

**UTAH POWER & LIGHT COMPANY
SUBSIDENCE MONITORING PROGRAM
ANNUAL REPORT FOR 1989**

May 1990

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SUBSIDENCE MONITORING PROGRAM
ANNUAL REPORT FOR 1989**

May 1990

Submitted to:

**United States Department of the Interior
Office of Surface Mining
Minerals Management Service
Utah Division of Oil, Gas and Mining**

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APPENDICES

Des-Bee-Dove Mines

Deer Creek Mine

Wilberg/Cottonwood Mine

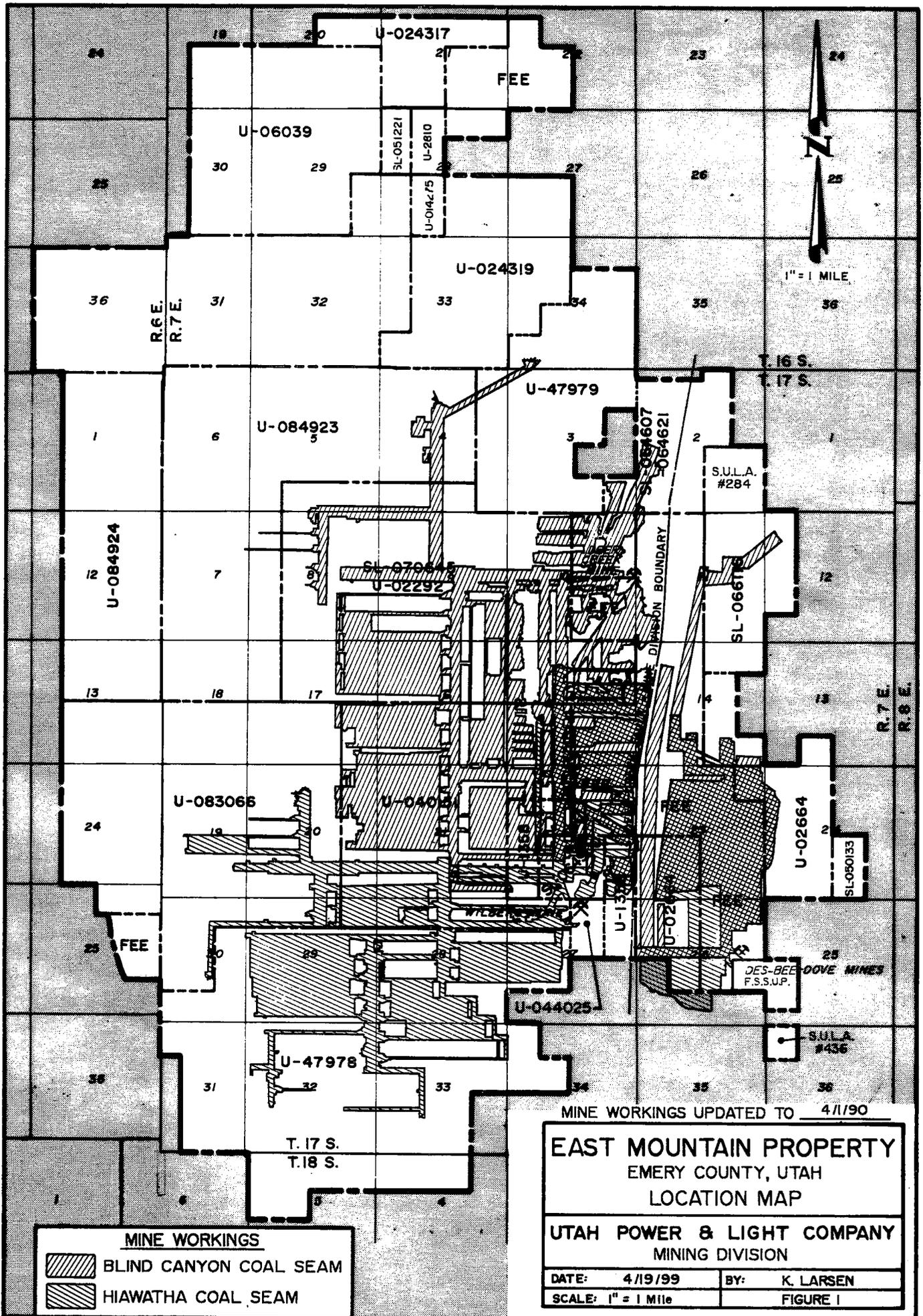
Spring Map with 5-Year Mine Plan Showing Subsidence

Utah Power & Light Company's (UP&L) East Mountain Subsidence Monitoring Study is an ongoing project designed to detect, observe, and report the effects of mining-induced subsidence above the Deer Creek, Wilberg/Cottonwood, and Des-Bee-Dove Mines (see Figure 1). This, the ninth such annual report submitted, covers the period between August 31, 1988 and August 31, 1989.

The initial report submitted in 1982 details the monitoring methods used in the study; therefore, they are not discussed in depth here. Briefly, UP&L uses aerial photogrammetric survey methods and annual helicopter reconnaissance flights to monitor subsidence. A change in the method of reading the aerial photographs may result in some slight changes in measured subsidence in some areas. In the past, elevations of points to be read were hand-picked by a machine operator. Beginning with the 1989 data, points are read automatically by a machine set to read a grid of any desired spacing. Coverage is generally better with the new method, though the individual points are different.

Location

Figure 2 shows all areas above UP&L's coal mines which have potential for mining-induced subsidence. Several helicopter reconnaissance flights during 1989 revealed no new areas of visible surface disturbance. In areas where subsidence has been detected, data is shown in the form of contour maps and profiles. Both indicate elevation change from pre-mining elevations. The profile figures may show data for several years to better track the subsidence history of the area.



MINE WORKINGS

 BLIND CANYON COAL SEAM

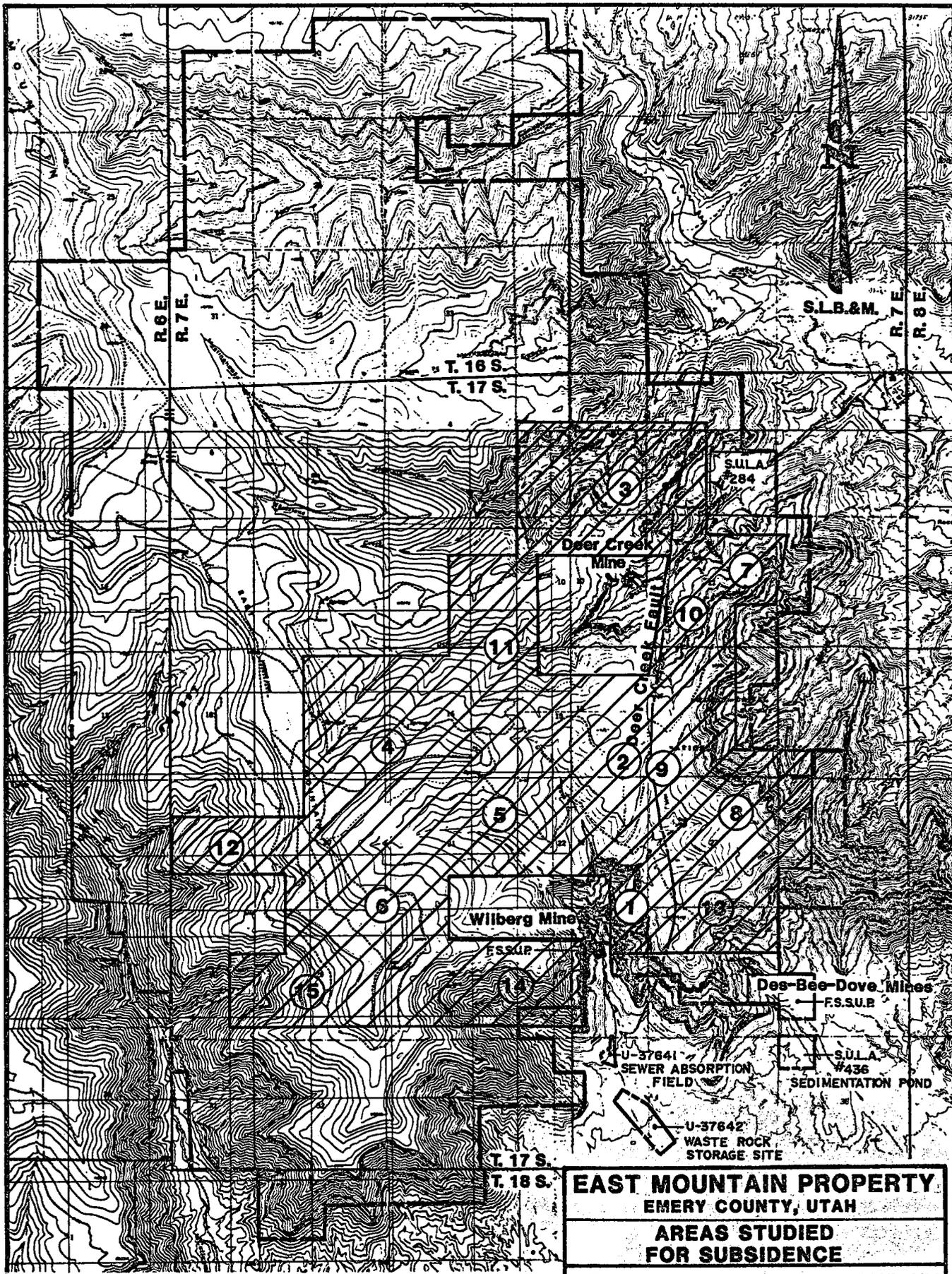
 HIAWATHA COAL SEAM

MINE WORKINGS UPDATED TO 4/1/90

EAST MOUNTAIN PROPERTY
 EMERY COUNTY, UTAH
 LOCATION MAP

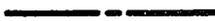
UTAH POWER & LIGHT COMPANY
 MINING DIVISION

DATE: 4/19/99	BY: K. LARSEN
SCALE: 1" = 1 Mile	FIGURE I



NUMBERS KEYED TO TEXT

 = AREAS STUDIED FOR SUBSIDENCE

 = U.P.&.CO. PERMIT BOUNDARY LINE

EAST MOUNTAIN PROPERTY
EMERY COUNTY, UTAH

AREAS STUDIED
FOR SUBSIDENCE

UTAH POWER & LIGHT COMPANY
 DEPARTMENT OF MINING & EXPLORATION

DATE: 2/11/86
 SCALE: 1" = 1 Mile

BY: LJ GUM
 FIGURE 2

In many areas of subsidence the angle-of-draw has been calculated and reported; however, in the majority of cases the angle should not be considered the actual final angle-of-draw due to several factors. For example, the zone of subsidence to date may be small and contained within the underlying mined area, suggesting that the subsidence has not yet reached its maximum extent. Also, many mined sections are surrounded by other older workings which influence the calculation. In a few areas where the mined-out workings are surrounded by burned coal, the failure of clinker beds promotes subsidence outside the mined area resulting in an angle-of-draw greater than might be expected.

Area 1

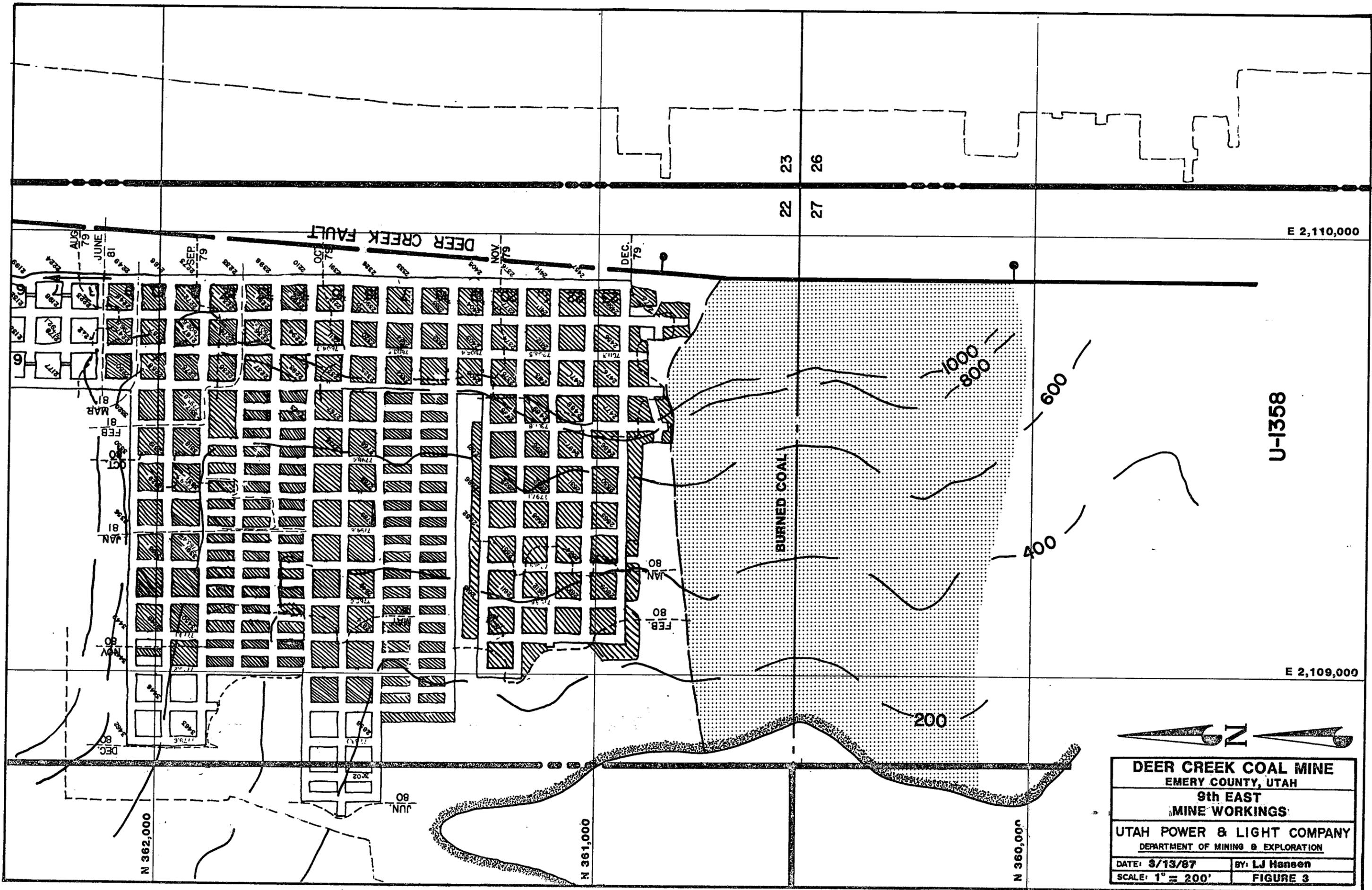
Deer Creek 9th East - Wilberg 1st Right

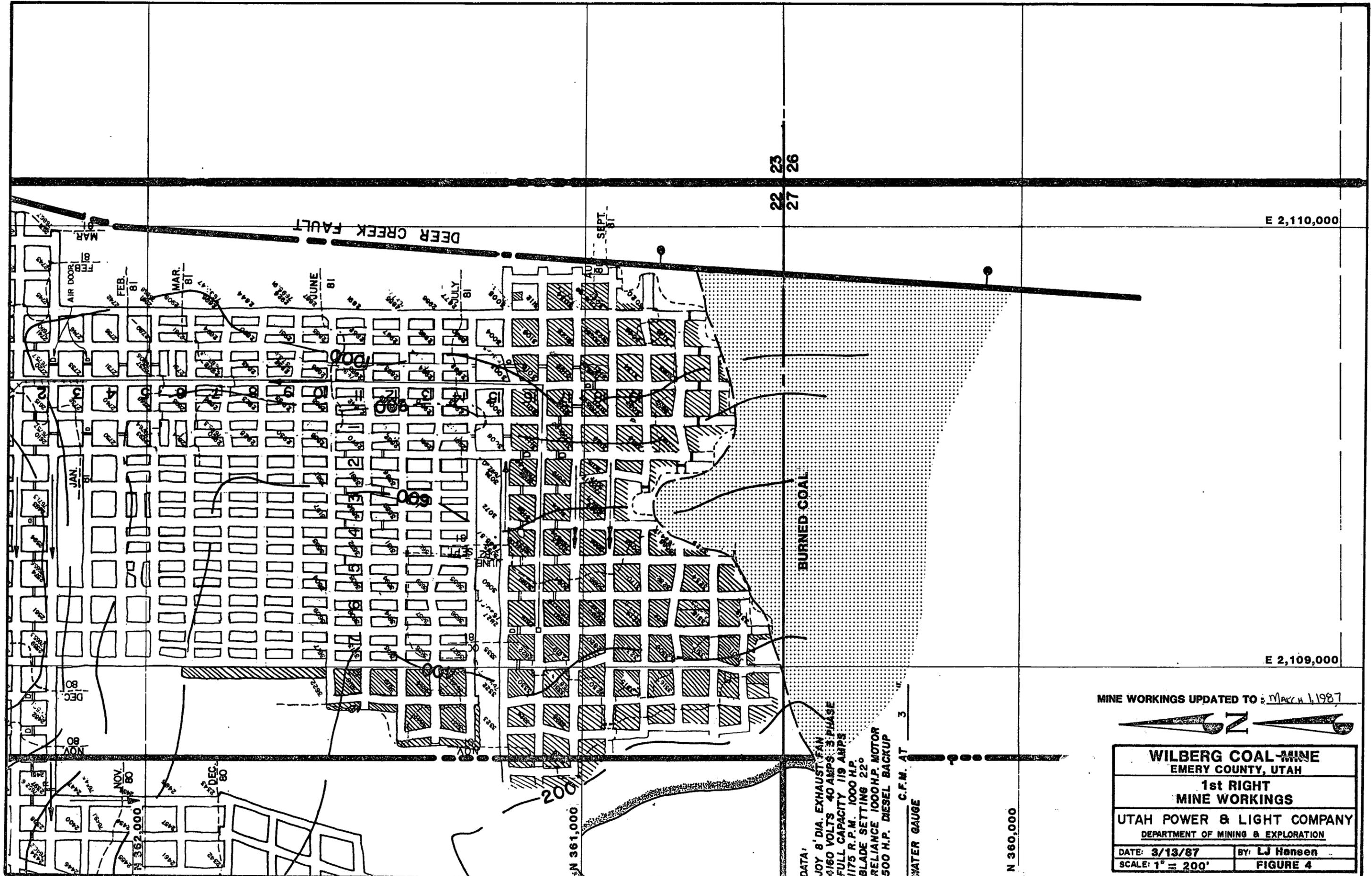
Subsidence in Area 1 was first documented in the 1981 Subsidence Monitoring Report submitted in 1982. The relationship of the subsidence to the underlying Deer Creek and Wilberg mine workings is shown in Figures 3, 4, and 5. Each map covers the same area, Figure 5 being a contour map of subsidence on the surface over the mine workings depicted in the other two figures. The most recent mining in this area occurred in the Wilberg 1st Right section in June 1984.

Figures 6 and 7 are north to south and west to east profiles showing the amount of subsidence in this area during the past seven years. The location of each line is shown on Figure 5. The area has seen little change since 1985. Maximum subsidence remains at about twenty-seven (27) feet. A detailed look from a helicopter revealed that the subsidence maximum is located on a steep slope, about 200 feet south of the southernmost mining, where a good-sized rotational slump has occurred. The workings here are also surrounded by burned coal. It is probable that the combination of steep slopes and crushing of clinker beds has allowed subsidence to occur well outside the area of mine workings. An inspection of the area from the ground indicates that many of the open fractures forming the graben-like structure have begun to heal and fill in with soil.

Calculation of the angle-of-draw is complicated because the workings are nearly surrounded by faults, burned coal, and other mine workings. Due to this complexity, angle-of-draw was not determined for Area 1.

There are no springs, and no hydrologic impacts due to mining have been observed at this location.



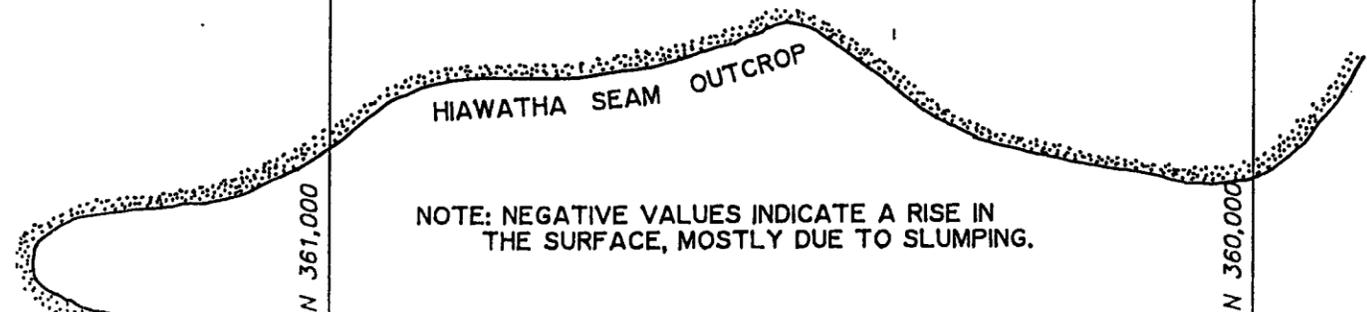
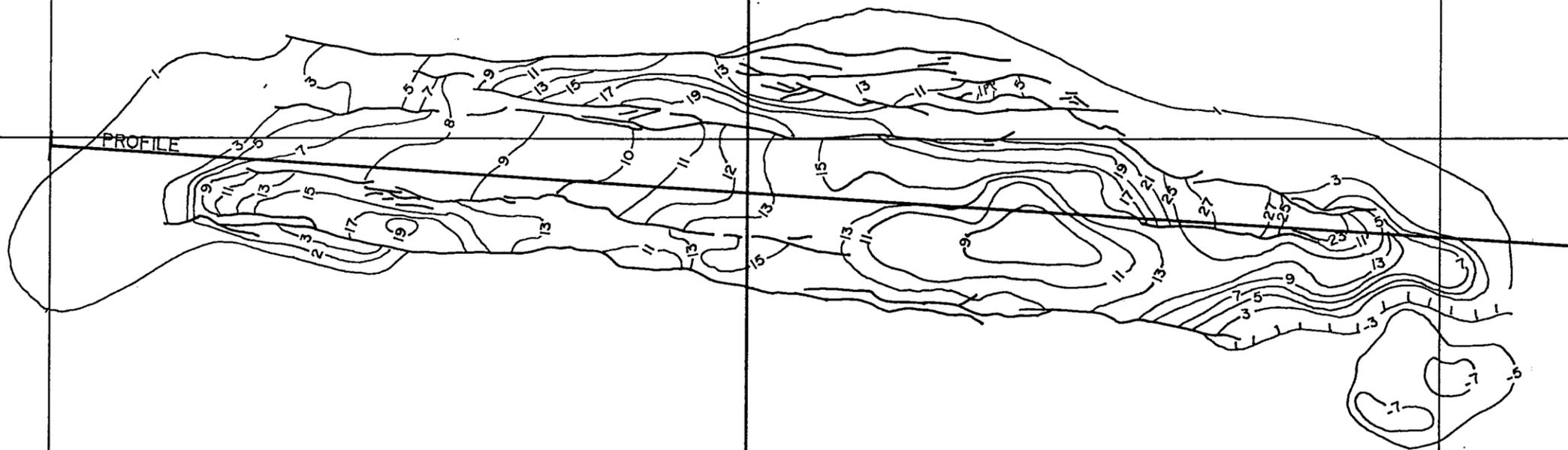


DATA:
 JOY 8' DIA. EXHAUST FAN
 4160 VOLTS 40 AMPS 3 PHASE
 FULL CAPACITY 119 AMPS
 1175 R.P.M. 1000 H.P.
 BLADE SETTING 22°
 RELIANCE 1000H.P. MOTOR
 500 H.P. DIESEL BACKUP
 C.F.M. AT 3"
 WATER GAUGE

MINE WORKINGS UPDATED TO: MARCH 1, 1987



WILBERG COAL MINE EMERY COUNTY, UTAH	
1st RIGHT MINE WORKINGS	
UTAH POWER & LIGHT COMPANY DEPARTMENT OF MINING & EXPLORATION	
DATE: 3/13/87	BY: LJ Hansen
SCALE: 1" = 200'	FIGURE 4



NOTE: NEGATIVE VALUES INDICATE A RISE IN THE SURFACE, MOSTLY DUE TO SLUMPING.

