

# NORTH DAKOTA GEOLOGICAL SURVEY

Wilson M. Laird, State Geologist

Report of Investigation Number 29

Preliminary Report on the

*Newburg - Spearfish Charles*

and

*South Westhope - Spearfish Charles*

*Pools*

by

Clarence B. Folsom, Jr.

Miller Hansen

and

Sidney B. Anderson



Grand Forks, North Dakota, 1958

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# GEOLOGY OF NEWBURG AND SOUTH WESTHOPE FIELDS

by Sidney B. Anderson

## Introduction

This report discusses in a preliminary way the geology and engineering characteristics of the Newburg and South Westhope fields. Because the fields are so similar and because of their proximity to each other and because of the possibility they may connect they have been included in the same report.

No attempt is made in the report to discuss each formation represented in the fields. Only the Mississippian Charles and Triassic Spearfish formations will be discussed in any detail as they are the only formations currently producing oil in the fields.

The writers wish to acknowledge the help of Clarence G. Carlson in the preparation of the geological material and Ronald E. Guttenberg for the drafting of the figures.

## Geology

The Madison Group of the Mississippian period in this area consists of three formations which are in ascending order the Lodgepole formation, the Mission Canyon and the Charles.

The Lodgepole and Mission Canyon formations are in general composed of massive marine limestones. The Lodgepole in general is composed of light gray dense fragmental and crystalline limestone, while the Mission Canyon is composed of yellow brown oolitic and fragmental porous limestone with a small bed of anhydrite occurring near the center of the formation.

The Charles formation is composed of alternating beds of pinkish to gray anhydrite and light yellow gray finely crystalline and microcrystalline to fragmental limestone with some good intergranular porosity and minor secondary anhydrite inclusions. The Charles formation rests conformably on the Mission Canyon formation. The Charles in this area has been truncated by post-Mississippian erosion and is unconformably overlain by the Triassic Spearfish formation, and regionally, is probably a facies of the Mission Canyon.

The "Triassic" Spearfish formation in the Newburg and South Westhope area is composed largely of reddish brown, brownish gray, light gray, and greenish gray siltstone, with a clean thin light tan sandstone being developed near the base of the formation. In general the "Basal Sand Unit" is generally a siltstone similar to that described above, except that it contains a higher percentage of larger quartz grains, and appears to have considerably better porosity than the upper part of the formation.

Four maps and one cross section were constructed to help interpret the geology of the fields. Also included with the maps and cross section is a core description on the Amerada Petroleum Corporation Nermyr Tract 1, No. 1 well (Figure 11). The map areas follow: a map of the Newburg area, (Figure 1); a contour map of the Mississippian Erosional Surface, (Figure 2); a structure contour map on the "Charles" "C" Bed, (Figure 3); an isopach map of the total Spearfish, (Figure 4); and an isopach map on the basal Spearfish sand (Figure 5).

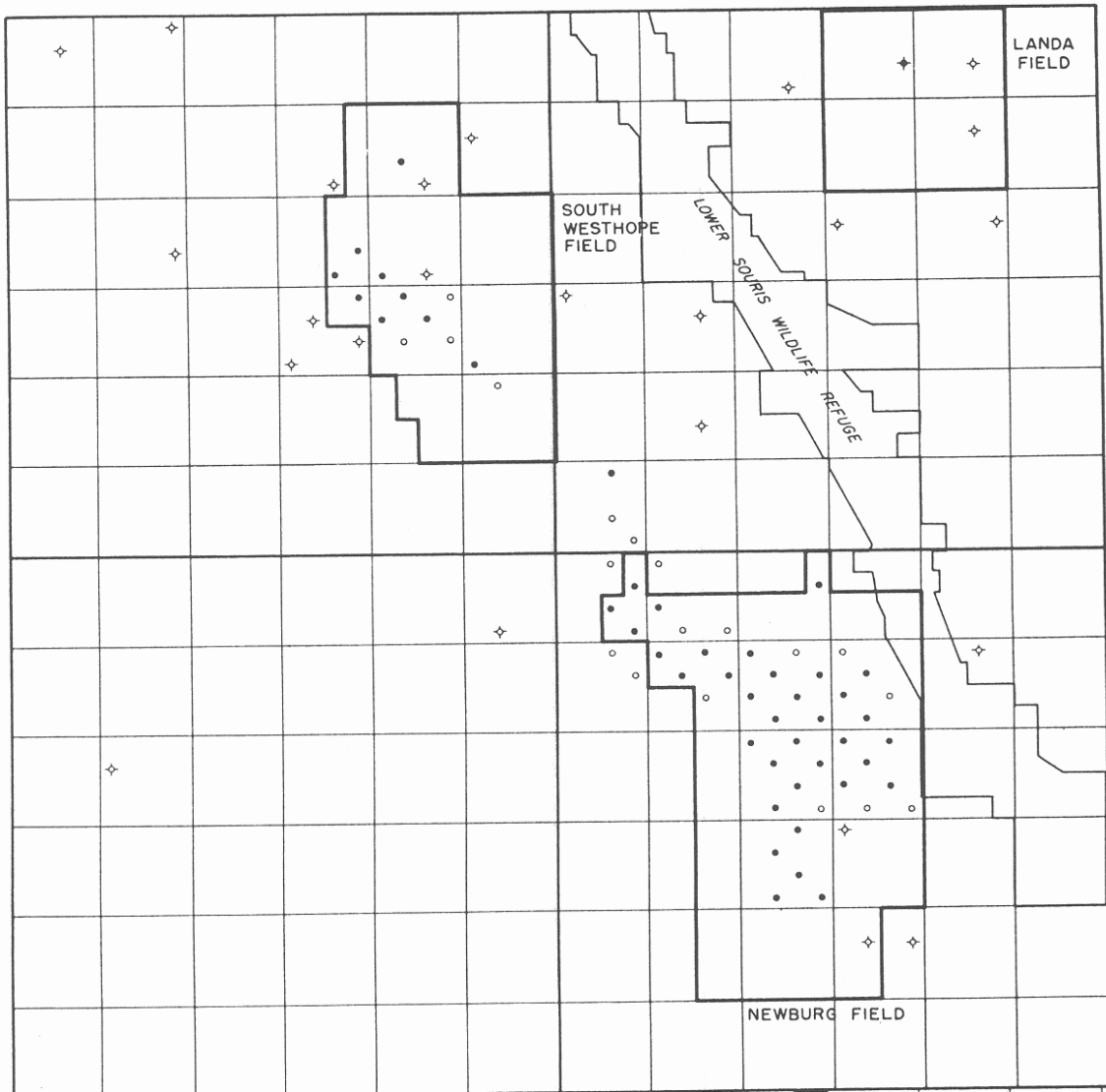
The cross section (Figure 6) extends from the South Westhope field to the Amerada Petroleum Corporation Beauchamp #1 well in the southern end of the Newburg field. Several marker beds in the Mississippian Charles formation have been used for correlation purposes on the cross section. These beds either are zones of porosity or contain zones of porosity and have in this paper been designated Beds "A", "B", "C", and "D" in ascending order. Bed "A" is equivalent to the term 'State 'A' Zone', which has been extensively used by the various operators. Bed "B" is equivalent to the term "Midale Beds". The limestone portion of Bed "C" is known locally in the field areas as the "Lower Berentson Zone", this bed is an excellent marker horizon and was used in making the structure map of the Newburg and South Westhope fields (Figure 3). Bed "D" is equivalent to the upper part of the zone known as the "Ratcliffe Beds". The Spearfish formation unconformably overlies this last named bed in most of the field area except in the Amerada Beauchamp #1 well where a remnant of the Poplar beds overlie the "D" Bed. Some of the main features to be noted on this cross section are the truncation of the Mississippian beds by the Post-Mississippian unconformity, which shows that the wells which are structurally higher are eroded more deeply, and the perforated intervals of the producing wells.

The map on the Charles unconformity (Figure 2) has a striking resemblance to the structure map (Figure 3) in the Newburg field; however, the unconformity map has little or no resemblance to the structure map in the South Westhope field.

The structure map (Figure 3) was constructed on Bed "C" of the Charles formation, this bed is an excellent marker in the area, however, in a few wells the erosion represented by the unconformity is so deep that this bed has been removed. In these wells the datum has been extrapolated from Bed "A". The structure map shows very little deviation from the regional dip, the only notable exceptions being the apparent anticlinal and synclinal trends in the South Westhope field.

R. 80 W.

R. 79 W.



T. 162 N.

T. 161 N.

T. 160 N.

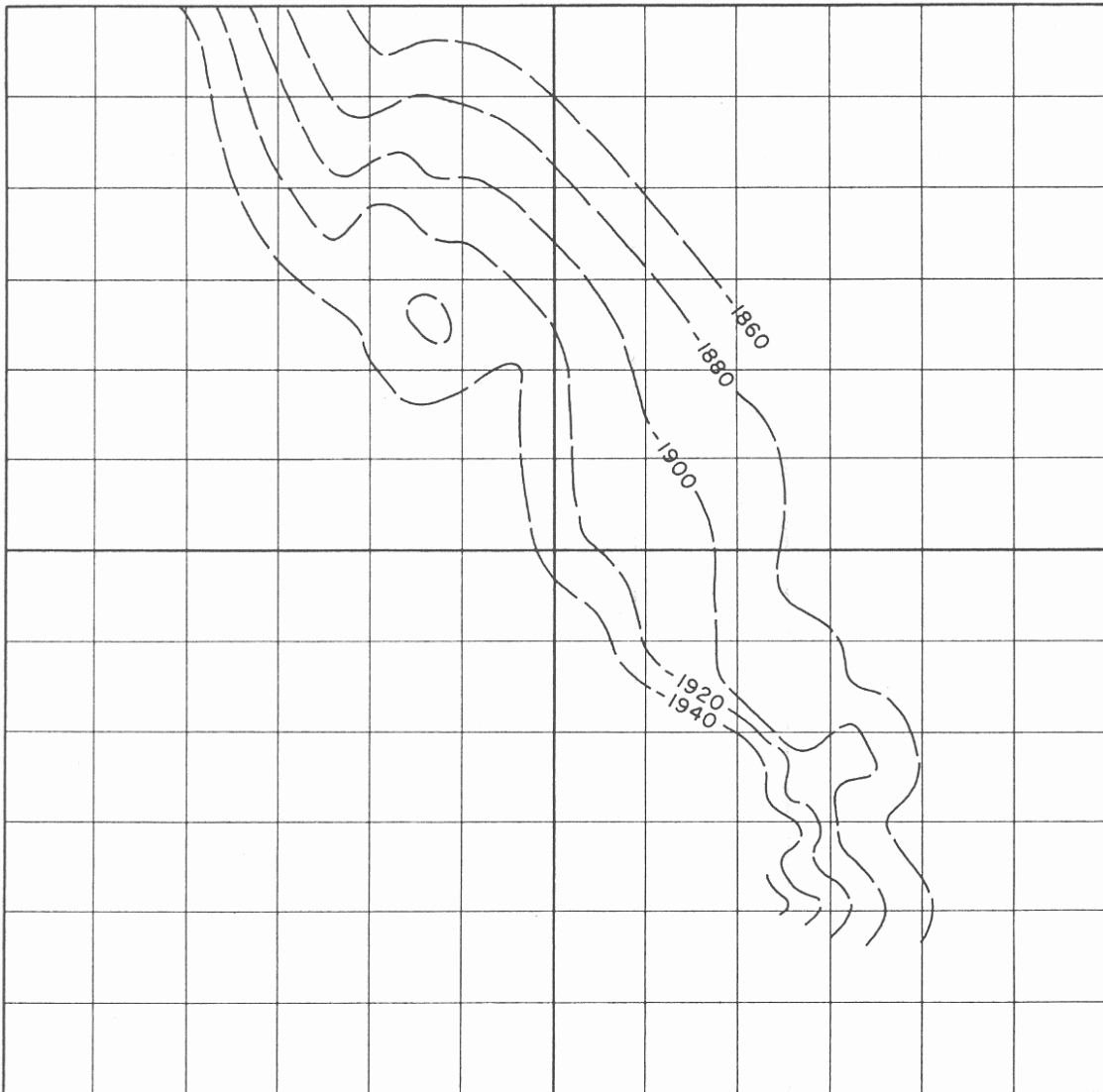
T. 159 N.

