

UTAH POWER & LIGHT COMPANY
SUBSIDENCE MONITORING PROGRAM
ANNUAL REPORT FOR 1986

April 1987

RECEIVED
JUN 22 1987

DIVISION OF
OIL, GAS & MINING

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

TABLE OF CONTENTS

	<u>Page</u>
Introduction	1
Deer Creek 9th East, Wilberg 1st Right	4
Deer Creek 5th through 8th East Longwall Panels, Wilberg 6th, 7th, and 10th through 13th Right Longwall Panels	5
Deer Creek 1st North Area	7
Deer Creek 2nd through 6th Right Longwall Panels	8
Deer Creek 2nd through 5th Left Longwall Panels	10
Wilberg 1st and 2nd West Longwall Panels	11
Beehive 2nd North off 8th West	12
Beehive 3rd through 8th West and 3rd through 9th East Deseret 3rd through 9th West and 1st through 5th East	13
Little Dove 1st North	14
Old American Fuel Mine	15
Deer Creek A North-A South and C North Longwall Panel	16
Wilberg 2nd Left Longwall Panel	17
Des-Bee-Dove Southern Areas	18
Predicted Maximum Subsidence	19
Mitigation of Surface Effects	22
Summary	23

APPENDICES

Des-Bee-Dove Mines

Deer Creek Mine

Wilberg Mine

Introduction

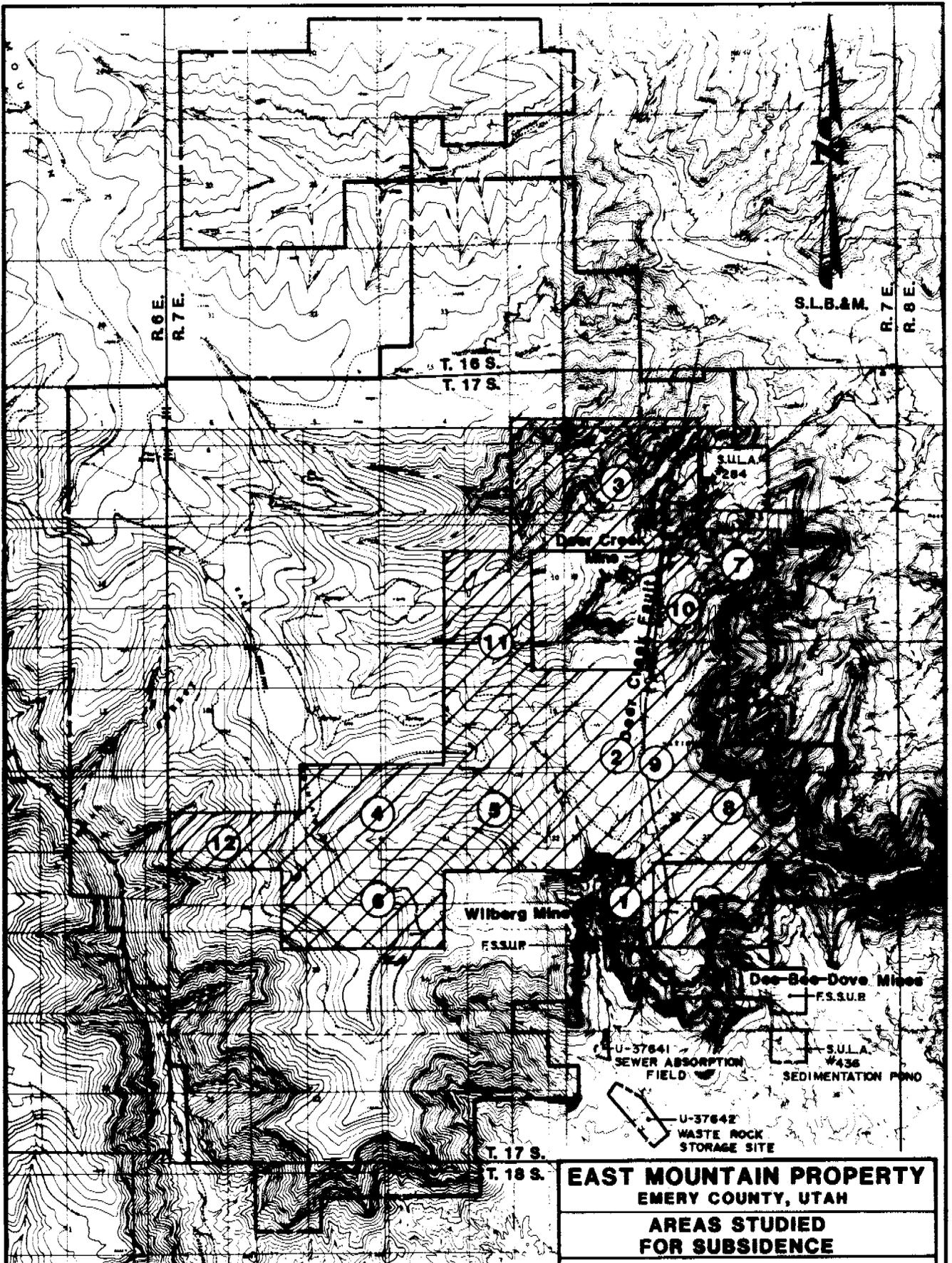
Utah Power & Light Company's (UP&L) East Mountain Subsidence Monitoring Study is an ongoing project designed to detect, observe, and report the effects of mining induced subsidence above the Deer Creek, Wilberg-Cottonwood, and Des-Bee-Dove Mines (see Figure 1). This, the sixth such annual report submitted, covers the period between August 31, 1985 and August 31, 1986.

The initial report submitted in 1982 details the monitoring methods used in this study; therefore, they are not discussed in depth here. Briefly, UP&L uses aerial photogrammetric survey methods augmented by conventional monumented on-the-ground surveys and an annual helicopter reconnaissance flight to monitor subsidence. Conventional surveying above multiple seam longwall mining in the Deer Creek and Wilberg mines previously performed by the U.S. Bureau of Mines was taken over by UP&L in 1986. This work was contracted to a private firm and will continue as long as deemed necessary.

Location

Figure 2 shows all areas above UP&L's coal mines which have potential for mining induced subsidence and were studied in 1986 to detect subsidence. A helicopter reconnaissance flight on May 19, 1986 revealed no new areas of fractures. A small rock slide was observed to have occurred over an area of burned coal to the northeast of the Deer Creek 1st North workings. The slide may not be related to mining.

One new area of subsidence, over the southern areas of the Des-Bee-Dove Mines (Area 13), is shown in this report.



S.L.B.&M.
R. 7 E.
R. 8 E.

T. 16 S.
T. 17 S.

S.U.L.A.
#284

Deer Creek Mine

Deer Creek Equip

Wilberg Mine

F.S.S.U.P.

Dee-See-Dove Mines

F.S.S.U.B.

U-37641
SEWER ABSORPTION
FIELD

S.U.L.A.
#436
SEDIMENTATION POND

U-37642
WASTE ROCK
STORAGE SITE

T. 17 S.
T. 18 S.

**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

NUMBERS KEYED TO TEXT

 = AREAS STUDIED FOR SUBSIDENCE

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

Several areas have shown no notable change in subsidence over the past two (2) years. In the cases where subsidence appears to have stabilized and mining has ceased or been completed we will begin monitoring subsidence every other year instead of annually. Aerial photographs will be taken annually over all areas where mining has occurred, but in these particular areas photographs will be read only every other year. In areas where mining is still active or subsidence has not stabilized we will continue to monitor photogrammetrically on an annual basis.

Each of the areas shown in Figure 2 is discussed in detail in the following paragraphs. Previous reports described the topographic and geologic setting of the subsidence areas; thus, mention of such will only be made when necessary in this report. If the reader has questions regarding this information, previous reports should be consulted.

As mentioned, various methods have been employed in detecting and measuring subsidence. Unless otherwise noted, measurements in the following were made by aerial photogrammetry.

In many areas of subsidence the angle-of-draw has been calculated and reported herein. In the majority of cases, however, the angle should not be considered the final actual angle-of-draw due to several factors. For example, in some cases the zone of subsidence which has occurred to date covers a small area and is contained within the area of final mining, suggesting that the subsidence has not yet reached its maximum; therefore, calculation of angle-of-draw would be meaningless. Many sections are surrounded by other, older workings. In these cases an angle-of-draw calculation may not be accurate due to the influence of the older workings. In some areas where workings are

surrounded by burned coal, the failure of clinker beds promotes subsidence outside of the mined area, giving an angle-of-draw much greater than might be expected.

Area 1

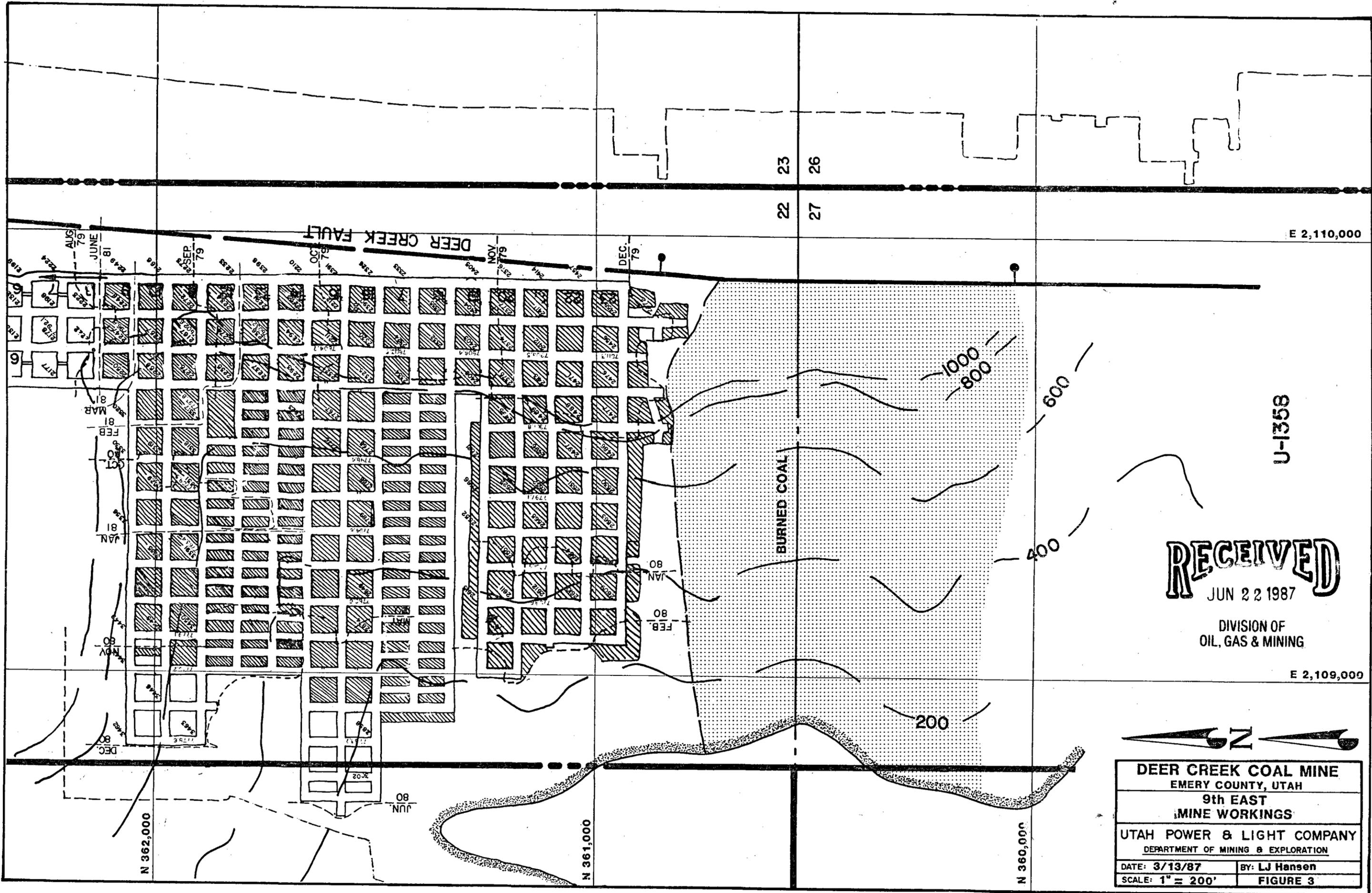
Deer Creek 9th East - Wilberg 1st Right

Subsidence in this area was first documented in the 1981 subsidence monitoring report submitted in December 1982. The relationship of the area of subsidence with the present Deer Creek and Wilberg Mine workings is shown in Figures 3, 4, and 5. The Deer Creek 9th East workings in this area have been abandoned since 1981 but pillar extraction in Wilberg 1st Right proceeded until June 1984.

Subsidence monitoring during 1986 showed little or no change in subsidence from 1985. The maximum subsidence observed to date is 25 feet and occurs on a steep slope about 200 feet south of the southernmost mined-out area in 1st Right Wilberg over an area in which both the Hiawatha and Blind Canyon Seams are burned. This supports the theory that the clinker beds have been crushed, allowing subsidence to occur well outside the area of mine workings. An on-the-ground inspection of this area revealed that some of the fractures have begun to heal spontaneously with the soils filling in and smoothing out the fractures.

The angle-of-draw of subsidence in this area appears to be influenced by the Deer Creek Fault plane. On the east side of the mine workings the subsidence abruptly stops about 200 feet east of the mine workings, which coincides with the Deer Creek Fault surface trace. In this area the mine workings are covered with 1200 feet of overburden, indicating a 9.5° angle of draw on subsidence.

No hydrologic impacts have been observed within this area of subsidence.

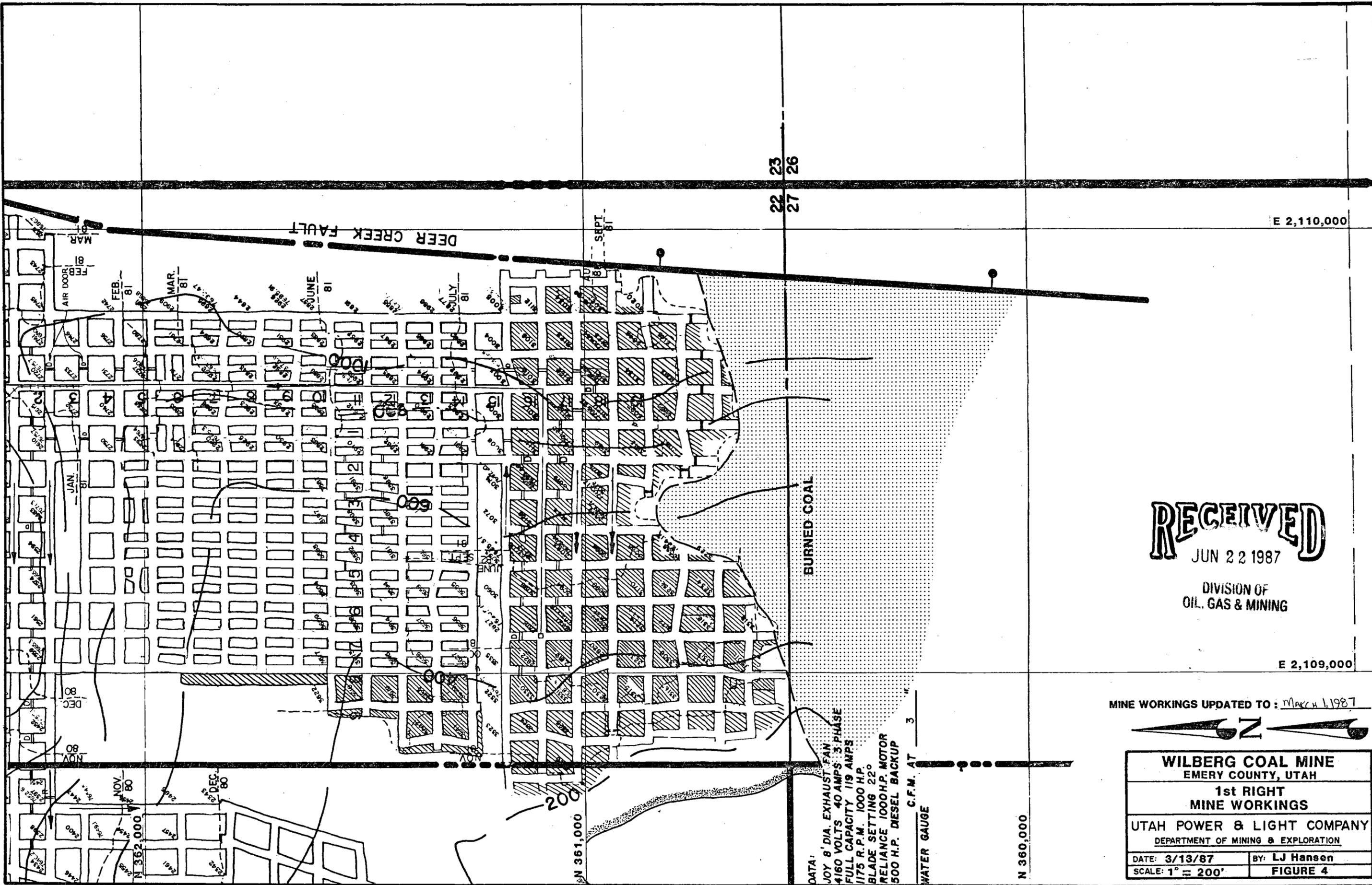


U-1358

RECEIVED
 JUN 22 1987

DIVISION OF
 OIL, GAS & MINING

DEER CREEK COAL MINE EMERY COUNTY, UTAH 9th EAST MINE WORKINGS	
UTAH POWER & LIGHT COMPANY DEPARTMENT OF MINING & EXPLORATION	
DATE: 3/13/87	BY: LJ Hansen
SCALE: 1" = 200'	FIGURE 3



23
26
22
27

E 2,110,000

E 2,109,000

RECEIVED
JUN 22 1987

DIVISION OF
OIL, GAS & MINING

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

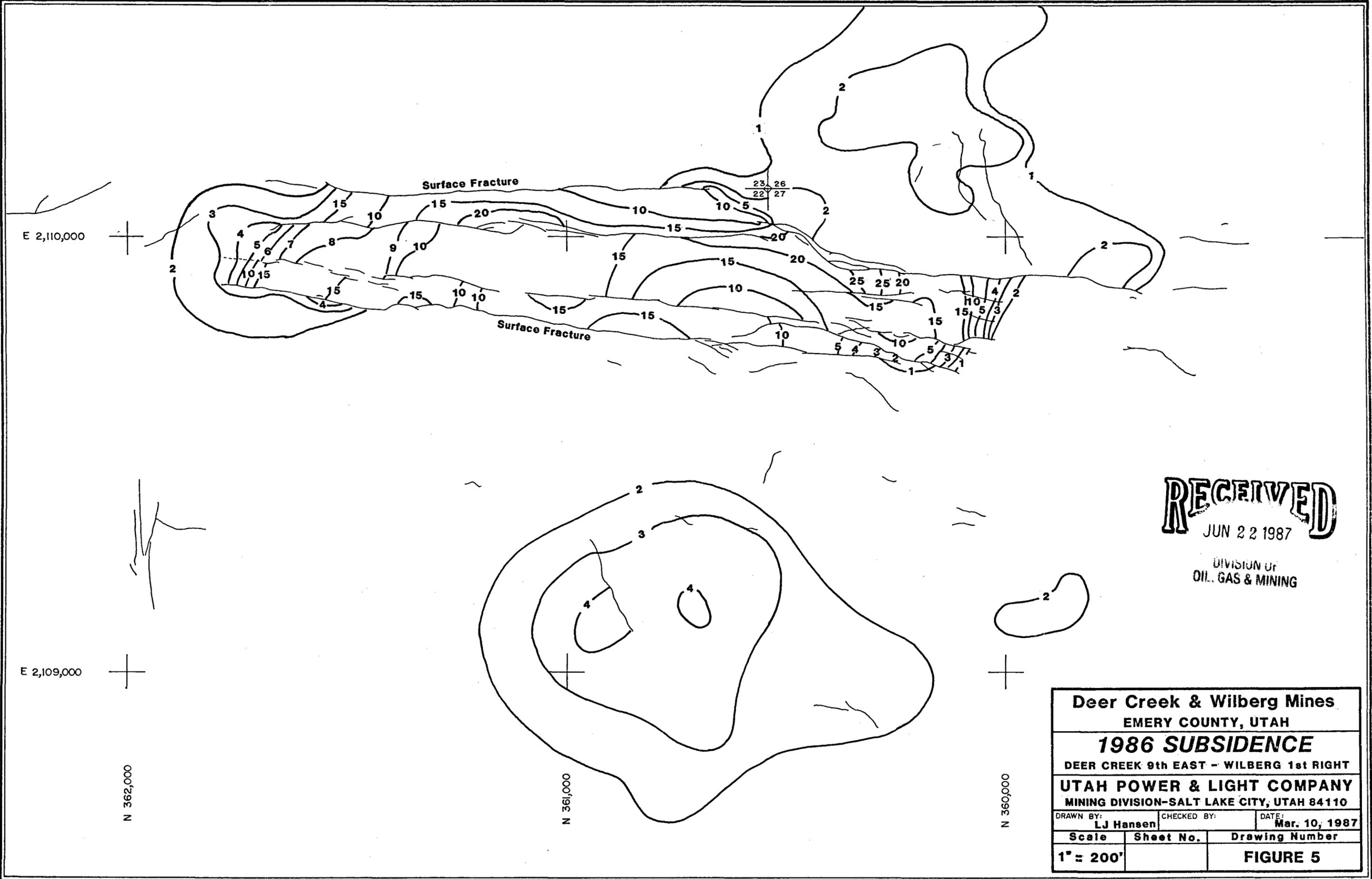
DATA:
JOY 8' DIA. EXHAUST FAN
4160 VOLTS 40 AMPS 3-PHASE
FULL CAPACITY 119 AMPS
1175 R.P.M. 1000 H.P.
BLADE SETTING 22°
RELIANCE 1000 H.P. MOTOR
500 H.P. DIESEL BACKUP

C.F.M. AT
WATER GAUGE

N 360,000

N 361,000

200'



RECEIVED
 JUN 22 1987

DIVISION OF
 OIL, GAS & MINING

Deer Creek & Wilberg Mines		
EMERY COUNTY, UTAH		
1986 SUBSIDENCE		
DEER CREEK 9th EAST - WILBERG 1st RIGHT		
UTAH POWER & LIGHT COMPANY		
MINING DIVISION-SALT LAKE CITY, UTAH 84110		
DRAWN BY: LJ Hansen	CHECKED BY:	DATE: Mar. 10, 1987
Scale	Sheet No.	Drawing Number
1" = 200'		FIGURE 5

Area 2

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

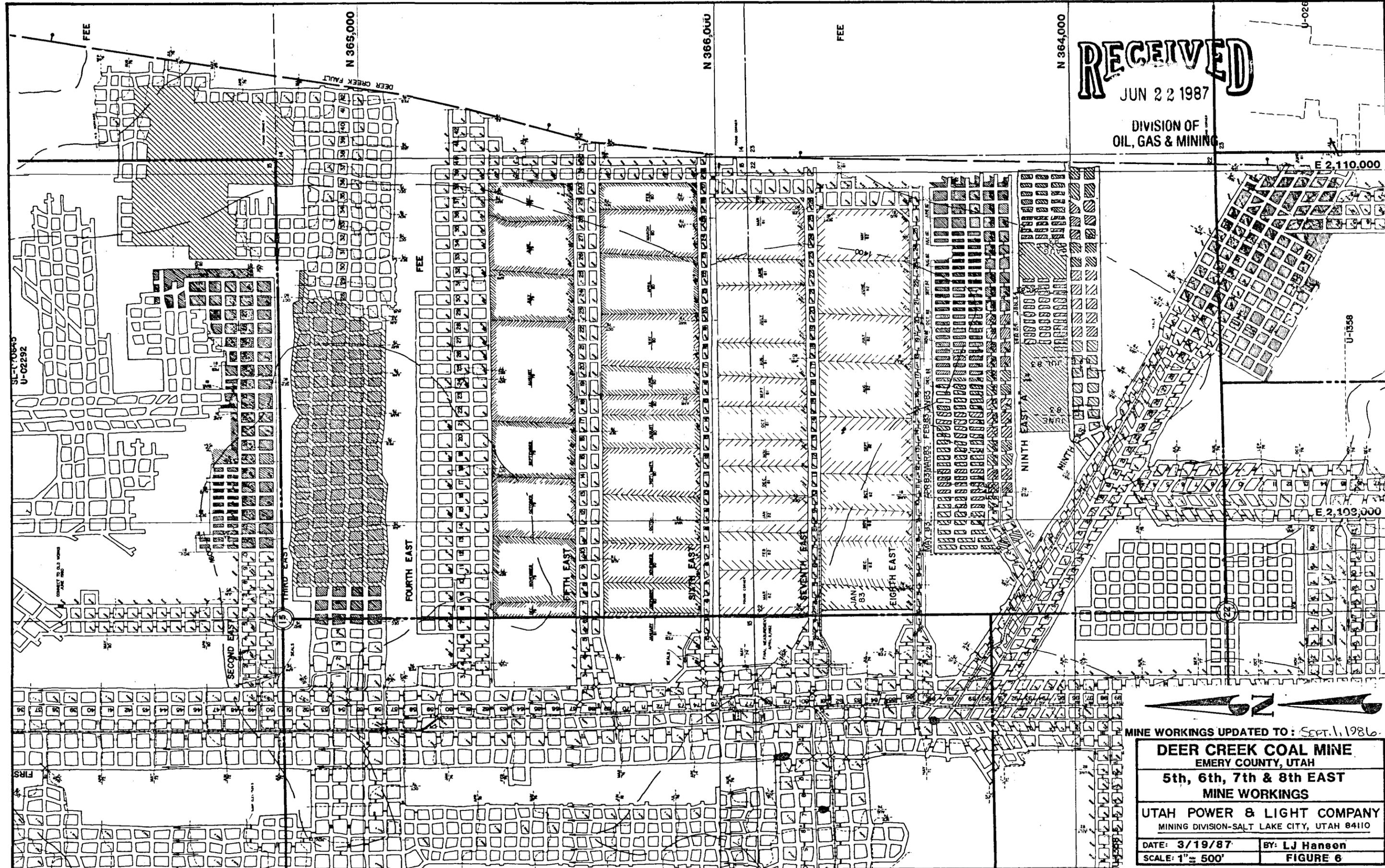
Wilberg 6th, 7th, and 10th through 13th Right Longwall Panels

Mining in the Deer Creek Mine in this area had been completed by February 1985. Underlying this seam coal extraction in the Wilberg Mine continued from September 1, 1984 until December 19, 1984, when mining was interrupted due to a fire. During this time the 6th Right panel, 620 feet of the 5th Right panel, and 1000 feet of the 13th Right panel were completed. From July through December 1985 new main entries were driven around the fire area (Figures 6 and 7).

