# BOARD OF OIL, GAS & MINING
# FIELD TRIP

August 21, 1986

East Mountain Subsidence

J. B. King Reclamation

Leaders:
Kathryn M. Mutz, Biologist
Richard V. Smith, Geologist

Mining Technical Staff

Utah Division of Oil, Gas and Mining

## TABLE OF CONTENTS


| | Page |
|---|---|
| INTRODUCTION . . . . . | 1 |
| EAST MOUNTAIN SUBSIDENCE . . . . . | 1 |
| J. B. KING RECLAMATION . . . . . | 12 |
| ROAD LOG . . . . . | 20 |
| SELECTED REFERENCES . . . . . | 24 |

## INTRODUCTION

This field trip has been organized into morning and afternoon sessions that will primarily address technical issues related to mining-induced subsidence and post-mining reclamation. The morning session, entitled East Mountain Subsidence, will focus on areas above Utah Power and Light Company's mining operations. The afternoon session will inspect portions of Western States Minerals former mining operations and is entitled J.B. King Mine Reclamation.

## EAST MOUNTAIN SUBSIDENCE

### GENERAL OVERVIEW

Utah and federal statutes and regulations pertaining to subsidence embody the concept that the finite non-renewable resource (i.e., coal) will not be developed at the irreparable expense of renewable resources (e.g., aquifers, wildlife, grazinglands, etc.). Accordingly, if renewable resource lands exist within or adjacent to the permit area, the operator must demonstrate subsidence will not cause material damage to the renewable resource or diminution of reasonably foreseeable use. "Renewable resource lands" are defined as "aquifers and areas for the recharge of aquifers and other underground waters, areas for agricultural or silvicultural production of food and fiber and grazinglands." With regard to underground mining in Utah, nearly all areas above mine workings are "renewable resource lands".

In addition, Utah regulations require that anyone conducting mining activities "...minimize disturbances and adverse impacts ... on fish, wildlife and related environmental values ...". Mine permit applicants must explain how they will "... utilize impact control measures, management techniques and monitoring methods to protect or enhance.... species such as eagles, migratory birds or other animals protected by State or Federal law. The Federal laws applicable to Utah Power and Light mine subsidence are the Migratory Bird Treaty Act and the Eagle Protection Act.

Demonstrating that subsidence will not cause material damage to or diminuition of reasonably foreseeable use of the renewable resource requires the ability to accurately predict the location, magnitude and timing of various components of ground movement. At

present, rock mechanics and other site-specific geologic data are unavailable in Utah to analytically project explicit locations and magnitudes of mining-induced subsidence. Alternatively, Division staff and operators must rely on theoretical methodologies that have variable applicability to Utah mining conditions for deriving required regulatory findings.

Subsidence mechanics are conceptually depicted in Figure 1 below.

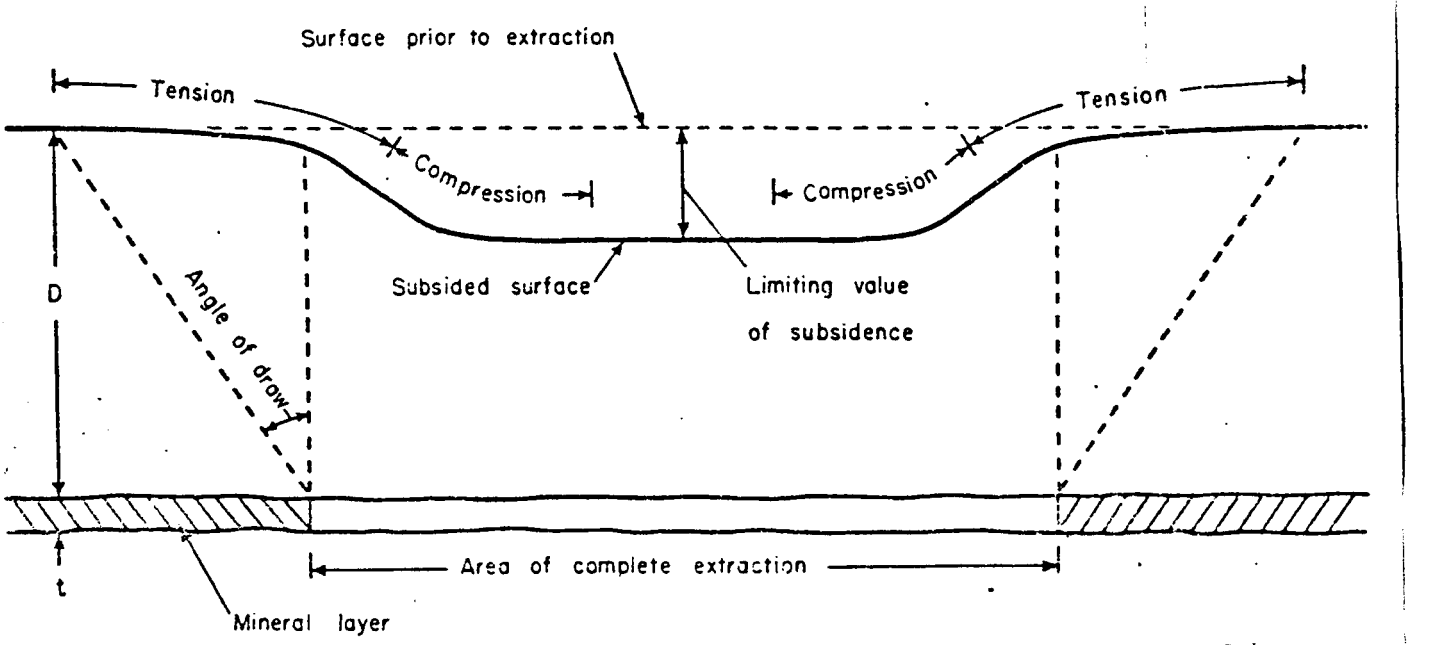



Figure 1. Subsidence Mechanics

A value for maximum subsidence may be calculated when the thickness and properties of the seam, angle of draw, width of excavation, depth and type of overburden and inclination of strata and surface are known. In Utah, lack of data requires that values for several of these parameters be assumed, usually from studies done elsewhere in Europe or eastern North America. Not surprisingly, the projected and measured values for maximum subsidence are often dissimilar.

