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GEOLOGICAL SURVEY

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# COAL RESOURCES OF THE JOES VALLEY RESERVOIR QUADRANGLE SANPETE AND EMERY COUNTIES, UTAH

By

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# INTRODUCTION

## Purpose

This report was compiled to support the land planning work of the Bureau of Land Management 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. It supplements the land planning requirements of the Federal Coal Leasing Amendments Act of 1976 (Public Law 94-377) sec. (3)(B) which states, in part, that "Each land-use plan prepared by the Secretary [of the Interior] (or in the case of lands within the National Forest System, the Secretary of Agriculture pursuant to subparagraph (A)(i)) shall include an assessment of the amount of coal deposits in such land, identifying the amount of such coal which is recoverable by deep mining operations and the amount of coal which is recoverable by surface mining operations."

Published and unpublished public information were used as data sources for this study. No new drilling or field mapping was done to supplement this study. No confidential or proprietary data were used.

## Location

The Joes Valley Reservoir quadrangle lies on the west side of the central part of the Wasatch Plateau coal field in Sanpete and Emery Counties in south central Utah. The city of Manti is the county seat of Sanpete County and lies 14 miles (23 km) west of the quadrangle. The city of Castle Dale, the county seat of Emery County, is located 12 miles (19 km) east and 3 miles (5 km) south of the quadrangle. Other towns in the vicinity include Ephraim which is 11 miles (18 km) west, Orangeville is 11 miles (18 km) east, and Huntington is 15 miles (24 km) east of the quadrangle.

## Accessibility

Utah Highway 29 runs through the central part of the quadrangle from east to west. This highway provides access from Castle Dale and Orangeville on the east side of the Wasatch Plateau to the town of Ephraim and Sanpete Valley on the west side. The highway is paved from Orangeville to the west side of Joes Valley Reservoir. The highway is a light-duty gravel road west of Joes Valley Reservoir. Gravel roads also run north and south from Joes Valley Reservoir to the boundaries of the quadrangle. Several unimproved dirt roads and jeep trails provide access to some of the canyons and ridges in other parts of the quadrangle including Wagon Road Ridge, Dragon Ridge, Reeder Canyon, Reeder Ridge, Olsen Bench, and Clay Bench.

The nearest railroad is a branch line of the Denver and Rio Grande Western Railroad which runs through Sanpete Valley on the west side of the Wasatch Plateau. This railroad passes through Manti and Ephraim and joins the main line of the railroad at Thistle Junction approximately 44 miles (71 km) north of the quadrangle. The railroad provides connections to Salt Lake City, Utah and Denver, Colorado.

## Physiography

The Wasatch Plateau is a high and deeply dissected tableland. The eastern margin of the Plateau is approximately 80 miles (129 km) long and consists of sparsley vegetated sandstone cliffs and steep shale slopes cut by numerous steep-walled canyons. The sedimentary rocks are gently dipping, generally less than 10 degrees.

The Joes Valley Reservoir quadrangle lies in the central part of the Wasatch Plateau. Surface elevations in the quadrangle range from 6,740 ft

(2,054 m) where Cottonwood Creek leaves the east side of the quadrangle in Straight Canyon to 10,800 ft (3,292 m) on Clay Bench in the northwest corner.

Lower Joes Valley is a north-south trending faulted valley in which Joes Valley Reservoir is impounded. The earth-fill dam is located at the head of Straight Canyon and the spillway elevation of the dam is 6,990 ft (2,131 m) above sea level. The reservoir provides water storage, flood control, and recreational facilities for the region. Almost the entire quadrangle area drains into Joes Valley Reservoir. The reservoir discharges into Cottonwood Creek which flows eastward through Orangeville and Castle Dale into the San Rafael River.

## Climate

The climate of the Wasatch Plateau varies with altitude from semi-arid in the lowest elevations to alpine in the highest. The normal annual precipitation in the Joes Valley Reservoir quadrangle ranges from 15 inches (38 cm) in Straight Canyon on the east side of the quadrangle to approximately 38 inches (97 cm) in the northwest corner of the quadrangle (U.S. Department of Commerce, (1964)).

Temperatures on the high plateau are cool in the summer and cold in the winter. Maximum summertime temperatures are expected to reach 85 degrees F (29 degrees C) and minimum winter temperatures may drop to -30 degrees F (-34 degrees C) or lower.

## Land Status

The east side of the Joes Valley Reservoir quadrangle includes part of the Wasatch Plateau Coal Recoverable Resource Area (KRCRA) (see figure 1). Approximately 2,600 acres (1,052 ha) lie within the KRCRA and include

