LARGE FORMAT EXHIBIT HAS BEEN REMOVED AND IS LOCATED IN THE NEXT FILE

PRELIMINARY PRINT

CORE LABORATORIES, INC. *Petroleum Reservoir Engineering*

COMPANY	MAGNOLIA PETROLEUM COMPANY	DATE ON	6-11-56	FILE NO.	NP-3-522 S
WELL	FEDERAL COX NO. 2	DATE OFF	6-18-56	ENGRS.	BOONE
FIELD	CROSSROADS	FORMATION	AS NOTED	ELEV.	4050' DF
COUNTY	LEA STATE NEW MEXICO	DRLG. FLD.	OIL EMULSION	CORES	CHRIS. 2 5/8"
LOCATION	12-9-36	REMARKS	SAMPLED AS DIRECTED BY CLIENT		

Special Analysis

CORE REPORT

SAND · LIMESTONE · CONGLOMERATE · CHERT · SHALE · DOLOMITE

ST-STYLOLITIC
F-FRACTURED
S-SLIGHTLY
V-VUGULAR

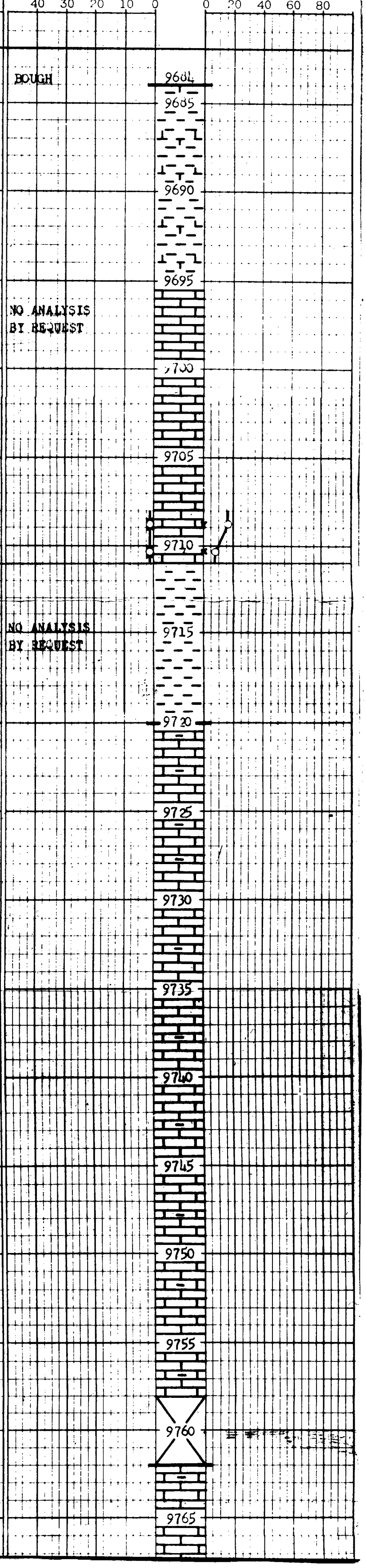
SAMPLE NUMBER	DEPTH FEET	PERMEABILITY, MILLIDARCYS MAX.	PERMEABILITY, MILLIDARCYS 90°	POROSITY PERCENT	RESIDUAL SATURATION, PORE SPACE OIL	RESIDUAL SATURATION, PORE SPACE TOTAL WATER	VISUAL DESCRIPTION
	Top of Bough "C"						
	WHOLE-CORE ANALYSIS						
	NO ANALYSIS BY REQUEST						
1	9708.0-09.7	0.3	0.2	1.3	0.0	84.7	F,S
2	9709.7-11.2	0.3	0.2	1.3	TR	92.3	F,ST
	Bottom of Bough "C"						
	NO ANALYSIS BY REQUEST						

PERMEABILITY, Maximum O - O
MILLIDARCYS
40 30 20 10 0

TOTAL WATER O - O
PERCENT PORE SPACE
80 60 40 20 0

POROSITY X----X
PERCENT
40 30 20 10 0

OIL SATURATION X----X
PERCENT PORE SPACE
0 20 40 60 80



PRELIMINARY PRINT

CORE LABORATORIES, INC. *Petroleum Reservoir Engineering*

COMPANY (Gulf. WARREN PETROLEUM CORPORATION)
WELL FEDERAL-MILLS NO. 2
FIELD WILDCAT
COUNTY LEA STATE NEW MEXICO
LOCATION

DATE ON 4/27/54
DATE OFF 4/28/54
FORMATION BOUGH
DRLG. FLD. WATER BASE MUD
REMARKS SAMPLED BY A REPRESENTATIVE OF WARREN PETROLEUM CORPORATION

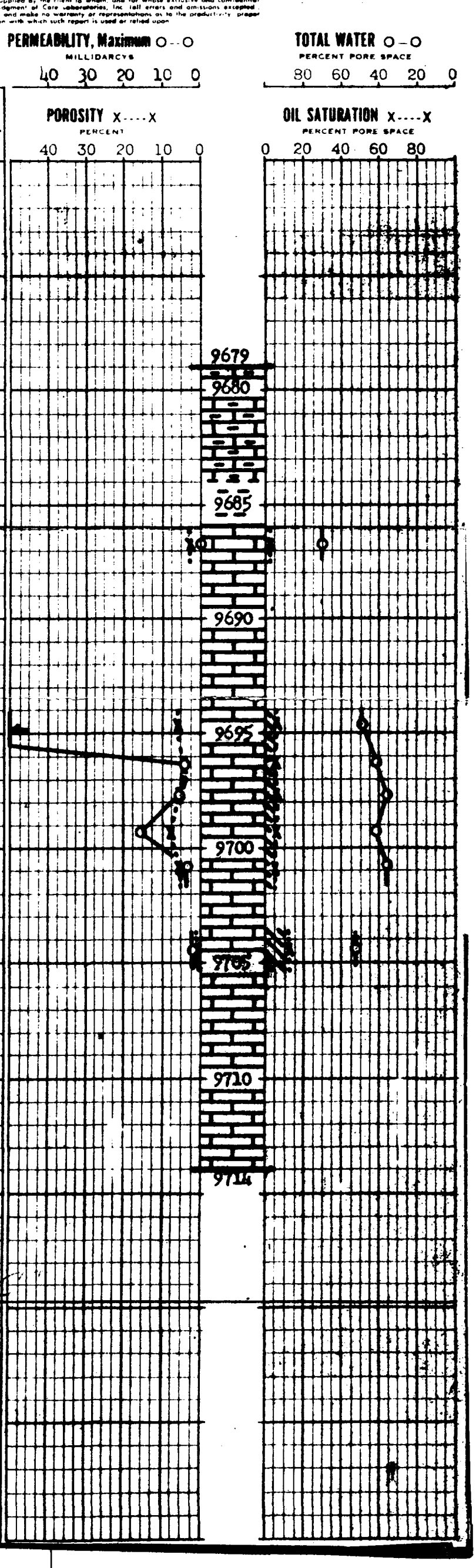
FILE NO. LABL-131 S
ENGRS. RLB;WBM
ELEV. 4068' DF
CORES DOWDCO 3½"

Special Analysis

CORE REPORT

SAND LIMESTONE CONGLOMERATE CHERT
SHALE DOLOMITE

SAMPLE NUMBER	DEPTH FEET	PERMEABILITY MILLIDARCYS MAX	PERMEABILITY MILLIDARCYS 90°	POROSITY %	RESIDUAL SATURATION % PORE SPACE OIL	RESIDUAL SATURATION % PORE SPACE TOTAL WATER	VISUAL DESCRIPTION
	SL-SLIGHTLY F-FRACTURED V-VUGULAR						
	Top of Bough "C"						
1	9686.0-87.6	<0.1	<0.1	3.0	3.3	70.0	SLV
2	9694.0-95.4	507	435	6.5	6.2	49.2	V
3	9695.4-97.0	4.3	1.7	4.9	6.1	40.8	V
4	9697.0-98.4	5.3	4.9	6.7	6.0	35.8	V
5	9698.4-00.0	16	10	7.5	6.7	41.3	V
6	9700.0-01.8	3.4	0.7	5.6	5.4	35.7	V,F
7	9703.7-05.3	2.2	<0.1	1.7	11.8	53.0	F
	Approximate Bottom of Bough "C"						



PROGRESS PRINT

CORE LABORATORIES, INC. CORE LAB — Reservoir Engineering

COMPANY	MAGNOLIA PETROLEUM COMPANY	DATE ON	3-19-56
WELL	FEDERAL CHILDERS NO. 2	DATE OFF	
FIELD	CHILDERS *Allison Penn*	FORMATION	AS NOTED
COUNTY	LEA	STATE	NEW MEXICO
LOCATION	SEC 11-T-S-R36E	DRLG. FLD.	WBM
FILE NO.	WP-3-449 S	ENGRS.	BOONE
ELEV.	4056' DF	CORES	CHRISTENSEN 25/8
REMARKS	SAMPLED BY A REPRESENTATIVE OF MAGNOLIA PETROLEUM COMPANY		

