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# COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE COW CREEK QUADRANGLE, ROUTT COUNTY, COLORADO

[Report includes 14 plates]

Prepared for

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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# INTRODUCTION

## Purpose

This text is to be used in conjunction with Coal Resource Occurrence and Coal Development Potential Maps of the Cow Creek quadrangle, Routt County, Colorado. This report was compiled to support the land-planning work of the Bureau of Land Management (BLM) and to provide a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA's) in the western United States. This investigation was undertaken by Dames & Moore, Denver, Colorado, at the request of the United States Geological Survey under contract number 14-08-0001-15789. The resource information gathered for this report is in response to the Federal Coal Leasing Amendments Act of 1976 (P.L. 94-377). Published and unpublished public information was used as the data base for this study. No new drilling or field mapping was done as part of this study, nor was any confidential data used.

## Location

The Cow Creek quadrangle is located in south-central Routt County in northwestern Colorado, approximately 6 miles (10 km) west-southwest of Steamboat Springs and 32 miles (57 km) east-southeast of Craig, Colorado via U.S. Highway 40. With the exception of a few ranches, the area within the quadrangle is unpopulated.

## Accessibility

U.S. Highway 40 passes through the northwestern quarter of the Cow Creek quadrangle. Several light-duty, all-weather roads are present throughout the area, and the remainder of the quadrangle is accessible by several unimproved roads.

Railway service for the Cow Creek quadrangle is providhe northwestern quarter of the quadrangle and also runs north-south along the quadrangle's western edge. The rail line is the major transportation route for coal shipped east from northwestern Colorado.

## Physiography

The Cow Creek quadrangle lies in the southern part of the Wyoming Basin physiographic province as defined by Howard and Williams (1972), approximately 13 miles (21 km) east of the Williams Fork Mountains and 13 miles (21 km) west of the Continental Divide.

Approximately 1,500 feet (457 m) of relief is present in the Cow Creek quadrangle. Elevations vary from 8,000 feet (2,438 m) in the eastern portion of the quadrangle, to approximately 6,500 feet (1,981 m) along the Yampa River and Trout Creek valleys. The landscape within the quadrangle is dominated by moderate slopes along the upland portions of the stream divides, and by relatively steeper slopes along the lower stream valleys.

The major drainage system present in the Cow Creek quadrangle is the Yampa River, which flows through the northern portion of the quadrangle. Both Cow Creek, which drains the eastern half of the quadrangle, and Trout Creek which drains the western half, flow northward into the Yampa River. The Elk River flows southward and joins the Yampa River in the northern portion of the Cow Creek quadrangle in sec. 18, T. 6 N., R. 85 W.

## Climate and Vegetation

The climate of northwestern Colorado is semiarid. Clear, sunny days prevail in the Cow Creek area, with daily temperatures varying from 0° to 35° F (-18° to 2° C) in January to 42° to 80° F (6° to 27° C) in July. Annual precipitation in the area averages 20 inches (51 cm), most of which occurs as snowfall during the winter months (U.S. Bureau of Land Management, 1977).

Open to very-dense stands of deciduous trees, often relatively small in size, occur at higher elevations in the Cow Creek quadrangle where moisture and soil depth are adequate. At lower elevations, the typical vegetation is sage brush and mountain shrubs and ranges from 2 to 8 feet (0.6 to 2.4 m) high. The lower flat-lying areas, generally

associated with the Yampa River, are used as agricultural land (U.S. Bureau of Land Management, 1977).

### Land Status

The Cow Creek quadrangle lies on the eastern edge of the Yampa Known Recoverable Coal Resource Area (KRCRA). Only the southwestern corner of the quadrangle lies within the KRCRA, and most of that area is privately owned (plate 2). One active coal lease is located within the KRCRA in secs. 19 and 20, T. 5 N., R. 85 W., along the extreme southern edge of the quadrangle.