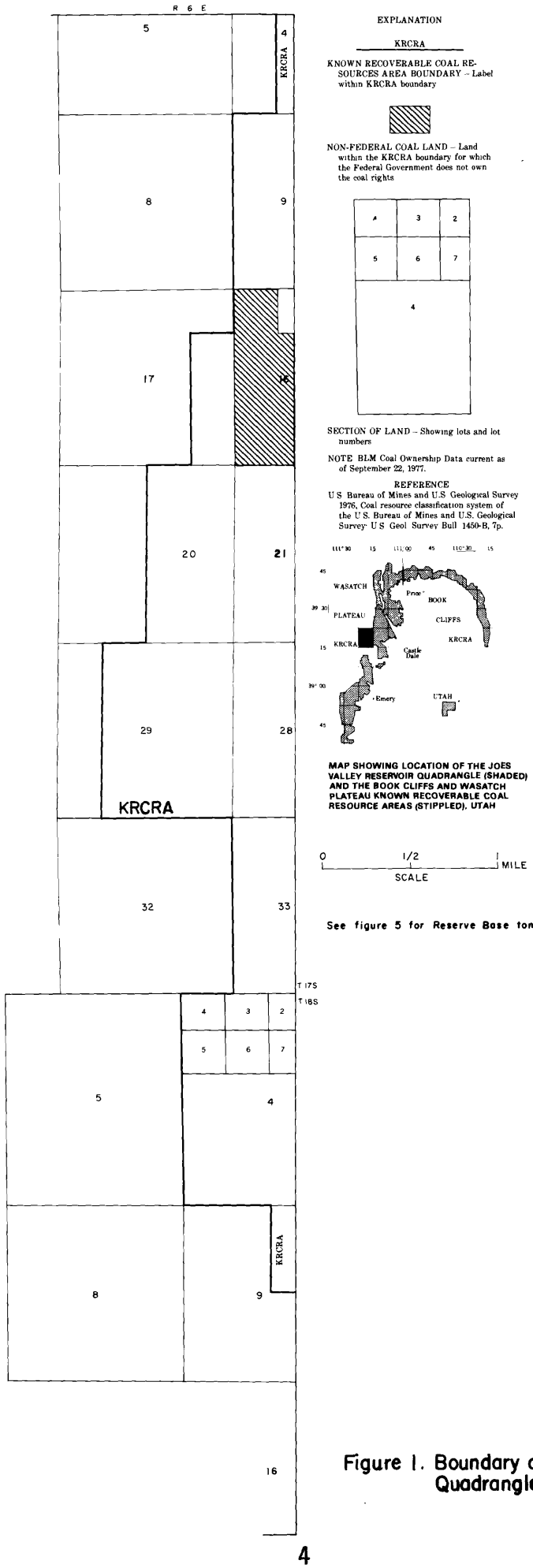



Figure 1. Boundary and coal data map, Joes Valley Reserv Quadrangle, Sanpete and Emery Counties, Utah.

2,400 acres (971 ha) of unleased Federal land and 200 acres (81 ha) of non-Federal land. There were no Federal coal leases in the KRCRA at the time the land status was reviewed for this report (1977).

## GENERAL GEOLOGY

### Previous Work

Spieker (1931) mapped and described the geology and coal occurrences in the Wasatch Plateau. The stratigraphy of the area was described by Lupton (1916), Spieker and Reeside (1925), Spieker (1949), Katich (1954), and Hayes and others (1977). Doelling (1972) compiled the geology and available coal data for the coal field. Reports on recent drilling in the area were prepared by Blanchard, Ellis, and Roberts (1977) and Davis and Doelling (1977).

### Stratigraphy

The coal beds of economic importance in the Wasatch Plateau field are Upper Cretaceous in age, and are confined to the Blackhawk Formation of the Mesaverde Group. This group includes, in ascending order: Star Point Sandstone, Blackhawk Formation, Castlegate Sandstone, and Price River Formation. The Upper Cretaceous Mancos Shale underlies the Starpoint Sandstone.

The North Horn Formation of Upper Cretaceous and Paleocene ages overlies the Price River Formation and is in turn overlain by the Flagstaff Limestone of Paleocene age (see figure 2).

The oldest stratigraphic unit exposed in the quadrangle is the Blackhawk Formation which crops out on the east side of the quadrangle in Straight Canyon and along the faulted sides of Lower Joes Valley. It is also exposed in the upthrown fault blocks in the northwest quarter of the quadrangle (Hintze and Stokes, 1964). The Blackhawk Formation consists of alternating beds of shale, siltstone, sandstone, and coal. Recent drilling in the

