APPENDIX 25

COAL REPORT

Price Field Office

Resource Management Plan

Bureau of Land Management

125 South 600 West

Price, Utah 84501

Table of Contents

1. Introduction 1
   A. Background 1
   B. Study Methodology 1
   C. Point Data Preparation 3
   D. Setting 3
2. Known Occurrences and Characteristics 5
   A. Book Cliffs Coal Field 5
      1. Setting 5
      2. Coal Geology 7
      3. Coal Quality 8
      4. Coal Resources 10
   B. Wasatch Plateau Coal Field 11
      1. Setting 11
      2. Coal Geology 12
      3. Coal Quality 12
      4. Coal Resources 14
   C. Emery Coal Field 15
      1. Setting 15
      2. Coal Geology 16
      3. Coal Quality 16
      4. Coal Resources 18
3. Past Production and Trends 18
   A. Introduction 18
   B. Book Cliffs Coal Field 19
   C. Wasatch Coal Field 20
   D. Emery Coal Field 21
4. Current Production and Exploration Activities 22
   A. Coal Industry Structure 22
   B. Andalex Resources Incorporated 22
   C. Canyon Fuel Company LLC 23
   D. Co-op Mining Company 24
   E. Cyprus Plateau Mining Company 24
   F. Interwest Mining Company 25
   G. Lodestar Energy Incorporated 25
   H. Coal Markets 26
5. Geologic Potential 27
   A. Book Cliffs Field 27
   B. Wasatch Plateau Coal Field 28
   C. Emery Coal Field 30
6. References 31
7. Appendix A 32
8. Appendix B 33
9. Maps
   A. Map 39 34
   B. Map 40 35

C. Map 41 36
D. Map 6 37

List of Tables

C-1 Utah's six major coalfields, with original minable resources in billions of tons.

C-2 Coal quality statistics for Subseam 1 (Wattis this report) bed from the Upper Cretaceous Blackhawk Formation in the Book Cliffs coalfield (as-received basis).

C-3 Coal quality statistics for Castlegate A bed from the Upper Cretaceous Blackhawk Formation in the Book cliffs coalfield (as-received basis).

C-4 Coal quality statistics for Castlegate B bed from the Upper Cretaceous Blackhawk Formation in the Book Cliffs coalfield (as-received basis).

C-5 Coal quality statistics for Kenilworth bed from the Upper Cretaceous Blackhawk Formation in the Book Cliffs coalfield (as-received basis).

C-6 Coal quality statistics for Gilson bed from the Upper Cretaceous Blackhawk Formation in the Book Cliffs coalfield (as-received basis).

C-7 Coal quality statistics for Rock Canyon bed from the Upper Cretaceous Blackhawk Formation in the Book Cliffs coalfield (as-received basis).

C-8 Coal quality statistics for Lower Sunnyside bed from the Upper Cretaceous Blackhawk Formation in the Book Cliffs coalfield (as-received basis).

C-9 Remaining, in-place, coal resources by mining period for the Book Cliffs coalfield given in millions of short tons

C-11 Coal quality statistics for the Blind canyon bed from the Upper Cretaceous Blackhawk Formation in the Wasatch Plateau coalfield

C-12 Coal quality statistics for the Castlegate A bed from the Upper Cretaceous Blackhawk Formation in the Wasatch Plateau coalfield

C-13 Coal quality statistics for the Hiawatha bed from the Upper Cretaceous Blackhawk Formation in the Wasatch Plateau coalfield

C-14 Coal quality statistics for the Upper Hiawatha bed from the Upper Cretaceous Blackhawk Formation in the Wasatch Plateau coalfield

C-15 Remaining, in-place resources by mining period for the Wasatch Plateau coalfield within Carbon and Emery Counties given in millions of short tons

C-16 Coal quality statistics for the A bed from the Upper Cretaceous Ferron Sandstone Member of the Mancos Shale in the Emery coalfield

C-17 Coal quality statistics for the C bed from the Upper Cretaceous Ferron Sandstone Member of the Mancos Shale in the Emery Coalfield

C-18 Coal quality statistics for the G bed from the Upper Cretaceous Ferron Sandstone Member of the Mancos Shale in the Emery Coalfield (as-received basis).

C-19 Coal quality statistics for the I bed from the Upper Cretaceous Ferron Sandstone Member of the Mancos Shale in the Emery coalfield (as-received basis).

C-20 ???

C-21 Original, in-place coal resources by county for the southern part of Emery coalfield given in millions of short tons

C-22 Utah coal sales statistics, 1998-2001

C-23 Recoverable Coal Reserve Budget by mining period fro the Book Cliffs coalfield in millions of short tons

C-24 Recoverable Coal Reserve budget for Carbon and Emery Counties by mining period for the Wasatch Plateau coalfield in millions of short tons

C-25 Recoverable Coal Reserve budget by county for the Emery coalfield given in millions of short tons.

List of Figures

C1 West-East cross section of the Upper Cretaceous rocks of Carbon and Emery Counties, Utah.

COAL RESOURCES

INTRODUCTION

Background

To assist the U.S. Bureau of Land Management (BLM) update its management plan for the Price Field Office, which covers Carbon and Emery Counties in Utah, the Utah Geological Survey (UGS) was asked to generate information on the remaining recoverable coal reserves in the area, and a reasonably foreseeable development scenario for those reserves. The UGS provided a database with the location and thickness at various coal measurement points, and information on previously mined areas, faulting, and natural and cultural features that might inhibit future mining that had been compiled for resource studies of the Book Cliffs and Wasatch Plateau coalfields (see Map 39) with funding from the U.S Geological Survey (USGS). Coal information for the Emery coalfield comes from an older resource study by the UGS (Doelling, 1972); an up-dated estimate of the available coal in the Emery coalfield (Map 39), although in progress, was not available at the time of the current BLM planning effort. BLM mining engineers provided the engineering parameters used by the UGS for its evaluation to derive the coal reserves that would be economic to mine under current, and reasonably foreseeable market conditions.

Study Methodology

This study was undertaken using ArcView software (version 3.2, Environmental Systems Research Institute [ESRI]) with ESRI's Spatial Analyst software extension running on a personal computer with a Windows NT operating system. This Geographic Information System (GIS) software allows for the simultaneous analysis of various combinations of resource parameters and the ability to easily repeat an analysis using different assumptions and parameters. Specific details related to the current GIS methodology employed follow.

Calculation of coal resources requires the determination of three parameters: the extent of minable coal in each bed (area), the distribution of the bed thickness in that area, and an estimation of the density of the coal. Maps showing the areal extent and thickness of identified coalbeds were constructed from scattered points of observation (drill hole records and outcrop measurements). ESRI's Spatial Analyst software extension allows the choice of different mathematical methods to interpolate between, and extrapolate beyond, point data to construct coal thickness maps of various individual coal beds. An inverse distance weighting method (set to examine the six nearest neighbors and use a fourth-order, distance-weighting function) was

selected to assign thickness values to individual 30-by 30-meter cells in a grid covering the areal extent of the Blackhawk Formation in the study area. The coal thickness information was combined with information on mined-out areas, faulting, depth of cover, and other technical and cultural features that would potentially limit future mining to define the remaining coal resources.

Using these various, individual, coal bed-thickness grid maps, polygonal areas were outlined with BLM engineering guidance to define the coal that would likely be economic to mine within the next 30 years. These polygonal areas generally had to contain coal thicker than seven feet, have overburden cover greater than 200 feet and less than 2,500 feet, and have resources that could be classified in the USGS "demonstrated" resource reliability category (Wood and others, 1983) for at least 80 percent of the resource area. The resulting grids of the areas likely to be mined in the next 30 years were converted from a floating-point (decimal) format to integer values. For example, all cells with coalbed thickness values greater than 7 but less than 8 feet were reclassified to the integer 7; for resource calculations we assign these cells a thickness of 7.5 feet of coal. This approximation significantly reduces the size of the resulting data sets and allows subsequent analyses to be undertaken in a reasonable amount of computation time (minutes rather than hours). Classification of coalbed thickness as integer data also allows convenient tabulation in Arcview of the areal extent of these thickness intervals; tables containing these data were exported to a spreadsheet for final calculation of the total tons of coal in each thickness interval. The coal resource calculations were accomplished by applying the USGS standard coal density factor for bituminous coal of 1,800 tons of coal per acre-foot (Wood and others, 1983).

For each of the resource areas identified for future mining in the Book Cliffs and Wasatch Plateau coalfields (map 39), the BLM mining engineers determined if it would be mined in the first or second 15-year period, and the recovery factor to apply to the identified resources to determine the recoverable reserves. Only general information is available at this time on the quality of the coal, or roof and floor conditions in the various minable tracts delineated. Specific information on the quality of the coal and roof and floor conditions in the various tracts would help identify areas with quality problems, or difficult mining conditions that might further restrict the recoverable coal in the delineated tracts. Some attempt to account for theses factors was made in applying slightly different recovery factors to some tracts. Future study of these economic aspects of the reserves identified is warranted, however, this present study identifies the maximum area likely to be of interest for coal development in the next 30 years and an idea of the magnitude of remaining recoverable reserves.

Point Data Preparation

Point data used in this study originate from a database compiled by the UGS over the past 20 years for the National Coal Resources Data System (NCRDS), which is a state cooperative program funded by the USGS. This database includes information from both unpublished and published sources. The BLM also provided additional records as part of a cooperative data sharing agreement with the UGS.

"Keypunch" NCRDS files in ASCII format, as well as BLM files in dBase format, were imported into a spreadsheet for simplification as a table of X, Y, Z data (easting, northing, and thickness or elevation) for each coalbed and exported as dBase (*.dbf) files for use in the ArcView GIS program. All data records were re-examined to verify correlations and spatial accuracy. Where necessary, spatial coordinates were converted to the Universal Transverse Mercator zone 12 coordinate system and bed identifications were revised or assigned. Bed thickness and depth is recorded to the nearest tenth of a foot. Elevation (above mean sea level) is also recorded to the nearest tenth of a foot, while spatial coordinates are recorded to the nearest tenth of a meter. However, the overall precision of the elevation and spatial data is probably closer to tens (rather than tenths) of meters; varied sources and vintages of the data hinder more exacting precision estimates.

Data from over 4,000 point locations were examined for possible use, and 1,961 data records were selected as the most reliable and useful (map 40). We preferentially selected drill hole data (1,153 points) since they provide the most reliable coal bed thickness, depth, and location values. Measured section data (808 points) were selected in areas where drill hole data are lacking; such data indicate minimum coal thickness since coal beds in Utah often thin at the outcrop as a result of weathering, slumping, or burning (Doelling, 1968). Furthermore, the precise elevation of coal beds in the measured sections was often difficult to determine. Accordingly, where we judged an elevation record for a measured section record unreliable, the record was not used to construct a coalbed elevation map. The selected point data were used to prepare coal bed elevation, interburden, and thickness maps.

Setting

Carbon and Emery Counties include all or part of three of the state's 22 coalfields: the Wasatch Plateau, Book Cliffs, and Emery coalfields (map 39). These three coalfields, each of which originally contained a resource estimated at over two billion tons of minable coal, make up half of the state's six major fields, and together, were estimated by Doelling (1972) to make up about one-third of the state’s coal resources. Mining currently occurs only in the Book Cliffs and Wasatch Plateau coalfields, although one mine in the Emery coalfield is preparing to re-open.

Table C-1. Utah's six major coalfields, with original minable resources in billions of tons. (coalbeds ≤ 3,000 feet deep and ≥ 4 feet thick; from Doelling 1972; Anderson, 1983)

COALFIELD	IDENTIFIED RESOURCES	HYPOTHETICAL RESOURCES	GRAND TOTAL
Alton	1.870	0.279	2.149
*Book Cliffs	3.527	0.157	3.684
*Emery	1.430	0.635	2.065
Kaiparowits Plateau	7.878	7.320	15.198
Kolob	2.014	-	2.014
*Wasatch Plateau	6.379	3.888	10.267
TOTAL	23.098	12.279	35.377

* field has resources in Carbon or Emery County

Carbon and Emery Counties have numerous, thick, coal zones, many in excess of 15 feet thick. However, most of the coal zones are lenticular, and commonly split into several thinner beds that thin rapidly or even disappear over a distance of a few miles. The lenticular nature of the coal, rapid lateral changes in the nature of floor and roof strata, intertonguing stratigraphic relations of the coal-bearing rocks, and faulting make correlation of individual coal beds difficult. The average thickness of the coal beds included in the resource estimates given above is slightly over 6 feet. At present, nearly all Carbon and Emery County operations are mining beds thicker than 6 feet. The coal beds of Carbon and Emery Counties occur in Upper Cretaceous strata; those of the Book Cliffs and Wasatch Plateau coalfields occur in the Blackhawk Formation, while the coals of the Emery coalfield are found in the Ferron Sandstone Member of the Mancos Shale.

