UNITED STATES DEPARTMENT OF LABOR
MINE SAFETY AND HEALTH ADMINISTRATION
TECHNICAL SUPPORT

**PHASE II**

# MINE VENTILATION PRESSURE-AIR QUANTITY AND FACE VENTILATION INVESTIGATIONS

Investigative Report No. P323-V227

Blue Creek No. 4 Mine - I.D. No. 01-01247
Jim Walter Resources, Incorporated
Brookwood, Tuscaloosa County, Alabama

December 6-12, 1989

by

Gary E. Smith, Gary J. Wirth and Joseph M Denk

Originating Office

Pittsburgh Health Technology Center
Ventilation Division
Edward J. Miller, Chief
4800 Forbes Avenue
Pittsburgh, Pennsylvania 15213

cc'd 5/20/03
OSRV

3/8/90 cc: No. 4 Mine
~~MSHA - District 30~~
Hueytown

AB14- HEAR SF
AB18- HEAR SF

<u>PHASE II</u>

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## INTRODUCTION

From December 6-12, 1989, concurrent ventilation pressure-air quantity, face ventilation and dust investigations were conducted by personnel from the Pittsburgh Health Technology Center (PHTC) at the Blue Creek No. 4 Mine, Jim Walter Resources, Incorporated, Brookwood, Alabama. This report includes the results of the limited pressure-air quantity and face ventilation investigations. A separate report of the dust investigation will be forthcoming from the Dust Division, PHTC. A list of personnel participating in the investigations is included as Appendix I.

The purpose of the investigations was to gather sufficient data to evaluate the ventilation systems on the Longwall No. 1 and Longwall No. 2 Sections in the western portion of the mine. These investigations comprised Phase II of a three phase project requested by the District Manager, Coal Mine Safety and Health (CMS&H) District 7, to assist in the review of the Ventilation System and Methane and Dust Control Plan for the Blue Creek No. 4 Mine as it relates to longwalls. Phase I was completed in September 1989 and the results were released by the Ventilation and Dust Divisions as Report Nos. P318-V222 and DD-90-2C, respectively.

Phases III will involve similar investigations on the Longwall No. 2 Section. The scheduling of this phase is dependent on the rate of mining as the section approaches the end of the panel extraction.

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[1] Mining Engineer, Ventilation Division, PHTC

## GENERAL INFORMATION

The Blue Creek No. 4 Mine was opened by four intake airshafts and two return airshafts into the Blue Creek Coalbed, which was approximately 96 inches thick. Coal was produced on four developing continuous miner sections and two retreating longwall sections. Daily coal production was 12,000 tons. Coal was transported from the sections to the skips at the production shaft by a network of belt conveyors. The service shaft was used for transporting personnel and supplies from the surface. Battery and diesel rail vehicles were used for transport throughout the mine. The total underground employment was 500 persons.

At the time of the investigations, the mine utilized an extensive underground and surface degasification program to recover 13.4 million cubic feet per day (cfd) of methane. This system combined in-seam horizontal drainage prior to mining with vertical gob well drainage after mining. The horizontal degasification program involved drilling in-seam boreholes spaced 250 feet apart, along the length of a developing longwall panel. The horizontal boreholes were connected to an underground pipeline for methane drainage. Once the longwall retreat approached a borehole location, the borehole was converted for water infusion to allay dust concentrations on the active face as it mined through the immediate area. There were approximately 90 horizontal boreholes on-line for methane drainage producing 1.4 million cfd. The vertical gob well program consisted of drilling boreholes from the surface prior to retreat mining (an average of three wells per panel) through the New Castle Coalbed, which was located approximately 30 to 50 feet above the proposed longwall panel. The vertical boreholes were connected to a commercial pipeline to recover methane and were left on-line after mining was completed on the panel. There were approximately 24 gob wells on-line producing 12.0 million cfd of methane. In addition to the methane captured by the degasification system, the mine liberated approximately 13.0 million cfd of methane to the atmosphere through the existing mine fans.

## BACKGROUND LONGWALL SECTIONS

The two longwall sections were similar, the primary difference being the length of the face. Each unit was developed as a four entry longwall section and each is the mirror image of the other. Figure 1 is a copy of the mine map showing the Longwall No. 1 Section. The section had been developed with a panel width of 780 feet and a length of 5,500 feet. At the time of the investigations, the panel had been retreated approximately 3,100 feet. The section was the fifth successive longwall unit, or "E" Panel, driven south off of the 1 West entries. As each panel was retreated it added to the total area of the Southwest Gob (approximately 1.01 square miles). At the time of the investigation, the Southwest Gob had not yet been sealed in accordance with the progressive sealing plan (a.k.a. progressive ventilation) in effect at the mine. Therefore, the previous five longwall panels were open to the bleeder entries.

Figure 2 is a copy of the mine map showing the Longwall No. 2 Section. The section had a panel width of 850 feet and a length of 5,100 feet. At the time of the investigations, the panel had been retreated approximately 2,700 feet. The section was the seventh successive longwall unit, or "G" Panel, driven north off of the 3 West entries. As each panel was retreated it added to the total area of the Northwest Gob (approximately 1.35 square miles). In accordance with the progressive sealing plan, the expanding Northwest Gob was sealed on three sides (north, east and south) with the exception of the previous mined-out panel abutting the active longwall section. The perimeter of this open portion of the gob was ventilated with a split of airflow regulated by the NW and SW Gob Vents. The environmental monitoring system installed at the mine was used to continuously monitor for methane ($CH_4$) and carbon monoxide (CO) concentrations at these two gob vents. According to the Ventilation System and Methane and Dust Control Plan, the methane monitors were set to alert at 1.5 percent and the carbon monoxide monitors were set to alert at 35 ppm. The alarm levels were set at 2.0 percent methane and 50 ppm carbon monoxide.

On each section, coal was mined on three shifts per day using an Anderson Mavor Model 500 Double Drum Shearer. A 54 inch diameter drum with 54 bits and a 30 inch web depth was located on the headgate and tailgate sides of the machine. Two operators positioned at either end of the shearer controlled its movement across the face. The sections employed a unidirectional mining sequence in which coal was mined during a cutting pass traversing the face from the tailgate to the headgate entries. The return or cleanup pass traversed the face in the opposite direction.

During the time of the investigations, both longwall units were experiencing operational problems which resulted in lower than normal coal production for each shift. On the Longwall No. 1 Section the first three shields on the headgate side of the face were sinking into the soft bottom and had to be supported with wooden crib blocks in order to move the panline. In addition, used forty pound steel rails on 1-foot centers were required to support the roof strata above the headgate entry. The used rails were supported by a wall of solid concrete cribs built against the coal panel. Before the shearer could cut out at the headgate, these concrete blocks had to be removed. The labor required to support the shields and remove the concrete blocks involved most of the face crew and consequently production was severely limited. On the Longwall No. 2 Section (as during the Phase I investigation) there were delays caused by rock being cut and/or falling in near the tailgate side of the face. Also there were mechanical problems which resulted in replacing the tail drive gearbox and one of the cutting drums on the shearer. The latter problem caused the cancellation of the third sampling shift on the section.

According to the company personnel, normal production involved four to five cutting passes of the shearer per shift along the face on the Longwall No. 1 Section and three to four cutting passes per shift along the face on the Longwall No. 2 Section. Assuming a mining height of 5 feet, a web depth of 2.5 feet and a density of 80 pounds per cubic foot of coal mined, raw tonnages were calculated for a normal shift on each section. Normal shift production would range between 1,520 - 1,900 raw tons on the Longwall No. 1 Section and 1,245 - 1,660 raw tons on the Longwall No. 2 Section. As mentioned above, both sections were experiencing operational problems. This resulted in a limited amount of cuts being observed during a total of five shifts on the sections. On the Longwall No. 1 Section one full cut was mined on each of the first two shifts and two full cuts were mined on the third shift. On the Longwall No. 2 Section two full cuts were mined on each of the two shifts. However, tonnage figures obtained from the company do not reflect the limited mining observed. Reportedly, the production on the sections were: 2,244 tons, 1,631 tons and 1,488 tons on the three shifts on Longwall No. 1; and 1,139 tons and 1,608 tons on the two shifts on Longwall No. 2.

According to the Ventilation System and Methane and Dust Control Plan, a methane monitor was installed on the tailgate of the active longwalls to monitor any movement of gob gas toward the longwall. The methane monitor for each section was located on the panline near the tailgate end of the face at the No. 154 and No. 170 shield, respectively, as shown in Figure 3.

Approximately 157 and 172 Thyssen 2-legged 575 ton shields were used for roof control across the Longwall No. 1 and No. 2 faces, respectively. Each shield had been modified with a Kloechner ram system and Gullick-Dobson valve bank. The shields were manually advanced by four shield setters on each section that were responsible for moving 39 and 43 shields each.

The Longwall No. 1 panel had been drilled with 10 horizontal in-seam degasification boreholes along the panel length and three active vertical gob wells located inby the face. The Longwall No. 2 panel had been drilled with 18 horizontal in-seam boreholes along the panel length and three vertical gob wells inby the face. The active face on each section was mining coal from a portion of the longwall panel where successful degasification and water infusion had been conducted prior to the investigation through the in-seam horizontal boreholes. Reportedly, the methane production from the horizontal boreholes in the panels could not be discriminated from the total 1.4 million cfd collected by the horizontal degasification system. The methane production from the vertical gob wells is outlined in Table 1 for each longwall panel. Between June 1, 1989 and December 9, 1989 the total methane removed from the strata above the Longwall No. 1 and No. 2 panels via the vertical gob wells was 214,319,000 cf and 313,443,000 cf, respectively.

## LIMITED MINE VENTILATION PRESSURE-QUANTITY INVESTIGATION

### MINE VENTILATION

During the investigation, airflow was induced into the mine by three surface mounted exhaust fans. At the South Return Shaft a Joy Axivane Mine Fan, Model M144-79-890, operated at a pressure of 15.8 inches of water and a fan speed of 880 RPM. At the North Return Shaft two TLT Babcock, Incorporated, Variable Pitch Axial Fans, Model GAF 31.5/18-1, operated in parallel at a pressure of 17.5 inches of water and at fan speeds of 880 RPM.