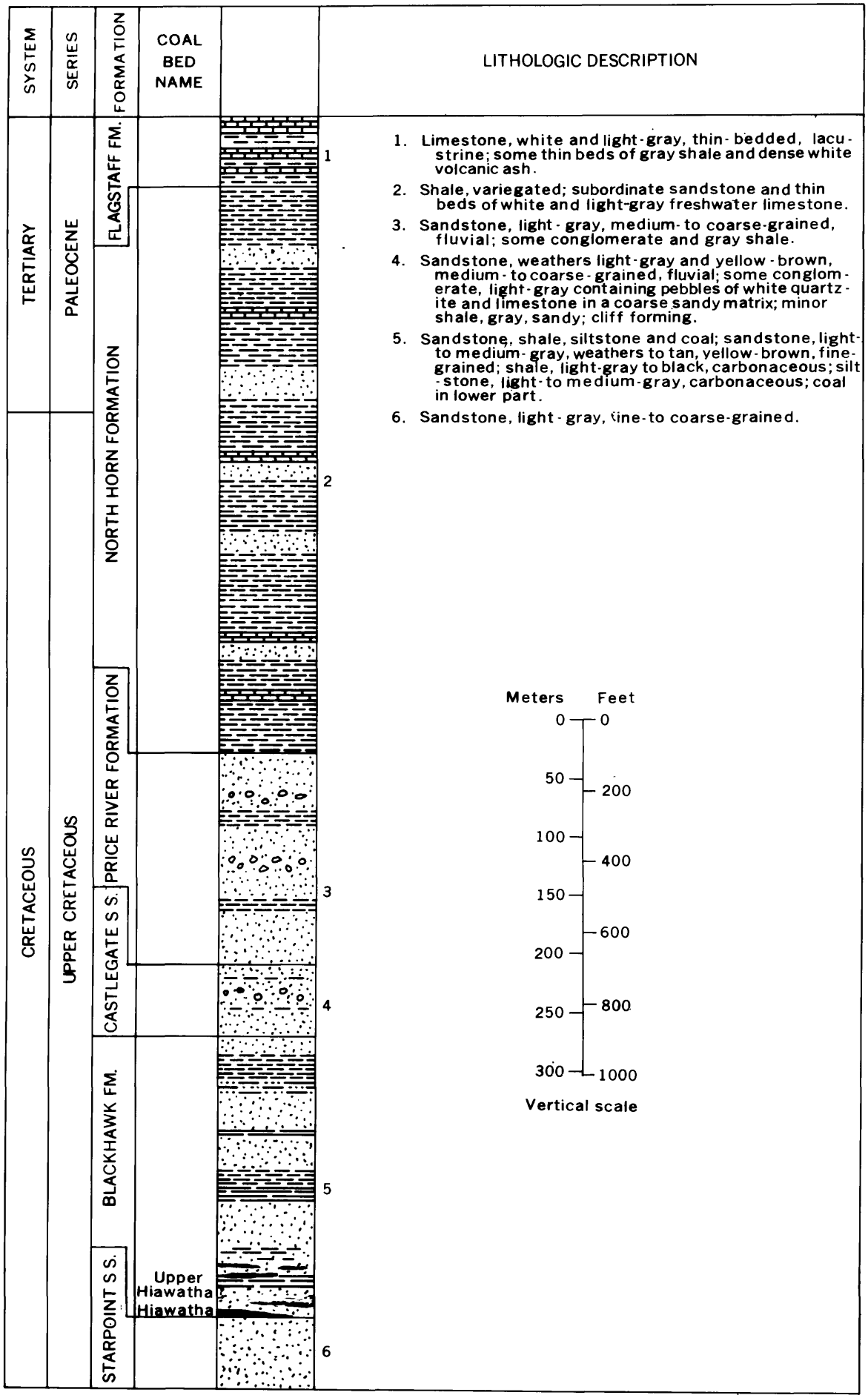



FIGURE 2. Composite columnar section, Joes Valley Reservoir Quadrangle, Sanpete and Emery Counties, Utah.

adjoining quadrangle to the east indicates that the formation is up to 1,039 ft (317 m) thick (Davis and Doelling, 1977). The coal beds occur in the lower 200 to 300 ft (61 to 91 m) of the formation.

In this area the Blackhawk is unconformably overlain by the Castlegate Sandstone which was formerly classified as a member of the Price River Formation (Spieker, 1931). The unconformity represents a change from the lagoonal and litoral environments of the Blackhawk to fluvial continental of the Castlegate. The Castlegate occurs as a massive cliff of medium- to coarse-grained sandstone and minor interbedded shale partings and conglomerate lenses. It ranges in thickness from 150 to 500 ft (46 to 152 m). The overlying Price River Formation ranges from 400 to 800 ft (122 to 244 m) thick and is lithologically similar to the Castlegate Sandstone but is not as massive appearing and is less resistant than the Castlegate.

The North Horn Formation overlies the Price River Formation and is composed of variegated shale, sandstone, and limestone. The North Horn Formation is overlain by the Flagstaff Limestone which consists of yellowish-gray to cream, evenly-bedded, resistant limestone. The Flagstaff Limestone caps the high ridges on the west side of the quadrangle including Clay Bench, Olsen Bench, and Wagon Road Ridge. Several small fault blocks in Lower Joes Valley are also capped with the limestone.

## Structure

The prominent structural feature in the quadrangle is the north-south trending graben called Lower Joes Valley. The graben is a long down-dropped block bounded by normal faults in the Joes Valley fault zone. This is one of the major fault zones in the Wasatch Plateau and is at least 70 miles (113 km) in length and 2 miles (3 km) in width. Along the east

boundary fault of the graben in section 20, T. 17 S., R. 6 E. the Flagstaff Limestone abutts against upper Blackhawk strata. A measured section here has proved a stratigraphic displacement of 2,300 ft (701 m) (Davis and Doelling, 1977, p. 9).

On the southeast side of the quadrangle the rocks dip from 3 to 5 degrees to the west. On the northeast side of the quadrangle the rocks have a similar inclination to the southwest and south (Davis and Doelling, 1977).

The dip of beds in the narrow blocks and slices in the fault zone may exhibit dips greater than 5 degrees.

## COAL GEOLOGY

Seven named and several unnamed coal beds occur in the adjoining quadrangle to the east (AAA Engineering and Drafting, Inc., 1979a). Many of the beds are thin and lenticular with limited areal extent. In ascending order, the named coal beds are the Hiawatha, Upper Hiawatha, Cottonwood, Blind Canyon, Bear Canyon, Upper Bear Canyon, and Upper Grimes Wash. The coal beds occur in the Lower 300 ft (91 m) of the Blackhawk Formation which consists of alternating beds of sandstone, siltstone and shale. Many of the siltstones and darker shales are carbonaceous and contain leaf imprints of sequoias, ferns, and willows (Davis and Doelling, 1977).

