UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

TEXT TO ACCOMPANY:

COAL RESOURCE OCCURRENCE

AND

COAL DEVELOPMENT POTENTIAL

MAPS

OF THE

PLEASANTDALE QUADRANGLE,

CAMPBELL COUNTY, WYOMING

BY

INTRASEARCH INC.

DENVER, COLORADO

OPEN FILE REPORT 79-052
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 Pleasantdale Quadrangle, Campbell County, Wyoming. This CRO and CDP map series (U. S. Geological Survey Open-File Report 79-052) includes 40 plates. The project is compiled by IntraSearch Inc., 5351 South Roslyn Street, Englewood, Colorado, under KRCRA Eastern Powder River Basin, Wyoming Contract Number 14-08-0001-17180. This contract is part of a program to provide an inventory of unleased federal coal in Known Recoverable Coal Resource Areas (KRCRAs) in the western United States.

The Pleasantdale Quadrangle is located in Campbell County, in northeastern Wyoming. It encompasses all or parts of Townships 47 and 48 North, Ranges 73 and 74 West, and covers the area: 44°00' to 44°07'30" north latitude; 105°37'30" to 105°45' west longitude.

Main access to the Pleasantdale Quadrangle is provided by Wyoming State Highway 50, which traverses the western half of the area in a north-south direction. Clarkelen Road, a maintained gravel road, crosses the eastern part of the area from north to south. Highway 50 and Clarkelen Road are connected within the quadrangle by Hannum Road, a light-duty road which traverses the central part of the area between the two major roads. Minor roads and trails branch from the main roads to provide access to the more remote areas of the quadrangle. The nearest railroad is the Burlington Northern trackage 15 miles (24 km) to the east.

Caballo Creek flows southeastward through the northeast quadrant and provides drainage for the northern part of the area. Hoe Creek flows eastward through the south-central area, draining the southern part of the quadrangle. Both of these intermittent streams are tributaries of the Belle

Fourche River. Minor areas in the northwest corner of this quadrangle are part of the Powder River Basin watershed. The moderately rugged terrain includes a prominant ridge along the western boundary of the quadrangle where elevations in excess of 5220 feet (1591 m) above sealevel can be observed. Elevations of 4720 feet (1439 m) above sealevel along the lower Caballo Creek valley are the lowest within the Pleasantdale Quadrangle.

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

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

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

Surface and subsurface geological and engineering extrapolations drawn from the current data base suggest the occurrence of approximately 11.5 billion tons (10.4 billion metric tons) of unleased federal coal resources in the Pleasantdale Quadrangle.

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

II. Geology

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

Outcrops of the Wasatch Formation and the Tongue River Member of the Fort Union Formation cover most of the areas of major coal resource occurrence in the Powder River Basin. The Tongue River Member is composed of very fine-grained sandstones, siltstones, claystones, shales, carbonaceous shales, and numerous coal beds. The Lebo Member of the Fort Union Formation consists of light- to dark-gray very fine-grained to conglomeratic sandstone with interbedded siltstone, claystone, carbonaceous shale and thin coal beds. Thin bedded calcareous ironstone concretions interbedded with massive white sandstone and slightly bentonitic shale occur throughout the unit (Denson and Horn, 1975). The Lebo Member is mapped at the surface northeast of Recluse, Wyoming. Here, the Lebo Member is east of the principal coal outcrops and associated clinkers (McKay, 1974), and it presumably projects into the subsurface beneath much of the basin. One of the principal characteristics for separating the Lebo and Tullock Members (collectively referred to as the Ludlow Member east of Miles City, Montana) from the overlying Tongue River Member is the color differential between the lighter-colored upper portion and the somewhat darker lower portion (Brown, 1958). Although geologists are trying to develop criteria for subsurface recognition of the Lebo-Tullock and Tongue River-Lebo contacts through the use of subsurface data from geophysical logs, no definitive guidelines are known to have been published. Hence, for subsurface mapping purposes, the Fort Union Formation is not divided into its members for this study.

