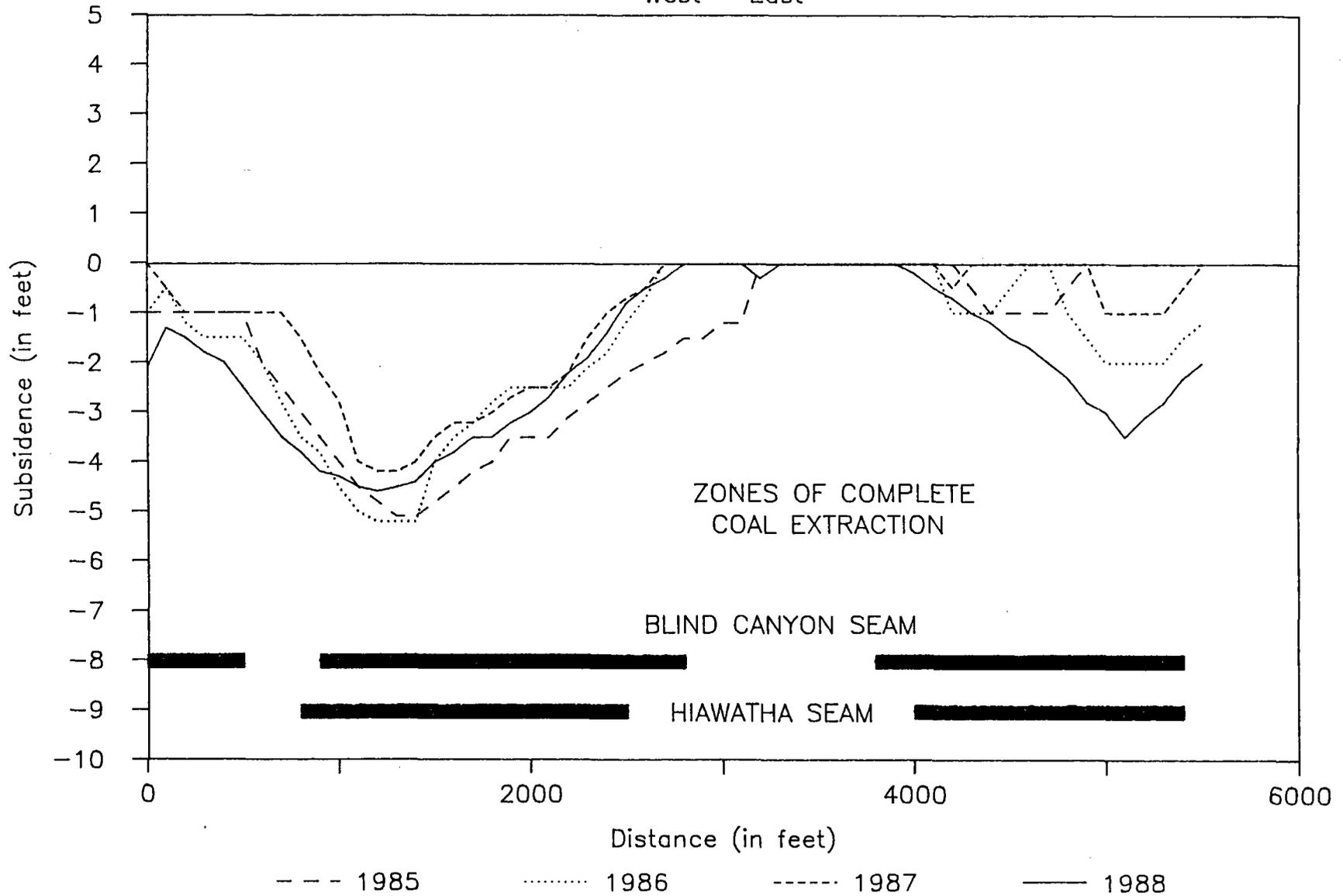


# AREA 8 SUBSIDENCE PROFILE

West - East



**FIGURE 32**

## Area 9

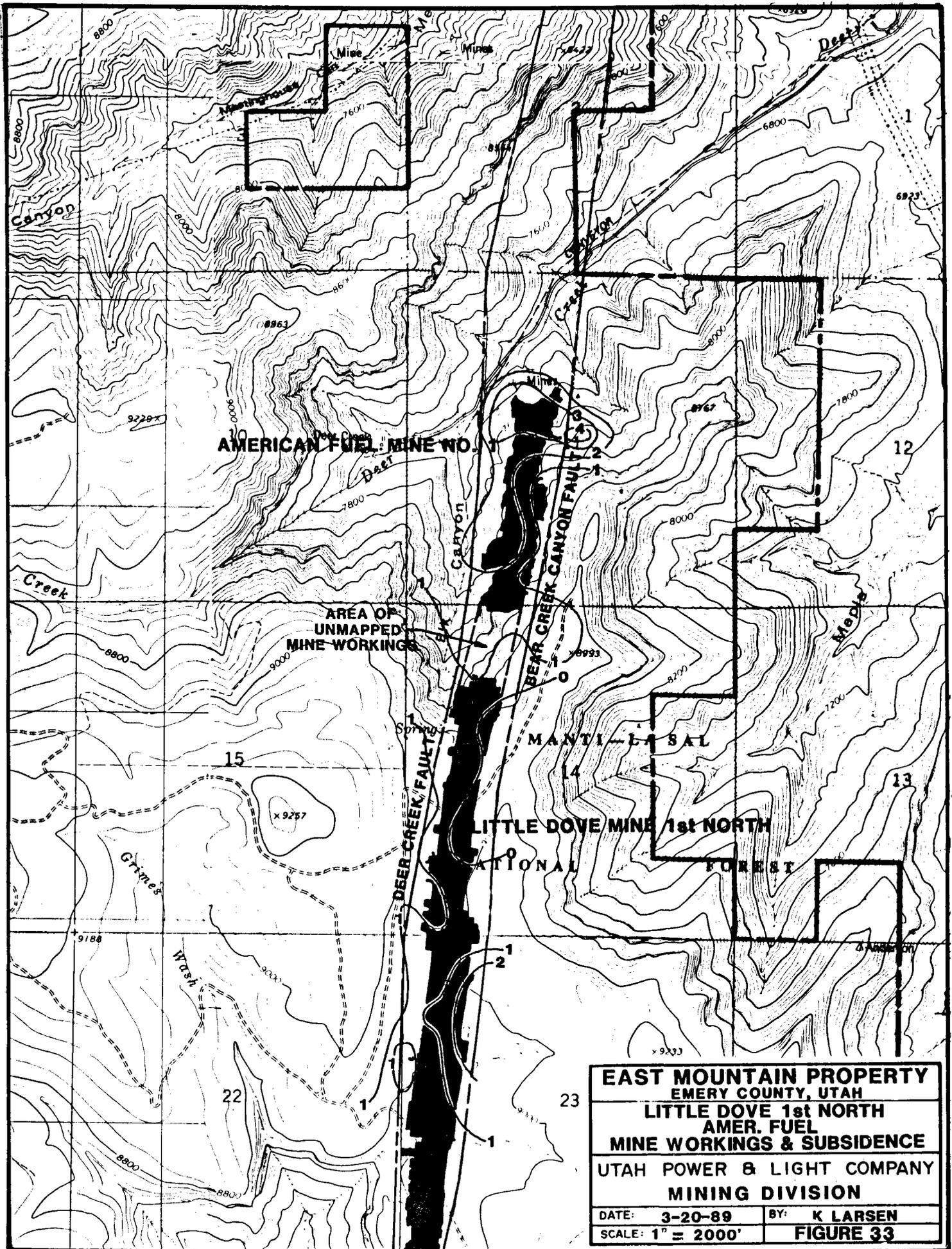
### Little Dove 1st North

The 1st North section of the Little Dove Mine and the American Fuel Mine workings are located in a graben formed by the Deer Creek and Bear Creek Canyon faults (Figure 33). In August 1982 the Little Dove workings, mining in a northerly direction, intersected the old workings of the American Fuel Mine about 1000 feet south of where available maps indicated they extend. Mining conditions in that area of Little Dove revealed that strata were highly stressed. In some cases pillars were crushed before they could be extracted. At that time pillar extraction mining was begun in 1st North and continued to the south with minor interruptions from 1982 through much of 1987.

To date the maximum observed subsidence over 1st North is about two (2) feet, occurring over some of the most recently extracted pillars (Figure 33). The northern portions of the 1st North workings and subsidence are included in Area 8, which appears to have stabilized.

Any angle-of-draw calculation would be affected by both the surrounding mine workings of other mines and by the faults on either side; therefore, no angle-of-draw has been calculated for the 1st North area of the Little Dove Mine.

No fractures, slumps, or other effects have been seen over the workings. Mining has had no known effect on the hydrology of the area.



Area 10

Old American Fuel Mine

The old American Fuel Mine workings are also located in the graben formed by the Deer Creek and Bear Creek Canyon faults just north of the Little Dove 1st North section (Figures 33 and 28). The latest mining in the American Fuel Mine terminated in 1986. Maximum subsidence remains at about four (4) feet. Since no significant subsidence has taken place in this area over the past three years, we wish, with DOGM approval, to discontinue annual monitoring. The 1986 Subsidence Monitoring Report contains the latest detail concerning the area.

