REPORT ON THE FEASIBILITY OF SECONDARY RECOVERY IN THE CAPROCK FIELD, LEA AND CHAVES COUNTIES, NEW MEXICO

Prepared For:

Cooperative Producing Association
Amarillo
Texas

Requested By:

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March 10, 1950

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Considerable time has been spent in a study of the Caprock Field Reservoir in order to determine the probable results from a secondary oil recovery program. An engineering committee was formed of the Caprock Field Operators and a concerted effort was made, primarily by the Cooperative Producing Association, to organize a fieldwide application of a secondary recovery program. Concrete evidence was presented by all companies that some type of secondary recovery method was feasible and would probably increase the amount of recoverable oil. The data presented, however, did not conclusively show the definite type of injection medium that would be applicable for the field. To inject water into the Caprock pay was not considered economical due to the scarcity of any known surface or subsurface water in the area. The use of gas was not advisable in that there was insufficient volume available with which to attempt a secondary recovery or repressuring program (see Tabulation 1). The only logical solution to the problem was injection of air, but due to experimental nature of this method of injection, agreement among the various operators could not be reached.

Working on the supposition that a secondary recovery method was absolutely essential for the future life of the field and with full realization that now is the time to commence such a program before all the available reservoir energy is depleted, the Cooperative Producing Association decided to formulate plans for an experimental air injection program. The conclusions reached after a complete investigation was that the injection should be experimentally commenced on the State "A" lease located in the north end of the field, and that air without additive casinghead gas should

ILLEGIBLE

be used with the introduction of measured quantities of water to create a "Sweep or bank" effect. The mixing of air and the produced casinghead gas was not considered feasible in that G.P.M. test of the gas produced by offset wells showed a gasoline content that would probably be dangerous to process in that explosive mixtures might occur (see Tabulation 2). The following is a brief summary of the information derived by this investigation of the properties with estimates as to the amount of additional oil recovery that may be expected by the application of a secondary recovery program:

CAPROCK FIELD DISCUSSION

The Caprock Field of Lea and Chaves Counties, New Mexico is generally located in Townships 12 and 13 South and Ranges 31 and 32 East. The field was discovered by G. P. Livermore, State-Dean No. 1, located in Section 30, T-12-S, R-32-E, when an oil productive Queen sand member was encountered between an interval of 3025 to 3052 feet. This well was subsequently deepened to 4385 feet in order to test the San Andres limestone; however, the zone was watered. The well was thus plugged back to the upper oil show and completed for 40 barrels of oil per day in October of 1940.

To January 1, 1949, there had been 136 wells drilled in the Caprock area of which 10 were completed as dry holes, 91 were pumping and 33 were flowing. As of the present date the majority of the wells in the field are being pumped, and there are two wells shut in as a result of edge water encroachment. The Caprock Field has a cumulative oil recovery to January 1, 1949 of 2,012,680 barrels. During the year of 1948, 124 producing wells produced 932,269 barrels of oil with 2,084 barrels of water. The crude is 38 degrees gravity with a sulphur content of 1.07 per cent. Until September 1, 1947 the oil produced from this field was curtailed as a result of inadequate crude shipping facilities; however, at this time the Stanolind Pipe

Line Company installed a gathering system, and capacity production has subsequently occurred.

The oil accumulation in the Caprock Field is considered to be a permeability lens or stratigraphic trap within the Artesia Red Sand, a member of the Queen Sandstone of Permian Age, occurring between a depth of 3000 to 3200 feet. The sand is fine to coarsely grained and is, in the oil productive parts, oxidized to a gray-white color. The permeability is not uniform, varying both in vertical and horizontal distribution. The pay section is approximately 25 feet in gross thickness with an average of eight to ten feet of net effective pay.

Wells in the area are generally drilled by rotary to the point of setting the oil string on top of the oil productive sand and are completed with cable tools. It was general practice in the completion of many Caprock wells to barely penetrate the more permeable member of the pay section. Rework completions of some of these older wells have shown that the higher rate of production decline exhibited by many of these wells can be decreased by drilling of the complete pay section and shooting with from 30 to 120 quarts of nitroglycerine.

SUMMARY OF AVAILABLE DATA

Available reservoir information on the Caprock Field is not sufficient for a complete analysis of this accumulation. There is a complete lack of gas-oil ratio history on a fieldwide basis, and electric logs have been run on but two wells. Core analysis is available on several wells; however, these analyses appear to be confined to the less permeable parts of the pay section. This is as a result of extremely difficult experience with either rotary or cable tool core barrels in recovering the more permeable, noncemented, pay section. A single bottom hole oil sample in the field has been taken. Physical well record data are available, and pay thickness is generally of record on some of the wells, but is lacking on the better wells that

have not drilled to the entire pay section. Several records of bottom hole pressure surveys are enclosed, but productivity indices have not been taken. The oil production record is complete as reported to the State Conservation Commission; however, it is only reliable by tank batteries.

CAPROCK RESERVOIR CONDITION

The net effective pay of the Caprock Field is estimated to comprise from eight to ten feet of fine- to coarse-grained, well oil-saturated sandstones. The permeability of one part of the pay section is of high order. This zone has been analyzed from 250 to 850 millidarcies on two different samples. The oil is undersaturated with gas, and a solution gas-oil ratio is reported on one analysis to be 260 cubic feet per barrel. The porosity is high, averaging 19 per cent on the uncemented parts, and the connate water content is variable from a lowest point of 6.5 to 31.8 for an overall average of approximately 18 per cent.

Little evidence exists to substantiate a water drive in the field. The water currently produced by edge wells is considered to be as a result of release of formation connate water with the lowering reservoir pressures. The rate of water influx does not appear to be proportional to the rate of fluid withdrawal from the reservoir. There are many indications of permeability barriers within the field, and it is reasonable to assume that reservoir edge barriers may exist, and thereby prevent effective pressure maintenance from water influx. A concrete effort was made to determine whether or not the operators in the field would be interested in artificial water flood, air or gas injection program. Much effort and time was put into this undertaking; however, the various operators in the field were evidently reticent to cooperate with one another.

OIL RESERVE ESTIMATION

The oil reserves estimated to be recoverable by primary means from the Cooperative Producing Associated properties have been attempted by three separate methods.

Oil Production Decline:

The use of oil production decline was considered applicable as the properties have produced to capacity since the installation of a pipeline to the field in September of 1947. All leases have been examined separately, and enclosed are oil production decline graphs on the State "A" and "G" leases located in the area of the proposed experimental air injection and for comparison, a graph on all of the leases (Enclosure 2). The present indicated decline for the State "A" lease is 3.25 per cent per month. The calculated future expected oil recovery to an economic limit of 30 barrels per well per month is 12,246 barrels for an ultimate oil recovery per well of 54,847 barrels. The State "G" lease, with a present decline rate of 4.15 per cent per month, is calculated to have a future oil recovery of 15,518 barrels for an ultimate oil recovery per well of 51,552 barrels. An average of all Cooperative Producing Association wells has shown a decline of three per cent per month for future estimated oil recovery per well, to the economic limit of 30 barrels per well per month of 11,800 barrels, or an ultimate oil recovery per well of 36,052 barrels.

Pressure Decline versus Cumulative Oil Production:

Lease average bottom hole pressure data from several general field-wide surveys have been plotted against the cumulative oil production of these leases (Enclosure 3). Bottom hole pressure maps of the last available surveys are also enclosed (Enclosures 5, 6 and 7). It is calculated on pressure decline that the State "A" will have an ultimate oil recovery per well to a

depletion pressure of 50 p.s.i.g., approximately 47,851 barrels with a future oil recovery of 5250 barrels of oil. On the same set of conditions it is estimated that the five-well State "G" lease will have ultimate oil recovery per well of 39,600 barrels for a future recovery of 3566 barrels. The bottom hole pressure survey of March 16, 1950 did not include all of the subject wells, but using an average of 200 pound pressure decline, confirmation of the curve established by previous surveys is obtained.