## GENERAL GEOLOGY

### Previous Work

The first geologic description of the general area in which the Cow Creek quadrangle is located was published by Emmons (1877) as part of the Survey of the Fortieth Parallel. The decision to build a railroad into the region stimulated several investigations of coal between 1886 and 1905, including papers by Chisholm (1887), Hewett (1889), Hills (1893), Storrs (1902), and Parsons and Liddell (1903). Fenneman and Gale (1906) published a geologic report on the Yampa Coal Field, including a description of the geology and coal occurrence in the Cow Creek quadrangle. In 1955, Bass and others expanded Fenneman and Gale's work in their report on the geology and mineral fuels of parts of Routt and Moffat Counties. The report by Bass and others is the most comprehensive work on the area and forms the basis from which this study is taken.

### Stratigraphy

The majority of the rocks which crop out in the Cow Creek quadrangle are Late Cretaceous in age, and include the coal-bearing Iles and Williams Fork Formations of the Mesaverde Group.

Approximately 1,000+ feet (305+ m) of the Late Cretaceous-age Mancos Shale, which is generally 4,000+ feet (1,200+ m) thick, is exposed in the northern portion of the quadrangle (Tweto, 1976). The Mancos Shale is composed of dark-gray marine shale with interbedded sandy shale

and tan thin-bedded silty sandstone. The number and thickness of these beds of sandy shale and sandstone increase toward the top of the formation (Bass and others, 1955). No coal is present in the Mancos Shale.

The Late Cretaceous-age Mesaverde Group conformably overlies the Mancos Shale in the Cow Creek quadrangle. The Mesaverde Group contains two formations, the Iles and the Williams Fork. The 1,300-foot-(396-m-) thick Iles Formation crops out in a generally north-south trending band in the western portion of the quadrangle. It consists of ledge-forming sandstone beds interbedded with gray sandy shales and coal beds. Two major sandstone units are recognized in the Iles Formation in the Cow Creek quadrangle, a double-ledge-forming sandstone bed located approximately 400 feet (122 m) above the base of the Iles Formation, and the Trout Creek Sandstone Member, which forms the contact between the Iles Formation and the overlying Williams Fork Formation. Coal beds begin approximately 400 feet (122 m) above the base of the Iles Formation and extend up to the base of the Trout Creek Sandstone Member. These coal beds comprise the Lower Coal Group of the Mesaverde Group (Fenneman and Gale, 1906).

The Williams Fork Formation, which is also exposed along the western edge of the Cow Creek quadrangle, conformably overlies the Iles Formation. The Williams Fork Formation, which is approximately 1,200 feet (366 m) thick in the Cow Creek area, is divided generally into four sequences, a lower coal-bearing sequence; a marine shaly sequence; the Twentymile Sandstone Member; and an upper transitional, shaly sandstone sequence (Ryer, 1977).

The lower coal-bearing sequence of the Williams Fork Formation is called the Middle Coal Group of the Mesaverde Group (Fenneman and Gale, 1906), and contains approximately 500 feet (152 m) of interbedded siltstone, silty sandstone, very fine-grained sandstone, and coal. Two major coal beds, the Wolf Creek and the Wadge, are found in the Middle Coal Group. They are stratigraphically located approximately 50 feet (15 m) and 210 feet (64 m), respectively, above the top of the Trout Creek

Sandstone Member. The overlying marine shaly sequence, which is approximately 190 fet (58 m) thick in the Cow Creek area, is composed of dark-gray to brown shale and siltstone and eventually grades into the overlying Twentymile Sandstone Member. The Twentymile Sandstone Member, which is approximately 180 feet (55 m) thick in the Cow Creek quadrangle, is a massive white ledge-forming sandstone unit which contains interbedded silty and sandy shale near its base. A well-defined contact is found between the Twentymile Sandstone Member and the overlying transitional sequence. This thick transitional sequence ranges in thickness from 200 to 400 feet (61 to 122 m) and is composed of sandstone, sandy shale, dark-gray shale, and a few local coals. These local coals are designated as the Upper Coal Group of the Mesaverde Group (Fenneman and Gale, 1906).

Approximately 150 feet (46 m) of the Lewis Shale is exposed in an isolated area along the southeastern edge of the quadrangle. The Lewis Shale conformably overlies the Williams Fork Formation and consists of homogeneous dark-gray to bluish-gray marine shale which is non-coal-bearing.