The heat content of Carbon and Emery Counties' bituminous coal is high compared with that of the subbituminous coals typically produced in Montana, New Mexico, and Wyoming. Typical as-received heat contents range from 11,500 to 12,900 British thermal units (Btu) per pound of coal. Sulfur content is usually low (< 1 weight percent) in the major coalfields of Carbon and Emery Counties, but there are some areas with medium (1 to 2 weight percent) sulfur, particularly in the Emery coalfield. Near-surface coal quality is commonly degraded by oxidation, or it may be burned, for a considerable distance away from the outcrop.

KNOWN OCCURRENCES AND CHARACTERISTICS

Book Cliffs Coalfield

Setting

The Book Cliffs coalfield extends 70 miles across northern Carbon and eastern Emery counties, with an average width of 4 miles (Doelling, 1972). The field parallels the path of a line of the Union Pacific Railroad, which gives mine operators in this field a distinct transportation advantage over the mine operators in other major Utah coalfields. The coalbeds in the Book Cliffs field occur in the Upper Cretaceous Blackhawk Formation. This formation consists of six members, the Spring Canyon, Aberdeen, Kenilworth, Sunnyside, Grassy, and Desert in ascending order (figure C1). The first four members are the major coal-bearing units in the Book Cliffs coalfield. The lower members successively thin and pinch out to the east and south causing a general thinning of the Blackhawk Formation itself.

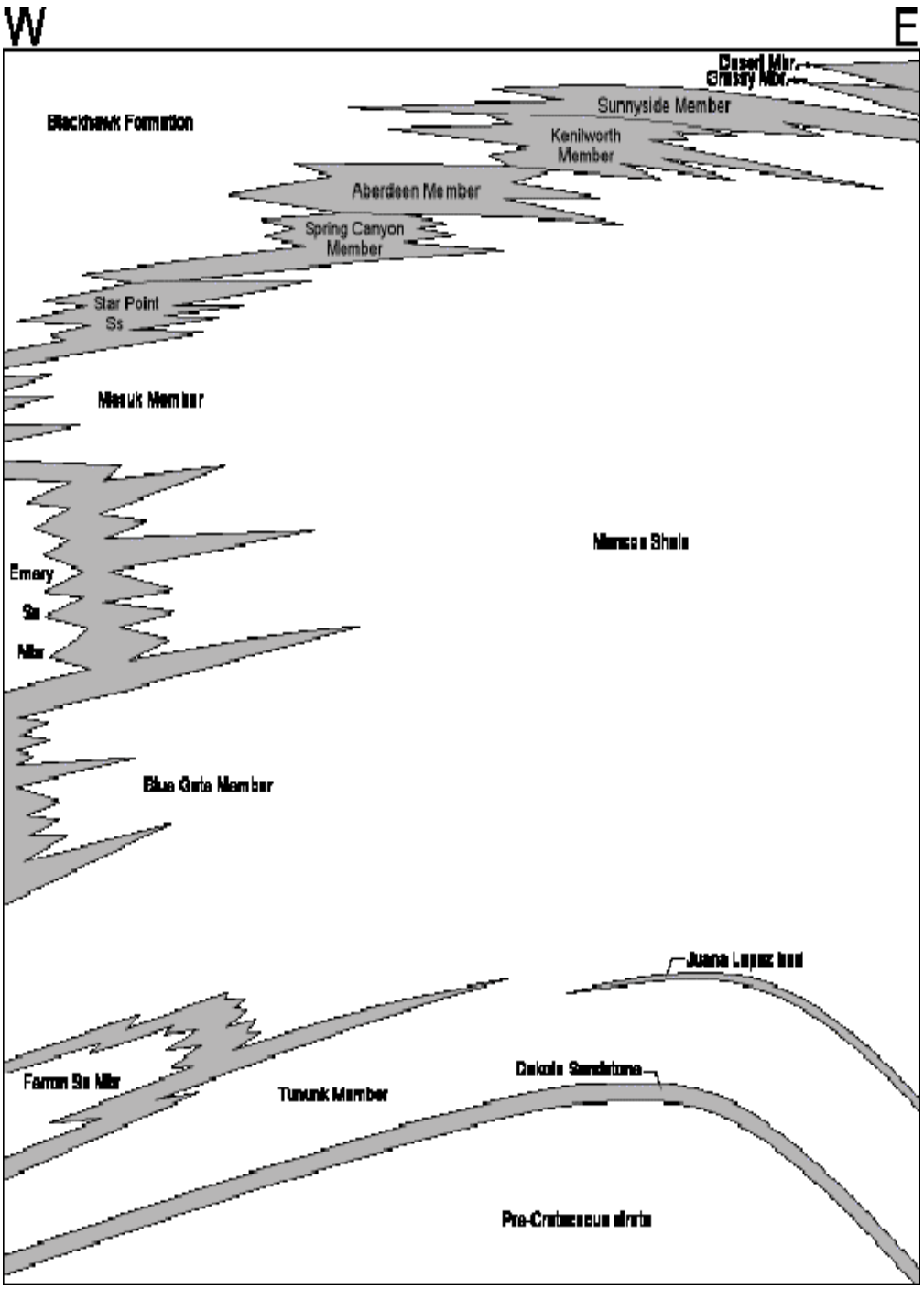


Figure C1. West-east cross section of the Upper Cretaceous rocks of Carbon and Emery Counties, Utah.

The coalbeds dip north and east at an average of 4 to 8 degrees in the Book Cliffs, but locally dips may be as high as 15 degrees (Doelling, 1972). Overburden increases rapidly north from the outcrop under an increasing blanket of younger Cretaceous and Tertiary sedimentary rocks. The area of minable resources (less than 2,500 feet of cover) is limited to a band about four to five miles down dip from the outcrop. Significant faults are present only in the Sunnyside and Woodside areas (map 39), but the faults are generally sufficiently wide-spaced to accommodate mining operations.

Coal Geology

The Book Cliffs field has been subdivided into four mining areas named, from west to east, Castlegate, Soldier Canyon, Sunnyside, and Woodside (map 39). Major coalbeds, or group of beds, in ascending order in the Castlegate area include the Spring Canyon coal group, the Castlegate coal group, and the Kenilworth bed. In the Soldier Canyon and Sunnyside areas, the major coal beds are the Gilson bed, and the Rock Canyon bed of the Kenilworth coal group, and coals of the Sunnyside group. Finally, in the Woodside area, major coals are found in the Sunnyside Member, with less significant coals in the Grassy, and Desert members of the Blackhawk Formation. The coal beds are usually lenticular and commonly split into several thinner benches or thin rapidly over a distance of a few miles. The minable thickness range of the major beds for each of the various Book Cliffs coal areas is listed below in descending stratigraphic order:

Castlegate Area beds	Thickness Range (ft)
Castlegate D	7 to 18
Kenilworth	7 to 10
Castlegate C	7 to 13
Castlegate B	7 to 11
Castlegate A	7 to 24
Subseam 3 (Spring Canyon)	7 to 10

Soldier Canyon Area beds	Thickness Range (ft)
Sunnyside Zone	7 to 10
Rock Canyon	7 to 13
Gilson	7 to 13

Sunnyside Area beds	Thickness Range (ft)
Sunnyside Zone	7 to 10
Rock Canyon (NW only)	7 to 13
Gilson (NW only)	7 to 13

Woodside Area beds	Thickness Range (ft)
Sunnyside Zone	7 to 13

Coal Quality

Coal from the Book Cliffs field generally has low ash contents, low to moderate sulfur contents, and high heat contents. The rank of the coal ranges from high-volatile C bituminous to high-volatile A bituminous, with the higher rank coals found in the eastern part of the field. The coal beds in the Sunnyside and Woodside areas are particularly noted for their good coking quality. Coal quality statistics for seven coal zones or beds from the Book Cliffs coalfield with 30 or more proximate analyses or 10 or more ultimate analyses are given below. The analytical data provided here comes from a UGS coal quality database, now in digital form, much of which was originally complied by Doelling (1972).

Table C-2. Coal quality statistics for Subseam 1 (Wattis this report) bed from the Upper Cretaceous Blackhawk Formation in the Book Cliffs coalfield (as-received basis).

	Mean	Maximum	Minimum	Standard Deviation	Sample Population
Ash (%)	7.1	20.8	4.3	2.2	71
Btu/lb	12,833	13,900	7,045	920	72
Fix. Carbon (%)	44.6	50.0	33.9	2.3	70
Vol. Matter (%)	44.19	48.5	31.4	2.6	70
Sulfur (%)	1.0	2.1	0.3	0.4	63
Moisture (%)	4.10	24.50	0.62	2.97	73

Table C-3. Coal quality statistics for Castlegate A bed from the Upper Cretaceous Blackhawk Formation in the Book Cliffs coalfield (as-received basis).

	Mean	Maximum	Minimum	Standard Deviation	Sample Population
Ash (%)	5.8	10.9	3.0	1.3	124
Btu/lb	12,819	14,460	11,840	432	116
Fix. Carbon (%)	47.37	54.50	28.34	2.72	117
Vol. Matter (%)	41.85	64.31	38.30	2.78	117
Sulfur (%)	0.6	5.2	0.3	0.5	117
Moisture (%)	4.9	10.3	1.2	1.8	124
Carbon (%)	74.39	80.70	70.19	2.29	34
Hydrogen (%)	5.7	6.4	5.0	0.3	34
Nitrogen (%)	1.4	1.6	0.9	0.1	34
Oxygen (%)	12.5	16.5	9.5	1.9	34
Chlorine (%)	0.01	0.08	0.00	0.02	14

Table C-4. Coal quality statistics for Castlegate B bed from the Upper Cretaceous Blackhawk Formation in the Book Cliffs coalfield (as-received basis).

	Mean	Maximum	Minimum	Standard Deviation	Sample Population
Ash (%)	6.3	12.8	3.8	1.1	233
Btu/lb	12,910	13,902	11,608	286	235
Fix. Carbon (%)	46.8	50.5	39.4	1.5	231
Vol. Matter (%)	42.9	46.4	38.7	1.2	231
Sulfur (%)	0.4	1.0	0.2	0.2	228
Moisture (%)	4.1	10.4	0.9	1.3	238
Carbon (%)	73.46	76.90	69.62	1.91	20
Hydrogen (%)	5.60	6.06	5.10	0.27	20
Nitrogen (%)	1.4	1.6	1.3	0.1	20
Oxygen (%)	13.0	15.1	11.0	1.3	20
Chlorine (%)	---	---	---	---	--

Table C-5. Coal quality statistics for Kenilworth bed from the Upper Cretaceous Blackhawk Formation in the Book Cliffs coalfield (as-received basis).

	Mean	Maximum	Minimum	Standard Deviation	Sample Population
Ash (%)	6.88	13.19	4.10	1.42	133
Btu/lb	12,783	14,360	11,629	302	129
Fix. Carbon (%)	46.99	53.34	40.97	1.93	129
Vol. Matter (%)	41.9	46.3	35.7	1.8	130
Sulfur (%)	0.38	0.70	0.10	0.11	117
Moisture (%)	4.2	8.1	1.9	1.2	133
Carbon (%)	74.2	80.5	71.8	2.6	15
Hydrogen (%)	5.7	6.0	5.0	0.2	15
Nitrogen (%)	1.4	1.5	1.2	0.1	15
Oxygen (%)	12.48	15.72	10.00	1.49	15
Chlorine (%)	---	---	---	---	--

Table C-6. Coal quality statistics for Gilson bed from the Upper Cretaceous Blackhawk Formation in the Book Cliffs coalfield (as-received basis).

