YATES PETROLEUM CORP.
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DATE: 09/09/92 DE NOVO
EXHIBIT NO. 55 A

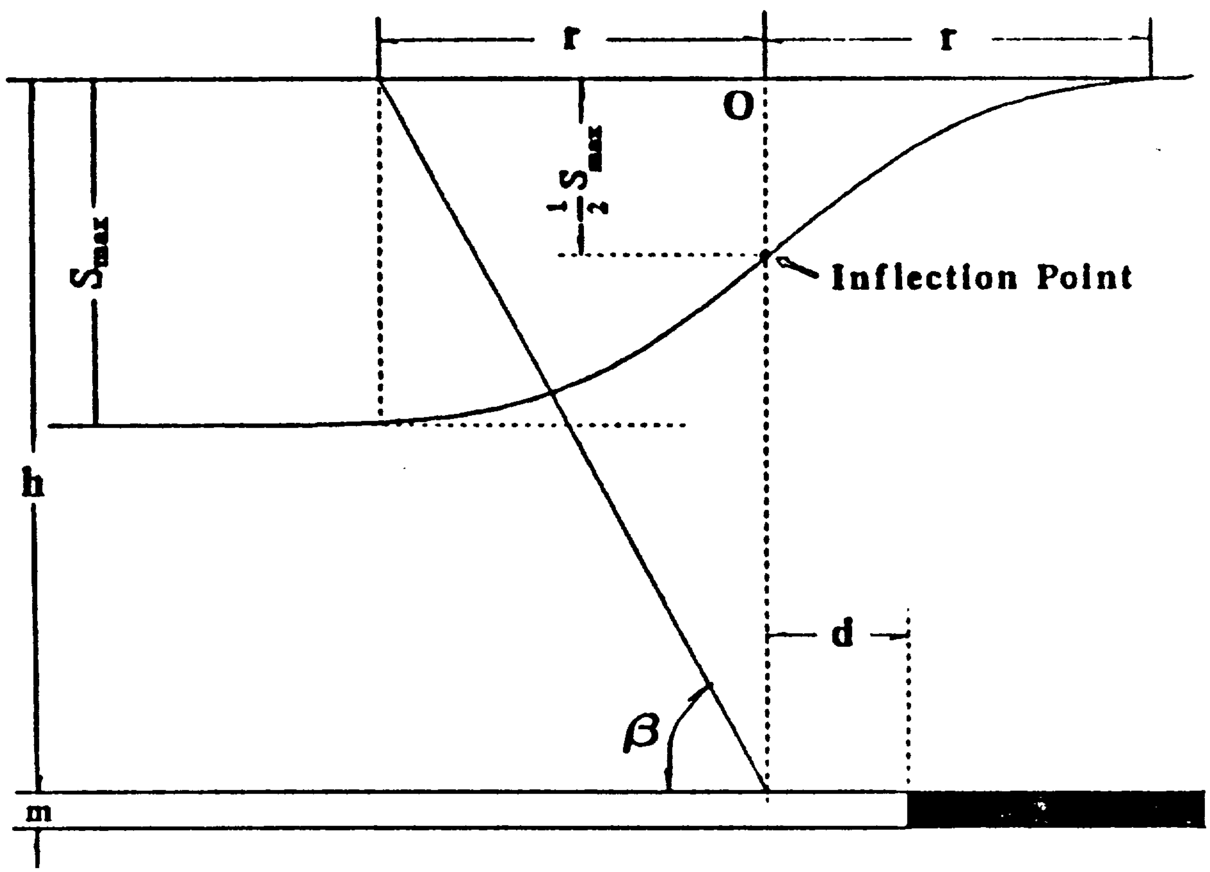

Fig. 2.5. Definition of radius (r) and angle (β) of major influence.

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S-2

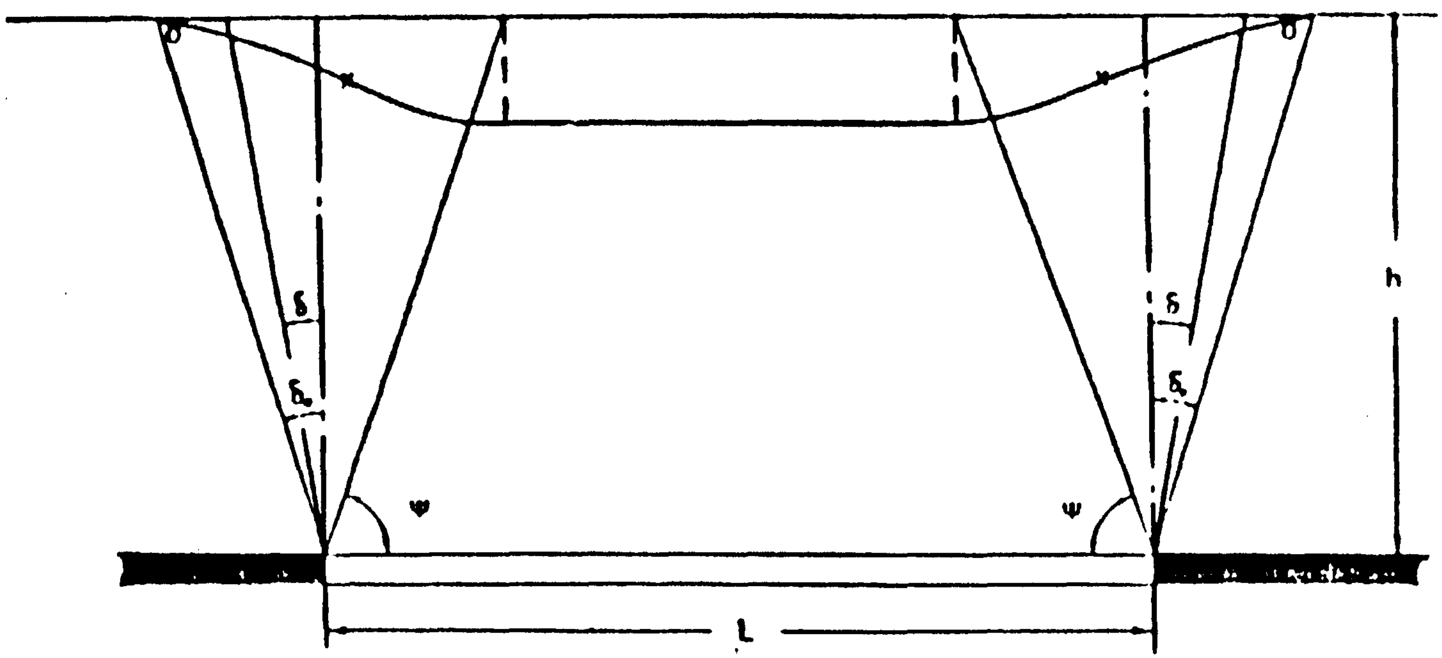

Fig. 2.3. Terminologies used associated with subsidence profile.

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S-3

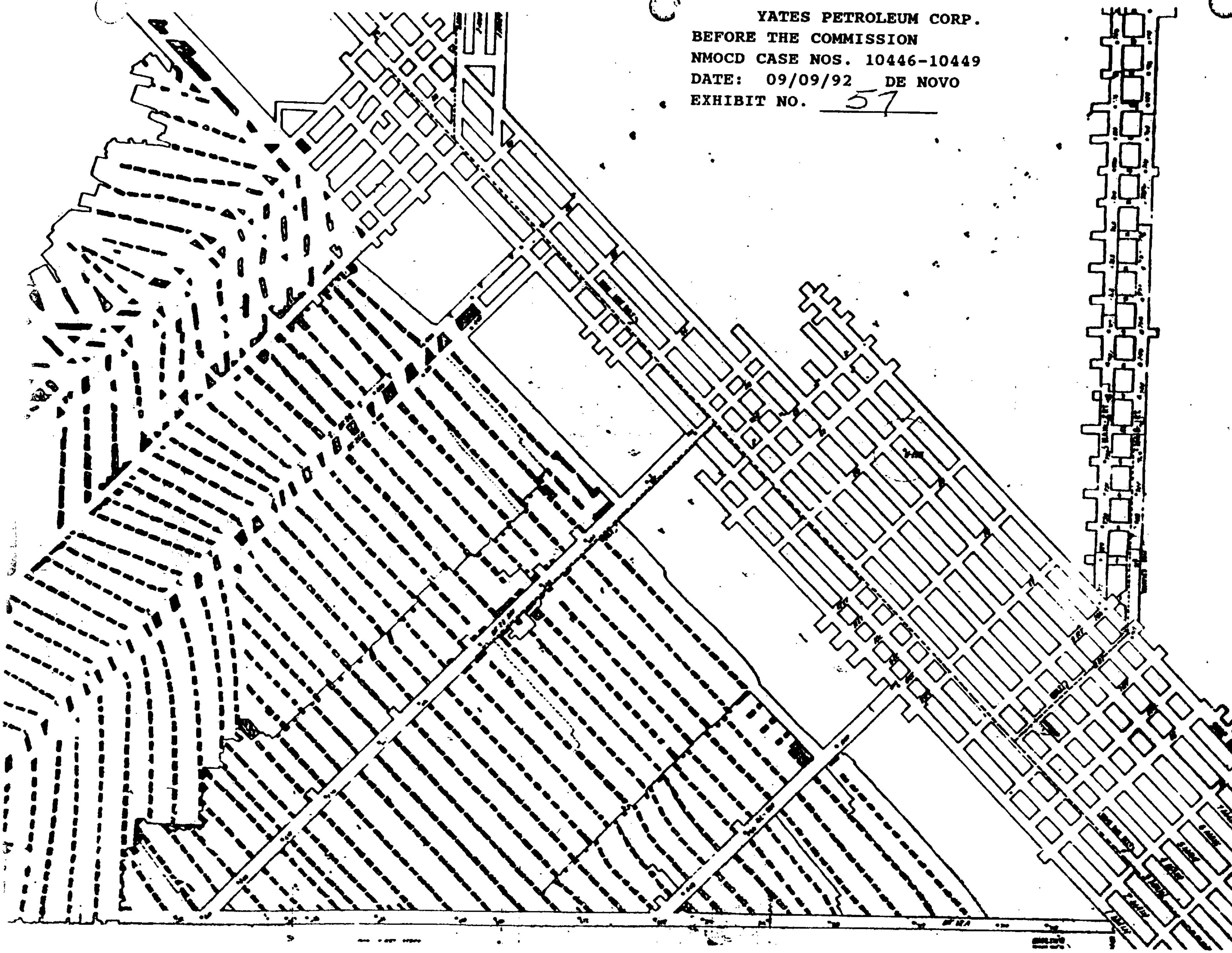

FIGURE 1: MAP OF THE AREA MINED BY THE MODIFIED LONGWALL SYSTEM. NOTE MODIFICATIONS OF SYSTEM AS MINING PROGRESSED TO

65AM22

S 4

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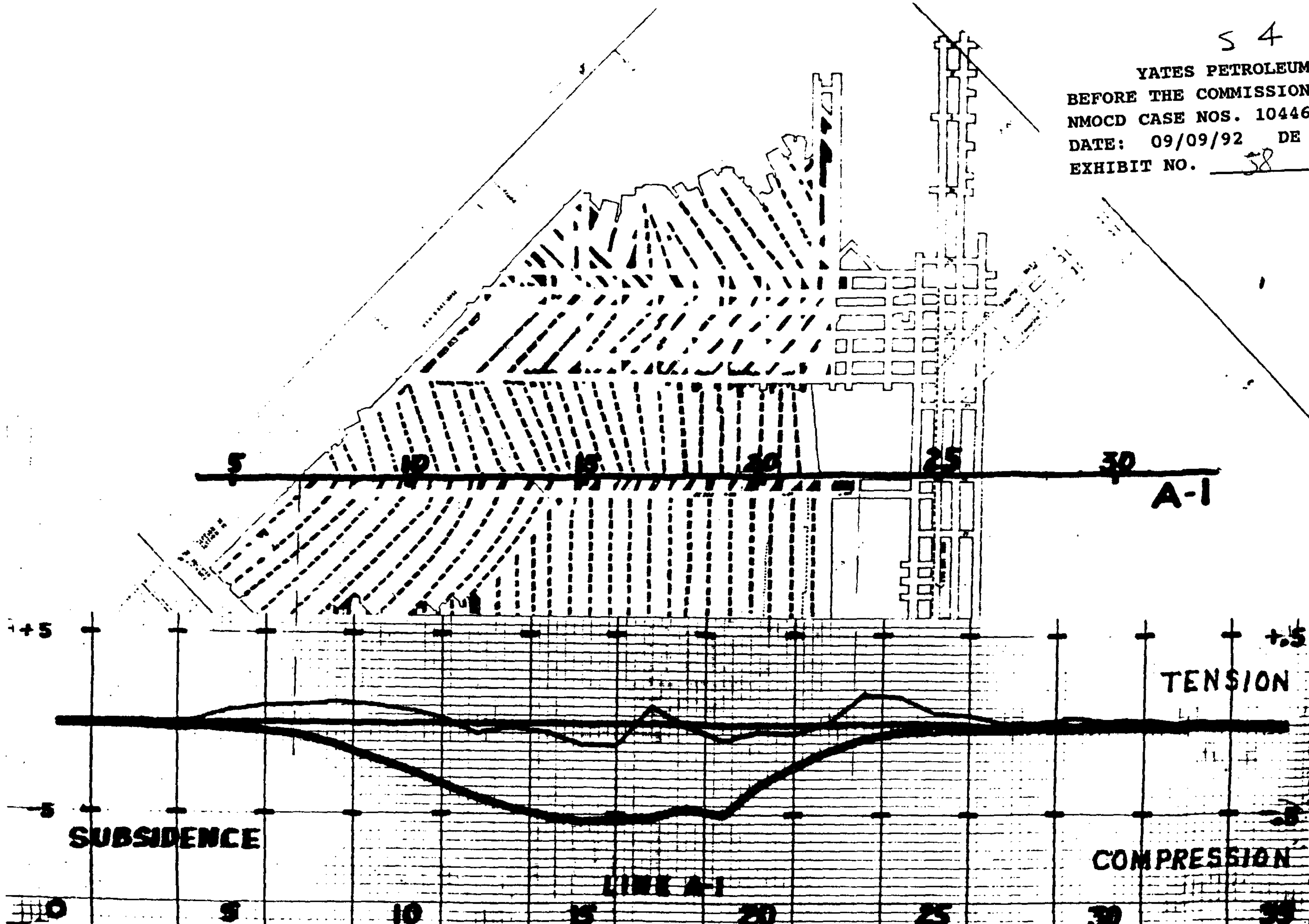

FIGURE 2: SUBSIDENCE AND STRAIN LINE A-1 ON THE SURFACE OVER THE MODIFIED LONGWALL OPERATION. STATIONS ARE IN HUNDREDS OF FEET.

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55

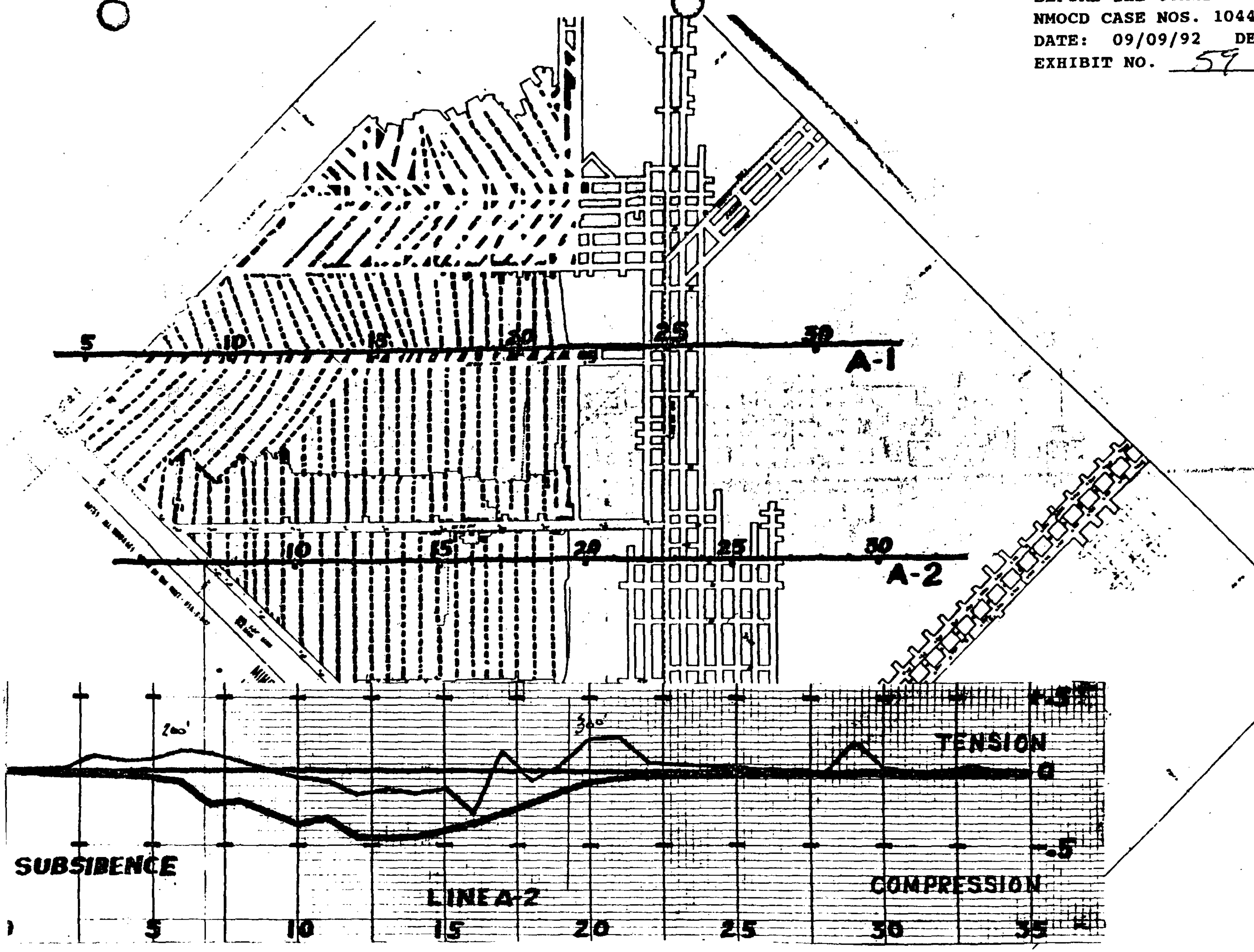

FIGURE 3: SUBSIDENCE (HEAVY LINE) AND STRAIN LINE A-2 OVER THE LONGWALL OPERATION. LEFT SCALE IS SUBSIDENCE IN FEET, RIGHT SCALE IS STRAIN IN TENTHS OF PERCENT.