CAD FILE NAME/DISK#: DCCDNL/KL5

UTAH POWER & LIGHT
 MINING DIVISION
P.O. BOX 310, HARRISBURG, UTAH 84408

DEER CREEK/WILBERG COAL MINES
 1989 SUBSIDENCE
 DEER CREEK 9th EAST
 WILBERG 1st RIGHT

DRAWN BY: J. GARRETT	FIGURE 5	
SCALE: 1" = 200'	DRAWING #:	
DATE: 4-24-90	SHEET 1 OF 1	REV. —

N 362,000

N 361,000

N 360,000

E 2,110,000

E 2,109,000

AREA 1 SUBSIDENCE PROFILE

South - North

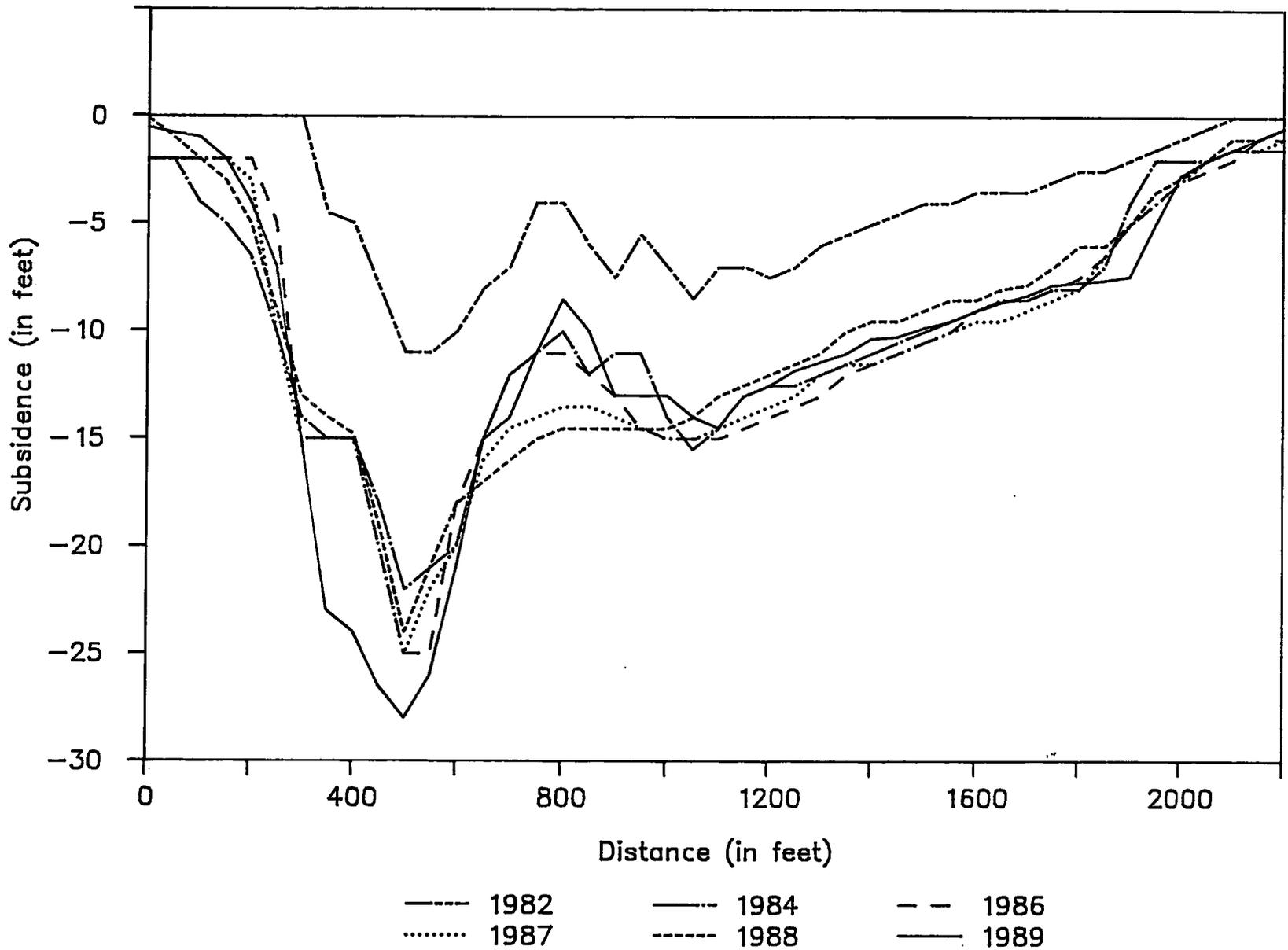
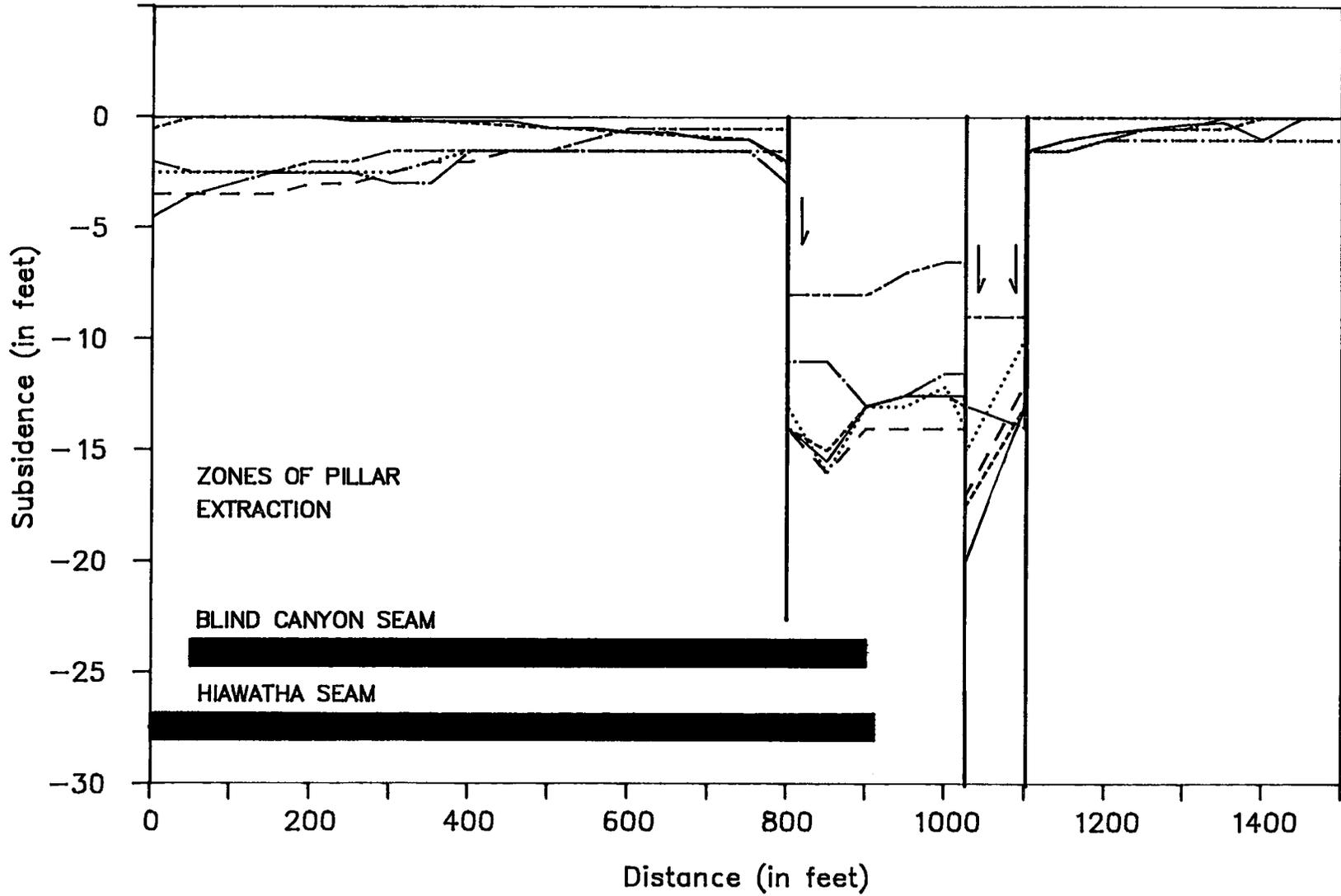


FIGURE 6

AREA 1 SUBSIDENCE PROFILE

West - East



----- 1982	----- 1984	--- 1986
..... 1987	----- 1988	----- 1989

FIGURE 7

Area 2

Deer Creek 5th, 6th, 7th, and 8th East Longwall Panels

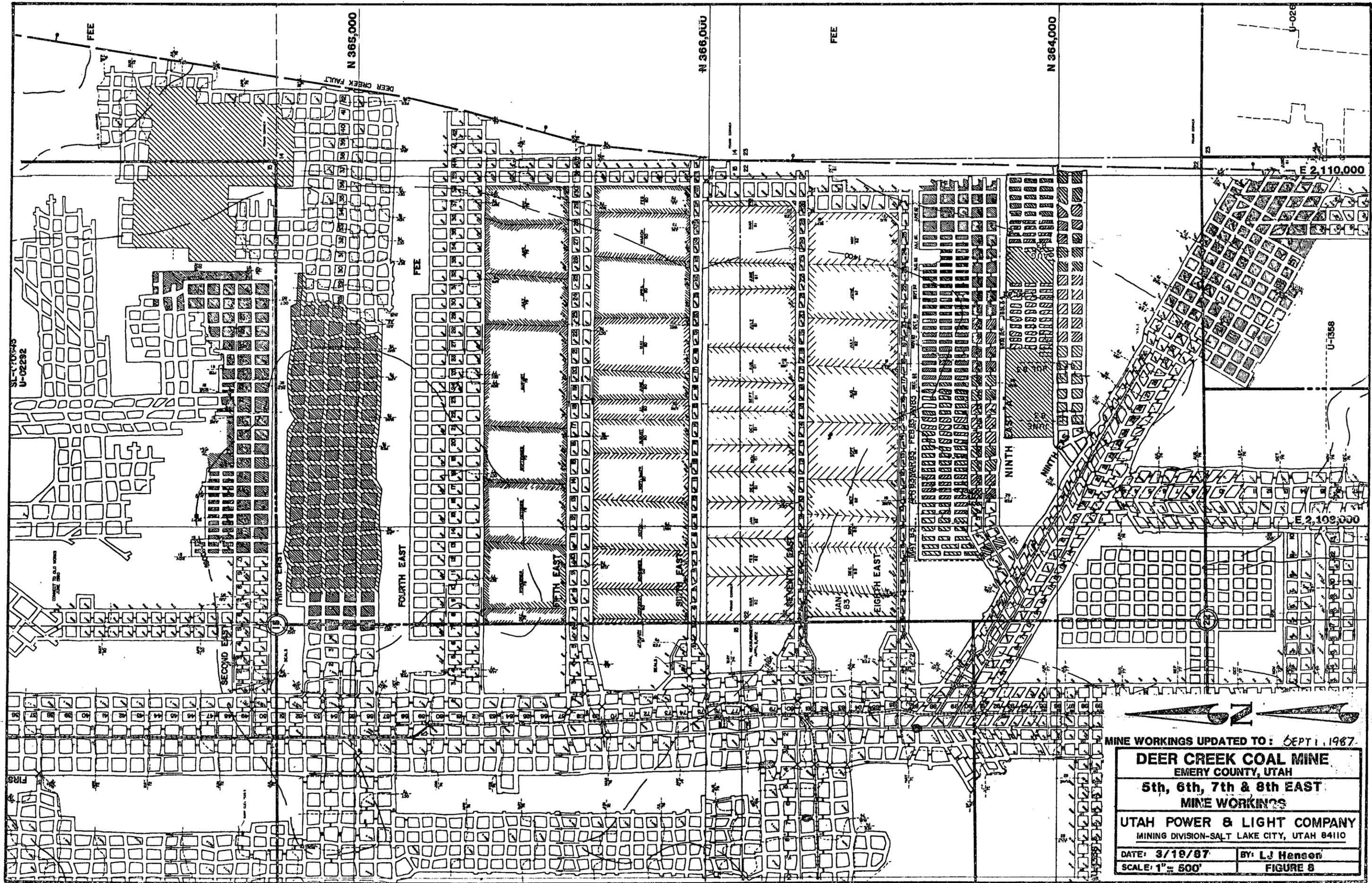
Wilberg 3rd through 13th Right Panels

Mining in the Deer Creek Mine in Area 2 was completed by February 1985. Coal extraction in the underlying Wilberg Mine 3rd and 4th Right panels was completed between September 1987 and the end of January 1988 (Figures 8 and 9).

Maximum subsidence in Area 2 remains at just under twelve (12) feet and occurs over the Deer Creek 6th East and the Wilberg 6th and 7th Right longwall panels (Figure 10). The subsidence profiles (Figures 11 and 12) indicate that ground movement over much of the area has stabilized, but the subsidence trough continues to elongate over the most recently mined panels. Neither UP&L nor other contracted personnel have detected any surface fissures or other visible disturbance in the area.

Angle-of-draw has been calculated where possible. On the eastern side of Area 2 the angle is influenced by the Deer Creek Fault and the adjacent Little Dove Mine workings across the fault; thus, no angle was calculated. On other sides it ranges from less than zero to 11 degrees.

No springs have been identified over the subsidence area but two springs, one-fourth to one-third mile to the west, show no effects from mining (see Hydrologic Monitoring Report, 1989).

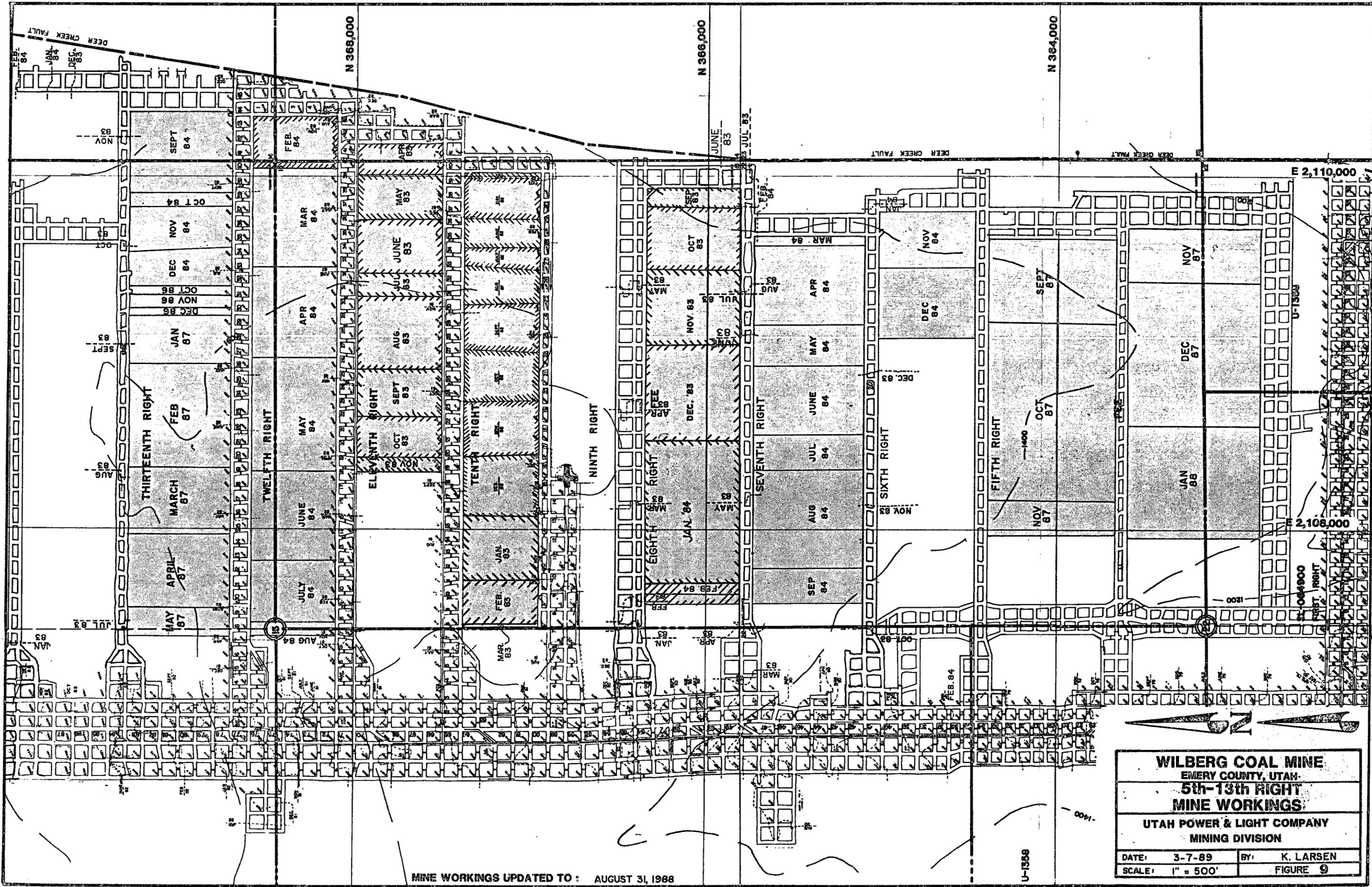


MINE WORKINGS UPDATED TO: SEPT. 1987.

DEER CREEK COAL MINE
 EMERY COUNTY, UTAH
 5th, 6th, 7th & 8th EAST
 MINE WORKINGS

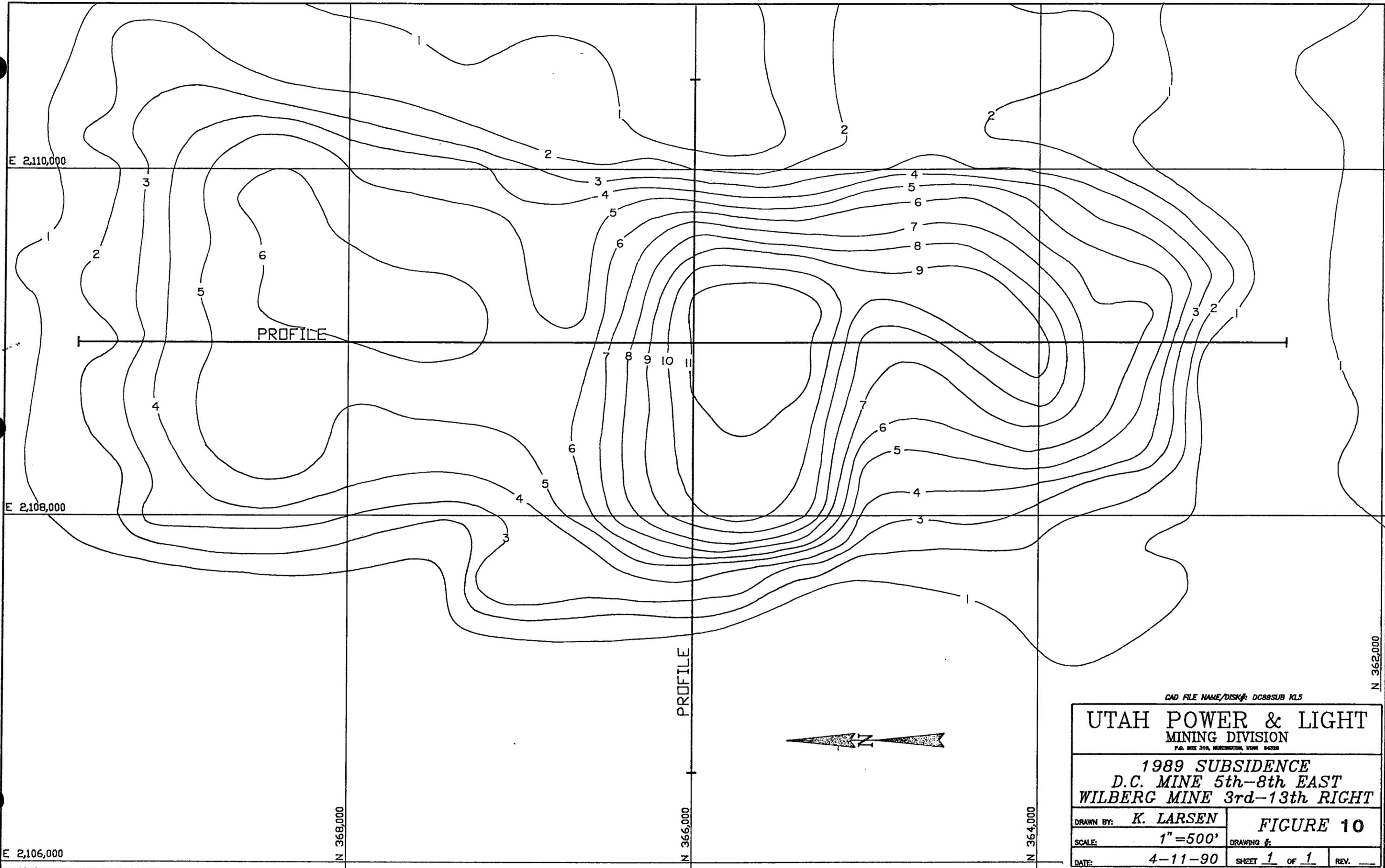
UTAH POWER & LIGHT COMPANY
 MINING DIVISION-SALT LAKE CITY, UTAH 84110

DATE: 3/19/87 BY: L.J. Hansen
 SCALE: 1" = 500' FIGURE 8



MINE WORKINGS UPDATED TO : AUGUST 31, 1988

WILBERG COAL MINE
 EMERY COUNTY, UTAH
 5th-13th RIGHT
 MINE WORKINGS
 UTAH POWER & LIGHT COMPANY
 MINING DIVISION
 DATE: 3-7-89 BY: K. LARSEN
 SCALE: 1" = 500' FIGURE 9



E 2,110,000

E 2,108,000

E 2,106,000

N 368,000

N 366,000

N 364,000

N 362,000

CAD FILE NAME/DISK#: DC88SUB KLS

UTAH POWER & LIGHT
 MINING DIVISION
P.O. BOX 310, MURKIN, UTAH 84328

1989 SUBSIDENCE
D.C. MINE 5th-8th EAST
WILBERG MINE 3rd-13th RIGHT

DRAWN BY: K. LARSEN	FIGURE 10
SCALE: 1"=500'	
DATE: 4-11-90	DRAWING #: SHEET 1 of 1 REV. ---

AREA 2 SUBSIDENCE PROFILE

Deer Creek 5-8 East and Wilberg 3-13 Right
North - South

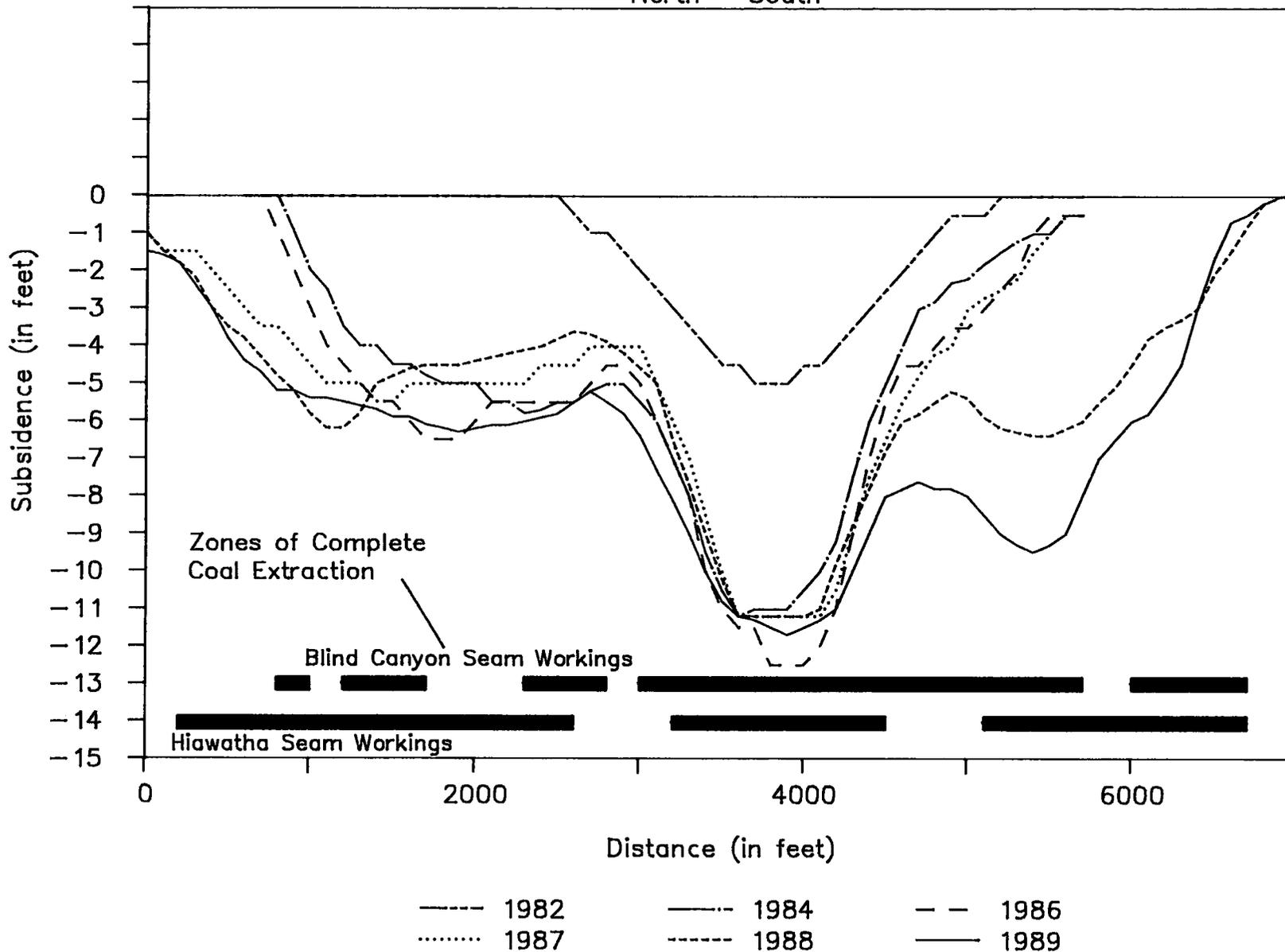


FIGURE 11

AREA 2 SUBSIDENCE PROFILE
 Deer Creek 5-8 East and Wilberg 3-13 Right
 West - East

