APPENDIX 8—COAL RESOURCES WITHIN THE RICHFIELD PLANNING AREA

This appendix includes four documents that address coal resources within the Richfield planning area:

- Coal Resource Evaluation of the Henry Mountains Coal Field, July 2004
- Coal Resources of the BLM Richfield Planning Area, July 2003
- Coal Unsuitability Report, Henry Mountains Coal Field (draft), March 2005
- Coal Unsuitability Report, Wasatch Plateau and Emery Coal Fields (draft), March 2005

Federal regulations provide detailed guidance for addressing coal resources in Bureau of Land Management (BLM) land use planning under 43 CFR 3400, 30 CFR 700, and elsewhere. How these regulations are addressed in the Richfield Resource Management Plan (RMP)/Draft Environmental Impact Statement (DEIS) is summarized in Table A8-1 and explained in detail in the attached reports.

Table A8-1. Federal Regulations Related to Coal

Topic	Federal Regulations (30 and 43 CFR)	Richfield RMP/DEIS
General Direction for Coal in Land Use Planning	43 CFR 3420.1-4 (a) The Secretary may not hold a lease sale under this part unless the lands containing the coal deposits are included in a comprehensive land use plan. 43 CFR 3420.1-4 (d) A comprehensive land use plan…shall contain an estimate of the amount of coal recoverable by either surface or underground means or both.	The two coal resource evaluations included in this appendix identify lands containing coal deposits, including estimates of the amount of coal recoverable by surface and underground means.
Call for Coal Resource Information	43 CFR 3420.1-2 (a) Prior to or as part of the initiation of a land use plan…a Call for Coal Resource Information shall be made to formally solicit indications of interest and information on coal resource development potential and on other resources which may be affected by coal development…	A "Call for Coal Resource and Other Resource Information for Public Lands in Garfield, Piute, Sanpete, Sevier, and Wayne Counties, Utah" was published in the Federal Register on May 2, 2003. During the 30-day comment period, two responses were received, one from the State of Utah School and Institutional Lands Administration and the other from the State of Utah Division of Oil, Gas and Mining.
Coal Screening Process	43 CFR 3420.1-4 (e) The major land use planning decision concerning the coal resource shall be the identification of areas acceptable for further leasing which shall be identified by *the [four step] screening process* below:	

Topic	Federal Regulations (30 and 43 CFR)	Richfield RMP/DEIS
Coal Screening Process Step 1: Coal Report	43 CFR 3420.1-4 (e) (1) Only those areas that have development potential may be identified as acceptable for further consideration. The [BLM] shall estimate coal development potential… Where such information is determined to indicate development potential for an area, the area may be included in the land use planning evaluation for coal leasing.	A coal resource evaluation for the Richfield Field Office (RFO) was completed in June 2003. A coal resource evaluation for the Henry Mountain coal field was completed and signed in September 2004. Estimates of amounts of coal recoverable by surface and underground mining are included in the evaluations.
Coal Screening Process Step 2: Coal Unsuitability	43 CFR 3420.1-4 (e) (2) The [BLM] or the surface managing agency conducting the land use planning shall, using the unsuitability criteria and procedures set out in subpart 3461 of this title, review Federal lands to assess where there are areas unsuitable for all or stipulated methods of mining… (The unsuitability criteria are listed under 43 CFR 3461.5.)	Draft unsuitability reports for the Wasatch Plateau and Emery and Henry Mountains coal fields, developed in consultation with the U.S. Fish and Wildlife Service (USFWS), US Forest Service (USFS), and State of Utah, are included in this appendix. Public comment on these reports is invited at this time. Following an analysis of comments, final unsuitability reports will be included in the final Environmental Impact Statement (EIS).
Disclosure of Application of Unsuitability Criteria in the RMP.	43 CFR 3461.2-1 (b) (1) The authorized officer shall describe in the comprehensive land use plan…the results of the application of each unsuitability criteria, exception and exemption [and]…shall state…those areas which could be leased only subject to conditions or stipulations to conform to the application of the criteria or exceptions. Such areas may be ultimately leased provided that these conditions or stipulations are contained in the lease.	The application of the unsuitability criteria is described in the unsuitability reports.
Public Comment on Unsuitability	43 CFR 3461.2-1 (a) (2) Public comments on the application of the unsuitability criteria shall be solicited by a notice published in the Federal Register. This call for comments may be part of the call for public comments on the draft land-use or land-use analysis.	The Notice of Availability for the Draft Resource Management Plan and Draft Environmental Impact Statement includes this statement regarding the unsuitability analysis: "The application of the Federal coal unsuitability criteria to the Henry Mountain and Emery coal fields is included in Appendix D of the draft environmental impact statement. As required by 43 CFR 3461.2-1(a)(2), the public is invited to comment on the results of the application of the criteria and the application process used. The criteria are listed under 43 CFR 3461.5."
Adequacy of Data Used in Unsuitability Determinations	43 CFR 3461.2-2 (b) (2) …The comprehensive land use plan…shall include an indication of the adequacy and reliability of the data involved…	Draft unsuitability determinations were made in consultation with the USFWS, USFS, and State of Utah. They are now open for public comment.

Topic	Federal Regulations (30 and 43 CFR)	Richfield RMP/DEIS
Revising the Unsuitability Determinations After the RMP Is Approved	43 CFR 3461.2-2 (c) Any unsuitability assessments which result from either a designation or a termination of a designation of Federal lands as unsuitable by the Office of Surface Mining Reclamation and Enforcement, or from changes warranted by additional data acquired in the activity planning process, may be made without formally revising the comprehensive land use plan…	Outside the scope of the RMP.
Petition Process for Unsuitability	30 CFR 769.11 Any person having an interest which is or may be adversely affected by surface coal mining operations to be conducted on Federal lands may petition the Secretary to have an area designated as unsuitable for all or certain types of surface coal mining operations, or to have an existing designation terminated… For the purpose of this section, a person having an interest which is or may be adversely affected must demonstrate how he or she meets an "injury in fact" test by describing the injury to his or her specific interests and demonstrate how he or she is among the injured.	Outside the scope of the RMP.
Coal Screening Process Step 3: Multiple Use Analysis	43 CFR 3420.1 (3) Multiple land use decisions shall be made which may eliminate additional coal deposits from further consideration for leasing to protect other resource values and land uses that are locally, regionally, or nationally important or unique and that are not included in the unsuitability criteria… Such values and uses include, but are not limited to, those identified in section 522(a)(3) of the Surface Mining Reclamation and Control Act of 1977 and as defined in 30 CFR 762.5[1]. In making these multiple use decisions, the [BLM] or the surface managing agency conducting the land use planning shall place particular emphasis on protecting the following: Air and water quality; wetlands, riparian areas and sole-source aquifers; the Federal lands which, if leased, would adversely affect units of the National Park System, the National Wildlife Refuge System, the National System of Trails, and the National Wild and Scenic Rivers System.	This step will be completed if and when there is interest in coal leasing. The USFS will complete this analysis for the national forest lands in its land use planning process.

Topic	Federal Regulations (30 and 43 CFR)	Richfield RMP/DEIS
Coal Screening Process Step 4: Consultation With Other Surface Owners	43 CFR 3420.1-5 (4) (i) While preparing a comprehensive land use plan or land use analysis, the [BLM] shall consult with all surface owners who meet the criteria in paragraphs (gg) (1) and (2) of 3400.0-5 of this title, and whose lands overlie coal deposits, to determine preference for or against mining by other than underground methods.	This step will be completed if and when there is interest in coal leasing.
Hearing Requirements	3420.1-5 After public notice, the [BLM] or other surface management agency shall conduct a public hearing on the proposed comprehensive land use management plan analysis if it involves the potential for coal leasing before it is adopted if such a hearing is requested by any person who is or may be adversely affected by the adoption of the plan. A hearing conducted under part 1600 of this title of this chapter shall fulfill this requirement.	The Notice of Availability for the Draft Resource Management Plan and Draft Environmental Impact Statements includes this statement: "…Additionally, the BLM shall conduct a public hearing on the proposed comprehensive land use plan if it involves the potential for coal leasing before it is adopted if such a hearing is requested by any person who is or may be adversely affected by adoption of this plan."

30 CFR 762.5 Definitions. For the purposes of this part:

Fragile lands *means areas containing natural, ecologic, scientific, or esthetic resources that cold be significantly damaged by surface coal mining operations. Examples of fragile lands include valuable habitats for fish or wildlife, critical habitats for endangered or threatened species of animals or plants, uncommon geologic formations, paleontological sites, National Natural Landmarks, areas where mining may result in flooding, environmental corridors containing a concentration of ecologic and esthetic features, and areas of high recreational value due to high environmental quality.*

Historic lands *mean areas containing historic, cultural, or scientific resources. Examples of historic lands include archaeological sites, properties listed or eligible for listing on a State or National Register of Historic Places, National Historic Landmarks, properties having religious or cultural significance to Native Americans or religious groups, and properties for which historic designation is pending.*

Natural hazard lands *means geographic areas in which natural conditions exist which pose, or as a result of surface coal mining operations, may pose a threat to the health, safety or welfare of people, property or the environment, including areas subject to landslides, cave-ins, large or encroaching sand dunes, severe wind or soil erosion, frequent flooding, avalanches and areas of unstable geology.*

Renewable resource lands *mean geographic areas which contribute significantly to the long-range productivity of water supply or food or fiber products, such lands to include aquifers and aquifer recharge areas.*

Form 3060-1
(July 1984)

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Not
Applicable

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND
MANAGEMENT

MINERAL REPORT

COAL RESOURCE EVALUATION OF THE HENRY MOUNTAINS COAL FIELD, GARFIELD AND WAYNE COUNTIES, UTAH

(Title)

LANDS INVOLVED

Tps. 27-34 S., Rs. 7-11 E.
Salt Lake Meridian

Prepared By:

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(Signature)

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(Title)

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(Date)

Technical Approval:

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(Signature)

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Management Acknowledgement:

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(Signature)

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☆ U.S. Government Printing Office: 1994-573-004/01002

COAL RESOURCE EVALUATION OF THE HENRY MOUNTAINS COAL FIELD

INTRODUCTION

The Bureau of Land Management (BLM) is preparing a land use plan, referred to as a Resource Management Plan (RMP), which will address the management of public land that is administered by the Richfield Field Office. Coal is one of the resources that will be addressed in this plan. To plan for coal exploration and development, the areas with a coal resource, the quantity of recoverable coal, and the development potential must be identified to the extent feasible.

In this report, the coal resources in the Henry Mountains coal field are evaluated to determine the public land that should be considered for the Federal leasing of coal resources. The conclusions in this report are limited to the action prompting this review and are not intended for any other purpose.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Coal resources have been identified in the Ferron Sandstone and Muley Canyon Sandstone Members of the Mancos Shale in the Henry Mountains coal field. The Dakota Sandstone also contains coal beds, but the coal is not considered a resource. Total, in-place, coal resources considered to have development potential by surface and underground methods are 278.6 million tons in the Ferron Sandstone and 1,472.1 million tons in the Muley Canyon.

Coal resources in central Utah, namely the Wasatch Plateau and Book Cliff coal fields, are expected to meet the demand for Utah coal in the next 15 years or longer, assuming market conditions do not change significantly. The above described Henry Mountains coal field is an additional coal resource that has development potential.

It is recommended that those areas in the Henry Mountains coal field with a coal resource that have development potential be considered for coal leasing in the planning for the RFO. Those areas are identified on maps contained in this report.

ACKNOWLEDGEMENT

This resource evaluation is based primarily on recent published reports by Tabet (1999, 2000) and an unpublished report by Tabet (2002). Tabet's reports provide an adequate evaluation of the coal resources that allows for an assessment of the coal potential as part of land use planning and the preparation of a RMP. I would like to gratefully acknowledge David E. Tabet, Utah Geological Survey, for granting permission to use his reports as the basis for this evaluation.

LANDS INVOLVED

The lands involved are public lands managed by the RFO within the Henry Mountains coal field (Figure 1). The coal field is defined by the outcrop boundary of the Ferron Sandstone Member of the Mancos Shale.

The coal field is approximately 48 miles long in a north–south direction and up to 18 miles wide in an east–west direction. Generally, the land is located within Tps. 27-34 S., Rs. 8-11 E., SLM, Garfield and Wayne counties, Utah.

State Highway 24, which is a main highway to Hanksville and the Henry Mountains area, crosses the northern part of the coal field. The Notom Road, from Highway 24 southward, provides general access to the west side of the field. The Notom Road is paved at its north end.

No rail lines are developed in the area. The nearest railroad is at Green River, which is 60 miles away.

Surface and mineral ownership is shown in Figure 2. No Federal coal leases are currently held on the subject public lands. Federal leases for other mineral resources and mining claims were not checked for this report because the resulting information would not have a bearing on determining coal resources. Portions of the coal field are included within designated wilderness study areas (WSAs). As WSAs are not relevant to determining where coal resources may be situated on the ground, WSAs are not addressed in this report. However, WSAs will need to be addressed in the land use planning process through the application of unsuitability criteria.

A portion of the subject lands has been classified as a Known Recoverable Coal Resource Area (KRCRA) (Figure 3). At one time, KRCRA was a classification used to identify lands that met the minimum standards for recoverable coal in accordance with standard mining methods and to designate lands that would be leased through a competitive process. Under current Federal regulations, coal is leased by a competitive process.

PHYSIOGRAPHIC SETTING

The Henry Mountains coal field is in the Colorado Plateau physiographic province (Stokes 1986) as displayed in Figure 4. The Colorado Plateau is characterized by relatively undeformed Paleozoic and Mesozoic sedimentary strata, but in places, the strata are folded into monoclines and anticlines and are displaced by faults. The coal field is mostly in the Henry Mountains subdivision, with the northern part extending into the Green River Desert.

The Henry Mountains coal field lies between the Henry Mountains on the east and the Waterpocket Fold on the west. The Henry Mountains contain several prominent peaks that are greater than 11,000 feet in elevation which were formed by igneous intrusions, referred to as laccoliths, which have domed the surrounding sedimentary strata. The Waterpocket Fold is a monocline on the east flank of the Circle Cliffs and is a prominent, regional ridge (reef) that is the main physiographic feature of Capitol Reef National Park. Other landforms include buttes and mesas, such as Factory Butte and Swap, Tarantula, Cave Flat, and Wildcat Mesas. Factory Butte is the prominent landform at the northern end of the field; Swap Mesa is near the southern end. The low point in elevation is 4,600 feet at the northern end of the coal field.

The terrain in the coal field is generally rugged and dissected by stream channels. Most channels are ephemeral, with the exception of the Fremont River, which cuts the North and South Caineville mesas, which are on the north end of coal field.

GEOLOGIC SETTING

Stratigraphy

The exposed bedrock near the Henry Mountains coal field is predominantly sedimentary strata of Jurassic and Cretaceous age (see Figures 5 and 6). The Jurassic strata crop out around the perimeter of the coal field while the Cretaceous strata are exposed in the center. These formations contain conglomerate, sandstone, and shale or mudstone of variable thickness and distribution, and were deposited in various marine, marine shoreline, deltaic, fluvial, and continental environments. The peaks of the Henry Mountains are dioritic igneous intrusive rocks. The regional stratigraphy is well described in other reports, namely Hunt et al.(1953) and Doelling (1972), and is not the focus of this report.

The coal-bearing units in the coal field are part of the Dakota Sandstone and Mancos Shale, which are Upper Cretaceous in age. Nomenclature of the Upper Cretaceous stratigraphy, in particular the Mancos Shale, has been developed through numerous investigations and has been revised through the years. Gilbert (1877) and Spieker and Reeside (1926) completed early studies in the basin, and in recent years, Peterson et al. (1975, 1980), Smith (1983), and Eaton (1990) proposed changes to the nomenclature. Peterson et al. determined that the sandstone unit between the Blue Gate and Masuk Members of the Mancos Shale in the Henry Mountains basin did not correlate with the type section of the Emery Sandstone at the Wasatch Plateau. Smith recommended that the Emery Sandstone Member in the Henry Mountains basin be named the Muley Canyon Sandstone, replacing the name Emery Sandstone. Eaton proposed formation status for the Masuk and Muley Canyon Sandstone Members, and that the coal-bearing strata of the Muley Canyon should be included in the Masuk Formation. In addition, the Mesaverde Formation is now named the Tarantula Sandstone.

Tabet (1999, 2000) adopted the stratigraphy proposed by Smith (1983), although the changes proposed by Eaton (1990) may better reflect stratigraphic relationships (Figure 7). As Tabet was compiling geologic information from existing maps, using Eaton's proposal would have made correlation more difficult and Smith's nomenclature could be easily adopted. Because this report is based primarily on Tabet (2000), the Upper Cretaceous stratigraphic nomenclature that will be utilized for this report, in ascending order, is the Dakota Sandstone; the Tununk, Ferron Sandstone, Blue Gate, Muley Canyon Sandstone, and Masuk Members of the Mancos Shale; and the Tarantula Sandstone.

Structure

The coal field lies in a structural basin, the Henry Mountains syncline, which is asymmetric and has a north-trending axis. The syncline lies between the Waterpocket Fold on the west and the Monument Uplift to the east. Strata exposed on the west limb of the syncline, the Waterpocket Fold, dip easterly at 20 to 30 degrees, whereas in the central part of the basin, strata are nearly horizontal in aspect. The east side of the coal field is defined by the Henry Mountains, where strata have a generally westerly dip of 10 degrees.

HISTORY OF COAL EXPLORATION AND DEVELOPMENT

Coal has historically been mined from the Henry Mountain coal field for primarily local use. Coal in the Ferron Sandstone was mined from the Stanton mine at the south end of the field from 1888 to 1900 to supply power for gold dredges on the Colorado River. A mine near Factory Butte, also in the Ferron Sandstone, operated from 1908 to the 1950s and was re-opened in 1978 for a short period of time, when coal was hauled to Green River. There was active mining in Muley Canyon at Sweetwater Creek and

Dugout Creek from about 1914 until the 1940s. Coal from these two mines was used to supply power for drill rigs in the Green River Desert.

In the 1970s Amax leased Federal land in the Henry Mountain coal field and exploration for surface minable coal was conducted by several companies. Since the mid-1980s, exploration and development for Federal coal on Federal land has not been authorized in this area.

Total production for the coal field is reported at about 59,000 tons of coal (Doelling and Smith 1982). Most of this production was from the Factory Butte area at the north end of the field.

METHODOLOGY

Tabet (2000) evaluated coal data that had been collected by subsurface investigations completed by coal companies and the U.S. Geological Survey (USGS) during the 1970s and early 1980s and through outcrop studies by the Utah Geological Survey during the late 1980s. Outcrop data were used only if representative of the full thickness of the coal section. The data for the Ferron Sandstone and the Muley Canyon Sandstone Members of the Mancos Shale were used to determine the thickness of the coal zone (isopach) and the depth to the coal zone (overburden). Then, coal resources were identified in accordance with USGS guidelines. A mineral resource is a concentration of naturally occurring material in such form and amount that economic extraction of a commodity from the concentration is currently or potentially feasible (USGS Circular 831). Tabet (2000, p. R7) defined demonstrated, inferred, and hypothetical resources as—

"Demonstrated resources lie within 0.75 mi from a thickness-measurement point, inferred resources are between 0.75 and 3 mi from a thickness-measurement point, and hypothetical resources lie more than 3 mi from a thickness-measurement point."

Tabet further classified resources using the following depth categories: less than 100 feet, 100 to 1,000 feet, and 1,000 to 2,000 feet. Coal resources in the Ferron Sandstone and Muley Canyon Sandstone generally lie at depths of less than 2,000 feet.

Drill hole and outcrop samples and data were not examined for this assessment. Isopach and overburden maps from Tabet (2000) were used to delineate public lands with a coal resource. Individual coal beds were not identified by Tabet, rather the aggregate thickness of coal beds that are greater than 1 foot were used to determine a resource.

The mining method selected for extracting coal depends on the thickness of the coal bed(s) and the depth to the coal. Assessments of the coal potential in the Henry Mountains coal field and at other coal fields have used variable parameters. The parameters selected depend on the coal resource, the reliability of the data, and the current mining practices. In the Henry Mountains coal field, Doelling (1972) used a 4-foot mining thickness, whereas, a coal development potential report completed by Dames and Moore for the USGS in 1980 used a 5-foot mining thickness and a depth of 100 feet as break between surface and underground mining methods. Tabet (2002) used an approximate 7-foot thickness and 200-foot depth to assess coal resources in the Wasatch Plateau and Book Cliffs coal field in Carbon and Emery counties. Tabet (2003, in preparation and personal communication) is using a 4-foot thickness and a depth of less than 200 feet for surface mining and a 6-foot thickness and a depth of greater than 200 feet for underground mining in the Emery coal field in Sevier County.

For this report, coal resources that are greater than 2 feet in thickness and that have less than 100 feet of overburden are considered to have potential for development by surface mining methods. Underground, conventional mining methods were considered applicable to coal resources that are 6 feet or greater in

thickness and that have a depth of 100 feet or more. These parameters are adaptable to the data at hand from Tabet (1999, 2000) without a need to re-grid and re-tabulate the coal data points. By using a 6-foot thickness for underground mining, the deeper resource may be somewhat under-reported in terms of quantity and acreage. For purposes of delineating public land that should be furthered considered for coal leasing, this methodology is considered adequate for land use planning. For purposes of leasing, minable coal beds would need to be determined.

In this report, although all tonnage quantities are short tons, they are referred to simply as tons. Resource estimates are made without regard to surface or mineral estate; however, most of the land is public land managed by the BLM (Figure 2).

MINERAL DEPOSITS

Coal-bearing strata in the Henry Mountains basin are contained in three Upper Cretaceous stratigraphic units: the Dakota Sandstone and the Ferron Sandstone and Muley Canyon Sandstone Members of the Mancos Shale.

Dakota Sandstone

The Dakota Sandstone has a maximum thickness of 92 feet and has an average thickness of 35 feet; the Dakota Sandstone thickens from the north end of the coal field to the southwest (Hunt, *et al.* 1953; Peterson, *et al.* 1983, Tabet 2000). Coal beds within the Dakota Sandstone are thin, usually 2 feet or less in thickness, and their lateral extent is limited and discontinuous (Tabet 2000). Therefore the Dakota Sandstone does not have a coal resource that warrants consideration for development potential.

Ferron Sandstone Member

The Ferron Sandstone contains a lower marine unit and an upper non-marine unit. The upper unit averages 110 feet in thickness and contains a coal resource in a 50-foot interval that overlies the lower marine unit. The coal interval in the Ferron Sandstone consists of one to five beds that have a cumulative thickness of 16.5 feet; the average thickness of the individual coal beds is 1 to 3 feet and is rarely more than 4-feet (Tabet 2000).

The Ferron coal is not uniformly distributed across the coal field and is found in discontinuous pods that are 1 to 5 miles wide and 3 to 10 miles long (see Figure 8). The coal pods are primarily oriented lengthwise in an east-west direction, which may reflect deposition in swamps and fluvial channels or may reflect erosion prior to the deposition of the Blue Gate Member. Three areas, one each in the northern, central, and southern parts of the coal field, contain the thickest coal deposits. The assessment of the coal deposits of the Ferron Sandstone in the central area of the coal field has primarily been extrapolated from data collected from one oil and gas well.

The Ferron Sandstone is exposed in outcrop around the margins of the Henry Mountains coal field (see Figure 8). Coal in the Ferron Sandstone is not present in much of the coal field because of the discontinuity of the coal beds. Thus, the depth to the top of the Ferron Sandstone is mapped, rather than the depth to the Ferron coal. The top of the Ferron Sandstone is a close approximation to the top of the coal because the coal is in the upper part of the sandstone. The Ferron Sandstone is deeper toward the axis of the basin because of the synclinal nature of the Henry Mountains basin. The deepest part is east of Tarantula Mesa, where the depth slightly exceeds 2,000 feet. Most of the Ferron Sandstone is less than 1,000 feet in depth.

Coal Quality

Limited sampling and analysis have been completed on the Ferron coal. Four coal samples have been analyzed, including three from the northern and one from the southern parts of the coal field. Based on these four samples, Tabet (2000, p. R10) states that the apparent rank of the coal is high-volatile C bituminous and that the average for proximate analysis is 14.5% ash, 2.5% sulfur, 11,038 British thermal units (Btu) per pound, 5.8% moisture, 34.8% volatile matter, and 44.9% fixed carbon.

Muley Canyon Sandstone Member

Tabet (2000, p. R14) describes the Muley Canyon coal as follows:

"The upper part of the Muley Canyon Member is a nonmarine coal-bearing interval with thicknesses ranging from 92 to 209 ft thick and averaging 150 ft. This stratigraphic interval, referred to as the Muley Canyon coal zone * * * commonly contains three to four coal beds, but locally has as many as 10 beds. Individual beds range from 0 to 13.4 ft thick and are commonly 2-5 ft thick; aggregate thickness of coal is as much as 27.5 ft. * * * Most of the area underlain by this zone has at least 5 ft of total coal, and about half of the area has 10 ft or more of total coal."

The Muley Canyon coal is distributed more widely in the coal field than the Ferron Sandstone coal (see Figure 9). Similar to the Ferron Sandstone coal, the Muley Canyon coal is thickest near the central part of the Henry Mountains basin in pods that are oriented lengthwise in an east–west direction. The pods tend to be thicker on the west side of field.

The shallower coal beds (depths less than 100 feet) are generally exposed around the perimeter of the coal field. Most of the shallow coal is at the north and south ends of the extent of the Muley Canyon in the general area of Wildcat Mesa, Cave Flat, and Swap Mesa. The deepest coal, at slightly more than 1,000 feet, is under Tarantula Mesa where the coal zone is thicker than 24 feet.

Coal Quality

The Muley Canyon coal has been sampled in more detail than the Ferron Sandstone coal, although the samples are again mostly from the shallower coal beds at the northern and southern ends of the coal field. Based on 7 outcrop samples and 30 drill hole samples, the Muley Canyon coal's rank is sub-bituminous A to high-volatile bituminous C (Tabet 2000, p. R14). The average for proximate analyses of the Muley Canyon coal samples are 11.74% ash, 0.9% sulfur, 10,086 Btu per pound, 12.1% moisture, 35.34% volatile matter, and 40.82% fixed carbon, and the range in heat content is 7,710 to 12,491 Btu. Compared with the Ferron Sandstone coal, the Muley Canyon coal is a lower rank, has lower contents of heat, ash, and sulfur and has higher moisture content. In comparison with coal from the Wasatch Plateau and Book Cliff fields that averages 10% ash, 0.5-0.7% sulfur, and 11,500-12,900 Btu, the Muley Canyon coal has higher ash and sulfur contents and lower heat (Tabet 2000, 2002).

Thirteen samples from ash of the Muley Canyon coal were analyzed for major oxides. Major oxides are used to evaluate the potential for boiler slagging and fouling. Slagging and fouling refer to the accumulation of molten ash and sintered material in different parts of the boiler, and these build-ups could decrease boiler efficiency and life and increase operating costs. The ratio of the sum of the CaO and MgO to Fe_2O_3 determines whether the ash is lignitic or bituminous. In addition, NaO is indicative of fouling properties of the ash. Most of the Muley Canyon coal ash samples were lignitic and fell in the low fouling range.

Although more sampling has been completed in the Muley Canyon coal than the Ferron Sandstone coal, the sample population of the Muley Canyon is very small in comparison with typical sampling for resource evaluation in a field under exploration and development or for quality control in producing fields, such as those in central Utah. Tabet (2000) infers that quality control, blending of coals, selective mining, and selective washing of Muley Canyon coal could produce a low ash, low sulfur coal with low slagging and fouling characteristics that would be similar to other coal currently mined and produced in central Utah.

ECONOMIC EVALUATION

Worldwide and National Markets

The markets for coal have not been steady in recent years; however, consumption has remained constant on a worldwide scale (Guzzino 2003). The market for exported coal is now a prominent feature of global trade, and coal companies increasingly compete in a global market.

The prediction for markets varies from country to country. In the United States, coal consumption has been about 1.05 billion tons of coal for approximately the last 5 years (Guzzino 2003). This demand is predicted to remain fairly level for the next several years; however, improvement in the U.S. economy and technological changes could increase the demand.

In 2002, 1.1 billion tons were produced in the United States (Guzzino 2003). Warehouse stocks in the United States have remained at about 150 to 190 million tons. Electric power production is the largest market for coal in the United States, which commands about 88% of the total production. That demand has been fairly constant for several years. Because of the stability in demand, coal prices have also remained constant, at about $17 per ton.

Although other energy sources, such as natural gas or renewable resources, seem to have fewer environmental impact issues associated with them, the coal industry appears to be dedicated to finding ways to make coal a clean energy source in order to remain competitive with other fossil fuels and non-fossil fuels as part of the Climate Change initiative and the Clear Skies initiative (Guzzino 2003). Guzzino forecasts that "(t)he U.S. expects to gain greater utilization of its coal-fired power-generating capacity from the addition of new coal-burning units. While details surrounding new coal-fired generators still remain cloudy and idealistic, the subject of new nuclear capacity remains taboo, and renewable resources are still in their infancy…while demand for coal isn't expected to skyrocket, it doesn't seem to be diminishing either."

Utah Coal Markets, Production, and Coal Resources

Tabet (2002) reported that 27 million tons were produced in 2001 from mines in Utah, and the price for coal increased slightly. The active mines are large, efficient producers that use longwall mining technology. Five companies operate 11 mines in the state, and production from individual mines ranged from fewer than 1 million tons per year to 7 million tons per year in 2001. Since 1993, production from Utah has increased about 22%, an increase attributed to Utah's low-sulfur, high-quality, bituminous coal, which is favorable for compliance with Federal emission standards. The markets for Utah coal are electrical power, industrial, export to Pacific Rim nations, and residential and commercial customers, in descending order of significance.

In Utah, production has historically been mostly from underground mines in central Utah, namely in three coal fields—the Wasatch Plateau, Book Cliffs, and Emery fields (Tabet 2002). Production from the

Wasatch Plateau and Book Cliffs has exceeded that of Emery. Historically, other smaller fields in Utah have also produced but have not been as important as these three fields.

The Wasatch Plateau field in Carbon, Emery and Sevier counties has been the largest producer, with a total production of 523.7 million tons through 2001 from more than 80 mines (Tabet 2002). In 1986, production was about 14 million tons, and in 2001, production increased to 22 million tons. Approximately 81% of the total production in Utah in 2001 came from eight mines in the Wasatch Plateau field.

In the portion of the Wasatch Plateau field in Carbon and Emery counties, the remaining in-place resources that are available for mining are estimated at 1,054.8 million tons (Tabet 2002). That resource estimate is based on coal beds that are mostly greater than 7 feet in thickness and that are greater than 200 feet and less than 2,500 feet in depth. Using a 14-foot maximum, mining thickness, which is based on the cutting height of longwall equipment, and applying recoverability factors for individual tracts, the resources are reduced to 686.0 million tons. At a yearly production rate of 14 million tons, this recoverable resource would last for 49 years; at 22 million tons, the life would be 31 years. The minable coal resource estimate for that portion of the Wasatch Plateau field in Sevier County is in progress (Tabet 2003, personal communication).

