Text to accompany:

Open-File Report 79-800

1979

COAL RESOURCE OCCURRENCE MAPS AND COAL DEVELOPMENT POTENTIAL MAP OF THE NORTHWEST QUARTER OF THE GOULD PASS 15-MINUTE QUADRANGLE, SAN JUAN COUNTY, NEW MEXICO

[Report includes 27 plates]

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CONTENTS

CONTENTS

PLATES

CONTENTS

Page

TABLES

NORTHWEST QUARTER OF THE GOULD PASS 15-MINUTE QUADRANGLE

INTRODUCTION

Purpose

This text is to be used in conjunction with the Coal Resource Occurrence (CRO) Maps and Coal Development Potential (CDP) Map of the northwest quarter of the Gould Pass 15-minute quadrangle, San Juan County, New Mexico. These maps were compiled to provide a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA's) of the western United States. The work was performed under contract with the Conservation Division of the U.S. Geological Survey (Contract No. 14-08-0001-17172).

The resource information gathered in this program is in response to the Federal Coal Leasing Amendments Act of 1976 and is a part of the U.S. Geological Survey's coal program. The information provides basic data on coal resources for land-use planning purposes by the Bureau of Land Management, state and local governments, and the public.

Location

The northwest quarter of the Gould Pass 15-minute quadrangle is located in northeastern San Juan County, New Mexico. The area is approximately 27 miles (43 km) east-southeast of Farmington, New Mexico.

Accessibility

The northwest quarter of the Gould Pass quadrangle is accessible from New Mexico State Route 17 which extends across the northern part of the area. Light-duty roads provide access to remote areas of the quadrangle. The Atchison, Topeka, and Santa Fe Railway operates a route approximately 99 miles (159 km) to the southwest at Gallup, New Mexico.

Physiography

This quadrangle is in the north-central portion of the Central Basin area (Kelley, 1950) of the structural depression known as the San Juan Basin. Elevations range from 5,640 ft (1,719 m) in Canon Largo to 6,913 ft (2,107 m) on Manzanares Mesa. There are several mesas in this quadrangle; Manzanares Mesa in the north is the largest. The remainder of the quadrangle is typified by numerous canyons with intermittent streams which drain into Canon Largo. The intermittent stream, Canon Largo, flows to the northwest.

Climate

The climate of the San Juan Basin is arid to semi-arid. Annual precipitation is usually less than about 10 inches (25 cm) with slight variations across the basin due to elevational differences. Rainfall is rare in the early summer and winter; most precipitation is received in July and August as intense afternoon thundershowers. Annual temperatures range from below 0°F (-18°C) to over 100° (38°C) in the basin. Snowfall may occur from November to April.

Land Status

Approximately 80 percent of the quadrangle is in the northeastern portion of the San Juan Basin Known Recoverable Coal Resource Area. The Federal government owns the coal rights for approximately 92 percent of the KRCRA land within the quadrangle as shown on Plate 2 of the Coal Resource Occurrence Maps. No Federal coal leases occur in the quadrangle.

GENERAL GEOLOGY

Previous Work

Reeside (1924) mapped the surficial geology of the area on a scale of 1:250,000 as part of a study of the Upper Cretaceous and Tertiary formations of the San Juan Basin. Fassett and Hinds (1971) made subsurface interpretations of Fruitland Formation coal occurrences as part of a larger San Juan Basin coal study.

Geologic History

The San Juan Basin, an area of classic transgressive and regressive sedimentation, provided the ideal environment for formation of coals during Late Cretaceous time. At that time a shallow epeiric sea, which trended northwest-southeast, was northeast of the basin. The sea transgressed southwesterly into the basin area and regressed northeasterly numerous times;

consequently, sediments from varying environments were deposited across the basin. Noncarbonaceous terrestrial deposition predominated during Paleocene and Eocene time.