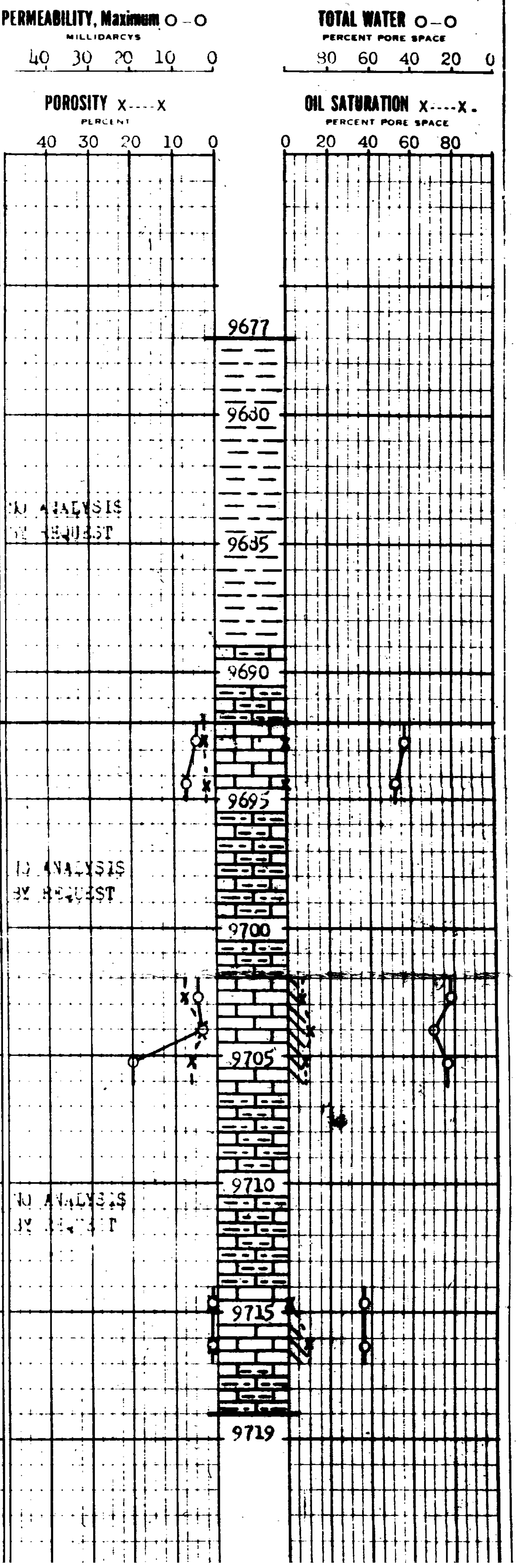
Special Analysis

CORE REPORT

SAND · LIMESTONE · CONGLOMERATE · CHERT · SHALE · DOLOMITE

V-VUGULAR
ST-STYLOLITIC
F-FRACTURED
S-SLIGHTLY
[illegible]

SAMPLE NUMBER	DEPTH FEET	PERMEABILITY MILLIDARCYS MAX	PERMEABILITY MILLIDARCYS 90	POROSITY	RESIDUAL SATURATION PORE SPACE OIL	RESIDUAL SATURATION PORE SPACE TOTAL WATER	VISUAL DESCRIPTION
	WHOLE-CORE ANALYSIS						
	Top of Bough "C"						
1	[illegible]-93.5	[illegible]	4.1	2.0	0.0	42.5	[illegible]
2	[illegible]-95.2	[illegible].5	0.[illegible]	2.1	TR	47.7	[illegible]
3	9702.0-03.4	4.5	1.3	7.5	6.7	21.4	V
4	03.4-04.5	3.[illegible]	1.6	3.7	10.[illegible]	[illegible].7	SV
5	9704.5-06.2	20	10	6.3	7.9	23.8	V,S
6	9714.0-15.5	0.6	[illegible]	1.4	TR	64.2	S
7	9715.5-17.0	0.1	0.1	1.1	9.9	63.6	S



CG-252

CORE LABORATORIES, INC. *Petroleum Reservoir Engineering*

COMPANY AMREN PETROLEUM CORPORATION — DATE ON Feb. 3, 1954 — FILE NO LBML-105 S
WELL FEDERAL-MILLS NO. 1 — DATE OFF Feb. 9, 1954 — ENGRS KLB, WBM
FIELD WILDCAT — FORMATION BOUGH — ELEV 4063' DF
COUNTY LEA — STATE NEW MEXICO — DRLG FLD AMERADA BASE MAP — CORES 3¼" DOWDCO
LOCATION SEC. 11 T9S R36E — REMARKS SAMPLED BY AMREN PETROLEUM CORPORATION

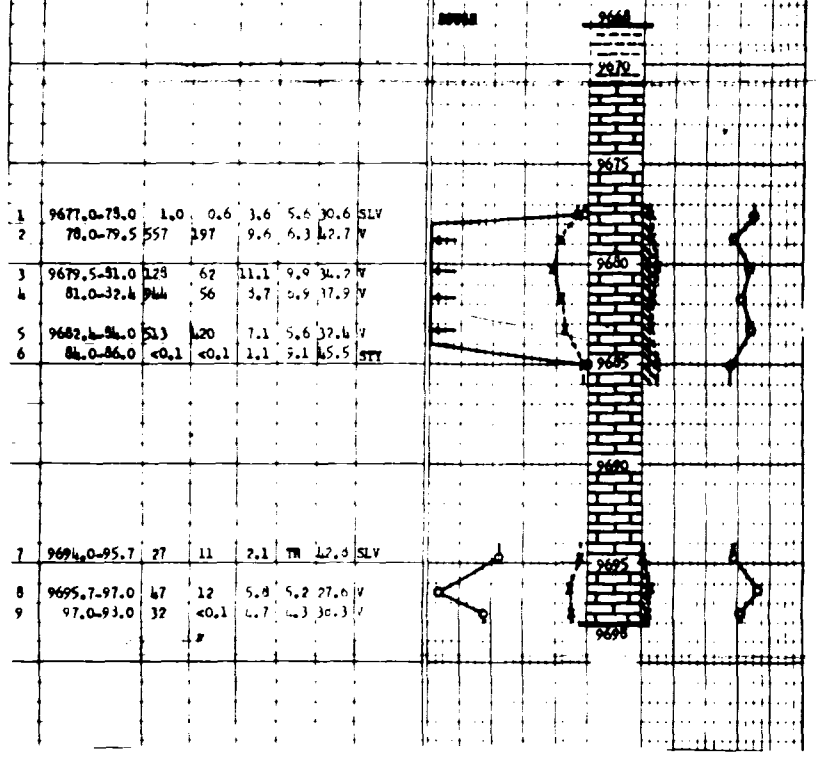
Special Analysis

CORE REPORT

SAND — SHALE

PERMEABILITY Maximum — TOTAL WATER
40 30 20 10 0
POROSITY — OIL SATURATION

SL -SLIGHTLY
V -VUGGY
STY-STYLOLITIC



1	9677.0-79.0	1.0	0.6	3.6	5.6	30.6	SLV
2	78.0-79.5	557	197	9.6	6.3	42.7	V
3	9679.5-81.0	129	62	11.1	9.9	34.7	V
4	81.0-82.5	944	56	3.7	6.9	17.9	V
5	9682.5-84.0	513	420	7.1	5.6	32.6	V
6	84.0-86.0	<0.1	<0.1	1.1	9.1	45.5	STY
7	9694.0-95.7	27	11	2.1	TR	42.3	SLV
8	9695.7-97.0	47	12	5.8	5.2	27.6	V
9	97.0-98.0	32	<0.1	4.7	4.3	30.3	V