The balance of airflow entering and leaving the mine is listed in Table 2. The air quantities were measured underground near each ventilation shaft as part of the investigation.

### LONGWALL NO. 1 SECTION VENTILATION

Figure 4 is a ventilation schematic showing mine airflow direction, air quantities and ventilating pressures throughout a limited area of the mine immediately surrounding the Longwall No. 1 Section. The ventilating pressures shown at various locations are given to the nearest 0.01 inches of water and the air quantities are given to the nearest 1,000 cfm (100,000 cfm is shown as 1.00). The air quantities and pressures have been balanced and are suitable for digital computer forecasting of the effects of changes to the segment of the ventilation system encompassed by the investigation. Also, included in the figure are the locations of vacuum bottle air samples (10 cc) taken throughout the area. The numbered locations correspond to the analytical results in the table included as part of the figure. Each 10 cc bottle sample was analyzed for oxygen ($O_2$), methane ($CH_4$), and carbon dioxide ($CO_2$).

Airflow was directed to the face through two intake entries and the belt conveyor entry (in accordance with petition for modification and decision granting the petition to use belt air at the face). Quantities measured at the mouth of the section in these entries totaled 322,000 cfm. Air quantities measured along the active face averaged 77,000 cfm on the headgate side and 80,000 cfm on the tailgate side.

Since the tailgate entries inby the active face leading to the southern bleeder entries had been severely restricted by floor heave and partial flooding, most of the return airflow from the face (96,000 cfm) was directed to the 1 West Main return entries through the tailgate return entries. An additional air quantity of 20,000 cfm was directed to the 1 West Main returns through a single headgate return entry. Airflow was also directed to the southern bleeder entries through regulators on the headgate entries (66,000 cfm) and through the Southwest Gob (140,000 cfm).

At the time of the investigation, the Southwest Gob had not yet been sealed in accordance with the progressive sealing plan in effect at the mine. Therefore, the previous five longwall panels were open to the bleeder entries and airflow was traveling into and out of the gob along the entire length of the bleeder entries. In one particular area in the "A Panel" bleeder connectors, low oxygen was detected with a hand-held instrument (MX-240). Company personnel observing the condition indicated that changes would be made immediately to correct the condition. The on-site CMS&H inspector and District personnel were made aware of this condition. The analysis of a vacuum bottle air sample taken at that time confirmed the hand-held measurements (Bottle sample No. 10: 18.64 percent oxygen, 0.74 percent methane and 1.18 percent carbon dioxide). These results were relayed to District 7, Birmingham Subdistrict personnel when they were received. The bottle sample analyses indicate acceptable air quality at all other locations.

## LONGWALL NO 2 SECTION VENTILATION

Figure 5 is a ventilation schematic showing mine airflow direction, air quantities and ventilating pressures throughout a limited area of the mine immediately surrounding the Longwall No. 2 Section. As mentioned above, the air quantities and pressures have been balanced and are suitable for digital computer forecasting of the effects of changes to the segment of the ventilation system encompassed by the investigation. Also, included in the figure are the locations of vacuum bottle air samples taken throughout the area. The numbered locations correspond to the analytical results in the table included as part of the figure. Each 10 cc bottle sample was analyzed for oxygen ($O_2$), methane ($CH_4$), and carbon dioxide ($CO_2$). The sample analyses indicate acceptable air quality at all locations.

Airflow was directed to the face through two intake entries and the belt conveyor entry (in accordance with petition for modification and decision granting the petition to use belt air at the face). Quantities measured at the mouth of the section in these entries totaled 275,000 cfm. Air quantities were measured along the active face on each shift and averaged 27,000 cfm on the headgate side and 37,000 cfm on the tailgate side. A separate split of intake airflow (30,000 cfm) was also directed through one of the tailgate entries. Of this intake split, 10,000 cfm exited the SW Gob Vent regulator, 15,000 cfm mixed with the return airflow on the tailgate side of the longwall and 5,000 cfm was directed to the northern bleeder entries through the gob.

Return airflow from the section was directed to the single return entry on the headgate side (20,000 cfm) or to the northern bleeder entries (255,000 cfm). Of the airflow that entered the northern bleeder entries, 70,000 cfm entered through the two regulators on the headgate entries, 22,000 cfm entered through the two regulators on the tailgate entries, 42,000 cfm entered as leakage through the permanent stoppings adjacent to the regulators in the headgate and tailgate entries, 92,000 cfm entered through the NW Gob Vent, and 49,000 cfm entered through the seals along the northern perimeter of the gob.

## VENTILATION PRESSURE GRADIENTS

Figure 6 shows the ventilation pressure losses incurred by airflow traveling from the mouth of the Longwall No. 1 Section to the North Gob Vent regulator. The gradient was constructed by plotting the total pressure at selected locations against the distance of the location from the mouth of the section. The steeper the slope on the pressure gradient, the greater the pressure loss per unit length. Increased or relatively higher pressure losses could be the result of high resistance to airflow or a high air quantity being directed through a limited number of entries.

As shown in the figure, the first segment on the gradient with a high pressure loss (0.68 inches of water) per unit length (200 feet) occurred near the overcast in the intake entries at the mouth of the section. In this area, the total intake airflow for the longwall section was restricted to a single entry. According to company personnel, this was normal practice at the mine in order to minimize leakage to the return aircourses through an additional set of overcasts. The next segment on the gradient with a high pressure loss (1.37 inches of water) per unit length (750 feet) occurred between the headgate and the tailgate of the longwall face. This resulted as a high air quantity (77,000 cfm) was directed through the restricted entry across the longwall face. And finally, the third segment on the gradient with a high pressure loss (1.91 inches of water) per unit length (750 feet) occurred between the tailgate of the longwall face and the return regulator at the mouth of the section. Again, this was due to a high air quantity (96,000 cfm) being directed through the restricted (heavily cribbed) return entries. At the time of the investigation, these three areas of high pressure loss did not substantially limit the available airflow for the section. However, if excessive pressure losses in the ventilation system on future longwall sections result in reduced or insufficient air quantities, then these three areas can be viewed as critical segments in terms of reducing mine resistance. Table 3 summarizes the major pressure losses for each segment shown on the pressure gradient.

Figure 7 shows the ventilation pressure losses incurred by airflow traveling from the mouth of the Longwall No. 2 Section to the NW Gob Vent. Table 4 summarizes the major pressure losses for each segment shown on the pressure gradient. Each of the segments on the gradient has little or no slope, indicating that at the time of the investigation there were no areas of high pressure loss within the portion of the mine around the Longwall No. 2 Section. Therefore, there are no needed improvements in terms of reduced mine resistance.

## FACE VENTILATION INVESTIGATION

### TEST PROCEDURE AND INSTRUMENTATION

Continuous remote sensing recording methanometers (CSE Corp., Model 180R) were used to detect and record methane concentrations on each longwall section. The instruments were calibrated throughout the range of 0.0 to 2.0 percent methane and the recorders were driven at a rate of four inches per hour. On each section, methane concentrations were monitored in the immediate intake entry, the belt conveyor entry, on the shearer and at six locations across the active face. Face area sampling locations included: Shields No. 10, 45, 85, 125, 152 and 154 (near the tailgate methane monitor) on the Longwall No. 1 Section and Shield Nos. 10, 45, 85, 125, 165 and 170 (near the tailgate methane monitor) on the Longwall No. 2 Section. Figures 8 and 9 show a schematic of each longwall face with the typical sampling locations.

The methane monitors placed in the intake and belt entries were hung approximately twelve inches from the roof near the center of each entry. However, along the active face this sampling method was not practical due to the adverse conditions and limited clearance above the shearer as it passed the proposed sampling locations. Therefore, a modified dust pump was used to draw an air sample from a location over the panline approximately six inches from the top plate of the shield through a flexible rubber tube to the methane monitor located along the walkway. A similar setup was used to draw an air sample from between the two drums on the shearer to the methane monitor mounted on the shearer body. Figure 10 shows the sampling technique used at the seven locations in the active face areas.

In addition to monitoring methane concentrations, a time study was conducted to relate activity on each face to the recorded methane concentrations. Air quantity measurements were taken in the belt conveyor, track and intake entries and in the face intake (at the No. 20 shield on each section) and face return (at the No. 152 shield on Longwall No. 1 and at the No. 165 shield on Longwall No. 2) on each shift. Tables 5 and 6 summarize the air quantity measurements at these locations for each section.

## METHANE DATA ANALYSIS

The information obtained from the time studies was correlated with the methanometer recording charts to find the peak and average methane concentrations at each sensor location during the five sampling shifts of the investigation. Calibration curves were used to convert the recorder chart readings to methane concentrations. The recorder methane concentrations were corrected to agree with vacuum bottle air samples (10 cc) that were taken prior to each shift at the various recorder locations. Typical methane concentrations encountered during the longwall mining cycle are illustrated in Figure 11, which is a copy of four recorder charts for a six hour period on December 11, 1989.

On each longwall section the lowest methane concentrations were recorded by the monitors in the immediate intake and belt conveyor entries. Airflow from these two entries on both sections mixed to provide the intake airflow for the active face. The lowest methane concentrations on the Longwall No. 1 (0.03 - 0.30 %) and Longwall No. 2 faces (0.12 - 0.68 %) were recorded prior to mining at the beginning of the shift and gradually increased from the headgate to the tailgate side. As shown in Figure 11, the methane concentrations increased during mining. The methane concentrations remained elevated for the duration of the shift at the return side monitor locations, except during idle periods when methane concentrations fell to the initial baseline levels.

The highest methane peaks recorded during mining on the Longwall No. 1 (0.12 - 0.69 %) and Longwall No. 2 faces (0.25 - 0.94 %) occurred as the shearer moved by the monitors on a cutting pass. None of these short duration (less than one minute) methane peaks exceeded 1.0 volume percent in approximately thirty four hours of monitoring face operations.

In addition, a methane recorder was mounted on the shearer of both longwalls to monitor methane concentrations in between the cutting drums as close to the face as possible. The recorded methane concentrations on the Longwall No. 1 (0.07 - 0.57 %) and Longwall No. 2 shearers (0.11 - 0.85 %) indicated that the methane between the drums was being diluted to acceptable levels. Tables 7 and 8 summarize the average methane concentrations, standard deviations, and range of values recorded at each monitor location during the investigation.