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

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

Some coal beds in the Powder River Basin exceed 200 feet (61 m) in thickness. Deposition of these thick, in-situ coal beds requires a delicate balance between subsidence of the earth's crust and in-filling by 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 in coal bed thickness throughout the basin relate to changes in the depositional environment. Drill hole data that indicate either the complete absence or extreme attenuation of a thick coal bed probably relate to location of the drill holes within the ancient stream channel system draining this lowland area in Early Cenozoic time. Where thick coal beds thin rapidly from the depocenter of a favorable depositional environment, it is not unusual to encounter a synclinal structure over the maximum coal thickness due to the differential compaction between organic debris in the coal depocenter and fine-grained clastics in the adjacent areas.

The Wasatch Formation of Eocene age crops out over most of the central part of the Powder River Basin and exhibits a disconformable contact with the underlying Fort Union Formation. The contact has been placed at various horizons by different workers; however, for the purpose of this report, the contact is positioned near the top of the Roland coal bed as mapped by Olive (1957) in northwestern Campbell County, Wyoming. It is considered to descend disconformably in the stratigraphic column to the top of the Wyodak-Anderson coal bed (Roland coal bed of Taff, 1909) along the eastern boundary of the coal measures.

No attempt was made to differentiate the Wasatch and Fort Union Formations on geophysical logs or in the subsurface mapping program for this project.

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

The Pleasantdale Quadrangle is located in an area where surface rocks are classified as the Wasatch Formation. Olive (1957) correlated coal beds in the Spotted Horse coal field with coal beds in the Sheridan coal field (Baker, 1929) and Gillette coal field (Dobbin and Barnett, 1927), Wyoming, and with coal beds in the Ashland coal field (Bass, 1932) in southeastern Montana. This report utilizes, where possible, the coal bed nomenclature used in previous reports. The Felix coal bed was named by Stone and Lupton (1910), and the Scott coal bed by Olive (1957). The Ulm and Smith coal beds were named by Taff (1909), and Baker (1929) assigned names to the Anderson, Canyon, and Wall coal beds. The Cook coal bed was named by Bass (1932).

IntraSearch's correlation of thick coal beds from the Spotted Horse coal field to Gillette points out that the Wyodak coal bed, named the "D" coal bed by Dobbin and Barnett (1927), is equivalent to the Anderson, Canyon, and all, or part, of the Cook coal beds to the north and west of Gillette, Wyoming. Correlation of this suite of coal beds with the Wyodak coal bed south and southwest of Gillette suggests that the Anderson and Canyon coal beds equate with the upper 10 to 25 percent of the thick Wyodak coal bed, and the Cook and Wall, 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, Moyer, and Oedekoven coal beds were informally named by IntraSearch (1978b, 1979, 1978a).

IntraSearch uses the Upper Wyodak, Middle Wyodak and Lower Wyodak nomenclature in the Pleasantdale Quadrangle. The Wyodak coal zone nomenclature is used in the Scaper Reservoir Quadrangle, which is directly east of the Pleasantdale Quadrangle. The names Upper Wyodak and Lower Wyodak are used in the Northwest Quarter of North Star School Quadrangle, located south of the Pleasantdale Quadrangle. The coal bed names of Anderson, Canyon, Cook, and Wall, are utilized in the quadrangles to the west and north, Double Tanks and Four Bar J Ranch, respectively. The Wyodak coal zones are equivalent to the Anderson, Canyon, Cook, and Wall coal beds.

Local. The Pleasantdale 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 comprised 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.

III. Data Sources

Areal geology of the coal outcrops and associated clinker is derived from the Geologic map and coal resources of the Pleasantdale Quadrangle (Grazis, 1977).

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

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

In some parts of the Powder River Basin, additional subsurface control is available from U. S. Geological Survey open-file reports that include geophysical and lithologic logs of shallow holes drilled specifically for coal exploration. A sparse scattering of subsurface data points are shown on unpublished CRO-CDP maps compiled by the U. S. Geological Survey, and where these data are utilized, the rock-coal intervals are shown on the Coal Data Map (Plate 1). Inasmuch as these drill holes have no identifier headings, they are not set forth on the Coal Data Sheet (Plate 3). The geophysical logs of these drill holes were not available to IntraSearch to ascertain the accuracy of horizontal location, topographic elevation, and downhole data interpretation.