CORE LABORATORIES, INC
Petroleum Reservoir Engineering
DALLAS

Page 1 of 1
File LBML-105 S
Well Federal-Mills No. 1

CORE SUMMARY AND CALCULATED RECOVERABLE OIL

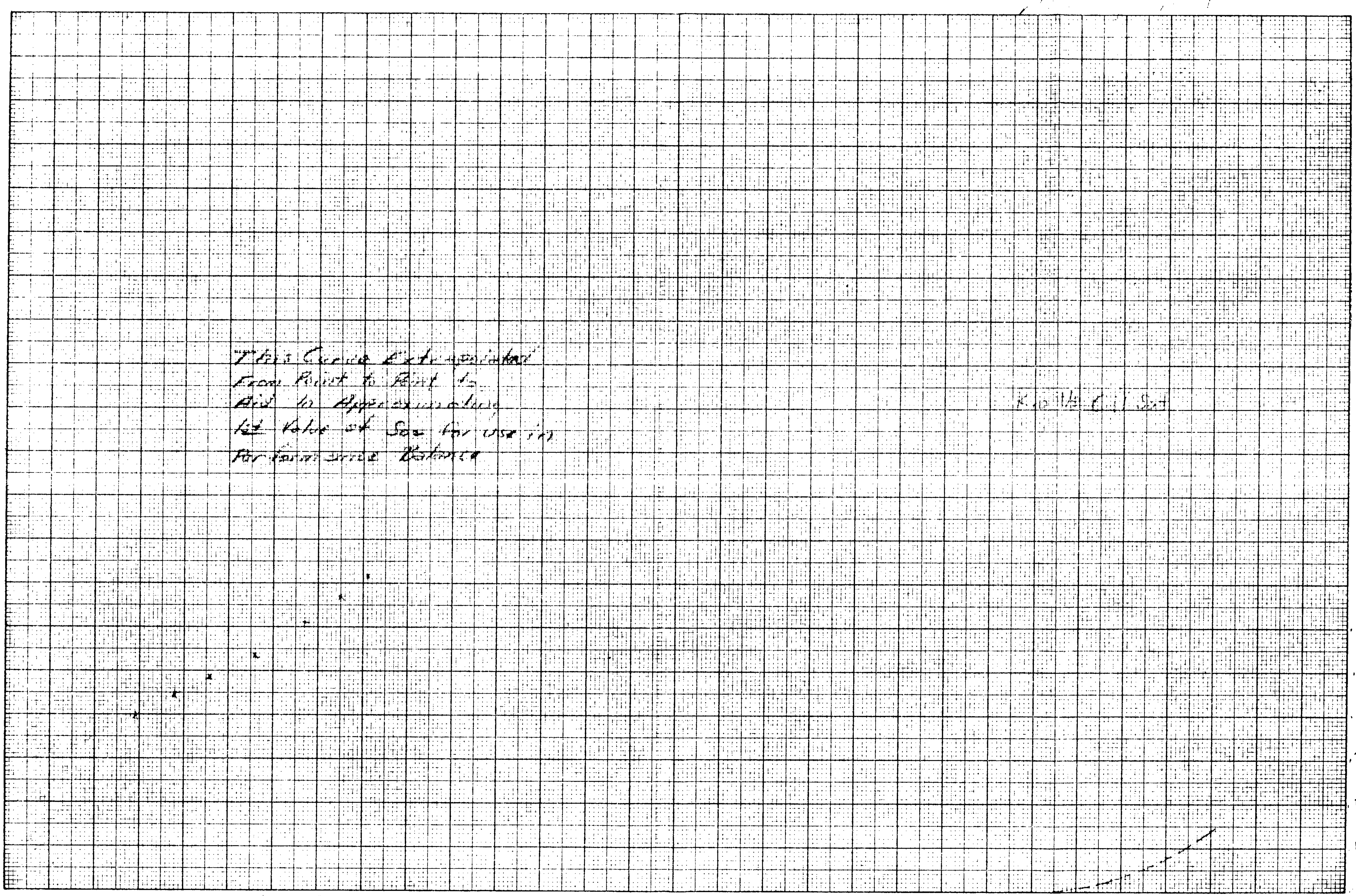
CORE SUMMARY

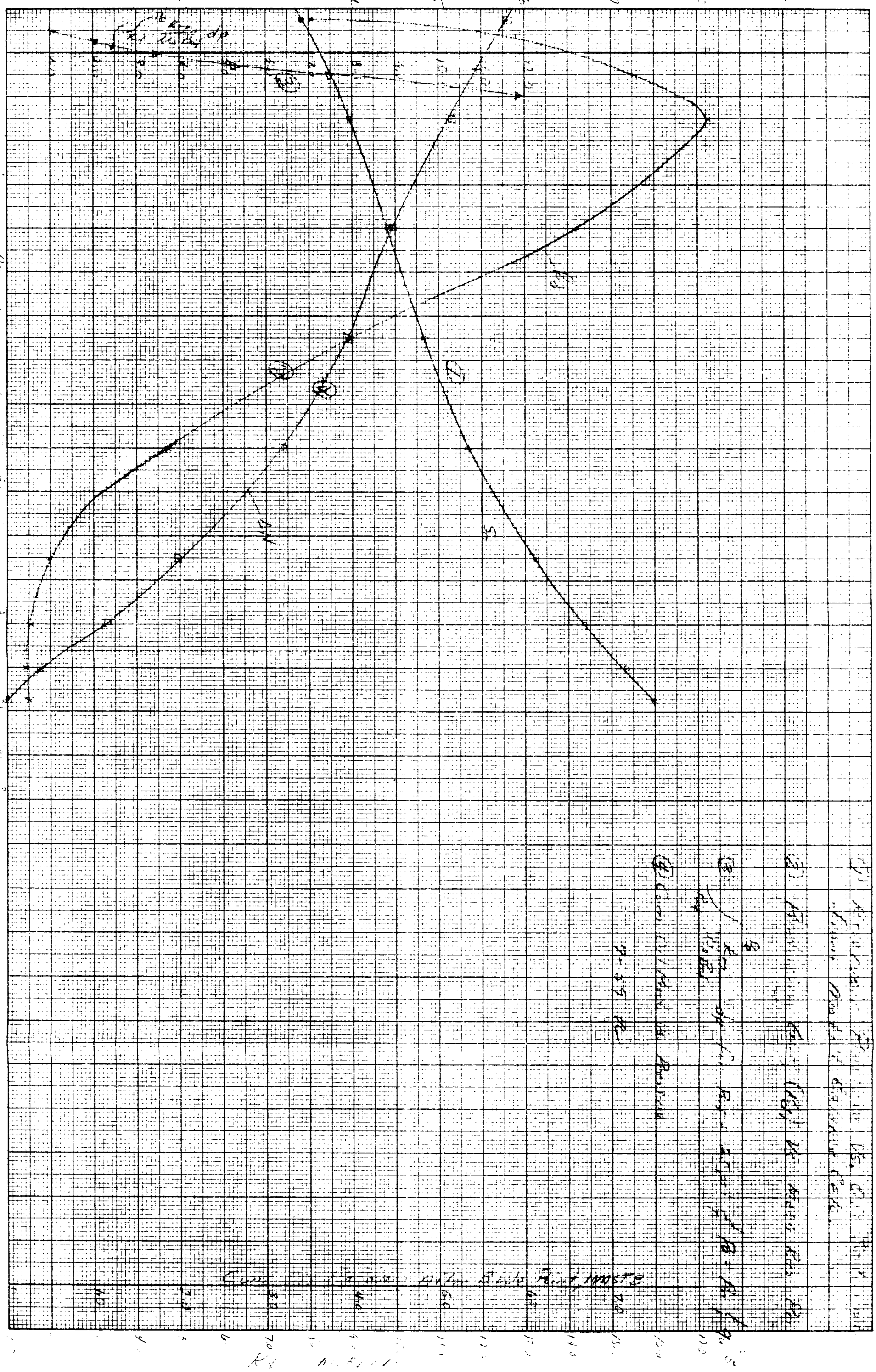
FORMATION NAME	Bough			
DEPTH - FEET	9677.0-9698.0			
% CORE RECOVERY	100			
FEET OF PERMEABLE PRODUCTIVE FORMATION RECOVERED	11.0			
AVERAGE PERMEABILITY MILLIDARCYS	Max. 281 90° 95			
CAPACITY - AVERAGE PERMEABILITY * FEET PRODUCTIVE FORMATION	Max. 3091 90° 1045			
AVERAGE POROSITY PERCENT	6.6			
AVERAGE RESIDUAL OIL SATURATION % PORE SPACE	5.5			
GRAVITY OF OIL - A.P.I.	47			
AVERAGE TOTAL WATER SATURATION % PORE SPACE	35.8			
AVERAGE CALCULATED CONNATE WATER SATURATION % PORE SPACE	35.8			
SOLUTION GAS-OIL RATIO CUBIC FEET PER BARREL (1)	1330			
FORMATION VOLUME FACTOR—VOLUME THAT ONE BARREL OF STOCK TANK OIL OCCUPIES IN RESERVOIR (1)	1.86			
CALCULATED RECOVERABLE OIL	Predictions dependent upon complete evaluation of reservoir. Structural position of well, total productive thickness of all zones and drainage area of well should be considered.			
BY NATURAL OR GAS EXPANSION BBLS PER ACRE FOOT (3)	35			
INCREASE DUE TO WATER DRIVE BBLS PER ACRE FOOT	.42			
TOTAL AFTER COMPLETE WATER DRIVE BBLS PER ACRE FOOT (3)	.77			

Core Laboratories, Inc.

R S Bynum, Jr.
R. S. Bynum, Jr.

NOTE
* REFER TO ATTACHED LETTER
(1) REDUCTION IN PRESSURE FROM Estimated SATURATION PRESSURE TO ATMOSPHERIC PRESSURE
(2) AFTER REDUCTION FROM ORIGINAL RESERVOIR PRESSURE TO ZERO POUNDS PER SQUARE INCH
(3) RESERVOIR PRESSURE MAINTAINED BY WATER DRIVE AT OR ABOVE Estimated ORIGINAL SATURATION PRESSURE
(4) NO ESTIMATE FOR GAS PHASE RESERVOIRS





ALLISON & NORTH ALLISON POOLS

BHP's vs Time for Individual Wells

- ⊙ - GULF, Fed-Mills No. 1
- × - OHIO, State "E" No. 1
- △ - ATLANTIC, St. "AD" No. 1
- ⊡ - ATLANTIC, St. "AE" No. 1
- ⊗ - ATLANTIC, Fed-Yates No. 1
- ⊙ - SUN, Mills No. 1
- ✱ - ATLANTIC, Fed-Gulf No. 1
- ◬ Cactus Sunray State A-2
- Initial Pressure

BOTTOM HOLE PRESSURE @ -5600', p.s.i.