Volumetric Analysis:

Complete information is lacking to provide an adequate oil reserve estimation by the volumetric analysis method. The information presently available from Core Laboratories, Incorporated, however, indicates that the following factors are probably applicable:

Barrels per acre foot	7758
Average Porosity	19%
Connate Water Factor	.83
Shrinkage Factor	.87
Recovery factor by primary means	20%
Indicated Recoverable Oil per acre foot	213 Bbls.
Indicated recoverable oil per acre @ 8 feet net pay	1704 Bbls.
Assumed drainage per well	40 Acres
Calculated ultimate oil recovery for average well	68,160 Bbls.

The discrepancies existent between the estimated oil apparently recoverable, based on pay volume, pressure decline and production decline is considerable. The rate of pressure decline is exceedingly great and should be seriously considered. The rate of oil productich decline is probably directly dependent upon the rate of pressure depletion. The end effect of gravity drainage is now known, but it is estimated that mechanics of

gravity drainage will not be efficient in this field. It is, however, apparent that some method of experimental secondary recovery program is needed and should be commenced before all available reservoir energy has been depleted. The increased oil recovery by secondary methods cannot be accurately calculated from the available field data, but it is entirely possible that an additional 20 to 30 per cent of the oil in place could be obtained.

SECONDARY RECOVERY PROGRAM

It was fairly evident that the normal secondary recovery method of water or gas injection is not applicable to these properties as water in quantity is not available and sufficient gas in the area is non-existent. A search was made into the available literature on the use of air injection for secondary recovery. There are several evident disadvantages to the use of air as an injection medium, such as corrosion of equipment, increasing the viscosity and decreasing the gravity of the produced crude, formation of gums and recycling of explosive mixtures. In order to help prevent the most serious of these conditions, gum formation and explosive mixtures, it was decided to inject air after the injection of a measured quantity of water plus additive chemicals to decrease gum formation and form a "bank or sweep" effect. It was in addition agreed to introduce water at set intervals in order to maintain the bank and decrease recycling "bypass". The recycling of possible explosive mixtures and bypass is to be additionally controlled by the use of low injection pressures and volumes. An investigation into pay versus volume relationship in other such air injection programs showed that if a volume equivalent to 1000 times the gross pay,or in this case 30,000 cubic feet a day is injected, the most efficiency is obtained.

The present intention of the Cooperative Producing Association is to experimentally inject air and water in well State No. 2 "A". The volume to be injected is from 20 to 40,000 cubic feet of gas per day at a pressure

not to exceed 200 p.s.i.g. Adequate two-stage air compressors will be installed as shown on Enclosure 1, and complete checking of volumes both at the input well and in all output wells will be installed. All possible safeguards will be maintained to prevent "bypass". The location of the input well is such as to result in the effect from injection being noticed on the subject wells before the offset producers. The volume to be injected is not considered to be sufficient to allow quick "bypass" or increases in the oil production of offset wells and will undoubtedly require 10 to 15 months before the results are noticed. The above outlined method of air and water injection for secondary oil recovery in the Caprock Field is considered to be the best method possible at the present time and an experimental program will probably in a year indicate its relative worth.

COOPERATIVE PRODUCING ASSOCIATION
STATE "A" & "G" LEASES
GAS-OIL RATIO SURVEY
MARCH, 1950
CAPROCK FIELD
LEA & CHAVES COUNTY, NEW MEXICO

Lease & Well	Oil Production Per Day	Gas Volume (Casing) MCF/Day	Casing Gas-Oil Ratio
State "A"- 1	14	*	-
2	14	*	-
3	14	15.7	1121
4	24	50.2	2091
5	14	*	-
6	42	30.2	719
7	14	*	-
8	14	*	-
State "G"- 1	42	32.5	773
4	20	65.9	3295
5	42	*	-
6	20	25.2	1260
7	20	*	-

Note: State "A"-3,4,5 & 6 & State "G"-1,4,5,6,7 tested during 12-hour flow at separator with 2" tester & 1/8-inch plate - insufficient to measure.

*Barely enough volume to run engine off casing - insufficient to measure from tubing.

FITTING, FITTING & JONES

Tabulation 1.

CHARCOAL GASOLINE TESTS ON SOME OF THE COOPERATIVE PRODUCING ASSOCIATION WELLS CAPROCK FIELD LEA AND CHAVES COUNTIES, NEW MEXICO

Lease & Well No.	G.P.M.	Recovery (c.c.)
State "E" No. 1	1.456	29
State "J" No. 3	1.606	42
State "A" No. 4	.962*	13
S. L. Williams No. 3	1.897	49
State "G" No. 6	1.092*	16
State "G" No. 1	1.393	33

*Slightly undersaturaged.

FITTING, FITTING & JONES

MARCH 16, 1950-SONOLOG
BOTTOM HOLE PRESSURE SURVEY
DATUM - 1400
COOPERATIVE PRODUCING ASSOCIATION
STATE "A" & "G" LEASES
CAPROCK FIELD
LEA & CHAVES COUNTY, NEW MEXICO

Lease & Well	Elev.	Datum Depth	Feet To Fluid	Feet of Fluid To Datum	Pressure of Gas Column	Pressure of Oil Column	Measured Casing Pressure P.S.i.G.	Datum Pressure P.S.i.G.
State "A"- 1	4395'	2995'	2604'	391'	21	141	5	167
2	4395'	2995'	2976'	19'	24	7	0	31
3	4391'	2991'	2960'	31'	24	11	20	55
4	4388'	2995'	2836'	159'	23	57	25	105
5	4386'	2990'	2356'	634'	19	230	10	259
6	4382'	2982'	2419'	563'	19	203	25	247
7	4383'	2983'	2670'	313'	21	149	10	180
8	4383'	2983'	2985'	-2'	24	35	10	69
State "G"- 1	4387'	2987'	2846'	141'	23	48	25	96
4	4374'	2974'	2909'	65'	23	20	1	44
5	4390'	2990'	2970'	20'	24	6	25	55
6	4384'	2984'	2376'	608'	19	255	15	259
7	4385'	2985'	2657'	328'	21	150	10	181

Tabulation 3.

AVERAGE PER WELL PRODUCTION
COOPERATIVE PRODUCING ASSOCIATED LEASES
CAPROCK FIELD, LEA AND CHAVES COUNTIES, NEW MEXICO

1947	State "A"	No. Wells	State "B"	No. Wells	All Leases	No. Wells
Jan.	379	6	693	3	427	28
Feb.	373	6	491	3	408	28
Mar.	469	6	709	3	472	28
Apr.	763	6	786	3	648	28
May	565	6	584	3	530	28
June	572	6	556	3	490	28
July	504	6	595	3	443	28
Aug.	570	6	723	3	636	28
Sept.*	891	6	1108	3	929	29
Oct.	1111	6	1442	3	1100	30
Nov.	993	6	1152	3	887	30
Dec.	1174	6	1437	3	1035	30
1950						
Jan.	335	8	620	5	385	38
Feb.	428	8	674	5	384	38

1948	State "A"	No. Wells	State "B"	No. Wells	All Leases	No. Wells
Jan.	1240	6	1236	3	1038	31
Feb.	946	6	1278	3	855	31
Mar.	1123	6	1384	3	908	31
Apr.	1039	6	1358	3	843	31
May	1137	6	1197	3	842	31
June	1007	6	1305	3	889	32
July	1096	6	1246	3	802	32
Aug.	725	6	1636	3	698	32
Sept.	600	6	1894	3	621	32
Oct.	636	6	1761	3	613	32
Nov.	577	6	1117	4	556	35
Dec.	802	6	1059	5	597	36

1949	State "A"	No. Wells	State "B"	No. Wells	All Leases	No. Wells
Jan.	640	7	1042	5	549	37
Feb.	506	7	910	5	495	37
Mar.	588	7	844	5	532	37
Apr.	632	7	877	5	512	37
May	521	7	781	5	491	37
June	525	8	715	5	436	38
July	453	8	630	3	396	38
Aug.	408	8	653	3	376	38
Sept.	383	8	647	5	400	38
Oct.	454	8	604	5	418	38
Nov.	426	8	533	5	437	38
Dec.	427	8	461	5	378	38

Lease Production to 3-1-50	260,804	180,193	921,577
Avg. Per Well Production to 3-1-50	42,601	36,039	24,252

*Pipe Line Installed.