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S-6

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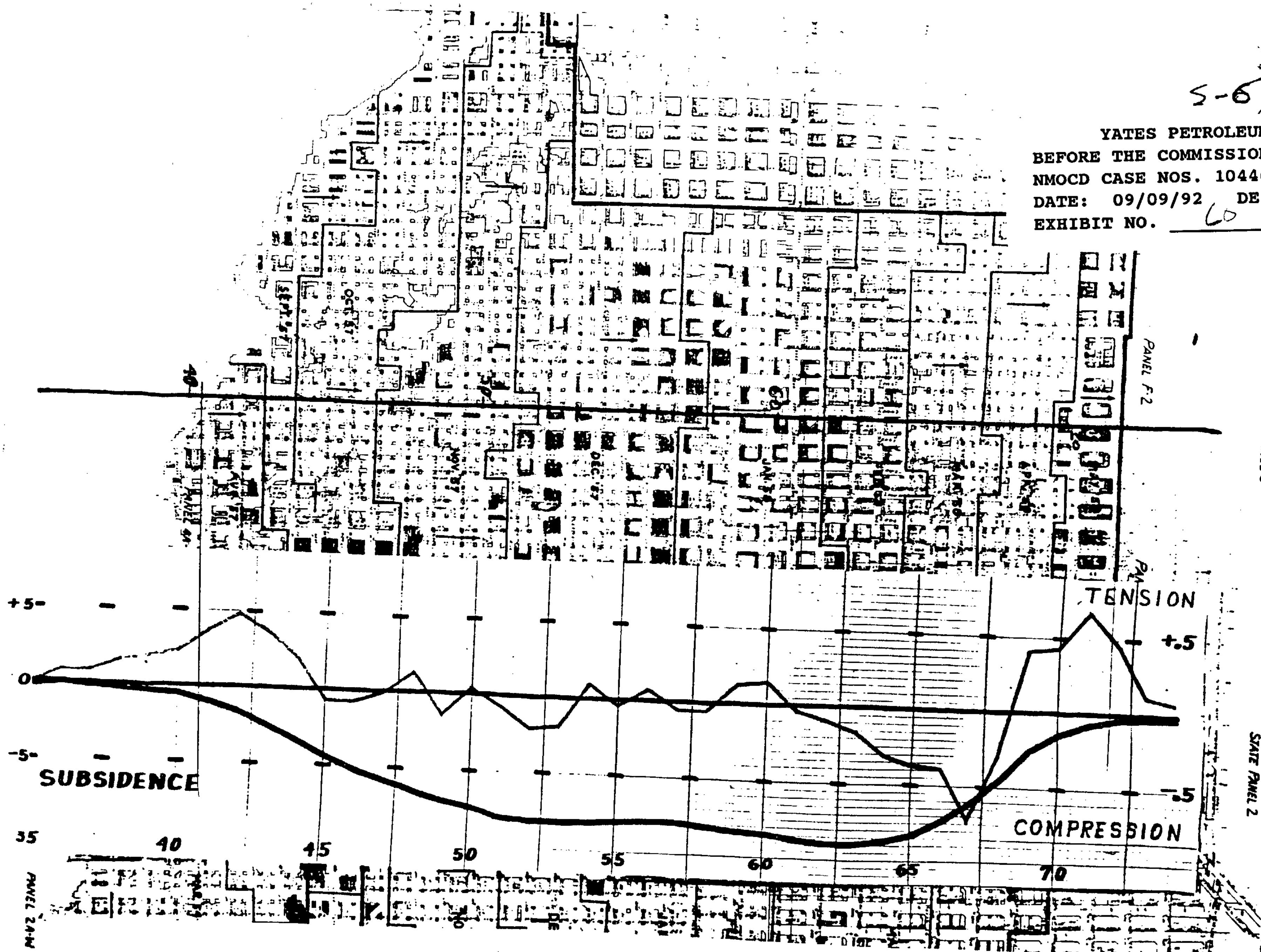

FIGURE 4: SUBSIDENCE AND STRAIN GRAPH OVER THE CONVENTIONAL FINAL MINED AREA. NOTE LOSS OF PILLARS DUE TO HEAVY GROUND, AND EXTREME LOADING AS INDICATED BY THE STRAIN GRAPH

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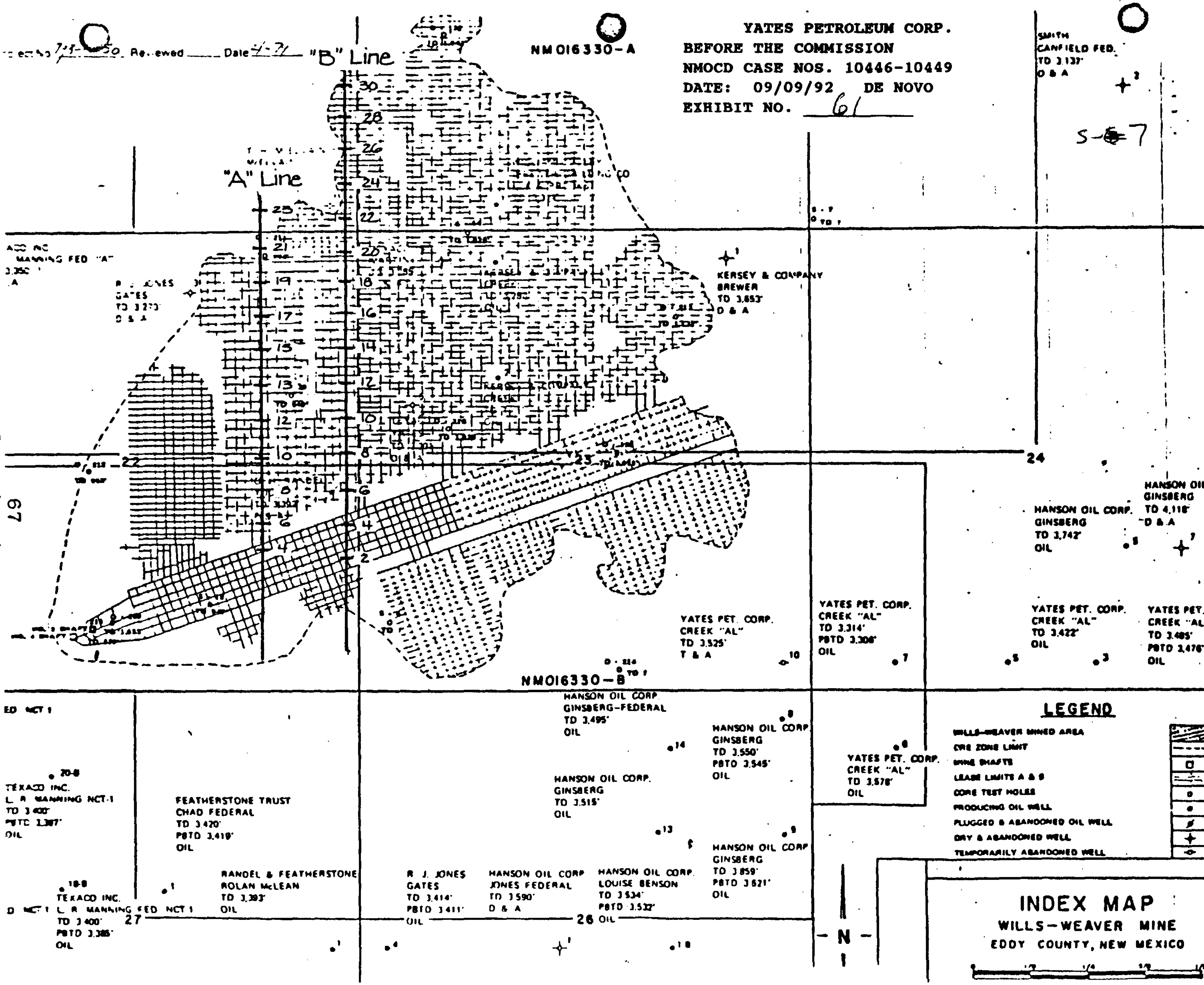


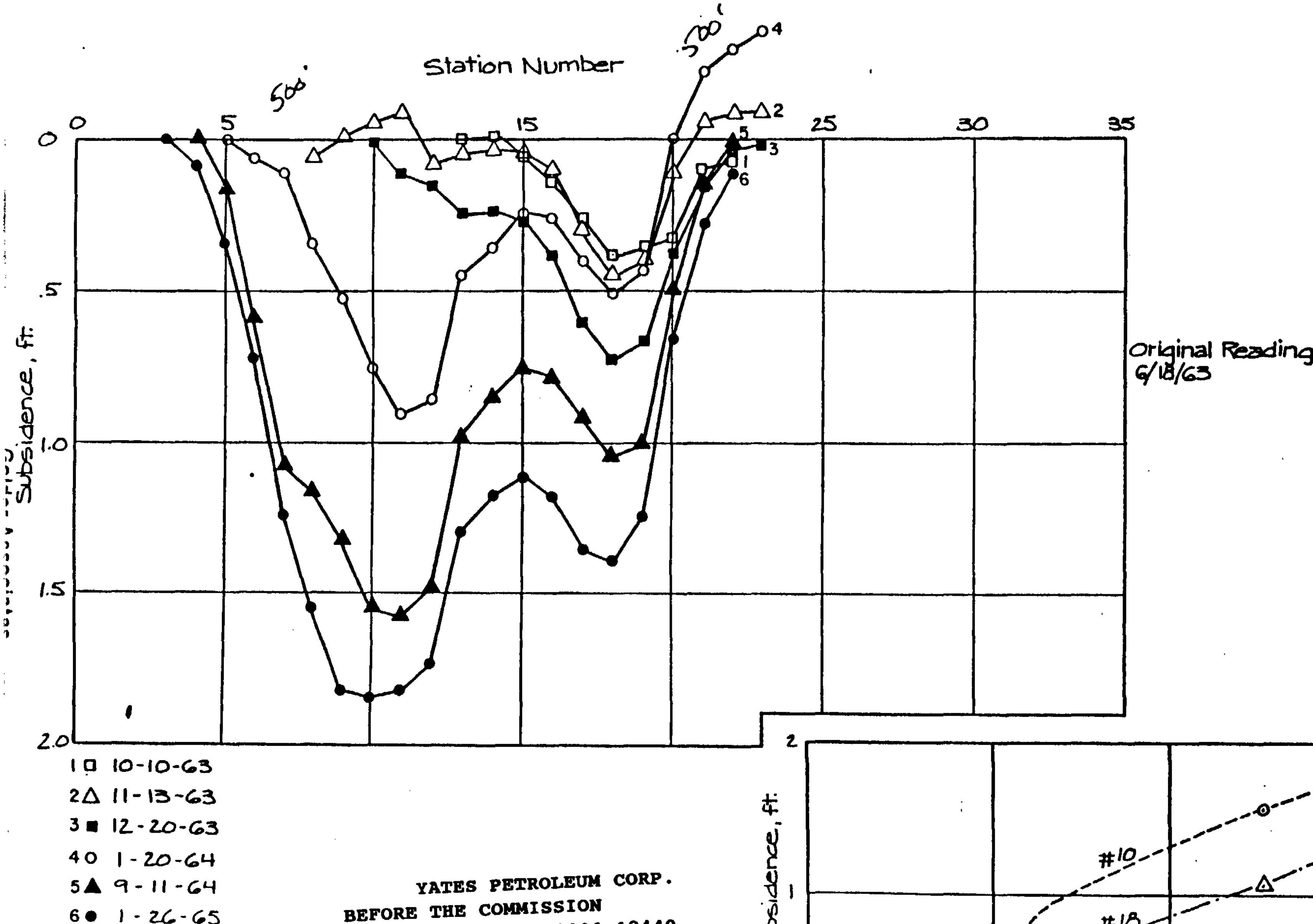
INDEX MAP
WILLS-WEAVER MINE
EDDY COUNTY, NEW MEXICO

Figure 4-4

AT WILLS - WEAVER

SURFACE SUBSIDENCE PROFILES AL[illegible]NG 'A' LINE OVER PANEL I NORTH

S8



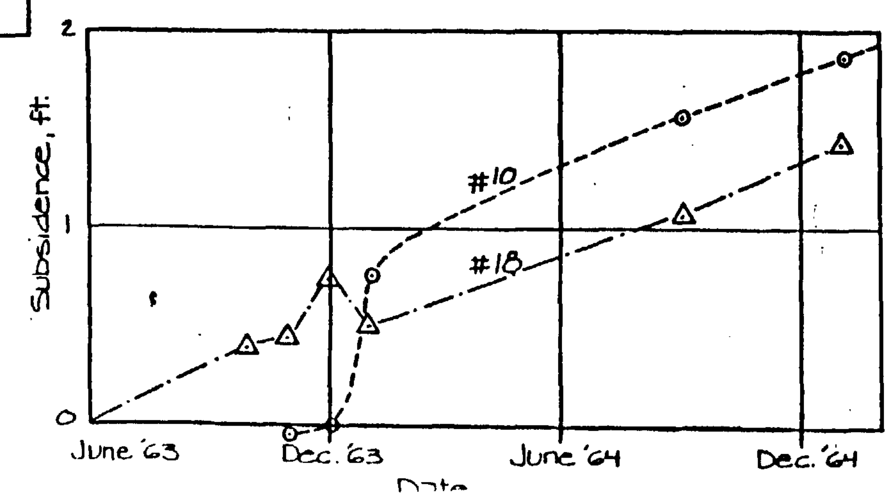


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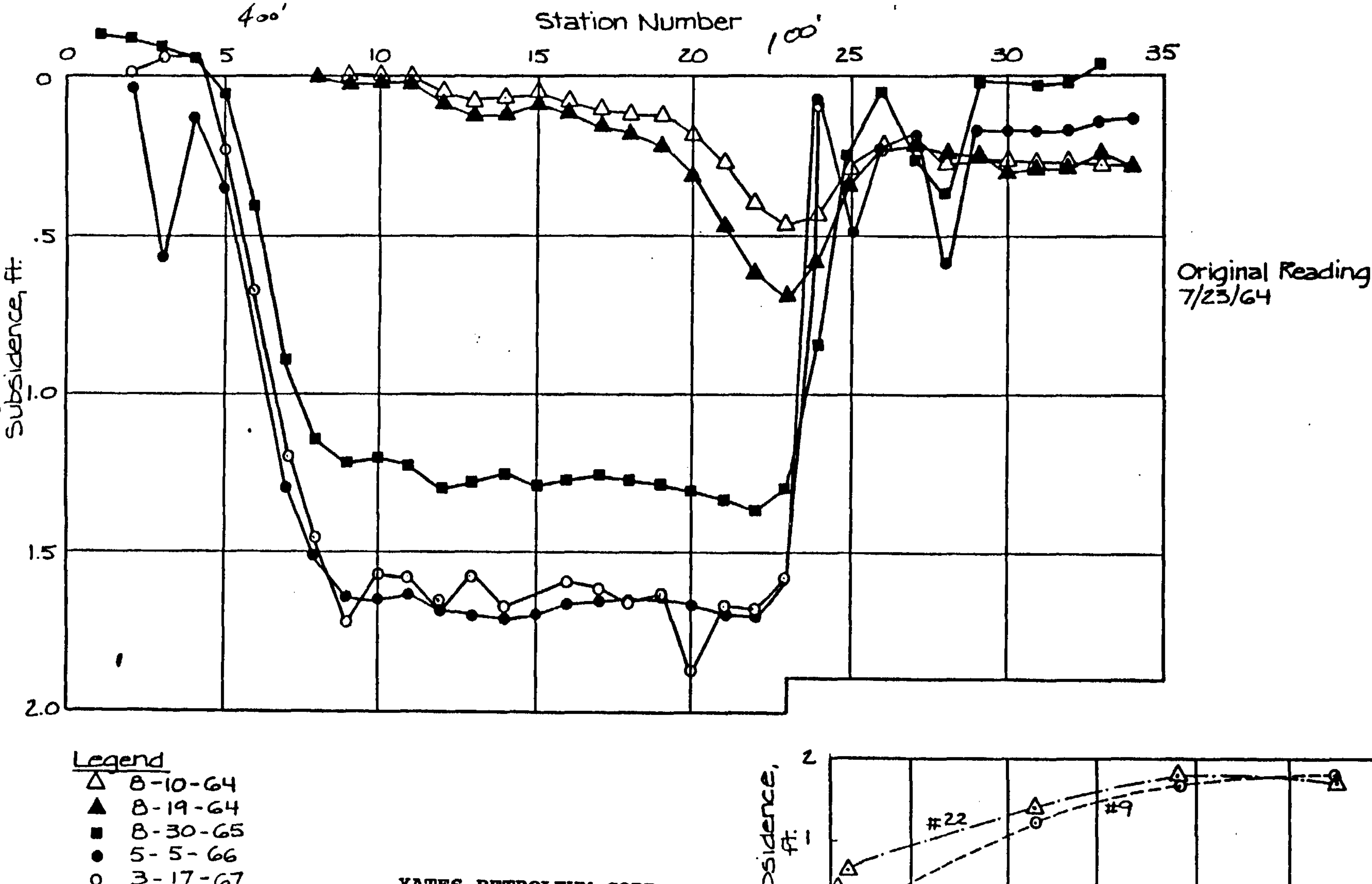
Figure 4 – 5