## METHANE LIBERATION

From methane data collected at monitoring stations along the face, it was obvious that the exposed longwall face liberated methane at all times and the rate at which it was released increased significantly during mining. In addition, the methane concentrations gradually built up from the headgate to the tailgate side of the longwall face over the course of the production shifts. To calculate the increase in methane (EM) from the headgate to the tailgate side of the longwall face over the course of a production shift, the following equation was used:

$$EM = [(C_R \times Q_R) - (C_I \times Q_I)] / 100$$

where,

EM = Estimated increase of methane from the headgate to the tailgate side of the longwall face, cfm,

$C_R$ = Average peak methane concentration in the face return (at the tailgate methane monitor), percent,

$Q_R$ = Air quantity passing over face return recorder, cfm,

$C_I$ = Average peak methane concentration in the face intake (No. 10 shield), percent,

$Q_I$ = Air quantity passing over face intake recorder, cfm.

Substituting the corresponding data from the investigation into the equation, the estimated methane increases from the headgate to the tailgate of the Longwall No. 1 Section were 217, 223 and 62 cfm, respectively for the three sampling shifts. For the Longwall No. 2 Section the estimated methane increases were 101 and 111 cfm, respectively for the two sampling shifts.

According to the Phase I findings, the estimated increase in methane from the headgate to the tailgate side of the Longwall No. 2 face was 211 cfm for a "normal" production shift. Since production on each longwall section was limited to less than normal levels during the Phase II investigation, calculations could not be made for an estimated increase in methane from the headgate to the tailgate side of each longwall face for a normal production shift.

## CONCLUSIONS

1. The mine utilized an extensive underground and surface degasification program to recover 13.4 million cfd of methane from the mine.

2. The mine liberated 16.0 million cfd of methane through the existing mine fans.

3 The active face on each section was mining coal from a portion of the longwall panel where successful degasification and water infusion had been conducted prior to the investigation.

4 The Longwall No. 1 Section had been developed with a panel width of 780 feet and a length of 5,500 feet. At the time of the investigation, the panel had been retreated approximately 3,100 feet.

5 The Longwall No. 1 Section was the sixth consecutive longwall unit driven south off of the 1 West entries. As each panel was retreated, it added to the total area of the Southwest Gob.

6 The Southwest Gob had not yet been sealed in accordance with the progressive sealing plan (a.k.a. progressive ventilation) in effect at the mine. Therefore, the previous five longwall panels were open to the bleeder entries.

7 The available intake airflow for the Longwall No 1 unit at the mouth of the section was 322,000 cfm

8 Air quantities measured along the active face of the Longwall No. 1 averaged 77,000 cfm on the headgate side and 80,000 cfm on the tailgate side for the three sampling shifts.

9 Normal production for the Longwall No. 1 Section was 1,520 to 1,900 raw tons per shift. Reportedly, tonnages mined during the three shifts of the investigation were 2,244, 1,631 and 1,488 tons, respectively.

10. The Longwall No. 2 Section had been developed with a panel width of 850 feet and a length of 5,100 feet. At the time of the investigation, the panel had been retreated approximately 2,700 feet.

11 The Longwall No. 2 Section was the seventh consecutive longwall unit driven north off of the 3 West entries. As each panel was retreated, it added to the total area of the Northwest Gob.

12. The open portion of the Northwest Gob was ventilated by a split of airflow, which was regulated at the NW and SW Gob Vents. The Gob Vents were monitored by the environmental monitoring system continuously for methane and carbon monoxide.

13 Normal production for the Longwall No. 2 Section was 1,245 to 1,660 raw tons per shift. Reportedly, tonnages mined during the two shifts of the investigation were 1,139 and 1,608 tons, respectively.

14. The available intake airflow for the Longwall No. 2 unit at the mouth of the section was 275,000 cfm.

15. Air quantities measured along the active face of the Longwall No. 2 averaged 27,000 cfm on the headgate side and 37,000 cfm on the tailgate side for the two sampling shifts.

16 In one area of the "A Panel" bleeder connectors, low oxygen was detected with a hand-held instrument. The analysis of a vacuum bottle air sample taken at that time confirmed the hand-held measurements (18.64 % oxygen, 0.74 % methane and 1.18 % carbon dioxide). These results were relayed to CMS&H District 7, Birmingham Subdistrict personnel when they were received. Company personnel observing the condition indicated that changes would be made immediately to correct the condition.

17 The analyses of the remaining vacuum bottle air samples taken during the investigation indicate acceptable air quality at all other locations.

18 The lowest methane concentrations in the face area of each longwall section were recorded prior to mining and during on-shift idle periods.

19 The highest methane concentrations in the face area of each longwall section were recorded during mining as the shearer passed each monitor location on a cutting pass. None of these short duration (less than one minute) methane peaks exceeded 1.0 volume percent.

20 The methane concentrations recorded on the shearer between the two cutting drums on each longwall section were being diluted to acceptable levels.

21. The methane concentrations on each longwall section gradually built up from the headgate to the tailgate side of the face over the course of the production shifts.

22. The highest average increase in methane from the headgate to the tailgate side of the Longwall No. 1 face over the course of the three sampling shifts was 223 cfm.

23. The highest average increase in methane from the headgate to the tailgate side of the Longwall No. 2 face over the course of the two sampling shifts was 111 cfm.

## ACKNOWLEDGEMENT

The cooperation and courtesies extended by mine management and union members during the investigations is greatly appreciated.

Gary E. Smith
Mining Engineer

Gary J. Wirth
Mining Engineer

Joseph M. Denk
Mining Engineer

Approved by

for
Edward J. Miller
Chief, Ventilation Division

## APPENDIX 1

Personnel participating in the investigations conducted at the Blue Creek No. 4 Mine, December 6-12, 1989, are as follows:

### MSHA - PITTSBURGH HEALTH TECHNOLOGY CENTER

J. Denk, Mining Engineer, Ventilation Div.
R. Ondrey, Mining Engineer, Dust Div.
G. Smith, Mining Engineer, Ventilation Div.
G. Wirth, Mining Engineer, Ventilation Div.

### MSHA - COAL MINE SAFETY AND HEALTH, DISTRICT 7

K Ely, Ventilation Specialist, Birmingham Subdistrict Office
J. Saunders, Coal Mine Inspector, Jasper Field Office

### JIM WALTER RESOURCES, INCORPORATED

W. Andrews, Safety Supv., Mine No. 4
J. Cooley, Mine Manager, Mine No. 4
D. Hagood, Sr. Engineer, Mine No. 4
B. Hendrix, Asst. Safety Supv., Mine No. 4
T. McNider, Deputy Mgr. Ventilation, CMO
G. Nicosia, Hort. Degas. Coordinator, Mine No 4
T. Sartain, Ventilation Engineer, CMO
D. Scott, Ventilation Engineer, Mine No. 4
L. Scott, Asst. Safety Supv., Mine No. 4
J. Stevenson, Mgr. Ventilation, CMO
and
The Longwall No. 1 Section Dayshift Crew
and
The Longwall No. 2 Section Dayshift Crew

### UNITED MINE WORKERS OF AMERICA

J. Casner, Safety Rep.
D. McAteer, Safety Rep.
H. Weber, Safety Rep.
T. Wilson, International Safety Rep

Table 2. Balance of Airflow Entering and Leaving the Mine

| Intake Shafts | Quantity (cfm) | Return Shafts | Quantity (cfm) |
|---|---|---|---|
| Service | 396,300 | South | 1,325,300 |
| Production | 555,800 | North | 1,874,700 |
| Main Intake | 747,200 | Total - | 3,200,000 |
| West Intake | 1,500,700 | | |
| Total - | 3,200,000 | | |

Table 3. Summary of Major Pressure Losses Through the Mine Aircourses Around the Longwall No. 1 Section.

| Mine Segment | Total Pressure Loss (inches of water) |
|---|---|
| Surface to Mouth of Longwall No. 1 | 3.66 |
| Mouth of Section to inby Overcast | 0.68 |
| Inby Overcast to Longwall Face | 0.97 |
| Headgate to Tailgate (Face) | 1.37 |
| Tailgate to Regulator (Tailgate Return) | 1.91 |
| Regulator Loss | 0.17 |
| Regulator to North Gob Vent | 0.48 |
| Total - | 9.24 |

Table 4 Summary of Major Pressure Losses Through the Mine Aircourses Around the Longwall No. 2 Section.

| Mine Segment | Total Pressure Loss (inches of water) |
|---|---|
| Surface to Mouth of Longwall No. 2 | 5.05 |
| Mouth of Section to Longwall Face | 0.36 |
| Headgate to Tailgate (Face) | 0.50 |
| Tailgate to Regulators (Tailgate Entries) | 0.74 |
| Regulator Loss | 5.95 |
| Regulators to NW Gob Vent | 0.10 |
| Total - | 12.70 |

Table 5. Summary of Air Quantities Measured on Each Sampling Shift of the Face Ventilation Investigation on the Longwall No. 1 Section.

| Location | 12-6-89 (cfm) | 12-7-89 (cfm) | 12-8-89 (cfm) |
|---|---|---|---|
| Intake Entry | 177,200 | 158,400 | 159,700 |
| Track Entry | 61,700 | 86,500 | 87,200 |
| Belt Conveyor Entry | 57,900 | 46,600 | 57,100 |
| Total - | 296,800 | 291,500 | 304,000 |
| Longwall Face: | | | |
| Headgate (No. 20 shield) | 74,500 | 85,100 | 70,700 |
| Tailgate (No. 152 shield) | 73,600 | 76,100 | 88,600 |

Table 6 Summary of Air Quantities Measured on Each Sampling Shift of the Face Ventilation Investigation on the Longwall No. 2 Section.

| Location | 12-11-89 (cfm) | 12-12-89 (cfm) |
|---|---|---|
| Intake Entry | 105,500 | 121,500 |
| Track Entry | 93,200 | 109,600 |
| Belt Conveyor Entry | 30,400 | 32,100 |
| Total - | 229,100 | 263,200 |
| Longwall Face: | | |
| Headgate (No. 20 shield) | 25,700 | 28,000 |
| Tailgate (No. 165 shield) | 32,100 | 42,000 |