WATER INJECTION TEST
COOPERATIVE PRODUCING ASSOCIATION
STATE 2-A
OCTOBER 25, 1951

Tank Gauge	Inches	Barrels	Time	Pressure, Pounds
23' 9"	.-		10:00 A.M.	0
23' 8-3/4"	.25	4.33	10:15 A.M.	0
23' 6-1/2"	2.25	38.99	10:30 A.M.	100
23' 4-3/4"	1.75	30.33	10:45 A.M.	175
23' 3-3/4"	1.00	17.33	11:00 A.M.	270
23' 3-1/2"	.25	4.33	11:15 A.M.	600
23' 3-1/4"	.25	4.33	11:30 A.M.	750
23' 3-1/4"	-	-	12:00 Noon	750
23' 3"	.25	4.33	1:00 P.M.	750
23' 2-3/4"	.25	4.33	2:00 P.M.	750
23' 2-3/4"	-	-	3:00 P.M.	750
23' 2-1/2"	.25	4.33	4:00 P.M.	750
23' 2-1/4"	-	-	5:00 P.M.	750
23' 2-1/8"	.12	2.08	6:00 P.M.	750
23' 2"	.13	2.25	7:00 P.M.	750
23' 1-3/4"	.25	4.33	8:00 P.M.	770
23' 1-3/4"	-	-	9:00 P.M.	770
23' 1-5/8"	.12	2.08	10:00 P.M.	770
23' 1-1/2"	.13	2.25	11:00 P.M.	800
23' 1-3/8"	.12	2.08	12:00 M.N.	750
23' 1-1/4"	.13	2.25	1:00 A.M.	700
	TOTAL -	129.95	15 Hours	

AVERAGE BARRELS OF WATER INJECTED PER HOUR - 8.66

AVERAGE BARRELS OF WATER INJECTED PER HOUR LAST EIGHT HOURS - 2.17

ROBERT D. FITTING, MIDLAND, TEXAS

Tabulation 1.

CAPROCK FIELD OPERATORS
PERCENTAGE PARTICIPATION FORMULA ANALYSIS
AS CALCULATED BY THE CAPROCK FIELD ENGINEERING COMMITTEE

Operator	Operator's Acreage		No. Presently Producing Wells		Production from 8-1-50 to 8-1-51		Production from 1-1-50 to 1-1-51		Comparative Est. Ultimate Oil Recovery		Est. Recovery by plus 1/2 Future Oil Recovery	
	Area	Per Cent	Wells	Per Cent	Production	Per Cent	Production	Per Cent	Barrels	Per Cent	Barrels	Per Cent
British-American	80	1.667	2	1.626	6,727	1.881	7,675	1.554	84,791	2.038	70,840	2.506
Cities Service Oil Co.	120	2.500	2(1)	1.626	10,384	2.904	12,699	2.571	100,537	2.416	93,110	3.293
Cooperative Prod. Assn.	1320	27.500	38(2)	30.894	97,524	27.272	141,057	28.563	1,425,136	34.251	909,544	32.171
Delfern Oil Company	600	12.500	15	12.195	62,373	17.442	101,246	20.502	768,443	18.469	449,970	15.916
Great Western Prod.	720	15.000	17	13.822	62,230	17.402	80,473	16.295	589,505	14.168	453,889	16.055
Gulf Oil Corp.	320	6.667	5(3)	4.065	18,560	5.190	18,647	3.776	144,190	3.466	107,557	3.804
Manry & Company	160	3.333	3(4)	2.439	9,960	2.785	13,494	2.732	92,089	2.213	60,863	2.153
Mid-Continent	40	0.833	1	0.813	2,808	0.785	2,451	0.497	23,996	0.577	12,889	0.456
Phillips Petro. Co.	240	5.000	6	4.878	22,157	6.196	28,337	5.738	127,746	3.070	121,412	4.295
Polis, A.K.	160	3.333	4	3.252	8,910	2.492	15,363	3.111	174,470	4.193	99,991	3.537
Resler Oil Co.(Page)	200	4.167	5	4.065	4,657	1.302	5,884	1.191	82,751	1.989	50,363	1.781
Vickers Petro. Corp.	600	12.500	19	15.447	38,619	10.799	51,294	10.387	404,280	9.716	290,670	10.281
Watson Drlg. Co.	80	1.667	2	1.626	3,332	0.933	3,926	0.796	33,341	0.801	24,122	0.853
Williams, Sam	160	3.333	4	3.252	9,360	2.617	11,294	2.287	109,529	2.633	81,965	2.899
TOTAL	4800		123		357,601		493,840		4,160,804		2,827,185	

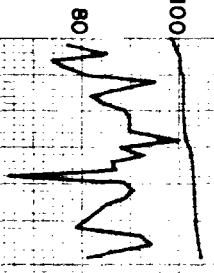
(1)One well temporarily abandoned.
(2)Includes input well.
(3)Two wells Temporarily Abandoned.
(4)One well not producing.

DAILY INJECTED AIR VOLUME IN THOUSANDS OF CUBIC FEET

20 40 60 80 100 120 140 160 180 200 220

SEPT. OCT. NOV. DEC.

5 10 15 20 25 5 10 15 20 25 5 10 15 20 25 5 10 15 20 25



CUMULATIVE AIR INJECTED VOLUME IN MILLIONS OF CUBIC FEET

5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85

DAILY INJECTED AIR VOLUME IN THOUSANDS OF CUBIC FEET

20 40 60 80 100 120 140 160 180 200 220

SEPT. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUNE JULY AUG.