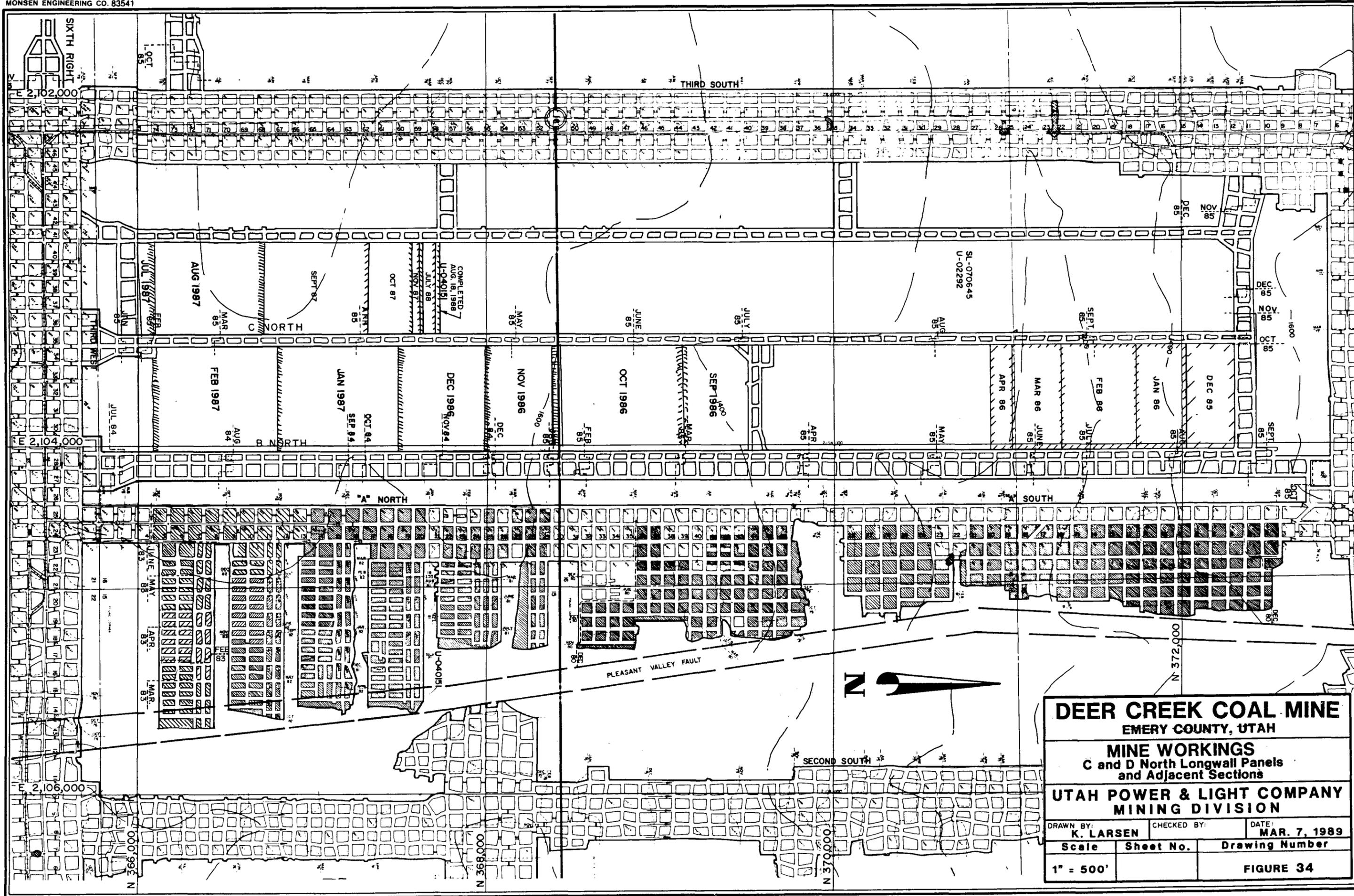
## Area 11

### Deer Creek C and D North Longwall Panels and Adjacent Sections

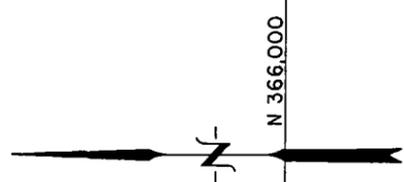
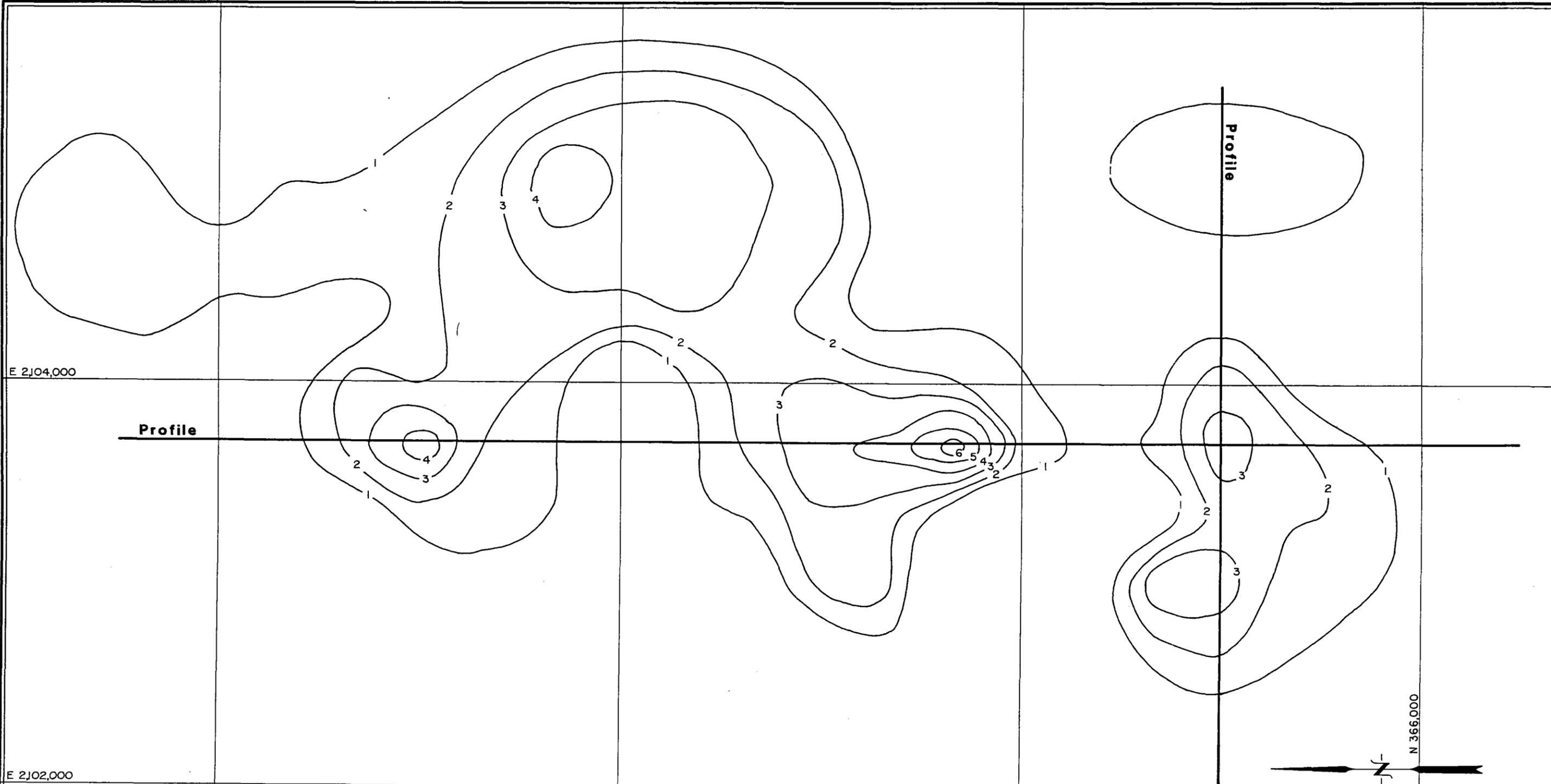
Longwall mining in the C North panel began in December 1984 and was terminated in April 1986 due to geologic complications. New setup entries were driven further south and mining resumed in September 1986; the panel was completed in March 1987. The D North longwall panel began production in July 1987, but after October 1987 production was limited due to poor coal quality. The panel was terminated in August 1988 at a length of 1750 feet. Pillar extraction mining in A North and A South was completed in June 1983 (Figure 34). Measurable subsidence to date has reached six (6) feet over C North and a little more than four (4) feet over the room-and-pillar sections (Figures 35, 36, and 37).

No fractures or disturbance of the surface of the area has been observed. The angle-of-draw measured ranges from less than zero to 28 degrees.

Three springs are located a few hundred feet to the west of the workings, but none falls within the area of measured subsidence. They have shown no effect due to mining (see Hydrologic Monitoring Report, 1988).



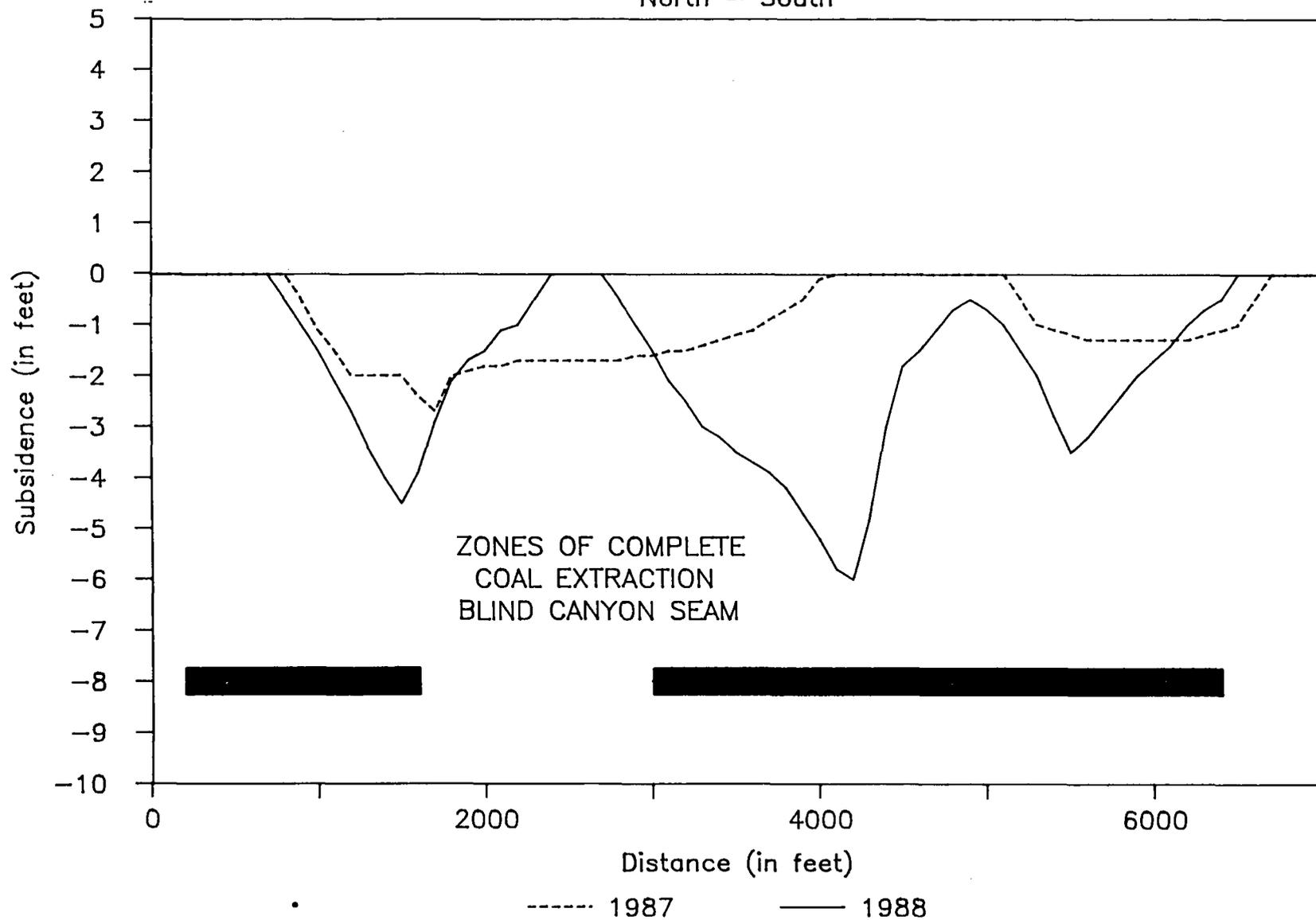
<b>DEER CREEK COAL MINE</b>		
EMERY COUNTY, UTAH		
<b>MINE WORKINGS</b>		
C and D North Longwall Panels and Adjacent Sections		
<b>UTAH POWER &amp; LIGHT COMPANY</b>		
<b>MINING DIVISION</b>		
DRAWN BY: <b>K. LARSEN</b>	CHECKED BY:	DATE: <b>MAR. 7, 1989</b>
Scale	Sheet No.	Drawing Number
1" = 500'		<b>FIGURE 34</b>