The Book Cliffs field in Carbon and Emery counties is the second largest producer, with a total production of 293.3 million tons through 2001 (Tabet 2002). From 1986 through 1995, production was in the range of 2 to 3 million tons per year, and since 1996, has been 3 to 5 million tons annually. Coal mined from the Book Cliffs accounted for approximately 19% of the Utah production in 2001.

In the Book Cliffs field, the remaining, in-place coal resources that are available for mining are estimated at 409.1 million tons (Tabet 2002). Using the similar parameters as those used for the Wasatch Plateau field, the recoverable resource estimate is 275.2 million tons. If the production rate held steady at 5 million tons per year, these resources would last for 55 years, and if production were to increase to 7 million tons annually, then the life would be 39 years.

The Emery field in Emery and Sevier counties is currently inactive, having ceased production when the last mine was closed in 1990. In 2002, plans were being developed for reopening that mine. For the field, total production through 1990 was 9.5 million tons, and peak production was fewer than 0.6 million tons in 1989.

In the Emery field, the original in-place resources are estimated at 675.8 million tons (Tabet 2002). Tabet, using a 66% recovery factor, estimated the recoverable reserves at 446.0 million tons. If past mining rates in this field were applied, the expected life would be very long.

MINERAL POTENTIAL OF THE HENRY MOUNTAINS COAL FIELD

Within the Henry Mountains coal field, coal resources are assigned a high potential, based on abundant direct and indirect evidence (H/D). Drill hole and outcrop data support that assignment and support that coal resources in the Ferron Sandstone and Muley Canyon Sandstone Members of the Mancos Shale are favorable for development. Coal is also found in the Dakota Sandstone, but based on available data, is not considered a resource.

Coal Resources—Ferron Sandstone Member

Tabet (2000) estimates 683.5 million tons of in-place, coal resources in Ferron Sandstone Member of the Mancos Shale. The reliability of the resource estimate is categorized as 27% as demonstrated, 67% as

inferred, and 6% as hypothetical. Greater than two-thirds of the total resources are in the lower confidence categories, inferred and hypothetical, which reflects that the coal has not been drilled adequately to reduce the distance between data points. Approximately 75% of the Ferron Sandstone coal resource is in Garfield County.

In Table A8-2, the coal resource is tabulated by thickness intervals (isopachs) of 2 to 6 feet, 6 to 10 feet, and greater than 10 feet, and by depth (overburden) intervals of zero to 100 feet, 100 to 1,000 feet, and 1,000 to 2,000 feet. The estimates include all coal beds that are thicker than 1 foot. The coal resource is generally thin, which is indicated by the fact that 68% of the total resource is in the thickness interval of 2 to 6 feet.

Table A8-2. Total Ferron Coal Zone Resources by Thickness and Depth of Cover

Depth (ft)	Thickness (ft)								
	2–6			6–10			10+		
	DEM	INF	HYP	DEM	INF	HYP	DEM	INF	HYP
0–100	54.2	5.1	0.0	6.7	2.2	0.0	6.9	0.0	0.0
100–1,000	81.3	187.4	12.8	20.0	84.4	0.0	5.5	0.0	0.0
1,000–2,000	4.3	103.3	16.0	4.5	75.3	9.8	4.0	0.0	0.0
TOTAL	**139.9**	**295.8**	**28.8**	**31.1**	**161.8**	**9.8**	**16.3**	**0.0**	**0.0**

All coal beds are greater than or equal to 1 foot thick; figures in millions of tons. DEM, demonstrated; INF, inferred; HYP, hypothetical. From Tabet (2000). Individual categories may not sum due to rounding in the original spreadsheet.

Based on a 2-foot minimum thickness and a 100-foot depth as the cut-off requirements for surface mining, 75.1 million tons are considered favorable for mining by surface methods. Deeper resources, which are 100 to 2,000 feet deep and which are 6 feet or greater in thickness, total 203.5 million tons and are considered favorable for underground mining methods. The total resource, considered to have development potential by surface or underground methods, is 278.6 million tons, which is 43% of the in-place resource.

Coal Resources—Muley Canyon Sandstone Member

Tabet (2000) estimates 1,526.1 million tons of in-place coal resources in the Muley Canyon Sandstone Member of the Mancos Shale. All of this resource is categorized as either demonstrated or inferred. The demonstrated resource is 62% of the total in-place resource, and the inferred accounts for 38%. The resource, which is almost exclusively in Garfield County, is only 7.5 million tons, which is approximately 0.5% of the total in-place resource in Wayne County.

In Table A8-3, the coal resource is tabulated by thickness intervals (isopachs) of 2 to 6 feet, 6 to 10 feet, and greater than 10 feet and by depth (overburden) intervals of zero to 100 feet, 100 to 1,000 feet, and 1,000 to 2,000 feet. In the Muley Canyon Sandstone, 91% of the coal resource is 6 feet or thicker and 70% is thicker than 10 feet, which is generally thicker than the Ferron coal. At Tarantula Mesa, one bed is 6 to 12 feet thick. In addition, approximately 26% of the resource has less than 100 feet of cover and 71% is at depth of 1,000 feet or less. The estimates include all coal beds that are 1 feet thick or greater.

Table A8-3. Total Muley Canyon Coal Zone Resources by Thickness and Depth of Cover

Depth (ft)	Thickness (ft)						TOTAL
	2–6		6–10		10+		
	DEM	INF	DEM	INF	DEM	INF	
0–100	78.3	4.4	107.4	7.6	172.4	20.9	**391.0**
100–1,000	42.1	11.3	118.5	75.7	383.7	449.4	**1,087.7**
1,000–2,000	1.6	0.0	4.9	1.2	36.8	9.9	**54.4**
TOTAL	**121.9**	**15.8**	**230.9**	**84.5**	**592.8**	**480.2**	**1,526.1**

All coal beds are greater than or equal to 1 foot thick; figures in millions of tons. DEM, demonstrated; INF, inferred; HYP, hypothetical. From Tabet (2000). Individual categories may not sum due to rounding in the original spreadsheet.

Based on a 2-foot minimum thickness and a 100-foot depth as the cut-off requirements for surface mining, 391.0 million tons are considered favorable for mining by surface methods. Deeper resources, which are 100 to 1,000 feet deep and 1,000 to 2,000 feet deep and which are 6 feet or greater in thickness, total 1,080.1 million tons and are considered favorable for mining by underground methods. The total resource, considered to have development potential by surface or underground methods, is 1,472.1 million tons, which is 96% of the estimated, in-place, coal resource.

Development Potential

Past and current mining in Utah has been mainly from two coal fields in central Utah —the Wasatch Plateau and the Book Cliffs. The Emery field, also in central Utah has been the third largest producer. Based on a study by Tabet (2002), these three fields could meet the demand for Utah coal at current production rates for the next 15 years. These fields, especially the Wasatch Plateau and the Book Cliffs fields, have an infrastructure for transportation and accessibility in place. As marketing conditions change nationally and worldwide, the demand for Utah coal could also change, with an increase in demand, or with a decrease driven by the availability of coal from other nations in the global market. In the next 15 years, at current mining rates, the more easily mined central Utah coal may be depleted, and industry may be interested in evaluating other fields, such as the Henry Mountains field. However, at present, development of coal resources in the Henry Mountains field does not seem likely within the time frame of 15 to 20 years, which is the planning horizon of a BLM land use plan.

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FIGURES FOR COAL RESOURCE EVALUATION OF HENRY MOUNTAINS COAL FIELD

Figure 1 – Henry Mountains Coal Field

Figure 2 – Henry Mountains Surface Estate

Figure 3 – Henry Mountains Known Recoverable Coal Resources

Figure 4 – Physiographic Provinces of Utah

Figure 5 – Regional Geographic Provinces

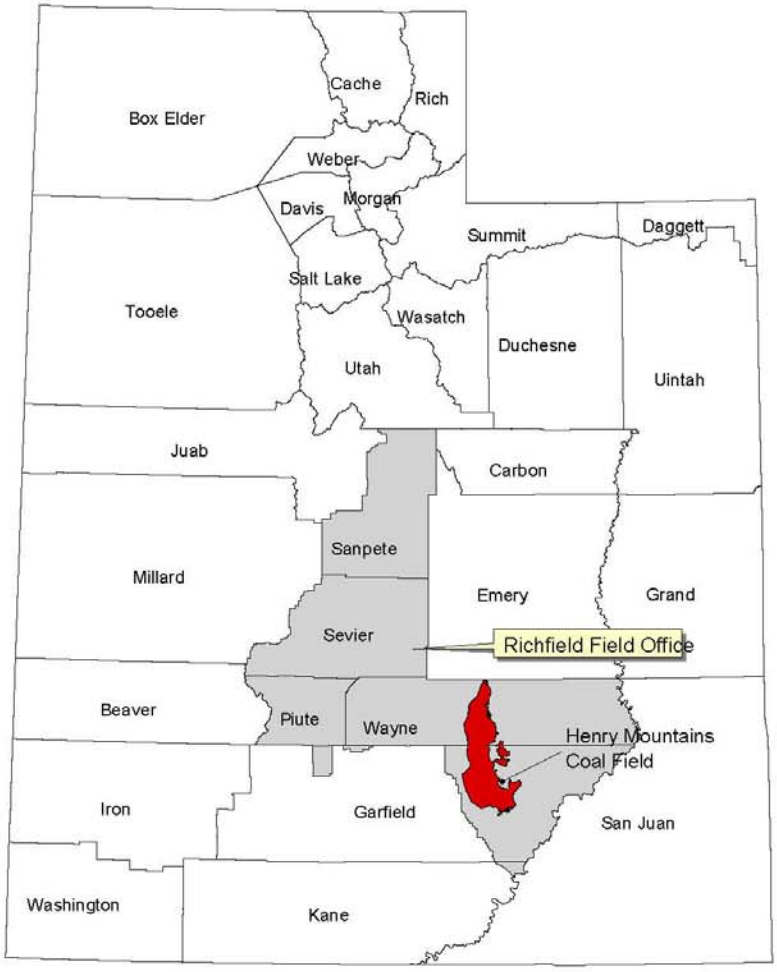
Figure 6 – Regional Stratigraphic Section

Figure 7 – Upper Cretaceous Strategic Nomenclature

Figure 8 – Ferron Coal Zone

Figure 9 – Muley Coal Zone

Figure 1: Location Map of the Richfield Field Office and the Henry Mountains Coal Field



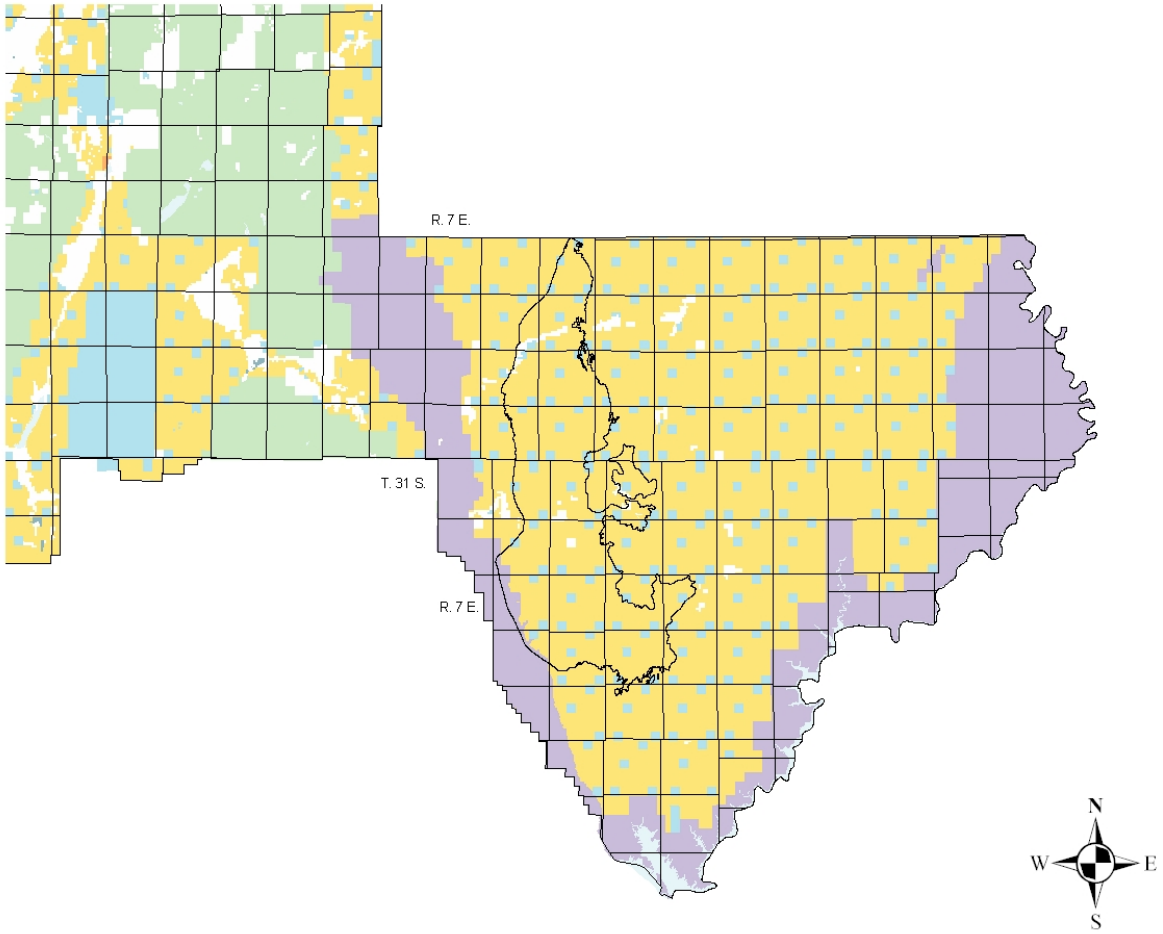
1:3,600,000

0 25 50 75 100 Miles

Source: BLM GIS Data Base and Tabet, 2000

N W E S

Figure 2: Surface Estate in the Vicinity of the Henry Mountains Coal Field



Henry Mountains Coal Field

Surface Estate

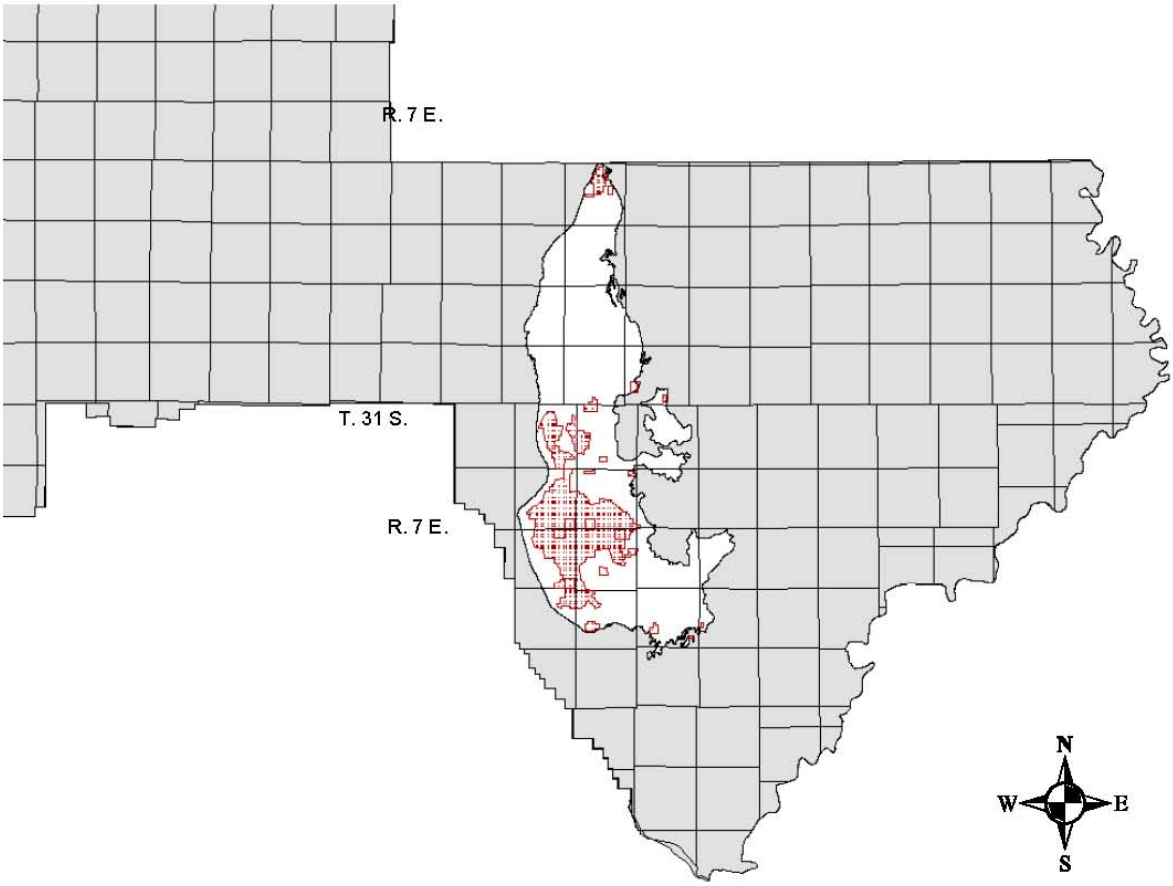
- Bureau of Land Management (BLM)
- BLM Wilderness Area
- US Forest Service (USFS)
- National Park Service (NPS)
- Water
- State

1:1,000,000

0 5 10 15 20 Miles

Source: BLM GIS Data Base and Tabet (2000)

Figure 3: Henry Mountains Known Recoverable Coal Resource Area



1:1,000,000

5 0 5 10 15 20 Miles

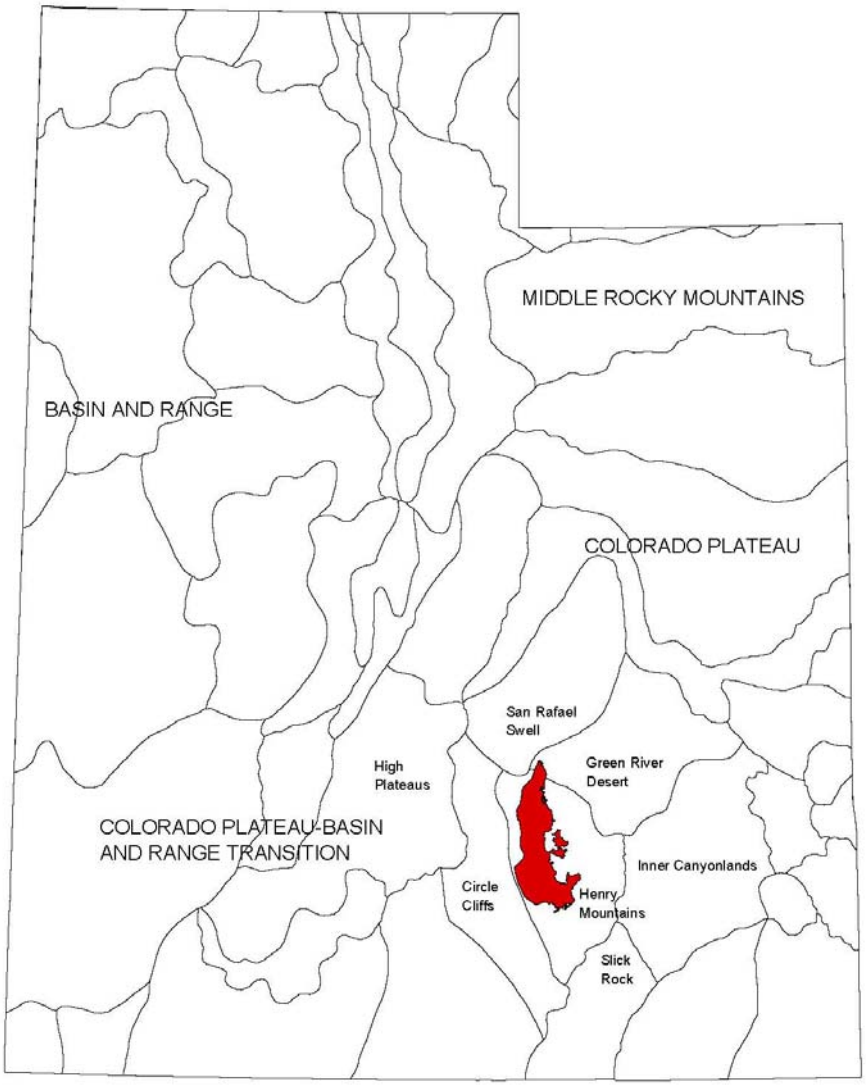
Henry Mountains Known Recoverable Resouce Area

Henry Mountains Coal Field

Richfield Field Office

Source: BLM GIS Data Base,and Tabet (2000)

Figure 4: Physiographic Provinces and Subdivisons of Utah



50 25 0 50 Miles

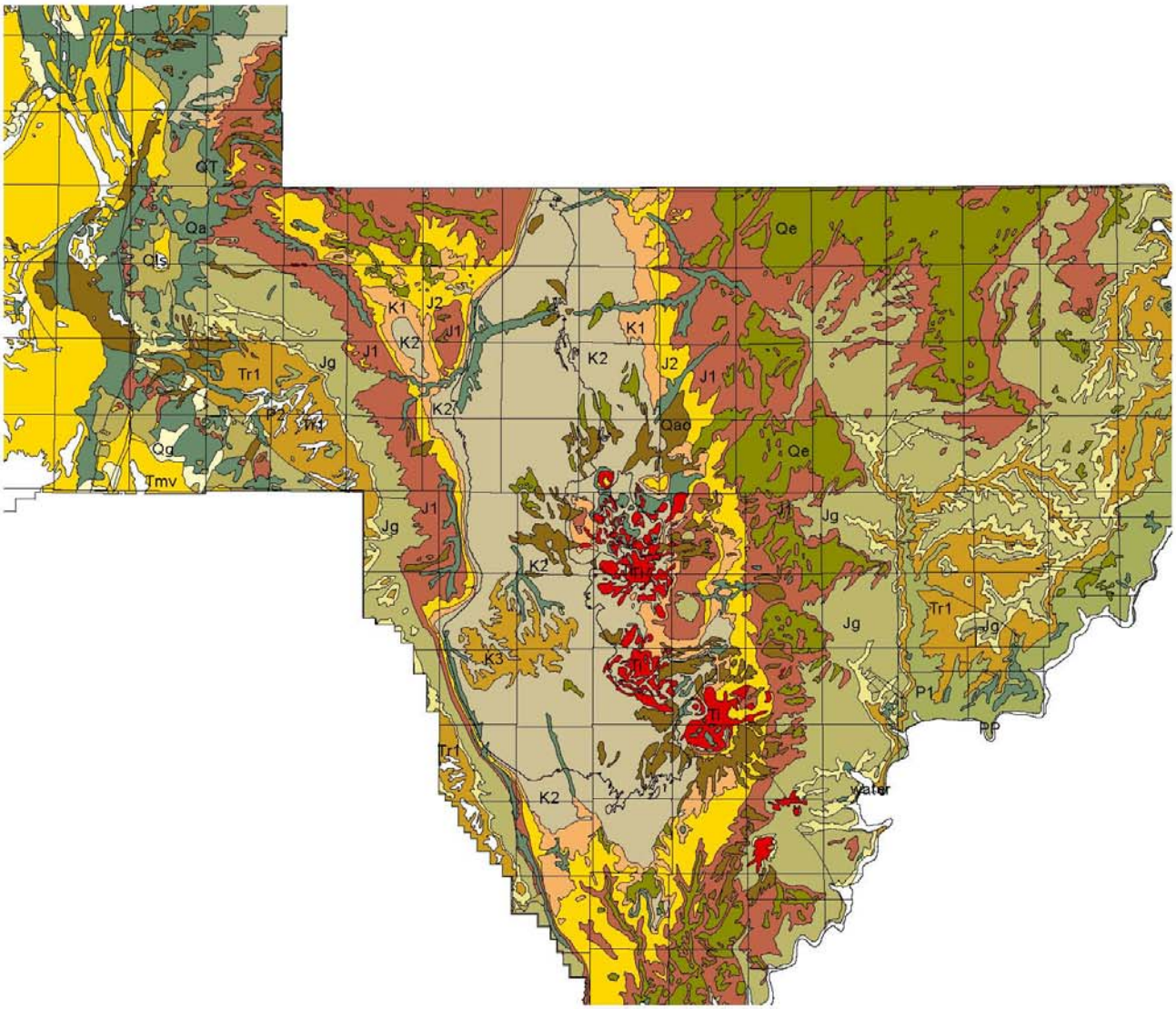
N
W E
S

Henry Mountains Coal Field

Physiographic provinces (caps) and subdivision in the vicinity of the coal field

Source: BLM GIS Data Base, Stokes (1986), and Tabet (2000)

Figure 5: Regional Geologic Map



Henry Mountains Coal Field

Geologic Map Units

- Qa--Alluvium
- Qao--Older Alluvium
- Qe--Eolian Deposits
- Qg--Glacial Deposits
- Qls--Landslides
- Ti--Intrusive Rocks
- Tmv--Miocene Volcanic Rocks
- K3--Tarantula Mesa Sandstone
- K2--Mancos Shale
- K1--Dakota Sandstone & Cedar Mountain Formation
- J2--Morrison Formation
- J1--San Rafael Group
- Jg--Glen Canyon Group
- Tr2--Chinle Formation
- Tr1--Moenkopi Formation
- P1--Cutler Group

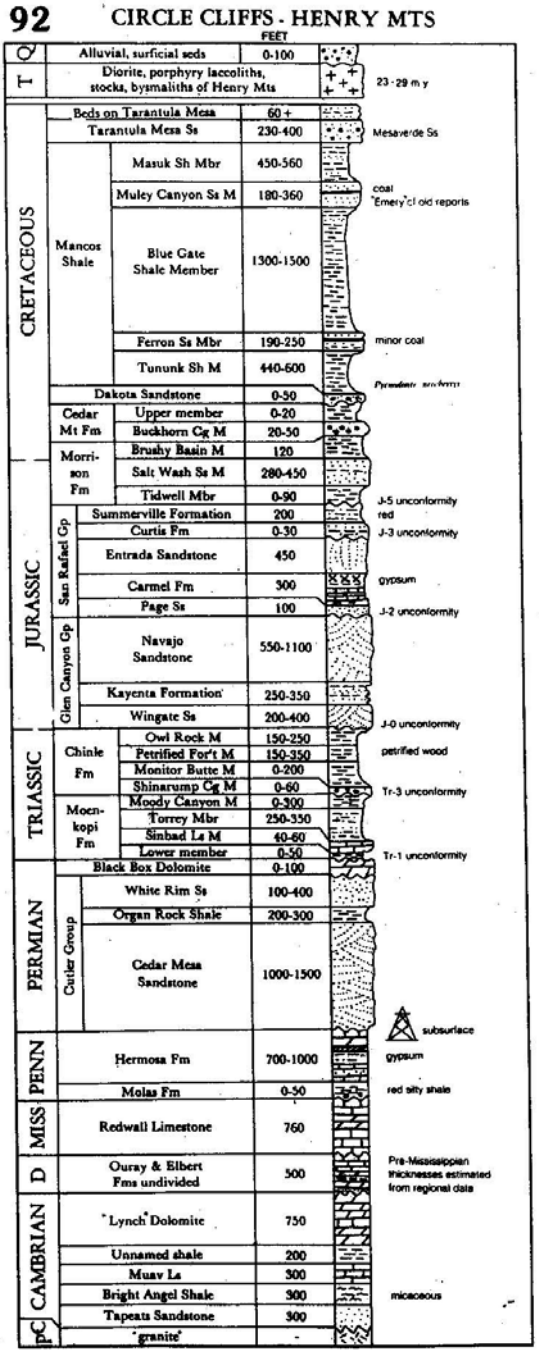
1:720,277.139346

0 5 10 Miles

N W E S

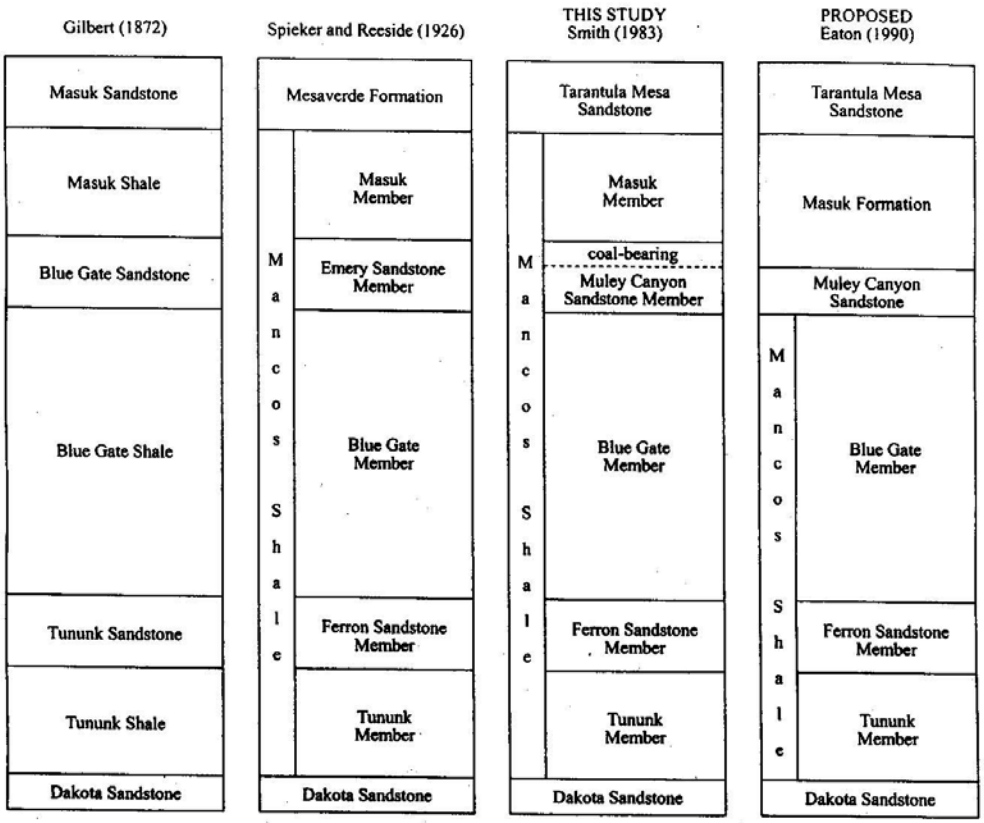
Source: BLM GIS Data Base, including Hintze (1980) and Tabet (2000)

Figure 6: Regional Stratigraphic Section (Hintze, 1988)



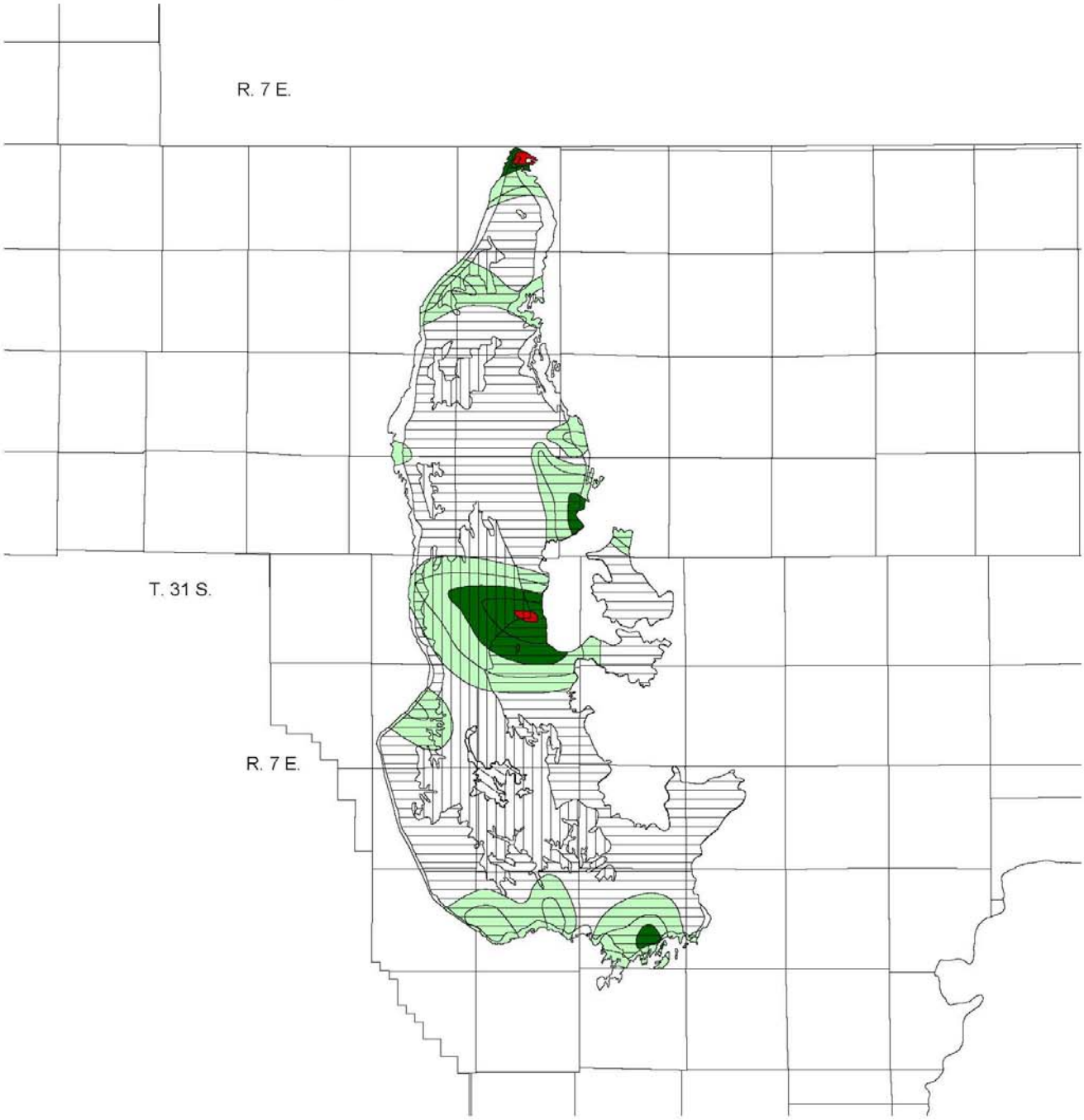
MAPS WITH TEXT–Hunt et al, 1957; Doelling, 1975; Hansen et al, 1984; Morris, 1984; Whitlock, 1984; Davidson, 1967; Baud, 1954; CENOZOIC–Hunt, 1956; Affleck & Hunt, 1980; CRETACEOUS–Smith, 1963; Law, 1979, 1980; Doelling & Graham, 1978a; Peterson et al, 1980; Lessard, 1973; Manfield, 1976; Lawyer, 1978; Molenaar, 1983; JURASSIC–Stokes, 1980; Peterson, 1980, 1984; Pipiringos & O'Sullivan, 1978; TRIASSIC–Lupe, 1984; Blakey, 1974; Fris, 1980; PERMIAN– Gridley, 1974; PALEOZOIC–Doelling, 1975; Munger et al, 1965; Wells, 1954; Irwin, 1971, 1976.