COMPRESSOR SHUT DOWN

COMPRESSOR SHUT DOWN - WATER INJECTED

WATER INJECTED

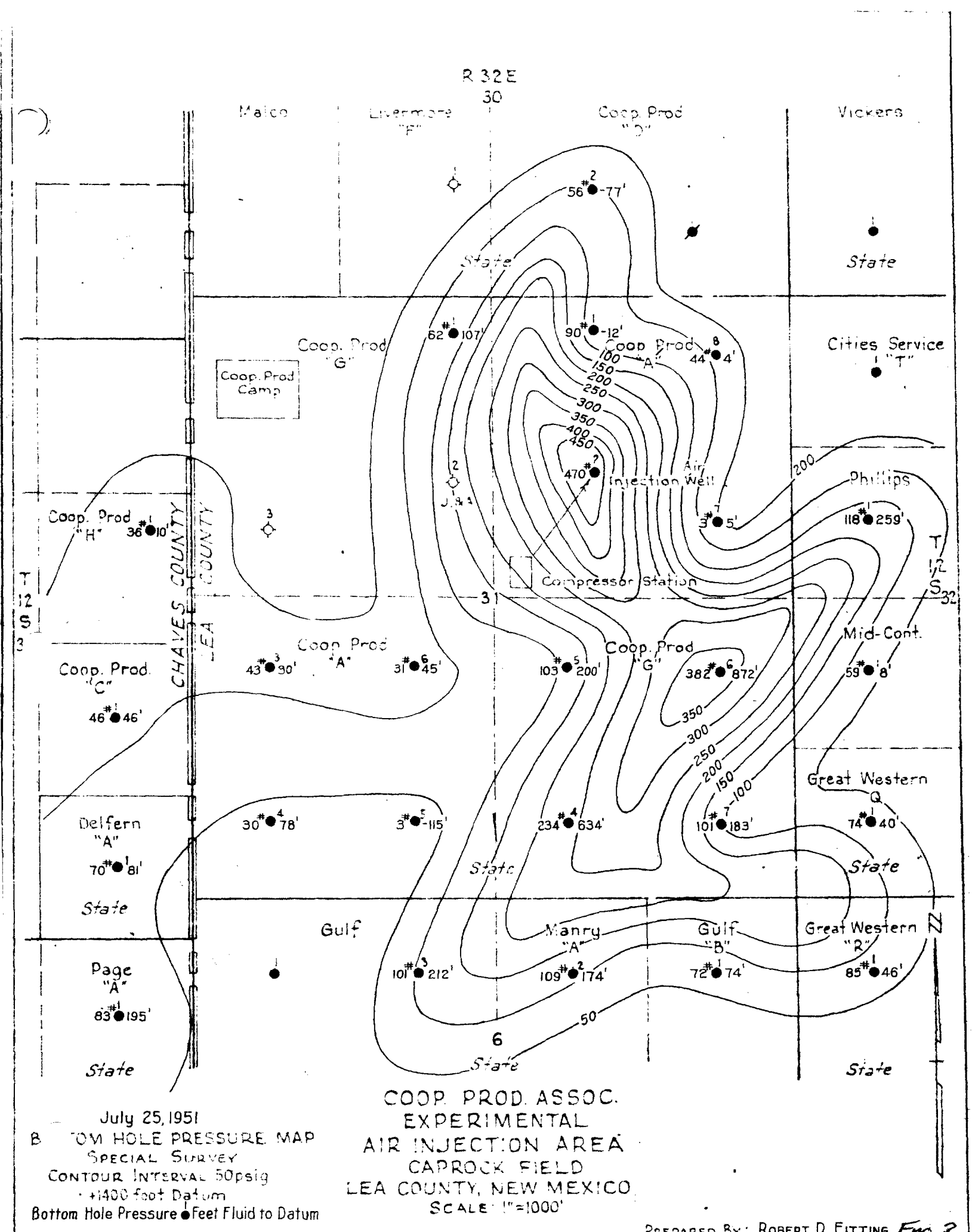
COMPRESSOR SHUT DOWN

CUMULATIVE AIR VOLUME

DAILY INJECTED VOLUME

CUMULATIVE AIR INJECTED VOLUME IN MILLIONS OF CUBIC FEET

2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34

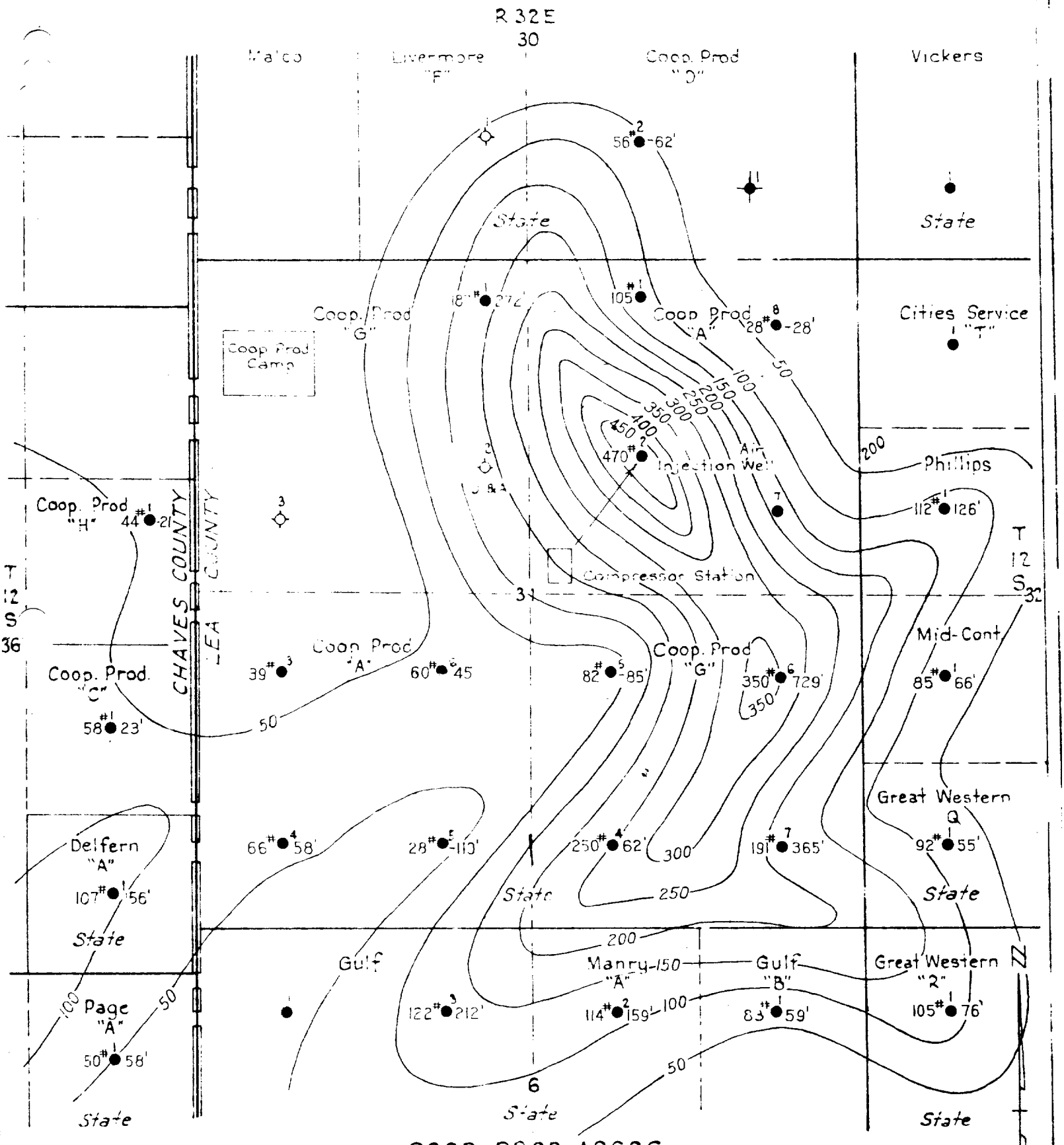


July 25, 1951
BOTTOM HOLE PRESSURE MAP
SPECIAL SURVEY
CONTOUR INTERVAL 50psig
+1400 foot Datum
Bottom Hole Pressure ● Feet Fluid to Datum

COOP. PROD. ASSOC.
EXPERIMENTAL
AIR INJECTION AREA
CAPROCK FIELD
LEA COUNTY, NEW MEXICO

SCALE 1"=1000'

