UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE COALMONT QUADRANGLE JACKSON COUNTY, COLORADO

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INTRODUCTION

Purpose

These maps were compiled to support the land-use planning work of the Bureau of Land Management and to provide a systematic coal resource inventory of Federal coal lands in the McCallum Known Recoverable Coal Resource Area (KRCRA) in response to the land-use planning requirements of the Federal Coal Leasing Amendments Act of 1976.

Published and unpublished non-proprietary information was used as the data sources for this study.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 Coalmont 7½-minute quadrangle is located in the west-central part of Jackson County in northwestern Colorado. The quadrangle is 8.5 miles (13.7 km) southwest of the town of Walden which is the county seat of Jackson County. The Colorado-Wyoming state line is approximately 26 miles (42 km) north of the quadrangle and the city of Denver is 86 miles (138 km) southeast of the quadrangle.

Accessibility

Colorado State Highway 14, a primary all-weather hard surface road, runs in a north-south direction through the east-central side of the quadrangle. This road provides accessibility to Walden and to U.S. Highway 40, about 12 miles (19 km) southwest of the quadrangle. A secondary all-weather hard surface road begins at Hebron on Colorado State Highway 14 and runs westward through the quadrangle. A branch of this road runs southward to the town of Coalmont in the Center of the quadrangle and then eastward to join Colorado State Highway 14 about 2.8 miles (4.5 km) south of Hebron. Unimproved dirt roads and light-duty gravel roads provide access to most of the other parts of the quadrangle except on the high areas of Pole Mountain in the southwest quarter of the quadrangle.

A branch line of the Union Pacific Railroad runs north-eastward from Coalmont to Laramie, Wyoming. The Walden-Jackson County airport is located on the northeast side of Walden.

Physiography

The Coalmont quadrangle lies on the southwest side of a broad intermontane topographic basin called North Park. The basin is almost entirely surrounded by mountains including the Park Range to the west, the Rabbit Ears Range to the south, and the Medicine Bow Range on the east. The quadrangles lies in the lowland area of the basin where there are rolling hills, shallow creeks, and dry washes. Pole Mountain covers approximately 7 square miles in the southwest part of the quadrangle, rising approximately 1,000 ft (305 m) above the lowlands around its base.

The relief in the quadrangle is approximately 1,184 ft (361 m). The low point is 8,050 ft (2,453 m) above mean sea level where Little Grizzly Creek intersects the north edge of the quadrangle. The high point is the top of Pole Mountain which is 9,234 ft (2,815 m) above sea level.

The main drainages are Grizzly Creek and Little Grizzly Creek which flow northward and northeastward through the quadrangle. These two creeks flow together approximately one mile (1.6 km) north of the quadrangle.

Climate

The Coalmont quadrangle has a mid-latitude steppe climate and semi-arid conditions prevail in the area. The normal annual precipitation for the quadrangle ranges from about 13 inches (33 cm) on the north side to 17 inches (43 cm) on the northeast corner (U.S. Department of Commerce, (1964)).

The nearest weather data-recording station is at Walden where a record high temperature of 91^{o} F (33^{o} C) and a record low temperature of -49^{o} F (-45^{o} C) were recorded (Colorado State Climatology Office, personal communication). The mean annual temperature at Walden is 36.5^{o} F (2.5^{o} C). The temperatures in the Coalmont quadrangle are expected to be in the range of those recorded at Walden (elevation-8,132 ft (2,479 m)), except on Pole Mountain where the temperatures are expected to be lower because of the higher elevation.

Land Status

The Coalmont quadrangle lies in the southwest part of the McCallum Known Recoverable Coal Resource Area (KRCRA). The KRCRA covers approximately 33,570 acres (13,586 ha) of the quadrangle. Plate 2 shows areas of non-Federal land and the KRCRA boundary. There were five existing Federal coal leases in this quadrangle when the land check for this report was made on the date shown on plate 2. A comparison of the area of Federal coal ownership and the non-Federal lands in the quadrangle area is shown in table 1.

Table 1.--Approximate distribution of Federal and non-Federal land areas in the Coalmont quadrangle, Jackson County, Colorado

Category	Approximate area (acres)[1]	Percent of quadrangle area
Leased Federal coal land	4,360	12
Non-Federal land	21,110	58
Unleased Federal coal ownership[2]	10,800	30
Total	36,270	100

[1] To convert acres to hectares, multiply acres by 0.4047
[2] Coal is known to be present in only one part of this area.

Previous Work

The earliest geological reconnaissance in this area was conducted by King (1876) and Hayden (1877) as part of the 40th Parallel survey. Beekly (1915) made a geological study of North Park and published a report which included a description of the coal occurrences. Guidebooks by the Wyoming Geological Assoication and the Rocky Mountain Association of Geologists contain papers on the geology of North Park (Severy and Thompson, 1953; Henkes, 1957; Montagne and Barnes, 1957). Hail (1965, 1968) published studies on the areal geology of the west side of North Park and Middle Park basins, Jackson and Grand Counties, Colorado. Erdmann (1941) conducted an extensive drilling program in the Coalmont quadrangle and published the drilling logs and a description of the coal deposits. Madden (1976) studied and reported on the geology of the McCallum coal field. Madden (1977a, 1977b) also conducted exploratory drilling in the Coalmont coal field and in the McCallum coal field. Madden and others (1977, 1978) reported on the coal geology of the entire North Park basin.

Miller (1934) described the north and south McCallum anticlines. Kinney (1970a, 1970b, 1971), Kinney and Hail (1970a, 1970b), and Kinney and others (1970) mapped the geology of the eastern part of North Park. Tweto (1976) compiled a geologic map of the Craig $1^{o} \times 2^{o}$ quadrangle. Behrendt and others (1969) made a geophysical study of the North Park area. Hail and Leopold (1960) published a paper on the palyology and age of the Coalmont Formation.

GENERAL GEOLOGY

Stratigraphy

With the exception of Quarternary gravel deposits and alluvium, the only formation exposed in the Coalmont quadrangle is the Coalmont Formation of Paleocene and Eocene age. "The Coalmont is largely nonresistant and easily eroded, and forms lowlands, flatlands, or slopes . . . Much of the area underlain by the Coalmont is commonly obscured by a cover of surficial material." (Hail, 1968) In some areas, however, moderately well cemented sandstone or conglomerate beds form cliffs, weak ridges, or hogbacks.

The Coalmont Formation is locally divided into the following three members in ascending order: Middle Park Member, middle member, and upper member. The Middle Park Member has a maximum thickness of 600 ft (183 m) in the Middle Park area south of the Coalmont quadrangle. The Middle Park Member thins to zero where overlapped by the middle member and may not be present in the quadrangle.