Evidence of the final retreat of the Late Cretaceous sea are the nearshore regressive Pictured Cliffs Sandstone and the overlying paludal Fruitland Formation which were deposited in successively higher stratigraphic positions to the northeast. Southwest (shoreward) of the beach deposits, swamps, which were dissected by streams, accumulated organic matter which later became coals of the Fruitland Formation. Deposition of organic material was influenced by the strandline as shown by both the continuity of the coal beds parallel to the north-south strandline in this part of the basin and their discontinuity perpendicular to it to the east.

The brackish-water swamp environment of the Fruitland moved farther to the northeast as the regression continued in that direction. Terrestrial freshwater sediments then covered this quadrangle as evidenced by the lacustrine, channel, and floodplain deposits of the Kirtland Shale. This sequence of events is evidenced by both an upward decrease in occurrence and thickness of Fruitland coals and a gradational change to noncarbonaceous deposits of the Kirtland. Continuous deposition during Late Cretaceous time ended with the Kirtland. The sea then retreated beyond the limits of the quadrangle area, and modern basin structure began to develop. An erosional unconformity developed in a relatively short time as part of the Cretaceous Kirtland Shale was removed.

Terrestrial deposition resumed in the Paleocene as represented by the Ojo Alamo Sandstone and the overlying Nacimiento Formation. Alluvial plain and floodplain deposits of the Ojo Alamo were followed by the thick, lithologically varied deposits of the Nacimiento during continuous nonmarine deposition. The Nacimiento was later exposed to erosion.

The Eocene San Jose Formation was subsequently deposited over the Nacimiento erosional surface, reflecting various nonmarine environments which developed across the basin. Deposition and structural deformation of the basin then ceased, and the warped strata of the San Juan Basin have been exposed to erosional processes to the present time.

Stratigraphy

The formations studied in this quadrangle range from Late Cretaceous to Eocene in age. They are, in order from oldest to youngest: the Pictured Cliffs Sandstone, Fruitland Formation, Kirtland Shale, Ojo Alamo Sandstone, Nacimiento Formation, and the San Jose Formation. A composite columnar section on CRO Plate 3 illustrates the stratigraphic relationships of these formations and is accompanied by lithologic descriptions of the individual formations.

The Pictured Cliffs Sandstone averages 130 ft (40 m) thick in the area. Because the unit is present throughout most of the San Juan Basin and easily recognized on geophysical logs, the top was picked as the datum (CRO Plate 3) for Fruitland coal correlations. The formation consists of a cream to light gray, calcareous, slightly micaceous sandstone interbedded with gray shale near the base of the unit. Intertonguing with the overlying Fruitland Formation occurs throughout the entire basin, and, consequently, minor Fruitland coal beds commonly are present in the upper portion of the Pictured Cliffs.

The major coal-bearing unit in the quadrangle is the Fruitland Formation. Wide variations in reported thickness of the Fruitland are common due to an indistinct upper contact, but the average is about 300 ft (91 m) in this quadrangle. Many authors have utilized various criteria to establish the upper contact, but, in general, for this study the uppermost coal was chosen (after Fassett and Hinds, 1971). The formation is primarily gray to brown, carbonaceous shale with scattered plant fossils, interbedded white to gray sandstone, and lenticular coal beds.

The Upper Cretaceous Kirtland Shale conformably overlies the Fruitland Formation and averages 560 ft (171 m) in thickness in this area. It consists predominantly of freshwater, gray-green to brown shale, interbedded gray-green siltstone, and minor beds of the many lithologic variations between shale and siltstone. The formation has previously been divided into several members by various authors; however, for the purposes of this report it was not necessary to distinguish between the individual members.

The Paleocene Ojo Alamo Sandstone unconformably overlies the Kirtland Shale. It is a white to gray, locally conglomeratic sandstone with interbedded gray-green to brown shale. In this area the Ojo Alamo averages 110 ft (34 m) in thickness.