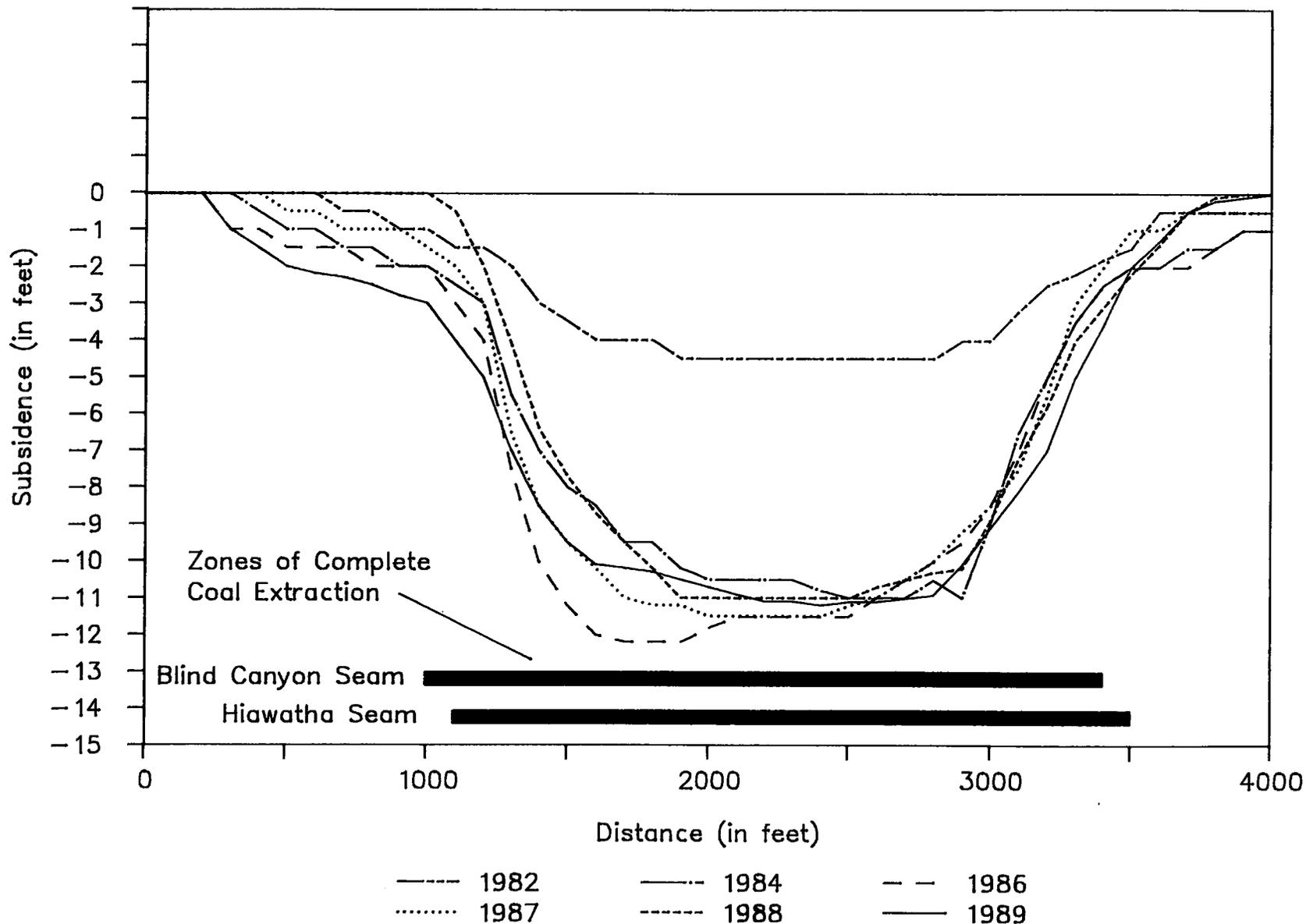


FIGURE 12

Area 3

Deer Creek 1st North Area

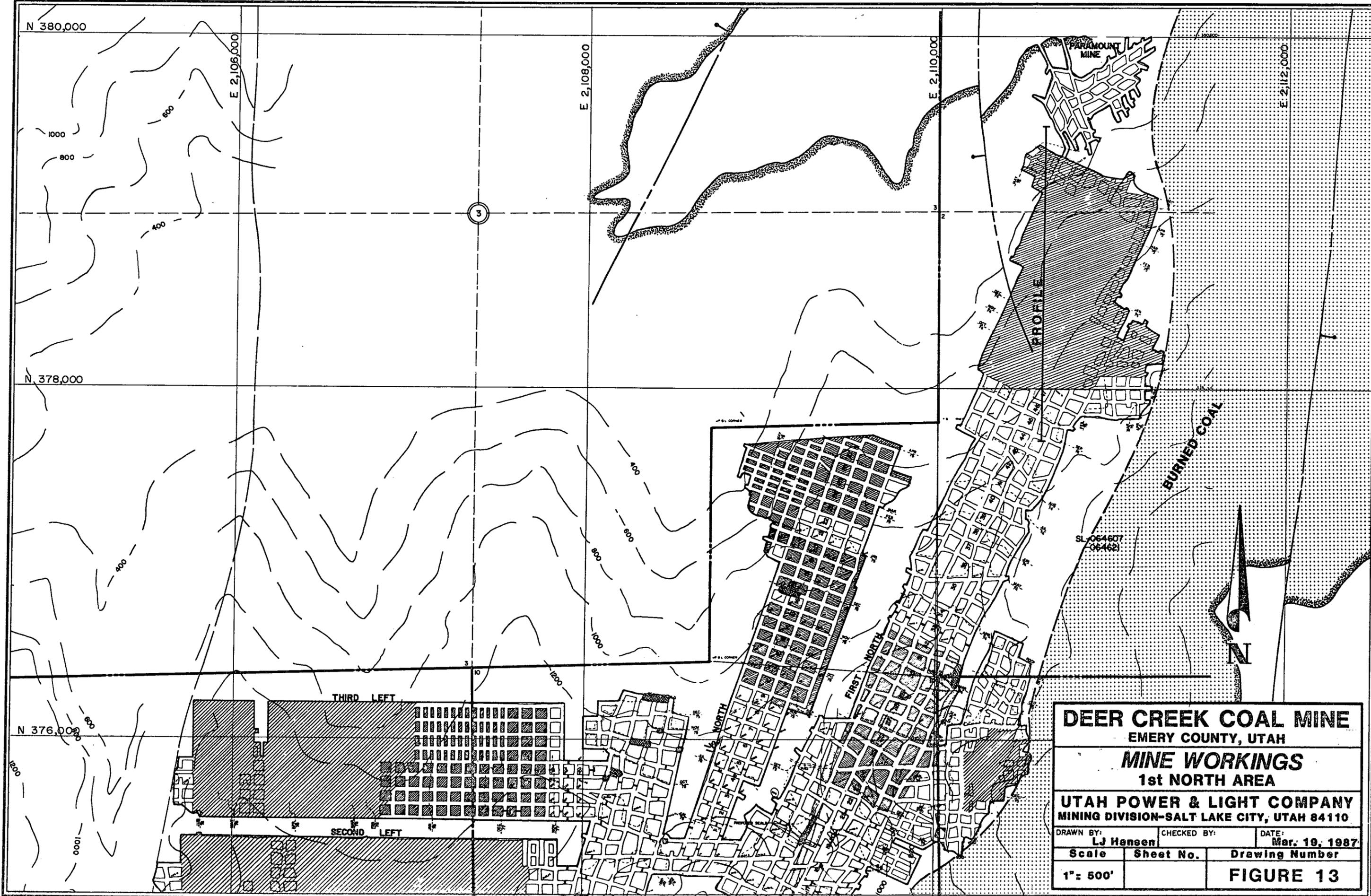
Most of the 1st North section of the Deer Creek Mine was abandoned and sealed in 1978 after being mined out. The southern portion is still open and may be used for access to a block of coal which lies to the west. Pillar extraction in the 3rd Left and 1-1/2 North sections was completed early in 1980 (Figure 13). Elevation changes of greater than five feet have been measured, but in many cases the change may be due to localized cliff failure or toppling of boulders on steep slopes.

The subsidence above 1st North occurs on a narrow ridge capped by a highly fractured sandstone, and a review of the subsidence data indicates that, due to the mode of subsidence, elevation change cannot be depicted accurately with a contour map. Figure 14 is a profile of total subsidence as it occurred along a line of points above the workings.

Helicopter surveys in 1989 did not reveal any new surface cracks or new areas of cliff failure.

No angle-of-draw was determined due to the steep slopes, burned coal, and mode of subsidence.

The strata surrounding and above the 1st North workings are generally dry; therefore, mining has not adversely affected the groundwater.

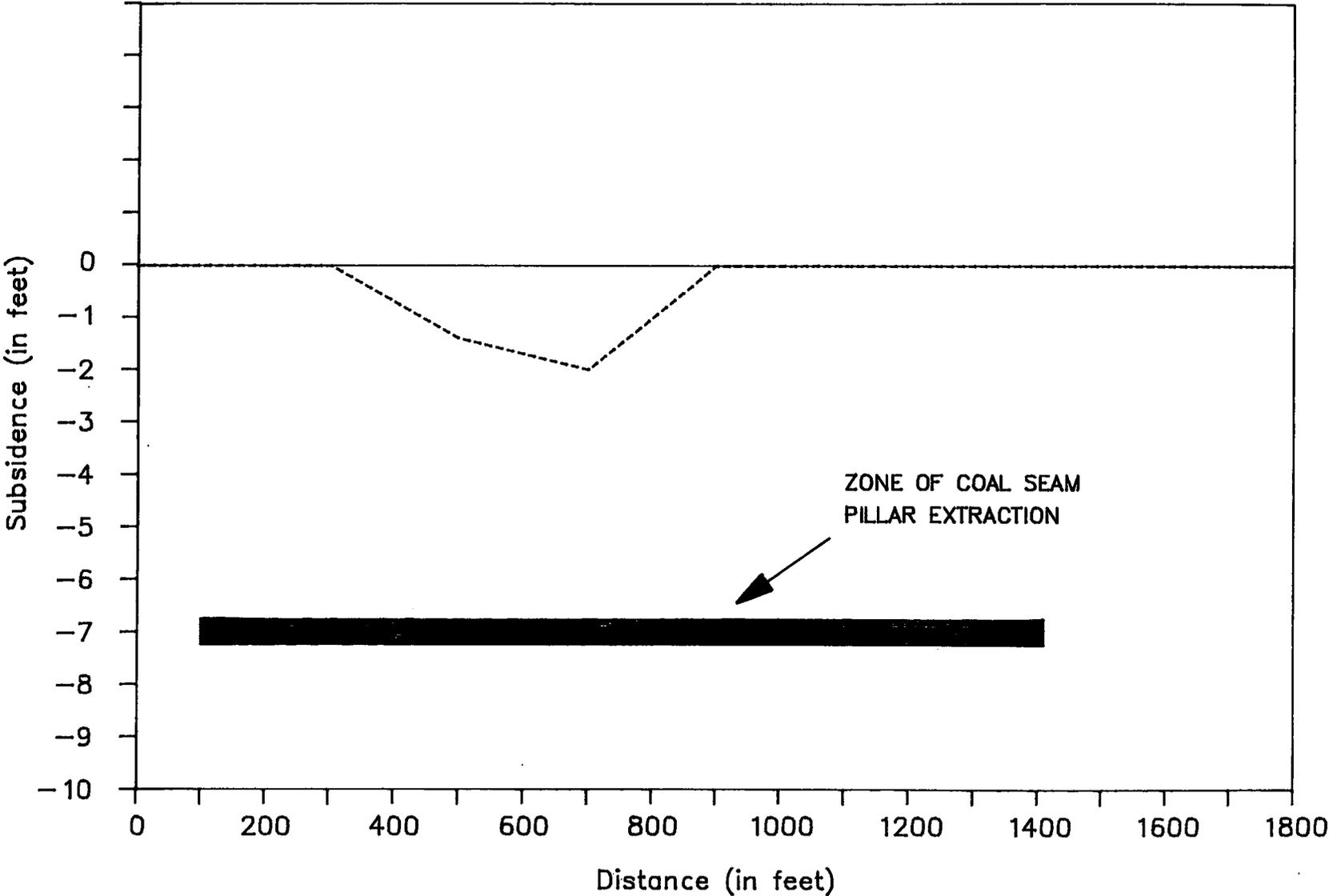


DEER CREEK COAL MINE
 EMERY COUNTY, UTAH
MINE WORKINGS
 1st NORTH AREA
 UTAH POWER & LIGHT COMPANY
 MINING DIVISION-SALT LAKE CITY, UTAH 84110

DRAWN BY: LJ Hansen	CHECKED BY:	DATE: Mar. 19, 1987
Scale 1" = 500'	Sheet No.	Drawing Number FIGURE 13

AREA 3 SUBSIDENCE PROFILE

North - South



----- 1989

FIGURE 14

Area 4

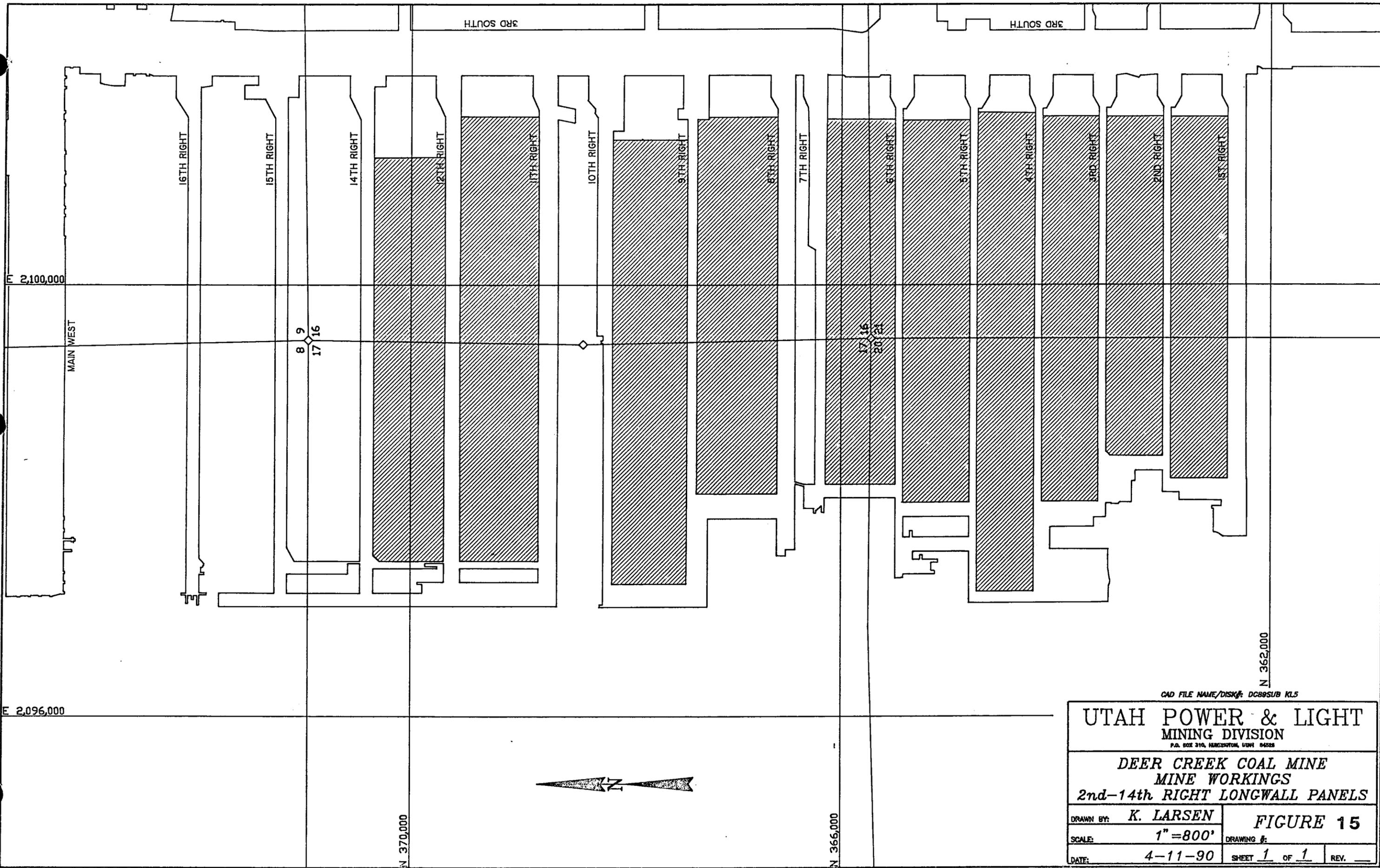
Deer Creek 2nd through 14th Right Longwall Panels

Subsidence in Area 4 was detected for the first time in 1984 by photogrammetric methods. Longwall mining commenced in the 2nd Right longwall panel in 1980 and by the end of August 1989 the 2nd through 7th Right panels; the 9th, 10th, 12th Right panels; and 3700 feet of the 14th Right panel had been completed (Figure 15).

Maximum subsidence is just under six (6) feet over the 3rd, 4th, and 5th Right longwall panels (Figure 16). The subsidence trough continues to extend northward over the most recently mined longwall panels (see Subsidence Profiles, Figures 17 and 18). The calculated angle-of-draw of the subsidence ranges from less than zero to 11 degrees.

Several springs are located on East Mountain above these longwall panels and the 2nd through 5th Left panels located directly to the east (see Area 5). Fluctuations in spring flow occur from year to year but seem to be related to variations in precipitation rather than mining. Flows are generally low in dry years and higher in wetter years (see Hydrologic Monitoring Report, 1989 and the Appendices to this report).

The left fork of the Grimes Wash drainage crosses the middle of the subsidence area. Stream monitoring has revealed no changes attributable to mining.



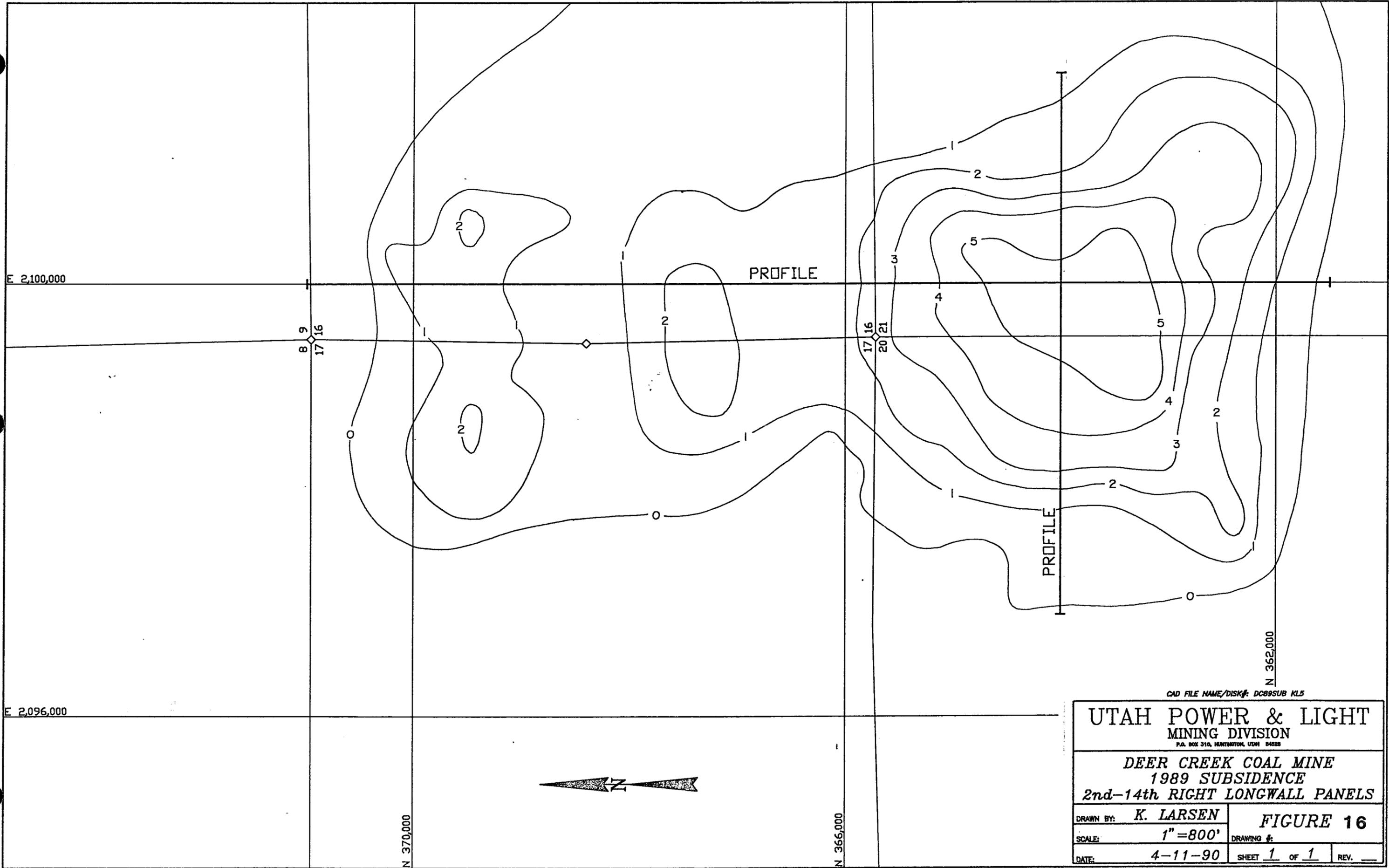
CAD FILE NAME/DISK#: DC88SUB KL5

UTAH POWER & LIGHT
 MINING DIVISION
P.O. BOX 310, HERRINGTON, UTAH 84528

DEER CREEK COAL MINE
MINE WORKINGS
2nd-14th RIGHT LONGWALL PANELS

DRAWN BY: **K. LARSEN**
 SCALE: **1"=800'**
 DATE: **4-11-90**

FIGURE 15
 DRAWING #:
 SHEET **1** OF **1** REV. **—**



CAD FILE NAME/DISK#: DC89SUB KL5

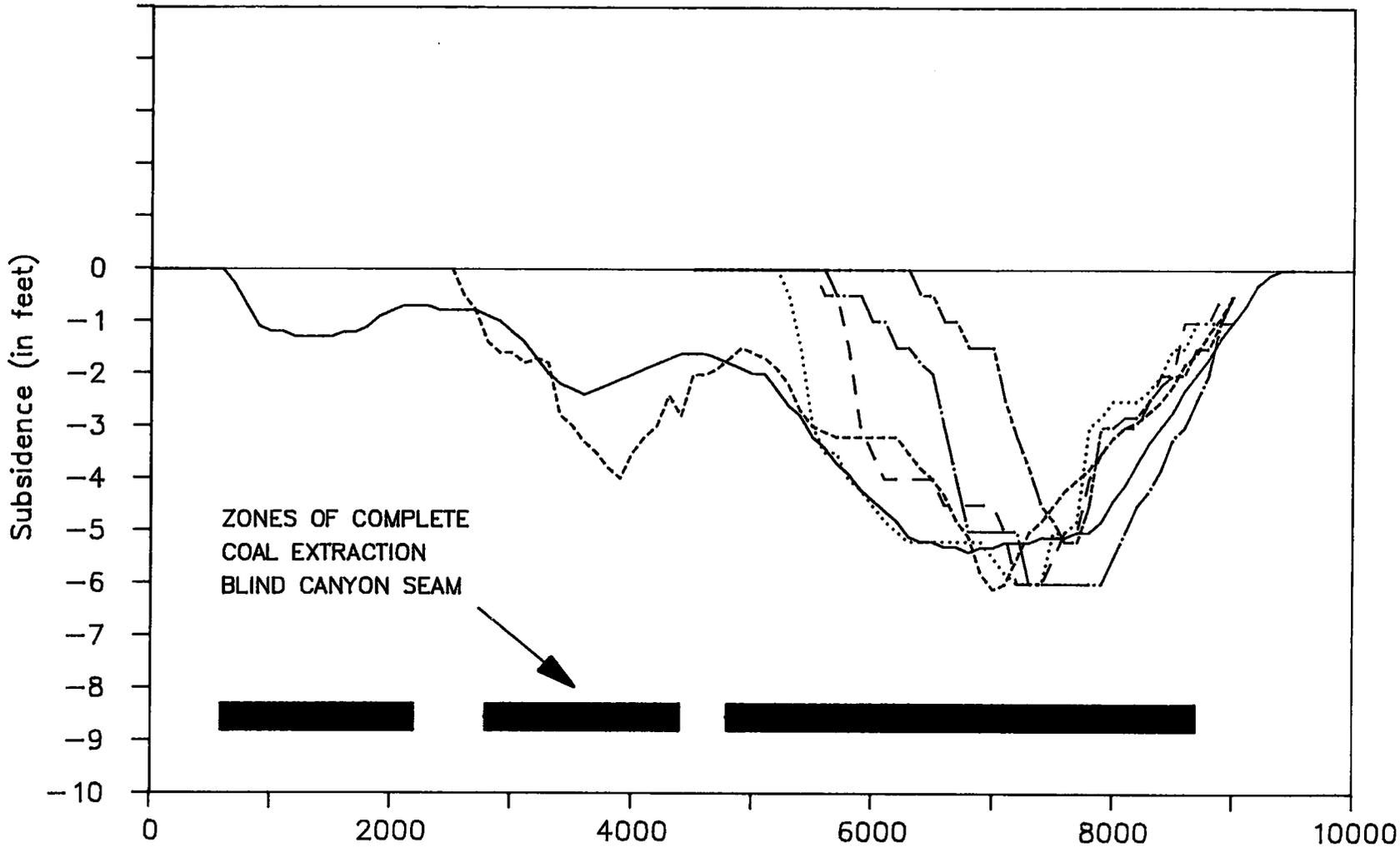
UTAH POWER & LIGHT
 MINING DIVISION
P.O. BOX 310, HARRINGTON, UTAH 84028

DEER CREEK COAL MINE
1989 SUBSIDENCE
2nd-14th RIGHT LONGWALL PANELS

DRAWN BY: K. LARSEN	FIGURE 16
SCALE: 1"=800'	DRAWING #:
DATE: 4-11-90	SHEET 1 OF 1 REV. ___

AREA 4 SUBSIDENCE PROFILE

North - South



-----	1984	-----	1985	- - -	1986
.....	1987	-----	1988	-----	1989

FIGURE 17

AREA 4 SUBSIDENCE PROFILE

West - East

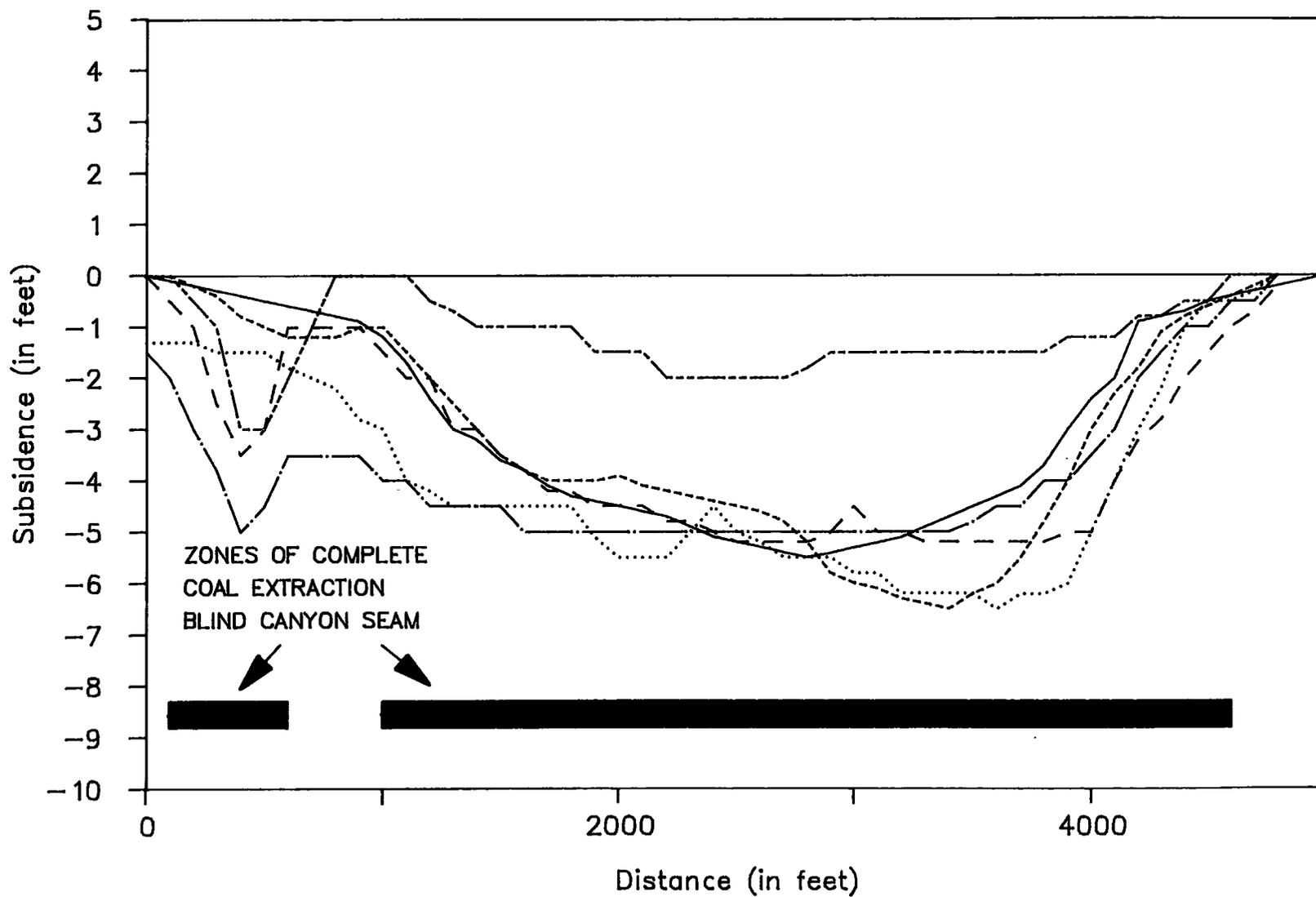


FIGURE 18

Area 5

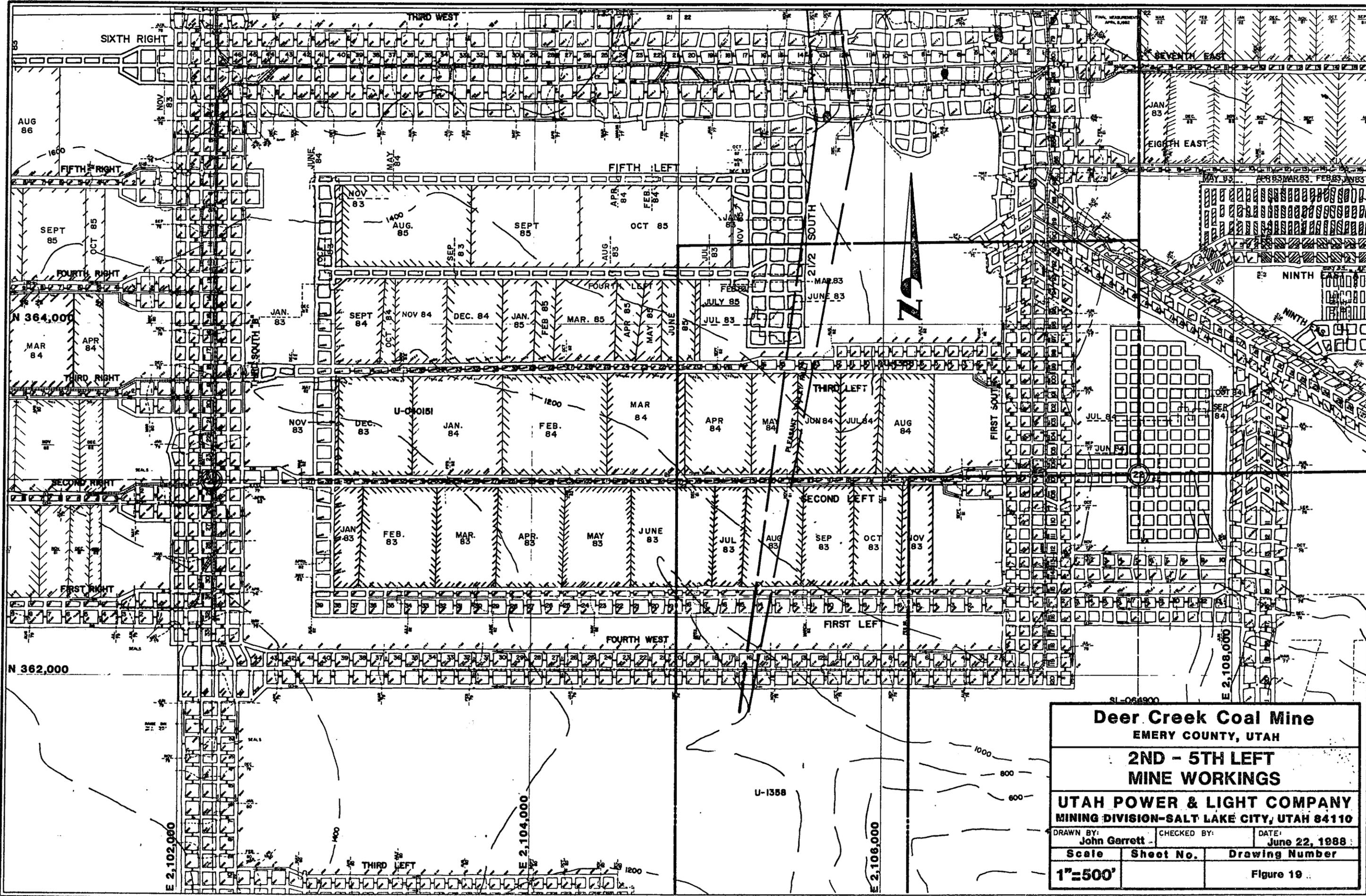
Deer Creek 2nd through 5th Left Longwall Panels

Photogrammetry revealed subsidence in Area 5 for the first time in 1984. Mining of the 2nd Left longwall panel began in January 1983, and by October 1985 all four panels had been completed (Figure 19).