Figure 7: Upper Cretaceous Stratigraphic Nomenclature



From Tabet (2000). This Study refers to Tabet (2000) and is the nomenclature used in this report as well.

Figure 8: Ferron Coal Zone



Ferron Coal Zone

Isopachs of Coal Zone

- 2-6 ft
- 6-10 ft
- Greater than 10 ft

Overburden Depth

- Less than 100 ft
- 100 to 1,000 ft
- 1,000 ft to 2,000 ft
- Greater than 2,000 ft

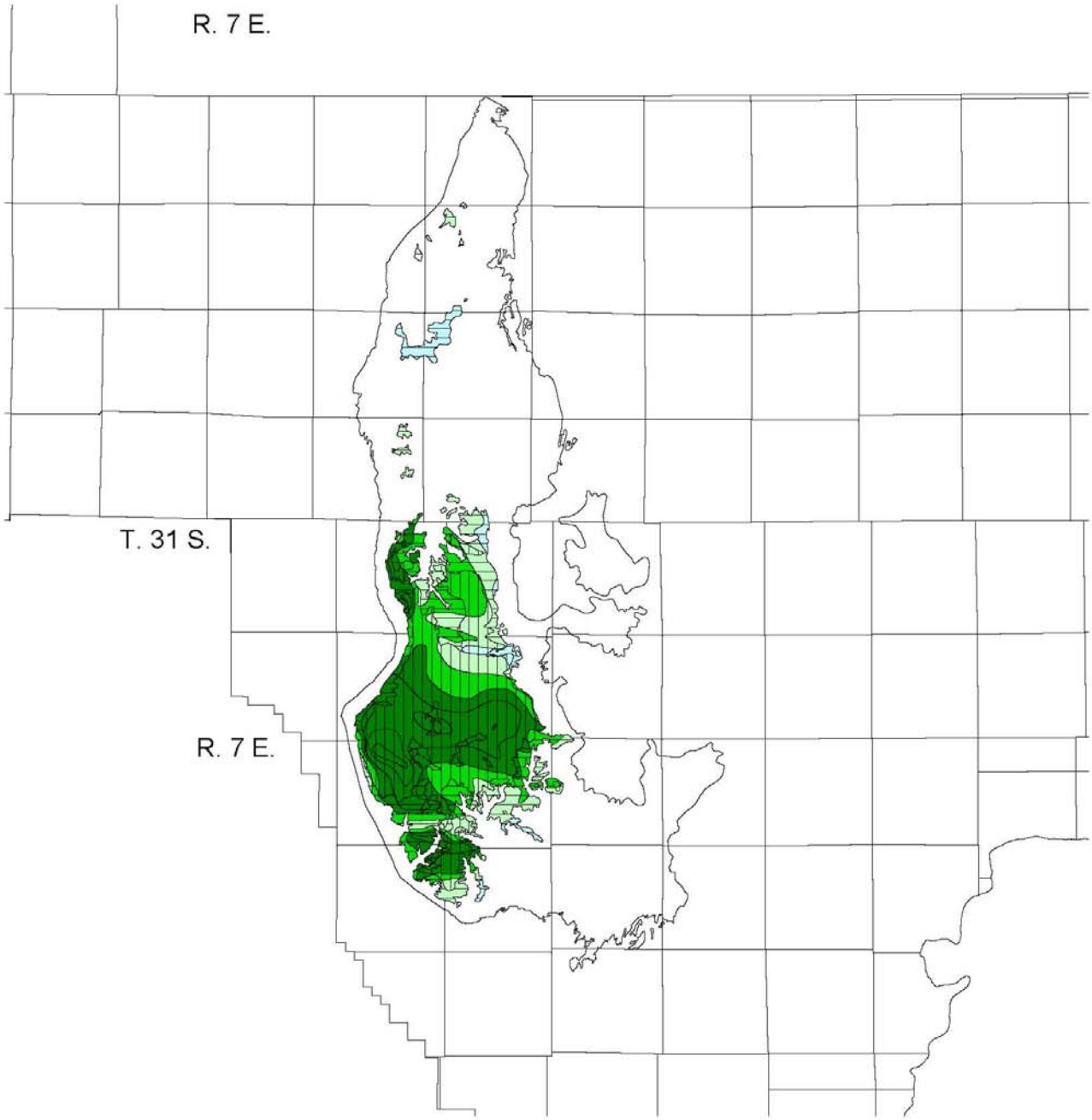
1:480,000

0 1 2 4 6 Miles

N W E S

Source: Tabet (2000) as modified

Figure 9: Muley Canyon Coal Zone



Muley Canyon Coal Zone

1:480,000

Isopachs of Coal Zone

- 0-2 ft
- 2-6 ft
- 6-10 ft
- Greater than 10 ft

Overburden Depth

- Less than 100 ft
- 100 to 1,000 ft
- Greater than 1,000 ft

0 1 2 4 6 Miles

N W E S

Source: Tabet (2000) as modified

COAL RESOURCES OF THE BLM RICHFIELD PLANNING AREA

EXECUTIVE SUMMARY

All or parts of three coal fields occur within the Richfield planning area: the Wasatch Plateau, Emery, and Henry Mountains coal fields. More than 290 million tons of unleased, recoverable coal remains in the southern Wasatch Plateau coal field, and these resources have the highest development potential. From 2003 through 2017, the coal immediately around the Southern Utah Fuel Company (SUFCO) mine will likely be developed to extend the life of that operation. In the 15 years beyond 2017, other minable resources near the SUFCO mine will also likely be mined to further sustain that operation. Additional coal resources in the southern Wasatch Plateau coal field that could support new mines in the next 30 years occur in the area west of the SUFCO mine once called the Skumpah Canyon tract, the area to the west of the Joes Valley graben around Ferron Canyon, and the area a few miles north of Interstate 70 under the Old Woman Plateau.

The area with the second highest development potential is the Sevier County portion of the Emery coal field, where 190 million tons of recoverable coal resources have been identified. These resources will probably be developed after the Emery County portion of the Emery coal field resources are exhausted around 2030.

Attractive, but more remote coal resources occur in the Henry Mountains coal field, where 130 million tons of recoverable coal resources have been identified. These resources will probably become more important as the resources in the Book Cliffs, Wasatch Plateau, and Emery coal fields are approaching exhaustion— possibly starting by 2030.

INTRODUCTION

Background

To assist the U.S. Bureau of Land Management (BLM) in updating its management plan for the Richfield area, which covers all or parts of Garfield, Piute, Sanpete, Sevier, and Wayne counties in Utah, the Utah Geological Survey (UGS) was asked to generate information on the unleased, recoverable coal resources in the area and provide a reasonably foreseeable development scenario for those resources. The UGS used location and thickness data from its geographic informational system (GIS), information on previously mined areas, fault locations, and natural and cultural features that might inhibit future mining that had been compiled for coal availability studies of the Emery and Wasatch Plateau coal fields with funding from the U.S Geological Survey (USGS), to examine those fields. The analysis of the coal resources for the Henry Mountains coal field was modified from an earlier resource study by the UGS (Tabet 1999); rather than generating coal thickness maps by gridding and contouring via computer, hand-drawn coal isopach maps were digitized to provide thickness data for the new estimate of available coal in the Henry Mountains coal field. BLM mining engineers provided the engineering guidance used by the UGS for its evaluation to derive the coal resources that would be economical to mine under current and reasonably foreseeable market conditions.

Study Methods

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 98™, or higher, operating system. This 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 estimate of the density of the coal. Maps showing the extent and thickness of identified coal beds were constructed from scattered points of observation (drill hole records and outcrop measurements), or digitized from existing hand drawn coal isopach maps. 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 using a fourth-order, distance-weighting function) was selected to assign thickness values to individual 30-meter by 30-meter cells in a grid covering the areal extent of the coal formations in the study area. To define the remaining coal resources, the coal thickness information was combined with information on past mining, current leases, faulting, depth of cover, and other technical and cultural features that would potentially limit future mining.

Using these various individual coal bed thickness maps, polygonal areas were outlined to define the coal that would likely be economical to mine in the future. These polygonal areas generally had to contain coal thicker than 6 feet, cover greater than 100 feet and less than 2,500 feet, and contain resources that could be classified in the USGS's "demonstrated" resource reliability category (Wood et al., 1983) for at least 80% of the resource area. The resulting grids of the areas likely to be mined were converted from a floating-point (decimal) format to integer values. For example, all cells with coal bed thickness values greater than 6 but less than 8 feet were reclassified to the integer 7; for resource calculations, these cells were assigned a thickness of 7 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 coal bed 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, *et al.* 1983).

For the resource areas identified for future mining in the Wasatch Plateau coal fields, BLM mining engineers provided the recovery factor to apply to the identified resources to determine the recoverable resources; slightly lower recovery factors were applied to the Emery and Henry Mountains fields because less is known about mining conditions there. In general, coal in tracts suitable for surface mining were assigned an 80% recovery factor, those suitable for longwall mining were assigned a 60 to 70% recovery factor, and tracts suitable for extraction with continuous miners were assigned a 50% recovery factor. Only general information is available at this time regarding the quality of the coal and the roof and floor conditions in the various delineated minable tracts. Specific information about 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 tracts delineated. Some attempt to account for these factors was made in applying slightly different recovery factors to some tracts. Detailed mine planning and study of the economic aspects of extracting and marketing the resources identified is warranted to actually classify them as reserves; however, this study identifies the maximum area likely to be of interest for coal development in the next 30 years and gives an idea of the magnitude of recoverable resources remaining.

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 in part by the USGS. This database includes information from both unpublished and published sources. The BLM provided additional records as part of a cooperative data sharing agreement.

Keypunched 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 coal bed and exported as dBase (*.dbf) files for use in the ArcView™ GIS program. All data records were reexamined 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 is recorded to the nearest tenth of a foot. Elevation (mean sea level) and spatial coordinates are uniformly 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 thousands of point locations were examined for possible use, and only the most reliable data records were selected. Drill hole data were preferentially selected because they provide the most reliable coal bed thickness, depth, and location values. Measured section data were selected in areas where drill hole data were lacking; such data indicate minimum coal thickness because coal beds in Utah commonly 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 it was judged an elevation record for a measured section record was unreliable, the record was not used to construct a coal bed elevation map. The selected point data were used to prepare coal bed elevation, interburden, and thickness maps.

Setting

Garfield, Piute, Sanpete, Sevier, and Wayne counties include all or part of 3 of the state's 22 coal fields: the Emery, Henry Mountains, and the southern part of the Wasatch Plateau coal fields. These three coal fields together originally contained a resource estimated at more than 12.8 billion tons of minable coal (see Table A8-4), and were estimated by Doelling (1972a, b) to make up about one-third of the state's coal resources. As of 2003, mining occurs only in the Book Cliffs, Emery, and Wasatch Plateau coal fields.

Table A8-4 shows selected Utah coal fields with original minable resources in billions of tons. (coal beds $\leq$ 3,000 feet deep and $\geq$ 4 feet thick; from Doelling 1972a, Anderson 1983, Tabet 1999)

Table A8-4. Selected Utah Coal Fields With Original Minable Resources in Billions of Tons.

Coal Field	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
*Henry Mountains	0.543	0.000	0.543
Kaiparowits Plateau	7.878	7.320	15.198
Kolob	2.014	0.000	2.014

Coal Field	Identified Resources	Hypothetical Resources	Grand Total
*Wasatch Plateau	6.379	3.888	10.267
TOTAL	**23.641**	**12.279**	**35.920**

* Field has resources in the Richfield Resource Area

The Emery, Henry Mountains, and Wasatch Plateau coal fields have numerous thick coal zones, some in excess of 15 feet thick. However, most of the coal zones are lenticular and commonly split into several thinner beds and then disappear over a distance of a few miles. The lenticular nature of the coal, the non-uniformity of floor and roof strata over even small areas, the 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 more than 6 feet. At present, nearly all Utah coal operations are mining beds thicker than 6 feet. The coal beds of the Richfield District planning area occur in Upper Cretaceous strata; those of the Henry Mountains coal field occur in both the Ferron Sandstone Member of the Mancos Shale and the Muley Canyon Sandstone; the Wasatch Plateau coals occur in the Blackhawk Formation; and the coals of the Emery coal field are found in the Ferron Sandstone Member of the Mancos Shale.

The heat content of the Richfield planning area's bituminous coal is high compared with that of the sub-bituminous coals typically produced in Montana, New Mexico, and Wyoming. Typical as-received heat contents range from 10,000 to 12,700 British thermal units (Btu) per pound of coal. Sulfur content is usually low (< 1 weight percent) in the coal fields of the planning area, but there are some areas with medium to high (1 to 3 weight percent) sulfur, particularly in the Emery and Henry Mountains coal fields. Near-surface coal quality is commonly degraded by oxidation and it may be burned for a considerable distance from the outcrop.

KNOWN OCCURRENCES AND CHARACTERISTICS

Henry Mountains Coal Field

Setting

The remote Henry Mountains coal field occurs in an area of scenic beauty. The striking Waterpocket Fold to the west has been set aside, in part, as Capitol Reef National Park, while to the south and southeast are parts of Glen Canyon National Recreation Area (NRA). BLM administers the majority of the coal-bearing lands in the coal field. The Henry Mountains coal field area has few paved roads and no railroads. State Highway 24 crosses the northern part of the coal field and is the only paved road in the area. State Routes 95 and 276 run parallel to and 10 miles east of the eastern margin of the coal field. Access to most parts of the coal field is limited to dirt roads. The nearest rail line is the Union Pacific line at Green River about 60 miles to the north. The remote, relatively roadless nature of the Henry Mountains coal field area led the BLM in 1990 to delineate three proposed wilderness areas covering parts of the coal field. The wilderness alternatives proposed by the Utah State Office of the BLM in 1990 for portions of the three Wilderness Study Areas (WSAs) in the Henry Mountains coal field constrain potential development of the coal resources of only a few sections of land, leaving the majority of the area open for future development. Although the BLM (1999) conducted a re-inventory of Utah lands for wilderness that substantially increased the areas in the Henry Mountains coal field considered to have wilderness potential, those lands have been withdrawn from wilderness protection as the result of settlement of a lawsuit brought by the State of Utah against the U.S. Department of the Interior (DOI).

Elevations in the area of the Henry Mountains coal field range from about 4,600 feet at the far northern end of the field to more than 11,000 feet in the central Henry Mountains. The topography varies from steep, rugged terrain in the Henry Mountains on the east, to a series of dissected mesas and buttes in the central part of the coal field, to cuestas and hogback ridges along the western margin of the coal field.

The principal Cretaceous coal-bearing strata of the Henry Mountains coal field cover parts of central Wayne and Garfield counties. Cretaceous strata are preserved in a structural basin, the Henry Mountains syncline, which is bounded on the west by the monocline of the Waterpocket Fold, and on the east by the Monument upwarp. This north–south elongated basin extends about 50 miles along its axis and is 2 to 18 miles wide.

Along the Waterpocket Fold on the west, the Cretaceous strata have an average inclination of 25 to 30 degrees to the east (Doelling 1972b). Within the center of the basin the strata are nearly horizontal, while the strata on the eastern flank of the basin generally dip gently to the west at less than 10 degrees, except near the Henry Mountains intrusive bodies, where they may be steeply folded and faulted. The only significant faulting unrelated to the intrusive bodies of the Henry Mountains is at the far northern end of the basin near Factory Butte, where a series of east–west trending normal faults with displacements of less than 30 feet have been mapped (Doelling 1972b).

Coal Geology

A small amount of unminable coal occurs in the Dakota Sandstone, and minable quantities occur in the Ferron Sandstone Member of the Mancos Shale and Muley Canyon Formation. The unminable coal in the Dakota Sandstone extends into a very small portion of south central Emery County. The Dakota coals are very thin and discontinuous and are an insignificant resource. The coals of the Ferron are locally thick, but not very continuous, and have limited potentially minable resources. Muley Canyon coals are the thickest, most continuous, and have the largest potentially minable resource (Doelling 1972b).

Ferron Coals—the coals in the Ferron Sandstone Member of the Mancos Shale occur in the upper nonmarine strata,, in a 50-foot-thick zone immediately above the lower marine part of the Ferron. The coal interval contains one to five beds that have an aggregate thickness ranging from zero to 16.5 feet. Coal beds seldom exceed 4 feet in thickness and commonly average 1 to 3 feet thick.

The areal distribution of coal is patchy, with isolated, east-west elongated pods found in three separate locations across the Henry Mountains basin. The pods are approximately 1 to 5 miles wide and from 3 to 10 miles long. Although the coal thickness data are primarily from the margins of the coal field, it appears that the coal is best developed in three widely separated areas in the northern, central, and southern parts of the field. The coal estimates in the central area are more speculative than the other two because they rely heavily on data from a single, deep petroleum well. The Ferron coal in the northern area near Factory Butte is the thickest and occurs under cover of less than 200 feet of overburden over an area of a few square miles.

Because the depositional environment for the Ferron in the Henry Mountains basin has been interpreted as a fluvial-deltaic complex (Uresk 1979, Hill 1982), the east–west elongate coal pods might reflect interfluvial swamps formed on eastward prograding fluvial-deltaic lobes that formed in the northern, central, and southern parts of the basin. However, the original distribution of coal near the top of the Ferron might have been altered by erosion prior to the deposition of the overlying Blue Gate Member, leaving a coal bearing unit of variable thickness.

The coal in the Ferron Sandstone generally occurs in its upper portion, but in many places throughout the field no is coal present. Therefore, the top of the Ferron was mapped because it approximated the depth

to the coal zone throughout the whole coal field. The top of the Ferron is exposed around the margins of the Henry Mountains basin, and it reaches a maximum depth of slightly more than 2,000 feet under a several-square-mile area beneath the highest portions of Tarantula Mesa in the central part of the basin. Thus, all the Ferron coal deposits of the Henry Mountains coal field, where thick enough to mine, occur at potentially minable depths.

Muley Canyon Coals—The upper part of the Muley Canyon Sandstone is a nonmarine coal-bearing interval, which ranges from 92 to 209 feet thick and averages about 150 feet thick. This stratigraphic interval is considered the Muley Canyon coal zone in this report. Coal in this zone commonly occurs in 3 to 4 beds, but as many as 10 coal beds can be found locally. Individual coal beds range from zero to 13.4 feet thick but are commonly 2 to 5 feet thick. The aggregate thickness of all the coal beds in the Muley Canyon zone ranges from zero to 27.5 feet. Most of area underlain by this zone has at least 5 feet of total coal, and about half of the area has 10 feet or more of total coal.

Unlike the Ferron, coal occurs throughout the area underlain by the Muley Canyon Sandstone. The Muley Canyon coals are thickest in elongate pods oriented in an east–west direction that tend to be thicker on the west side of the basin and that thin gradually to the east (Tabet 1999). The largest thick pod of coal lies in the center of the basin, as was the case with the Ferron coals.

Potentially surface-minable coal is found under broad areas at the northern and southern ends of the Muley Canyon coal zone's extent, where less than 100 feet of cover is common (Tabet 1999). The extensive, thick Muley Canyon coal under Tarantula Mesa reaches a maximum depth of slightly more than 1,000 feet, and therefore is extractable via underground mining methods at shallow to moderate depths.

Coal Quality

Chemistry of the Ferron Coals—The analytical data provided here comes from a UGS coal quality database, now in digital form, much of which was originally complied by Doelling (1972a). Only four coal sample analyses from the Ferron have been published for the Henry Mountains coal field (see Table A8-5). These coals have an apparent rank of high-volatile C bituminous. The four samples are from the northern (three samples) and southern (one sample) edges of the field. The mean values for the sample analyses indicate the coals are high in ash (14.5%) and sulfur (2.5%) contents.

Table A8-5. Proximate Analyses of Ferron Coal Samples from the Henry Mountains Basin

Cadastral Location	Moisture (%)	Volatile Matter (%)	Fixed Carbon (%)	Ash (%)	Sulfur (%)	Btu per Pound (%)
02-27S-09E	8.3	34.1	43.8	13.8	1.6	10,650
11-27S-09E	4.9	33.5	48.7	12.9	2.6	10,920
11-27S-09E	5.5	33.6	44.9	16.0	2.5	10,840
36-34S-10E	4.6	38.1	42.2	15.1	3.2	11,743
Mean	**5.8**	**34.8**	**44.9**	**14.5**	**2.5**	**11,038**
Minimum	**4.6**	**33.5**	**42.2**	**12.9**	**1.6**	**10,650**
Maximum	**8.3**	**38.1**	**48.7**	**16.0**	**3.2**	**11,743**
STD.DEV.	**1.7**	**2.2**	**2.8**	**1.4**	**0.7**	**483**

Chemistry of the Muley Canyon Coals—The coal beds in the Muley Canyon have been more extensively sampled than those in the Ferron, but the samples are not uniformly distributed over the whole area underlain by these coals. The samples come primarily from the northern and southern ends of the field (from areas with shallow cover) and not as many are from the deeper central portion of the field. The Muley Canyon analyses come from 3 shallow prospects and 29 drill cores (see Table A8-6).

The Muley Canyon coal has an apparent rank of sub-bituminous A to high-volatile bituminous C (Hatch, *et al.* 1979, Law 1980). This slightly lower rank than the Ferron coals translates to a lower heat content and higher moisture content for the Muley Canyon coals.

The mean ash content of the Muley Canyon coals, at 12.1%, is less than that of the Ferron coals, but is higher than the coals produced from the Wasatch Plateau and Book Cliffs coal fields, which typically have an average ash content of about 10%. The ash content of the Muley Canyon coals varies across the coal field, and is highest in two east–west trending lobate-shaped areas—one each in the northern and southern parts of the field.

The sulfur content of the Muley Canyon coals can range as high as 3.2% (see Table A8-6), which is as high as the Ferron coals, but the mean sulfur content of the Muley Canyon samples is considerably less at 0.94%. In comparison, the sulfur content of coal presently produced from the Wasatch Plateau and Book Cliffs coal fields ranges from 0.5 to 1.0%. The sulfur content of the Muley Canyon coals across the coal field is highest in one east–west trending area that occurs in the same area as the northern high-ash area (Tabet 1999).

Table A8-6. Proximate Analyses of Muley Canyon Coal Core and Prospect Samples

Cadastral Location	Moisture (%)	Volatile Matter (%)	Fixed Carbon (%)	Ash (%)	Sulfur (%)	Btu per Pound (%)
22-31S-8E	11.5	35.3	40.3	12.9	0.8	10,110
22-31S-8E	11.0	35.4	37.0	16.6	0.4	9,440
22-31S-8E	9.5	32.7	33.3	24.5	2.0	8,510
23-31S-8E	11.6	36.6	42.7	9.1	0.6	10,620
23-31S-8E	10.3	36.0	36.3	17.4	0.7	9,400
23-31S-8E	10.9	38.2	42.4	8.5	1.0	10,790
36-31S-8E	13.51	31.99	35.69	18.81	0.53	9,015
36-31S-8E	13.87	34.37	41.33	10.43	1.0	10,204
07-31S-9E	13.1	34.0	45.1	7.8	0.7	10,210
17-31S-9E	13.0	35.0	37.7	14.3	0.7	9,670
18-31S-9E	12.5	33.6	35.7	18.2	0.7	9,300
18-31S-9E	12.7	32.2	32.0	23.1	3.2	8,520
19-31S-9E	12.5	34.6	39.3	13.6	0.5	9,990
19-31S-9E	13.7	36.5	42.7	7.1	0.6	10,600
20-31S-9E	11.6	35.4	36.3	16.7	2.8	9,610
20-31S-9E	12.1	37.1	41.4	9.4	0.4	10,660
30-31S-9E	10.9	36.5	45.9	6.8	0.8	10,700
30-31S-9E	11.5	38.5	40.8	7.7	1.5	12,491
05-32S-9E	13.6	32.56	39.3	14.54	0.8	9,597
05-32S-9E	13.6	35.25	36.19	14.96	0.69	9,652
12-33S-8E	14.7	27.4	30.6	27.3	0.4	7,710
24-33S-8E	14.37	35.57	35.14	16.92	0.99	9,156

Cadastral Location	Moisture (%)	Volatile Matter (%)	Fixed Carbon (%)	Ash (%)	Sulfur (%)	Btu per Pound (%)
24-33S-8E	14.37	34.92	42.47	8.24	1.16	10,231
24-33S-8E	14.37	35.61	45.48	4.54	1.09	10,759
02-33S-9E	10.48	38.29	45.25	5.98	0.78	11,468
11-33S-9E	11.34	36.09	43.86	8.71	0.46	10,856
11-33S-9E	13.7	37.2	44.19	4.91	0.47	11,121
14-33S-9E	12.29	36.65	45.49	5.57	0.55	11,147
22-33S-9E	13.3	36.23	39.33	11.14	1.05	8,178
23-33S-9E	13.48	34.45	43.61	8.46	0.83	10,660
23-33S-9E	13.3	36.36	43.36	5.97	0.67	11,010
23-33S-9E	14.28	34.89	43.51	7.32	1.12	10,718
Mean	**12.1**	**35.2**	**40.1**	**12.1**	**0.94**	**10,067**
Minimum	**9.5**	**27.4**	**30.6**	**4.54**	**0.40**	**7,710**
Maximum	**14.7**	**38.5**	**45.9**	**27.3**	**3.20**	**12,491**
STD. DEV.	**1.4**	**2.2**	**4.3**	**6.0**	**0.64**	**1,030**
(Statistics for 28 samples with less than 20% ash)						
Mean	**12.6**	**35.6**	**41.0**	**10.8**	**0.84**	**10,255**
Minimum	**10.3**	**31.99**	**35.14**	**4.54**	**0.46**	**8,178**
Maximum	**14.4**	**38.5**	**45.9**	**18.81**	**2.8**	**12,491**
STD. DEV.	**1.3**	**1.5**	**3.5**	**4.5**	**0.46**	**876**

The heat content of Muley Canyon coals ranges from 7,710 to 12,491 Btu per pound and averages 10,067 Btu per pound (see Table A8-6). The average heat content of these coals is considerably below the 11,400 to 12,000 Btu/lb range currently produced at mines in Carbon and Emery counties. The heat content distribution across the coal field consists of east–west trends with low heat areas corresponding directly with areas having high-ash contents (Tabet 1999). In addition to the primary east–west trend of the heat content values, the heat content of the Muley Canyon coals appears to be slightly higher on the eastern side of the field than on the west, suggesting that the coals on the eastern side of the field were possibly thermally upgraded by the intrusion of the Henry Mountains laccoliths.

The ash chemistry of some of the Muley Canyon coals has also been analyzed (Hatch, *et al.* 1979). This allows for an evaluation of the boiler slagging and fouling characteristics of these coals. Table A8-7 gives the analyzed values of the major oxides in the coal ash that can be used to predict coal utilization characteristics.

The physical and chemical transformations that the minerals in the coal ash undergo during combustion are complex processes. Vaninetti and Busch (1981) define slagging as the buildup of molten ash materials within the lower furnace section of a boiler, and fouling as the accumulation of sintered ash in the convective passes section of a boiler. Both of these problems reduce boiler efficiency, increase operating costs, and shorten boiler life. Various indices can predict the combustion characteristics of coal ash, and two of them are presented in Table A8-8. The first step in analyzing ash combustion properties is to determine the type of coal ash present. Coal ash is characterized as either lignitic or bituminous, depending on the value determined by summing CaO and MgO values, and dividing the result by the Fe_2O_3 value. Coal ash is termed lignitic when the resulting value of this calculation is greater than 1.0, and bituminous when the value is less than 1.0. Most of the Muley Canyon ash analyses fall in the lignitic ash category, although two ash samples fall in the bituminous ash category. Both of these

bituminous ash analyses come from coal samples with high iron and sulfur contents, indicating high pyrite content.