The middle member ranges from 1,765 to 2,740 ft (538 to 835 m) in thickness in drill holes that penetrated the entire unit (Hail, 1968). The member consists of crossbedded arkosic sandstone and conglomeratic sandstone and gray or green sandy claystone or mudstone; carbonaceous shale and coal are sparse. In the Pole Mountain area, the middle and upper members are separated by an unconformity marked by an abrupt change from sandstone and conglomerate below to carbonaceous shale above. In other areas clear evidence for unconformity is lacking, and the eastward extent of the unconformity is unknown owing to lack of subsurface information (Hail, 1968).

The upper member of the Coalmont Formation consists of sandstone, claystone, mudstone, carbonaceous shale, and coal. Conglomeratic beds are present but are not abundant. The sandstone beds are fine- to coarse-grained, gray to light brownish gray. The beds are mostly soft and non-resistant but locally contain resistant slabs and ledges. The sandstone beds are massive to crossbedded and locally even bedded. They are arkosic and generally contain much white mica. The claystone and mudstone beds are olive green and gray and are non-resistant. The carbonaceous shale is chocolate brown, silty and fissle to blocky and locally contains abundant ironstone nodules. Coaly beds occur in the lower to middle part of the upper member in the Coalmont area. The middle member ranges from 1,765 to 2,740 ft (538 to 835 m) in thickness in drill holes in the quadrangle (Hail, 1968).

Structure

Numerous northwest-southeast trending faults occur in the central and and south central parts of the quadrangle (pl. 1). The faults are roughly parallel and form a series of horst-graben fault blocks with displacements possibly ranging up to about 300 ft (91 m). Much of the faulted area is underlain by the Riach coal bed (pl. 4) and the faults will influence the mining of coal in the quadrangle.

The axial traces of three anticlines and one syncline are shown on plate 1 on the south side of the quadrangle. The flanks of these folds have dips up to 24° and lie outside the area of the main Riach coal bed occurrence.

COAL GEOLOGY

In the Coalmont quadrangle the important coal beds occur in the upper member of the Coalmont Formation. Hendricks (1978) reports that "The coals in the middle member are thin and discontinuous, grading laterally into carbonaceous shales, and are occasionally truncated by channel scouring. The coals and carbonaceous shales were formed in poorly drained flood basins and swamps between anastomosing channels."

Riach Coal Bed

The thickest and most important coal bed in the quadrangle is the Riach coal bed which occurs in the lower to the middle part of the upper member of the Coalmont Formation. Hail (1968) reports that "The Riach and other coal beds are lenticular and grade laterally into carbonaceous shale within a few thousand feet."

The Riach bed ranges from 25 to 80 ft (8 to 24 m) in thickness (Erdmann, 1941). The coal isopach map (pl. 4) indicates that the bed generally thickens northward from its outcrop in several fault blocks near the south-central part of the quadrangle. A local thickening of the bed occurs on the west central side of the quadrangle where the hole drilled at index number 88 (pl. 1) encountered 61.0 ft (18.6 m) of coal. The coal isopach lines could not be extended into the northern part of quadrangle because of the lack of drill holes and outcrop measurements in that area. Therefore, an insufficient data line limits the northern extent of coal isopachs on plate 4.

Mexican Creek Coal Bed

Hail (1968) measured two sections of a coal bed in section 9, T. 6 N. R. 81 W. near Mexican Creek at index numbers 96 and 97 on plate 1. The bed at index number 96 was described as shaly coal and the bed at index number 97 consisted of coal totalling 8.0 ft (2.4 m) split with carbonaceous shale. This bed was referred to by Madden and others (1978) as the Mexican Creek coal bed and occurs in the extreme southwest corner of the Coalmont quadrangle. The bed is considered as bony coal in one of the measured sections and the other measured section is included in the list of isolated data points (table 2). The Mexican Creek coal bed is lenticular and occurs in the lower part of the upper member of the Coalmont Formation

Pole Mountain Coal Bed

A coal bed in the Pole Mountain area in the southwest quarter of the quadrangles was measured by Hail (1968) at the location of index numbers 92-95 (pl. 1). The bed has been called the Pole Mountain coal bed by Madden and others (1978) and consists of one or more beds of coal, most of which are bony. At the location of index no. 93 (pl. 1) Hail (1968, p. 107) measured 21 ft (6 m) of clinker and he said that "evidently at least two coal beds have burned to form the clinker, inasmuch as there is a thin bed of coal ash present in the upper part of the unit." One of Hail's measured sections (at index number 92) contained 5.5 ft (1.7 m) of coal and is included in the list of isolated data points (table 2). The Pole Mountain coal bed occurs in the lower to middle part of the upper member of the Coalmont Formation and may be 200 ft (61 m) or more stratigraphically lower than the Riach coal bed.

Shawver Coal Bed

A coal bed encountered in several drill holes in the east-central part of the quadrangle lies about 600 ft (183 m) above the Riach coal bed in the upper member of the Coalmont Formation and has been called the Shawver coal bed (Madden, 1979, U.S. Geol. Survey, personal communication). Thicknesses of the Shawver bed in the drill holes at index numbers 2, 10, 11, and 12 (pl. 1) range in total coal thickness from 10.0 to 14.0 ft (3 to 4 m). The few points of measurement for the Shawver bed on unleased Federal land are listed below in table 2 as isolated data points. Because of the limited number of points of measurement for the coal bed no thinning nor thickening trends are evident.

Isolated Data Points

In instances where isolated measurements of coal beds greater than 5 ft (1.5 m) thick 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 correlation with other coal beds. For this reason, isolated data point maps are included on a separate sheet (in U.S. Geological Survey files) for the non-isopachable coal beds. Resource data for these isolated data points were calculated for areas within ¼ mile (0.4 km) of the points of measurement and are listed in table 2 and shown by asterisks on plate 2.

Table 2.--Isolated data points in the Coalmont quadrangle, Jackson County, Colorado

Index No. (pl. 1)	Location	Coal Occurrence	Coal Bed Name	Coal thickness (ft) [1]	Measured area (acres) [2]	Resource tonnage (s.t.) [3]
10	NW¼NW¼ sec. 19 T. 7 N., R. 80 W.	Drill hole	Shawver	14.0	55	1,100,000
11	NW¼NW¼ sec. 19 T. 7 N., R. 80 W.	Drill hole	Shawver	10.0		
12	SW¼SW¼ sec. 19 T. 7 N., R. 80 W.	Drill hole	Shawver	12.0	63	1,300,000
66	SW¼NW¼ sec. 23 T. 7 N., R. 81 W.	Drill hole	Local	6.0	31	300,000
92	NE¼NW¼ sec. 4 T. 6 N., R. 81 W.	Outcrop	Pole Mtn.	5.5	18	200,000
97	NE¼SW¼ sec. 9 T. 6 N., R. 81 W.	Outcrop	Mexican Creek	7.5	18	200,00
					Total resource tonnage	3,100,000

[1] To convert feet to meters, multiply feet by 0.3048
[2] To convert acres to hectares, multiply acres by 0.4047
[3] To convert short tons to metric tons, multiply short tons by 0.9072

PROXIMATE ANALYSES OF THE COAL

Tables 3 and 4 show the proximate analyses of coal samples taken from the Riach coal bed in two mines located in the Coalmont quadrangle.