	Mean	Maximum	Minimum	Standard Deviation	Sample Population
Ash (%)	7.19	14.20	2.67	2.11	171
Btu/lb	12,594	13,642	11,648	421	172
Fix. Carbon (%)	49.69	55.45	44.00	1.81	167
Vol. Matter (%)	38.5	44.3	30.9	1.6	167
Sulfur (%)	0.49	1.29	0.05	0.13	154
Moisture (%)	4.62	8.50	2.07	1.11	178
Carbon (%)	74.31	78.48	65.90	3.07	13
Hydrogen (%)	5.17	6.10	4.32	0.40	13
Nitrogen (%)	1.45	1.61	1.30	0.09	13
Oxygen (%)	10.68	13.40	5.56	2.21	13
Chlorine (%)	0.03	0.08	0.0	0.03	8

Table C-7. Coal quality statistics for Rock Canyon bed from the Upper Cretaceous Blackhawk Formation in the Book Cliffs coalfield (as-received basis).

	Mean	Maximum	Minimum	Standard Deviation	Sample Population
Ash (%)	7.7	11.8	3.3	1.8	56
Btu/lb	12,512	13,676	11,390	416	55
Fix. Carbon (%)	49.0	53.8	45.2	1.6	55
Vol. Matter (%)	38.41	43.18	34.25	1.28	55
Sulfur (%)	0.7	2.4	0.3	0.4	55
Moisture (%)	4.83	7.90	1.95	1.07	56

Table C-8. Coal quality statistics for Lower Sunnyside bed from the Upper Cretaceous Blackhawk Formation in the Book Cliffs coalfield (as-received basis).

	Mean	Maximum	Minimum	Standard Deviation	Sample Population
Ash (%)	6.5	11.9	3.5	1.3	149
Btu/lb	12,745	14,220	9,527	490	150
Fix. Carbon (%)	50.3	74.3	41.6	3.1	143
Vol. Matter (%)	37.3	44.7	5.8	4.5	145
Sulfur (%)	0.8	3.0	0.1	0.3	142
Moisture (%)	5.33	15.17	1.90	1.67	161
Carbon (%)	73.1	81.6	62.2	2.8	31
Hydrogen (%)	5.46	5.86	4.30	0.35	31
Nitrogen (%)	1.5	1.6	1.2	0.1	31
Oxygen (%)	12.6	22.8	5.7	2.8	31
Chlorine (%)	0.01	0.07	0.00	0.03	6

The analyses for the seven beds, as summarized in tables C-2 through C-8, indicate that the coalbeds of the Book Cliffs coalfield are quite uniform in quality. The mean proximate analytical values show all the coalbeds are low in sulfur content (0.4-1.0 percent), low in ash content (5-8 percent), low in moisture content (4.1-5.33 percent), and high in heating value (12,512-12,910 Btu/lb) on an as-received basis.

Coal Resources

The Book Cliffs coalfield is one of Utah's six major coalfields with original minable resources in excess of two billion tons (Tabet, 2001). For this report, the remaining, in-place, resource base is limited to coal beds generally greater than seven feet thick, and with at least 200, but less than 2,500 feet of overburden. The coal resource estimates reported here were recalculated for this study to conform with mining and recovery parameters that the U.S. Bureau of Land Management (BLM) felt would allow the coal to be economic to mine in the next 30 years. The remaining, in-place coal resources of the Book Cliffs coalfield, separated out by mining period, are listed in table C-9. Other coal resources occur in the Book Cliffs coalfield, but they are thinner, or deeper, and would require a significant increase in the price of coal before they become economic to mine.

Table C-9. Remaining, in-place, coal resources by mining period for the Book Cliffs coalfield given in millions of short tons (for coal beds mostly > 7 feet thick and with >200, but < 2,500 feet of overburden).

Mining Period	Demonstrated	Inferred	Total
2003-2017	168.8	3.1	171.9
2018-2032	232.7	4.0	236.7
TOTAL	401.5	7.1	408.6

The coal resources defined for the period from 2003 though 2017 are found in just three of the coal beds of the Book Cliffs coalfield, the Castlegate A, the Gilson, and the Lower Sunnyside beds. Slightly over half of those resources are found in the Lower Sunnyside bed (see appendix A). In-place coal resources for the period beyond 2017 also include coal from the Wattis, Castlegate B, Castlegate C, Castlegate D, Kenilworth, Rock Canyon, and Upper Sunnyside coal beds. More than 98 percent of these remaining, in place, resources are in the demonstrated reliability category. Only 1.6 million tons (0.3 percent) of the 408.6 million tons of in-place coal identified in the Book Cliffs coalfield are less than seven feet thick. A more detailed summary of the remaining recoverable resources is provided in appendix A.

Wasatch Plateau Coalfield

Setting

The Wasatch Plateau coalfield extends southwest about 90 miles from western Carbon County, through western Emery County, and into eastern Sanpete and Sevier Counties (Doelling and Smith, 1982). Doelling and Smith (1982) expanded the field to include the formerly separate Mt. Pleasant and Salina Canyon coalfields as parts of a "larger" Wasatch Plateau coalfield. The field, as they defined it, is 13 to 22 miles wide. The eastern edge of the field is bounded by the outcrop of the coal-bearing Blackhawk Formation, and the western edge is bounded by a series of faults near the western margin of the Wasatch Plateau in Sanpete and Sevier Counties. Carbon and Emery counties contain the northern and central Wasatch Plateau coalfield areas (map 39).

Only the northern part of the field is directly served by rail transportation. One spur leaves the main line of the Union Pacific Railroad at the town of Colton and heads 15 miles southwest to serve the mines near Scofield, Utah. Three other spurs branch off at the town of Helper, two running five miles west, and one running 20 miles south. The longest one, which runs south to the town of Hiawatha, formerly served the Plateau mine of RAG Coal Company.

Rail shipment of coal production from the southern end of the field first requires a truck haul 55 miles westward to a loadout on a branch of the Union Pacific Railroad west of the town of Levan.

Coal Geology

Most of the coal in the Wasatch Plateau field is found in the lower third of the Blackhawk Formation. Eight individual beds have been identified which contain coal more than seven feet thick. A greater number of thick beds occur in the northern portion of the field than in the southern portion. Major coal bed groups of the Wasatch Plateau include, in ascending order, the Hiawatha zone (consisting of the Knight, Acord Lakes, Axel Anderson, and Cottonwood beds), the Blind Canyon zone, the Wattis zone, the Gordon zone, the Castlegate A zone, and the Castlegate D zone. The thickness range of minable coal for the major zones of the northern, central, and southern parts of the Wasatch Plateau field follows:

Northern Wasatch Plateau beds	Thickness Range (ft)
Castlegate D (Tank)	6 to 8
Gordon (Bob Wright-McKinnon)	6 to 18
Wattis (Upper O'Connor of Scofield area)	6 to 16
Blind Canyon (Lower O'Connor B of Scofield area)	6 to 25
Cottonwood (Lower O'Connor A of Scofield area)	6 to 29
Axel Anderson (Flat Canyon of Scofield area)	6 to 15

Central Wasatch Plateau beds	Thickness Range (ft)
Wattis	6 to 16
Blind Canyon (Bear Canyon -Third)	7 to 25
Cottonwood (Hiawatha)	6 to 29
Axel Anderson (Hiawatha)	6 to 15
Acord Lakes (Hiawatha)	6 to 15

Southern Wasatch Plateau beds	Thickness Range (ft)
Axel Anderson	6 to 15
Acord Lakes (Upper Hiawatha)	6 to 20
Knight (Hiawatha)	6 to 17

The coal beds generally have shallow dips to the west, but are cut by several major north-south trending fault zones, or grabens, with displacements ranging from a few feet to a several hundred feet. These normal faults offset the coal beds and interfere with mining; however, there is usually sufficient room between the faults to conduct mining (Doelling, 1972).

Coal Quality

Coal beds of the Wasatch Plateau field generally have good quality, with low ash and

sulfur contents, and high heat contents. Most of the coals are high-volatile C bituminous in rank, although locally some coals in the northern part of the field are high-volatile B bituminous.

The Wasatch Plateau coal beds are often resin-rich and may contain between 2 and 15 percent resin by volume. Although not presently used, the resin has been historically recovered as a byproduct for use in adhesives, in paints and coatings, and as a binder in printing ink (Tabet and others, 1995a). Coal quality statistics are summarized in Tables C-11 through C-14 for four Wasatch Plateau field coal beds which have a sample population of more than 30 proximate analyses, and usually more than 20 ultimate analyses (UGS coal quality database, in preparation). The names reported for the Wasatch Plateau coal beds in the coal quality database does not reflect the new names assigned to the beds based on newer understanding of the stratigraphic relations of the beds. Time constraints did not allow the analytical data to be updated with new bed names, thus the analyses are reported here use the older bed names originally assigned. Those four Wasatch Plateau coal beds (using older names) are the Blind Canyon, the Castlegate A, the Hiawatha, and the Upper Hiawatha.

Table C-11. Coal quality statistics for the Blind Canyon bed from the Upper Cretaceous Blackhawk Formation in the Wasatch Plateau coalfield (as-received basis).

	Mean	Maximum	Minimum	Standard Deviation	Sample Population
Ash (%)	7.1	18.3	2.3	2.3	144
Btu/lb	12,844	13,966	10,800	463	142
Fix. Carbon (%)	44.96	50.08	37.50	2.12	136
Vol. Matter (%)	42.8	48.4	37.5	1.7	139
Sulfur (%)	0.52	1.10	0.29	0.14	130
Moisture (%)	5.13	8.37	1.20	1.11	145
Carbon (%)	72.74	80.50	67.69	3.15	21
Hydrogen (%)	5.72	6.66	4.69	0.48	21
Nitrogen (%)	1.3	1.6	0.6	0.2	20
Oxygen (%)	11.81	16.50	8.82	1.94	21
Chlorine (%)	0.01	0.03	0.00	0.01	8

Table C-12. Coal quality statistics for the Castlegate A bed from the Upper Cretaceous Blackhawk Formation in the Wasatch Plateau coalfield (as-received basis).

	Mean	Maximum	Minimum	Standard Deviation	Sample Population
Ash (%)	6.0	13.5	2.8	2.0	103
Btu/lb	12,206	14,170	10,475	593	93
Fix. Carbon (%)	45.2	53.5	28.3	2.7	95
Vol. Matter (%)	41.6	54.3	36.6	2.5	95
Sulfur (%)	0.59	1.60	0.31	0.18	81
Moisture (%)	7.3	14.1	3.6	1.8	105
Carbon (%)	72.1	79.0	67.5	3.1	17
Hydrogen (%)	5.75	6.31	5.30	0.26	17
Nitrogen (%)	1.4	1.6	1.1	0.1	17
Oxygen (%)	14.8	20.3	11.4	2.8	17
Chlorine (%)	0.0	0.0	0.0	0.0	4

Table C-13. Coal quality statistics for the Hiawatha bed from the Upper Cretaceous Blackhawk Formation in the Wasatch Plateau coalfield (as-received basis).

	Mean	Maximum	Minimum	Standard Deviation	Sample Population
Ash (%)	6.67	25.72	0.05	1.98	521
Btu/lb	12,689	14,530	9,073	487	521
Fix. Carbon (%)	45.64	54.40	31.26	1.89	502
Vol. Matter (%)	42.0	47.4	4.4	2.3	509
Sulfur (%)	0.63	4.06	0.29	0.25	479
Moisture (%)	5.55	14.24	0.70	1.58	537
Carbon (%)	71.60	81.88	51.38	6.05	58
Hydrogen (%)	5.51	6.30	3.89	0.51	58
Nitrogen (%)	1.3	1.7	0.3	0.2	58
Oxygen (%)	12.18	17.18	9.25	2.18	58
Chlorine (%)	0.05	0.13	0.00	0.04	22

Table C-14. Coal quality statistics for the Upper Hiawatha bed from the Upper Cretaceous Blackhawk Formation in the Wasatch Plateau coalfield (as-received basis).