Table A8-7. Major Oxide Composition of the Ash (in Percent) From 13 Muley Canyon Coal Samples From the Henry Mountains Coal Field

Cadastral Location	Acidic Oxides			Basic Oxides					Ash
	SiO_2	Al_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	Fe_2O_3	
22-31S-8E	60.0	12.0	1.00	8.9	2.00	0.75	0.44	5.8	13.0
22-31S-8E	54.0	27.0	0.79	9.0	1.03	0.95	1.20	1.0	19.6
22-31S-8E	57.0	24.0	1.00	6.0	1.18	0.28	1.10	1.0	10.2
23-31S-8E	53.0	14.0	0.88	13.0	2.09	2.75	0.43	3.5	9.8
23-31S-8E	51.0	23.0	0.88	14.0	1.27	1.09	0.66	1.9	20.0
23-31S-8E	38.0	22.0	1.20	16.0	2.53	1.62	0.31	4.9	9.1
17-31S-9E	58.0	17.0	0.87	10.0	1.96	0.13	0.73	3.3	14.5
18-31S-9E	61.0	17.0	1.00	6.2	1.58	0.54	1.20	2.5	19.7
18-31S-9E	50.0	12.0	0.70	6.5	1.49	0.92	1.20	17.0	19.6
19-31S-9E	65.0	14.0	1.00	8.4	1.76	0.51	0.62	2.5	15.6
19-31S-9E	30.0	11.0	0.60	29.0	2.80	1.30	0.48	4.4	8.3
20-31S-9E	65.0	7.8	1.20	12.0	2.31	0.24	0.54	3.1	10.8
20-31S-9E	46.0	18.0	1.10	7.5	1.36	0.40	0.74	15.0	18.3
Mean	**52.9**	**16.8**	**0.94**	**11.3**	**1.80**	**0.88**	**0.74**	**5.5**	**14.5**
Minimum	**30.0**	**7.8**	**0.60**	**6.0**	**1.03**	**0.13**	**0.31**	**1.0**	**8.3**
Maximum	**65.0**	**27.0**	**1.20**	**29.0**	**2.80**	**2.75**	**1.20**	**17.0**	**20.0**
STD. DEV.	**10.2**	**5.8**	**0.18**	**6.2**	**0.54**	**0.71**	**0.32**	**4.9**	**4.6**

Table A8-8. Ash Type, Fouling, and Slagging Evaluation of the Oxide Composition of Muley Canyon Coal Ash

Cadastral Location	Ash Type ($CaO+MgO/Fe_2O_3$)	Fouling Severity (Percent Na_2O)	Slagging Severity (Base/Acid ratio*)
22-31S-8E	1.88(lignitic)	0.75(low)	0.245(low)
22-31S-8E	10.03(lignitic)	0.95(low)	0.161(low)
22-31S-8E	1.14(lignitic)	0.28(low)	0.181(low)
23-31S-8E	4.31(lignitic)	2.75(low)	0.320(med-severe)
23-31S-8E	8.04(lignitic)	1.09(low)	0.253(med-severe)
23-31S-8E	3.78(lignitic)	1.62(low)	0.414(med-severe)
17-31S-9E	3.62(lignitic)	0.13(low)	0.212(low)
18-31S-9E	3.11(lignitic)	0.54(low)	0.152(low)
18-31S-9E	0.47(bituminous)	0.92(medium)	0.432(low)
19-31S-9E	4.06(lignitic)	0.51(low)	0.172(low)
19-31S-9E	7.23(lignitic)	1.30(low)	0.913(low)
20-31S-9E	4.62(lignitic)	0.24(low)	0.246(low)
20-31S-9E	0.59(bituminous)	0.40(low)	0.384(low)
Mean	**4.07(lignitic)**	**0.88(low)**	**0.314(med-severe)**

* Base/Acid Ratio = $CaO+MgO+Na_2O+K_2O+Fe_2O_3/SiO2+Al_2O_3+TiO_2$

Sodium content in the ash is critical to various indices of ash-fouling potential; the simplest indicator of fouling is the total sodium oxide content of the ash alone. Bituminous and lignitic ash coals respond differently to increased sodium oxide content. Coals in the bituminous category are much more sensitive to small increases in sodium oxide. The change in ash-fouling tendency with increasing sodium oxide content, according to Vaninetti and Busch (1981), is illustrated in Table A8-9.

Table A8-9. Fouling Tendency

Factor	Ash Type	Low	Medium	High	Severe
Na_2O% in ash	bituminous	<0.5	0.5–1.0	1.0-2.5	>2.5
Na_2O% in ash	lignitic	<3.0	3.0–5.0	>5.0	

When examining just the sodium content of the ash, all but one of the Muley Canyon coal ash samples fall in the low-fouling potential range.

If coal from the Muley Canyon were mined, various quality control strategies including blending, selective mining, or selective washing could probably produce a low-ash, low-sulfur coal product similar to that presently produced in central Utah. The foregoing analysis of the ash chemistry predicts that most of the Muley Canyon coal produced would have low- to moderate-slagging and low-fouling boiler combustion properties, but detailed, site-specific sampling is needed for each area to be mined.

Coal Resources

Ferron Sandstone Member Resources—The Ferron Sandstone contains an estimated 683.5 million short tons of in-place coal resources. About three-quarters of the coal resources lie in Garfield County. Because of limited exploration data, only 27%, or 187.3 million tons, of the total resources fall into the demonstrated resource category (occurring within 0.75 miles of a thickness measurement point). The bulk of the coal resource, 67%, falls into the inferred resource category (occurring between 0.75 and 3 miles from a thickness measurement point). Only a few percent of the resources lie more than 3 miles from a thickness measurement point, or within the hypothetical category.

Eleven percent of Ferron Sandstone coal resources, or 75.1 million short tons, lie under 100 feet or less of cover. Most of the coal resources, 89%, have cover exceeding 100 feet. Although most of the coal is deeper than 100 feet, all the coal is less than 2,000 feet deep.

As mentioned above, the coal beds in the Ferron Sandstone are generally thin, and this is reflected by the fact that 68% of the resources fall into the 2- to- 6-foot thick resource category. Less than one-third of the coal resources have an aggregate thickness greater than 6 ft. The thickest coal occurs at the far northern extent of the Ferron Sandstone near Factory Butte.

In summary, the majority of the Ferron coal resources are poorly defined by USGS reliability standards, and are primarily less than 6 feet thick, deeper that 100 feet, and lie within Garfield County. The in-place coal resources for the Ferron zone are summarized by thickness, depth, and reliability categories, as well as by county, in Table A8-10, Table A8-11, and Table A8-12. Readers are cautioned that the individual resource categories in the tables may not sum to totals at the bottoms of the tables due to independent rounding.

Table A8-10. In-place Ferron Coal Zone Resources by Thickness and County

County	Thickness (ft)									Total
	2–6			6–10			10+			
	DEM[1]	INF[2]	HYP[3]	DEM	INF	HYP	DEM	INF	HYP	
Wayne	65.1	71.2	0.0	12.0	8.8	0.0	8.6	0.0	0.0	165.7
Garfield	74.8	224.6	28.8	19.1	153.0	9.8	7.7	0.0	0.0	517.8
Total	**139.9**	**295.8**	**28.8**	**31.1**	**161.8**	**9.8**	**16.3**	**0.0**	**0.0**	**683.5**

[1] DEM = Demonstrated, [2] INF = Inferred, [3] HYP = Hypothetical
(coal beds ≥ one foot thick; figures in millions of short tons).

Table A8-11. In-place Ferron Coal Zone Resources by Thickness and Depth of Cover

Depth (ft)	Thickness (ft)									Total
	2–6			6–10			10+			
	DEM[1]	INF[2]	HYP[3]	DEM	INF	HYP	DEM	INF	HYP	
0-100	54.2	5.1	0.0	6.7	2.2	0.0	6.9	0.0	0.0	75.1
100-1,000	81.3	187.4	12.8	20.0	84.4	0.0	5.5	0.0	0.0	391.3
1-2,000	4.3	103.3	16.0	4.5	75.3	9.8	4.0	0.0	0.0	217.2
Total	**139.9**	**295.8**	**28.8**	**31.1**	**161.8**	**9.8**	**16.3**	**0.0**	**0.0**	**683.5**

[1] DEM = Demonstrated, [2] INF = Inferred, [3] HYP = Hypothetical
(coal beds ≥ one foot thick; figures in millions of short tons).

Table A8-12. In-place Ferron Coal Zone Resources by Thickness and Township Tier

Tier	Thickness (ft)									TOTAL
	2–6			6–10			10+			
	DEM[1]	INF[2]	HYP[3]	DEM	INF	HYP	DEM	INF	HYP	
T. 27 S.	13.3	4.4	0.0	7.6	0.0	0.0	8.6	0.0	0.0	33.9
T. 28 S.	19.8	28.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.2
T. 29 S.	13.2	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.6
T. 30 S.	18.8	35.0	0.0	4.4	8.8	0.0	0.0	0.0	0.0	67.0
T. 31 S.	13.8	102.4	15.4	12.4	149.1	9.8	7.7	0.0	0.0	310.6
T. 32 S.	11.2	44.8	13.5	0.0	0.0	0.0	0.0	0.0	0.0	69.5
T. 33 S.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T. 34 S.	49.8	77.3	0.0	6.7	3.9	0.0	0.0	0.0	0.0	137.7
Total	**139.9**	**295.8**	**28.8**	**31.1**	**161.8**	**9.8**	**16.3**	**0.0**	**0.0**	**683.5**

[1] DEM = Demonstrated, [2] INF = Inferred, [3] HYP = Hypothetical
(coal beds ≥ one foot thick; figures in millions of short tons).

Muley Canyon Resources—The Muley Canyon Sandstone contains 1,526.1 million short tons of in-place coal resources. Because of fairly uniformly spaced exploration data, 62%, or 945.6 million tons, of the total coal resources fall into the demonstrated, or the most reliable, resource category. The remaining 38% of the coal resources, 580.5 million tons, fall into the inferred resource category, or those resources occurring at between 0.75 and 3 miles from a thickness measurement point. None of the coal resources

fall into the hypothetical category (more than 3 miles from a thickness measurement point). There are ample minable coal resources in the Muley Canyon Sandstone, but only half of one percent occur within the Wayne County portion of the field.

Looking at the coal resources by depth of cover shows that 25.6%, or 391 million short tons, lie under 100 feet or less of cover. Most of the coal resources, 74.4%, are under more than 100 feet of overburden. Although most of the coal is deeper than 100 feet, all of the coal in the Muley Canyon zone is less than 1,500 feet deep, and most of the deep coal lies under less than 1,000 feet of overburden.

Ninety-one percent of the Muley Canyon resources have a total coal thickness of 6 feet or greater. In fact, about 70% of the coal resources have a total coal thickness of more than 10 feet. Under much of the area below Tarantula Mesa, the Muley Canyon coal zone consists primary of one 6 to 12 feet thick bed (Tabet 1999). Only 9% of the coal resources have a thickness of less than 6 feet.

In summary, the Muley Canyon coal resources are mostly well defined according to the USGS reliability standards, greater than 6 feet thick, deeper that 100 feet, and lie within Garfield County. The in-place coal resources for the total Muley Canyon coal zone are summarized by thickness, depth, reliability, and county categories in Table A8-13, Table A8-14, and Table A8-15. Note that the individual resource categories in the tables below may not sum to totals at the bottoms of the tables due to independent rounding.

Table A8-13. Total Muley Canyon Coal Zone Resources by Thickness and Depth of Cover

	Thickness (ft)						
Depth (ft)	2–6		6–10		10+		Total
	DEM[1]	INF[2]	DEM	INF	DEM	INF	
0-100	78.3	4.4	107.4	7.6	172.4	20.9	391.0
100-1,000	42.1	11.3	118.5	75.7	383.7	449.4	1,080.7
1-2,000	1.6	0.0	4.9	1.2	36.8	9.9	54.4
Total	**121.9**	**15.8**	**230.9**	**84.5**	**592.8**	**480.2**	**1,526.1**

[1] DEM = Demonstrated, [2] INF = Inferred.
(coal beds ≥ one foot thick; figures in millions of short tons).

Table A8-14. Total Muley Canyon Coal Zone Resources by Thickness and County

	Thickness (ft)						
County	2–6		6–10		10+		Total
	DEM[1]	INF[2]	DEM	INF	DEM	INF	
Wayne	7.3	0.0	0.2	0.0	0.0	0.0	7.5
Garfield	114.6	15.8	230.7	84.5	592.8	480.2	1,518.6
TOTAL	**121.9**	**15.8**	**230.9**	**84.5**	**592.8**	**480.2**	**1,526.1**

[1] DEM = Demonstrated, [2] INF = Inferred.
(coal beds ≥ one foot thick; figures in millions of short tons).

Table A8-15. Total Muley Canyon Coal Zone Resources by Thickness and Township Tier

Tier	Thickness (ft)						Total
	2–6		6–10		10+		
	DEM[1]	INF[2]	DEM	INF	DEM	INF	
T. 30 S.	7.3	0.0	0.2	0.0	0.0	0.0	7.5
T. 31 S.	45.5	2.5	89.1	6.5	86.0	0.0	229.6
T. 32 S.	21.5	10.9	61.0	44.4	205.1	293.8	636.7
T. 33 S.	40.7	0.6	77.0	27.5	259.8	169.2	574.8
T. 34 S.	6.9	1.8	3.6	6.1	41.9	17.2	77.5
Total	**121.9**	**15.8**	**230.9**	**84.5**	**592.8**	**480.2**	**1,526.1**

[1] DEM = Demonstrated, [2] INF = Inferred.
(coal beds ≥ one foot thick; figures in millions of short tons).

Wasatch Plateau Coal Field

Setting

The Wasatch Plateau coal field extends southwest about 90 miles from western Carbon County, through western Emery County, and into eastern Sanpete and Sevier counties (Doelling and Smith 1982). The field, as defined by Doelling and Smith (1982), is 13 to 22 miles wide. The outcrop of the coal-bearing Blackhawk Formation forms the eastern edge of the field, and the western edge is bounded by a series of faults forming the Musinia graben near the western edge of the plateau in Sanpete and Sevier counties. Sanpete and Sevier counties contain roughly the southwestern half of the "larger" Wasatch Plateau coal field.

Only the northern third 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. Three other spurs branch off at the town of Helper, two running 5 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 that contain coal more than 6 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 southern part of the Wasatch Plateau field in Sanpete and Sevier counties can be found in Table A8-16.

Table A8-16. Thickness Range of Minable Coal for the Major Zones of the Southern Part of the Wasatch Plateau Field in Sanpete and Sevier Counties

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 1972a).

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 with resin contents of 2 to 15%. Although not presently used, the resin has been historically recovered as a by-product for use in adhesives, paints and coatings, and as a binder in printing ink (Tabet, *et al.* 1995a). Coal quality statistics are summarized in Table A8-17 and Table A8-18 for two southern Wasatch Plateau field coal beds that 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 do 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, and thus the analyses reported here use the older bed names originally assigned. Those two Wasatch Plateau coal beds (using original names) are the Hiawatha, and the Upper Hiawatha.

Table A8-17. Coal Quality Statistics for the Hiawatha Bed From the Upper Cretaceous Blackhawk Formation in the Wasatch Plateau Coal Field (As-received Basis)

Characteristic	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
Fixed Carbon (%)	45.64	54.40	31.26	1.89	502
Volatile 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 A8-18. Blackhawk Formation in the Wasatch Plateau Coal Field (As-received Basis)

Characteristic	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
Fixed Carbon (%)	45.28	51.95	34.66	4.03	30
Volatile 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 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 and volatile matter content than the other bed 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 coal field is a major Utah coal field with original, in-place coal resources in excess of 10.2 billion tons (Doelling 1972a). Based on UGS work carried out using BLM criteria, at the end of 2002, the Wasatch Plateau contained 1,122.5 billion tons of remaining, unleased, in-place coal resources that were in coal beds at least 6 feet thick and that occurred between depths of 200 to 2,500 feet. The amount of coal likely to be mined and recovered in the near future is discussed in the reasonably foreseeable development scenario at the end of this report. Some of the coal resources in the Sevier County portion of the Wasatch Plateau field are likely to be mined in the next 30 years to provide extended life for the SUFCO mine there. There are also additional resources that could support at least two new mines in the Sanpete and Sevier counties portion of the Wasatch Plateau, but their development would likely occur in the more distant part of the 30-year planning horizon.

Emery Coal Field

Setting

The Emery coal field 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 and the site of the nearest rail loadout. The field, as originally defined, is bounded on the east by an erosional escarpment, and on the west by a fault zone (Doelling 1972a). Surface exposures show the coal thinning and pinching out 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, Tabet, *et al*, 1995b). Based on published coal thickness data, the

northern boundary of the field should be defined near Price and could potentially extend farther north into the Uinta Basin.

Coal Geology

The coal of the Emery field occurs in the upper part of the 300- to 900-foot-thick Ferron Sandstone Member of the Mancos Shale. Where exposed, this unit contains 13 coal beds, 4 of which exceed 7 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 1972a). 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% 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 coal field are given in Table A8-19.

Table A8-19. Thickness Ranges of the Major Coal Beds in the Emery Coal Field

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 those for coals from the Book Cliffs and Wasatch Plateau coal fields. The rank of the coal is considered to be high-volatile C bituminous where fresh and unweathered. Shallow coal beds are commonly oxidized or burned for a considerable distance away from the outcrop. Summary coal quality data for several beds from the southern Emery coalfield are shown in Table A8-20, Table A8-21, Table A8-22, and Table A8-23.

Table A8-20. Coal Quality Statistics for the A Bed From the Upper Cretaceous Ferron Sandstone Member of the Mancos Shale in the Southern Emery Coal Field (As-received Basis)

Characteristic	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
Fixed Carbon (%)	46.32	51.01	37.88	4.38	10
Volatile 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

Characteristic	Mean	Maximum	Minimum	Standard Deviation	Sample Population
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 A8-21. Coal Quality Statistics for the C Bed From the Upper Cretaceous Ferron Sandstone Member of the Mancos Shale in the Southern Emery Coal Field (As-received Basis)

Characteristic	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
Fixed Carbon (%)	43.42	47.90	39.60	3.39	6
Volatile 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 A8-22. Coal Quality Statistics for the G Bed From the Upper Cretaceous Ferron Sandstone Member of the Mancos Shale in the Emery Coal Field (as-received basis).

Characteristic	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
Fixed Carbon (%)	43.48	50.49	29.69	5.71	12
Volatile 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 A8-23. Coal Quality Statistics for the I Bed From the Upper Cretaceous Ferron Sandstone Member of the Mancos Shale in the Southern Emery Coal Field (As-received Basis)

Characteristic	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
Fixed Carbon (%)	47.4	51.9	37.3	2.9	46
Volatile 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 coal field is also a major Utah coalfield; Quick, *et al.* (in preparation) estimate remaining, in-place, minable coal resources for the southern portion of the field to be 948 million tons. Emery County contains 68% of the in-place, minable coal resources of the Emery coal field, or 644 million tons. The Sevier County portion of the Emery coal field contains the remaining 32% of the resource, or 304 million tons, and this portion of the field is likely to be mined later than the Emery County portion of the field.

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 be predominantly from the Book Cliffs, Wasatch Plateau, and the Emery fields in this region. However, most of the easy-to-mine coal in this region will likely be depleted in the next 20 to 25 years, and coal from elsewhere in Utah will likely need to be mined to provide fuel for the state's power plants. One nearby field with coal resources favorable for mining is the Henry Mountains coal field.

Henry Mountains Coal Field

Coal in the Henry Mountains coal field has been mined in the past on a very limited scale from both the Ferron Sandstone Member of the Mancos Shale and Muley Canyon Sandstone. This coal was used locally to supply ranchers and residents of nearby towns (Doelling 1972b). Doelling (1972b) estimated the total tonnage removed from the field at about 9,000 tons, with most of it coming from the Ferron.

Ferron coal was first developed at the south end of the coal field at the Stanton mine. A couple thousand tons of coal was mined intermittently between 1888 and 1900 to supply gold dredges on the Colorado River to the south (Doelling 1972b). Small-scale mining of Ferron coal took place over a longer period at the far northern end of the field near Factory Butte. Mining in this area began in 1908 and continued

sporadically up through the 1970s. From 1908 through the 1950s, underground coal mining removed about 5,900 tons for local use. Later, the Atlas-Dirty Devil Mining Company briefly attempted strip mining the coal near Factory Butte in the late 1970s. This company opened a surface mine in June 1978, trucked the coal to Green River, and sent a test shipment by rail to the power plant at Moapa, Nevada (Uresk 1979). Problems with coal quality prevented this operation from reaching full production.

The Muley Canyon coals were first developed around 1914 by tunneling into outcrops at the northern extent of this unit. Several small mines were opened along Sweetwater and Dugout creeks to supply coal for local use (Hunt, *et al.* 1953). Hunt et al. (1953) claim this coal was also later used to fuel a rig drilling a couple of test wells in the Green River Desert. The last known activity at these mines was in the 1940s (Doelling 1972b), and the total coal removed from these mines is estimated to be about 1,000 tons.

During the mid 1970s, AMAX Coal Company, Cayman Corporation, Consolidation Coal Company, Gulf Mineral Resources Company, and the Federal Government carried out widespread exploration on lands covering most of the Muley Canyon coal area. The primary interest at the time was evaluating surface-minable coal deposits, but environmental concerns and limitations, particularly bison herd habitat, eventually caused all prospecting areas to be dropped by 1983. The availability of the exploration data from the combined efforts of all the parties active in the 1970s has allowed the delineation of more than 120 million tons of deep Muley Canyon coal resources that could be mined with less surface disturbance than the originally anticipated surface mines.

Wasatch Plateau Coal Field

The Wasatch Plateau coal field covers parts of Carbon, Emery, Sanpete, and Sevier counties. Overall, this field has both the greatest annual and greatest cumulative coal production of any coal field in the State of Utah (Utah Department of Natural Resources 2003). Coal in this field was first developed in Carbon County during the late 19th 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 more than 80 mines through 2001 has totaled 523.7 million tons.

In 2001, eight active mines in this field produced 21.92 million tons of coal, or about 81% of the state's total. Production from this field has increased rapidly since the mid-1980s, doubling since 1986.

Emery Coalfield

Consolidation Coal Company idled the Emery coal mine in 1990, and through 1994 the activity at the mine was limited to shipping a very small quantity of coal from its stockpile. In 1995, Consolidation Coal decided to seal the portals of the mine and limit maintenance to pumping water to keep the mine from flooding. In early 2002, the company announced plans to re-open the Emery mine and did so by the end of that year.

Production from the Emery coal field has been erratic. Falling 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 was about 9.5 million tons (Utah Department of Natural Resources 2003).

CURRENT PRODUCTION ACTIVITIES

Introduction

According to U.S. Mine Safety and Health Administration records, Utah's 2002 coal production was 24.7 million tons, a significant drop from the 2001 level of 27.0 million tons. A weak U.S. economy in 2002 led the average mine-mouth coal price to drop a few percent from 2001, but coal prices should rebound if the U.S. economy starts to grow in late 2003. Most of Utah's coal production comes from large, highly productive mines equipped with longwall mining machines. Four of Utah's mines produced more than 3 million tons in 2002 and rank among the nation's largest underground coal mines.

Coal Industry Structure

The Utah coal industry is highly competitive and production over time has steadily become concentrated among fewer companies with fewer, but larger mines. For example, Utah had 29 mines operated by 16 companies in 1982; however, by 2001 only 11 coal mines were operated by 5 parent coal companies. In addition to raw coal producers, one company, DTE Utah Synfuel (a subsidiary of Detroit Edison), processes and pelletizes coal for sale as a synthetic fuel. As of 2003, the five parent coal companies operating Utah coal mines are Andalex Resources Incorporated (three mines), Canyon Fuel Company (three mines), CONSOL Energy Incorporated (1 mine), CO-OP Mining Company (one mine), and Interwest Mining Company (one mine). Cyprus Plateau Mining Company exited the Utah coal mining business as recently as 2000, and Lodestar Mining Incorporated shut its last Utah coal mine in early 2003 as a result of bankruptcy.

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. In 2003, mining at the Tower Division is currently limited to continuous miner operations, but the mine has requested some new Federal leases to the north of the existing leases in the hope of restarting longwall mining there. Andalex, through its subsidiary Genwal Resources, operates a second coal mine, the Crandall Canyon mine, which is located in the Wasatch Plateau coal field. Andalex purchased its 50% interest in this company in 1994 from Nevada Power; the Intermountain Power Agency (IPA) owns the remaining 50% of Genwal Resources. Longwall reserves at this mine were exhausted in early 2003, and the mine will decrease production as it reverts to a continuous miner operation. Andalex's third mine, West Ridge, was opened in the Book Cliffs coal field in 2000 on leases it purchased from British Petroleum in 1997. Like the Crandall Canyon mine, West Ridge mine is operated by Andalex, but jointly owned by Andalex and the IPA through a company named West Ridge Resources. The West Ridge mine had a longwall mining machine installed in 2001. Production in 2002 from the Tower Division, Crandall Canyon, and West Ridge mines was 0.7, 3.3, and 2.3 million tons, respectively. These three mine sites accounted for 25% of Utah's 2002 coal production.

Canyon Fuel Company, LLC

Canyon Fuel Company operated three coal mines with longwall machines in Utah in 2002. Canyon Fuel Company is a joint venture between Arch Coal Company (65%) and a subsidiary of the Itochu Corporation (35%). The partnership originally included a 9% interest in the Los Angeles Export Terminal Company, but during 2001, Canyon Fuel wrote off the value of its investment in that bankrupt terminal, and the terminal was dismantled in 2003. The three Utah mines operated by Canyon Fuel are the Dugout Canyon, Skyline, and SUFCO mines.

The Dugout Canyon mine, opened in 1998, is in the Book Cliffs coal field, while the Skyline and SUFCO mines are in the Wasatch Plateau coal field. During 2002, these three mines produced a combined total of 13.15 million tons, with 2.08 at Dugout Canyon, 3.48 at Skyline, and 7.60 at SUFCO. Canyon Fuel's mines accounted for 53% of the annual tonnage of coal produced in Utah in 2002. However, in 2003, low coal prices, a depressed market, and difficult mining conditions caused Canyon Fuel to announce that the Skyline mine would be idled in the second quarter of 2004. Although that mine has undeveloped resources on leases to the north, they will not be developed until the coal market improves according to the company statement.

CO-OP Mining Company

The CO-OP Mining Company, a family-owned company, operates the Bear Canyon #1 and #3 mines; the Bear Canyon #2 was idled in 2001. These mines use continuous mining machinery to recover the coal. During 2002, these two mines in the Wasatch Plateau coal field produced a combined total of 0.96 million tons, or about 4% of the state's total for that year. In 1997, the company purchased the Mohrland property from the IPA to provide at least 30 million tons of coal resources for future mining development. This 3,000-acre tract lies due east of the Bear Canyon #1 mine, but is separated from it by a major fault.

Interwest Mining Company

In 2002, PacifiCorp subsidiary Interwest Mining Company operated just one longwall mine in Utah, the Deer Creek mine. This mine produced 3.98 million tons of coal in 2002, or 16% of the state's total coal production for that year. This mine is located in the Wasatch Plateau coal field. The life of the Deer Creek mine was extended in 1999 with the acquisition of the Mill Fork Federal lease tract, which added another 46 million tons of coal to the company holdings.

CONSOL Energy Incorporated

CONSOL Energy reopened the Emery mine in late 2002 after being idle since 1990. Production from this mine in 2002 totaled 0.03 million tons, or one-tenth of one percent of the state's total for that year. This is the only mine operating in the Emery coal field. From 1998 through 2002, Utah has seen the closure of the Star Point, Trail Mountain, and White Oak mines in the Wasatch Plateau coal field, and the Soldier Canyon and Willow Creek mines in the Book Cliffs coal field; the loss of all this productive capacity probably has created a market opportunity that the Emery mine can exploit to remain competitive. This market opportunity will also be enhanced as the Crandall Canyon mine stops longwall production in 2003 and reverts to a smaller, continuous miner operation. CONSOL hopes that the loss of productive capacity at other Utah mines in recent years will allow the Emery mine to ramp up production and eventually install a longwall machine.

Coal Markets

Since the beginning of the new millennia, Utah has experienced a contraction in the number of market segments consuming its coal (Utah Department of Natural Resources 2003). During the late 1990s, coal exports to Pacific Rim nations accounted for 10% of Utah coal production, but by 2003 a strong U.S. dollar, strong competition from Australian and Indonesian producers, and weak Asian economies combined to eliminate an overseas market for Utah coal. Also, the late-2002 final closure of the Geneva Steel coke ovens permanently ended the small coking market for Utah coal.

Utah's main coal market is at electric utility and cogeneration plants primarily in Utah, Nevada, and California. This market segment has traditionally consumed about 75% of the coal produced in Utah, and with the loss of the export market, this market segment's share will increase. The second largest market

for Utah coal is the industrial sector, which has historically consumed about 13% of Utah coal production. The final segment supplied by Utah coal producers is the residential and commercial market; this segment has traditionally consumed 1 or 2% of annual production. Even with the loss of the export and coking coal markets, demand for Utah coal is likely to require annual coal production near 25 million tons for the foreseeable future. Should the plans to expand Utah's electric generation capacity at the Hunter or IPA power stations materialize in the next 10 years, the annual demand for Utah coal could rise to the 30 million ton level. In spite of increasing environmental regulation of emissions from coal-fired power plants, coal still remains a low-cost fuel for electricity generation.

Extraction of Utah coal has been accelerating at a rapid pace in the last 20 years. A time span of 111 years was needed to produce the first 415 million tons of coal from Utah, but only 20 more years were required to produce the second 415 million tons (e.g., by 2001). The next 415 million tons will probably be extracted in 15 years, or by about 2016. Previous UGS work for the BLM identified about 960 million tons of potentially recoverable coal in the Carbon and Emery counties portion of the Book Cliffs and Wasatch Plateau. This estimate was optimistic because it did not take into account site-specific problems in certain areas such as inferior coal quality, losses owing to problems like unmanageable roof and floor, lands that may be unacceptable for leasing, or difficulties such as unexpectedly high levels of water or gas infusions that may hinder actual coal recovery in some areas. At best, these reserves could provide all the coal needed to supply traditional markets for the next 30 years. However, in spite of the potential of the Book Cliffs and Wasatch Plateau fields in Carbon and Emery counties to hypothetically provide all the coal needed by current markets, one mine has reopened in 2002 in the Emery coal field, showing that other market forces such as ease of permitting, proximity to specific customers, or restrictive coal ownership patterns may push coal production into fields outside the Book Cliffs and Wasatch Plateau fields in the next 30 years before the reserves in the latter fields are fully depleted. Therefore, alternative supply regions, such as the Emery and Henry Mountains coal fields, need to be kept open for potential future development in the event there is unanticipated early reserve depletion or abandonment in currently operating areas.