Table 7. Summary of Average Methane Concentrations, Standard Deviations, and Range of Values Recorded at Each Monitor Location on the Longwall No. 1 Section.

| Monitor Location | 12-6-89 (% methane) | 12-7-89 (% methane) | 12-8-89 (% methane) |
|---|---|---|---|
| Intake: | | | |
| Average | 0.01 | 0.02 | 0.03 |
| Std. Dev | 0.00 | 0.01 | 0.00 |
| Range | - | 0.01 - 0.04 | - |
| Belt: | | | |
| Average | 0.05 | 0.05 | 0.12 |
| Std. Dev. | 0.02 | 0.01 | 0.03 |
| Range | 0.04 - 0.11 | 0.03 - 0.07 | 0.04 - 0.19 |
| No. 10 Shield: | | | |
| Average | 0.11 | 0.11 | 0.09 |
| Std. Dev. | 0.01 | 0.01 | 0.01 |
| Range | 0.10 - 0.13 | 0.10 - 0.13 | 0.09 - 0.12 |
| No. 45 Shield: | | | |
| Average | 0.13 | - | 0.11 |
| Std. Dev. | 0.02 | - | 0.05 |
| Range | 0.09 - 0.17 | - | 0.08 - 0.23 |
| No. 85 Shield: | | | |
| Average | 0.09 | 0.18 | 0.18 |
| Std. Dev. | 0.03 | 0.03 | 0.02 |
| Range | 0.03 - 0.13 | 0.12 - 0.26 | 0.14 - 0.22 |
| No. 125 Shield: | | | |
| Average | 0.26 | 0.25 | 0.20 |
| Std. Dev. | 0.02 | 0.03 | 0.02 |
| Range | 0.20 - 0.29 | 0.21 - 0.33 | 0.15 - 0.25 |
| No. 152 Shield | | | |
| Average | 0.38 | 0.26 | 0.21 |
| Std. Dev. | 0.02 | 0.02 | 0.02 |
| Range | 0.34 - 0.42 | 0.23 - 0.31 | 0.17 - 0.25 |
| Tailgate (At No. 154 Shield Near Methane Monitor) | | | |
| Average | 0.40 | 0.36 | 0.20 |
| Std. Dev. | 0.15 | 0.04 | 0.06 |
| Range | 0.20 - 0.69 | 0.30 - 0.57 | 0.13 - 0.35 |
| Shearer: | | | |
| Average | 0.13 | 0.23 | 0.22 |
| Std. Dev. | 0.04 | 0.09 | 0.12 |
| Range | 0.08 - 0.23 | 0.13 - 0.57 | 0.07 - 0.54 |

Table 8. Summary of Average Methane Concentrations, Standard Deviations, and Range of Values Recorded at Each Monitor Location on the Longwall No. 2 Section.

| Monitor Location | 12-11-89 (% Methane) | 12-12-89 (% Methane) |
|---|---|---|
| Intake: | | |
| Average | 0.16 | 0.12 |
| Std. Dev | 0.02 | 0.01 |
| Range | 0.13 - 0.18 | 0.10 - 0.13 |
| Belt: | | |
| Average | 0.33 | 0.30 |
| Std. Dev. | 0.01 | 0.02 |
| Range | 0.31 - 0.37 | 0.28 - 0.34 |
| No. 10 Shield: | | |
| Average | 0.23 | 0.23 |
| Std. Dev. | 0.02 | 0.02 |
| Range | 0.12 - 0.25 | 0.19 - 0.28 |
| No. 45 Shield | | |
| Average | 0.30 | 0.28 |
| Std. Dev. | 0.04 | 0.05 |
| Range | 0.24 - 0.41 | 0.23 - 0.43 |
| No. 85 Shield: | | |
| Average | - | 0.52 |
| Std. Dev. | - | 0.05 |
| Range | - | 0.36 - 0.65 |
| No. 125 Shield: | | |
| Average | 0.56 | 0.46 |
| Std. Dev. | 0.03 | 0.04 |
| Range | 0.51 - 0.61 | 0.39 - 0.56 |
| No. 165 Shield: | | |
| Average | 0.48 | 0.48 |
| Std. Dev. | 0.04 | 0.05 |
| Range | 0.41 - 0.57 | 0.37 - 0.57 |
| Tailgate (At No. 170 Shield Near Methane Monitor): | | |
| Average | 0.68 | 0.74 |
| Std. Dev. | 0.10 | 0.05 |
| Range | 0.47 - 0.94 | 0.68 - 0.90 |
| Shearer: | | |
| Average | 0.26 | 0.38 |
| Std. Dev. | 0.16 | 0.13 |
| Range | 0.11 - 0.85 | 0.16 - 0.51 |