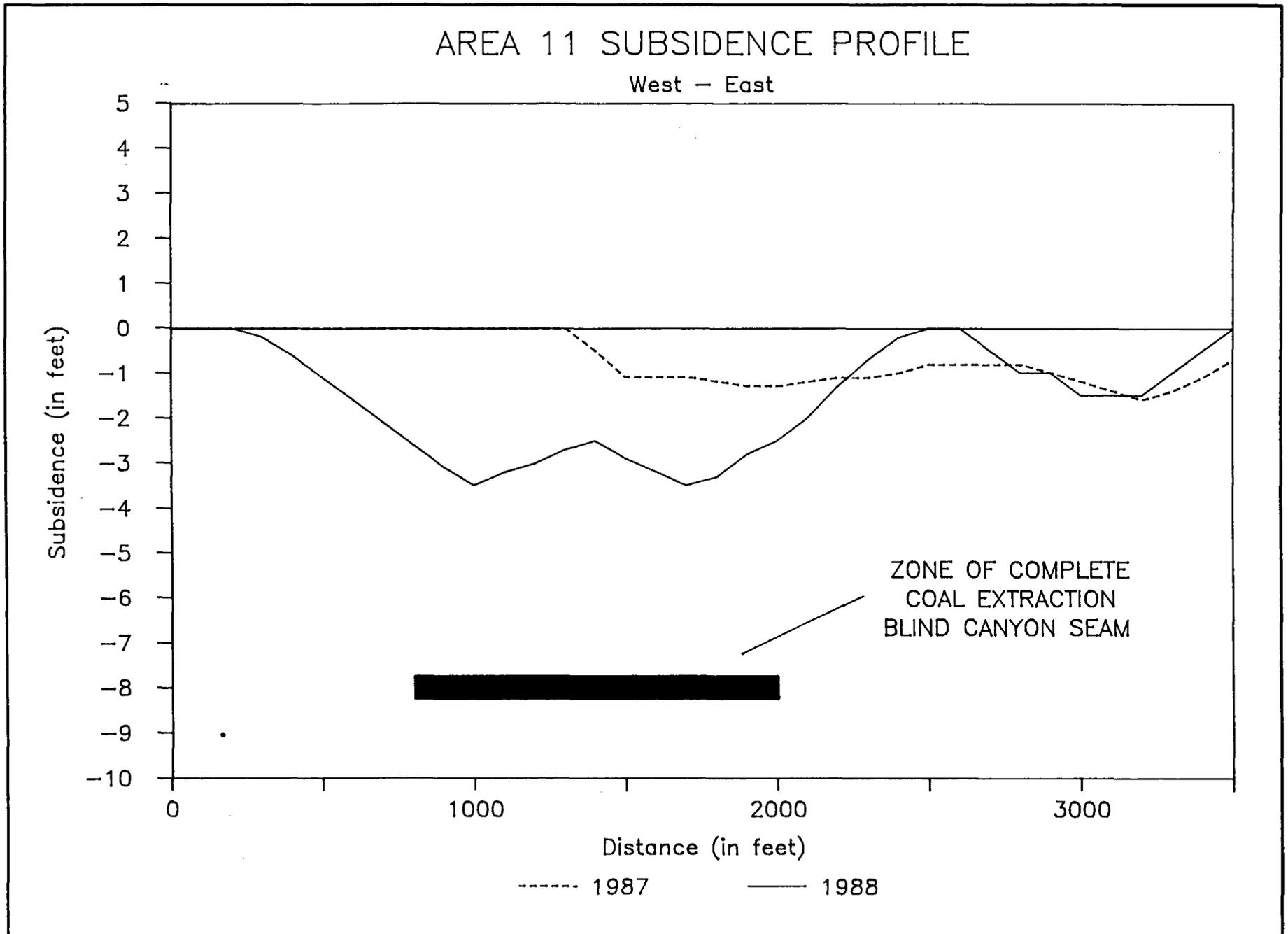
<b>DEER CREEK COAL MINE</b>		
EMERY COUNTY, UTAH		
1988 SUBSIDENCE C & D NORTH LONGWALL PANELS AND ADJACENT SECTIONS		
<b>UTAH POWER &amp; LIGHT COMPANY</b>		
<b>MINING DIVISION</b>		
DRAWN BY: <b>K. LARSEN</b>	CHECKED BY:	DATE: <b>MAR. 3, 1989</b>
Scale	Sheet No.	Drawing Number
1" = 500'		<b>FIGURE 35</b>

# AREA 11 SUBSIDENCE PROFILE

North - South



**FIGURE 36**



**FIGURE 37**

## Area 12

### Wilberg 2nd Left Longwall Panel

The 2nd Left longwall panel is located in the western portion of the Wilberg Mine (Figure 2). A block of coal measuring 2300 feet by 530 feet was extracted during 1981 and 1982. To date no measurable subsidence has occurred and no visible surface disturbance has been observed. Overburden ranges from 1500 to 1900 feet over the panel. It is somewhat surprising that no movement has been detected since subsidence has been observed in other instances where smaller blocks of coal were extracted and overburden was of similar thickness. The area will continue to be monitored periodically, but not annually, upon approval from DOGM.

One spring is located approximately 800 feet northeast of the extracted workings on the surface. It has not been affected by mining.

### Area 13

#### Des-Bee-Dove Southern Area

Area 13, covering the southern portions of the Deseret, Beehive, and Little Dove Mines, was first monitored for subsidence in 1986. Some of the sections were mined before baseline survey data were established; therefore, subsidence measured over these sections will likely not represent what actually occurred. The 4th North section in the Little Dove Mine was completed in February 1987 (Figures 38 and 39).

Maximum subsidence over the area as of August 1988 was about two (2) feet (Figures 40 and 41).

No visible surface disturbance of any kind has been found.

There are no known springs over the workings, and mining is not expected to have any effect on the hydrology of the area.

U-1358

DEER CREEK FAULT

E 2,110,000

E 2,112,000

E 2,114,000

E 2,116,000

N 362,000

U-02664

N 360,000

22

23

27

26

23

26

23

24

26

25

SECOND WEST

FIRST WEST

THIRD EAST

FEE

SECOND EAST

FIRST EAST

FIRST NORTH

SECOND NORTH

THIRD NORTH

FOURTH NORTH

MAIN NORTH

MAIN WEST

Beehive Mine Portals

Little Dove Mine Portals

N 358,000



**Beehive & Little Dove Coal Mines**  
EMERY COUNTY, UTAH

**SOUTHERN AREAS**  
**MINE WORKINGS**

**UTAH POWER & LIGHT COMPANY**  
**MINING DIVISION**

DRAWN BY: <b>LJ Hansen</b>	CHECKED BY:	DATE: <b>MAR. 6, 1989</b>
Scale	Sheet No.	Drawing Number
<b>1" = 500'</b>		<b>FIGURE 38</b>

U-1358

E 2,110,000

E 2,114,000

E 2,114,000

E 2,116,000

N 362,000

U-02664

22 23  
27 26

23 24  
26 25

U-02664

Profile

N 360,000

DEER CREEK FAULT

Profile



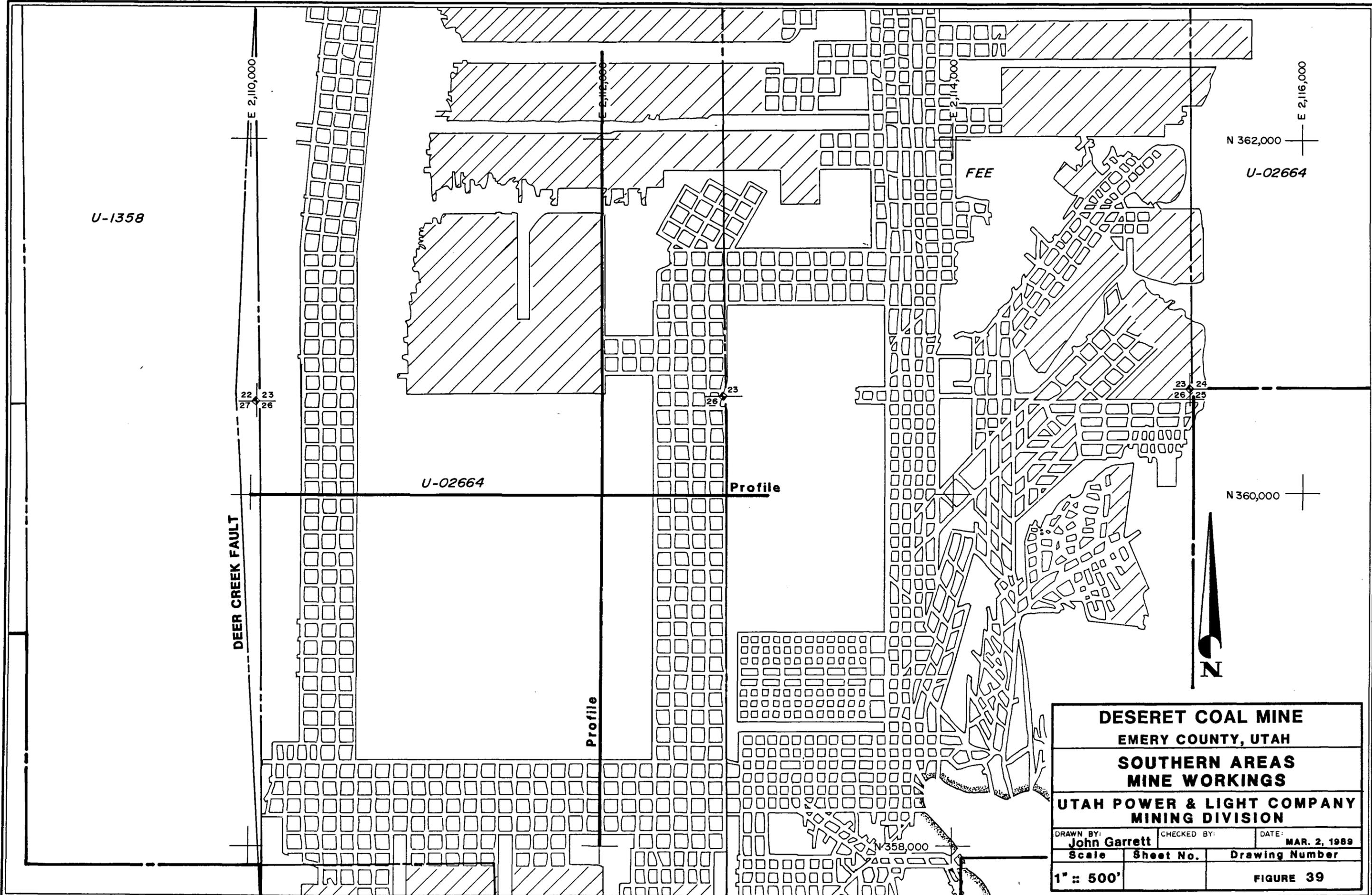
**DESERET COAL MINE**  
**EMERY COUNTY, UTAH**  
**SOUTHERN AREAS**  
**MINE WORKINGS**

**UTAH POWER & LIGHT COMPANY**  
**MINING DIVISION**

DRAWN BY: **John Garrett** CHECKED BY: DATE: **MAR. 2, 1989**  
Scale Sheet No. Drawing Number

