OPEN FILE 84-8

# ESTIMATED OIL AND GAS RESERVES FOR BACA COUNTY, COLORADO

Compiled by
A. H. Scanlon

Funded by the Department of Local Affairs--
Division of Commerce and Development

Colorado Geological Survey
Department of Natural Resources
State of Colorado
Denver, Colorado
1984

# OPEN FILE 84-08

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Acknowledgments

I would like to thank the staff of the Colorado Oil & Gas Conservation Commission (C.O.G.C.C.) who provided considerable assistance during the course of this compilation, and the staff of the Colorado Geological Survey, who assisted in the manuscript preparation.

However, I assume full responsibility for any errors or omissions in these tabulations. Users of this OPEN-FILE REPORT could provide a significant service if they would inform the Colorado Geological Survey of any misinformation or omissions.

This project was completed by the staff of the Colorado Geological Survey as part of a grant from the Department of Local Affairs - Division of Commerce and Development.

A. H. Scanlon
Senior Geologist

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# ESTIMATED OIL AND GAS RESERVES FOR BACA COUNTY, COLORADO

## Introduction

This report is the sixth* in a series of oil and gas reserve investigations undertaken for those counties in which oil and/or gas is currently being produced.

This study involves Baca County, located in the southeastern corner of Colorado. The eastern edge of this county is part of the Hugoton Embayment. Baca County covers 2,565 square miles. In this county, oil and/or gas are produced from, in descending order of age, the Red Cave (Lyons) Sandstone, Wabaunsee Carbonate, Topeka Carbonate, Lansing Limestone, Morrowan Sandstone and Keyes Sandstone.

There are 10 fields considered active producers as of September 30, 1983. Of these, 3 are classified as oil fields (based on cumulative gas-oil ratio (GOR) of <15:1), and 7 are classified as gas fields (based on cumulative GOR >15:1).

* Refer to:
OPEN-FILE REPORT 84-3: Estimated Oil and Gas Reserves for Washington County, Colorado;
OPEN-FILE REPORT 84-4: Estimated Oil and Gas Reserves for Rio Blanco County, Colorado;
OPEN-FILE REPORT 84-5: Estimated Oil and Gas Reserves for Adams County, Colorado;
OPEN-FILE REPORT 84-6: Estimated Oil and Gas Reserves for Weld County, Colorado; and
OPEN-FILE REPORT 84-7: Estimated Oil and Gas Reserves for Arapahoe County, Colorado.

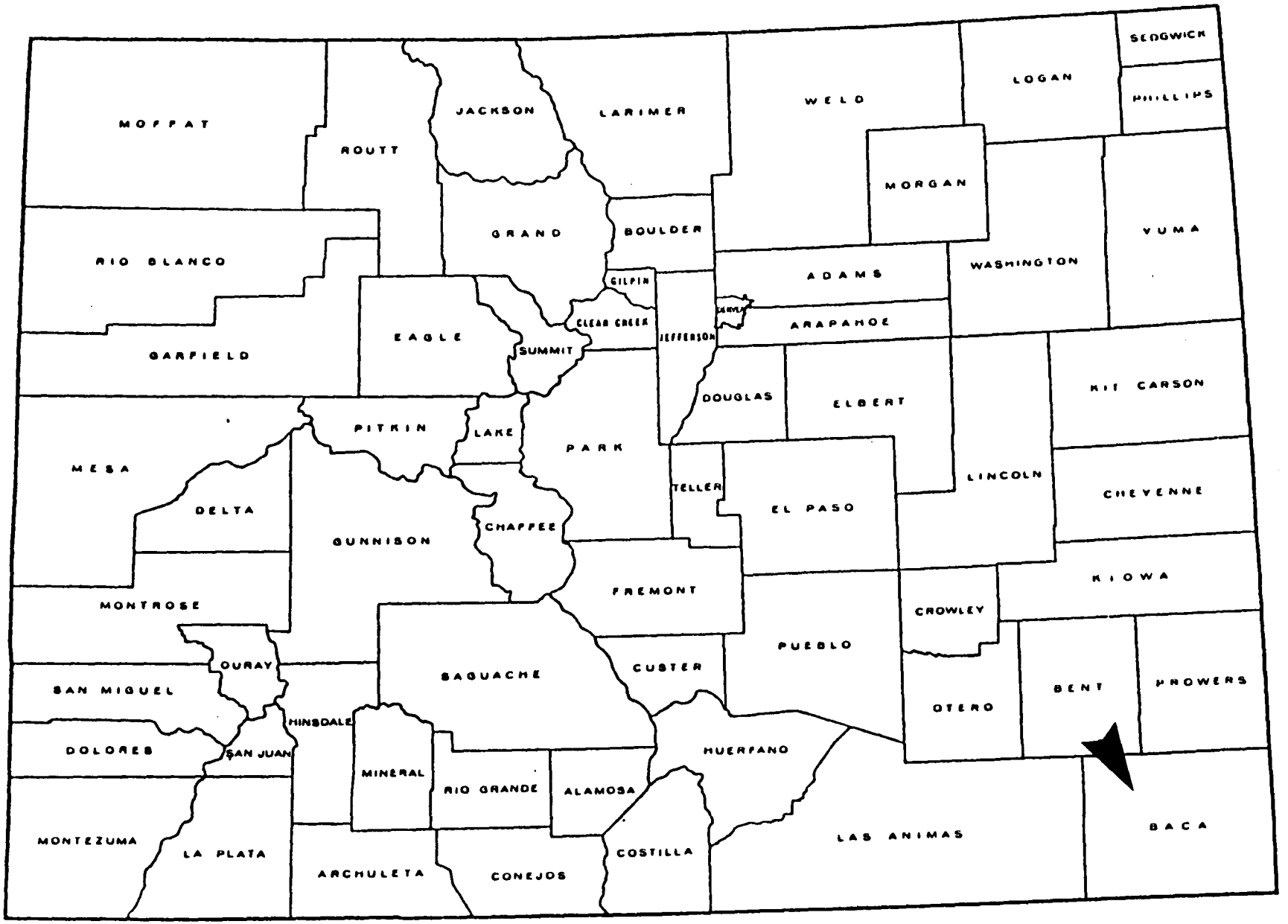



Figure 1. County Location Map

## Method of Approach

Production decline curves are plotted for each currently producing horizon within each field, hereafter referred to as a field-horizon. There are 17 production decline curves plotted, one for each field-horizon. Production data were obtained from the C.O.G.C.C. annual production books. These books contain records of yearly production data, dating back to 1952. All production decline curves are plotted as rate (annual production in barrels of oil or MCF of gas) versus time (in years). The rate scale was adjusted to accommodate each field-horizon.

## Oil Reserve Calculations

There are 4 oil field-horizons. Production histories have allowed for decline rates to be calculated for 3 of these. The remaining oil field-horizon has not produced for a long enough time (less than 1 year) to determine a reliable decline rate. For the previously mentioned 3 fields, decline rates were determined based on actual past production and recorded, see Table I. These decline rates were then applied to the equation:

$$Rr = \frac{q1 - qf}{-\ln (1-dy)}$$

where: Rr = remaining reserves
q1 = current annual production
qf = final economic production rate (see note below.)
-ln = negative natural log
dy = yearly decline rate (in percent)

The ultimate recoverable was then determined by adding the estimated reserves to the cumulative production. These values are listed in Table I.

Note: the final economic production rate used was one barrel of oil per day per well, for one year; therefore 365 barrels, multiplied by the number of wells needed to keep field production economic. In most cases this was one well. The number of wells used was determined at the discretion of the author.

For associated gas production, estimated reserves were calculated in the same manner as that described in the Gas Reserve Calculations section.

## Gas Reserve Calculations

There are 13 gas field-horizons. Production histories have allowed for decline rates to be calculated for 9 of these. The remaining 4 gas field-horizons have not produced for a long enough time (less than 3 years) to determine a reliable decline rate. Decline rates were determined for the 13 previously mentioned field-horizons (see Table I) and applied to the equation:

$$S = \frac{a(1-r^n)}{1-r}$$

Where: S = gas reserves
a = current annual gas production
r = (1-dy) where dy = annual decline rate
n = number of years -- 20 years was used in all cases except where noted in the remarks column of Table I.

Results can be found in Table I.

For the associated oil production, where this production was significant, the same method to determine estimated oil reserves was used, as discussed in the previous section. Whether oil production was considered significant or not was determined by the author. In all cases, if oil production indicated any kind of trend, reserves were calculated. A few cases arose where oil production, though a trend was indicated, did not exceed the economic limit (as discussed previously) of one barrel of oil per day per year, and therefore no reserve estimate was calculated, or an economic limit of zero was used.

Results

The following figures are for those field-horizons for which reserves could be calculated. Estimated oil reserves for Baca County totaled 1,064,172 barrels. Estimated gas reserves for Baca County totaled 32,556,964 MCF. Note that the gas reserve calculations are based on a 20-year projection, therefore they do not account for gas production after the year 2002.

These figures also do not account for production increases due to secondary and/or tertiary recovery not already in progress, or account for undiscovered reserves, nor do they reflect changes in economics or demand.

In 11 to 12 years, roughly half of the estimated oil reserves in Baca County will have been produced. Roughly one half of the estimated gas reserves for the next 20-year period are expected to be produced in approximately four years.

In this county there are two classes of field-horizons: I) those with a long enough production history to calculate reserves with confidence, and II) those new field-horizons with essentially no production history, or for other reasons, reserves cannot be calculated.

To be able to calculate total county oil and gas reserves, it was necessary to apply the overall decline rates (5.6 percent per year for oil and 15.6 percent per year for gas) obtained from class I field-horizons to the current production from Class II field-horizons.

Using this approach on current production from Class II field-horizons (8,132 Bbls. of oil and 41,841 MCF of gas) additional reserves of 109,441 Bbls. of oil and 259,189 MCF of gas were obtained. This gives total county reserves (Class I and II) of 1,173,613 Bbls. of oil and 32,816,153 MCF of gas.

To insure that the reserve figures calculated for Class II are reasonable using this method, a comparison was made between the sources (producing horizons) of the Class I and Class II field-horizons. It was determined that there were some significant differences in the sources of production for the two groups. Therefore, it is concluded that the overall decline rates applied are somewhat questionable for the Class I estimated reserves.