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

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

IV. Coal Bed Occurrence

Wasatch and Fort Union Formation coal beds that are present in all or part of the Pleasantdale Quadrangle include, in descending stratigraphic order, the local, Ulm, Scott, local, Upper and Lower Felix, Upper and Lower Smith, Upper Wyodak coal beds, Middle Wyodak coal zone, Lower Wyodak coal zone, local, and the Wildcat-Moyer-Oedekoven coal zone. A complete suite of maps (coal isopach, structure, mining ratio where appropriate, overburden/interburden isopach, areal distribution of identified resources and identified resources) was prepared for each of these coal beds or coal zones except for the Scott coal bed and the local coal beds where insufficient data and coal thickness preclude detailed mapping.

Physical and chemical analyses for the Ulm and Felix coal beds are published for the Pleasantdale Quadrangle. The proximate analyses for the coal beds performed on a general "as received" basis are as follows:

COAL BED NAME			ASH %	FIXED CARBON %	MOISTURE %	VOLATILES %	SULFUR %	BTU/LB
Ulm	(U)	Hole 7323	7.288	33.626	30.070	29.016	1.309	7730
Felix	(U)	Hole 7324	6.993	35.200	25.010	32.798	0.629	8544
Lower Smith	(U)	Hole 7372C	6.167	33.340	29.610	30.883	1.068	8215
Wyodak	(U)	Hole 755	4.438	35.522	27.405	32.719	0.207	8568

(U) - U. S. Geological Survey and Montana Bureau of Mines and Geology - 1973 and 1976.

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

The Ulm coal bed is eroded from approximately 95 percent of the quadrangle, and is present only at higher elevations along the western border. The thickness of the coal bed varies from 10 to 15 feet (3 to 5 m) and dips 1 to 2 degrees northward. The Ulm coal bed is within 200 feet (61 m) of the surface in the Pleasantdale Quadrangle.

The Felix coal zone is approximately 500 feet (152 m) below the Ulm coal bed. The coal thickness varies from 25 feet (8 m) in the south-central and west-central regions to 40 feet (12 m) in the northeast corner and along the east-central border of the area (Plate 9). The non-coal interburden within the Felix coal zone attains a maximum thickness of approximately 77 feet (23 m) in the southeastern portion of the quadrangle. Structure contours drawn on the top of the Felix coal zone define a series of two northwest-plunging anticlines and two northwest-plunging synclines (Plate 10). The Felix coal zone varies in depth from less than 100 feet (30 m) to greater than 500 feet (152 m) within the quadrangle.

The Smith coal zone, 206 to 343 feet (81 to 105 m) below the Felix coal zone, consists of two coal beds with 58 to 90 feet (18 to 27 m) of interburden between them. The Smith coal beds are absent over most of the north-central and northwestern areas of the quadrangle. They attain a maximum thickness of 32 feet (10 m) near the east-central border. The Upper Smith coal bed attains a maximum thickness of 12 feet (4 m), and the Lower Smith attains a maximum of 20 feet (6 m) in thickness. The structural contour configuration, drawn on top of the Smith coal zone, depicts a westward dip with a localized northwest-plunging anticline in the southeast-central part of the area. The Smith coal zone varies from less than 600 feet (183 m) to greater than 1000 feet (305 m) beneath the surface of the quadrangle.

The Upper Wyodak coal bed is separated from the Smith coal zone by 96 to 157 feet (29 to 48 m) of clastic debris. The variation in thickness of the Upper Wyodak coal bed is 20 to 50 feet (6 to 15 m) with the thickest coal in the northeast and southwest corners. A band of thin coal trends northwesterly through the east-central portion of the quadrangle

(Plate 19). In the northeastern corner of the quadrangle the Upper Wyodak and Middle Wyodak coal beds converge into a single 101 foot (31 m) thick coal bed. IntraSearch Inc., arbitrarily picked the Upper Wyodak coal to be 30 feet (9 m) thick in that area. The remaining 71 feet (22 m) of coal thickness is considered to be Middle Wyodak. Structure contours drawn on the top of the Upper Wyodak coal bed portray a broad, complex, west-plunging anticline in the southern half of the quadrangle. The north limb of the anticline dips north to northeast into a narrow northwest-southeast-trending syncline located in the northeastern quadrant and along the north-central edge of the quadrangle (Plate 20). The Upper Wyodak coal bed is at a depth of less than 700 feet (213 m) to greater than 1250 feet (381 m) throughout the quadrangle (Plate 21).