Project No 7?3-1?0 Reviewed ____ Date 4-79

5-9



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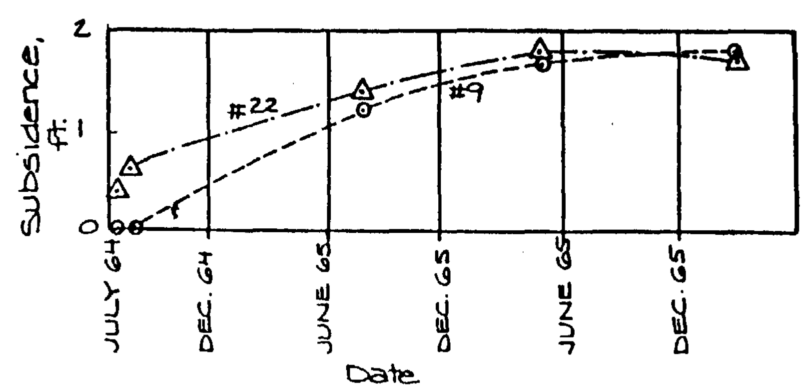


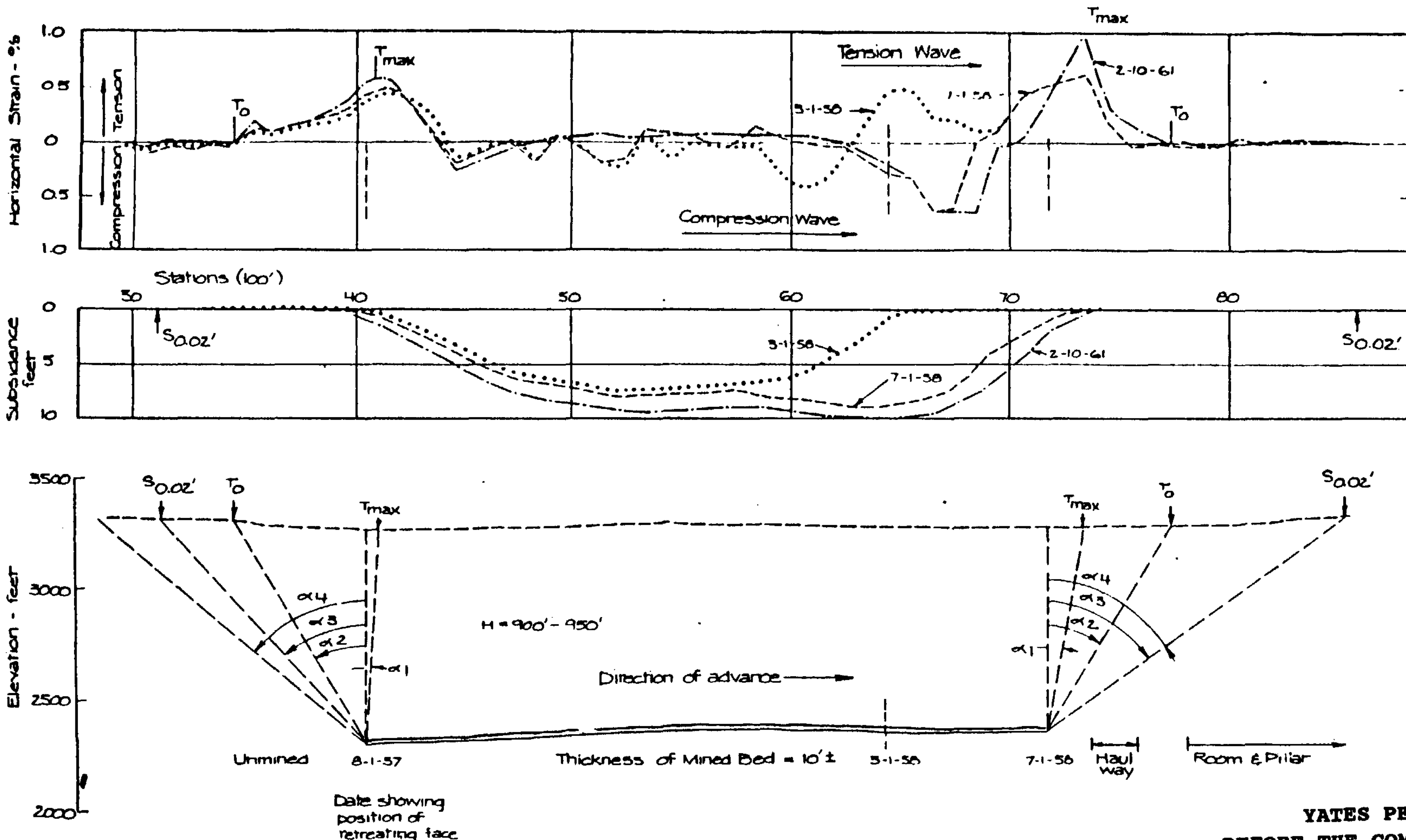
SURFACE SUBSIDENCE PROFILES ALONG
'B' LINE OVER PANEL 2 NORTH

Figure 4-6

Figure 4

PROFILE OF SUBSIDENCE AND HORIZONTAL STRAIN

(after Deere, 1961)



	α1	α2	α3	α4	H x tan α3
Left side - Unmined Area	-3°	31°	42°	>49°	910'
Right side - Room & Pillar Area	10°	32°	55°	56°	1350'
Basis of Angle	Tmax	To	S0.02'	Limit	

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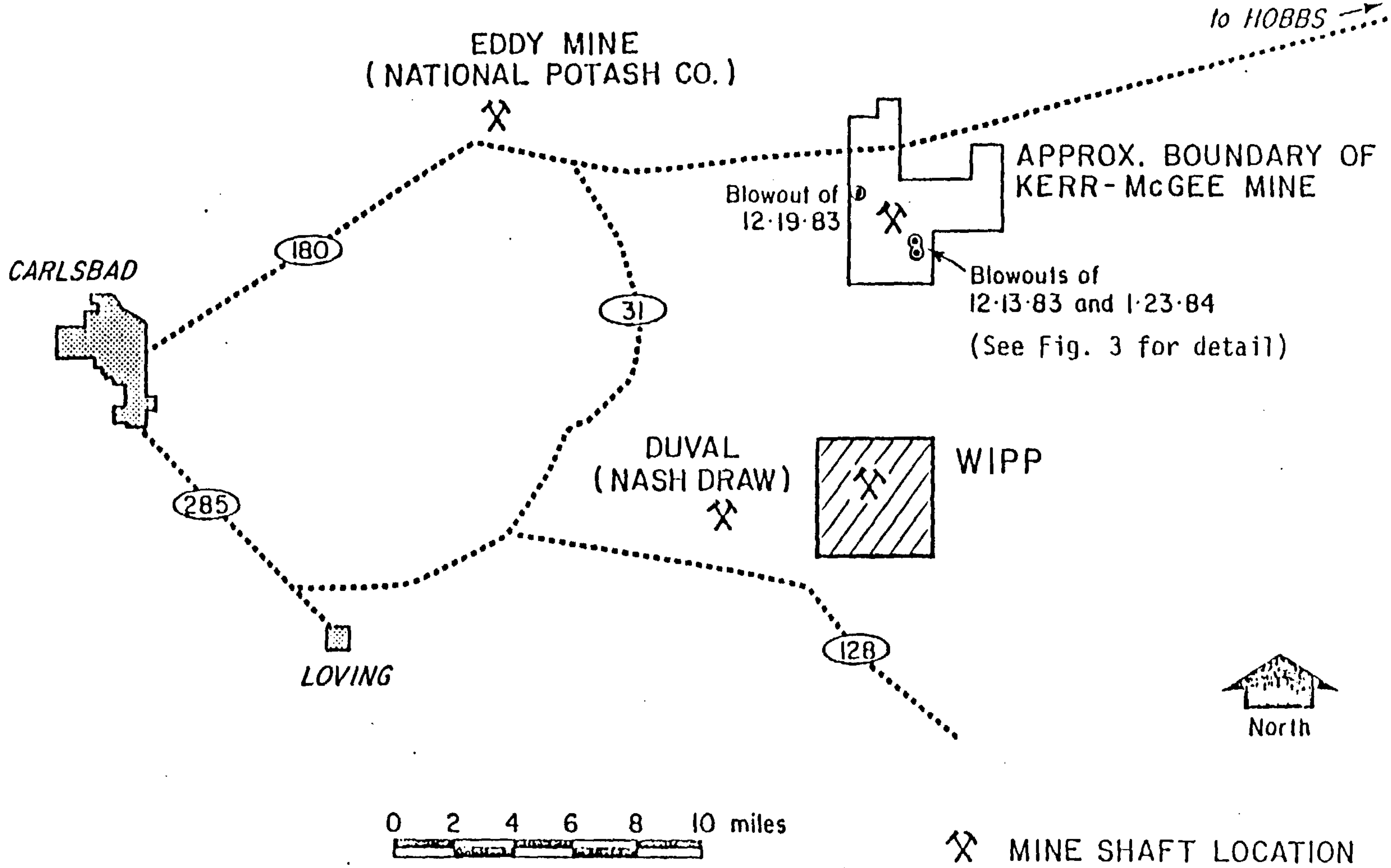

Figure 2. Location of the WIPP site and potash mines where gas blowouts have been documented.

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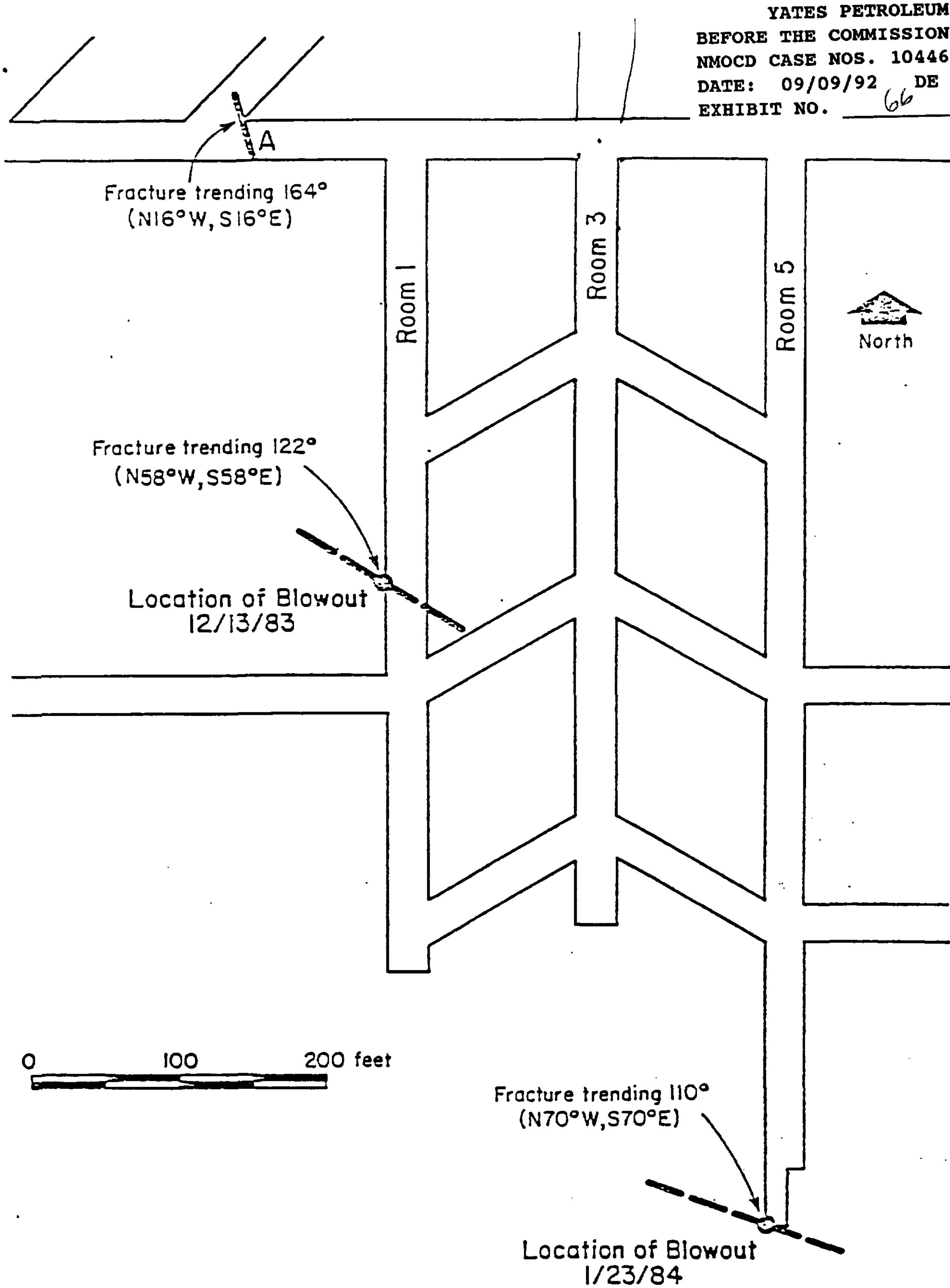

Figure 3. Detailed layout of Area 169 at the Kerr-McGee mine where the gas blowouts of 12·13·1983 and 1·23·1984 occurred. The orientation of fractures is shown. The fracture at A resulted from a previous blowout. (See Fig. 2 for location within the mine)

YATES PETROLEUM CORP.
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PROFESSIONAL RESUME

T. B. O'Brien

PERSONAL DATA

T. B. O'Brien
#2 Lazywood Lane
Midland, Texas 79705

Phone: 915-684-8588 (Home)
915-682-6373 (Office)

EDUCATIONAL BACKGROUND

High School - Evergreen, Louisiana

College - B. S. Chemical Engineering 1948
Louisiana State University

PROFESSIONAL STATUS

Registered Professional Engineer - Chemical and Petroleum, since 1953 - Louisiana

Registered Professional Engineer, since 1976 - Texas

PROFESSIONAL EXPERIENCE

October, 1992 - Named Engineer of the Year, Society of Petroleum Engineers

July 1991 - Activities continued as in 1988. Elected to Society of Petroleum Engineers Permian Basin Section Hall of Fame. Company is coordinating fire fighting operation for Kuwait Oil Company. Personally consulting with KOC and fire fighting companies on management problems and fire fighting techniques.

February 1988 - Continued consulting engineering activities with increasing emphasis on consultation with management of domestic and foreign oil companies. Designed and provided engineering and operational assistance on several 25,000 foot Anadarako Basin Wells. Analyzed well problems and gave operational advice to operating companies and drilling contractors. Entered into a joint venture with a drilling contractor to drill 15,000 foot and deeper wells on turnkey contracts. Provided operational aid to a mining company and drilling contractor on use of oil field drilling rigs and techniques in drilling deep hard rock core holes. Provided on site management and operational supervision of wells with significant problems. Provided aid to operators, contractors, individuals, manufacturers, service companies and their attorneys when involved in litigation and, when necessary, gave expert testimony in the realm of oil field operations.

January 1982 - Formed O'Brien Goins Ritter & Associates and OGR Operating Company, Inc. to explore, develop and operate oil and gas properties. (In 1987 changes to O'Brien Goins Simpson Exploration Company and OGS Operating Company, Inc.)

Continued engineering consulting activities with increasing emphasis on expert testimony and consultation with management of national oil companies.

May 1977 - Consulting Drilling Engineer
Formed O'Brien Goins Engineering, Inc. with W. C. Goins, Jr. (In 1978 changed to O'Brien Goins Simpson, Inc.) Our primary activity is consulting with oil company management on the full range of drilling activity including well planning, drilling and completion problems. While our work involved all types of wells throughout the U.S. and a number of other countries, the majority of our effort in concentrated on difficult, usually deep wells, wells presenting unique problems, blowout prevention and control and critiquing drilling operations.

In June 1980 formed O'Brien Goins Simpson & Associates, Inc. and OGE Drilling, Inc. OGE Drilling provides well planning, operation supervision and management of oil and gas wells specializing in deep, high pressured sour gas wells. O'Brien Goins Simpson & Associates (OGS&A) provides technical consultants to the drilling industry both domestic and foreign, specializing in deep drilling technology, drilling fluids, blowout prevention, cementing, tubular good problems, design and management of blowout relief wells. OGS&A provides several schools and symposiums on a number of advanced drilling engineering topics.