PREPARED BY: ROBERT D. FITTING Eng. R

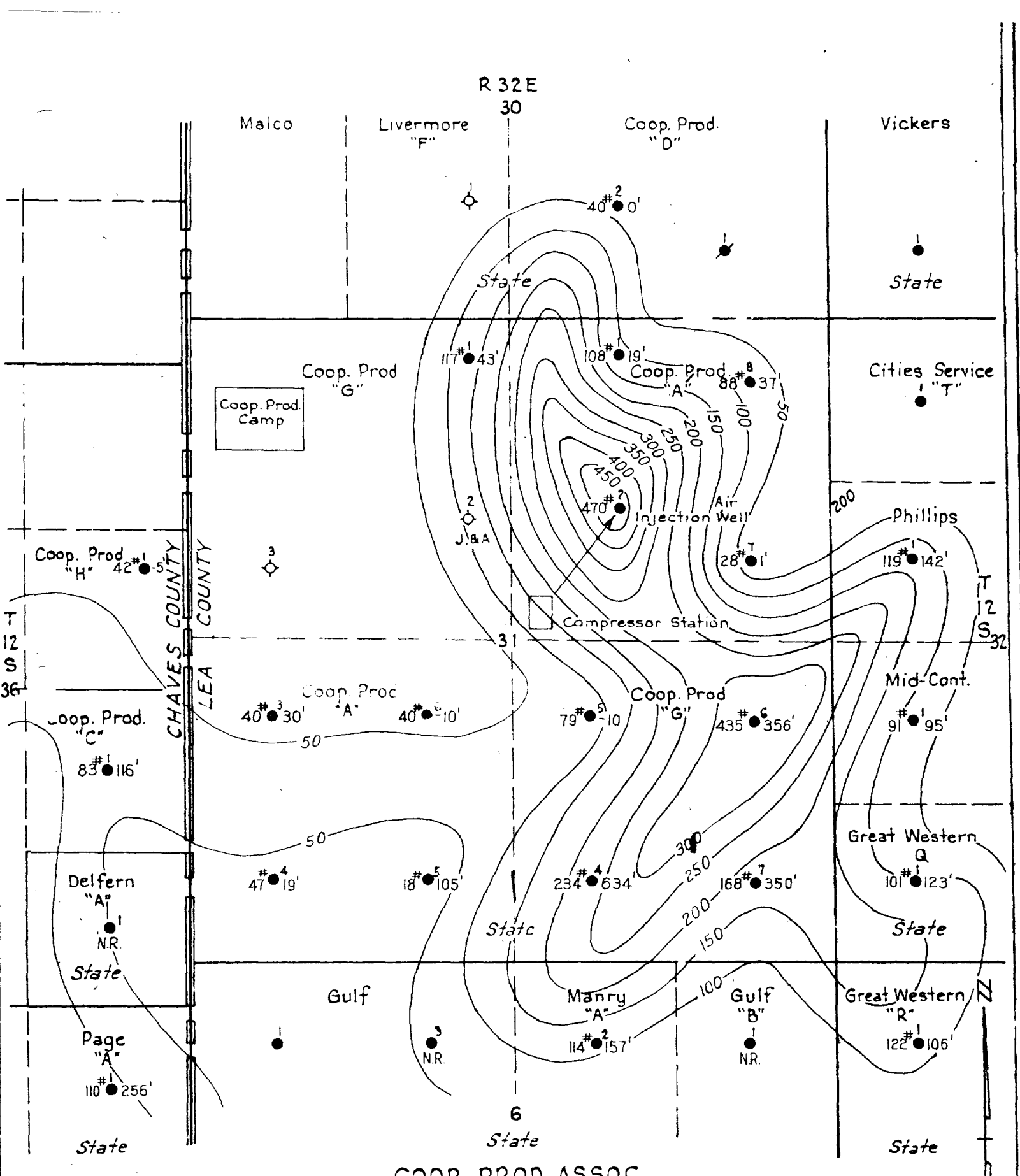


August 25, 1951
BOTTOM HOLE PRESSURE MAP
SPECIAL SURVEY
CONTOUR INTERVAL 50psig
+1400 foot Datum
Bottom Hole Pressure ● Feet Fluid to Datum

COOP. PROD. ASSOC.
EXPERIMENTAL
AIR INJECTION AREA
CAPROCK FIELD
LEA COUNTY, NEW MEXICO

SCALE 1"=1000'

PREPARED BY: ROBERT D. FITTING Enc. 3



September 25, 1951

BOTTOM HOLE PRESSURE MAP
SPECIAL SURVEY
CONTOUR INTERVAL 50 psig
+1400 foot Datum
Bottom Hole Pressure Feet Fluid Datum

COOP. PROD. ASSOC. EXPERIMENTAL AIR INJECTION AREA CAPROCK FIELD LEA COUNTY, NEW MEXICO

SCALE: 1"=1000'

PREPARED BY: ROBERT D. FITTING

Exc. 4

LEASES ADJACENT TO AIR INPUT WELL
CAPROCK FIELD
LEA & CHAVES COUNTIES, NEW MEXICO

GROSS OIL PRODUCTION IN BARRELS

20,000
10,000
1000
100

Monthly Decline Rate: 5.9%

Monthly Decline Rate: 2.9%

Leases Used:

Cooperative, Malco Max A
Cooperative, Liv. Max G
Great Western, State Q
Gulf, Lea St
Gulf, Lea St B
Manry, St A
Mid-Continent, St "13"
Phillips, Caprock

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

19 49 | 19 50 | 19 51 | 19 | 19 | 19 | 19 | 19 | 19 | 19

Production Decline Graph
Gross Oil Production
- vs -
Time in Months

NUMBER OF WELLS - 27

COOPERATIVE PRODUCING ASSOCIATION
MALCO MAXWELL A LEASE
CAPROCK FIELD
LEA & CHAVES COUNTIES, NEW MEXICO

MONTHLY PER WELL OIL PRODUCTION IN BARRELS

1000

100

10

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

19 47 | 19 48 | 19 49 | 19 50 | 19 51 | 19 | 19 | 19 | 19 | 19

6 | 7 | 8 | 7 | 6 7

Production Decline Graph
Monthly Per Well Oil Production
- vs -
Time In Months

159-205L KEUFFEL & ESSER CO.
Made in U.S.A.

Enc. 6

COOPERATIVE PRODUCING ASSOCIATION
LIVERMORE MAXWELL STATE G LEASE
CAPROCK FIELD
LEA & CHAVES COUNTIES, NEW MEXICO

MONTHLY PER WELL OIL PRODUCTION IN BARRELS

1000
100
10

3 4 5

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

19 47 | 19 48 | 19 49 | 19 50 | 19 51 | 19 | 19 | 19 | 19 | 19

Production Decline Graph
Monthly Per Well Oil Production
- vs -
Time in Months

GREAT WESTERN PROD. INC.
STATE Q LEASE
CAPROCK FIELD
LEA & CHAVES COUNTIES, NEW MEXICO

MONTHLY PER WELL OIL PRODUCTION IN BARRELS

Monthly Decline Rate: 5.6%

NUMBER OF WELLS

2 — 3

19 47 | 19 48 | 19 49 | 19 50 | 19 51 | 19 | 19 | 19 | 19 | 19

Production Decline Graph
Monthly Per Well Oil Production
- Vs -
Time in Months

Enc. 8

GULF OIL CORP.
LEA STATE LEASE
CAPROCK FIELD
LEA & CHAVES COUNTIES, NEW MEXICO

MONTHLY PER WELL OIL PRODUCTION IN BARRELS

1000
100
10

Monthly Decline Rate: 5.15%

Monthly Average

Off Production

1 2 3

NUMBER OF WELLS

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

19 47 | 19 48 | 19 49 | 19 50 | 19 51 | 19 ____ | 19 ____ | 19 ____ | 19 ____ | 19 ____

Production Decline Graph
Monthly Per Well Oil Production
- vs -
Time in Months

COOPERATIVE PRODUCING ASSOCIATION
MALCO MAXWELL A LEASE
CAPROCK FIELD
LEA & CHAVES COUNTIES, NEW MEXICO

MONTHLY PER WELL OIL PRODUCTION IN BARRELS

1000

6 7 8 7 6 7

19 47 | 19 48 | 19 49 | 19 50 | 19 51 | 19 | 19 | 19 | 19 | 19

Production Decline Graph
Monthly Per Well Oil Production
- vs -
Time in Months

359-2051 KEUFFEL & ESSER CO.
Ten Years by Months
Semi-Logarithmic, 3 Cycles.
MADE IN U.S.A.