## LIST OF ABBREVIATIONS USED IN TABLE OF RESERVE DATA

| | |
|---|---|
| 'a' | annual gas production |
| ABD. | abandoned |
| Approx. | approximate, approximately |
| Avg. | average, averaged |
| Bbls. | barrels |
| B.W.E. | Bottom Water Encrochment |
| calc. | calculate, calculated |
| Co.(s) | county (counties) |
| cond. | condensate |
| ck. | Creek |
| Cum. | cumulative |
| Dak. | Dakota Sandstone |
| Deplet. | Depletion |
| dy | annual decline rate |
| Econ. | Economic |
| Est. | Estimated |
| Exp. | Expansion |
| g | gas |
| Gas Exp. | Gas Expansion |
| G.C.E. | Gas Cap Expansion |
| G.E. | Gas Expansion |
| GOR | Gas-Oil Ratio |
| Inc. | Increase, increasing, increased |
| Inj. | Injection, injected |
| Lmtd. | Limited |
| MCF | Thousand cubic feet |
| Miss. | Mississippian |
| Mos. | Months |
| Mtn. | Mountain |
| N | North |
| N.P. | New Production or less than five years production, therefore, no reliable annual decline rate could be calculated to apply to the equations to calculate reserves. |
| No. | number, numbers, North |
| o | oil |
| P and A | Plug (ged) and Abandon (ed) |
| Poss. | Possible |
| Prod. | Production, produced |
| Proj. | Projection, projected |
| q | current annual production of oil |
| qf | final economic production of oil |
| react. | reactivated |
| Rr | Remaining reserves-oil |
| S | Remaining reserves-gas |
| S.G.D. | Solution Gas Drive |
| S.I.(SI) | Shut-in |
| So | South |
| W | West |
| W.D. | Water Drive |
| Yr or Yrs | Year or years |

TABLE I
OPEN FILE 84-8
RESERVE DATA FOR BACA COUNTY

| FIELD NAME/ PRODUCING HORIZON | LOCATION | DATE OF DISCOVERY | TYPE OF DRIVE | Dy | CUMULATIVE PRODUCTION 12/31/82 | | ESTIMATED RESERVES | | ULTIMATE RECOVERABLE | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | OIL (Bbls.) ()Condensate (Bbls.) | GAS (MCF) | OIL (Bbls.) | GAS (MCF) | OIL (Bbls.) ()Condensate (Bbls.) | GAS (MCF) | |
| 1. Campo/Lansing | 3S-46W | 1983 | | | 8,132 | | | | | | N.P. Cum.Prod. is thru 9/83. |
| 2. Flank/Morrow | 33 & 34S-42 & 43W | 1961 | | 7.1 -o | 1,540,282 ( 1915 ) | 6,354,932 | 592,927 | See Remarks | 2,133,209 (+ 1915) | +6,354,932 | No Gas Prod. in '80,'82,'83 |
| 3. Flank/Topeka | 33 & 34S-42 & 43W | 1965 | | | | 445,123 | | | | | Gas Prod. has been SI Last 3 years. |
| 4. Greenwood/ Morrow | 32-35S - 41 & 42W | 1968 | | 2.9 -o<br>8.5 -g | 227,797 | 141,393 | 345,036 | 26,664 | 572,833 | 168,057 | |
| 5. Greenwood/ Red Cave | 32-35S - 41 & 42W | 1973 | | 11.5 -g | | 631,450 | | 448,800 | | 1,080,250 | |
| 6. Greenwood/ Topeka-Lansing | 32-35S - 41 & 42W | 1954 | Depletion | 9.5 -g | 356 | 10,004,868 | | 4,159,196 | +356 | 14,164,064 | |
| 7. Midway/Lansing | 33S - 42W | 1980 | | | | 16,671 | | | | | N.P. |
| 8. Midway/Morrow | 33S - 42W | 1965 | | 5.2 -g | (2132) | 642,140 | | 80,625 | (+2132) | 722,765 | |
| 9. Midway/Topeka | 33S - 42W | 1965 | Depletion | 7.6 -g | | 10,723,328 | | 1,409,752 | | 12,133,080 | |
| 10.Playa/Topeka | 32S - 44W | 1967 | Depletion | 9.3 -g | | 10,111,693 | | 1,701,959 | | 11,813,652 | |
| 11.Stonington/ Topeka | 31S - 42W | 1976 | Depletion | 18.2 -g | | 2,746,489 | | 2,580,675 | | 5,327,164 | |
| 12.Verde/Keyes | 34S - 42W | 1972 | | 5.8 -o | 88,948 | 1,412 | 126,209 | | 215,157 | +1,412 | |
| 13.Vilas/Topeka | 30-32S - 44 & 45W | 1968 | Depletion | 12.8 -g | | 22,138,541 | | 12,505,367 | | 34,643,908 | |
| 14.Walsh/Topeka | 31S - 43W | 1962 | Depletion | 3.7 -g | (18) | 18,024,132 | | 8,579,754 | (+18) | 26,603,886 | NOTE-Used 83 Prod. for 'a' thru 9/83 |
| 15.Walsh/Topeka/ Wabaunsee | 31S - 43W | 1982 | Depletion | | | 23,937 | | | | | N.P. |
| 16.Walsh/ Wabaunsee | 31S - 43W | 1981 | | | | 33,883 | | | | | N.P. |
| 17.Windmill/ Topeka 'C' | 32S - 42W | 1975 | Depletion | 10.1 g | (13) | 779,061 | | 1,351,873 | (+13) | 2,130,934 | |
| COUNTY TOTAL OF ESTIMATED RESERVES | | | | | | | 1,064,172 Bbls. | 32,556,964 MCF | | | |

## Reference List

Colorado Oil and Gas Conservation Commission Production Records and Injected Fluids - Water and/or Gas-File.

Crouch, M.C., III, editor, 1982 Oil and Gas Fields of Colorado, Nebraska and Adjacent Areas: Rocky Mountain Association of Geologists, vols. I and II, 791 pp.

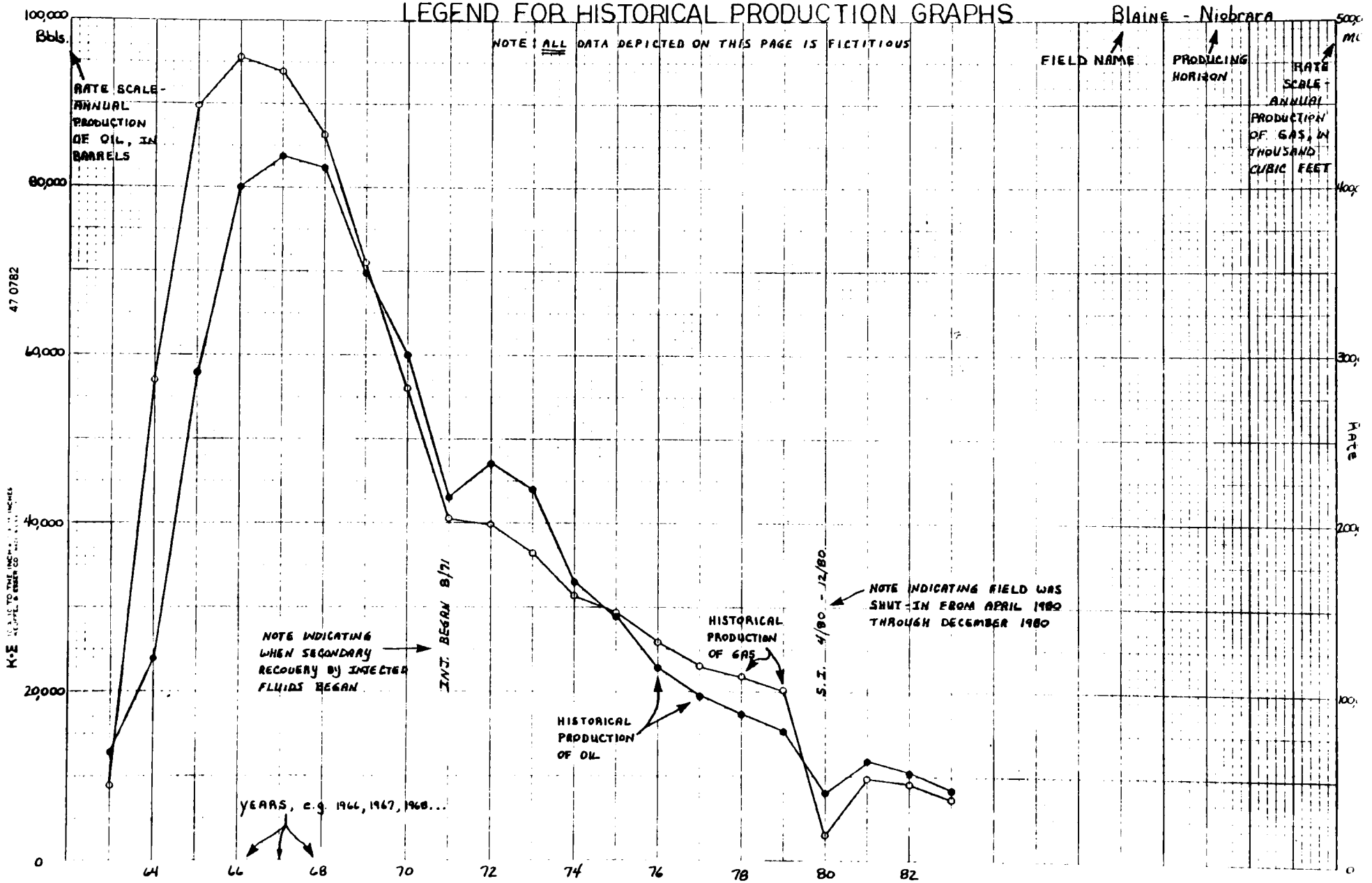
Haun, J.D., Cardwell, A.L., Herrod, W.H. and Cronoble, J.M., 1976. Oil and Gas Reserves of Colorado in Colorado School of Mines Research Institute, Mineral Industries Bulletin, v. 19, #5.

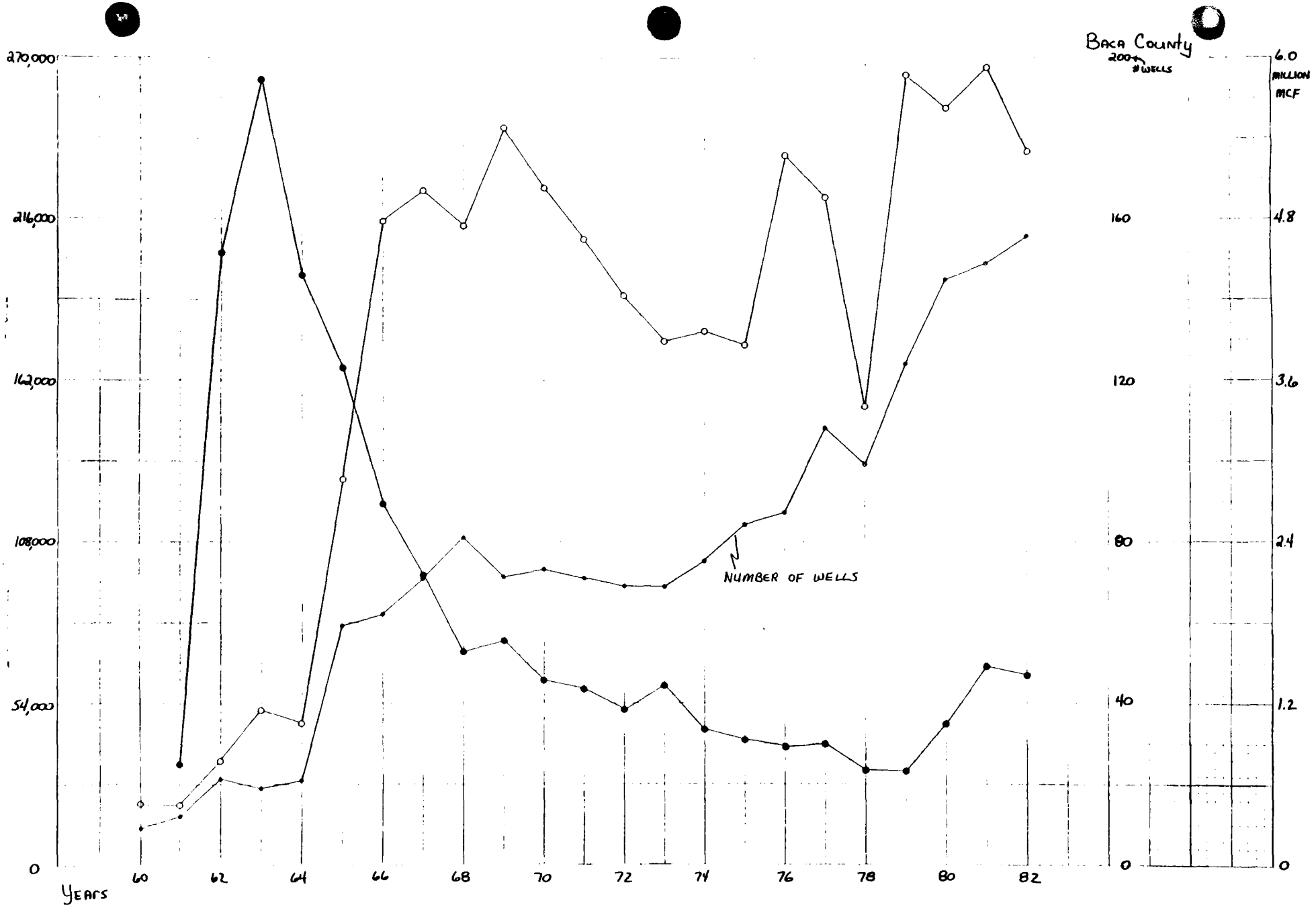
Parker, J.M., editor, 1961 Oil and Gas Field volume: Colorado-Nebraska: Rocky Mountain Association of Geologists, 389 pp.