Approximately 1,200 ft (366 m) of the Paleocene Nacimiento Formation overlie the Ojo Alamo Sandstone. These rocks are exposed in the southwestern corner of the quadrangle where they consist of gray-green to brown shale, interbedded tan to gray-green, micaceous siltstone, and interbedded tan to gray, locally conglomeratic, silty sandstone.

The San Jose Formation of Eocene age unconformably overlies the Nacimiento Formation and crops out in the northern and eastern parts of the quadrangle area. It consists of white to gray, locally conglomeratic sandstone, gray-green shale, and siltstone.

Structure

The axis of the San Juan Basin is about 12 miles (19 km) north and northeast of the northwest quarter of the Gould Pass 15-minute quadrangle area and trends in an arcuate pattern across the northern portion of the Central Basin (Baltz, 1967). Reeside (1924) stated that the rocks in this area are "nearly horizontal."

COAL GEOLOGY

Individual coal beds are not continuous across the San Juan Basin because the coal related strata are progressively younger from southwest to northeast; the strata rise in steps due to minor transgressions which occurred during the overall retreat of the sea. However, for the exclusive purpose of reserve and reserve base calculations, the Fruitland coal beds have been correlated and mapped as if they were single beds, continuous throughout the basin.

A lithologic datum was used for correlation of the coals (CRO Plate 3). The primarily marine sandstone unit (Pictured Cliffs) which underlies the coal-bearing formation (Fruitland) was used as a datum since it represents a more laterally continuous boundary than any of the overlying paludal, fluvial, and lacustrine deposits of the coal-bearing formation. Also, the sandstone unit is generally more easily recognized on geophysical logs. As shown on CRO Plate 3, the top of the Pictured Cliffs Sandstone has been used as a datum for each drill hole and the coals have been plotted in the column and correlated based upon their position relative to the datum.

Six coal beds (Fruitland 1, Fruitland 2, Fruitland 3, Fruitland 4, Fruitland 5, Fruitland 6) and a coal zone (Fruitland) were identified in the subsurface of this quadrangle (CRO Plate 1). The Fruitland 1 (Fr 1) coal bed is defined by the authors as the lowermost coal of the Fruitland Formation; it is generally directly above the Pictured Cliffs Sandstone. The Fruitland 2 (Fr 2) coal bed is above the Fruitland 1 separated by a rock interval of 20 to 77 ft (6.1-23.5 m); the Fruitland 3 (Fr 3) coal bed is above the Fruitland 2 separated by a rock interval of 6 to 30 ft (1.8-9.1 m); the Fruitland 4 (Fr 4) coal bed is above the Fruitland 3 separated by a rock interval of 8 to 46 ft (2.4-14.0 m); the Fruitland 5 (Fr 5) coal bed is above the Fruitland 4 separated by a rock interval of 21 to 100 ft (6.4-30.5 m); the Fruitland 6 (Fr 6) coal bed is above the Fruitland 5 separated by a rock interval of 23 to 48 ft (7.0-14.6 m). Between these coal beds there occasionally is a local (L) coal which is discontinuous.

The remaining coals in the upper portion of the Fruitland Formation have been designated as the Fruitland coal zone (Fr zone). These coals are generally noncorrelative, discontinuous, and less than reserve base thickness (5 ft [1.5 m]) as specified by the U.S. Geological Survey. Due to these characteristics, derivative maps were not constructed.

Fruitland Formation coals in the central part of the San Juan Basin are considered high volatile A bituminous in rank. The rank has been determined on a moist, mineral-matter-free basis with calorific values averaging 15,371 Btu's per pound (35,753 kj/kg) (Amer. Soc. for Testing and Materials, 1977). The coal is hard, brittle, and black with a bright luster. The coal readily slakes with exposure to weather; however, it stocks fairly well when protected. The "as received" analyses indicate moisture content of 1.2 to 1.7 percent, ash content ranging from 10.7 to 28.5 percent, sulfur content varying from 0.6 to 2.2 percent, and heating values on the order of 12,073 Btu's per pound (28,082 kj/kg). Analyses of several Fruitland Formation coals are given in Table 1 (Bauer and Reeside, 1921; Dane, 1936; Fassett and Hinds, 1971).