### Hiawatha Coal Bed

The Hiawatha coal bed is the most persistent and well-developed coal bed known in the explored areas of the adjoining quadrangles to the east and south. In those areas the bed ranges in thickness from about 1 ft (0.3 m) to over 18 ft (5.5 m) in measured sections and drill holes. One hole was drilled 3,000 ft (914 m) east of the Joes Valley Reservoir quadrangle

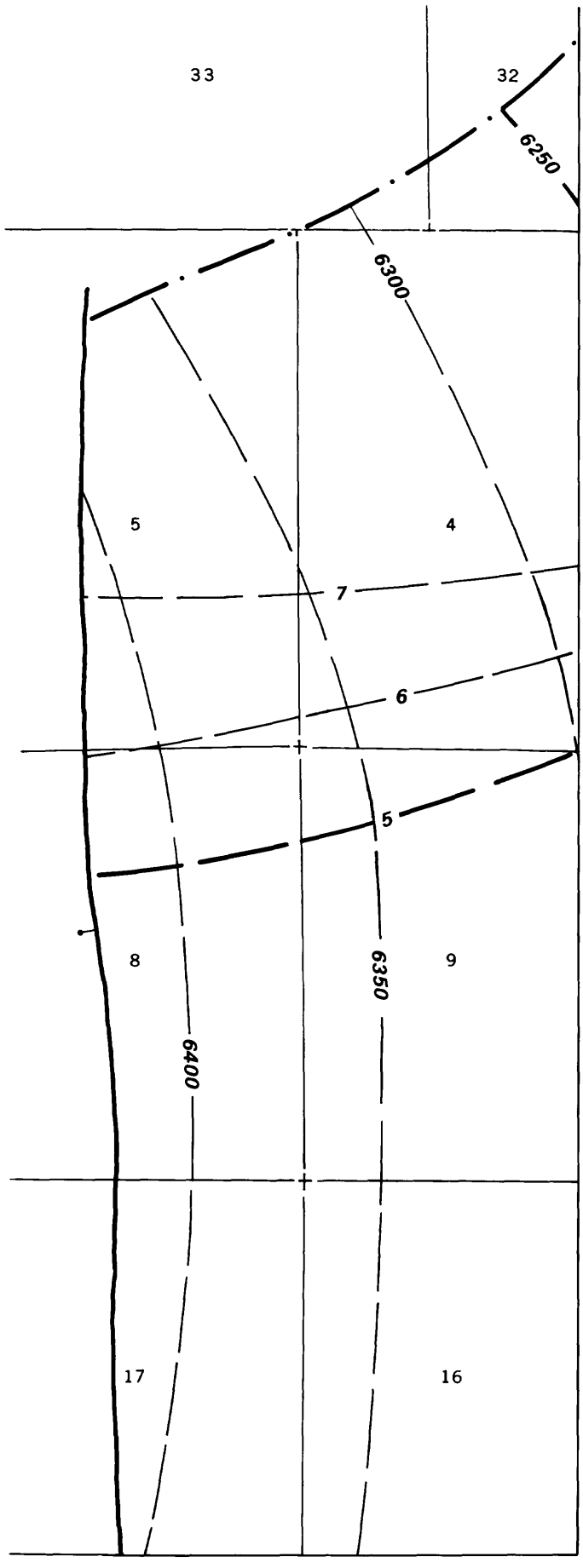
in NW¼ NW¼ Section 3, T. 18 S., R. 6 E. encountered the Hiawatha coal bed where it was 7.3 ft (2.2 m) thick. An isopach map of the bed (AAA Engineering and Drafting, Inc., 1979a) indicates that the coal thickness continues westward into this quadrangle but thins southward and thickens northward. The isopach lines have been projected into the Joes Valley Reservoir quadrangle as shown on figure 3. Another hole was drilled approximately 8,000 ft (2,438 m) east of the quadrangle in the SE¼ SE¼ Section 3, T. 17 S., R. 6 E. The coal bed is 9.4 ft (2.9 m) thick at that point and apparently thins northward. The projected Reserve Base area for this bed underlies a small part of the northeast corner of this quadrangle (figure 5).

### Upper Hiawatha Coal Bed

The Upper Hiawatha coal bed is thin and lenticular in the outcrop area of the adjoining quadrangle to the east. The bed occurs from 15 to 30 ft (4.6 to 9.1 m) above the Hiawatha bed and generally consists of two or more thin beds split by partings. The bed is Reserve Base thickness in only one measured section at the Black Diamond mine on the north side of Straight Canyon where the bed is 6.0 ft (1.8 m) thick. The coal bed thins rapidly westward from the mine and is missing in the hole drilled 3,000 ft (914 m) east of the Joes Valley Reservoir quadrangle. It is expected that the Upper Hiawatha coal bed will be thin or absent in this quadrangle.

### Cottonwood Coal Bed

The Cottonwood coal bed is thin and lenticular in measured sections in the adjoining quadrangle to the east in the upper Cottonwood Canyon area. There the bed is less than 5 ft (1.5 m) thick and occurs about 30 ft (9.1 m) above the Hiawatha bed. The Cottonwood bed "may be continuous




EXPLANATION

5

4

ISOPACHS–Showing thickness of coal, in feet. Long dashed where inferred. Isopach interval 1 foot.

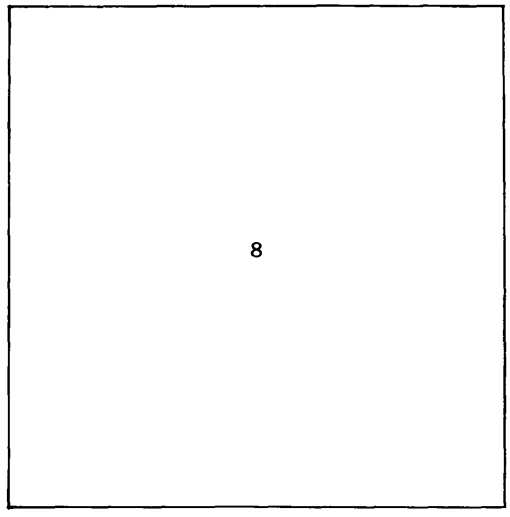
6250

6300

STRUCTURE CONTOURS–Drawn on top of coal bed. long dashed where vertical accuracy possibly not within 25 feet; Contour interval is 50 feet (15.2m). Datum is mean sea level.