## EAST MOUNTAIN

Utah Power and Light Company (UP&L) operates the Deer Creek, Cottonwood (formerly Wilberg) and Des-Bee-Dove mines beneath approximately 22,500 acres on East Mountain. All three mines are within the Wasatch Plateau Coal Field. Multiple seam mining is projected to occur in, ascending order, the Hiawatha, Blind Canyon and Cottonwood seams of the Blackhawk Formation (Figure 2). Approximately 70 percent of production will be by the longwall mining method.

| System | Series | Stratigraphic Unit | Thickness (feet) | Lithology and water-bearing characteristics |
|---|---|---|---|---|
| Quaternary | Holocene and Pleistocene | Quaternary deposits | 0-100 | Alluvium and colluvium; clay, silt, sand, gravel, and boulders; yields water to springs that may cease to flow in late summer. |
| Tertiary | Paleocene | North Horn Formation | 800± | Variegated shale and mudstone with interbeds of tan-to-gray sandstone; all of fluvial and lacustrine origin; yields water to springs. |
| Cretaceous | Upper Cretaceous | Price River Formation | 600-700 | Gray-to-brown, fine-to-coarse, and conglomeratic fluvial sandstone with thin beds of gray shale; yields water to springs locally. |
| | | Castlegate Sandstone | 150-250 | Tan-to-brown fluvial sandstone and conglomerate; forms cliffs in most exposures; yields water to springs locally. |
| | | Blackhawk Formation | 600-700 | Tan-to-gray discontinuous sandstone and gray carbonaceous shales with coal beds; all of marginal marine and paludal origin; locally scour-and-fill deposits of fluvial sandstone within less permeable sediments; yields water to springs and coal mines, mainly where fractured or jointed. |
| | | Star Point Sandstone | 350-450 | Light-gray, white, massive, and thin-bedded sandstone, grading downward from a massive cliff-forming unit at the top to thin interbedded sandstone and shale at the base; all of marginal marine and marine origin; yields water to springs and mines where fractured and jointed. |
| | | Mancos Shale | 600-800 | Dark-gray marine shale with thin, discontinuous layers of gray limestone and sandstone; yields water to springs locally. |

Figure 2. Generalized Stratigraphy of East Mountain (Modified from Danielson, 1981)

The United States Bureau of Mines (USBM) and UP&L have cooperatively monitored subsidence over several longwall panels since the fall of 1979 (Fejes, 1983). A subsidence grid was established to the north of the Wilberg portals over the Deer Creek 5-8 East (Blind Canyon seam) and Wilberg 6, 7, 10-13 Right (Hiawatha seam) Longwall Panels. Data from this study indicate an average angle-of-draw of $25^{0}$ and maximum subsidence exceeding predicted values by 50 percent.

UP&L has identified, to date, 11 areas that have experienced subsidence (Figure 3). Maximum subsidence data through 1985 are given below for each area.

| Area | Maximum Subsidence |
|---|---|
| 1 | 25 feet |
| 2 | 12 |
| 3 | 15 |
| 4 | 7 |
| 5 | 5 |
| 6 | 4 |
| 7 | 14 |
| 8 | 5 |
| 9 | 2 |
| 10 | 4 |
| 11 | 1 |

Source: UP&L Subsidence Monitoring Program, Annual Report for 1985

In summary, UP&L and USBM have initiated a concerted effort to derive site-specific data relating to ground movement and thereby, characterize subsidence mechanics on East Mountain. Accordingly, future permitting actions should be enhanced by more accurate subsidence predictions.

This portion of the field trip will focus on Subsidence Area 1 (see Figure 3 and Figure 4). UP&L became aware of significant displacement in Area 1 during the summer of 1982. At that time, the surface had subsided approximately 11 feet. The John T. Boyd Company was engaged to "investigate and render an opinion on the cause of surface subsidence" (UP&L, 1982). The consultant suggested that mining-induced movement along the Deer Creek fault trace caused a cantilevering effect and subsequent rotation of the cliff face (Figure 5). The following combination of factors were identified as potential causes of failure.