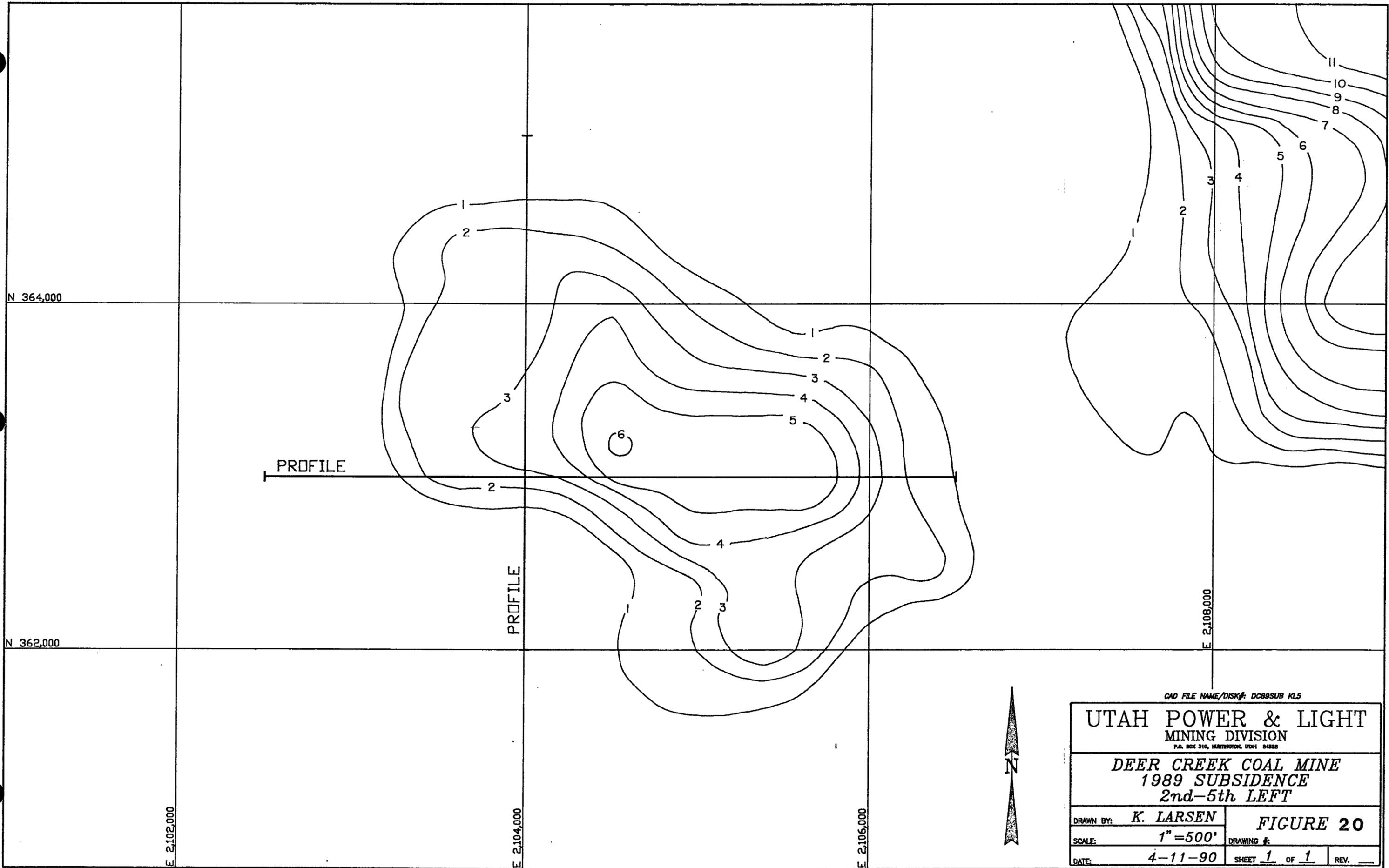
Maximum subsidence over the panels is about six (6) feet and occurs over the 3rd and 4th Left longwall panels (Figure 20). Little change has occurred in the area since 1986 (Figures 21 and 22). No surface disturbance has been identified over the panels.

As mentioned in the previous section, none of the springs located above the workings show any adverse effects due to mining.

Measured angle-of-draw is generally less than zero except in one place south of the panels along the Pleasant Valley Fault, where subsidence extended to an angle of 58 degrees.



<p>SL-068900</p> <p>Deer Creek Coal Mine EMERY COUNTY, UTAH</p> <p>2ND - 5TH LEFT MINE WORKINGS</p> <p>UTAH POWER & LIGHT COMPANY MINING DIVISION-SALT LAKE CITY, UTAH 84110</p>		
<p>DRAWN BY: John Garrett</p>	<p>CHECKED BY:</p>	<p>DATE: June 22, 1988</p>
<p>Scale 1"=500'</p>	<p>Sheet No.</p>	<p>Drawing Number Figure 19</p>



CAD FILE NAME/DISK#: DC88SUB KLS

UTAH POWER & LIGHT
 MINING DIVISION
P.O. BOX 310, HARRINGTON, UTAH 84302

DEER CREEK COAL MINE
1989 SUBSIDENCE
2nd-5th LEFT

DRAWN BY: **K. LARSEN**

FIGURE 20

SCALE: **1"=500'**

DRAWING #:

DATE: **4-11-90**

SHEET **1** OF **1** REV. **___**

AREA 5 SUBSIDENCE PROFILE

North - South

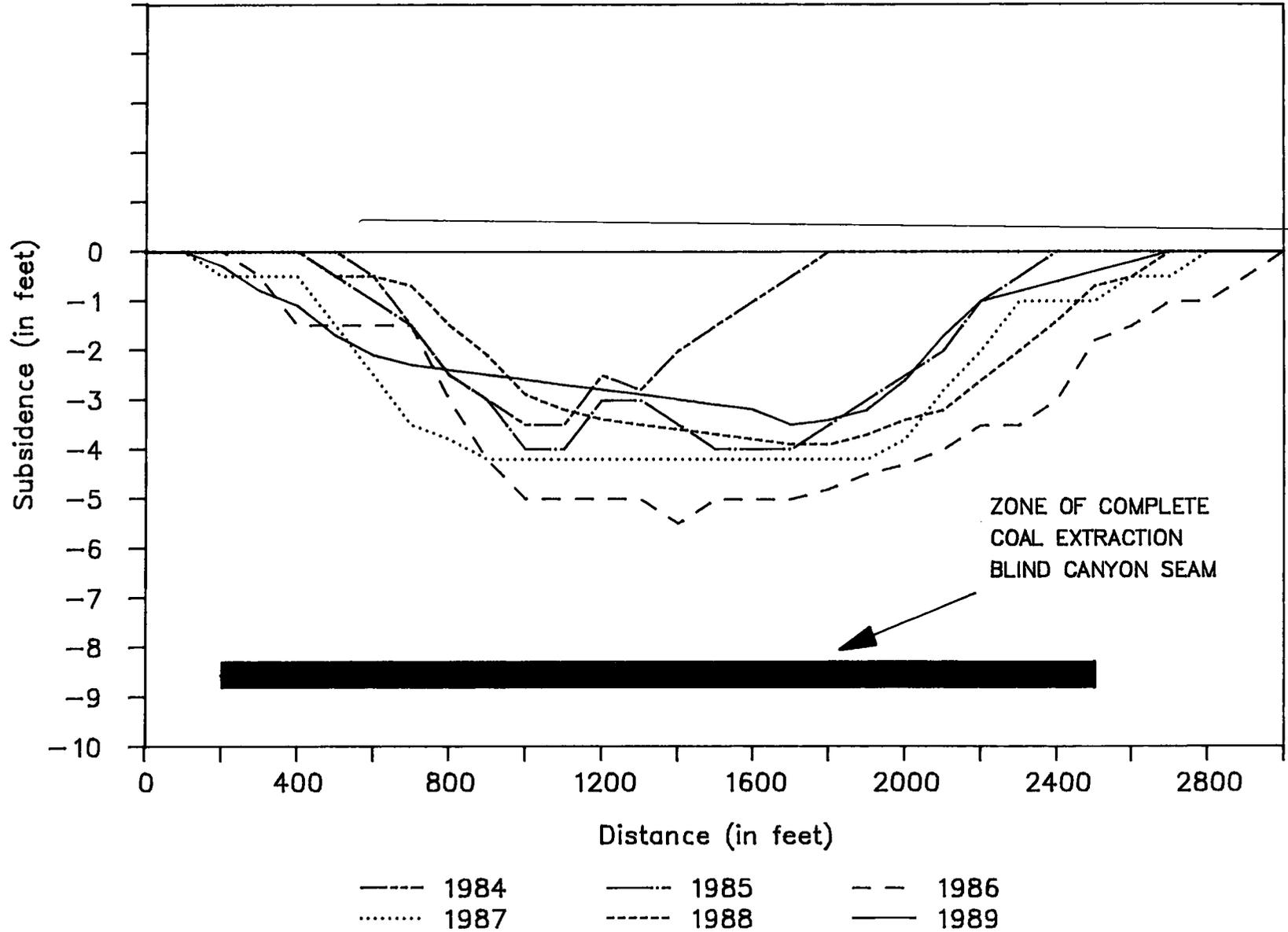


FIGURE 21

AREA 5 SUBSIDENCE PROFILE

West - East

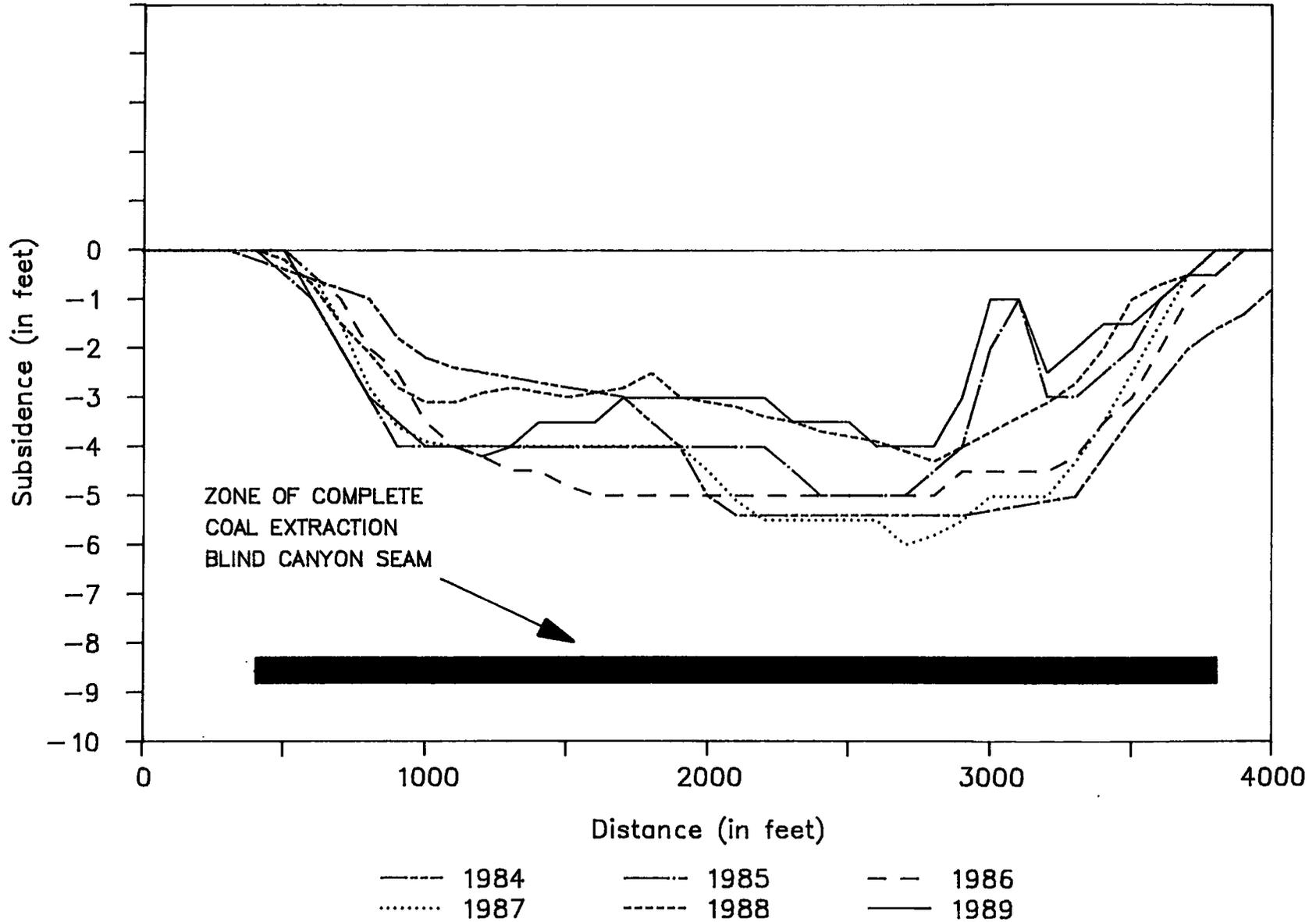


FIGURE 22

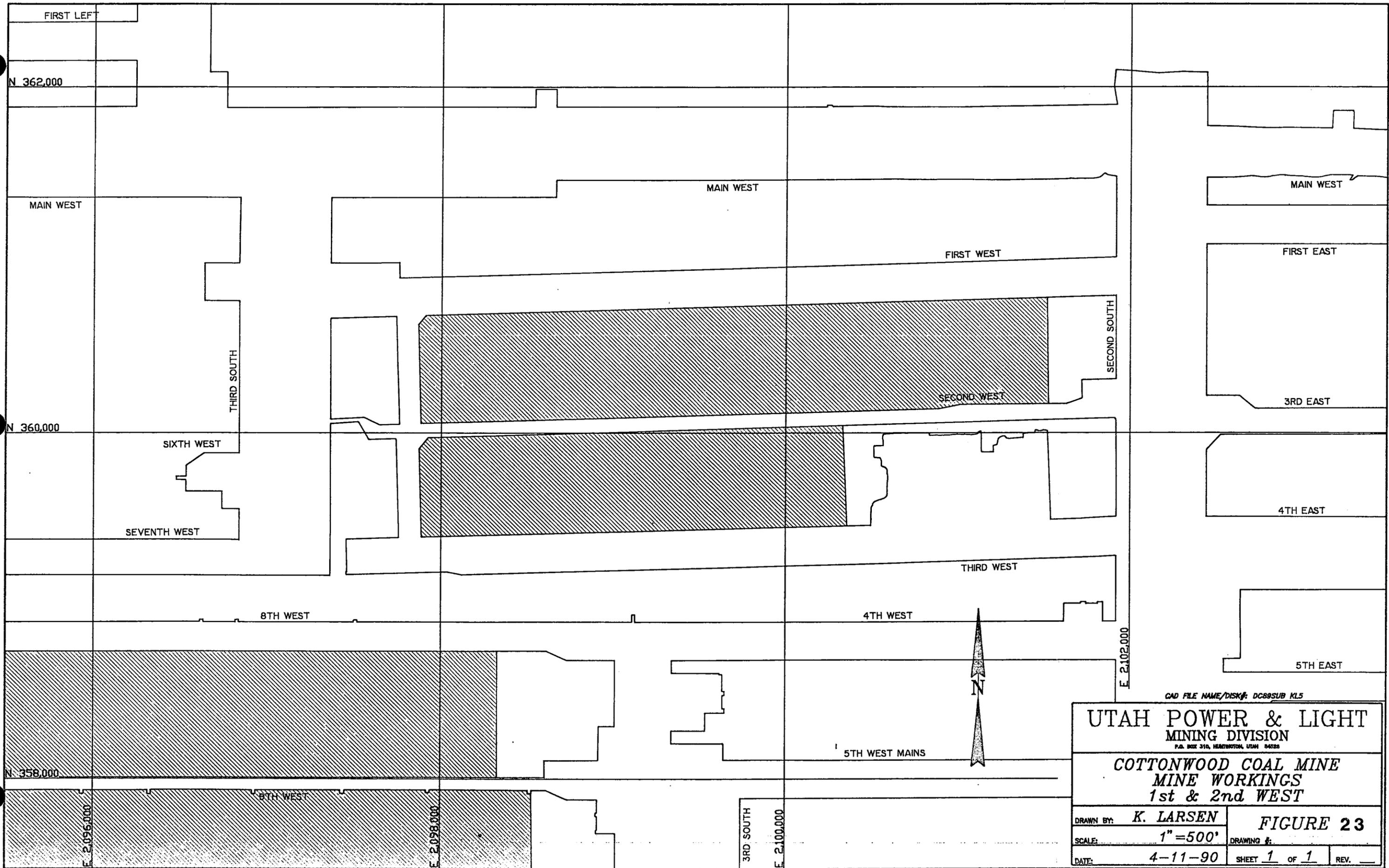
Area 6

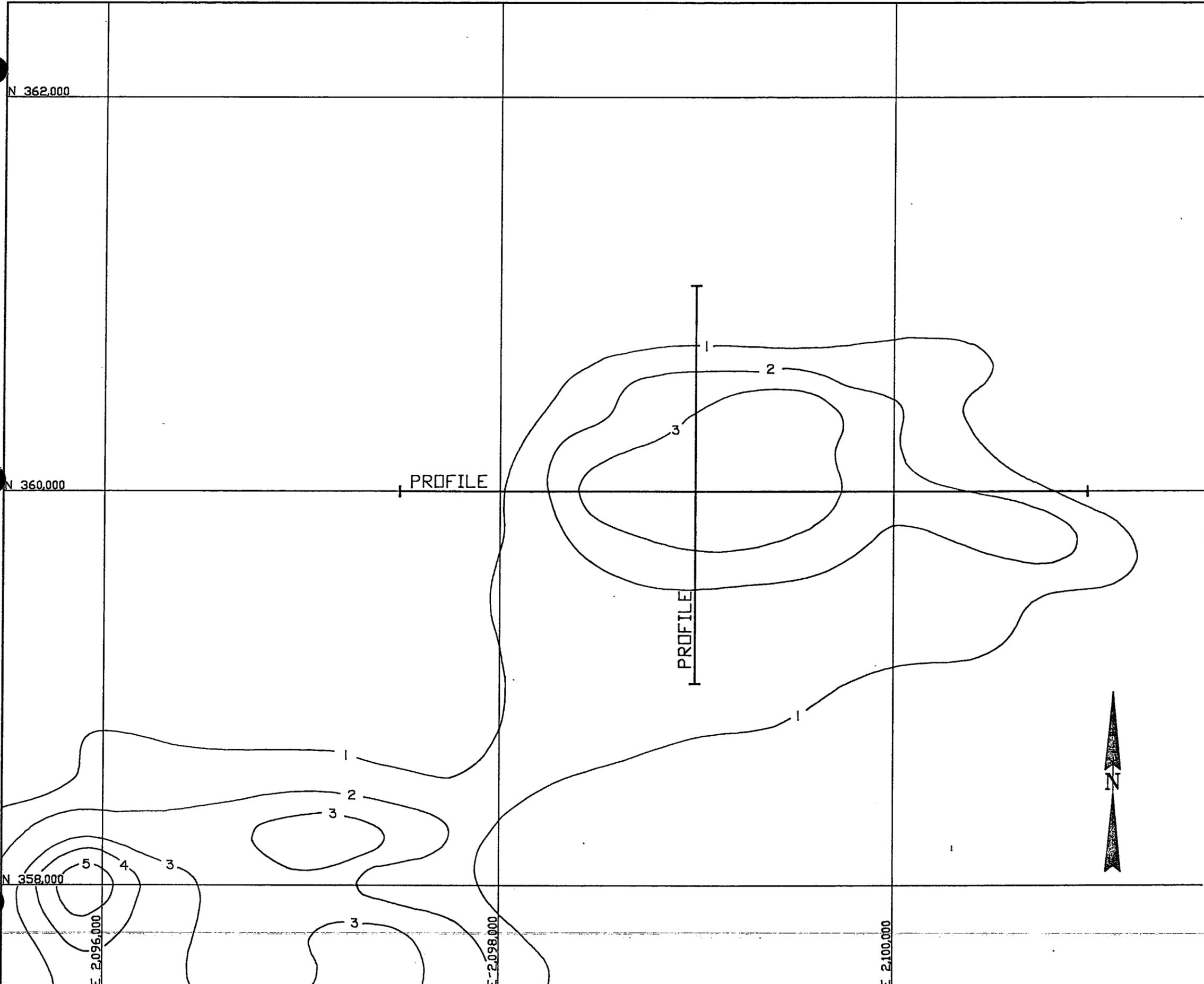
Wilberg 1st and 2nd West Longwall Panels

Mining in the Wilberg 1st and 2nd West longwall panels was completed in June 1983, and subsidence continued into the 1984 monitoring period (Figure 23). Since late 1984 no significant additional movement has been detected and the area appears to have stabilized with approximately three (3) feet of subsidence (Figure 24). The subsidence profiles (Figures 25 and 26) show some irregularity from year to year, but the variation is within the margin of error in the photogrammetric method (± 0.7 feet).

Calculated angle-of-draw ranges from less than zero to 6 degrees where not influenced by other workings. The subsidence trough formed over these workings has elongated to the southwest to merge with the trough forming over the 9th through 12th West panels in the Cottonwood Mine (see Area 15).

Four springs located just north of the area show no effect from the subsidence (see Hydrologic Monitoring Report, 1989).