REASONABLY FORESEEABLE DEVELOPMENT

Introduction

While it is impossible to know precisely when and where minable coal resources will be developed in the next 15 or 30 years, the coal resources that are of minable thickness and at favorable depths can be identified as potentially recoverable in the fields outside the traditional mining areas of the Book Cliffs and Wasatch Plateau coal fields in Carbon and Emery counties. Within the Richfield planning area, there are three coal areas that are attractive for future coal mining development. They are, in decreasing order of development potential, the Wasatch Plateau coal field of Sanpete and Sevier counties, the Emery coal field of Sevier County, and the Henry Mountains coal field of Garfield and Wayne counties.

Wasatch Plateau Coal Field (Sanpete and Sevier Counties)

Based on work by the UGS for the BLM, an estimated recoverable resource base of 773.8 million tons of unleased coal is available for mining in the Wasatch Plateau coal field. About 162.8 million tons are likely to be mined in the period from 2003 through 2017, along with the already leased coal resources. Of the coal to be mined in the first 15-year period, about 101 million tons will come from the Carbon-Emery portion to the Wasatch Plateau, while 51.5 million tons is estimated to be recovered from the Sevier County portion near the SUFCO mine (see Table A8-24).

Another 621.0 million tons of recoverable coal is available for mining from 2018 through 2032 and beyond. About 61% of the coal to be recovered in the second 15-year period is expected to come from Carbon and Emery counties, and 39% is expected to come from Sanpete and Sevier counties (see Table A8-24). More than 95% 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, *et al.* 1983). In total, the Sanpete and Sevier counties portion of the Wasatch Plateau contains about 291.1 million tons of recoverable coal.

Table A8-24. Remaining, In-place, Demonstrated (95%) Unleased Resources by Mining Period for the Wasatch Plateau Coal Field

Mining Period	Counties	In-place	Recoverable
2003-2017	Carbon-Emery	148.7	101.3
2018-2032+	Carbon-Emery	558.0	381.3
2003-2017	Sanpete-Sevier	73.5	51.5
2018-2032+	Sanpete-Sevier	342.3	239.7
Total	**All Counties**	**1,122.5**	**773.8**

Given in millions of short tons (for coal beds mostly > 6 feet thick, and with > 200 feet, but < 2,500 feet of overburden).

Emery Coal Field

The UGS has recently reappraised the available coal in the Emery coal field with funding provided by the USGS. Within the Emery coal field, the UGS identified 948 million tons of demonstrated in-place coal resources, the majority of which occur in Emery County (644 million tons), but there are also 304 million tons identified in Sevier County (see Table A8-25). The coal was broken out as either surface or deep minable, with 96% being deep or underground minable. The deep minable coal occurs in eight beds that are 6 feet thick or greater, and the surface minable coal occurs in one bed that is 4 feet thick or greater. The majority of the coal in Sevier County occurs in the A bed (58%), the lowest one stratigraphically. Another 31% of the in-place coal resource occurs in the I bed, with small amounts in the other six coal beds. Recoverable coal was estimated at 65% of the in-place deep coal and 80% of the in-place surface minable coal. Using these recovery factors, there are about 190 million tons of deep recoverable coal, and 9 million tons of surface minable coal in the Sevier County portion of the Emery coal field. The Sevier County minable resources would probably be mined after the Emery County portion of the field, which contains an estimated 304 million tons of recoverable deep minable coal and 141 million tons of recoverable surface minable coal. The Emery County portion of the Emery coal field reserves is sufficient to last at least 30 years, so the Sevier County reserves are likely to be mined only near the end of the 30-year planning horizon.

Table A8-25. Original, In-place, Demonstrated, Minable Coal Resources (Millions of Tons) Given by County for the Southern Emery Coal Field

Mining Period	County	In-place		Recoverable		Total Recoverable
		Surface	Deep	Surface (80%)	Deep (65%)	
2003-17	Emery	0	49	0	32	32
2018-32	Emery	176	419	141	272	413
2030-50	Sevier	11	292	9	190	199
TOTAL		**188**	**760**	**150**	**494**	**644**

From Quick, *et al.* in preparation; for coal beds averaging $\geq$ 6 feet thick and with < 2,500 feet of cover.

Henry Mountains Coal Field

The Henry Mountains coal field contains two areas in the Richfield planning area that have a slim chance of being mined in the next 30 years, but that may draw some serious attention in the next 50 years. One area, located to the north of Factory Butte in Wayne County, contains surface minable Ferron Sandstone coal. The second area, primarily in Garfield County, contains deep minable Muley Canyon Sandstone coal.

While the Henry Mountains coal field contains hundreds of millions of tons of in-place coal in the Ferron zone, only a small portion of these resources have any chance of being mined in the next 30 years. The Ferron Sandstone Member resources with the best development potential are the surface-minable resources near Factory Butte. These resources are the closest to rail transport and the central Utah power plants, they are thickest and shallowest, and they have been extensively drilled, which would allow for adequate and prompt mine planning. The major drawbacks of these resources are their moderately high sulfur content (2 to 3%) and the small size of the resource. However, as the resources in Carbon and Emery counties dwindle, this area could produce one million tons annually over a 14-year period, and the higher sulfur coal could be blended at a power plant with lower sulfur coal from elsewhere. The in-place and strip-mine recoverable coal resources from the Factory Butte area of the Ferron Sandstone Member are summarized in Table A8-26.

Table A8-26. In-place and Recoverable Coal Resources by Mining Period for the Ferron Sandstone Member in the Henry Mountains Coal Field

Mining Period	In-place	Recoverable (80%)
2030 or beyond	17.60	14.08

Given in millions of short tons (for coal in beds mostly > 6 feet thick and with <100 feet of overburden).

The coal resources of the Muley Canyon Sandstone in Garfield County originally attracted industry attention for the significant surface-minable tonnages that occur around the periphery of Tarantula Mesa; however, it is unlikely that future surface mining will be permitted within sight of nearby Capitol Reef National Park. Therefore, the deeper Muley Canyon coal resources found under Tarantula Mesa have the best chance of being mined in the foreseeable future because they could be mined with little or no visual impact on Capitol Reef National Park if developed from the east side of Tarantula Mesa. These deep minable resources generally occur as one bed that is 8 to 14 feet thick and has overburden of less than 1,500 feet, which would be ideal for high-efficiency longwall mining methods. While the whole area under Tarantula Mesa contains more than 500 million tons of in-place, deep minable resources in the Muley Canyon, only 179.5 million tons meet the BLM criterion requiring that at least 80% of the resources fall in the demonstrated reliability category. Because little is known of the ease or difficulty of underground mining of coal from the Muley Canyon, a conservative mining recovery factor of 65% was applied to the demonstrated resources to arrive at an estimated recoverable coal resource of 116.7 million tons (see Table A8-27). This is enough coal to support a longwall mine producing 4 million tons per year for nearly 30 years. The earliest date any potential development of the Muley Canyon coal could occur is estimated to be about 2030.

Table A8-27. In-place and Recoverable Coal Resources by Mining Period for the Muley Canyon Sandstone in the Henry Mountains Coal Field

Mining Period	In-place	Recoverable (65%)
2030 or beyond	179.5	116.7

Given in millions of short tons (for coal in beds mostly > 6 feet thick and between 100 feet and 1,500 feet of overburden).

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COAL UNSUITABILITY REPORT HENRY MOUNTAINS COAL FIELD

INTRODUCTION

The Bureau of Land Management has the responsibility for implementing Federal regulations 43 CFR 3461, Federal Lands Review: Unsuitability for Mining. The general unsuitability criteria, the Federal land review, and the prohibitions against mining are derived from the applicable sections of the Surface Mining Control and Reclamation Act of 1977 [30 U.S.C. 1272(a), (b), (e)]. This review of coal unsuitability is in conjunction with the revision of the existing land use plan and the development of a Resource Management Plan for the Richfield Field Office.

As addressed at 43 CFR 3420.1-4, the Secretary of the Interior may not hold a lease sale of public land containing coal deposits, unless the land is subject to a comprehensive land use plan. Only those lands that have coal resources with development potential may be considered as acceptable for further consideration for leasing. The coal resources, which are evaluated for unsuitability, have been delineated in a report, *Coal Resource Evaluation of the Henry Mountains Coal Field, Garfield and Wayne Counties, Utah* (2004). The coal report identifies public land that has a coal resource that is to be considered for coal leasing through the land use planning.

This report addresses the unsuitability of the coal resources that have potential for development in the Henry Mountains coal field. Following the identification of the coal resources with development potential, the Bureau of Land Management shall determine whether areas are unsuitable for all or certain stipulated methods of mining. The Department of the Interior has developed 20 criteria that are used for this determination, which are presented at 43 CFR 3461.5.

GEOLOGIC SETTING

The Henry Mountains coal field contains predominately sedimentary strata, which are Jurassic and Cretaceous in age. The coal field is ovate in general outline with dimensions that are approximately 48 miles long in a north-south direction and as much as 18 miles wide in an east-west direction. The Jurassic strata crop out around the perimeter of the field, and the Cretaceous strata are exposed in the central part. The coal-bearing strata are mapped as part of the Ferron Sandstone and the Muley Canyon Sandstone Members of the Mancos Shale.

The Henry Mountains coal field is in a structural basin, centered on the Henry Mountains syncline. The west limb is defined by the Waterpocket Fold; the east limb coincides with the intrusive rocks of the Henry Mountains. The coal-bearing strata between the limbs of the basin are nearly horizontal.

LANDS CONSIDERED

Generally, the Henry Mountains coal field is at T. 27-34 S., R. 8-11 E., SLM, Garfield and Wayne Counties, Utah (Map 1), and the coal field contains 302,876 acres. Most of the land in the coal field is owned by the U.S., but State and privately owned lands are also interspersed with the Federal lands. The Federal lands are administered by the Richfield Field Office of the Bureau of Land Management. Currently, no Federal coal leases are authorized on public lands located within the Henry Mountains coal field.

COAL RESOURCES

A total of 2,209.6 million tons of in-place coal has been identified in the Henry Mountains coal field. This estimate is from the coal report, which is based mostly on resource information from Tabet (1999, 2000).

In the coal report, coal resources that are greater than 2 feet in thickness and that have less than 100 feet of overburden are considered to have potential for development by surface mining methods. Underground, conventional, mining methods are considered applicable to coal resources that are 6 feet or greater in thickness and that have a depth of 100 feet or more.

An exception to the surface and underground parameters was made at Factory Butte at T. 27 S., R. 9 E, where a 270 acre area has slightly greater than 100 feet of overburden. Since the majority of the coal resource at Factory Butte meets the parameters for surface mining, this coal resource that exceeded the 100-foot depth parameter was designated as a surface minable resource.

Surface minable coal resources total approximately 466.1 million tons and by underground minable coal resources total approximately 1,283.6 million tons. Thus, the total coal resource that is considered favorable for mining by surface or underground methods is 1,749.7 million tons. The coal resources that are considered to have development potential are displayed on Map 2. Ownership of the land with coal resources that has development potential is shown in Table A8-28.

Table A8-28. Henry Mountains Coal Resources

Land Status	Surface Minable Acres	Underground Minable Acres
BLM	36,028	50,512
NPS	1,170	756
State	5,556	3,869
Private	414	1,253
Total	**43,168**	**56,390**

Split ownership of private surface and Federal minerals is not presented in the above totals, due to limitations of the current GIS data base. The unsuitability criteria are applied to the Federal lands containing coal resources, as defined at 43 CFR 3400.0-5(o) and required by the regulations at 43 CFR 3461.2-1.

EVALUATION OF THE UNSUITABILITY CRITERIA

The coal resources with development potential are assessed for the unsuitability criteria as outlined at 43 CFR 3461.5. Underground mining of coal deposits is exempt from the criteria, where there would be no surface coal mining operations as stated at 3461.1.1(a). Surface mining operations include surface operations and surface impacts incident to an underground mine as stated at 43 CFR 3400.0-5(mm). In addition, at 43 CFR 3461.1(b), where underground mining will include surface operations and surface impacts on Federal lands to which a criterion applies, the lands shall be assessed as unsuitable unless an exception or exemption applies. Each criterion is subject to exceptions and/or exemptions as prescribed in the regulations.

As stated above, the criteria are applied to the Federal lands with coal resources that are identified as having development potential.

Criterion 1

Summary of the Criterion: All Federal lands included in the following land systems or categories shall be considered unsuitable: National Park System, National Wildlife Refuge System, National System of Trails, National Wilderness Preservation System, National Wild and Scenic Rivers System, National Recreation Areas, lands acquired with money derived from the Land and Water Conservation Fund, National Forests, and Federal lands in incorporated cities, towns, and villages.

1,926 acres of land with the identified coal resources are included within Capitol Reef National Park (Map 1). This land is deemed to be unsuitable for coal leasing. None of the remaining coal resources with development potential are contained within any of the other listed land systems or categories.

The exemptions for valid existing rights do not apply.

Criterion 2

Summary of the Criterion: Federal lands that are within rights-of-way, easements or surface leases for residential, commercial, industrial, or other public purposes on Federally owned surface shall be considered unsuitable.

Several authorized rights-of-way encompass Federal lands with coal resources having development potential (Map 3). These are listed in Table A8-29 below.

Table A8-29. Authorized Rights-of-Way

Serial Number	Holder	Legal Description	Type	Width (ft)
UTU-047320	Garfield County	T. 31 S., R. 9 E., Sec. 30, 31 T. 32 S., R. 9 E., Sec. 5, 6	Road	50
UTU-051955	Tercero Corp	T. 31 S., R. 9 E., Sec. 33	Water Facility	10
UTU-051980	Garfield County	T. 31 S., R. 8 E., Sec. 23-26	Road	50
UTU-0 094714	Federal Highway Administration	T. 28 S., R. 9 E., Sec. 22	Federal Aid Highway	200
UTU-0 057537	Garkane Power Association	T. 28 S., R. 9 E., Sec. 22	Power Transmission Line	50

The coal resources subject to a right-of-way are considered unsuitable; however, exceptions may be applicable where:

- All or certain types of coal development (e.g., underground mining) will not interfere with the purpose of the right-of-way or easement, or
- The right-of-way or easement was issued for a purpose for which it is not being used,
- The parties involved in the right-of-way or easement agree, in writing, to leasing,
- It is impractical to exclude such areas due to the location of coal and method of mining and such areas or uses can be protected through appropriate stipulations.

The above-listed rights-of-way are subject to surface and/or underground mining methods. Mining by underground methods is exempt and should not interfere with the intended use of a right-of-way facility. Where there could be surface operations and surface impacts associated with underground mining, the

impacts would be mitigated, subject to an agreement with the right-of-way holder at the time of a specific leasing proposal. Where the coal resources would be mined by surface methods, the facility could be moved during the mining operations and re-located when the land is reclaimed, again, subject to an agreement with the right-of-way holder. Any agreements with the affected holder of the right-of-way would be negotiated at the time of the specific leasing proposal. The Federal lands subject to the above rights-of-way are considered suitable.

The exemption for substantial legal and financial commitments and on-going mining operations does not apply, since coal exploration and development are not currently present or authorized.

Criterion 3

Summary of the Criterion: The terms used in this criterion have their meaning set out in the Office of Surface Mining Reclamation and Enforcement regulations at Chapter VII of Title 30 of the Code of Federal Regulations. Federal lands affected by Section 522(e) (4) and (5) of the Surface Mining Control and Reclamation Act of 1977 shall be considered unsuitable. This includes lands within 100 feet of the outside boundary of a public road right-of-way, lands within 100 feet of a cemetery, or lands within 300 feet of any public building, school, church, community or institutional building, public park, or occupied dwelling.

Exceptions are allowed, if a lease may be issued for lands:

- Used as mine access roads or haulage roads that join the right-of-way for a public road;
- For which the Office of Surface Mining and Reclamation and Enforcement has issued a permit to have public roads relocated;
- If, after public notice and opportunity for public hearing in the locality, a written finding is made by the authorized officer that the interests of the public and the landowners affected by mining within 100 feet of a public road will be protected;
- For which owners of occupied dwellings have given written permission to mine within 300 feet of their buildings.

The coal lands of the Henry Mountain Coal Field do not fall within the stated distances of a cemetery, public building, school, church, community or institutional building, or public park.

Federal lands with development potential for coal resources are located within the100-foot extension of the rights-of-way for a road or highway, which are listed under Criterion 2. Those road and highway rights-of-way are subject to surface and/or underground mining methods. Mining by underground methods is exempt from this review and should not interfere with the intended use of a right-of-way facility. Where the coal resources would be mined by surface methods or a surface operation or impact would be associated with underground mining, the coal would only be leased in compliance with the Office of Surface Mining Reclamation and Enforcement following a public notice and hearing. The Federal lands within the 100-foot extension of road or highway rights-of-way, as listed under Criterion 2, are considered suitable for leasing under this Criterion.

Occupied dwellings are located at T. 31 S., R. 9 E., Sec. 21 at the Starlight Ranch, and T. 31 S., R. 9 E., sec. 32 at the King Ranch. These are furnished dwellings that are not occupied on a long-term basis. Specific distances to the dwellings from the coal resource on Federal land are unknown at this time; however, the distance to the dwellings is believed to be more than 300 feet.

At this time, the Federal lands are considered suitable for mining. If a proposal for leasing is submitted, then appropriate review would be completed with the involvement of the Office of Surface Mining and Reclamation and Enforcement and the public.

Criterion 4

Summary of the Criterion: Federal lands designated as wilderness study areas shall be considered unsuitable while under review by the Administration and the Congress for possible wilderness designation.

Three WSAs encompass lands with coal resources that have development potential by surface or underground mining methods (Map 4). As stated in the Federal regulations at 43 CRF 3461.1, underground mining is exempt from the unsuitability criteria; however, surface operations and surface impacts, which could be associated with underground mining, are unsuitable.

Coal leasing is subject to the Interim Management Policy for Land under Wilderness Review (IMP) in Section B.2.c. of Chapter 3 (Rel. 8-67, 7/5/95), as stated:

> "The coal unsuitability criteria will be applied to *all* coal lands being considered in the BLM's planning system. The *only* BLM-administered lands that will be offered for competitive lease sale are those on which a final wilderness inventory decision has determined that the lands lack wilderness characteristics. Once the Congress has determined that a WSA will not be designated as wilderness, the area may be considered for competitive lease." (Italics added.)

All lands that are presently included within the boundaries of a WSA have been determined to have wilderness characteristics.

Under Federal regulation the general exemption for underground mining applies to Federal land in a WSA if there are no surface operations or surface impacts. However, based on IMP, coal lands within a WSA cannot be offered for leasing at the present time.

The total acreage of land within WSAs that is unsuitable by either surface or underground methods is 28,683 acres. Approximately 1,400 acres of State land are included in that figure. However, State land is not part of a WSA and unsuitability under the Federal regulations does not apply to the State minerals.

A WSA is a temporary designation, pending Congress either legislatively designating the land as part of the National Wilderness System or releasing the land from consideration under the Wilderness Act. Federal land that is released by act of Congress would then be considered suitable for coal leasing under this Criterion, because such land would no longer be within a WSA or subject to IMP.

As authorized leases are not present on Federal lands, valid existing rights are non-existent. An exemption for existing leases is not applicable.

Criterion 5

Summary of the Criterion: Scenic Federal lands designated by visual resource management (VRM) analysis as Class I (an area of outstanding scenic quality or high visual sensitivity) but not currently on the National Register of Natural Landmarks shall be considered unsuitable.

Federal lands are being considered for designation as VRM Class I under all the alternatives in the Environmental Impact Statement for the Richfield Field Office Resource Management Plan (RMP) (Map 4). The lands, which are proposed for VRM Class I, are coincident with the designated WSAs.

An exception is allowed for the issuance of a lease if the surface management agency determines that surface coal mining operations will not significantly diminish or adversely affect the scenic quality of the designated area. The Federal lands that would be mined by underground methods are exempt; however, the location of the surface facilities would need to be considered in applying the visual resource objectives of Class I. The lands that would be mined by surface methods are considered unsuitable with the VRM Class I objectives. However, all lands that would be designated as VRM Class I in the RMP are unsuitable for surface and underground mining methods under Criterion 4 due to the coincidental boundaries of WSAs and VRM Class I and due to the non-impairment standard of IMP that would disallow the issuance of a lease within WSAs at the present time.

The exemption for substantial legal and financial commitments and on-going mining operations does not apply, since coal exploration and development are not currently present or authorized.

Criterion 6

Summary of the Criterion: Federal lands under permit and being used for scientific studies involving food or fiber production, natural resources, or technology demonstrations and experiments shall be considered unsuitable for the duration of the study.

None of the subject lands are under permit for the described scientific studies. This criterion is not applicable to the subject lands.

Criterion 7

Summary of the Criterion: All publicly or privately owned places which are included in the National Register of Historic Places shall be considered unsuitable.

There are no listed sites within the subject lands that are included on the National Register of Historic Places. This criterion is not applicable.

Criterion 8

Summary of the Criterion: Federal lands designated as natural areas or as National Natural Landmarks shall be considered unsuitable.

None of the subject lands are designated as part of a National Natural Landmark. This criterion is not applicable.

Criterion 9

Summary of the Criterion: Federally designated critical habitat for listed threatened or endangered (T&E) plant and animal species, and habitat proposed to be designated as critical for listed threatened or endangered plant and animal species or species proposed for listing, and habitat for Federal threatened or endangered species which is determined by the Fish and Wildlife Service and the surface management agency to be of essential value and where the presence of threatened or endangered species has been scientifically documented, shall be considered unsuitable.

An exception allows that a lease may be issued and mining operations approved if, after consultation with the Fish and Wildlife Service, it is determined that the proposed activity is not likely to jeopardize the continued existence of the listed species and/or its critical habitat.

Designated critical habitat for the Mexican spotted owl (*Strix occidentalis*) has been delineated by the U.S. Fish and Wildlife Service (Map 5). This critical habitat overlaps 13,753 acres of surface minable coal resources and 22,317 acres of underground minable coal resources.

BLM has completed inventories of Federal land and has identified areas within designated critical habitat which contains the constituent elements for Mexican spotted owl (Attachment 1). The critical habitat, based on the constituent elements and survey work, is also shown on Map 5. The critical habitat with the constituent elements as inventoried by BLM encompasses 576 acres of surface minable coal and 52 acres of underground minable coal.

The lands with coal resources that would be developed by underground mining are exempt from review. Surface operations and impacts are considered unsuitable, unless at the time of leasing, the Fish and Wildlife Service determines that the proposed activity is not likely to jeopardize the continued existence of the listed species.

If surface mining were to occur, the mining would be completed in stages, or mining units, with mining in one area while an adjacent, previously mined-out area would be reclaimed to restore the critical habitat. Thus, with concurrent mining and reclamation, surface mining would not impact all the acreage within a given lease at one time. Also, all of the above listed land with an identified potential for surface mining may not be developed, because the coal reserves that would support a mine could be less than the currently identified coal resource. However, the coal lands contained within the designated critical habitat with the constituent elements for Mexican spotted owl are considered unsuitable for surface coal mining and surface operations and impacts associated with underground mining. The inventoried habitat is also contained within a WSA and is unsuitable for leasing under Criterion 4.

Occurrences of Wright's fishhook cactus (*Sclerocactus wrightiae*) are known and documented in the vicinity of Factory Butte (Attachment 2). Habitat that is considered to be of essential value for this species encompasses the surface minable resource at T. 27-28 S., R. 8-9 E. These documented occurrences and habitat of essential value are not shown on Map 5 because the species could be further threatened by collection if the specific locations or habitat of essential value is included in a public document. The coal resources in vicinity of Factory Butte encompass 2,895 acres of Federal coal resources that are considered unsuitable for leasing.

The exemption for substantial legal and financial commitments and on-going mining operations does not apply, since coal exploration and development are not currently present or authorized.

Criterion 10

Summary of the Criterion: Federal lands containing habitat determined to be critical or essential for plant or animal species listed by a state pursuant to state law as endangered or threatened shall be considered unsuitable.

Habitat for the Mexican spotted owl is determined to be critical or essential by the State of Utah. This land is the same as identified for Criterion 9 (Map 5). The coal lands contained within the identified Mexican spotted owl habitat are considered unsuitable for surface coal mining and surface operations and impacts associated with underground mining. This habitat is also contained within a WSA and is unsuitable for leasing under Criterion 4.

The exemption for substantial legal and financial commitments and on-going mining operations does not apply, since coal exploration and development are not currently present or authorized.

Criterion 11

Summary of the Criterion: A bald or golden eagle nest or site on Federal lands that is determined to be active, and an appropriate buffer zone of land around the nest site, shall be considered unsuitable. Consideration of availability of habitat of prey species and of terrain shall be included in the determination. Buffer zones shall be determined in consultation with the Fish and Wildlife Service.

Active eagle nests are not known to be present on the Federal lands under consideration for leasing, based on surveys and knowledge of BLM biologists (Attachment 3). Therefore, this criterion does not apply to the subject lands. If active nests or sites are found at the time of leasing, then consultation will occur with the U.S. Fish and Wildlife Service and appropriate mitigations as outlined in the RMP will be applied.

Criterion 12

Summary of the Criterion: Bald or golden eagle roost and concentration areas on Federal lands, used during migration and wintering, shall be considered unsuitable.

Eagle roosts are not known to be present on the subject lands, therefore, this criterion does not apply. If roosts or concentration areas are found at the time of leasing, then consultation will occur with the U.S. Fish and Wildlife Service and appropriate mitigations as outlined in the RMP will be applied.

Criterion 13

Summary of the Criterion: Federal lands containing a falcon (excluding kestrel) cliff nesting site with an active nest shall be considered unsuitable. A buffer zone will be included around the nest site which considers the availability of habitat for prey species and terrain. Buffer zones shall be determined in consultation with the Fish and Wildlife Service.

Falcon cliff nesting sites with an active nest are not known to be present on the Federal lands (Attachment 3). This criterion does not apply to the subject lands. If an active cliff nesting site is found at the time of leasing, then consultation will occur with the U.S. Fish and Wildlife Service and appropriate mitigations as outlined in the RMP will be applied.

Criterion 14

Summary of the Criterion: Federal lands which are high priority habitat for a migratory bird species of high Federal interest on a regional or national basis, as determined by the surface management agency and the Fish and Wildlife Service, shall be considered unsuitable.

There is no high priority habitat for migratory bird species on the subject lands. This criterion is not applicable.

Criterion 15

Summary of the Criterion: Federal lands which the surface management agency and state jointly agree are habitat for resident species of fish, wildlife, and plants of high interest to the state and which are

essential for maintaining these priority wildlife and plant species shall be considered unsuitable. Examples of such lands include:

- Active dancing and strutting grounds for sage grouse,
- Winter ranges crucial for deer, antelope, and elk,
- Migration corridor for elk, and
- Extremes of range for plant species.

A lease may be issued if, after consultation with the state, the surface management agency determines that all or certain stipulated methods of coal mining will not have a significant long-term impact on the species being protected.

In accordance with the Utah Division of Wildlife Resources, crucial habitat is necessary to sustain the existence and/or perpetuation or introduction of one or more species of historic or existing high interest wildlife during crucial periods of their life cycle. This classification includes all habitats that are highly sensitive to surface disturbance and areas where fish or wildlife management considerations dictate that surface disturbance could not be tolerated by the species.

Coal resources with development potential by surface and underground mining methods are overlain by habitat that is crucial for bison and deer on the Henry Mountains (Maps 6 & 7). The acreage of crucial habitat is identified in Table A8-30.

Table A8-30. Acreage of Minable Coal Resources

Crucial Habitat	Surface Methods	Underground Methods
Bison	33,588	56,877
Deer	14,085	30,408

The coal resources within the crucial deer habitat are also included within the boundaries of the crucial bison habitat; thus, the acreage above for the deer is included in the acreage for the bison.

If surface mining were to occur, the mining would be completed in stages, or mining units, with mining in one area while an adjacent, previously mined-out area would be reclaimed to restore the crucial habitat. Thus, with concurrent mining and reclamation, surface mining would not impact all the acreage within a given lease at one time. Also, all the above land with an identified potential for surface mining may not be developed, because the coal reserves that would support a mine could be less than the currently identified coal resource.

This criterion provides that a lease may be issued, if after consultation with the state, a determination is made that all or certain stipulated methods of coal mining will not have a significant long-term impact on the species being protected. Given that exception, depending on the location, acreage, and specifics of an application to lease coal, impacts to the crucial habitat may be mitigated such that surface coal mining would not have a long-term impact to the species.

Underground mining is exempt. However, surface facilities associated with the coal mining could be located within the crucial habitat and could include a mine portal, buildings, and construction of roads. Haulage of mined coal would also be necessary. The location of these facilities and associated haulage roads could be located as to minimize or reduce the impact to the habitat. Surface operations and impacts would not have an adverse, long-term impact on the bison and deer habitat.

The exemption for substantial legal and financial commitments and on-going mining operations does not apply, since coal exploration and development are not authorized.

Criterion 16

Summary of the Criterion: Federal land in riverine, coastal and special floodplains (100-year recurrence interval) on which the surface management agency determines that mining could not be undertaken without substantial threat of loss of life or property shall be considered unsuitable for all or certain stipulated methods of coal mining.

Federal lands with a coal resource having development potential may be present along some streams, most notably the Fremont River in T. 28 S., R. 9 E., Section 22. Surface mining could be undertaken without substantial threat of loss to life or property. Any mining which is authorized would need to contain lease stipulations to control flooding and potential hazards associated with such events. Underground mining is exempt from review, and surface operations would not result in a substantial threat of loss of life or property. The coal resources having development potential are considered suitable for leasing.

The exemption for substantial legal and financial commitments and on-going mining operations does not apply, since coal exploration and development are not currently present or authorized.

Criterion 17

Summary of the Criterion: Federal lands which have been committed by surface management agency to use as municipal watersheds shall be considered unsuitable.

None of the subject lands with coal resources that have potential for development are within a municipal watershed. This criterion is not applicable.

Criterion 18

Summary of the Criterion: Federal lands with National Resource Waters, including areas identified by states in their water quality management plans and a buffer zone of Federal lands ¼ mile from the outer edge of the far banks of the water, shall be considered unsuitable.

None of the subject lands with coal resources that have potential for development include National Resource Waters which the State of Utah considers as High Quality Waters. This criterion is not applicable.

Criterion 19

Summary of the Criterion: Federal lands identified by the surface management agency, in consultation with the state in which they are located, as alluvial valley floors according to the definition in §3400.0-5(a) of this title, the standards in 30 CFR 822, the final alluvial valley floor guidelines of the Office of Surface Mining Reclamation and Enforcement when published, and approved state programs under the Surface Mining Control and Reclamation Act of 1977, where mining would interrupt, discontinue, or preclude farming, shall be considered unsuitable. Additionally, when mining Federal land outside an alluvial valley floor would materially damage the quantity or quality of water in the surface or underground water systems that would supply alluvial valley floors, the land shall be considered unsuitable.

There are no known conflicts with farming. The Fremont River has a relatively small alluvial valley floor. If surface mining were to occur within the alluvial valley floor, then mining and reclamation would be completed in a manner to minimize disturbances to the hydrologic balance within the permit area by reestablishing the essential hydrologic functions of the alluvial valley floors. Similarly, if mining were to occur outside of the alluvial valley floor, then mining and reclamation would be completed in a manner to minimize disturbances to the hydrologic balance by preserving the essential hydrologic functions. This criterion is not applicable.

