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

[Report includes 20 plates]

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NORTHEAST QUARTER OF THE BLOOMFIELD 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 northeast quarter of the Bloomfield 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 northeast quarter of the Bloomfield 15-minute quadrangle is located in northeastern San Juan County, New Mexico. The area is approximately 21 miles (34 km) east-southeast of Farmington, New Mexico.

Accessibility

The northeast quarter of the Bloomfield 15-minute quadrangle is accessible from New Mexico State Routes 17 and 115 which extend across the area. Light-duty roads provide further access to remote parts of the quadrangle. The Atchison, Topeka, and Santa Fe Railway operates an east-west route approximately 97 miles (156 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 5,512 ft (1,680 m) in the western San Juan River Valley to 7,040 ft (2,146 m) atop Harris Mesa in the southeast. The San Juan River flows through the area from the northeast to the west-central part of the area. The intermittent stream in Canon Largo flows in a northwest direction and joins the river in the north-central part of the quadrangle. The eastern and southern portions of the quadrangle are characterized by mesas; the western portion is dissected by tributaries of the San Juan River which form steep-walled canyons.

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°F (38°C) in the basin. Snowfall may occur from November to April.

Land Status

The quadrangle is in the northeast portion of the San Juan Basin Known Recoverable Coal Resource Area. The Federal Government owns the coal rights for approximately 82 percent of the KRCRA land within the quadrangle as shown on Plate 2 of the Coal Resource Occurrence Maps. No Federal coal leases occur within 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. More recently, 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.

Depositional evidence of the final retreat of the Late Cretaceous sea is the nearshore regressive Pictured Cliffs Sandstone. 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 less continuous Fruitland coals appear to be noncorrelative, but are stratigraphically equivalent in terms of their relative position within the Fruitland Formation.

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 indicated 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 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: Pictured Cliffs Sandstone, Fruitland Formation, Kirtland Shale, Ojo Alamo Sandstone, Nacimiento Formation, and 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 100 ft (30 m) thick in this area. Because this unit is persistent 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 white to cream, slightly micaceous, kaolinitic 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 are common due to an indistinct upper contact with the Kirtland Shale, but the average is about 270 ft (82 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 primarily consists of gray carbonaceous shale, interbedded cream sandstone, interbedded gray-green micaceous siltstone, and lenticular coal beds.

The Upper Cretaceous Kirtland Shale conformably overlies the Fruitland Formation and averages 660 ft (201 m) in thickness in this area. It is predominantly freshwater, purple to gray-green shale with plant fossils and interbedded tan to gray-green, micaceous siltstone with plant fossils. 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 light gray, locally conglomeratic sandstone with interbedded gray to brown shale and averages 130 ft (40 m) in thickness.

Approximately 1,200 ft (366 m) of the Paleocene Nacimiento Formation overlie the Ojo Alamo Sandstone. These rocks are exposed over most of the quadrangle where they consist of cream to light gray, arkosic, locally conglomeratic, micaceous, kaolinitic, friable sandstone, interbedded purple to gray-green shale, and interbedded tan to gray-green, micaceous siltstone.

The San Jose Formation of Eocene age unconformably overlies the Nacimiento Formation and crops out in the northeastern and southeastern parts of the quadrangle area. The San Jose consists of white to cream, locally conglomeratic, slightly calcareous, friable sandstone, interbedded tan to gray, micaceous siltstone, and many lithologies gradational between the two.

Structure

The northeast quarter of the Bloomfield 15-minute quadrangle is in the Central Basin area (Kelley, 1950) of the major structural depression known as the San Juan Basin. The axis of the basin is about 13 miles (21 km) to the north and northeast of the quadrangle area and trends in an arcuate pattern across the northern portion of the Central Basin area (Baltz, 1967). Reeside (1924) stated that the rocks in the area are "nearly horizontal."