A thin layer of Tertiary-age Browns Park Formation rests unconformably on the Mancos Shale and Iles Formation in the eastern part of the quadrangle (Tweto, 1976). The Browns Park Formation consists of semi-consolidated white tuffaceous sand, claystone, and conglomerate.

The rocks exposed in the Cow Creek quadrangle accumulated close to the western edge of a Late Cretaceous-age epeirogenic seaway which covered part of the western interior of North America. Several transgressive-regressive cycles caused the deposition of a series of marine, near-shore marine, and non-marine sediments in the Cow Creek area. The Mancos Shale was deposited in an offshore marine environment which existed east of the shifting strand line. Deposition of the Mancos Shale in the quadrangle area ended with the eastern movement of the shoreline, and the subsequent deposition of the Iles Formation. The interbedded sandstones, shales, and coals of the Iles and Williams Fork Formations were deposited as a result of minor changes in the position of the

shoreline. During the deposition of these two formations, near-shore marine, littoral, brackish and fresh-water, and fluvial environments existed in the Yampa KRCRA.

The major coal beds which have wide areal extent were deposited near the seaward margins of the non-marine environments, probably in large brackish-water lagoons or swamps. The slow migration of this depositional environment is responsible for the wide distribution of the Wadge and Wolf Creek coal beds in the Yampa study area. Coal beds of limited areal extent were generally deposited in environments associated with fluvial systems, such as back-levee and coastal plain swamps, interchannel basin areas, and abandoned channels. The major sandstones of the Iles and Williams Fork Formations, such as the Trout Creek and Twentymile Sandstone Members, were deposited in shallow marine and near-shore environments. A large rise in sea level caused a landward movement of the shoreline, which resulted in the end of deposition of the near-shore and continental sediments of the Mesaverde Group. After this rise in sea level, the marine Lewis Shale was deposited in the Cow Creek quadrangle area.

## Extrusive Rocks

A dense, black resistant basalt flow is exposed in an isolated area in the south-central portion of the quadrangle (Tweto, 1976). Nothing is known of the true areal extent of the basalt, since the Browns Park Formation generally blankets the area east of the outcrop.

## Structure

The Yampa KRCRA lies in the southern extension of the Washakie/ Sand Wash structural basin of south-central Wyoming. The basin is bordered on the east by the Park Range, some 5 miles (8 km) east of the Cow Creek quadrangle, and on the southwest by the Axial Basin anticline, approximately 40 miles (64 km) southwest of the quadrangle.

The Cow Creek quadrangle lies on the eastern edge of the northwest-trending Twentymile Park syncline. Structural information is available for only the southwestern portion of the quadrangle, where dips vary from

6° to 16° to the northwest to 6° to the southwest. Two northeast-trending faults offset the Cretaceous-age rocks in the southwestern corner of the quadrangle.

Structure contour maps of the Wolf Creek and Wadge coal beds (plates 5 and 9) are based on a regional structure contour map of the top of the Trout Creek Sandstone Member constructed by Bass and others (1955). It is assumed that the structure of the Wolf Creek and Wadge coal beds duplicate that of the Trout Creek Sandstone Member. Minor modifications were made where necessary to accomodate outcrop and drill-hole data. In addition, drill holes from which the elevation of the top of the Wolf Creek or Wadge coal beds could not be determined are not shown on plates 5 or 9 and were not used as data points in map construction.

## COAL GEOLOGY

Several coal beds in the Lower and Middle Coal Groups of the Mesaverde Group have been identified in this quadrangle and the Upper Coal Group is inferred to be present in the southwestern quarter of the quadrangle. The Lower Coal Group includes all coal beds beginning approximately 400 feet (122 m) above the base of the Iles Formation and extending upward to the base of the Trout Creek Sandstone Member (Bass and others, 1955). No coal beds were identified below the Lower Coal Group in this quadrangle. The Middle Coal Group includes the coal beds between the Trout Creek Sandstone Member of the Iles Formation and the Twentymile Sandstone Member of the Williams Fork Formation. The Upper Coal Group includes the Williams Fork coal beds above the Twentymile Sandstone Member and extends to the contact between the Williams Fork Formation and the Lewis Shale. Coals of the Upper and Lower Groups are characteristically lenticular and of limited areal extent, while some of the coals in the Middle Group persist over a large area.