Table 3.--Proximate analysis of coal from the Riach bed in the Riach mine, sec. 24, T. 7 N., R. 81 W., Jackson County, Colorado (Beekly, 1915)

Lab Sample No.	Moisture %	Volatile Matter %	Fixed Carbon %	Ash %	Sulphur %	Heat Value Btu/lb[1]
12601	18.0	38.5	36.2	7.33	0.74	9,570

[1] To convert Btu/lb to Kj/kg multiply by 2.326

Table 4.--Proximate analysis of coal from the Riach bed in the Grizzly Creek strip mine, sec. 32, T. 7 N., R. 80 W., Jackson County, Colorado (Boreck and others, 1977)

Sample No.	Moisture %	Volatile Matter %	Fixed Carbon	Ash %	Sulphur %	Heat Value Btu/lb
75-H-11	14.5	29.3	24.7	31.5	0.6	6,520
75-H-12	17.2	37.3	36.9	8.6	0.6	9,520
75-H-13	17.8	32.0	37.1	13.1	1.0	8,600
75-H-14	19.4	33.7	41.4	5.5	0.7	9,570
75-H-15	20.2	34.5	34.1	11.2	0.9	8,630

[1] To convert Btu/lb to Kj/kg multiply by 2.326

On the basis of the analyses shown in tables 3 and 4, the Riach coal at the sampling sites is subbituminous B in rank (American Society for Testing and Materials, 1977). No analyses of coal from the Shawver, Pole Mountain, Mexican Creek, or local coal beds are available.

MINING OPERATIONS

Coal mining in North Park dates back to the late 1800's and early 1900's. Available information indicates that a number of mines (now inactive or abandoned) produced coal in the Coalmont quadrangle. Information pertaining to these mines is listed in table 5.

Coal was first mined commercially in the Coalmont district about 1909 and continued to be mined until near the close of World War II. The district was idle until about 1959 when a surface mine was opened in the NE¼ sec. 23, T. 7 N., R. 81 W. Then in 1975 the Grizzly Creek mine was opened in sec. 32, T. 7 N., R. 80 W. It operated about one year.

Table 5.--Coal mines (abandoned) in the Coalmont quadrangle, Jackson County, Colorado

Mine Name	Approximate Location[1]	Coal Bed Name	Coal Thickness (ft)[2]	Production (s.t.)[3]	Period(s) of Operation
Coalmont	Sec. 23, 24 T. 7 N., R. 81 W.	Riach	20-65	310,179	1909-19
Grizzly Creek	Sec. 32 T. 7 N., R. 80 W.	Riach	25	65,000	1975
Moore No.1 (Rabbit Ear)	Sec. 23-26 T. 7 N., R. 81 W.	Riach	30-50	647,173	1922-34, 1938
Moore No.2	Sec. 24 T. 7 N., R. 81 W.	Riach	30-75	9,060	1922-24
Moore and Moore	Sec. 25, 26 T. 7 N., R. 81 W.	Riach	20-40	493,127	1915-21 1935-51
Rosebud	Sec. 14, 23, 26 T. 7 N., R. 81 W.	Riach	13	313,460	1958-60
Unknown	Sec. 9 T. 6 N., R. 81 W.	Mexican Creek	7.5	Unknown	Unknown

[1] Locations of mines with production figures as reported by the Colorado Division of Mines (personal communication). Specific locations and outlines of mined areas are unknown.
[2] To convert feet to meters, multiply feet by 0.3048
[3] To convert short tons to metric tons, multiply short tons by 0.9072

COAL RESOURCES

The principal sources of data used in the construction of the coal isopach, structure contour, and coal data maps were Madden (1977a), Erdmann (1941), Hail (1968), and logs of holes drilled by the Kemmerer Coal Company. The Kemmerer Coal Company drilled many more holes than shown on plate 1. Some of the holes were drilled too close together to clearly show them all with the map scale used. Therefore, only typical representative logs were utilized in areas where drill holes were very closely spaced. Several oil and gas test wells have been drilled in the area and the available logs of these wells were inspected for reliable coal-bed data, but the logs were generally non-definitive for coal, or the wells were drilled in non-coal bearing areas.

The coal isopach map was constructed by using a point-data net derived from coal-thickness measurements of an individual coal bed obtained from surface exposures and correlated well logs located within the quadrangle boundary and a 3-mile (4.8-km)-wide zone around the quadrangle. Measured coal thickness values were used directly in the point-data net where the rocks dip less than 25^{o}. The principle of uniform variation in thickness between data points was used to establish the position of the isopach lines.

The structure contour map was constructed by using a point-data net derived from well logs and surface exposures. The elevation of the top of the contoured coal bed was based on surface altitude and measured depth to the top of the isopached coal bed. A secondary set of data-net points was generated by laying a structure contour map over a topographic contour map and then calculating apparent overburden thickness values at the intersections of structure contour lines and surface topographic contour lines.

Coal thickness data was obtained from the coal isopach map (pl. 4) for resource calculations. The coal-bed acreage (measured by planimeter) multiplied by the average isopach thickness of the coal bed multiplied by a conversion factor of 1,770 short tons of coal per acre-foot (13,018 metric tons of coal per hectare-meter) for subbituminous coal yields coal resources in short tons. Reserve Base and Reserve values for the Riach coal bed are shown on plate 7 and are rounded to the nearest tenth of a million short tons. The Reserve values are based on a subsurface mining recoverability factor of 50 percent and a surface mining recoverability factor of 85 percent.

The following criteria for coal resource determinations are given in the U.S. Geological Survey Bulletin 1450-B: "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 coals 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) 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 [a collective term for the sum of coal in both Measured and Indicated Resources and Reserves] for which there is geologic evidence. The points of observation are 1½ (2.4 km) to 6 miles (9.5 km) apart. Inferred coal is projected to extend as 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, p. B6 and B7).