In 1986 this area was surveyed by both photogrammetric methods and conventional on-the-ground methods (Figures 8a and 8b). Once again, the two surveys were in fairly close agreement. The photogrammetric survey showed a maximum of 12 feet of subsidence while on-the-ground methods indicated that nearly 12 feet had occurred. In both surveys maximum subsidence of the Deer Creek 6th East and Wilberg 6th and 7th Right longwall panels occurred. Although the magnitude of the subsidence did not increase, the area continued to elongate to the north and south in 1986. The photogrammetric survey appears to show greater detail since data points are more evenly spaced than with the conventional survey. It is interesting to note that the shape of the subsidence trough seems to be influenced more by the Wilberg Mine workings than the workings in the Deer Creek Mine. Neither UP&L nor contracted survey personnel have detected any surface fissures or any other visible disturbance.

RECEIVED
JUN 22 1987

DIVISION OF
OIL, GAS & MINING



S.L. 10895
U-02292

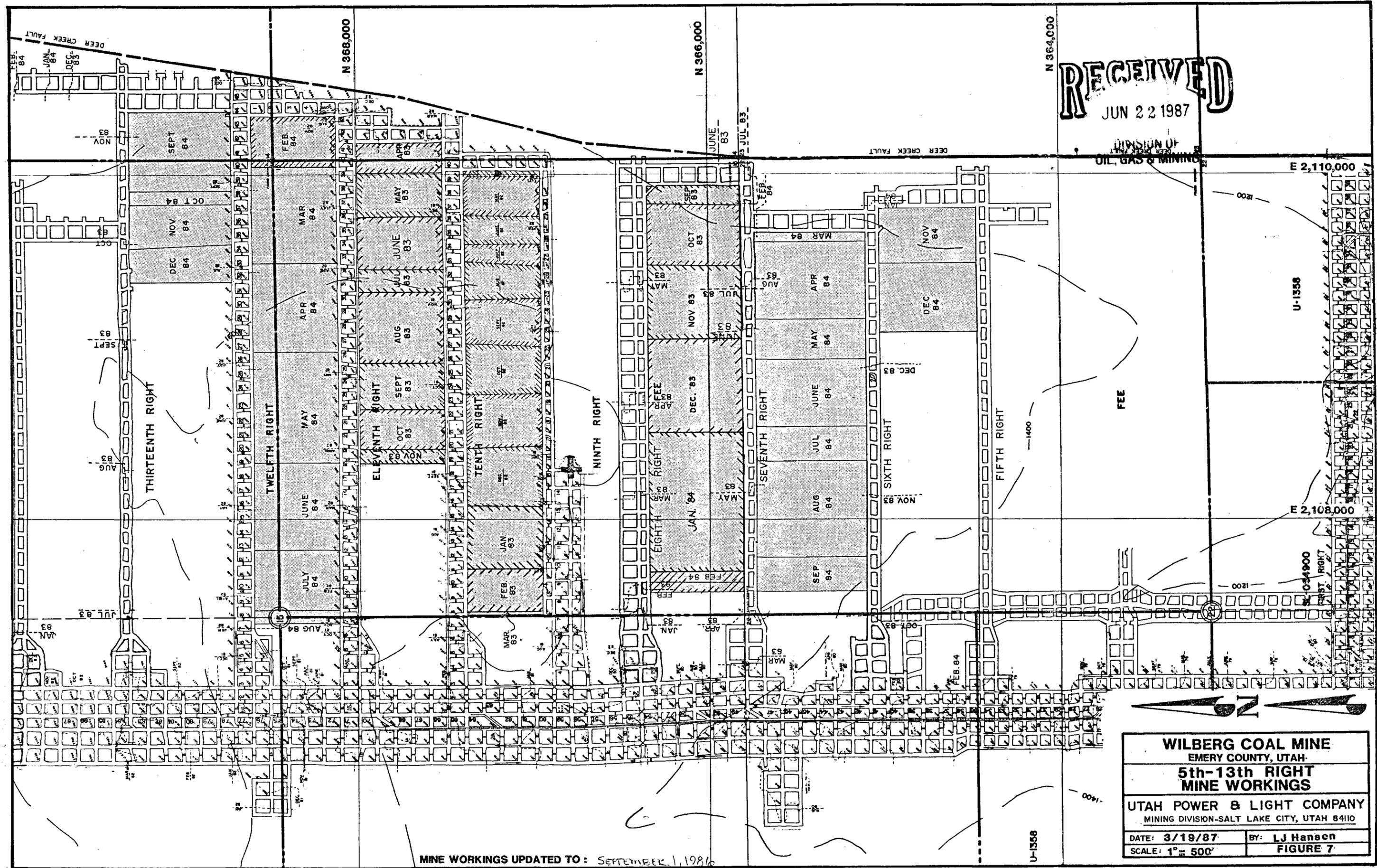
U-1558

MINE WORKINGS UPDATED TO: Sept. 1, 1986.

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: LJ Hansen
SCALE: 1" = 500'	FIGURE 6

RECEIVED
JUN 22 1987

DIVISION OF
OIL, GAS & MINING



MINE WORKINGS UPDATED TO: SEPTEMBER 1, 1986

WILBERG COAL MINE EMERY COUNTY, UTAH	
5th-13th RIGHT MINE WORKINGS	
UTAH POWER & LIGHT COMPANY MINING DIVISION-SALT LAKE CITY, UTAH 84110	
DATE: 3/19/87	BY: LJ Hansen
SCALE: 1" = 500'	FIGURE 7

U-1356

U-1356

U-1356

FEE

FIFTH RIGHT

SIXTH RIGHT

SEVENTH RIGHT

EIGHTH RIGHT

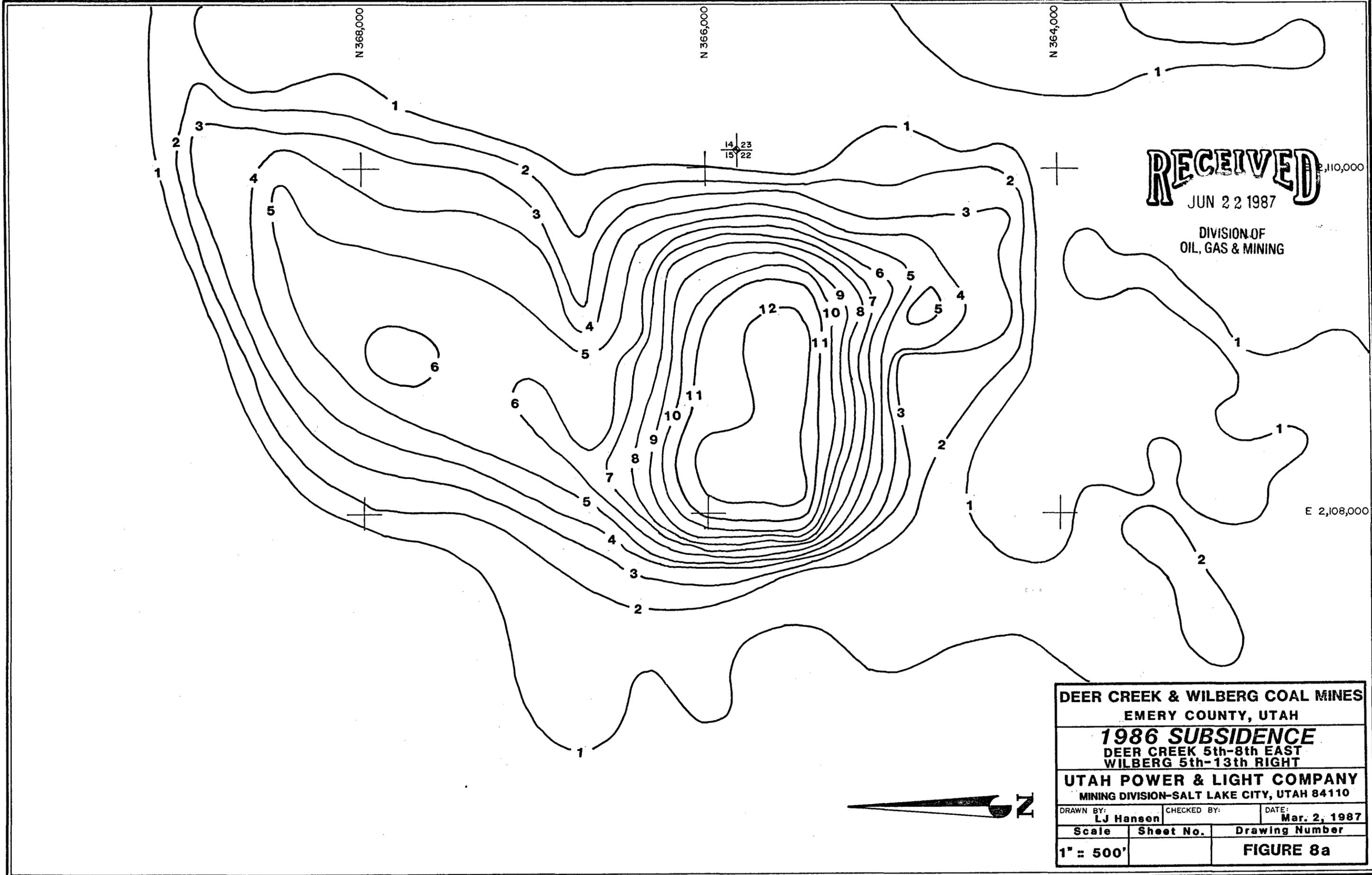
NINTH RIGHT

TENTH RIGHT

ELEVENTH RIGHT

TWELFTH RIGHT

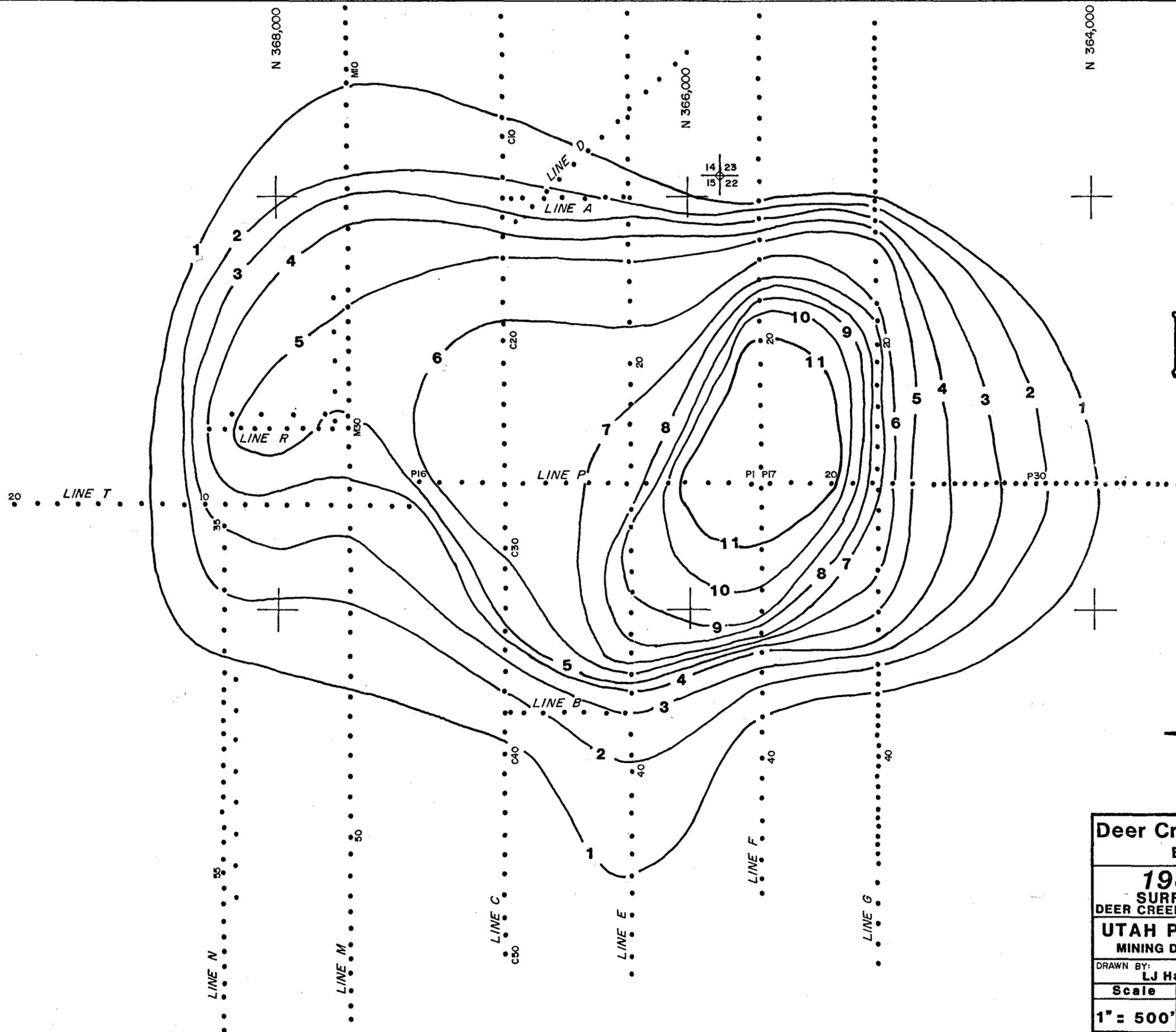
THIRTEENTH RIGHT



RECEIVED
JUN 22 1987

DIVISION OF
OIL, GAS & MINING

DEER CREEK & WILBERG COAL MINES		
EMERY COUNTY, UTAH		
1986 SUBSIDENCE		
DEER CREEK 5th-8th EAST WILBERG 5th-13th RIGHT		
UTAH POWER & LIGHT COMPANY		
MINING DIVISION-SALT LAKE CITY, UTAH 84110		
DRAWN BY: LJ Hansen	CHECKED BY:	DATE: Mar. 2, 1987
Scale 1" = 500'	Sheet No.	Drawing Number FIGURE 8a



RECEIVED
 JUN 22 1987

DIVISION OF
 OIL, GAS & MINING



Deer Creek & Wilberg Coal Mines EMERY COUNTY, UTAH		
1986 SUBSIDENCE		
SURFACE MONUMENT SURVEY		
DEER CREEK 5th-8th EAST WILBERG 5th-13th RIGHT		
UTAH POWER & LIGHT COMPANY		
MINING DIVISION-SALT LAKE CITY, UTAH 84110		
DRAWN BY: LJ Hansen	CHECKED BY:	DATE: Mar. 2, 1987
Scale 1" = 500'	Sheet No.	Drawing Number FIGURE 8b

Angle-of-draw has been calculated where possible for the area. On the eastern side the angle is influenced by the Deer Creek Fault and adjacent Little Dove Mine workings across the fault; it ranges from vertical to 18° . On the north and south the maximum angles-of-draw are 10° and 23° , respectively. On the western side the angle ranges from near vertical to 20° .

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, 1986).

Area 3

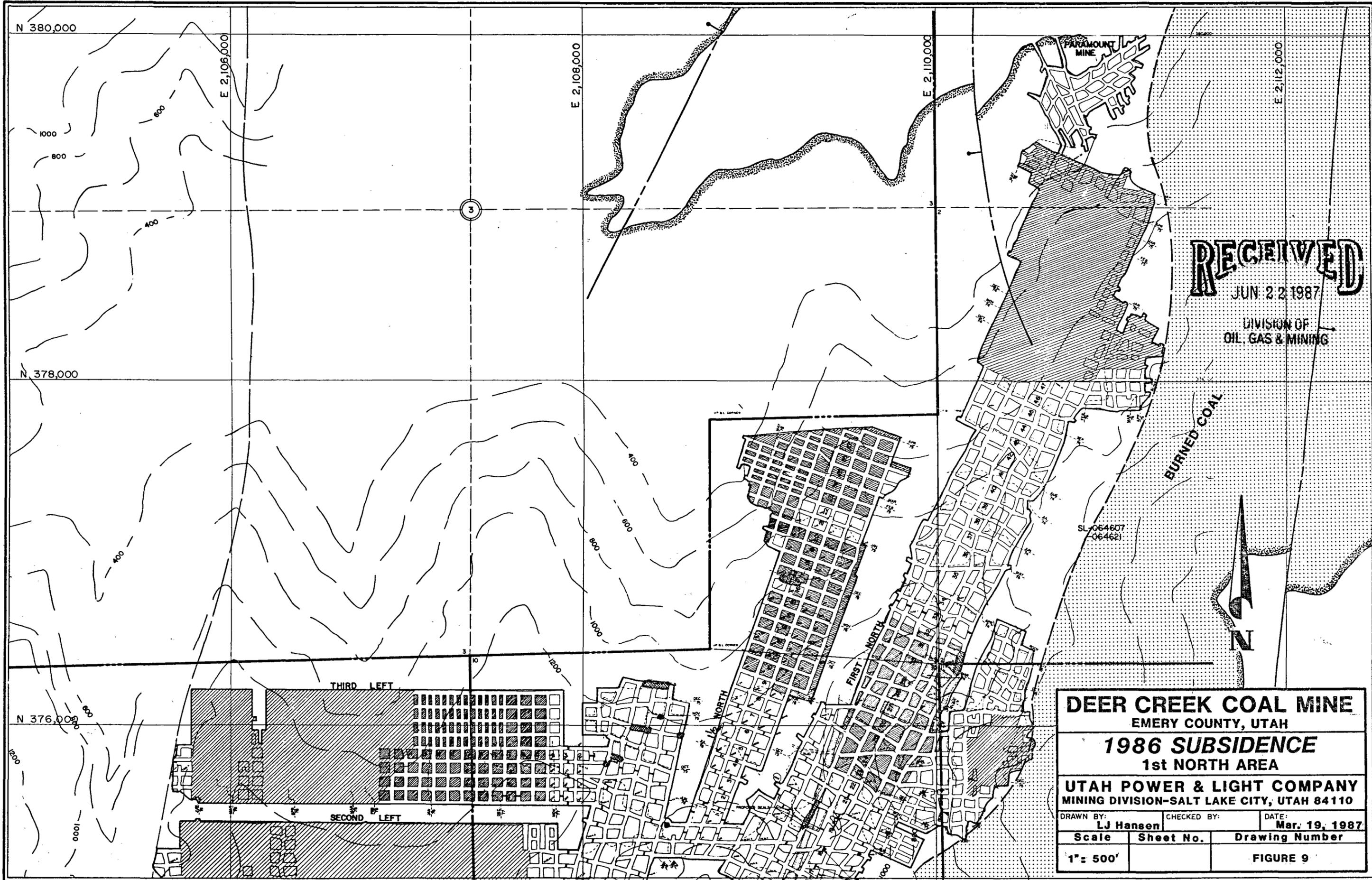
Deer Creek 1st North Area

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 will 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. The greatest subsidence observed over this area is 3 feet. It occurred over an area of burned coal 600 feet northeast of the 1st North workings (Figures 9 and 10). Other points showing greater elevation changes (up to 15 feet) were noted but these have been attributed to mass wasting, such as movement of a large boulder or escarpment failure. One rock slide occurred since the last monitoring period but it is so far (nearly 2000 feet) from the nearest workings that it is probably not related to mining.

In the past two years no measurable increase in subsidence has occurred and, since the workings in the area are no longer active, subsidence will now be monitored on an every-other-year basis.

The calculated angle-of-draw for the area ranges from vertical to 40°, but the measurements are influenced by burned coal, steep slopes, and fracturing, which have complicated the subsidence process.

The strata in the area are dry because they lack adequate hydrologic recharge. Therefore, the subsidence will not affect the hydrology.



RECEIVED
 JUN 22 1987

DIVISION OF
 OIL, GAS & MINING

BURNED COAL

SL 064607
 064621



DEER CREEK COAL MINE		
EMERY COUNTY, UTAH		
1986 SUBSIDENCE		
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 9

N 380,000

N 378,000

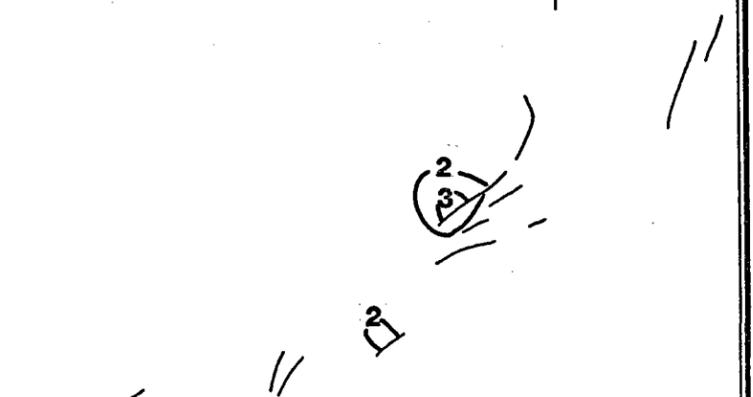
N 376,000

E 2,106,000

E 2,108,000

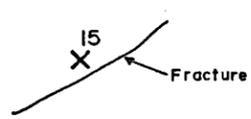
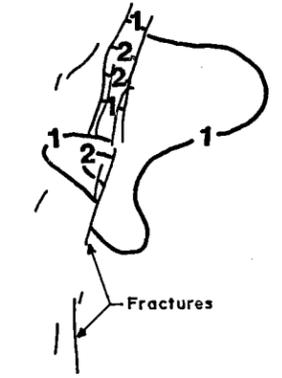
E 2,110,000

E 2,112,000



RECEIVED
JUN 22 1987

DIVISION OF
OIL, GAS & MINING



DEER CREEK COAL MINE		
EMERY COUNTY, UTAH		
1986 SUBSIDENCE		
1st NORTH AREA		
UTAH POWER & LIGHT COMPANY		
MINING DIVISION-SALT LAKE CITY, UTAH 84110		
DRAWN BY: LJ Hansen	CHECKED BY:	DATE: Feb. 27, 1987
Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 10

X=Point of Slope or Cliff Failure. These are Isolated Points With No Surrounding Subsidence. Number Indicates Elevation Drop in Feet.