Fruitland 1 Coal Bed

The Fruitland 1 coal bed has been mapped only in areas of less than 3,000 ft (914 m) of overburden (the study limit). The structure contour map (CRO Plate 5) shows that the coal bed dips less than 1° to the northeast. As a result of topography and dip, the overburden (CRO Plate 6) varies in thickness from less than 2,100 ft (640 m) in Canon Largo to more than 3,000 ft (914 m) on Manzanares Mesa. As illustrated by the isopach map (CRO Plate 4) the coal bed has a thickness of more than 20 ft (6.1 m) in the southwestern and northern portions of the quadrangle. Thickness decreases in all directions from these areas, and the coal bed is absent from a few small areas in the eastern and southeastern portions of the quadrangle.

Chemical Analyses of the Fruitland 1 Coal Bed - No known analyses of Fruitland coals from this quadrangle are available; however, analyses of several coals of the Fruitland Formation from the area surrounding this quadrangle are given in Table 1 (Fassett and Hinds, 1971).

TABLE 1

Analyses of coal samples from the Fruitland Formation

(Form of analysis: A, as received; B, moisture free; C, moisture and ash free)

U.S. Bureau Mines Lab No.	Well or Other Source	Location			Approx. Depth Interval of Sample (ft.)	Form of Analysis	Proximate, percent					Heating Value (Btu)	Remarks
		Section	T.N.	R.W.			Mois-ture	Volatile matter	Fixed Carbon	Ash	Sulfur		
H-7560	El Paso Nat. Gas S.J.U. 29-6 No. 66	SW¼ 9	29	6	3,575-3,580	A	1.2	27.7	42.6	28.5	0.6	10,780	
						B	---	28.0	43.1	28.9	0.6	10,910	
						C	---	39.4	60.6	----	0.8	15,330	
H-16310	Aztec Oil & Gas Cain No. 16-D	SW¼ 30	29	9	1,985-2,005	A	1.6	41.1	46.6	10.7	0.7	13,310	
						B	---	41.7	47.5	10.8	0.7	13,520	
						C	---	46.8	53.2	----	0.7	15,160	
H-15142	El Paso Nat. Gas S.J.U. 30-6 No. 37	NE¼ 10	30	6	3,100-3,105	A	1.5	24.1	49.4	25.0	0.7	11,310	
						B	---	24.5	50.1	25.4	0.7	11,480	
						C	---	32.8	67.2	----	0.9	15,380	
H-50079	Delhi-Taylor Moore No. 6	NE¼ 5	30	8	2,800-3,028	A	1.7	32.6	41.4	24.3	1.8	11,250	
						B	---	33.2	42.1	24.7	1.8	11,440	
						C	---	44.0	56.0	----	2.4	15,190	
H-35925	El Paso Nat. Gas Turner No. 3	SE¼ 28	30	9	2,385-2,390	A	1.5	39.9	45.5	13.1	2.2	12,960	
						B	---	40.5	46.2	13.3	2.2	13,150	
						C	---	46.7	53.3	----	2.5	15,170	
H-50012	Delhi-Taylor Barrett No. 1	SW¼ 20	31	9	3,230-3,255	A	1.3	33.7	49.2	15.8	0.7	12,830	
						B	---	34.1	49.9	16.0	0.7	13,000	
						C	---	40.6	59.4	----	0.9	15,470	

To convert Btu's/lb to kj/kg, multiply Btu's/lb by 2.326.
To convert feet to meters, multiply feet by 0.3048.

Fruitland 2 Coal Bed

The Fruitland 2 coal bed has been mapped only in areas of less than 3,000 ft (914 m) of overburden (the study limit). The coal bed dips less than 1° to the northeast as shown by the structure contour map (CRO Plate 9). Because of topography and dip, the overburden (CRO Plate 10) ranges from less than 2,000 ft (610 m) in the Canon Largo to more than 3,000 ft (914 m) thick on Manzanares Mesa. The coal bed has a thickness of more than 25 ft (7.6 m) in the northeastern part of the quadrangle as shown by the isopach map (CRO Plate 8). The thickness decreases in all directions, and the coal is absent from parts of the central and the southwestern portions of the quadrangle.

