Eng Review

ENGINEERING REVIEW

and

Proposed Waterflood

Ebor Field

Lodgepole Zone

Manitoba

Sun Oil Company,
805 8th Avenue S. W.,
CALGARY, Alberta.
September 12, 1962.

Introduction

The Ebor field is located two miles off the S. W. flank of Daly Field. It has an areal extent of about 440 acres and consists of 11 wells. At this time two wells, Dome Cal Standard Ebor 13-23-9-29 WPM and Calstan Ebor 15-23-9-29 WPM, have been abandoned. The three Dome Cox - H.B. Ebor produce only during the summer months. The first well in this pool was Dome Harris Cox Ebor 14-23 which was completed August 31, 1954. By August, 1955 the pool was completely developed with completion of 11 wells.

Production rate decline has been very rapid, typical of a highly undersaturated solution gas drive reservoir which will have a low recovery of the oil in place.

Water rates have also decline which suggest that the pool does not have an effective water drive. The pool is currently producing at approximately 30 bopd which is very close to the economic limit.

There is very little information upon which to base a firm forecast of floodability. The probability of a successful waterflood is reasonably good and is the only alternative to abandonment of the pool.

Geology

The producing section in the Ebor Field lies above the "Transitional Zone" in the Daly Field and is partly correlative with Stanton's Upper Whitewater member. It consists primarily of a limestone to dolomitic limestone to dolomite partially plugged with secondary anhydrite.

The porosity appears to be poor to fair, intercrystalline with some pin point to small vugs and is very banded. The better porosity falls within the more completely dolomitized sections.

Figures 1 & 2 (Contours on Top Porosity & Top of Miss. Unconformity) are very similar indicating a relatively uniform cap overlying the porosity. In most cases wells were not drilled deep enough to obtain a structural horizon on which to map, so it is difficult to ascertain if the fall-off in the north and east direction is structural or merely erosional.

Production History

This pool has experienced a very rapid decline in production rate. During 1955, the first full year of production, the average production was 116 bopd. By comparison, during 1957, the average production was 65 bopd; and during 1961 it was 39 bopd (Table #1). Water production has declined at a more rapid rate than the oil. This is shown quite clearly by the W.O.R. curve for the McDougall lease (6 wells) on Figure #7.

During June, 1962 the pool produced 1,115 BO and 93 BW, resulting in a cumulative production as of June 31, 1962 of 179,013 BO and 40,301 BW.

Primary Recovery

The rapid decline in production rate associated with low GOR's suggests a highly undersaturated solution gas drive type reservoir. The decline in WOR indicates the lack of an effective water drive. In view of this production history the primary recovery, as a percent of oil in place, will be low. The probable order of magnitude is 8 to 10%. A graph (Figure #8) of average oil rate versus cumulative oil produced indicate a primary reserve of 196,000 barrels of oil.

Waterflood Recovery

It is difficult to make a proper analysis of the feasibility of waterflooding this pool. The areal extent of the pool is rather indistinctly defined and the net pay is difficult to assess. This makes determination of oil in place next to impossible. Also, the reservoir pressure history and the reservoir fluid properties are not available. However the following discussion presents some idea of what may be expected in the way of waterflood recovery.

1. The residual oil at the start of flood is estimated to be 85% to 90% of the original oil in place. This is based on a estimated primary recovery of 8 to 10% and a shrinkage of approximately 0.95 stock tank bbls. per reservoir bbls.

2. The residual oil in the waterflooded portion of the reservoir is estimated at 23% of the pore volume. This is based routine core analysis residual oil data from Sun McDougall 4-26 and 12-26 adjusted for shrinkage.

3. The waterflood unit displacement efficient is estimated at 62% of the hydrocarbon volume. This was determined from the residual oil saturation (Sor) of 23% and the estimated connate water saturation (S_w) of 40% as follows:

$$\frac{1 - S_w - Sor}{1 - S_w} = \frac{1.0 - .40 - .23}{1.0 - .40} \times 100 = 62\%$$

61.666

4. The vertical sweep efficiency is estimated at 85%. This is a judgment factor based on the relatively poor permeability stratification.

5. The areal sweep efficiency is estimated at 65%. This is also a judgment factor based on the maximum sweep efficiency for a 5 Spot pattern (73%) being reduced somehwat because this pool is small, the pattern would not be complete and could have large edge effects.

6. The overall waterflood efficiency is estimated at 34%.

(Unit Displacement)		(Vertical Sweep)		(Areal Sweep)		
62%	X	85%	X	65%	=	34%

7. The increase in recovery of waterflooding over primary is approximately 24% and would represent some 470,000 Bbls. of oil. It should be kept in mind that this value is based on a great number of speculative estimates.

Completion Practices

The general completion practice has been to drill approximately 100' into the Lodgepole Zone, set 5½" casing, perforate approximately 17' and Frac with 10,000# of sand. Exceptions are 3 wells which have 7" casing and two wells which are completed open hole. Details of individual wells are shown on Table #2.

Proposed Pilot Waterflood

Preliminary estimates indicate that waterflooding the Ebor Field (Lodgepole Zone) will result in an increase in recoverable reserves of approximately 24% or 470,000 Bbls. of oil. The economic success of this project will depend, to a great extent, on obtaining stabilized injection rates of the order of 70 - 100 bbls. per day, per injection well and the availability of a low cost adequate water supply. To answer these questions Sun Oil proposed an injection test using McDougall 11-26 and to evaluate source water sand in the Swan River and Jurassic zones in McDougall 4-26.

McDougall 11-26 was selected for pilot test because it was an average, or slightly above average, well as evidenced by production history (Figure #4). Also it would be an injection well on a proposed expanded 5 Spot flood involving 3-26, 5-26, 7-26 and 11-26. It is proposed to inject water into the existing perforations at a depth of 2584 - 94' (Figure #3).

A source of water is a fairly serious problem as the shallow sand in this area does not appear to be very well developed. The Jurassic Sands appear to offer the best possibility. For a limited period of time the California Standard Company obtained water for the Daly Field waterflood from the Jurassic Sand in Daly 2-1-10-28 W1; the interval perforated was 2039-75' and the capacity of the well was approximately 1,000 B/D. McDougall 4-26 has a fairly good Jurassic sand development at a depth of 2400-20'. It also has 7" casing which would permit dual completion as a producing oil well if the flood is expanded. If this interval does not provide adequate water supply several other Jurassic Sands and possibly the Swan River Zone will be investigated as water source zones.

Conclusions

1. The Ebor reservoir recovery mechanism is a combination of fluid expansion and weak solution gas drive which will result in a low primary recovery of approx. 196,000 Bls. of oil.

2. The Ebor reservoir has essentially reached the economic limit of primary production.

3. Waterflooding may increase the reserves by approx. 470,000 Bbls. of oil. However the economic success depends on injection rates and an adequate water supply.