FIGURE I  
MAP OF NEWBURG AREA

R. 81 W.

R. 80 W.

R. 79 W.



T. 162 N.

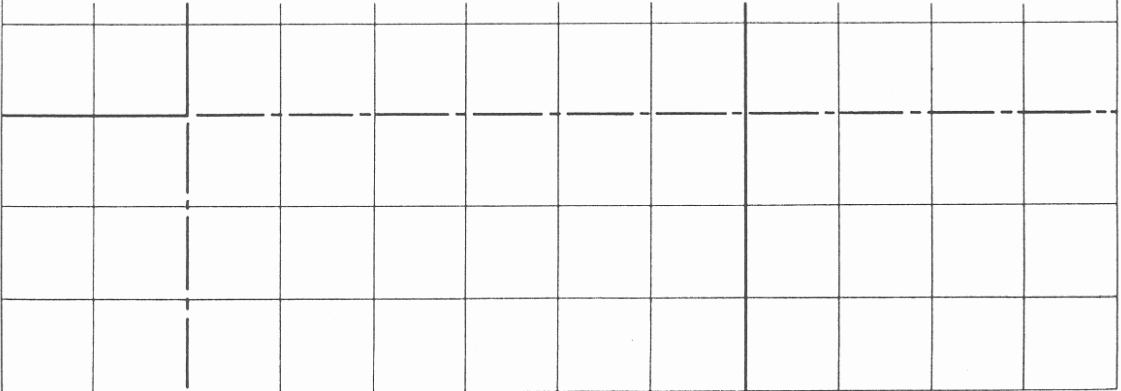
T. 161 N.

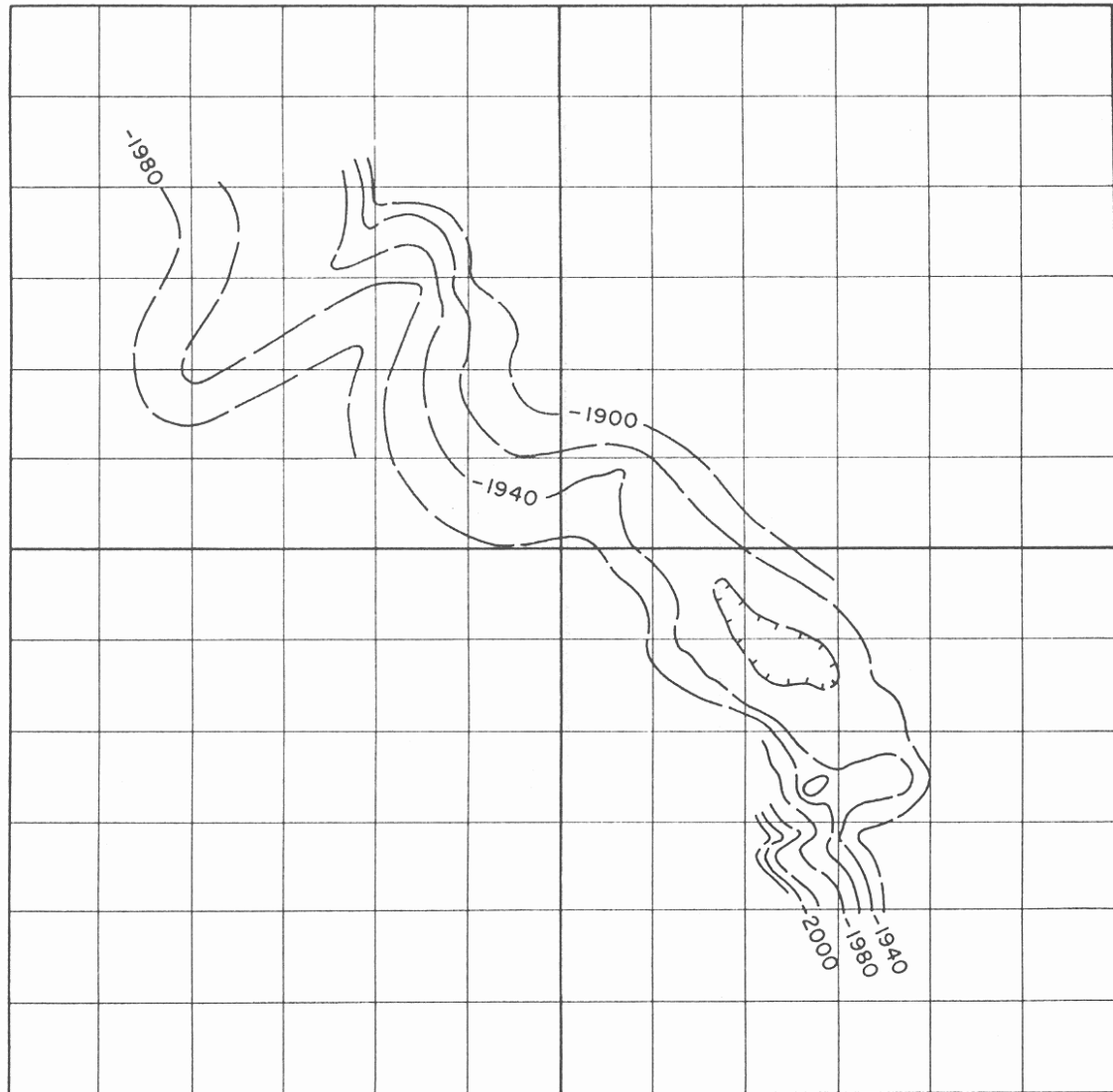
T. 160 N.

T. 159 N.

FIGURE 2

— CONTOURS ON MISSISSIPPIAN EROSIONAL SURFACE —  
CONTOUR INTERVAL = 20'





T. 162 N.

T. 161 N.

T. 160 N.

T. 159 N.

FIGURE 3  
STRUCTURE ON "CHARLES" "C" BED  
CONTOUR INTERVAL = 20'