FAULT–Bar and ball on downthrown side.

INSUFFICIENT DATA LINE–Coal thickness cannot be determined beyond line shown because of insufficient data.




SECTION OF LAND

To convert feet to meters, multiply feet by 0.3048.

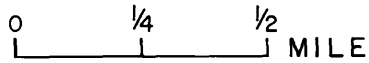



Figure 3. Isopach and structure contour map of the Hiawatha coal bed, Joes Valley Reservoir Quadrangle, Sanpete and Emery Counties, Utah.

with the Upper Hiawatha bed, and it is here separately identified largely because of its consistent and apparently restricted appearance in Cottonwood Canyon" (Spieker, 1931, p. 154). There is no evidence that this bed is present in the Joes Valley Reservoir quadrangle.

### Blind Canyon Coal Bed

The Blind Canyon coal bed occurs from 55 to 70 ft (16.8 to 21.3 m) above the Hiawatha coal bed and is lenticular in the Cottonwood Canyon area in the adjoining quadrangle to the east (AAA Engineering and Drafting, Inc., 1979a). It is now known to be continuous with the Blind Canyon bed of Huntington Canyon to the northeast. The bed is generally thin and split by partings. However, at widely separated points in the north and south parts of the adjoining quadrangle the coal is 6.0 and 7.5 ft (1.8 and 2.3 m) thick. Spieker (1931) suggests that the bed exposed in the south part is evidence of a lens which extends under the eastern edge of North Horn Mountain. There is no evidence that this lens continues far enough westward to reach the Joes Valley Reservoir quadrangle.

### Bear Canyon Coal Bed

The Bear Canyon coal bed occurs in several measured sections and two drill holes in the adjoining quadrangle to the east (AAA Engineering and Drafting, Inc., 1979a). The bed lies from 90 to 110 ft (27 to 34 m) above the Hiawatha coal bed and is generally thin in that quadrangle where the bed is probably continuous between Grimes Wash and Cottonwood Canyon (Spieker, 1931, p. 156). The bed is 6.6 ft (2.0 m) thick in a drill hole near the center of the south edge of that quadrangle. In the hole drilled 3,000 ft (914 m) west of the Joes Valley Reservoir quadrangle the bed was encountered as two beds 1.6 and 0.5 ft (0.5 and 0.2 m) thick split by a 2.7-ft (0.8-m) rock interval. The bed is expected to be thin or absent in this quadrangle.

### Upper Bear Canyon Coal Bed

The Upper Bear Canyon coal bed occurs from 120 to 150 ft (37 to 46 m) above the Hiawatha bed in the adjoining quadrangle to the east (AAA Engineering and Drafting, Inc., 1979a). In the Cottonwood Canyon area the Upper Bear Canyon bed is not known to be more than 3.5 ft (1.1 m) thick. It is expected to be thin or absent in the Joes Valley Reservoir quadrangle.

### Upper Grimes Wash Coal Bed

The Upper Grimes Wash coal bed is generally less than 3 ft (0.9 m) thick in the adjoining quadrangle to the east (AAA Engineering and Drafting, Inc., 1979a) and occurs about 190 ft (58 m) above the Hiawatha coal bed. The bed is present on the east side of Cottonwood Canyon but is apparently absent on the west side. There is no evidence that the bed is present in the Joes Valley Reservoir quadrangle.

### Chemical Analyses of the Coal

Doelling (1972, p. 207) tabulated the ranges and the averages of coal analyses of samples from the Hiawatha coal bed in the adjoining quadrangle to the east. A summary of the analyses is shown in the following table.

Table 1. Average coal analyses, Southwest Quarter of the Hiawatha 15-minute Quadrangle, Emery County, Utah.*

| | No. Analyses | Percent as-received | |
|---|---|---|---|
| | | Average | Range |
| Moisture | 27 | 4.7 | 1.5-13.2 |
| Volatile matter | 16 | 41.6 | 37.9-43.7 |
| Fixed carbon | 16 | 46.4 | 43.2-48.7 |
| Ash | 20 | 6.5 | 4.2-8.8 |
| Sulfur | 18 | 0.57 | 0.38-0.7 |
| Btu/lb** | 23 | 12,905 | 11,376-13,452 |

*Doelling (1972, p. 207)
**To convert Btu/lb to Kj/kg multiply by 2.326

Based on the average analysis shown above, the Hiawatha coal is ranked as high volatile B bituminous (American Society of Testing and Materials, 1977).

## Mining Operations

Coal has been produced from several mines in the adjoining quadrangle to the east at various times since 1898. At this writing (1979) one mine, the Trail Mountain mine, was active in that quadrangle. No coal is known to have been mined in the Joes Valley Reservoir quadrangle.