Recommendations

1. That an injection test of two to three months duration be run on McDougall 11-26.

2. That the Jurassic Sand interval 2400 - 20' in McDougall 4-26 be tested as a water source zone. If this proves inadequate additional Jurassic Sands and possibly the Swan River Zone should be tested.

3. If the above tests indicate a stabilized rate in excess of 70 B/D and a water supply in excess of 300 B/D immediate steps should be taken to expand the flood to a full scale 5 Spot pattern as soon as possible.

TABLE # 1

PRODUCTION HISTORY

EBOR FIELD

Year	Cumulative Oil Dec. 31/Bbls.	Yearly Production Bbls.	Daily Production/Bbls.
1954	2,485	2,485	-
1955	46,027	43,542	116
1956	82,522	36,495	100
1957	106,107	23,585	65
1958	127,217	21,110	57
1959	144,132	16,915	46
1960	159,713	15,581	43
1961	173,820	14,107	39
1962 (1st Half)	179,013	5,193	28
Jul [illegible]	180,112	[illegible] (215 days)	29

TABLE 2

Summary of Completion Practices

Ebor Field

Well	KB	To	Top Miss. (Lodgepole)	Casing Size - Depth	Perforations	Treatment
13-23	1749	2769	2614	7" @ 2632	2632 - 94 (OH)	Frac. 10,000# 220 B. Crude
14-23	1742	2710	2597	5½ @ 2686	2686 - 2711 (OH) 2616 - 34	Frac. 10,000# Frac. 10,000#
15-23	1723	2741	2585	7" @ 2680	2598 - 2604 2626 - 2632	Frac.
2-26	1708	2668	2561	5½ @ 2638	2594 - 2614	Frac.
3-26	1733.5	2659	2594	5½ @ 2660	2610 - 25	Frac.
4-26	1747	2783	2595	7" @ 2728	2604 - 10 2616 - 24 2642 - 48	Acid - 2 Bbls. & Frac.
5-26	1734	2680	2587	5½ @ 2672	2667 - 74	Frac. 9,000# - 144 Bbls. Crude
				Re. Perfs.	2593 - 97 2599 - 2606	WO squeezed perf. Acid 4 Bbls. Frac. Sanded off.
6-26	1714	2659	2560	5½ @ 2647	2612 - 2628 2648 - 2659 (OH)	Acidized - 2 Bbls. Frac. 10,500# WO Acidized 1,000 gals. XFMW. Frac. 9,100#
7-26	1696	2939	2570	5½ @ 2720	2600 - 14	Frac. 10,000# - 250# Adomite
11-26	1683	2628	2546	5½ @ 2628	2584 - 94	Frac. 9,000# - 124 Bbls. oil
12-26	1716	2662	2577	5½ @ 2652	2641 - 2649	Frac. 10,000# - 100 Bbls. oil