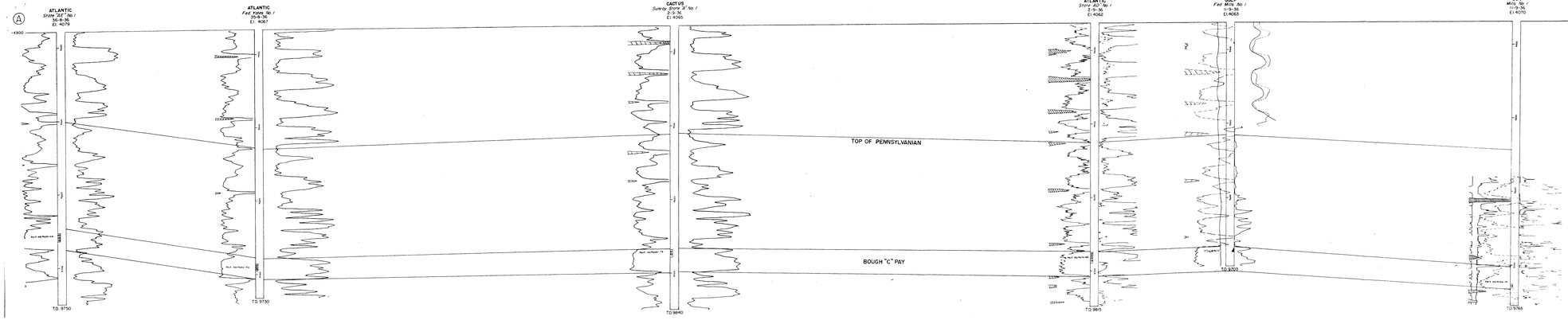
4000
3500
3000
2500
2000
1500
1000
500
0

(GULF, Fed-Mills No. 1)
(OHIO, State "E" No. 1)
(SUN, Mills No. 1)
(ATLANTIC, State "AD" No. 1)
(ATLANTIC, State "AE" No. 1)
(ATLANTIC, Fed-Yates No. 1)
(ATLANTIC, Fed-Gulf No. 1)
Cactus Sunray State A-2

Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

1954 1955 1956 1957 1958 1959 1960 19 19 19

K&E 10 YEARS BY MONTHS 359-200L
X 110 DIVISIONS
KEUFFEL & ESSER CO.



ALLISON & N.ALLISON POOLS
Lea & Roosevelt Co's, New Mexico
North-South Cross-Section
Horizontal Scale: 1"=300'
Vertical Scale: 1"=40'
Date Prepared 3-59
Prepared By Atlantic Refining Co.
Cross Section A-A'

Ex 3

LARGE FORMAT
EXHIBIT HAS
BEEN REMOVED
AND IS LOCATED
IN THE NEXT FILE

LARGE FORMAT
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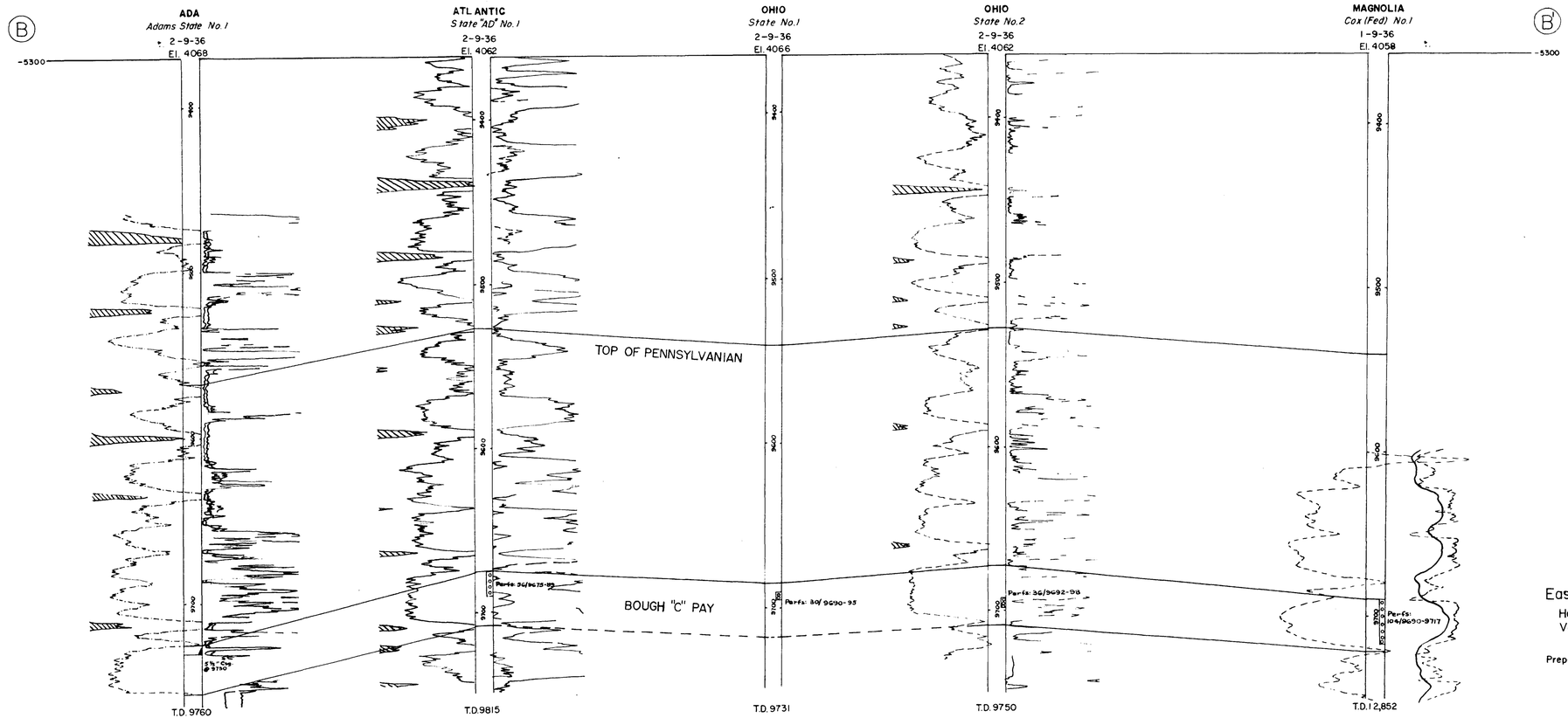


ALLISON POOL

Lea County, New Mexico

East-West Cross-Section

Horizontal Scale: 1" = 300'

Vertical Scale: 1" = 40'

Date Prepared 3-59

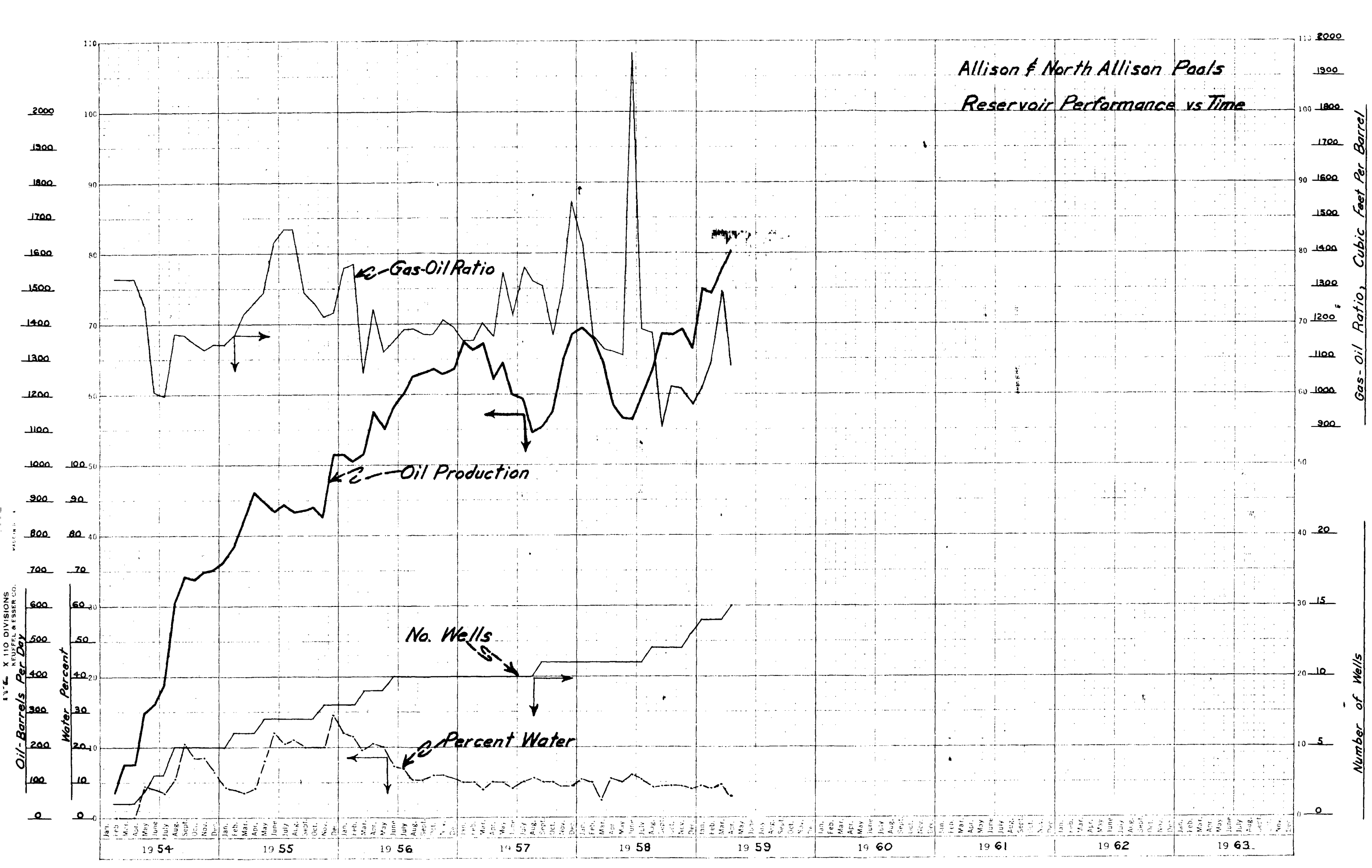
Prepared By Atlantic Refining Co.