Coal resource tonnages were calculated for measured, indicated, and inferred categories in the unleased areas of Federal coal land where the coal is 5 ft. (1.5 m) or more thick and lies within 3,000 ft (914 m) of the surface. The criteria cited above were used in calculating Reserve Base and Reserve data in this report and differ from those stated in U.S. Geological Survey Bulletin 1450-B, which calls for a maximum depth of 1,000 ft (300 m) for subbituminous coal.

In this study, coal 5 ft (1.5 m) or more thick lying between the ground surface and a depth of 200 ft (61 m) is considered amenable to surface mining methods; coal 5 ft (1.5 m) or more thick lying between 200 ft (61 m) and 3,00 ft (914 m) below ground level in beds having dips of less than 15^o is considered mineable by conventional subsurface methods. Coal of Reserve Base thickness lying between 200 ft (61 m) and 3,000 ft (914 m) below ground level with dips greater than 15^o is assumed to be suitable for in situ coal gasification.

Reserve Base tonnages of Federal coal per section for the isopached coal bed are shown on plate 2 and total approximately 58.0 million short tons (52.6 million metric tons) for the unleased Federal coal lands within the quadrangle. Reserve Base tonnage for surface mining methods in the unleased Federal land in the quadrangle is 7.9 million short tons (7.2 million metric tons) and all occurs in the areas rated as high development potential on plate 8. The Reserve Base tonnage for subsurface mining methods in the unleased Federal land in the quadrangle 50.1 million short tons (45.5 million metric tons) and all occurs in the areas rated as high development potential on plate 9.

Resource tonnages calculated for isolated data points (non-isopached coal beds) are classified as inferred coal and placed in the unknown development potential category. The coal resources for the isolated data points are shown in table 2 and total 3.1 million short tons (2.8 million metric tons). In this quadrangle, coal resources of unknown development potential are projected to extend as a ¼ mile (0.4 km) wide belt from the outcrop or points of measurement at the isolated data points.

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

COAL DEVELOPMENT POTENTIAL

Coal development potential areas are drawn (pl. 8 and 9) so as to coincide with the boundaries of smallest legal land subdivision shown on plate 2. In sections or parts of sections where no land subdivisions have been surveyed by the BLM (U.S. Bureau of Land Management), approximate 40-acre (16-ha) parcels have been used to show the limits of high-, moderate-, or low-development-potential areas.

The designation of 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, lot or tract of unleased Federal coal land. For example, a certain 40-acre (16-ha) parcel is totally underlain by a coal bed of "moderate-" development-potential. If a small corner of the same 40-acre (16-ha) area is also underlain by another coal bed of "high-" development-potential, the entire 40-acre (16-ha) area is given a "high-" development-potential rating even though most of the area is rated "moderate".

Development Potential Using Surface Mining Methods

Areas where the coal beds 5 ft (1.5 m) or more in thickness are overlain by 200 ft (61 m) or less of overburden are considered to have a surface mining potential and were assigned a high-, moderate-, or low-development-potential on the basis of the mining ratio (cubic yards of overburden per ton of recoverable coal). The following formula is used to calculate mining ratios:

$$MR = \frac{t_o\ (0.911)}{t_c\ (rf)}$$

Where MR = mining ratio (cubic yards of overburden per ton of recoverable coal)

t_o = thickness of overburden (in feet)

t_c = thickness of coal (in feet)

rf = recovery factor

0.911 = factor for subbituminous coal

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

Areas of high-, moderate-, or low-development-potential for surface mining methods are here defined as areas underlain by coal beds having respective mining-ratio values of 0 to 10, 10 to 15, and greater than 15. 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 (1979, unpublished data).

The coal development potential using surface mining methods is shown on plate 8. Approximately 6 percent of the unleased Federal land area in this quadrangle is classified as having a high-development-potential using surface mining methods. No land has a moderate-development potential, and none has a low development potential. The remaining Federal land in the quadrangle has an unknown surface mining development potential or no development potential. Areas of unknown surface mining development potential are those not known to contain coal beds 5 ft (1.5 m) or more thick that are within 200 ft (61.0 m) of the surface; however, coal beds 5 ft (1.5 m) or more thick could be present in the area. Lands where it is known that no coal beds occur within 200 ft (61.0 m) of the surface have no surface-mining development potential.

The tonnage of Reserves recoverable by surface mining methods are calculated on a recoverability factor of 85 percent (specified by the

U.S. Geological Survey, unpublished data, 1979) of the Reserve Base tonnage.

Development Potential Using Subsurface Mining Methods and In Situ Coal Gasification

The coal development potential for areas in which subsurface development of coal is assumed possible is shown on plate 9. In this quadrangle, areas where coal beds dip 15° or less, are 5 ft. (1.5 m) or more thick and are overlain by 200 to 1,000 ft. (61 to 305 m) of overburden are considered to have a high-development-potential for conventional subsurface mining methods. Approximately 11 percent of the unleased Federal land in this quadrangle has a "high" classification. Areas where such beds are overlain by 1,000-2,000 ft (305-610 m) and 2,000 ft (610-914 m) of overburden are rated as having moderate- and low-development-potentials, respectively. In this quadrangle there are no areas classified with a moderate- or low-development-potential using conventional subsurface mining methods. Areas that contain no known coal in beds 5 ft. (1.5 m) or more thick but do contain coal-bearing units at depths between 200 to 3,000 ft. (61-914 m) are classified as areas of unknown coal development potential. Areas where it is known that no coal beds occur or where coal beds are present at depths greater than 3,000 ft. (914 m) have no coal-development potential.

Reserve Base tonnages have been calculated for all areas within the quadrangle where the coal beds are known to be 5 ft. (1.5 m) or more thick. Reserves are based on a recoverability factor of 50 percent (specified by the U.S. Geological Survey, unpublished data, 1979) and have been calculated for only that part of the Reserve Base considered to be suitable for conventional subsurface mining methods. An arbitrary dip limit of 15° is assumed to be the maximum dip suitable for conventional subsurface mining methods.

The development potential using in situ coal gasification applies to areas that contain coal beds 5 ft (1.5 m) or more thick dipping in excess of 15°. The coal beds in this quadrangle generally have dips less than 15° and are not classified as having a development potential for using in situ coal gasification.

Reserves have not been calculated for the non-isopached coal beds at isolated data points. The areas controlled by those points have been assigned an unknown development potential. Resource tonnages included in the unknown development potential category for areas within ¼ mile (0.4 km) of isolated data points are shown in table 2. No distinction has been made between surface and subsurface mining resources in the areas controlled by isolated data points.