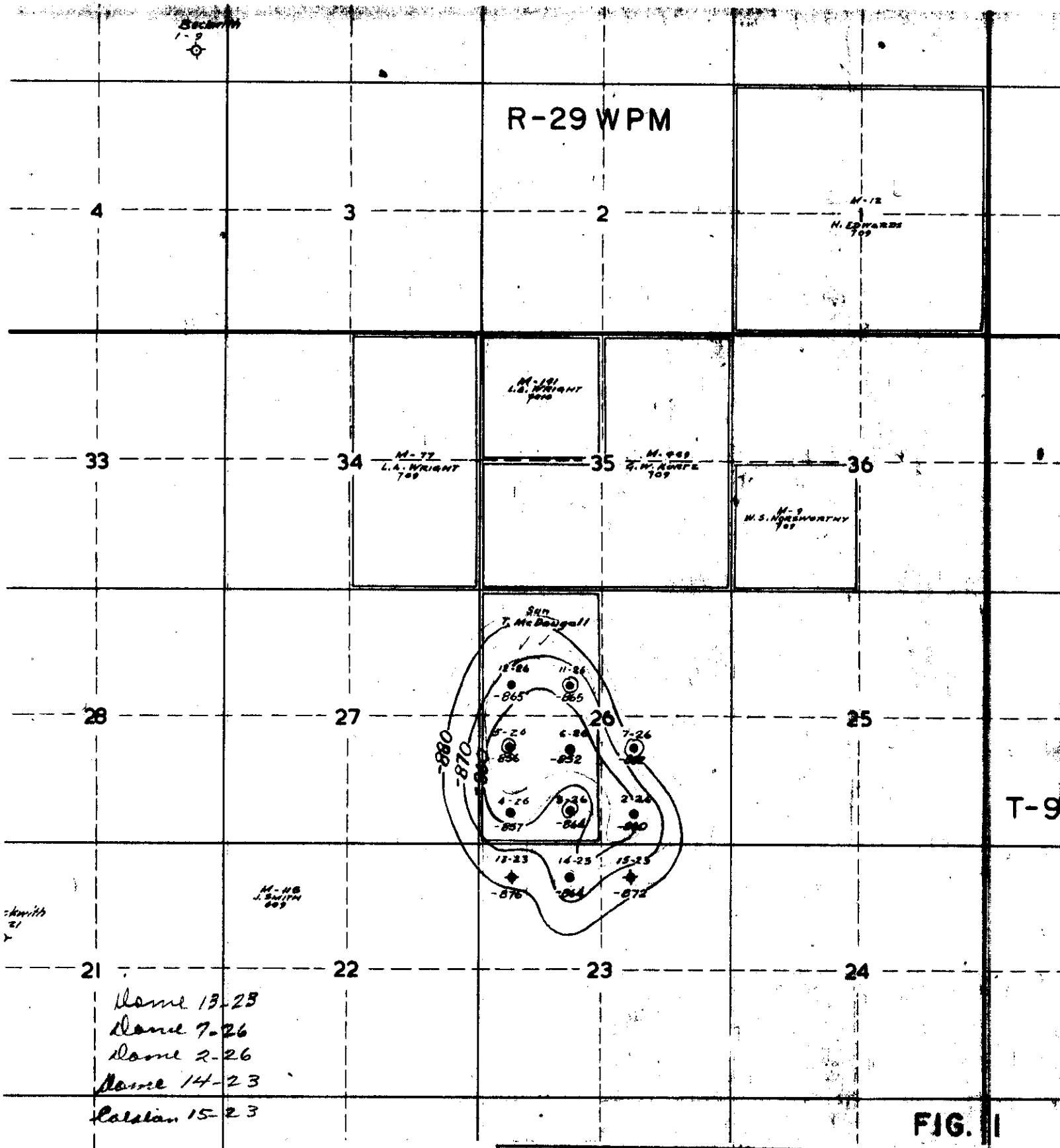


FIG. 1

WELL REFERENCE

- ABANDONED WELL
- OIL WELL
- LOC. OR DRILLING
- GAS WELL
- SUN LEASES

SUN OIL COMPANY

EBOR FIELD

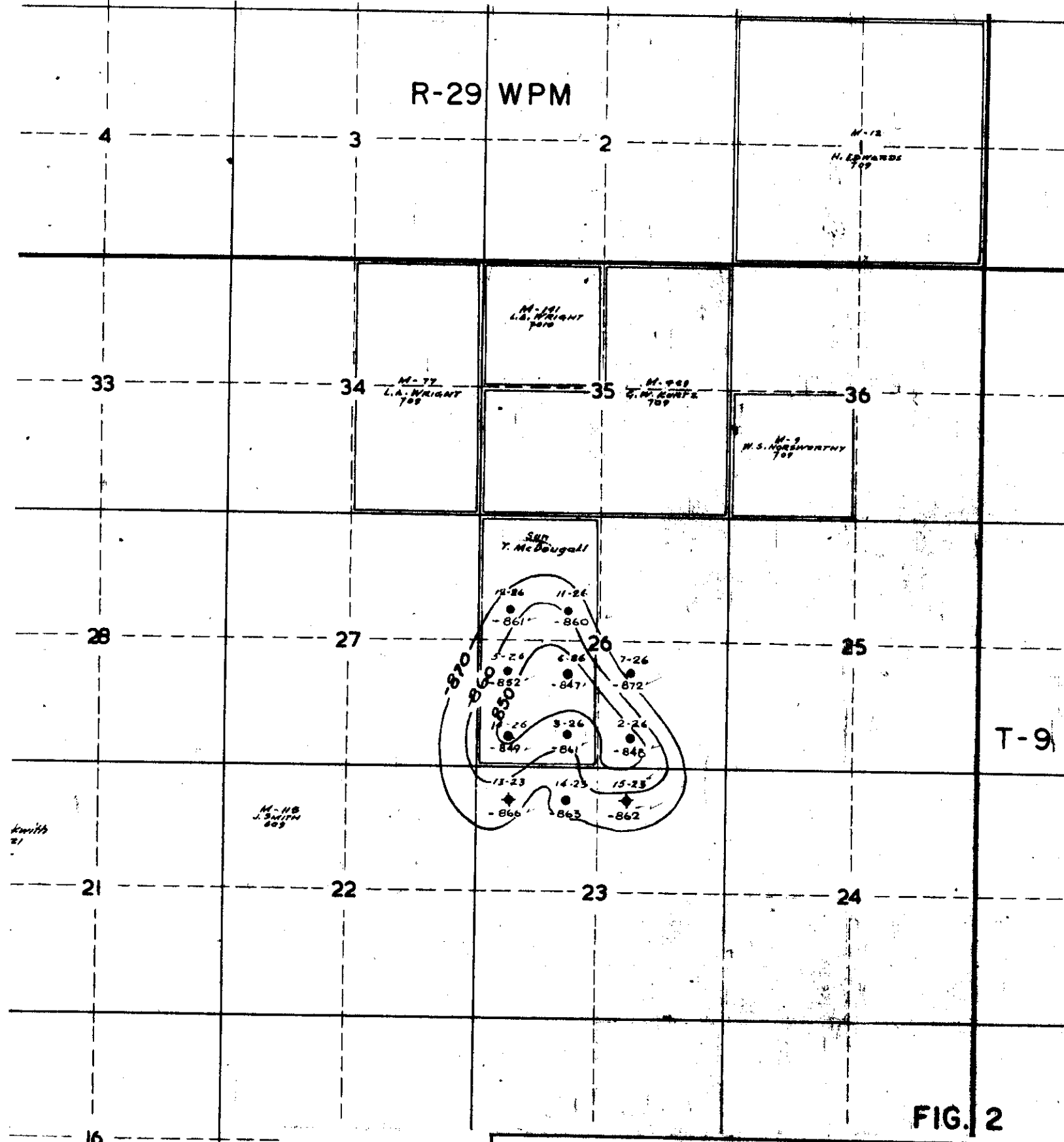
MANITOBA

CONTOURED ON: TOP POROSITY

CONTOUR INTERVAL: 10 FEET

DATE: SEPT. 5, 1962 GEOLOGY BY G. P. W.

SCALE: 2" = 1 Mile DRAFTING BY L.S.L.