CAD FILE NAME/DISK#: DC88SUB KLS

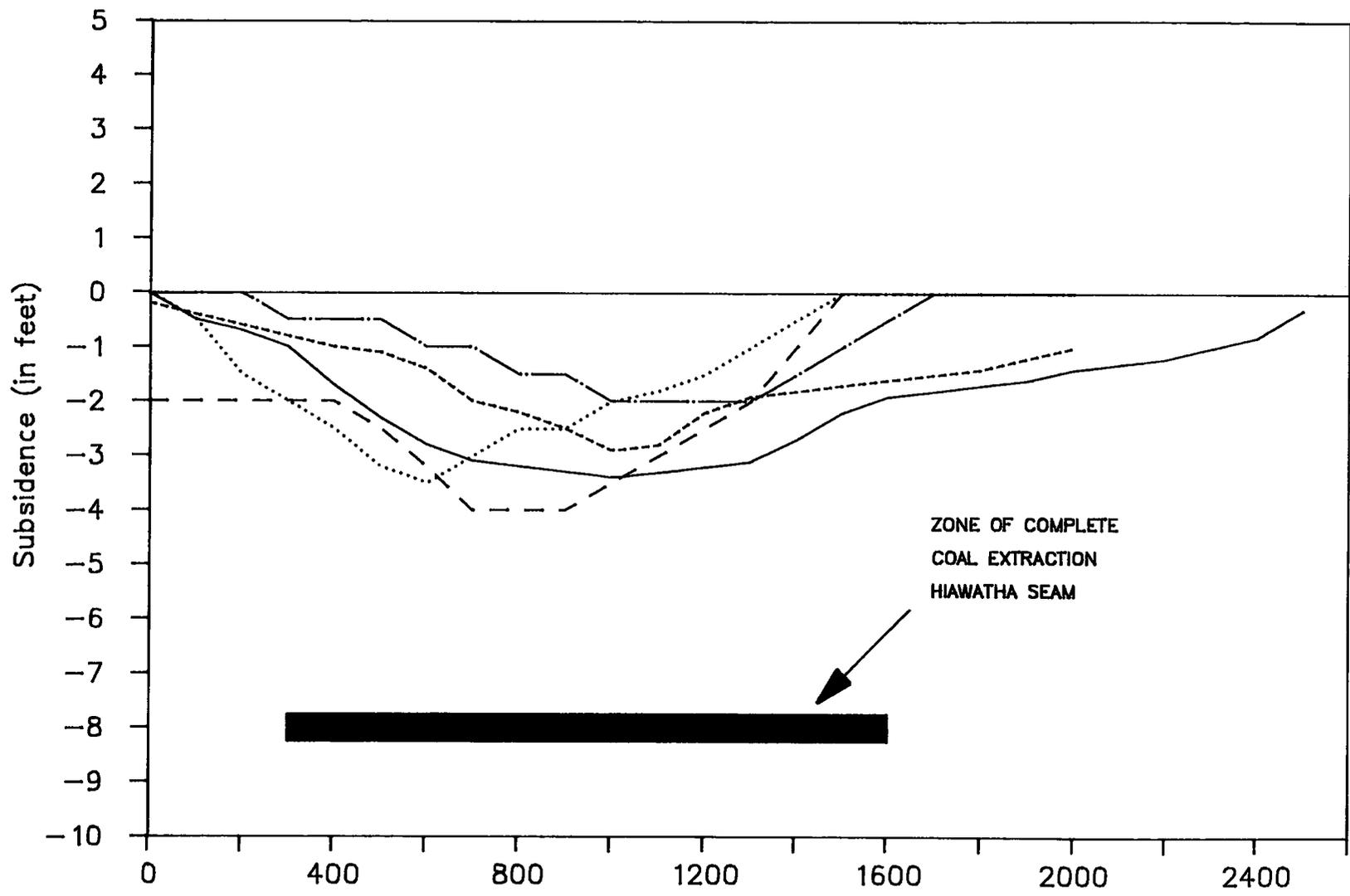
UTAH POWER & LIGHT
 MINING DIVISION
P.O. BOX 310, HARTWORTH, UTAH 84028

COTTONWOOD COAL MINE
 1989 SUBSIDENCE
 1st & 2nd WEST

DRAWN BY:	K. LARSEN	FIGURE 24	
SCALE:	1" = 500'	DRAWING #:	
DATE:	4-11-90	SHEET	1 OF 1 REV. _____

AREA 6 SUBSIDENCE PROFILE

North - South



— 1983 - - 1985 1987 - - - - 1988 — 1989

FIGURE 25

AREA 6 SUBSIDENCE PROFILE

West - East

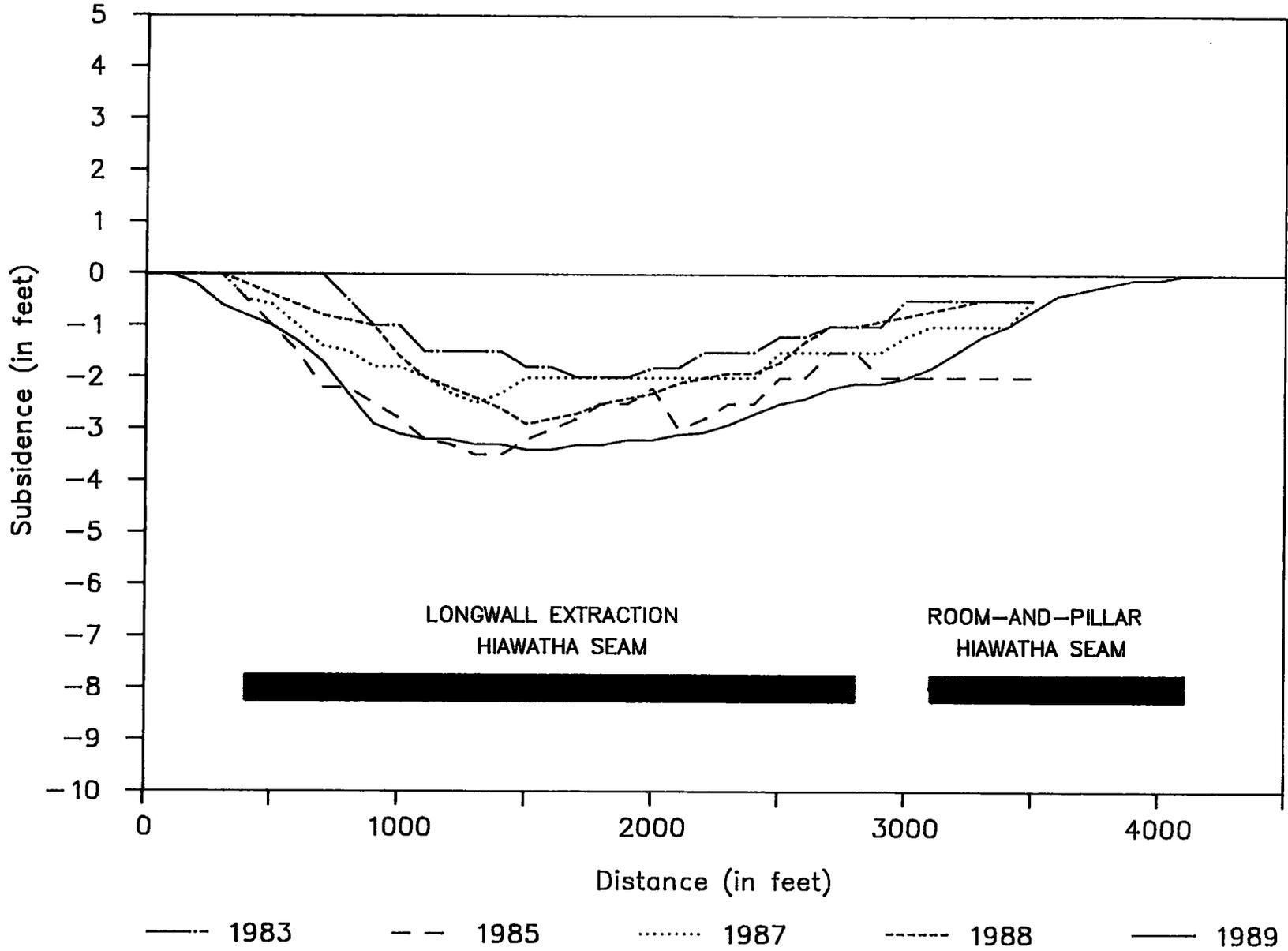


FIGURE 26

Area 7

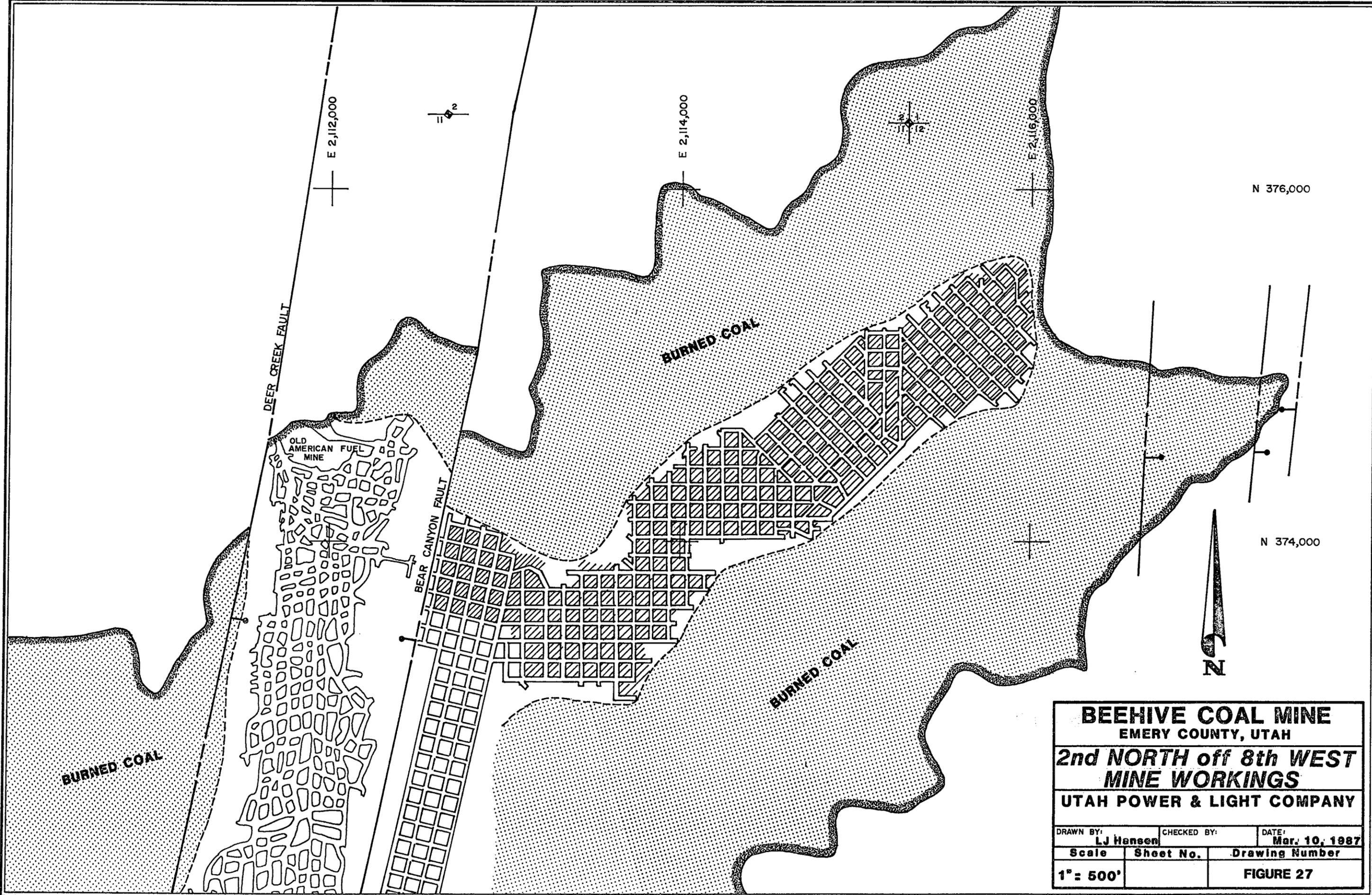
Beehive Mine 2nd North off 8th West

Pillar extraction mining in 2nd North was completed in 1983 and, as shown in Figures 27, 28, and 29, little additional subsidence has occurred over the workings since 1984. The workings are surrounded by burned coal.

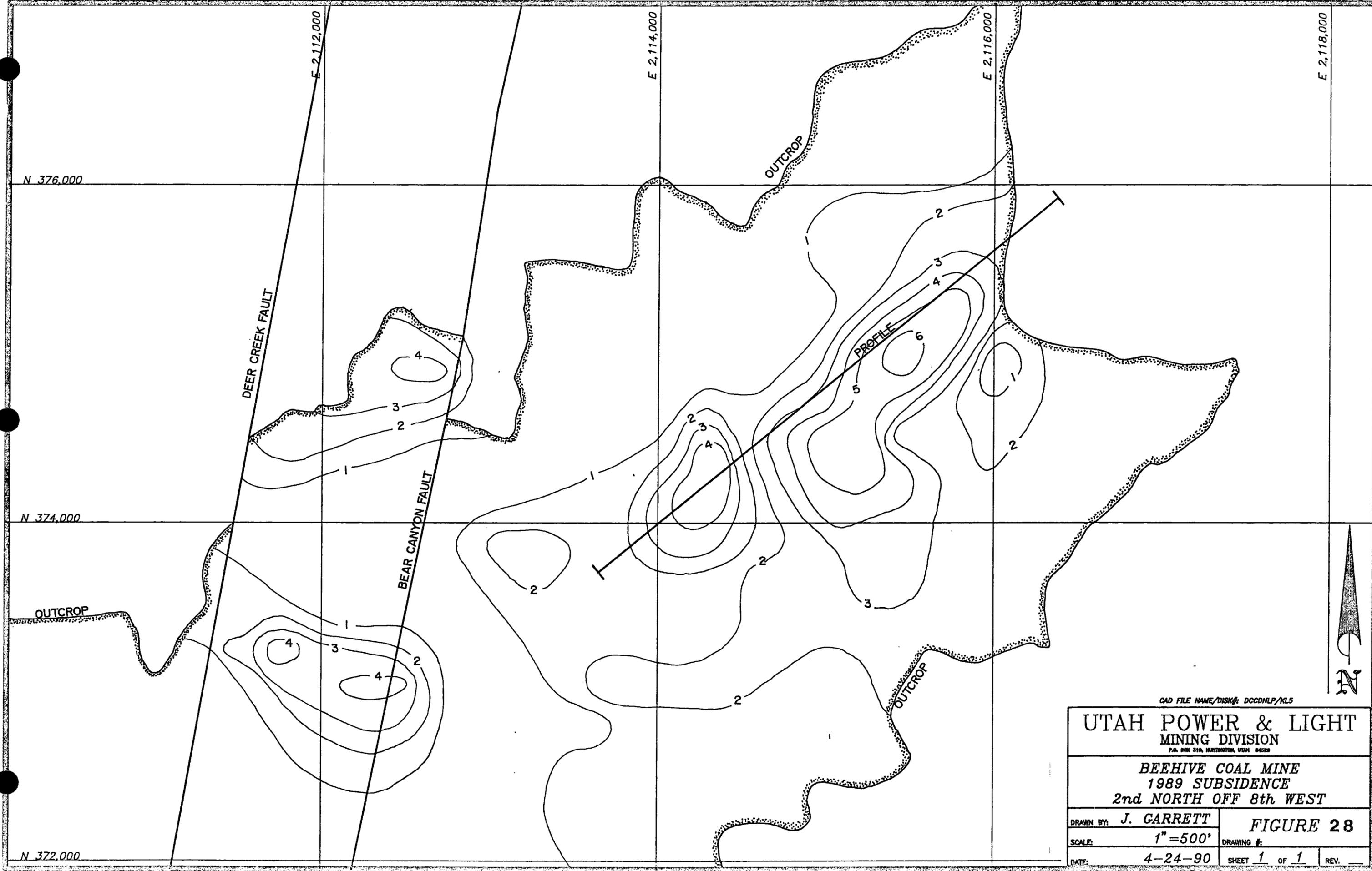
Maximum subsidence remains at about six (6) feet. In examining the area by helicopter and aerial photography it is apparent that much of the elevation change measured was due to cliff failure and mass wasting on the steep slopes above the workings, where the rocks were highly fractured prior to mining.

It was not possible to get an accurate angle-of-draw because crushing of the surrounding clinker beds allowed subsidence several thousand feet from the mine workings in some cases.

The subsidence has had no known influence on the strata in the area since they lack adequate recharge and are generally dry.



BEEHIVE COAL MINE		
EMERY COUNTY, UTAH		
2nd NORTH off 8th WEST		
MINE WORKINGS		
UTAH POWER & LIGHT COMPANY		
DRAWN BY: LJ Hansen	CHECKED BY:	DATE: Mar. 10, 1987
Scale 1" = 500'	Sheet No.	Drawing Number FIGURE 27



CAD FILE NAME/DISK#: DCCDNL/MLS

UTAH POWER & LIGHT
 MINING DIVISION
P.O. BOX 310, HARRINGTON, UTAH 84528

BEEHIVE COAL MINE
1989 SUBSIDENCE
2nd NORTH OFF 8th WEST

DRAWN BY: J. GARRETT	FIGURE 28
SCALE: 1"=500'	DRAWING #:
DATE: 4-24-90	SHEET 1 OF 1 REV. —

AREA 7 SUBSIDENCE PROFILE

Southwest - Northeast

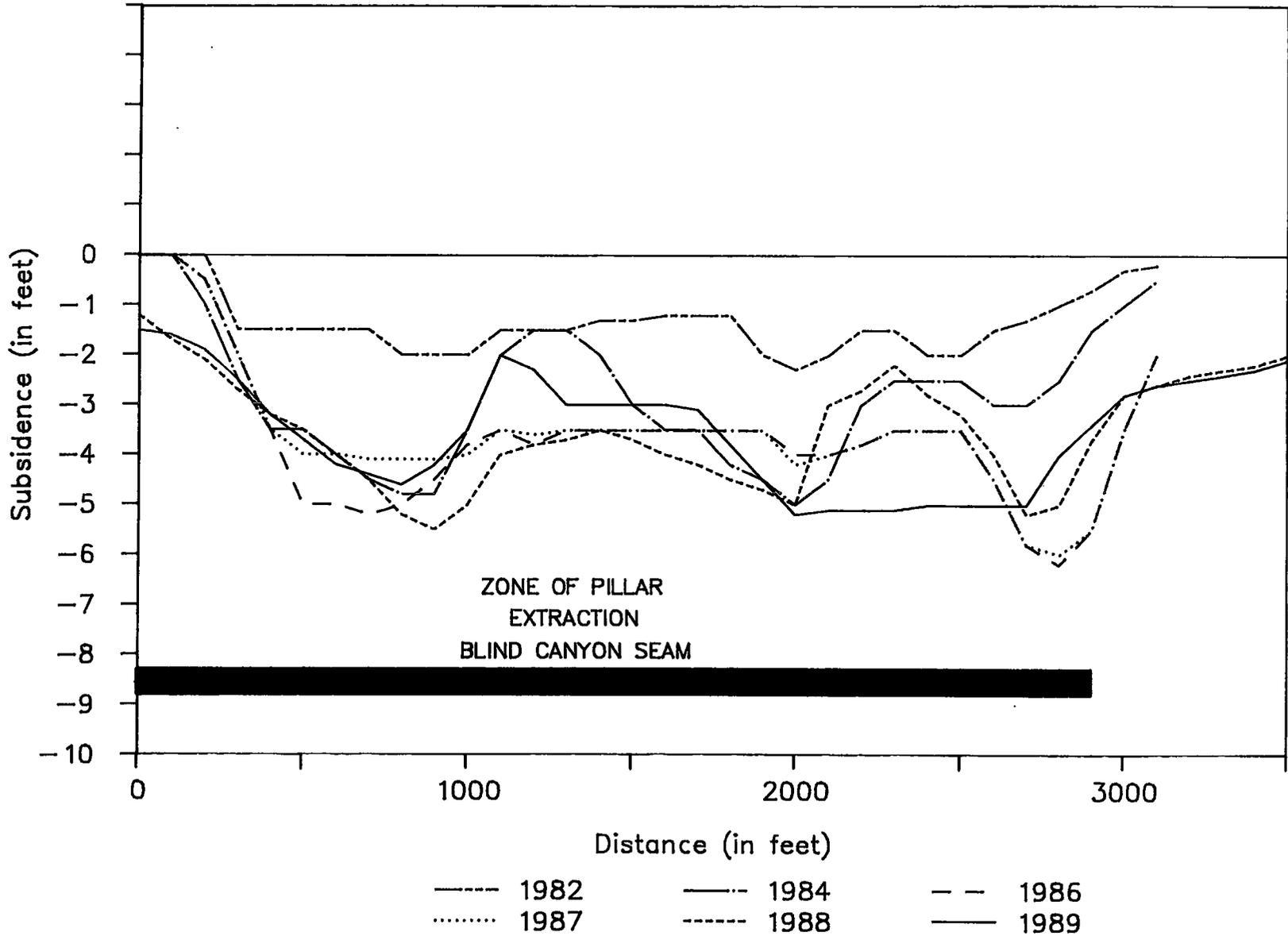


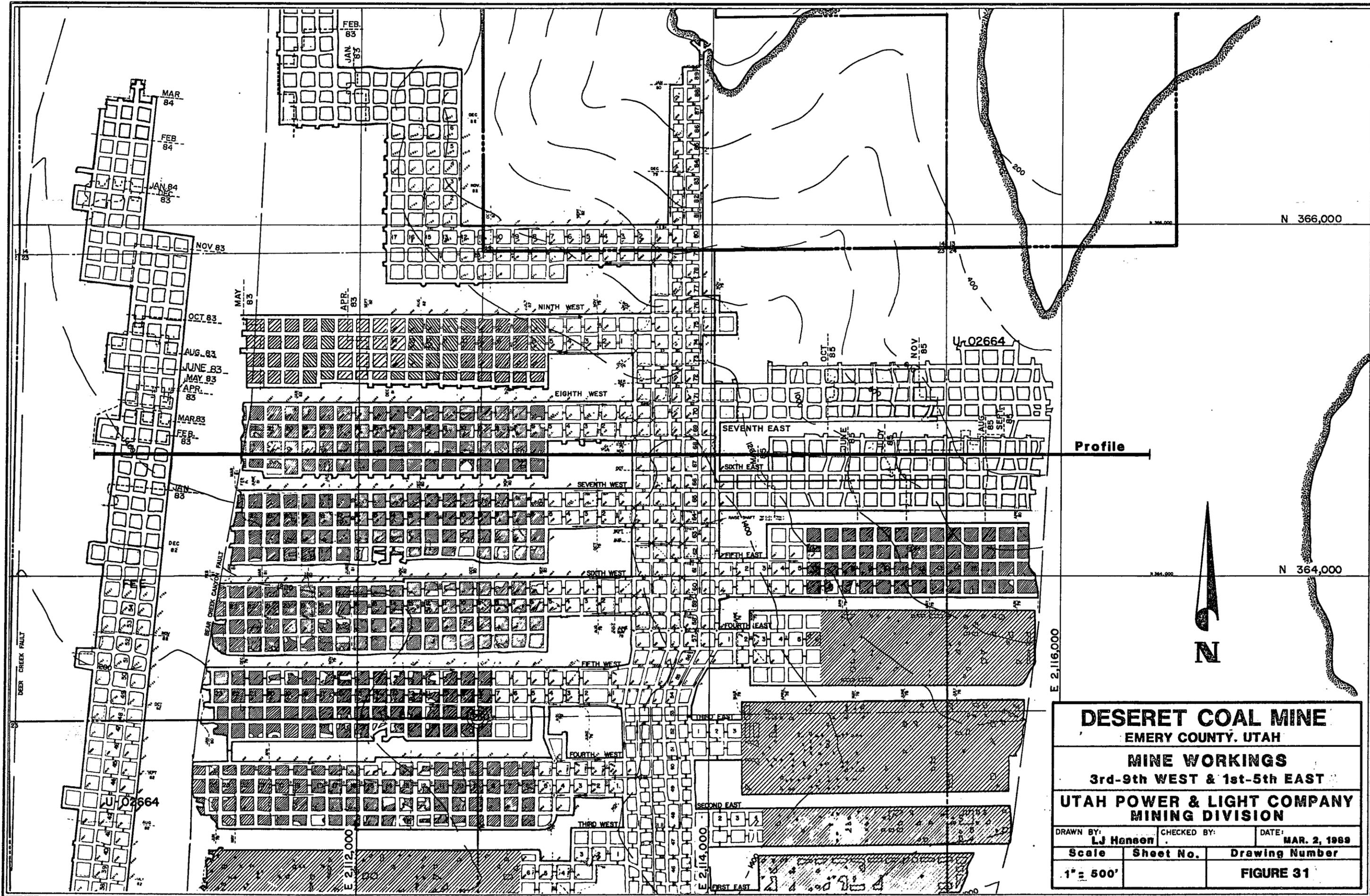
FIGURE 29

Area 8

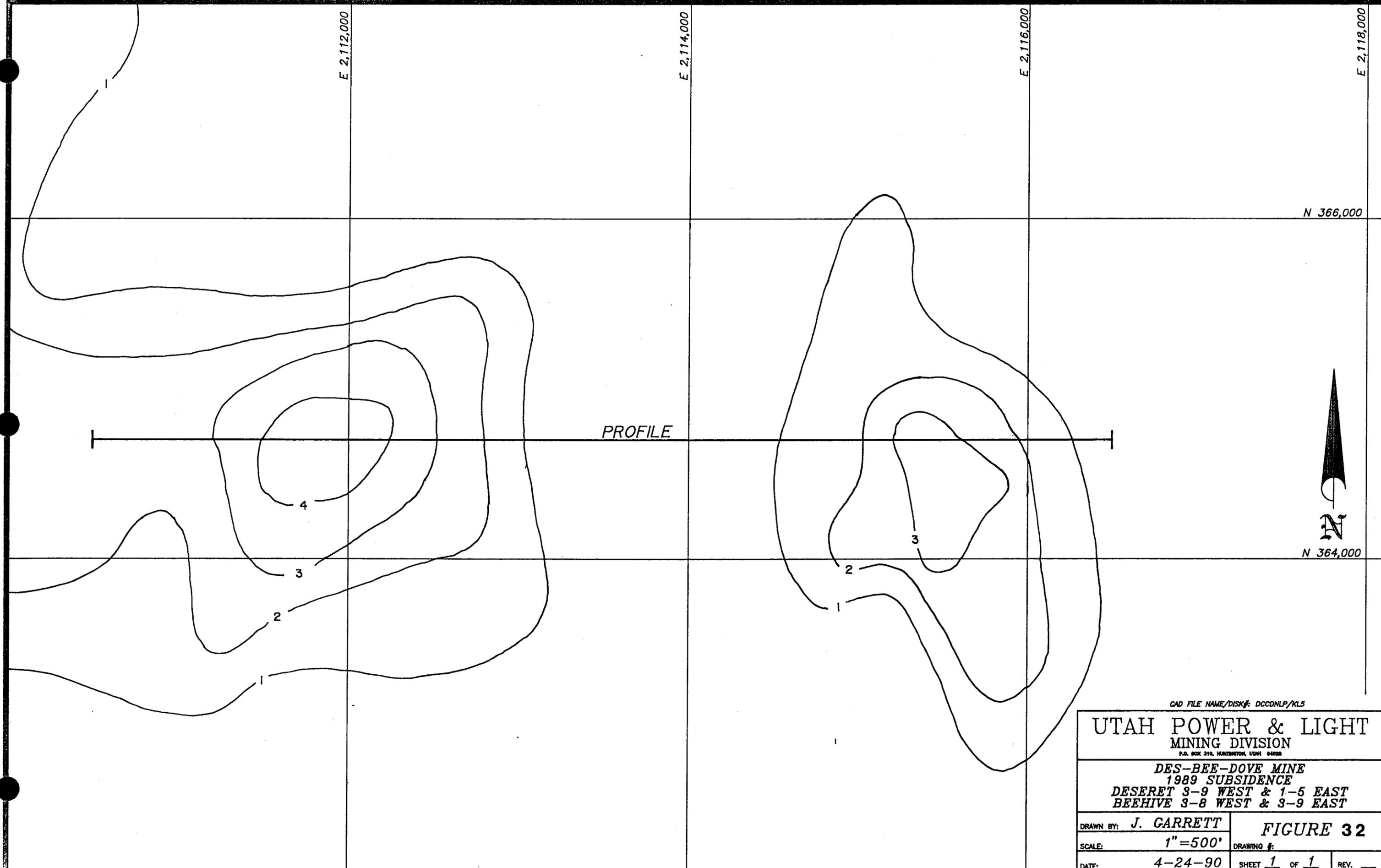
Beehive 3rd Through 8th West and 3rd Through 9th East

Deseret 3rd Through 9th West and 1st Through 5th East

Some of the subsidence in Area 8 may have gone undetected because pillar extraction, and presumably subsidence, in part of the area was completed before the establishment of baseline survey data (Figures 30, 31, and 32). The west to east subsidence profile of the area depicted in Figure 33 indicates it had reached a stable state, at near 4.5 feet of subsidence, over the western sections by 1986. On the eastern side subsidence has remained at about 3.5 feet for the last two years. Where not influenced by other workings, angle-of-draw reached a maximum of 31 degrees on the eastern edge of the area.