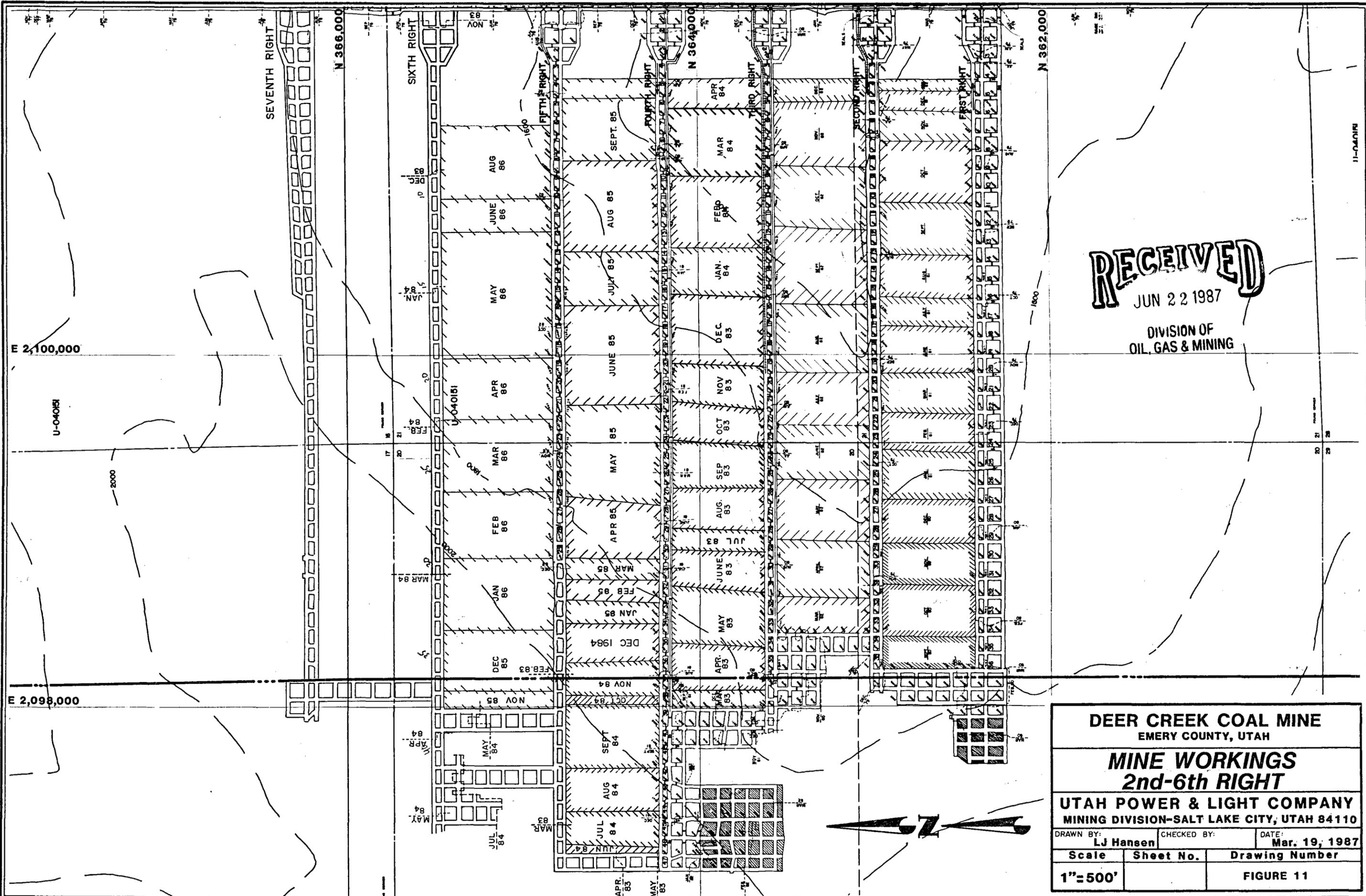
Area 4

Deer Creek 2nd through 6th Right Longwall Panels

Subsidence in this area 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 1986, the 2nd, 3rd, 4th, and 5th Right panels as well as 3300 feet of the 6th Right longwall panel had been completed (Figure 11).

The maximum subsidence yet noted is nearly 7 feet over the 3rd and 4th Right longwall panels (Figure 12). Curiously, where subsidence of up to 5 feet was measured in 1985 over two (2) room-and-pillar sections to the west of these panels, 1986 measurement shows only 3 feet. The surface above these sections forms steep slopes, and it is assumed that some type of ground movement has caused the original depressions to fill slightly. However, no slumping or fractures have been noted in any part of the area, either on the ground or from the air. The calculated angle-of-draw of the subsidence ranges from near vertical to about 22°, but more meaningful estimates may be possible when subsidence has stabilized.

Several springs are located on East Mountain above the Deer Creek 1st through 5th Right and 1st through 5th Left (see Area 5) mine workings. Figure 13 is a graph comparing the discharge from these springs with the annual precipitation on East Mountain. Fluctuations in spring flow appear to be related to variations in precipitation. The relationship appears to hold well for all years except 1985. In examining temperature data obtained from a weather station on East Mountain we found that during the months April and May of 1985



RECEIVED
 JUN 22 1987

DIVISION OF
 OIL, GAS & MINING

DEER CREEK COAL MINE
 EMERY COUNTY, UTAH

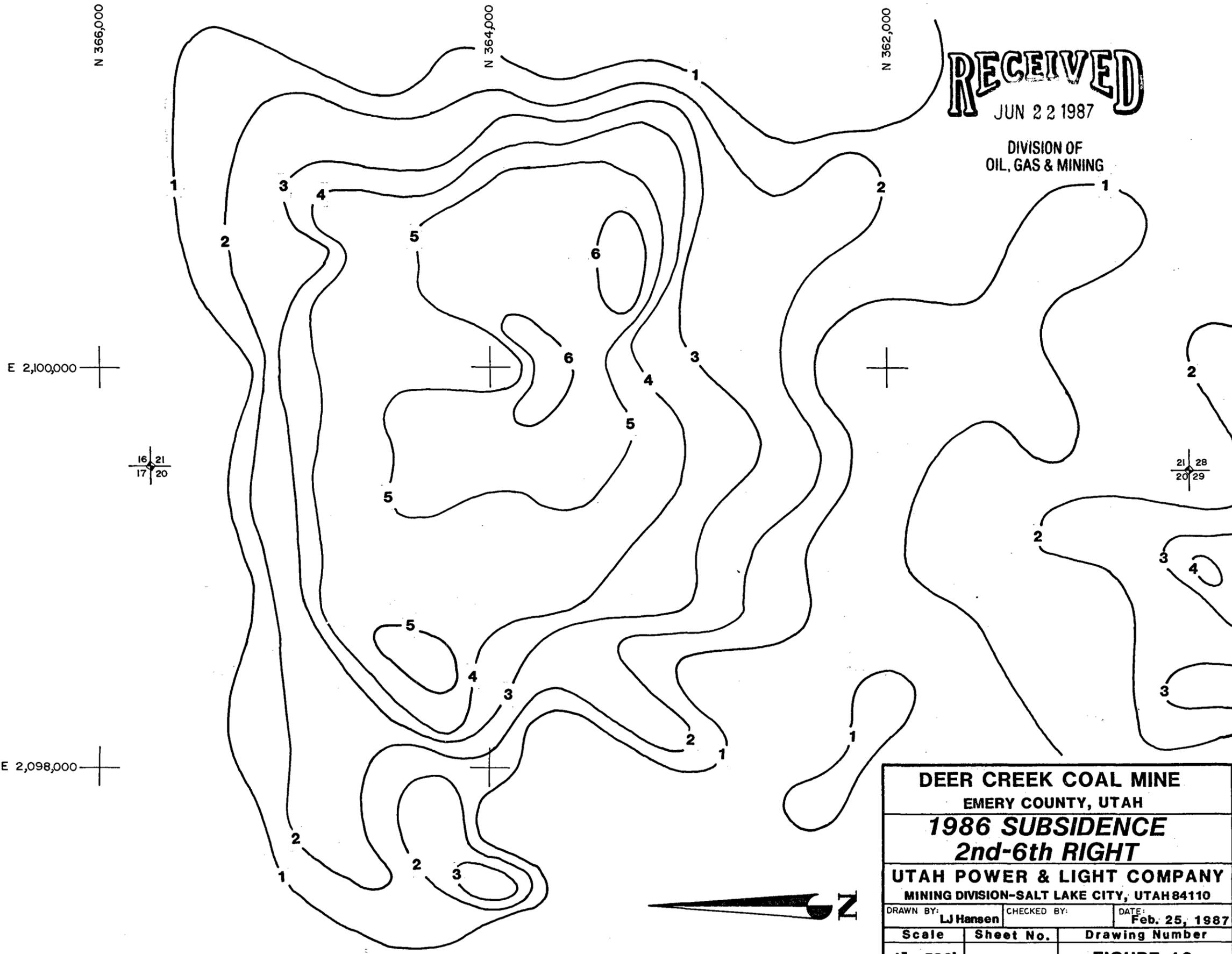
MINE WORKINGS
2nd-6th RIGHT

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

DRAWN BY: **LJ Hansen** CHECKED BY: DATE: **Mar. 19, 1987**

Scale Sheet No. Drawing Number

1"=500' **FIGURE 11**

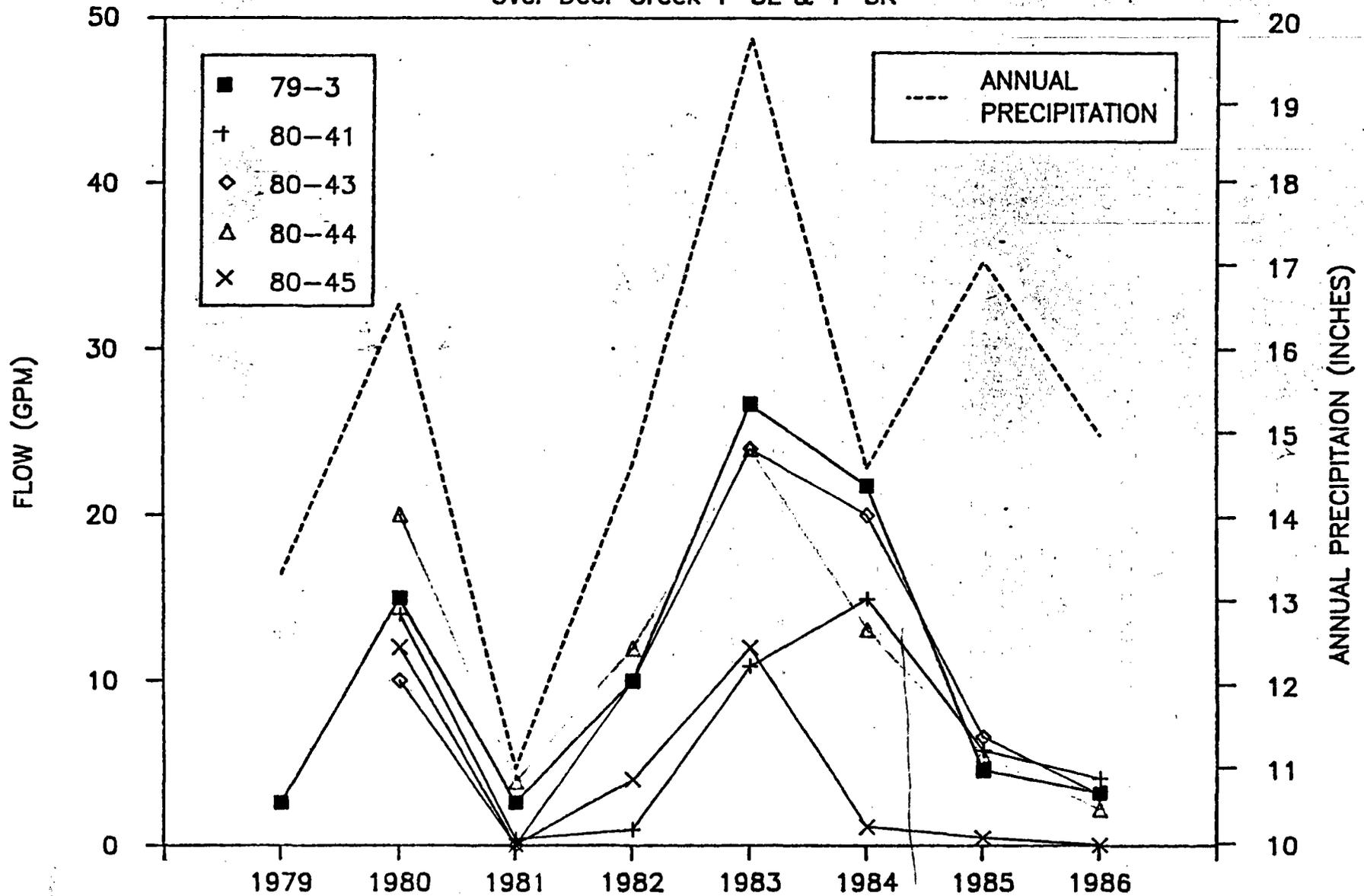


RECEIVED
 JUN 22 1987

DIVISION OF
 OIL, GAS & MINING

DEER CREEK COAL MINE		
EMERY COUNTY, UTAH		
1986 SUBSIDENCE		
2nd-6th RIGHT		
UTAH POWER & LIGHT COMPANY		
MINING DIVISION-SALT LAKE CITY, UTAH 84110		
DRAWN BY: LJ Hansen	CHECKED BY:	DATE: Feb. 25, 1987
Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 12

Figure 13
EAST MOUNTAIN SPRINGS
 Over Deer Creek 1-5L & 1-5R



temperatures averaged 7 degrees above normal. The unusually high temperatures caused most of the snow-melt to occur before the springs could be sampled in July, when peak runoff usually occurs, accounting for the lower than expected spring discharges measured in 1985.

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

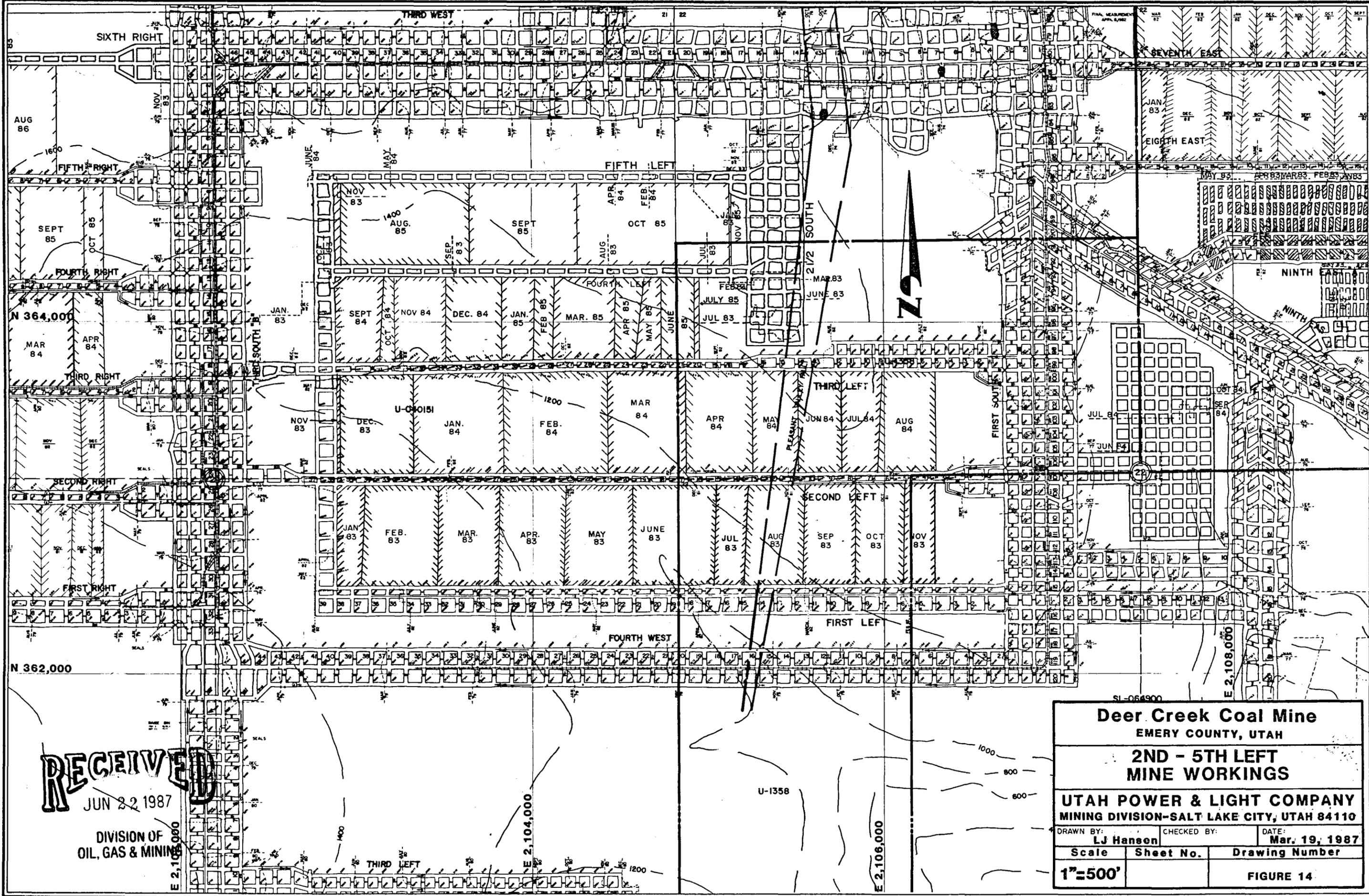
Area 5

Deer Creek 2nd through 5th Left Longwall Panels

Photogrammetric monitoring revealed subsidence in the area for the first time in 1984. Mining of the 2nd Left panel began in January 1983, and by September 1986 all four panels had been completed (Figure 14).

Maximum subsidence over the panels continues to be 5 feet and occurs over much of the 3rd Left panel (Figure 15). The maximum angle-of-draw is now approximately 23° but, since the area may continue to subside for a time, this is not considered a reliable figure. No surface disturbance has been seen.

As mentioned in the previous section, it is believed that none of the springs located above these workings show any adverse effects due to mining (see Figure 13 in the preceding section).



SI-064900

Deer Creek Coal Mine
EMERY COUNTY, UTAH

2ND - 5TH LEFT
MINE WORKINGS

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

DRAWN BY: LJ Hansen		CHECKED BY:		DATE: Mar. 19, 1987
Scale	Sheet No.	Drawing Number		
1"=500'		FIGURE 14		

RECEIVED
JUN 22 1987
DIVISION OF
OIL, GAS & MINING

N 364,000

N 362,000



E 2,102,000

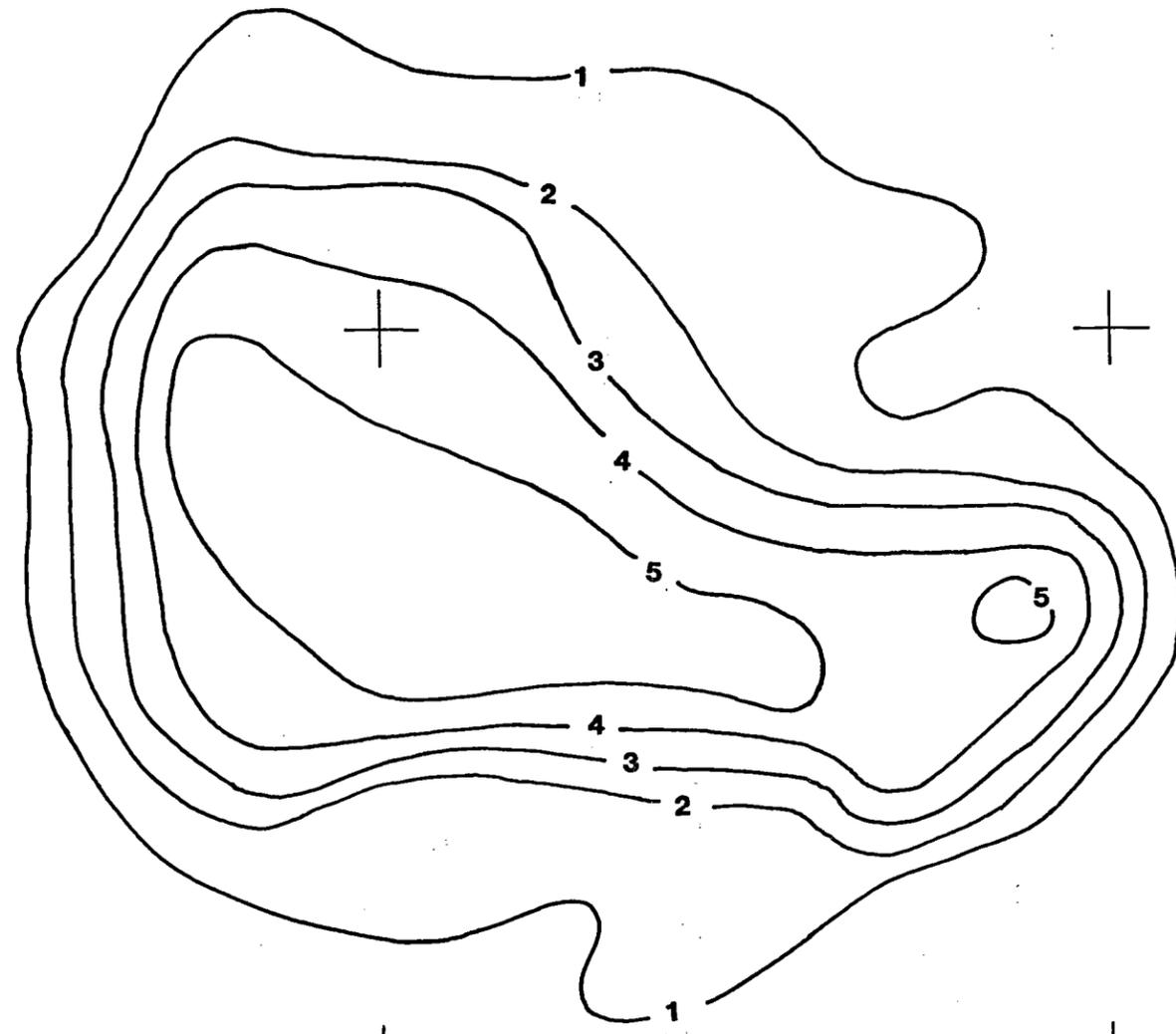


E 2,104,000



E 2,106,000

E 2,108,000



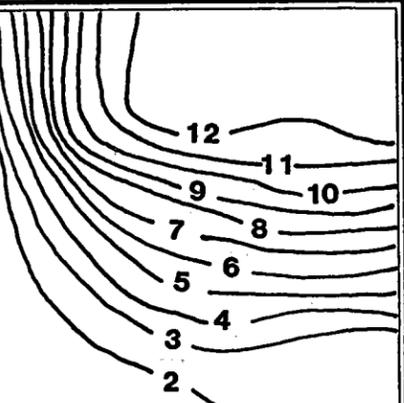
RECEIVED
JUN 22 1987

DIVISION OF
OIL, GAS & MINING

1

2

1



DEER CREEK COAL MINE		
EMERY COUNTY, UTAH		
1986 SUBSIDENCE		
2nd-5th LEFT		
UTAH POWER & LIGHT COMPANY		
MINING DIVISION-SALT LAKE CITY, UTAH 84110		
DRAWN BY: LJ Hansen	CHECKED BY:	DATE: Mar. 3, 1987
Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 15

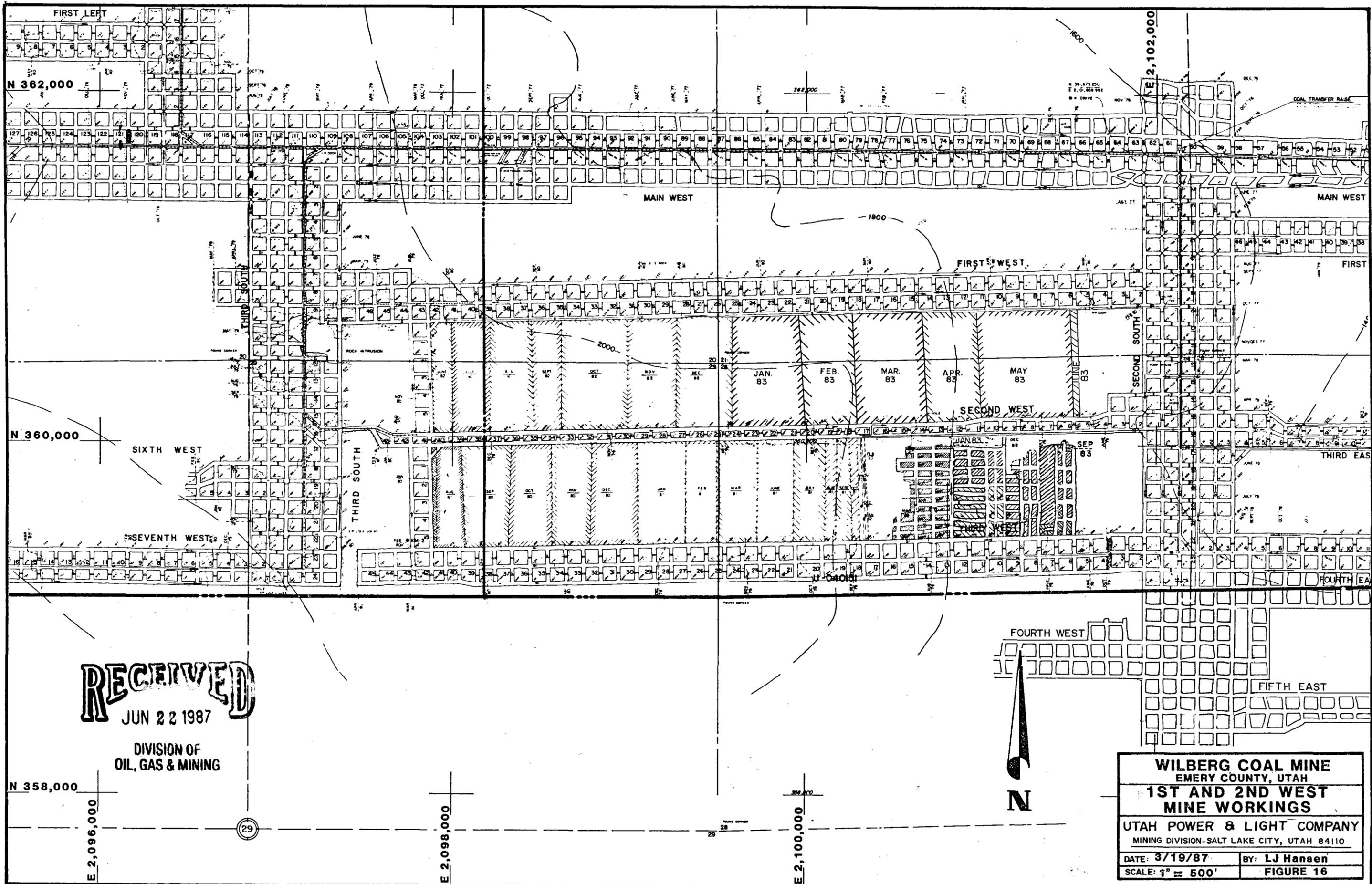
Area 6

Wilberg 1st and 2nd West Longwall Panels

Subsidence over the Wilberg 1st and 2nd West longwall panels was first detected in 1983 by U. S. Bureau of Mines surface monument surveys (Figure 16). Mining in the panels was completed in early June 1983 but subsidence continued in the 1984 monitoring period. Since late 1984, however, no additional movement has been detected and the area has stabilized. The area will now be monitored for subsidence on an every-other-year basis.