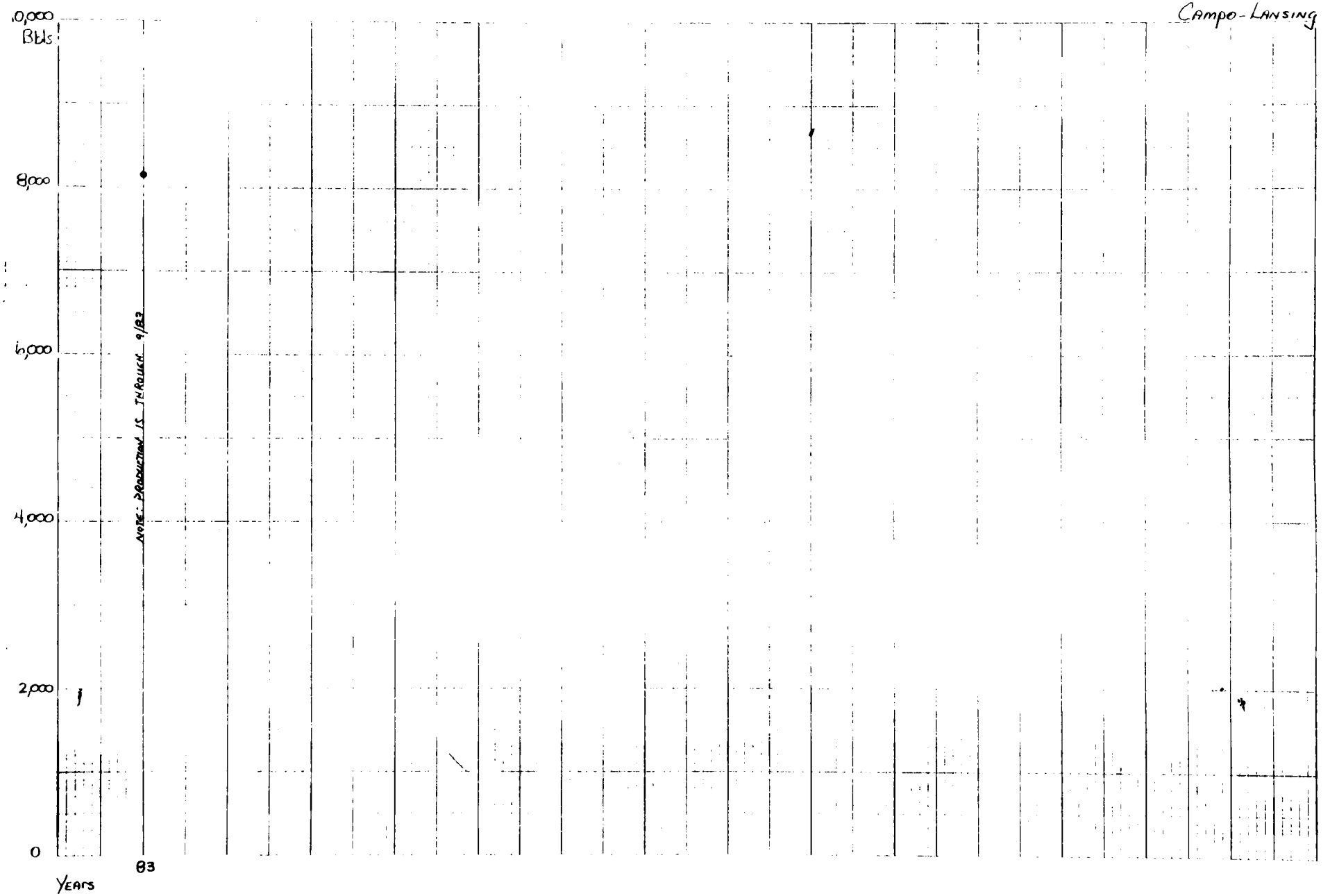
## Appendix I

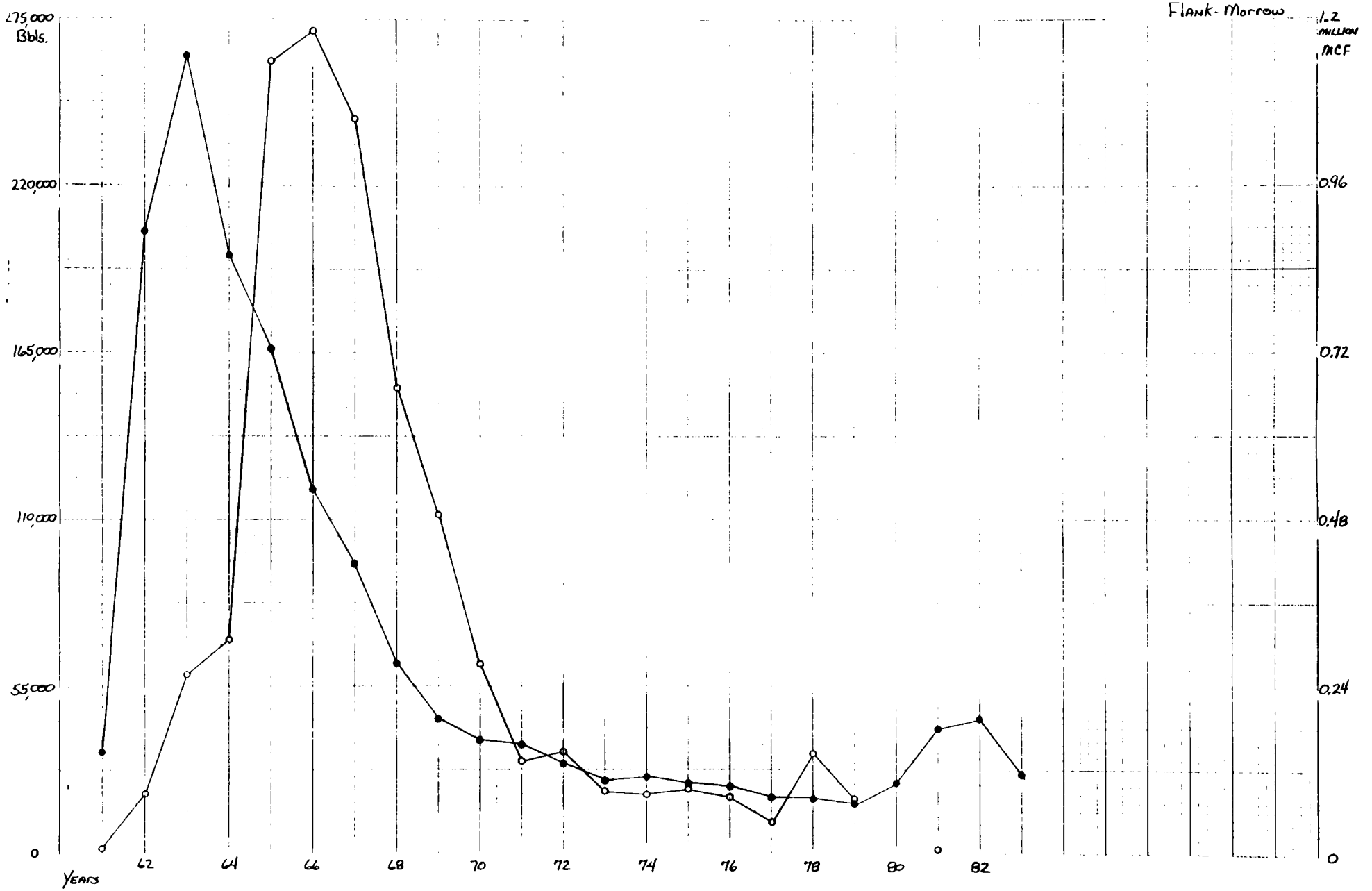
Historical production decline curve graphs for Baca County. These graphs are presented in alphabetical order by Field name and then by producing horizons within each field.

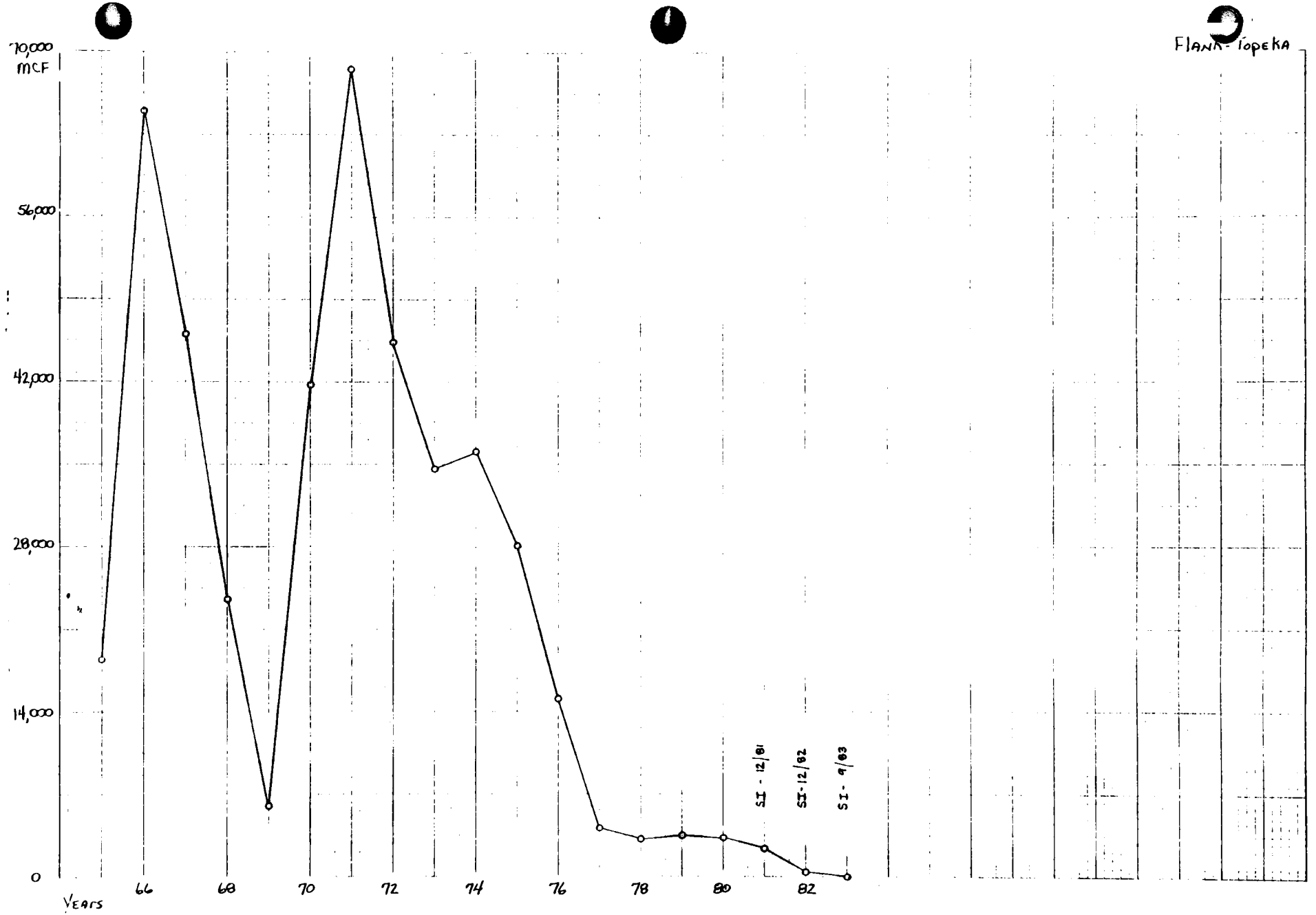
Note that only those fields actively producing as of 9-30-83 are included. Abandoned fields or field-horizons are <u>not</u> included.