Appeared as expert witness in regulatory hearing in Texas, New Mexico, Oklahoma and Utah. Gave testimony as expert witness in both state and federal court. Arbitrated disputes between operators and between operators and drilling contractors.

January 1976 - Consulting Drilling Engineer

As an independent engineer consulted with several independent operators and small companies on drilling and completion of deep oil and gas wells. Supervised drilling of several deep wells. Set up an operating department for a small gas company. Was an expert witness in several legal matters. Represented an operator at an USGS hearing in connection with an offshore blowout. Acted as consultant to a major drilling contractor on matters related to extending drill pipe life - including corrosion problems, thread lubricants and handling techniques.

Was distinguished lecturer 1976-1977 for Society of Petroleum Engineers - Topic: New Developments in Deep Drilling Techniques.

July 1967 - Operations Manager for Roden Oil Company (a West Texas

Independent). In late 1969, Roden was merged into Houston Natural Gas Corporation and became HNG Oil Corporation. Was Vice-President - Drilling and Production in charge of all field operations and associated administrative activated. Initially supervised two people and operated three large drilling rigs. At end of period supervised 100 people and operated as many as fourteen rigs in West Texas, Texas Gulf Coast, Oklahoma and New Mexico. During period HNG Oil Company increased reserves value from $4,000,000 to over $300,000,000. Drilled more than 500 wells of which more than 50 were deeper than 17,000'.

Primary responsibilities were planning and supervision of drilling activities with particular emphasis on unique well conditions; well completions an establishment of organization both operational and administrative.

Additionally coordinated establishment of computer systems for production accounting and reporting, cost accounting, material handling system and a system coordinating this data with Financial Accounting.

During period introduced and developed a number of innovations in deep drilling related to drilling fluids systems, air drilling, casing programs, well control, underbalanced drilling, directional drilling, crooked hole problems and well completion equipment.

July 1964 - District Drilling Engineer Houston District Gulf Oil Corporation (Houston District was comprised of Southeast half of Texas and offshore Texas).

Was in direct charge of Gulf's drilling operation in that area. Drilling 30-50 wells per year ranging in depth from 3500' to 17000' both onshore and offshore.

For a four month period was assigned to Gulf Ethiopia to plan and initiate a drilling operation in the Red Sea. Responsibilities included planning the well, mobilizing rig and material and arranging importation and local handling of rig, material and expatriate personnel both physically and in accordance with requirements of governmental authorities.

Duties included lectures in Gulf's school for drilling engineers on tubular goods design.

Ran one of the first sea bottom hanging systems for casing.

January 1958 - July 1964

Staff Chemist - Later Staff Drilling Engineer Houston Technical Laboratory Gulf Oil Corporation Head Drilling Unit - supervised two engineers and two technicians in drilling mud and cement laboratory. Set up and policed specifications for drilling mud materials. Designed drilling fluids for specialized drilling and workover situations. Evaluated numerous mud systems and mud products for use in Gulf's operations. Was member of API Standardization Committee on Drilling Mud.

Tested cement composition for utility in oil field application. Participated in development of low fluid loss cement compositions and supervised their employment in primary and remedial cement applications.

Made numerous engineering studies relative to drilling techniques and operations. Among those were: Selection of drilling rig equipment optimum economic operation, optimization of drilling parameters, development of a recommended tubular goods design practice, field economic evaluation of hydraulics as a drilling parameter.

Developed jointly with W. C. Goins, Jr, the basic method for control of threatened blowouts presently accepted as the industry standard. Was chairman of the Joint API-AIDC committee that developed the first blowout simulator used in blowout control schools. Developed Gulf's casing design manual.

Engaged in numerous filed operations both domestic and foreign. Those operations included the introduction of new techniques, supervision of operations for cost reduction, blowout control, fishing jobs, studies of particular problems regarding cements and cementing techniques, drilling muds, air drilling.

Expanded and updated drilling engineering school. Lectures to school on a number of drilling related topics.

Taught in several industry schools.

Consulted with operational elements of Gulf on well planning, rig selection, optimization of drilling parameters. Critiqued drilling operations.

These activities necessitated work in 25 of the United Stated and 13 other countries.

Was a member of the APT Standard Committee on tubular goods, was chairman of several API study groups related to drilling and was chairman of API Drilling and Production Practice Committee.

July 1954 - January 1958 - Drilling Engineer New Orleans (District) Gulf Oil Corporation Was responsible for repair and maintenance of six company owned drilling rigs. Prepared cost estimated for drilling budget, selected drilling rigs, took drilling bids for contract rigs, designed well programs including casing and mud programs, specified tubular goods to be purchased for a 100-200 well per year operation, maintained cost control records. Supervised directly operation of wells both onshore and offshore - these being wells with some unusual conditions or in trouble.

Was a member of four man task force that drilled that drilled an 18000 foot well in an area where several previous attempts had failed.

Made engineering studies of drilling parameters, evaluated drilling equipment, made economic studies of drilling operations.

Taught casing design in Gulf's drilling school.

January 1953 - July 1953 Drilling Engineer Gulf Oil Corporation Was assigned to an offshore equipment construction group. Responsible for design and installation of mud system and the drilling water and ships water system on two drilling tenders. Designed and installed one of the earliest bulk mud and cement handling systems.

Was involved in design of one of the earliest jack-up rigs for offshore operations. Responsible for sizing and selection of much of the drilling equipment an for its arrangement aboard the rig.

October and - November 1953
Detached for special assignment to observe drilling operations of Mene Grande in Eastern Venezuela to evaluate operations there for possible application on the U.S. Gulf Coast and to critique certain of their operations.

June 1952 - January 1953
District Drilling Mud Engineer New Orleans District Gulf Oil Corporation
Was responsible for planning and operation of drilling mud program for Gulf's South Louisiana onshore and offshore operations. Ran the first successful sea water muds. Supervised field drilling operations to improve operating techniques and overcome drilling problems.

January 1952 - June 1952
Petroleum Engineer Lafayette Area Gulf Oil Corporation
Tested oil and gas wells, prepared reports to regulatory bodies, made well studies for recompletions and workovers, designed and installed production facilities. Supervised well completion and workover operations, relieved drill foreman.

January 1949 - January 1952
Drilling Mud Engineer South Louisiana Zone Gulf Oil Corporation. Did drilling mud and drilling engineering work in the U.S. Gulf Coast area. Mainly field work on mud trouble

jobs. Relieved drill foreman. Did engineering studies evaluating rig efficiency and rig equipment.

November 1948 - January 1949	Drilling Mud Engineer Gulf Oil Corporation Attended Gulf's drilling mud school at their Houston Chemical Laboratory.
June 1948 - November 1948	Roughneck-Derrickman Gulf Oil Corporation Worked on Gulf's Rig 56 at West Bay, Louisiana.
September 1947 - January 1948	Chief Chemist St. Mary's Sugar Co-op Set up process control laboratory. Supervised three bench chemists and six helpers. Responsible for process control and performed special analyses.
June 1947 - September 1947	Paymaster St. Mary's Sugar Co-op Worked as Paymaster, kept payroll records for construction of sugar mill.

T. B. O'Brien

Publications

"Using Sea Water For Drilling Muds,"

World Oil, May 1955, Volume 140, No. 6 (Also in 1955 API Drilling and Production Practice)

"How We Can Improve Drilling Operations,"

Oil & Gas Journal, June 22, 1959, Vol. 57, No. 26

"How to Control Blowouts,"

World Oil, May, June, July , 1960, Three parts

"How To Insure Against Blowouts,"

Oil & Gas Journal, June 20, 22, 27, 1960, Three parts

"What To Do When Well Kicks While Making a Trip,"

Oil & Gas Journal, July 4, 1960

"Detecting and Controlling Threatened Blowouts,"

Oil & Gas Journal, Oct. 15, 1962, Vol., 60, No. 42

"The Role of Filtration in Cement Squeezing,"

API Drilling and Production Practice 1961.

"Are Tubular Strings Being Designed Properly?," Two Parts

World Oil, November and December 1961, Volume 153, No. 6 and No. 7

"A New Approach to Tubular String Design," - Four parts

World Oil, November and December 1961, January and February 1962

"New Bit Designs Drill Hard Formations Faster,"
World Oil, June 1970

"Deep Duals Simplified,"
SPE #3904, 1972 Deep Drilling Symposium, Amarillo, Texas.

"Mud Separators Are Vital to Effective Well Control,"
World Oil, February 1973

"What It Takes to Drill Ultra-Deep Wells Successfully,"
World Oil, August 1973, Vol., 177, No. 2

"People - The Drilling Problem,"
Society of Petroleum Engineers of AIME, Paper #5167, 1974.

"Drilling,"
Oil & Gas Journal, Vol. 72, No. 8, 1974

"Drilling Costs: A Current Appraisal of a Major Problem,"
World Oil, October 1976, Vol. 183, No. 5

"Poor Performance (Incapable people and unused technology add up to poor quality of operation),"
Drilling - the wellsite publication, February 1977, Vol., 38, No. 4

"Crooked Hole Problems in Deep Wells,"
Petroleum Engineer, March 1977, Vol., 49, No. 3

"Relaxed Fluid Loss Controls on Invert Muds Increases ROP,"
World Oil, August 1977, Vol., 185, No. 2

"Invert Mud End Excessive Drag,"

Drilling DEW, the wellsite publication, April 1978, Vol. 39, No. 6

"Invert Mud Cut Costs on Deep Delaware Basin,"

Southwestern Petroleum Short Course (Texas Tech) April 1978.

"Blowouts: Why Some Happen and What To Do About It,"

World Oil, October 1978, Vol., 187, No. 5.

"Deep Drilling Problems - Some Answers and Possible Solutions,"

SPE #7850, 1979 Deep Drilling Symposium, Amarillo, Texas.

"Handling Gas in an Oil Mud Takes Special Precautions,"

World Oil, January 1981, Vol., 192, No. 1.

"Why Some Casing Failures Happen,"

World Oil, October 1984, pp. 60-63.

"Hole Cleaning Some Field Results,"

Society of Petroleum Engineers of AIME Paper #13442,
SPE-IDAC Drilling Conference, New Orleans, March 1985.

"Hang Casing Right and Reduce Failures,"

Society of Petroleum Engineers of AIME Paper #16105, 1986.

"Some Turnkey Contract Considerations,"

1989 Thirty-Sixth Southwestern Petroleum Short Course, April 17, 1989.

YATES PETROLEUM CORP.
BEFORE THE COMMISSION
NMOCD CASE NOS. 10446-10449
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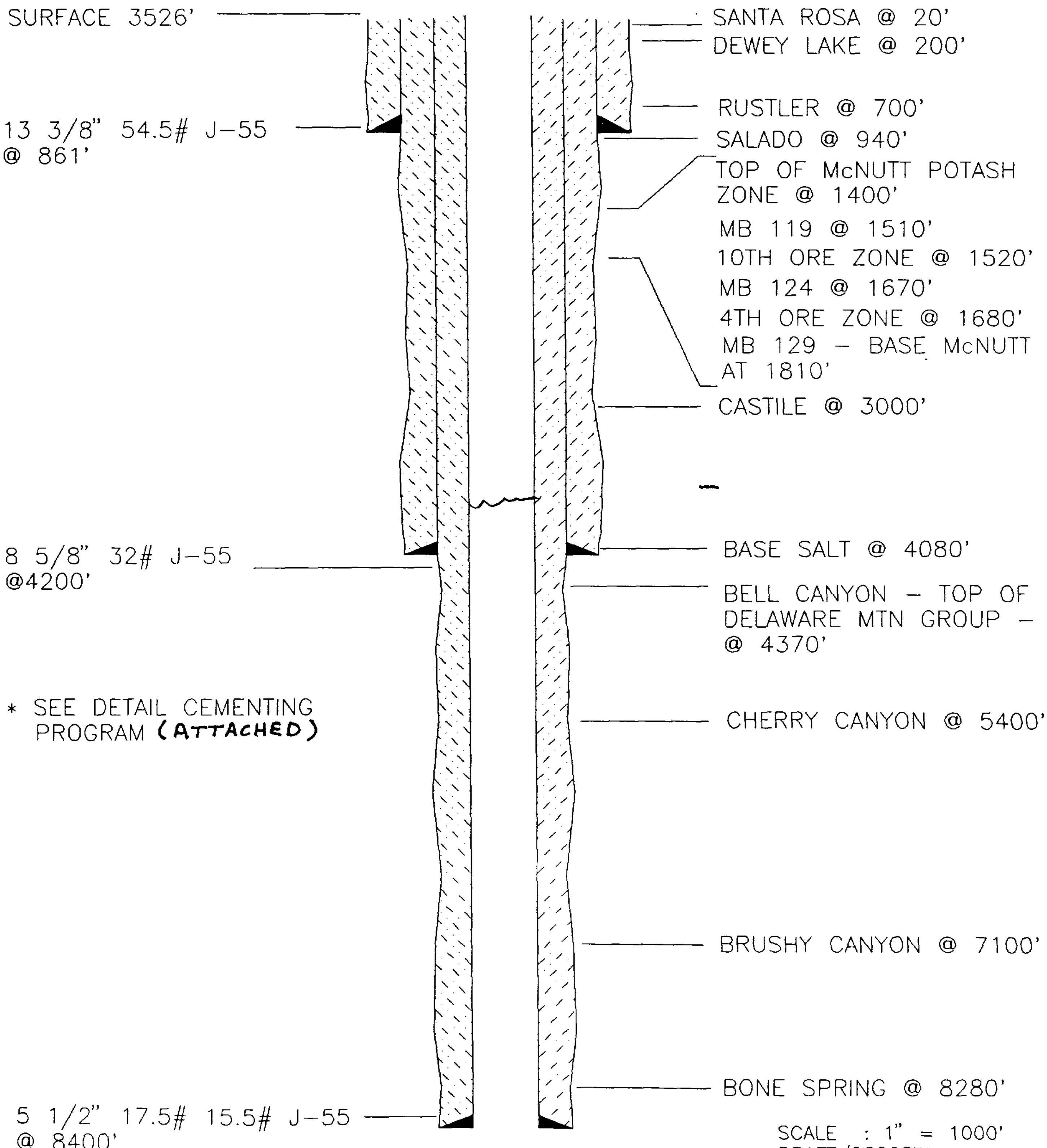
CASING PROGRAM AND GEOLOGIC FORMATIONS
YATES FLORA "AKF" NO. 1

UNIT N - SEC. 2 - T22S - R31E
EDDY COUNTY, NEW MEXICO



SCALE : 1" = 1000'
DRAFT/92028W

TYPICAL CEMENTING PROGRAM FOR WELLS IN SECTION 2-T21S-R31E

SURFACE CASING CEMENTING PROGRAM

Ran 20 joints 13-3/8" 54.50# J-55 (866.50') casing, set 861'. Texas Pattern Notched guide shoe set 861'. Insert float set 818'. Cemented with 600 sacks "HLC" + 2% CaC12 + 1/2#/sx Flocele (yield 1.89, weight 12.9). Tailed in with 200 sacks "C" + 2% CaC12 (yield 1.32, weight 14.8). Bumped plug to 400 psi, float held OK. Circulated 190 sacks to pit.

INTERMEDIATE CASING CEMENTING PROGRAM

Ran 96 joints 8-5/8" 32# HC-80 & J-55 (4205.75') casing, set 4200'. Float shoe set 4200'. Float collar set 4157'. Cemented with 1600 sacks Pacesetter Lite "C" + 10#/sx Salt + 5#/sx Gilsonite + 1/4#/sx Celloseal (yield 1.94, weight 12. 9). Tailed in with 200 sacks "C" + 2% CaC12 (yield 1.32, weight 14.8). Bumped plug to 1750 psi, released pressure and float held OK. Circulated 275 sacks.

PRODUCTION CASING CEMENTING PROGRAM

DETAILED CASING REPORT: Ran 202 joints 5-1/2" casing as follows:

38 joints 17# J-55		1592.37'
145 joints 15.5# J-55		6063.78'
19 joints 17# J-55		795.20'
	TOTAL	8451.55'

Casing set 8450'. Float shoe set 8450'. Float collar set 8408.42'. DV tools at 4485' and 7401'. Short joint 6794'. Cemented in 3 stages as follows: Stage I - 225 sacks "H" + 8#/sx CSE + .6% CF-14 + 5#/sx Gilsonite + .35% Thriftylite (yield 1.75, weight 13.6). Bumped plug to 1000 psi, OK. Circulated 67 sacks. Opened DV tool and circulated 3 hours. Stage II - 700 sacks "H" + 8#/sx CSE + .5% CF-14 + 5#/sx Cilsonite +.35 % Thriftylite (yield 1.82, weight 13.4). Bumped plug to 2950 psi, OK. Circulated 139 sacks. Opened DV tool and circulated 3 hours. Stage III - 425 sacks Super "C" (yield 2.25, weight 11.5). Tailed in with 200 sacks "C" Neat (yield 1.32, weight 14.8). Bumped plug to 3000 psi, float and casing held OK. Circulated 87 sacks.