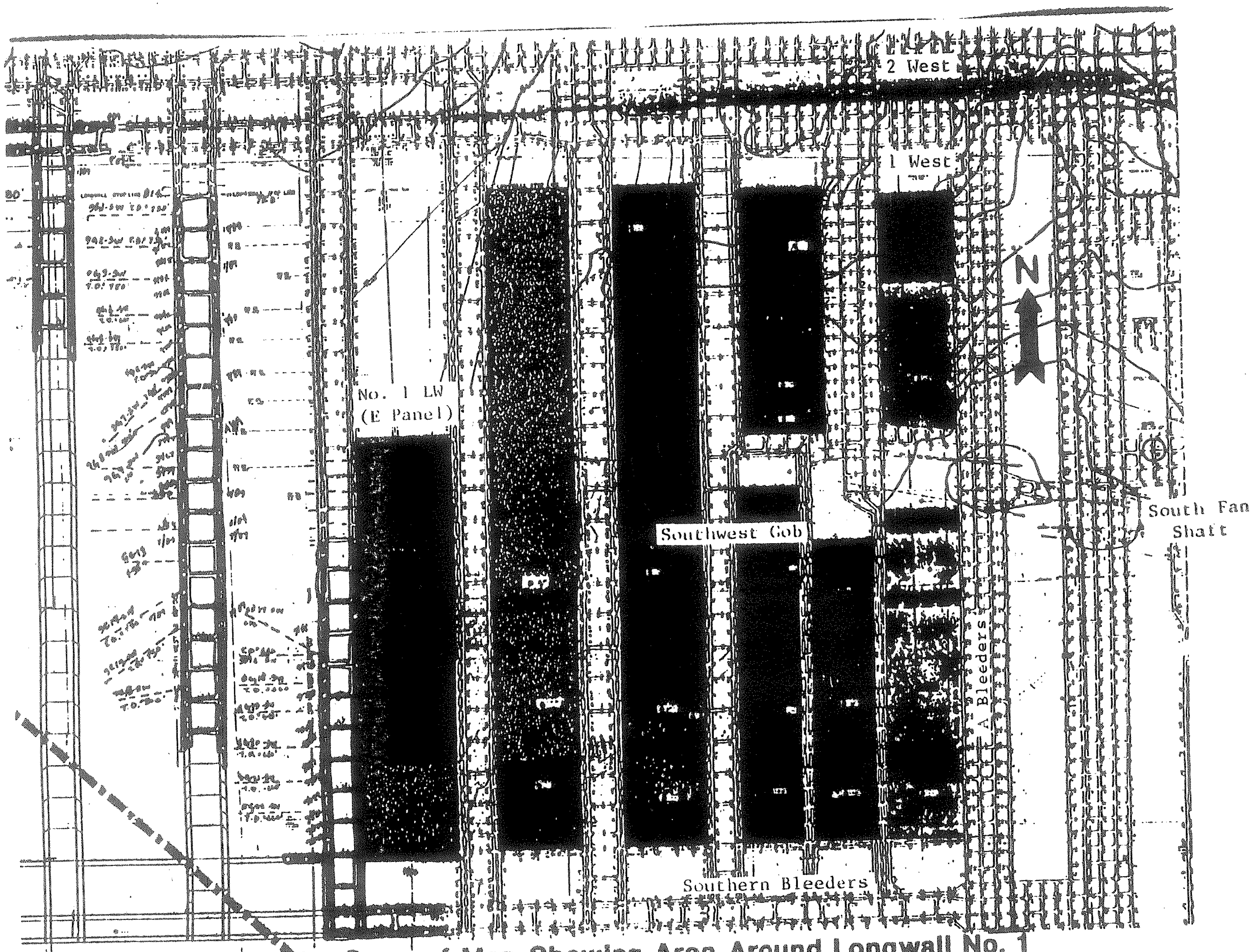



FIGURE 1 - Copy of Map Showing Area Around Longwall No. 1

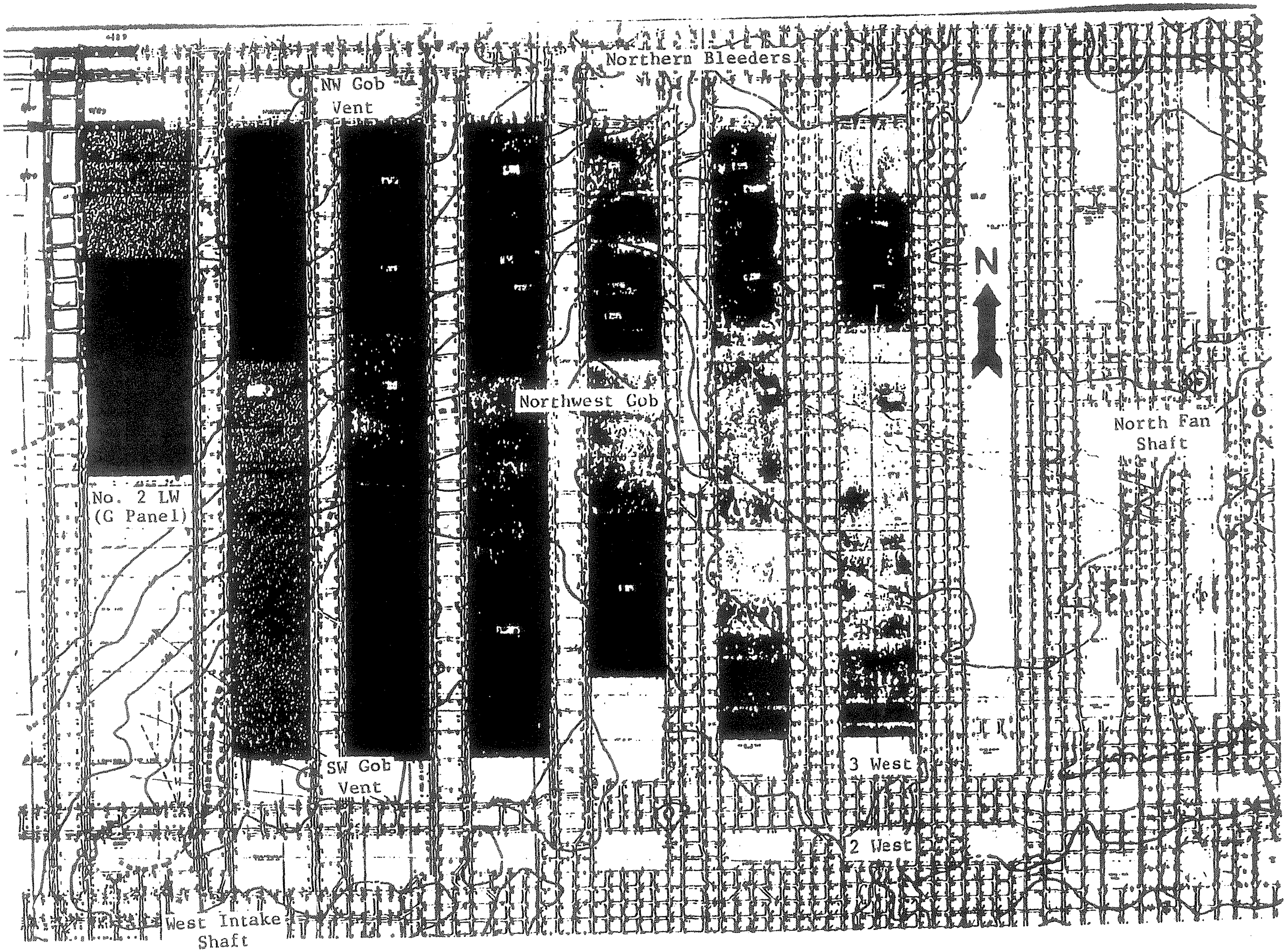



FIGURE 2 - Copy of Map Showing Area Around Longwall No. 2

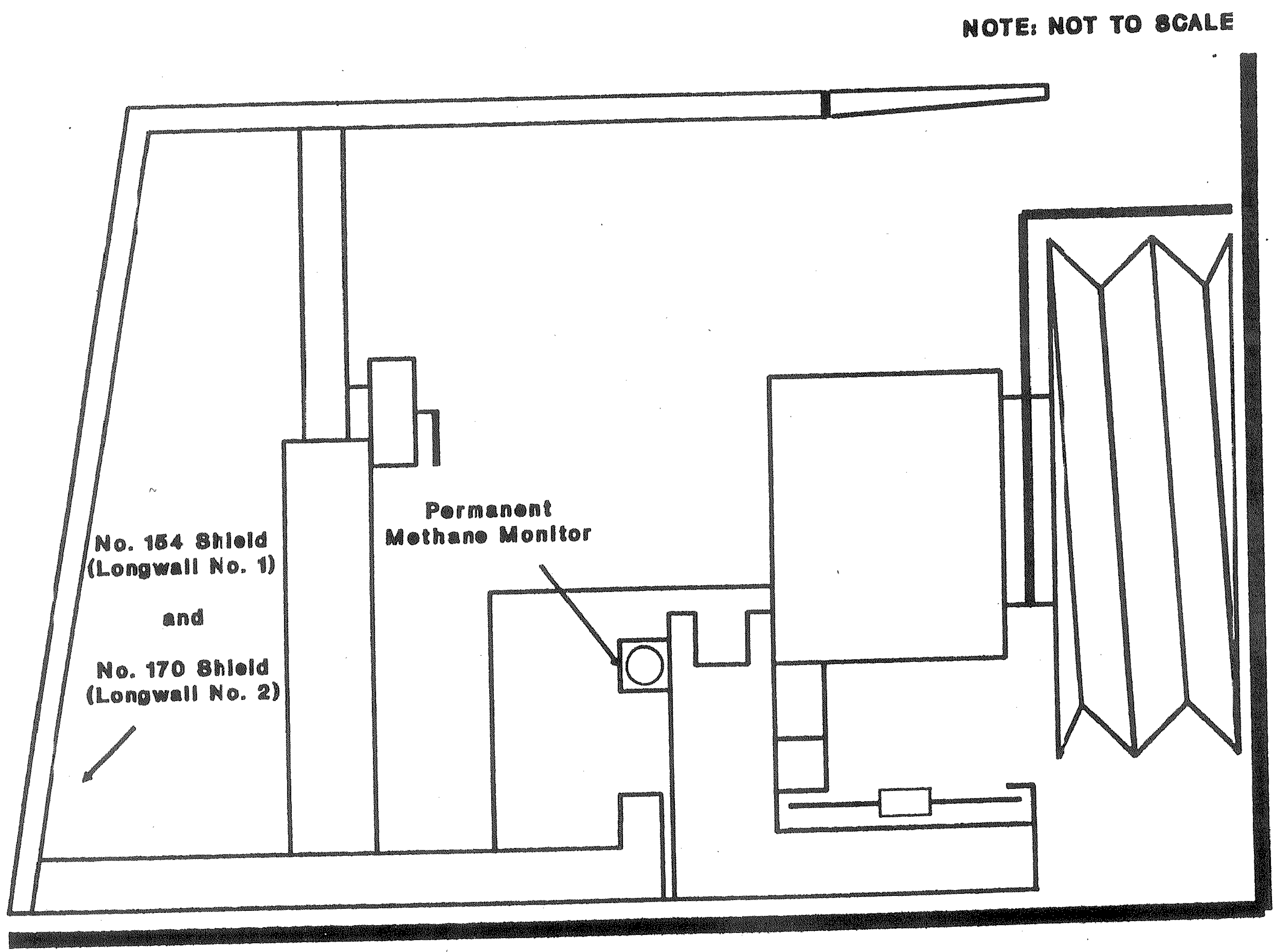
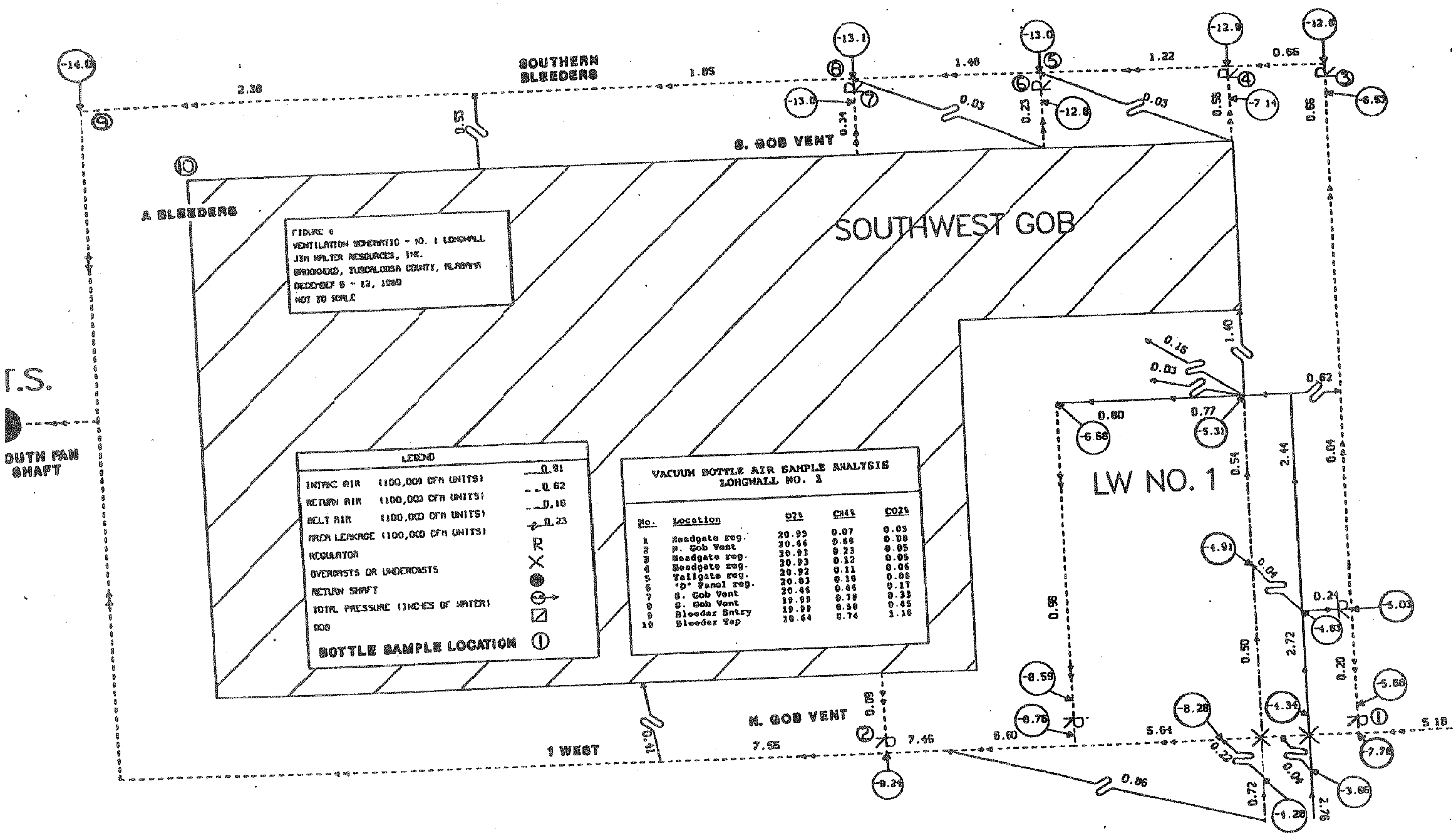