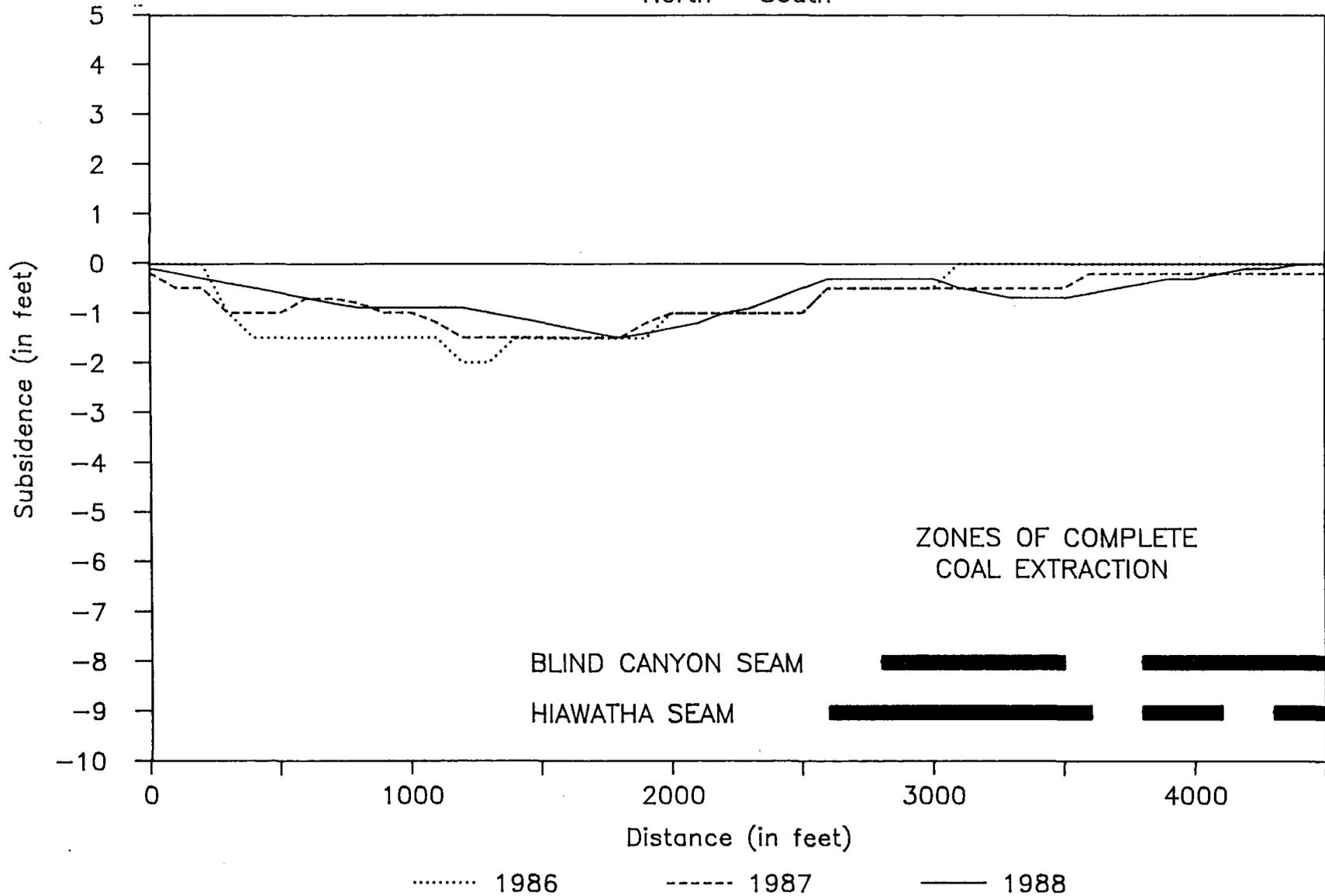
1" = 500'

FIGURE 39



# AREA 13 SUBSIDENCE PROFILE

North - South



**FIGURE 40**

# AREA 13 SUBSIDENCE PROFILE

West - East

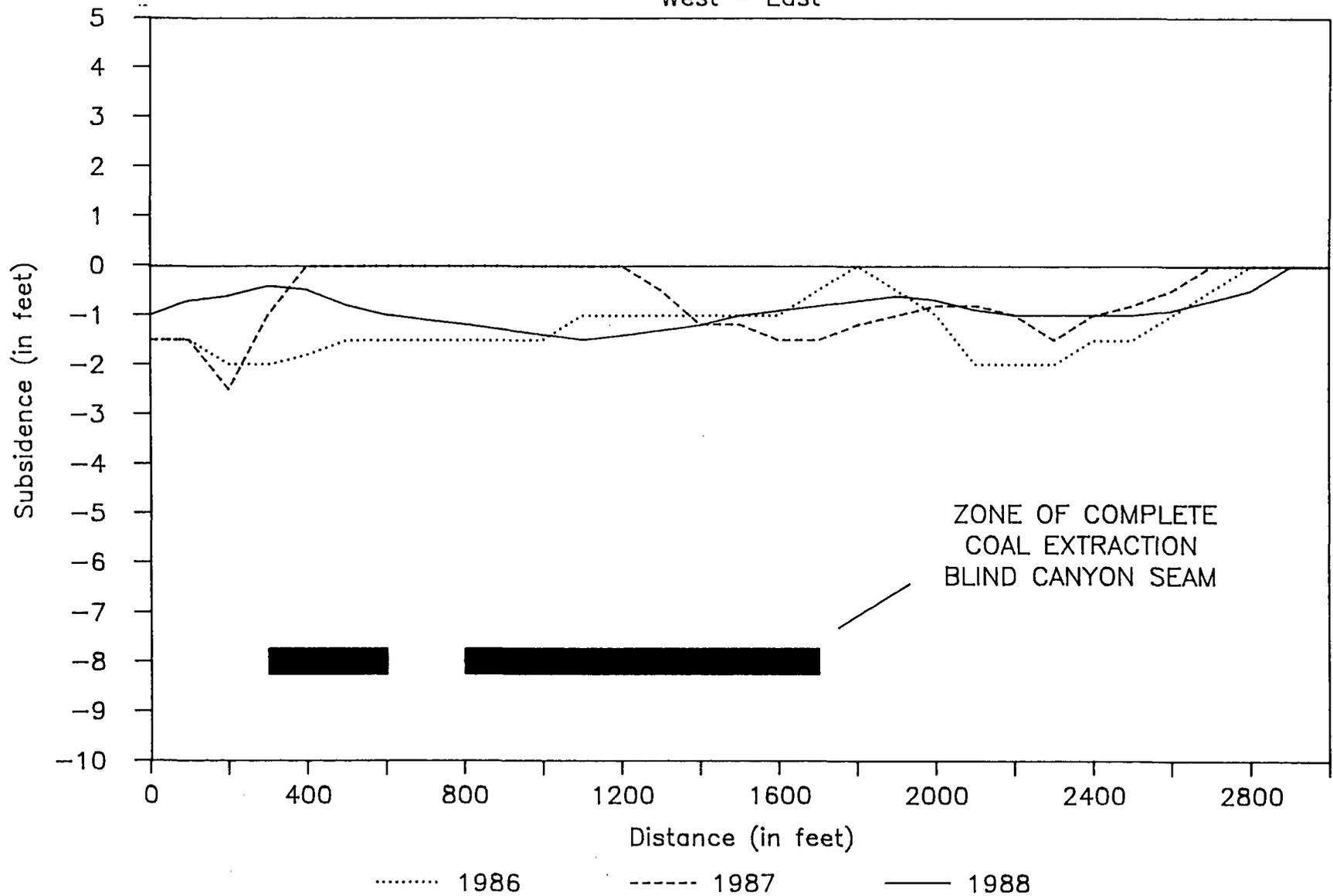


FIGURE 41

## Area 14

### Cottonwood 6th and 7th East Longwall Panels

Subsidence in Area 14 was first monitored and detected in 1987. Mining began in the 6th East panel in September 1986 and continued until the panel was completed in March 1987. Mining in the 7th East panel began in April 1987, and the panel was finished in September 1987 (Figure 42).

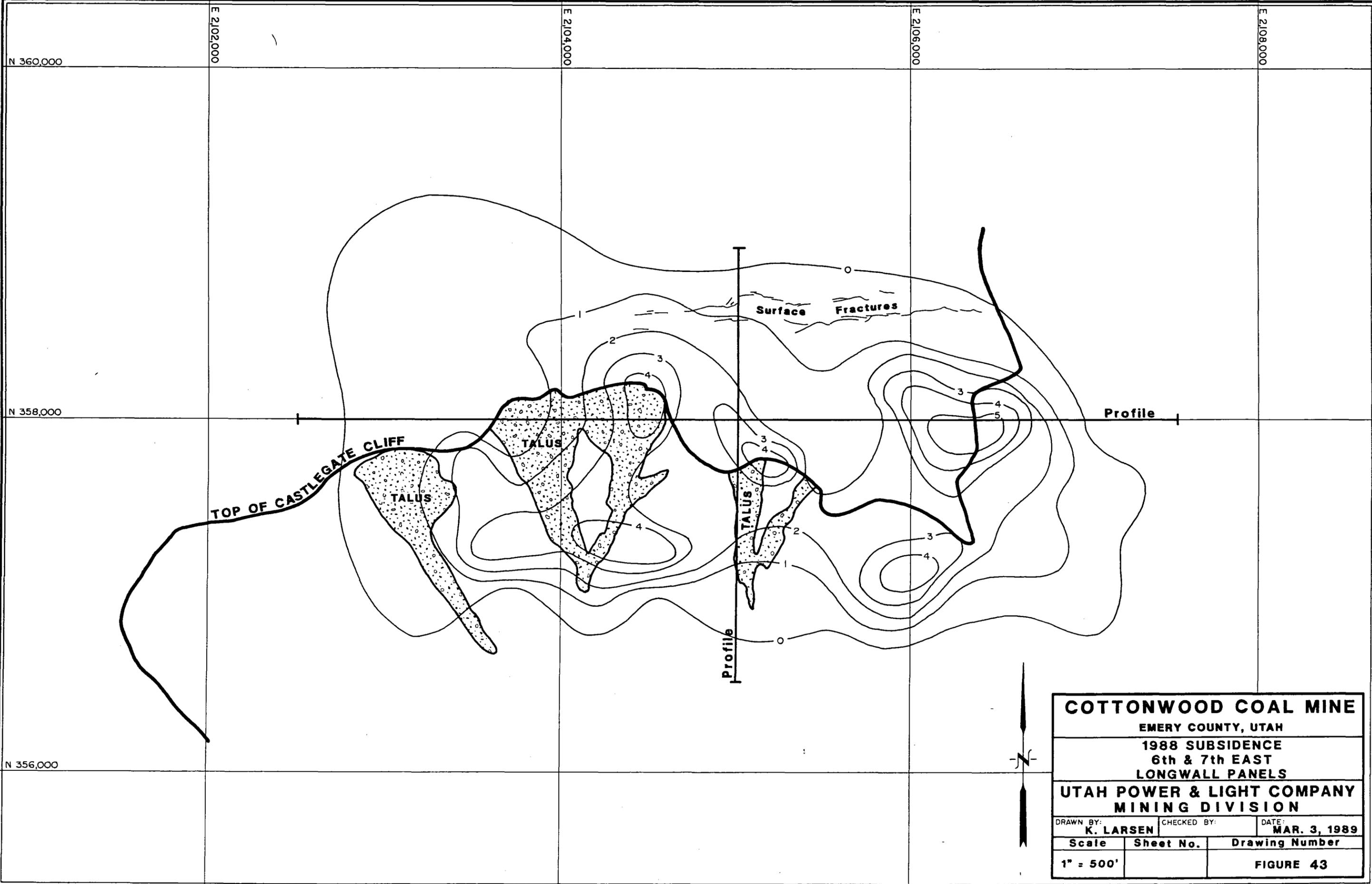
Topography consists of very steep south facing slopes and cliffs with slopes covered by a few scattered pinon, juniper, mountain brush, and grasses. Overburden ranges from near 1400 feet to 200 feet.