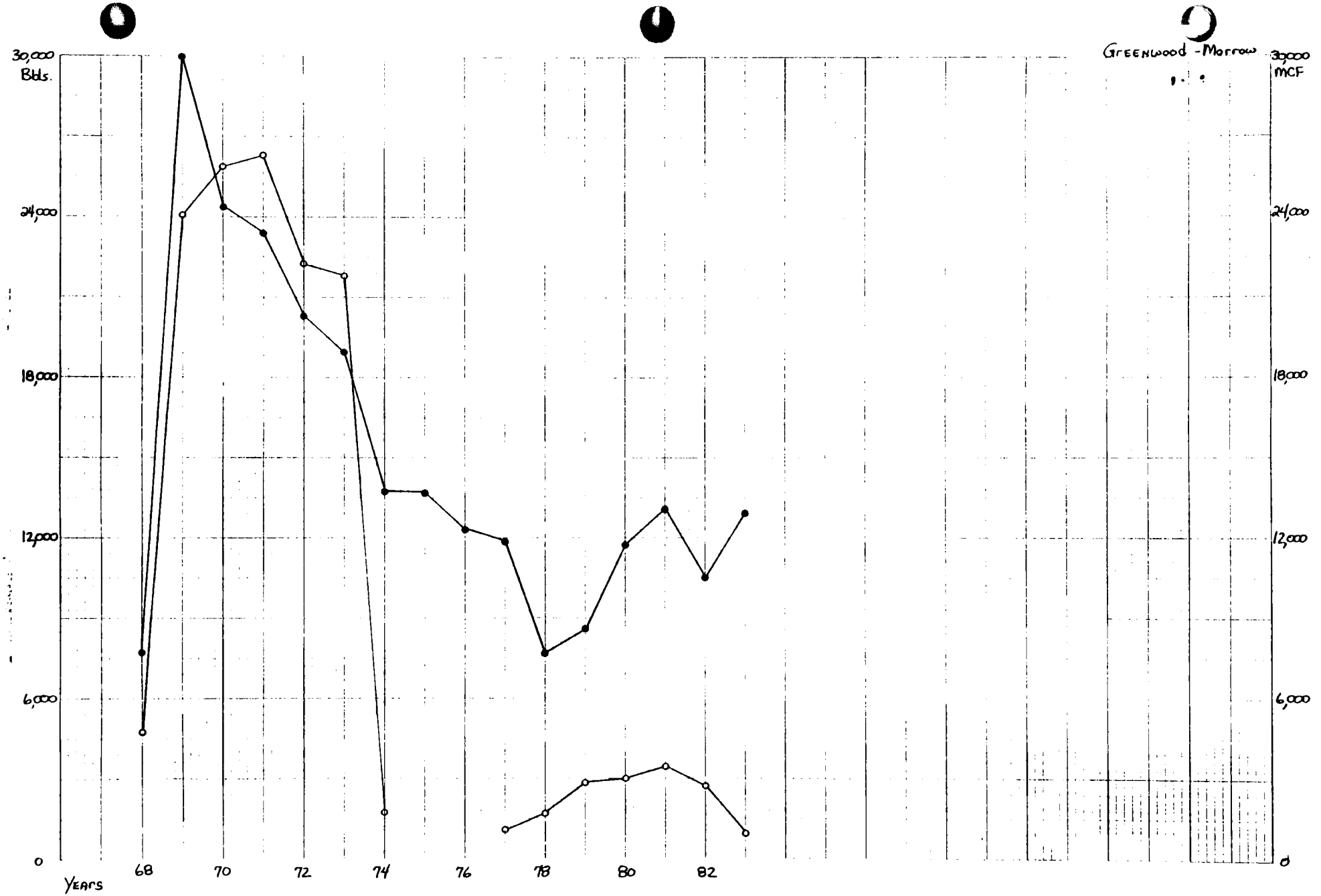

LEGEND FOR HISTORICAL PRODUCTION GRAPHS
NOTE: ALL DATA DEPICTED ON THIS PAGE IS FICTITIOUS
Blaine - Niobrara
FIELD NAME
PRODUCING HORIZON
RATE SCALE - ANNUAL PRODUCTION OF GAS, IN THOUSAND CUBIC FEET
RATE SCALE - ANNUAL PRODUCTION OF OIL, IN BARRELS
100,000 Bbls.
80,000
60,000
40,000
20,000
0
500
400
300
200
100
0
64
66
68
70
72
74
76
78
80
82
YEARS, e.g. 1966, 1967, 1968...
NOTE INDICATING WHEN SECONDARY RECOVERY BY INJECTED FLUIDS BEGAN
INJ. BEGAN 8/71
HISTORICAL PRODUCTION OF OIL
HISTORICAL PRODUCTION OF GAS
S.I. 4/80 - 12/80
NOTE INDICATING FIELD WAS SHUT-IN FROM APRIL 1980 THROUGH DECEMBER 1980
47 0782

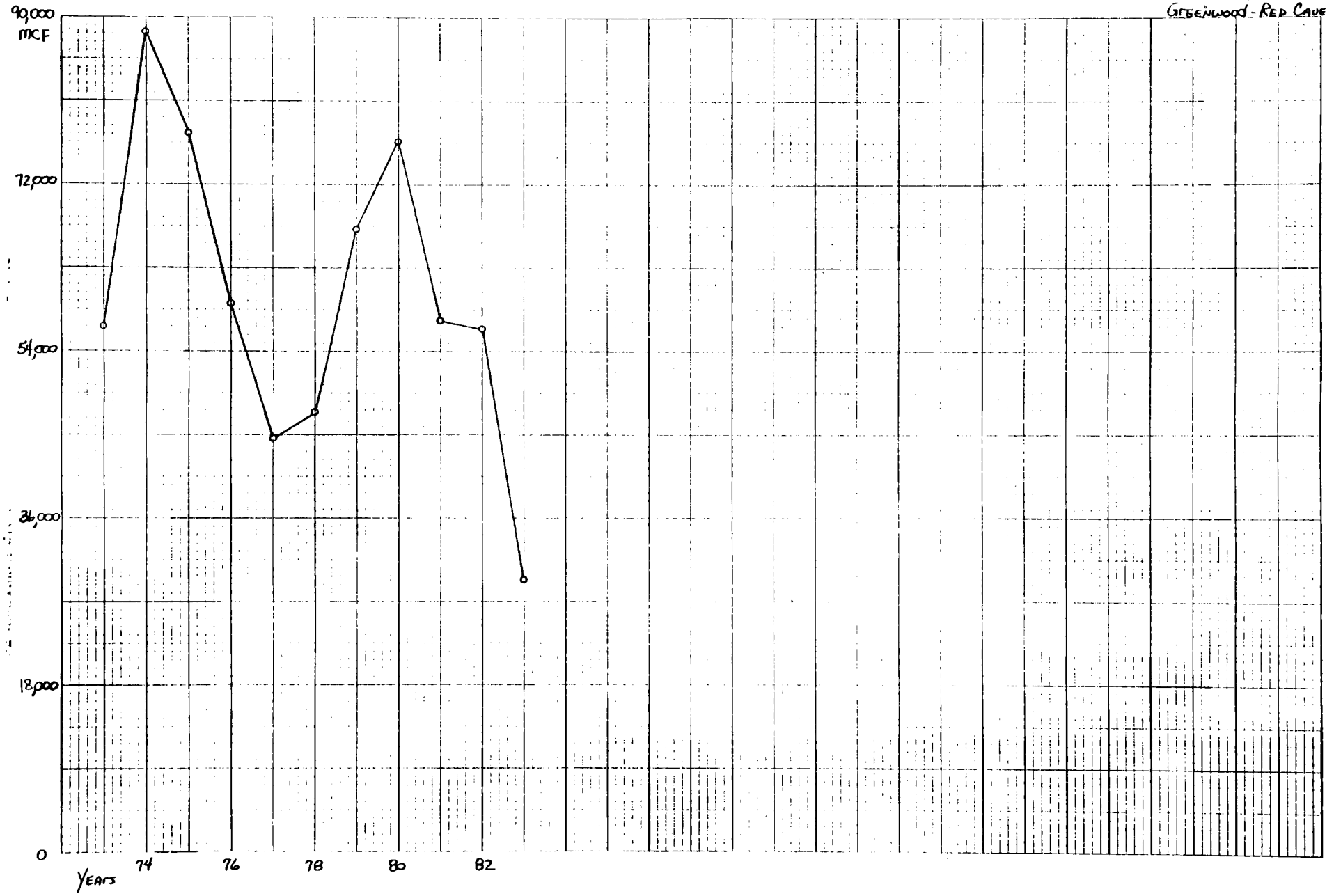

Baca County
200 # WELLS
270,000
216,000
162,000
108,000
54,000
0
160
120
80
40
0
6.0
MILLION MCF
4.8
3.6
2.4
1.2
0
NUMBER OF WELLS
YEARS
60
62
64
66
68
70
72
74
76
78
80
82