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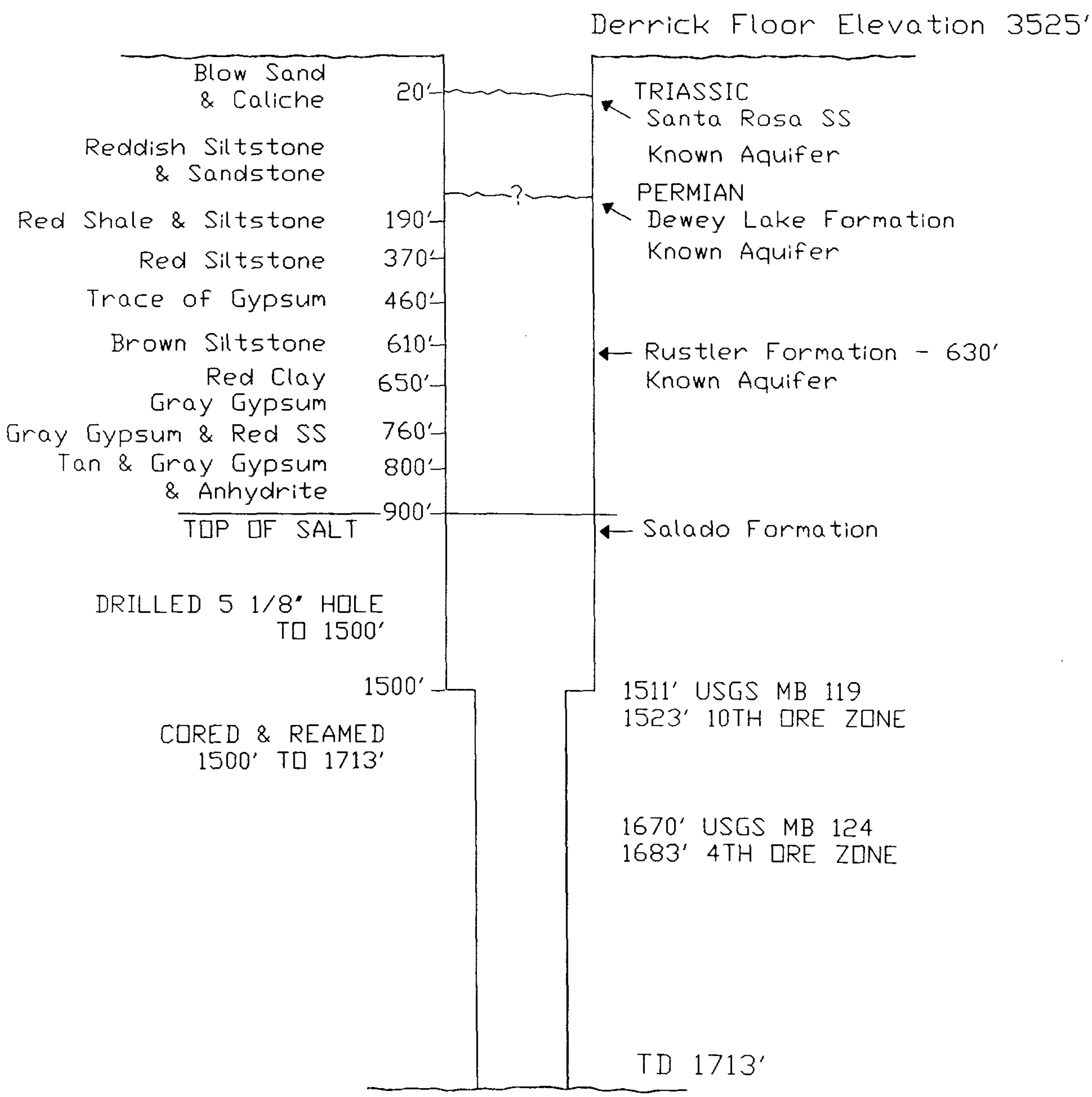
NEW MEXICO POTASH
CORE HOLE K-162
SEC. 2 – T22S – R31E
EDDY COUNTY, NEW MEXICO



K-162 Spud 3 am 12-11-91

Plugged 7 pm 12-12-91

NO CASING SET

HOLE PLUGGED WITH CEMENT FROM 1713' TO SURFACE

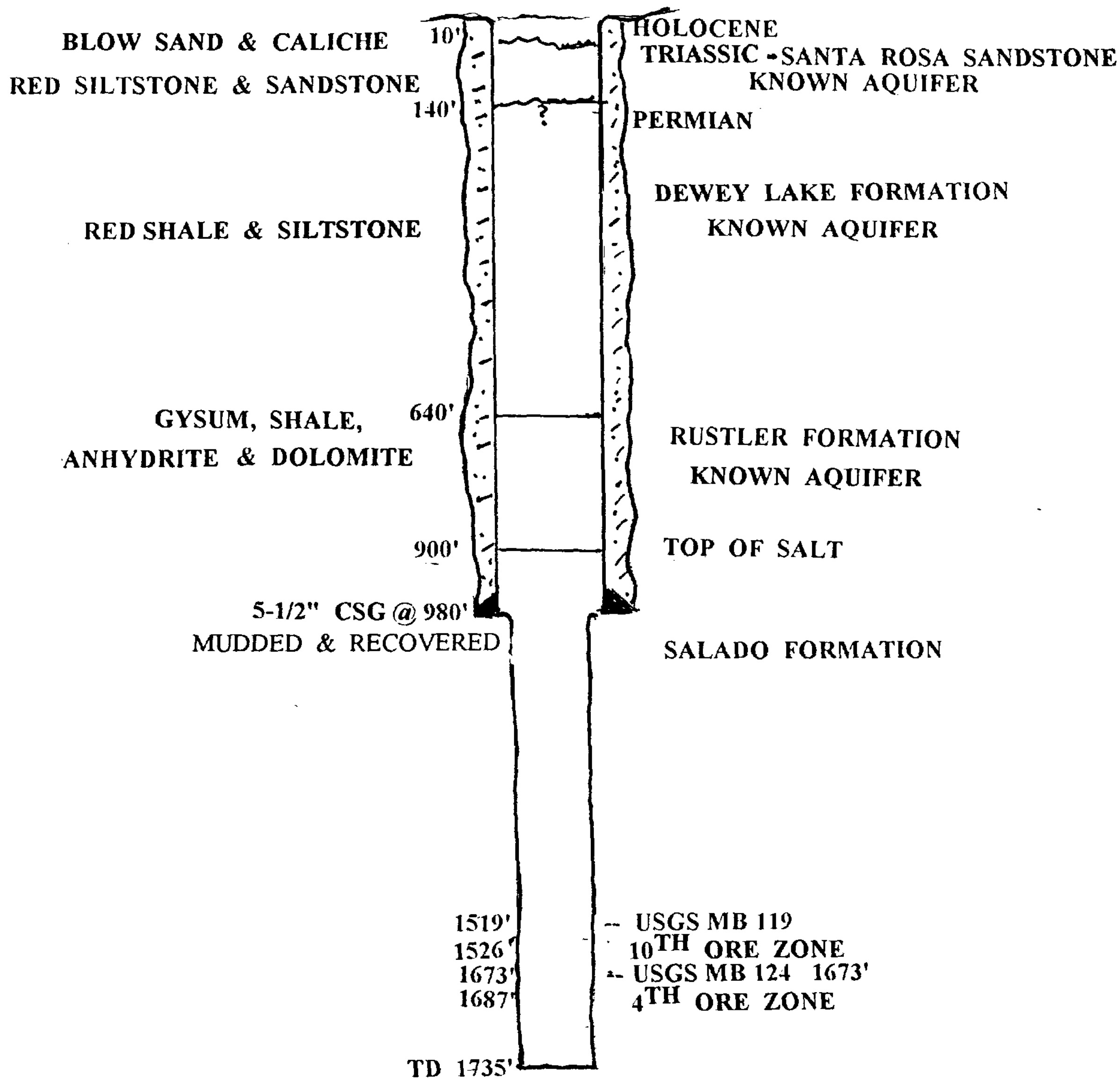
Map #92028G
(10/14/92 LF)
DRAWING NOT TO SCALE

FARM CHEMICAL RESOURCES DEVELOPMENT CORP.

CORE HOLE FC-81

SEC 3-T22S-R31E, 300' FSL & 200' FWL, EDDY COUNTY, NM

FC-81 - SPUD 10/10/61, COMPLETED 10/24/61, GROUND ELEVATION 3471', TD 1735'



DRILLED WITH ROCK BIT TO 980', SET 5-1/2" CASING AT 980'
RECOVERED ALL, CORED FROM 980' TO TOTAL DEPTH OF 1735' TD 1735'
SET CEMENT PLUGS 0 - 10', 640 - 880', 900 - 1735'

YATES PETROLEUM CORP.
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DEMONSTRATION OF SAFETY PLUGGING OF OIL WELLS PENETRATING APPALACHIAN COAL MINES

by

G. E. Rennick and J. Pasini III
Morgantown Energy Research Center, Morgantown, W. Va.
F. E. Armstrong and J. R. Abrams
Bartlesville Energy Research Center, Bartlesville, Okla.

Bureau of Mines Coal Mine Health and Safety Research Program

Technical Progress Report - 56

July 1972

U.S. DEPARTMENT OF THE INTERIOR

This report is based on work done under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Christopher Coal Co., a Division of Consolidation Coal Co.

YATES PETROLEUM CORP.
BEFORE THE COMMISSION
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EXHIBIT NO. 11

CONTENTS

ILLUSTRATIONS

TABLE

DEMONSTRATION OF SAFETY PLUGGING OF OIL WELLS PENETRATING APPALACHIAN COAL MINES

by

G. E. Rennick,[1] J. Pasini III,[2] F. E. Armstrong,[3] and J. R. Abrams[4]

ABSTRACT

An oil well penetrating the Pittsburgh bituminous coalbed in northern West Virginia was plugged and safely mined through 3 months later. A sensitive chemical tracer, introduced into the oil reservoir before the test, was not detected in the mine air following the plugging and during mining of the pillar and penetration of the well. Effectiveness of the plugging in preventing reservoir gas from entering the mine through the well hole was verified by continuous monitoring of the mine air for indications of sulfur hexafluoride, an inert gas detectable in amounts as minute as 1/2 part per billion. Expandable cement and fly ash-gel-water slurry were utilized to seal the well above and below the coal seam. Three other wells were also plugged using various techniques.

INTRODUCTION

Plugging of abandoned oil wells is being investigated as a means of solving various problems these wells pose to coal-mining operations. Coalbeds at relatively shallow depths are often penetrated by boreholes drilled into oil and gas formations below the coal. In the Appalachian area, thousands of oil and gas wells that penetrate minable coalbeds have been abandoned or produce only marginal amounts of oil and/or gas. Only about 40 percent of the wells are still producing oil or gas; the rest quite likely could be abandoned in favor of mining operations.

The Federal coal-mining regulation[5] requires barriers to be established and maintained around oil and gas wells in accordance with State laws and regulations. These barriers must be at least 300 feet in diameter, although greater or lesser barriers may be permitted by the Secretary of the Interior or his authorized representative. The purpose of the barriers is to prevent

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[1] Petroleum engineer.
[2] Research supervisor.
[3] Project leader.
[4] Electronic development technician.
[5] Interim Mandatory Safety Standard for Underground Mines, section 317(a), Federal Coal Mine Health and Safety Act (30 U.S.C. 877(a), 30 CFR 75.1700).

combustible gases from entering the mine and to prevent accidental shearing of wells in mining operations. Many of the wells that intersect coalbeds in the Appalachian area enter essentially pressure-depleted reservoirs, and of them, many have been plugged and abandoned. A 300-foot pillar around a well represents a quantity of unminable coal and complicates the design of entryways, haulageways, and ventilating systems. Areas in which wells are drilled on close, irregular spacing (2.5 acres or less) can be completely unminable. Also, 300-foot pillars around wells in which the pressures exceed several hundred pounds per square inch would not contain the gas in the event of serious leaks. In the case of marginally productive reservoirs, it would be more satisfactory to permanently and safely plug the well below the coalbed, thereby permitting mining of the pillar.

Elimination of random well pillars would allow the use of longwall and shortwall mining systems (which are inherently safer than conventional mining techniques), improve the ventilation system to reduce hazards associated with methane, and simplify the haulage system. Additional advantages that increase safety include modification of the mining cycle to eliminate abrupt changes and improved roof conditions relative to those that exist when there are random pillars.

ACKNOWLEDGMENTS

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Mining through of this well was witnessed by Frank Rutledge, district mine inspector, State of West Virginia; Joseph Marshalek and Paul J. Componation, Federal coal mine inspectors, Bureau of Mines Coal Mine Health and Safety District D; Messrs. Poland, Simon, Smith, Hicks, and Thomas and Stanley Hopwood, section foreman, Osage No. 3, Christopher Coal Co.; and J. Pasini III, research supervisor, and G. E. Rennick, petroleum engineer, Morgantown Energy Research Center, Bureau of Mines.

WELL-PLUGGING MATERIALS

Various cement types and water mixtures were tested in the laboratory to determine the properties that could be expected of the cement plugs. Properties of the three cements that were selected for plugging the four test wells are as follows:

	Chem Comp[1] (expanding cement)	Pozmix[1] (fly ash and cement)	Portland
Water..............gal/sack..	6.30	5.80	6.30
Shrinkage[2]..............pct..	.80	7.60	5.70
Sand grain density..g/cu cm..	2.07	2.12	2.23
Bulk density........g/cu cm..	1.71	1.48	1.53
Porosity................pct..	17.40	30.10	31.30
Effective air permeability md..	.14	3.90	.40

[1] Reference to specific brands is made for identification only and does not imply endorsement by the Bureau of Mines.
[2] Shrinkage is very difficult to determine; therefore, these values show the relative shrinkage effect.

Weight of the fly ash-gel-water slurry used as filler plug was 14.4 pounds per gallon when 98 pounds of fly ash and 2 pounds of Aquagel were mixed with 6.3 gallons of water.

WELL SELECTION

Several coal companies in the Morgantown, W. Va., area were particularly interested in well plugging because they planned to conduct longwall mining in certain sections that would necessitate mining through wells rather than pillaring around them. Timing of the work, however, necessitated selection of wells in an area that could be mined through within a 1-year period. Also, permission of the well owner was required to plug and mine through the wells to coincide with mining operations within the 1-year period. Ultimately, four wells in Clay district, Monongalia County, W. Va., were selected because at least one could be mined through within the necessary time. Figure 1 shows the locations of the four wells and the status of mining operations when the well owner agreed to let the Bureau of Mines plug the wells.

WELL TESTING AND PLUGGING

Three of the four wells selected for plugging had been drilled in the early 1890's, and the fourth--Fetty Heirs well 10, a water injection well--was drilled in 1965. Two wells still had derricks over them; the engine house, belt hall, and band wheel were intact and operative (fig. 2). Fieldwork was commenced in the same way operators normally do in this area: The pipe derricks were first cut down; then the engine house, belt halls, and other equipment was dismantled for salvage. A portable drilling rig was then set up over the well.

The rods and tubing were first pulled, and then tools were run to bottom to make sure that the well was open to the original productive sand (Big Injun). A pressure-recording instrument was run in, and the well was then shut in to build up the pressure at the bottom of the hole.

Gamma ray-neutron and caliper logs were obtained to accurately locate the formation and the five coalbeds penetrated by the wells, obtain a record of the well casings, and select packer seat locations. Several of the wells were

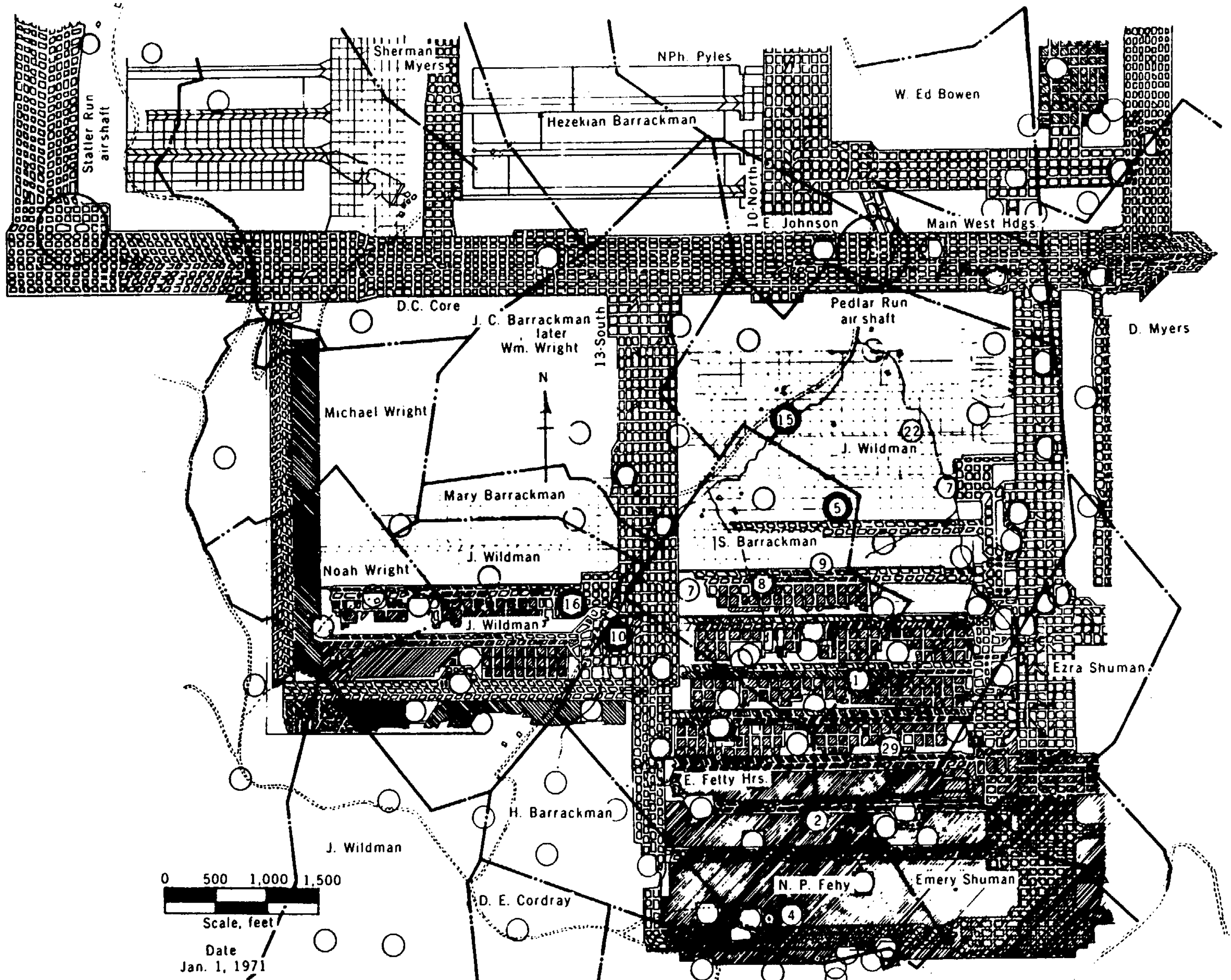

FIGURE 1. - Location of Wells With Respect to Mining Operations in Christopher Coal Co.'s Osage No. 3 Mine, January 1, 1971.