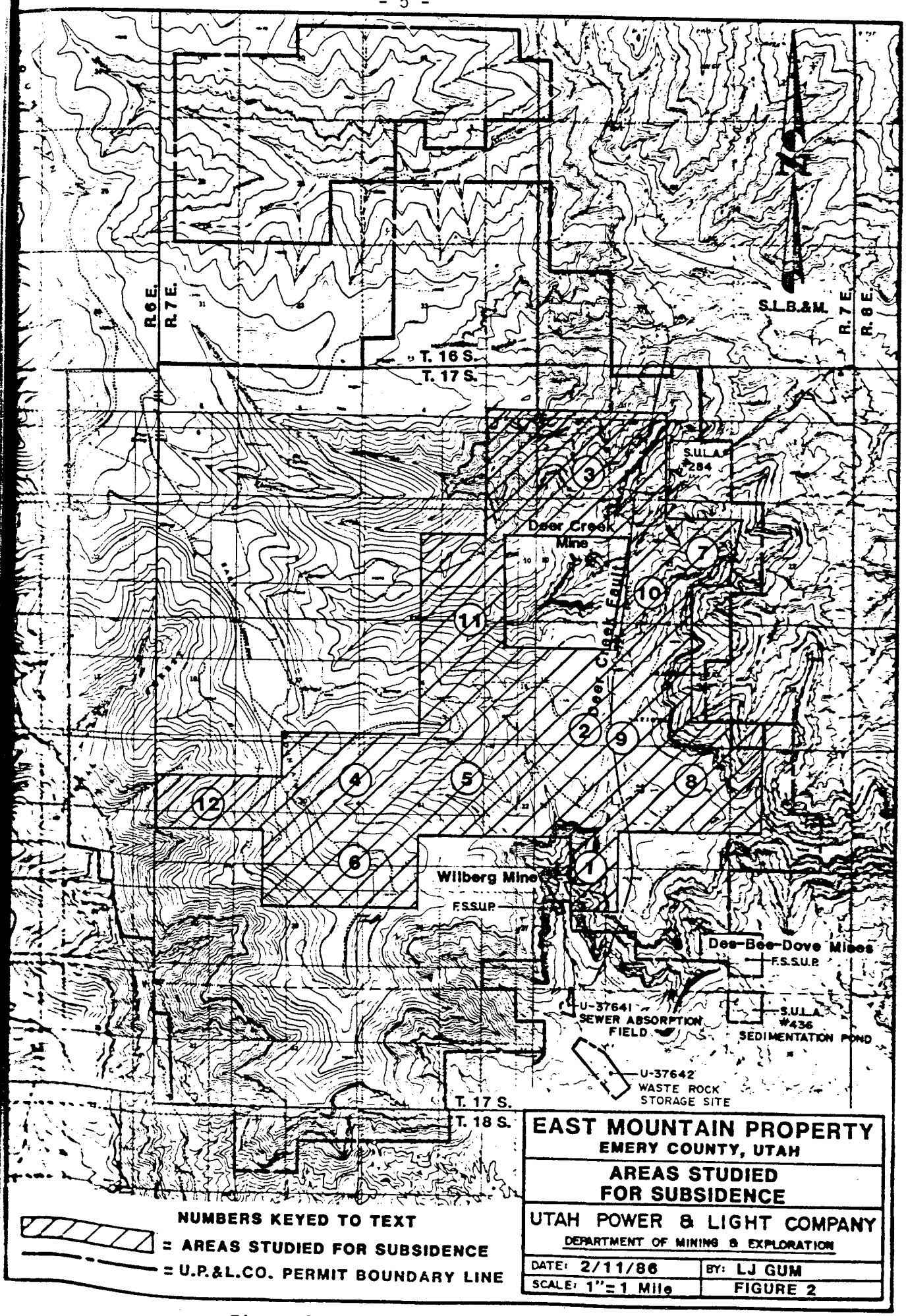



Figure 3. East Mountain Subsidence Area

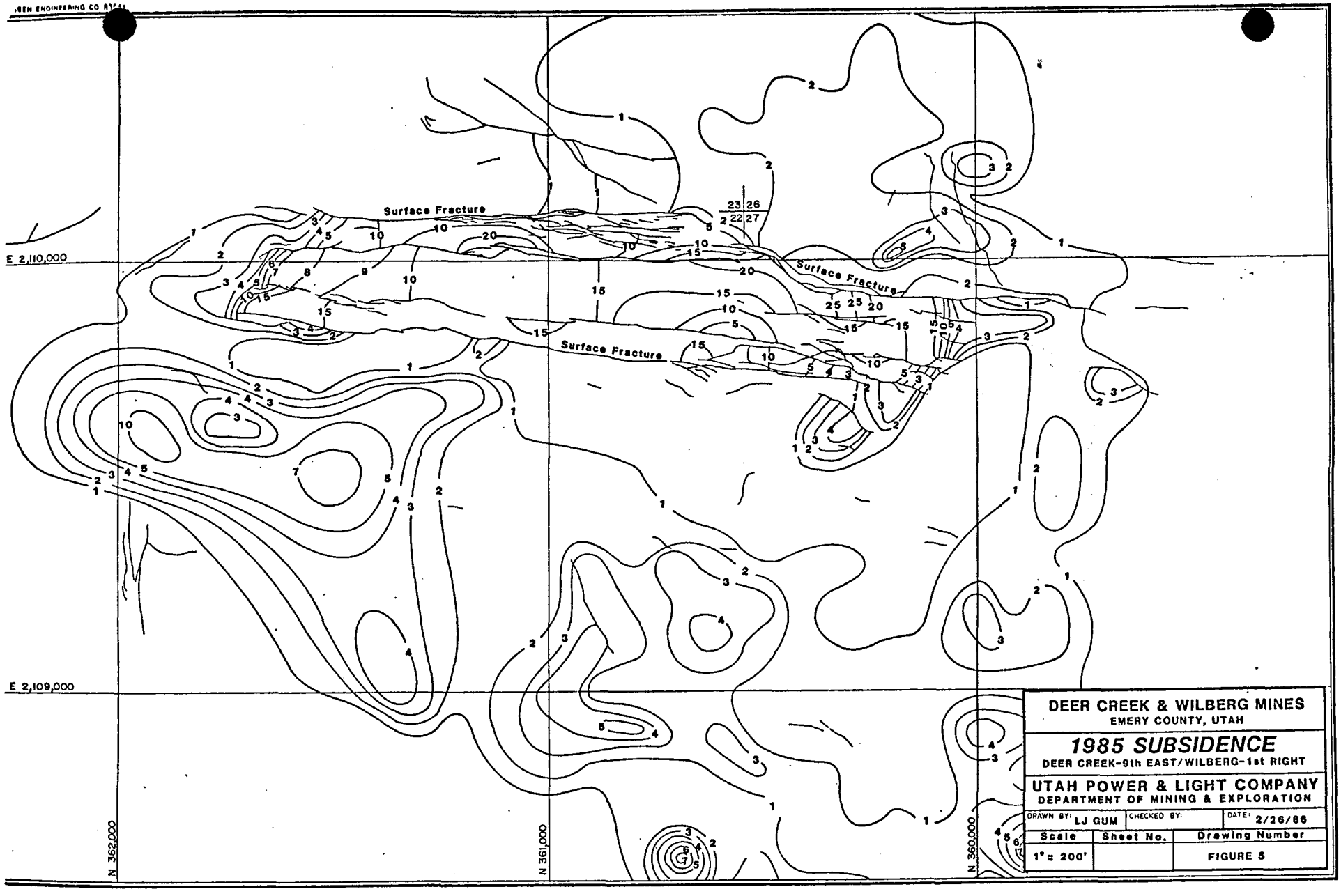



Figure 4. Maximum Subsidence, Area 1.