Chemical Analyses of the Fruitland 2 Coal Bed - No known analyses of Fruitland coals from this quadrangle are available; however, analyses of several coals of the Fruitland Formation from the area surrounding this quadrangle are given in Table 1 (Fassett and Hinds, 1971).

Fruitland 3 Coal Bed

The Fruitland 3 coal bed has been mapped only in areas of less than 3,000 ft (914 m) of overburden (the study limit). The coal dips less than 1° to the northeast as shown by the structure contour map (CRO Plate 13). Due to topography and dip, the overburden (CRO Plate 14) thickness varies from less than 2,000 ft (610 m) in Canon Largo to more than 3,000 ft (914 m) on Manzanares Mesa. The coal bed thickness, as illustrated by the isopach map (CRO Plate 12), is more than 15 ft (4.6 m) in the northern and southeastern parts of the quadrangle. The thickness decreases from these areas, and the coal is absent from parts of the northeast, south, and southwest.

Chemical Analyses of the Fruitland 3 Coal Bed - No known analyses of Fruitland coals are available for this quadrangle; however, analyses of several coals of the Fruitland Formation from the area surrounding this quadrangle are given in Table 1 (Fassett and Hinds, 1971).

Fruitland 4 Coal Bed

The Fruitland 4 coal bed has been mapped only in areas of less than 3,000 ft (914 m) of overburden (the study limit). The dip of the coal bed is generally less than 1° to the northeast as indicated by the structure contour map (CRO Plate 17). As a result of topography and dip, the thickness of the overburden (CRO Plate 18) ranges from less than 2,000 ft (610 m) in Canon Largo and Carrizo Creek to more than 3,000 ft (914 m) on Manzanares Mesa. The isopach map (CRO Plate 16) shows the coal bed is greater than 20 ft (6.1 m) thick in the northeastern part of the quadrangle and, in general, thins in all directions. A relatively large noncoal-bearing area extends across the center of the quadrangle in a northwest-southeast direction; the coal bed is also absent from two smaller areas in the southwest.

Chemical Analyses of the Fruitland 4 Coal Bed - No known analyses of Fruitland coals are available for this quadrangle; however, analyses of several coals of the Fruitland Formation from the area surrounding this quadrangle are given in Table 1 (Fassett and Hinds, 1971).

Fruitland 5 Coal Bed

The Fruitland 5 coal bed has been mapped only in areas of less than 3,000 ft (914 m) of overburden (the study limit). As indicated by the structure contour map (CRO Plate 21) the coal bed dips generally less than 1° to the northeast. Due to topography and dip, the overburden (CRO Plate 22) varies in thickness from less than 2,000 ft (610 m) in Canon Largo and Carrizo Creek to more than 3,000 ft (914 m) on Manzanares Mesa. The isopach map (CRO Plate 20) shows that the coal bed attains a thickness of greater than 20 ft (6.1 m) in the extreme northeast corner of the quadrangle. The thickness decreases and is less than 5 ft (1.5 m) throughout most of the remainder of the quadrangle. The coal bed is absent from much of the western edge of the quadrangle and from two smaller areas in the southeast.

Chemical Analyses of the Fruitland 5 Coal Bed - No known analyses of Fruitland coals are available for this quadrangle; however, analyses of several coals of the Fruitland Formation from the area surrounding this quadrangle are given in Table 1 (Fassett and Hinds, 1971).