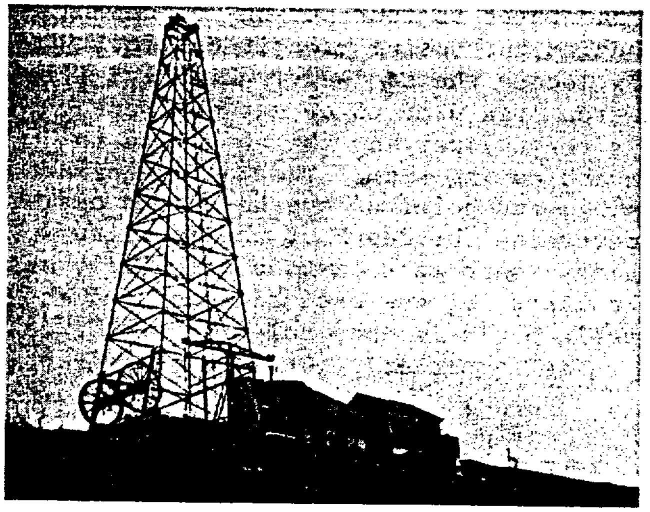

FIGURE 2. - Typical Surface Equipment on Old Wells in Clay District, Monongalia County, W. Va.

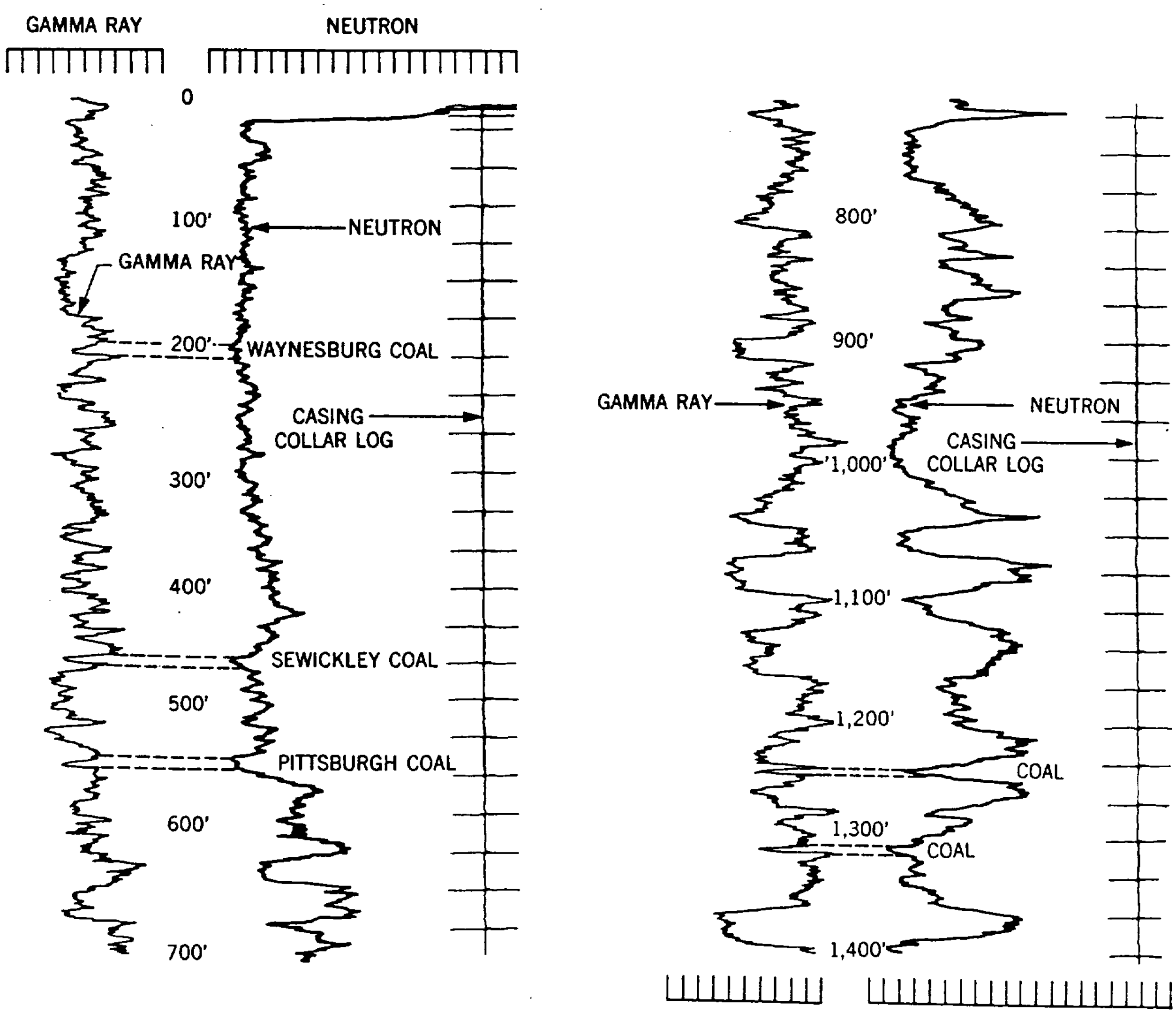

FIGURE 3. - Gamma Ray-Neutron Well Log Showing Location of Coalbeds.

logged two or three times because they had three to four strings of casing. In several cases, the presence of gas behind the casing made it difficult to interpret the neutron log and accurately locate the coalbeds. Figure 3 illustrates the combination of gamma ray-neutron logs used to detect coalbeds through the well casing. Figure 4 shows the caliper log that was used to select a packer seat and determine hole and casing size. The casing-collar log shows casing collars, bottom of casing, and holes or breaks in the casing. The gamma ray-neutron log was used to determine the depth of the petroleum-producing formation, to ascertain lithology (such as sandstone or shale), and for correlating with other wells. The caliper log was used to determine the condition of the pipe and locate a suitable place in open hole, below the casing and above the producing formation, to set a packer. (Details are given in the appendix.)

A mechanical packer was set in all four wells--the main deviation from normal plugging procedure. A Lynes production-injection packer was used because of its expanding feature: the element can pass through the smallest well casing but can expand enough to seal against the wall of the open hole, thereby preventing leakage. To determine if each well was properly plugged--that is, to establish that there was no communication in the wellbore between the oil- and gas-producing formations and the coalbeds--a gas tracer was injected into the producing formation before it was plugged.

Sulfur hexafluoride (SF_6) was used as the tracer gas. SF_6 is inert, not present in the environment, and can be detected with a gas chromatograph in quantities as low as 1/2 part per billion. The SF_6 was injected at pressures below 300 psi so it would remain in a gaseous state. Injection of the tracer (100 lb--about 250 scf) was followed by injection of enough nitrogen to force SF_6 from the tubing into the oil and gas formation. A 2-inch bridge plug was then set in a tubing nipple at the top of the packer. When the bridge plug was run in the tubing, a high-pressure lubricator with grease seals was used to prevent the tracer and nitrogen from leaking back into the casing. A J-tool in the tubing string above the nipple on the packer released the tubing from the packer. An expanding cement plug was then placed on top of the packer by pumping the slurry through the tubing. After the cement plug was in place, the tubing and the inner (production) string of casing was pulled from the well. Field experience in the areas where plugging is being conducted is important because the formation can cave in if too much casing is pulled, thus preventing reentry to place cement plugs.

Three wells were plugged back up to the base of the Pittsburgh coalbed and the casing was either pulled to expose the coal or ripped opposite the coalbed (figs. 5-7). The casing in Fetty Heirs well 10 was only 6 years old and had been cemented in. To prevent any possible safety hazard in the mine from perforation of the casing opposite the coal, a sand formation below the coal was perforated and the well was plugged back up to the base of this perforated zone (fig. 8). This provided test conditions similar to the other wells; that is, the annulus could be checked for tracer leaks. After each well was ready for testing, a vacuum pump was connected at the top of the well and samples were withdrawn daily (fig. 9). Samples were also obtained from all wells that are numbered in figure 1, and from two return air shafts

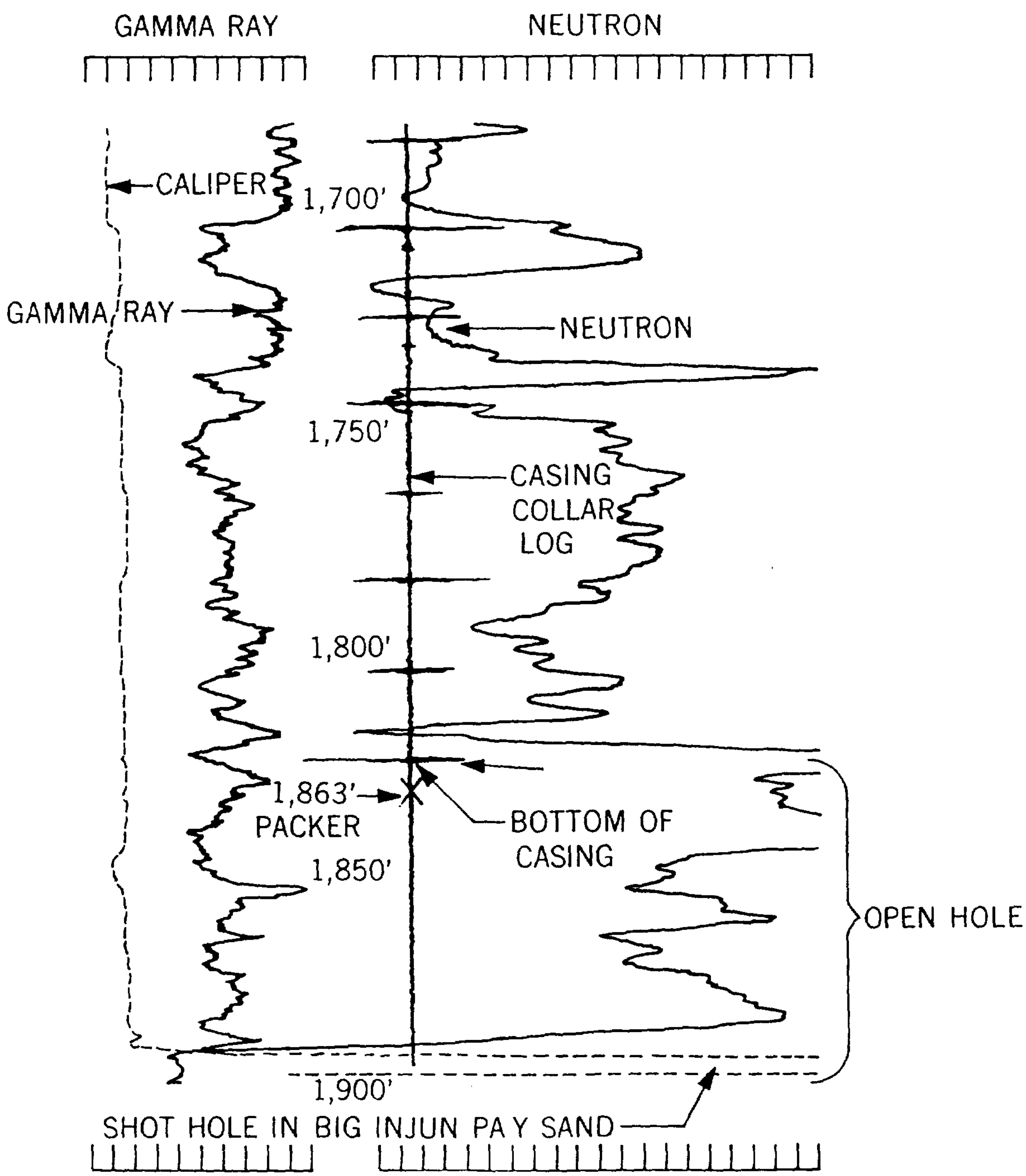

FIGURE 4. - Gamma Ray, Neutron, Caliper, and Casing-Collar Logs Showing Bottom Section of Plugged Well.

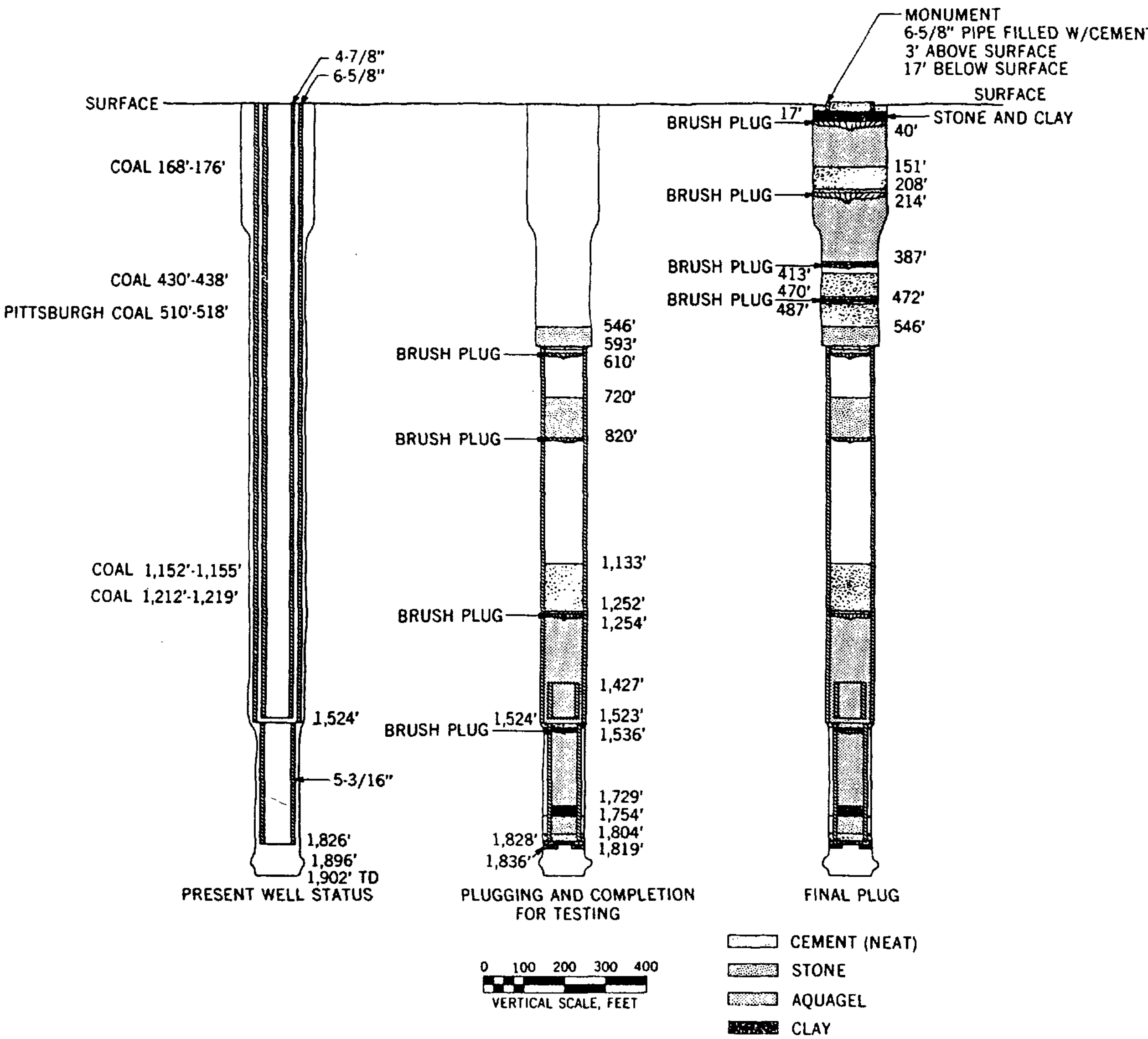

FIGURE 5. - J. Wildman Well 15, l to r, Before and After Partial Plugging and Completion for Testing, and After Plugging to Surface.