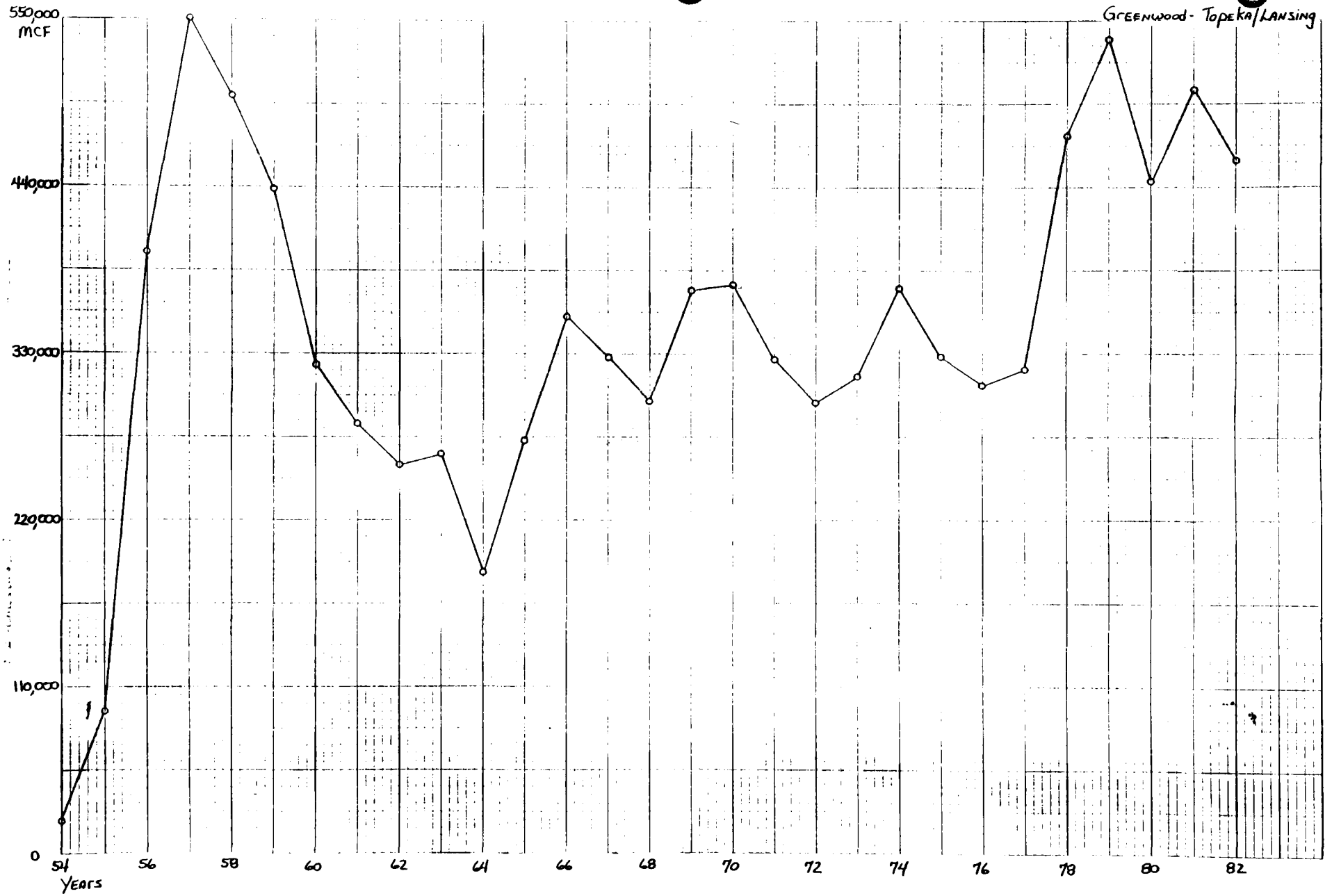

CAMPO-LANSING
10,000
BBLS
8,000
6,000
4,000
2,000
0
NOTE: PRODUCTION IS THROUGH 9/83
83
YEARS

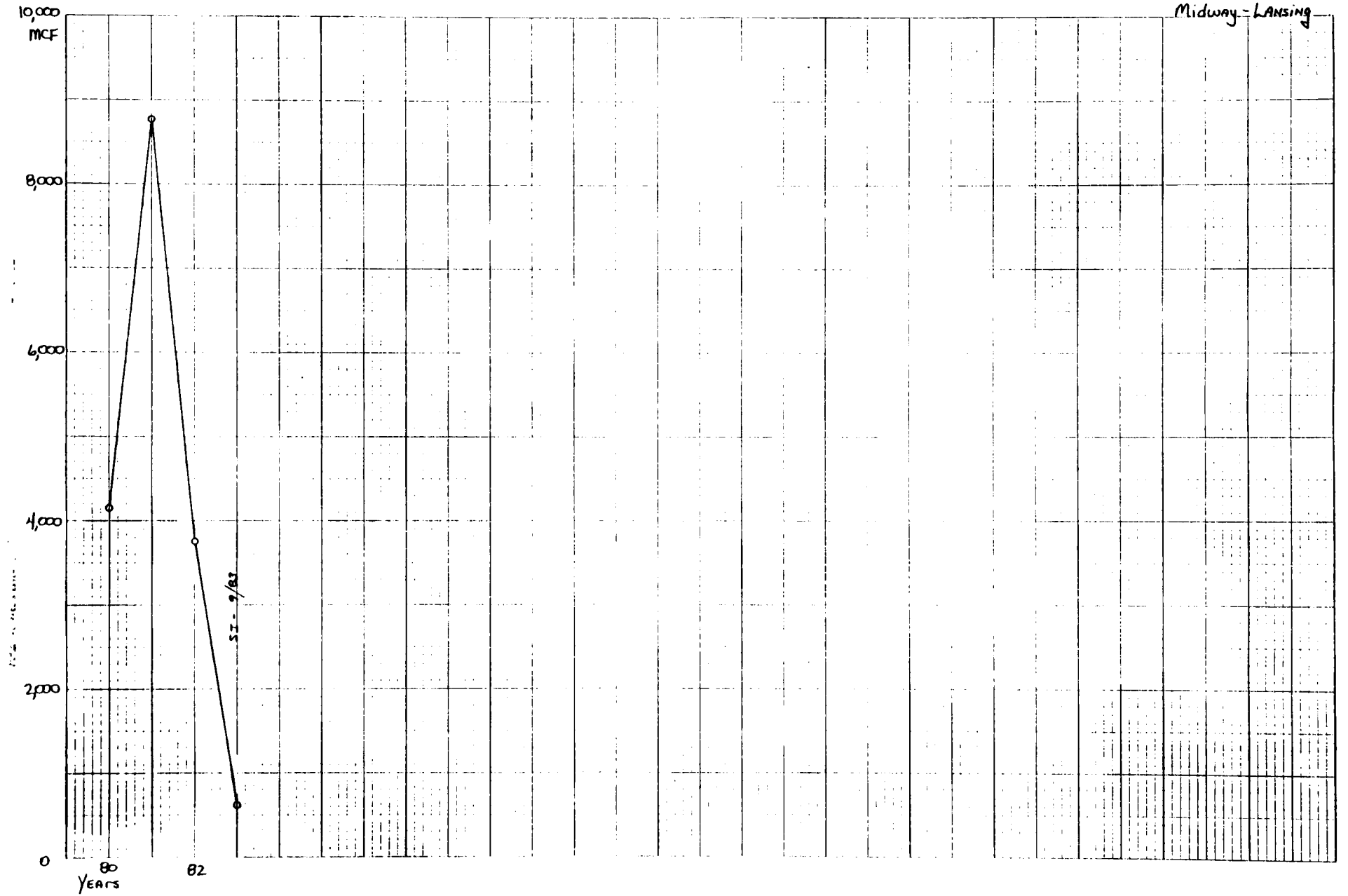

Flank-Morrow
275,000 Bbls.
220,000
165,000
110,000
55,000
0
1.2 million MCF
0.96
0.72
0.48
0.24
0
Years
62
64
66
68
70
72
74
76
78
80
82

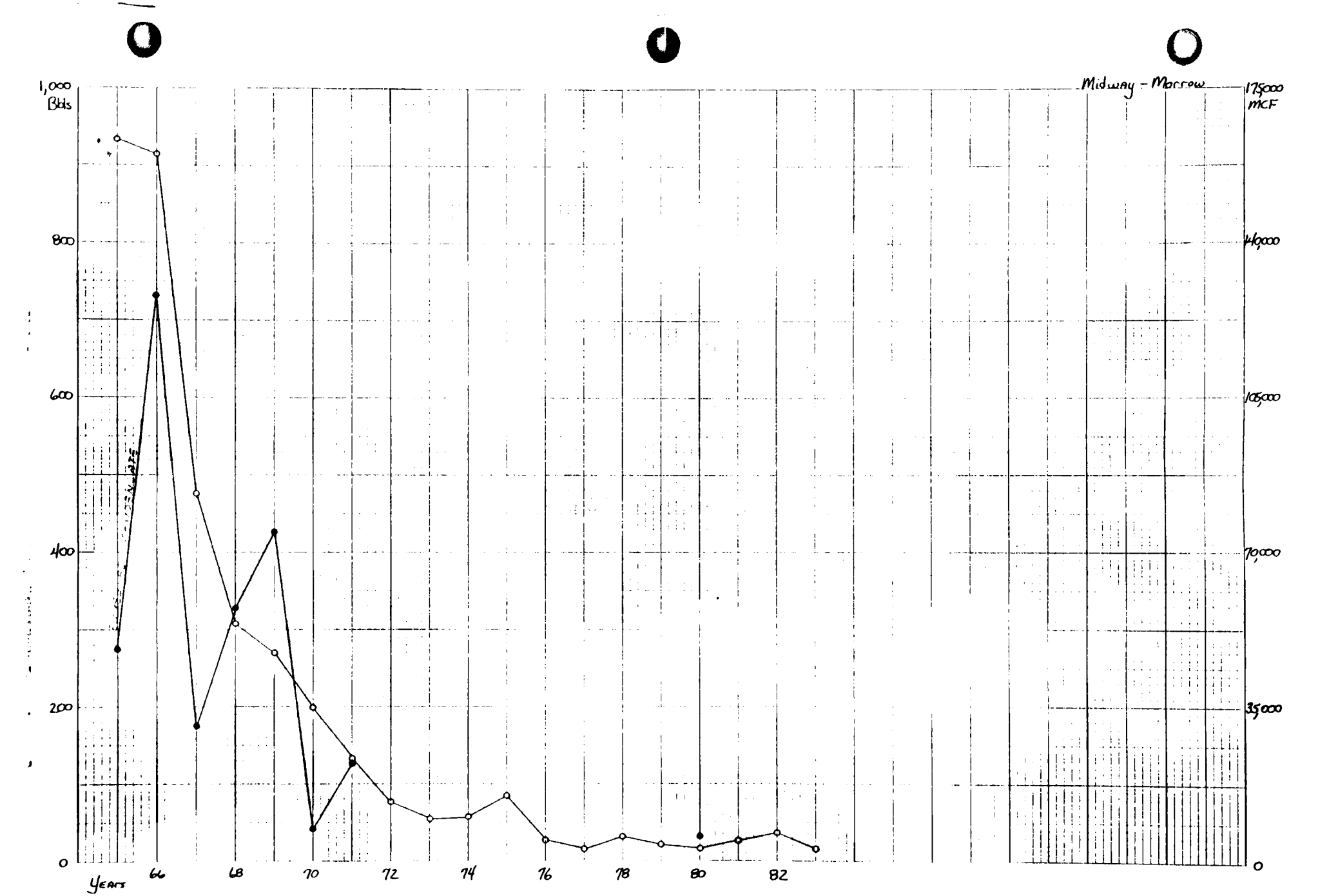

70,000
MCF
56,000
42,000
28,000
14,000
0
YEARS
66
68
70
72
74
76
78
80
82
SI - 12/81
SI-12/82
SI - 9/83
FLANK - TOPEKA

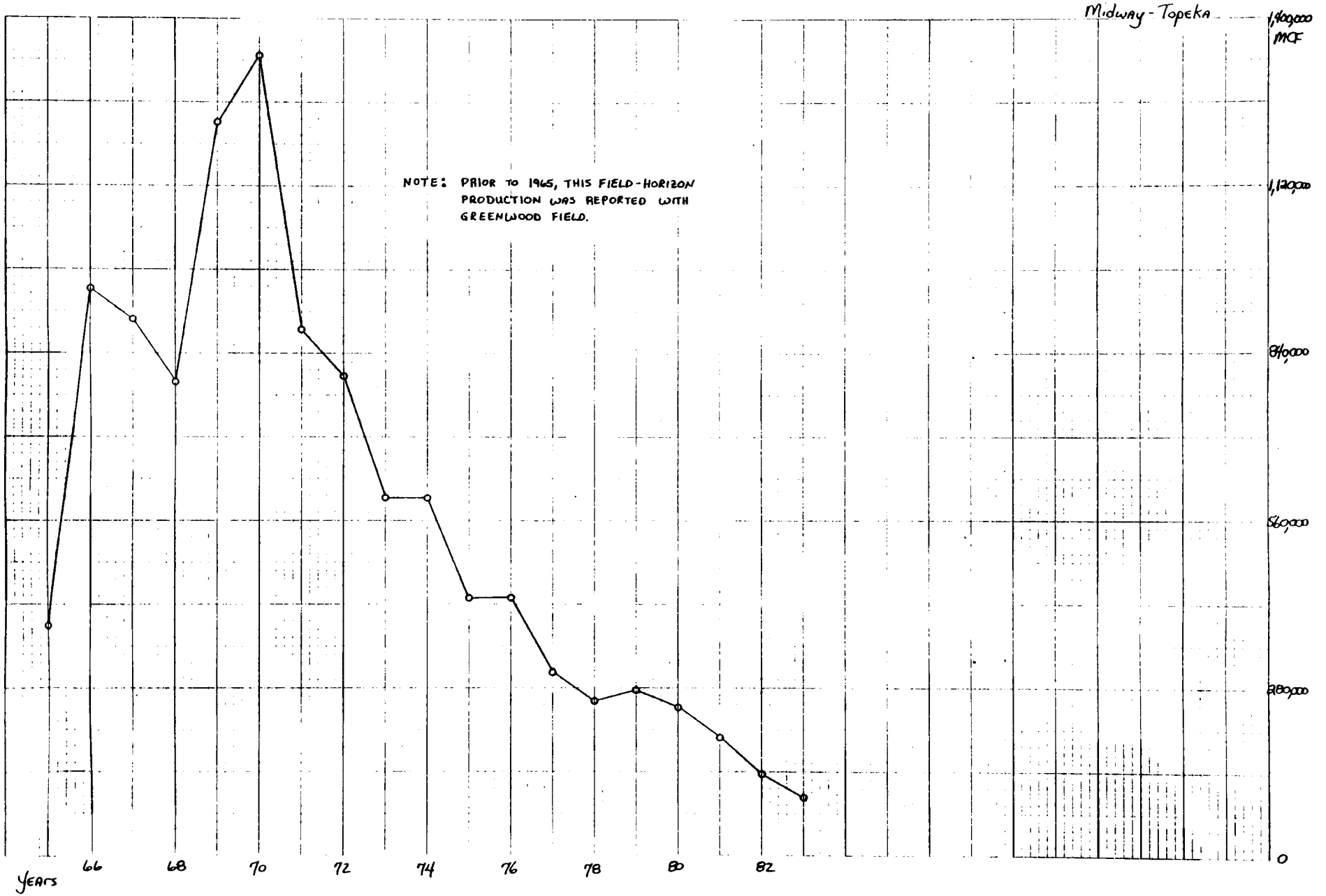

GREENWOOD - MORROW
30,000
Bbls.
24,000
18,000
12,000
6,000
0
30,000
MCF
24,000
18,000
12,000
6,000
0
68
70
72
74
76
78
80
82
YEARS