Maximum subsidence reached just over 5 feet (Figure 17); no surface disturbance of any kind has been found. On the south side of the workings the subsidence diminishes to less than 0.5 feet within 1200 feet. With 2000 feet of overburden this equates to an angle-of-draw of 21 degrees.

Four springs located just north of the area show no effect from the subsidence. (See Hydrologic Monitoring Report, 1986).



RECEIVED
 JUN 22 1987

DIVISION OF
 OIL, GAS & MINING

WILBERG COAL MINE	
EMERY COUNTY, UTAH	
1ST AND 2ND WEST	
MINE WORKINGS	
UTAH POWER & LIGHT COMPANY	
MINING DIVISION-SALT LAKE CITY, UTAH 84110	
DATE: 3/19/87	BY: LJ Hansen
SCALE: 1" = 500'	FIGURE 16

N 362,000 — E 2,096,000

E 2,098,000

E 2,100,000

E 2,102,000

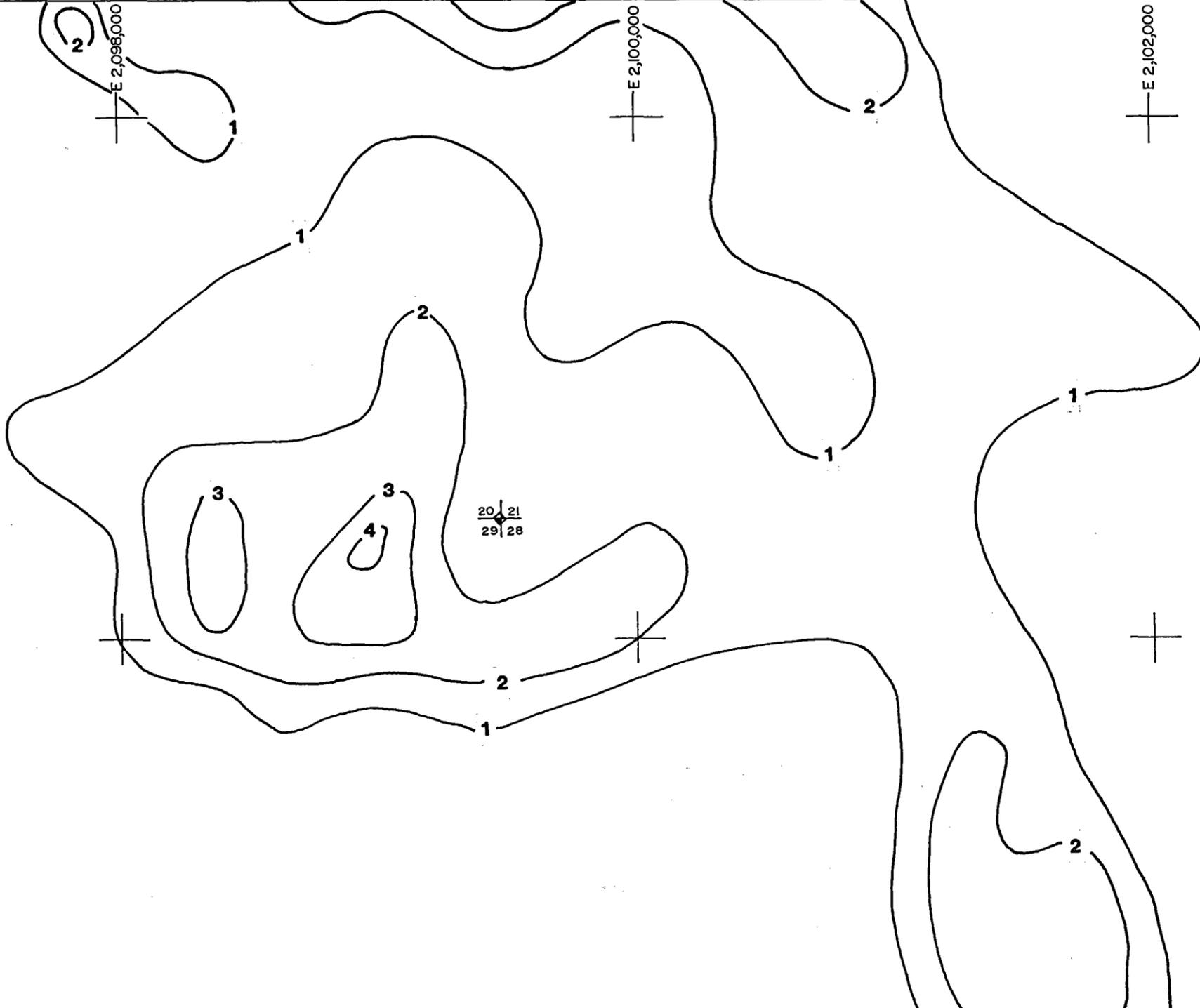
N 360,000

N 358,000

20
29

20 21
29 28

28
29



RECEIVED
JUN 22 1987

DIVISION OF
OIL, GAS & MINING



WILBERG COAL MINE		
EMERY COUNTY, UTAH		
1986 SUBSIDENCE		
1st & 2nd WEST		
UTAH POWER & LIGHT COMPANY		
MINING DIVISION-SALT LAKE CITY, UTAH 84110		
DRAWN BY: LJ Hansen	CHECKED BY:	DATE: Feb. 25, 1987
Scale 1" = 500'	Sheet No.	Drawing Number FIGURE 17

Area 7

Beehive Mine 2nd North off 8th West

Pillar extraction mining was terminated in December 1983 in this section of the Beehive Mine. The area is surrounded by burned coal (Figure 18).

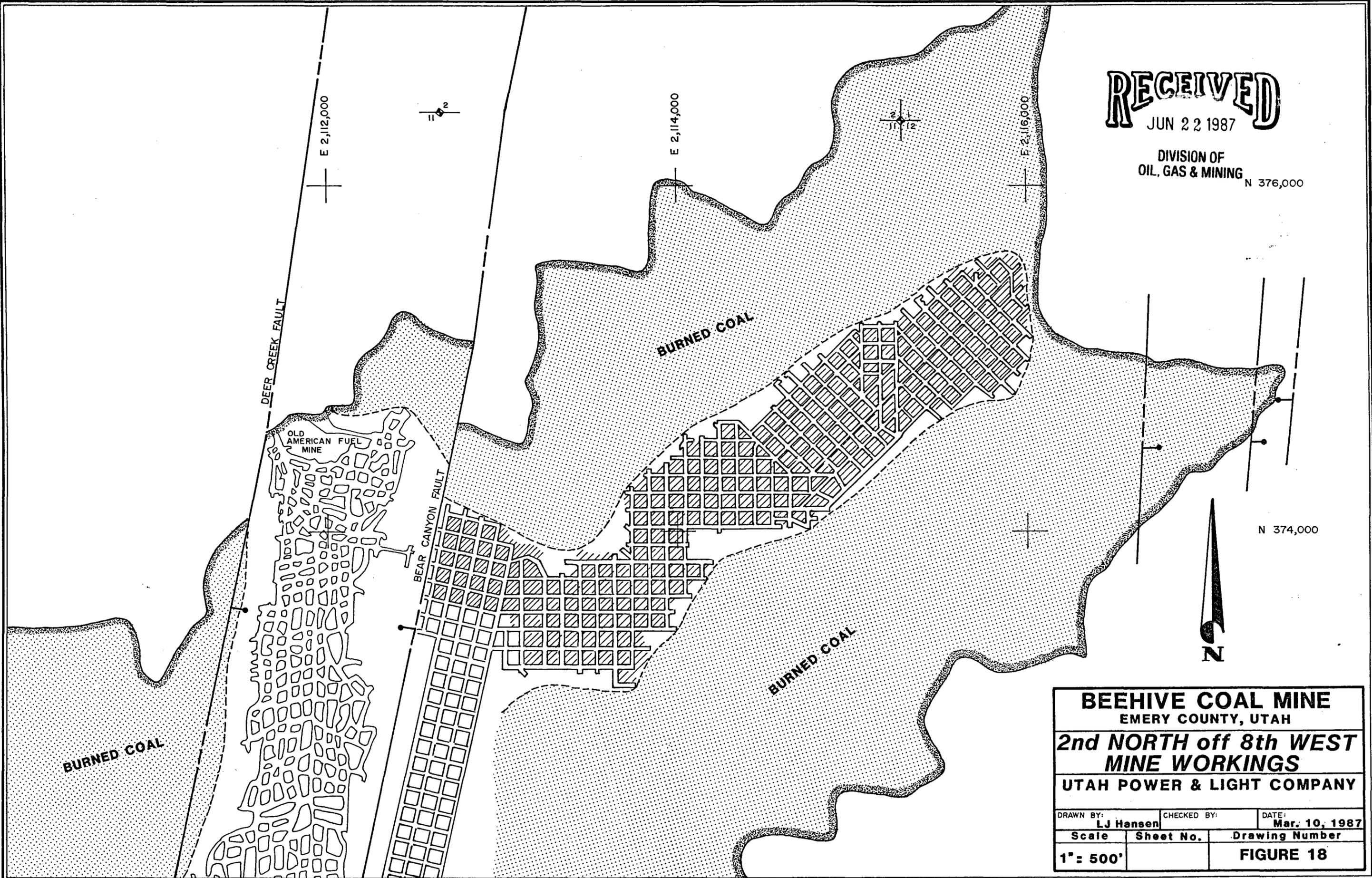
Since late 1984 little additional subsidence has occurred over the workings. Maximum subsidence reached 6 feet and appears to have stopped. Subsidence in this area will now be monitored every second year instead of annually due to the stabilization. Mass wasting of some type, probably movement of large boulders or blocks of sandstone cliff material (Figure 19), occurred at two locations. The rocks on the ridge overlying the workings were highly fractured prior to mining, and, given the fractured nature of the strata on the surface and the fact that the area overlies burned coal, it is probable that other instances of movement may occur.

Angle-of-draw has been calculated with a range from near vertical to well over 60° but, due to the very steep slopes and surrounding clinker beds, the angles have little meaning in terms of true angle-of-draw.

The strata here lack adequate recharge and are dry. It is not expected that the subsidence will influence the hydrology in the area.

RECEIVED
JUN 22 1987

DIVISION OF
OIL, GAS & MINING
N 376,000



BEEHIVE COAL MINE
EMERY COUNTY, UTAH

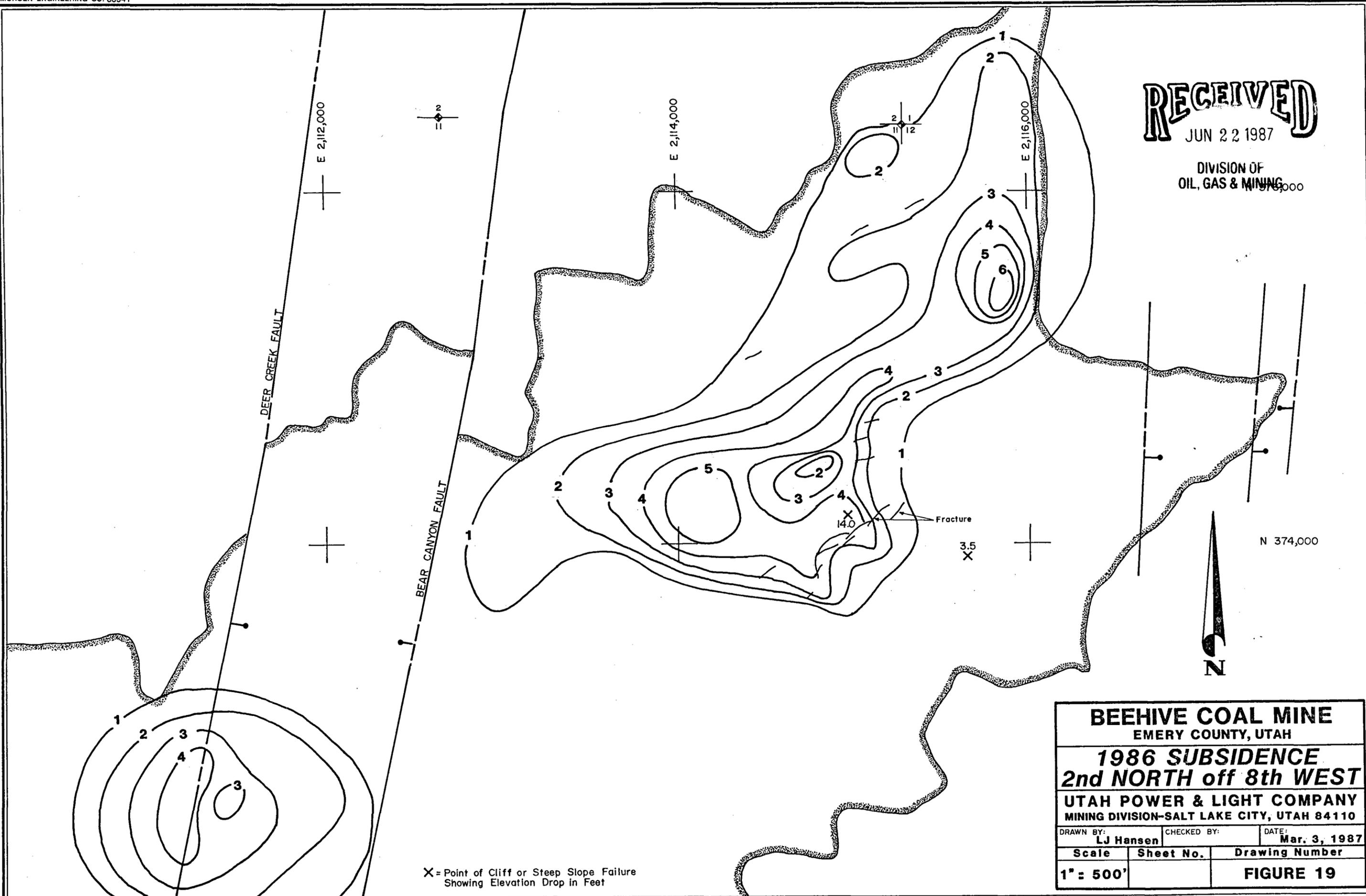
2nd NORTH off 8th WEST
MINE WORKINGS

UTAH POWER & LIGHT COMPANY

DRAWN BY: LJ Hansen		CHECKED BY:	DATE: Mar. 10, 1987
Scale	Sheet No.	Drawing Number	
1" = 500'		FIGURE 18	

RECEIVED
JUN 22 1987

DIVISION OF
OIL, GAS & MINING



X = Point of Cliff or Steep Slope Failure
Showing Elevation Drop in Feet

BEEHIVE COAL MINE EMERY COUNTY, UTAH		
1986 SUBSIDENCE 2nd NORTH off 8th WEST		
UTAH POWER & LIGHT COMPANY MINING DIVISION-SALT LAKE CITY, UTAH 84110		
DRAWN BY: LJ Hansen	CHECKED BY:	DATE: Mar. 3, 1987
Scale 1" = 500'	Sheet No.	Drawing Number
FIGURE 19		

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 this area may have gone undetected because pillar extraction, and presumable subsidence, in part of the Beehive Mine occurred before the establishment of baseline elevation data (Figures 20 and 21). The only measurable subsidence would be due to pillar extraction in the underlying Deseret Mine and would not be a true indication of total subsidence.

Subsidence in the southern part of the area is somewhat less than expected, probably due to the above reasons. Further north, where mining in both seams has been more recent, observed subsidence reached 5 feet in 1985 and did not increase in 1986. The extent of the subsidence appears to have spread westward over the 1st North Little Dove workings (Figure 22). Pillar extraction mining was active in the 1st North section during the monitoring period.

Calculated angles-of-draw range from 0 to 10 degrees.

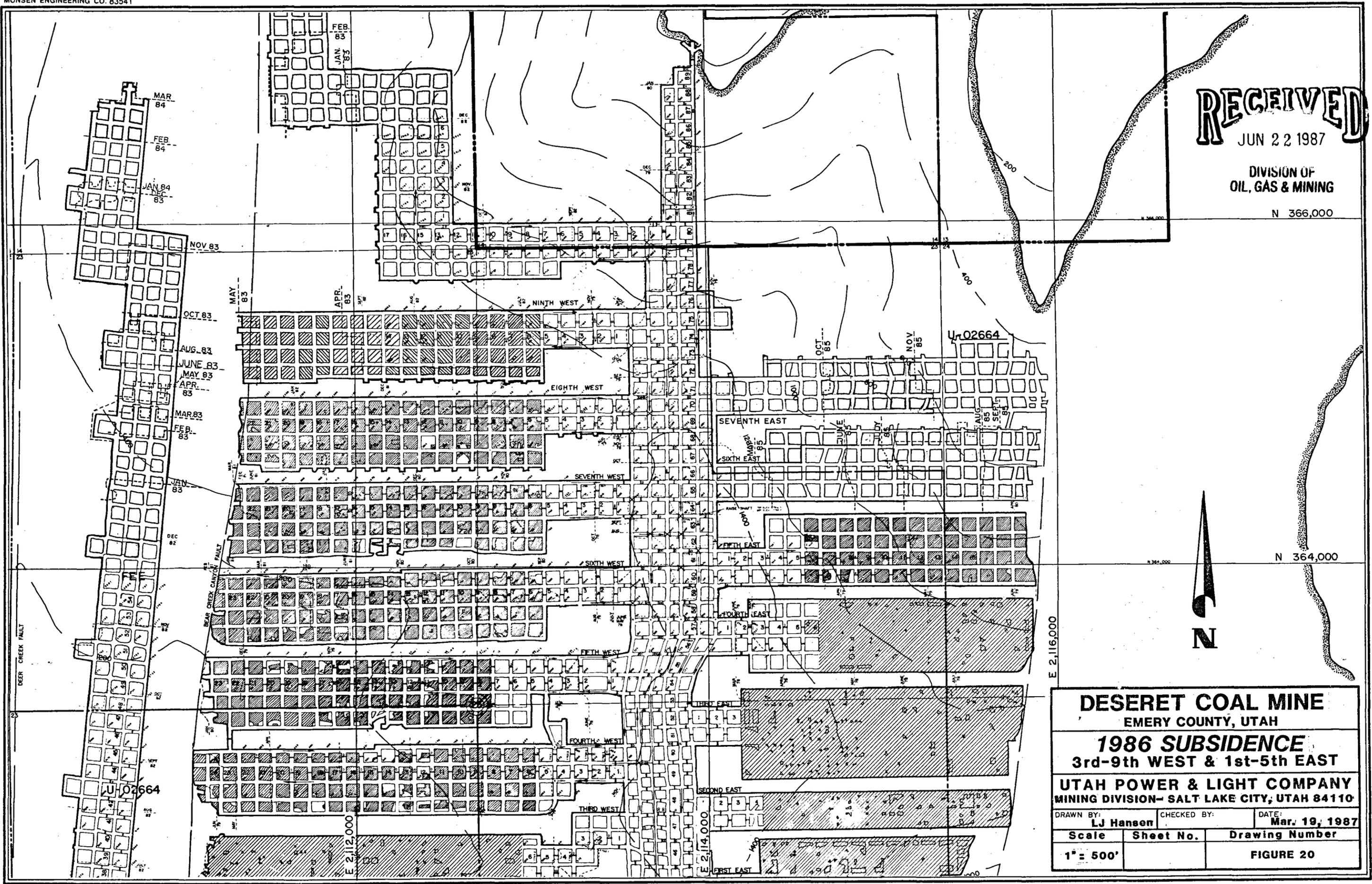
No surface fractures or other visible signs of disturbance have been noted in the area.

There are no springs in the immediate vicinity and it is believed that the subsidence has not affected the hydrology.