Enc. 10

MANRY & COMPANY
STATE "A" LEASE
SEC. 6, 13-S, 32-E
CAPROCK FIELD
LEA & CHAVES COUNTIES, NEW MEXICO

Monthly Decline: 7.4%

MONTHLY PER WELL OIL PRODUCTION IN BARRELS

NUMBER OF WELLS

2 | 1

Production Decline Graph
Monthly Per Well Oil Production
- vs -
Time in Months

19 47 | 19 48 | 19 49 | 19 50 | 19 51 | 19 ___ | 19 ___ | 19 ___ | 19 ___ | 19 ___

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

Exc. 11

PHILLIPS PETROLEUM CO.
CAPROCK LEASE
CAPROCK FIELD
LEA & CHAVES COUNTIES, NEW MEXICO

Monthly Decline Rate: 5.3%

MONTHLY PER WELL OIL PRODUCTION IN BARRELS

1000

NUMBER OF WELLS

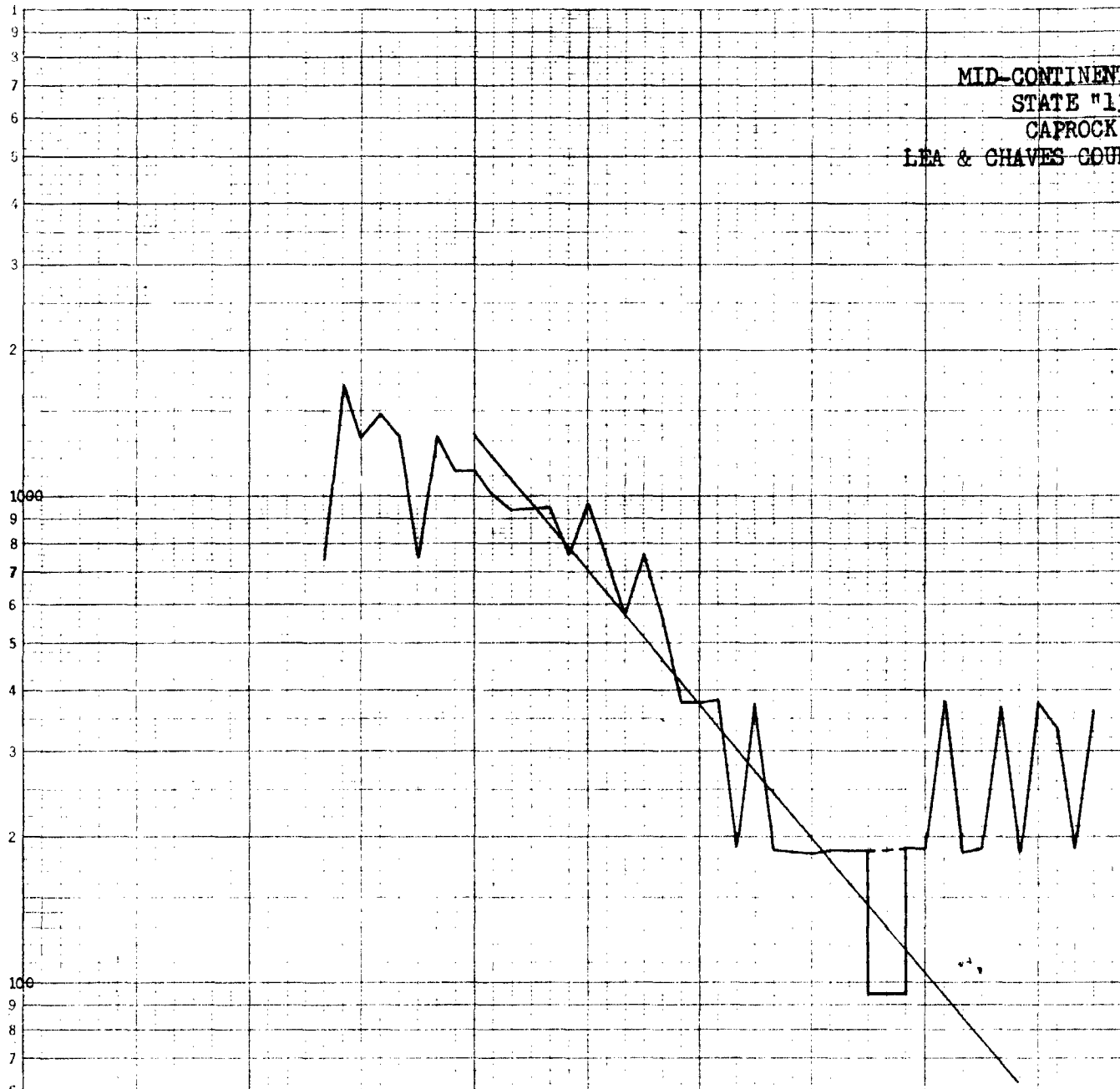
1 + 3 — 4

19 47 | 19 48 | 19 49 | 19 50 | 19 51 | 19 ___ | 19 ___ | 19 ___ | 19 ___ | 19 ___