Cross Section B-B'

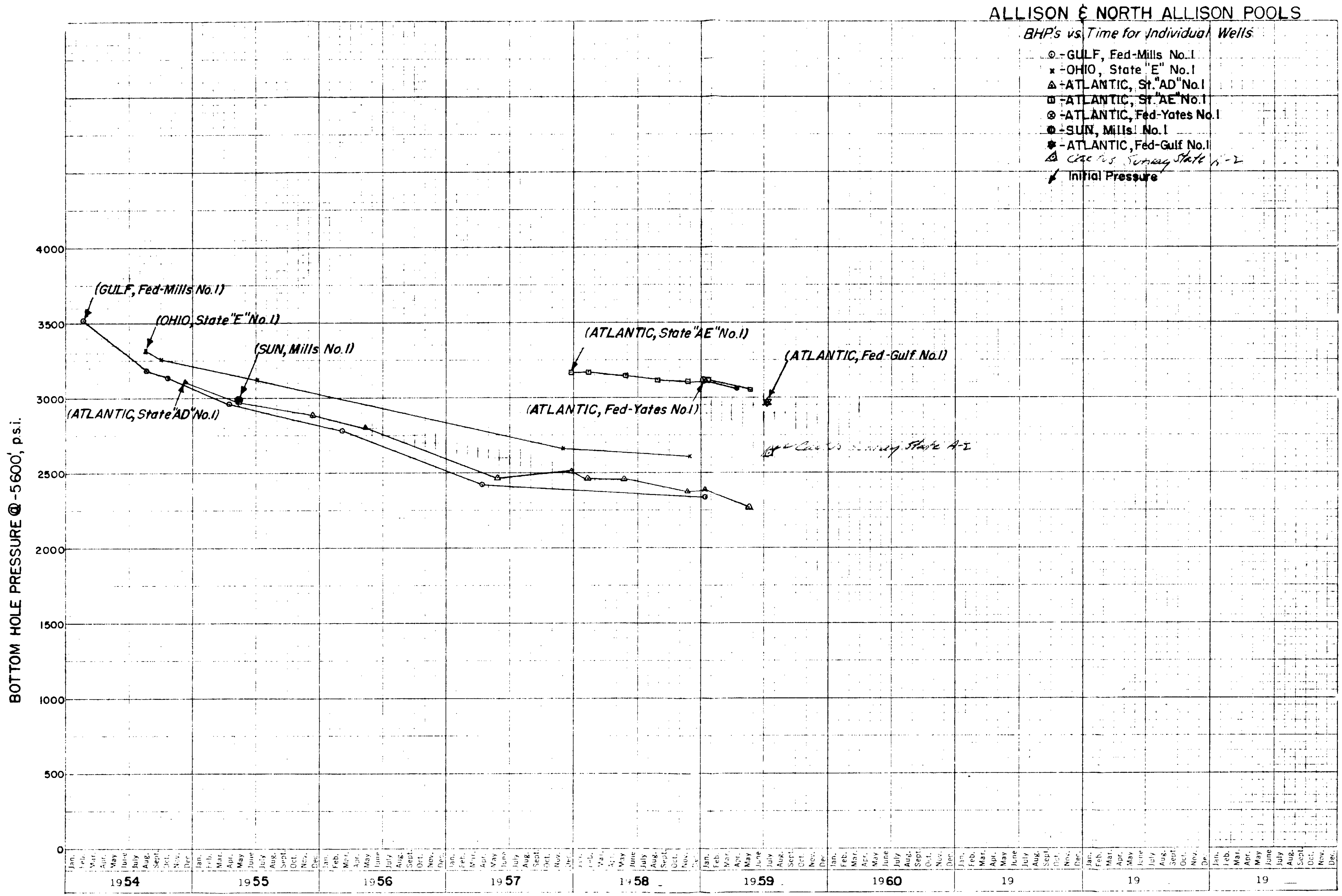
Ex. 4

LARGE FORMAT
EXHIBIT HAS
BEEN REMOVED
AND IS LOCATED
IN THE NEXT FILE

Allison & North Allison Pools
Reservoir Performance vs Time



KEUFFEL & ESSER CO. 8 X 10 DIVISIONS


ALLISON & NORTH ALLISON POOLS
BHP's vs Time for Individual Wells
⊙ - GULF, Fed-Mills No.1
x - OHIO, State "E" No.1
△ - ATLANTIC, St."AD" No.1
⊡ - ATLANTIC, St."AE" No.1
⊗ - ATLANTIC, Fed-Yates No.1
● - SUN, Mills No.1
✱ - ATLANTIC, Fed-Gulf No.1
Initial Pressure
(GULF, Fed-Mills No.1)
(OHIO, State "E" No.1)
(SUN, Mills No.1)
(ATLANTIC, State "AD" No.1)
(ATLANTIC, State "AE" No.1)
(ATLANTIC, Fed-Yates No.1)
(ATLANTIC, Fed-Gulf No.1)
BOTTOM HOLE PRESSURE @-5600', p.s.i.
4000
3500
3000
2500
2000
1500
1000
500
0
1954
1955
1956
1957
1958
1959
1960
19
19
19

LARGE FORMAT
EXHIBIT HAS
BEEN REMOVED
AND IS LOCATED
IN THE NEXT FILE

EXHIBITS FOR CASE 1637

REHEARING OF ATLANTIC'S
APPLICATION FOR 80-ACRE
SPACING IN ALLISON
AND NORTH ALLISON POOLS

July 15, 1959, Regular Statewide Hearing

BASIC DATA

ALLISON AND NORTH ALLISON POOLS

1. Physical Properties of Reservoir Rock
   - A. Porosity - 5.15% (Avg. of 5 cores)
   - B. Permeability - 107.2 md. (Avg. of 5 cores)
   - C. Saturation - estimated 75% oil, 25% water
   - D. Type of porosity - matrix and vugular

2. Structural Features
   - A. WOC - undetermined
   - B. GOC - none observed
   - C. Gross pay thickness - Bough "C" - 30-50'
   - D. Arithmetic avg. net pay thickness - 8.94'
   - E. Dip - gentle, 100' to 150' per mile
   - F. Anticlinal structure - limits undefined

3. Fluid Characteristics
   - A. Average oil gravity - 48° API
   - B. Salinity of water - 107,316 ppm, NaCl
   - C. Saturation pressure - 3150 psig
   - D. Solution gas-oil ratio - 1517 CF/B at 3150 psia
   - E. Formation volume factor - 1.821 at 3518 psi
   - F. Viscosity of oil - .19 cp at 3150 psi
   - G. Compressibility of saturated oil at 156°F - from 3150 psi to 5000 psi - 23.03×10^{-6} Vol/vol/psi

4. Pressures And Temperatures
   - A. Original pressure - 3518 psig
   - B. Reservoir temperature - 156°F
   - C. January, 1959, weighted average pressure at -5600' - 2734 psig (Shut-in from 72 hours to 168 hours prior to test)
   - D. Average productivity index - 5.01 (Range: 2.22 - 11.88)

5. Statistical Data
   - A. Oil production rate - 47,447 barrels for April, 1959
   - B. Cumulative oil production to 5-1-59 - 1,998,553 barrels
   - C. Average GOR - see graph
   - D. Water production - see graph
   - E. Well count - 16 producing, 1 drilling, 2 dry

6. Well Completion Methods - Casing Perforations Most Common

7. Area Within Recommended Boundary - 2320 Acres

8. Average Well Density - 80 Ac/Well

9. Disposition of Gas for Month of April, 1959
   - A. Vent - 7810 MCF
   - B. Lease - 1374 MCF
   - C. Sold - 47,162 MCF (Sinclair, Magnolia, Phillips)

ALLISON POOL
LEA COUNTY, NEW MEXICO
SUMMARY OF CORE ANALYSES

OPERATOR:	Gulf	Gulf	Magnolia	Magnolia	Magnolia	Average
LEASE AND WELL:	Fed. Mills #1	Fed. Mills #2	Fed. Childers #1	Fed. Childers #2	Fed. Cox #2	-
PAY INTERVAL FROM CORE:	9677-9698'	9694-9705.3'	9687-9704'	9692-9717'	9708-9711.2'	-
NET PAY FROM CORE:	11.0'	9.4'	4.5'	10.4'	3.2'	7.7'
WEIGHTED AVERAGE POROSITY:	6.7%	8.1%	1.8%	3.5%	1.3%	5.15%
WEIGHTED AVERAGE PERMEABILITY:	301 md.	80.6 md.	.7 md.	6.0 md.	.3 md.	107.2 md.