COAL GEOLOGY

Four coal beds (Fruitland 1, Fruitland 2, Fruitland 3, Fruitland 4) 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 39 to 94 ft (11.9-28.7 m); the Fruitland 3 (Fr 3) coal bed is above the Fruitland 2 separated by a rock interval of 8 to 59 ft (2.4-18.0 m); the Fruitland 4 (Fr 4) coal bed is above the Fruitland 3 separated by a rock interval of 25 to

106 ft (7.6-32.3 m). Occasionally there is a local (L) coal bed which is noncorrelative and discontinuous in the rock interval between the named beds (CRO Plate 3). Although the named beds have been correlated and mapped as consistent horizons, they may actually be several different coal beds that are lithostratigraphically equivalent but not laterally continuous.

The remaining coals in the upper portion of the Fruitland Formation are grouped together as the Fruitland coal zone (Fr zone). These coals are generally noncorrelative, discontinuous, and less than reserve base thickness (5 ft [1.5 m]); an exception is a 5-ft (1.5-m) coal in drill hole 13 (CRO Plate 3). 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 14,833 Btu's per pound (34,502 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 varying from 1.4 to 2.6 percent, ash content ranging from 9.8 to 20.4 percent, sulfur content of 0.5 to 2.2 percent, and heating values on the order of 12,358 Btu's per pound (28,745 kj/kg). Analyses of several Fruitland Formation coals are given in Table 1 (Bauer and Reeside, 1921; Dane, 1936; 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 Section	Location T.N.	Location R.W.	Approx. Depth Interval of Sample (ft.)	Form of Analysis	Proximate, percent Moisture	Proximate, percent Volatile matter	Proximate, percent Fixed Carbon	Proximate, percent Ash	Sulfur	Heating Value (Btu)	Remarks
H-13061	Aztec Oil & Gas Reid No. 23-D	SW¼ 17	28	9	1,985-1,990	A	1.4	36.1	42.1	20.4	0.8	11,670	
						B	—	36.6	42.7	20.7	0.8	11,830	
						C	—	46.2	53.8	—	1.0	14,920	
H-5472	Aztec Oil & Gas Caine No. 13	NW¼ 16	28	10	1,842-1,853	A	1.6	38.4	40.7	19.3	0.6	11,760	
						B	—	39.0	41.4	19.6	0.6	11,950	
						C	—	48.5	51.5	—	0.8	14,870	
H-12704	Redfern & Herd Redfern & Herd No. 5	SW¼ 10	28	11	1,490-1,500	A	2.1	39.8	43.4	14.7	0.6	12,190	
						B	—	40.7	44.3	15.0	0.6	12,460	
						C	—	47.9	52.1	—	0.7	14,670	
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-27541	Aztec Oil & Gas Greniar "B" No. 3	SW¼ 5	29	10	2,065-2,080	A	2.3	39.1	42.1	16.5	1.9	12,020	
						B	—	40.0	43.1	16.9	2.0	12,300	
						C	—	48.1	51.9	—	2.4	14,800	
H-27540	Aztec Oil & Gas Grenier "B" No. 3	SW¼ 5	29	10	2,150-2,160	A	2.0	40.6	47.6	9.8	0.5	13,300	
						B	—	41.4	48.6	10.0	0.5	13,560	
						C	—	46.0	54.0	—	0.6	15,070	
H-3028	International Oil Fogelson No. 1-9	NW¼ 9	29	11	1,905-1,910	A	1.8	39.9	43.9	14.4	0.7	12,360	
						B	—	40.6	44.8	14.6	0.7	12,590	
						C	—	47.6	52.4	—	0.8	14,750	
H-13060	Tidewater N.M.-Fed. No. 12-E	SE¼ 12	29	11	2,065-2,070	A	2.1	38.7	47.9	11.3	0.6	12,830	
						B	—	39.5	48.9	11.6	0.6	13,100	
						C	—	44.7	55.3	—	0.7	14,820	

TABLE 1 (Continued)