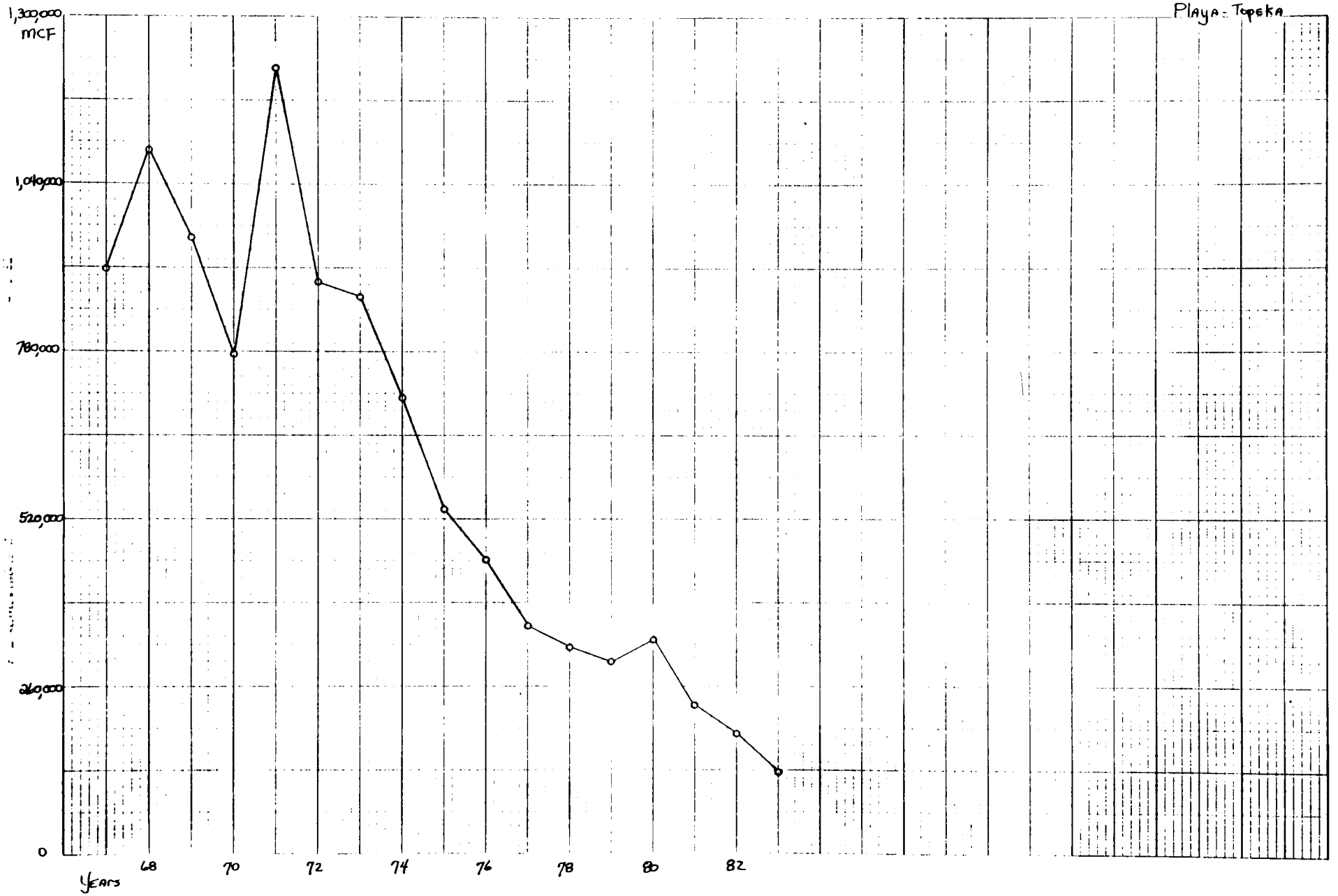

GREENWOOD - RED CAVE
90,000
MCF
72,000
54,000
36,000
18,000
0
74
76
78
80
82
YEARS


Greenwood - Topeka/Lansing
550,000 MCF
440,000
330,000
220,000
110,000
0
54
56
58
60
62
64
66
68
70
72
74
76
78
80
82
Years

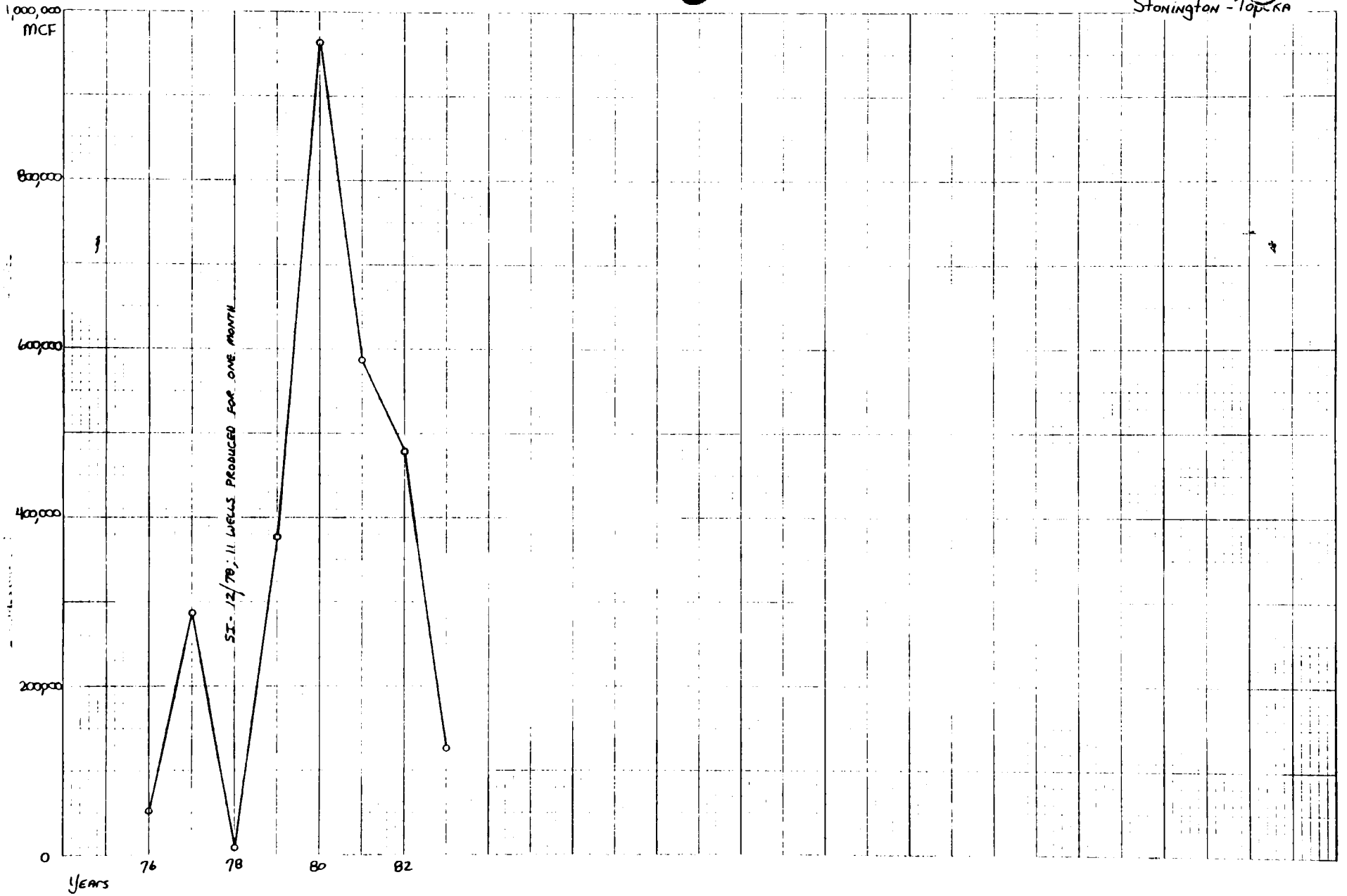

Midway - Lansing
10,000
MCF
8,000
6,000
4,000
2,000
0
80
82
Years
SI - 9/82

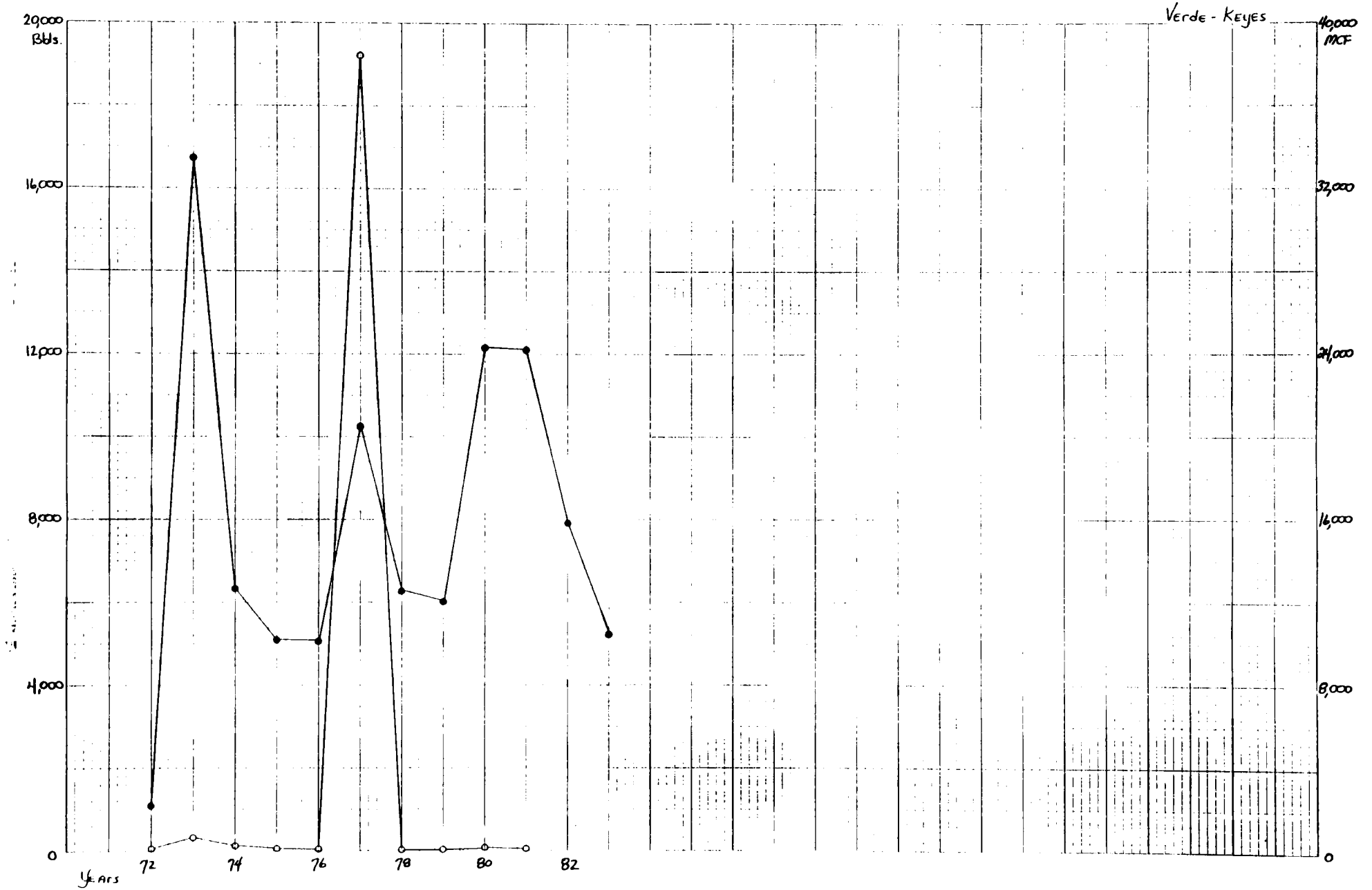

Midway - Morrow
1,000 Bbls
800
600
400
200
0
175000 MCF
140,000
105,000
70,000
35,000
0
Years
66
68
70
72
74
76
78
80
82