FIGURE 3 - Location of Methane Monitor on Longwall Tailgates




LEGEND

| | | |
|---|---|---|
| INTAKE AIR | (100,000 CFM UNITS) | 0.91 |
| RETURN AIR | (100,000 CFM UNITS) | 0.62 |
| BELT AIR | (100,000 CFM UNITS) | 0.16 |
| AREA LEAKAGE | (100,000 CFM UNITS) | 0.23 |
| REGULATOR | | R |
| OVERCASTS OR UNDERCASTS | | X |
| RETURN SHAFT | | ● |
| TOTAL PRESSURE (INCHES OF WATER) | | |
| GOB | | |
| **BOTTLE SAMPLE LOCATION** | | ① |

FIGURE 4
VENTILATION SCHEMATIC - NO. 1 LONGWALL
JIM WALTER RESOURCES, INC.
BROOKWOOD, TUSCALOOSA COUNTY, ALABAMA
DECEMBER 6 - 12, 1989
NOT TO SCALE

**VACUUM BOTTLE AIR SAMPLE ANALYSIS**
**LONGWALL NO. 1**

| No. | Location | O2% | CH4% | CO2% |
|---|---|---|---|---|
| 1 | Headgate reg. | 20.95 | 0.07 | 0.05 |
| 2 | N. Gob Vent | 20.66 | 0.60 | 0.08 |
| 3 | Headgate reg. | 20.93 | 0.23 | 0.05 |
| 4 | Headgate reg. | 20.93 | 0.12 | 0.05 |
| 5 | Tailgate reg. | 20.92 | 0.11 | 0.06 |
| 6 | "D" Panel reg. | 20.83 | 0.10 | 0.08 |
| 7 | S. Gob Vent | 20.46 | 0.46 | 0.17 |
| 8 | S. Gob Vent | 19.99 | 0.70 | 0.33 |
| 9 | Bleeder Entry | 19.99 | 0.50 | 0.45 |
| 10 | Bleeder Top | 18.64 | 0.74 | 1.10 |

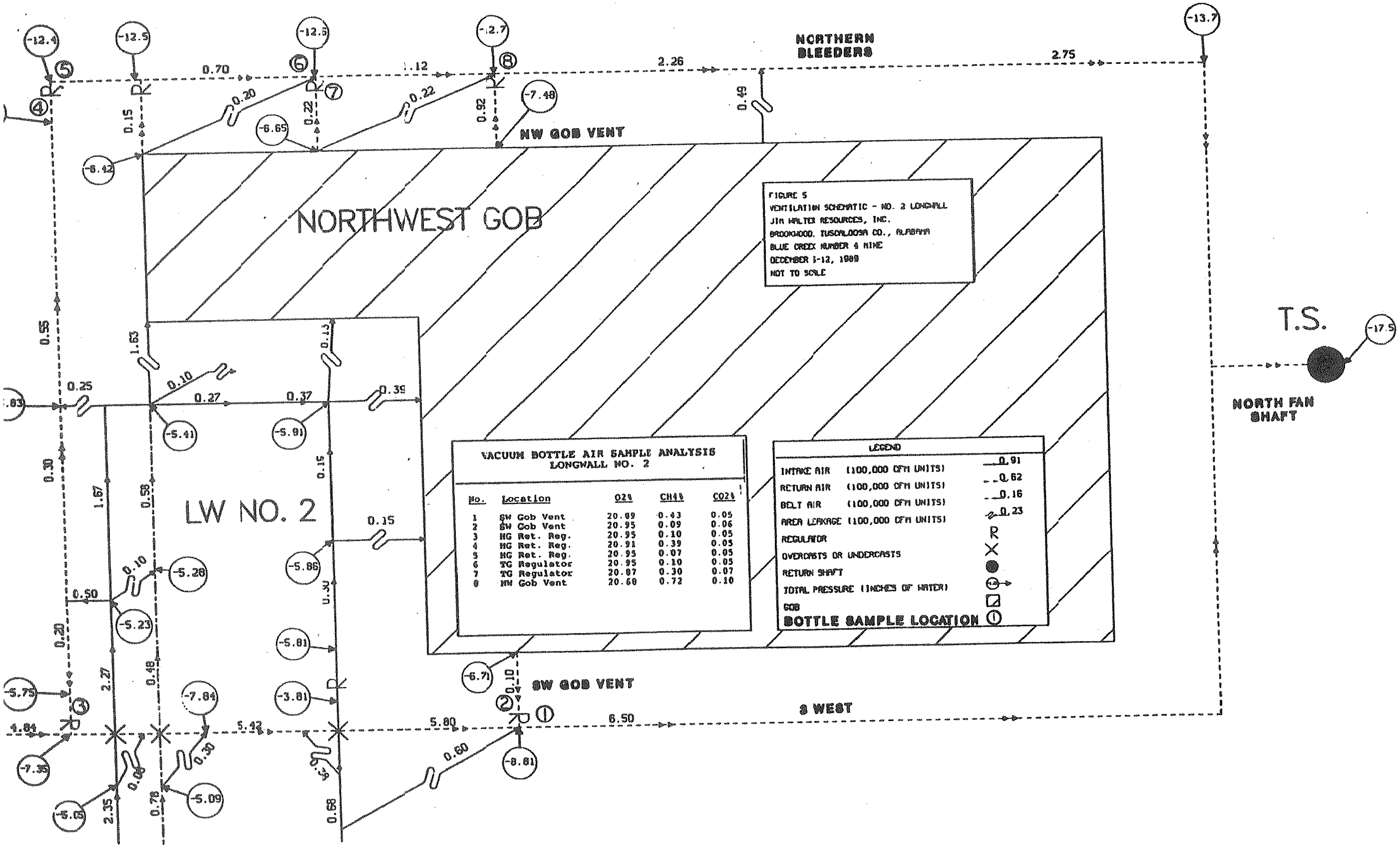



FIGURE 5
VENTILATION SCHEMATIC - NO. 2 LONGWALL
JIM WALTER RESOURCES, INC.
BROOKWOOD, TUSCALOOSA CO., ALABAMA
BLUE CREEK NUMBER 4 MINE
DECEMBER 5-12, 1989
NOT TO SCALE

VACUUM BOTTLE AIR SAMPLE ANALYSIS
LONGWALL NO. 2

| No. | Location | O2% | CH4% | CO2% |
|---|---|---|---|---|
| 1 | SW Gob Vent | 20.89 | 0.43 | 0.05 |
| 2 | SW Gob Vent | 20.95 | 0.09 | 0.06 |
| 3 | HG Ret. Reg. | 20.95 | 0.10 | 0.05 |
| 4 | HG Ret. Reg. | 20.91 | 0.39 | 0.05 |
| 5 | HG Ret. Reg. | 20.95 | 0.07 | 0.05 |
| 6 | TG Regulator | 20.95 | 0.10 | 0.05 |
| 7 | TG Regulator | 20.87 | 0.30 | 0.07 |
| 8 | NW Gob Vent | 20.60 | 0.72 | 0.10 |

