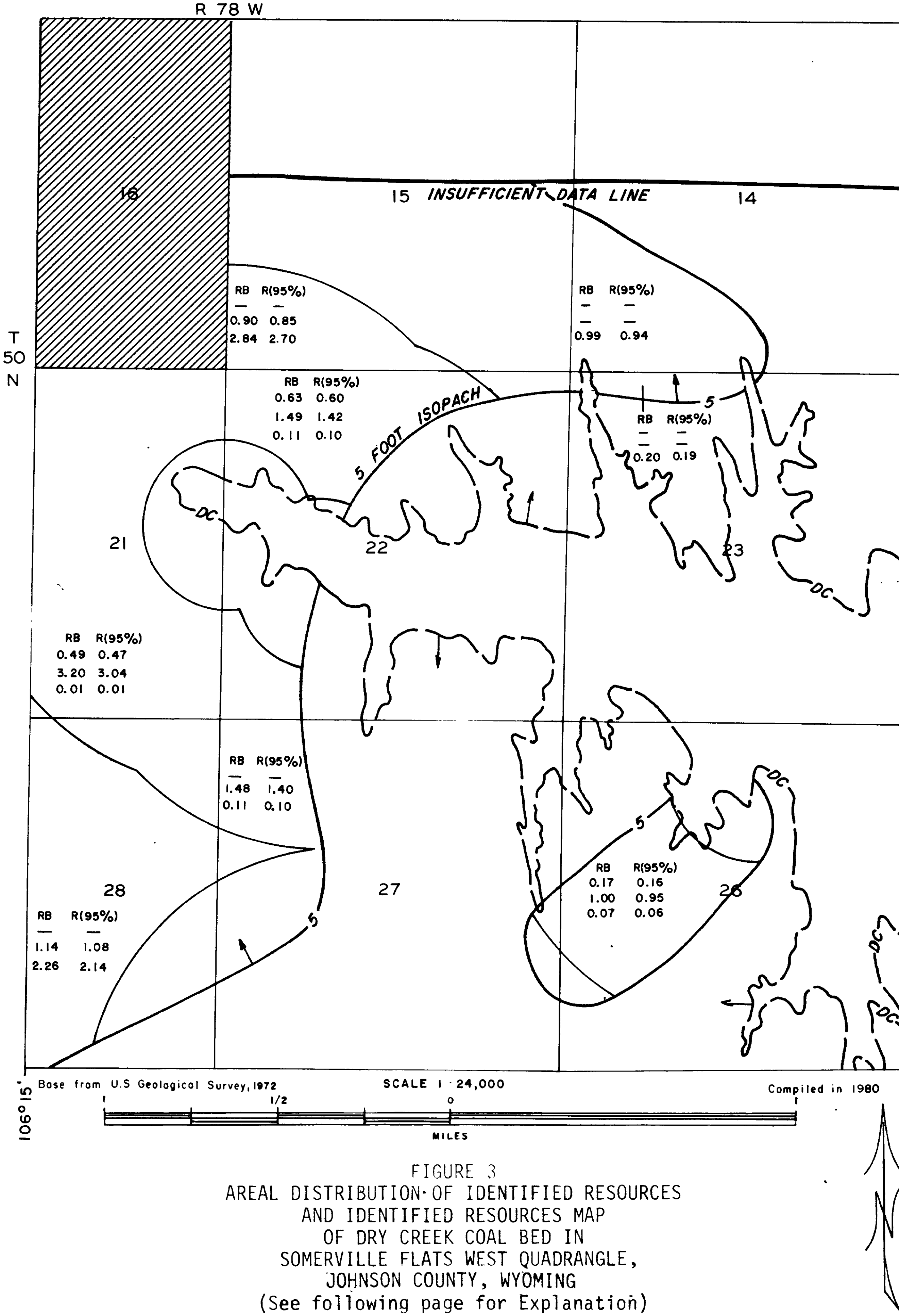
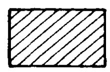