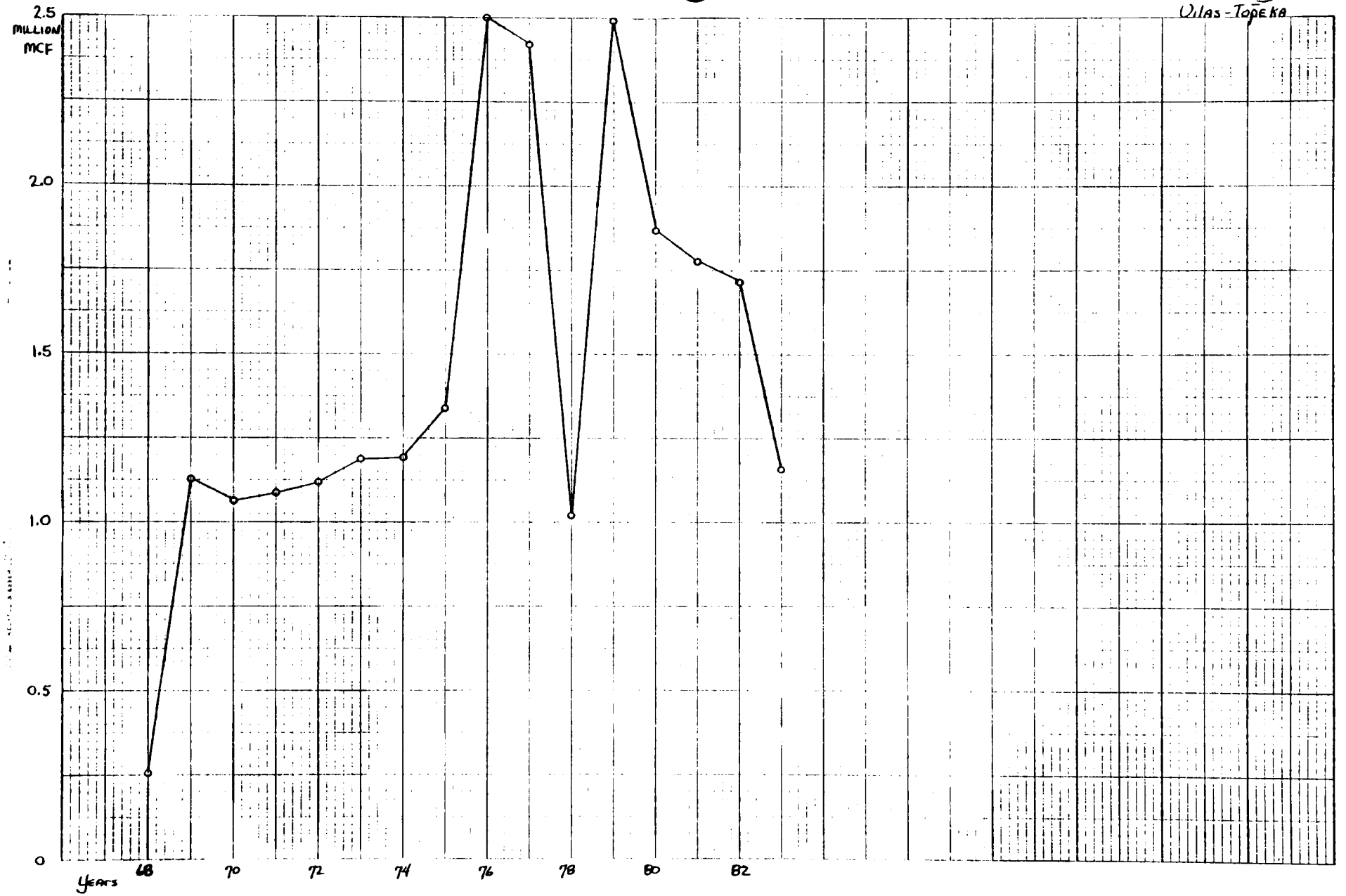

Midway - Topeka
1,400,000
MCF
1,120,000
840,000
560,000
280,000
0
NOTE: PRIOR TO 1965, THIS FIELD-HORIZON PRODUCTION WAS REPORTED WITH GREENWOOD FIELD.
66
68
70
72
74
76
78
80
82
YEARS

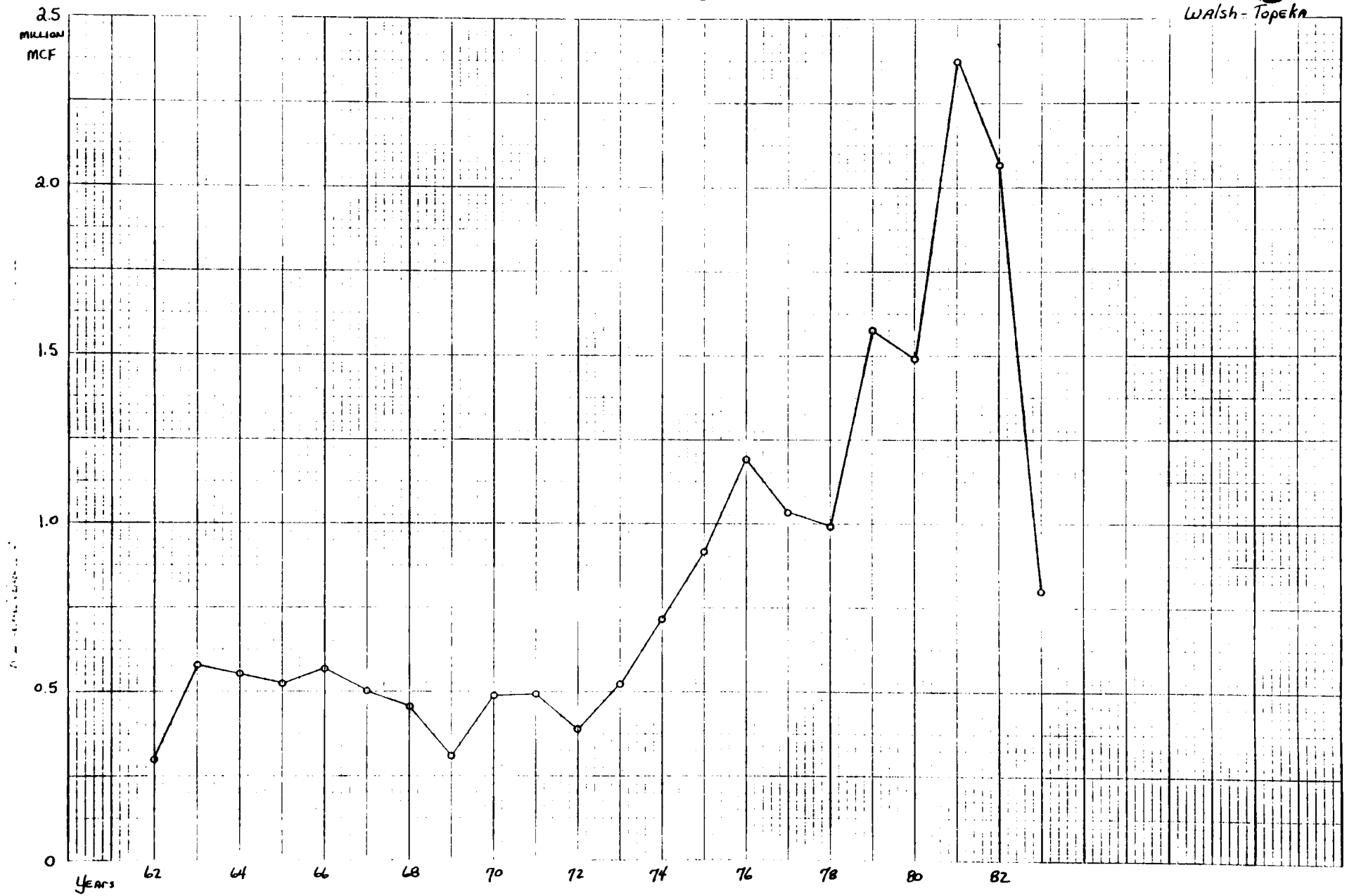

Playa - Topeka
1,300,000 MCF
1,040,000
780,000
520,000
260,000
0
68
70
72
74
76
78
80
82
Years