ECONOMICS OF DRILLING ONE WELL PER 40 ACRES IN ALLISON AND NORTH ALLISON POOLS

REVENUE

Oil

(70,000) (1.0 - .125) ($2.95) =	$180,688
Less Severance Taxes At $0.1369/BO	8,385
Gross Oil Revenue Less Severance Taxes	172,303

Gas

(70,000) (1.0 - .125) (1.517) ($0.08)	7,433
Less Severance Taxes At 0.0264 Of Value	196
Gross Gas Revenue Less Severance Taxes	7,237
Total Gross Revenue Less Severance Taxes	179,540

COST

Drilling	175,000
Pumping Equipment	30,000
Flow Lines	1,600
Total Cost	206,600
Loss - 40 Acre Well	27,060

CONDITIONS

Oil In Place Per 40 Acres	70,000 barrels
Gas-Oil, Ratio	1517 cubic feet per barrel
Oil Price	$2.95 per barrel
Casinghead Gas Price	$0.08 per MCF

Recovery factor has been used as 1.0. In practice, recovery factor will range between 0.2 and 0.5. Oil and gas recovery and revenue will be reduced proportionately. Operating expenses, which were neglected, will increase total costs.

NET PAY BY WELLS
ALLISON AND NORTH ALLISON POOLS

OPERATOR, LEASE & WELL	NET PAY, FT.
Ada Oil Co.	
Adams St. No. 1	6
Atlantic Refining Co.	
Federal-Gulf No. 1	20
Federal-Yates No. 1	9
State "AD" No. 1	4
State "AE" No. 1	13
Cactus Drilling Co.	
Sunray State "A" No. 1	10
Sunray State "A" No. 2	4
Gulf Oil Corp.	
Mills (Fed.) No. 1	11
Mills (Fed.) No. 2	9
Magnolia Petroleum Co.	
Childers (Federal) No. 1	7
Childers (Federal) No. 2	12
Cox (Federal) No. 1	7
Cox (Federal) No. 2	3
Ohio Oil Co.	
State "A" No. 1	5
State "A" No. 2	10
Sun Oil Co.	
R. G. Mills No. 1	9
Trice Production Co.	
Merrill No. 1	13

Arithmetic Average Thickness - 8.94'

VOLUMETRIC CALCULATION
FOR OIL IN PLACE - 40 ACRE TRACT
ALLISON AND NORTH ALLISON POOLS
LEA AND ROOSEVELT COUNTIES,
NEW MEXICO

$$N_1 = \frac{7758 \times \phi \times (1 - Sw) \times h \times A}{B_o}$$

$$= \frac{7758 \times .0515 \times (1 - .25) \times 8.94 \times 40}{1.821}$$

= 58,841 barrels

A recovery factor of 30% is believed to be reasonable for the Allison and North Allison Pools. Recoverable oil per 40-acre location would therefore be:

Recoverable oil = $.30 \times N_1$

= .30 x 58,841 barrels

= 17,652 barrels

Definition of Symbols:

N_1 = Original oil in place per 40 acre tract, stock tank barrels

ϕ = Porosity as a fraction, .0515

Sw = Interstitial water saturation, fraction of pore space - .25

h = Net pay thickness, feet - 8.94

A = Area for which oil in place is being calculated - 40 acres

B_o = Original oil formation volume factor, barrels of reservoir space per barrel of stock tank oil - 1.821

7758 = Number of barrels per acre-foot

VARIATIONS REQUIRED IN APPLIED
DATA TO ACCOUNT FOR OIL PRODUCED
GULF MILLS NO. 1 WELL
ALLISON POOL

Estimated Recoverable Oil For 40 Acre Tract Assigned To Gulf's Federal Mills No. 1 is:

$$\text{Recoverable Oil} = \frac{7758 \times \phi \times A \times h \times (1-Sw) \times R.F.}{B_o}$$

$$= \frac{7758 \times .067 \times 40 \times 11 \times (1-.25) \times .30}{1.821}$$

$$= 28,258 \text{ STB}$$

RF is the recovery factor and is estimated to be 30%. Other symbols in the above equation are defined on the Exhibit showing volumetric calculations for oil in place.

The measured oil production from Gulf's Federal Mills No. 1 was 273,437 barrels as of May 1, 1959. The tabulation below shows what each variable in the above equation would have to be to account for the volume of oil actually produced from the tract as of May 1, 1959, if all variables but one are equal to their applied values. In reviewing this Table, it should be remembered that 28,258 STB is the estimated ultimate recovery of oil that was originally situated beneath the 40-acre tract. The 273,437 barrel figure is what the well has actually produced and of course the well is still producing. An even greater variation in the applied values and required values would exist if the required values were based on actual ultimate recovery.

	Applied Values	Required Values
Net Pay	11 feet	106.4 feet
Porosity	6.7%	64.8%
Recovery Factor	30%	290.3%
Water Saturation	25%	<0%
Formation Volume Factor	1.821	0.188

All applied values are measured except water saturation and recovery factor. Water saturation usually occurs between 15% and 60% but cannot be less than 0%. Recovery factor will occur normally between 15% and 50%.

ECONOMICS OF DRILLING ONE WELL PER 40 ACRES IN ALLISON AND NORTH ALLISON POOLS

REVENUE		
Oil		
(17,652) (1.0 - .125) ($2.95) =		$ 45,566
Less Severance Taxes At $0.1369/BO.		2,115
Gross Oil Revenue Less Severance Taxes.		$ 43,451
Gas		
(17,652) (1.0 - .125) (3.540) ($0.08)		$ 4,374
Less Severance Taxes At 0.0264 Of Value		115
Gross Gas Revenue Less Severance Taxes.		$ 4,259
Total Gross Revenue Less Severance Taxes.		$ 47,710
COSTS		
Development		
Drilling.		$ 175,000
Pumping Equipment		30,000
Flow Lines.		1,600
Total Development Cost.		$ 206,600
Operating		
($0.08) (17,652).		$ 1,412
Total Costs		$ 208,012
Loss Per 40-Acre Well		$ 160,302

CONDITIONS		
Recoverable Oil In Place Per 40 Acres	17,652	barrels
Average Gas-Oil Ratio Throughout Life	3,540	cubic feet per bbl.
Oil Price	$ 2.95	per barrel
Casinghead Gas Price.	$ 0.08	per MCF
Operating Cost.	$ 0.08	per barrel
Royalty	1/8	
All Wells Completed At Same Time		

RESULTS OF INVESTIGATION OF DRAINAGE
ALLISON AND NORTH ALLISON POOLS

CASE	I	II	III
OPERATOR WELL LOCATION	Atlantic Fed. Yates #1 SE NE Sec. 35 T-8S, R-36E	Ohio State E-6859"A"#2 SE SE Sec. 2 T-9S, R-36E	Cactus Sunray St. "A" #1 NW NE Sec. 2 T-9S, R-36E
OIL IN PLACE BY VOLUMETRIC CALCULATION FOR 80 AC., STB	118,470	112,959	112,959
CALCULATED PRODUCTION BY EXPANSION OF RESERVOIR FLUIDS & ROCK ABOVE BUBBLE POINT (3518-3150 psi), STB	1,414	1,588	1,588
CALCULATED PRODUCTION BY EXPANSION OF RESERVOIR FLUIDS BELOW BUBBLE POINT, STB	1,815	12,204	6,131
PRESSURE INCREMENT FOR CALCULATION BELOW BUBBLE POINT, psi	3150-3059	3150-2602	3150-2803
TOTAL CALCULATED PRODUCTION FROM EXPANSION FOR 80 AC. TRACT, STB	3,229	13,792	7,719
ACTUAL MEASURED PRODUCTION FROM WELL AS OF DATE OF LAST PRESSURE, STB	14,653	124,399	19,053
PRODUCTION DUE TO DRAINAGE FROM OTHER AREAS, STB	11,424	110,607	11,334
CALCULATED DRAINAGE AREA, ACRES	360	720	200