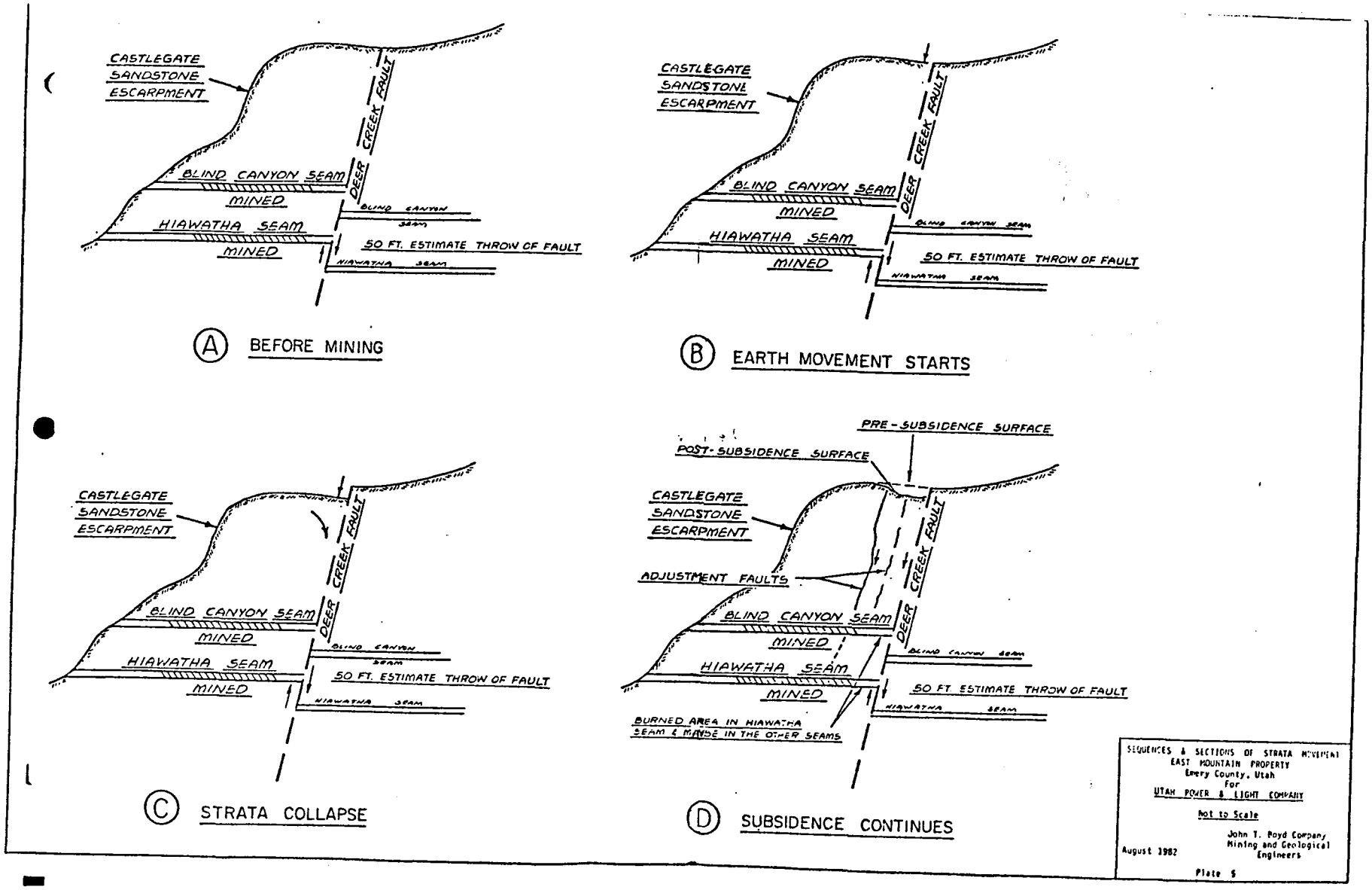



Figure 5. Subsidence Sequence, East Mountain.

(a) Proximity of the Deer Creek fault and associated parallel fractures.

(b) Burned areas in the vicinity of the fault in possibly four seams, Upper Blind Canyon, Lower Blind Canyon (Deer Creek mine), Cottonwood and Hiawatha (Wilberg mine).

(c) Proximity to the outcrop and Castlegate sandstone escarpment.

(d) Full extraction of coal pillar parallel and adjacent to the Deer Creek fault for 1,300 feet (3 panels) in the Blind Canyon seam and 400 feet (1 panel) in the Hiawatha seam.

As of 1985, the surface has subsided a maximum of 25 feet and a spring has appeared.

Inasmuch as operators (and the Division) are unable, at present, to precisely predict the location, magnitude and timing of ground movement, the Division has attempted to assure regulatory compliance by identifying mitigation that restores renewable resource lands and fairly compensates owners for lost revenue. Typical mitigative action that is incorporated into permits is given below.

1. Commit to restoring areas impacted by subsidence cracks which are of a size or nature that could either injure or kill livestock or wildlife. Restoration shall encompass backfilling cracks, recontouring the affected land surface including measures to prevent rilling and revegetation in accordance with the approved permanent revegetation plan. Restoration shall be undertaken after annual subsidence survey data indicate that the surface has stabilized, but in all cases restoration shall be completed prior to bond release.

2. Commit to compensate surface owners for lands which cannot be safely grazed due to hazards caused by the surface effects of subsidence.

3. Commit to compensate at fair market value, owners of livestock which are injured or killed as a direct result of surface hazards caused by subsidence.

## GOLDEN EAGLE NESTING AND SUBSIDENCE MONITORING

Active Golden Eagle (GE) nests are located on vertical sandstone cliffs which overlie longwall panels of the Cottonwood Mine. Sufficient data are not currently available to predict how longwall mining out beyond the sandstone cliff face will impact cliff faces and their nests. Utah Power and Light, in conjunction with the Division of Oil, Gas and Mining, Division of Wildlife Resources and U.S. Fish and Wildlife Service, has designed a monitoring program in Newberry Canyon to (1) determine the impact of longwall mining on cliff subsidence and spalling at the Cottonwood Mine, and (2) to determine the effects, if any, of this subsidence on GE nests (Figure 6).

Cliff subsidence monitoring will use total station Electronic Distance Metering (EDM) equipment and standard surveying practices. Four reflector prisms are installed on the cliff above the nest area. They will be used to determine both horizontal and vertical movement of the cliff. Fracturing and spalling of the cliff face will be determined by analyzing photos taken with a telephoto lens from a permanent ground station. A portion of representative cliffs, beyond the limits of predicted subsidence, will be monitored as a control site to provide comparative data.