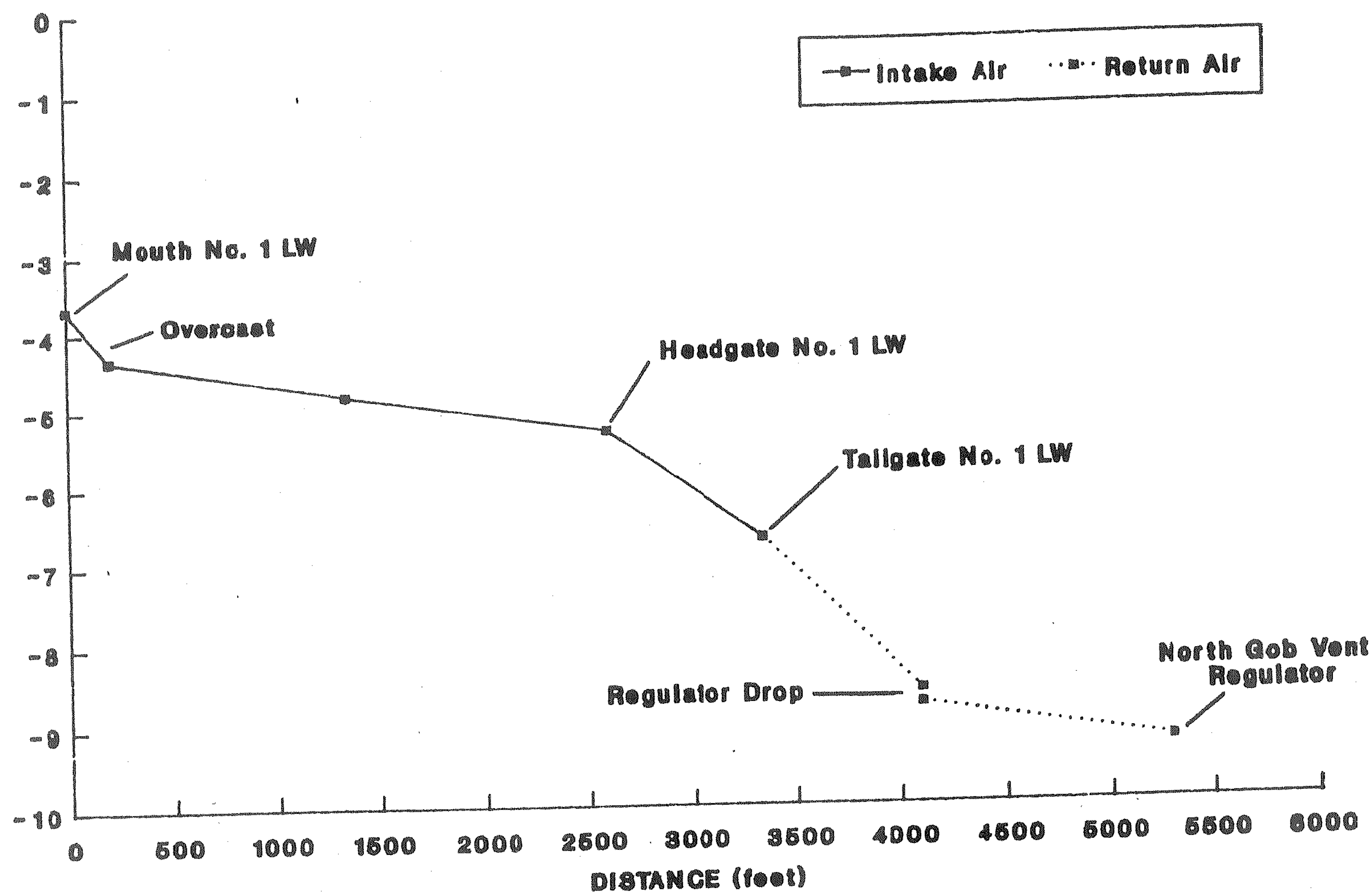



FIGURE 6 - Pressure Gradient for Longwall No. 1

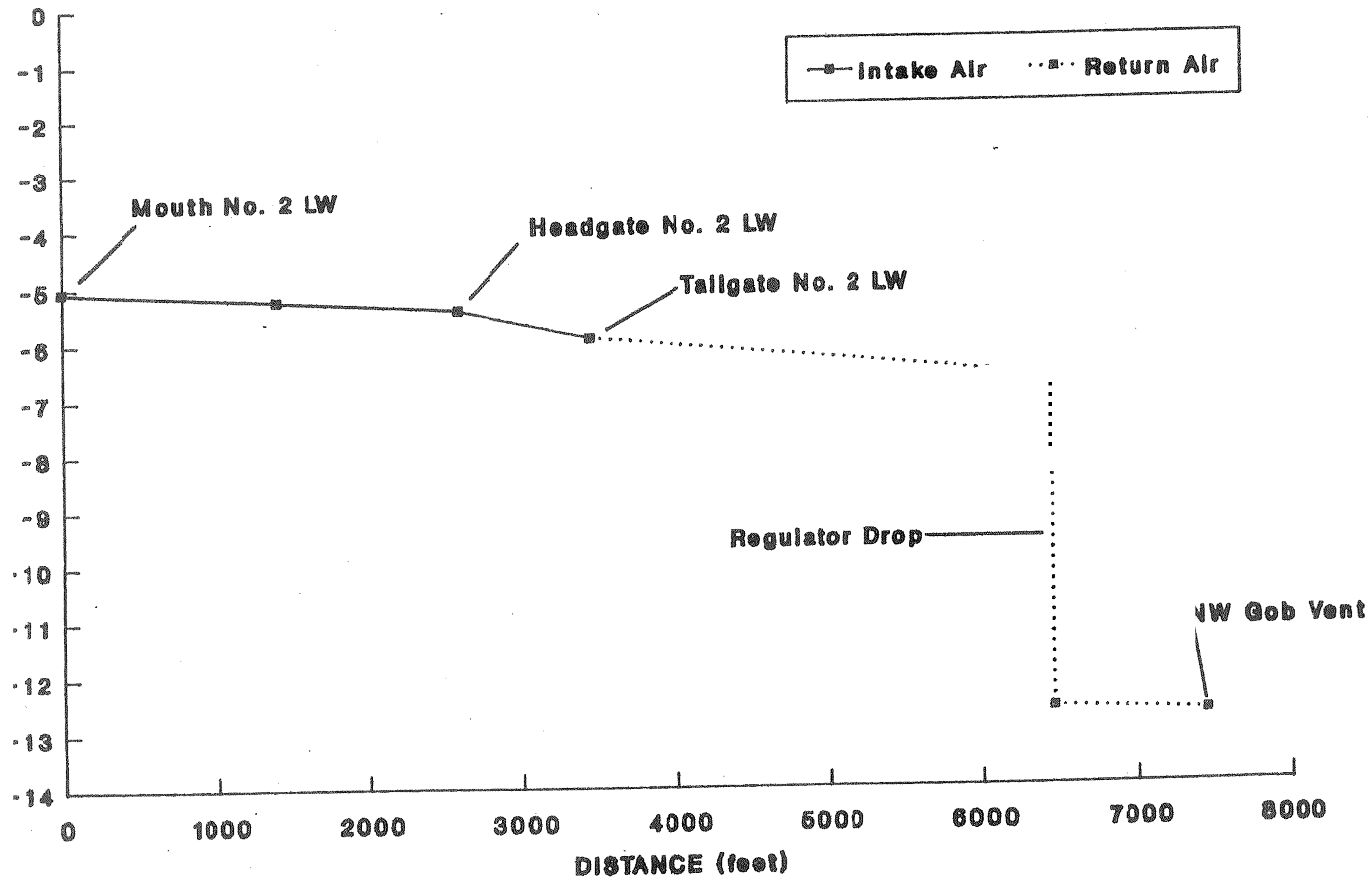



FIGURE 7 - Pressure Gradient for Longwall No. 2

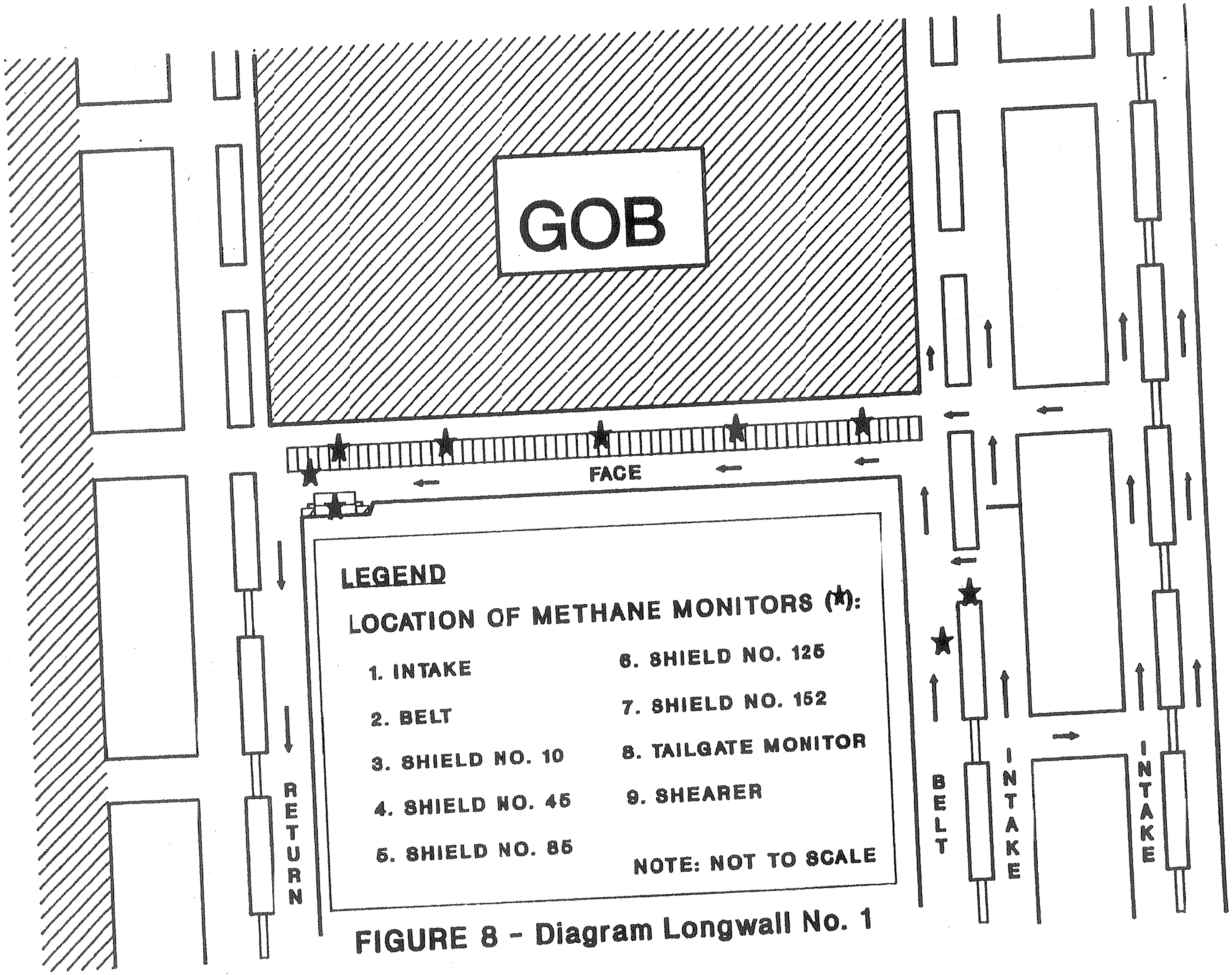



FIGURE 8 - Diagram Longwall No. 1