RECEIVED
JUN 22 1987

DIVISION OF
OIL, GAS & MINING

N 366,000



E 2,116,000



N 364,000

DESERET COAL MINE
EMERY COUNTY, UTAH

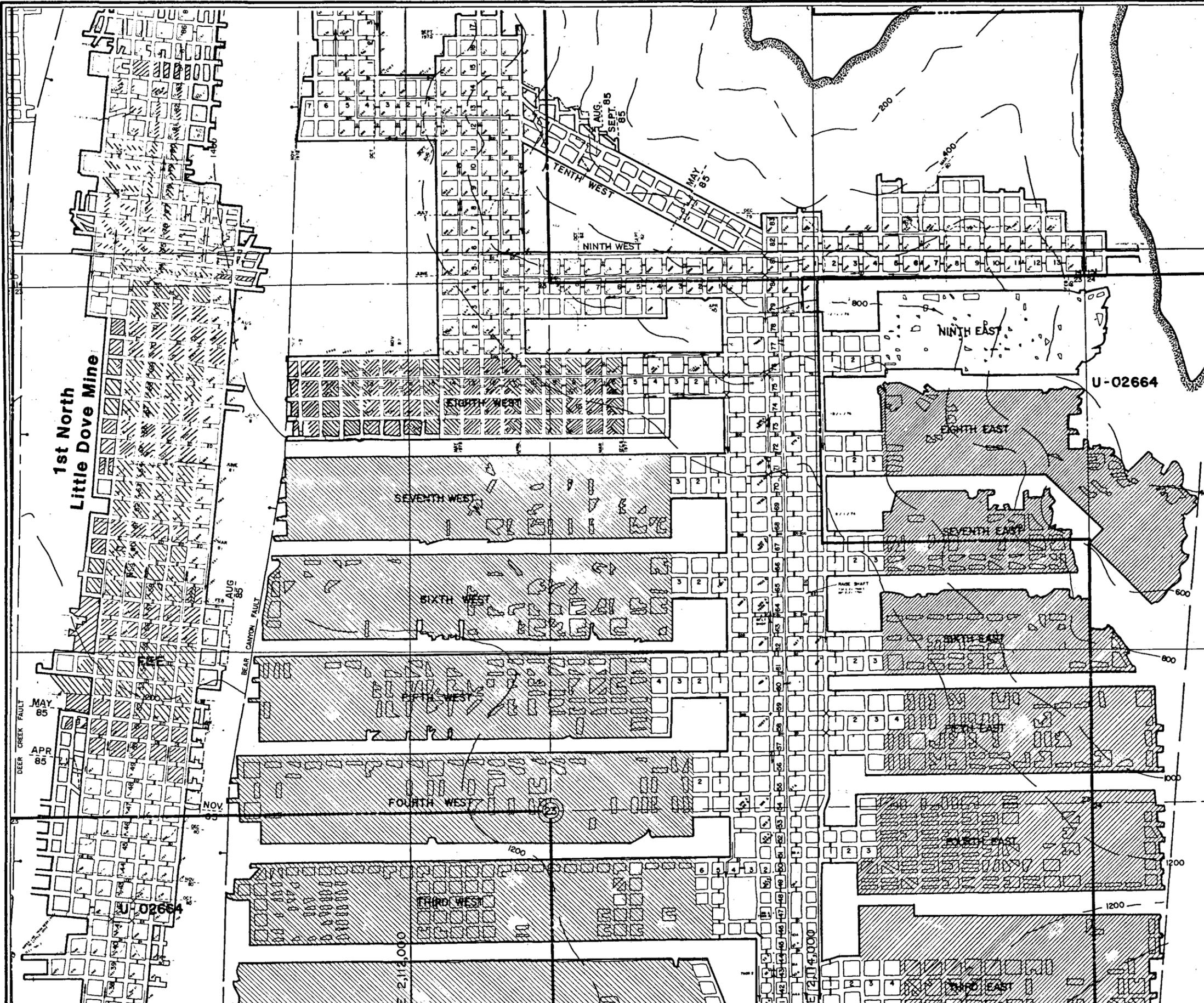
1986 SUBSIDENCE
3rd-9th WEST & 1st-5th EAST

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

DRAWN BY: LJ Hansen	CHECKED BY:	DATE: Mar. 19, 1987
Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 20

RECEIVED
JUN 22 1987

DIVISION OF
OIL, GAS & MINING
N 366,000



E 2,116,000

BEEHIVE COAL MINE
EMERY COUNTY, UTAH

1986 SUBSIDENCE
3rd-8th WEST & 3rd-9th EAST

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

DRAWN BY: LJ Hansen	CHECKED BY:	DATE: Mar. 19, 1987
Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 21

RECEIVED
JUN 22 1987

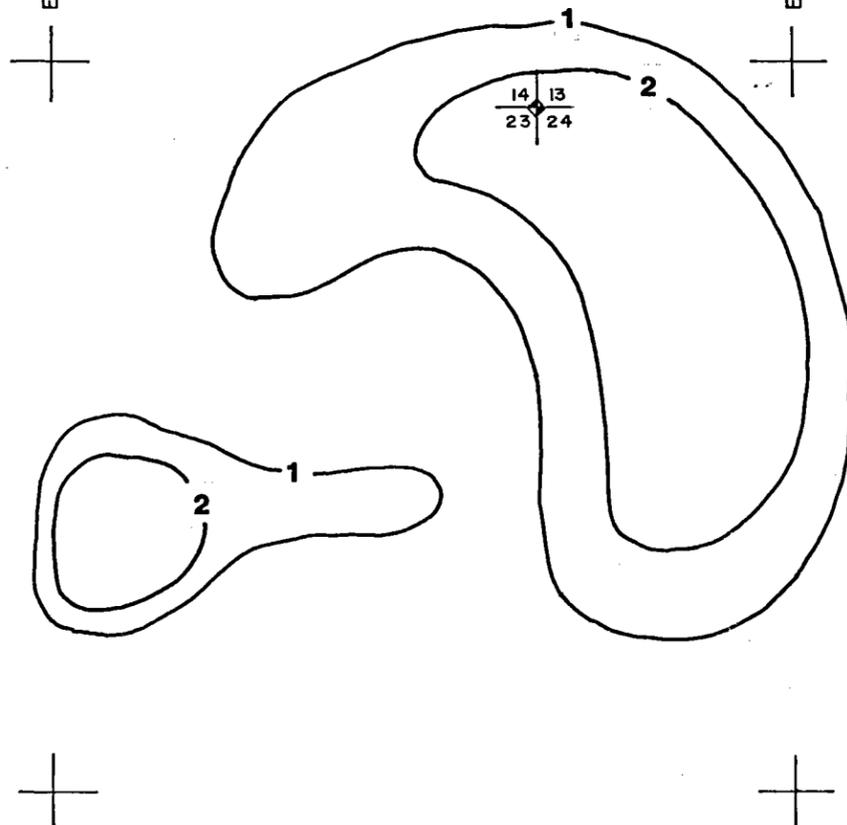
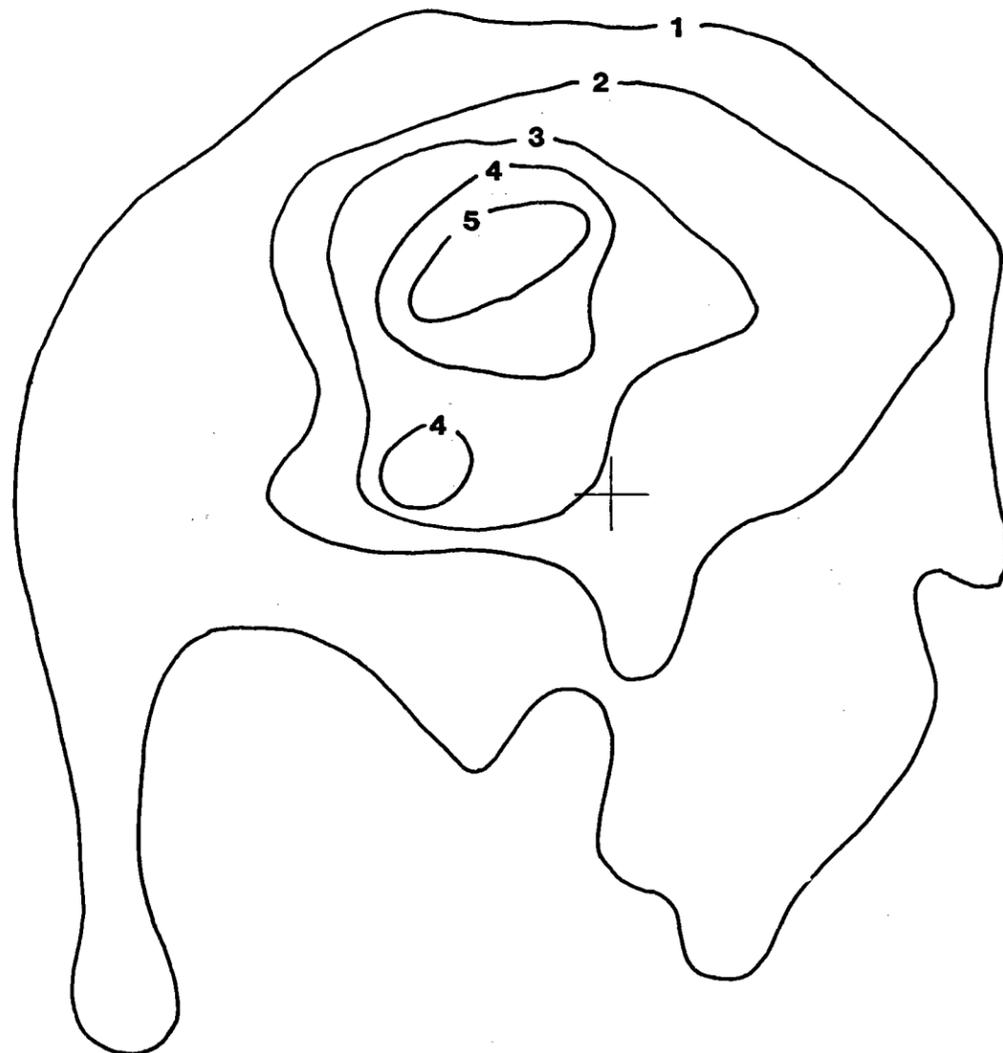
DIVISION OF
OIL, GAS & MINING

15 14
22 23

E 2,112,000

E 2,114,000

E 2,116,000
N 366,000



N 364,000

DES-BEE-DOVE COAL MINES		
EMERY COUNTY, UTAH		
1986 SUBSIDENCE		
BEEHIVE 3rd-9th WEST & 3rd-9th EAST DESERET 3rd-9th WEST & 1st-5th EAST		
UTAH POWER & LIGHT COMPANY		
DEPARTMENT OF MINING & EXPLORATION		
DRAWN BY: LJ Hansen	CHECKED BY:	DATE: Mar. 9, 1987
Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 22

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 23). In August of 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 the latest monitoring period.

To date the maximum observed subsidence over 1st North is a little over 3 feet, occurring over some of the most recently extracted pillars (Figures 28 and 30). The remaining portions of the 1st North workings and subsidence can be seen in Figures 21, 22, and 23.

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 this part 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.

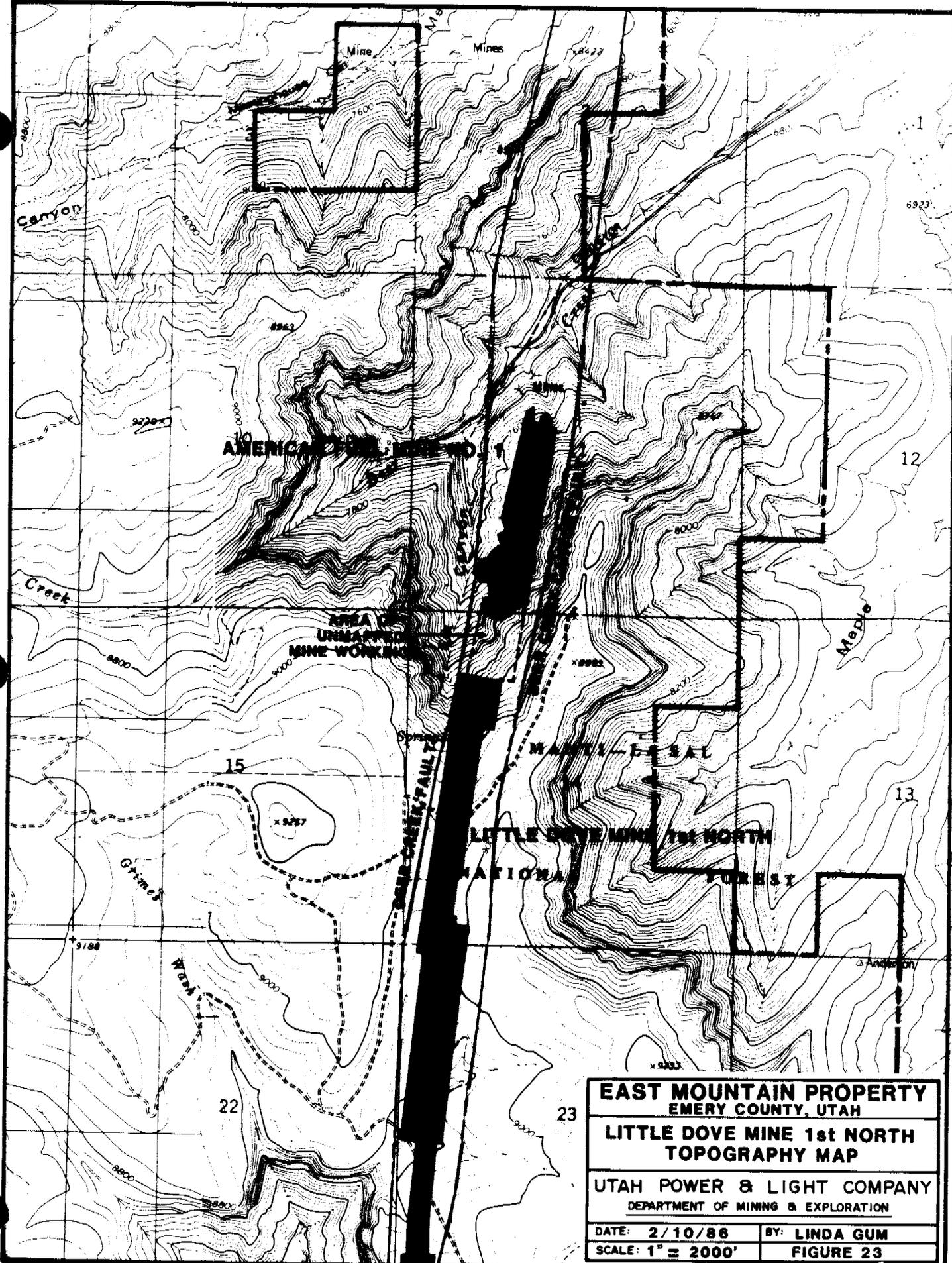
Area 10

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 (Figure 23). The latest mining in the old American Fuel Mine occurred in 1966. Since UP&L began observations, maximum subsidence has reached 4 feet over these old workings and has not increased in the last two years (Figures 24 and 25). Another small subsidence zone further south shows almost 3 feet of subsidence along the Bear Creek Canyon Fault between the American Fuel and Beehive Mine workings. Since no measurable change has occurred over this area in the past two years, monitoring will be done every other year rather than annually.

On the east side of the American Fuel Mine workings the angle-of-draw has been calculated at 10 to 15 degrees; on the west side slumping on a steep slope over possible burned coal has made angle-of-draw determination impossible.

The subsidence is not known to have affected the hydrology of the area in any way. There are no known springs in the area.



EAST MOUNTAIN PROPERTY	
EMERY COUNTY, UTAH	
LITTLE DOVE MINE 1st NORTH	
TOPOGRAPHY MAP	
UTAH POWER & LIGHT COMPANY	
DEPARTMENT OF MINING & EXPLORATION	
DATE: 2/10/86	BY: LINDA GUM
SCALE: 1" = 2000'	FIGURE 23

E 2,111,000

N 373,000

RECEIVED
JUN 22 1987

DIVISION OF
OIL, GAS & MINING

N 371,000

N 372,000

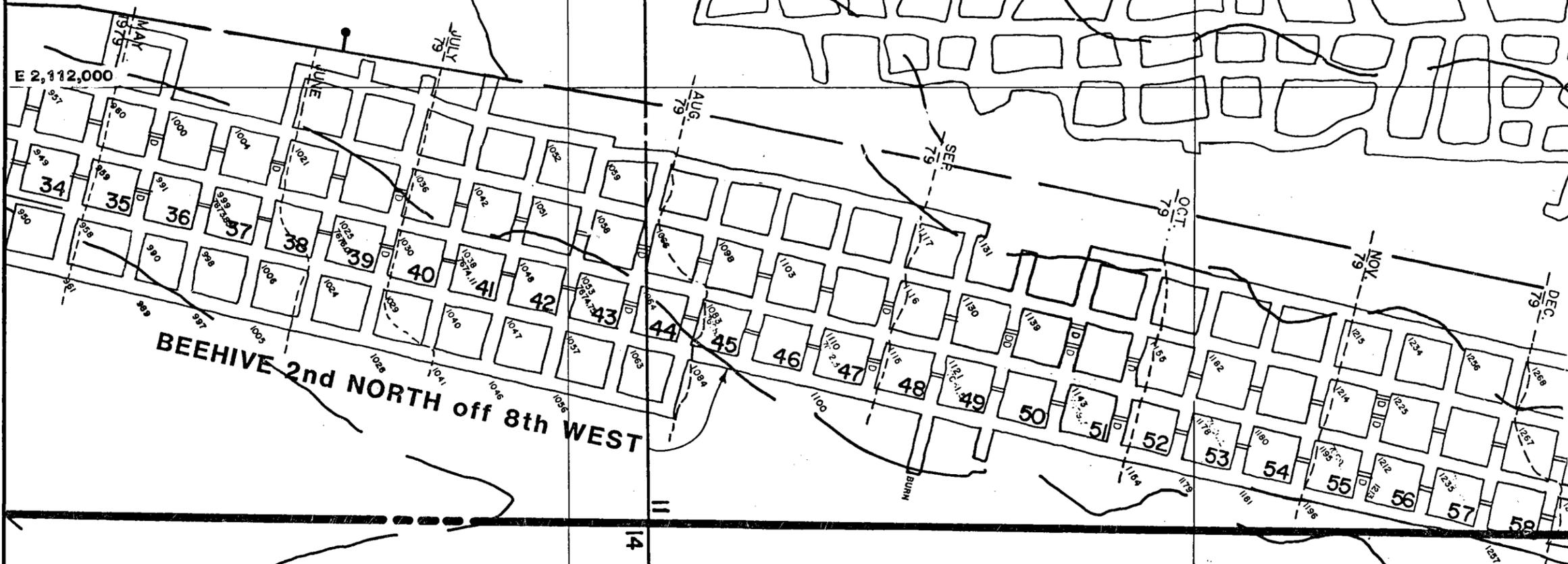
OLD AMERICAN FUEL MINE

AREA OF UNMAPPED
OLD MINE WORKINGS

FEE

800
600
1000

E 2,112,000

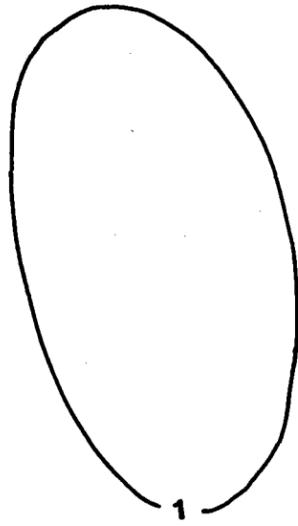


BEEHIVE 2nd NORTH off 8th WEST

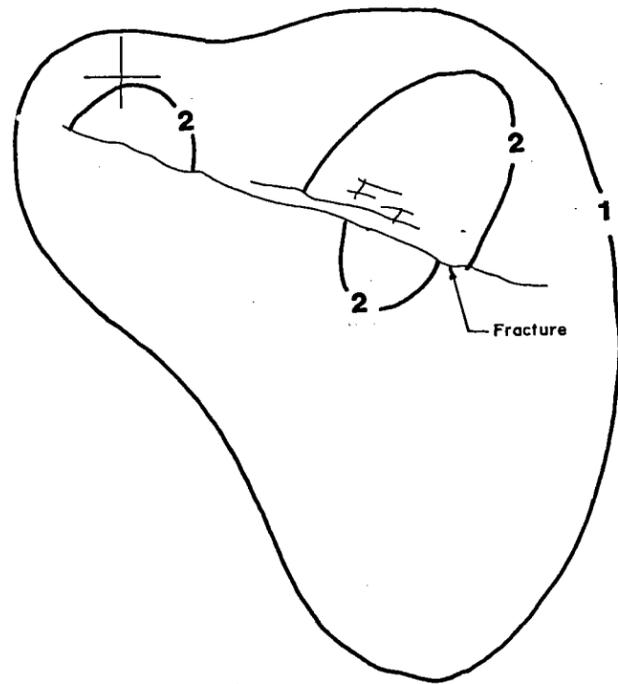


OLD AMERICAN FUEL MINE EMERY COUNTY, UTAH	
MINE WORKINGS	
UTAH POWER & LIGHT COMPANY MINING DIVISION-SALT LAKE CITY, UTAH 84110	
DATE: 3/19/87	BY: LJ Hansen
SCALE: 1" = 200'	FIGURE 24

E 2,110,000



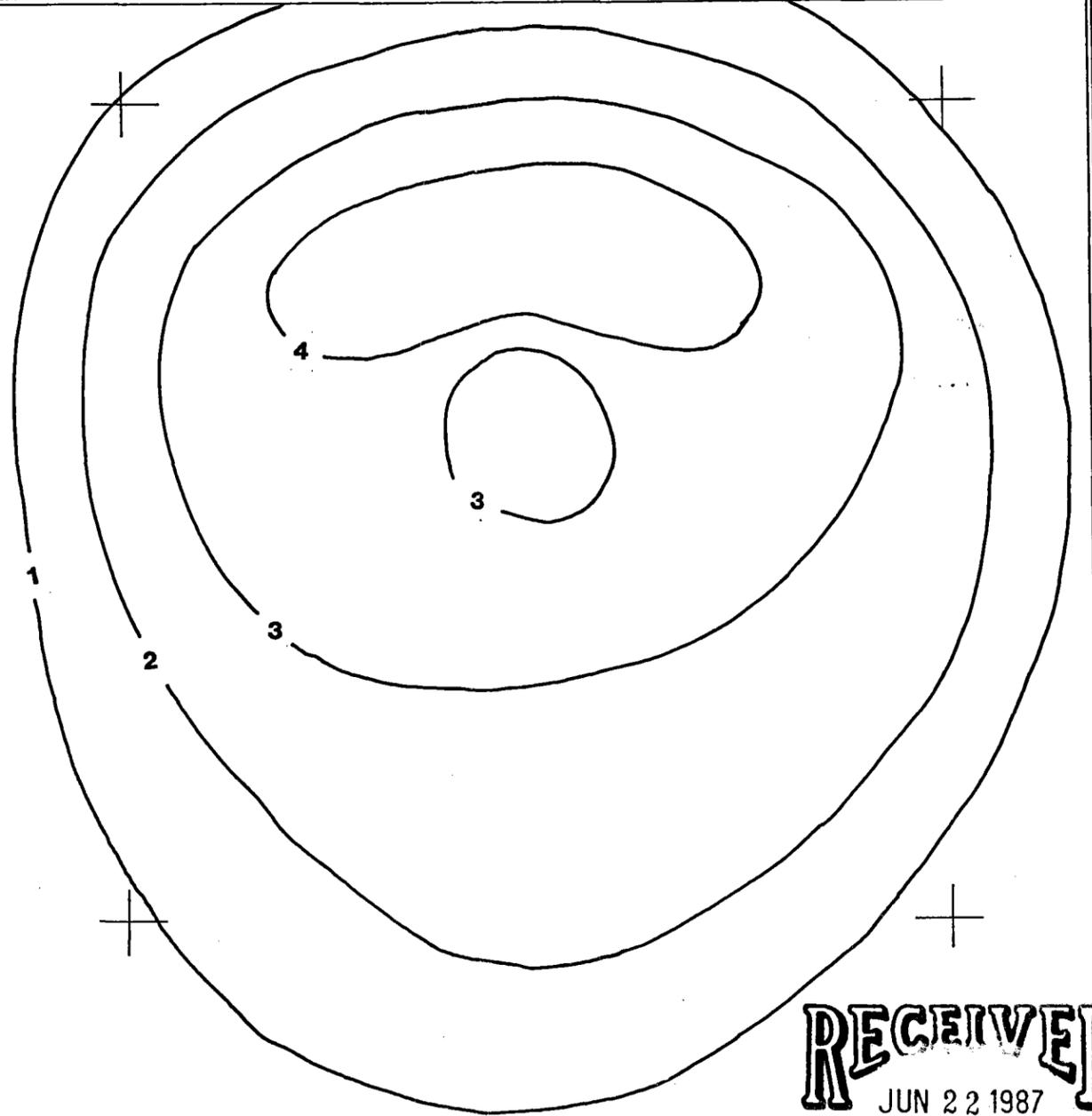
E 2,112,000



N 371,000



N 372,000



RECEIVED
JUN 22 1987

DIVISION OF
OIL, GAS & MINING

OLD AMERICAN FUEL MINE EMERY COUNTY, UTAH		
1986 SUBSIDENCE		
UTAH POWER & LIGHT COMPANY MINING DIVISION-SALT LAKE CITY, UTAH 84110		
DRAWN BY: LJ Hansen	CHECKED BY:	DATE: Mar. 4, 1987
Scale 1" = 200'	Sheet No.	Drawing Number FIGURE 25

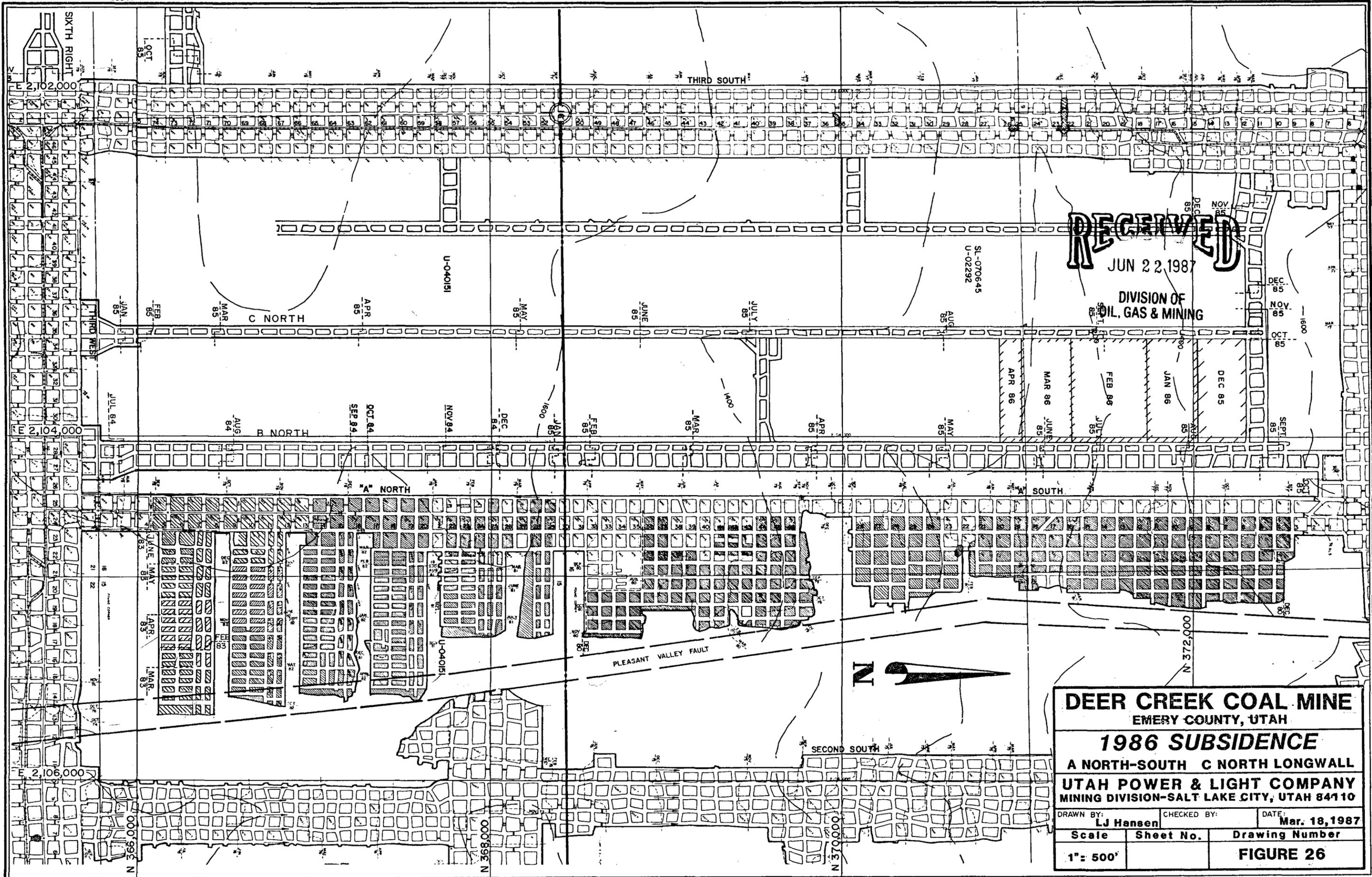
Area 11

Deer Creek A North - A South and C North Longwall Panel

Pillar extraction mining in A North and A South was completed in June 1983. 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 during May 1986, but mining of the panel did not begin again until after the monitoring period had ended (Figure 26). Measurable subsidence in 1986 reached just over 3 feet over both the A North - A South sections and C North (Figure 27).