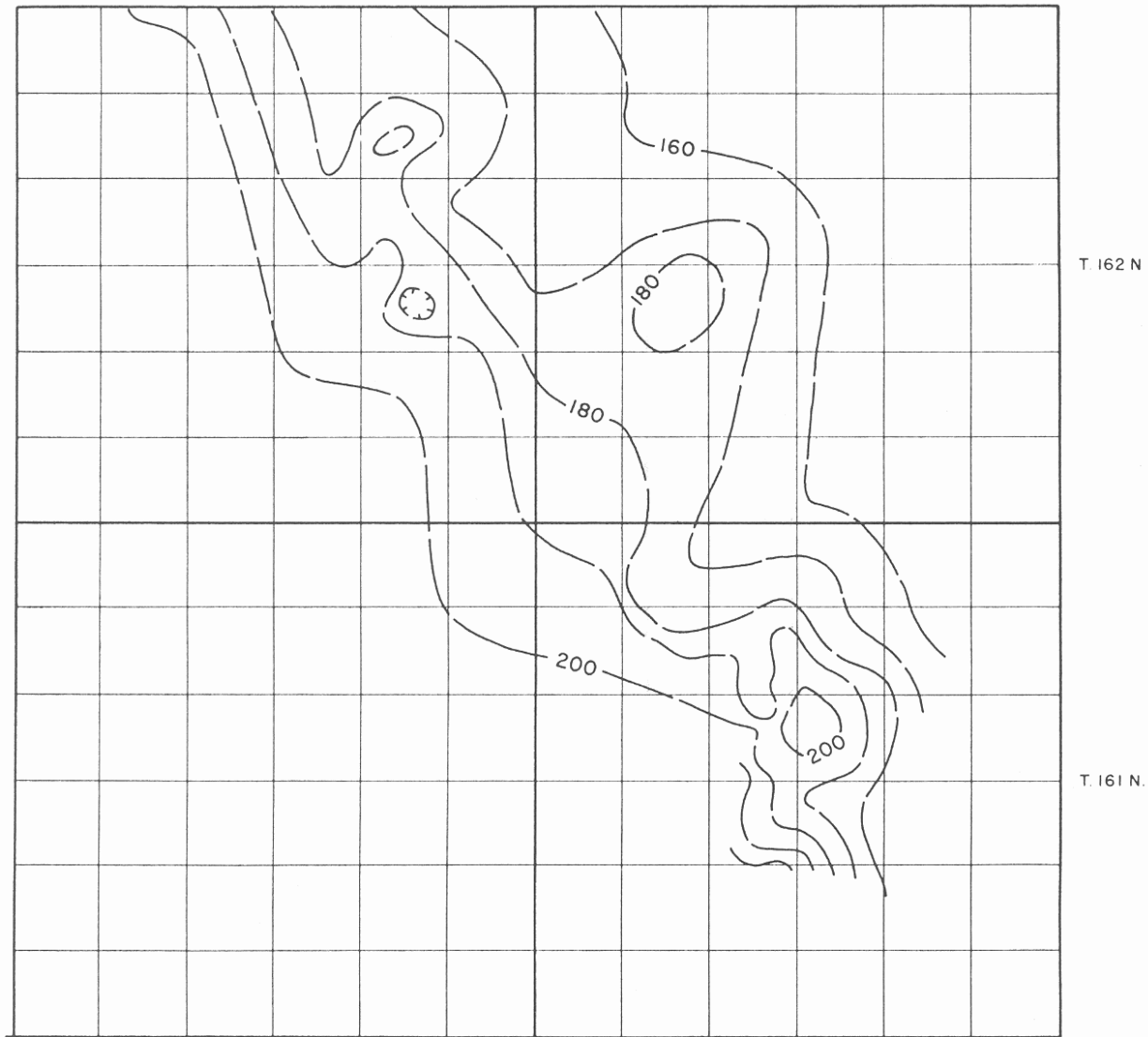


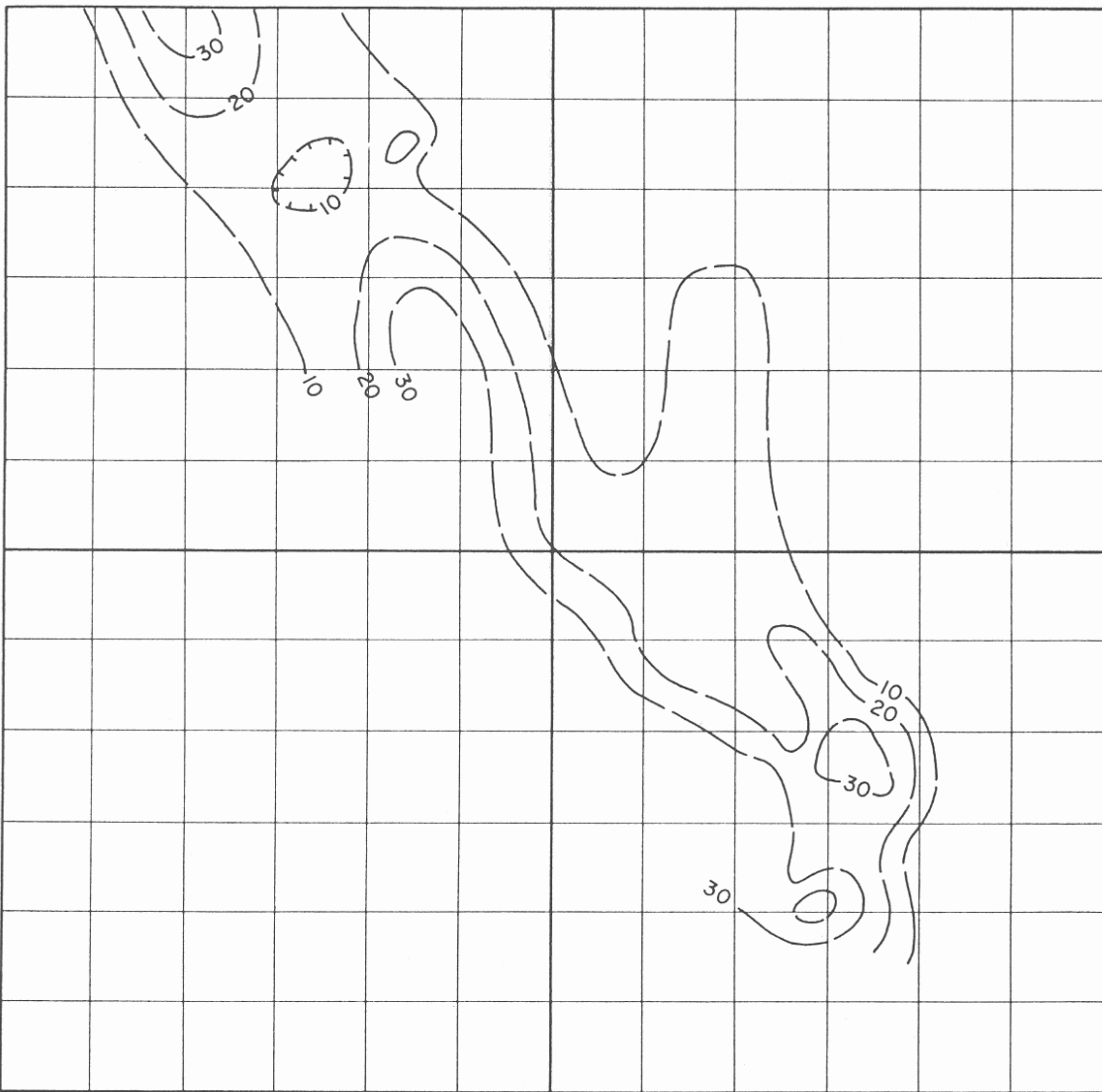
FIGURE 4  
SPEARFISH ISOPACH  
CONTOUR INTERVAL = 10'

T. 162 N

T. 161 N.

T. 160 N.

T. 159 N.



T. 162 N.

T. 161 N.

T. 160 N.

T. 159 N.

FIGURE 5  
SPEARFISH "BASAL SAND" ISOPACH  
CONTOUR INTERVAL = 10'

CARDINAL DRLG. & LUBAR  
A. HOUMANN NO. 1  
SW SE 10-162-80

FELMONT OIL, ET AL  
R. SMITH NO. 1  
SW SW 14-162-80

CARDINAL DRLG. & LUBAR  
P. KING NO. A-1  
SW SW 24-162-80

HUNT OIL  
H. NERMYR NO. 1  
NW NE 31-162-79

CALIFORNIA CO.  
R. HENRY NO. 1  
NW SW 9-161-79

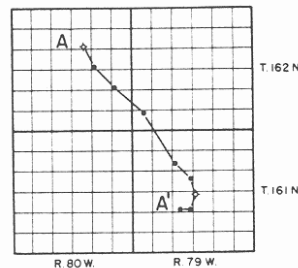
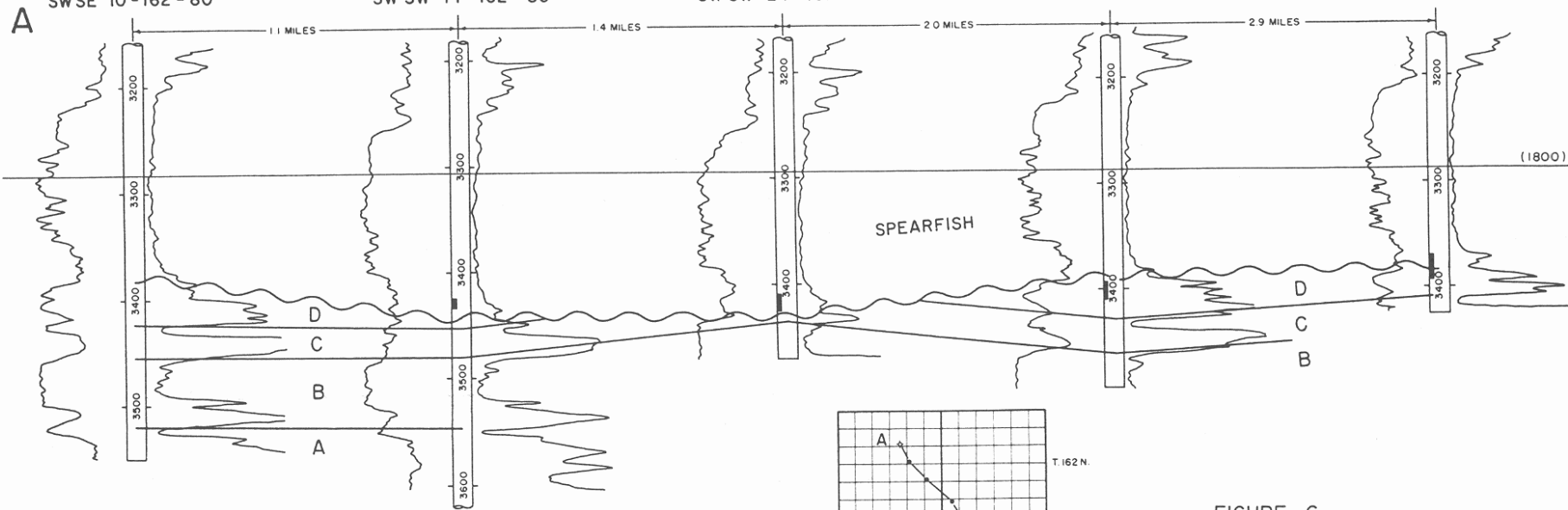


FIGURE 6

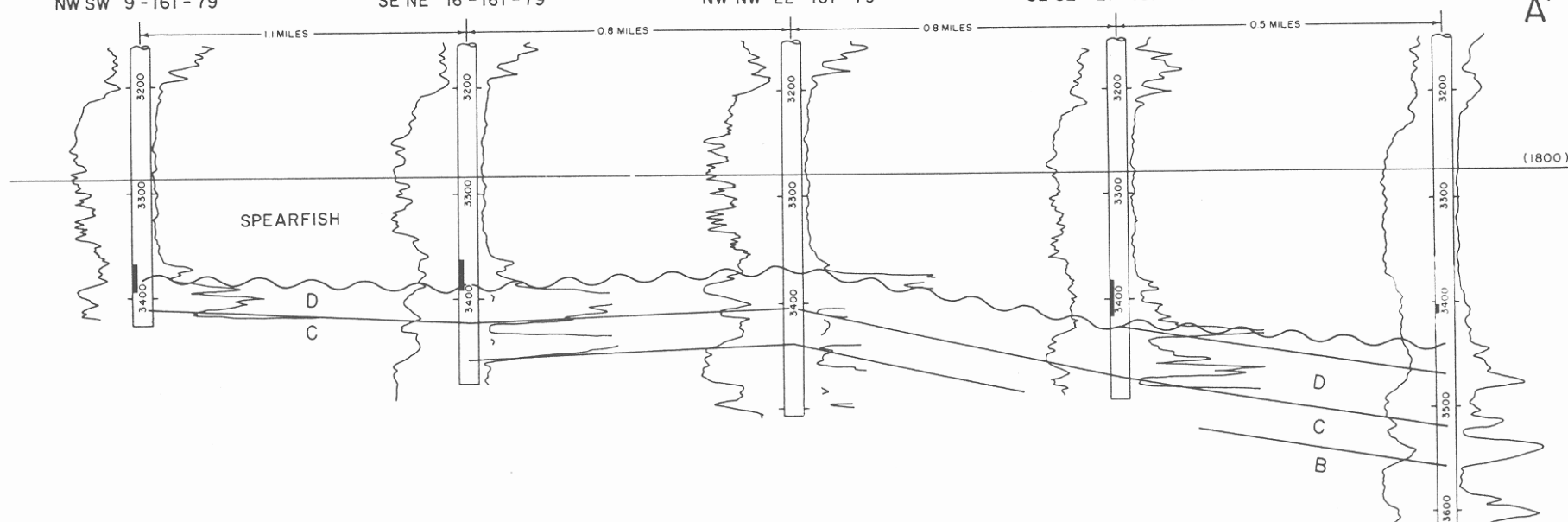
CALIFORNIA CO.  
R. HENRY NO. 1  
NW SW 9-161-79

AMERADA PET.  
A. NERMYR TR. NO. 1  
SE NE 16-161-79

CARDINAL DRLG. CO.  
R. HENRY NO. 1  
NW NW 22-161-79

AMERADA PET.  
L. HENRY "B" NO. 1  
SE SE 21-161-79

AMERADA PET.  
A. BEAUCHAMP NO. 1  
SE SW 21-161-79



Figures 4 and 5 are isopach maps. Figure 4 is an isopach map on the total Spearfish formation, while Figure 5 is an isopach map on the "Basal Spearfish Sand". In general when these isopach maps are compared it will be noted that where the "Basal Sand" thickens the total Spearfish also thickens. It should also be noted that in general where there is little or no sand there is no production.

The core description (Figure 11) on the Amerada Petroleum Corporation Nermyr Tract 1 No. 1 is included to show the general lithology of the producing section of the Spearfish formation and of the upper part of the Charles formation.

### Accumulation of Oil

The accumulation of oil in the Newburg and South Westhope fields is apparently stratigraphically rather than structurally controlled. The structure in the fields reflects regional dip rather largely. In the South Westhope field, there is an apparent anticlinal nose plunging to the southwest; paralleling this on the south is a synclinal trend. There are wells in the syncline that are producing oil, while there are two dry wells on the anticlinal nose. This is because the "D" Beds are missing in the two dry holes and because the "Basal Spearfish Sand" is not well developed in these wells.

It appears that the truncation of the Charles "D" Bed and subsequent deposition of the overlying Spearfish formation may well be responsible for the accumulation of the oil in the South Westhope and Newburg fields. The oil apparently migrated through the porous Charles "D" Bed until it reached the unconformity where it moved into the porous "Lower Unit" of the Spearfish formation.

The basal unit of the Spearfish formation appears to contain considerably more porosity and is lenticular with denser beds of the Spearfish overlying it. This restricts the movement of the oil both vertically and horizontally. Thus the oil is trapped in the "Lower Sand Unit" of the Spearfish and in the Charles "D" Bed.

# NEWBURG AREA MAGNETIC MAP

by Miller Hansen

This map of the Newburg and South Westhope fields was completed in August, 1958 for the purpose of determining the magnetic relationships near Newburg, North Dakota with the hope that the information may be useful in exploration in this vicinity.

An Askania vertical component magnetometer with a calibrated sensitivity of 26.2 gammas per scale division was used in making the field observations.

The map shows a similarity between the magnetic high to the north and the magnetic low to the east and south of each field, and also in the location of the anomalies with respect to the oil producing areas. The low east of the Newburg field and the high to the southwest represent a magnetic reflection attributed either to faulting, (Jakosky, 1950) or to differences in the magnetic susceptibility of the basement rocks (Vacquier, 1951).

In Section 10, T. 160 N., R. 80 W., the basement rocks should lie at an elevation of about 6200 feet below sea level, on the basis of extrapolation from the California Thompson well in Section 31, T. 160 N., R. 81 W. Total depth to the basement should be about 7700 feet and this estimate compares favorably with the depth computation based on the method of Peters (1949) as applied to the Newburg high. Application of Peters' method which involves the width of the band of uniformly spaced contours on the flank of the anomaly, gave a depth estimate of 7400 feet.