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.			Moisture	Volatile matter	Fixed Carbon	Ash	Sulfur		
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-19882	El Paso Nat. Gas Ludwick No. 20	SW¼ 29	30	10	2,340-2,360	A	2.3	33.1	39.9	24.7	0.7	10,800	
						B	---	33.9	40.9	25.2	0.7	11,060	
						C	---	45.3	54.7	----	0.9	14,790	
H-19883	El Paso Nat. Gas Ludwick No. 20	SW¼ 29	30	10	2,505-2,515	A	2.6	41.7	44.5	11.2	0.6	13,080	
						B	---	42.9	45.6	11.5	0.6	13,420	
						C	---	48.4	51.6	----	0.7	15,160	
H-13062	Aztec Oil & Gas Ruby Jones No. 1	NE¼ 7	30	11	2,020-2,030	A	1.4	37.2	44.1	17.3	0.6	12,010	
						B	---	37.7	44.8	17.5	0.6	12,180	
						C	---	45.7	54.3	----	0.7	14,770	

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

Fruitland 1 Coal Bed

The 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 5) the coal bed dips less than 1° to the northeast. As a result of topography and dip, overburden (CRO Plate 6) varies from less than 1,800 ft (549 m) in the San Juan River Valley and Armenta Canyon to greater than 3,000 ft (914) m) on Harris Mesa. The isopach map (CRO Plate 4) illustrates that the coal bed is greater than 15 ft (4.6 m) thick in the southern and central parts of the quadrangle. The coal decreases in thickness in all directions and is absent in a small area in the north-central part of the quadrangle.

Chemical Analyses of the Fruitland 1 Coal Bed - Analyses of several coals of the Fruitland Formation from this quadrangle and the surrounding area are given in Table 1 (Fassett and Hinds, 1971).

Fruitland 2 Coal Bed

The coal bed 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 9) the coal bed dips less than 1° to the northeast. Due to topography and dip, overburden (CRO Plate 10) ranges from less than 1,800 ft (549 m) in the San Juan River Valley, Munoz Canyon, and Armenta Canyon to greater than 3,000 ft (914 m) on Harris Mesa. The isopach map (CRO Plate 8) shows that the coal bed has a thickness of greater than 10 ft (3.0 m) in the north. It thins in all directions and is absent in several parts of the quadrangle.

Chemical Analyses of the Fruitland 2 Coal Bed - Analyses of several coals of the Fruitland Formation from this quadrangle and the surrounding area are given in Table 1 (Fassett and Hinds, 1971).

Fruitland 3 Coal Bed

The 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 13) the coal bed dips less than 1° to the northeast. As a result of topography and dip, overburden (CRO Plate 14) varies from less than 1,700 ft (518 m) in the San Juan River Valley and Armenta Canyon to greater than 3,000 ft (914 m) on Harris Mesa. The isopach map (CRO Plate 12) shows the coal is greater than 10 ft (3.0 m) thick in the south-central, northeast, and northwest parts of the quadrangle. In general, it decreases in thickness in all directions from these areas and is absent in portions of the east and southwest.

Chemical Analyses of the Fruitland 3 Coal Bed - Analyses of several coals of the Fruitland Formation from this quadrangle and the surrounding area are given in Table 1 (Fassett and Hinds, 1971).

Fruitland 4 Coal Bed

The coal bed 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 17) the coal bed dips less than 1° to the northeast. As a result of topography and dip, overburden (CRO Plate 18) varies from less than

1,600 ft (488 m) in Armenta Canyon to greater than 3,000 ft (914 m) on Harris Mesa. The isopach map (CRO Plate 16) shows that the coal bed has a thickness of greater than 10 ft (3.0 m) in the north-central part of the quadrangle. It thins to the south and is absent in portions of the south and west.

Chemical Analyses of the Fruitland 4 Coal Bed - Analyses of several coals of the Fruitland Formation from this quadrangle and the surrounding area are given in Table 1 (Fassett and Hinds, 1971).