No fractures or disturbance of the surface of the area have been observed. No angle-of-draw was calculated since movement on the surface is just beginning.

Three springs are located a few hundred feet to the west of these workings, but none falls within the area of measured subsidence. Their hydrology has shown no effect due to mining.



RECEIVED
 JUN 22 1987
 DIVISION OF OIL, GAS & MINING

DEER CREEK COAL MINE
 EMERY COUNTY, UTAH

1986 SUBSIDENCE

A NORTH-SOUTH C NORTH LONGWALL
 UTAH POWER & LIGHT COMPANY
 MINING DIVISION-SALT LAKE CITY, UTAH 84110

DRAWN BY: **LJ Hansen** CHECKED BY: DATE: **Mar. 18, 1987**

Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 26

E 2,102,000
N 366,000

N 368,000

N 370,000

N 372,000

E 2,104,000

21 16
22 15

E 2,106,000

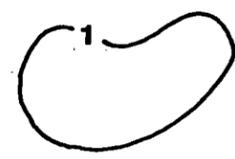
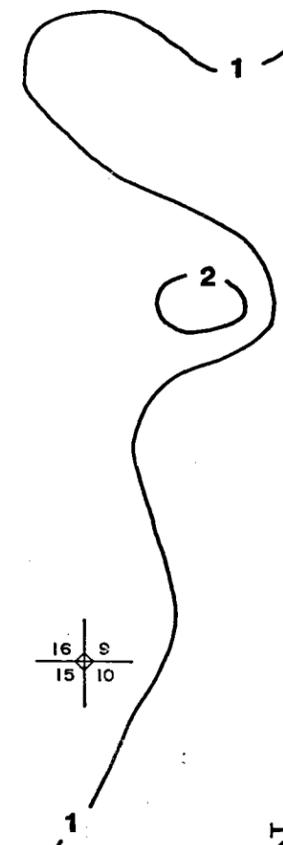
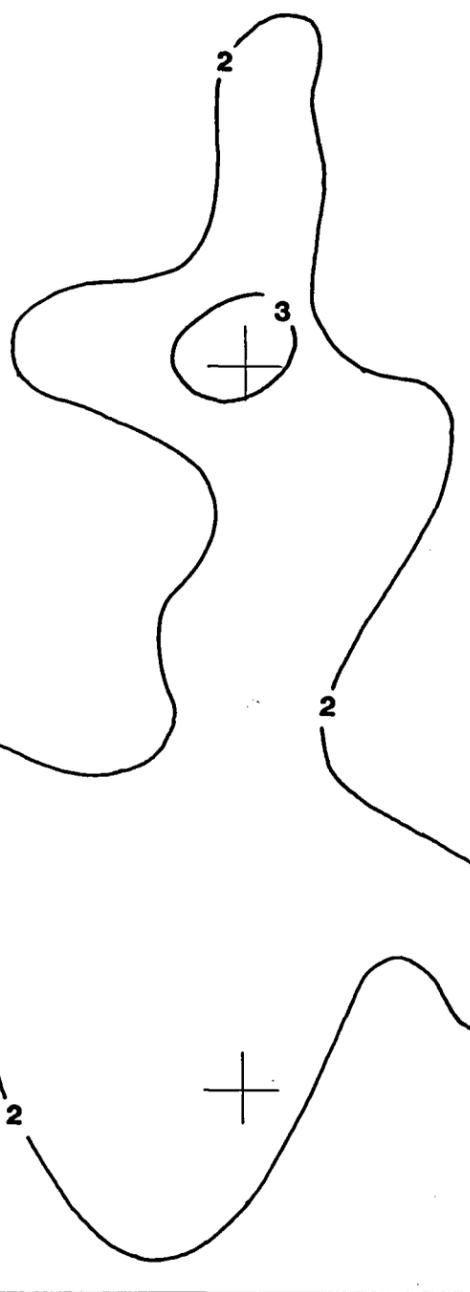
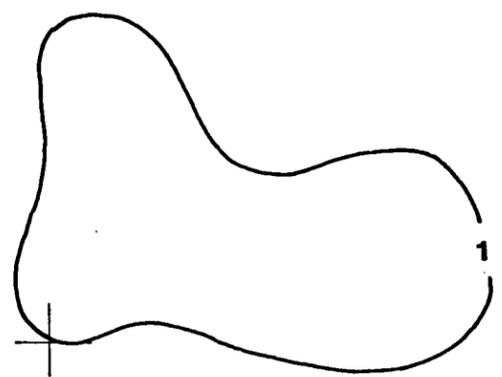
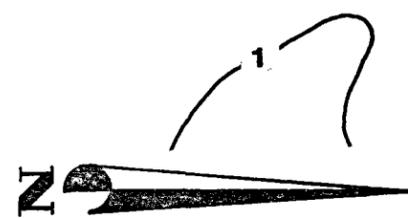
RECEIVED
JUN 22 1987

DIVISION OF
OIL, GAS & MINING

DEER CREEK COAL MINE
EMERY COUNTY, UTAH
1986 SUBSIDENCE
A NORTH-SOUTH
C NORTH LONGWALL PANEL

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

DRAWN BY: LJ Hansen	CHECKED BY:	DATE: Mar. 18, 1987
Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 27



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 seen. 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. We will continue to monitor the area every other year.

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

Area 13

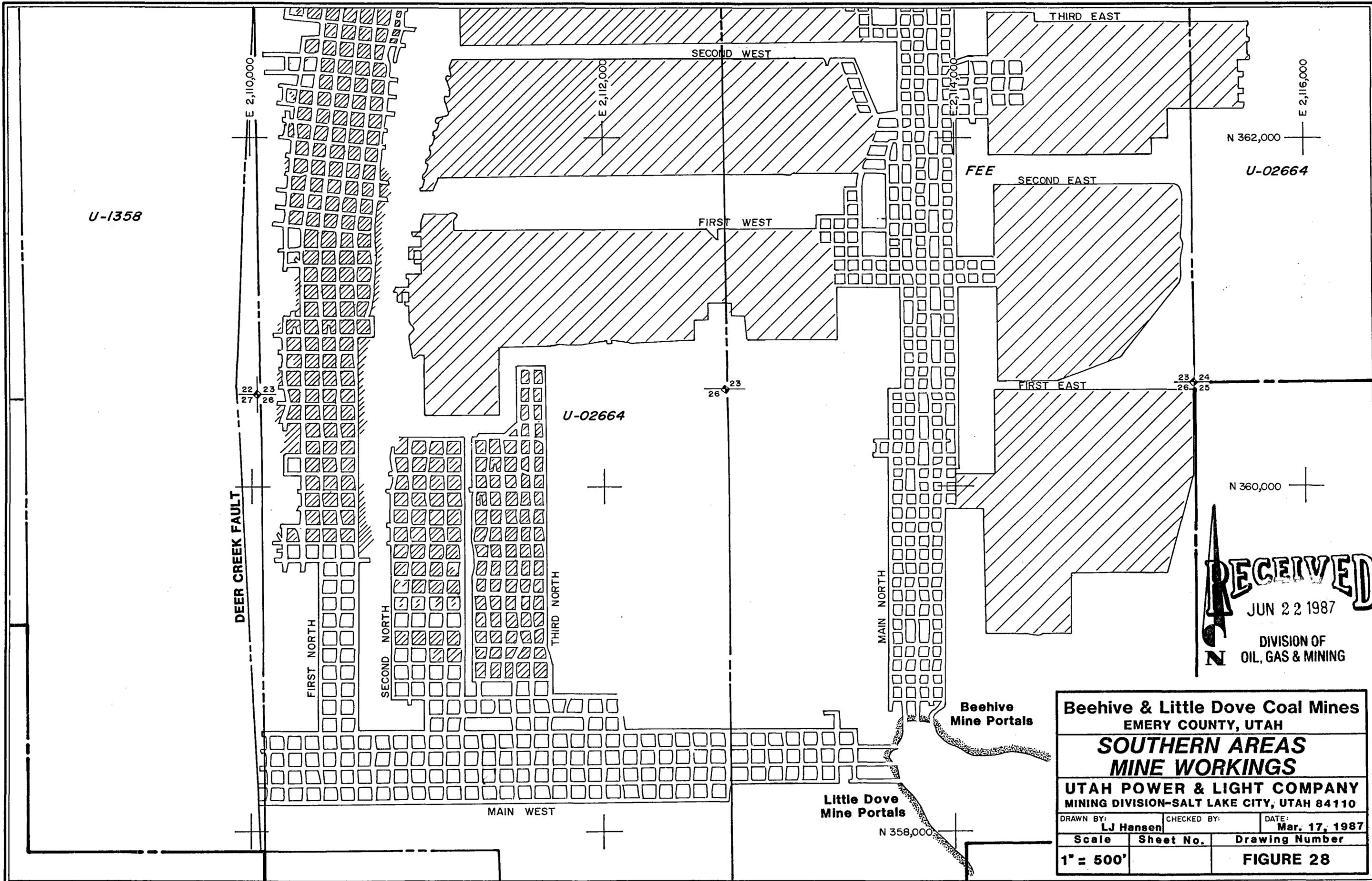
Des-Bee-Dove Southern Areas

This area was first monitored for subsidence in 1986. The area covers the southern portions of the Deseret, Beehive, and Little Dove Mines. Some of the sections in the area were mined before baseline elevation data were established; therefore, subsidence measured over these sections will not likely represent what actually occurred. In other areas, such as 1st, 2nd, and 3rd North, Little Dove, pillar extraction was active during the time since baseline elevations were established and measured subsidence should represent true subsidence (Figures 28 and 29).

Maximum subsidence over the area as of August 1986 was 3 feet, occurring over both 1st North, Little Dove and some older workings further to the northeast (Figure-30).

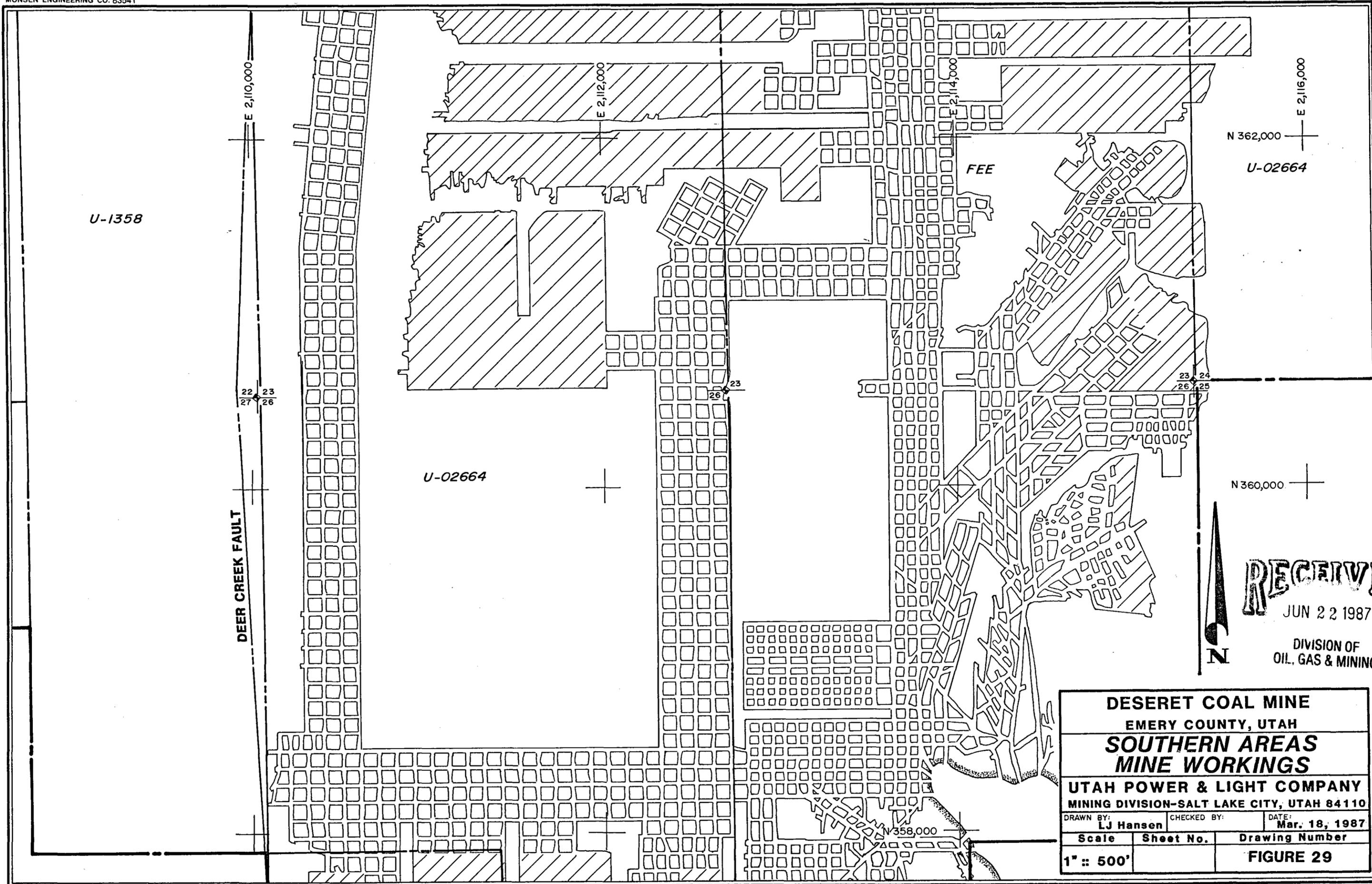
No visible surface disturbance of any kind has been found.

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



RECEIVED
 JUN 22 1987
 DIVISION OF
 OIL, GAS & MINING

Beehive & Little Dove Coal Mines		
EMERY COUNTY, UTAH		
SOUTHERN AREAS		
MINE WORKINGS		
UTAH POWER & LIGHT COMPANY		
MINING DIVISION-SALT LAKE CITY, UTAH 84110		
DRAWN BY: LJ Hansen	CHECKED BY:	DATE: Mar. 17, 1987
Scale 1" = 500'	Sheet No.	Drawing Number
		FIGURE 28



N 362,000
 E 2,116,000
 U-02664

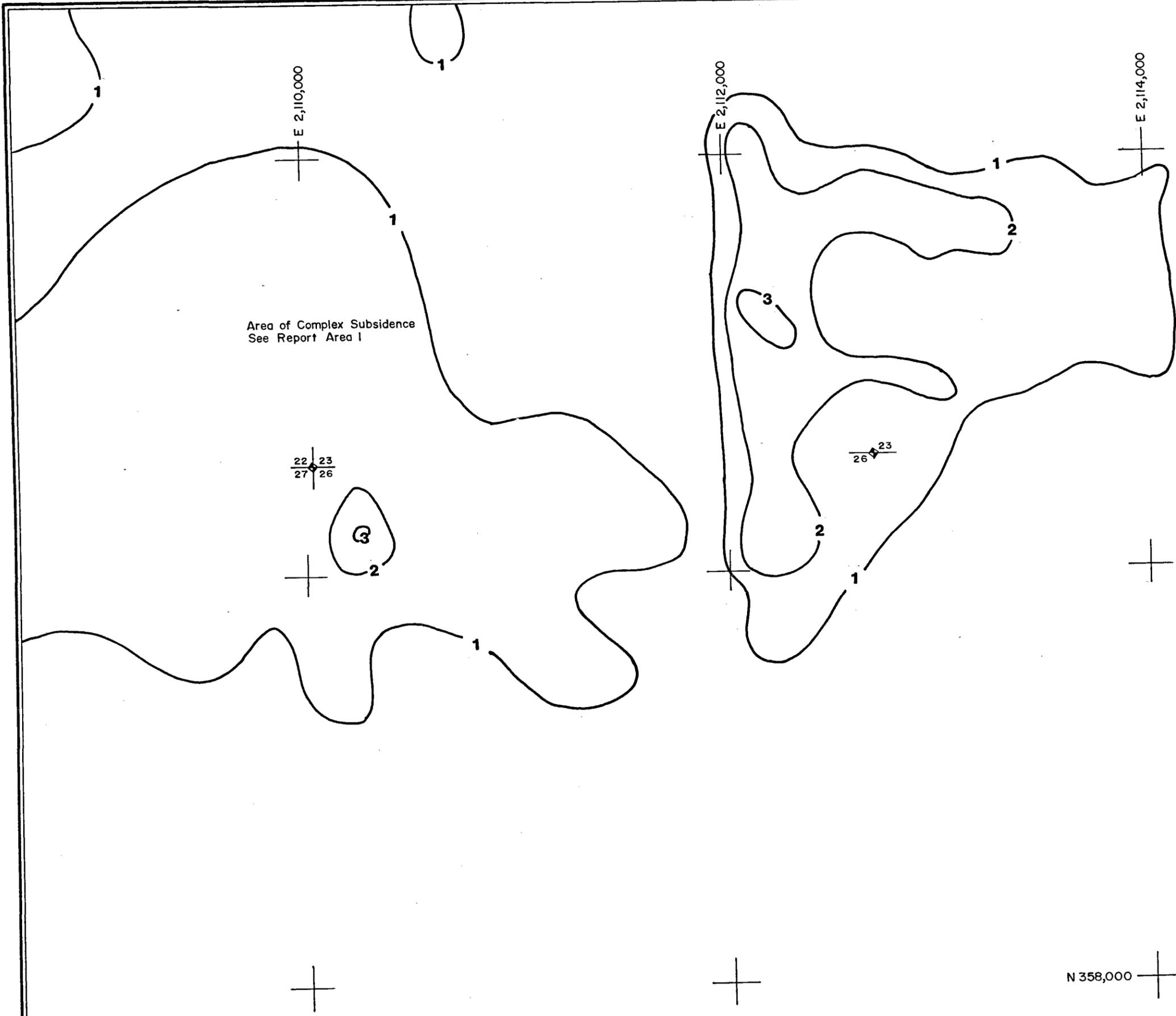
N 360,000



RECEIVED
 JUN 22 1987

DIVISION OF
 OIL, GAS & MINING

DESERET COAL MINE		
EMERY COUNTY, UTAH		
SOUTHERN AREAS		
MINE WORKINGS		
UTAH POWER & LIGHT COMPANY		
MINING DIVISION-SALT LAKE CITY, UTAH 84110		
DRAWN BY: LJ Hansen	CHECKED BY:	DATE: Mar. 18, 1987
Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 29



N 362,000 — E 2,116,000

23 24
26 25

N 360,000 —

RECEIVED
JUN 22 1987
DIVISION OF
OIL, GAS & MINING

N 358,000 —

DES-BEE-DOVE COAL MINES EMERY COUNTY, UTAH		
1986 SUBSIDENCE SOUTHERN AREAS		
UTAH POWER & LIGHT COMPANY MINING DIVISION-SALT LAKE CITY, UTAH 84110		
DRAWN BY: LJ Hansen	CHECKED BY:	DATE: Mar. 4, 1987
Scale 1" = 500'	Sheet No.	Drawing Number FIGURE 30

Predicted Maximum Subsidence

Using methods developed by the British National Coal Board (NCB), we have once again made a comparison between observed and predicted maximum subsidence for the various areas on UP&L's property. 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>
*DC 9E/W 1R	8.9	25.2
DC 5-8E/W, 5-13R	14.4	12.9
DC 1N Area	5.4	3.5
DC 2-6R	8.6	6.2
DC 2-5L	7.7	6.4
W 1-2W	5.3	4.2
Bee 2N off 8W	9.9	6.2
Bee/Des E&W Sections	6.3	5.0
Old American Fuel Mine	7.3	4.4
LD 1N	4.6	3.1
DC A N&S and CN Longwall	4.1	3.1
W 2L	1.8	0

* This area does not fit the NCB prediction model.

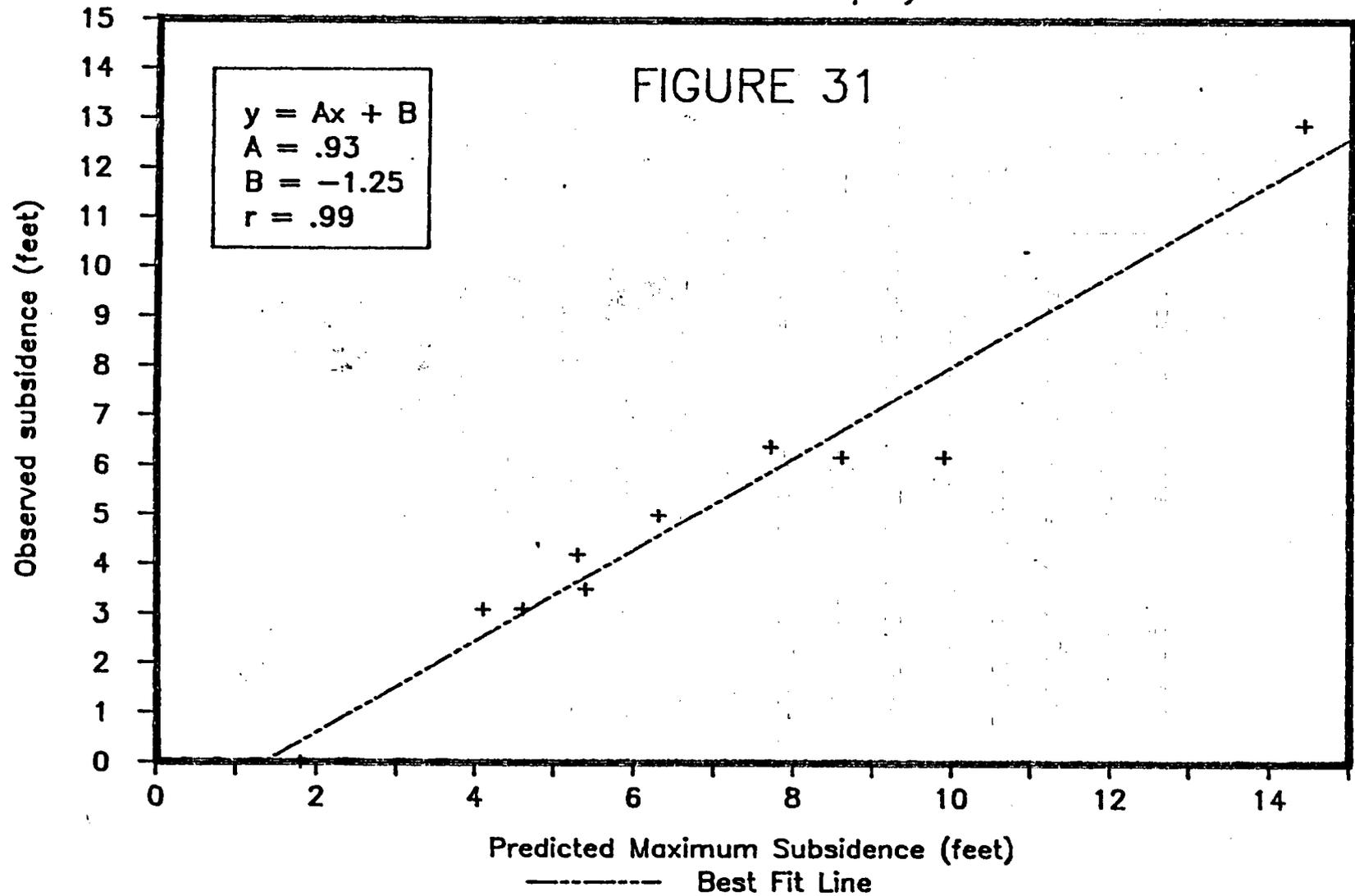
In all areas except one subsidence is less than the maximum predicted by the NCB model. This may be due to the fact that in some areas, such as C North, mining occurred very recently and subsidence has not yet reached its maximum. It could also be that the observed subsidence shown here represents the actual maximum subsidence for these particular geologic conditions. We believe this to be the case since subsidence appears to have ceased in several areas where the NCB predicted maxima were not reached. Figure 31 shows the relationship between predicted and observed subsidence. From the slope of the regression line ($A = .93$) the average observed subsidence is 93% of the NCB predicted maximum.