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SUN OIL COMPANY

EBOR FIELD

MANITOBA

CONTOURED ON: TOP MISS. UNCONFORMITY

CONTOUR INTERVAL: 10 FEET

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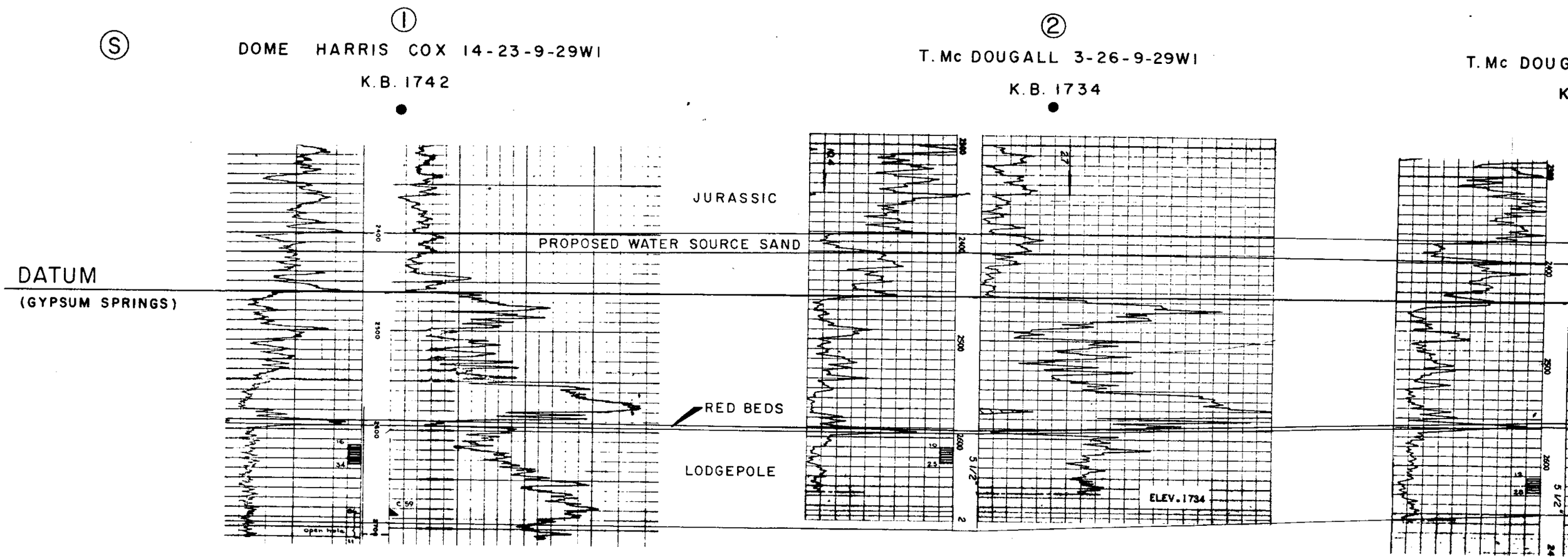
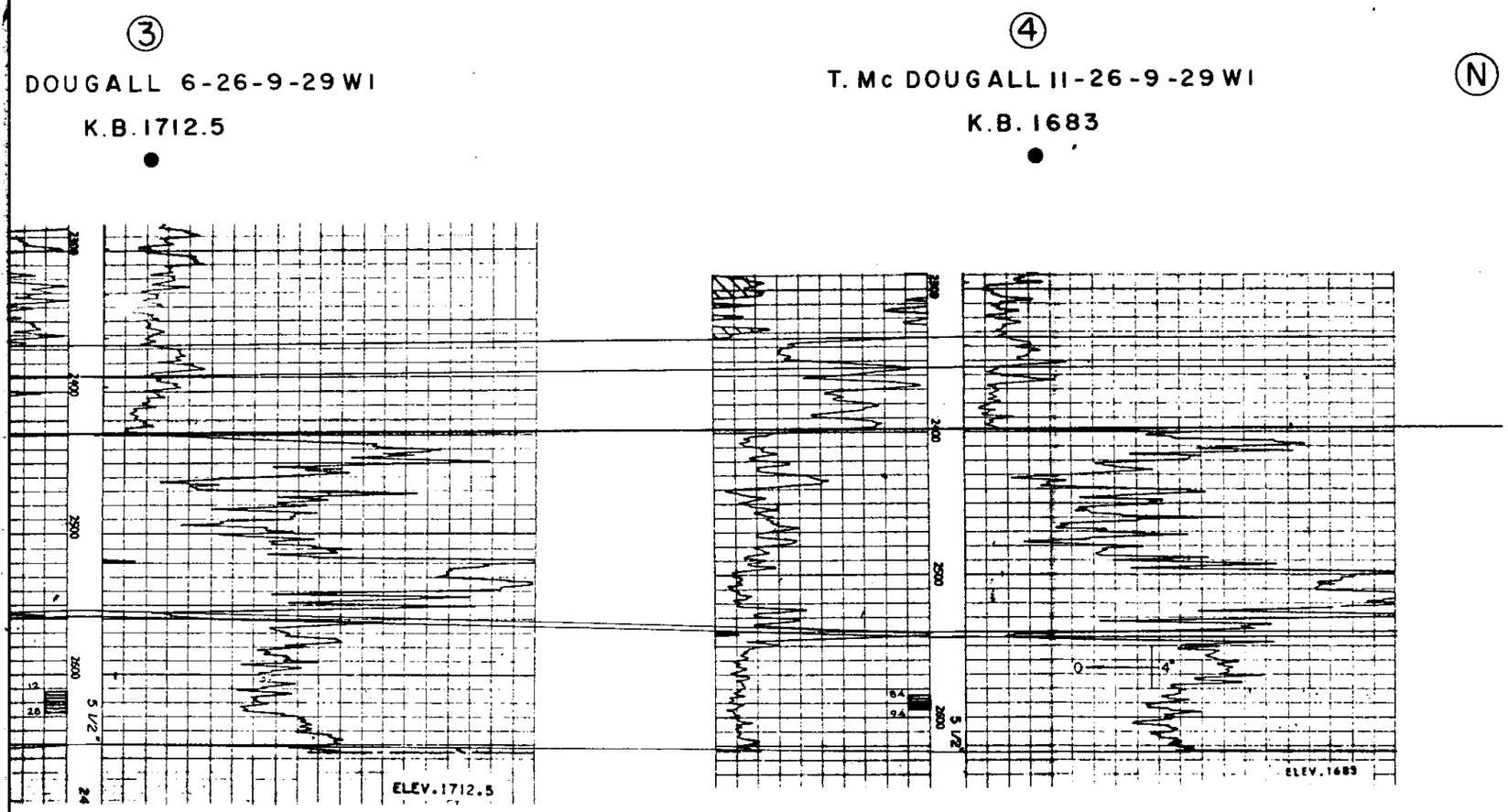
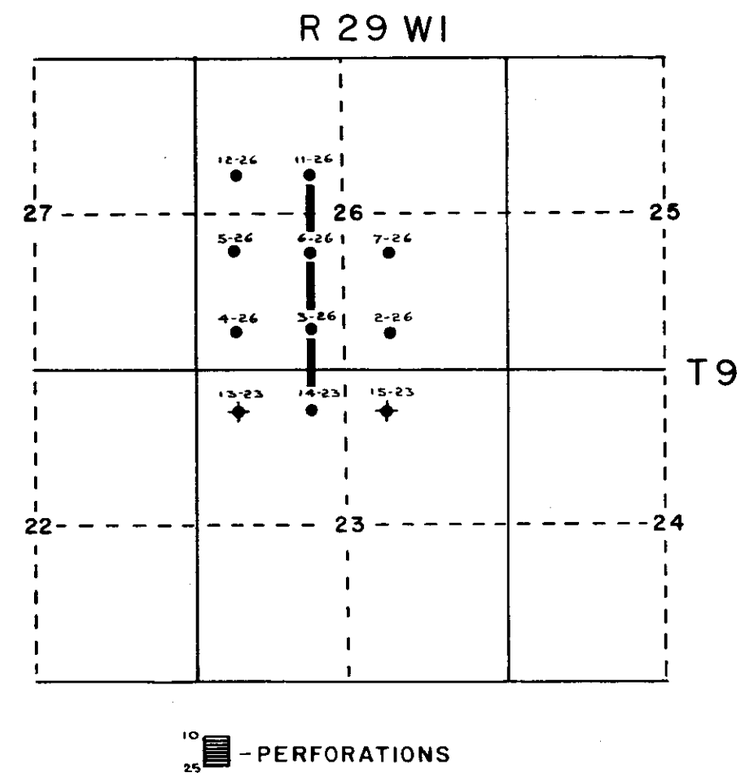

S
1
DOME HARRIS COX 14-23-9-29W1
K.B. 1742
2
T. Mc DOUGALL 3-26-9-29W1
K.B. 1734
T. Mc DOUG
K
DATUM
(GYPSUM SPRINGS)
JURASSIC
PROPOSED WATER SOURCE SAND
RED BEDS
LODGEPOLE
2400
2500
2600
2700
2800
5 1/2"
ELEV. 1734
open hole