Criterion 20

Summary of the Criterion: Federal lands in a state to which is applicable a criterion (i) proposed by the state or Indian tribe located in the planning area, and (ii) adopted by rulemaking by the Secretary, shall be considered unsuitable.

The State of Utah has adopted unsuitability criteria under rule R645-103-300, Utah Criteria for Designating Areas as Unsuitable for Coal Mining and Reclamation Operations. The criteria are similar to the Federal criteria at 43 CFR 3461, which are addressed in this report.

The coal resources that are assessed in this report are not located on tribal lands. An Indian tribe has not proposed or adopted any criteria for coal mining unsuitability that would be applicable to the subject Federal lands.

SUMMARY OF THE UNSUITABILITY EVALUATION

The coal resources with development potential in the Henry Mountains coal field have been evaluated in consideration of the 20 unsuitability criteria. Based on the criteria, the coal resources which are considered suitable for leasing are shown on Map 8. Coal resources have been determined to be unsuitable for leasing, based on Criteria 4 (WSAs) and 9 (T&E plants). The coal resources criteria were applied to Federal land only. The summary of acreage by land ownership is identified in Table A8-31.

Table A8-31. Acreage of Minable Coal Resources

Land Status	Surface Methods	Underground Methods
BLM	4,683	41,842
NPS	0	0

Only Federal surface estate is included in the above totals, since the criteria only apply to Federal lands. Some split estate (private surface and Federal minerals) may not be reflected in the above total, since the GIS data base does not include such information. There is not a significant acreage of split estate in the Henry Mountains coal field.

MAPS FOR HENRY MOUNTAINS COAL UNSUITABILITY EVALUATION

Map 1 – Location

Map 2 – Land Ownership

Map 3 – Rights of Way

Map 4 – Wilderness Study Areas

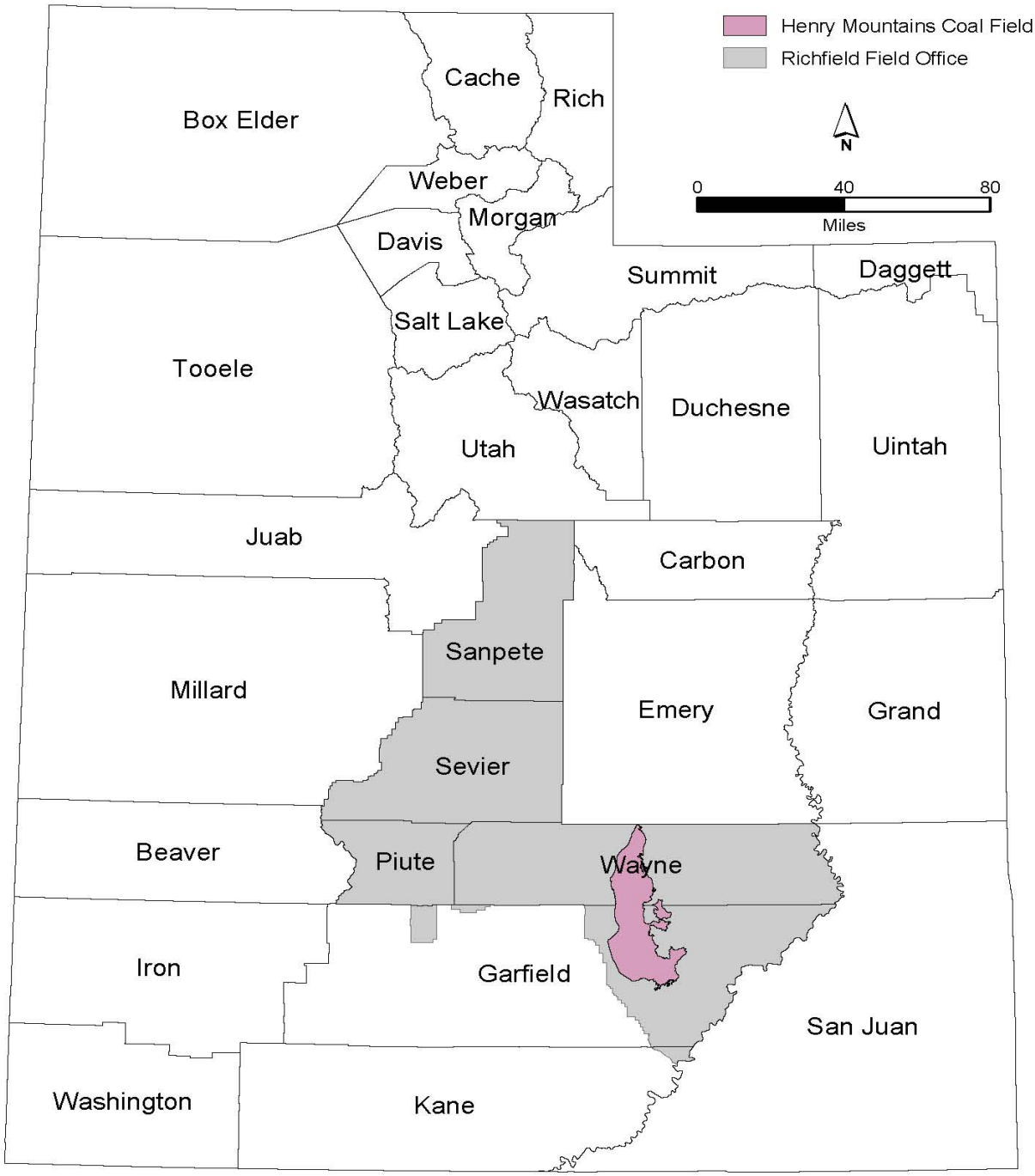
Map 5 – Threatened and Endangered Species

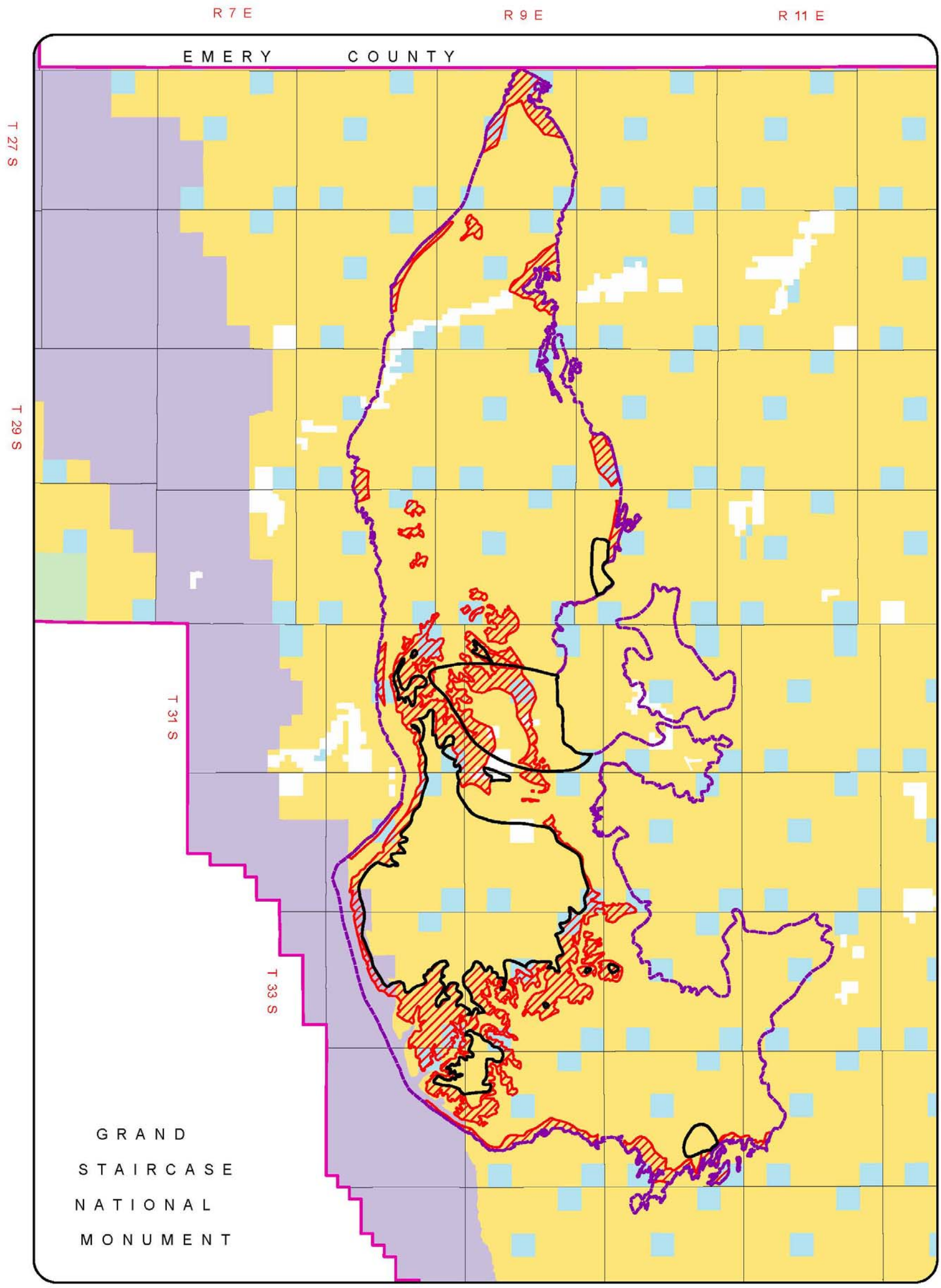
Map 6 – Deer Habitat

Map 7 – Bison Habitat

Map 8 – Henry Mountains Coal Suitability

Map 1 - General Location Map





Coal Unsuitability Report - Henry Mtns. Coal Field
Map 2 - Land Status

Surface Mineable Coal
Underground Mineable Coal
Henry Mtns. Coal Field

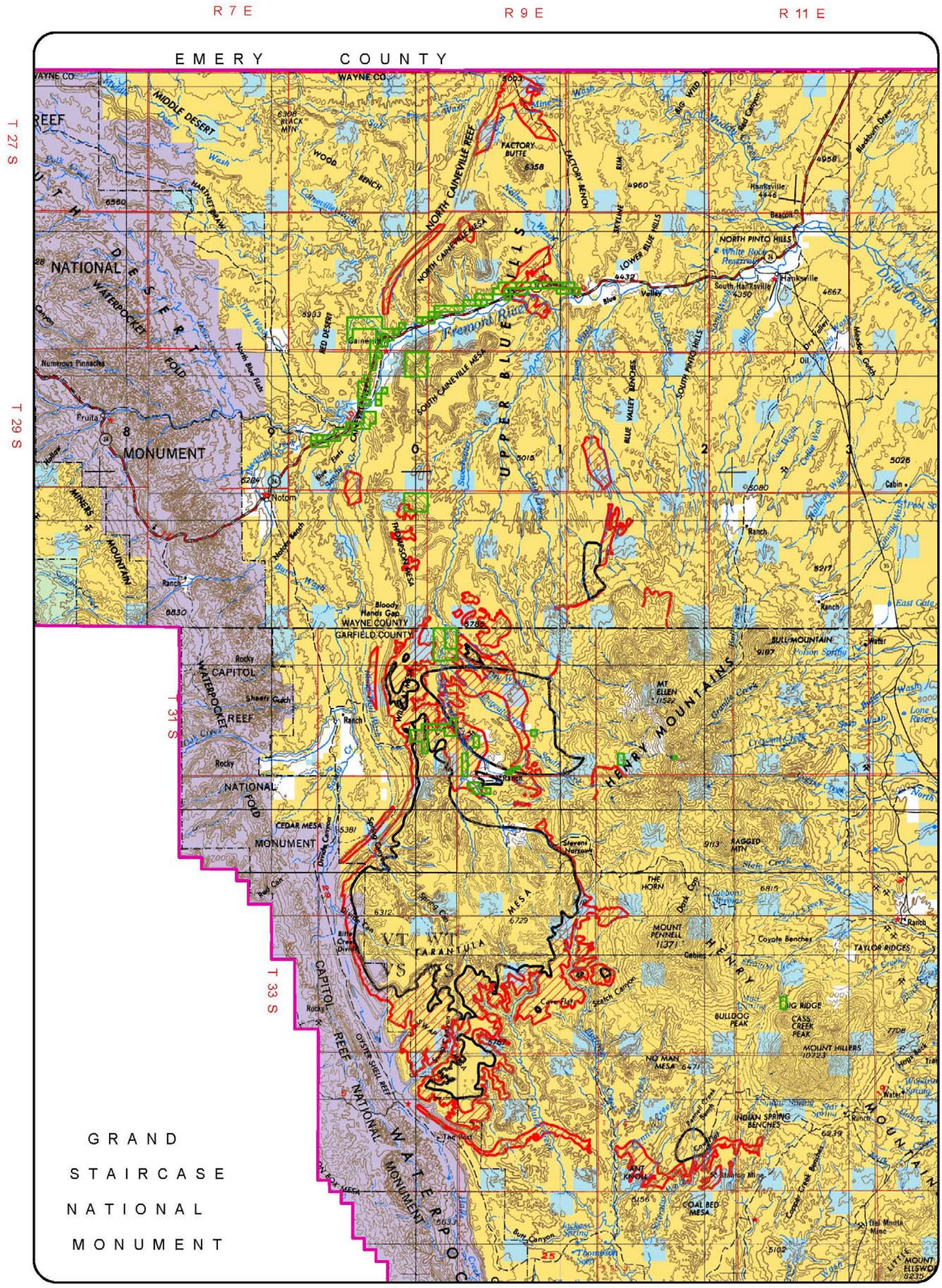
BLM
National Park Service
State
Private

N

0 4 8
Miles

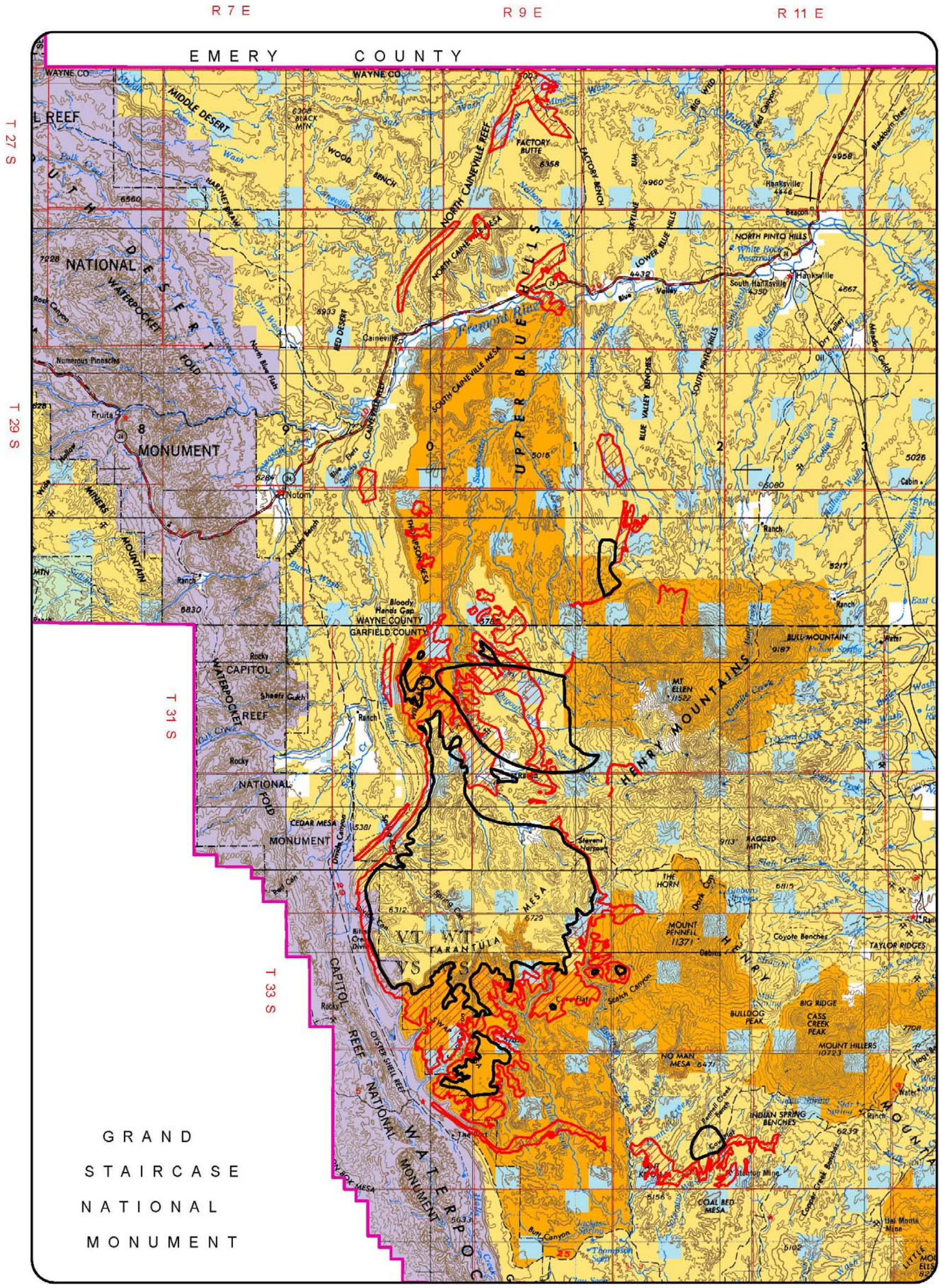
SCALE 1:250,000

Bureau of Land Management
Richfield Field Office
August 4, 2004



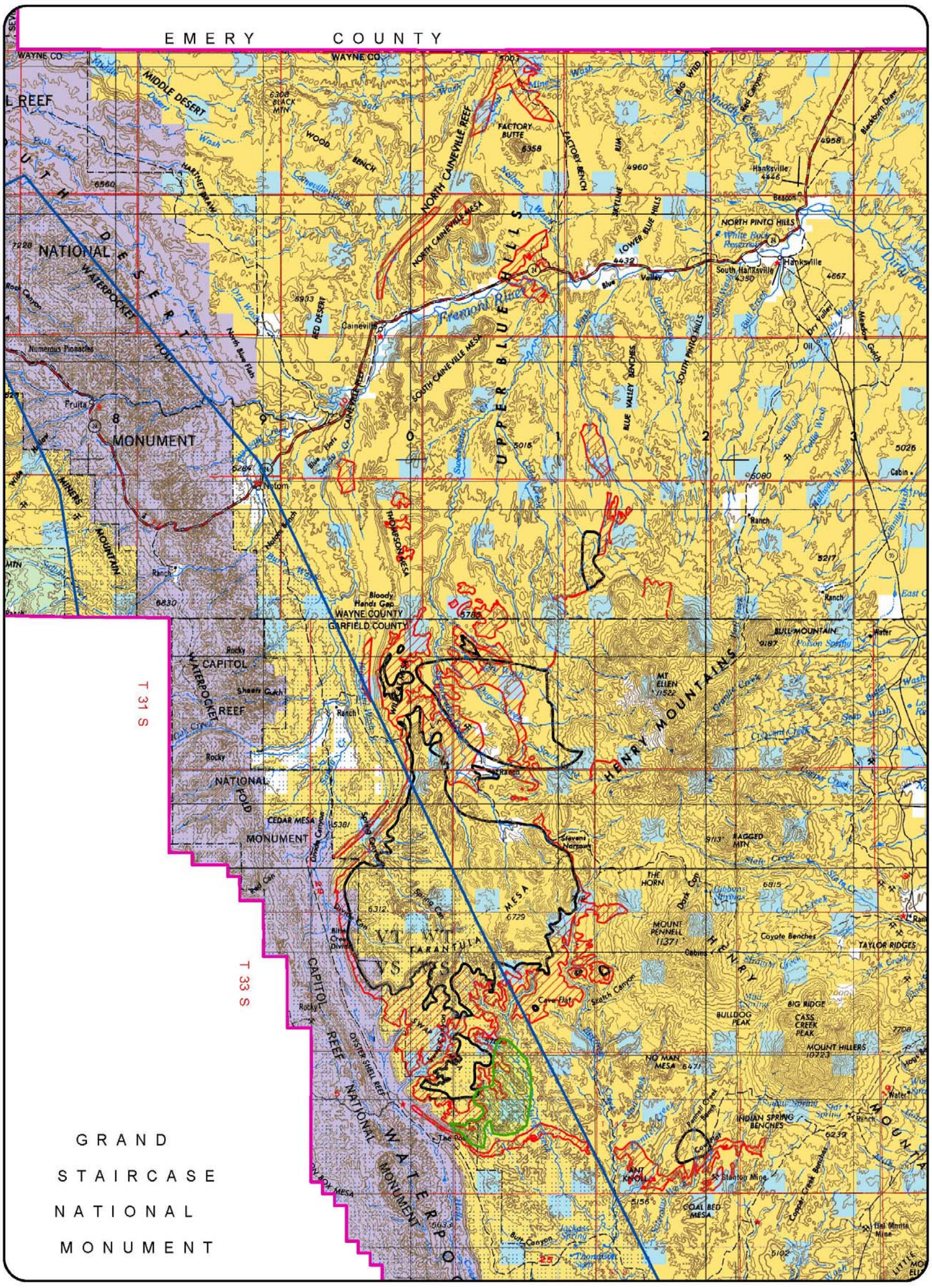
Coal Unsuitability Report - Henry Mtns. Coal Field
Map 3 - Rights of Way (Criterion 2)

Bureau of Land Management
Richfield Field Office
August 4, 2004



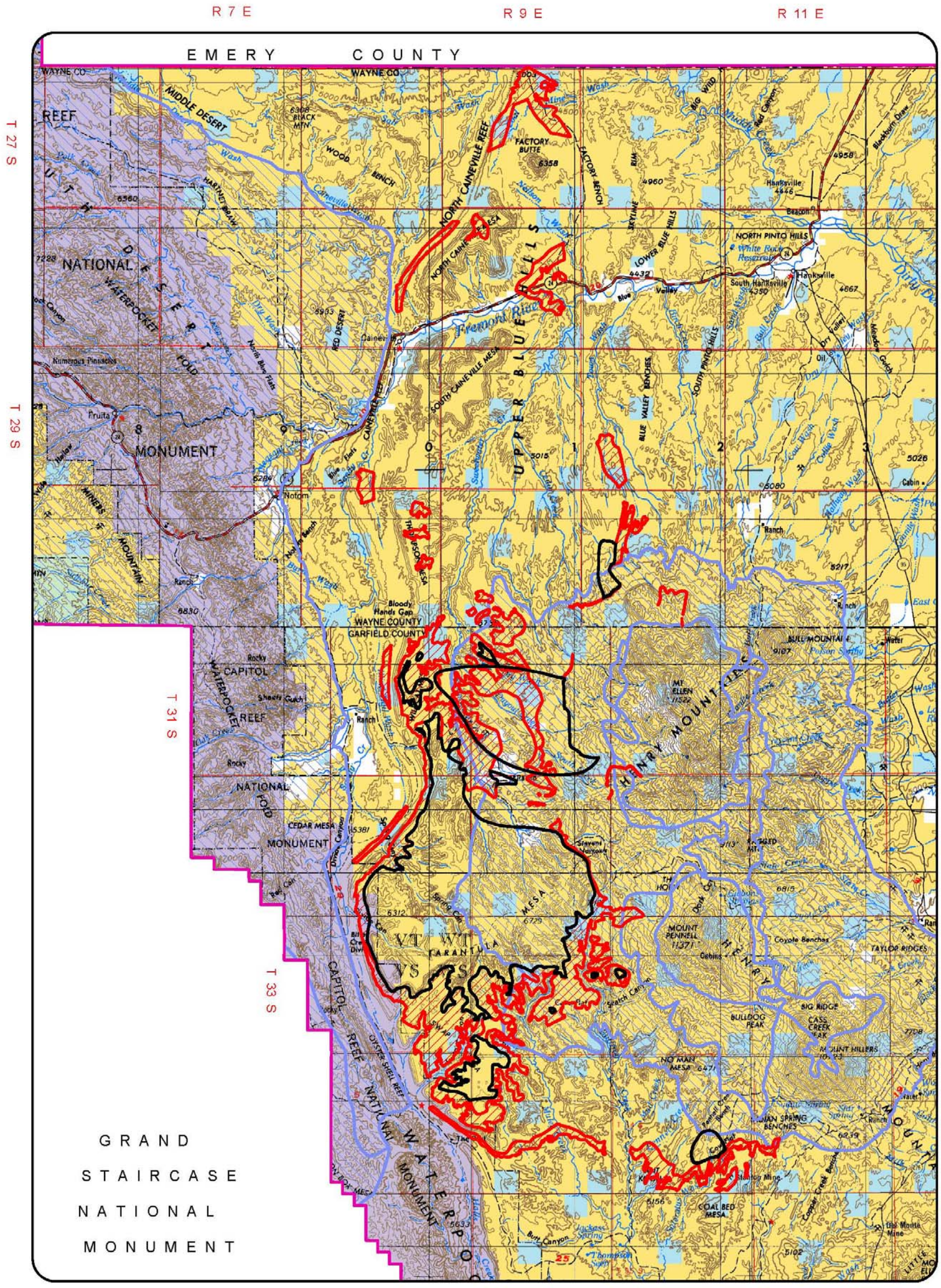
Coal Unsuitability Report - Henry Mtns. Coal Field
Map 4 - WSA's and VRM Class I (Criteria 4 & 5)

Bureau of Land Management
Richfield Field Office
August 4, 2004



Coal Unsuitability Report - Henry Mtns. Coal Field
Map 5 - Listed T&E Species (Criterion 9)

Bureau of Land Management
Richfield Field Office
August 4, 2004



Crucial Mule Deer Habitat
Surface Mineable Coal
Underground Mineable Coal
BLM
National Park Service
State
Private

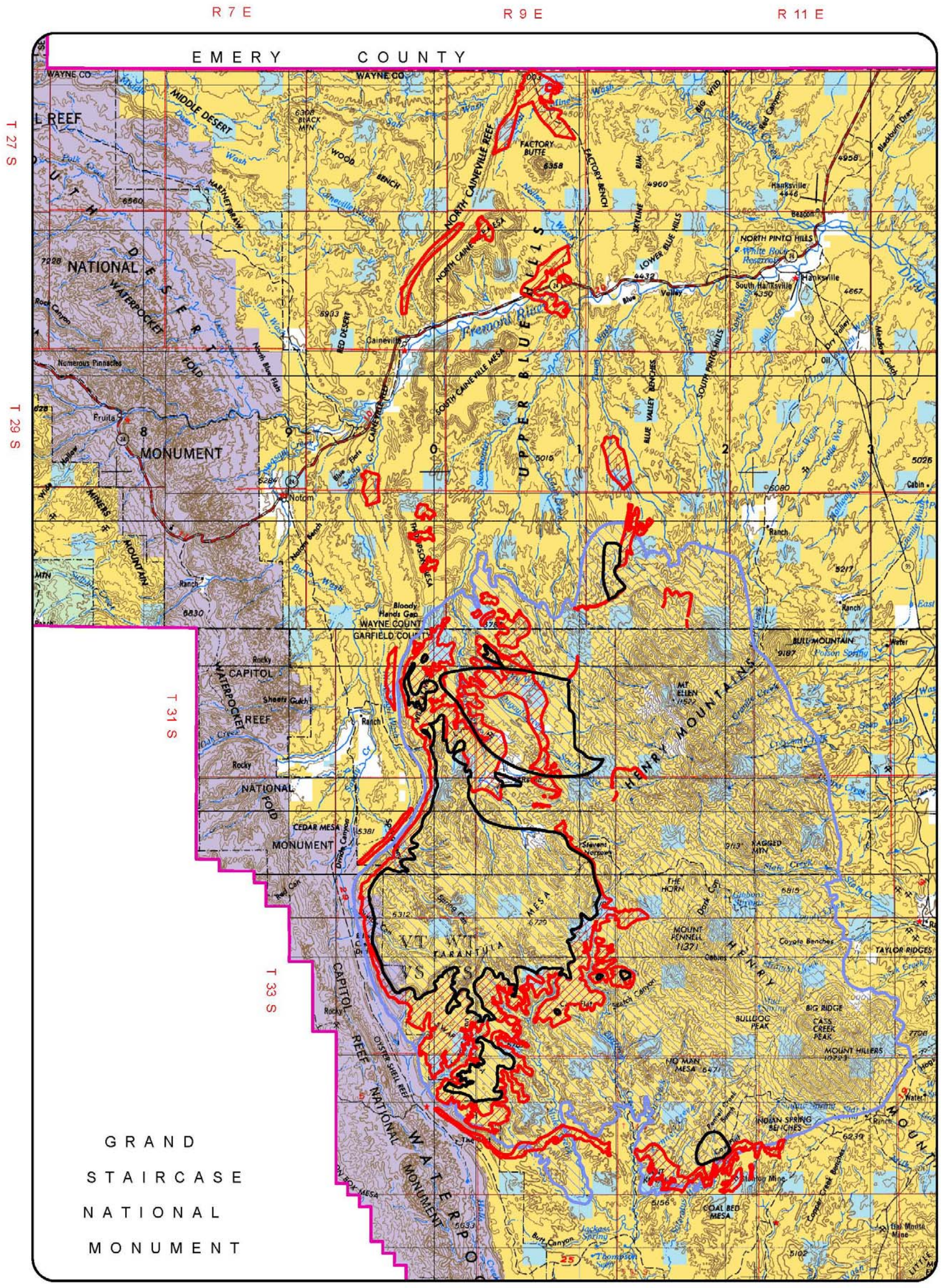
Coal Unsuitability Report - Henry Mtns. Coal Field
Map 6 - Mule Deer Crucial Habitat (Criterion 15)

N

0 5 10
Miles

SCALE 1:250,000

Bureau of Land Management
Richfield Field Office
August 4, 2004



Crucial Bison Habitat
Surface Mineable Coal
Underground Mineable Coal
BLM
National Park Service
State
Private

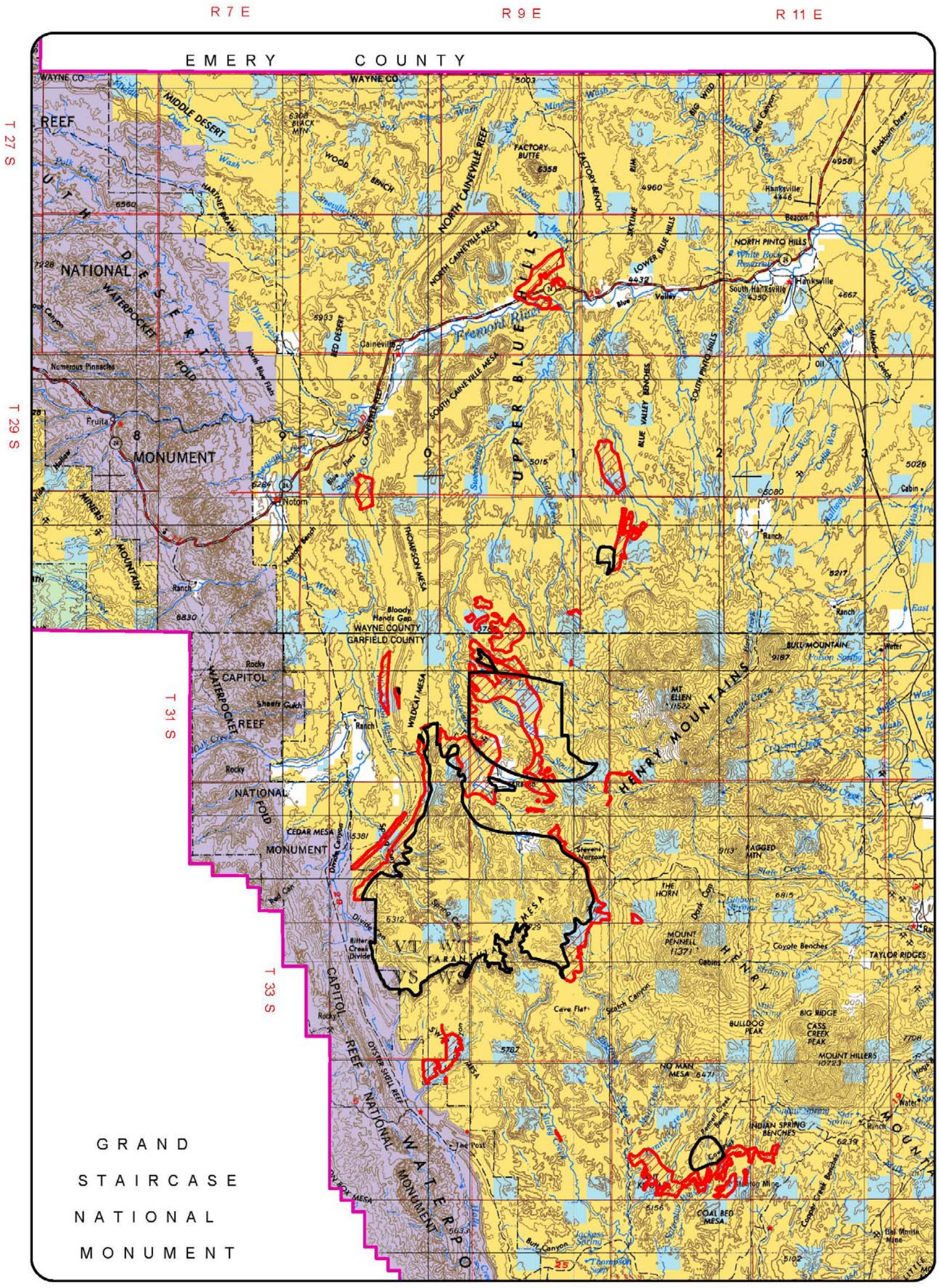
Coal Unsuitability Report - Henry Mtns. Coal Field
Map 7 - Crucial Bison Habitat (Criterion 15)

N

0 5 10
Miles

SCALE 1:250,000

Bureau of Land Management
Richfield Field Office
August 4, 2004



Coal Unsuitability Report - Henry Mtns. Coal Field
Map 8 - Coal Resources Considered Suitable for Leasing

Surface Mineable Coal
Underground Mineable Coal

BLM
National Park Service
State
Private

N

0 5 10
Miles

SCALE 1:250,000

Bureau of Land Management
Richfield Field Office
August 4, 2004

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COAL UNSUITABILITY REPORT WASATCH PLATEAU AND EMERY COAL FIELDS

INTRODUCTION

The Bureau of Land Management (BLM) has the responsibility for implementing Federal regulations 43 CFR 3461, Federal Lands Review: Unsuitability for Mining. The general unsuitability criteria, the Federal land review, and the prohibitions against mining are derived from the applicable sections of the Surface Mining Control and Reclamation Act of 1977 [30 U.S.C. 1272(a), (b), (e)]. This review of coal unsuitability is in conjunction with the revision of the existing land use plan and the development of a Resource Management Plan for the Richfield Field Office.