The one anomalous area is the DC 9th East - Wilberg 1st Right area. This case does not fit the special conditions necessary for prediction by the NCB method. The mine workings there 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 this area occurs on a steep slope below a cliff, where slumping has occurred. The 25.2 feet measured here is due in part to mass wasting on the steep slope.

In previous reports other areas of anomalously high subsidence were reported. Reexamination of the data available and observations from helicopter have led us to change this interpretation. It appears that above the Deer Creek 1st North and Beehive 2nd North

PREDICTED vs OBSERVED SUBSIDENCE

East Mountain Property



off 8th West sections some sort of mass wasting, such as movement of a large boulder, resulted in an elevation drop at one measurement point. The elevation drop at such a point does not, therefore, represent actual subsidence.

Mitigation of Surface Effects

Over most areas where subsidence has occurred on East Mountain present land use has not been affected in any way. Areas 2, 4, 5, 6, 8, 9, 11, and 13 are good examples of subsidence without visible surface disturbance or adverse hydrologic effects. In such areas no mitigation is necessary at this time.

In a few areas, such as areas 1, 3, 7, and 10, 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. The U. S. Forest Service has recommended that no reclamation be undertaken in this area at this time. UP&L will reclaim the area when and if the Forest Service determines it is necessary.

In areas 3, 7, and 10, where only minor fracturing has occurred on remote ridges and/or where present 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 these areas.

Summary

As of August 1986 UP&L has identified twelve 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 occurs in the steep cliff areas 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 stresses by brittle deformation (fracturing). The remaining fractures which have been discovered are reactivated surface traces of the Bear Creek Canyon or Deer Creek Faults.

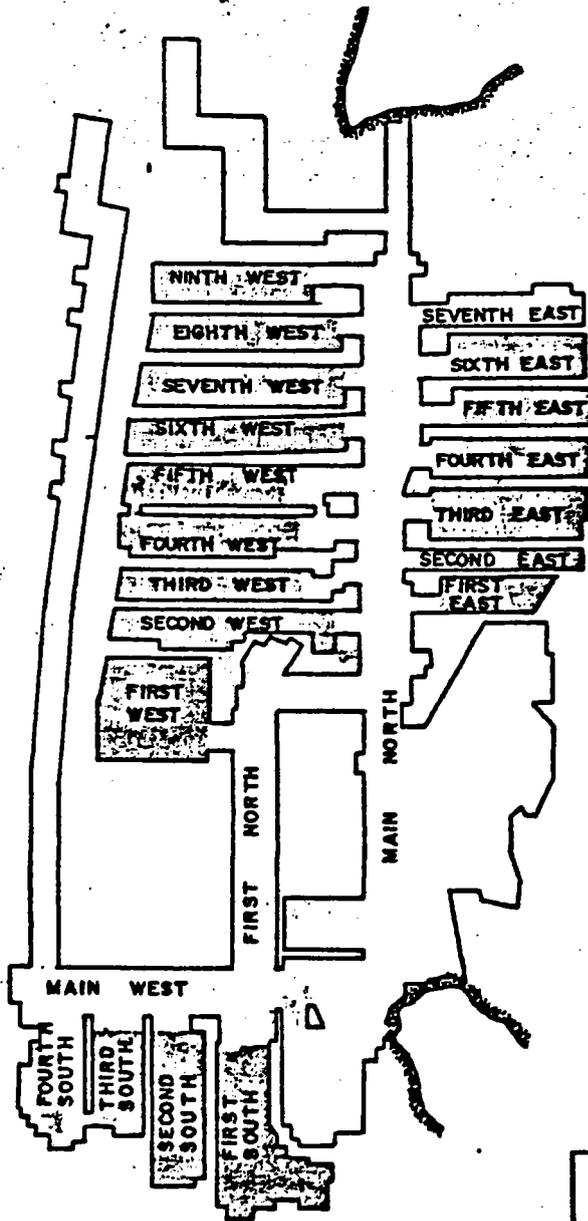
In areas where overburden is thicker and other, more clay-rich formation crop out, longwall and room-and-pillar mining methods have allowed the multiple seam mining of large quantities of coal without apparent impact on the environment because the overburden yields through plastic deformation. Areas such as the Beehive - Deseret east and west room-and-pillar sections and the Deer Creek 4th through 8th East - Wilberg 5th through 13th Right longwall panels have demonstrated that subsidence can occur over a broad area with no visible or hydrologic effects. In excess of eighty percent of the East Mountain property has conditions similar to these areas. It is, therefore, felt that 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.

Once again, an effort was made 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



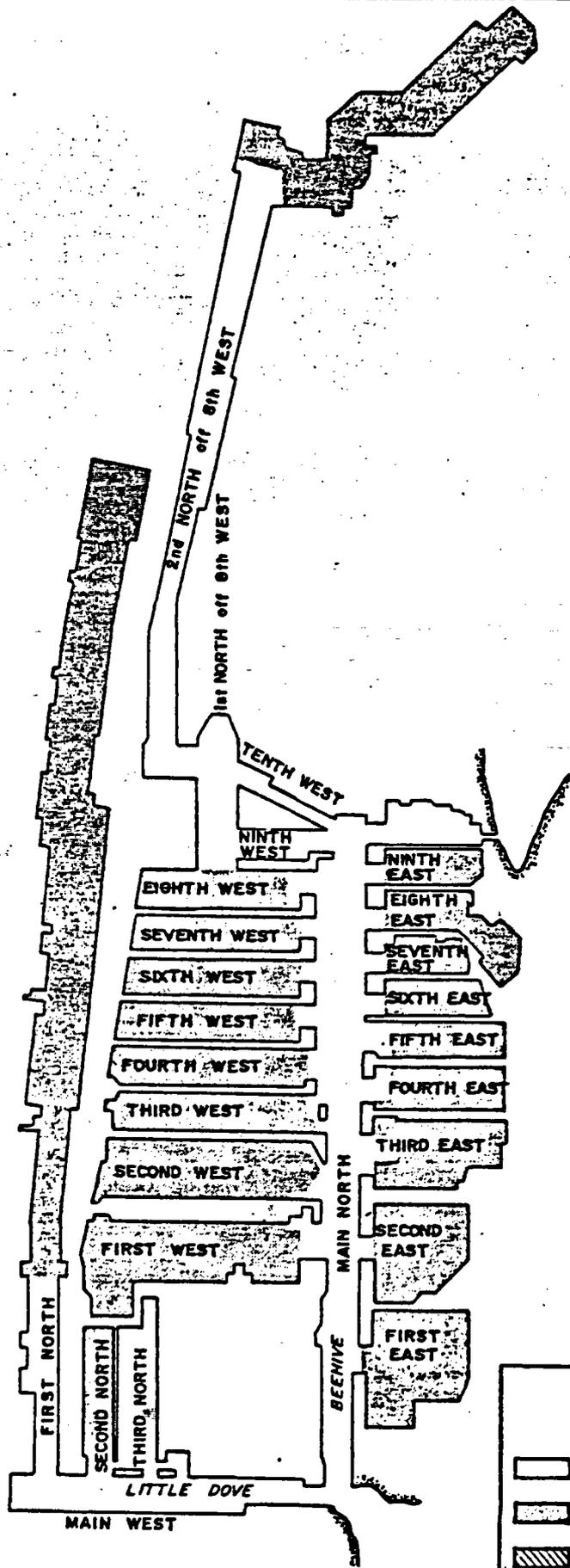
LEGEND

	MINE WORKINGS
	MINING COMPLETED
	ACTIVE MINING AREA

MINE WORKINGS UPDATED TO 9/1/86

DESERET COAL MINE

SCALE: 1" = 200'



BEEHIVE & LITTLE DOVE COAL MINES

SCALE: 1" = 200'

UPDATED TO: 9/1986

Deer Creek Mine

DEER CREEK COAL MINE

SCALE: 1" = 2000'



THIRD NORTH

MAIN WEST

LEGEND

-  MINE WORKINGS
-  MINING COMPLETED
-  ACTIVE MINING AREA

MINE WORKINGS UPDATED TO 9/1/86

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

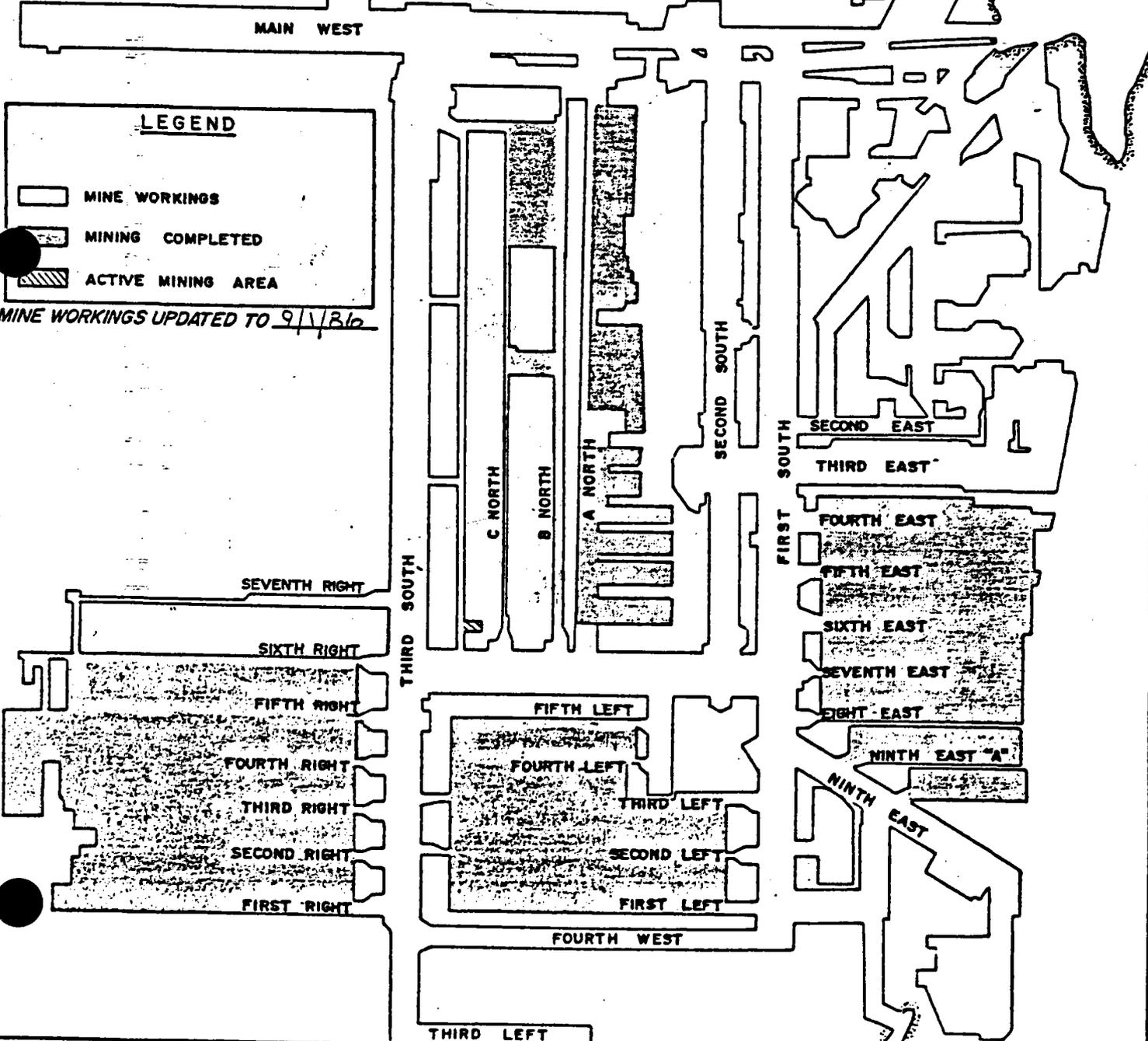
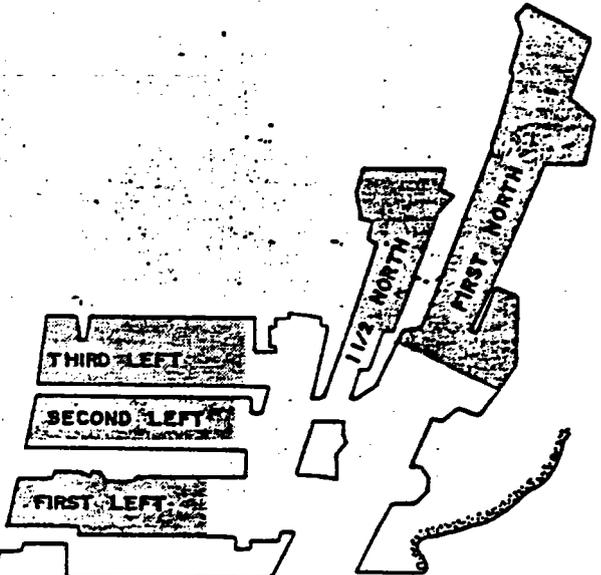
THIRD LEFT

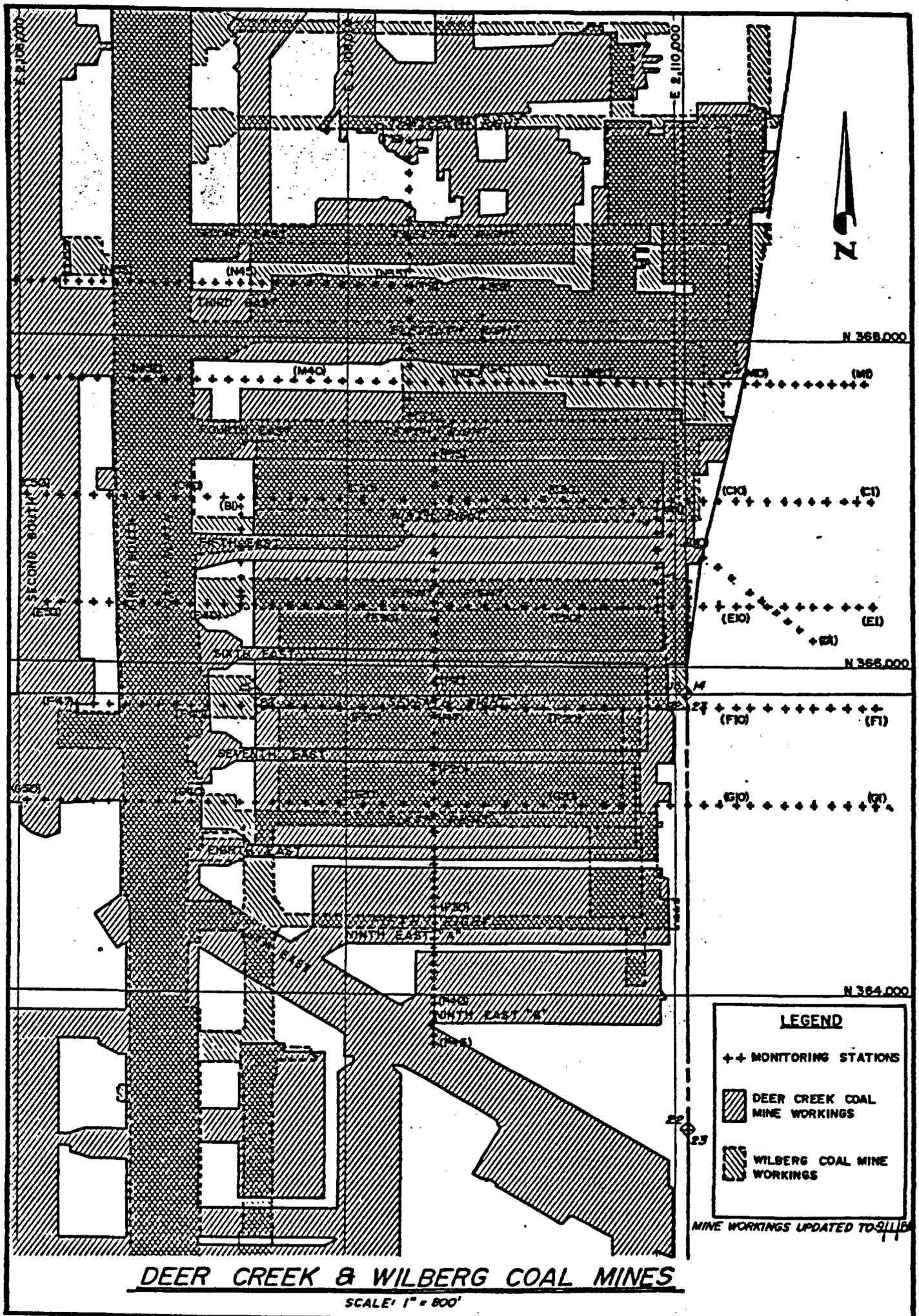
SECOND LEFT

FIRST LEFT

FOURTH WEST

THIRD LEFT





N 368,000

N 366,000

N 364,000

E 2,110,000

LEGEND

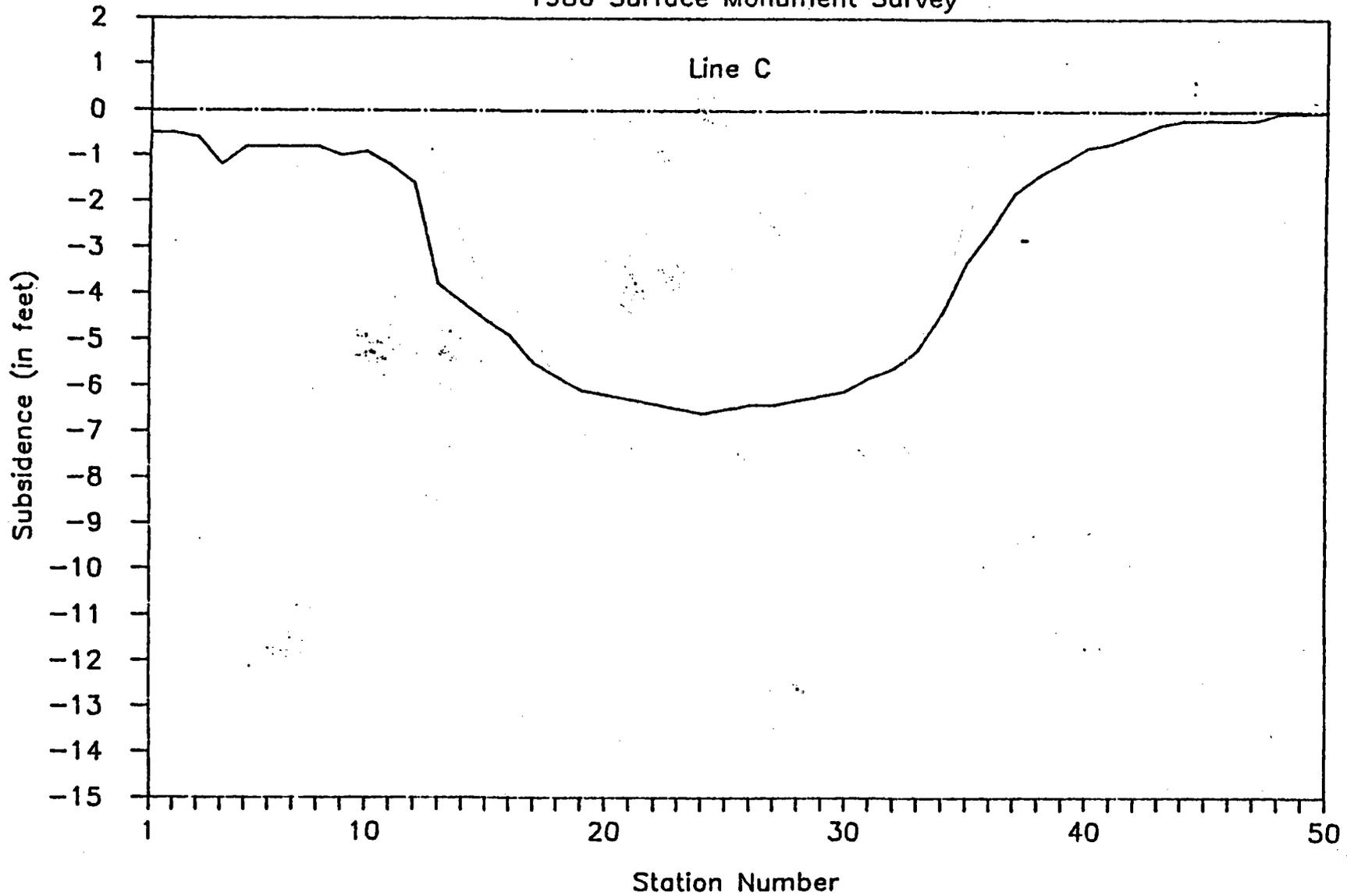
- ++ MONITORING STATIONS
-  DEER CREEK COAL MINE WORKINGS
-  WILBERG COAL MINE WORKINGS

MINE WORKINGS UPDATED TO 5/1/16

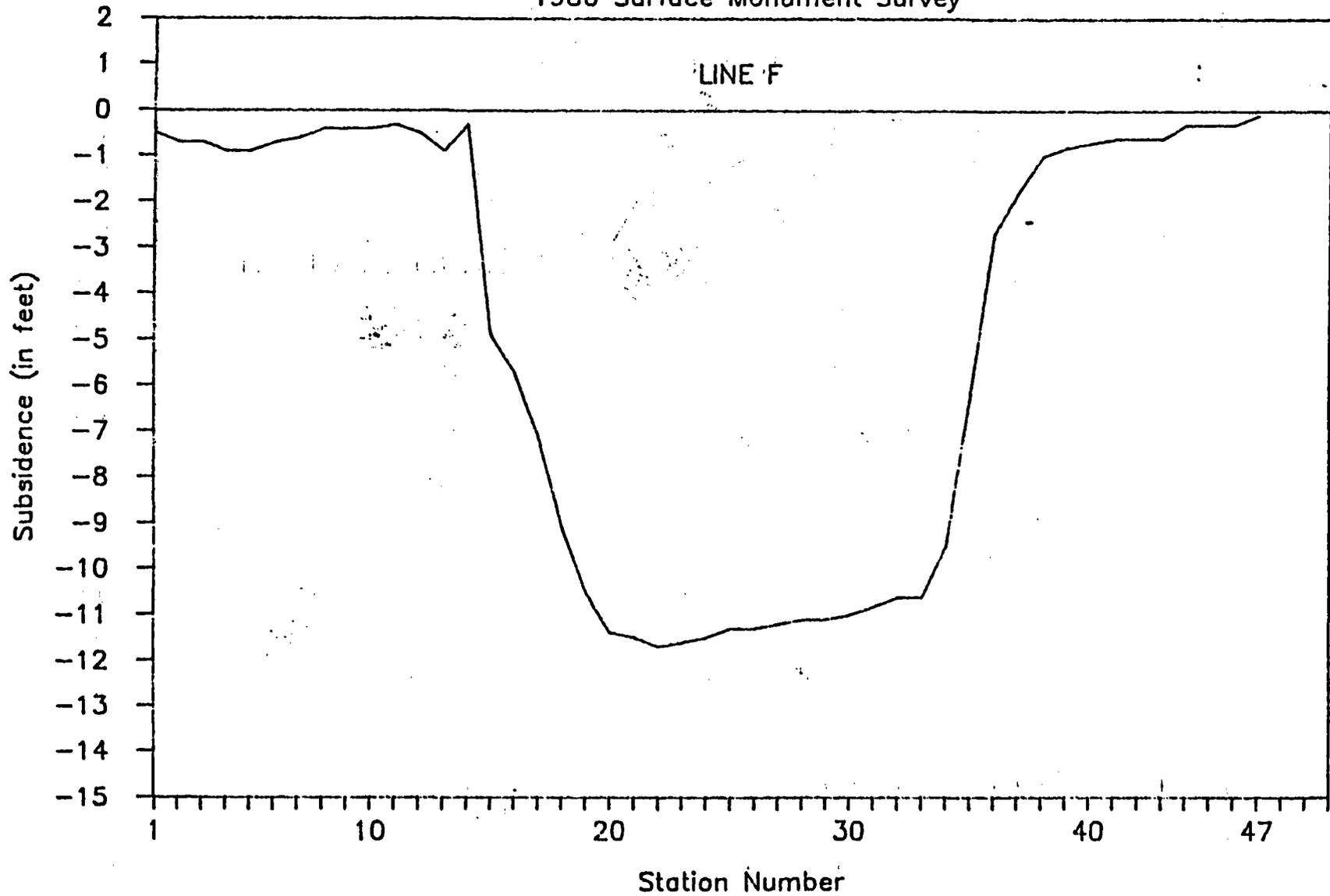
DEER CREEK & WILBERG COAL MINES

SCALE: 1" = 800'