In this report, coal beds that exceed Reserve Base thickness which are not formally named have been numbered with bracketed numbers for identification purposes in this quadrangle only.

## Lower Coal Group

The Lower Coal Group lies approximately 400 feet (122 m) above the base of the Iles Formation and extends up to the base of the Trout Creek Sandstone Member. Bass and others (1955) identified three coal zones in the Lower Group (Zones 1, 2, and 3). The intervals between the zones are approximately 100 and 125 feet (30 and 38 m), respectively.

### Coal Zone 1

Coal beds in the lowest coal zone (Zone 1) of the Lower Coal Group are deeply buried in the subsurface of this quadrangle and none of the coal beds appear to achieve the Reserve Base thickness of 5 feet (1.5 m) in the area.

### Coal Zone 2

Two coal beds in Zone 2 exceed Reserve Base thickness in sec. 8, T. 4 N., R. 85 W. The lower coal bed, LG2[1], which is 6.0 feet (1.8 m) thick, is separated from the upper coal bed, LG2[2], which is 7.8 feet (2.4 m) thick, by 33.2 feet (10.1 m) of rock. These beds are identified in only one drill hole and cannot be correlated with other beds. Therefore, they have been treated as isolated data points (see Isolated Data Points section of this report). Zone 2 contains other coal beds, but they are not of Reserve Base thickness in this quadrangle.

No known chemical analyses have been made on the coals in Zone 2, but these coals are assumed to be similar in quality to other Lower Group Zone 2 coals located in the Oak Creek quadrangle (table 1), and are ranked as high-volatile bituminous B (Fieldner and others, 1937).

### Coal Zone 3

Only one coal bed in Zone 3, the LG3[3], is greater than Reserve Base thickness and was measured in an outcrop in sec. 1, T. 5 N., R. 86 W. The LG3 [3] coal bed is 7.0 feet (2.1 m) thick at this location and cannot be correlated with other coal beds. Therefore, this coal bed has been treated as an isolated data point. Zone 3 contains other coal beds, but they do not exceed Reserve Base thickness in this quadrangle.

No known chemical analyses have been made of these coals in the Cow Creek quadrangle, but they are assumed to be similar in quality to other Lower Group coals in the area, and are ranked as high-volatile bituminous B (Fieldner and others, 1937).

## Middle Coal Group

The Middle Coal Group is located between the Trout Creek and the Twentymile Sandstone Members and contains the Wolf Creek and the Wadge coal beds. These two major coal beds are separated stratigraphically by approximately 160 feet (49 m) of interbedded sandstone and shale. The Lennox coal bed, located approximately 50 feet (15 m) above the Wadge coal bed, has not been identified in drill holes or outcrops in the Cow Creek quadrangle. However, according to Bass and others (1955), and from data projected from the adjacent Rattlesnake Butte, Milner, and Oak Creek quadrangles, the Lennox coal bed is most likely present in this quadrangle and probably does not attain Reserve Base thickness.

### Wolf Creek Coal Bed

The Wolf Creek coal bed is identified in the southwestern corner of the quadrangle in outcrops and in drill holes and is located approximately 50 feet (15 m) stratigraphically above the Trout Creek Sandstone Member. In general, the Wolf Creek coal bed is less than Reserve Base thickness in the Cow Creek quadrangle except in one outcrop near the southern edge where the coal bed was measured to be 5.0 feet (1.5 m) thick. The bed contains rock partings, varying from several thin partings to a single 12-foot (4-m) split.

No known chemical analysis of the Wolf Creek coal bed has been made in this quadrangle, but its quality is assumed to be similar to that of the bed in the Rattlesnake Butte quadrangle, and is ranked as high-volatile bituminous B (Jones and Murray, 1977).