	Mean	Maximum	Minimum	Standard Deviation	Sample Population
Ash (%)	8.99	25.09	2.79	5.07	34
Btu/lb	11,503	12,396	9,443	750	29
Fix. Carbon (%)	45.28	51.95	34.66	4.03	30
Vol. Matter (%)	37.73	44.52	33.10	2.45	32
Sulfur (%)	0.54	1.46	0.28	0.24	34
Moisture (%)	8.04	12.9	2.66	1.87	31
Carbon (%)	64.90	69.75	53.09	4.80	22
Hydrogen (%)	4.59	5.20	3.99	0.32	22
Nitrogen (%)	1.13	1.44	0.96	0.12	22
Oxygen (%)	11.07	18.0	9.22	1.67	22
Chlorine (%)	0.01	0.11	0.00	0.02	21

The Wasatch Plateau coal beds have similar mean proximate and ultimate analytical values, but the Upper Hiawatha (Acord Lakes) bed, which mainly occurs in the southern part of the field, shows the greatest quality differences. This bed is slightly higher in ash and moisture, and slightly lower in heat content, fixed carbon content, and volatile matter content than the other three beds reported here. In general, the coals of the Wasatch Plateau decrease slightly in rank and heat content from north to south.

Coal Resources

The Wasatch Plateau coalfield is also a major Utah coalfield with original, in-place coal resources in excess of 10.2 billion tons (Doelling,1972). Using the same criteria and procedures described above for the Book Cliffs coalfield, an estimated resource base of 1,054.8 million tons of in-place coal is available for mining in Carbon and Emery Counties within the Wasatch Plateau coalfield (see Table C-15). About 331.7 million tons have been defined as likely to be mined in the period from 2003 through 2017, with another 723.1 million tons of coal available for

mining from 2018 through 2032. Over 94 percent of the coal resource base identified for mining in the first 15 years is found in the Axel Anderson, Cottonwood, and Blind Canyon coal beds, with lesser amounts in the Acord Lakes, and Castlegate D beds. Over 94 percent of the coal identified as available for mining in the next 30 years lies within 0.75 miles of a thickness measurement point, or in the demonstrated resource reliability category (Wood and others, 1983). Only 20.4 million tons (1.9 percent) of the 1,054.8 million tons of the in-place coal resources identified in the Carbon and Emery Counties part of the Wasatch Plateau falls in the six- to seven-foot-thick category.

Table C-15. Remaining, in-place resources by mining period for the Wasatch Plateau coalfield within Carbon and Emery Counties given in millions of short tons (for coal beds mostly > 7 feet thick, and with > 200 feet, but < 2,500 feet of overburden).

Mining Period	Demonstrated	Inferred	Total
2003 - 2017	308.1	23.6	331.7
2018 - 2032	688.0	35.1	723.1
TOTAL	996.1	58.7	1,054.8

Emery Coalfield

Setting

The Emery coalfield (map 39) was originally defined from the surface exposures of the Ferron Sandstone Member of the Mancos Shale (Lupton, 1916). The surface exposures cover an area 25 miles long and 2 to 10 miles wide near the Sevier-Emery County border. This area lies about 45 miles southwest of Price, Utah, and the site of the nearest rail loadout. The original field is bounded on the east by an erosional escarpment and on the west by a fault zone (Doelling, 1972). Surface exposures show the coal thinning and disappearing to the north; however, published drilling data show that similar thick coal beds also occur in the Upper Cretaceous Ferron Sandstone in the subsurface extending northward all the way to Price (Bunnell and Holberg, 1991, and Tabet and others, 1995b). Based on published coal thickness data, the northern boundary of the field could be defined near Price, Utah, and could potentially extend further north into the Uinta Basin. Future exploration along this subsurface Ferron Sandstone trend will expand the known extent of coal resources of the Emery coalfield. For the purpose of this report, the Emery coalfield is confined to the area originally defined by Lupton (1916).

Coal Geology

The coal of the Emery field occurs in the 300- to 900-foot-thick Ferron Sandstone Member of the Mancos Shale (figure C1). Where exposed in the south, this unit contains 13 coalbeds, four of which exceed seven feet in thickness. Lupton (1916) gave the beds letter designations from A to M in ascending order of occurrence. Beds I and J are the most important, and the separation between them is minimal in many areas, resulting in a single bed up to 25 feet thick (Doelling, 1972). The dip of the coal beds varies from 2 to 12 degrees to the west, with most between 4 and 7 degrees. Faulting is minor and presents little difficulty to mining. In the southern end of the field 76 percent of the resources are under less than 1,000 feet of cover, and very thin overburden in some areas makes surface mining possible. The reported thickness ranges of the major coal beds in the Emery coalfield are given below:

	Emery Field Beds	Thickness Range (ft)
upper group	J bed	6 to 13
	I bed	6 to 30
lower group	C bed	6 to 20
	A bed	6 to 16

Coal Quality

The quality of coal from the Emery field, particularly the sulfur and ash contents, is quite variable throughout the field. Generally the sulfur and ash contents of the beds from this field are somewhat higher than for coals from the Book Cliffs and Wasatch Plateau coalfields. The rank of coal is high-volatile C bituminous where fresh and unweathered; shallow coal beds are often oxidized or burned for a considerable distance away from the outcrop. Coal quality statistics for several beds from this coalfield are shown in Tables C-16 to C-19.

Table C-16. Coal quality statistics for the A bed from the Upper Cretaceous Ferron Sandstone Member of the Mancos Shale in the Emery coalfield (as-received basis).

	Mean	Maximum	Minimum	Standard Deviation	Sample Population
Ash (%)	13.22	29.33	4.70	8.76	10
Btu/lb	11,979	13,529	9,504	1,393	10
Fix. Carbon (%)	46.32	51.01	37.88	4.38	10
Vol. Matter (%)	37.04	41.97	28.65	4.63	10
Sulfur (%)	0.78	1.46	0.37	0.33	10
Moisture (%)	3.43	5.10	2.60	0.87	10
Carbon (%)	66.63	74.84	53.44	7.70	9
Hydrogen (%)	4.85	5.50	3.88	0.66	9
Nitrogen (%)	1.25	1.47	0.88	0.17	9
Oxygen (%)	10.48	15.50	8.52	2.46	9
Chlorine (%)	0.03	0.06	0.00	0.02	8

Table C-17. Coal quality statistics for the C bed from the Upper Cretaceous Ferron Sandstone Member of the Mancos Shale in the Emery coalfield (as-received basis).

	Mean	Maximum	Minimum	Standard Deviation	Sample Population
Ash (%)	14.54	23.60	6.60	6.81	6
Btu/lb	11,275	12,300	9,965	913	6
Fix. Carbon (%)	43.42	47.90	39.60	3.39	6
Vol. Matter (%)	37.79	40.70	33.40	2.79	6
Sulfur (%)	1.26	2.10	0.66	0.63	6
Moisture (%)	4.25	5.21	2.30	1.14	6
Carbon (%)	64.98	68.60	58.90	4.48	4
Hydrogen (%)	5.30	5.70	4.80	0.42	4
Nitrogen (%)	1.18	1.30	1.00	0.15	4
Oxygen (%)	14.65	16.40	12.70	1.74	4
Chlorine (%)	---	---	---	---	--

Table C-18. Coal quality statistics for the G bed from the Upper Cretaceous Ferron Sandstone Member of the Mancos Shale in the Emery coalfield (as-received basis).

	Mean	Maximum	Minimum	Standard Deviation	Sample Population
Ash (%)	14.15	39.09	3.74	9.40	12
Btu/lb	11,630	13,319	8,020	1,520	12
Fix. Carbon (%)	43.48	50.49	29.69	5.71	12
Vol. Matter (%)	38.06	43.81	25.72	4.62	12
Sulfur (%)	1.03	2.22	0.09	0.83	7
Moisture (%)	4.30	8.80	3.14	1.60	12
Carbon (%)	61.96	72.81	44.81	9.43	7
Hydrogen (%)	4.67	5.10	3.35	0.64	7
Nitrogen (%)	1.24	1.52	1.06	0.18	7
Oxygen (%)	10.06	18.90	5.35	4.28	7
Chlorine (%)	0.03	0.06	0.00	0.03	7

Table C-19. Coal quality statistics for the I bed from the Upper Cretaceous Ferron Sandstone Member of the Mancos Shale in the Emery coalfield (as-received basis).

	Mean	Maximum	Minimum	Standard Deviation	Sample Population
Ash (%)	8.20	17.26	4.01	2.95	47
Btu/lb	12,179	13,139	8,467	889	43
Fix. Carbon (%)	47.4	51.9	37.3	2.9	46
Vol. Matter (%)	38.91	43.89	34.30	1.72	46
Sulfur (%)	1.12	6.58	0.31	1.11	46
Moisture (%)	5.5	16.7	2.8	2.4	47
Carbon (%)	68.58	73.8	61.25	3.87	13
Hydrogen (%)	5.2	5.7	4.8	0.3	13
Nitrogen (%)	1.26	1.35	1.10	0.07	13
Oxygen (%)	13.06	18.80	5.82	3.42	13
Chlorine (%)	0.05	0.07	0.03	0.02	2

Coal Resources

The Emery coalfield is also a major Utah coalfield; original, in-place coal resources are estimated by Doelling (1972) at 675.8 million tons, for the currently defined southern portion of the field. Inclusion of coal beds as thin as four feet thick in the resource estimate dramatically increases the in-place coal resources to over 3.5 billion tons.

Emery County contains 40 percent of the in-place coal resources of the Emery coalfield, or 273.1 million tons (see table C-21). No coal resource estimates have been published for the northern, more deeply buried portion of the field, but Bunnell and Holberg (1991) indicate the resources in this area are substantial, and some are at minable depths. The Utah Geological Survey is compiling information on the thickness and depth of the coals in the Ferron Sandstone of the northern Emery coalfield from coal bed gas drill holes for use in future studies of the coal resources of this area.

Table C-21. Original, in-place coal resources by county for the southern part of the Emery coalfield given in millions of short tons (from Doelling, 1972: for coal beds averaging $\geq$ 7 feet thick and with < 2,500 feet of cover).

County	Demonstrated	Inferred	Total
Emery	200.8	72.3	273.1
Sevier	185.8	216.9	402.7
Total	386.6	289.2	675.8

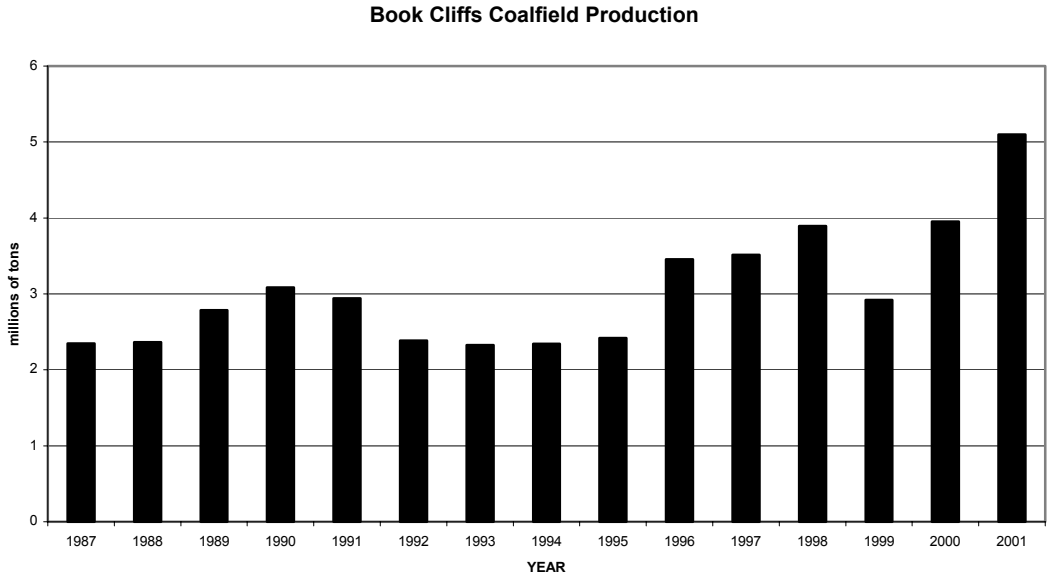
PAST PRODUCTION AND TRENDS

Introduction

Historically, most Utah coal production has come from underground mines in central Utah, and future production will probably continue to come predominantly from this region. The three important coalfields of central Utah, and Carbon and Emery counties, are the Book Cliffs, Wasatch Plateau, and the Emery fields.