As addressed at 43 CFR 3420.1-4, the Secretary of the Interior may not hold a lease sale of public land containing coal deposits, unless the land is subject to a comprehensive land use plan. Only those lands that have coal resources with development potential may be considered as acceptable for further consideration for leasing. The coal resources, which are evaluated for unsuitability, have been delineated in a report, *Coal Resources of the BLM Richfield Planning Area* (2003). The coal report identifies public land that has a coal resource that is to be considered for coal leasing through the land use planning.

This report addresses the unsuitability of the coal resources that have potential for development in the Wasatch Plateau and Emery coal fields. Following the identification of the coal resources with development potential, the Bureau of Land Management shall determine whether areas are unsuitable for all or certain stipulated methods of mining. The Department of the Interior has developed 20 criteria that are used for this determination, which are presented at 43 CFR 3461.5.

GEOLOGIC SETTING

The Wasatch Plateau coal field is on the eastern side of the Wasatch Plateau, whereas the Emery coal field overlaps the Wasatch Plateau and a portion of the Mancos Shale Lowland. The coal fields are elongated in a northeast direction.

The coal deposits in the Emery and Wasatch Plateau coal fields are Cretaceous in age. The Emery coal beds are in the Ferron Sandstone Member of the Mancos Shale and stratigraphically below the Wasatch Plateau coal beds which are in the Blackhawk Formation.

The Wasatch Plateau is an escarpment on the east side of the plateau, and the coal beds have gentle westward dips with local displacement by faulting. The Emery field is located to the east of and topographically lower than the Wasatch Plateau field.

LANDS CONSIDERED

The Emery and Wasatch Plateau coal fields are located in central Utah (Map 1). The Emery coal field is in Sevier, Emery, and Carbon Counties, whereas the Wasatch Plateau coal field is also in Sanpete County (Map 1). This unsuitability report addresses *only* the coal resources which have development potential in Sevier and Sanpete County (Map 2). The coal resources in these two counties are within the planning area for the Richfield Field Office, Bureau of Land Management.

Within the planning area, the Emery coal field includes Federal land that is managed by the Bureau of Land Management Richfield Field Office and the US Forest Service Fishlake National Forest. The Wasatch Plateau coal field includes Federal land that is managed by BLM Richfield Field Office, and the Fishlake and Manti-La Sal National Forests. Within the planning area, the Emery coal field contains 41,849 acres, and the Wasatch Plateau coal field contains 103,808 acres. The acreage of land with development potential for coal resources is given for each coal field in the subsequent Coal Resources Section.

Within the planning area, Federal coal leases are not currently authorized within the Emery coal field; There are currently seven Federal coal leases authorized within the Wasatch Plateau and none in the Emery coal field. Most of the approximately 23,937 acres under Federal coal leases, are within the boundaries of the Fishlake and Manti-LaSal National Forests (Map 2). The existing Federal coal leases (UTSL-0062583, UTU-028297, UTU- 047080, UTU-062453, UTU-0149084, UTU-063214, and UTU-076195) are not subject to this unsuitability review (43 CFR 3461.3-2).

Further reference in this report to coal fields and coal resources is only to the portions within the subject planning area.

COAL RESOURCES

The Emery coal field contains an estimated 303 million tons of in-place, unleased, minable coal resources; the Wasatch Plateau contains 415.8 million tons of in-place, unleased, minable coal resources (Tabet 2003, p. 41). These estimates include only coal beds of an average thickness of 6 feet or greater with less than 2,500 feet of overburden for underground mining and coal beds of a minimum thickness of a 4 feet and a maximum overburden of 100 feet for surface mining.

In the Emery field, approximately 11 million tons could be mined by surface methods and 292 million tons by underground methods. The coal resources in the Wasatch Plateau field could be mined by underground methods only.

Ownership of lands with coal resources that have development potential is summarized in Table A8-32 and Table A8-33 below.

Table A8-32. Emery Coal Field Coal Resources

Land Status	Surface Minable Acres	Underground Minable Acres
BLM	149	9,624
USFS	534	3,542
State	0	1,673
Private	28	1,164
Total	**711**	**16,003**

Table A8-33. Wasatch Plateau Coal Field Coal Resources

Land Status	Surface Minable Acres	Underground Minable Acres
BLM	0	0
USFS	0	18,672
State	0	0
Private	0	3,956
Total	**0**	**22,628**

Split ownership of private surface and Federal minerals is not included in the above totals, due to limitations of the current GIS data base. The largest tract of split estate with Federal coal resources is in the vicinity of Acord Lakes. The unsuitability criteria are applied to Federal lands, as defined at 43 CFR 3400.0-5(o) and required by the regulations at 43 CFR 3461.2-1.

EVALUATION OF THE UNSUITABILITY CRITERIA

The coal resources with development potential are assessed for the unsuitability criteria as outlined at 43 CFR 3461.5. Underground mining of coal deposits is exempt from the criteria, where there would be no surface coal mining operations as stated at 3461.1(a). Surface mining operations include surface operations and surface impacts incident to an underground mine as defined at 43 CFR 3400.0-5(mm). In addition, at 43 CFR 3461.1(b), where underground mining will include surface operations and surface impacts on Federal lands to which a criterion applies, the lands shall be assessed as unsuitable unless an exception or exemption applies. Each criterion is subject to exceptions and/or exemptions as prescribed in the regulations.

As stated above, the criteria are applied to the Federal lands with coal resources that are identified as having development potential, not to all the coal deposits within the coal fields.

Criterion 1

Summary of the Criterion: All Federal lands included in the following land systems or categories shall be considered unsuitable: National Park System, National Wildlife Refuge System, National System of Trails, National Wilderness Preservation System, National Wild and Scenic Rivers System, National Recreation Areas, lands acquired with money derived from the Land and Water Conservation Fund, National Forests, and Federal lands in incorporated cities, towns, and villages.

Federal lands with coal resources with development potential are located within the Fishlake and Manti La-Sal National Forests (Map 2 and Table A8-32 and Table A8-33 above). An exception for leasing on National Forest is allowed, if:

> "* * * the Secretary finds no significant recreational, timber, economic or other values which may be incompatible with the lease; and (A) surface operations and impacts are incident to an underground coal mine, or (B) where the Secretary of Agriculture determines, with respect to lands which do not have significant forest cover within those National Forests west of the 100th Meridian, that surface mining may be in compliance with Multiple-Use Sustained Yield Act of 1960, the Federal Coal Leasing Amendments of 1976 and the Surface Mining Control and Reclamation Act of 1977."

The USFS has determined that *no significant recreational, timber, economic or other values* which may be incompatible with the lease are present within both National Forests. The coal resources that have development potential by underground methods meet the underground exemption, and any associated surface operations and impacts meet the above exception. Coal resources within the Fishlake National Forest at T. 25 S., R. 4 E. that have development potential by surface mining methods would meet the exception, since significant forest cover is not present and coal mining would be in compliance with the stated laws.

Criterion 2

Summary of the Criterion: Federal lands that are within rights-of-way or easements or within surface leases for residential, commercial, industrial, or other public purposes, on Federally-owned surface shall be considered unsuitable.

Within the Emery coal field, several authorized rights-of-way encompass BLM-administered, Federal lands with coal resources which have development potential (Map 3). These are listed in Table A8-34 below.

Table A8-34. BLM-Administered, Authorized Rights-of-Way within Emery Coal Field

Serial Number	Holder	Legal Description	Type	Acres (ac) or Width (ft)
UTSL-0062677	Federal Highway Administration	T. 23 S., R. 5 E., Sec. 1, 11, 12, 14, 22, 27	Highway	400 ft
UTSL-0062873	Federal Highway Administration	T. 23 S., R. 5 E., Sec. 27, 34	Highway	400 ft
UTU-008966	Federal Highway Administration	T. 23 S., R. 5 E., Sec. 33, 34, 35 T. 24 S., R. 5 E., Sec. 3	Highway	400 ft
UTU-043522	Sevier County	T. 23 S., R. 5 E., Sec. 11, 12, 13	Road	100 ft
UTU- 0107441	Federal Highway Administration	T. 23 S., R. 5 E., Sec. 25	Material Site	166 ac
UTU- 0110883	Federal Highway Administration	T. 23 S., R. 5 E., Sec. 25, 26, 35	Highway	500 ft
UTU- 0136803	Federal Highway Administration	T. 23 S., R. 5 E., Sec. 25	Material Site	203 ac
UTU- 072941	Sevier County	T. 24 S., R. 5 E., Sec. 13	Road	45 ft
UTU- 057036	Federal Highway Administration	T. 25 S., R. 5 E., Sec. 6	Highway	200 ft

This criterion is subject to exceptions. A lease may be issued and mining operations approved, in such areas, if the surface management agency determines that:

- All or certain types of coal development (e.g., underground mining) will not interfere with the purpose of the rights-of-way or easement, or
- The right-of-way or easement was granted for mining purposes,
- The right-of-way or easement was issued for a purpose for which it is not being used,
- The parties involved in the right-of-way or easement agree, in writing, to leasing,
- It is impractical to exclude such areas due to the location of coal and method of mining and such areas or used can be protected through appropriate stipulations.

All the above-listed rights-of-way on BLM-administered lands are subject to development by underground mining, and right-of-way UTU-72941 is also subject to surface mining. Mining by underground methods is exempt and should not interfere with the intended use of a right-of-way facility. Where there could be surface operations and surface impacts associated with underground mining, the impacts would be mitigated, subject to an agreement with the right-of-way holder at the time of a specific leasing proposal. Where the coal resources would be mined by surface methods, the right-of-way facility could be moved during the mining operations and re-located when the land is reclaimed, again, subject to

an agreement with the right-of-way holder. The Federal lands subject to the above rights-of-way are considered suitable.

There are no current rights-of-way or easements on NFS lands considered in this report.

The existing coal leases on the Fishlake National Forest are exempt from this criterion.

Criterion 3

Summary of the Criterion: The terms used in this criterion have their meaning set out in the Office of Surface Mining Reclamation and Enforcement regulations at Chapter VII of Title 30 of the Code of Federal Regulations. Federal lands affected by Section 522(e) (4) and (5) of the Surface Mining Control and Reclamation Act of 1977 shall be considered unsuitable. This includes lands within 100 feet of the outside line of a right-of-way of a public road, within 100 feet of a cemetery, or within 300 feet of any public building, school, church, community or institutional building, public park or occupied dwelling.

Exceptions are allowed, if a lease may be issued for lands:

- Used as mine access roads or haulage roads that join the right-of-way for a public road;
- For which the Office of Surface Mining Reclamation and Enforcement has issued a permit to have public roads relocated;
- If, after public notice and opportunity for public hearing in the locality, a written finding is made by the authorized officer that the interests of the public and the landowners affected by mining within 100 feet of a public road will be protected;
- For which owners of occupied dwellings have given written permission to mine within 300 feet of their buildings.

The subject coal lands do not fall within the stated distances of a cemetery, public building, school, church, community or institutional building, or public park.

BLM-administered, Federal lands with development potential for coal resources are located within 100 feet of the rights-of-way for a road or highway, which are listed under Criterion 2. The listed road and highway rights-of-way are subject to underground mining methods, and the right-of-way UTU- 072941 is also subject to surface mining. Mining by underground methods is exempt from this review. Where the coal resources would be mined by surface methods or a surface operation or impact would be associated with underground mining, the coal would only be leased in compliance with the Office of Surface Mining Reclamation and Enforcement and following a public notice and hearing. The Federal lands within 100 feet of road or highway rights-of-way, as listed under Criterion 2, are considered suitable for leasing under this Criterion.

Occupied dwellings are located at T. 22 S., R. 4 E., at Acord Lakes on private surface estate and Federal coal estate. This land would be developed by underground mining methods, and as stated previously, underground mining is exempt from this review, except for surface operations and impacts. Under the exception for this criterion, written permission is required from the owner of an occupied dwelling if surface operations of coal mining are within 300 feet of the occupied dwelling. If surface operations associated with the underground mining are necessary within the 300-foot distance, then that will be addressed as an impact at the time of leasing, and permission from the affected landowner(s) will be sought. However, it is likely that the design of a mine would involve locating surface facilities and impacts on unoccupied lands.

A dwelling is also located at T. 25 S., R. 4 E., Section 22 NE¼SE¼ at Paradise Valley on private land. This structure is more than 300 feet from the identified lands with a potentially developable coal resource as determined from the USGS Geyser Peak 7.5 minute topographic quadrangle (scale 1:24,000).

Criterion 4

Summary of the Criterion: Federal lands designated as wilderness study areas shall be considered unsuitable while under review by the Administration and the Congress for possible wilderness designation.

None of the subject Federal lands are presently within designated wilderness study areas. Some lands administered by the U.S. Forest Service are however being evaluated (inventoried) to determine if those lands have the characteristics of a wilderness study area. In accordance with the criterion, for any Federal land which is to be leased or mined prior to completion of the wilderness inventory by the surface management agency, the environmental assessment or impact statement on the lease sale or mine plan shall consider whether the lands have the characteristics of a wilderness study area. If the finding is affirmative, the land shall be considered unsuitable, unless issuance of noncompetitive coal leases and mining on leases is authorized under the Wilderness Act and the Federal Land Policy and Management Act of 1976 (FLPMA).

None of the subject Federal lands are within a designated wilderness study area.

Criterion 5

Summary of the Criterion: Scenic Federal lands designated by visual resource management analysis as Class I (an area of outstanding scenic quality or high vessel sensitivity) but not currently on the National Register of Natural Landmarks shall be considered unsuitable.

None of the BLM-administered Federal lands are presently located within areas designated as visual resource management Class I, and none of the National Forest lands are presently located within areas designated as visual resource management Class A, which is equivalent to Class I in the BLM classification. Therefore, this criterion is not applicable to the subject lands.

Criterion 6

Summary of the Criterion: Federal lands under permit and being used for scientific studies involving food or fiber production, natural resources, or technology demonstrations and experiments shall be considered unsuitable for the duration of the study.

None of the subject lands are under permit for the described scientific studies. This criterion is not applicable to the subject lands.

Criterion 7

Summary of the Criterion: All publicly or privately owned places which are included in the National Register of Historic Places shall be considered unsuitable.

Presently, there are no listed sites on the subject lands that are included on the National Register of Historic Places. This criterion is not applicable. Any subsequently listed sites and eligible sites will be further evaluated at the time of leasing.

Criterion 8

Summary of the Criterion: Federal lands designated as natural areas or as National Natural Landmarks shall be considered unsuitable.

None of the subject lands are designated as a National Natural Landmark.

Criterion 9

Summary of the Criterion: Federally designated critical habitat for listed threatened or endangered plant and animal species, habitat proposed to be designated as critical for listed threatened or endangered plant and animal species or species proposed for listing, and habitat for Federal threatened or endangered species which is determined by the Fish and Wildlife Service and the surface management agency to be of essential value and where the presence of threatened or endangered species has been scientifically documented, shall be considered unsuitable.

Based upon data currently available, the Federal lands do not meet the guidelines for this criterion. Surveys have been completed in these areas for several other projects. No listed threatened or endangered plant or animal species have been definitely found. No critical habitat is presently designated on the subject lands. Therefore, this criterion does not apply to the subject lands. Subsequently designated critical habitat, proposed critical habitat, and essential-value habitat will be further evaluated at the time of leasing.

Criterion 10

Summary of the Criterion: Federal lands containing habitat determined to be critical or essential for plant or animal species listed by a state, pursuant to state law, as endangered or threatened shall be considered unsuitable.

The State of Utah has not listed any plant species as endangered or threatened, pursuant to State law. Therefore, the criterion does not apply to plant species. The State has listed endangered or threatened animal species, but these are the same as the Federally listed animal species. The State of Utah recognizes the Federal listings and habitat designations. As stated in Criterion 9, no listed endangered or threatened animal species have been found. No critical habitat has presently been designated which on subject lands with coal resources. Therefore, the criterion does not apply to the subject lands. Subsequently designated critical habitat and essential-value habitat will be further evaluated at the time of leasing.

Criterion 11

Summary of the Criterion: A bald or golden eagle nest or site on Federal lands that is determined to be active, including an appropriate buffer zone of land around the nest site, shall be considered unsuitable. Consideration of availability of habitat of prey species and of terrain shall be included in the determination. Buffer zones shall be determined in consultation with the Fish and Wildlife Service.

Eagle nests are not known to be present on the subject lands, therefore this criterion does not apply. If nests or sites are found at the time of leasing, then consultation will occur with the U.S. Fish and Wildlife Service and appropriate mitigations as outlined in the RMP will be applied. The subject Federal lands will be subject to inventory and site-specific analysis at the time of leasing.

Criterion 12

Summary of the Criterion: Bald or golden eagle roost and concentration areas on Federal lands used during migration and wintering shall be considered unsuitable.

Eagle roosts are not known to be present on the subject Federal lands, therefore this criterion does not apply. If roosts or concentration areas are found at the time of leasing, then consultation will occur with the U.S. Fish and Wildlife Service and appropriate mitigations as outlined in the RMP will be applied.

Criterion 13

Summary of the Criterion: Federal lands containing a falcon (excluding kestrel) cliff nesting site with an active nest and including a buffer zone of Federal land around the nest site shall be considered unsuitable. Consideration of availability of habitat for prey species and of terrain shall be included in the determination of buffer zones. Buffer zones shall be determined in consultation with the Fish and Wildlife Service.

Active falcon nesting sites are not known to be present on the subject Federal lands, therefore this criterion does not apply to the subject lands. If active nesting sites are found at the time of leasing, then consultation will occur with the U.S. Fish and Wildlife Service and appropriate mitigations as outlined in the land use plan will be applied.

Criterion 14

Summary of the Criterion: Federal lands which are high priority habitat for a migratory bird species of high Federal interest on a regional or national basis, as determined by the surface management agency and the Fish and Wildlife Service, shall be considered unsuitable.

High priority habitat for migratory birds overlaps a portion of the underground minable coal resource in the vicinity of Old Woman Plateau. The acreage involved is 2,048. The exemption for underground mining applies to this habitat; however surface operations and surface impacts may be unsuitable or be mitigated at the time of leasing. The Federal lands will be subject to inventory and site-specific analysis at the time of leasing.

Criterion 15

Summary of the Criterion: Federal lands which the surface management agency and state jointly agree are habitat for resident species of fish, wildlife, and plants of high interest to the state and which are essential for maintaining these priority wildlife and plant species shall be considered unsuitable. Examples of such lands include:

- Active dancing and strutting grounds for sage grouse,
- Winter ranges crucial for deer, antelope, and elk,
- Migration corridor for elk, and
- Extremes of range for plant species.

A lease may be issued if, after consultation with the state, the surface management agency determines that all or certain stipulated methods of coal mining will not have a significant long-term impact on the species being protected.

Underground mining is exempt. Surface facilities associated with the coal mining could be located within the crucial habitat and could include a mine portal, buildings, and construction of roads. Haulage of mined coal would also be necessary. The location of these facilities and associated haulage could be located as to minimize or reduce the impact to the habitat. Surface operations and impacts would not have an adverse, long-term impact on the crucial habitats.

Crucial habitat for deer, elk, and black bear overlaps Federal lands with coal resources that would be mined by underground methods (Maps 5, 6, and 7). The coal resources that would be developed by underground mining on BLM and National Forest lands are exempt from this criterion. Surface operations and surface impacts that would be associated with this type of mining would not have a long-term effect on the species, as determined in consultation with the USFS and the Division of Wildlife Resources, State of Utah. Underground mining meets the exception of this criterion, and surface operations and surface impacts would be subject to a site-specific review as part of the consideration of an application to lease coal.

Crucial habitat for deer, elk, and black bear is present on the Fishlake National Forest at T. 25 S., R. 4 E., in an area that could be mined by surface methods (Maps 5, 6, and 7). The maximum area that would be surface mined would involve approximately 534 acres of National Forest lands. If surface mining were to occur, the mining would probably be completed in stages, or mining units, with mining in one area while an adjacent, previously mined-out area would be reclaimed to restore the crucial habitat. Thus, with concurrent mining and reclamation, surface mining would not impact all the acreage within a given lease at one time. Also, all the above land with an identified potential for surface mining may not be developed, because the coal reserves that would support a mine could be less than the currently identified coal resource. However, this land that could have surface mining is unsuitable, as determined in consultation with the USFS and the Division of Wildlife Resources, State of Utah.

Crucial habitat for deer and elk is present on BLM-administered lands at T. 24 S., R. 5 E. that could be mined by surface methods (Maps 5 and 6). The surface minable coal resource is approximately 149 acres. Whereas, the elk habitat only partially overlaps the surface minable coal, the deer habitat encompasses all of the land with the surface minable coal resource. The surface minable coal resource at this location is considered unsuitable, as determined in consultation with the USFS and the Division of Wildlife Resources, State of Utah.

The existing Federal leases are exempt from this criterion.

Criterion 16

Summary of the Criterion: Federal land in riverine, coastal and special floodplains (100-year recurrence interval) on which the surface management agency determines that mining could not be undertaken without substantial threat of loss of life or property shall be considered unsuitable for all or certain stipulated methods of coal mining.

None of the subject lands are on lands where mining would result in substantial loss of life or property. Therefore, this criterion is not applicable.

Criterion 17

Summary of the Criterion: Federal lands which have been committed by surface management agency to use as municipal watersheds shall be considered unsuitable.

None of the subject lands with coal resource that has potential for development are within a municipal watershed. Therefore this criterion is not applicable.

Criterion 18

Summary of the Criterion: Federal lands with National Resource Waters, as identified by states in their water quality management plans including a buffer zone of Federal lands ¼ mile from the outer edge of the water bodies shall be considered unsuitable.

The State of Utah considers National Resource Waters as High Quality Waters (State Code R317-2-12). High Quality Waters are considered to be all surface waters geographically located within the boundaries of National Forests and certain designated stream channels or basins. Underground minable coal resources are exempt from this criterion. An exception to this criterion may be granted when the surface management agency determines that a buffer zone is unnecessary.

Surface streams cross many of the coal resource tracts in the Wasatch Plateau within the National Forests (Map 8). These National Forest System lands have development potential by underground mining. A coal resource at T. 25 S., R. 4 E. has potential by surface mining. Surface mining and surface operations and surface impacts that could be associated with underground mining would be subject to site-specific analysis and the consideration of buffers as mitigation at the time of leasing; therefore, impacts to High Quality Waters could be mitigated at the time of leasing.

None of the coal resources with development potential on BLM land are classified as High Quality Waters by the State. Therefore, the coal resources with development potential on BLM land are considered available for leasing under this criterion.

Criterion 19

Summary of the Criterion: Federal lands identified by the surface management agency, in consultation with the state in which they are located, as alluvial valley floors according to the definition in §3400.0-5(a) of this title, the standards in 30 CFR 822, the final alluvial valley floor guidelines of the Office of Surface Mining Reclamation and Enforcement when published, and approved state programs under the Surface Mining Control and Reclamation Act of 1977, where mining would interrupt, discontinue, or preclude farming, shall be considered unsuitable. Additionally, when mining Federal land outside an alluvial valley floor would materially damage the quantity or quality of water in the surface or underground water systems that would supply alluvial valley floors, the land shall be considered unsuitable.

No alluvial valley floors occur on lands, considered in this report and there are no known conflicts between minable land and farming land. Impacts to water quality can be addressed at the time of evaluating specific mining proposals and can be mitigated at that time. Therefore, this criterion is not applicable.

Criterion 20

Summary of the Criterion: Federal lands in a state to which is applicable a criterion (i) proposed by the state or Indian tribe located in the planning area, and (ii) adopted by rulemaking by the Secretary, shall be considered unsuitable.

The State of Utah under State rule, R645-103-300, Utah Criteria for Designating Areas as Unsuitable for Coal Mining and Reclamation Operations, has developed unsuitability criteria, which are similar to the Federal criteria at 43 CFR 3461 as addressed in this report. No Indian tribe has proposed a criterion for coal mining unsuitability. Therefore, this criterion is not applicable at this time.

SUMMARY OF THE UNSUITABILITY EVALUATION

The coal resources with development potential in the Emery and Wasatch Plateau coal fields have been evaluated in consideration of the 20 unsuitability criteria. Based on the criteria, the coal resources which could be developed by surface mining methods in the Emery coal field at T. 25 S., R. 4 E., on the Fishlake National Forest and at T. 24 S., R. 5 E. on the BLM are considered to be unsuitable for leasing. Thus, 534 acres on the National Forest and the 149 acres on BLM would not be available for coal leasing. The other coal resources within Sanpete and Sevier Counties with development potential by underground methods are considered suitable for leasing (Map 9). The acreage considered suitable for the consideration of leasing of Federal coal resources is listed below in Table A8-35 and Table A8-36.

Table A8-35. Emery Coal Field Federal Coal Resources

Land Status	Surface Minable Acres	Underground Minable Acres
BLM	149	9,624
USFS	534	3,542
Total	**683**	**13,166**

Table A8-36. Wasatch Plateau Coal Field Federal Coal Resources

Land Status	Surface Minable Acres	Underground Minable Acres
USFS	0	18,672
Total	**0**	**18,672**

Private and state lands are not subject to the unsuitability criteria for Federal lands and are not included in the above totals.