SUN OIL COMPANY

EBOR FIELD

MANITOBA

CROSS SECTION

SEPTEMBER 1962

FIG. 3

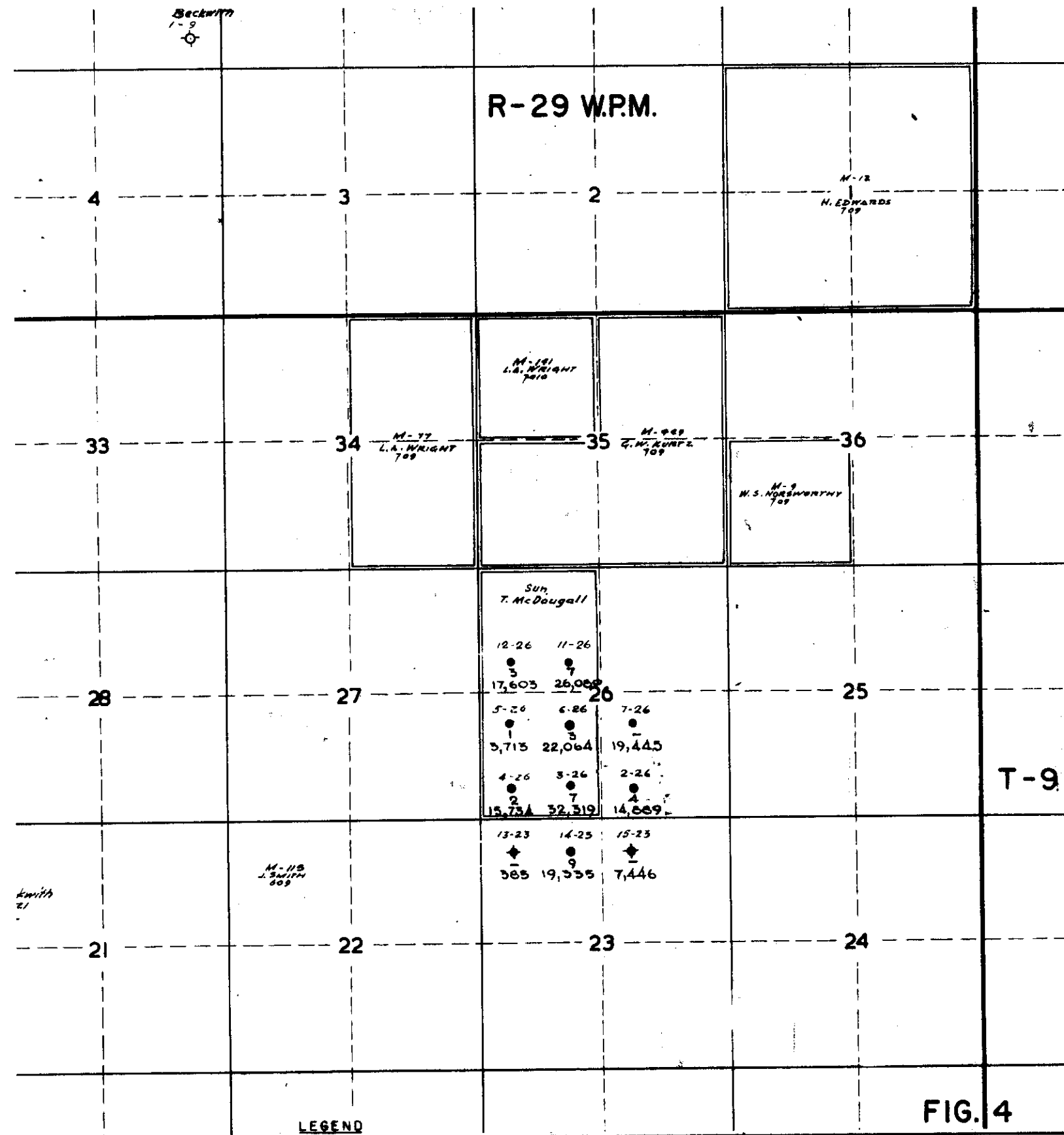


FIG. 4

SUN OIL COMPANY

EBOR FIELD

MANITOBA

LODGEPOLE ZONE

PRODUCTION STATUS : JUNE 1962

DATE: SEPT. 10, 1962 BY J. A. CRATE

SCALE: 2" = 1 Mile DRAFTING BY L.S.L.