FIGURE 3
AREAL DISTRIBUTION OF IDENTIFIED RESOURCES
AND IDENTIFIED RESOURCES MAP
OF DRY CREEK COAL BED IN
SOMERVILLE FLATS WEST QUADRANGLE,
JOHNSON COUNTY, WYOMING
(See following page for Explanation)

EXPLANATION FOR FIGURE 3

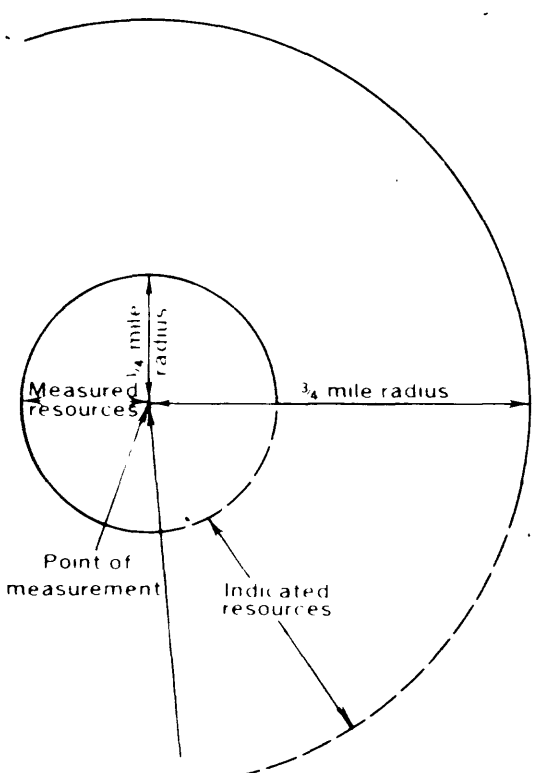


NON-FEDERAL COAL LAND-Coal tonnages not evaluated.

TRACE OF COAL BED OUTCROP-Arrow points toward the coal-bearing area. Coal bed dashed where inferred or projected.

RB	R(95%	
–	–	(Measured)
0.90	0.85	(Indicated)
2.84	2.70	(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).



BOUNDARY LINES-Enclosing areas of measured, indicated and inferred coal resources of the coal bed. Dashed where projected from adjacent quadrangles.

Reserves are not calculated for coal beds greater than 500 feet in depth.

To convert miles to kilometers multiply miles by 1.609.