Evaluation of impacts on GE nesting includes obtaining a "take permit" for inactive Golden Eagle nests to be undermined, providing baseline (1986) and follow-up (1987) data on the GE population within a 10-mile radius of Newberry Canyon through a helicopter survey and ground observations (see Road Log Map). Condition of both active and inactive nests in Newberry Canyon will be obtained in conjunction with the photo analysis of the cliff faces.

Utah Power and Light will cooperate with the U.S. Fish and Wildlife Service in developing appropriate mitigation or compensation measures if adverse subsidence related impacts occur.

The subsidence and raptor monitoring study is intended to provide the data necessary to expedite permitting of future longwall mining (e.g., Miller Canyon area) without adversely impacting the area's GE population.

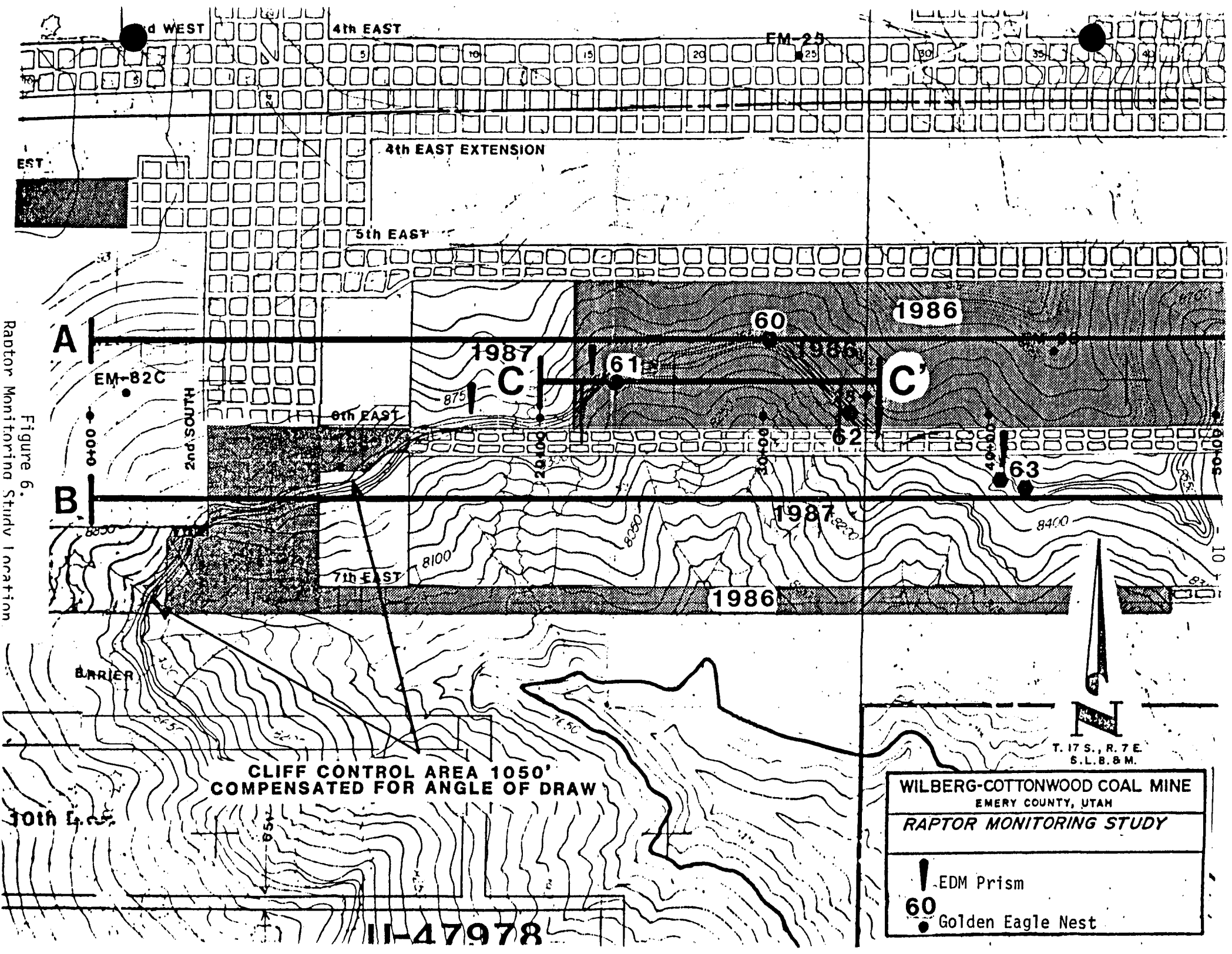



Figure 6.
Raptor Monitoring Study Location

# J. B. KING RECLAMATION

## GENERAL OVERVIEW

Western States Minerals Corporation's J. B. King Mine is located on a state lease adjacent to Dog Valley in the east-central portion of the Emery Coal Field, approximately 10 miles south of Emery (Figure 7).

Mining began in 1930 and continued until 1970 at the Dog Valley Mine. Western States Minerals Corporation acquired the Dog Valley Mine in 1976 and renamed it the J. B. King Mine. Mining was terminated and the J. B. King Mine was designated inactive in 1985. A permit was issued and final reclamation was initiated during the fall of 1985.

The permit area encompasses 320 acres. Mining occurred in the Ferron "I" seam. Production was from room and pillar mining methods with secondary pillaring. Overburden thickness ranged from 80 to 135 feet. The stratigraphy of the J. B. King Mine area is given in Figure 8.

## RECLAMATION

Reclamation of the mine included seven portal closures, removal of all structures, burial of coal refuse with four feet of soil, drainage and sediment controls, final grading, and revegetation.