Book Cliffs Coalfield

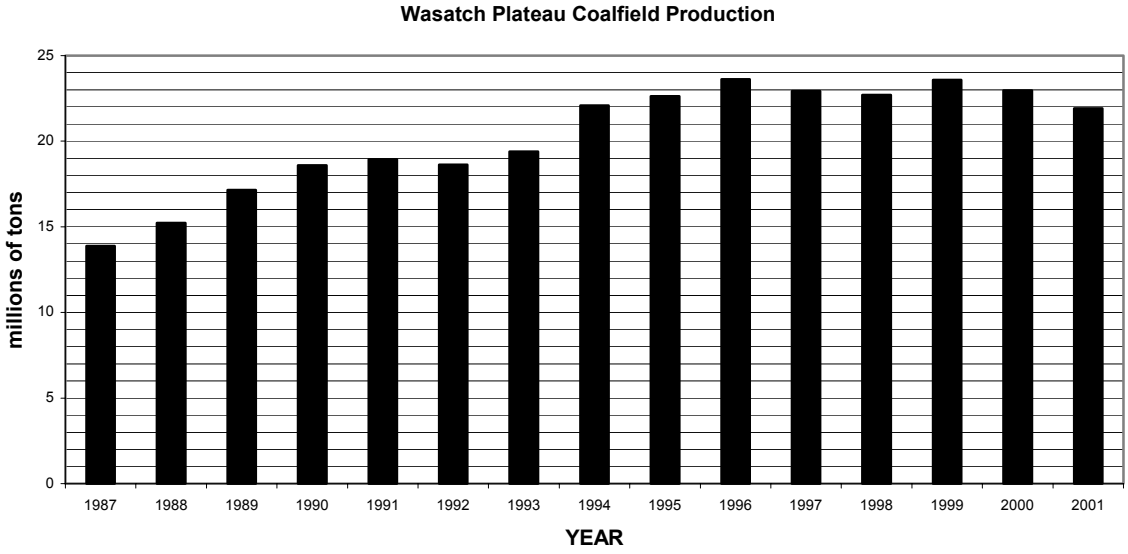
The Book Cliffs coalfield is the second most important field in the state and has produced a total of 293.3 million tons from 1889 through 2001 (Utah Energy Office, in preparation). Since 1996, annual coal production from this field has increased from the two to three million ton per year range it had maintained for about 10 years to the three to five million ton range. Production from this field in 2001 came from four mines, and totaled 5.11 million tons (see graph), or about 19 percent of the state's production.



Wasatch Plateau Coalfield

The Wasatch Plateau coalfield covers parts of Carbon, Emery, Sanpete, and Sevier counties. Overall, this field has both the greatest annual and cumulative coal production of any coalfield in the state of Utah (Utah Energy Office, in preparation). Coal in this field was first developed in the Carbon County portion during the late nineteenth century. Over the years, production has expanded from the northern, Carbon County portion of the field to the central and southern parts of the field in Emery and Sevier Counties. The Sanpete County portion of the field is generally deep and has not been mined. Cumulative production from over 80 mines through 2001 has totaled 523.7 million tons.

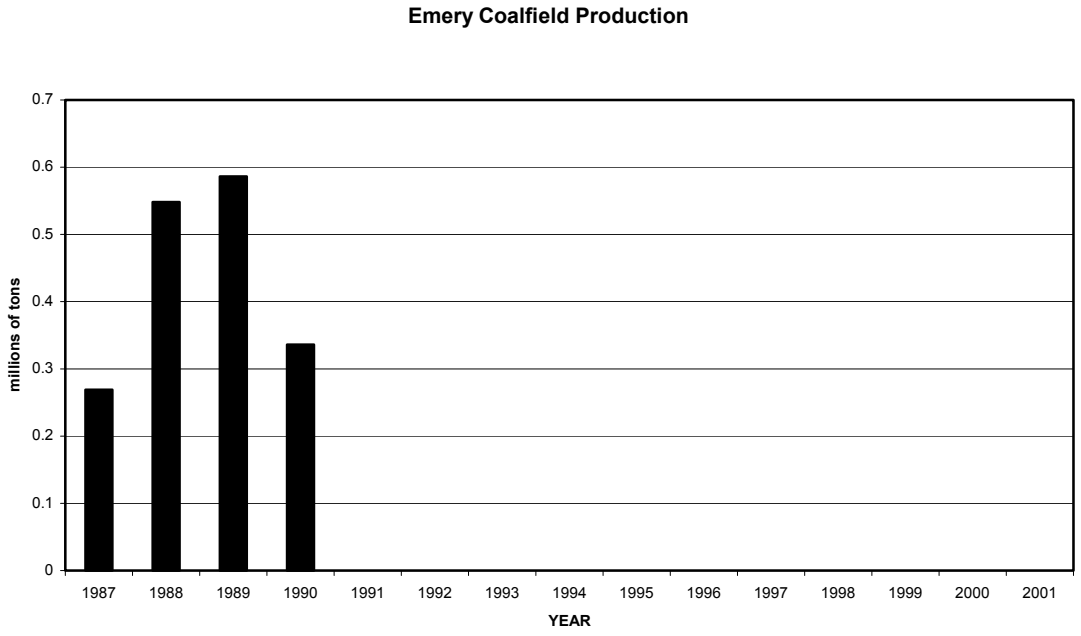
There were eight active mines in this field in 2001, which produced 21.92 million tons of coal (see graph), or about 81 percent of the state's total. Production from this field has increased rapidly since the mid-1980's, doubling since 1986.



Emery Coalfield

The Emery coalfield's last active mine ceased production in 1990 when Consolidation Coal Company idled its Emery mine. Through 1994, this mine's activity was limited to shipping a very small quantity of coal from its stockpile, and in 1995, Consolidation Coal decided seal the portals of the mine and limit maintenance to pumping water to keep the mine from flooding. The company announced plans in early 2002 to re-open its Emery mine later in that year.

Production from the Emery coalfield was erratic during its last few years of mining until the final year of production in 1990 (see graph). Low coal prices, and the lack of nearby rail transportation have undoubtedly hindered large-scale development of the abundant coal resources from this field. Total production from the field through 2001 is estimated at 9.5 million tons (Utah Energy Office, in preparation).



CURRENT PRODUCTION AND EXPLORATION ACTIVITIES

According to the Utah Energy Office (in preparation), the state's 2001 coal sales reached 26.58 million tons from production of 27.03 million tons. Increased demand for Utah coal finally translated to higher prices in 2001, and the average price paid per ton of coal edged slightly higher. Most of the present coal tonnage comes from large, highly-productive mines equipped with longwall mining machines; four of Utah's mines rank among the top 20 of the nation's largest underground coal mines.

Coal Industry Structure

The Utah coal industry is highly competitive and production has become concentrated among fewer, but larger mines. For example, Utah had 29 mines operated by 16 companies In 1982, but by 2001 there were only 11 coal mines operated by 5 parent companies in just the Book Cliffs and Wasatch Plateau coalfields. In addition, one company, Covol Industries, reprocesses waste coal and sells it as a fuel. The current 5 parent companies operating Utah coal mines are Andalex Resources Incorporated, Canyon Fuel Company LLC (Arch Coal), CO-OP Mining Company, Interwest Mining Company, and Lodestar Mining, Incorporated. Cyprus Plateau Mining Company operated mines in Utah as recently as 2000, but all their mines are closed and in reclamation as of 2002.

Andalex Resources Incorporated

Andalex Resources has operated coal mines in Utah since 1980, when it opened the Tower Division to operate the Aberdeen, Apex, Centennial, and Pinnacle mines in the Book Cliffs field northeast of Price, Utah. Mining at this division is currently limited to a continuous miner operation at the Tower Division. In late 1994 Nevada Power sold Andalex Resources its 50 percent interest in the Crandall Canyon mine located in the Wasatch Plateau coalfield. Since buying a 50-percent stake and assuming the role of operator at that mine, Andalex has expanded the production capacity of the mine by leasing an additional 18 million tons of recoverable federal coal reserves and installing a longwall mining machine. In 1996, Andalex Resource also expanded the coal handling capacity of its Wildcat loadout facility to 3.5 million tons per year to handle the company’s growing production. Longwall reserves at the Crandall Canyon mine will be exhausted by 2003, and the mine will revert back to a smaller continuous miner operation. Production from Andalex’s Tower Division mine and Crandall Canyon mine for 2001 was 0.8 million tons and 4.0 million tons respectively.

In addition to these existing mines, Andalex Resources opened a new mine on the B Canyon property it purchased in early 1997 from British Petroleum. The new mine, named West Ridge, is located in the Book Cliffs coalfield north of the town of Sunnyside. Construction on this new 3-million-ton-per-year mine was completed in 2000, and the longwall machine was installed in 2001, raising production for that year to 2.3 million tons. The coal is trucked to the Andalex's existing Wildcat loadout near Helper, Utah. Andalex's three mines accounted for 17.8 percent of Utah's 2001 coal production.

Canyon Fuel Company LLC

In March 1998, ARCO Coal Company sold its 65 percent interest in the Canyon Fuel Company LLC (the remaining 35 percent is owned by Itochu Corporation), to Arch Coal Company. Canyon Fuel owns three Utah coal operating companies and a nine percent interest in the Los Angeles Export Terminal Company. The three operating companies owned by Canyon Fuel are: the Soldier Creek Coal Company, the Southern Utah Fuel Company, and the Utah Fuel Company.

The Soldier Creek Coal Company operated the Soldier Canyon mine in the Book Cliffs coalfield, until 1998. Additional recoverable coal exists to the north and east of the Soldier Canyon workings, but production of these deeper resources has been deferred until the coal resources of the Dugout Canyon mine have been depleted. Meanwhile, the Soldier Creek Coal Company has shifted production to the 2.5-million-ton-per-year underground mine Dugout Canyon mine, located on state coal leases to the east of the Soldier Canyon mine. Initial coal production from the newer mine began in 1998 and totaled 0.17 million tons, and production for 2001 grew to 2.0 million tons. Initial mining has come from the Rock Canyon coal bed, but future mining will come from the Gilson bed.

The Southern Utah Fuel Company operates the SUFCO mine in the Sevier county portion of the Wasatch Plateau coalfield. This longwall mine produced 7.0 millions tons of coal from the Upper Hiawatha bed in 2001. In May 1999, to ensure an extended productive life for the SUFCO mine, Canyon Fuel leased The Pines federal coal tract. This tract, which lies immediately east of the SUFCO mine, adds approximately 70 million tons of additional recoverable coal to the mine.

The Utah Fuel Company operates one longwall mine in the northern part of the Wasatch Plateau coalfield, the Skyline No. 3 mine near Scofield, Utah. This mine had production of 4.1 million tons of coal in 2001 from the Lower O'Connor bed. The recoverable coal reserves of the Utah Fuel Company were augmented by the acquisition in May 1996 of the Winter Quarters federal lease tract containing about 28 million tons. In 1998, the company applied for 2,612

acres of additional federal coal to the west of its holdings in a tract known as the Flat Canyon tract; the tract, containing an estimated 36 million tons of recoverable coal, may be offered for sale in 2003.

The 2001 production from all of the Utah coalmines controlled by Canyon Fuel Company totaled 12.86 million tons. This amounted to 47.6 percent of the Utah's total 2001 coal production. These mine properties contained an estimated 300 million tons of recoverable coal according to a 1998 news release announcing the Canyon Fuel Company purchase by Arch Coal Company.

CO-OP Mining Company

The CO-OP Mining Company, a family-owned company, operates the Bear Canyon #1 and #2 mines. These room-and-pillar mines lie in the Emery County portion of the Wasatch Plateau coalfield. In 2001, production from these mines was 1.25 million tons, or 4.6 percent of the state's total production. As with other Utah coal operators, CO-OP Mining recently added to its coal reserves by purchasing the Mohrland property from the Intermountain Power Agency in early 1997. This nearly 3,000-acre tract lies due east of the Bear Canyon #1 mine, but is separated from it by a major fault. The Mohrland property also includes an existing loadout on the Utah Railway.