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

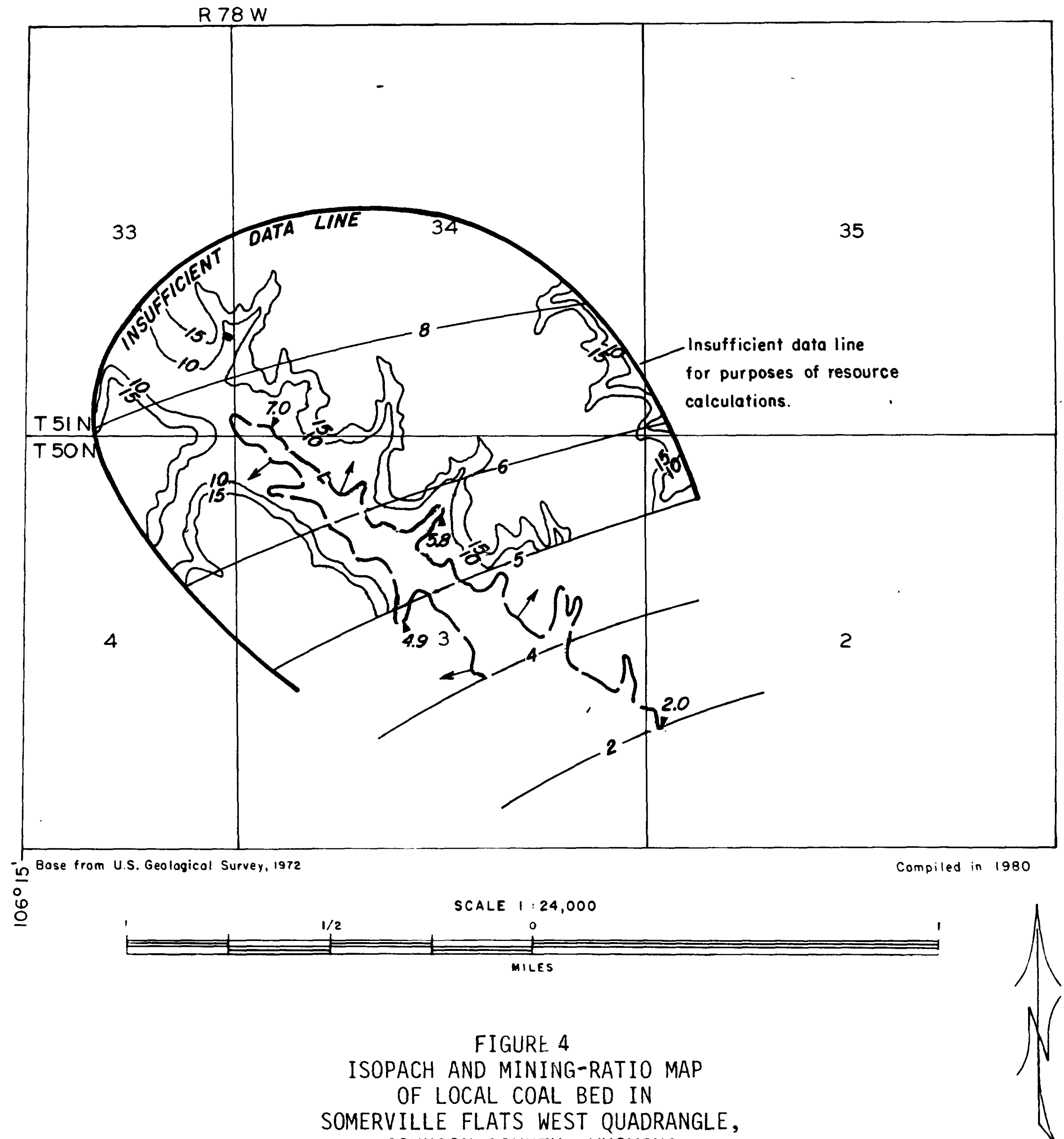
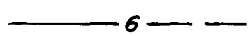
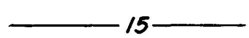


FIGURE 4
ISOPACH AND MINING-RATIO MAP
OF LOCAL COAL BED IN
SOMERVILLE FLATS WEST QUADRANGLE,
JOHNSON COUNTY, WYOMING
(See following page for Explanation)

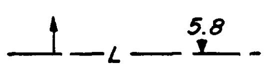
EXPLANATION FOR FIGURE 4



ISOPACH OF COAL BED-Showing thickness in feet. Isopach interval 2 feet, with an intermediate 5 foot contour. Dashed where coal is burned or eroded.



MINING-RATIO CONTOUR-Number indicates cubic yards of overburden per ton of recoverable coal by surface mining methods. Contours shown only in area suitable for surface mining within the stripping limit.



TRACE OF COAL BED OUTCROP-Showing coal thickness in feet, measured at triangle. Arrow points toward the coal-bearing area. Coal bed dashed where inferred or projected.

To convert feet to meters, multiply feet by 0.3048.