Five acres were drill seeded with about 20 pounds/acre of seed. Because of difficulties with equipment, the remaining 23 acres of surface disturbance were broadcast seeded at 39 pounds per acre. Prior to seeding, the area was fertilized with 150 pound/acre urea and 50 pounds/acre double phosphate. The entire area was mulched with barley straw (3000 pounds/acre) and crimped with a double-gang farm disc. The following native species comprised the seed mix:

Grasses

- Western, Thickspike, Streambank and Beardless wheatgrasses
- Blue grama grass
- Galleta grass
- Indian ricegrass
- Needle and thread grass
- Big bluegrass

Forbs

- Gooseberry globemallow
- Palmer penstemon
- Yellow sweetclover

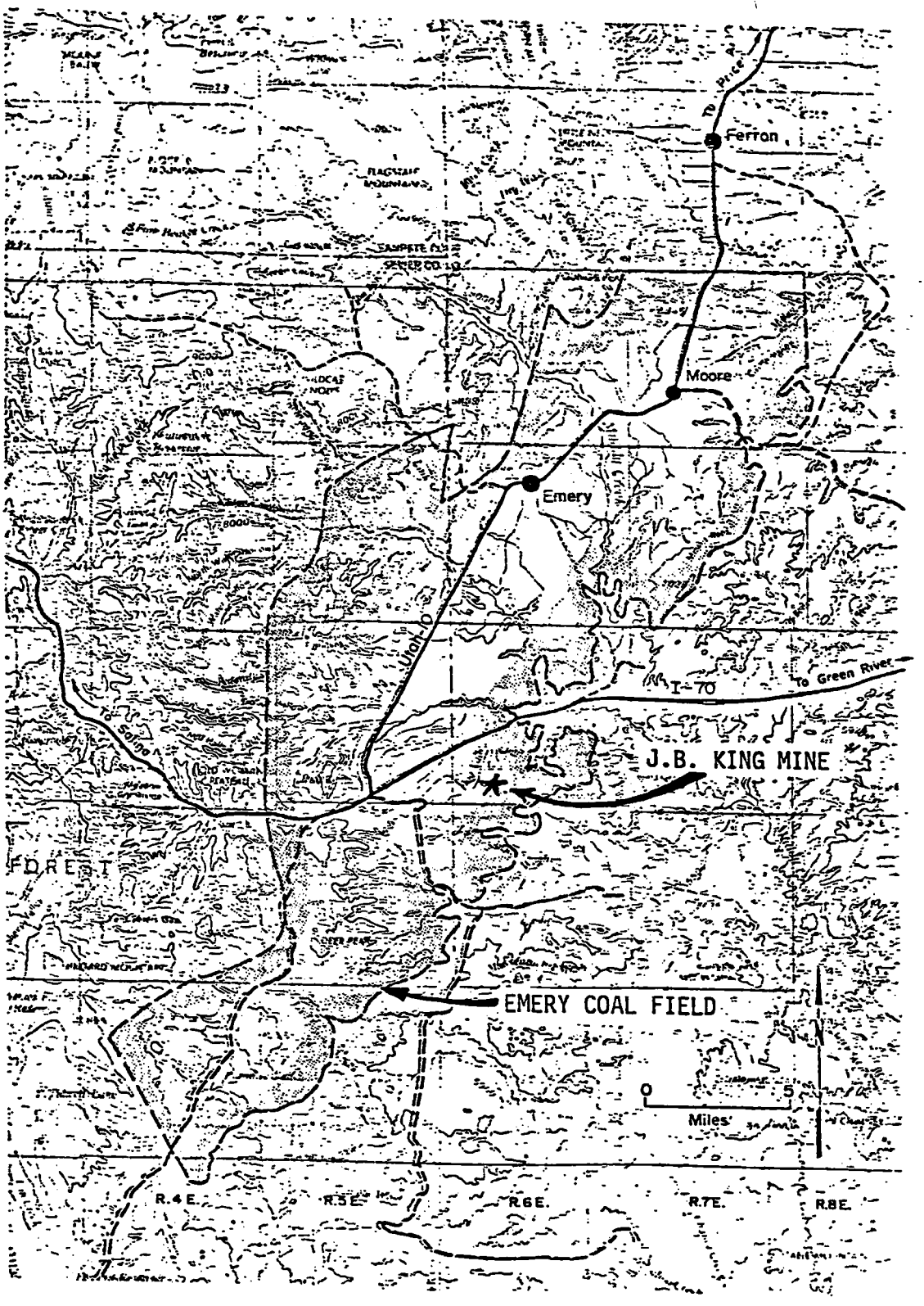



Figure 7. Emery Coal Field (from Doelling 1972).

| System | Series | Stratigraphic Unit | | Thickness (feet) | Description |
|---|---|---|---|---|---|
| Quaternary | Holocene<br>Pleistocene | Quaternary Deposit | | Variable | Surficial stream terrace and channel and alluvial fan deposits. |
| Upper Cretaceous | Coniacian | | Blue Gate Shale Member | 1,600 | Pale blue-gray, modular and irregularly bedded marine mudstone and siltstone. |
| | Tuconian | | Ferron Sandstone Member (major coal seams) | 400-500 | Alternating yellow-gray sandstone, sandy shale and gray shale with important coal beds of Emery Coal Field. |
| | Cenomanian | | Tununk Shale Member | 600-700 | Blue-gray to black sandy marine mudstone. |

Figure 8. Stratigraphy of the J. B. King Mine Area (modified from Doelling 1972).

Shrubs

Fringed sage
Fourwing saltbush
Shadscale
Winterfat
Rubber rabbitbrush

In addition to seeding, 5000 shrub seedlings were planted in clumps throughout the site. Seedlings were planted in April of 1986.

Sixty percent ($262,577) of the reclamation bond (Phase I bond release) was released to Western States Minerals in March, 1986 after approval of the final site grading. A surety for the remaining $126,078 will be held by the Division for a 10 year period of extended liability. To gain Phase II and Phase III bond release, Western States Minerals must demonstrate successful revegetation of the site. To demonstrate success of vegetation, the reclaimed area will be compared to a "reference" area in the undisturbed native vegetation.

Test Plots

Test plots were established on the refuse pile in order to evaluate the effectiveness of two fertilization rates and of soil (0", 6", 12", 24" and 48") spread over the refuse. Division technical staff will sample and evaluate soils and vegetation data on an annual basis.

Subsidence

Subsidence monitoring above the abandoned workings has identified zones of mining induced tension fractures above and adjacent to outcrop barrier pillars along the eastern boundary of the permit area. The zones of tensional fracturing are up to several tens of feet wide and hundreds of feet long. The operator has attempted to recondition "open" tension fractures by filling them with straw, lumber and rocks and roto-tilling the surface. Several small areas have washed out since last fall and will require minor reconditioning this fall. The remaining surface area has uniformly subsided a maximum of seven feet.