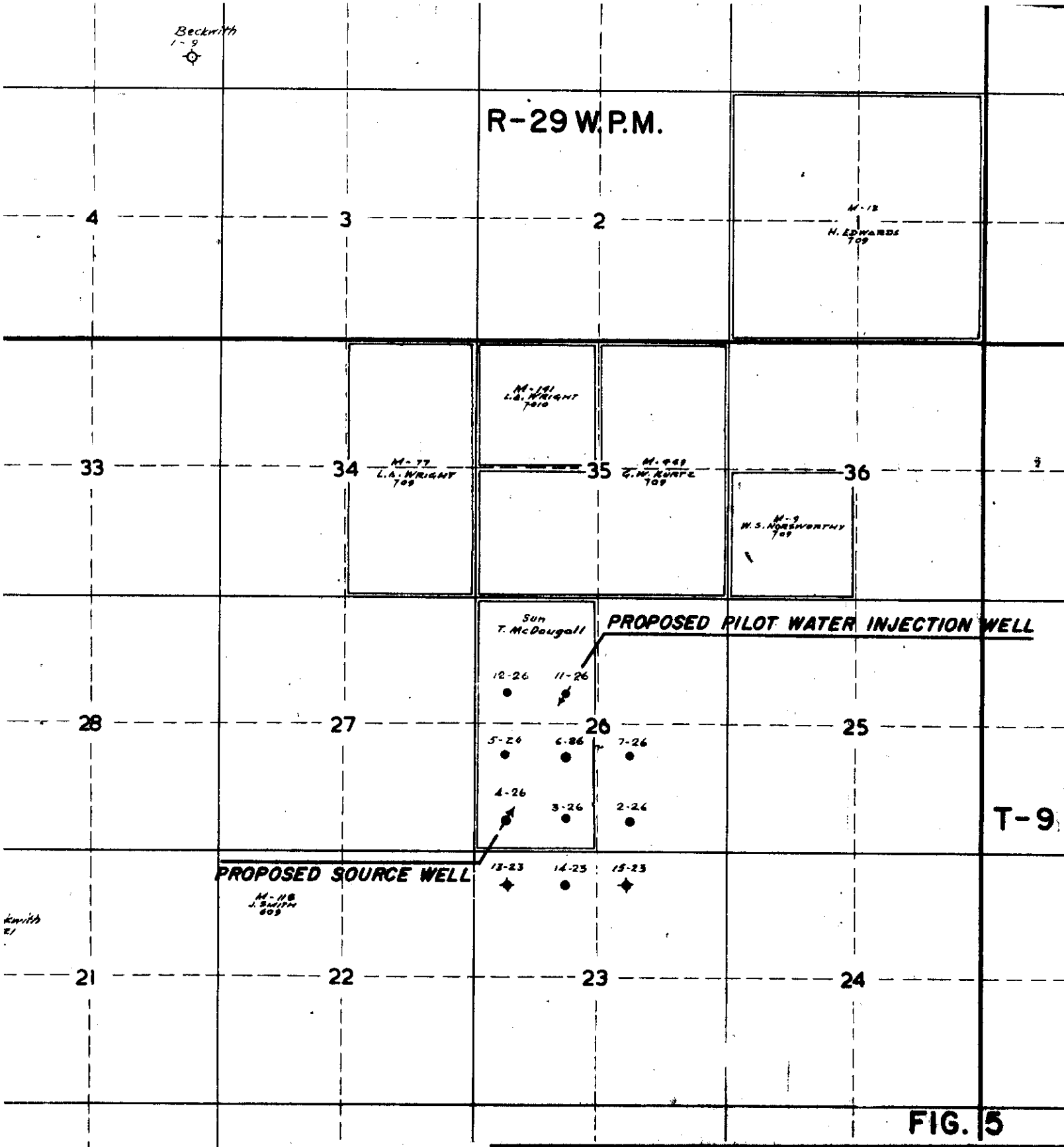


FIG. 5

SUN OIL COMPANY

EBOR FIELD

MANITOBA

LODGEPOLE ZONE

PROPOSED PILOT WATERFLOOD

DATE: SEPT. 10, 1962 BY J. A. CRATE

SCALE: 2" = 1 Mile DRAFTING BY L.S.L.

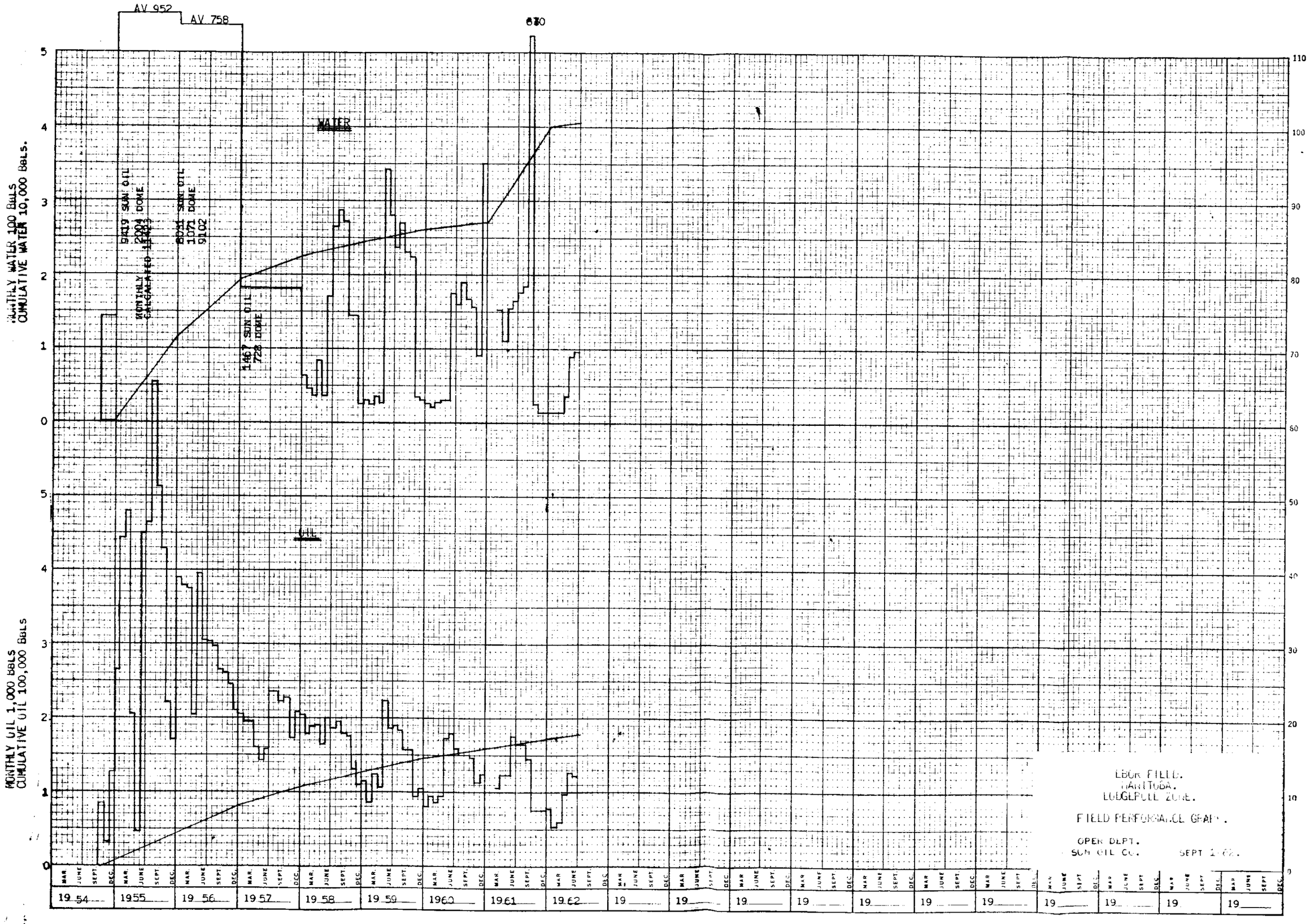
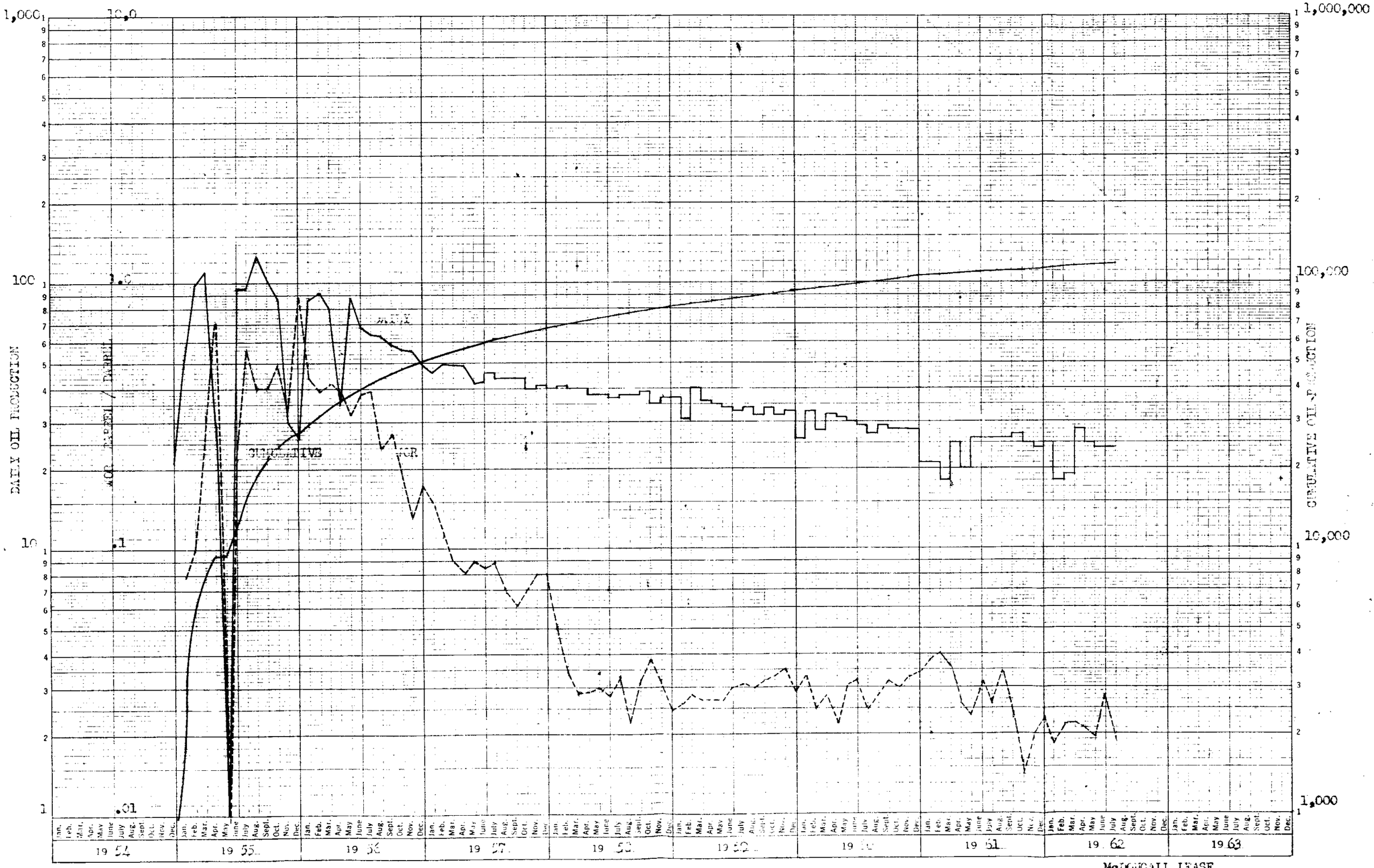