Although the California Thompson well is outside the mapped area, a line of observations was run to the southwest corner of Section 31, T. 160 N., R. 81 W. where a reading of 4932 gammas was observed. This reading indicates only a slight rise from the lowest observed reading of 4916 gammas at the southwest corner of Section 3, T. 159 N., R. 81 W., three miles east and one mile south of the observation taken near the Thompson well.

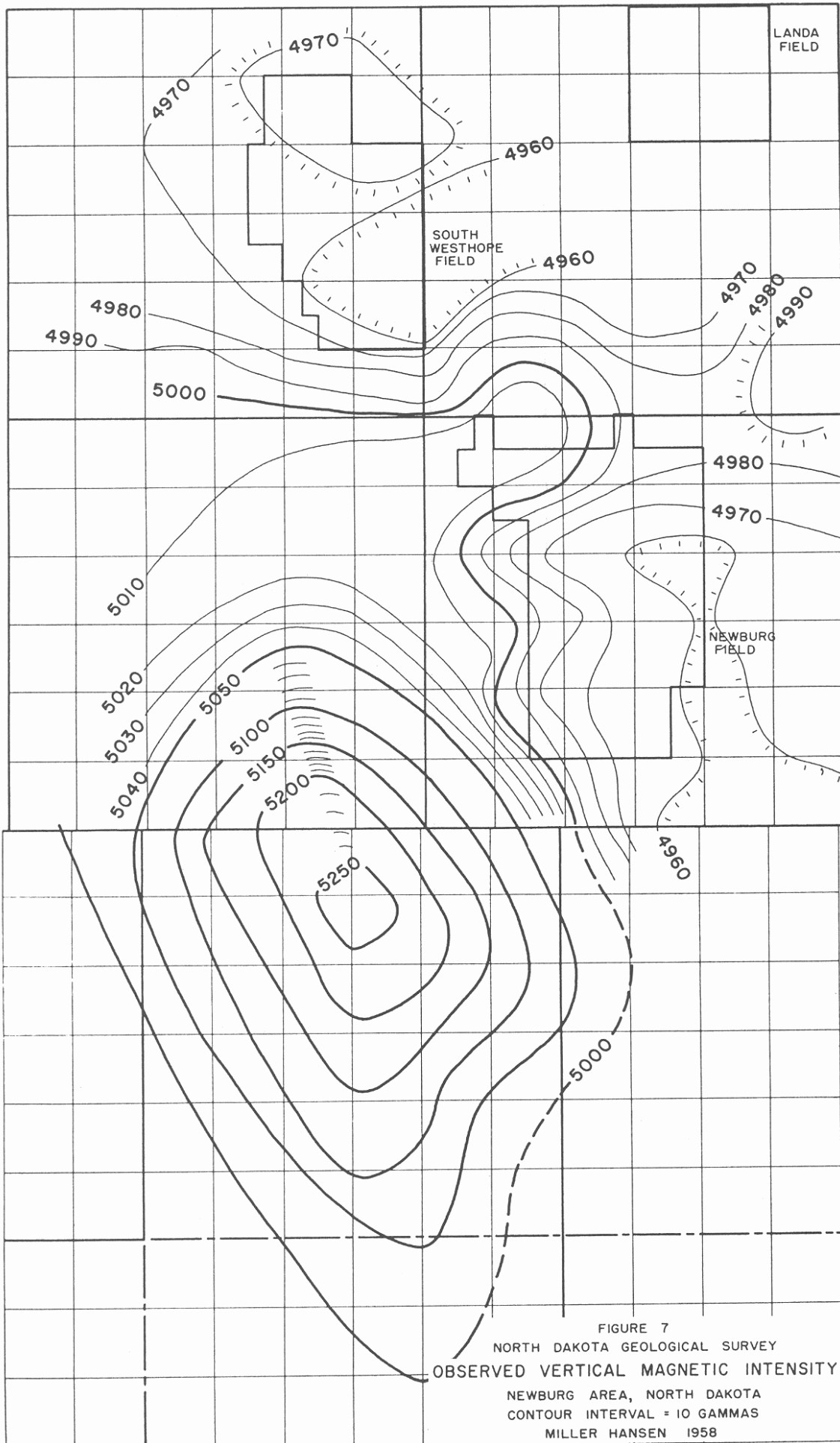
The Newburg high presents several possibilities for exploration. The Amerada Luddington # 1 (Section 5, T. 160 N., R. 80 W.) and the Winona Gagnon # 1 (Section 17, T. 161 N., R. 80 W.) and the Winona Anderson # 1 (Section 23, T. 160 N., R. 80 W.) are the only tests of shallow production zones, and cuttings and core studies of the California Thompson well (Towse, 1952) indicate that the possibility of deeper production should be given more consideration.

## References

- Jakosky, J. J., 1950, Exploration geophysics: 2nd edition, p. 226.  
Peters, L. J., 1949, The direct approach to magnetic interpretation and its practical application: Geophysics, Vol. 14, No. 3, p. 311.  
Towse, D. F., 1952, Summary of the California Thompson # 1 well, Bottineau County, North Dakota: North Dakota Geol. Survey Circular 7.  
Vacquier, Victor, et al, 1951, Interpretation of magnetic maps: Geol. Soc. America Memoir 47, p. 8.

R. 80 W.

R. 79 W.



LANDA FIELD

T. 162 N.

SOUTH WESTHOPE FIELD

NEWBURG FIELD

T. 161 N.

T. 160 N.

T. 159 N.

FIGURE 7  
 NORTH DAKOTA GEOLOGICAL SURVEY  
 OBSERVED VERTICAL MAGNETIC INTENSITY  
 NEWBURG AREA, NORTH DAKOTA  
 CONTOUR INTERVAL = 10 GAMMAS  
 MILLER HANSEN 1958

R. 81 W.

R. 80 W.

R. 79 W.

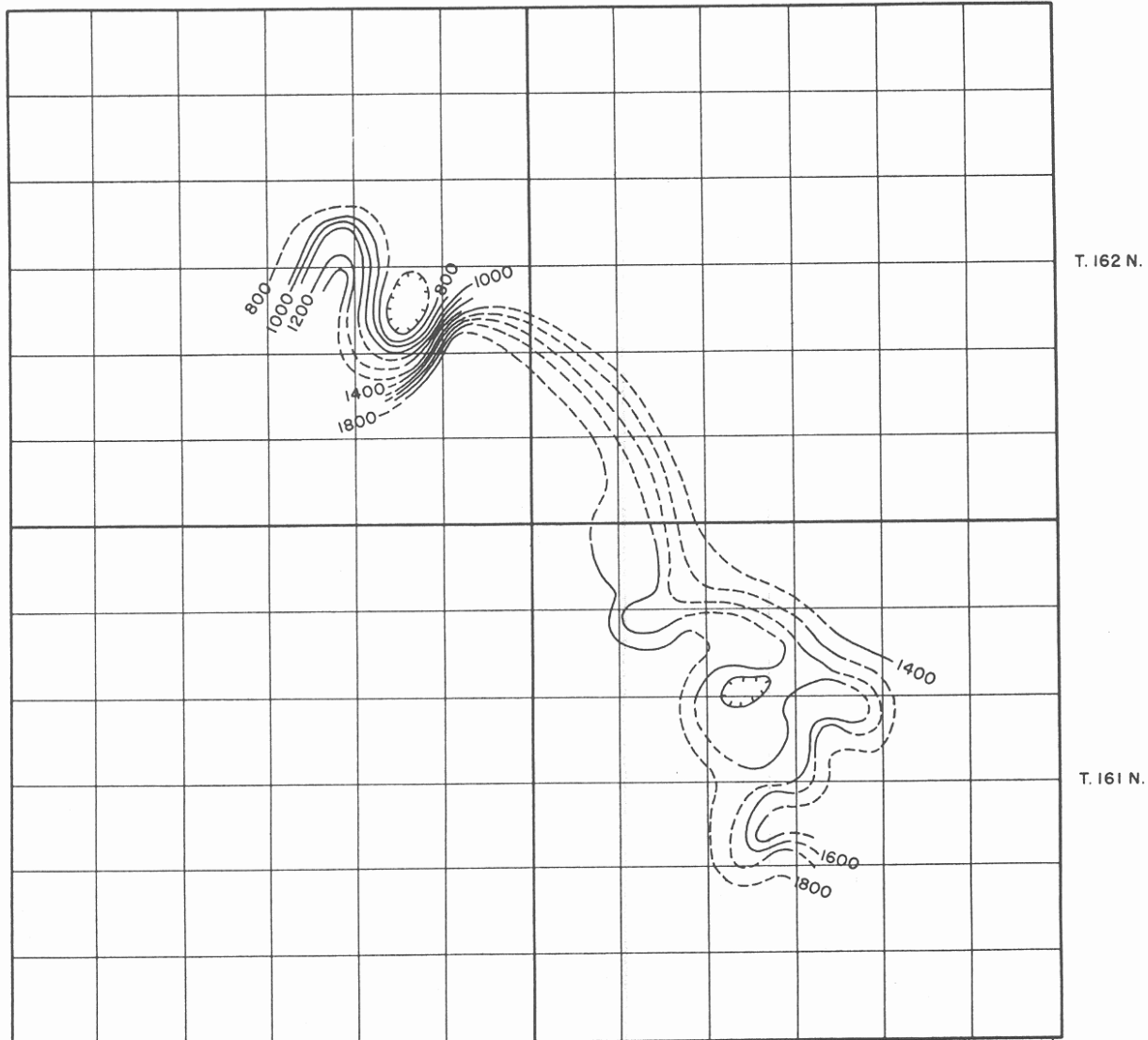


FIGURE 8  
ISOBARIC MAP  
CONTOUR INTERVAL = 100 PSI  
DATUM = 1925 S.L.  
MARCH 1958

T. 162 N.

T. 161 N.

T. 160 N.

T. 159 N.

## RESERVOIR CHARACTERISTICS

by Clarence B. Folsom, Jr.

### Newburg Field

Amerada Petroleum Corporation's A. U. Beauchamp #1 was spudded 15 June 1955 in the center of the SE SW of Section 21, T. 161 N., R. 79W., Bottineau County. The drilling site was about 2 1/2 miles north of the townsite of Newburg, in Bottineau County, North Dakota. Cardinal Drilling Company, of Bismarck, North Dakota, was the contractor.

Nine and five-eighths inch surface casing was set at 212 feet with 125 sacks of cement. Drilling continued, without incident, to the Dakota formation which was drill stem tested from 2192 to 2203 feet (Kelly bushing elevation, 1473 feet above sea level). The tool was open two hours and shut-in 15 minutes. A strong blow of air occurred for one hour and thirty minutes and fresh water, estimated at 210 gallons per minute, flowed for the remainder of the test. Recovery from the first DST was as follows:

180 feet fresh water, muddy, slightly gas cut  
2023 feet fresh water  
IHP 1220 psig.  
IFP 390 psig.  
FFP 900 psig.  
BHP 905 psig.  
FHP 1200 psig.

Drill stem test #2 was made from 2790 to 2816, in the Sundance formation. The tool was open two hours, shut-in thirty minutes. A weak blow of air followed for six minutes and then died. After one hour the fluid was by-passed and a second weak blow occurred for one minute. Recovery from the second DST was as follows:

40 feet of drilling mud.  
IHP 1465 psig.  
IFP 0 psig.  
FFP 10 psig.  
BHP 225 psig.  
FHP 1400 psig.