It appears that the operator's attempts to recondition tension fractures will be successful and the state grazing allotment (renewable resource) above the abandoned workings will not experience a significant or sustained mining-induced subsidence impact.

djh
9206R/42
8/19/86

J. B. KING
RECLAMATION

Final Reclamation, 1985

Final Reclamation, 1985

J. B. KING
OPERATIONS

Shop and Office Buildings, 1982

Portal and Highwall Area, 1982

J. B. KING
OPERATIONS

Loadout, 1979

Loadout and Refuse Pile, 1982

J. B. KING
RECLAMATION

Final Reclamation, Aerial View, 1986

## ROAD LOG

| Approximate Mileage | |
|---|---|
| 0. 0 | Leave Radisson at 7:30 a.m. Take U.S. 6 East. |
| 1. 5 | Take a right onto State Highway 10 South towards Huntington. |
| 29. 1 | Take a right onto State Highway 29 West. |
| 33. 3 | Take a right following State Highway 29 West and sign to Upper Joe's Valley Reservoir. |
| 36. 2 | Monument commemorating lives lost in Wilberg fire on right. |
| 41. 2 | Turn right following Cottonwood Canyon Road. |
| 43. 7 | On the right is Miller Canyon location of several Golden Eagle nests. An eaglet was fledged from the canyon this spring. The UP&L mine plan includes longwall mining beneath these cliffs. Subsidence monitoring, to be discussed later, will provide data to help evaluate impacts on eagle nesting. |
| 44. 2 | UP&L Cottonwood Portal interim and permanent reclamation. County road construction for improved access to the Trail Mountain Mine removed a sediment pond collecting runoff from the lower reclamation area. A small area exemption is being applied to permit use of alternative sediment controls (gabions) to replace the sediment pond. |
| 44. 3 | Trail Mountain Mine. Production by room and pillar methods in the Hiawatha seam. |
| 45. 2 | Crossing Roans Canyon Graben. Note damp areas on road cuts and water in road ditch. UP&L drove a development entry north towards the Roans Canyon Graben. Prior to crossing the graben, UP&L drilled five boreholes to assess the ground water regime. Each borehole produced approximately 125 gpm and indicated a major in-mine water handling problem if the graben were crossed at the initial location. Additional fractures permability analyses suggested that the development entry should be moved one mile towards the west. |

47. 3 Approaching Indian Creek Field:

Township 17 South, Range 6 East, Sections 2,3,10,11,14

Designated in 1985-

Production: December 1985
Monthly: 52 barrels of oil, 56,564 MCF gas
Total Cum.: 893 barrels oil, 793,675 MCF gas, 115 barrels water
4 producing wells
TD: 6,000 feet
Perforations: 5,500 feet
Geology: Ferron sandstone member of the Mancos Shale Formation
Operator: VORTT Exploration
Mixed mountain shrub vegetation community, excellent deer habitat.

48. 4 Historical monument worthy of inspection.

49. 8 Turn right at Mill Canyon.

50. 2 Vicinity is Grassland vegetation type with Salina wildrye as the dominant species. Many of the mines include this type.

53. 0 East Mountain Vegetation Project. Aspen seeding not very successful. Surrounding vegetation type is sagebrush-grassland community.

53. 7 1984 drill site, reclaimed in 1985. Site included a large mud pit. Good use of rocks and wood debris for diversity and to limit erosion. Vegetation cover is good considering thin soils on the Flagstaff Limestone.

55. 3 Take left fork to Burnt Tree Spring.

56. 2 STOP 1

General orientation and overview:
Left fork of Grimes Wash
Stratigraphy, including abundant fresh water snail fossils in Flagstaff Limestone.

59. 2 Traversing ridge that overlooks Huntington Canyon. Agricultural fields include Huntington Power Plant experimental farm and Wildlife Resources big game plantings.

61.4 STOP 2

East Mountain subsidence, Area 1.

67. 5 Turn left following sign to Snow Lake.

68. 2 LUNCH

UP&L East Mountain drilling camp.

Brief presentation by Chris Shingleton, UP&L Director of Property Management, on UP&L reorganization and future mining plans.

74. 5 Turn left following Cottonwood Canyon Road.

82. 6 Turn left following State Highway 29 East.

87. 6 Turn left onto Des-Bee-Dove/Cottonwood Haul Road.

89. 6 Bear left onto Cottonwood Haul Road. Road to right is Des-Bee-Dove Haul Road.

90. 8 Wilberg Waste Rock Disposal area on the right. Eight cells permitted. Three have been reclaimed. Revegetation monitoring includes exclosures which demonstrate problems with rodent grazing. To the east a wildlife (deer) mitigation project has been initiated to compensate for habitat lost in construction of the disposal area.