### Wadge Coal Bed

The Wadge coal bed is recognized throughout the southwestern part of the quadrangle and was mined at the Energy No. 3 Mine, the Hutchinson Mine, and the Hutchinson Mine of Tom Chergo (Bass and others, 1955). The bed lies approximately 210 feet (64 m) above the Trout Creek Sandstone Member and varies in thickness from 8 to 10 feet (2.4 to 3.0 m).

Chemical analyses of samples of Wadge coals taken from mines in the area are presented in table 1. The coal is ranked as high-volatile bituminous C on a moist, mineral-matter-free basis according to ASTM Standard Specification D 388-77 (American Society for Testing and Materials, 1977).

### Upper Coal Group

No Upper Group coals are identified from outcrop or drill hole information in the Cow Creek quadrangle, but they are inferred to be present in the southwestern quarter of the quadrangle based on structural data, and are shown in the composite columnar section on plate 3 for diagrammatic purposes only.

### Isolated Data Points

In instances where isolated measurements of coal beds of Reserve Base thickness (greater than 5 feet or 1.5 meters) are encountered, the standard criteria for construction of isopach, structure contour, mining ratio, and overburden isopach maps are not available. The lack of data concerning these beds limits the extent to which they can be reasonably projected in any direction and usually precludes correlations with other, better known coal beds. Coal beds identified by bracketed numbers and letters are not formally named, but are used for identification purposes in this quadrangle only. Isolated data point maps appear on plate 12.

## COAL RESOURCES

Data from drill holes, mine measured sections, and outcrop measurements were used to construct outcrop, isopach, and structure contour maps

of the Wadge and Wolf Creek coal beds. The source of each indexed data point shown on plate 1 is listed in table 4.

Coal resources were calculated using data obtained from the coal isopach maps (plates 4 and 8) and the isolated data point maps (plate 12). The coal bed acreage (measured by planimeter) multiplied by the average isopached thickness of the coal bed, and by a conversion factor of 1,800 short tons of coal per acre-foot (13,238 metric tons per hectare-meter) for bituminous coal, yields the coal resources in short tons (metric tons) for each isopached coal bed. Coal beds thicker than 5 feet (1.5 m) that lie less than 3,000 feet (914 m) below the ground surface are included. This criteria differs somewhat from that used in calculating Reserve Base and Reserve tonnages as stated in U.S. Geological Survey Bulletin 1450-B which calls for a minimum thickness of 28 inches (70 cm) and a maximum depth of 1,000 feet (305 m) for bituminous coal.

Reserve Base and Reserve tonnages for the isopached and non-isopached coal beds are shown on plates 7, 11, and 12, and are rounded to the nearest 10,000 short tons (9,072 metric tons). Coal Reserve Base tonnages per Federal section are shown on plate 2 and total approximately 9.07 million short tons (8.23 million metric tons) for the entire quadrangle, including tonnages from the isolated data points. Reserve Base tonnages in the various development potential categories for surface and subsurface mining methods are shown in tables 2 and 3.

Dames & Moore has not made any determination of economic recoverability for any of the coal beds described in this report.

## COAL DEVELOPMENT POTENTIAL

Coal development potential areas are drawn so as to coincide with the boundaries of the smallest legal land subdivisions shown on plate 2. In sections or portions of sections where no land subdivisions have been surveyed by the BLM, approximate 40-acre (16-ha) parcels have been used to show the limits of the high, moderate, or low development potentials. A constraint imposed by the BLM specifies that the highest

development potential affecting any portion of a 40-acre (16-ha) lot, tract, or parcel be applied to that entire lot, tract, or parcel. For example, if 5 acres (2 ha) within a parcel meet criteria for a high development potential, 25 acres (10 ha) a moderate development potential, and 10 acres (4 ha) a low development potential, then the entire 40 acres (16 ha) are assigned a high development potential.

### Development Potential for Surface Mining Methods

Areas where coal beds of Reserve Base thickness are overlain by 200 feet (61 m) or less of overburden are considered to have potential for surface mining and can be 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:

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

where MR = mining ratio

$t_o$ = thickness of overburden in feet

$t_c$ = thickness of coal in feet

rf = recovery factor (85 percent for this quadrangle)

cf = conversion factor to yield MR value in terms of cubic yards of overburden per short tons of recoverable coal:
0.911 for subbituminous coal
0.896 for bituminous coal

Note: To convert mining ratio to cubic meters of overburden per metric ton of recoverable coal, multiply MR by 0.8428.