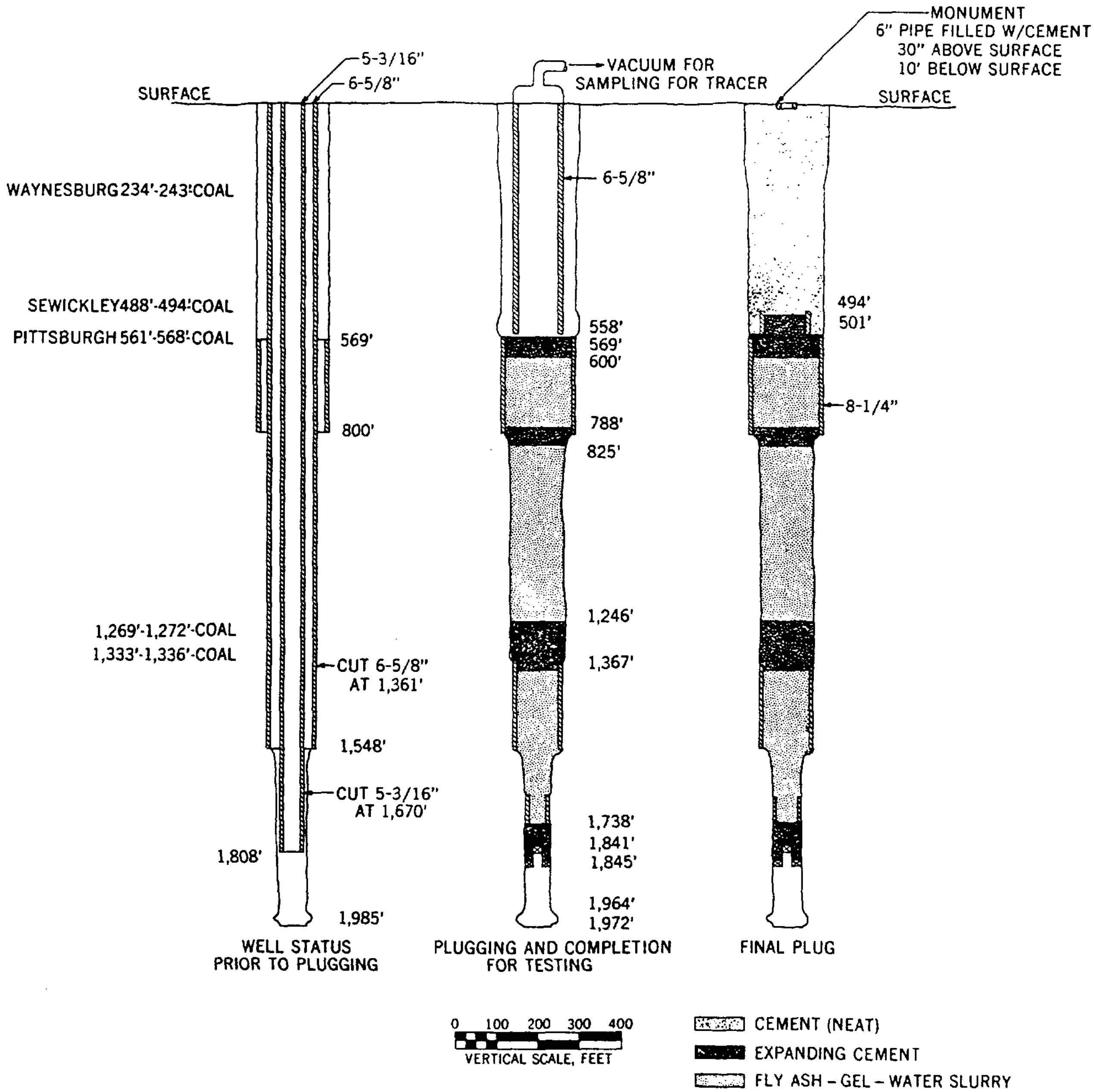

FIGURE 6. - J. Wildman Well 16, l to r, Before and After Partial Plugging and Completion for Testing, and After Plugging to Surface.

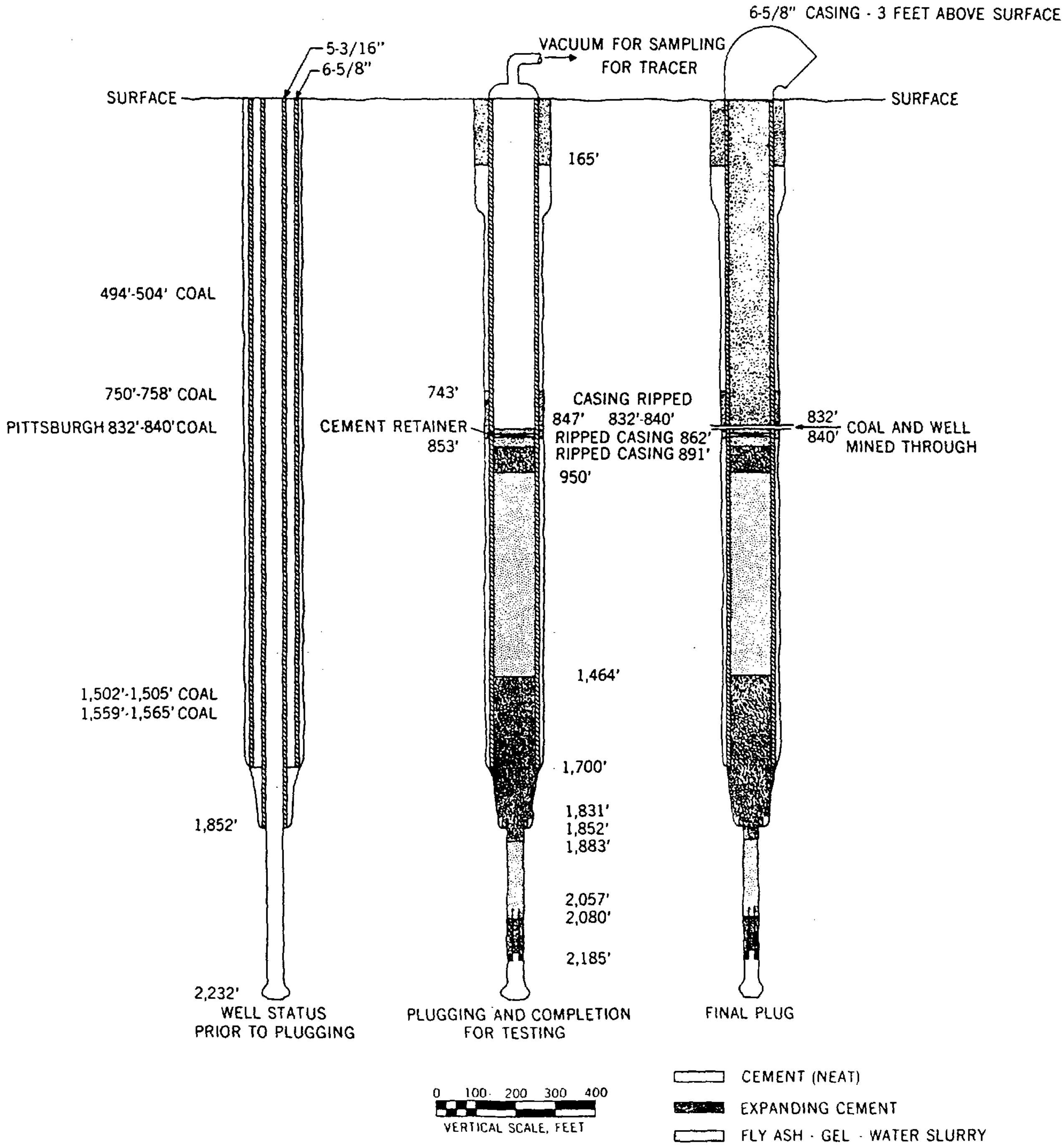

FIGURE 7. - S. Barrackman Well 5, l to r, Before and After Partial Plugging and Completion for Testing, and After Plugging to Surface.

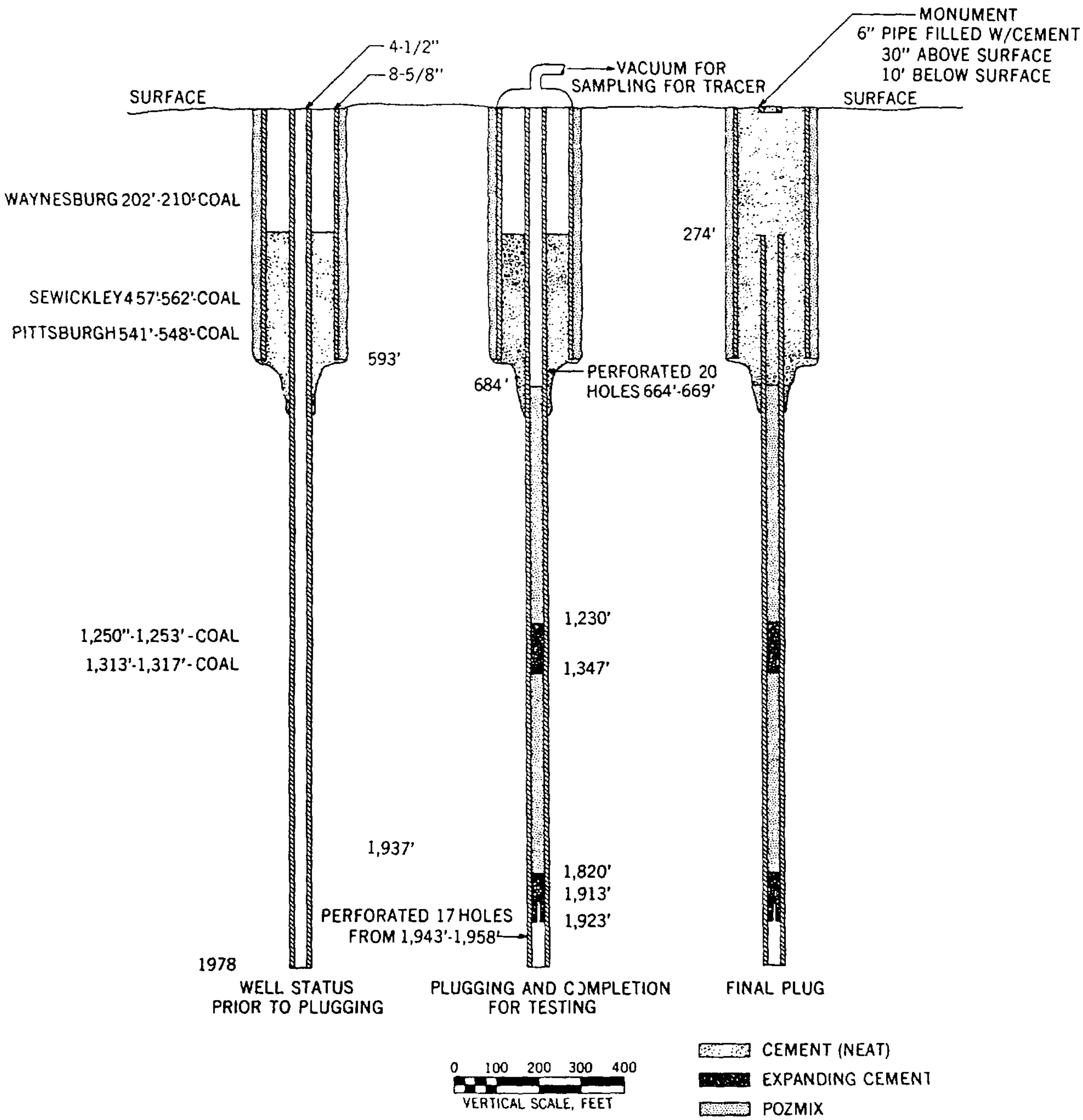

FIGURE 8. - Fetty Heirs Well 10, l to r, Before and After Partial Plugging and Completion for Testing, and After Plugging to Surface.

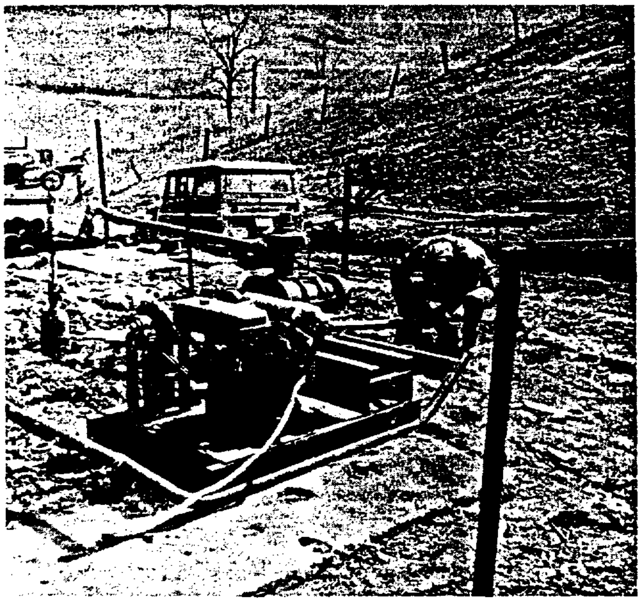

FIGURE 9. - Sampling a Plugged Well for SF_6 Tracer.

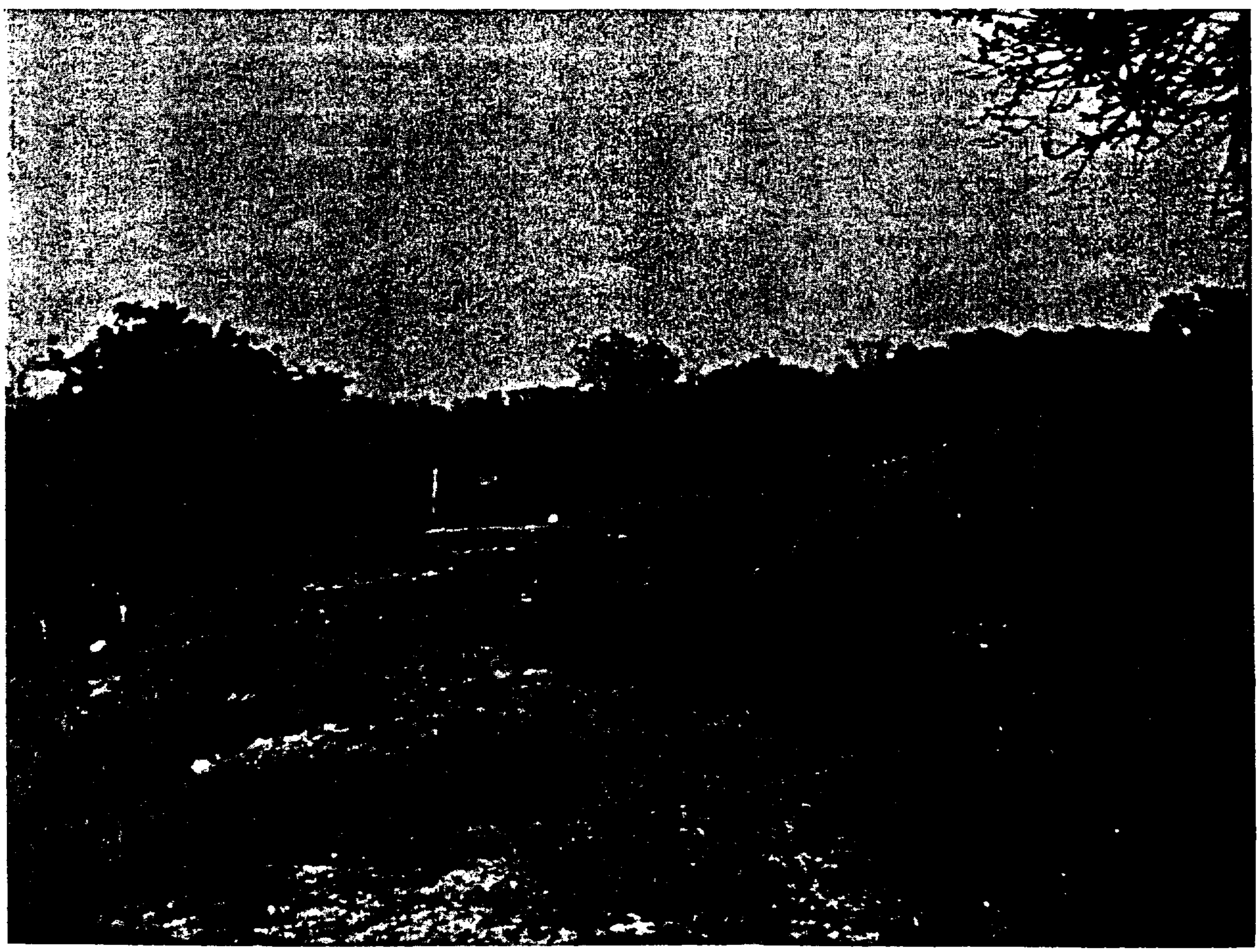

FIGURE 10. - Well at Surface After Grading and Reseeding.

serving the area of the mine near the plugged wells. Except for two or three occasions, no SF_6 was detected in samples obtained twice daily, including weekends, from March 16 to August 31. Instances in which SF_6 was detected can be attributed to unavoidable contamination from the mechanics of injection. However, the real effectiveness of the SF_6 as a tracer was revealed when it migrated through the producing formation and showed in the gas samples from S. Barrackman well 9, a producing well, after July 12 in amounts ranging up to about 200,000 parts per billion.