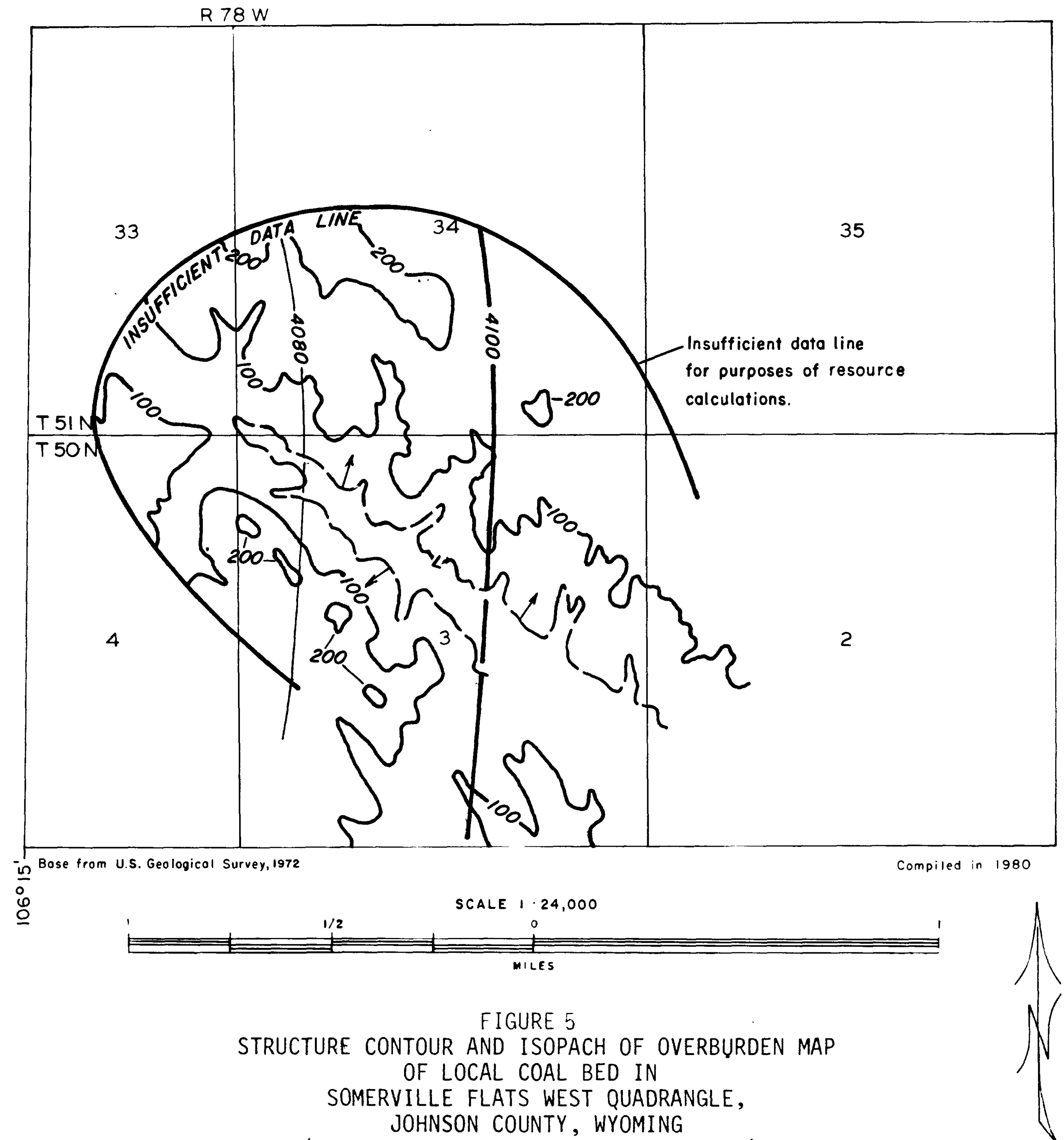


FIGURE 5
STRUCTURE CONTOUR AND ISOPACH OF OVERBURDEN MAP
OF LOCAL COAL BED IN
SOMERVILLE FLATS WEST QUADRANGLE,
JOHNSON COUNTY, WYOMING
(See following page for Explanation)

EXPLANATION FOR FIGURE 5

4080 4100	STRUCTURE CONTOURS-Drawn on top of coal bed. Contour interval 20 feet. Datum is mean sea level. Dashed where coal is burned or eroded.
100	OVERBURDEN ISOPACH-Showing thickness of overburden in feet, from the surface to the top of the coal bed. Isopach interval 100 feet.
L	TRACE OF COAL BED OUTCROP-Arrow points toward the coal-bearing area. Coal bed dashed where inferred or projected.

To convert feet to meters, multiply feet by 0.3048.