The Middle Wyodak coal zone is a maximum of 365 feet (111 m) beneath the Upper Wyodak coal bed. The two coal beds converge in the northeastern portion of the quadrangle. The Middle Wyodak coal zone is comprised of two to four coal beds with a total non-coal interval of 4 to 63 feet (1.2 to 19 m) within the coal zone. The total coal thickness varies from 107 feet (33 m) in the east-central region, to less than 20 feet (6 m) along the north edge of the northeast and near the southwest corners of the quadrant. The thickest Middle Wyodak coal trends in an east-west direction through the middle of the Pleasantdale Quadrangle and thins to the north and southeast (Plate 24). The structural configuration of the Middle Wyodak coal zone shows two broad west-plunging anticlines in the northern and southern parts of the quadrangle, with a west-plunging syncline in the middle (Plate 25). The Middle Wyodak coal zone is buried at a depth of less than 900 feet (274 m) to greater than 1500 feet (457 m) throughout the area (Plate 26).

The Lower Wyodak coal zone is separated from the Middle Wyodak coal zone by from 37 to 219 feet (11 to 67 m) of clastic rocks and consists of two or three coal beds. The combined coal thickness is 25 to 57 feet (8 to 17 m) with the thick coal located in the northwest quadrant and in the south-central area near the border of the quadrangle. The thin coal is in the southeast and southwest corners. Total interburden within the Lower Wyodak coal zone varies from 29 to 190 feet (9 to 58 m). The structure contour map (Plate 30) portrays a westward dip interrupted by a broad west-plunging anticline in the southeastern part of the area, a northwest-plunging syncline in the southwest corner, and a southwest-plunging syncline in the northwest corner. The Lower Wyodak coal zone is less than 1200 feet (366 m) to more than 1750 feet (533 m) below the surface throughout the quadrangle.

The Wildcat-Moyer-Oedekoven coal zone is 137 to 371 feet (42 to 113 m) below the Lower Wyodak coal zone. Total thickness of the coal beds within the Wildcat-Moyer-Oedekoven coal zone varies between 9 and 42 feet (2.7 and 13 m) with the thinnest coal concentrated in the northwest quadrant and west-central part of the area. The thickest coal is present in the east-central area (Plate 34). The Wildcat and Moyer coal beds merge into a single coal bed in the eastern half of the quadrangle. The combined coal thickness of the Wildcat-Moyer coal bed varies from 9 to 18 feet (2.7 to 5 m). Where the coal beds are separated, the Wildcat coal bed is 5 to 8 feet (1.5 to 2.4 m) thick and the Moyer coal bed is 3 to 5 feet (0.9 to 1.5 m) thick. The Oedekoven coal bed attains a maximum thickness of 24 feet (7 m) in the eastern portion of the quadrangle and thins to 3 feet (0.9 m) in the northwestern portion of the quadrangle. Total interburden within the Wildcat-Moyer-Oedekoven coal zone varies from 176 to 453 feet (54 to 138 m).

The structure contours, drawn on top of the Wildcat coal bed depict a north-south-trending, closed anticline through the center of the quadrangle with a parallel syncline in the eastern part of the area (Plate 35). The Wildcat-Moyer-Oedekoven coal zone is less than 1750 feet (533 m) to greater than 2250 feet (685 m) beneath the surface throughout the Pleasantdale Quadrangle.

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

Subsurface mapping is based on geologic data within, and adjacent, to the Pleasantdale 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 surface 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, 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 at the intersections of coal bed and overburden isopach contours using coal structure, coal isopach, and topographic control. On the Areal Distribution of Identified Resources Map (ADIR), coal bed reserves are not calculated where the coal is less than 5 feet (1.5 m) thick, where the coal occurs at a depth greater than 500 feet (152 m), where non-federal coal exists, or where federal coal leases, preference-right lease applications, and coal prospecting permits exist.