Areas of high, moderate, and low development potential for surface mining methods are defined as areas underlain by coal beds having respective mining ratio values of 0 to 10, 10 to 15, and greater than 15, as shown on plates 6 and 10. These mining ratio values for each development potential category are based on economic and technological criteria and were provided by the U.S. Geological Survey.

Areas where the coal data is absent or extremely limited between the 200-foot (61-m) overburden line and the outcrop are assigned unknown development potentials for surface mining methods. This applies to the areas where no known coal beds of 5 feet (1.5 m) or more thick occur and to those areas influenced by isolated data points. Limited knowledge pertaining the to the areal distribution, thickness, depth, and attitude of the coals in these areas prevents accurate evalution of the development potential in the high, moderate, or low categories. The areas influenced by isolated data points in this quadrangle contain approximately 0.87 million short tons (0.79 million metric tons) of coal available for surface mining.

The coal development potential for surface mining methods is shown on plate 13. Of the Federal land areas having a known development potential for surface mining methods, all are rated high. The remaining Federal lands within the KRCRA boundary are classified as having unknown development potential for surface mining methods.

### Development Potential for Subsurface and In-Situ Mining Methods

Areas considered to have a development potential for conventional subsurface mining methods are those areas where the coal beds of Reserve Base thickness are between 200 and 3,000 feet (61 and 914 m) below the ground surface with dips of 15° or less. Coal beds of Reserve Base thickness lying between 200 and 3,000 feet (61 and 914 m) below the ground surface, dipping greater than 15°, are considered to have potential for in-situ mining methods.

Areas of high, moderate, and low development potential for subsurface mining methods are defined as areas underlain by coal beds at depths ranging from 200 to 1,000 feet (61 to 305 m), 1,000 to 2,000 feet (305 to 610 m), and 2,000 to 3,000 feet (610 to 914 m) below the ground surface, respectively.

Areas where the coal data is absent or extremely limited between 200 and 3,000 feet (61 and 914 m) below the ground surface are assigned unknown development potentials. This applies to those areas influenced by isolated data points and to the areas where no known coal beds of Reserve Base thickness occur. The areas influenced by isolated data points in this quadrangle contain approximately 5.40 million short tons (4.90 million metric tons) of coal available for conventional subsurface mining.

The coal development potential for conventional subsurface mining is shown on plate 14. All of the Federal land areas classified as having known development potential for conventional subsurface mining methods are rated high. The remaining Federal land within the KRCRA boundary is classified as having unknown development potential.

Because the coal beds in this quadrangle have dips less than 15°, all Federal land areas within the KRCRA boundary have been rated as having unknown development potential for in-situ mining methods.

Table 1. Chemical analyses of coals on an as-received basis, Cow Creek quadrangle, Routt County, Colorado.

| LOCATION | COAL BED NAME | Source | Proximate | | | | Ultimate | | | | | Heating value | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Moisture | Volatile matter | Fixed carbon | Ash | Sulfur | Hydrogen | Carbon | Nitrogen | Oxygen | Calories | Btu/lb * |
| T. 5 N., R. 86 W., sec. 1,2 Energy Strip #3 Mine | Wadge | 2 | 10 | - | - | 8-9 | 0.5 | - | - | - | - | - | 11,300 |
| T. 5 N., R. 86 W., sec. 12, SE ¼ Hutchinson Mine | Wadge | 1 | 12.5 | 35.2 | 46.9 | 5.4 | 0.4 | 5.8 | 63.3 | 1.43 | 23.6 | 6,135 | 11,050 |
| T. 5 N., R. 86 W., sec. 13, NW¼ NE¼ Hutchinson Mine of Tom Chergo | Wadge | 1 | 12.8 | 37.2 | 44.4 | 5.6 | 0.4 | 5.8 | 63.3 | 1.49 | 23.5 | 6,130 | 11,030 |
| T. 4 N., R. 86 W., sec. 10 Middle Creek Mine (Rattlesnake Butte quadrangle) | Wolf Creek | 4 | 8.0 | 42.9 | 47.3 | 9.8 | 0.5 | - | - | - | - | - | 11,460 |
| T. 4 N., R. 86 W., sec. 13,18, Hayden #3 Mine (Oak Creek quadrangle) | Pinnacle (Lower Coal Group, No.2) | 3 | 8.9 | 37.8 | 48.5 | 4.8 | 0.7 | - | - | - | - | 6,672 | 12,010 |