91. 0 STOP 3

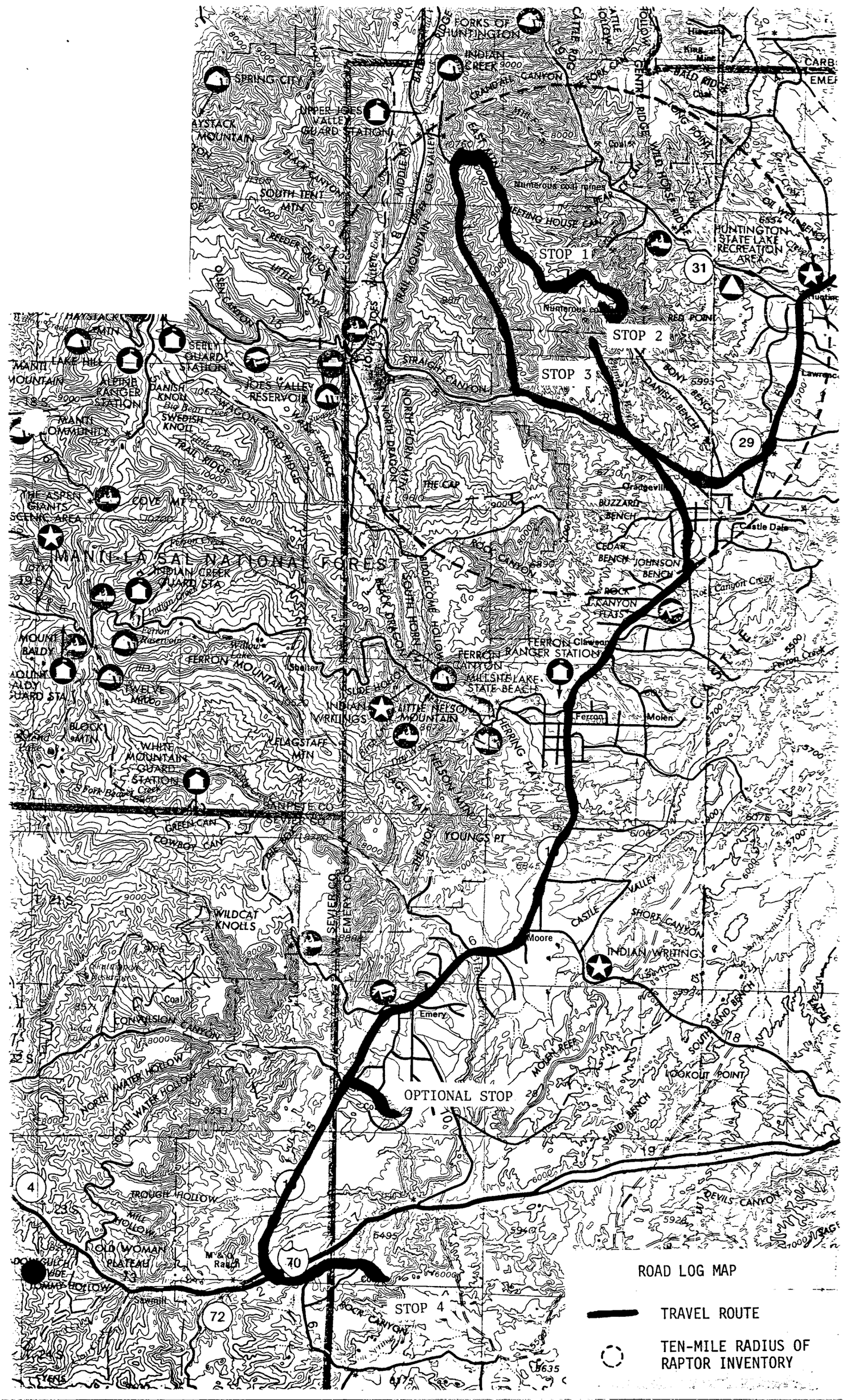
Parking area to left for Newberry Canyon raptor and subsidence monitoring discussion.

Turn around and follow haul road to State Highway 10

95. 4 Turn right following State Highway 10 South. Hunter Power Plant in foreground.

115. 4 Turn left following haul road to Consolidation Coal Company's Emery Deep Mine.

| | |
|---|---|
| 117. 9 | OPTIONAL STOP |
| | Brief inspection of Emery Deep Mine. |
| | Return to State Highway 10. |
| 120. 4 | Turn left following State Highway 10 south. |
| 130. 4 | Fremont Junction. Proceed under I-70 overpass and turn left. |
| 135. 4 | STOP 4 |
| | J. B. King Mine. |


STOP 1
STOP 2
STOP 3
STOP 4
OPTIONAL STOP
ROAD LOG MAP
TRAVEL ROUTE
TEN-MILE RADIUS OF RAPTOR INVENTORY
MANTI-LA SAL NATIONAL FOREST
FORKS OF HUNTINGTON
INDIAN CREEK
SPRING CITY
UPPER JOES VALLEY GUARD STATION
SOUTH TENT MTN
HUNTINGTON STATE LAKE RECREATION AREA
SEELY GUARD STATION
JOES VALLEY RESERVOIR
ALPINE RANGER STATION
MANTI COMMUNITY
THE ASPEN GIANTS SCENIC AREA
COVE MT
INDIAN CREEK GUARD STA
MOUNT BALDY
FERRON MOUNTAIN
TWELVE MILE
WHITE MOUNTAIN GUARD STATION
FLAGSTAFF MTN
FERRON RANGER STATION
FERRON CANYON
MILLSITE LAKE STATE BEACH
LITTLE NELSON MOUNTAIN
INDIAN WRITINGS
HERRING FLAT
YOUNGS PT
WILDCAT KNOLLS
CONVULSION CANYON
NORTH WATER HOLLOW
SOUTH WATER HOLLOW
TROUGH HOLLOW
OLD WOMAN PLATEAU
CASTLE VALLEY
SHORT CANYON
INDIAN WRITING
LOOKOUT POINT
DEVILS CANYON
SAND BENCH
SOUTH SAND BENCH
MOLEN REEF
ROCK CANYON
BUZZARD BENCH
CEDAR BENCH
JOHNSON BENCH
ROCK CANYON FLATS
BONY BENCH
DANISH BENCH
RED POINT
STRAIGHT CANYON
NORTH HORN MTN
NORTH DRAGON
BLACK DRAGON
SOUTH HORN MT
BIDDLECOME HOLLOW
THE CAP
Ferron
Molen
Moore
Emery
Castle Dale
Orangeville
Lawrence
Huntington
Clawson
Sawmill
M & O Ranch
SEVIER CO
EMERY CO
SANPETE CO
GREEN CAN
COWBOY CAN
Coal
Numerous coal mines
31
29
70
72
4

## SELECTED REFERENCES

Danielson, T. W., Re Millard, M.D., and Fuller, R. H., 1981. Hydrology of the coal-resource areas in the upper drainages of Huntington and Cottonwood Creeks, Central Utah: U.S. Geological Survey, Water-Resources Invest., Open-File Rept. 81-539, 85 p.

Doelling, H. H., 1972, Central Utah coal fields: Utah Geological and Mineralogical Survey, Monograph No. 3, 571 p.

Utah Power and Light Company, Annual Subsidence Monitoring Report for 1981: 18 p., unpublished.

Utah Power and Light Company, Annual Subsidence Monitoring Report for 1985: 21 p., unpublished.