Sampling was continued while all four wells were being plugged back to the base of the Pittsburgh coalbed. Plugging to the surface was then completed and each site was graded to surface specifications and sealed (fig. 10).

Details of the plugging of the four wells are given in the appendix.

MINING THROUGH A PLUGGED WELL

S. Barrackman well 5 was the first well plugged and legally mined through after passage of the Coal Mine Health and Safety Act of 1969. An agreement between the Christopher Coal Co. and the U.S. Department of the Interior, entered into July 31, 1971 (Contract No. 14-09-0070-448), gave the company an exception to the mandatory safety standard in section 317(a) of the Federal Coal Mine Health and Safety Act of 1969 (30 CFR 75.1700) to remove the entire barrier around W. H. Allen well 5 (S. Barrackman) in section 16-A off 12 south, Osage No. 3 mine. Section 501(c) of the Federal Coal Mine Health and Safety Act authorizes the Secretary of the Interior (delegated to the Director, Bureau of Mines, June 25, 1970, 215 DM 9.1L, 9.1P, and 9.1Q) to grant exceptions to the application of mandatory health and safety standards to a coal mine operator who conducts experimental and demonstration projects on behalf of the Director, Bureau of Mines.

Before proceeding with the project, Christopher Coal Co. also obtained a permit from the State of West Virginia for the company to mine to and through the oil well, under the supervision and control of the Bureau of Mines.

The section crew and others who were to observe the mining through of S. Barrackman well 5 entered the mine on the midnight shift, August 7, 1971. Section 16-A had been heavily rock dusted by the previous shift, and a methane check was made and the accessible roof and ribs around the block of coal containing the well were inspected at time of entry. No methane was detected, and the roof and ribs around the well support pillar were in good condition. Mining toward the well was started at 1:00 a.m. No methane was detected until mining had proceeded to within 29 feet of the well, at which time 0.03 percent methane was recorded and crude oil was detected by smell but not by sight. Methane concentration when mining reached 14 feet from the well rose to 0.1 percent and continued at this level until the well was mined into at 4:10 a.m. Vacuum-bottle samples taken from around the casing were subsequently analyzed for SF_6 and methane (table 1); methane content of air in the face area was 0.12 percent (near roof). The crude oil odor was attributed to a 1-1/2-inch hole where the casing had corroded. This hole has probably existed for years and allowed crude oil to enter the coal around the well.

TABLE 1. - Gas concentrations after mining through S. Barrackman well 5, Osage No. 3 mine, Christopher Coal Co., percent

(Dash indicates no analysis)

	Time	Location in mine	SF_6	Methane	Oxygen	Carbon dioxide	Nitrogen
Aug. 7	04:10	At well casing.....	0	-	-	-	-
7	04:42	.......do..........	0	-	-	-	-
7	04:45	.......do..........	-	0.12	21.95	0	77.93
7	10:48	.......do..........	0	-	-	-	-
7	10:49	.......do..........	-	.06	21.94	0	78.00
7	16:32	.......do..........	-	.04	22.08	.05	77.83
7	16:33	.......do...........	0	-	-	-	-
8	08:10	Casing in roof......	-	.04	21.91	0	78.05
8	08:40	Casing in pavement..	0	-	-	-	-
8	08:40	.......do...........	-	.05	21.89	0	78.06
8	08:40	In entry............	-	.03	21.95	.09	77.93
8	16:20	.......do...........	0	-	-	-	-
9	11:30	.......do...........	0	-	-	-	-
10	09:00	At bleeder 16-A[1]....	0	-	-	-	-
11	10:20	.......do...........	0	-	-	-	-
12	09:20	.......do...........	0	-	-	-	-
13	11:30	.......do...........	0	-	-	-	-
14	08:30	.......do...........	0	-	-	-	-
16	08:25	.......do...........	0	-	-	-	-
17	11:00	.......do...........	0	-	-	-	-
18	10:30	.......do...........	0	-	-	-	-
20	13:00	.......do...........	0	-	-	-	-
23	10:45	.......do...........	0	-	-	-	-
24	14:10	.......do...........	0	-	-	-	-
25	12:20	.......do...........	0	-	-	-	-
26	12:30	.......do...........	0	-	-	-	-
27	12:20	.......do...........	0	-	-	-	-
30	12:15	.......do...........	0	-	-	-	-
Nov. 23	-	.......do..........	0	-	-	-	-

[1]Well in "gob."

In mining through, the well casing was broken off (the casing had been ripped from the surface prior to cementing, fig. 11), by moving the continuous miner (ripper) head back and forth. Vacuum-bottle gas samples were taken from the well casing after it was removed. Methanometer readings in face area of the coal showed 0.1 percent methane. Both the dense cement jacket around the casing and the cement within the casing were in excellent condition. Gas samples were extracted from the casing until the section became a "gob" area. No tracer was detected in samples from the "gob" bleeder ventilating section 16-A through November 1971, thus indicating an excellent well seal.

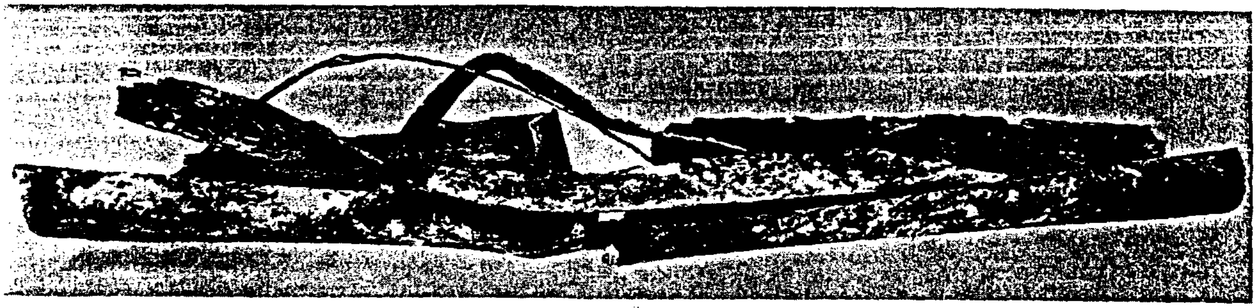

FIGURE 11. - Casing From S. Barrackman Well 5 After Mining Through and Removal From Pittsburgh Coalbed.

CONCLUSIONS

This work demonstrated that active low-pressure oil and natural gas wells intersecting coal seams can be plugged and safely mined through, and will remain sealed even if the petroleum-producing formation is repressured.

The precise location of the well in the coalbed should be known to facilitate safe mining-through operations, and well logs should be run before the wells are plugged to accurately locate the minable coalbeds, petroleum-producing formations, and well casing.

Consideration should be given to possible use of old wells as power and rock-dust-supply holes and for methane drainage before mining through, and later as "gob" drainage holes, thus offsetting part of the costs of plugging.

APPENDIX.--DETAILED SUMMARY FOR PLUGGING WELLS

J. Wildman Well 16 (Fig. 6)

	Operation	Description
1.	Geophysical well logs	Gamma ray-neutron and caliper (total depth)
2.	Bottom-hole pressure buildup	110 psi after 113 hours' shut-in time
3.	Production injection packer set	1,845 feet
4.	Injection test	100,000 scf of nitrogen at 2,200 to 2,400 psi, shut-in pressure 2,400 psi, 5-hour shut-in pressure 600 psi, 19-hour shut-in pressure 350 psi
5.	Injection of SF_6	Bled wellhead pressure down to 50 psi, injected 250 scf SF_6 at 94 psi, injected 17,000 scf N_2 at 300 psi, injected 53,000 scf N_2 at 1,200 psi
6.	2-inch bridge plug set	1,841 feet
7.	Placed plug (through tubing)	Top of packer to 1,738 feet expanding cement (20 sacks)
8.	Cut 5-3/16-inch casing	1,670 feet (pulled all casing)
9.	Cut 6-5/8-inch casing	1,361 feet (pulled 131 feet)
10.	Placed plugs (through tubing)	1,738 to 1,367 feet, fly ash-gel-water slurry (3 tons fly ash and 125 lb Aquagel)
		1,367 to 1,246 feet expanding cement (38 sacks)
11.	Pulled 6-5/8-inch casing to 558 feet	
12.	Geophysical well logs	Gamma ray-neutron and caliper
13.	Placed plugs (through tubing)	1,246 to 825 feet, fly ash-gel-water slurry (5.4 tons fly ash and 65 lb Aquagel)
		825 to 788 feet expanding cement (14 sacks)

Operation	Description
	788 to 600 feet fly ash-gel-water slurry (2.4 tons fly ash and 35 lb Aquagel)
	600 to 569 feet expanding cement (8 sacks)
14. Moved rig from well and connected vacuum pump for sampling	
15. Collect sample to be analyzed for SF_6	80 days
16. Moved rig onto well to complete plugging	
17. Placed cement plug (dump bailer)	569 to 501 feet expanding cement (20 sacks)
18. Cut 6-5/8-inch casing	494 feet
19. Placed cement plug (poured from surface)	501 to 351 feet neat cement (135 sacks)
20. Pulled 6-5/8-inch casing	494 feet
21. Placed plug (through tubing)	351 feet to surface, neat cement (294 sacks)
22. Set well monument	10 feet below to 30 inches above surface (6-5/8-inch casing filled with 15 sacks neat cement)
23. Graded and seeded area	Grass growing

Fetty Heirs Well 10 (Fig. 8)

1. Geophysical well logs	Gamma ray-neutron and caliper (total depth)
2. Bottom-hole pressure buildup	131 psi after 68 hours' shut-in time
3. Production injection packer set	1,923 feet
4. Injection test	50,000 scf of nitrogen, shut-in pressure 1,280 psi, 1-hour shut-in pressure 840 psi

Operation	Description
5. Injection of SF_6	Bled wellhead pressure down to 160 psi
	Injected 2,000 scf nitrogen and 125 lb SF_6 at 275 psi (N_2 and SF_6 simultaneously)
	Injected 38,000 scf N_2 at 1,040 psi
	Shut-in pressure after 16 hours 480 psi
	1 barrel water used to wash down tubing
6. 2-inch bridge plugs set	1,913 feet
7. Placed plugs (through tubing)	Top of packer to 1,820 feet expanding cement (7 sacks)
	1,820 to 1,347 feet, Pozmix cement (22 sacks)
	1,347 to 1,230 feet, expanding cement (8 sacks)
	1,230 to 684 feet, Pozmix cement (24 sacks)
8. Perforated casing	20 holes, 664 to 669 feet
9. Collect samples to be analyzed for SF_6	58 days
10. Moved rig onto well to complete plugging	
11. Cut 4-1/2-inch casing	274 feet (pulled from hole)
12. Placed plug (through tubing)	684 feet to surface, neat cement (150 sacks)
13. Set well monument	10 feet below surface to 30 inches above (filled 6-inch casing with cement)
14. Graded and seeded area	Grass growing

S. Barrackman Well 5 (Fig. 7)

1. Geophysical well logs	Gamma ray-neutron and caliper (total depth)

Operation	Description
2. Bottom-hole pressure buildup	48 psi after 46 hours' shut-in time at 78° F
3. Production injection packer set	2,185 feet
4. Injection test	225 scf nitrogen at 110 psi, 12 scf nitrogen at 80 psi (14 hours)
5. Injection of SF_6	Bled wellhead pressure down to 40 psi, injected 325 scf N_2 and 125 lb SF_6 (N_2 and SF_6 injected simultaneously)
	Injected 800 scf nitrogen, shut-in pressure after 14 hours 80 psi
6. 2-inch bridge plug set	2,180 feet
7. Placed plugs (through tubing)	Top of packer to 2,080 feet, expanding cement (10 sacks)
	2,080 to 1,883 feet, fly ash-gel-water slurry (1 ton fly ash and 40 lb Aquagel)
	1,883 to 1,843 feet, expanding cement (8 sacks)
8. Cut 5-3/16-inch casing	1,831 feet (pulled all casing)
9. Geophysical well log	Gamma ray-neutron and caliper (to 1,843 feet)
10. Placed plug (dump bailer)	1,843 to 1,778 feet, expanding cement (27 sacks)
11. Directional survey	1,000 feet, determine exact location of well in mine
12. Placed plugs (through tubing)	1,778 to 1,464 feet, expanding cement (58 sacks)
	1,464 to 950 feet, fly ash-gel-water slurry (4 tons fly ash and 200 lb Aquagel)
	950 to 887 feet, expanding cement (13 sacks)
13. Ripped casing	862 feet, 3 cuts 1 foot long
14. Cement retainer set	853 feet

Operation		Description
15.	Placed plugs (through tubing)	887 to 853 feet, neat cement (35 sacks)
		864 to 743 feet behind 6-5/8-inch casing (squeezed 16 sacks of neat cement at 400 psi wellhead pressure)
		853 to 847 feet, neat cement (1 sack)
16.	Placed cement behind 6-5/8-inch casing	165 feet to surface, neat cement (300 sacks) (165 feet of 1-inch pipe run in annulus to place cement)
17.	Ripped casing (to weaken casing and to sample for possible tracer leaks behind casing)	832 to 840 feet, 4 cuts (2 cuts, 4 feet fall into other cuts)
18.	Collect samples to be analyzed for SF_6	73 days
19.	Placed plug (through tubing)	847 feet to surface, neat cement (200 sacks)
20.	Set well monument	10 feet below to 3 feet above surface (filled with cement)
21.	Graded and seeded area	See figure 10

J. Wildman Well 15 (Fig. 5)

1.	Geophysical well logs	Gamma ray-neutron and caliper (total depth)
2.	Bottom-hole pressure buildup	99 psi after 64 hours' shut-in time
3.	Production injection packer set	1,836 feet
4.	Injection test	500 scf nitrogen at 60 psi
5.	Injection of SF_6	Injected 250 scf N_2 and 125 lb SF_6 at 90 psi (N_2 and SF_6 injected simultaneously)
		Injected 1,000 scf N_2, shut-in pressure 175 psi, shut-in pressure after 13 hours 110 psi
6.	2-inch bridge plug set	1,828 feet

Operation	Description
7. Placed plugs	Top of packer to 1,819 feet, field stone (bridge)
	1,819 to 1,804 feet, neat cement (2 sacks)
	1,804 to 1,754 feet, limestone chips (bridge)
	1,754 to 1,729 feet, clay
	1,729 to 1,534, gelled water (230 gal water and 1 sack Aquagel)
	1,538 feet set brush plug (branch of tree)
	1,538 to 1,536 feet, limestone chips (bridge)
	1,536 to 1,523 feet, neat cement (3 sacks)
8. Cut 4-7/8-inch casing	1,427 feet (pulled all casing)
9. Placed plugs	1,523 to 1,254 feet, Aquagel and water
	1,254 feet, brush plug
	1,254 to 1,252 feet, limestone chips (bridge)
	1,252 to 1,133 feet, neat cement (30 sacks)
	820 feet, brush plug
	820 to 720 feet, limestone chips (bridge)
	610 feet, brush plug
	610 to 600 feet, limestone chips (bridge)
	600 to 593 feet, neat cement (5 sacks)
10. Pulled casing	532 feet, 6-5/8-inch casing cut at 593 feet (removed 61 feet of casing)

Operation	Description
11. Placed plugs	593 to 546 feet, limestone chips (bridge)
	546 to 534 feet, neat cement (2 sacks)
12. Geophysical well logs	Gamma ray-neutron and caliper (to 534 feet)
13. Pulled casing	511 feet, Pittsburgh coalbed exposed (pulled casing to 468 feet)
14. Geophysical well logs	Gamma ray-neutron and caliper (to 534 feet)
15. Placed plugs	534 to 487 feet, neat cement (21 sacks)
	472 feet, brush plug
	472 to 470 feet, limestone chips (bridge)
	470 to 413 feet, neat cement (pulled casing to 383 feet)
	389 feet, brush plug
	389 to 387, limestone chips (bridge)
	387 to 214 feet, Aquagel and water (4 sacks Aquagel) (pulled casing to 189 feet) 214 feet brush plug
16. Hole caved	192 feet bridged
	Drilled out bridge and lost brush plug (pulled 6-5/8-inch casing from well--189 feet)
17. Placed plugs	214 feet, brush plug
	214 to 208 feet, limestone chips (bridge)
	208 to 151 feet, neat cement (57 sacks)
	151 to 40 feet, Aquagel and water
	40 feet, brush plug
	40 to 17 feet, stone and clay (bridge)

Operation	Description
18. Set well monument	17 feet below to 3 feet above surface, neat cement inside and out (13 sacks)
19. Graded and seeded area	Grass growing

	STRAIGHT		DIRECTIONAL
HORIZONTAL DISP	0		2660
TRUE VERTICAL DEPTH (TVD)	8500		8500
DRY HOLE COST	450K		700K
COMPLETED COST	600K	300K	900K
PRODUCTIVE LIFE	14 YRS		12 YRS
DAILY PROD @ ECON LIMIT	2 BPD		13 BPD
BBL OIL WASTED			5000 BBL
VALUE OF OIL LOST			$100,000
OPERATING COST/DAY	50		200
OPERATING COST 14 YRS	255K	621K	876K
PRESENT WORTH OF LOSS		310K	
VALUE OF ST HOLE	850K		
INCREMENTAL COST			
OF DIR HOLE @ PW	610K		
PW VALUE OF DIR HOLE	240K		

PW = PRESENT VALUE 10%

YATES PETROLEUM CORP.
BEFORE THE COMMISSION
NMOCD CASE NOS. 10446-10449
DATE: 09/09/92 DE NOVO
EXHIBIT NO. 72