The Castlegate Sandstone forms a 200-foot high escarpment along the north side of Newberry Canyon with numerous naturally occurring joints and fractures. Stress caused by removal of coal was transferred to the fractures resulting in brittle failure of the cliff face (spalling) in some places. Talus from the spalling has accumulated on the steep slopes below the cliffs on older natural talus slopes. The newer debris remains mostly above the coal outcrop level and reaches the canyon floor in only one location. Surface cracks have been observed and mapped along the ridge above the cliff. The cracks are discontinuous and extend for approximately 2000 feet parallel to the northern edge of the 6th East longwall panel. A few cracks are also found directly on top of the Castlegate Sandstone escarpment.

Maximum subsidence to date is over five (5) feet, occurring over the eastern end of the 6th East panel (Figure 43).

Calculated angle-of-draw ranges from less than zero to 29 degrees.

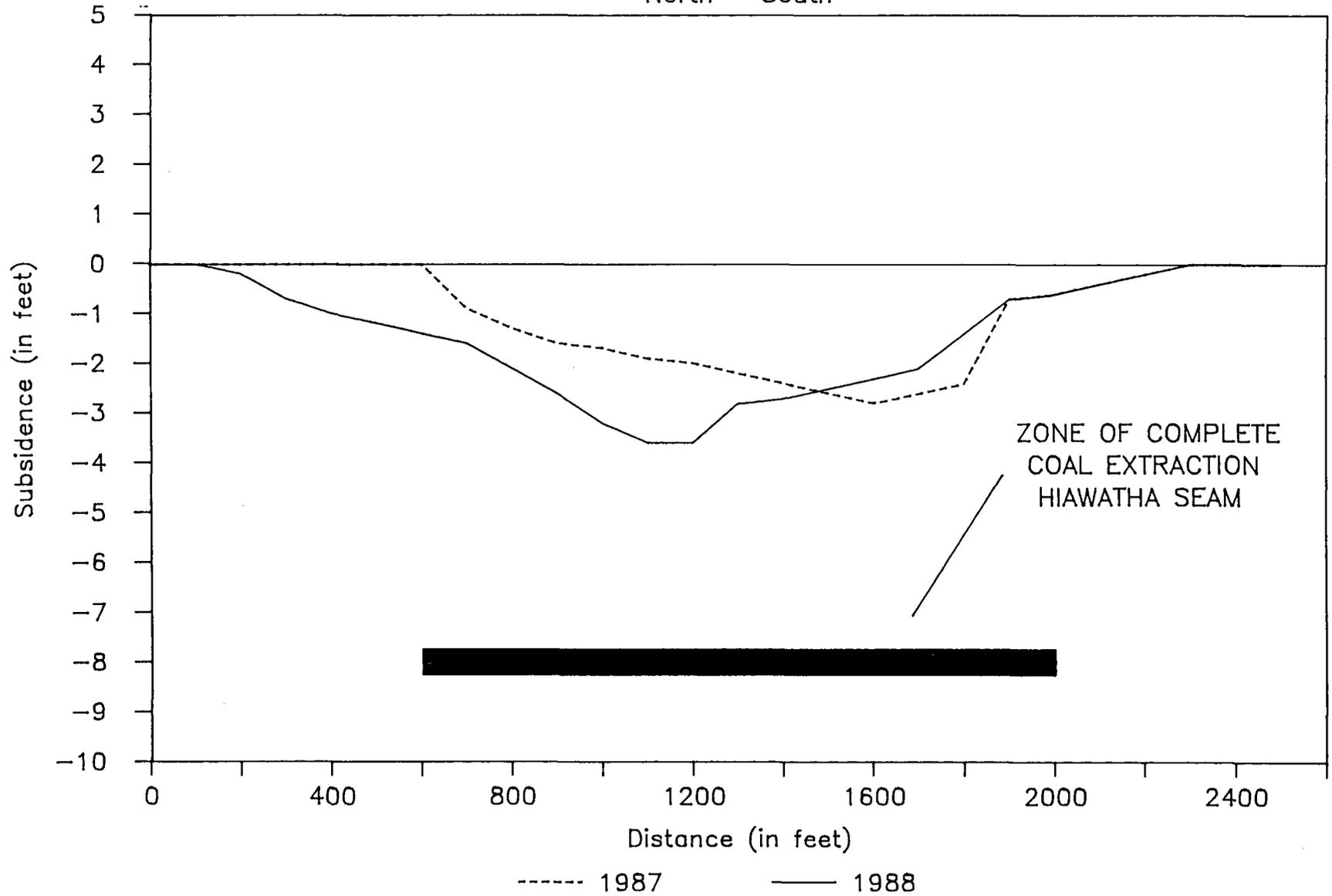




<b>COTTONWOOD COAL MINE</b>		
EMERY COUNTY, UTAH		
1988 SUBSIDENCE		
6th & 7th EAST		
LONGWALL PANELS		
<b>UTAH POWER &amp; LIGHT COMPANY</b>		
<b>MINING DIVISION</b>		
DRAWN BY:	CHECKED BY:	DATE:
K. LARSEN		MAR. 3, 1989
Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 43

# AREA 14 SUBSIDENCE PROFILE

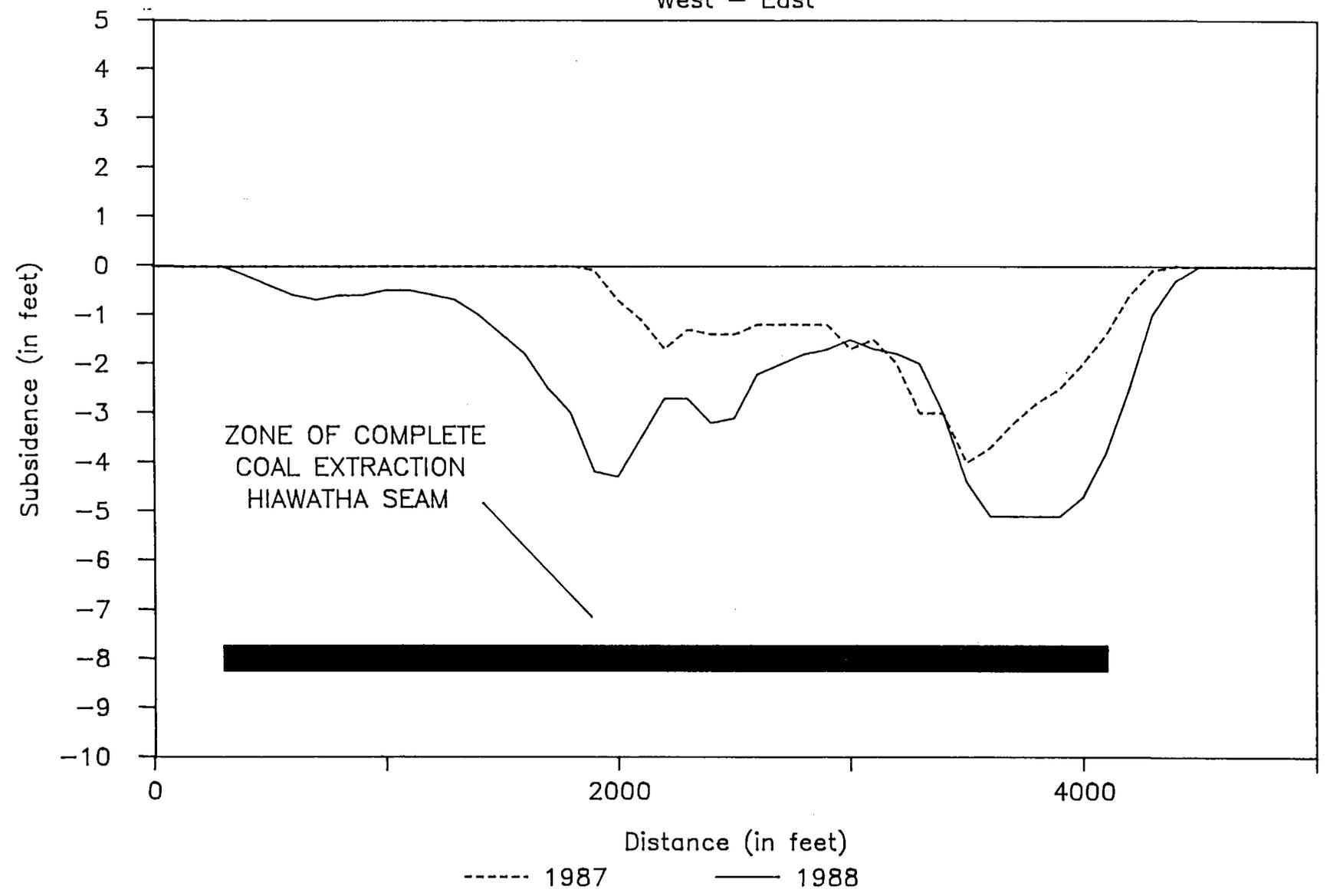
North - South



**FIGURE 44**

# AREA 14 SUBSIDENCE PROFILE

West - East



**FIGURE 45**

There are no springs in the vicinity of Area 14. The strata are generally dry; thus, mining is expected to have no adverse impact on the hydrology.

Wildlife in the area includes deer, elk, nesting golden eagles in spring and summer, wintering bald eagles, hares, rabbits, grouse, and other species. Grazing cattle can also be found along the ridge top in the summer months.

The major impacts associated with subsidence and resulting cliff failure, surface cracking, and talus deposition in Area 14 are 1) possible loss of golden eagle nests and/or nest sites, 2) disruption of grazing and hunting land use, and 3) loss of wildlife habitat.

Prior to longwall mining in the area an eagle monitoring plan was developed and implemented. It went into effect in February 1986 and is an ongoing program. The purpose of the plan is to collect data whereby the impacts of subsidence and cliff spalling upon eagle nesting can be assessed. The report entitled "Assessment of Mining Related Impacts in Newberry Canyon" submitted to the Utah Division of Oil, Gas and Mining discusses all mining related impacts in Area 14 and includes the eagle monitoring plan as an appendix.

Mitigation of effects due to mining may be required in Area 14. A detailed assessment is given in the Newberry Canyon report. Briefly, mitigation may include 1) backfilling, recontouring, and revegetating surface cracks, where accessible; 2) creating artificial eagle nesting sites; and 3) improvement of habitat for existing species or developing habitat for another desirable species.

In all likelihood most of the mitigation measures will be unnecessary. UP&L will continue to monitor subsidence to assess the significance of related impacts.

## Area 15

### Cottonwood 9th and 10th West Longwall Panels

Subsidence in 9th and 10th West was first monitored and detected in 1988 since longwall extraction there began during this monitoring period. Between February and August 1988 the entire 9th West panel and 2530 feet of the 10th West panel were extracted (Figure 46).