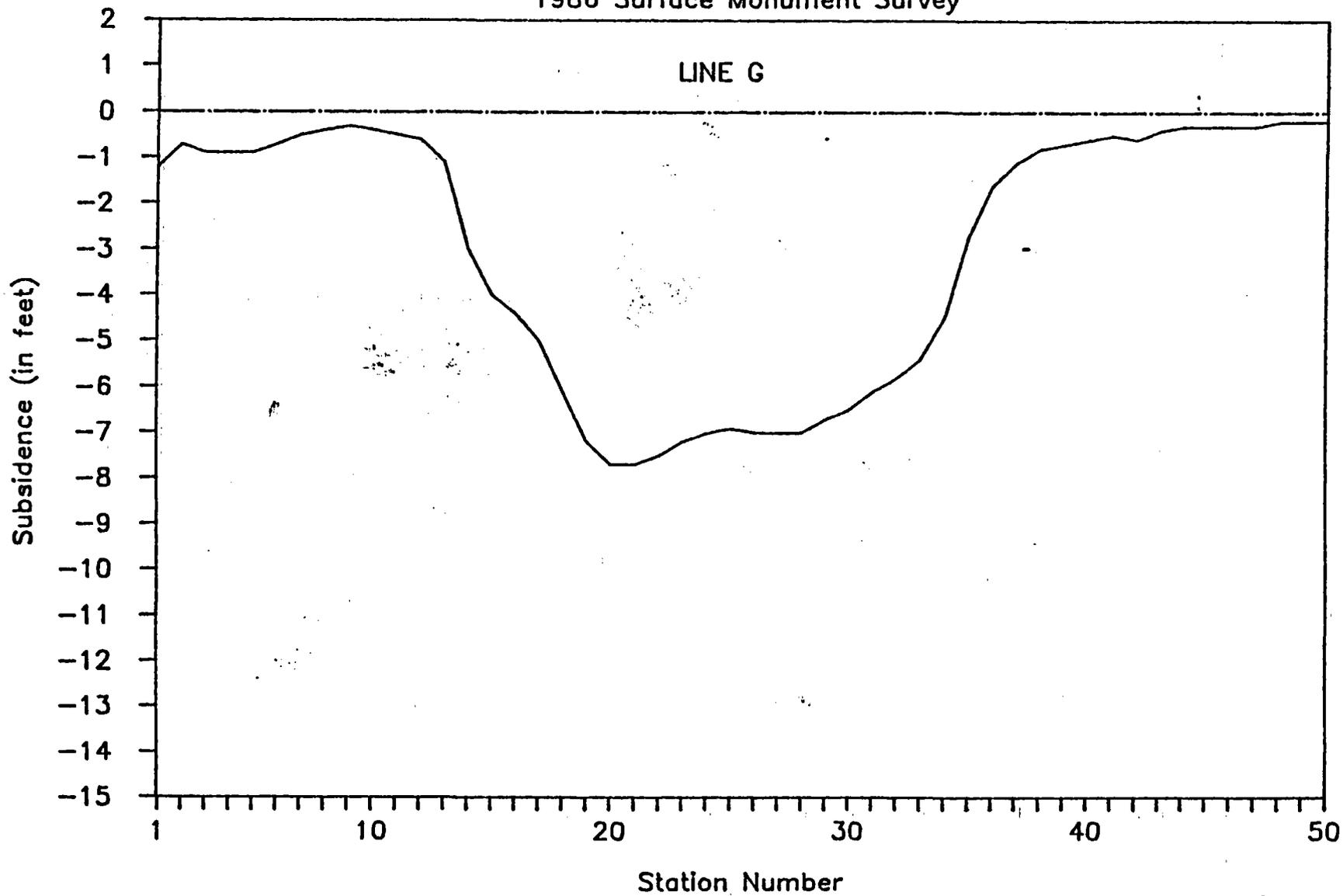
DEER CREEK - WILBERG SUBSIDENCE
MULTI-SEAM LONGWALL EXTRACTION
1986 Surface Monument Survey



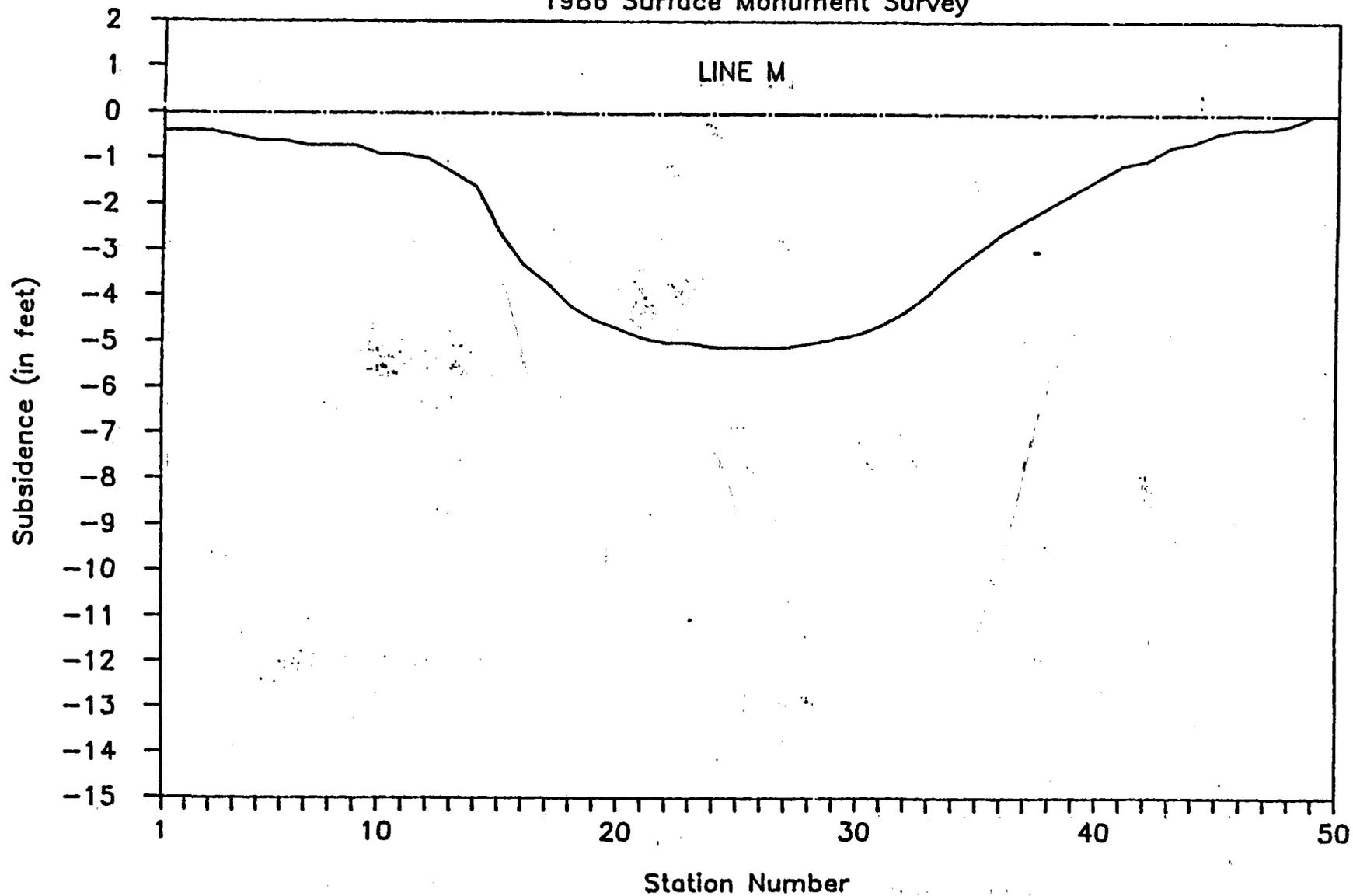
DEER CREEK — WILBERG SUBSIDENCE
MULTI-SEAM LONGWALL EXTRACTION
1986 Surface Monument Survey



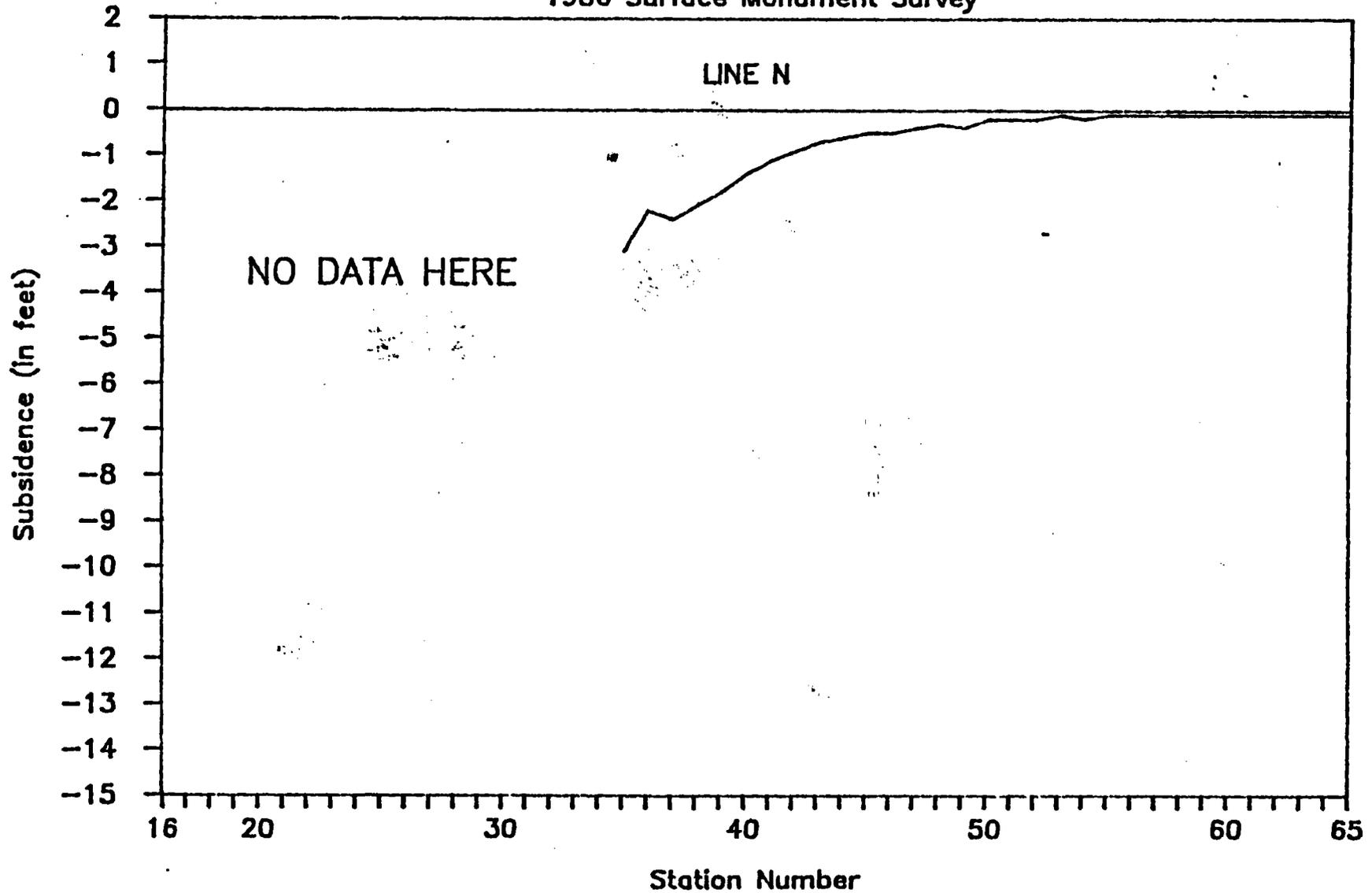
DEER CREEK — WILBERG SUBSIDENCE
MULTI-SEAM LONGWALL EXTRACTION
1986 Surface Monument Survey



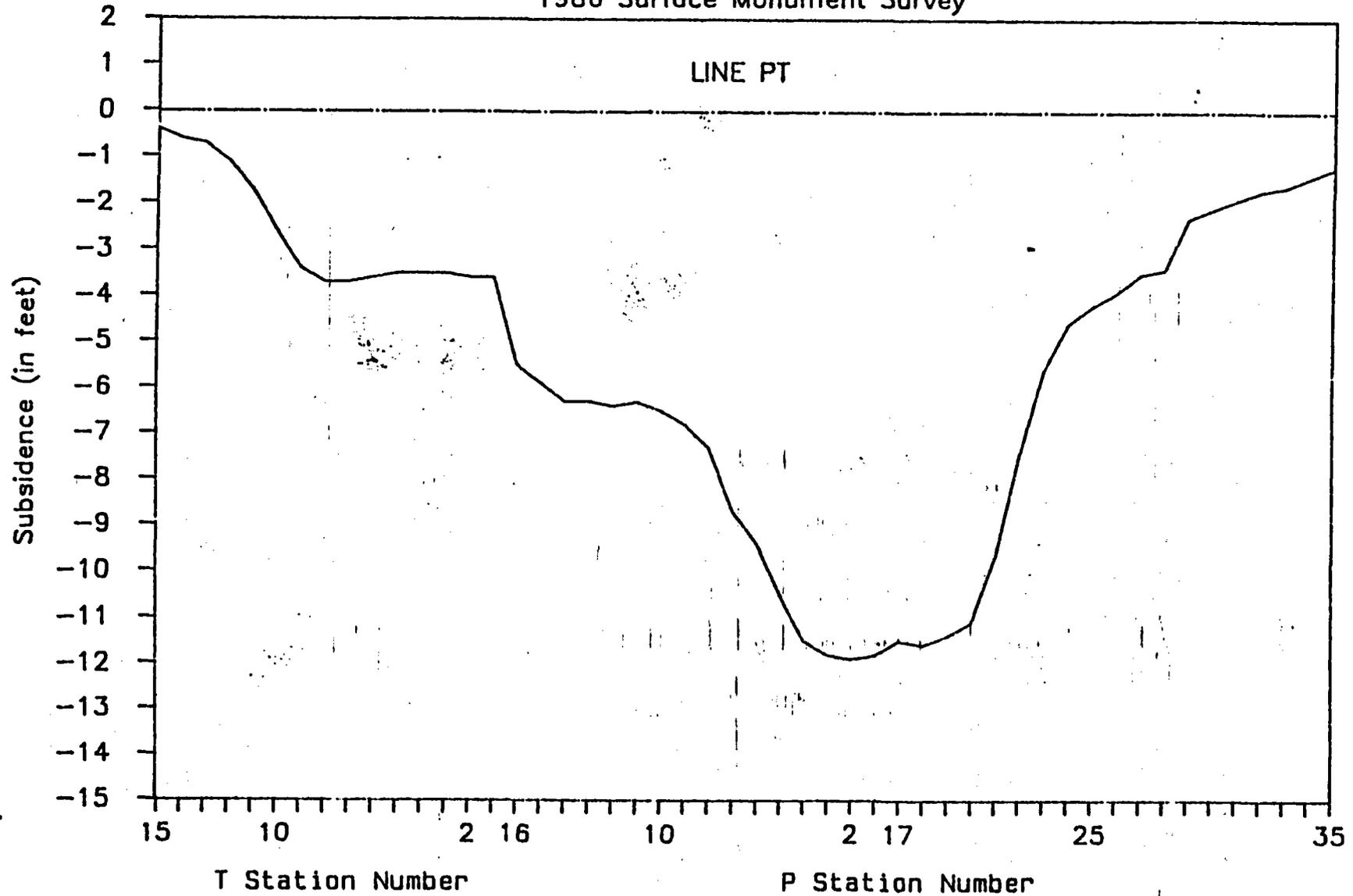
DEER CREEK - WILBERG SUBSIDENCE
MULTI-SEAM LONGWALL EXTRACTION
1986 Surface Monument Survey



DEER CREEK — WILBERG SUBSIDENCE
MULTI-SEAM LONGWALL EXTRACTION
1986 Surface Monument Survey



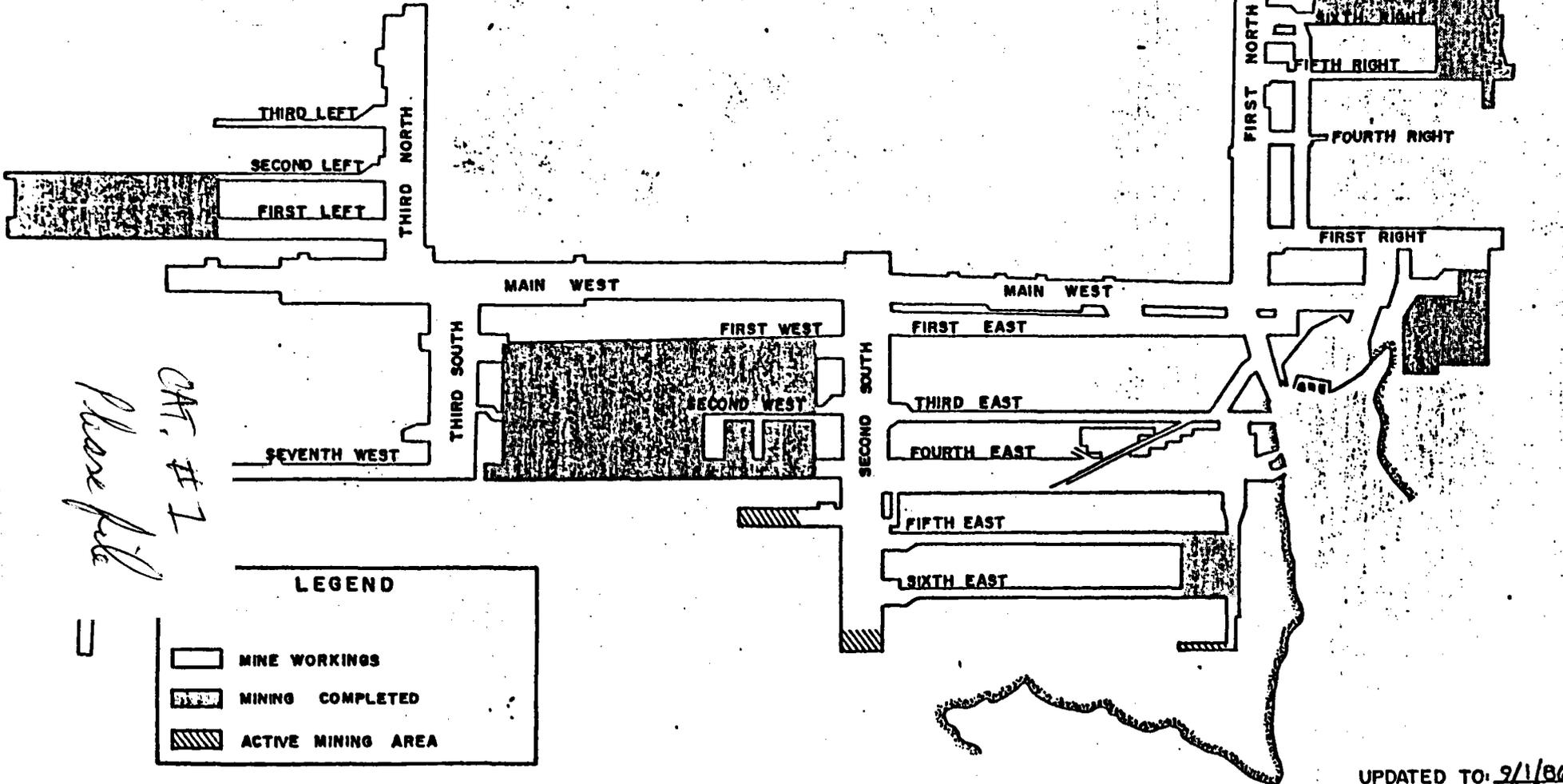
DEER CREEK — WILBERG SUBSIDENCE
MULTI-SEAM LONGWALL EXTRACTION
1986 Surface Monument Survey



Wilberg Mine

WILBERG COAL MINE

SCALE: 1" = 2000'



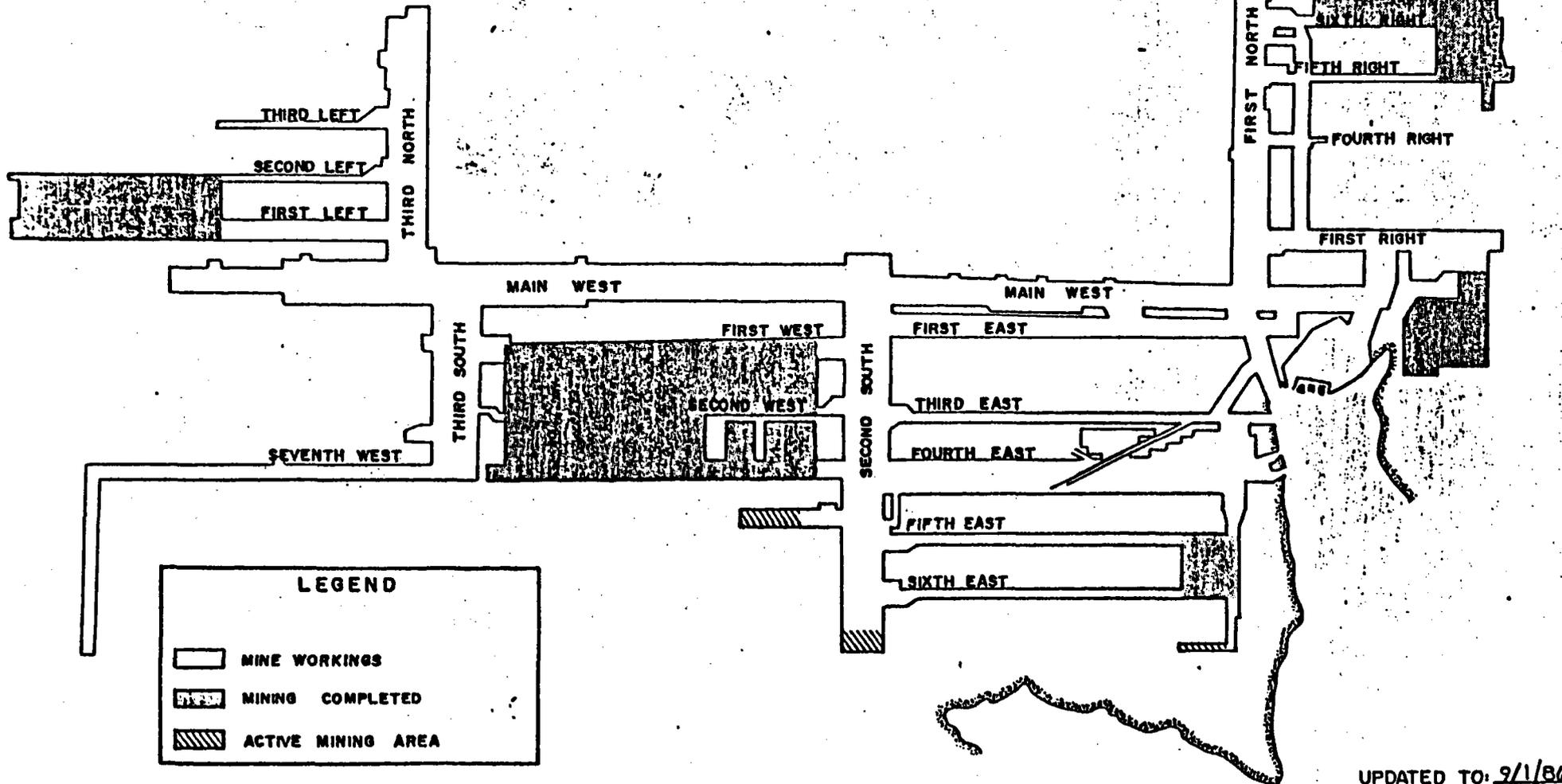
LEGEND

-  MINE WORKINGS
-  MINING COMPLETED
-  ACTIVE MINING AREA

UPDATED TO: 9/1/86

WILBERG COAL MINE

SCALE: 1" = 2000'



UPDATED TO: 9/1/86