Drill-stem test #3 was taken from 3395-3420, in the Spearfish formation. The tool was open two hours and shut-in thirty minutes, with no water cushion. Air blow increased to strong in seven minutes and remained strong for remainder of the test. Recovery was as follows:

192 feet free oil, 22.8° API with grind-out 2% drilling mud.  
123 feet dark brown oil cut drilling mud (est. 50%).  
IHP 1800 psig.  
IFP 120 psig.  
FFP 180 psig.  
BHP 1530 psig.  
FHP 1840 psig.

Drill stem test #4 was taken from 3476 to 3509 feet in the Madison formation. The tool was open two hours and shut-in for thirty minutes with no water cushion. Air increased to strong blow in 1 1/2 hours, decreasing to weak blow at end of test. Recovery was as follows:

75 feet of oil and gas cut drilling mud (est. less than 1%).  
300 feet white salt water.  
IHP 1940 psig.  
IFP 0 psig.  
FFP 150 psig.  
BHP 1670 psig.  
FHP 1890 psig.

A total of 89 feet in the Spearfish and Charles formations were cored and 72 feet were recovered. The loss was mainly in the Charles section.

The well reached a total depth of 4080 feet on 16 July 1955 and was plugged back to 3600 feet. Production casing (5 1/2" OD) was set at 3550 feet with 250 sacks of cement. Casing was perforated from 3403 to 3411 feet, with four shots per foot, and swabbed four hours, recovering load water with a scum of oil.

A packer was set at 3229 feet with tubing to 3409 feet and the well was acidized with 200 gallons. Twelve barrels of oil and seven barrels of BS & W were recovered in 10 3/4 hours of swabbing, with 12 barrels of oil being recovered in an additional 13 hours, for a total of 24 barrels of oil and 7 barrels of BS & W during the first day.

The well was reperforated from 3403 feet to 3411 feet with thirty-two, 9/16" super gun, bullets. In 23 1/2 hours of swabbing, 9 barrels of new oil, 13 barrels of load oil, and 7 barrels of BS were recovered and the rig

was released. The gravity of the oil was 34.6<sup>o</sup> API (corrected).

The well was plugged back to 3507 feet and the perforations were treated with 2000 gallons of Petro Jel and 1000 pounds of sand, following which the well flowed 71 barrels of load oil and 20 barrels BS & W in 23 1/2 hours on a 3/4" choke, T.P. = 0.

Subsequent tests recovered 23 barrels new oil, 27 barrels load oil and 20 barrels water in 24 hours; 38 barrels of oil and 34 barrels water in 24 hours; 10 barrels of oil and 21 barrels of water in 24 hours; and 18 barrels of oil and 28 barrels of water in 24 hours. All of the flow tests were through a 3/4" choke and with no tubing pressure.

The well was shut-in for four days and tubing pressure was recorded at 325. The well was opened for 18 hours and flowed 12 barrels of oil and 40 barrels of water on a 3/4" choke.

After further tests the well was completed for an initial potential of 28 barrels of 34.5<sup>o</sup> API oil and 26 barrels of water per day on a 3/4" choke. There was not enough gas to measure. The completion report, submitted to the State Geologist listed the well as complete at 7:15 p.m. on 10 July 1955 with production of 73 barrels of oil and 22% water, based on 23 1/2 hour actual gauge.

The North Dakota State Industrial Commission held a hearing on 26 August 1955, at Bismarck, North Dakota, for the purpose of establishing a temporary spacing for the new field, which was designated the Newburg field. Witnesses for Amerada Petroleum Corporation testified to the effect that the reservoir was probably a lenticular accumulation in the basal Spearfish sand. They stated the original reservoir pressure to be 1910 psi. The estimated cost of the well and lease equipment was \$59,000.

At the time of the hearing no market had been found for the oil. The Industrial Commission ordered the field developed on a temporary spacing of one well to forty acres. The order included a description of the area affected, being a total of four square miles.

During the 25 months that it remained the lone producer, the Beauchamp well, produced a total of 12,388 barrels of oil and 28,625 barrels of water. The Beauchamp remained the only producing well in the field until 13 September 1957 when Amerada completed its L. D. Henry #1 a mile and a quarter north of the discovery well.

Following completion of the L. D. Henry #1 further development followed rapidly and on the third anniversary of the discovery well, 33 wells

were producing, two dry holes had been abandoned within the field limits, four rigs were drilling, and ten additional locations had been staked. Monthly oil production is increasing as additional wells are completed.

A reservoir pressure survey was made in March and April, 1958, and indicated an average reservoir pressure of 1,682 psi or a drop of 228 psi for a cumulative production of 92,577 barrels of oil, or 406 barrels of oil per pound per square inch pressure drop.

The decline in average barrels of oil per well day has had a rather unique history. In evaluating the chart (Figure 9) it should be remembered that only one well was producing until mid 1957. The discovery well established, during the first half of 1956, a decline rate of 14 barrels per well per day per year.

Performance of the discovery well improved during the last half of 1956, but the same rate of decline asserted itself during the following six months, and is apparently continuing during the first half of 1958, even though more wells are involved than before.

On 17 December 1957 the Industrial Commission held a second hearing for the purpose of determining the proper spacing for the field. Witnesses for the Amerada Petroleum Corporation testified that the pressure observed in Amerada's Kvalheim #1, on completion, was comparable to the original reservoir pressure observed in the discovery well (APC Beauchamp #1) about 12,400 feet away, whereas the pressure in the Amerada Scheflo #1, about 11,750 feet away from the discovery well was below original reservoir pressure. As a result of this hearing proper spacing was established at one well per 80 acres with wells to be located in the southeast and northwest quarters of each quarter section.

It is interesting to note that the original producing well, although only marginal, had created a large area of reduced pressure in the reservoir with a resultant probable flow of fluid toward the point of low pressure.

Water constituted 10.4% of the fluid produced in the Newburg field during the month of June 1958. To date there is no conclusive evidence to substantiate the existence of an active water drive in the reservoir. Characteristics of the Spearfish sand would not indicate extensive lateral movement of water in that formation but it could possibly occur in the Charles section of the reservoir.

The history of water production in the field suggests that the oil-water contact is found at about -1936 feet below sea level in those wells producing from the Charles or Charles and Spearfish. The largest water producer in the field is completed in the Spearfish section only with the lowest perforation at -1928 feet.

THE FREDERICKS COMPANY, CHICAGO, ILL. NO. 347  
MADE IN U.S.A.