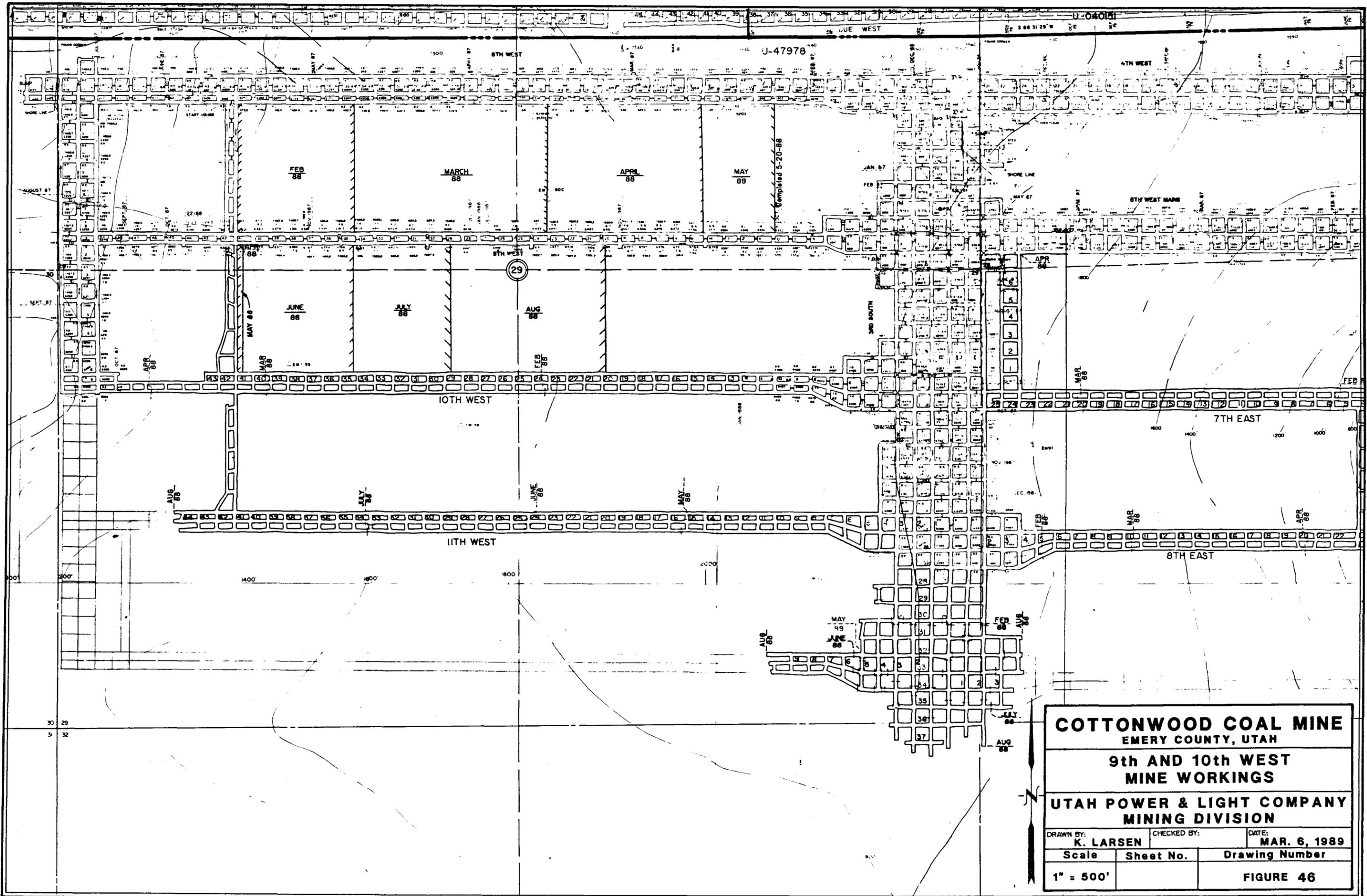
The surface above these panels is comprised mainly of steep to moderate slopes with a small flat area forming the top of East Mountain on the area's eastern edge. Overburden ranges from 1200 feet to over 2000 feet, increasing eastward.

Due to a stipulation by the U.S. Forest Service, both panels were shortened on their western ends to prevent possible failure of portions of the Castlegate Sandstone escarpment in Miller Canyon.

Maximum measured subsidence to date is over five (5) feet above the western ends of the panels (Figure 47).

Calculated angle-of-draw is less than zero on west, south, and east, and reaches 25 degrees on the north where older workings may be causing subsidence to the north of the 9th West panel.

There are no known springs in the area.

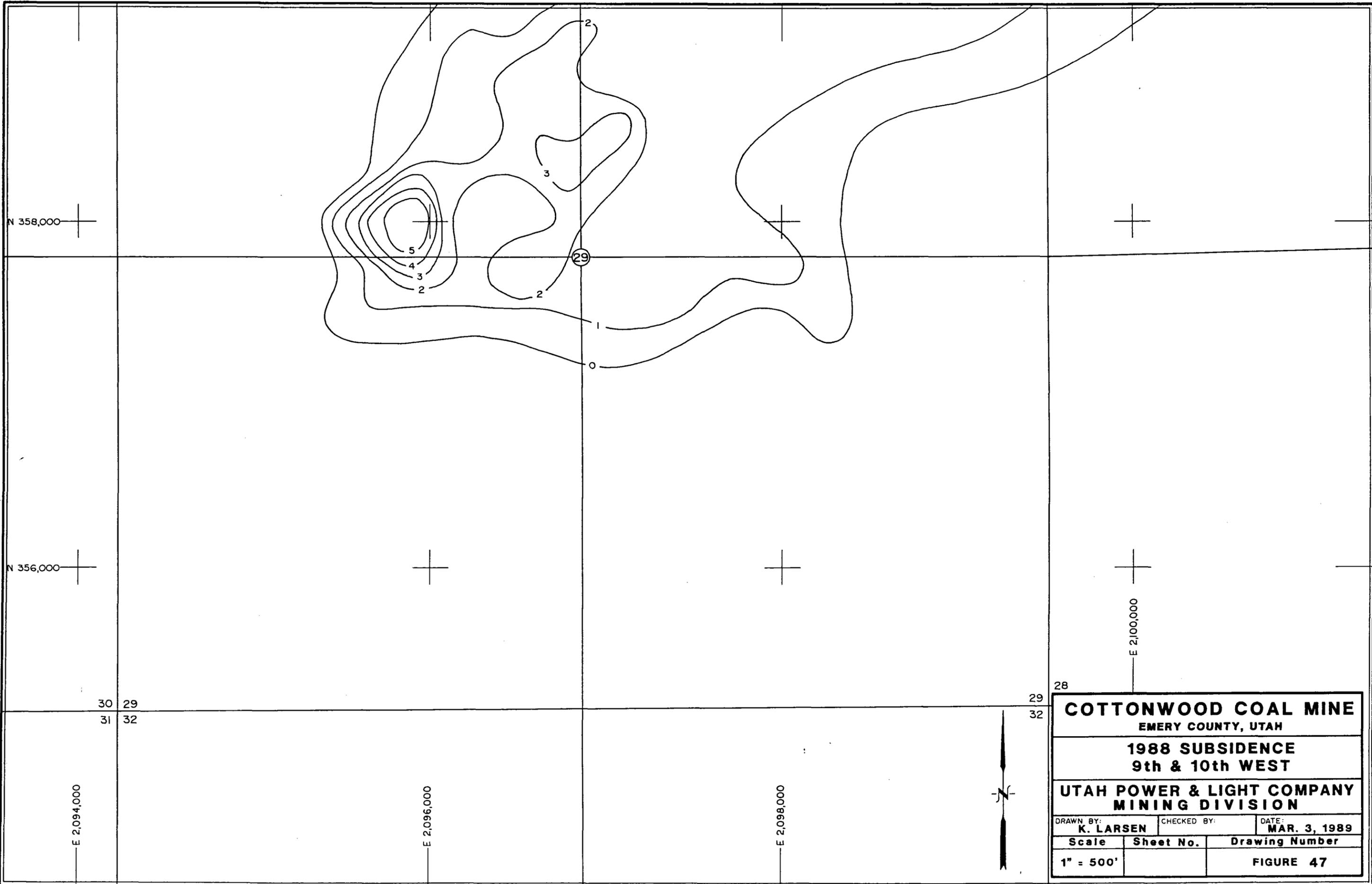


**COTTONWOOD COAL MINE**  
 EMERY COUNTY, UTAH

**9th AND 10th WEST**  
 MINE WORKINGS

**UTAH POWER & LIGHT COMPANY**  
 MINING DIVISION

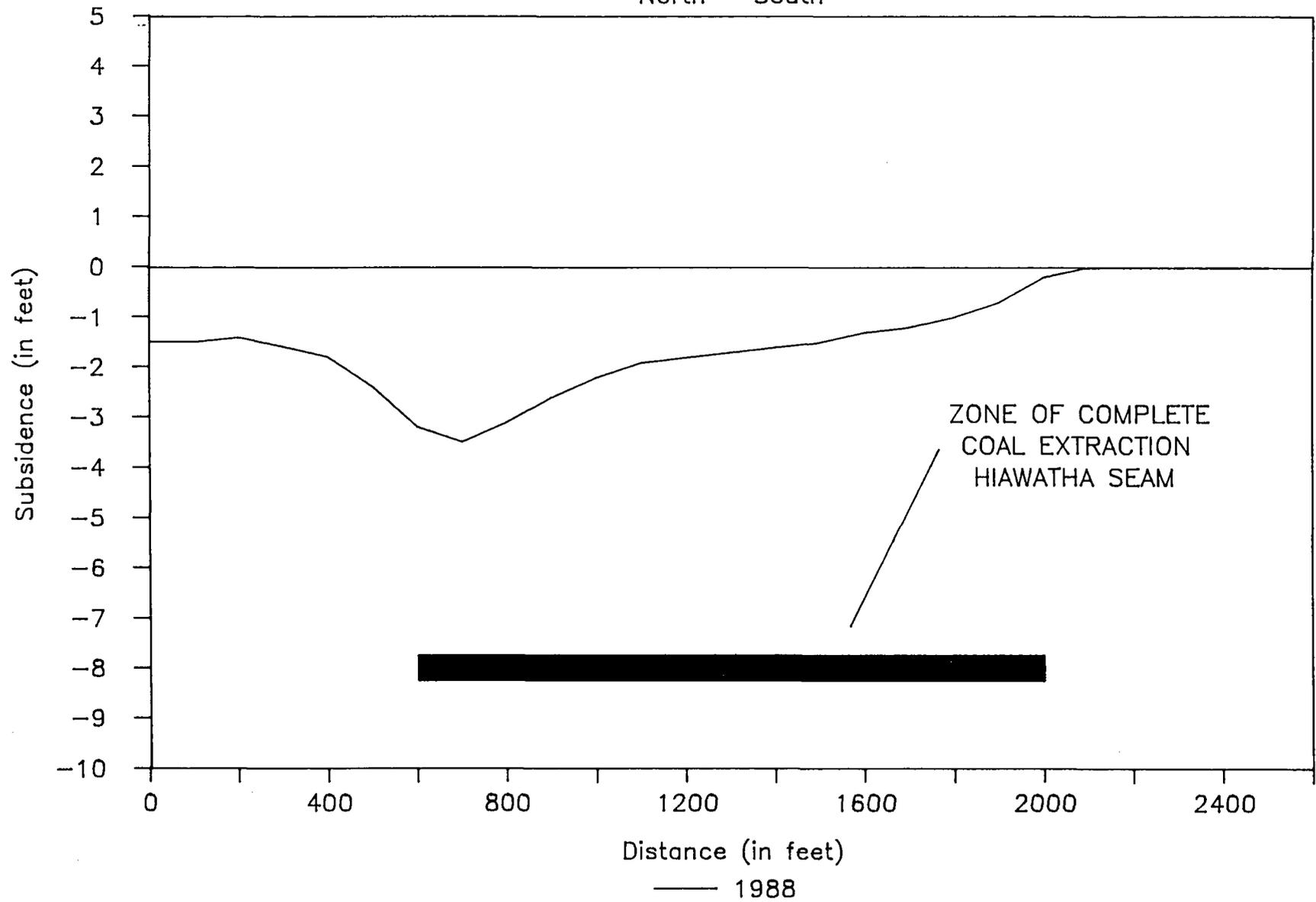
DRAWN BY: <b>K. LARSEN</b>	CHECKED BY:	DATE: <b>MAR. 6, 1989</b>
Scale	Sheet No.	Drawing Number
<b>1" = 500'</b>		<b>FIGURE 46</b>