Fruitland 6 Coal Bed

The Fruitland 6 coal bed is present in the northeast, north, and southeast parts of the quadrangle and has been mapped only in areas of less than 3,000 ft (914 m) of overburden (the study limit). As shown by the structure contour map (CRO Plate 25) the coal bed dips less than 1° to the northeast. As a result of topography and dip, the overburden (CRO Plate 26) varies in thickness from less than 1,900 ft (579 m) in Canon Largo and

Carrizo Creek to more than 3,000 ft (914 m) on Manzanares Mesa. As shown on the isopach map (CRO Plate 24), the coal bed is absent from much of the quadrangle and is greater than 5 ft (1.5 m) thick only in the northeast portion of the quadrangle.

Chemical Analyses of the Fruitland 6 Coal Bed - No known analyses of Fruitland coals are available for this quadrangle; however, analyses of several coals of the Fruitland Formation from the area surrounding this quadrangle are given in Table 1 (Fassett and Hinds, 1971).

COAL RESOURCES

Coal resource data from oil and gas wells (El Paso Natural Gas Co., 1978, unpublished data in well log library in Farmington, New Mexico) was used in the construction of isopach and structure contour maps of coals in this quadrangle. All of the coals studied in the northwest quarter of the Gould Pass 15-minute quadrangle are more than 200 ft (61 m) below the ground surface and, thus, have no outcrop or surface development potential.

The U.S. Geological Survey designated the Fruitland 1, Fruitland 2, Fruitland 3, Fruitland 4, Fruitland 5, and Fruitland 6 coal beds for the determination of coal resources in this quadrangle. Coals of the Fruitland zone were not evaluated because they are discontinuous, noncorrelative, and generally less than the reserve base thickness (5 ft [1.5 m]).

For Reserve Base and Reserve calculations, each coal bed was areally divided into measured, indicated, and inferred resource categories (CRO Plates 7, 11, 15, 19, and 23) according to criteria established in U.S. Geological Survey Bulletin 1450-B. Data for calculation of Reserve Base and

Reserves for each category were obtained from the respective coal isopach (CRO Plates 4, 8, 12, 16, 20, and 24) and areal distribution maps (CRO Plates 7, 11, 15, 19 and 23) for each coal bed. The surface area of each isopached bed was measured by planimeter, in acres, for each category, then multiplied by both the average isopached thickness of the coal bed and 1,800 short tons of coal per acre-foot (13,239 tons/hectare-meter), the conversion factor for bituminous coal. This yields the Reserve Base coal, in short tons, for each coal bed.

In order to calculate Reserves, a recovery factor of 50 percent was applied to the Reserve Base tonnages for underground coal. However, in areas of underground coal exceeding 12 ft (3.7 m) in thickness, the Reserves (mineable coal) were calculated on the basis of a maximum coal bed thickness of 12 ft (3.7 m), which represents the maximum economically mineable thickness for a single coal bed in this area by current underground mining technology.

Reserve Base and Reserve values for measured, indicated, and inferred categories of coal for the Fruitland 1, Fruitland 2, Fruitland 3, Fruitland 4, Fruitland 5, and Fruitland 6 beds are shown on CRO Plates 7, 11, 15, 19, and 23, respectively, and are rounded to the nearest hundredth of a million short tons. The total coal Reserve Base, by section, is shown on CRO Plate 2 and totals approximately 896 million short tons (813 million metric tons).

The coal development potential for each bed was calculated in a manner similar to the Reserve Base, from planimetered measurements, in acres, for areas of high, moderate, and low potential for subsurface mining methods. The northwest quarter of the Gould Pass 15-minute quadrangle has development potential for subsurface mining methods only (CDP Plate 27).

COAL DEVELOPMENT POTENTIAL

Coal beds of 5 ft (1.5 m) or more in thickness which are overlain by 200 to 3,000 ft (61-914 m) of overburden are considered to have potential for underground mining and are designated as having high, moderate, or low development potential according to the overburden thickness: 200 to 1,000 ft (61-305 m), high; 1,000 to 2,000 ft (305-610 m), moderate; and 2,000 to 3,000 ft (610-914 m), low. Table 2 summarizes the coal development potential, in short tons, for underground coal of the Fruitland 1, Fruitland 2, Fruitland 3, Fruitland 4, Fruitland 5, and Fruitland 6 coal beds.