Production Decline Graph
Monthly Per Well Oil Production
- vs -
Time in Months

MID-CONTINENT PET. CORP.
STATE "13" LEASE
CAPROCK FIELD
LEA & CHAVES COUNTIES, NEW MEXICO

MONTHLY PER WELL OIL PRODUCTION IN BARRELS



Production Decline Graph
Monthly Per Well Oil Production
- vs -
Time in Months

19 47 | 19 48 | 19 49 | 19 50 | 19 51 | 19 | 19 | 19 | 19 | 19

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

COOPERATIVE PRODUCING ASSOCIATED
CAPROOK FIELD
LEA AND CHAVES COUNTIES, NEW MEXICO

State "A" Lease

State "G" Lease

MONTHLY PER WELL OIL PRODUCTION IN BARRELS

Pipeline Installed

Monthly Decline Rate 3.25%

Pipeline Installed

Monthly Decline Rate 4.15%

NUMBER OF WELLS 6 7 8

NUMBER OF WELLS 3 4 5

Production Graph
Monthly Per Well Oil Production in Bbls.
- vs -
Time in Months

COOPERATIVE PRODUCING ASSOCIATED
ALL LEASES
CAPROCK FIELD
LEA AND CHAVES COUNTIES, NEW MEXICO

MONTHLY PER WELL OIL PRODUCTION IN BARRELS

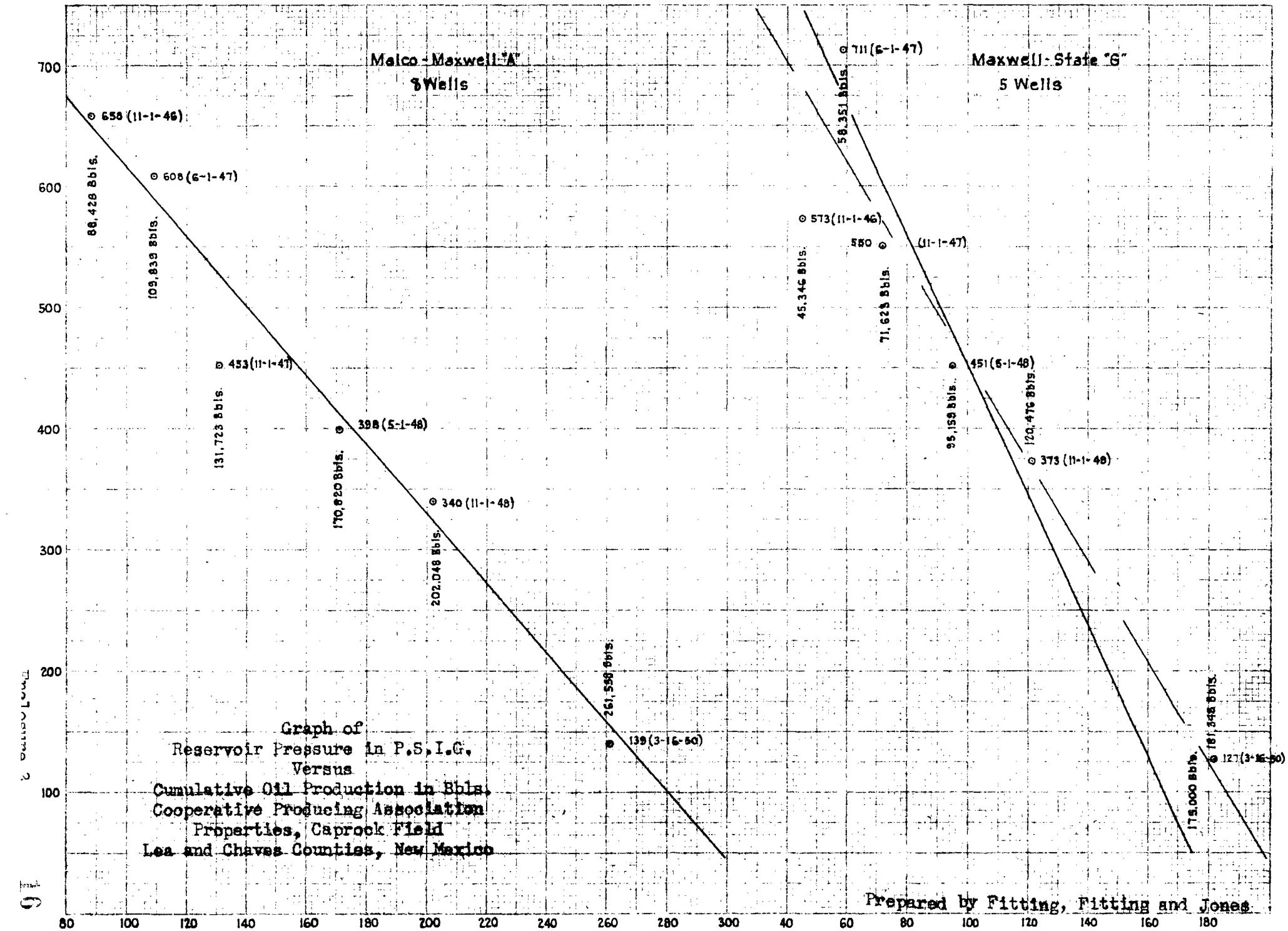
Pipeline Installed

Monthly Decline Rate 3%

NUMBER OF WELLS
28 29 30 31 32 35 36 37 38

19 47 19 48 19 49 19 50 19 19 19 19 19 19 19

Production Graph
Monthly Per Well Oil Production in Bbs.
- vs -
Time in Months

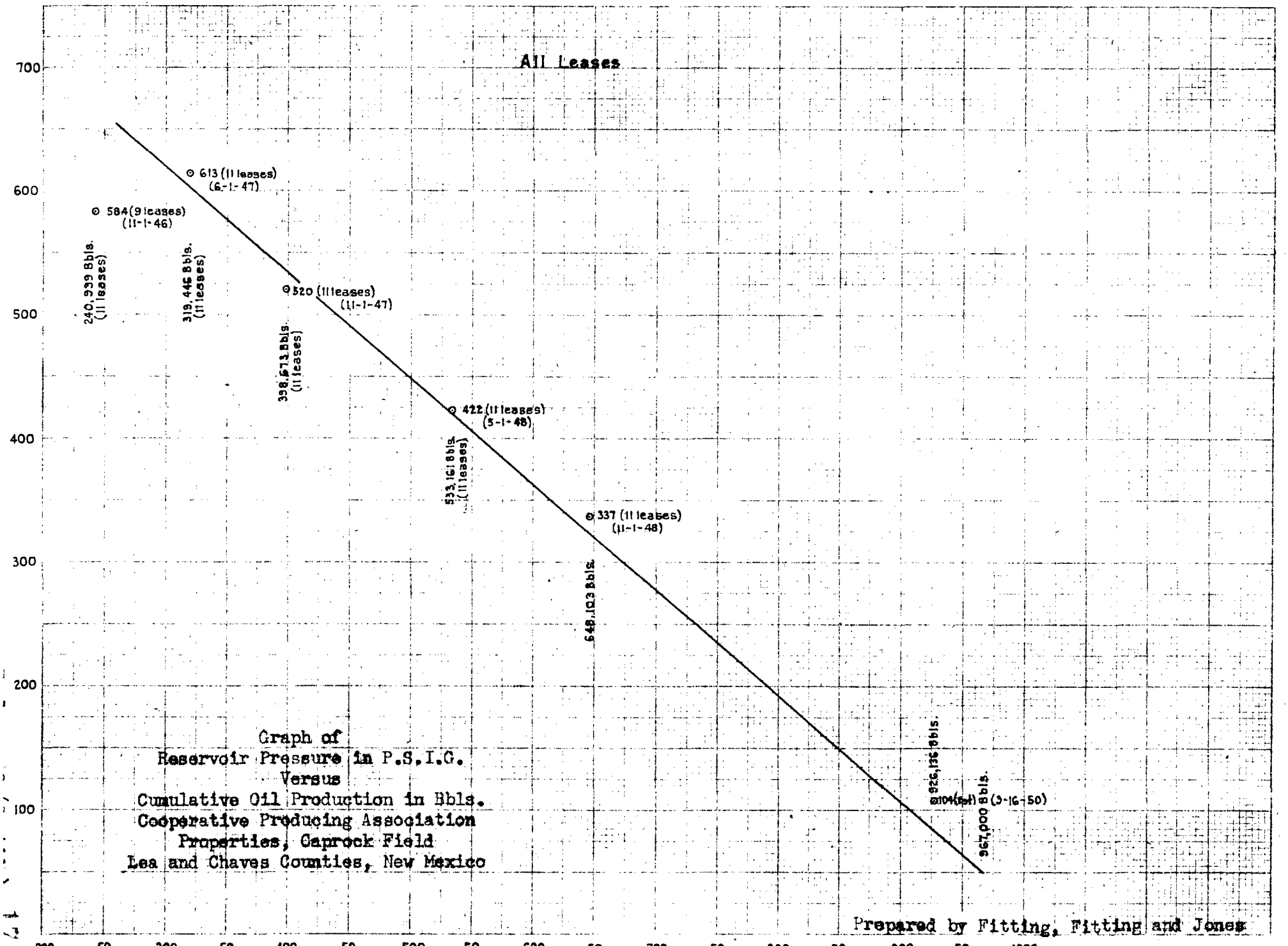


Graph of
Reservoir Pressure in P.S.I.G.
Versus
Cumulative Oil Production in Bbls.
Cooperative Producing Association
Properties, Caprock Field
Lea and Chaves Counties, New Mexico