COAL RESOURCES

Coal resource data from oil and gas wells (El Paso Natural Gas Co., well log library) was utilized in the construction of isopach and structure contour maps of coals in this quadrangle. All of the coals studied in the northeast quarter of the Bloomfield 15-minute quadrangle occur 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, and Fruitland 4 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, and 19) 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, and 16) and areal distribution maps (CRO Plates 7, 11, 15, and 19) 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, and Fruitland 4 beds are shown on CRO Plates 7, 11, 15, and 19, 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 1,046 million short tons (949 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 northeast quarter of the Bloomfield 15-minute quadrangle has development potential for subsurface mining methods only (CDP Plate 20).

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, and Fruitland 4 coal beds.

Development Potential for Surface Mining Methods

All coals studied in the northeast quarter of the Bloomfield 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

All four coal beds in this quadrangle have both moderate and low development potential. Underground coal of the Fruitland 1 bed has moderate development potential in the north-central, northwest, and southwestern parts of the quadrangle (CDP Plate 20). The coal bed thickness in these areas is generally greater than 10 ft (3.0 m) (CRO Plate 4) increasing to 18 ft (5.5 m) in the southwest, and the overburden increases from approximately

TABLE 2

COAL RESOURCE DATA FOR UNDERGROUND MINING METHODS FOR FEDERAL COAL LANDS (in short tons) IN THE NORTHEAST QUARTER OF THE BLOOMFIELD 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 4	--	10,290,000	30,480,000	40,770,000
Fruitland 3	--	112,750,000	127,560,000	240,310,000
Fruitland 2	--	36,410,000	42,200,000	78,610,000
Fruitland 1	--	181,240,000	505,010,000	686,250,000
TOTAL	--	340,690,000	705,250,000	1,045,940,000

1,770 to 2,000 ft (539-610 m) to the east (CRO Plate 6). Coal of the Fruitland 2 has moderate development potential in the southwest and east-central areas where the thickness of the coal bed is 5 to 6 ft (1.5-1.8 m) and 5 ft (1.5 m) (CRO Plate 8) respectively, and the overburden thickness varies from 1,800 to 2,000 ft (549-610 m) (CRO Plate 10).

The Fruitland 3 and Fruitland 4 coal beds also have moderate potential for development in the area. The Fruitland 3 has overburden from 1,800 to 2,000 ft (549-610 m) thick (CRO Plate 14) in the north-northeast, northwest-central, and west-central parts of the quadrangle. Coal bed thickness in these areas ranges from 5 to 7 ft (1.5-2.1 m) in the west to 14 ft (4.3 m) in the north-northeast (CRO Plate 12). The Fruitland 4 overburden ranges from 1,890 to 2,000 ft (576-610 m) (CRO Plate 18) in the small areas of moderate potential in the south-central and north-central parts of the quadrangle. The Fruitland 4 is approximately 5 to 8 ft (1.5-2.4 m) thick in these areas (CRO Plate 16).

All four coal beds have low development potential in the area. Coal of the Fruitland 1 has low potential over most of the northern and eastern parts of the quadrangle and in a small isolated area in the southwest, where the coal bed thickness varies from 5 to 18 ft (1.5-5.5 m) and the overburden increases from 2,000 to 3,000 ft (610-914 m) to the east-southeast. The Fruitland 2 coal bed has low development potential in the north-central, east-central, and south-central areas. The coal thickness is 5 to 8 ft (1.5-2.4 m) and overburden ranges from approximately 2,000 to 2,200 ft (610-671 m) thick in these areas.

In the northwest, northeast, and southwest the Fruitland 3 has low development potential, where the coal bed thickness varies from 5 to 10 ft

(1.5-3.0 m) and the overburden ranges from 2,000 to 3,000 ft (610-914 m). Coal of the Fruitland 4 has low potential in the northeast and south-central parts of the quadrangle. The coal is 5 to 9 ft (1.5-2.7 m) thick in these areas, and overburden thickness ranges from 2,000 to 2,800 ft (610-853 m).

The remainder of the quadrangle area (southwest) has unknown development potential for areas where the coal beds occur outside the 3,000-foot (914-m) overburden study limit. The small area of unknown potential at the southern border is the result of coal less than 5 ft (1.5 m) thick in the southwest quarter of the Bloomfield 15-minute quadrangle.

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