DESERET COAL MINE		
EMERY COUNTY, UTAH		
MINE WORKINGS		
3rd-9th WEST & 1st-5th EAST		
UTAH POWER & LIGHT COMPANY		
MINING DIVISION		
DRAWN BY: LJ Hansen	CHECKED BY:	DATE: MAR. 2, 1969
Scale 1" = 500'	Sheet No.	Drawing Number
FIGURE 31		



CAD FILE NAME/DISK#: DCCDNL/P/KL5

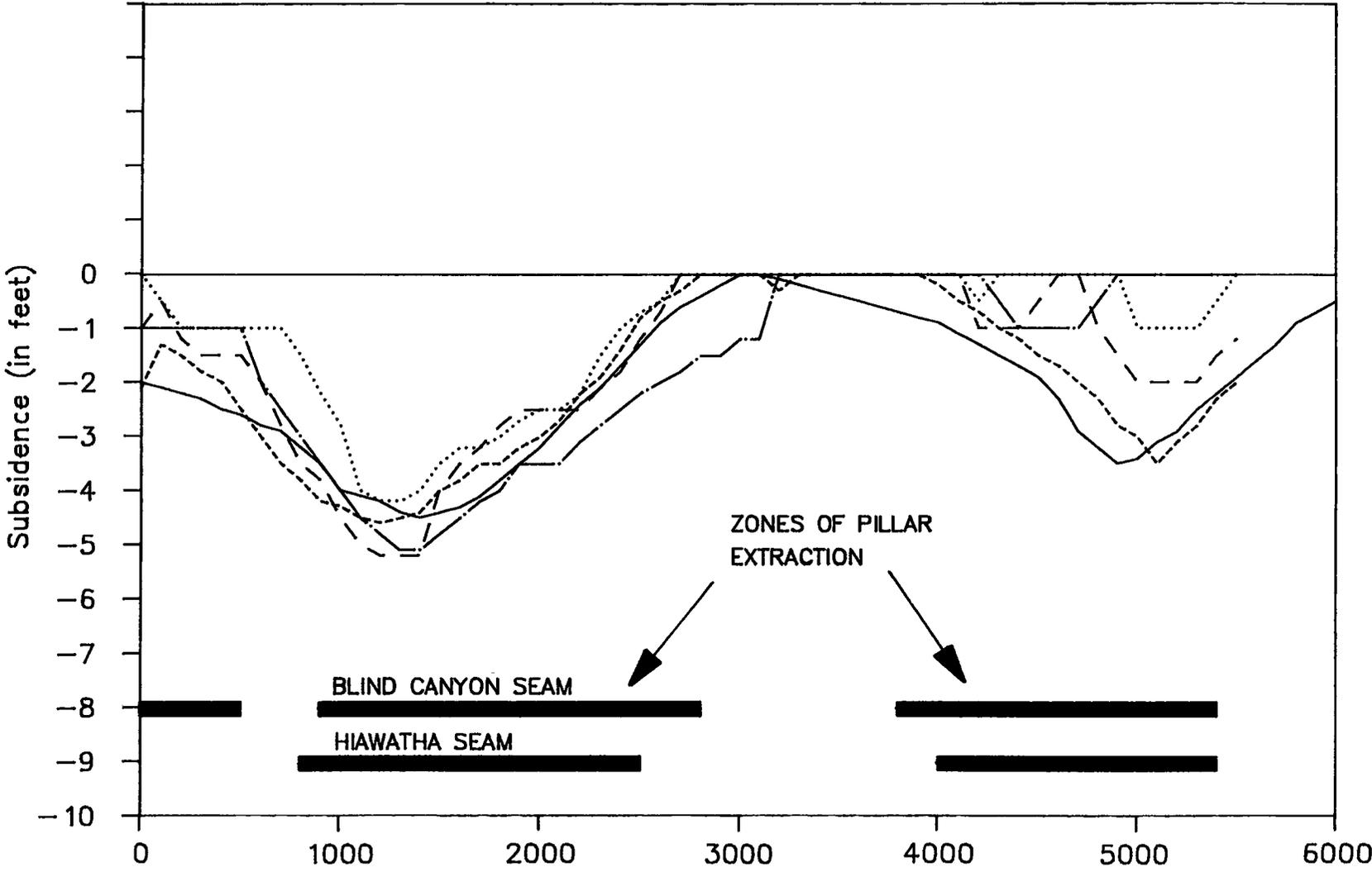
UTAH POWER & LIGHT
MINING DIVISION
P.O. BOX 310, HANDBURTON, UTAH 84038

DES-BEE-DOVE MINE
1989 SUBSIDENCE
DESERET 3-9 WEST & 1-5 EAST
BEEHIVE 3-8 WEST & 3-9 EAST

DRAWN BY: J. GARRETT	FIGURE 32	
SCALE: 1" = 500'	DRAWING #:	
DATE: 4-24-90	SHEET 1 OF 1	REV. —

AREA 8 SUBSIDENCE PROFILE

West - East



— · — 1985 - - - 1986 ····· 1987 - · - · - 1988 — 1989

FIGURE 33

Areas 9 and 10

Little Dove 1st North and the old American Fuel Mine

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 (see figures for Areas 7 and 8). 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 three (3) feet, occurring over some of the most recently extracted pillars. No other notable subsidence has been detected over the remainder of 1st North.

Subsidence of over four (4) feet has been measured above the American Fuel Mine workings.

Any angle-of-draw calculation would be affected by both the surrounding mine workings and the faults on either side; therefore, no angle-of-draw was calculated for either the 1st North area of the Little Dove Mine or the old American Fuel Mine.

No fractures are known over the 1st North workings, but some cliff failure and fractures are probably present over the American Fuel Mine on the cliffs and steep slopes.

Mining has had no known effect on the hydrology of the areas.

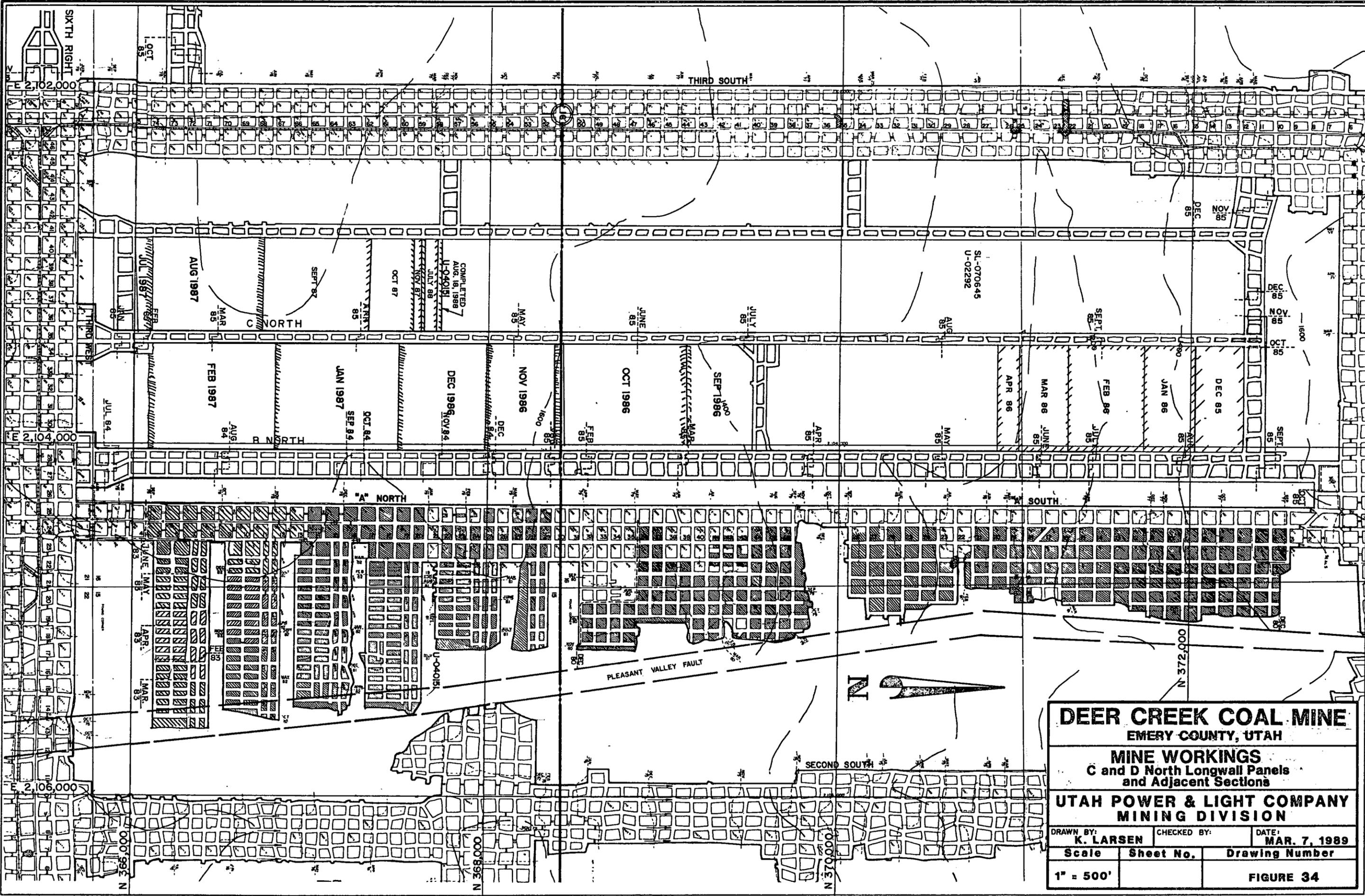
Area 11

Deer Creek C and D North Longwall Panels

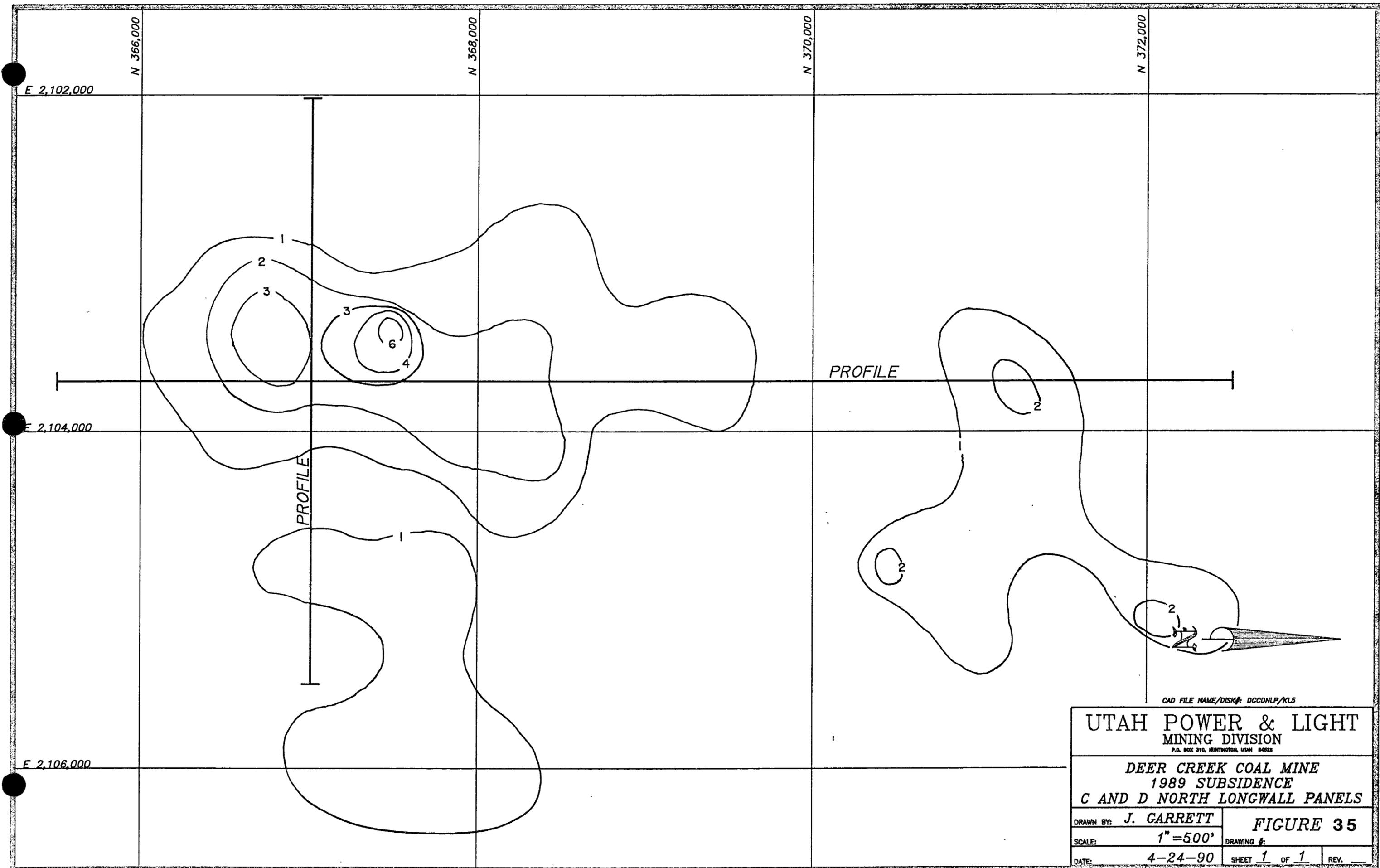
Longwall mining in the C North panel began in December 1984 and was terminated in April 1986 due to geologic complications. New setup entries were driven further south and mining resumed in September 1986; the panel was completed in March 1987. The D North longwall panel began production in July 1987, 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 and D North and a little more than two (2) 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, 1989 and the Appendices to this report).



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



CAD FILE NAME/DISK#: DCCONLP/KLS

UTAH POWER & LIGHT
MINING DIVISION
P.O. BOX 310, HARRINGTON, UTAH 84028

DEER CREEK COAL MINE
1989 SUBSIDENCE
C AND D NORTH LONGWALL PANELS

DRAWN BY: J. GARRETT	FIGURE 35	
SCALE: 1" = 500'	DRAWING #:	
DATE: 4-24-90	SHEET 1 of 1	REV. _____

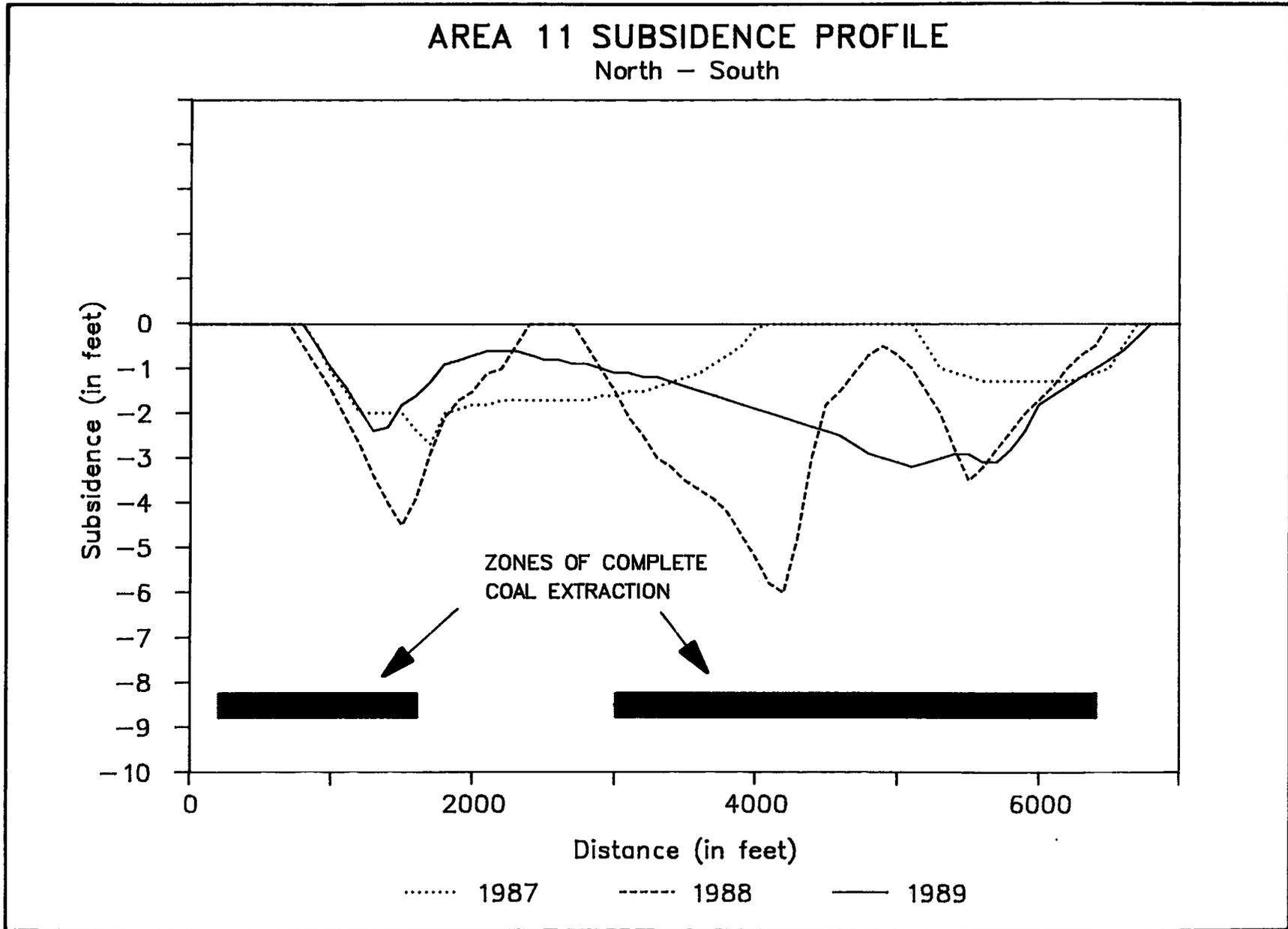


FIGURE 36

AREA 11 SUBSIDENCE PROFILE

West - East

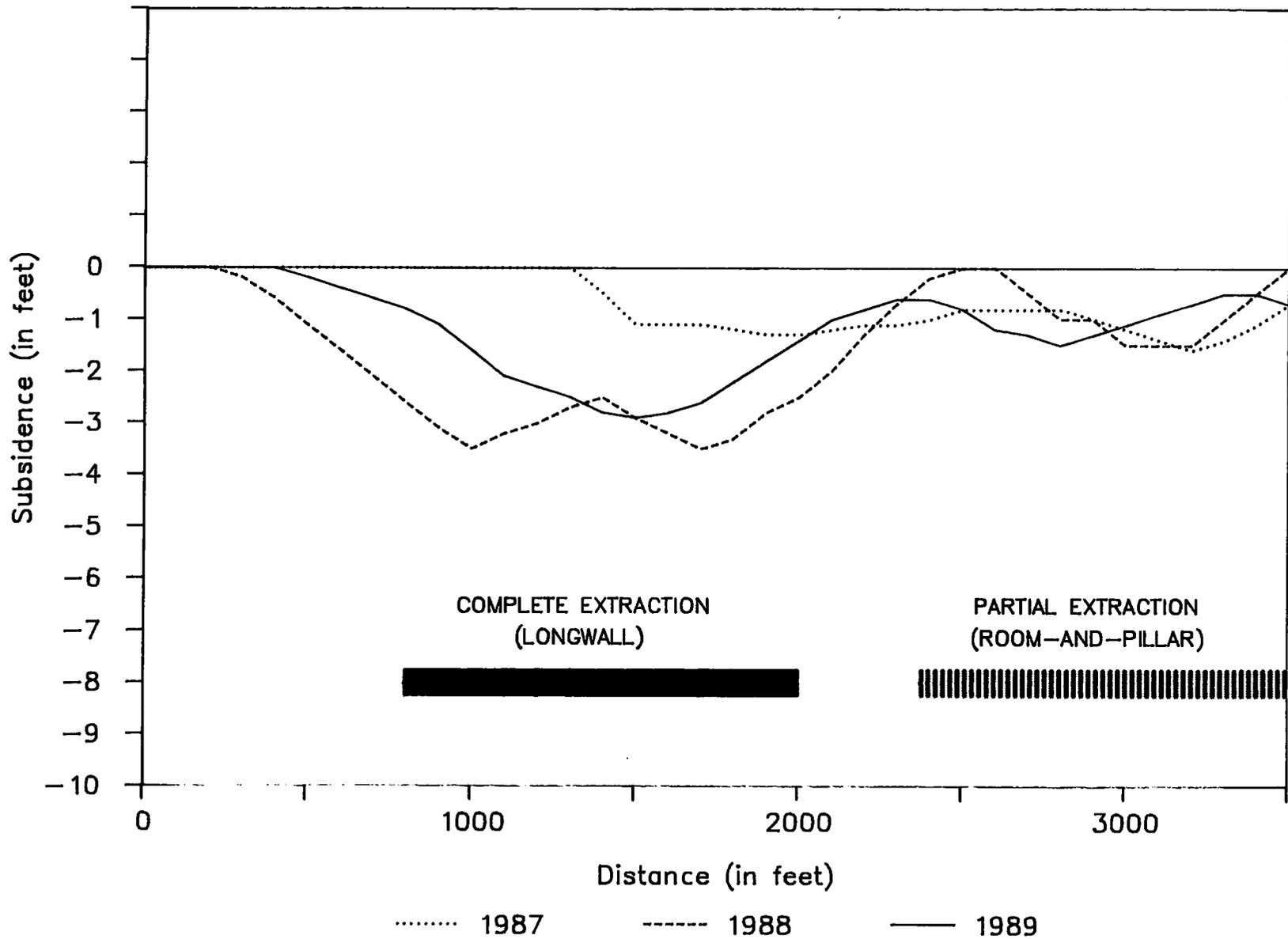


FIGURE 37

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.

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 Areas

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).

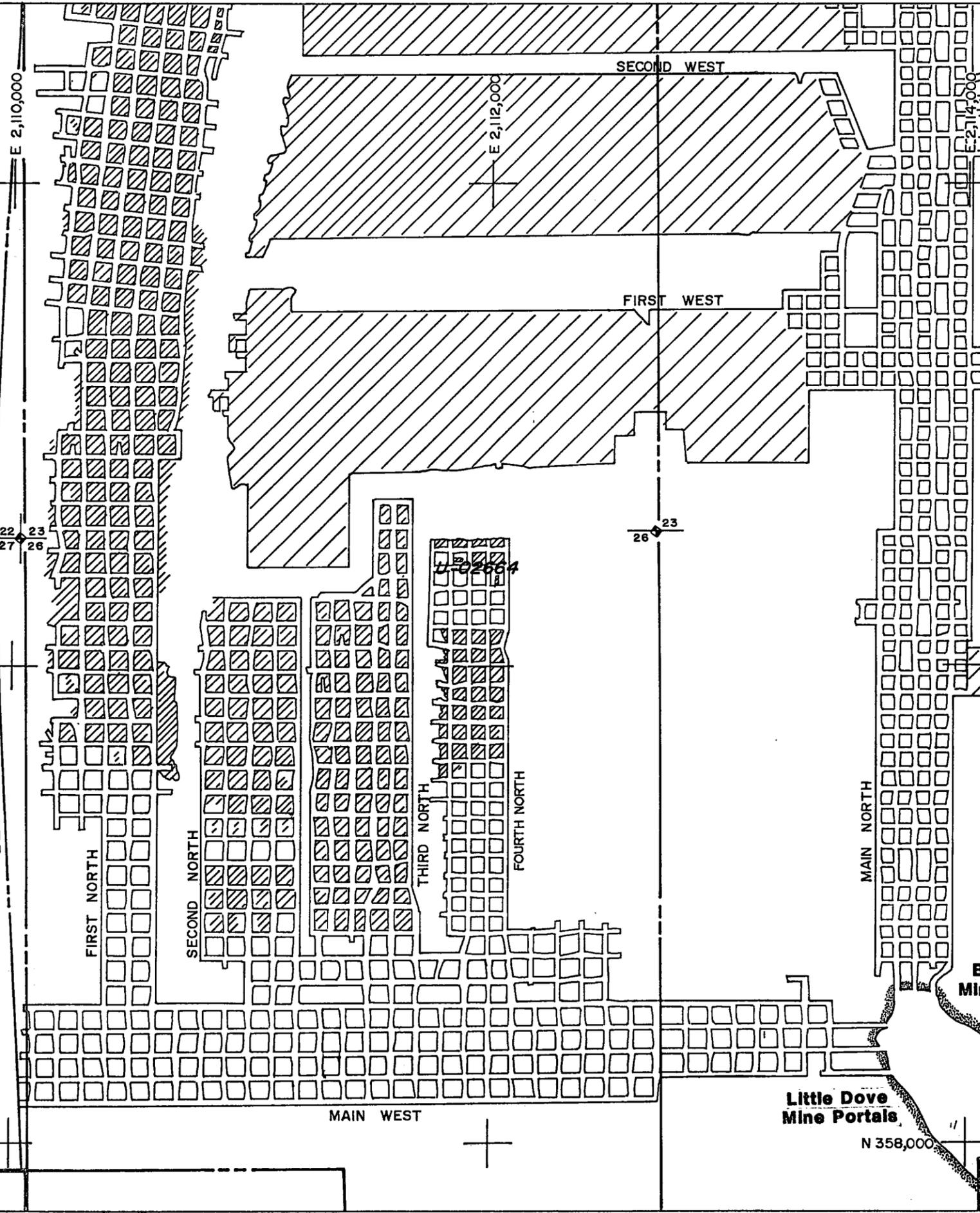
Maximum subsidence over the area as of August 1989 was about two (2) feet (Figures 40, 41, and 42).