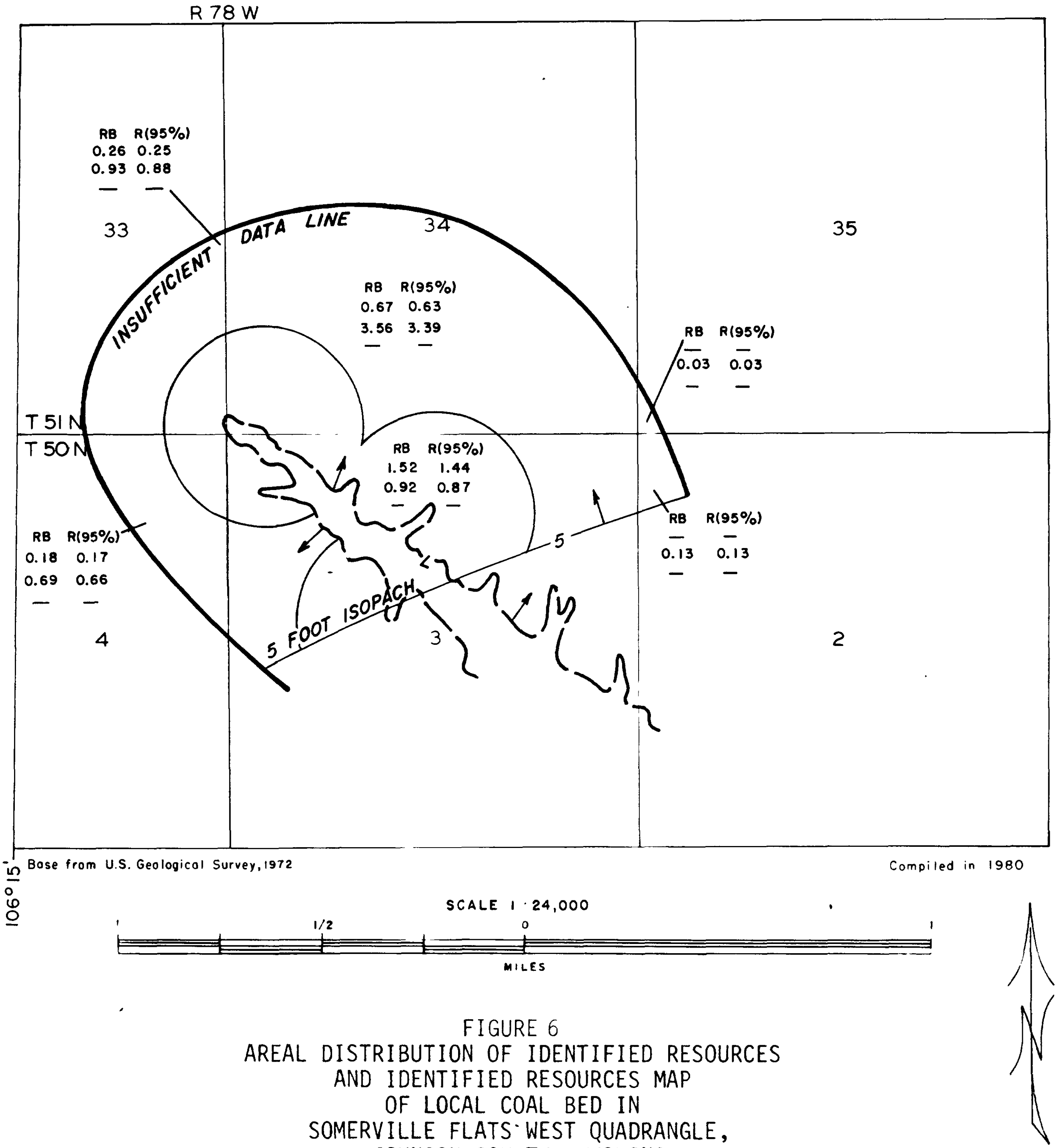
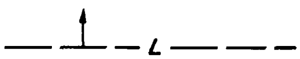