AV 952
AV 758
WATER
OIL
MONTHLY WATER 100 BBLS
CUMULATIVE WATER 10,000 BBLS.
MONTHLY OIL 1,000 BBLS
CUMULATIVE OIL 100,000 BBLS
9419 SUN OIL
2004 DOME
8221 SUN OIL
1071 DOME
9102
1467 SUN OIL
728 DOME
19 54
1955
19 56
19 57
19 58
19 59
1960
1961
1962
LBOR FIELD.
MANITOBA.
LODGEPOLE ZONE.
FIELD PERFORMANCE GRAPH.
OPER DEPT.
SUN OIL CO.
SEPT 1-62.
K+E 20 YEARS BY MONTHS X 110 DIVISIONS KEUFFEL & ESSER CO. 359-210L

FIGURE 6



McDOUGALL LEASE

EDOR LODGEPOLE

FIGURE 7

K+E 10 YEARS BY MONTHS X 3 CYCLES KEUFFEL & ESSER CO. 359-205L MADE IN U.S.A.

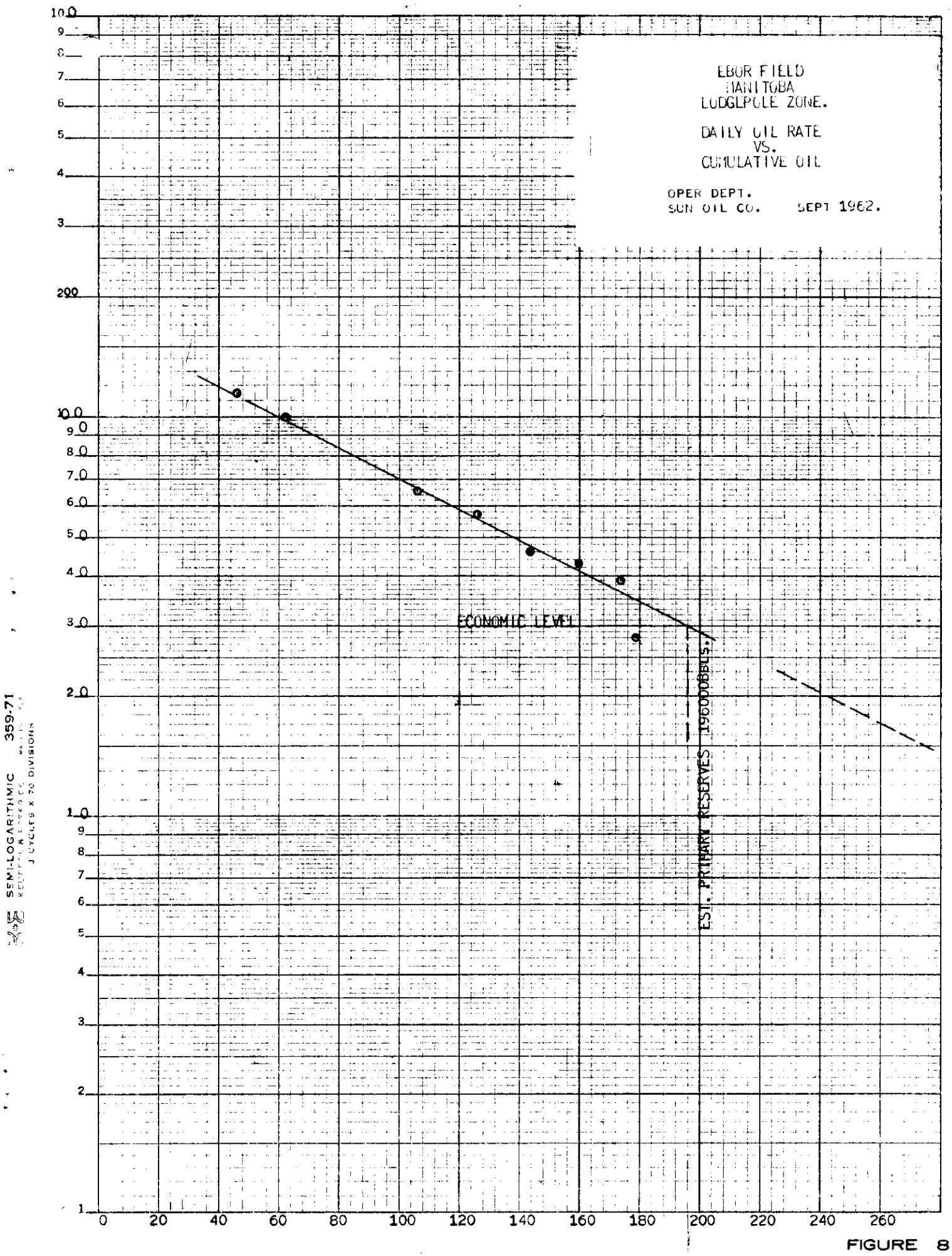

EBOR FIELD
MANITOBA
LODGEPOLE ZONE.
DAILY OIL RATE
VS.
CUMULATIVE OIL
OPER DEPT.
SUN OIL CO. SEPT 1962.
ECONOMIC LEVEL
EST. PRIMARY RESERVES 196000 BBLS.
SEMI-LOGARITHMIC 359-71
3 CYCLES X 70 DIVISIONS
0
20
40
60
80
100
120
140
160
180
200
220
240
260