SAMPLE CALCULATION
FOR PRODUCTION DUE TO
EXPANSION OF RESERVOIR
FLUID & ROCK--80 ACRE
TRACT SITUATED ABOUT
ATLANTIC'S FEDERAL YATES NO. 1

Calculation of original oil-in-place:

$$N_1 = \frac{7758 \times \phi \times h \times (1-Sw) \times A}{B_o}$$

$$= \frac{7758 \times .0515 \times 9 \times (1-.25) \times 80}{1.821}$$

= 118,470 Stock Tank Barrels

Calculation of production due to expansion of reservoir fluids and rock above the bubble point:

Pressure increment is from 3518 psi down to 3150 psi.

$$\Delta N = \frac{N_{f1}\, Bo_{f1}\left[(C_{om} - C_{wm}) + \left(\frac{C_{wm} + C_f}{S_{o1}}\right)\right]\Delta P \times 10^{-6} - B_w \Delta W_p}{Bo_{f2}}$$

$$= \frac{118,470 \times 1.821\left[(23.03 - 3.1) + \left(\frac{3.1 + 6.5}{.75}\right)\right] 368 \times 10^{-6} - 0}{1.837}$$

= 1414 STB

Calculation of production due to reservoir fluid expansion below the bubble point:

Pressure increment is from 3150 psi down to 3059 psi. The latter pressure was measured on April 21, 1959.

Oil in place at bubble point is 118,470 bbls - 1414 bbls = 117,056 STB

Since gas liberation in the reservoir is a differential process, the barrels of stock tank oil-in-place must be changed to residual differential barrels. This is done as follows:

$$N_d = N_f \frac{B_{of}}{B_{od}}$$

$$= 117,056 \left(\frac{1.831}{1.860}\right)$$

= 115,604 Residual Differential Barrels

Differential reservoir production below the bubble point is as follows:

$$\Delta N_d = \frac{N_{d1}\left[B_{g2}(R_{sd1} - R_{sd2}) + \frac{1_{F1}}{N_{d1}} (B_{g2} - B_{g1}) - (B_{od1} - B_{od2}) \right] - B_w \Delta W_p}{(B_{od2} - B_{g2}R_{sd2} + B_{g2}R_{sdm})}$$

$$= \frac{115,604\left[.826\ (1.525 - 1.455) + 0 - (1.860 - 1.831) \right] - 0}{(1.831 - .826 \times 1.455 + .826 \times 1.490)}$$

$$= 1790 \text{ RDB}$$

The above differential production can be converted to flash production as follows:

$$\Delta N_f = \Delta N_d \left(\frac{B_{od}}{B_{of}}\right)_m = 1790 \left(\frac{1.847}{1.821}\right) = 1815 \text{ STB}$$

Note: Flash production is considered to be equivalent to stock tank production.

Total calculated production from original reservoir pressure to 3059 psi is:

1414 STB + 1815 STB = 3229 STB

Nomenclature for Material Balance Calculations

a = $p_{sc}T/2.92$, (RVB)(PSIA)/(MSCF)

B_{of} = Flash PVT basis, oil formation volume factor, RVB/STB

B_{od} = Differential PVT basis, oil formation volume factor, RVB/RDB

B_g = Gas formation volume factor, RVB/MSCF

B_w = Water formation volume factor RVB/STB

c_o = Oil compressibility, RVB per MMRVB per PSI

c_w = Water compressibility, RVB per MMRVB per PSI

c_f = Formation (rock) compressibility, RVB per MMRVB per PSI

c_t = Total (average) compressibility of fluid-rock system, RVB per MMRVB per PSI

G_{dl} = Total reservoir gas in-place differential PVT basis) at pressure p_1, MMSCF
(In retrograde systems below the dew point this is the gas equivalent of both the gas and liquid phases in the reservoir: total mols in-place times conversion factor from mols to standard cubic feet.)
(In oil reservoirs this is the sum of the free gas and the gas in solution.)

ΔG_d = Decrease in total (differential) gas in-place over interval, MMSCF

G_{Fi} = Reservoir free gas in-place at pressure p_1, MMSCF

ΔG_F = Reservoir free gas produced over an interval, MMSCF

ΔG_{sp} = Separator gas production over interval, MMSCF
(For non-volatile oil reservoirs and gas reservoirs, this is the actual separator gas produced. For volatile oil reservoirs, this is the separator gas which would be obtained if there were no liquid condensing out from the reservoir free gas produced.)

ΔG_p = Total surface gas production over interval, MMSCF

ΔG_R = Actual separator gas produced over interval (for volatile oil systems), MMSCF

$\left(\frac{\Delta G_F}{\Delta N_C}\right)$ = Total reservoir free gas production to yield one stock tank barrel of condensate (for volatile oil systems), MSCF/STB.

$\left(\frac{\Delta G_{RF}}{\Delta G_F}\right)$ = Separator gas obtained from a unit of total reservoir free gas produced (for volatile oil systems), SCF/SCF

ΔG_{sl} = Reservoir gas equivalent of separator liquid (for gas reservoirs), MMSCF

$(GE)_{sl}$ = Equivalent "reservoir gas" of separator liquid per stock tank barrel of oil production (for gas reservoirs), MSCF/STB. (This is the mols of separator liquid, per STB of oil obtained, times the conversion factor from mols to standard cubic feet. This is usually for the high pressure separator liquid. If the reported gas production includes the low pressure separator gas, this is for the low pressure separator liquid.)

N_{fl} = Flash oil in-place at pressure p_1, MSTB (Reservoir oil volume in-place divided by flash formation volume factor.)

ΔN_f = Decrease in flash oil in-place over interval, MSTB

N_{dl} = Differential oil in-place at pressure p_1, MRDB (Reservoir oil volume in-place divided by differential formation volume factor.)

ΔN_d = Decrease in differential oil in-place over interval, MRDB

ΔN_p = Surface oil production over interval, MSTB
For volatile oil reservoirs this is the oil obtained from the saturated reservoir oil production only and does not include the oil condensed out from the reservoir free gas production. For non-volatile oil reservoirs and for gas reservoirs this is the total stock tank oil production.

ΔN_c = Oil which condenses out of reservoir free gas production at surface (for volatile oil systems), MSTB

ΔN_R = Actual oil production over interval for volatile oil systems, MSTB ($\Delta N_R = \Delta N_c + \Delta N_p$)

n = Lb.-mols of hydrocarbons in-place in reservoir

p = Average reservoir pressure, PSIG for oil reservoirs, PSIA for gas reservoirs

Δp = Pressure decrease during interval, PSI

p_{sc} = Standard pressure, PSIA (14.7 for most states; in Louisiana it is 15.03 PSIA)

R_{sf} = Flash PVT basis, solution gas-oil ratio, MSCF/STB

R = Gas constant (for gas reservoirs) = 10.73 (ft^3)(PSIA) per (^oR) (lb. mol)

$(R_s)_{sp}$ = Gas in solution in separator liquid, MSCF/STB

R_{sd} = Differential PVT basis, solution gas-oil ratio, MSCF/RDB

S_o = Oil saturation, fraction of total pore space

S_w = Water saturation, fraction of total pore space

T = Reservoir temperature, °R = (°F plus 460)

T_{sc} = Standard temperature, °R (T_{sc} = 520 °R)