Prepared by Fitting, Fitting and Jones

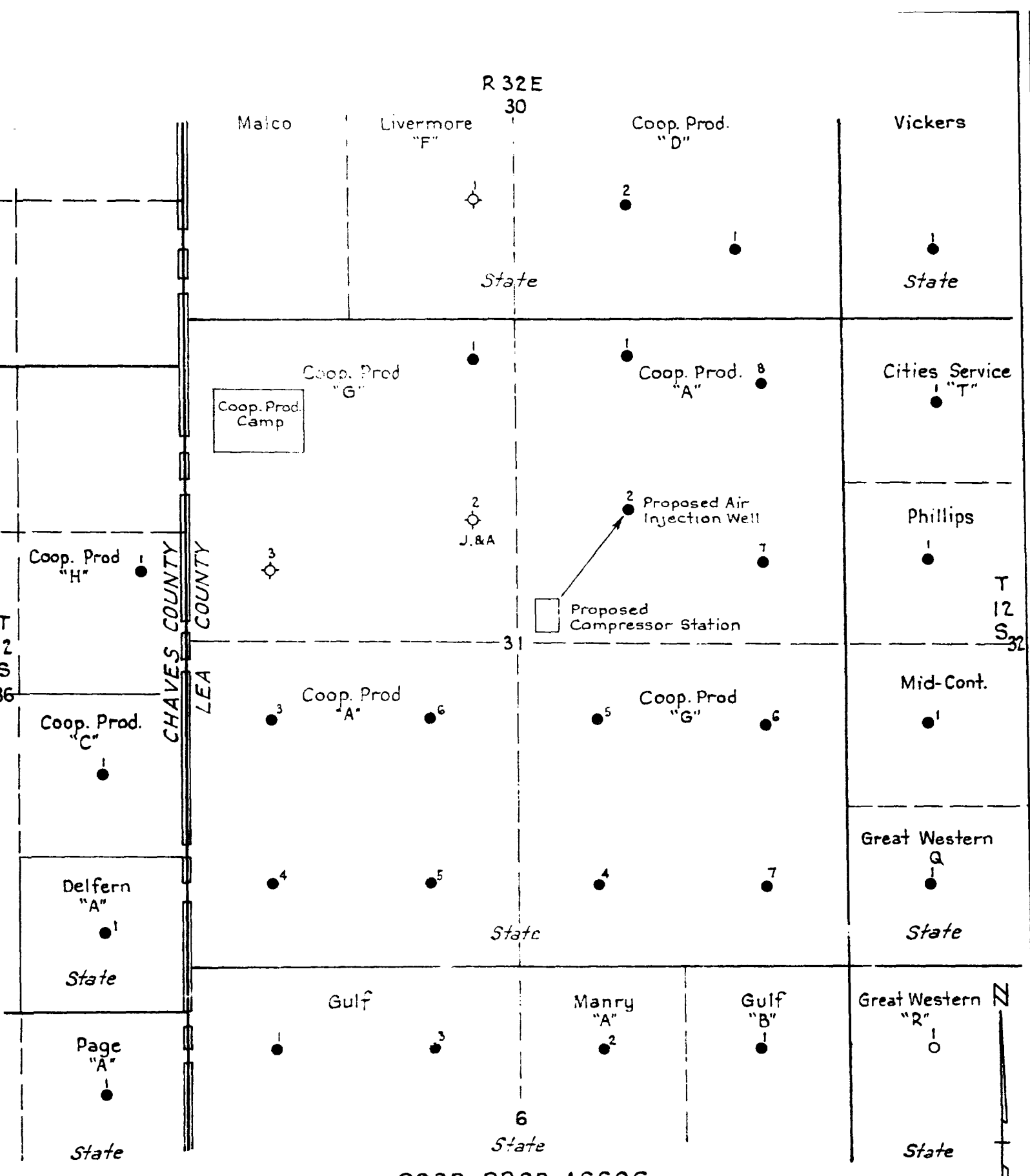
Exhibit No. 2

Case No. 69



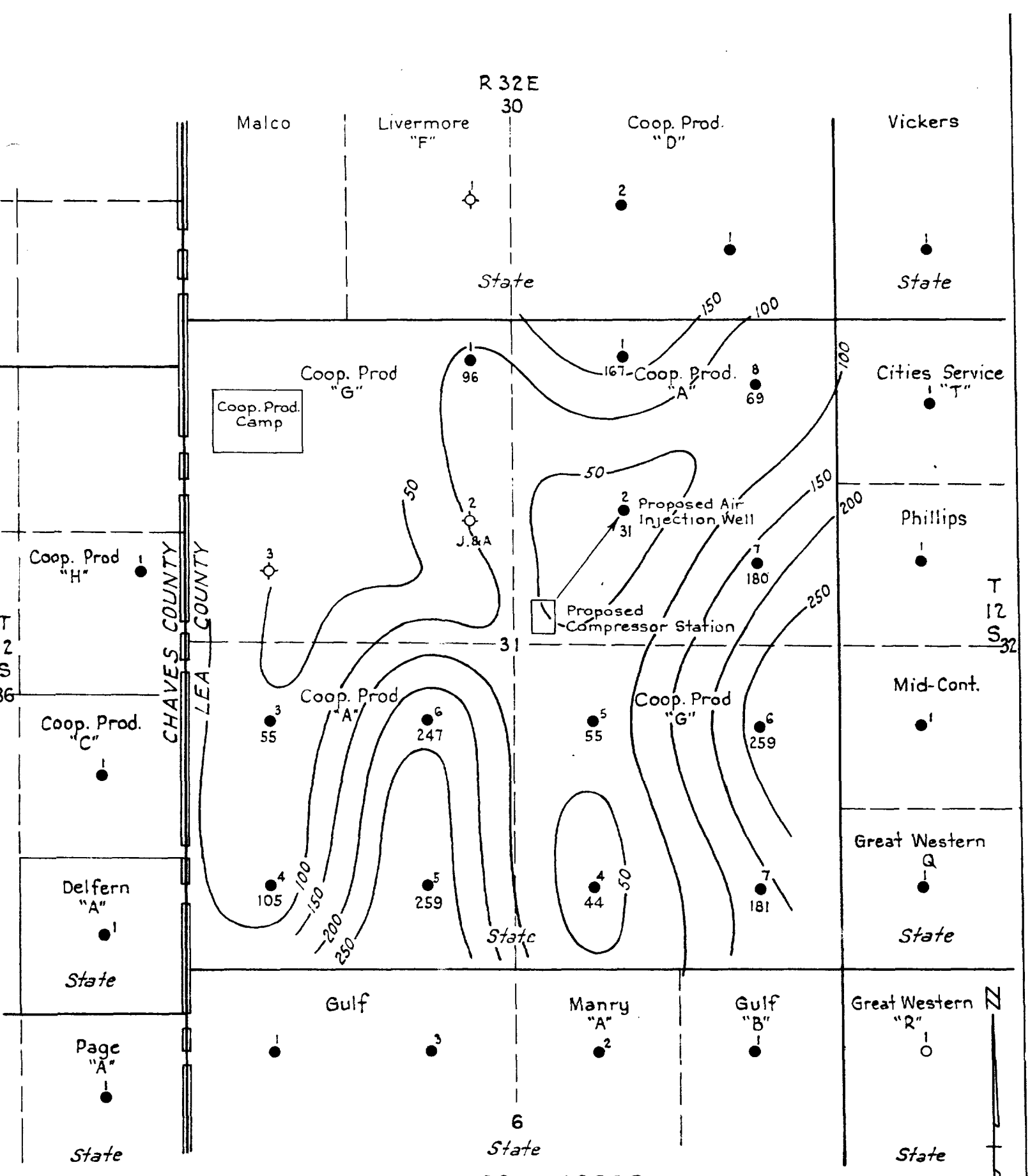
Graph of
Reservoir Pressure in P.S.I.G.
Versus
Cumulative Oil Production in Bbls.
Cooperative Producing Association
Properties, Caprock Field
Lea and Chaves Counties, New Mexico

Prepared by Fitting, Fitting and Jones



COOP. PROD. ASSOC.
EXPERIMENTAL
AIR INJECTION AREA
CAPROCK FIELD
LEA COUNTY, NEW MEXICO
SCALE: 1"=1000'

Enclosure A.



MARCH 16, 1950
BOTTOM HOLE PRESSURE MAP
SPECIAL SURVEY
CONTOUR INTERVAL 50 psig
+1400 foot Datum

COOP. PROD. ASSOC.
EXPERIMENTAL
AIR INJECTION AREA
CAPROCK FIELD
LEA COUNTY, NEW MEXICO

SCALE: 1"=1000'

Enclosure 5.

PREPARED BY: FITTING FITTING & JONES