Cyprus Plateau Mining Company

Cyprus Plateau Mining Company was sold to RAG International Mining Company of Essen, Germany in mid-1999. Plateau Mining was the operator of the Star Point mine complex in the Wasatch Plateau coalfield for a number of years. Production at the Star Point #2 mine in 2000 and totaled 0.09 million tons. This was the final year of production at this mine because the available reserves were depleted. Final reclamation of this mine is nearing completion. The company had hoped to shift production to a new mine in the Book Cliffs coalfield to the north of Helper, Utah. In April 1996, Cyprus Plateau Mining Company received a permit for a 5-million-ton-per-year mine from the Utah Division of Oil, Gas and Mining, and the first coal was produced in September 1996. Coal production for the Willow Creek mine in 2000 totaled 1.35 million tons, but the mine was sealed in November 2000 after the second fire in two years broke out in the gob behind the longwall. The future of longwall mining at the Willow Creek mine is uncertain now that the mine has been closed, and may be moving into reclamation. Because of the unfavorable mining conditions, the remaining minable resources are not expected to become economic to mine until the period from 2018 through 2032.

Interwest Mining Company

Interwest Mining Company, a subsidiary of PacifiCorp, operated two longwall mines in the Emery County portion of the Wasatch Plateau coalfield. Interwest Mining purchased the Trail Mountain mine from ARCO Coal Company in 1992 and idled the mine until the second half of 1995, when longwall reserves at the Cottonwood mine were depleted. Also in 1992, Interwest Mining submitted an application to lease the Cottonwood Canyon federal tract containing an additional 75 million tons of recoverable coal in the Hiawatha bed that lie to the north and west of the Trail Mountain mine; no sale date has been set. The Trail Mountain mine resumed full operation in 1996 using a longwall machine and produced 3.41 million tons of coal in 1998. In 2001, the Trail Mountain produced 0.9 million tons, but was closed again when difficult mining conditions were encountered and the company decided to purchase coal on the open market rather than continue to operate this mine. The company's interest in leasing the Cottonwood tract has diminished with the closure of the Trail Mountain mine, and the aquisition of additional reserves for its nearby Deer Creek mine.

Interwest Mining's second operation, the Deer Creek mine, produces coal from the Blind Canyon bed, with future plans to also mine coal from the stratigraphically lower Hiawatha (Axel Anderson) bed. Longwall production from this mine in 2001 totaled 4.3 million tons, but the level of production will likely increase with the closure of the Trail Mountain mine. The life of the Deer Creek mine was extended with the acquisition of the Mill Fork federal lease tract in 1999, which adds another 46 million tons of recoverable coal to the company holdings. Total 2001 production for the Interwest Mining Company operation was 5.26 million tons, or 19.5 percent of the state's total.

Lodestar Energy, Incorporated

Lodestar Energy, owned by Renco, Inc., operates on the properties of Valley Camp of Utah, Incorporated that were originally owned by the Quaker State Oil Company. Lodestar has mined out the underground resources at the White Oak #2 mine (Lower O'Connor bed), and has begun reclamation of the surface facilities at that mine. As part of the reclamation effort, they received permission to recover several hundred thousand tons of shallow coal near the portals and loadout via surface mining. This surface mine is called the Whiskey Creek mine. Lodestar's last coal production from the White Oak mine was in 2001, and totaled 0.52 million tons. Lodestar has applied to lease 5.5 million tons of in-place coal on the Slaughter House Canyon federal tract to the east of its White Oak mine, and proposes to surface mine the shallow coal of that tract.

Lodestar also operates the Horizon Coal Company, which owns property in the northern Wasatch Plateau coalfield. Horizon Coal Company has a mine permit to develop coal reserves behind the abandoned Blue Blaze/Consumers Mine in the Gordon Creek area. Production at the Horizon mine began in early 1998 and totaled 0.11 million tons, but was shut down the following year due to permitting problems. The permitted mine capacity is 1.5 million tons per year. To allow for continued life of the Horizon mine, an additional 1,288 acres of federal coal was leased in 1998 in the Beaver Creek tract. This tract, which lies to the north of existing Horizon holdings, contains about 6 million tons of coal in the Hiawatha bed. With the depletion of the White Oak mine underground reserves in 2001, the company attempted to restart the Horizon mine in late 2001, but difficult mining conditions caused the mine to be idled by mid 2002. The closure and inactivity at the Lodestar mines has created market opportunities for other central Utah coalmines.

Coal Markets

Utah coal is shipped to utility and industrial markets mainly in the western U.S., including the states of Utah, California, Nevada, Washington, Arizona, Idaho, and Colorado. Starting in 1994, the *Federal Clean Air Act of 1990* required the implementation a new phase of emission standards, which resulted in increased shipments of Utah's low-sulfur coal to markets in the eastern United States. Those eastern U.S. states receiving Utah coal in 2001 included Illinois, Pennsylvania, Tennessee, and Virginia (Utah Energy Office, in preparation). Utah's high quality, bituminous coal also has a significant export market to several Pacific Rim countries. Increased demand for Utah’s high-quality coal has caused production to increase about 22 percent from 1993 through 2001. This rapid growth in production has caused coal companies to look for ways to expand production at existing operations and to look for new opportunities to open mines in previously mined and virgin areas of central Utah.

The market segments served by Utah coal operators in 2001, listed in decreasing order, included the electric utility, industrial, Pacific Rim export, and residential/commercial segments. Statistical data from the Utah Energy Office (in preparation) on coal sales and mines from 1998 to 2001 and estimates for 2002 are summarized in Table C-22. It appears that coal prices may have bottomed in 2000, after years of steady decline since the 1980s. As the easily mined coal is depleted in the next 15 years, an increase in sales price will be needed to allow mining companies to go after coal that is deeper or has other factor that make it more difficult to mine than present reserve blocks.

Table C-22. Utah coal sales statistics, 1998-2001 (sales figures are in millions of tons)

	1998	1999	2000	2001	2002*
Total Sales	26.974	26.180	27.629	26.930	27.000
Elec. Util.	20.516	20.072	20.915	20.088	20.500
Industrial	3.429	3.359	3.526	3.822	3.500
P.R. Export	2.735	2.567	2.960	2.394	3.000
Res./Com.	0.294	0.182	0.223	0.627	0.500
Coke Plant	0.000	0.000	0.005	0.000	0.000
No. of Mines	15	14	14	12	13
No. of Operators	10	10	10	10	11
Ave. Price/ton (FOB mine)	$17.83	$17.36	$16.93	$17.50	$17.75

*estimated values

GEOLOGIC POTENTIAL

Book Cliffs Field

Although production from this field was relatively steady in the 1990s, it appears that production during the next decade will grow with the renewed interest in developing the abundant coal resources of this field. Three mines are operating in this field and a fourth mine is planned by a separate company. Plateau Mining had begun producing coal in 1996 at the Willow Creek mine just north of Price with plans to eventually produce up to 5 million-tons-per-year. Two fires in the span of two years led RAG Coal to permanently close this mine in 2002, after no buyer could be found. The misfortune at the Willow Creek mine has improved market opportunities for the other Book Cliffs coalmines. In 1999, Canyon Fuels brought the 2 million-ton-per-year Dugout Canyon underground mine into production; it lies immediately east of its idled Soldier Canyon mine. Secondly, Andalex Resources opened the 3 million-ton-per-year West Ridge mine in 2001 on the B Canyon property northwest of Sunnyside it purchased from British Petroleum. Finally, Utah American Energy is attempting to bring the Lila Canyon mine into production on leases southwest of the old Horse Canyon mine. At full production, these new mines could push annual coal production from the Book Cliffs field to a record 7 million tons. Production of coal from tracts at, or adjacent to, the Tower Division, Dugout Canyon, West Ridge, and Lila Canyon mines are the resource expected to be extracted in the next 15 years (Map 41).

Remaining in-place coal resources for the Book Cliffs field is estimated at 409.1 million tons. The minable resources are derived by first limiting the maximum thickness to 14 feet, the maximum cutting height of current longwall equipment. This leaves in-place minable resources of 393.4 million tons. Using recovery factors of 60 and 70 percent for the various tracts

identified, results in an estimated remaining recoverable coal reserve in the Book Cliffs coalfield of 275.2 million tons. This is enough coal to provide about 55 years of production at 2001 production rates (5 million tons per year), but only 39 years if production increases to the 7 million tons per year rate. The recoverable reserve defined here appear to be more than what is strictly need for mining in the next 30 years; however, the reserves in the Book Cliffs are more difficult to mine because they are gassy, generally deeper, and have more quality problems, and thus all of these reserve may not be economic to mine. The reserves listed for the period 2003 through 2017 are part of, or adjacent to, existing permitted mines. The reserves listed for the second 15-year period are accessible, but are beyond the reserves closest to the current or planned mines.

Table C-23. Recoverable Coal Reserve budget by mining period for the Book Cliffs coalfield in millions of short tons (coal beds ≥ 7 feet thick and with > 200 feet of cover, but < 2,500 feet of cover).

Reliability Category	Economic Resource Base		Minable Resource Base		Recoverable Reserve Base	
	2003-17	2018-32	2003-17	2018-32	2003-17	2018-32
Demonstrated	168.8	232.7	166.3	219.5	116.3	153.6
Inferred	3.1	4.5	3.1	4.5	2.2	3.1
TOTAL	171.9	237.2	169.4	224.0	118.5	156.7

Leasing of federal coal in the Book Cliffs coalfield has already tied up a majority (83.9 percent) of the 118.5 million tons of coal reserves identified as recoverable in the next 15 years (see appendix A and Map 6). Adding state and private leases held in this field would result in the total leased coal being over 90 percent of the recoverable reserves. Existing federal leases have also tied up about 45 percent of the 156.7 million tons of reserves identified for mining in the period from 2108 through 2032 years, and adding state and private leases would easily push the total leased coal to over 50 percent of those recoverable reserves. The largest block of currently unleased federal coal in the Book Cliffs is the old south lease block once held by Kaiser Steel at the far southeast end of the field.

Wasatch Plateau Coalfield

Remaining, in-place resources in the Wasatch Plateau coalfield are calculated to be 1,054.8 million tons. Carbon and Emery Counties contain the majority of these resources, but over 300 million tons also fall within Sevier and Sanpete Counties. These minable resources

are derived by limiting the maximum thickness to 14 feet, the maximum cutting height of current longwall equipment. This leaves in-place minable resources of 1,014.8 million tons. Using recovery factors between 25 and 70 percent for the various tracts identified, results in an estimated remaining recoverable coal reserve for the Wasatch Plateau coalfield of 686.0 million tons. The coal resources likely to be mined in the next 15 years in Carbon and Emery Counites are primarily adjacent to the existing mining operations at the Skyline, Bear Canyon, and Deer Creek mines (Map 41). The coal resources identified for mining during the period from 2018 through 2032 have reasonable access, but would generally entail permitting new mining operations. The remaining recoverable reserves in the Carbon and Emery County portion of the Wasatch Plateau field are sufficient for about 49 more years of production at annual rate of 14 million tons; however, further study of the coal quality of specific tracts might lead to further reductions of the recoverable reserve base, so this is a maximum disturbance scenario and not all tracts may be mined.

Table C-24. Recoverable Coal Reserve budget for Carbon and Emery Counties by mining period for the Wasatch Plateau coalfield in millions of short tons (coalbeds ≥ 7 feet thick and with > 200 feet of cover, but < 2,500 feet of cover).

Reliability Category	In-Place Resource Base		Minable Resource Base		Recoverable Reserves Base	
	2003-17	2018-32	2003-17	2018-32	2003-17	2018-32
Demonstrated	308.1	688.0	298.4	658.2	201.1	444.5
Inferred	23.6	35.1	23.3	34.9	16.3	24.1
TOTAL	331.7	723.1	321.7	693.1	217.4	468.6

Leasing of federal coal, as well as the state lease on the Mill Fork tract, has tied up 53.4 percent of the 217.4 million tons of coal reserves identified as recoverable in the next 15 years in the Wasatch Plateau coalfield (see appendix B). Adding in other state and private leases held in this field would result in the total leased coal being about 60 percent of the reserves to be mined in the next 15 years. Major areas of unleased federal coal in Carbon and Emery Counties that are likely to be mined in the initial 15 year period are the Cottonwood tract and the Flat Canyon tract.