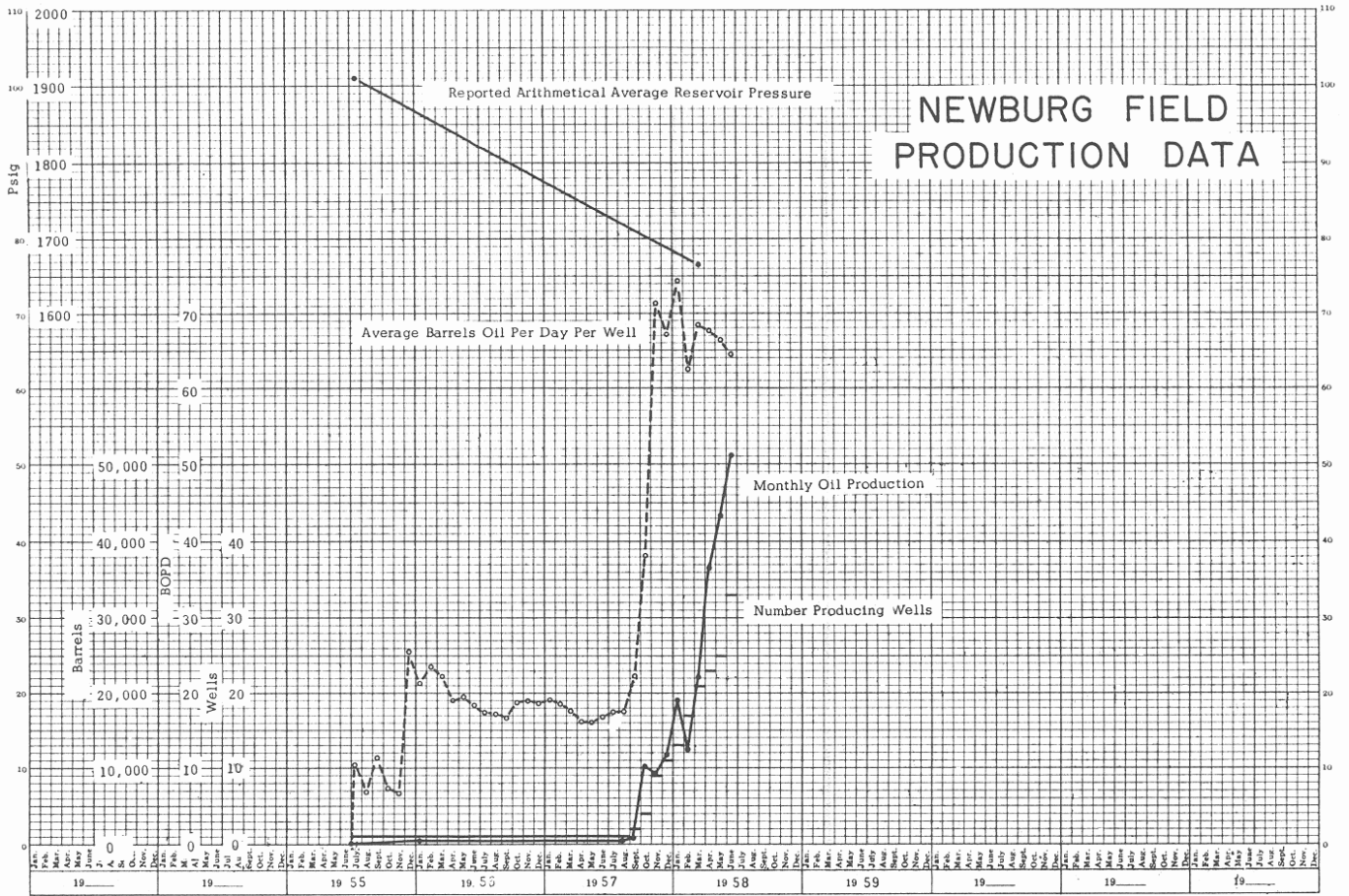


FIGURE 9

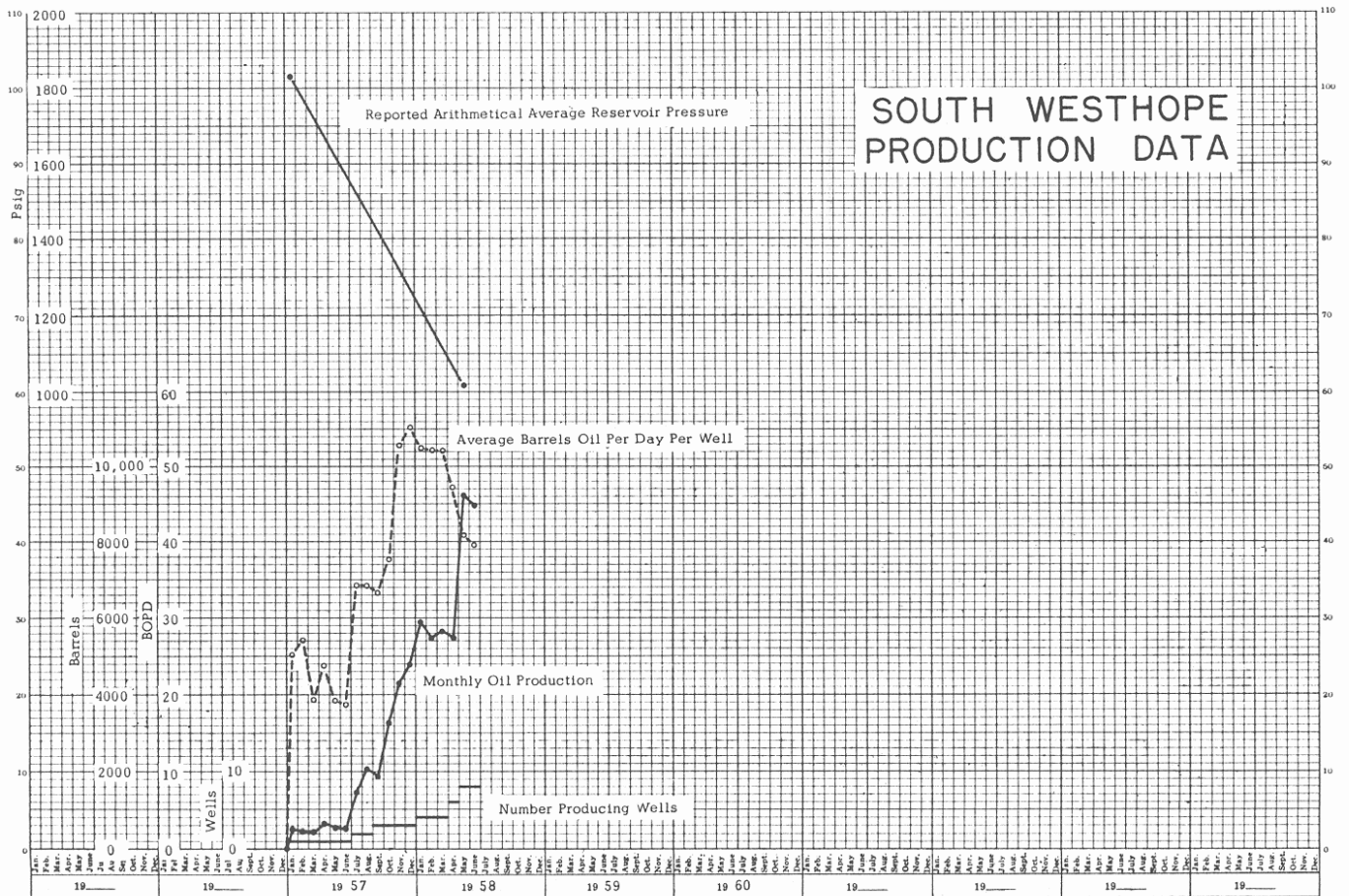


FIGURE 10

## South Westhope Field

The Leach Oil Corporation completed its Russell R. Smith # 1 in the SW SW Section 14, T. 162 N., R. 80 W., Bottineau County, North Dakota, on 27 December 1956. The initial potential of the well was 20 barrels of oil and 1 barrel of water per day, on the pump. The well was drilled to a total depth of 3680 feet and plugged back to 3570 feet. Perforations were made in 5 1/2" casing, from 3486 feet to 3491 feet with six shots per foot. The perforations were treated with 250 gallons MCA and a pump installed.

Two drill-stem tests on the Smith well were made. The first, from 3425 feet to 3435 feet, yielded 1700 feet of gas, 35 feet of slightly oil cut mud, and 350 feet of clean, gassy oil (35° API). The second test, from 3481 feet to 3491 feet, yielded 38 feet of drilling mud, 50 feet of gassy, oil-cut mud, 58 feet of gassy, oil-cut, watery mud, 58 feet of gassy, oily, water-mud emulsion, 58 feet of water, gassy emulsion, and 58 feet of salt water.

In June 1958 the well was reworked with 64 perforations from 3417 feet to 3427 feet and given a wash with 250 gallons MCA. The first production after reworking was 16 barrels of oil per day on the pump, a four barrel per day increase over the previous month.

Due to the marginal nature of the discovery well, further development did not occur until June of 1957. There are now 8 producing wells, two dry holes, two wells drilling, and one undrilled location with the field limits.

The Industrial Commission held a hearing on 19 February 1957 to set the temporary spacing for the development of the field. As a result of that hearing, temporary spacing of 80 acres per well was established for an area totaling 1920 acres, with wells to be located in the center of the southwest and northeast quarters of each quarter section. A second hearing was held on 15 July 1958 to consider proper spacing for the field and the eighty acre spacing was confirmed.

On 19 May 1958 Hunt Oil Company spudded its H. Nermyr #1 in NW NE Section 31, T. 162 N., R. 79 W., two miles southeast of production in the South Westhope field and 1 1/4 miles north of Newburg production.

The well was completed on 28 June with six shots per foot from 3382 feet to 3390 feet. The perforations were treated with 500 gallons of acid and the well pumped 35 barrels of oil and two barrels of water on initial test.

### Comparisons Between the Newburg and South Westhope Fields

Reservoir conditions in the two fields appear to be similar. Porosity ranges from 10 to 15%, with 56 samples, from five wells in the South Westhope

field, giving an arithmetical average of 14.5%.

The permeability will vary from less than ten to more than 100 md. The 55 samples analyzed, from the South Westhope field, showed 23 with less than 10 md, 18 from 10 to 50 md, 4 from 50 to 100 md, and 10 in excess of 100 md.

Total thickness of the pay zone in the Newburg field reaches a maximum of 58 feet. This includes the section of the Charles formation which is productive in that area. Maximum pay thickness in the South Westhope field is about 15 feet and is limited to the Spearfish formation. Of this, 15 feet only 10 feet is considered to be net effective pay.

The productive history of the two fields indicates that both are producing by gas expansion. No reservoir fluid samples have been reported and saturation pressure and solution gas-oil ratios are not known.

Although water is present in both formations it does not appear to be effective as a driving mechanism. Connate water saturation in core analysis will average about 35 to 40 percent.

The reservoir volume factor is estimated to be about 1.35 and ultimate recovery may be expected to constitute about 25% of the original oil in place, based on the low producing gas-oil ratios. It appears that producible reserves in these fields will be on the order of 150 barrels per acre foot.

Pressure interference between wells is evident in the South Westhope field where successive wells found successively lower pressures in the reservoir when offsetting older producing wells.

The irregular pattern of water production in both fields indicates that water being produced is interstitial water rather than bottom water.

The initial reservoir pressure in the South Westhope field was 1830 psi at a datum of 1925 below sea level, compared to an original pressure of 1910 psi in the Newburg area, at the same datum.

The pressures used to compile Figure 8 are the pressures reported to the office of the State Geologist. Since the reports are notarized they must be assumed to be correct. The isobaric map would indicate that the two fields are producing from different hydrostatic units, but the line of separation is probably about a mile north of the present southern boundary of the South Westhope field.

## FUTURE POSSIBILITIES

by Sidney B. Anderson

An interesting possibility in this area and one worthy of further work, is the magnetometer "high" (Figure 7) located southwest of the Newburg field. This is interesting not only for shallow production but also as a prospect for deeper production in the formations of the Devonian, Silurian and Ordovician. The California Company Blanche Thompson #1 well (SW SW Section 31, T. 160 N., R. 81 W.), was drilled a few miles southwest of this high and cores from the well show that there are zones of excellent porosity in these lower horizons, particularly in the Silurian beds, which should make fine reservoirs for the accumulation of oil.

All along the "East Side" of the Williston Basin where the porous beds of the Charles and Mission Canyon formations have been truncated by post-Mississippian erosion, oil fields similar to the Newburg, South Westhope and other fields in the Bottineau area may be found. Detailed subsurface work coupled with more drilling will be needed to locate these areas.

The type of oil accumulation found in the Newburg and South Westhope fields could well be repeated elsewhere along the truncated edge of the "D" Bed, and also along the truncated edges of the other porous beds in the Charles and Mission Canyon formations. An interesting area in this respect is the area to the west and south of the Wiley and Wayne fields. The "D" bed has been eroded in the area extending from near the Westhope field through the Wayne and Wiley fields, this would indicate that the "D" bed should be truncated to the west and south of the Wayne and Wiley field, possibly creating a stratigraphic trap similar to that found in the Newburg and South Westhope fields.