Development Potential for Surface Mining Methods

All coals studied in the northwest quarter of the Gould Pass 15-minute quadrangle occur more than 200 ft (61 m) below the ground surface and, thus, they have no coal development potential for surface mining methods.

Development Potential for Subsurface Mining Methods

Coal of moderate development potential in this quadrangle (CDP Plate 27) occurs in the southwest corner due to the Fruitland 1 and 3 coal beds (CRO Plates 7 and 15), in the south-central due to the Fruitland 3 coal bed, and in the west-central due to the Fruitland 2 coal bed (CRO Plate 11). The coal varies in thickness from 8 to 17 ft (2.4-5.2 m) for the Fruitland 1 coal bed (CRO Plate 4), 5 to 6 ft (1.5-1.8 m) for the Fruitland 2 (CRO Plate

TABLE 2

COAL RESOURCE DATA FOR UNDERGROUND MINING METHODS FOR FEDERAL COAL LANDS (in short tons) IN THE NORTHWEST QUARTER OF THE GOULD PASS 15-MINUTE QUADRANGLE, SAN JUAN COUNTY, NEW MEXICO

(To convert short tons to metric tons, multiply by 0.9072)

Coal Bed	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Fruitland 6	--	--	110,000	110,000
Fruitland 5	--	--	3,040,000	3,040,000
Fruitland 4	--	--	55,520,000	55,520,000
Fruitland 3	--	16,500,000	313,650,000	330,150,000
Fruitland 2	--	1,160,000	14,390,000	15,550,000
Fruitland 1	--	4,810,000	487,040,000	491,850,000
TOTAL	--	22,470,000	873,750,000	896,220,000

8), and 5 to 12 ft (1.5-3.7 m) for the Fruitland 3 coal bed (CRO Plate 12), with the overburden thickness for these coal beds slightly less than 2,000 ft (610 m) (CRO Plates 6, 10, and 14).

Most of the remaining area in the quadrangle inside the KRCRA boundary has low development potential due to the Fruitland 1, Fruitland 2, Fruitland 3, Fruitland 4, Fruitland 5, and Fruitland 6 coal beds. Low potential of the Fruitland 1 coal bed is found over most of the quadrangle varying in thickness from 5 to 20 ft (1.5-6.1 m), with overburden ranging in thickness from 2,000 ft (610 m) in the southwest to 3,000 ft (914 m) in the north. The Fruitland 2 coal bed has low potential in the central, west-central, and northeast parts of the quadrangle where the coal bed thickness is 5 to 20 ft (1.5-6.1 m) thick, and overburden increases in thickness from 2,000 ft (610 m) in the west-central to 3,000 ft (914 m) in the northwest. The Fruitland 3 coal bed occurs in most of the northwest and southeast quadrants, with low development potential where the coal bed thickness ranges from 5 to 19 ft (1.5-5.8 m), and overburden ranges from 2,000 to 3,000 ft (610-914 m) in thickness towards the north. The Fruitland 4 coal bed occurs only along the northern border with low potential where the coal bed thickness varies from 5 to 15 ft (1.5-4.8 m) (CRO Plate 16), and the overburden thickness ranges from 2,400 to 3,000 ft (732-914 m) (CRO Plate 18). Mineable coal of the Fruitland 5 and Fruitland 6 coal beds occur in small isolated areas in the central to north-central parts of the quadrangle having low development potential where the coal bed thickness is 5 to 6 ft (1.5-1.8 m) (CRO Plates 20 and 24), and overburden thickness varies from 2,400 to 3,000 ft (732-914 m) (CRO Plates 22 and 26).

Several areas in the south-central, east-central, and north-central parts of the quadrangle have unknown development potential where the six Fruitland coal beds are all less than the reserve base thickness of 5 ft (1.5 m) or are overlain by more than 3,000 ft (914 m) of overburden.

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