MAPS FOR WASATCH PLATEAU AND EMERY COAL UNSUITABILITY

Map 1 – Location

Map 2 – Land Ownership

Map 3 – Rights-of-Way

Map 5 – Deer Habitat

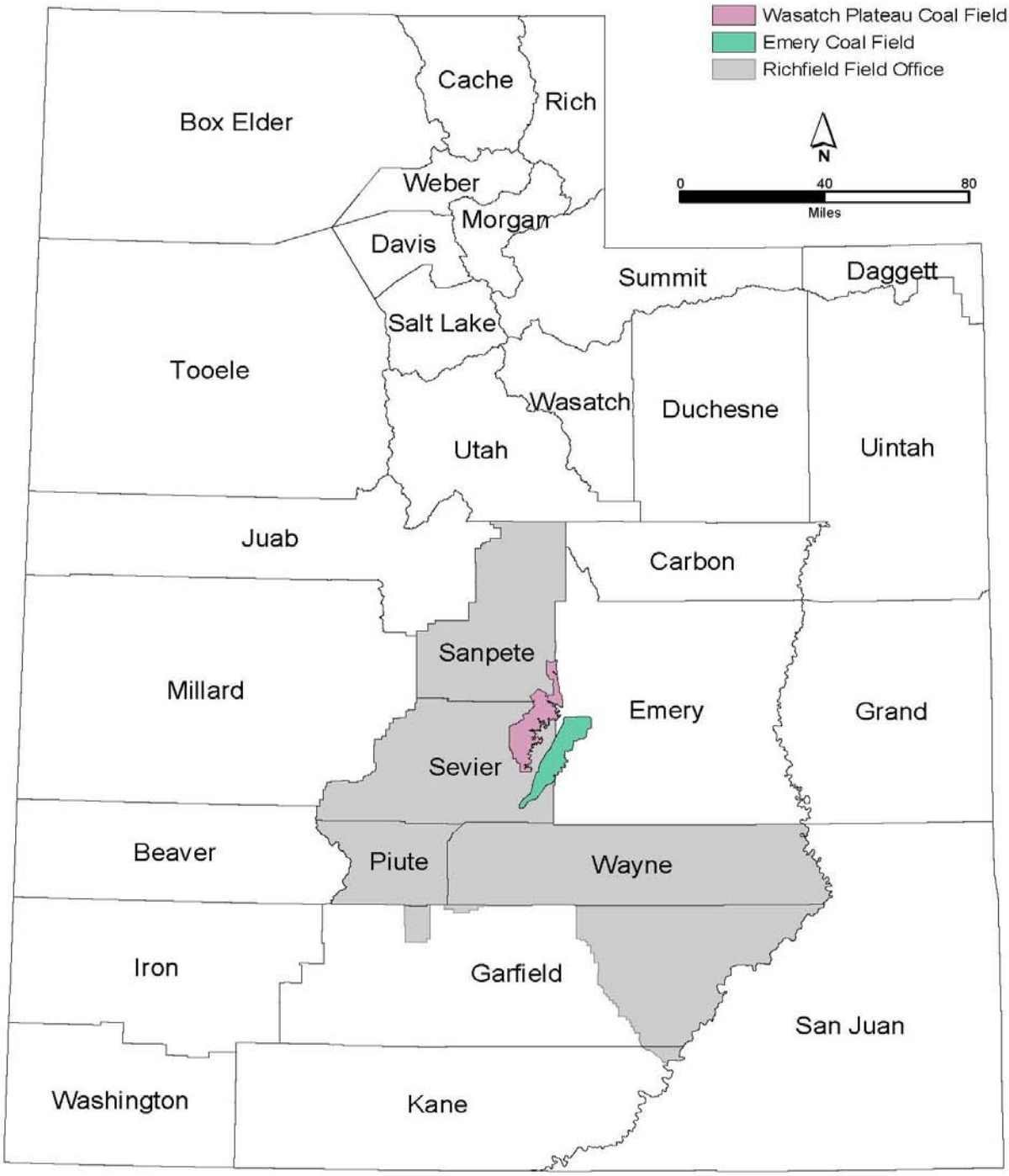
Map 6 – Elk Habitat

Map 7 – Bear Habitat

Map 8 – Natural Resource Waters

Map 9 – Coal Suitability

Map 1 - General Location Map



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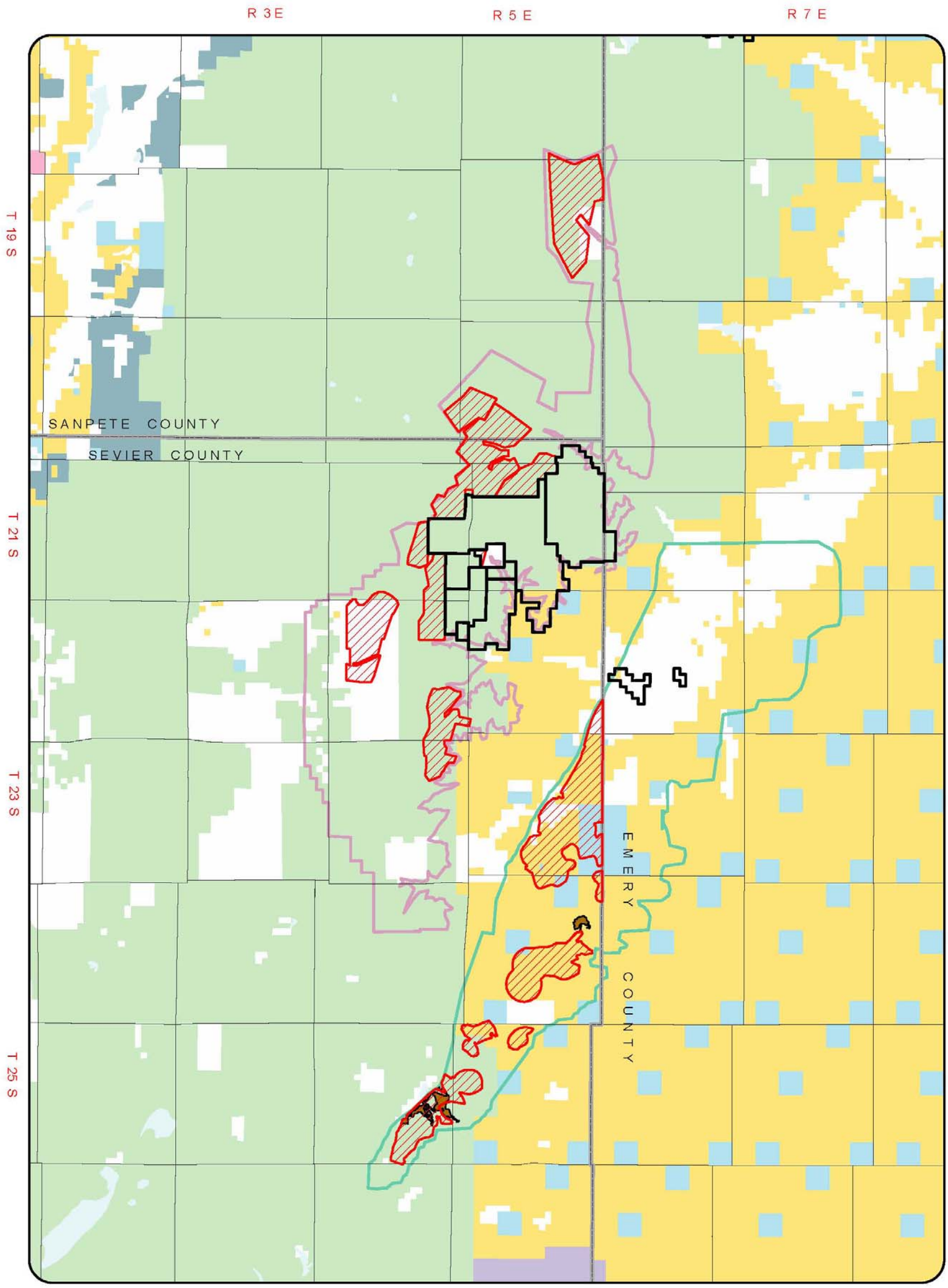


Coal Unsuitability Report - Emery and Wasatch Plateau Coal Fields
Map 2 - Land Status

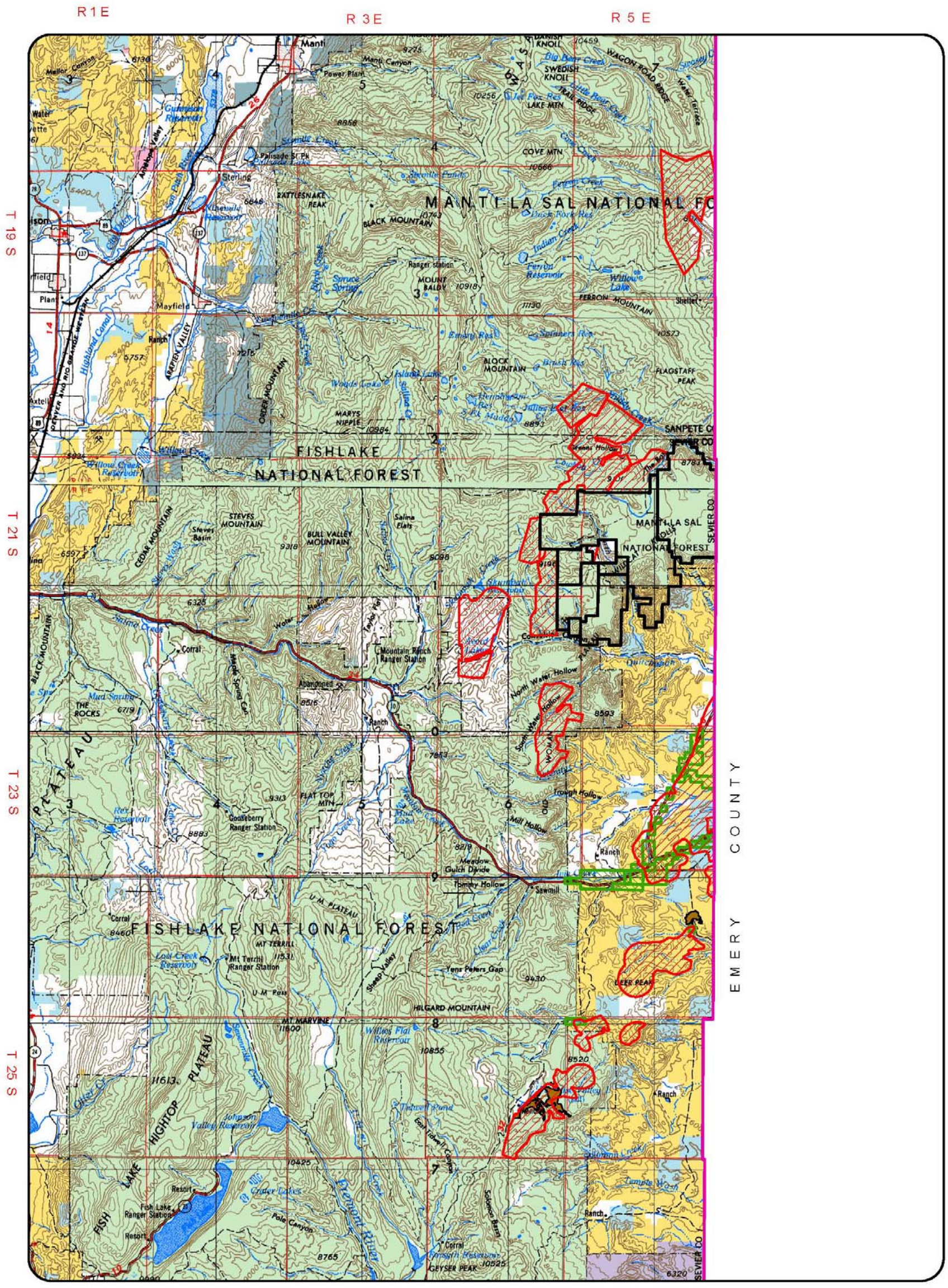
Underground Mineable Coal
Surface Mineable Coal
Coal Leases
Wasatch Plateau Coal Field
Emery Coal Field

BLM
Forest Service
State
National Park
Private

Bureau of Land Management
Richfield Field Office
August 3, 2004

N

0 5 10
Miles
SCALE 1:250,000



Coal Unsuitability Report - Emery and Wasatch Plateau Coal Fields
Map 3 - Rights of Way (Criterion 2)

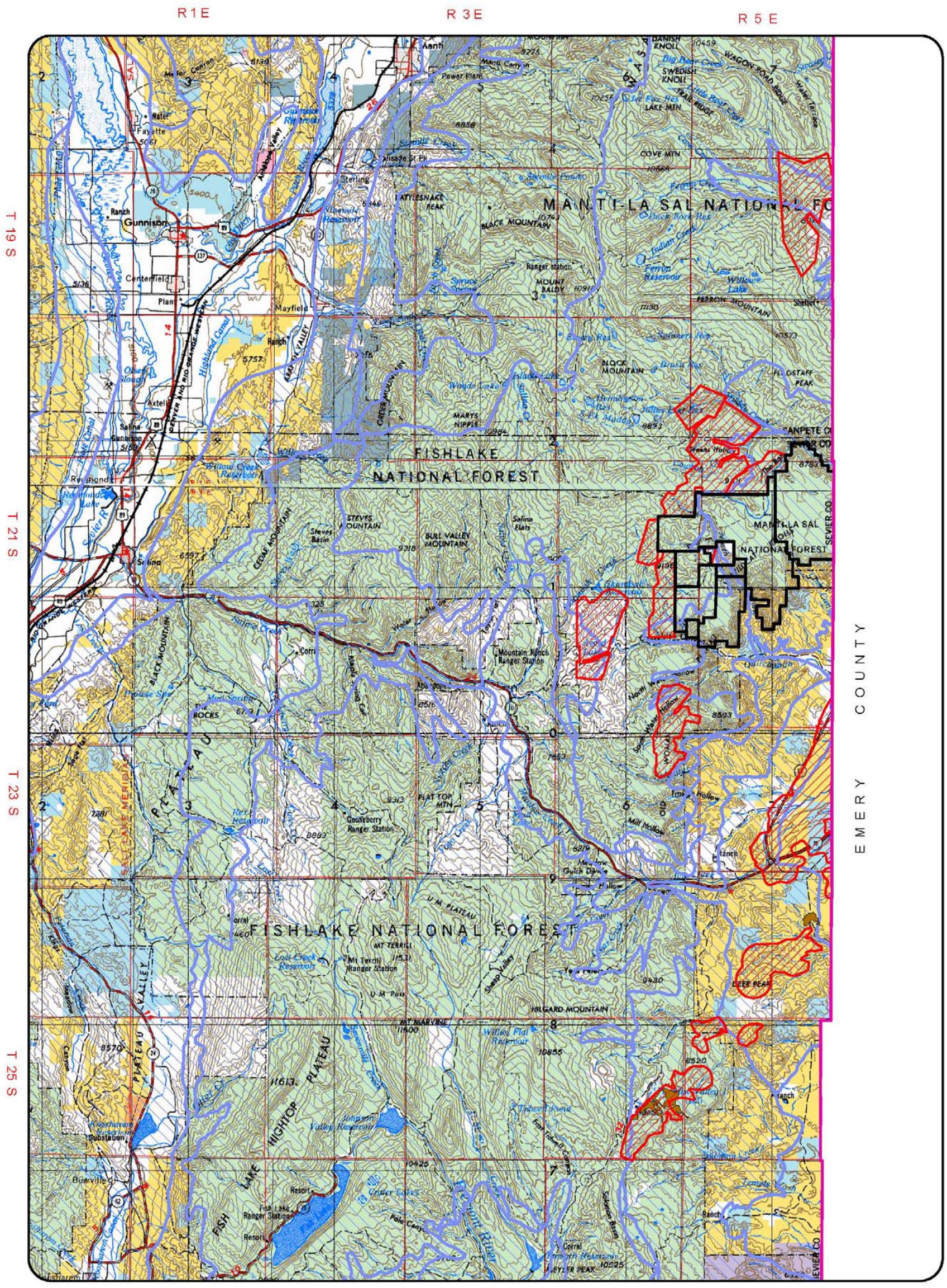
Bureau of Land Management
Richfield Field Office
August 3, 2004

Underground Mineable Coal
Surface Mineable Coal
Federal Coal Leases
Rights of Way

BLM
Forest Service
State
National Park
Private

N

0 5 10
Miles
SCALE 1:250,000



Coal Unsuitability Report - Emery and Wasatch Plateau Coal Fields
Map 5 - Crucial Deer Habitat (Criterion 15)

Bureau of Land Management
Richfield Field Office
August 3, 2004

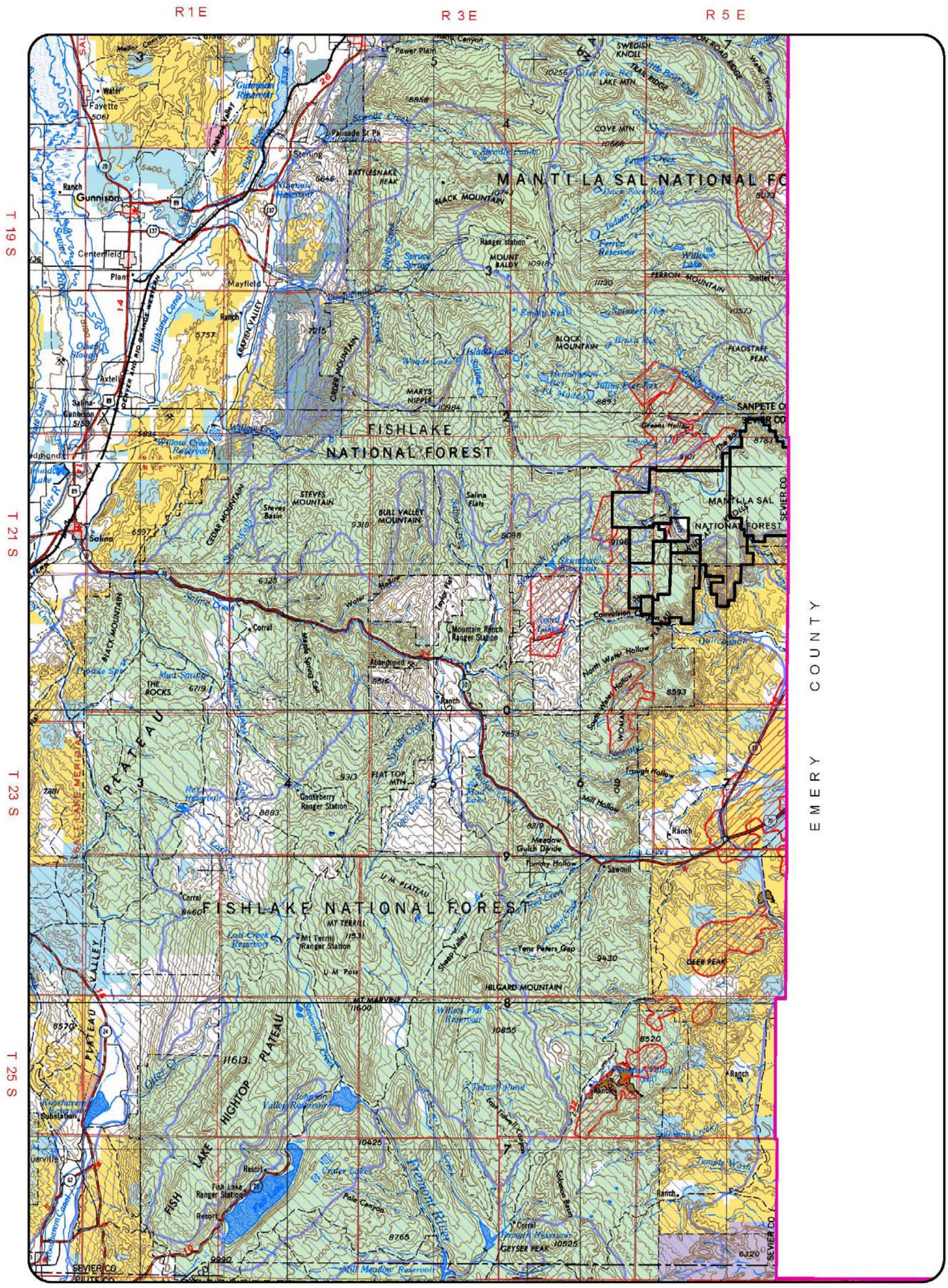
- Underground Mineable Coal
- Surface Mineable Coal
- Federal Coal Leases
- Crucial Deer Habitat

- BLM
- Forest Service
- State
- National Park
- Private

N

0 5 10
Miles

SCALE 1:250,000



Coal Unsuitability Report - Emery and Wasatch Plateau Coal Fields
Map 6 - Crucial Elk Habitat (Criterion 15)

Bureau of Land Management
Richfield Field Office
August 3, 2004

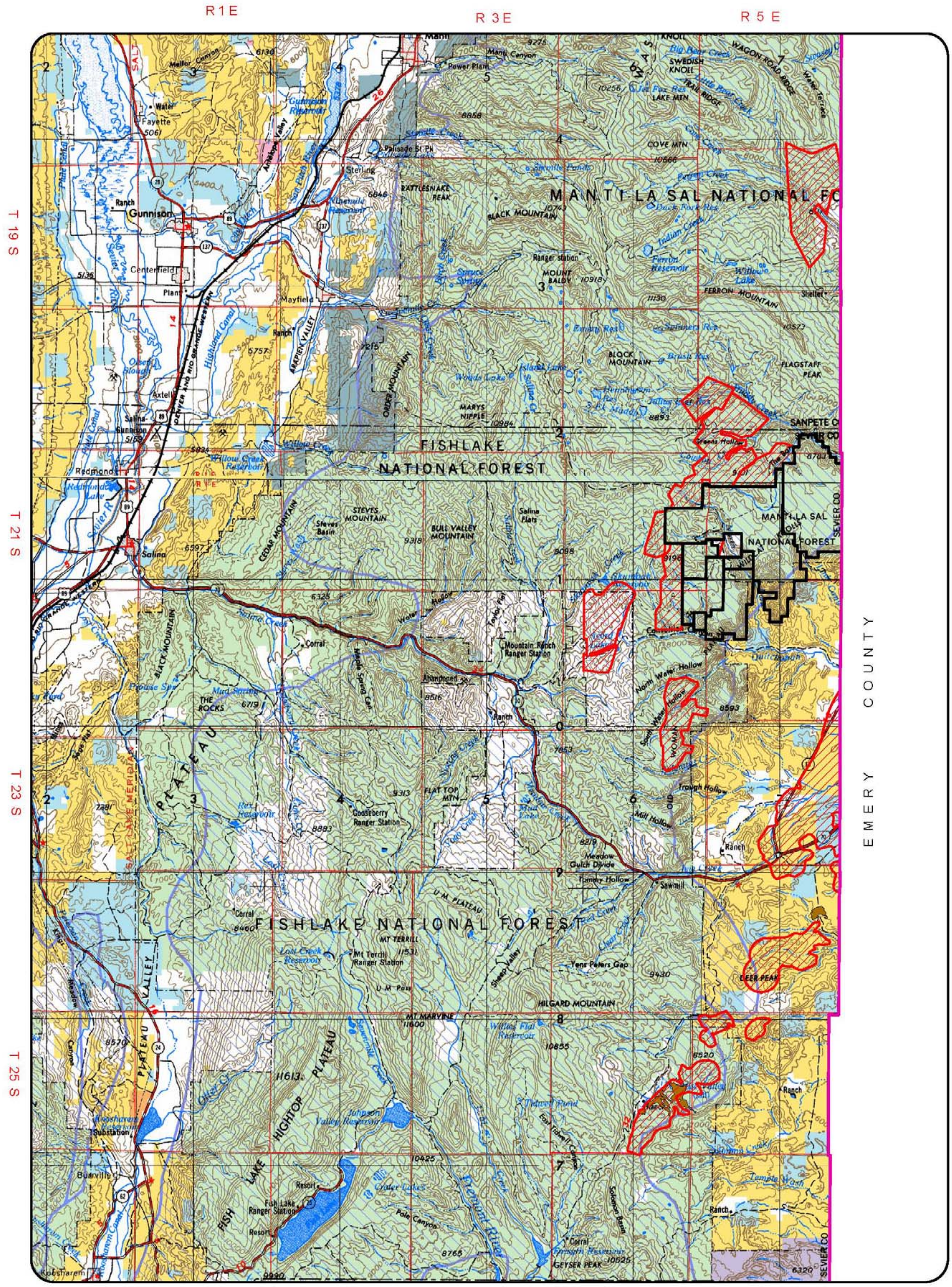
Underground Mineable Coal
Surface Mineable Coal
Federal Coal Leases
Crucial Elk Habitat

BLM
Forest Service
State
National Park
Private

N

0 5 10
Miles

SCALE 1:250,000



Coal Unsuitability Report - Emery and Wasatch Plateau Coal Fields
Map 7 - Crucial Black Bear Habitat (Criterion 15)

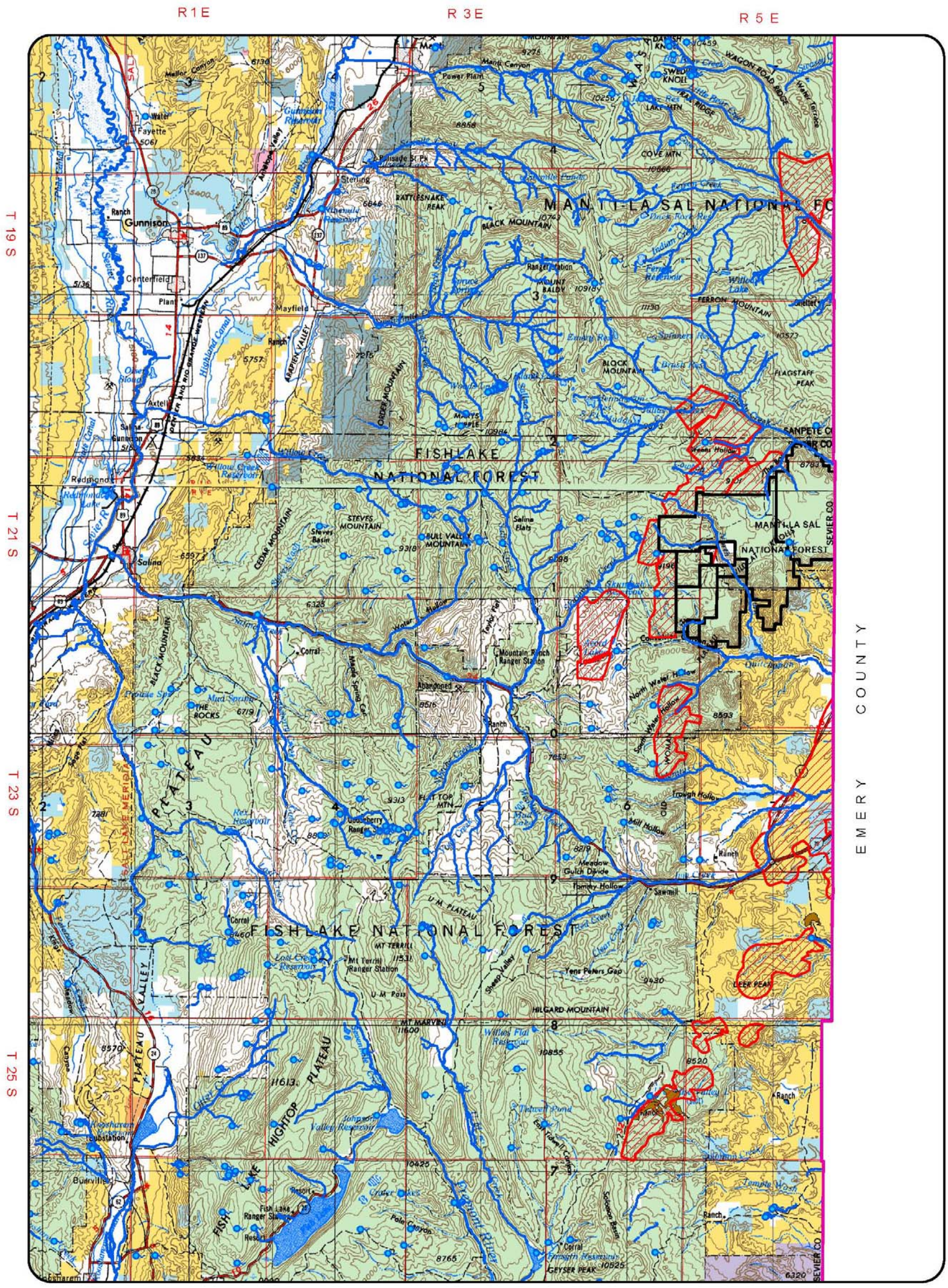
Bureau of Land Management
Richfield Field Office
August 3, 2004

Underground Mineable Coal
Surface Mineable Coal
Federal Coal Leases
Crucial Black Bear Habitat

BLM
Forest Service
State
National Park
Private

N

0 5 10
Miles
SCALE 1:250,000



Coal Unsuitability Report - Emery and Wasatch Plateau Coal Fields
Map 8 - National Resource Waters (Criterion 18)*

* Only Waters on National Forest Lands are considered National Resource Waters

Springs
Perennial Streams
Underground Mineable Coal
Surface Mineable Coal
Federal Coal Leases

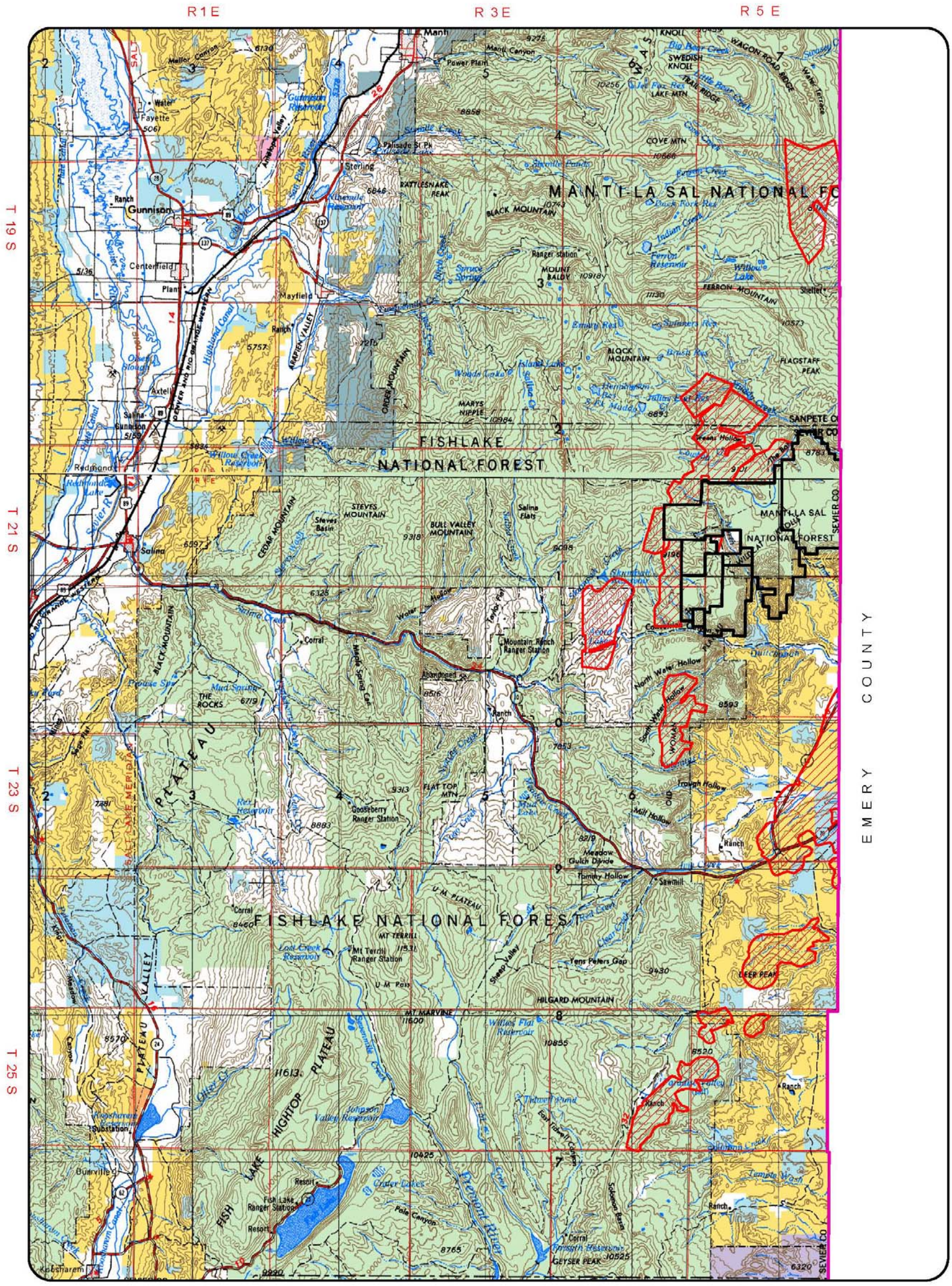
BLM
Forest Service
State
National Park
Private

Bureau of Land Management
Richfield Field Office
August 3, 2004

N

0 5 10
Miles

SCALE 1:250,000



Coal Unsuitability Report - Emery and Wasatch Plateau Coal Fields
Map 9 - Coal Resources Considered Suitable for Leasing

Bureau of Land Management
Richfield Field Office
August 3, 2004

Underground Mineable Coal
Federal Coal Leases

BLM
Forest Service
State
National Park
Private

N

0 5 10
Miles

SCALE 1:250,000