## COAL RESOURCES

Coal resource tonnages were calculated for indicated and inferred categories in unleased areas of Federal coal land within the KRCRA boundary. Data obtained from the coal isopach map of the Hiawatha coal bed in the adjoining quadrangle to the east (AAA Engineering and Drafting, Inc., 1979a) were projected into this quadrangle to obtain the Reserve Base values (figure 5). The coal-bed acreage (measured by planimeter) multiplied by the average isopached thickness of the coal bed times a conversion factor of 1,800 short tons of coal per acre-foot of bituminous coal yields the coal resources in short tons of coal for the isopached coal bed. Reserve Base and Reserve values for the Hiawatha coal bed are shown on figure 5. The values are rounded to the nearest tenth of a million short tons and the Reserve values are based on a subsurface mining recoverability factor of 50 percent.

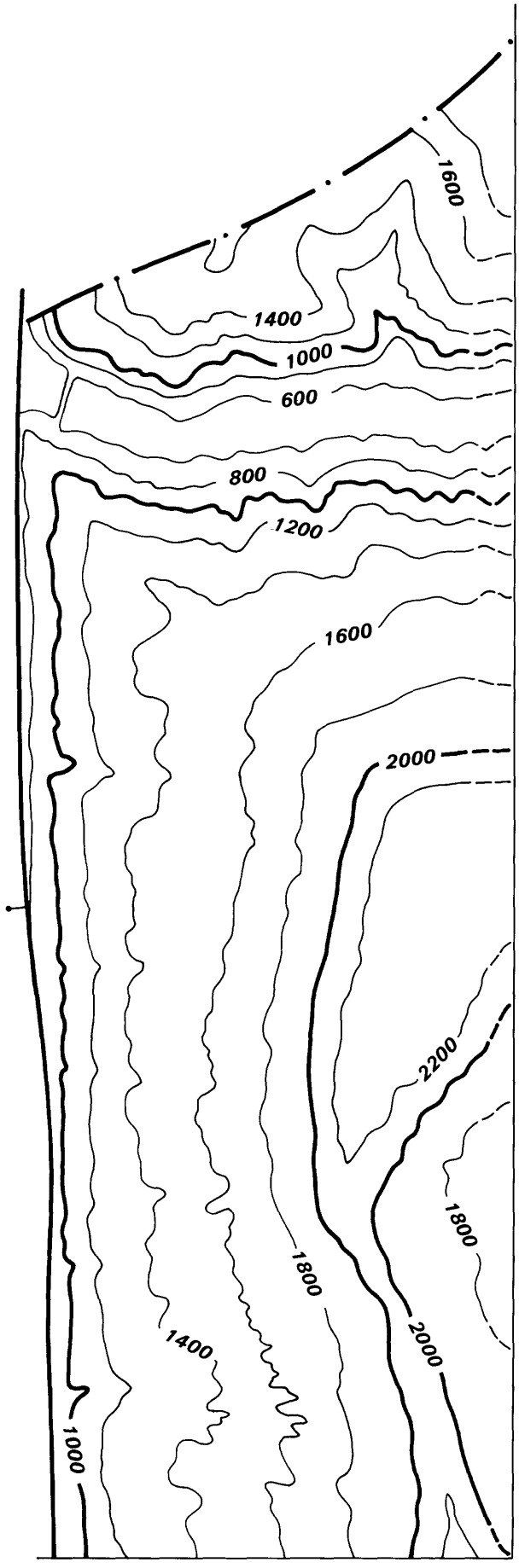
"Measured resources are computed from dimensions revealed in outcrops, trenches, mine workings, and drill holes. The points of observation and measurement are so closely spaced and the thickness and extent of coal are so well defined that the tonnage is judged to be accurate within 20

percent of true tonnage. Although the spacing of the points of observation necessary to demonstrate continuity of the coal differs from region to region according to the character of the coal beds, the points of observation are no greater than ½ mile (0.8 km) apart. Measured coal is projected to extend as a ¼ mile (0.4 km) wide belt from the outcrop or points of observation or measurement.

"Indicated resources are computed partly from specified measurements and partly from projection of visible data for a reasonable distance on the basis of geologic evidence. The points of observation are ½ (0.8 km) to 1½ miles (2.4 km) apart. Indicated coal is projected to extend as a ½-mile (0.8-km) wide belt that lies more than ¼ mile (0.4 km) from the outcrop or points of observation or measurement.

"Inferred quantitative estimates are based largely on broad knowledge of the geologic character of the bed or region and where few measurements of bed thickness are available. The estimates are based primarily on an assumed continuation from Demonstrated coal for which there is geologic evidence. The points of observation are 1½ miles (2.4 km) to 6 miles (9.6 km) apart. Inferred coal is projected to extend as a 2¼-mile (3.6 km) wide belt that lies more than 3/4 mile (1.2 km) from the outcrop or points of observation or measurement." (U.S. Bureau of Mines and U.S. Geological Survey, 1976).

Coal Reserve Base tonnages per Federal section shown on figure 5 total approximately 7.6 million short tons (6.9 million metric tons) for the isopached coal bed in the unleased Federal coal lands within the KRCRA boundary in the Joes Valley Reservoir quadrangle. These data are summarized in the following tabulation.




EXPLANATION

1000

800

OVERBURDEN ISOPACHS – Showing thickness of overburden, in feet, from the surface to top of the Hiawatha coal bed. Isopach interval 200 feet (61.0 m). Dashed where inferred.

INSUFFICIENT DATA LINE– Overburden cannot be determined beyond line shown because of insufficient data.

FAULT – Bar and ball on downthrown side.

To convert feet to meters, multiply feet by 0.3048.

0 1/4 1/2 MILE

Figure 4. Overburden isopach map of the Hiawatha coal bed, Joes Valley Reservoir Quadrangle, Sanpete and Emery Counties, Utah.