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



Beehive Mine Portals

Little Dove Mine Portals

Beehive & Little Dove Coal Mines		
EMERY COUNTY, UTAH		
SOUTHERN AREAS		
MINE WORKINGS		
UTAH POWER & LIGHT COMPANY		
MINING DIVISION		
DRAWN BY: LJ Hansen	CHECKED BY:	DATE: MAR. 6, 1989
Scale 1" = 500'	Sheet No.	Drawing Number FIGURE 38

U-1358

DEER CREEK FAULT

E 2,110,000

22 23
27 26

U-02664

Profile

Profile

E 2,112,000

23 24
26 25

E 2,114,000

FEE

N 362,000

U-02664

E 2,116,000

N 360,000



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, 1988
Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 39

N 358,000

AREA 13 SUBSIDENCE PROFILE

North - South

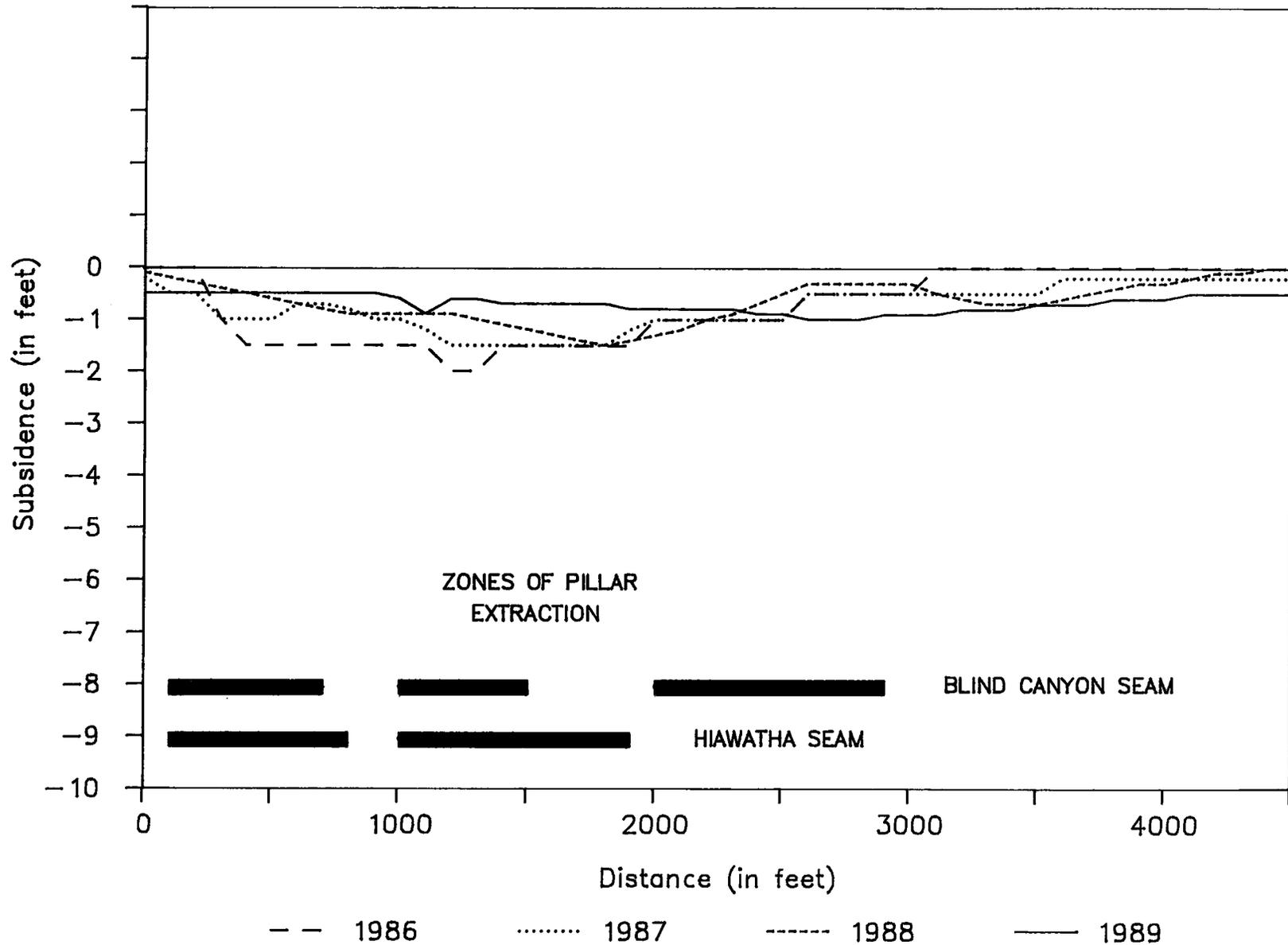


FIGURE 41

AREA 13 SUBSIDENCE PROFILE

West - East

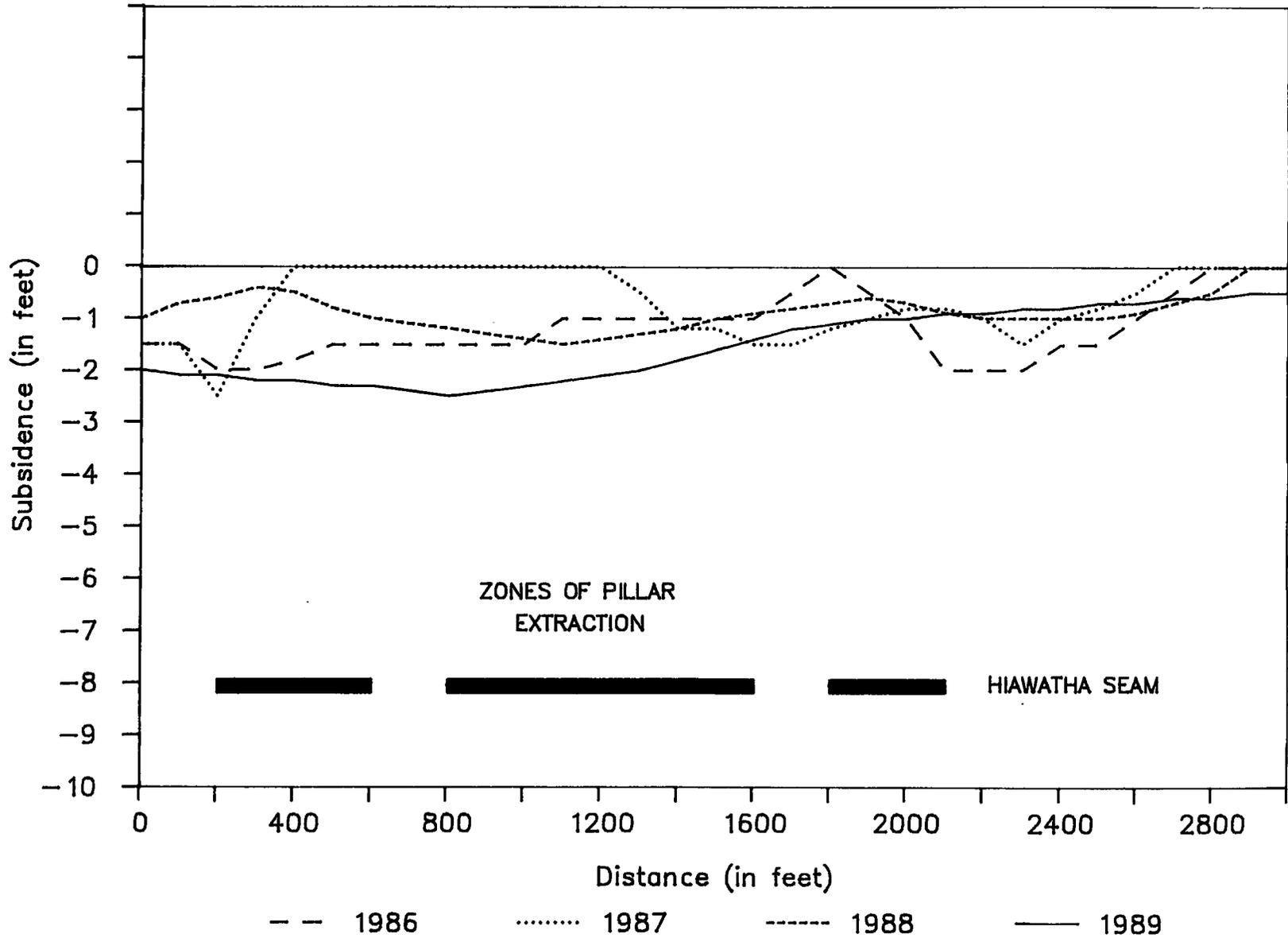


FIGURE 42

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 43).

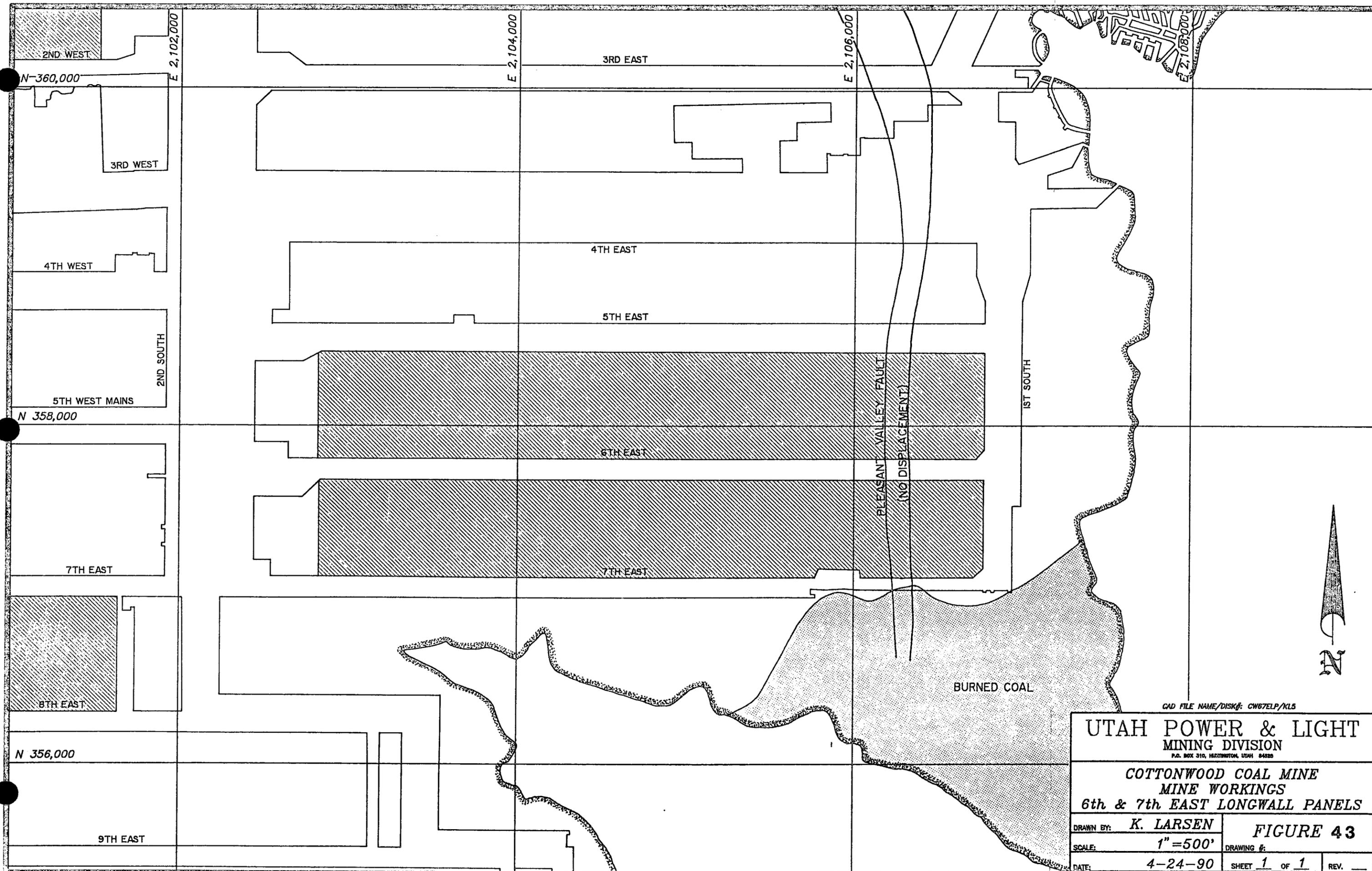
Topography consists of very steep south facing slopes and cliffs with slopes covered by a few scattered pinon, juniper, mountain brush, and grasses. Overburden ranges from near 1400 feet to 200 feet.

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 six (6) feet (Figure 44).

The angle-of-draw was not calculated because of the steep slopes, burned coal, and other workings surrounding the 6th and 7th East panels.

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.



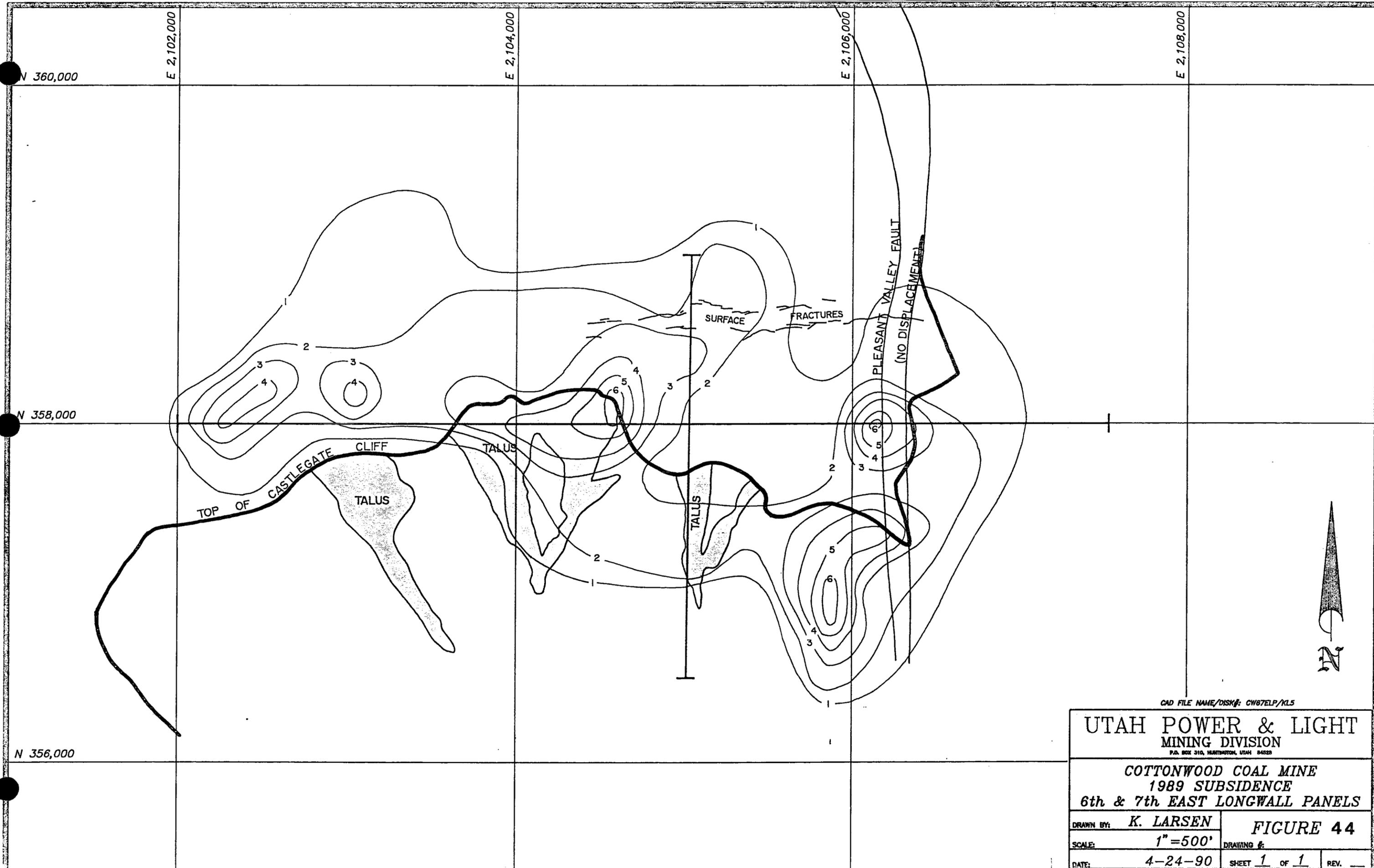
CAD FILE NAME/DISK#: CW67ELP/KLS

UTAH POWER & LIGHT
 MINING DIVISION
P.O. BOX 310, HARRINGTON, UTAH 84302

COTTONWOOD COAL MINE
MINE WORKINGS
6th & 7th EAST LONGWALL PANELS

DRAWN BY: **K. LARSEN**
 SCALE: **1" = 500'**
 DATE: **4-24-90**

FIGURE 43
 DRAWING #:
 SHEET **1** OF **1** REV. **—**



N 360,000

E 2,102,000

E 2,104,000

E 2,106,000

E 2,108,000

N 358,000

N 356,000

TOP OF CASTLEGATE CLIFF
TALUS

SURFACE
FRACTURES

PLEASANT VALLEY FAULT
(NO DISPLACEMENT)

TALUS

CAD FILE NAME/DISK#: CW87ELP/KLS

UTAH POWER & LIGHT
MINING DIVISION
P.O. BOX 310, HARTMINGTON, UTAH 84329

COTTONWOOD COAL MINE
1989 SUBSIDENCE
6th & 7th EAST LONGWALL PANELS

DRAWN BY: K. LARSEN

FIGURE 44

SCALE: 1"=500'

DRAWING #:

DATE: 4-24-90

SHEET 1 of 1 REV.

AREA 14 SUBSIDENCE PROFILE

West - East

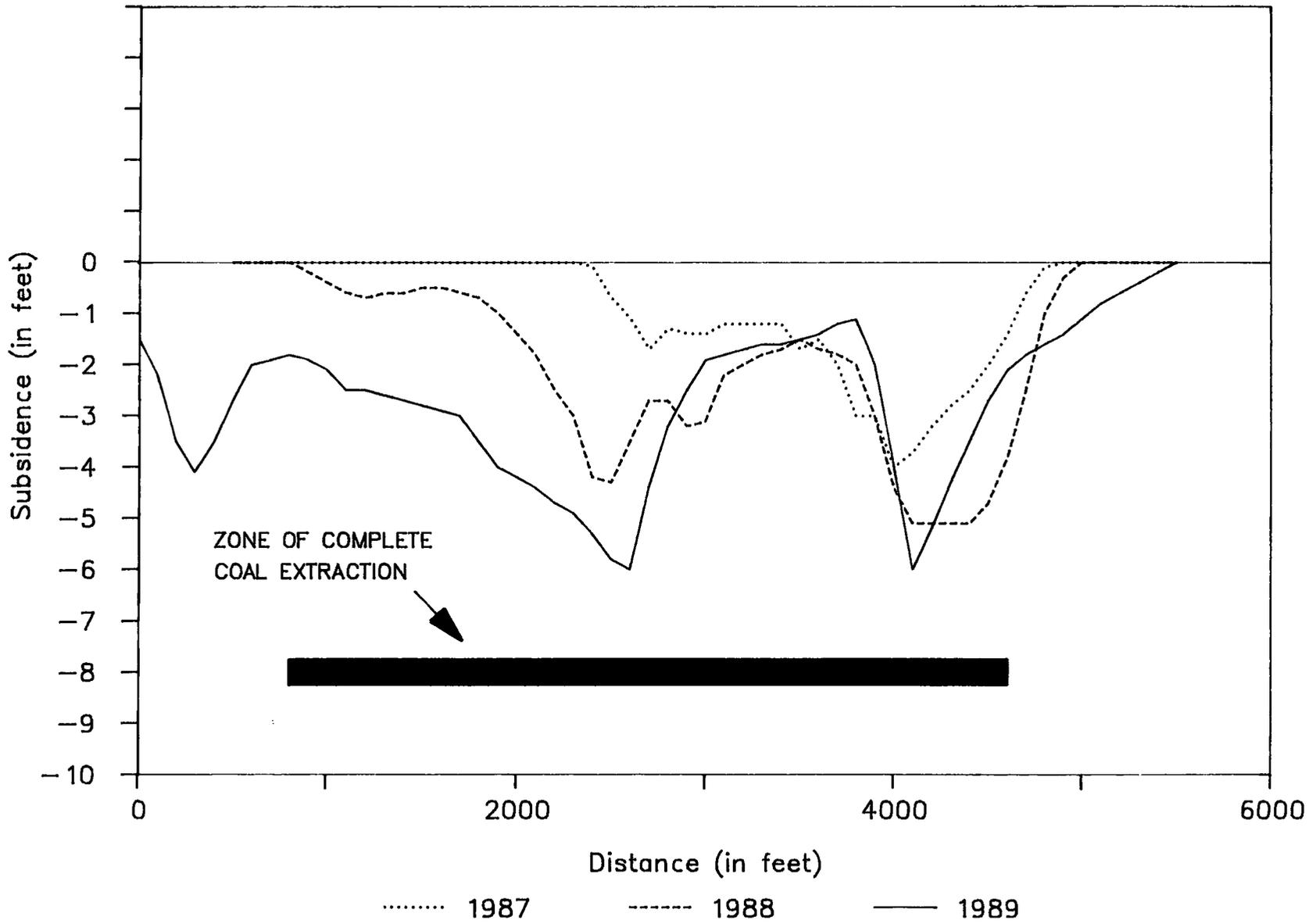


FIGURE 45

AREA 14 SUBSIDENCE PROFILE

North - South

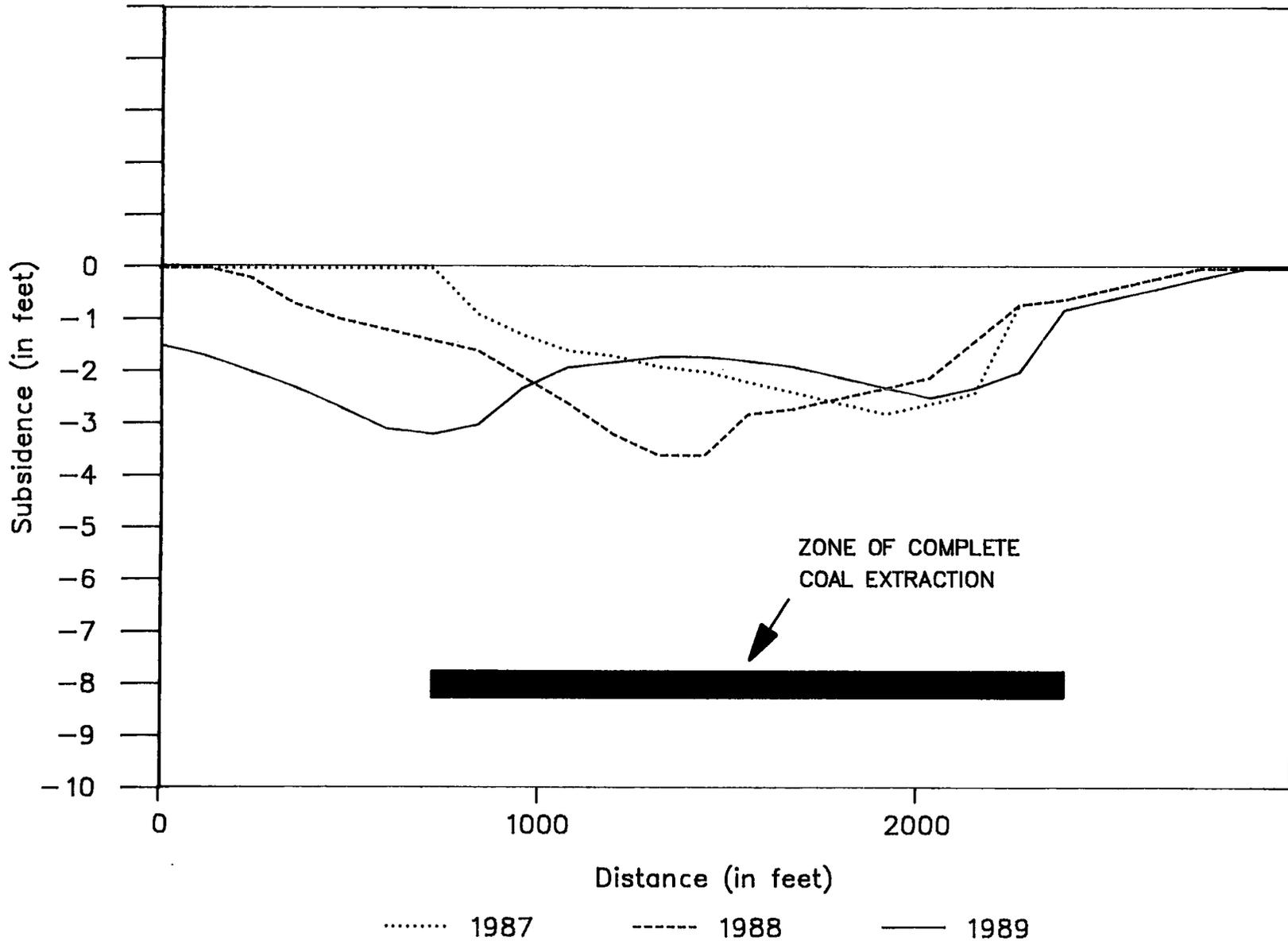


FIGURE 46

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 when longwall extraction began there. Between August 31, 1988 and August 31, 1989 the 10th, 11th, 12th, and 8th East panels were completed (Figure 47).

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 800 feet to over 2000 feet.

Maximum measured subsidence to date is over five (5) feet above 9th to 12th West and barely a foot over 8th East (Figure 48).

Calculated angle-of-draw is less than zero on the south and east and reaches 20 degrees on the west.

There are no known springs in the area.



8TH WEST

4TH WEST

9TH WEST

5TH WEST MAINS

N 358,000

10TH WEST

7TH EAST

11TH WEST

3RD SOUTH

8TH EAST

N 356,000

12TH WEST

9TH EAST

E 2,100,000

13TH WEST



E 2,094,000

4TH SOUTH

E 2,096,000

E 2,098,000

CAD FILE NAME/DISK#: DC89SUB KLS

UTAH POWER & LIGHT
MINING DIVISION

P.O. BOX 310, HARRISVILLE, UTAH 84028

COTTONWOOD COAL MINE
MINE WORKINGS
9th-12th WEST & 8th EAST LONGWALL PANELS

DRAWN BY: **K. LARSEN**

FIGURE 47

SCALE: **1"=500'**

DRAWING #:

DATE: **4-11-90**

SHEET **1** OF **1** REV. **___**

PROFILE

PROFILE

N 358,000

N 356,000

E 2100,000

E 2094,000

E 2096,000

E 2098,000

CAD FILE NAME/DISK#: DC88SUB KL5

UTAH POWER & LIGHT
MINING DIVISION
P.O. BOX 310, MURKIN, UTAH 84058

COTTONWOOD COAL MINE
1989 SUBSIDENCE
9th-12th WEST & 8th EAST LONGWALL PANELS

DRAWN BY: **K. LARSEN**

FIGURE 48

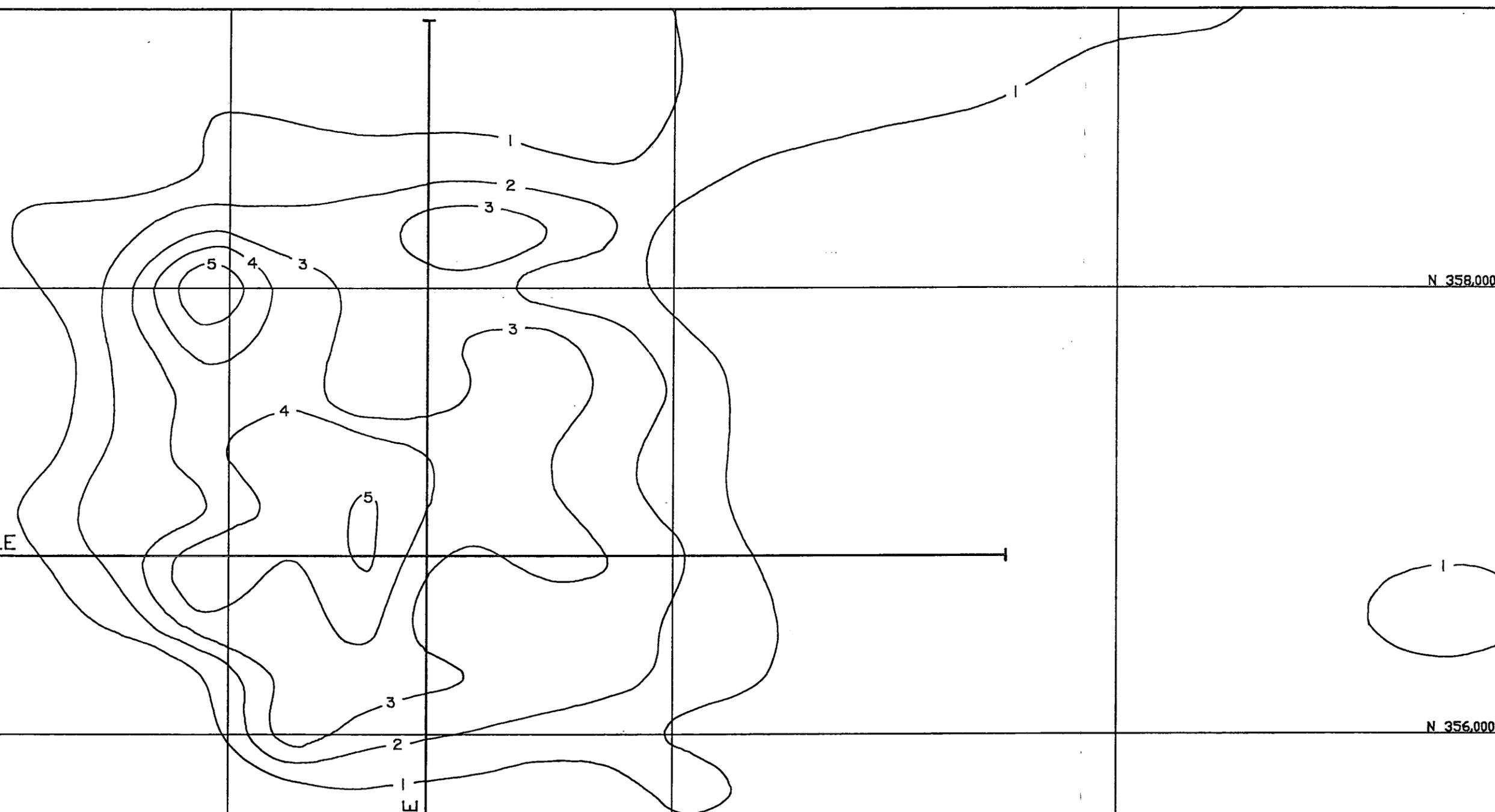
SCALE: **1" = 500'**

DRAWING #:

DATE: **4-11-90**

SHEET **1** OF **1**

REV. **---**



AREA 15 SUBSIDENCE PROFILE

West - East

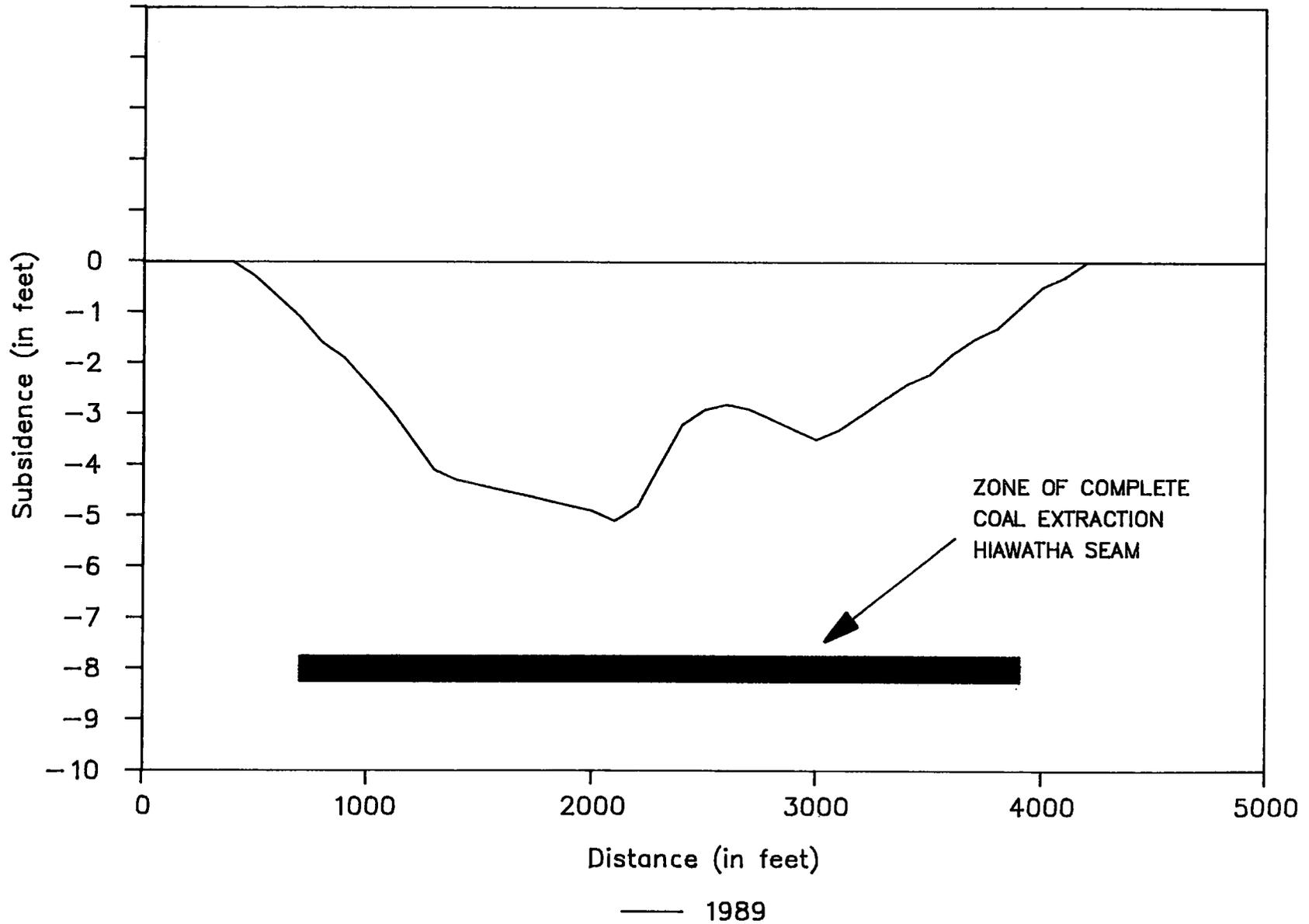


FIGURE 49

AREA 15 SUBSIDENCE PROFILE

North - South

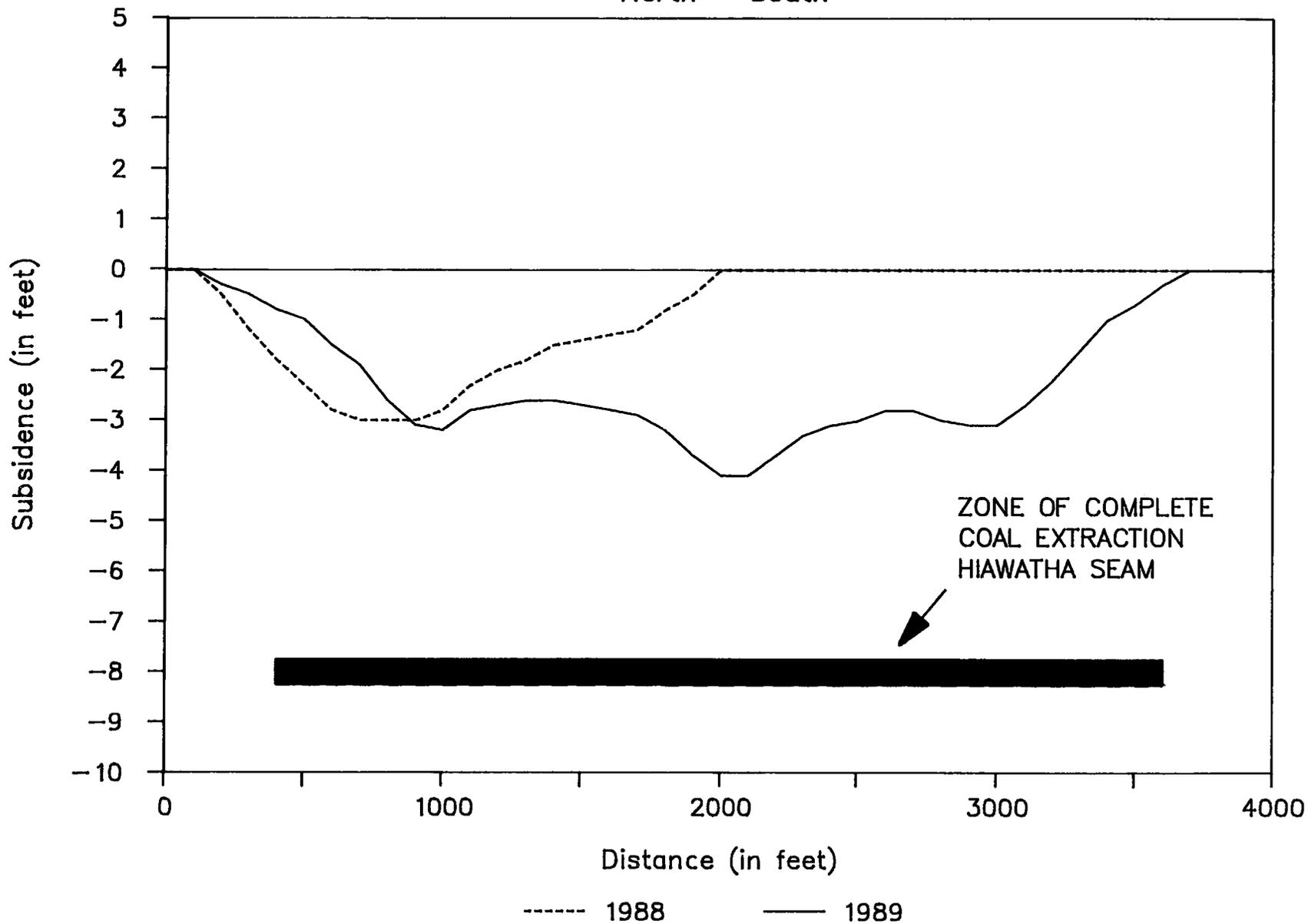


FIGURE 50

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	15.2	27.0	178
2 DC 5-8E/W, 3-13R	13.8	11.9	86
3 DC 1N Area	7.7	2.0	26
4 DC 2-14R	8.1	5.8	72
5 DC 2-5L	7.6	6.1	80
6 W 1-2W	5.0	3.5	69
7 Bee 2N off 8W	6.6	6.3	95
8 Bee/Des E&W Sections	6.8	4.5	66
9 LD 1N	4.3	2.5	58
10 Old American Fuel Mine	7.0	4.2	60
11 DC C&D N	5.9	6.2	106
12 W 2L	1.5	0	0
13 Des-Bee-Dove Southern Areas	2.0	2.5	125
14 Cottonwood 6-7E	6.7	6.2	92
15 Cottonwood 9-12W, 8E	6.3	5.5	87

* 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 51 shows the relationship between predicted and observed subsidence. From the slope of the regression line ($A = .83$) the average observed subsidence is eighty-three percent 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-seven (27) feet measured here must be due in part to mass wasting on the steep slope.

PREDICTED vs OBSERVED SUBSIDENCE

1989

East Mountain Property

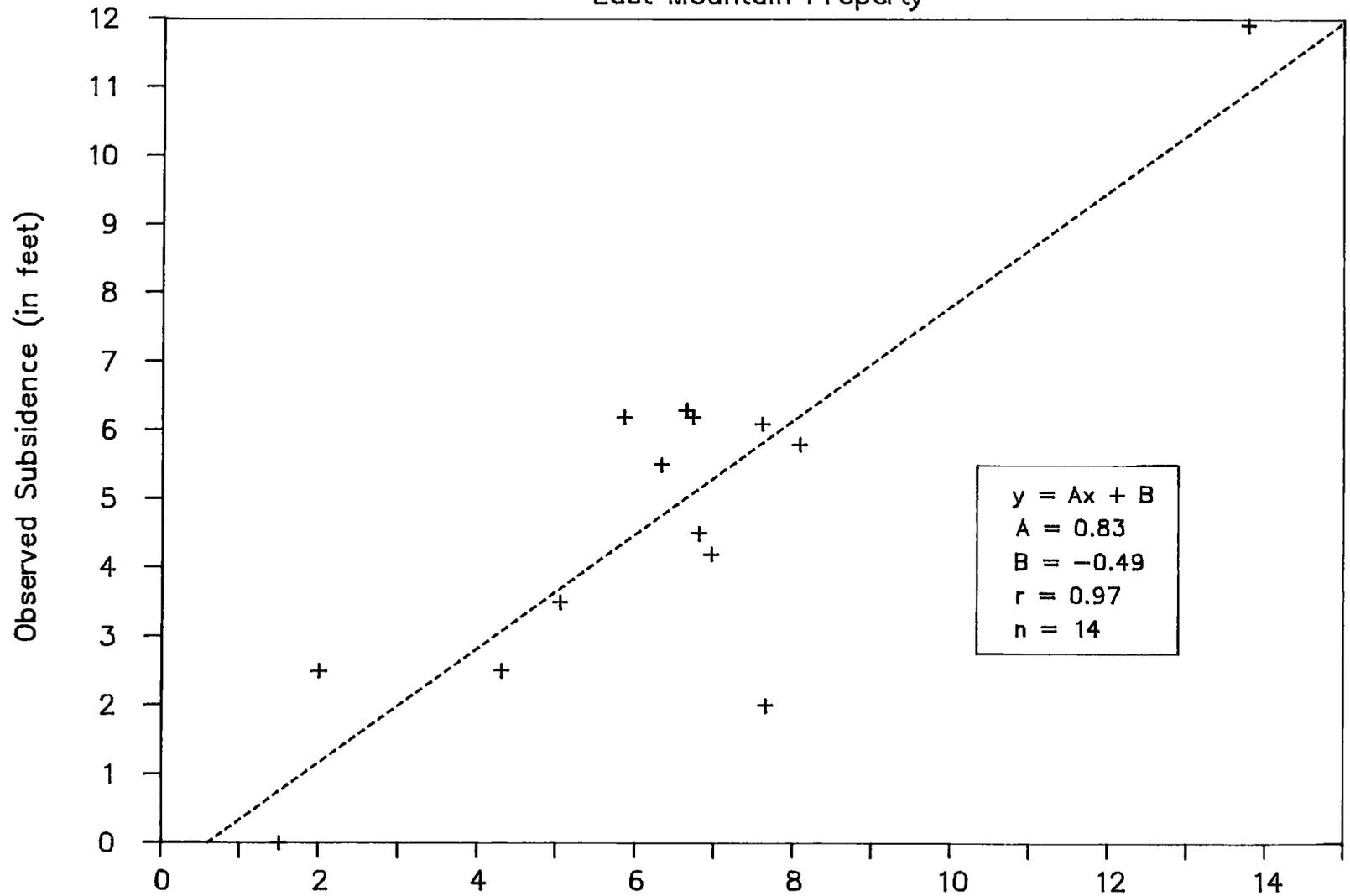


FIGURE 51

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, 8, 9, 11, 12, 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

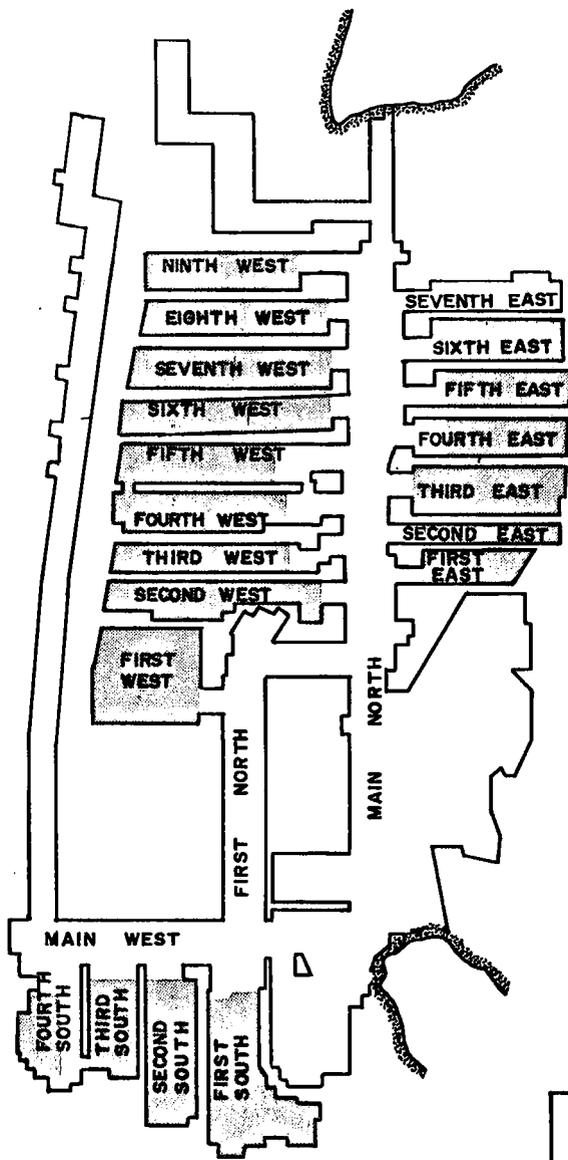
As of August 1988 UP&L has identified fifteen (15) areas of mining-induced subsidence on the East Mountain property. Terrain in the subsidence areas ranges from relatively flat mountain tops with thick overburden of up to 2,100 feet to steep slopes and cliffs with overburden of less than 200 feet. The 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.

APPENDICES

Des-Bee-Dove Mines



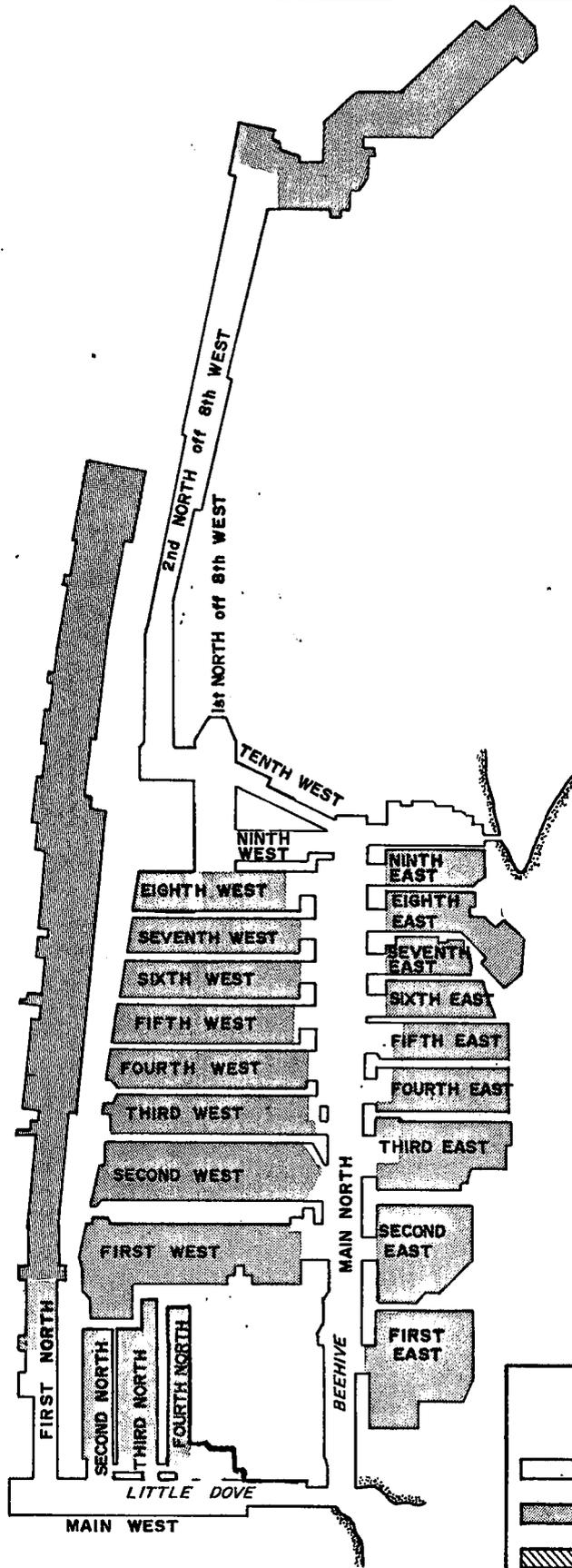
LEGEND

	MINE WORKINGS
	MINING COMPLETED
	ACTIVE MINING AREA

MINE WORKINGS UPDATED TO 9/1/86

DESERET COAL MINE

SCALE: 1" = 200'



LEGEND

-  MINE WORKINGS
-  MINING COMPLETED
-  ACTIVE MINING AREA

BEEHIVE & LITTLE DOVE COAL MINES

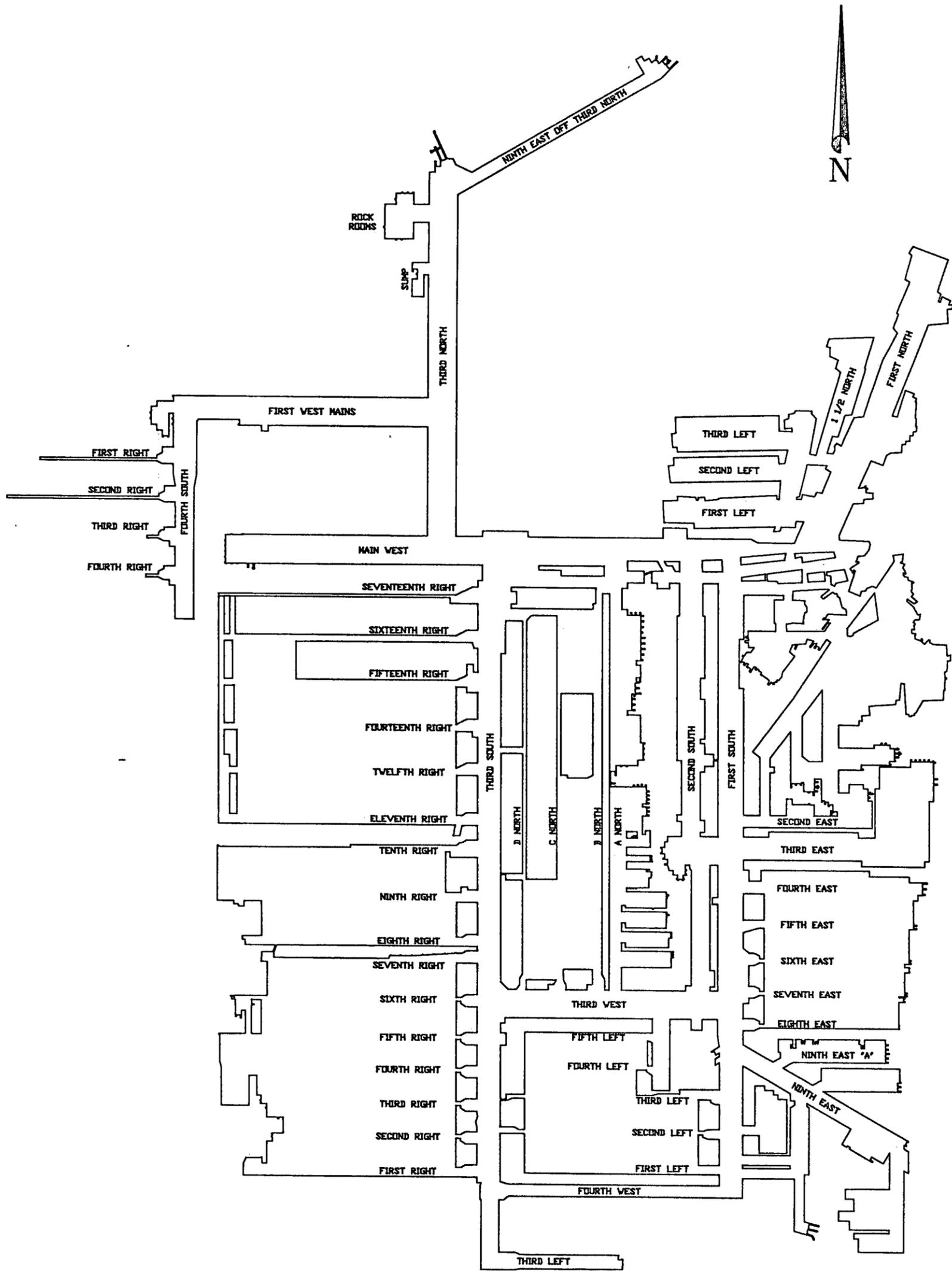
SCALE: 1" = 2000'

UPDATED TO: 5/30/86

Deer Creek Mine

DEER CREEK COAL MINE

SCALE: 1"=2000'

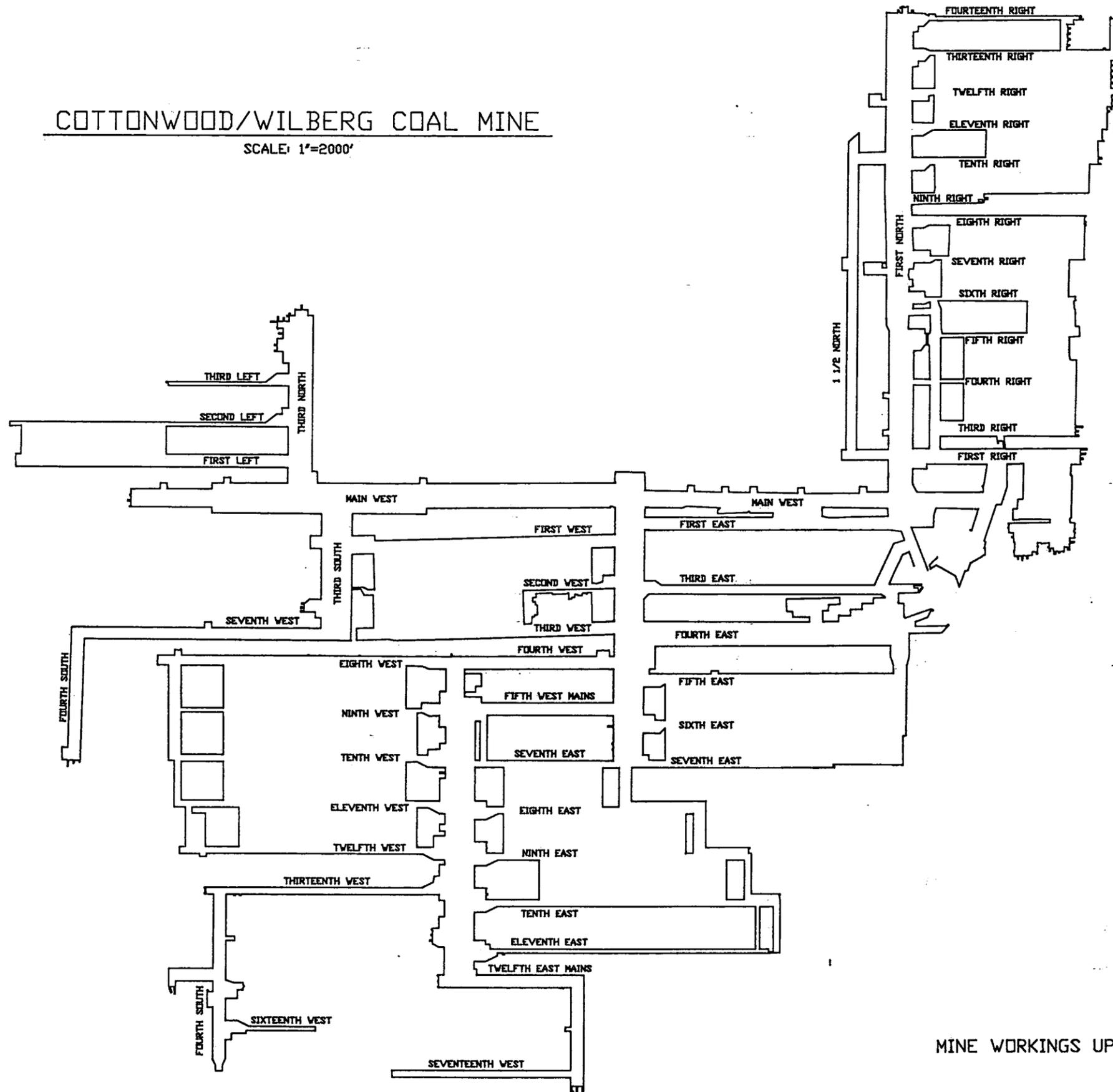


MINE WORKINGS UPDATED TO APRIL 1, 1990

Wilberg/Cottonwood Mine

COTTONWOOD/WILBERG COAL MINE

SCALE: 1"=2000'



MINE WORKINGS UPDATED TO APRIL 1, 1990

**Spring Map with 5-Year Mine Plan
Showing Subsidence**