Federal leasing of recoverable coal identified for mining in Carbon and Emery Counties for the period from 2108 through 2032 years has only tied up 18.6 percent of the 468.6 million tons of recoverable reserves, and adding state and private leases would push the total leased just a few percent higher. Large blocks of currently unleased federal coal in the Wasatch Plateau that are likely be developed in the second 15 year period occur in the North Horn

Mountain and Candland Mountain areas. Addition unleased federal coal occurs in Sevier County part of the Wasatch Plateau in the Ferron Canyon, Skumpah Canyon, and Old Woman Plateau areas, all within the southern part of the field.

Emery Coalfield

Original in-place economic resources for the Emery coalfield are estimated at 675.8 million tons (Doelling,1972). If we assume that the recoverable coal reserves for this field are a similar 66 percent of the estimated in-place economic resources as found in the Book Cliffs and Wasatch Plateau coalfields, then the recoverable reserves in the Emery coalfield are 446.0 million tons. This is very similar to the results of an earlier UGS study (Doelling and Smith, 1982), estimated that the remaining recoverable coal reserves in the Emery coalfield at 418.0 million tons. This remaining recoverable reserve estimate is presented in table C-25. Depending on the level of production that the Emery mine achieves after re-opening in 2002, the Emery coalfield could see its recoverable coal reserve base depleted by between 5 and 30 million tons over the period from 2003 through 2017. The Emery underground operation is the only anticipated mine development in the field in the next 15 years. Production at this mine will come initially from existing leases, but additional nearby coal will need to be leased to sustain production for more than five years.

Table C-25. Recoverable Coal Reserve budget by county for the Emery coalfield given in millions of short tons (modified from Doelling, 1982; for coal beds ≥ 4 feet thick and with ≤ 3,000 feet of overburden).

County	Original Reserve Base	Original Recoverable Reserves	Production (through 1998)	Remaining Reserves
Emery	830.544	248.250	9.545	238.705
Sevier	599.842	179.293	0.000	179.293
Total	1,430.386	427.543	9.545	417.998

Currently, federal leases of the recoverable coal reserves in the Emery coalfield have tied up only 880 acres of the recoverable reserves (all within Emery County), although past coal leasing and exploration in this field have been extensive. The additional state and private leases that exist would push the total leased coal to about 6,600 acres, and tie up at least 40 million tons of the remaining recoverable reserves in Emery County. This field contains substantial open federal acreage that could be leased for coal mining in the future.

REFERENCES

Anderson, P.B., 1983, Geologic map of the Pine Canyon quadrangle, Carbon County, Utah: Utah Geological and Mineral Survey Map 72, 14 p., 2 pl.

Bunnell, M.D., and Holberg, R.J., 1991, Coal beds of the Ferron Sandstone Member in the northern Castle Valley, east-central Utah, *in*, Chidsey, T.C., Jr., ed., Geology of east-central Utah:Utah Geological Association Publication 19, p. 157-172

Doelling, H.H., 1972, Central Utah coalfields: Sevier-Sanpete, Wasatch Plateau, Book Cliffs, and Emery: Utah Geolgical and Mineralogical Survey Monograph 3, 572 p.

Doelling, H.H., and Smith, M.R., 1982, Overview of Utah coal fields, 1982, *in*, Gurgel, K.D., ed., Proceedings of the fifth symposium on the geology of Rocky Mountain coal: Utah Geological and Mineral Survey Bulletin 118, p. 1-26.

Utah Energy Office, in preparation, 2001 Annual Review and Forecast of Utah coal production and distribution: Utah Department of Natural Resources, Energy Office, 28 p., 1 appendix.

Lupton, C.T., 1916, Geology and coal resources of the Castle Valley in Carbon, Emery, and Sevier Counties, Utah: U.S. Geological Survey Bulletin 628, 84 p.

Tabet, D.E., Hucka, B.P., and Sommer, S.N., 1995a, The resinite resources of selected coal seams of the Book Cliffs and Wasatch Plateau coal fields of central Utah: Utah Geological Survey Report of Investigation 225, 19 p.

Tabet, D.E., Hucka, B.P., and Sommer, S.N., 1995b, Maps of total Ferron coal, depth to the top, and vitrinite reflectance for the Ferron Sandstone Member of the Mancos Shale, central Utah: Utah Geological Survey Open-file Report 329, 3 plates, 1:250,000.

Utah Geological Survey, in preparation, digital database of Utah coal quality.

APPENDIX A

Recoverable and federally leased coal reserves in Carbon and Emery Counties by bed for the Book Cliffs coalfield, 2003-2017.

Coalbed Name	Thickness Range (ft)	In-place Tons	Minable Tons	Recovery Factor	Recoverable Tons	Federal Tons Leased
Castlegate A	6 - 11	1.1	1.1	0.6	0.7	0.7
Castlegate A	7 - 18	50.8	48.3	0.7	33.8	25.9
Gilson	6 - 12	30.3	30.3	0.7	21.2	10.4
L. Sunnyside	6 - 16	89.7	89.7	0.7	62.8	62.4
TOTAL	6 - 18	171.9	169.4	0.7	118.5	99.4

Recoverable and federally leased coal reserves in Carbon and Emery Counties by bed for the Book Cliffs coalfield, 2018-2032.

Coalbed Name	Thickness Range (ft)	In-place Tons	Minable Tons	Recovery Factor	Recoverable Tons	Federal Tons Leased
Wattis	7 - 11	24.3	24.3	0.7	17.0	9.2
Castlegate A	7 - 25	40.1	30.1	0.7	21.1	16.7
Castlegate B	6 - 12	13.7	13.7	0.7	9.6	3.5
Castlegate C	6 - 14	16.1	16.1	0.7	11.3	6.9
Castlegate D	6 - 19	45.6	42.4	0.7	29.7	17.9
Kenilworth	7 - 11	11.4	11.4	0.7	8.0	8.0
Gilson	7 - 14	28.4	28.4	0.7	19.9	1.3
Rock Canyon	7 - 14	13.0	13.0	0.7	9.1	0.8
L. Sunnyside	7 - 11	4.2	4.2	0.7	3.0	0.0
U. Sunnyside	6 - 14	40.3	40.3	0.7	28.2	6.8
TOTAL	6 - 25	237.1	223.9	0.7	156.9	71.1

APPENDIX B

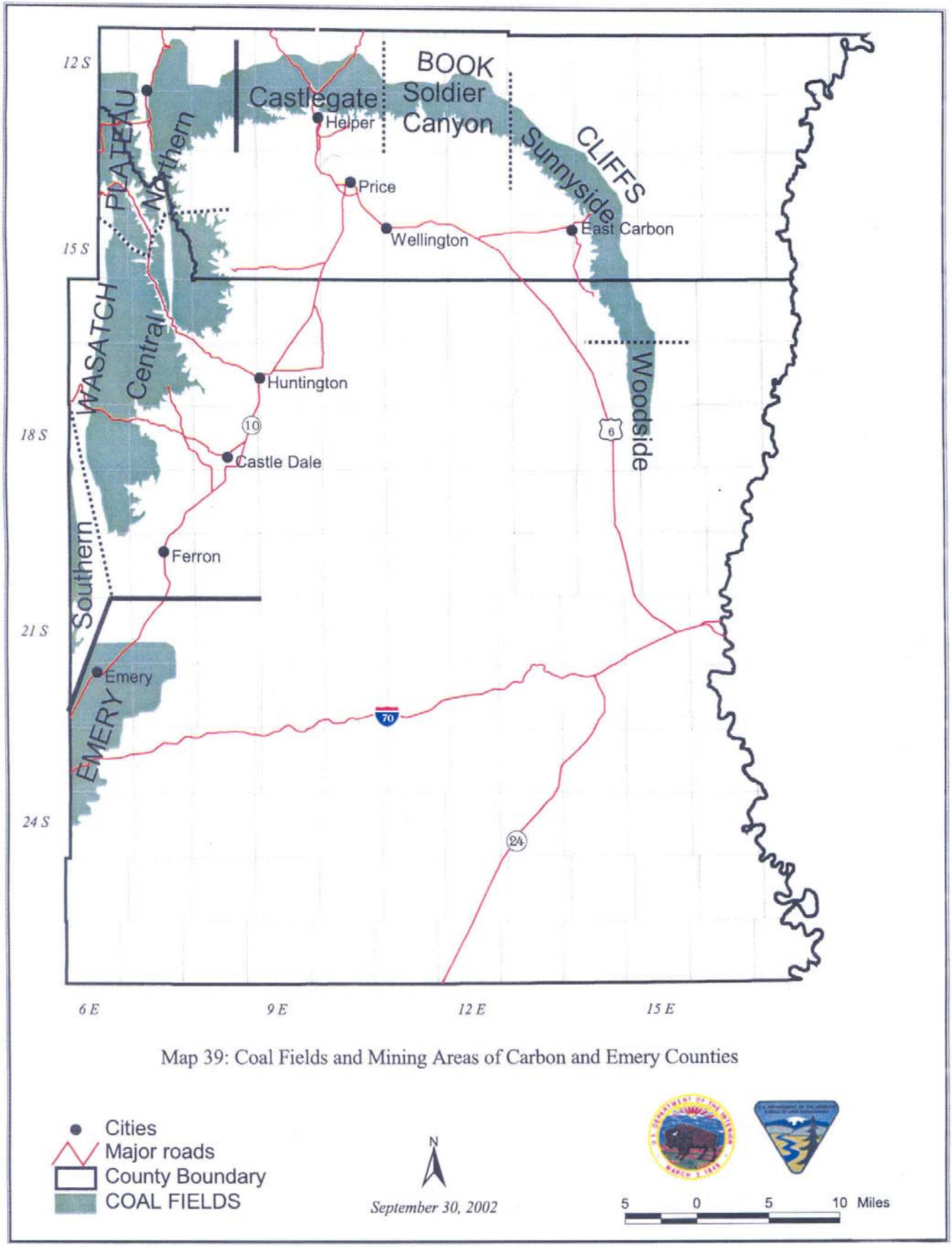
Recoverable and federally leased coal reserves in Carbon and Emery Counties by bed for the Wasatch Plateau coalfield, 2003-2017.