<b>COTTONWOOD COAL MINE</b>		
EMERY COUNTY, UTAH		
<b>1988 SUBSIDENCE</b>		
<b>9th &amp; 10th WEST</b>		
<b>UTAH POWER &amp; LIGHT COMPANY</b>		
<b>MINING DIVISION</b>		
<small>DRAWN BY:</small> <b>K. LARSEN</b>	<small>CHECKED BY:</small>	<small>DATE:</small> <b>MAR. 3, 1989</b>
<small>Scale</small>	<small>Sheet No.</small>	<small>Drawing Number</small>
<b>1" = 500'</b>		<b>FIGURE 47</b>

# AREA 15 SUBSIDENCE PROFILE

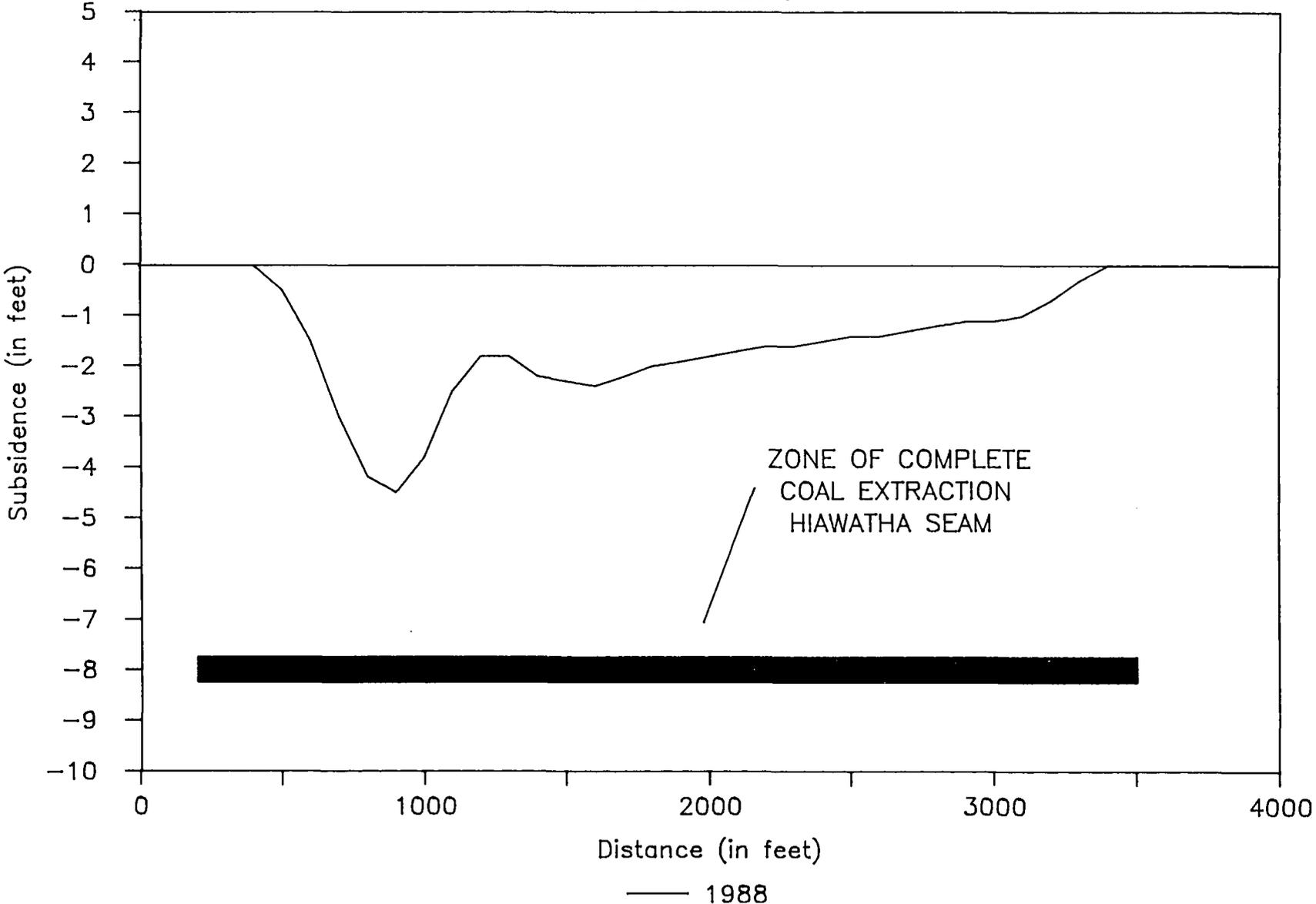
North - South



**FIGURE 48**

# AREA 15 SUBSIDENCE PROFILE

West — East



**FIGURE 49**

### Predicted Maximum Subsidence

A comparison between observed and predicted maximum subsidence for the various areas on UP&L's property has been made using a method developed by the British National Coal Board (NCB). The NCB method utilizes graphs compiled from numerous field observations and takes into consideration the length and width of the mined-out area, thickness of coal extracted, and depth of cover. The method is claimed to be correct to  $\pm 10\%$  in the majority of cases, assuming certain limiting conditions are met. The table below compares predicted maximum subsidence with observed subsidence for areas on East Mountain.

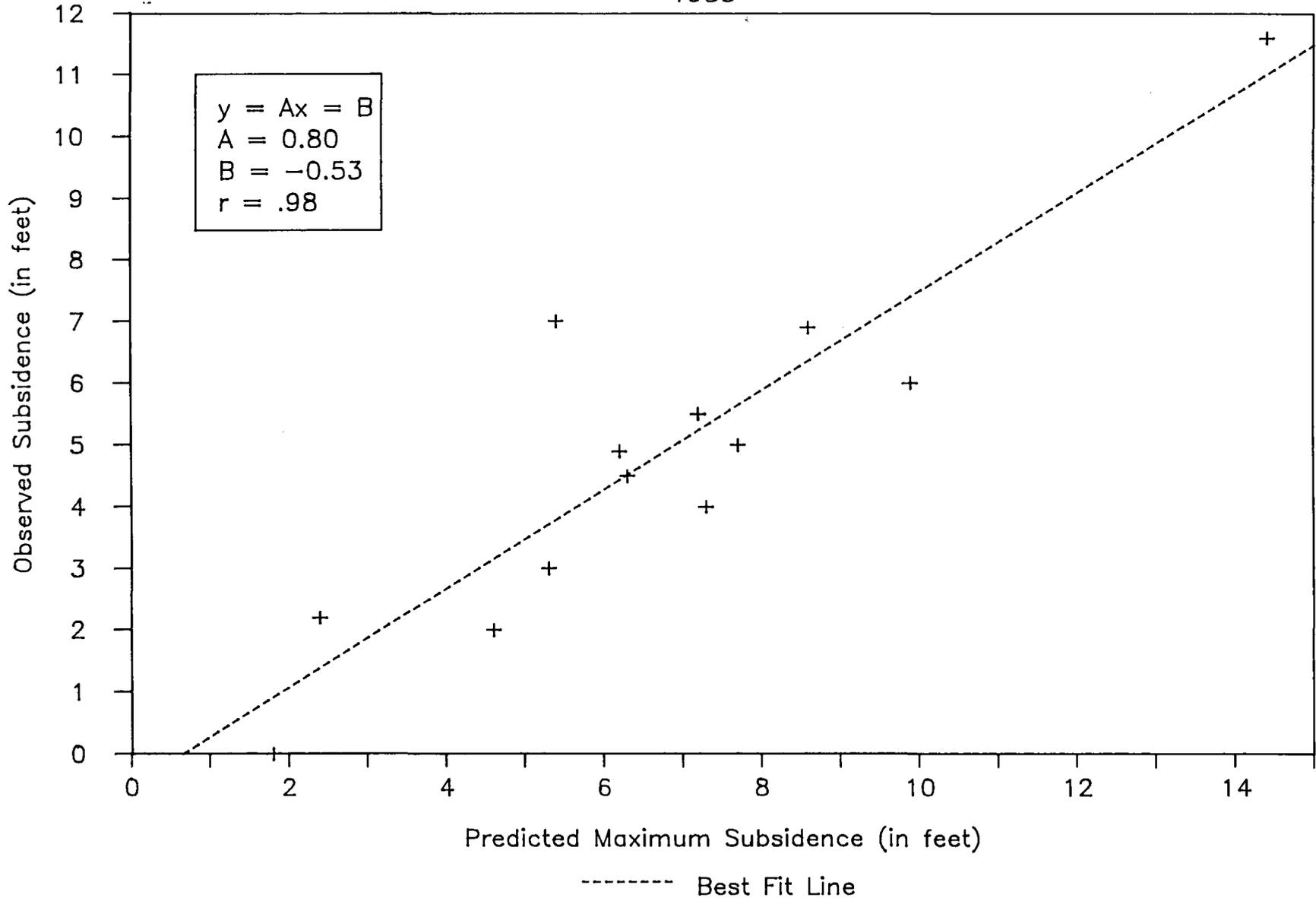
<u>Area</u>	<u>Subsidence (feet)</u>		
	<u>Predicted Maximum</u>	<u>Observed</u>	<u>% of Predicted</u>
*1 DC 9E/W 1R	8.9	25.0	281
2 DC 5-8E/W, 5-13R	14.4	11.6	81
3 DC 1N Area	5.4	7.0	130
4 DC 2-7R	8.6	6.9	80
5 DC 2-5L	7.7	5.0	65
6 W 1-2W	5.3	3.0	57
7 Bee 2N off 8W	9.9	6.0	61
8 Bee/Des E&W Sections	6.3	4.5	71
9 LD 1N	4.6	2.0	44
10 Old American Fuel Mine	7.3	4.0	55
11 DC A N&S and CN Longwall	6.2	4.4	71
12 W 2L	1.8	0	0
13 Des-Bee-Dove Southern Areas	2.4	2.2	92
14 Cottonwood 6-7E	7.2	5.5	76
15 Cottonwood 9-10W	7.2	5.5	76

\* This area does not fit the NCB prediction model.