Table 8.--Sources of data used on plate 1

Plate 1 Index No.	Source	Measured Section on Drill Hole No.
1	Madden, 1977a	C-98, p. 104
2	Do.	C-97, p. 102-103
3	The Kemmerer Coal Co.	CM-75
4	Do.	CM-128
5	Do.	CM-129
6	Do.	D.H. 11
7	Do.	CM-73
8	Madden, 1977a	C-96, p. 100
9	Do.	C-7, p. 31-32
10	Do.	C-8, p. 35-36
11	Do.	C-43, p. 68
12	Do.	C-44, p. 69
13	Do.	C-9, p. 37
14	The Kemmerer Coal Co.	CM-55
15	Do.	CM-566
16	Do.	CM-61
17	Do.	CM-61A
18	Do.	CM-59C
19	Do.	CM-59
20	Do.	CM-60D
21	Do.	CM-108A
22	Do.	CM-107A
23	Do.	CM-107
24	Do.	CM-112
25	Do.	CM-111
26	Do.	CM-111A
27	Do.	CM-110
28	Do.	CM-109A
29	Do.	CM-122
30	Do.	CM-118
31	Do.	CM-121
32	Do.	CM-42
33	Do.	CM-36
34	Do.	CM-39
35	Do.	CM-29
36	Do.	CM-33
37	Do.	CM-30
38	Do.	CM-63
39	Do.	CM-62
40	Do.	CM-67
41	Do.	CM-71
42	Do.	CM-3
43	Do.	CM-2
44	Do.	CM-1
45	Do.	CM-117
46	Do.	CM-101
47	Do.	CM-25
48	Do.	CM-17A

Table 8.--Sources of data used on plate 1 cont.

Plate 1 Index No.	Source	Measured Section on Drill Hole No.
49	Do.	CM-80
50	Do.	CM-82
51	Do.	CM-5
52	Do.	CM-5A
53	Do.	CM-84
54	Do.	CM-86A
55	Erdmann, 1941	D.H. 8, p. 106
56	The Kemmerer Coal Co.	CM-48B
57	Do.	CM-48
58	Do.	CM-48A
59	Do.	CM-142
60	Madden, 1977a	C-25, p. 49
61	The Kemmerer Coal Co.	CM-143
62	Erdmann, 1941	D.H. 47, p. 145
63	The Kemmerer Coal Co.	CM-141
64	Do.	CM-140
65	Madden, 1977a	C-27, p. 51-52
66	Do.	C-26, p. 50
67	The Kemmerer Coal Co.	CM-139
68	Do.	CM-138
69	Do.	CM-137
70	Erdmann, 1941	D.H. 40, p. 138
71	Do.	D.H. 35, p. 133
72	The Kemmerer Coal Co.	CM-146
73	Erdmann, 1941	D.H. 25, p. 129
74	Do.	D.H. 31, p. 129
75	Do.	D.H. 12, p. 110
76	The Kemmerer Coal Co.	CM-133B
77	Do.	CM-50
78	Eadmann, 1941	D.H. 5, p. 103
79	Do.	D.H. 65, p. 163
80	The Kemmerer Coal Co.	CM-90A
81	Do.	CM-90
82	Do.	CM-91A
83	Do.	D.H. 7
84	Do.	D.H. 1
85	Hail, 1968	C-9, p. 108
86	The Kemmerer Coal Co.	D.H. 5
87	Do.	D.H. 6
88	Do.	D.H. 3
89	Hail, 1968	C-8, p. 107
90	The Kemmerer Coal Co.	D.H. 2
91	Do.	D.H. 4
92	Hail, 1968	C-5, p. 107
93	Do.	C-4, p. 107
94	Do.	C-2, p. 106
95	Do.	C-1, p. 106
96	Do.	C-15, pl. 110
97	Do.	C-14, p. 109

REFERENCES

1. American Society for Testing and Materials, 1977, Standard specifications for classification of coals by rank, in Gaseous fuels, coal, and coke; atmospheric analysis: ASTM Publication D 388-77.

2. Beekly, S. L., 1915, Geology and coal resources of North Park Colorado: U.S. Geol. Survey Bull. 596.

3. Behrendt, J. C., and others, 1969, A geophysical study of North Park and the surrounding ranges, Colorado: Geol. Soc. American Bull., v. 80, no. 8.

4. Boreck, D. L., and others, 1977, Colorado coal analyses, 1975: Colorado Geol. Survey, Information Series 7.

5. Erdmann, E. C., 1941, Preliminary report on the geology of the Coalmont district, Jackson County, Colorado: U.S. Geol. Survey open-file report.

6. Hayden, F. V., 1877, Geological and geographical atlas: U.S. Geol. Survey Terr.

7. Hail, W. J., Jr., 1965, Geology of northwestern North Park, Colorado: U.S. Geol. Survey Bull. 1188.

8. ______________ 1968, Geology of southwestern North Park, vicinity: U.S. Geol. Survey Bull. 1257.

9. Hail, W. J., Jr., and Leopold, E. B., 1960, Paleocene and Eocene age of the Coalmont Formation, North Park, Colorado, in Short papers in the geological sciences: U.S. Geol. Survey Prof. Paper 400-B.

10. Hendricks, M. L., 1978, Stratigraphy of the Coalmont Formation near Coalmont, Jackson County, Colorado, in Proceedings of the second symposium of the geology of Rocky Mountain coal-1977: Colorado Geol. Survey.

11. Henkes, W. C., 1957, Coalmont area, Jackson County, Colorado, in Geology of North and Middle Park basins, Colorado: Rocky Mtn. Assoc. Geologists Guidebook, 1957.

12. King, Clarence, 1876, geological and topographical atlas: U.S. Geol. Explor. 40th Parallel.

13. Kinney, D. M., 1970a, Preliminary geologic map of the Gould quadrangle, North Park, Jackson County, Colorado: U.S. Geol. Survey open-file report.

14. ______________ 1970b, Preliminary geologic map of the Rand quadrangle, North Park, Jackson and Grand Counties, Colorado: U.S. Geol. Survey open-file report.

REFERENCES CONTINUED

15. ___________ 1971, Preliminary geologic map of "southwest third" of Kings Canyon quadrangle, North Park, Jackson County, Colorado: U.S. Geol. Survey open-file report.

16. Kinney, D. M., and Hail, W. J., Jr., 1959, Upper Cretaceous rocks in North Park, Jackson County, Colorado in Symposium on Cretaceous rocks of Colorado and ajacent areas: Rocky Mtn. Assoc. Geologists Guidebook.

17. ___________ 1970a, Preliminary geologic map of the Walden quadrangle, North Park, Jackson County, Colorado: U.S. Geol. Survey open-file map.