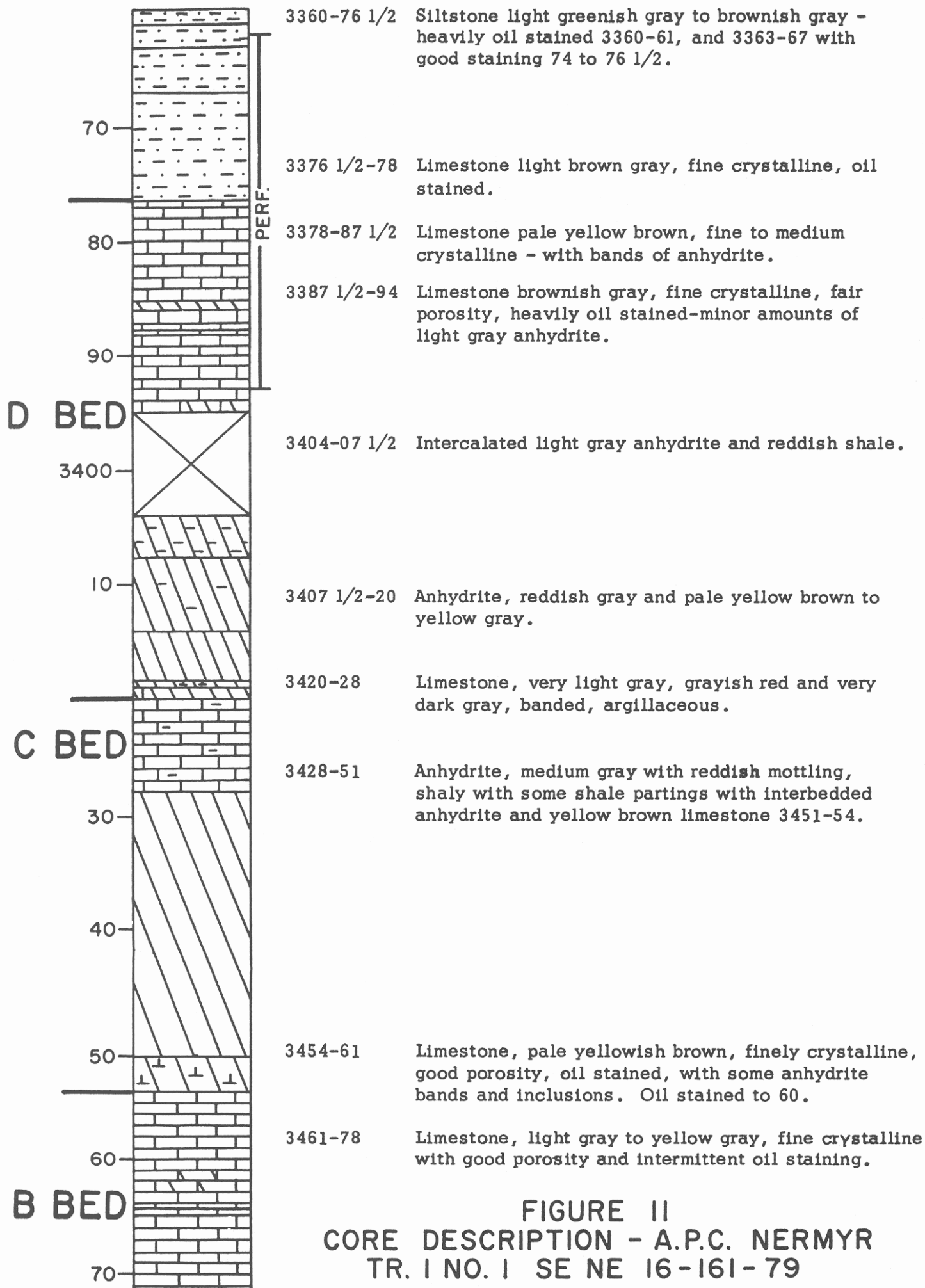


FIGURE II  
 CORE DESCRIPTION - A.P.C. NERMYR  
 TR. I NO. I SE NE 16-161-79



TABLE I

## COMPLETION DATA NEWBURG FIELD

| OPERATOR             | WELL                 | LOCATION             | KB             | TD   | PBD  | PERFED SHOTS |      | FRAC ACID | INITIAL POTENTIAL TEST |       |         |          | COMPLETE | BUYER |             |             |     |
|----------------------|----------------------|----------------------|----------------|------|------|--------------|------|-----------|------------------------|-------|---------|----------|----------|-------|-------------|-------------|-----|
|                      |                      |                      |                |      |      | From         | To   |           | OIL                    | WATER | GAS     | API      |          |       |             |             |     |
| AMERADA PETR. CORP   | A. U. BEAUCHAMP #1   | SESW 21-161-79       | 1473           | 4080 | 3600 | 3403         | 3411 | 8         | 200                    | Yes   | FLOW 73 | 22%      | NETM     | 35.1  | 10 JULY '55 | NWR         |     |
|                      | "                    | L. D. HENRY #1       | NWSE 16-161-79 | 1480 | 3665 | 3615         | 3375 | 3433      | 4                      | 1500  | No      | FLOW 102 | 0        | 74    | 35.9        | 13 SEPT '57 | NWR |
|                      | "                    | ARNOLD NERMYR T-1 #1 | SENE 16-161-79 | 1484 | 3481 | 3437         | 3362 | 3396      | 4                      | 250   | No      | FLOW 209 | 0        | 70    | 36.2        | 5 OCT '57   | NWR |
|                      | "                    | ROLLIN STAIR T-1 #1  | SENW 15-161-79 | 1485 | 3490 | 3441         | 3352 | 3410      | 4                      | 500   | No      | FLOW 211 | 0        | 74    | 36.0        | 17 OCT '57  | NWR |
| CARDINAL DRILLING CO | L. ROTHE #1          | SESE 9-161-79        | 1483           | 3465 | 3417 | 3351         | 3397 | 4         | 500                    | No    | FLOW 37 | 0        | 74       | 36.2  | 4 NOV '57   | NWR         |     |
|                      | LYMAN D. HENRY #1    | NWSE 21-161-79       | 1474           | 3449 | 3416 | 3380         | 3411 | 4         | 250                    | No    | PUMP 77 | 0.1%     | NT       | 37.6  | 9 NOV '57   | IR          |     |
|                      | "                    | S. M. SCHEFLO #1     | SESW 10-161-79 | 1482 | 3477 | 3429         | 3343 | 3393      | 4                      | 500   | No      | FLOW 75  | 5%       | 103   | 36.0        | 11 NOV '57  | NWR |
|                      | "                    | A. KVALHEIM #1       | NWSW 10-161-79 | 1487 | 3479 | 3433         | 3349 | 3397      | 4                      | 500   | No      | FLOW 30  | 3%       | 98    | 36.2        | 24 NOV '57  | NWR |
| AMERADA PETR. CORP   | ROLAND HENRY #2      | SESW 9-161-79        | 1483           | 3417 | 3402 | 3360         | 3394 | 4         | 500                    | No    | PUMP 85 | 31%      | -100     | 37.0  | 5 DEC '57   | IR          |     |
|                      | L. D. HENRY A #1     | SENW 16-161-79       | 1479           | 3471 | 3450 | 3383         | 3396 | 4         | 500                    | No    | FLOW 52 | 0        | 74       | 36.0  | 13 DEC '57  | NWR         |     |
|                      | "                    | L. D. HENRY B #1     | SESE 21-161-79 | 1479 | 3495 | 3458         | 3381 | 3417      | 4                      | 1250  | No      | PUMP 33  | 76.8%    | NETM  | 36.0        | 28 DEC '57  | NWR |
|                      | "                    | A. KVALHEIM A #1     | SENE 9-161-79  | 1483 | 3446 | 3409         | 3356 | 3378      | 4                      | 250   | No      | FLOW 30  | 0        | 72    | 37.9        | 10 JAN '58  | NWR |
| " "                  | "                    | "                    | "              | "    | "    | 3393         | 3404 | "         | "                      | "     | "       | "        | "        | "     | "           | "           |     |
|                      | "                    | R. L. STAIR #1       | NWSW 15-161-79 | 1488 | 3454 | 3417         | 3358 | 3378      | 4                      | 250   | No      | FLOW 20  | 1%       | 81    | 36.2        | 20 JAN '58  | NWR |
|                      | "                    | "                    | "              | "    | "    | 3395         | 3410 | "         | "                      | "     | "       | "        | "        | "     | "           | "           |     |
|                      | "                    | A. KVALHEIM A #2     | SENW 10-161-79 | 1478 | 3435 | 3398         | 3346 | 3365      | 4                      | 500   | No      | FLOW 30  | 0        | 70    | 37.5        | 2 FEB '58   | NWR |
| " "                  | "                    | S. M. SCHEFLO A #1   | NWNE 15-161-79 | 1484 | 3434 | 3412         | 3346 | 3372      | 4                      | 250   | No      | FLOW 92  | 0.5%     | 87    | 36.1        | 13 FEB '58  | NWR |
|                      | "                    | "                    | "              | "    | "    | 3380         | 3396 | "         | "                      | "     | "       | "        | "        | "     | "           | "           |     |
|                      | "                    | ROLAND HENRY #1      | NWSW 9-161-79  | 1487 | 3426 | 3423         | 3369 | 3394      | 6                      | 300   | No      | PUMP 124 | 0        | 82    | 38.3        | 21 FEB '58  | IR  |
|                      | "                    | ROLLIN STAIR T-1 #2  | NWNW 15-161-79 | 1483 | 3441 | 3433         | 3355 | 3380      | 4                      | 250   | No      | PUMP 98  | 1%       | 72    | 36.1        | 24 FEB '58  | NWR |
| CALIFORNIA COMPANY   | "                    | "                    | "              | "    | "    | 3404         | 3425 | "         | "                      | "     | "       | "        | "        | "     | "           | "           |     |
|                      | "                    | A. U. BEAUCHAMP #2   | SENW 21-161-79 | 1482 | 3492 | 3466         | 3397 | 3418      | 4                      | 250   | No      | PUMP 30  | 41%      | 79    | 37.6        | 8 MAR '58   | NWR |
|                      | "                    | L. ROTHE #2          | NWSE 9-161-79  | 1481 | 3397 | "            | 3353 | 3397      | OH                     | 250   | No      | FLOW 31  | 0        | 70    | 36.2        | 17 MAR '58  | NWR |
|                      | "                    | ROLAND HENRY #2      | SENE 8-161-79  | 1485 | 3422 | 3414         | 3365 | 3394      | 6                      | 300   | No      | PUMP 31  | 0.6%     | -100  | 38.2        | 29 MAR '58  | IR  |
| AMERADA PETR. CORP   | ARNOLD NERMYR T-1 #2 | NWNE 16-161-79       | 1484           | 3385 | "    | 3359         | 3385 | OH        | 250                    | No    | PUMP 88 | 0        | 68       | 36.1  | 31 MAR '58  | NWR         |     |
|                      | "                    | L. D. HENRY #2       | SESW 16-161-79 | 1487 | 3498 | 3436         | 3402 | 3435      | 4                      | 250   | No      | FLOW 24  | 4%       | 68    | 35.2        | 6 APR '58   | NWR |
|                      | "                    | ROLAND HENRY #3      | NWNE 8-161-79  | 1480 | 3425 | 3422         | 3366 | 3380      | 8                      | 300   | No      | PUMP 13  | 4%       | -100  | 38.1        | 14 APR '58  | IR  |
|                      | "                    | BERTHA HENRY #1      | SENW 8-161-79  | 1477 | 3439 | 3437         | 3375 | 3390      | 8                      | 1250  | Yes     | PUMP 120 | TRACE    | -100  | 38.1        | 12 MAY '58  | IR  |
| " "                  | "                    | "                    | "              | "    | "    | 3400         | 3408 | "         | "                      | "     | "       | "        | "        | "     | "           | "           |     |
|                      | "                    | BERTHA HENRY #2      | NWNW 8-161-79  | 1475 | 3431 | 3426         | 3376 | 3386      | 8                      | 800   | No      | S 20     | 0.1%     | -100  | 37.9        | 19 MAY '58  | IR  |
|                      | "                    | REGINALD HENRY #1    | SESE 6-161-79  | 1477 | 3461 | 3447         | 3392 | 3401      | 8                      | 250   | No      | S 31     | 0.2%     | -100  | 38.2        | 31 MAY '58  | IR  |
|                      | "                    | "                    | "              | "    | "    | 3390         | 3405 | "         | "                      | "     | "       | "        | "        | "     | "           | "           |     |
| AMERADA PETR. CORP   | L. ROTHE A #1        | SENW 9-161-79        | 1481           | 3452 | 3427 | 3364         | 3390 | 4         | 250                    | No    | FLOW 25 | 3.2%     | 66       | 37.5  | 1 JUN '58   | NWR         |     |
|                      | "                    | "                    | "              | "    | "    | 3397         | 3410 | "         | "                      | "     | "       | "        | "        | "     | "           | "           |     |
|                      | "                    | L. D. HENRY #3       | NWNE 21-161-79 | 1483 | 3500 | 3472         | 3384 | 3422      | 4                      | 250   | No      | PUMP 25  | 69.9%    | N.T.  | 36.2        | 10 JUN '58  | NWR |
|                      | "                    | KENNETH HENRY #1     | NWSE 6-161-79  | 1480 | 3474 | 3431         | 3401 | 3417      | 8                      | NONE  | No      | S 34     | 0.4%     | -100  | 38.1        | 12 JUN '58  | IR  |
| CALIFORNIA COMPANY   | ARNOLD NERMYR T-2 #1 | NWNW 16-161-79       | 1484           | 3488 | 3463 | 3408         | 3422 | 4         | 250                    | No    | PUMP 41 | 0        | N.T.     | 36.2  | 20 JUN '58  | NWR         |     |
|                      | "                    | REGINALD HENRY #2    | SENE 6-161-79  | 1486 | 3459 | 3440         | 3415 | 3422      | 8                      | 350   | No      | S 120    | 0.4%     | -100  | 38.1        | 24 JUN '58  | IR  |
|                      | "                    | "                    | "              | "    | "    | 3392         | 3407 | "         | "                      | "     | "       | "        | "        | "     | "           | "           |     |
|                      | "                    | "                    | "              | "    | "    | 3382         | 3390 | 6         | 500                    | No    | PUMP 35 | 4%       | 658      | 39.0  | 28 JUN '58  | IR          |     |
| HUNT OIL COMPANY     | H. NERMYR #1         | NWNE 31-162-79       | 1489           | 3493 | 3443 | 3382         | 3390 | 6         | 500                    | No    | PUMP 44 | 0        | 97       | 37.4  | 29 JUN '58  | NWR         |     |
|                      | "                    | L. ROTHE A #2        | NWNW 9-161-79  | 1485 | 3400 | "            | 3381 | 3400      | OH                     | 250   | No      | "        | "        | "     | "           | "           |     |