1. Bass and others, 1955
2. Dawson and Murray, 1978
3. Fieldner and others, 1937
4. Jones and Murray, 1977

* To convert Btu/lb to kJ/kg, multiply by 2.326

Table 2. -- Coal Reserve Base data for surface mining methods for Federal coal lands (in short tons) in the Cow Creek quadrangle, Routt County, Colorado.

| Coal Bed or Zone | High Development Potential | Moderate Development Potential | Low Development Potential | Unknown Development Potential | Total |
|---|---|---|---|---|---|
| Wadge | 1,030,000 | 520,000 | 210,000 | - | 1,760,000 |
| Wolf Creek | 50,000 | 20,000 | 10,000 | - | 80,000 |
| Isolated Data Points | - | - | - | 870,000 | 870,000 |
| Totals | 1,080,000 | 540,000 | 220,000 | 870,000 | 2,710,000 |

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

Table 3. -- Coal Reserve Base data for subsurface mining methods for Federal coal lands (in short tons) in the Cow Creek quadrangle, Routt County, Colorado.

| Coal Bed or Zone | High Development Potential | Moderate Development Potential | Low Development Potential | Unknown Development Potential | Total |
|---|---|---|---|---|---|
| Wadge | 960,000 | - | - | - | 960,000 |
| Isolated Data Points | - | - | - | 5,400,000 | 5,400,000 |
| Totals | 960,000 | - | - | 5,400,000 | 6,360,000 |

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

Table 4. -- Sources of data used on plate 1

| Plate 1 Index Number | Source | Data Base |
|---|---|---|
| 1 | Bass and others, 1955, U.S. Geological Survey Bulletin 1027-D, pl. 23 | Section B22 |
| 2 | ↓ | Section B23 |
| 3 | ↓ | Section B24 |
| 4 | ↓ | Section B25 |
| 5 | ↓ | Section B26 |
| 6 | Bass, N. W., 1955, U.S. Geological Survey, unpublished field notes | Drill hole No. 59 |
| 7 | Bass and others, 1955, U.S. Geological Survey Bulletin 1027-D, pl. 23 | Section B29 |
| 8 | ↓ | Section B27 |
| 9 | ↓ | Section B28 |
| 10 | Bass, N. W., 1955, U.S. Geological Survey, unpublished field notes | Drill hole No. W-5 |
| 11 | Bass and others, 1955, U.S. Geological Survey Bulletin 1027-D, pl. 23 | Section B83 |
| 12 | | Section B82 |
| 13 | U.S. Geological Survey Inactive Coal Prospecting Permit No. Denver 035183, Edward L. Prentiss | Drill hole No. MC-12 |
| 14 | Bass and others, 1955, U.S. Geological Survey Bulletin 1027-D, pl. 23 | Section B84 |
| 15 | Bass, N. W., 1955, U.S. Geological Survey, unpublished field notes | Drill hole No. W-6 |
| 16 | Bass and others, 1955, U.S. Geological Survey Bulletin 1027-D, pl. 23 | Section B86 |

Table 4. -- Continued

| Plate 1 Index Number | Source | Data Base |
|---|---|---|
| 17 | Bass and others, 1955, U.S. Geological Survey Bulletin 1027-D, pl. 23 | Section B89 |
| 18 | ↓ | Section B90 |
| 19 | U.S. Geological Survey Coal Prospecting Permit No. Colorado 794, Pittsburg & Midway Coal Co. | Drill hole No. MC-16 |
| 20 | Bass and others, 1955, U.S. Geological Survey Bulletin 1027-D, pl. 25 | Section B140 |

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