18. ___________ 1970b, Preliminary geologic map of the Hyannis Peak quadrangle, North and Middle Parks, Jackson and Grand Counties, Colorado: U.S. Geol. Survey open-file report.

19. Kinney D. M., and others, 1970, Preliminary geologic map of Cowdrey quadrangle, North Park, Jackson County, Colorado: U.S. Geol. Survey prelim. map, open-file.

20. Madden, D. H. 1976, Coal resource occurrence in the McCallum area (Cowdrey, Eagle Hill, Gould NW, Johnny Moore Mountain, and Walden quadrangles), Jackson County, Colorado: U.S. Geol. Survey unpublished report.

21. ___________ 1977a, Exploratory drilling in the Coalmont coal field, Jackson County, Colorado, June-November 1977: U.S. Geol. Survey Open-File Report 77-887.

22. ___________ 1977b, Exploratory drilling drilling in the McCallum coal field, Jackson County, Colorado, August-November 1977: U.S. Geol. Survey Open-File Report 77-888.

23. Madden, D. H., and others, 1977, McCallum Known Recoverable Coal Resource Area, Jackson County, Colorado: U.S. Geol. Survey, Minutes of the Mineral Land Evaluation Committee, unpublished report.

24. ___________ 1978, Revision of the McCallum Known Recoverable Coal Resource Area, Jackson County, Colorado: U.S. Geol. Survey Minutes of the Mineral Land Evaluation Committee, unpublished report.

25. Miller, J. C., 1934, Geology of the North and South McCallum anticlines, Jackson County, Colorado, with special reference to petroleum and carbon dioxide: U.S. Geol. Survey Circ. 5.

26. Montagne, J. M. de la, and Barnes, W. C., 1957 Stratigraphy of the North Park Formation in the North Park area, Colorado in Geology of North and Middle Park Basins, Colorado: Rocky Mtn. Assoc. Geologists Guidebook, 1957.

REFERENCES CONTINUED

27. Severy, C. L., and Thompson, R. M., 1953, Coalmont area, Jackson County, Colorado, in Laramie Basin, Wyoming, and North Park, Colorado: Wyoming Geol. Assoc. Guidebook 8th Ann. Field Conf.

28. Tweto, Ogden, 1976, Geologic map of the Craig 1^{o} x 2^{o} quadrangle, northwestern Colorado: U.S. Geol. Survey Misc. Inv. Series Map I-972.

29. U.S. Bureau of Mines and U.S. Geological Survey, 1976, Coal resource classification system of the U.S. Bureau of Mines and U.S. Geological Survey: U.S. Geol. Survey Bull. 1450-B.

30. U.S. Department of Commerce, (1964), Normal annual precipitation, 1931-1960, Colorado: Environmental Science Services Admin., Weather Bureau.

APPENDIX A

Coal and rock thicknesses for the measured sections and drill holes on CRO Coal Data Map, plate 1, Coalmont Quadrangle, Jackson County, Colorado.

1	2	3	4
GL 8218	GL 8130 (est.)	GL 8171	GL 8232
R 102.0	R 377.0	R 398.5	R 336.9
C 9.0 (R)	C 11.0 (SV)	C 21.7 (R)	C 15.0 (R)
R 2.0	R 12.0	R 19.8	R 8.1
C 12.0 (R)	C 5.0 (L)	TD 390	TD 360
R 96.0	R 2.0		
C 4.0 (L)	C 5.0 (L)		
R 475.0	R 148.0		
TD 700	TD 560		

5	6	7	8
GL 8192	GL 8227	GL 8188	GL 8160
R 325.5	R 33.0	R 300.2	R 271.0
C 2.7 (R)	C 6.0 (L)	BC 23.8 (R)	C 15.0 (R)
R 4.6	R 9.5	R 16.0	R 1.5
C 2.9 (R)	C 1.5 (L)	TD 340	C 24.0 (R)
R 1.1	R 116.0		R 1.0
C 10.0 (R)	TD 166		C 8.5 (R)
R 13.2			R 59.0
TD 360			TD 360

9	10	11	12
GL 8170	GL 8230	GL 8207	GL 8280 (est.)
R 309.0	R 76.0	R 65.0	R 29.0
C 10.0 (R)	C 9.0 (SV)	C 5.0 (SV)	BC 5.0 (L)
R 1.0	R 1.0	R 2.0	R 106.0
C 4.0 (R)	C 5.0 (SV)	C 5.0 (SV)	C 9.0 (R)
R 1.0	R 27.0	R 23.0	R 1.0
C 15.0 (R)	C 4.5 (L)	C 3.0 (L)	C 3.0 (R)
R 260.0	R 94.0	R 88.0	R 147.0
TD 600	C 3.5 (L)	C 3.0 (L)	TD 300
	R 33.0	R 7.0	
	C 4.0 (L)	C 3.0 (L)	
	R 243.0	R 96.0	
	TD 500	TD 300	

13	14	15	16
GL 8190	GL 8192 (est.)	GL 8182 (est.)	GL 8185
R 413.0	R 19.4	R 281.4	R 247.6
C 13.0 (R)	BC 14.9 (R)	C 21.1 (R)	C 25.8 (R)
R 1.0	R 265.7	R 17.5	R 7.3
C 3.0 (R)	TD 300	TD 320	C 1.8 (L)
R 50.0			R 17.5
TD 480			TD 300

17	18	19	20
GL 8189	GL 8185	GL 8188	GL 8172 (est.)
R 162.3	R 229.0	R 275.8	R 320.8
C 23.8 (R)	C 3.3 (R)	C 22.7 (R)	BC 1.6 (R)
R 3.4	R 0.5	R 21.5	C 18.2 (R)
C 0.3 (L)	C 6.3 (R)	TD 320	R 19.4
R 10.2	R 0.7		TD 360
TD 200	C 1.0 (R)		
	R 2.7		
	C 7.5 (R)		
	R 9.0		
	TD 260		

21	22	23	24
GL 8183	GL 8176	GL 8181	GL 8170
R 37.7	R 286.8	R 392.7	R 201.8
C 21.8 (R)	C 3.1 (R)	C 19.5 (R)	C 12.2 (R)
R 6.5	R 4.3	R 7.8	R 0.8
TD 400	C 17.6 (R)	TD 420	C 10.4 (R)
	R 8.2		R 14.8
	TD 320		TD 240