FIGURE 6
AREAL DISTRIBUTION OF IDENTIFIED RESOURCES
AND IDENTIFIED RESOURCES MAP
OF LOCAL COAL BED IN
SOMERVILLE FLATS WEST QUADRANGLE,
JOHNSON COUNTY, WYOMING
(See following page for Explanation)

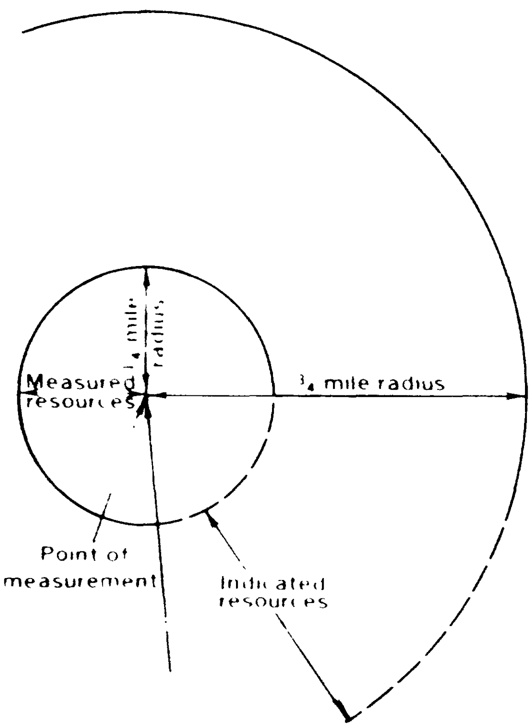
EXPLANATION FOR FIGURE 6



TRACE OF COAL BED OUTCROP-Arrow points toward the coal-bearing area. Coal bed dashed where inferred or projected.

RB	R(95%)	
0.26	0.25	(Measured)
0.93	0.88	(Indicated)
—	—	(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).



BOUNDARY LINES-Enclosing areas of measured, indicated and inferred coal resources of the coal bed. Dashed where projected from adjacent quadrangles.

Reserves are not calculated for coal beds greater than 500 feet in depth.

To convert miles to kilometers multiply miles by 1.609.

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

A Local coal bed ranging in thickness from 2 to 8 feet (0.6 to 2.4 m) is present in approximately 1 percent of the quadrangle, and is located in the northwest quadrant. Mapping of the Local coal bed is determined from surface measured sections and coal outcrop (Wegemann, 1913). Due to lack of subsurface and surface control for the Local coal bed, an insufficient data line is drawn. Structure contours drawn on the top of the Local coal bed depict a gentle, westward dip. The Local coal bed lies from 0 feet (0 m) to greater than 250 feet (76 m) beneath the surface (figure 5).

The Felix coal bed lies approximately 250 to 300 feet (76 to 91 m) beneath the Local coal bed where present, and 350 to 400 feet (107 to 122 m) beneath the Dry Creek coal bed where present. The Felix coal bed ranges in thickness from 0 to 6 feet (0 to 1.8 m) with maximum thickness in the southwest corner. The Felix coal bed is pinched out from the southeast corner and eroded in the northeast quarter of Somerville Flats West Quadrangle. Structure contours on the top of the Felix coal bed indicate a gentle, westward dip with minor flexures. The Felix coal bed occurs from 0 feet (0 m) to greater than 750 feet (229 m) beneath the surface.

The Smith coal zone is separated from the Felix coal bed, where present, by a sedimentary interval of 540 to 610 feet (165 to 186 m). Total coal zone thicknesses range from 12 to 40 feet (4 to 12 m) with the maximum thickness along the northern edge of the quadrangle, which honors data from the Mitchell Draw Quadrangle to the north. Locally, the Smith coal zone is at least four separate coal beds with the total non-coal interval between the various members attaining 178 feet (54 m). The main structural configuration on the Smith coal zone is a broad, north-plunging anticline, flanked by a syncline to the east. The Smith coal zone occurs from less than 550 feet (168 m) to greater than 1,300 feet (396 m) beneath the surface.