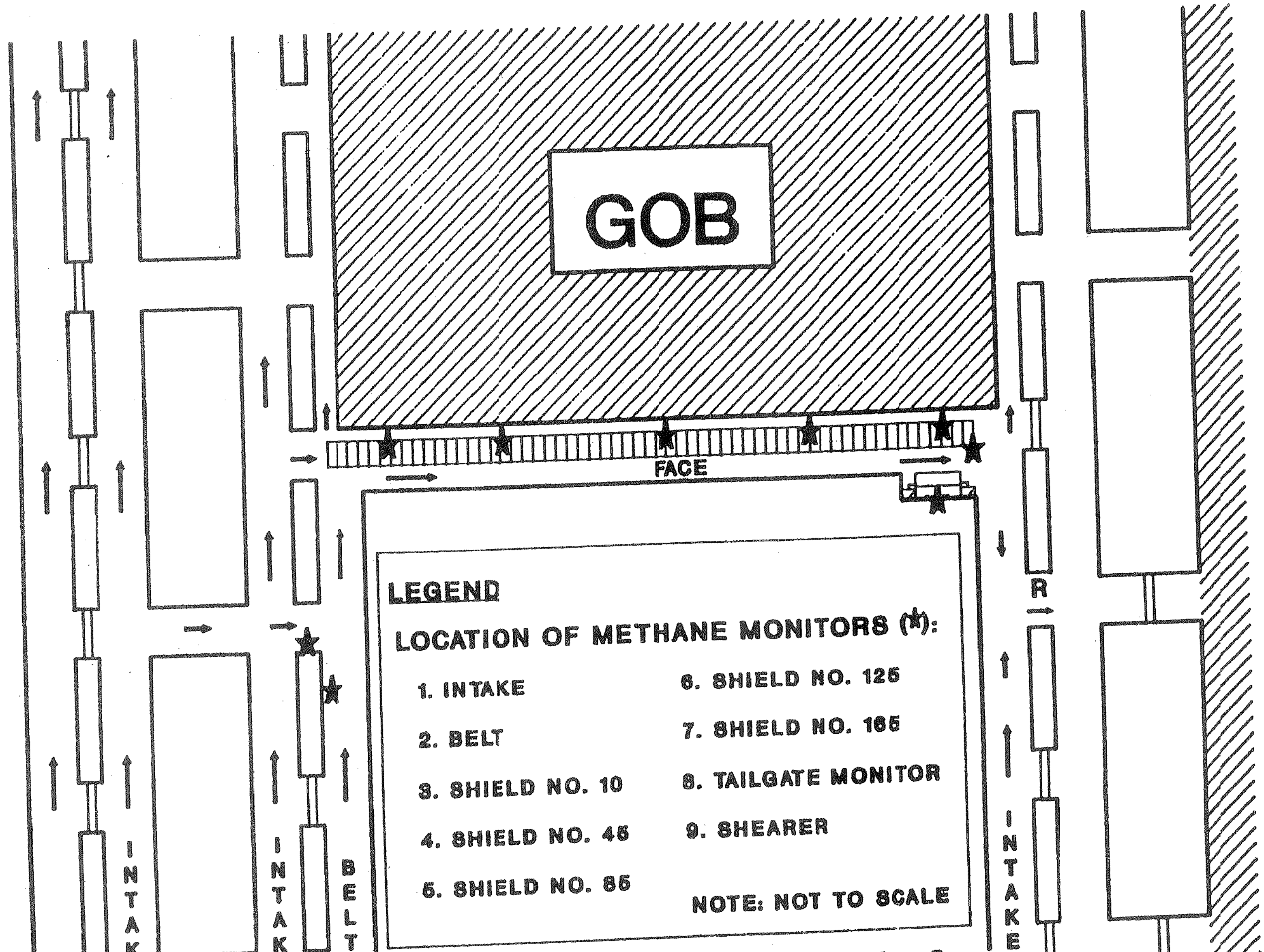



FIGURE 9 - Diagram Longwall No. 2

NOTE: NOT TO SCALE

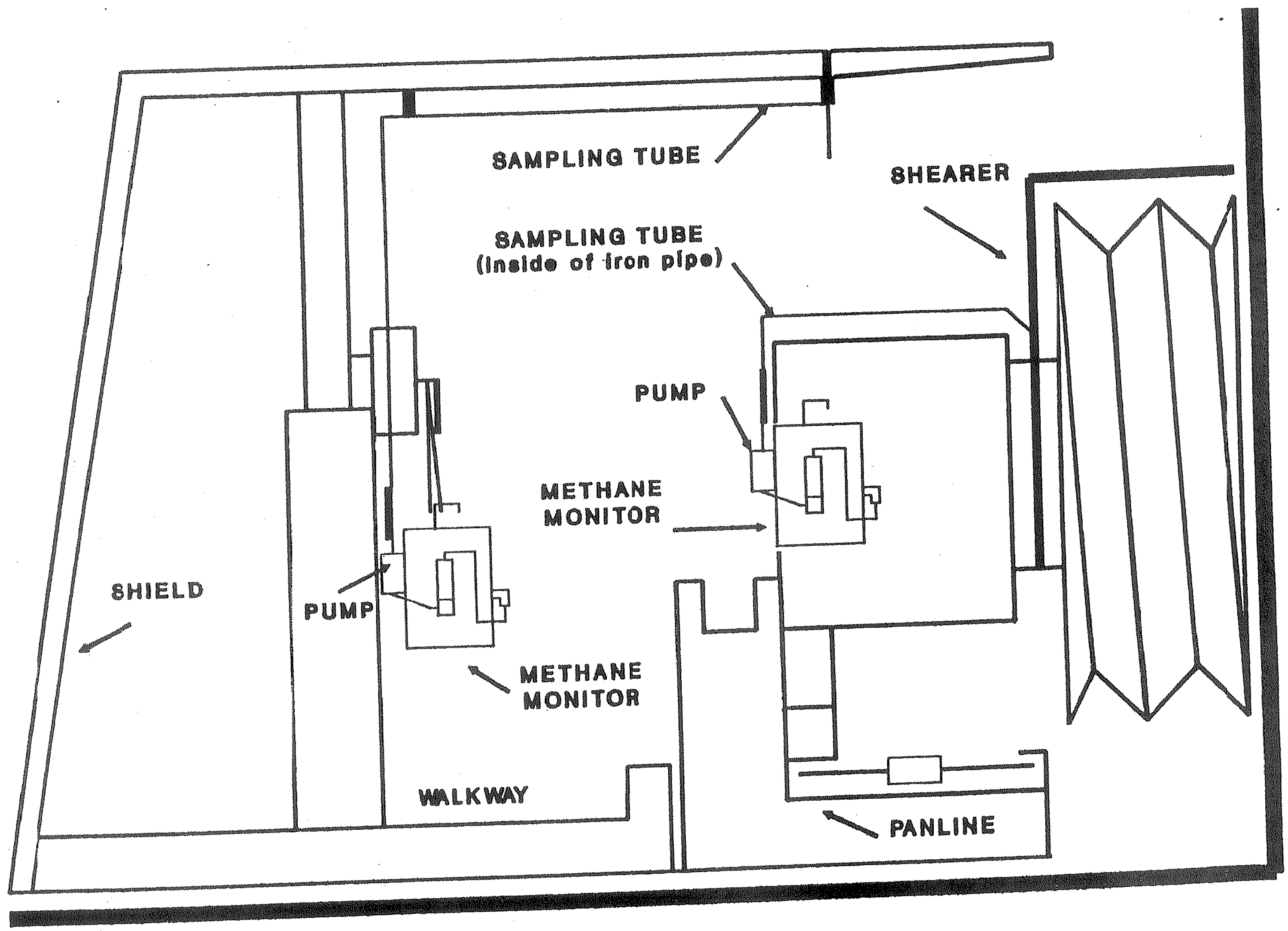



FIGURE 10 - Methane Sampling Setup in Face Area

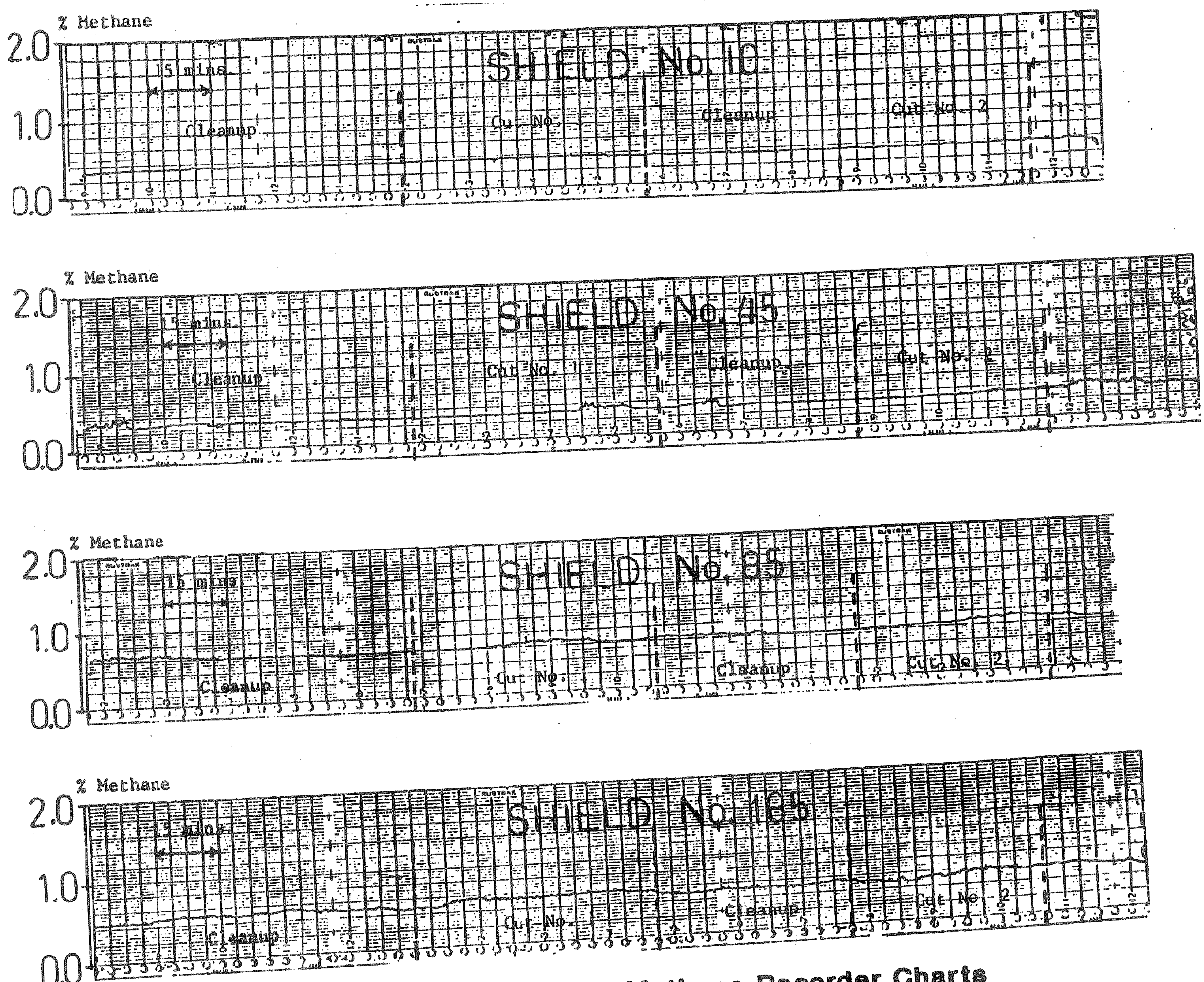



FIGURE 11 - Copy of Methane Recorder Charts