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

VI. Coal Development Potential

Strippable Coal Development Potential. Areas where coal beds are 5 feet (1.5 m) or more in thickness and are overlain by 500 feet

(152 m) or less of overburden are considered to have potential for surface mining and are assigned a high, moderate, or low development potential based on the mining ratio (cubic yards of overburden per ton of recoverable coal). The formula used to calculate mining ratios for subbituminous coal is as follows:

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

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

*A conversion factor of 0.922 is used for lignite.

A surface mining development potential map (Plate 39) was prepared utilizing the following mining ratio criteria for coal beds 5 to 40 feet (1.5 to 12 m) thick:

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

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

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

Approximately 35 percent of the Pleasantdale Quadrangle is rated high for surface mining potential. The moderately thick Felix coal bed, present at shallow depths, accounts for the high development potential for surface mining in the east and northeast portion of the quadrangle. Isolated areas of high development potential located in the northwest, west-central, and southwest portions of the quadrangle are the result of the Ulm coal bed capping the higher elevations of the quadrangle. Increasing overburden thicknesses above the Felix coal bed create moderate development potential over approximately 35 percent of the study area and low development potential over about 10 percent of the quadrangle. The area of no development potential by surface mining methods, covering approximately 12 percent of the quadrangle, is located in the areas where the Felix coal bed is deeper than 500 feet (152 m) and the Ulm coal bed is eroded. The remainder of the quadrangle is non-federal coal land. Table 1 sets forth the estimated strippable reserve base tonnages per coal bed for the quadrangle.

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

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

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

3. High development potential involves 200 feet (61 m) or more of total coal thickness buried from 1000 to 3000 feet (305 to 914 m).

The coal development potential for in-situ gasification within the Pleasantdale Quadrangle is rated as moderate throughout the study area except for the 200 acres (81 ha) of high development potential located in the south-central area, and approximately 130 acres (53 ha) of low development potential in the extreme northeast corner and along the east edge of the northeast quadrant. In the area of high development potential, the Upper Wyodak coal bed, and the Middle Wyodak, Lower Wyodak and Wildcat-Moyer-Oedekoven coal zones attain a combined coal thickness of 200 feet (61 m) or more and are buried deeper than 1000 feet (305 m). In the areas of moderate development potential, the combined, isopach thickness of the Smith coal zone, the Upper Wyodak coal bed, the Middle and Lower Wyodak coal zones, and the Wildcat-Moyer-Oedekoven coal zone is from 100 to 200 feet (30 to 61 m) thick and buried deeper than 1000 feet (305 m). The coal resource tonnage for in-situ gasification coal development potential totals approximately 10.0 billion tons (9.1 billion metric tons) (Table 3).

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

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

Coal Bed	High Development Potential (0-10:1 Mining Ratio)	Moderate Development Potential (10:1-15:1 Mining Ratio)	Low Development Potential (> 15:1 Mining Ratio)	Total
Ulm	38,490,000	4,760,000	-----	43,250,000
Felix	585,380,000	625,570,000	167,860,000	1,378,810,000
TOTAL	623,870,000	630,330,000	167,860,000	1,422,060,000

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

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
RESOURCE BASE				
Felix	-----	-----	331,580,000	331,580,000
Smith	-----	-----	286,070,000	286,070,000
Upper Wyodak	-----	-----	1,838,880,000	1,838,880,000
Middle Wyodak	-----	-----	3,871,880,000	3,871,880,000
Lower Wyodak	-----	-----	2,414,560,000	2,414,560,000
Wildcat-Moyer-Oedekoven	-----	-----	1,204,710,000	1,204,710,000
TOTAL	-----	-----	9,947,680,000	9,947,680,000
HYPOTHETICAL RESOURCES				
Smith	-----	-----	15,460,000	15,460,000
TOTAL	-----	-----	9,963,140,000	9,963,140,000

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

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Total
RESOURCE BASE				
	69,980,000	8,279,690,000	1,598,010,000	9,947,680,000
HYPOTHETICAL RESOURCE				
	----	----	15,460,000	15,460,000
TOTAL	69,980,000	8,279,690,000	1,613,470,000	9,963,140,000

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