FIGURE 8

December 1, 1976

Mead Petroleums Ltd.
Pipestone, Manitoba
R0M 1T0

Attention: Mr. H. S. Hannem
President

Dear Sir:

Re: Ebor Unit Wells
Sun T. McDougall Ebor WIW 5-26-9-29, Lic. No. 868
Sun T. McDougall Ebor WIW 11-26-9-29, Lic. No. 883

Further to our letter of October 27, 1976 in which we asked you to provide your comments on the reasons why you had not stated any future plans to use the above two wells for injection purposes, and also the costs involved to develop an adequate water supply system for injection in Ebor Unit, we advise that to date we have received no written reply to our letter from you other than our brief telephone conversation of earlier this month.

Please provide this office with your comments on the above mentioned items prior to January 1, 1977 in order that the processing of your applications on these two wells may be completed.

Yours sincerely,

Original Signed by H. C. Moster

H. C. Moster, P. Eng.,
Director, Petroleum Branch.

SE/et

October 27, 1976

Mead Petroleums Ltd.
Pipestone, Manitoba
R0M 1T0

Attention: Mr. M.S. Hannem
President

Dear Sir:

Re: Ebor Unit Wells
Sun T. McDougall Ebor WIW 5-26-9-29, Lic. No. 868
Sun T. McDougall Ebor WIW 11-26-9-29, Lic. No. 883

We acknowledge receipt of your applications to convert the above two injection wells to possible producers in the future.

Before completing the processing of your applications, please provide this office with your comments on the following:

1. The reasons why you have not stated any future plans to use the above two wells for injection purposes. It is our understanding that the lack of response to water injection in Ebor Unit No. 1 in the past was due to insufficient volumes of water injected into the reservoir.

2. The costs involved to develop an adequate water supply system for injection in this area (i.e. drilling of a new well, dually completing one of the active wells in the Jurassic Sands, transporting water from a nearby source, etc.).

An early reply will be appreciated.

Yours sincerely,

Original Signed by H. C. Moster

H. C. Moster, P. Eng.,
Director, Petroleum Branch.

HCM/et

October 12, 1976

Mead Petroleums Ltd.
Pipestone, Manitoba
ROM 1TO

Attention: Mr. M. S. Hannem

Dear Sir:

Re: Ebor Unit Wells
Sun T. McDougall Ebor WIW 5-26-9-29, Lic. No. 868
Sun T. McDougall Ebor WIW 11-26-9-29, Lic. No. 883

The above two wells have been suspended for more than ten (10) years. Neither well has received approval to suspend operation in accordance with Section 162 of Manitoba Revised Regulation M160-R1P.

As our files show that you are the present Unit operator of the above Unit, please submit to this office prior to November 15, 1976, applications (5-69-5M or MG-416) for each of the two wells stating your intentions for each along with supporting data.

Yours sincerely,

Original Signed by H. C. Moster

H. C. Moster, P. Eng.,
Director, Petroleum Branch

SE/cf

DEPARTMENT OF MINES, RESOURCES AND ENVIRONMENTAL MANAGEMENT

ROUTE SLIP

TO SAM	FROM JHM
TO	FROM

- ☐ For your approval or revision
- ☐ For your information
- ☐ Please take action
- ☐ Extracts of minutes for your information and action
- ☐ Please draft reply for signature of
- ☐ Reply direct with copy to me
- ☐ Please supply data for my reply
- ☐ Return with comments and/or recommendations
- ☐ Investigate and report
- ☐ Please sign
- ☐ Please return
- ☐ Please see me
- ☐ Please phone

Date 76 12 06 Subject Ebor (Mead)

Message

What further action is required?

MNR-A-94 Use reverse side if necessary

Mead Petroleum & Farms
Box 172,
Virden Man.
Nov 28-76

DEPT. OF MINES, RESOURCES AND ENVIRONMENTAL MANAGEMENT
DEC 3 1976
564B
PETROLEUM BRANCH

Department of Mines
Winnipeg Man.

Dear Clar.

In enclosing the review that Sun Oil did on the Ebor Unit.

I've taken over the operation myself so I can keep a closer eye on it. I don't think the flood itself was given a fair chance. I personally think if a person drilled a pilot well between 2 or 3 wells it may work. I talked to Ralph Atchison about this & he thought it would take about 250,000 bbls. to show any results By drilling out one of the existing wells down to the Jurassic Sands a person probably get enough water.

A person would have to run in 3 phase power for the injection well as I only have single phase power & it probably wouldn't handle the high pressure.

I thought I would put 5-26-9-29 & 11-26-9-29 back on production in the future until such time as the money could be made available.

If you have any suggestions to add to this I would appriciate hearing them

I was in & seen my banker today & he is preparing the ~~[illegible]~~ proper bond for the wells.

Yours Truly
M. Hannen

Clare: → SAM

12/14/76

Ebor Unit Injection Wells:

The following summerizes my thoughts as to the future steps we should follow:

1. I have reviewed the Engineering Review and operational report (attached) for this area. It is my opinion that further investigation is warranted to evaluate the feasibility of waterflooding, both technically and economically.

2. If the results of the investigation indicate that the area should be flooded immediately (feasible economically), then recommendations should be made to the Board to force Unit Operator to do so, 62(9)(d) of the Act. (I doubt very much if this would be the case).

3. If the results are not that positive, but still suggest reasonable response to waterflood and payout period then:

a. Board approach Unit operator to waterflood.

b. Because Unit operator indicated that Capital funds are not available at present to commence waterflooding, then Department could go into joint venture with operator to provide the fund necessary for the project in return of share of production. This is rather a complicated proposal due to the fact that the Unit is presently being operated on tract participation factors.

I am prepared to approve the ~~two~~ applications to suspend for both wells for 1 year period ~~until said~~ (by such time the study on this field would be completed) and provided that ~~we~~ the following condition be added to the applications:

* "No operation or disturbance of wellhead and for downhole equipment ~~is~~ shall be permitted ~~allowed~~ unless first approved in ~~a~~ writing ~~consent of~~ by the Director of Petroleum Branch." ~~is first obtained.~~

Please advise if above proposal meets with your approval.

SAN

1. process appln's with conditions
   - deadline of JAN 1/78
   - above condition *
2. draft letter
   - what we expect by JAN. 1/78
   - schedule of deposit?