The Anderson coal zone is located 150 to 310 feet (46 to 94 m) beneath the Smith coal zone within the quadrangle. The coal zone thickness ranges from 50 to 110 feet (15 to 34 m) with maximum thicknesses occurring along the eastern edge. The maximum thicknesses occur on the Somerville Flats West Quadrangle due to data located immediately east of the area in the Somerville Flats East Quadrangle. The Anderson coal zone separates into at least three separate coal beds locally, with the non-coal interval ranging from 3 to 82 feet (0.9 to 25 m) in thickness. A broad, closed syncline is located in the southwestern quarter, and a closed anticline occurs in the northwestern corner of the quadrangle. The Anderson coal zone lies from less than 750 feet (229 m) to greater than 1,750 feet (533 m) beneath the surface.

The Canyon-Cook coal bed occurs 100 to 300 feet (30 to 91 m) beneath the Anderson coal bed, and is composed of one thick coal bed within the quadrangle. The thickness ranges from 40 to 100 feet (12 to 30 m) with maximum thicknesses along the western edge, honoring subsurface data located in the Bear Draw Quadrangle. Structure contours drawn on the top of the Canyon-Cook coal bed indicate a northwest-trending anticline through the central area of the quadrangle, and a west-plunging synclinal feature in the southwest corner. The Canyon-Cook coal bed occurs from less than 1,200 feet (366 m) to greater than 2,000 feet (610 m) beneath the surface.

Approximately 110 to 180 feet (34 to 55 m) of clastic sediments separates the Wall coal bed from the Canyon-Cook coal bed. The Wall coal bed ranges in thickness from 0 feet (0 m) in the southwest corner to 40 feet (12 m) in the northeast corner. Structure contours drawn on the top of the Wall coal bed depict a broad, closed anticline through the center of the quadrangle. The Wall coal bed lies from less than 1,300 feet (396 m) to greater than 2,250 feet (686 m) beneath the surface.

The Pawnee coal zone is located 240 to 400 feet (73 to 122 m) beneath the Wall coal bed. The total coal zone thickness ranges from 15 to 42 feet (5 to 13 m) with the thickest occurrences located in the northeast quarter and in the west-central edge. The Pawnee coal zone locally separates into four coal beds with the total non-coal interval between the various members attaining 293 feet (89 m) in thickness. Structure contours drawn on top of the Pawnee coal zone indicate regional westward dip in the western half of the study area and a closed, northwest-trending anticline in the eastern half of the quadrangle. The Pawnee coal zone occurs from less than 1,650 feet (503 m) to greater than 2,550 feet (777 m) beneath the surface.

The Oedekoven-Local 1-Local 2 coal bed composite lies from 550 to 650 feet (168 to 198 m) beneath the Pawnee coal zone. The total projected coal zone thickness ranges from 5 to 35 feet (1.5 to 11 m) with thickest occurrences located in the northeast quarter of the study area and thinnest coal in the southwest corner. The clastic interval separating the coal beds composing the coal zone varies from 120 to 170 feet (37 to 52 m). Structure contours drawn on top of the Oedekoven coal bed indicate a northwest-plunging anticline and syncline extending across the northern half of the quadrangle. The Oedekoven-Local 1-Local 2 coal bed composite lies from less than 2,250 feet (686 m) to greater than 3,250 feet (991 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 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 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 Somerville Flats West 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 coal isopach contours do not honor surface measured sections, the surface thicknesses are thought to be attenuated by oxidation and/or erosion: hence, they are 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 are 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 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 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), and 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, and inferred parts of identified 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 1,750, or 1,770--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 tonnages (reserves) are 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 complex 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 39) was prepared utilizing the following mining ratio criteria for coal beds 5 feet 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 development potential is low for approximately 10 percent of the quadrangle, existing along the western portion of the study area, and along the extreme eastern edge of the northwest corner. The low development results from high overburden-to-coal thickness ratios for the Dry Creek, Local, and Felix coal beds. Less than 1 percent of Somerville Flats West Quadrangle is rated as high development potential. The high potential occurs mainly in the valley where the Dry Creek and Local coal beds outcrop and minimal overburden exist. Approximately 84 percent of the quadrangle is rated as no potential for surface mining due to the coal beds occurring greater than 500 feet (152 m) beneath the surface. The remaining 5 percent of the study area is classified as non-federal coal land. Table 1 sets forth the estimated strippable reserve base tonnages per coal bed for the Somerville Flats West Quadrangle.