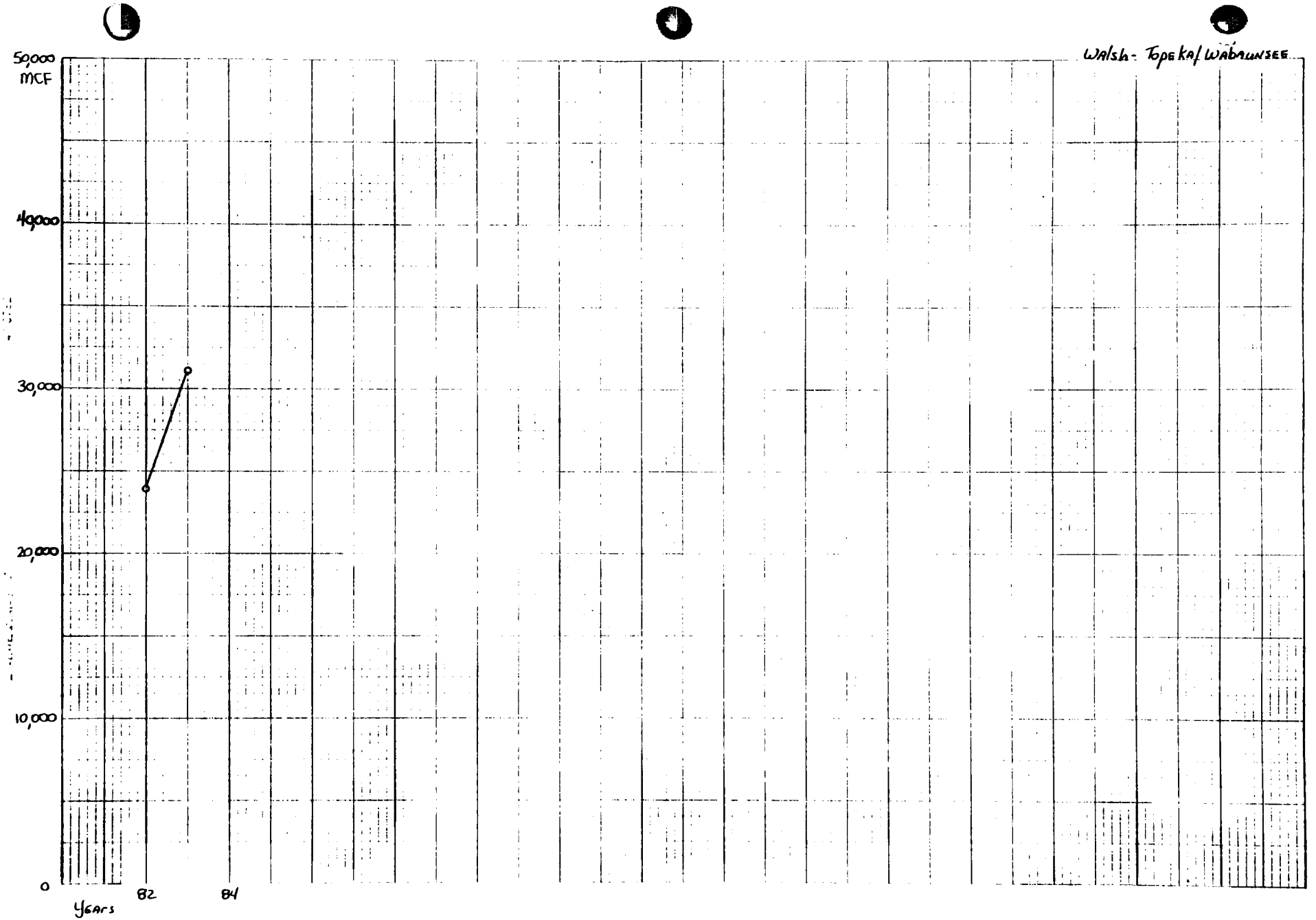
Stonington - Topeka

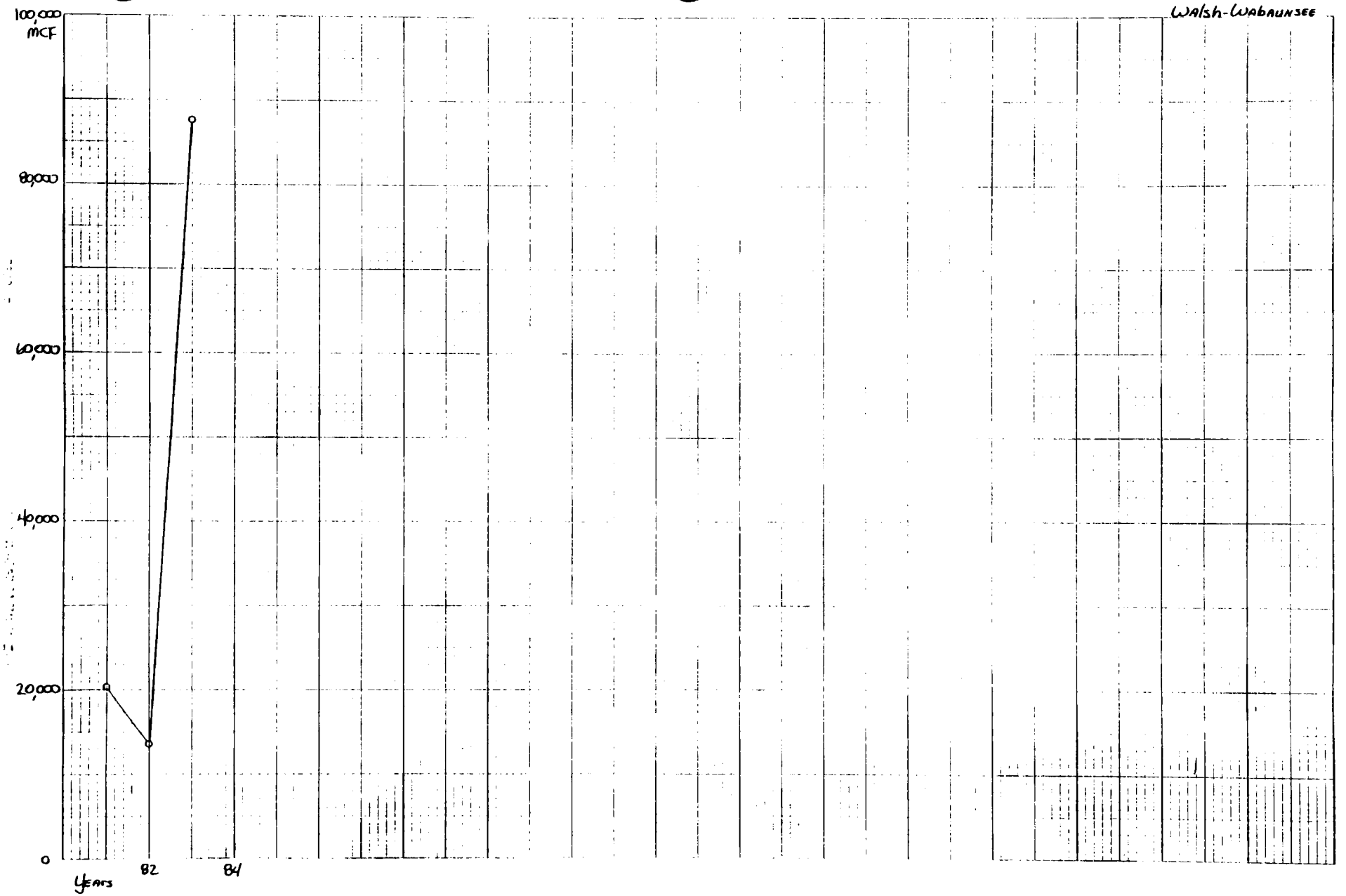


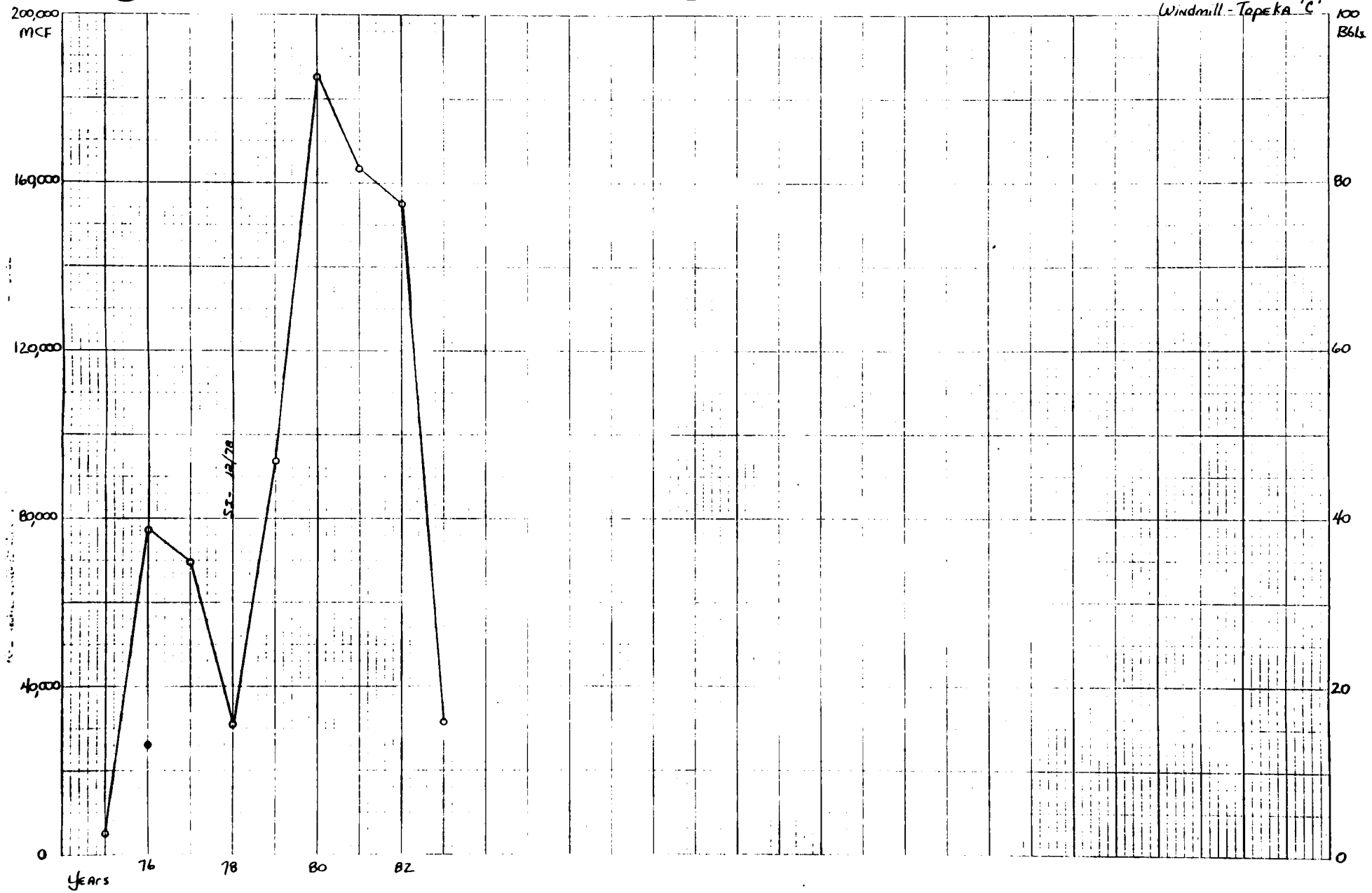

Verde - Keyes
20,000
Bbls.
16,000
12,000
8,000
4,000
0
40,000
MCF
32,000
24,000
16,000
8,000
0
72
74
76
78
80
82
Years


2.5
MILLION
MCF
2.0
1.5
1.0
0.5
0
Years
68
70
72
74
76
78
80
82
Oil as - Topeka


Walsh - Topeka
2.5
MILLION
MCF
2.0
1.5
1.0
0.5
0
Years
62
64
66
68
70
72
74
76
78
80
82


Walsh - Topeka/Wabaunsee
50,000
MCF
40,000
30,000
20,000
10,000
0
82
84
Years


WALSH-WABAUNSEE
100,000
MCF
80,000
60,000
40,000
20,000
0
YEARS
82
84


Windmill - Topeka 'C'
200,000 MCF
160,000
120,000
80,000
40,000
0
100 Bbls
80
60
40
20
0
SI - 12/78
76
78
80
82
Years

## Other Publications

INFORMATION SERIES 18--Oil and Gas fields of Colorado: Statistical Data through 1981.
MAP SERIES 22--Oil and Gas fields map of Colorado. 1983, (1:500,000).
OPEN-FILE REPORT 84-3: Estimated Oil and Gas Reserves for Washington County, Colorado:
OPEN-FILE REPORT 84-4: Estimated Oil and Gas Reserves for Rio Blanco County, Colorado.
OPEN-FILE REPORT 84-5: Estimated Oil and Gas Reserves for Adams County, Colorado;
OPEN-FILE REPORT 83-6: Estimated Oil and Gas Reserves for Weld County, Colorado;
OPEN-FILE REPORT 84-7: Estimated Oil and Gas Reserves for Arapahoe County, Colorado;
OPEN-FILE REPORT 84-8: Estimated Oil and Gas Reserves for Baca County, Colorado.
OPEN-FILE REPORT 84-9: Estimated Oil and Gas Reserves for Cheyenne County, Colorado.
OPEN-FILE REPORT 84-10: Estimated Oil and Gas Reserves for Garfield County, Colorado;
OPEN-FILE REPORT 84-11: Estimated Oil and Gas Reserves for La Plata County, Colorado;
OPEN-FILE REPORT 84-12: Estimated Oil and Gas Reserves for Moffat County, Colorado;
OPEN-FILE REPORT 84-13: Estimated Oil and Gas Reserves for Elbert County, Colorado;
OPEN-FILE REPORT 84-14: Estimated Oil and Gas Reserves for Mesa County, Colorado;
OPEN-FILE REPORT 84-15: Estimated Oil and Gas Reserves for Routt County, Colorado;
OPEN-FILE REPORT 84-16: Estimated Oil and Gas Reserves for Yuma County, Colorado

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