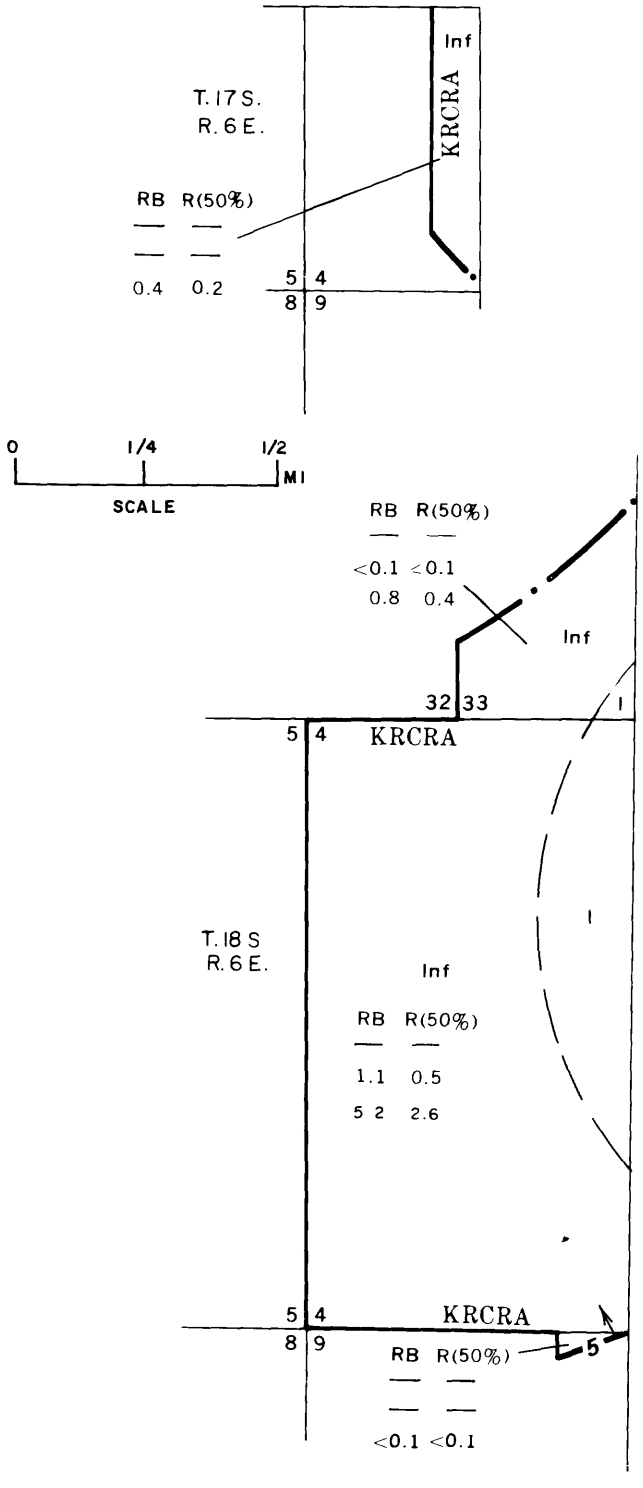



FIGURE 5. Areal distribution and identified resources map of the Hiawatha coal bed, Joes Valley Reservoir Quadrangle, Sanpete and Emery counties, Utah.

EXPLANATION

KRCRA

KRCRA BOUNDARY–Label within boundary.

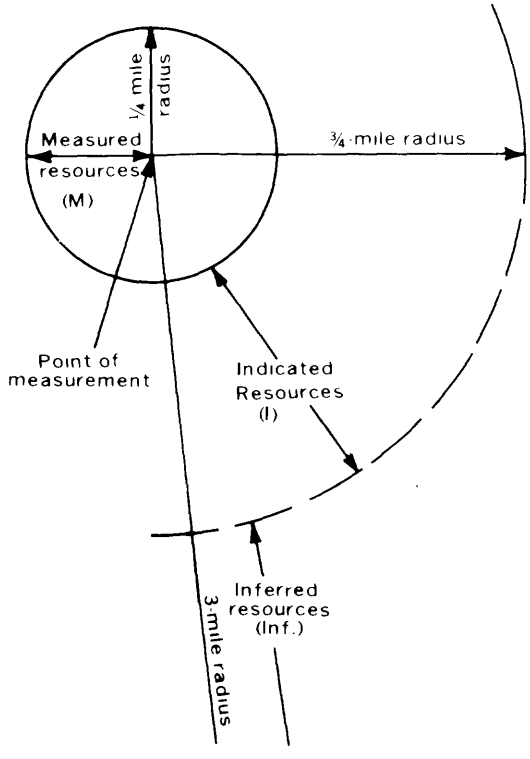
5

ISOPACH–Showing thickness of coal, in feet. Arrow points toward area where coal bed is 5 feet or more thick.

INSUFFICIENT DATA LINE–Coal resources were not calculated for areas beyond line shown because of insufficient data.

| RB | R(50%) | |
|---|---|---|
| — | — | (Measured) |
| <0.1 | <0.1 | (Indicated) |
| 0.8 | 0.4 | (Inferred) |

IDENTIFIED COAL RESOURCES–Showing totals for Reserve Base (RB) and Reserves (R), in millions of short tons, for each section or part of section of non-leased Federal coal land within the KRCRA. Reserve (R) tonnage is calculated by multiplying the Reserve Base (RB) tonnage by the appropriate recovery factor. Dash indicates no resource in that category.