Underground Mining Coal Development Potential. Subsurface coal mining development potential throughout the Somerville Flats West 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 development potential relates to the occurrence of coal beds more than 5 feet (1.5 m) thick buried from 500 to 3,000 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 1,000 feet (305 m) to 3,000 feet (914 m) beneath the surface, or 2) a coal bed or coal zone 5 feet (1.5 m) or more in thickness that lies 500 feet (152 m) to 1,000 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 1,000 to 3,000 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 1,000 to 3,000 feet (305 to 914 m).

The coal development potential for in-situ gasification (plate 40) on the Somerville Flats West Quadrangle is rated as moderate over 60 percent of the quadrangle, and is caused by thick Anderson, Canyon-Cook, and Wall coal beds occurring greater than 1,000 feet (305 m) beneath the surface. The moderate potential rating occurs in the southern half and northeastern quarter of the quadrangle. Approximately 35 percent of the study area is rated as high development potential and occurs in the northwest corner and along the western boundary in the southwest quarter where the Canyon-Cook coal bed thickens and is greater than 1,000 feet (305 m) deep. Less than 1 percent of the quadrangle is of low development potential caused by the Anderson coal bed lying less than 1,000 feet (305 m) deep. The remaining 5 percent of the quadrangle is classified as non-federal coal land. The coal resource tonnage totals for in-situ gasification are given on table 3.

Table 1.--Strippable Coal Reserve Base Data (in short tons) for Federal Coal Lands in the Somerville Flats West Quadrangle, Johnson 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
Reserve Base Resources				
Local	930,367	644,757	6,714,876	8,290,000
Dry Creek	1,681,196	936,487	13,592,317	16,210,000
Felix	798,380	660,189	15,431,431	16,890,000
TOTAL	3,409,943	2,241,433	35,738,624	41,390,000

Table 2.--Coal Reserve Base and Hypothetical Resource Data (in short tons) for Underground Mining Methods for Federal Coal Lands in the Somerville Flats West Quadrangle, Johnson County, Wyoming.

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Reserve Base Resources				
Felix	-	-	18,520,000	18,520,000
Smith	-	-	1,279,880,000	1,279,880,000
Anderson	-	-	3,365,850,000	3,365,850,000
Canyon-Cook	-	-	3,090,130,000	3,090,130,000
Wall	-	-	1,043,470,000	1,043,470,000
Pawnee	-	-	1,450,120,000	1,450,120,000
Odekoven-Local 1-Local 2	-	-	863,520,000	863,520,000
Total	-	-	11,111,490,000	11,111,490,000
Hypothetical Resources				
Smith	-	-	106,160,000	106,160,000
Anderson	-	-	220,780,000	220,780,000
Canyon-Cook	-	-	131,340,000	131,340,000
Wall	-	-	50,980,000	50,980,000
Pawnee	-	-	72,500,000	72,500,000
Odekoven-Local 1-Local 2	-	-	48,950,000	48,950,000
Total	-	-	630,710,000	630,710,000
GRAND TOTAL	-	-	11,742,200,000	11,742,200,000

Table 3.--Coal Reserve Base and Hypothetical Resource Data (in short tons) for In-Situ Gasification for Federal Coal Lands in the Somerville Flats West Quadrangle, Johnson County, Wyoming.

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Reserve Base Resources	3,078,980,000	7,983,140,000	49,370,000	11,111,490,000
Hypothetical Resources	-	-	630,710,000	630,710,000
TOTAL	3,078,980,000	7,983,140,000	680,080,000	11,742,200,000

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