25	26	27	28
GL 8170	GL 8208	GL 8204	GL 8202
R 76.5	R 114.2	R 64.2	R 225.4
C 4.9 (R)	C 5.2 (R)	C 0.2 (R)	C 2.4 (R)
R 0.4	R 0.9	R 3.9	R 1.2
C 1.0 (R)	C 19.0 (R)	C 5.7 (R)	C 1.7 (R)
R 1.2	R 22.6	R 1.2	R 0.5
C 10.9 (R)	TD 162	C 7.3 (R)	C 1.2 (R)
R 15.1		R 0.5	R 0.2
TD 110		C 11.0 (R)	C 0.6 (R)
		R 26.0	R 1.0
		TD 120	C 1.7 (R)
			R 0.6
			C 10.0 (R)
			R 15.5
			TD 262

29

GL 8180 (est.)
R 10.3
BC 1.7 (R)
C 8.3 (R)
R 19.7
TD 40

30

GL 8207
R 178.7
C 1.3 (R)
R 1.0
C 19.4 (R)
R 39.6
TD 240

31

GL 8203
R 290.8
C 23.2 (R)
R 26.0
TD 340

32

GL 8186
R 129.2
C 2.8 (R)
R 0.7
C 5.1 (R)
R 0.8
C 12.8 (R)
R 0.8
C 0.8 (R)
R 27.0
TD 180

33

GL 8196
R 44.6
C 10.1 (R)
R 1.5
C 11.3 (R)
R 12.5
TD 80

34

GL 8195
R 79.3
C 2.9 (R)
R 0.6
C 16.5 (R)
R 20.7
TD 120

35

GL 8245
R 42.5
BC 4.3 (R)
R 353.2
TD 400

36

GL 8310 (est.)
R 48.5
C 6.7 (R)
BC 0.8 (R)
C 39.0 (R)
R 23.0
TD 118

37

GL 8320 (est.)
R 102.2
C 2.6 (R)
R 0.4
C 41.8 (R)
R 13.0
TD 160

38

GL 8310
R 272.5
C 0.2 (L)
R 13.5
C 35.3 (R)
R 28.5
TD 350

39

GL 8219
R 384.4
C 27.4 (R)
R 8.2
TD 420

40

GL 8292
R 183.1
C 14.7 (R)
BC 0.2 (R)
C 19.6 (R)
R 12.4
TD 230

41

GL 8278
R 14.1
C 29.4 (R)
R 0.5
C 5.9 (R)
R 0.4
C 2.9 (R)
R 21.8
TD 75

42

GL 8312
R 65.2
BC 1.8 (L)
R 3.7
C 30.7 (R)
R 9.9
C 0.7 (L)
BC 0.6 (L)
R 287.4
TD 400

43

GL 8305
R 132.6
C 1.6 (L)
R 1.6
C 10.1 (R)
R 25.4
C 8.7 (L)
R 12.5
C 0.8 (L)
R 41.7
TD 235

44

GL 8293
R 331.4
C 10.6 (R)
R 1.0
C 9.3 (R)
R 47.7
TD 400

45

GL 8228
R 97.6
C 2.6 (R)
R 1.0
C 16.1 (R)
R 22.7
TD 140

46

GL 8271
R 31.1
C 26.9 (R)
R 22.0
TD 80

47

GL 8326
R 104.0
C 23.1 (R)
R 72.9
TD 200

48

GL 8357 (est.)
R 55.7
C 24.1 (R)
BC 2.5 (R)
R 17.7
TD 100

49

GL 8403
R 22.1
C 20.9 (R)
R 15.0
C 1.7 (L)
R 20.3
TD 80

50

GL 8315
R 148.1
C 3.9 (L)
R 84.4
C 15.2 (R)
R 7.2
BC 2.2 (L)
R 14.0
TD 275

51

GL 8373 (est.)
R 105.5
C 10.5 (R)
R 0.5
C 15.1 (R)
R 128.4
TD 260

52

GL 8390 (est.)
R 9.4
C 23.6 (R)
R 0.2
C 1.9 (R)
R 2.4
C 3.7 (R)
R 358.8
TD 400

53

GL 8402
R 109.8
C 19.8 (R)
R 2.0
BC 3.0 (R)
R 25.4
TD 160

54

GL 8419
R 70.3
C 27.3 (R)
R 42.4
TD 140

55

GL 8268 (est.)
R 36.0
C 12.0 (R)
R 3.0
C 3.0 (R)
R 1.0
C 11.0 (R)
R 1.0
C 9.0 (R)
R 3.0
BC 4.0 (R)
R 115.0
TD 198

56

GL 8262
R 80.0
C 43.0 (R)
R 2.0
C 4.0 (R)
R 71.0
TD 200

57

GL 8244
R 48.0
C 39.7 (R)
R 72.3
TD 160

58

GL 8255
R 103.0
C 16.0 (R)
TD 119

59

GL 8181
R 208.0
C 0.6 (L)
R 2.3
C 9.1 (R)
R 8.2
C 21.6 (R)
R 10.2
TD 260

60

GL 8170
*CL 25.0 (R)
R 175.0
TD 200

* CL - Clinker

61

GL 8175
R 210.7
C 4.6 (R)
R 1.7
BC 3.3 (R)
C 5.7 (R)
R 1.6
C 23.1 (R)
R 20.3
TD 271

62

GL 8224 (est.)
R 26.0
C 3.3 (L)
R 5.0
C 11.0 (L)
R 7.0
C 3.0 (L)
BC 3.0 (L)
C 2.0 (L)
R 8.0
BC 2.0 (L)
R 12.0
C 1.0 (L)
R 1.0

62 (cont)

C 2.0 (L)
BC 2.0 (L)
R 14.5
BC 6.0 (L)
R 14.0
BC 1.0 (L)
R 4.0
C 1.0 (L)
R 27.0
BC 1.0 (L)
R 12.0
BC 1.0 (L)
R 18.0
C 1.0 (L)

62 (cont)

R 7.0
C 1.0 (R)
R 1.0
C 43.0 (R)
R 2.0
TD 243

63

GL 8174
R 190.0
C 0.4 (R)
R 2.8
C 12.8 (R)
R 4.1
C 19.9 (R)
R 3.0
C 3.2 (R)
R 23.8
TD 260

64

GL 8178
R 137.9
BC 14.1 (R)
C 4.3 (R)
R 2.1
C 19.8 (R)
R 21.8
TD 200

65

GL 8170
R 24.0
BC 3.0 (R)
R 6.0
BC 7.0 (R)
R 260.0
TD 300

66

GL 8148 (est.)
R 44.0
BC 11.0 (R)
R 52.0
C 3.0 (L)
R 29.0
C 4.0 (L)
R 31.0
C 6.0 (L)
R 40.0
TD 220

67

GL 8186
R 225.7
C 5.6 (R)
R 68.7
TD 300

68

GL 8173
R 104.0
C 0.2 (R)
R 6.8
C 1.8 (R)
BC 14.2 (R)
R 1.0
C 0.3 (R)
R 18.2
TD 146

69

GL 8181
R 68.1
C 2.0 (R)
BC 6.4 (R)
R 1.3
C 0.9 (R)
BC 1.4 (R)
C 4.5 (R)
BC 1.2 (R)
R 54.2
TD 140

70

GL 8160
R 19.0
C 3.0 (R)
BC 2.0 (R)
R 14.0
BC 4.0 (R)
R 9.0
TD 51

71

GL 8196 (est.)
R 153.0
BC 1.0 (R)
R 3.0
C 7.0 (R)
BC 1.0 (R)
C 5.0 (R)
R 1.0
C 16.0 (R)
R 2.0
C 1.0 (R)
BC 2.0 (R)
R 3.0
TD 195