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

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

To convert feet to meters, multiply feet by 0.3048

Table 2. Coal Reserve Base data for subsurface mining methods for Federal coal lands (in short tons) in the Joes Valley Reservoir Quadrangle, Sanpete and Emery Counties, Utah.

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

| Coal Bed Name | High development potential | Moderate development potential | Low development potential | Total |
|---|---|---|---|---|
| Hiawatha | 3,600,000 | 4,000,000 | -0- | 7,600,000 |

AAA Engineering and Drafting, Inc. has not made any determination of economic mineability for any of the coal beds described in this report.

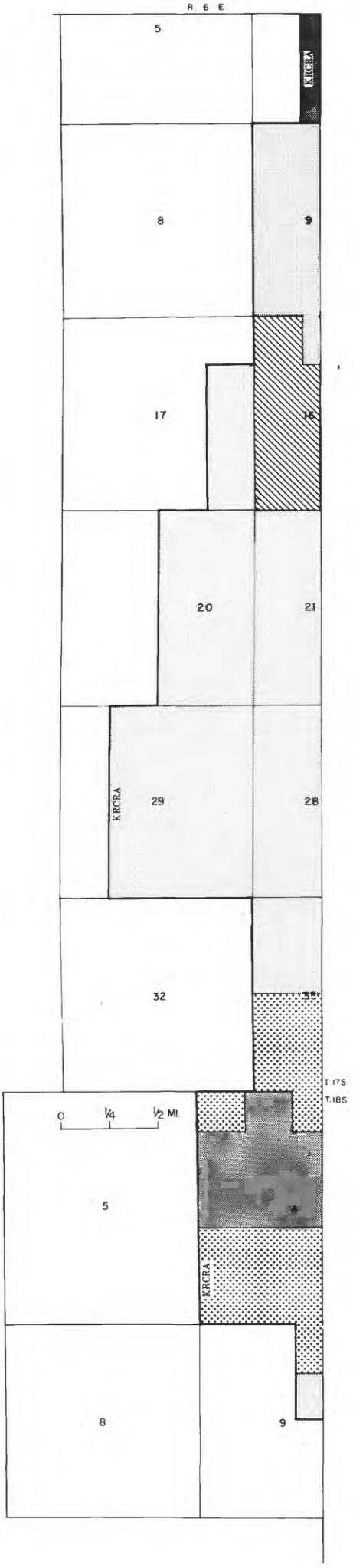
## COAL DEVELOPMENT POTENTIAL

### Development Potential for Surface Mining Methods

No development potential for surface mining methods exists in the area of this quadrangle because the depth to the Hiawatha coal bed is more than 200 ft (61 m) below ground surface (figure 4).

### Development Potential for Subsurface Mining and In Situ Coal Gasification Methods

The coal development potential for the subsurface mining of coal is shown on figure 6. The areas where coal beds 5 ft (1.5 m) or more in thickness are overlain by less than 1,000 ft (305 m) of overburden are classified as having a high development potential for subsurface mining. Areas where such beds are overlain by 1,000 to 2,000 ft (305 to 610 m) and 2,000 to 3,000 ft (610 to 914 m) of overburden are classified as having a moderate and low development potential respectively. Areas that contain no known coal in beds 5 ft (1.5 m) or more thick, but coal-bearing units are present at depths of less than 3,000 ft (194 m) are classified as areas




EXPLANATION

KRCRA

KRCRA BOUNDARY—Label within boundary.

NON-FEDERAL COAL LAND—Land for which the Federal Government does not own the coal rights, and for which the coal-development potential is not rated.

AREA OF HIGH-DEVELOPMENT POTENTIAL—Area contains coal in beds 5 feet (1.5m) or more thick between the coal outcrop and a depth of 1,000 feet (304.8 m).

AREA OF MODERATE COAL-DEVELOPMENT POTENTIAL—Area contains coal in beds 5 feet (1.5m) or more thick at depths ranging from 1,000 to 2,000 feet (304.8 to 609.6 m).

AREA OF UNKNOWN COAL-DEVELOPMENT POTENTIAL—Area contains no known coal in beds 5 feet (1.5m) or more thick, but coal-bearing units are present in area at depths of less than 3,000 feet (914.4 m).

FIGURE 6. Coal development potential map for subsurface mining methods, Joes Valley Reservoir Quadrangle, Sanpete and Emery counties, Utah.

of unknown coal development potential. Areas where no coal beds are known to occur or where coal beds are present at depths greater than 3,000 ft (914 m) have no coal development potential.

The coal development potential for subsurface mining methods in the KRCRA in the Joes Valley Reservoir quadrangle is shown on figure 6 and includes approximately 280 acres (113 ha) with a high development potential; 330 acres (134 ha) with a moderate development potential; and 1,790 acres (724 ha) with an unknown development potential.

The designation of a coal development potential classification is based on the occurrence of the highest-rated coal-bearing area that may occur within any fractional part of a 40-acre (16-ha) BLM land grid area or lot area of unleased Federal coal land. For example, if a 40-acre (16-ha) area is totally underlain by a coal bed with a moderate development potential and coal bed with a high development potential, the entire 40-acre (16-ha) area is classified as high development potential even though most of the area is classified as moderate development potential by the lower coal bed.

The classification of development potential for in situ coal gasification was not done because the coal bed dips are less than 15 degrees within the KRCRA in the Joes Valley Reservoir quadrangle. The criteria for selection of areas suitable for in situ coal gasification are a minimum coal thickness of 5 ft (1.5 m), dips of 15 to 90 degrees, and overburden greater than 200 ft (61 m) and less than 3,000 ft (914 m).

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