TABLE II

## COMPLETION DATA SOUTH WESTHOPE FIELD

| OPERATOR                                | WELL                | LOCATION       | KB   | TD   | PBD  | PERFED SHOTS |      |   | FRAC<br>ACID | INITIAL POTENTIAL TEST |       |     | COMPLETE | BUYER |      |            |    |
|---|---------------------|----------------|------|------|------|--------------|------|---|--------------|------------------------|-------|-----|----------|-------|------|------------|----|
|   |                     |                |      |      |      | FROM         | TO   |   |              | OIL                    | WATER | GAS |          |       | API  |            |    |
| LEACH OIL CORP                          | RUSSELL R. SMITH #1 | SWSW 14-162-80 | 1507 | 3680 | 3570 | 3425         | 3433 | 6 | 250          | No                     | PUMP  | 25  | 20%      | N.T.  | 37.0 | 28 JAN '57 | IR |
| LUBAR OIL COMPANY                       | P. M. KING #1       | NENW 23-162-80 | 1508 | 3502 | 3465 | 3401         | 3425 | 6 | 500          | No                     | FLOW  | 64  | 1 1/2%   | N.T.  | 37.6 | 10 JUL '57 | IR |
| "                                       | P. M. KING #3       | SWNE 23-162-80 | 1503 | 3704 | 3467 | 3411         | 3422 | 6 | 1250         | No                     | S     | 63  | 3%       | N.T.  | N.T. | 5 OCT '57  | IR |
| "                                       | GEORGE WRIGHT #1    | SWNW 24-162-80 | 1503 | 3480 | 3446 | 3416         | 3435 | 6 | 250          | No                     | PUMP  | 55  | 0        | -100  | 37.0 | 22 JAN '58 | IR |
| CARDINAL DRILLING CO.<br>& LUBAR OIL CO | MOORE E. JENSEN #1  | NESE 15-162-80 | 1498 | 3479 | 3446 | 3415         | 3433 | 4 | 500          | No                     | PUMP  | 20  | 0        | -100  | 37.9 | 24 APR '58 | IR |
| "                                       | KING A #1           | SWSW 24-162-80 | 1493 | 3471 | 3460 | 3410         | 3426 | 4 | 250          | No                     | PUMP  | 38  | 0        | -100  | 38.6 | 2 MAY '58  | IR |
| "                                       | ED WITTEMAN #1      | NENE 22-162-80 | 1500 | 3582 | 3443 | 3411         | 3427 | 4 | 500          | No                     | PUMP  | 37  | 0        | -100  | 38.9 | 7 MAY '58  | IR |
| "                                       | EDWARD E. JENSEN #1 | NESW 11-162-80 | 1496 | 3474 | 3434 | 3378         | 3393 | 4 | 250          | No                     | PUMP  | 47  | 0        | -100  | 38.2 | 20 MAY '58 | IR |

NWR - NORTH-EASTERN REFINERIES - ST. PAUL PARK, MINN.

IR - INTERNATIONAL REFINERIES - WRENSHALL, MINN.

TABLE III  
PRODUCTION DATA

NEWBURG

|             | DAYS<br>PROD. | BBLs<br>OIL | BBLs<br>H <sub>2</sub> O | BBLs/DAY<br>PER WELL<br>AVE. | RUNS   | LEASE<br>USE | MAX. BBLs<br>PER DAY | NO<br>WELLS | ARITH AVE<br>BHP | AVE<br>GOR |
|-------------|---------------|-------------|--------------------------|------------------------------|--------|--------------|----------------------|-------------|------------------|------------|
| <u>1955</u> |               |             |                          |                              |        |              |                      |             |                  |            |
| JULY        | 17            | 176         | 325                      | 10.35                        | 0      | 0            | 55                   | 1           | 1910             |            |
| AUGUST      | 30            | 207         | 776                      | 6.90                         | 0      | 0            | 8                    | 1           |                  |            |
| SEPTEMBER   | 9             | 102         | 381                      | 11.33                        | 473    | 0            | 38                   | 1           |                  |            |
| OCTOBER     | 23            | 165         | 617                      | 7.17                         | 0      | 0            | 32                   | 1           |                  |            |
| NOVEMBER    | 23            | 154         | 576                      | 6.70                         | 0      | 0            | 18                   | 1           |                  |            |
| DECEMBER    | 14            | 358         | 398                      | 25.57                        | 490    | 0            | 42                   | 1           |                  |            |
|             | 116           | 1162        | 3073                     |                              | 963    | 0            |                      |             |                  |            |
| <u>1956</u> |               |             |                          |                              |        |              |                      |             |                  |            |
| JANUARY     | 31            | 675         | 875                      | 21.77                        | 724    | 0            | 28                   | 1           |                  |            |
| FEBRUARY    | 28            | 660         | 855                      | 23.57                        | 735    | 0            | 27                   | 1           |                  |            |
| MARCH       | 31            | 687         | 1105                     | 22.16                        | 725    | 0            | 25                   | 1           |                  |            |
| APRIL       | 30            | 570         | 877                      | 19.00                        | 482    | 0            | 27                   | 1           |                  |            |
| MAY         | 30            | 581         | 1162                     | 19.37                        | 484    | 0            | 28                   | 1           |                  |            |
| JUNE        | 30            | 554         | 1108                     | 18.47                        | 719    | 0            | 23                   | 1           |                  |            |
| JULY        | 31            | 537         | 1402                     | 17.32                        | 475    | 0            | 20                   | 1           |                  |            |
| AUGUST      | 31            | 529         | 1381                     | 17.06                        | 479    | 0            | 18                   | 1           |                  |            |
| SEPTEMBER   | 30            | 503         | 1244                     | 16.77                        | 727    | 0            | 25                   | 1           |                  |            |
| OCTOBER     | 31            | 578         | 1428                     | 18.65                        | 485    | 0            | 20                   | 1           |                  |            |
| NOVEMBER    | 29            | 551         | 1363                     | 19.00                        | 494    | 0            | 27                   | 1           |                  |            |
| DECEMBER    | 31            | 578         | 1430                     | 18.65                        | 488    | 0            | 20                   | 1           |                  |            |
|             | 363           | 7003        | 14230                    |                              | 7017   | 0            |                      |             |                  |            |
| <u>1957</u> |               |             |                          |                              |        |              |                      |             |                  |            |
| JANUARY     | 31            | 590         | 1459                     | 19.03                        | 742    | 0            | 20                   | 1           |                  |            |
| FEBRUARY    | 28            | 517         | 1279                     | 18.46                        | 488    | 0            | 19                   | 1           |                  |            |
| MARCH       | 31            | 548         | 1355                     | 17.68                        | 488    | 0            | 18                   | 1           |                  |            |
| APRIL       | 30            | 485         | 1266                     | 16.17                        | 482    | 0            | 18                   | 1           |                  |            |
| MAY         | 31            | 497         | 1299                     | 16.03                        | 483    | 0            | 18                   | 1           |                  |            |
| JUNE        | 30            | 507         | 1491                     | 16.90                        | 482    | 0            | 18                   | 1           |                  |            |
| JULY        | 31            | 538         | 1583                     | 17.35                        | 481    | 0            | 18                   | 1           |                  |            |
| AUGUST      | 31            | 541         | 1591                     | 17.45                        | 478    | 0            | 20                   | 1           |                  |            |
| SEPTEMBER   | 39            | 867         | 1483                     | 22.23                        | 701    | 109          | 55                   | 2           |                  |            |
| OCTOBER     | 267           | 10160       | 11258                    | 38.05                        | 3600   | 384          | 306                  | 4           |                  |            |
| NOVEMBER    | 132           | 9410        | 474                      | 71.29                        | 9306   | 448          | 1090                 | 9           |                  |            |
| DECEMBER    | 176           | 11812       | 2354                     | 67.11                        | 10832  | 206          | 1037                 | 11          |                  |            |
|             | 857           | 36472       | 26891                    |                              | 28563  | 1147         |                      |             |                  |            |
| <u>1958</u> |               |             |                          |                              |        |              |                      |             |                  |            |
| JANUARY     | 256           | 18046       | 4735                     | 74.40                        | 16921  | 221          | 1089                 | 13          |                  |            |
| FEBRUARY    | 200           | 12532       | 6441                     | 62.66                        | 10501  | 88           | 1492                 | 17          |                  |            |
| MARCH       | 324           | 22140       | 4840                     | 68.33                        | 21090  | 0            | 1705                 | 21          | 1666             | 70         |
| APRIL       | 542           | 36699       | 7083                     | 67.71                        | 37483  | 710          | 1706                 | 23          |                  |            |
| MAY         | 653           | 43326       | 6805                     | 66.35                        | 42575  | 620          | 1430                 | 25          |                  |            |
| JUNE        | 794           | 51242       | 5939                     | 64.54                        | 52543  | 963          | 2324                 | 33          |                  |            |
|             | 2789          | 184985      | 35843                    |                              | 181113 | 2602         |                      |             |                  |            |
|             | 4105          | 229622      | 80037                    | 55.94                        | 217656 | 3749         |                      |             |                  |            |

WATER-OIL RATIO = 0.349

TABLE IV  
 PRODUCTION DATA  
 SOUTH WESTHOPE

|             | DAYS<br>PROD. | BBLs<br>OIL | BBLs<br>H <sub>2</sub> O | BBLs/DAY<br>PER WELL<br>AVE. | RUNS  | LEASE<br>USE | MAX. BBLs<br>PER DAY | NO.<br>WELLS | ARITH AVE<br>BHP | GOR  |
|-------------|---------------|-------------|--------------------------|------------------------------|-------|--------------|----------------------|--------------|------------------|------|
| <u>1957</u> |               |             |                          |                              |       |              |                      |              |                  |      |
| JANUARY     | 20            | 504         | 37                       | 25.2                         | 239   | 0            | 90                   | 1            | 1830             | -100 |
| FEBRUARY    | 18            | 487         | 92                       | 27.1                         | 472   | 0            | 50                   | 1            |                  |      |
| MARCH       | 25            | 484         | 93                       | 19.4                         | 474   | 0            | 30                   | 1            |                  |      |
| APRIL       | 26            | 621         | 130                      | 23.9                         | 711   | 0            | 33                   | 1            |                  |      |
| MAY         | 31            | 597         | 148                      | 19.3                         | 717   | 0            | 27                   | 1            |                  |      |
| JUNE        | 30            | 564         | 140                      | 18.8                         | 479   | 0            | 23                   | 1            |                  |      |
| JULY        | 51            | 1751        | 138                      | 34.3                         | 1576  | 0            | 92                   | 2            |                  |      |
| AUGUST      | 59            | 2015        | 118                      | 34.2                         | 1932  | 0            | 91                   | 2            |                  |      |
| SEPTEMBER   | 56            | 1865        | 120                      | 33.3                         | 1680  | 209          | 92                   | 3            |                  |      |
| OCTOBER     | 86            | 3258        | 118                      | 37.9                         | 3447  | 237          | 275                  | 3            |                  |      |
| NOVEMBER    | 81            | 4286        | 146                      | 52.9                         | 4075  | 0            | 220                  | 3            | 835              | -100 |
| DECEMBER    | 87            | 4792        | 125                      | 55.1                         | 5011  | 0            | 247                  | 3            |                  |      |
|             | 570           | 21224       | 1405                     |                              | 20813 | 446          |                      |              |                  |      |
| <u>1958</u> |               |             |                          |                              |       |              |                      |              |                  |      |
| JANUARY     | 112           | 5878        | 118                      | 52.5                         | 5607  | 110          | 320                  | 4            |                  |      |
| FEBRUARY    | 105           | 5476        | 96                       | 52.2                         | 4911  | 0            | 241                  | 4            |                  |      |
| MARCH       | 108           | 5631        | 99                       | 52.1                         | 5788  | 0            | 288                  | 4            |                  |      |
| APRIL       | 116           | 5479        | 84                       | 47.2                         | 5481  | 87           | 327                  | 6            |                  |      |
| MAY         | 226           | 9217        | 55                       | 40.8                         | 8182  | 120          | 452                  | 8            | 1019             | -100 |
| JUNE        | 227           | 8965        | 46                       | 39.5                         | 9625  | 0            | 406                  | 8            |                  |      |
|             | 894           | 40646       | 498                      |                              | 39594 | 317          |                      |              |                  |      |
|             | 1484          | 61870       | 1903                     |                              | 60407 | 763          |                      |              |                  |      |

WATER-OIL RATIO = 0.031