V = Volume, ft^3

V_p = Total pore space in reservoir, MRVB

V_g = Reservoir hydrocarbon volume (for gas reservoirs), MRVB

W_1 = Water in place at pressure p_1, MRVB

ΔW_e = Water influx (encroachment) over interval, MRVB

ΔW_p = Water production over interval, MSTB

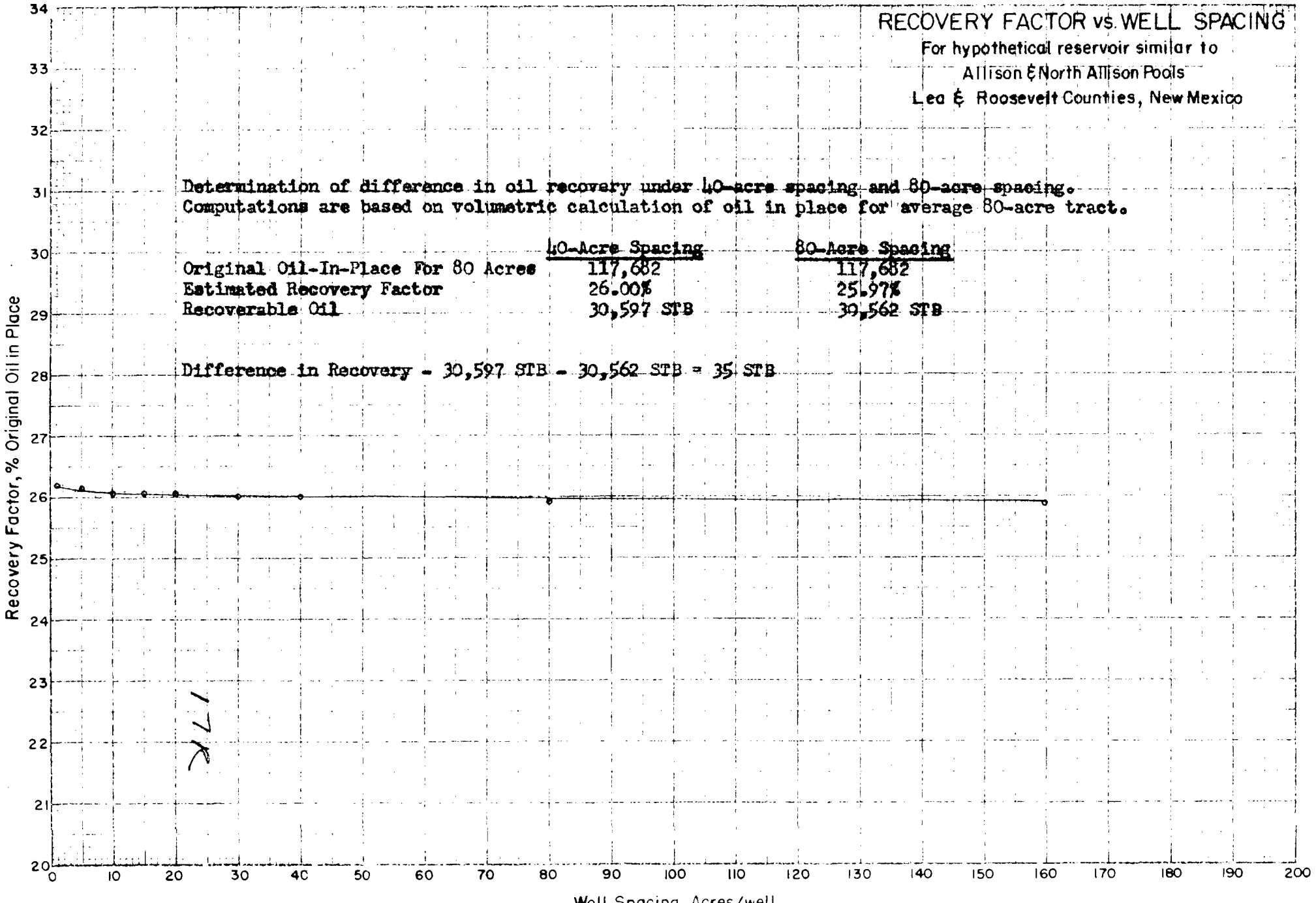
z = Compressibility factor in $pV = znRT$, gas equation
(For retrograde systems below the dew point this is for the average hydrocarbons in place, gas plus liquid phases.)

sub m = To refer to average pressure over an interval or to value of a PVT factor at average pressure over an interval.

sub b = To refer to bubble point pressure.

sub 1 = To refer to pressure, in-place values, and PVT factors, at start of an interval.

sub 2 = To refer to pressure, in-place values, and PVT factors, at end of an interval.


RECOVERY FACTOR vs. WELL SPACING
For hypothetical reservoir similar to
Allison & North Allison Pools
Lea & Roosevelt Counties, New Mexico
Determination of difference in oil recovery under 40-acre spacing and 80-acre spacing.
Computations are based on volumetric calculation of oil in place for average 80-acre tract.
40-Acre Spacing
80-Acre Spacing
Original Oil-In-Place For 80 Acres 117,682 117,682
Estimated Recovery Factor 26.00% 25.97%
Recoverable Oil 30,597 STB 30,562 STB
Difference in Recovery - 30,597 STB - 30,562 STB = 35 STB
Recovery Factor, % Original Oil in Place
Well Spacing, Acres/well
34
33
32
31
30
29
28
27
26
25
24
23
22
21
20
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200

ADDITIONAL COST TO DEVELOP
ALLISON AND NORTH ALLISON POOLS
ON 40 ACRES

29 Additional Wells on 40-Acre Spacing.

Each costs	$175,000 to drill
Flow lines	1,600
Pumps	30,000
	$206,600

29 x 206,600 = $5,991,400

Additional Pool Recovery on 40-Acre Spacing:

29 wells x 35 bbls/well = 1015 STB additional recovery for pool

LARGE FORMAT
EXHIBIT HAS
BEEN REMOVED
AND IS LOCATED
IN THE NEXT FILE

LARGE FORMAT EXHIBIT HAS BEEN REMOVED AND IS LOCATED IN THE NEXT FILE

SCHLUMBERGER WELL SURVEYING CORPORATION
HOUSTON, TEXAS

MICROLOGGING ®

COUNTY LEA
FIELD or LOCATION WILDCAT
WELL FEDERAL MILLS #1
COMPANY WARREN PETR. CORP.

COMPANY WARREN PETROLEUM CORPORATION
WELL FEDERAL MILLS #1
FIELD WILDCAT
LOCATION SEC. 11-9S-36E
COUNTY LEA
STATE NEW MEXICO

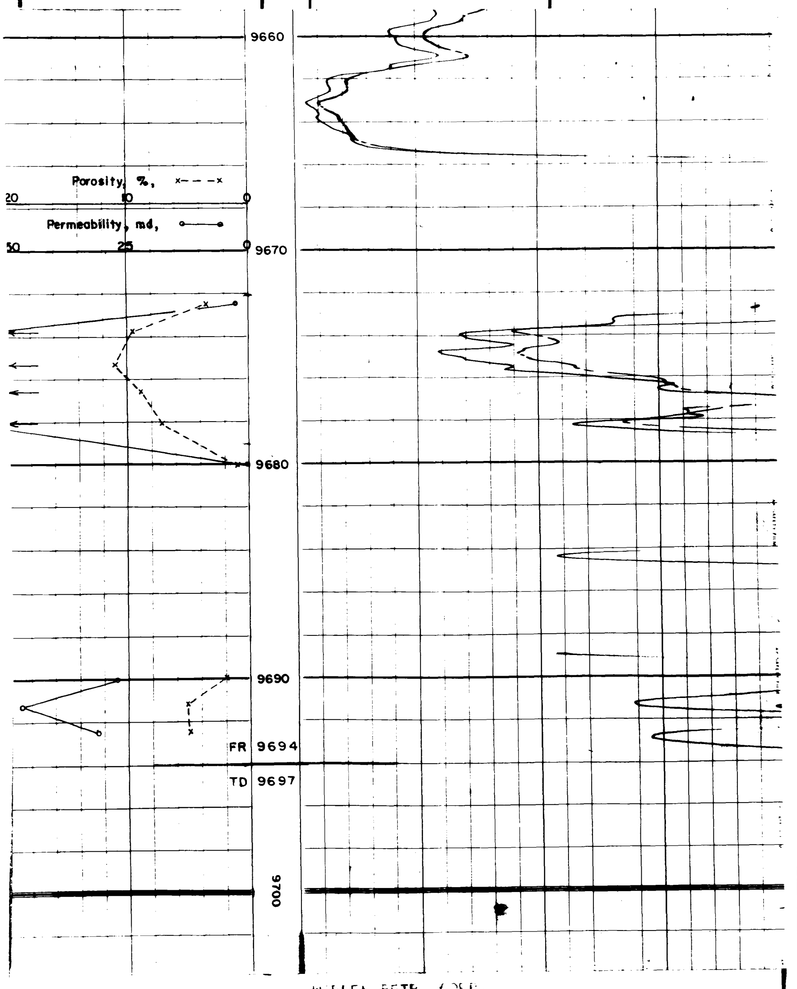
Location of Well: 660' FNL & 1980' FWL SEC. 11-9S-36E
Elevation: D.F.: 4063' K.B.: or G.L.:
ML, GRL (ES, LL, MLL)
FILING No.

RUN No.	1
Date	2-9-54
First Reading	9694
Last Reading	4800
Feet Measured	11094
Csg. Schlum.	4209
Csg. Driller	4210
Depth Reached	9697
Bottom Driller	9703
Depth Datum	KB 12' ABV. GL
Mud Not.	SALT GEL
" Density	10.1
" Viscosity	0778@65 °F
" Resist.	@ °F
" Res. BHT	03 @ 136 °F
" pH	@ °F
Wtr. Loss	2 CC 30 min.
Max. Temp. °F	136
Bit Size	8 3/4" 4209 to 9697; 6 1/8" 9695 to T.D.
Spcg.—	
MICRONITE	
MICRONITE	
MICRONITE	
Opr. Rig Time	3 Hrs.
Truck No.	1139
Recorded By	MITCHELL
Witness By	

FOLD HERE

REMARKS
Hydraulic Microlaterolog pad used to record Microlog.
SP recorded with Laterolog while descending into hole.

SPONTANEOUS-POTENTIAL millivolts	DEPTHS	RESISTIVITY -ohms. m²/m	
− 20 +	5" / 100	0 Micro Inverse 9/8x3/16 2	4
0		0	
RADIOACTIVITY INCREASES		0 Micro Normal 27/16 2	4
		0	
		RH − 0 − NC	



WARREN PETR. CORP.
FEDERAL MILLS #1
WILDCAT
LEA CO., N. M.

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