In all areas except one subsidence is less than the maximum predicted by the NCB model, possibly due to the fact that in some areas mining occurred very recently and subsidence has not yet reached its maximum. It could also be that the observed subsidence shown here represents the actual maximum subsidence for the particular geologic conditions -- probably the case in some areas since subsidence appears to have ceased in several areas where the NCB predicted maxima were not reached. Figure 50 shows the relationship between predicted and observed subsidence. From the slope of the regressions line ( $A = .80$ ) the average observed subsidence is eighty percent (80%) of the NCB predicted maximum. (Area 1 excluded from graph data.)

Area 1 (DC 9th East - Wilberg 1st Right) is the one anomalous area; it does not fit the special conditions necessary for prediction by the NCB method. The mine workings are surrounded by burned coal and bounded on the east by the Deer Creek Fault. As mentioned before, crushing of clinker beds and movement along the fault have added another complication to the subsidence. The maximum subsidence in the area occurs on a steep slope below a cliff, where slumping has occurred. The twenty-five (25) feet measured here must be due in part to mass wasting on the steep slope.

PREDICTED vs OBSERVED SUBSIDENCE  
East Mountain Property  
1988



**FIGURE 50**

### Mitigation of Surface Effects

Over most areas where subsidence has been observed on East Mountain, present land use has not been affected in any way. Areas 2, 4, 5, 6, 9, 11, 13, and 15 are good examples of subsidence without visible surface disturbance or adverse hydrologic effects. In such areas no mitigation is necessary.

In a few areas, such as Areas 1, 3, 7, 10, and 14, surface fractures have been detected. In order to protect livestock UP&L has erected a fence around Area 1 where fractures are of sufficient magnitude to pose a threat to wandering cattle. In Area 14, where cracks have also been observed, the U.S. Forest Service has determined that no fencing or other measures are needed unless "significant change" occurs in the area. The agency has recommended that no reclamation be undertaken in Areas 1 or 14 at this time; UP&L will reclaim the areas when and if it is deemed necessary.

As mentioned in the section of this report detailing Area 14, in order to mitigate the effects of subsidence there UP&L may be required to use other means which may include replacing possible lost eagle nesting sites, filling and recontouring surface cracks, and replacing or improving wildlife habitat. Again, whether or not UP&L is required to perform any of this work will depend on the assessment of the regulating state and federal agencies.

In Areas 3, 7, and 10, where only minor fracturing has occurred on remote ridges and/or where land use has not been affected, more damage would be done by gaining access to and repairing or fencing

fractures than can be justified; therefore, mitigation is counterproductive in those areas.

## Summary

As of August 1988 UP&L has identified fifteen (15) areas of mining-induced subsidence on the East Mountain property. Terrain in the subsidence areas ranges from relatively flat mountain tops with thick overburden of up to 2,100 feet to steep slopes and cliffs with overburden of less than 200 feet. The most noticeable subsidence effects occur in the steep cliff areas and where mining next to burned coal appears to have caused crushing of the clinker beds. Most of the fractures observed over mined areas have occurred under these conditions, especially where the Castlegate Sandstone (or similar lithologic unit) crops out or is near the surface. The sandstones yield to stress by brittle deformation (fracturing). The remaining fractures which have been discovered are reactivated surface traces of the Bear Creek Canyon or Deer Creek faults.

In areas where overburden is thicker and other, more clay-rich formations crop out, longwall and room-and-pillar mining methods have allowed the multiple seam mining of large quantities of coal without apparent impact on the environment because the overburden yields through plastic deformation. Areas such as the Beehive-Deseret east and west room-and-pillar sections (Areas 8 and 13) and the Deer Creek 4th through 8th East-Wilberg 3rd through 13th Right longwall panels (Area 2) have demonstrated that subsidence can occur over a broad area with no visible or hydrologic effects. In excess of eighty percent (80%) of the East Mountain property has conditions similar to those areas; therefore, the mining methods being utilized are well suited to the geologic

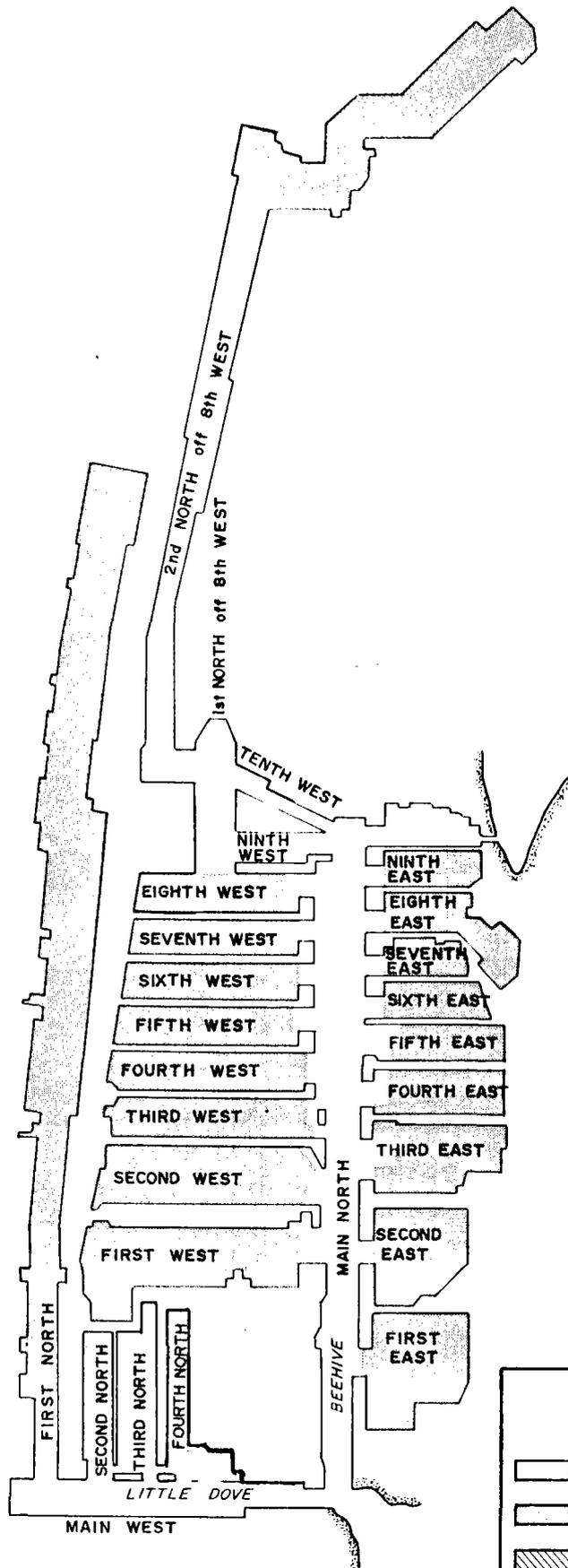
conditions, allowing subsidence to occur without impacting the hydrology or present land use of the area.

An effort was made again this year to predict maximum possible subsidence for the various areas where subsidence has been detected. The prediction was then compared with observed subsidence for each area. It appears that the actual subsidence occurring on East Mountain is slightly less than that predicted by the NCB model.

Because of the data presented herein it is UP&L's opinion that annual monitoring in Areas 5, 6, 7, 8, 10, and 12 is not necessary due to their demonstrated stability. UP&L will file a separate request with the Utah State Division of Oil, Gas and Mining for the suspension of annual monitoring in those areas. Aerial photographs will continue to be taken and, if necessary, they can be read later for elevation changes due to subsidence.

APPENDICES

Des-Bee-Dove Mines



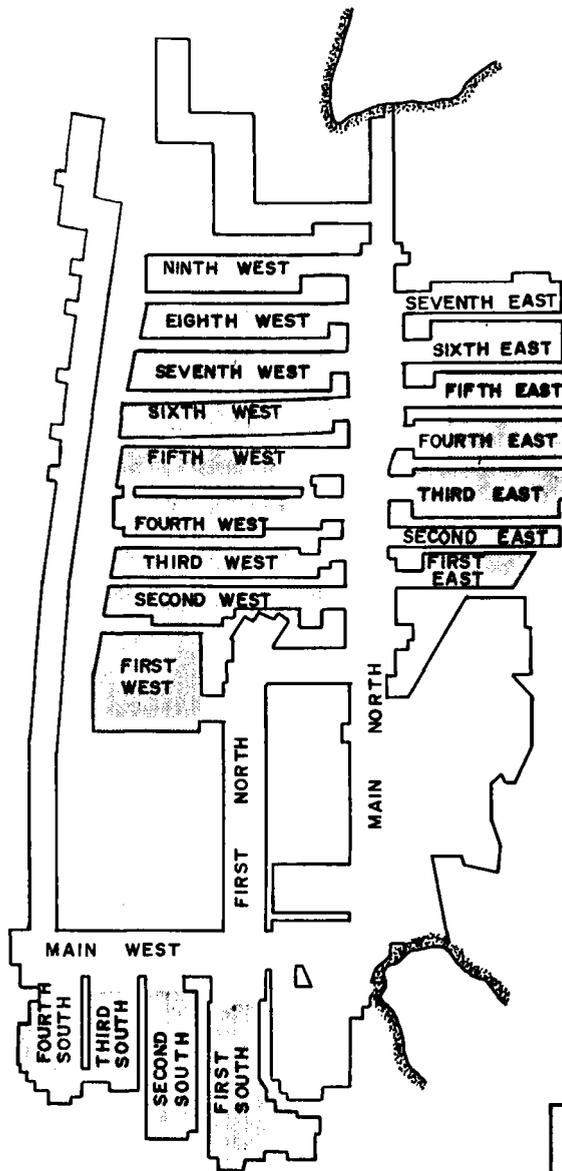
**LEGEND**

	MINE WORKINGS
	MINING COMPLETED
	ACTIVE MINING AREA

**BEEHIVE & LITTLE DOVE COAL MINES**

SCALE: 1" = 2000'

UPDATED TO: 5/30/86



LEGEND	
	MINE WORKINGS
	MINING COMPLETED
	ACTIVE MINING AREA

MINE WORKINGS UPDATED TO 9/1/86

# DESERET COAL MINE

SCALE: 1" = 2000'

Deer Creek Mine

# DEER CREEK COAL MINE

SCALE: 1" = 2000'



ROCK ROOMS

THIRD NORTH SUMP

FIRST WEST MAINS

THIRD NORTH

MAIN WEST

## LEGEND

- MINE WORKINGS
- MINING COMPLETED
- ACTIVE MINING AREA

MINE WORKINGS UPDATED TO 11/1/89

TENTH RIGHT

NINTH RIGHT

EIGHT RIGHT

SEVENTH RIGHT

SIXTH RIGHT

FIFTH RIGHT

FOURTH RIGHT

THIRD RIGHT

SECOND RIGHT

FIRST RIGHT

THIRD SOUTH

C NORTH

B NORTH

A NORTH

SECOND SOUTH

FIRST SOUTH

SECOND EAST

THIRD EAST

FOURTH EAST

FIFTH EAST

SIXTH EAST

SEVENTH EAST

EIGHT EAST

NINTH EAST "A"

NINTH EAST

FIFTH LEFT

FOURTH LEFT

THIRD LEFT

SECOND LEFT

FIRST LEFT

FOURTH WEST

THIRD LEFT

1 1/2 NORTH

FIRST NORTH

Wilberg/Cottonwood Mine

# COTTONWOOD/WILBERG MINES

SCALE: 1" = 2000'



**LEGEND**

- MINE WORKINGS
- MINING COMPLETED
- ACTIVE MINING AREA