Coalbed Name	Thickness Range (ft)	In-place Tons	Minable Tons	Recovery Factor	Recoverable Tons	Federal Tons Leased
Acord Lakes	6 - 8	1.1	1.1	0.7	0.8	0.8
Axel Anderson	6 - 16	160.6	160.2	0.7	112.1	31.4*
Cottonwood	6 - 26	59.9	53.5	0.7	37.5	33.2
Blind Canyon	6 - 17	74.2	71.3	0.7	49.9	41.7*
Blind Canyon	6 - 12	8.0	8.0	0.5	4.0	3.3
Blind Canyon	6 - 14	10.4	10.4	0.25	2.6	0.0
Castlegate D	6 - 9	17.4	17.4	0.7	10.5	5.7
TOTAL	6 - 26	331.7	321.7	0.68	217.4	116.1

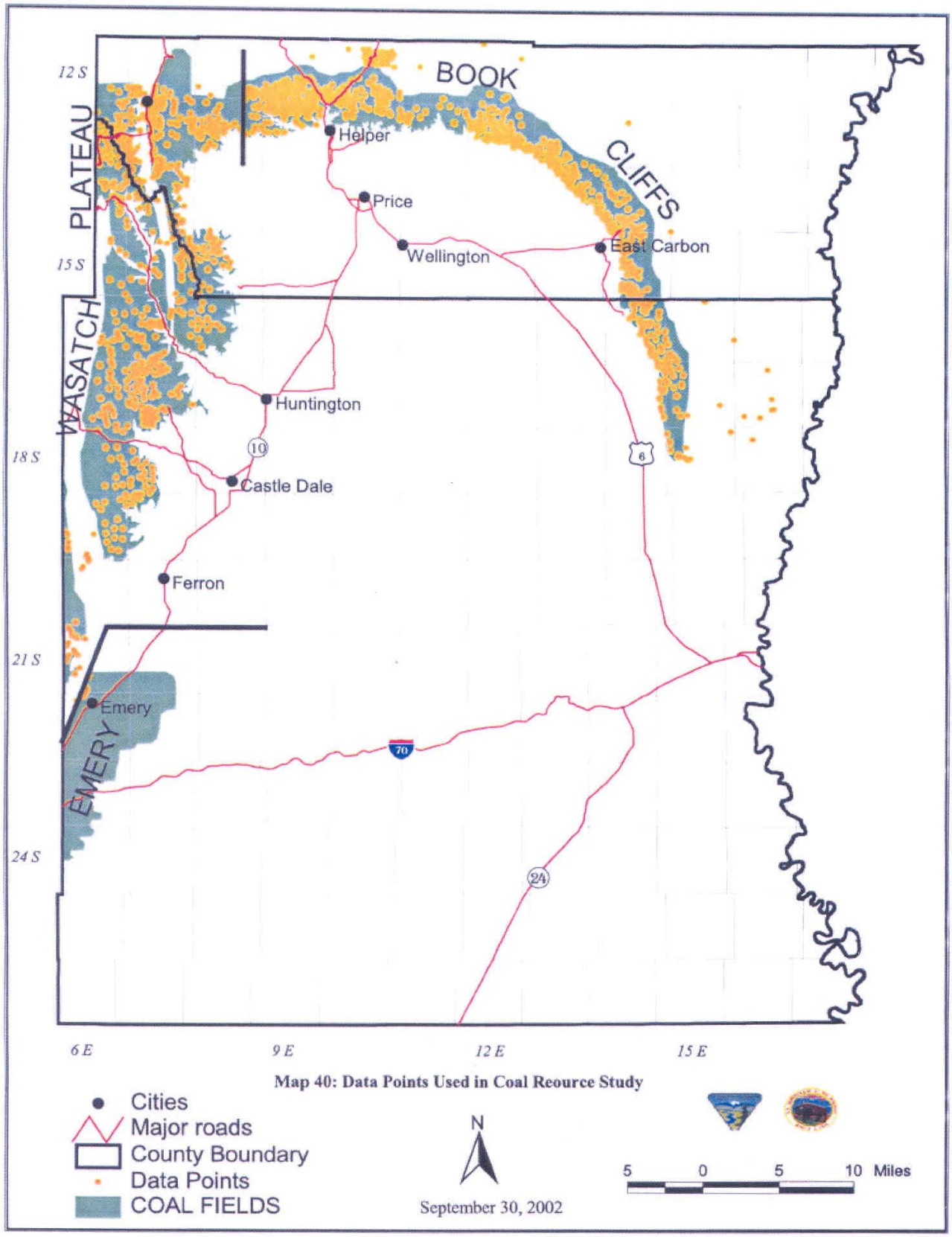
*includes Mill Fork state lease tract tonnage

Recoverable and federally leased coal reserves in Carbon and Emery Counties by bed for the Wasatch Plateau coalfield, 2018-2032.

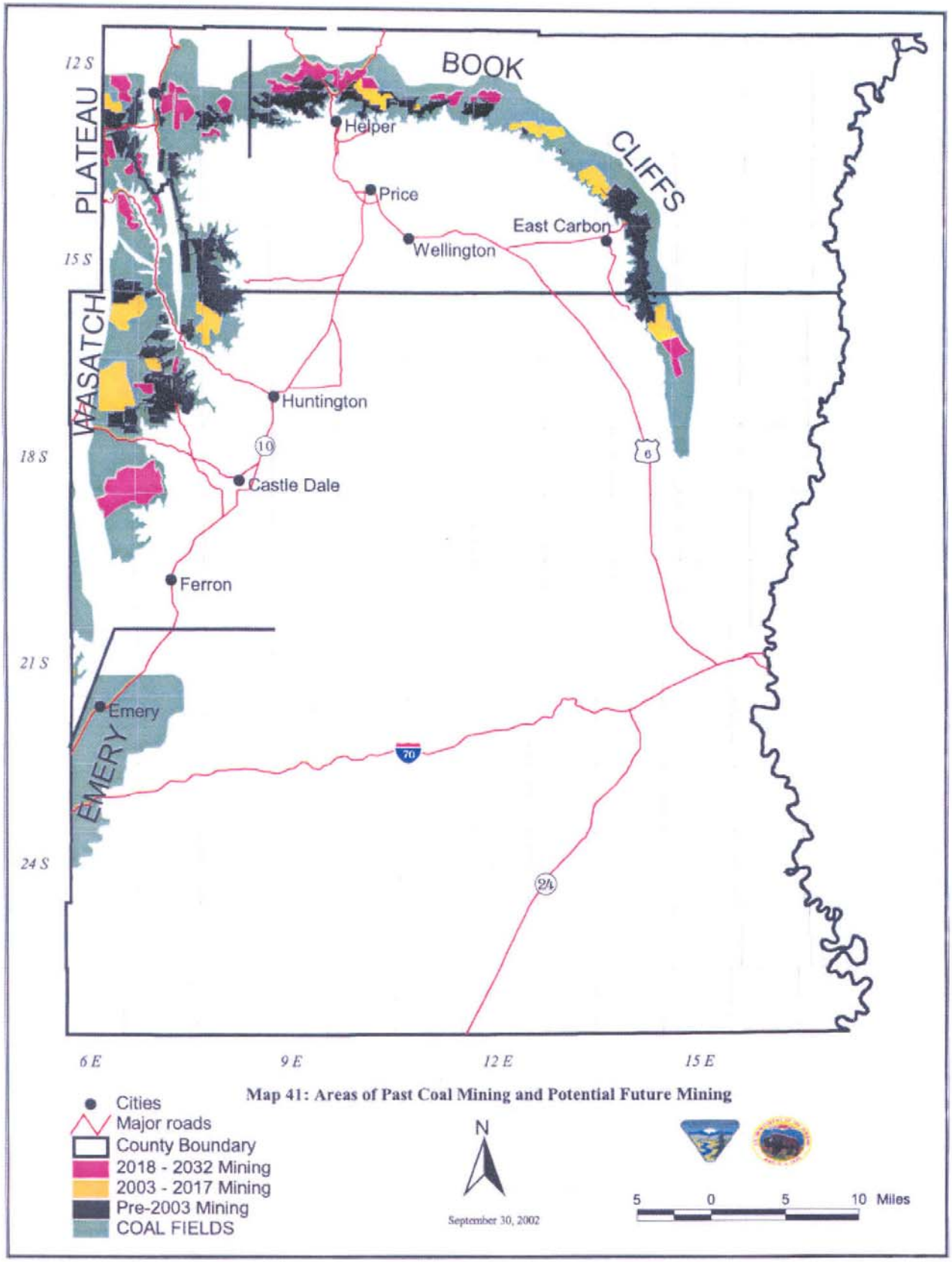
Coalbed Name	Thickness Range (ft)	In-place Tons	Minable Tons	Recovery Factor	Recoverable Tons	Federal Tons Leased
Knight	6 - 18	231.7	227.7	0.7	159.4	19.4
Acord Lakes	6 - 14	48.6	48.6	0.7	34.0	0.0
Axel Anderson	6 - 13	61.5	61.5	0.7	43.0	11.7
Cottonwood	6 - 30	30.9	27.0	0.7	18.9	8.0
Blind Canyon	7 - 26	188.7	168.1	0.7	117.7	8.0
Blind Canyon	6 - 13	4.8	4.8	0.5	2.4	2.2
Wattis	6 - 17	143.8	143.8	0.6	86.3	38.0
Gordon	6 - 19	13.1	11.6	0.6	6.9	0.0
TOTAL	6 - 30	723.1	693.1	0.68	468.6	87.3



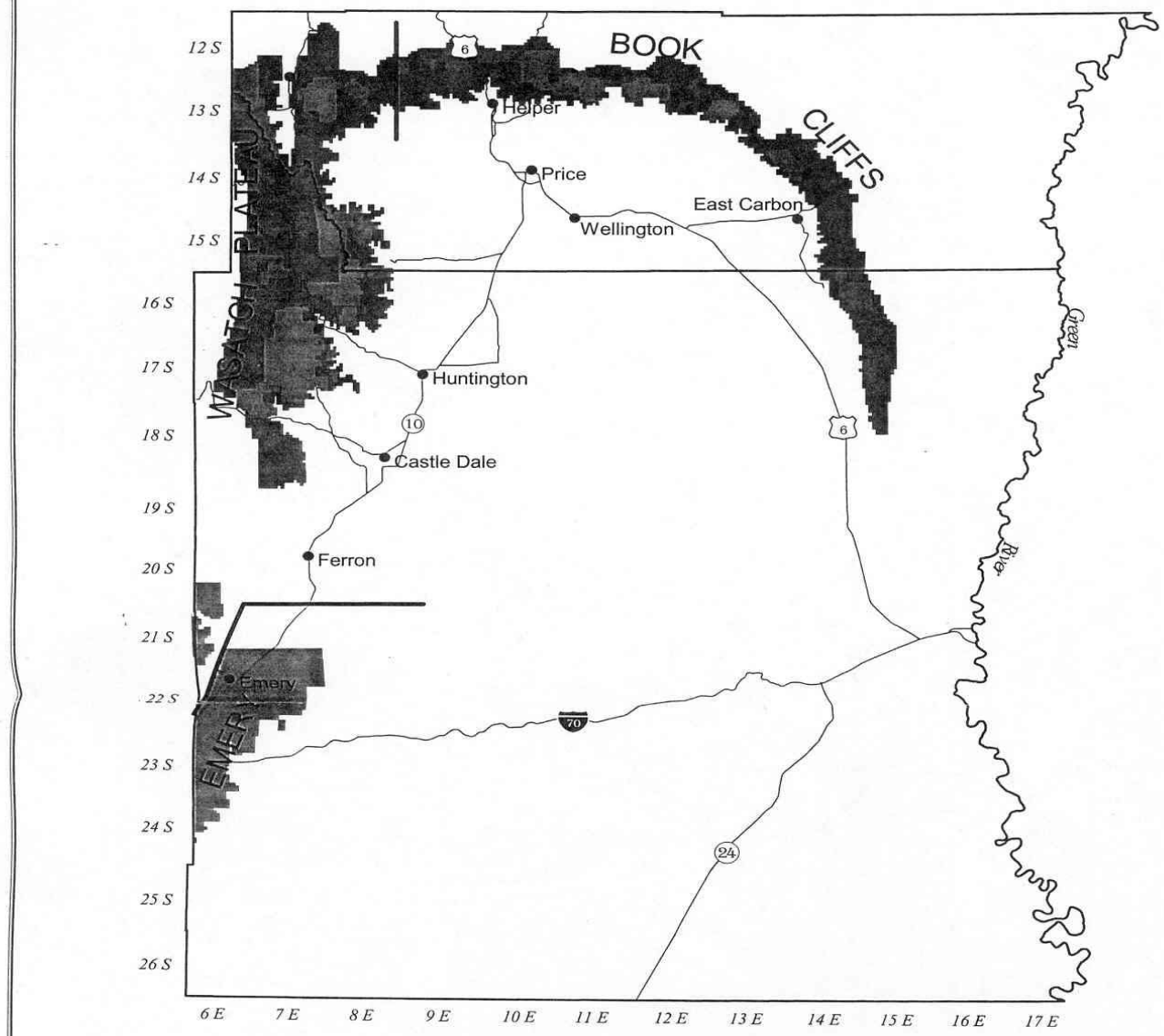
Map 39: Coal Fields and Mining Areas of Carbon and Emery Counties



Map 40: Data Points Used in Coal Reource Study



Map 41: Areas of Past Coal Mining and Potential Future Mining



Map 6: Known Recoverable Coal Resource Areas (KRCRAs), and Federal Coal Leases in the Planning Area

Cities
Major Roads
County Boundary
Federal Coal Lease
KRCRAs

N

September 30, 2002

Source: (BLM, 2002b)

5 0 5 10 Miles