72

GL 8199
R 83.5
C 5.9 (R)
R 0.4
BC 2.3 (R)
R 0.3
C 7.3 (R)
R 40.3
TD 140

73

GL 8181
R 46.0
BC 1.0 (R)
R 3.0
C 31.0 (R)
R 3.0
TD 84

74

GL 8196
R 117.0
BC 2.0 (R)
C 12.0 (R)
R 1.0
C 2.0 (R)
BC 1.0 (R)
C 10.0 (R)
BC 1.0 (R)
R 0.3
BC 3.0 (R)
R 1.0
C 4.0 (R)
R 4.0
TD 158

75

GL 8184 (est.)
R 9.0
BC 4.0 (R)
R 2.0
C 23.0 (R)
R 3.0
C 2.0 (R)
R 2.0
C 1.0 (R)
R 9.0
TD 55

76

GL 8205 (est.)
R 27.8
C 7.5 (R)
R 1.0
C 9.7 (R)
R 14.0
TD 60

77

GL 8185
R 130.0
C 34.0 (R)
R 76.0
TD 240

78

GL 8220 (est.)
R 9.0
BC 1.6 (L)
R 76.6
BC 8.0 (R)
R 14.0
TD 109

79

GL 8197 (est.)
R 32.0
C 5.0 (R)
R 2.0
C 19.0 (R)
R 4.0
TD 62

80

GL 8319
R 125.2
C 7.6 (R)
R 2.2
C 9.2 (R)
R 20.8
TD 165

81

GL 8350
R 278.6
C 11.4 (R)
R 20.0
TD 310

82

GL 8393 (est.)
R 179.3
C 3.2 (R)
R 167.5
TD 400

83

GL 8171
R 70.0
C 6.0 (R)
R 10.0
C 34.0 (R)
R 20.0
TD 140

84

GL 8217
R 81.0
C 5.0 (L)
R 1.0
C 1.0 (L)
R 116.0
C 0.5 (R)

84 (cont)

R 5.5
C 9.0 (R)
R 1.0
C 6.0 (R)
R 1.0
C 27.0 (R)
R 66.0
TD 320

85

R 11.0+
BC 2.0 (R)
R 5.5
BC 3.5 (R)
R 2+

86

GL 8347
R 196.0
C 2.0 (R)
R 2.0
C 26.0 (R)
R 2.0
C 7.0 (R)
R 1.0
C 9.0 (R)
R 75.0
TD 320

87

GL 8380
R 190.0
C 19.0 (R)
R 11.0
TD 220

88

GL 8260 (est.)
R 62.0
C 2.0 (R)
R 5.0
C 5.0 (R)
R 1.0
C 15.0 (R)
R 1.0
C 41.0 (R)
R 4.0
C 2.0 (L)

88 (cont)

R 2.0
C 1.0 (L)
R 4.0
TD 145

89

R 10+
BC 2.0 (T)
R 2.5
BC 1.0 (T)
R 6.0
C 3.0 (T)
BC 10.0 (T)
R 1.5
BC 0.5 (T)
R 3.5
NR 10+

90

GL 8274
R 40.8
C 0.2 (R)
R 1.0
C 1.0 (R)
R 5.3
C 4.7 (R)
R 1.0
C 5.0 (R)
R 2.0
C 0.8 (R)

90 (cont)

R 1.0
C 1.5 (R)
R 1.5
C 1.6 (R)
BC 0.9 (R)
R 0.6
BC 0.9 (R)
C 3.1 (R)
BC 0.3 (R)
C 2.3 (R)
BC 0.3 (R)

90 (cont)

C 3.5 (R)
BC 1.2 (R)
C 0.3 (R)
R 1.2
C 0.2 (R)
R 0.1
C 2.4 (R)
R 0.2
C 0.6 (R)
R 0.4
C 4.1 (R)

90 (cont)

R 0.1
C 3.2 (R))
R 1.4
C 0.6 (R)
R 0.4
C 0.7 (R)
R 0.5
C 1.6 (R)
R 0.1
C 0.7 (R)

90 (cont)

BC 0.4 (R)
C 1.1 (R)
R 0.4
BC 0.2 (R)
R 0.3
C 2.3 (R)
R 0.3
C 1.4 (R)
BC 0.4 (R)
C 0.7 (R)

90 (cont)

R 0.3
C 0.4 (R)
BC 0.3 (R)
C 0.9 (R)
R 0.3
C 0.5 (R)
BC 1.7 (R)
R 24.4
C 2.9 (L)
R 0.2

90 (cont)

C 2.1 (L)
R 0.2
C 0.8 (L)
R 18.2
TD 160

91

GL 8536 (est.)
R 37.0
C 1.0 (L)
R 7.0
C 6.0 (L)
R 29.0
C 6.0 (R)
R 4.0

91 (cont)

C 1.0 (R)
BC 5.0 (R)
R 4.0
BC 8.0 (R)
C 3.0 (R)
R 14.0
BC 3.0 (R)
R 4.0

91 (cont)

BC 10.0 (R)
R 118.0
TD 260

92

R 36.5
BC 2.5 (P)
C 5.5 (P)
R 114+

93	94	95	96
NR 66.0	R 53.0	R 3+	R 2.0
*CL 21.0 (P)	BC 3.0 (L)	*CL 2+ (P)	BC 1.0 (MC)
R 50.0	R 31.0	BC 11.0 (P)	R 2.0
	BC 9.0 (P)	R 9.0	BC 2.5 (MC)
	R 13.0	BC 1.0 (P)	R 2.5
	*CL 1.5+ (P)	R 1.0	BC 4.5 (MC)
	R 10.0	BC 8.0 (P)	R 2.0
		R 5.0	

97
R 15+
BC 1.5 (MC)
C 0.5 (MC)
R 2.0
C 2.0 (MC)
R 0.5
C 1.5 (MC)
R 2.0
C 4.0 (MC)
R 1.0

*CL - Clinker