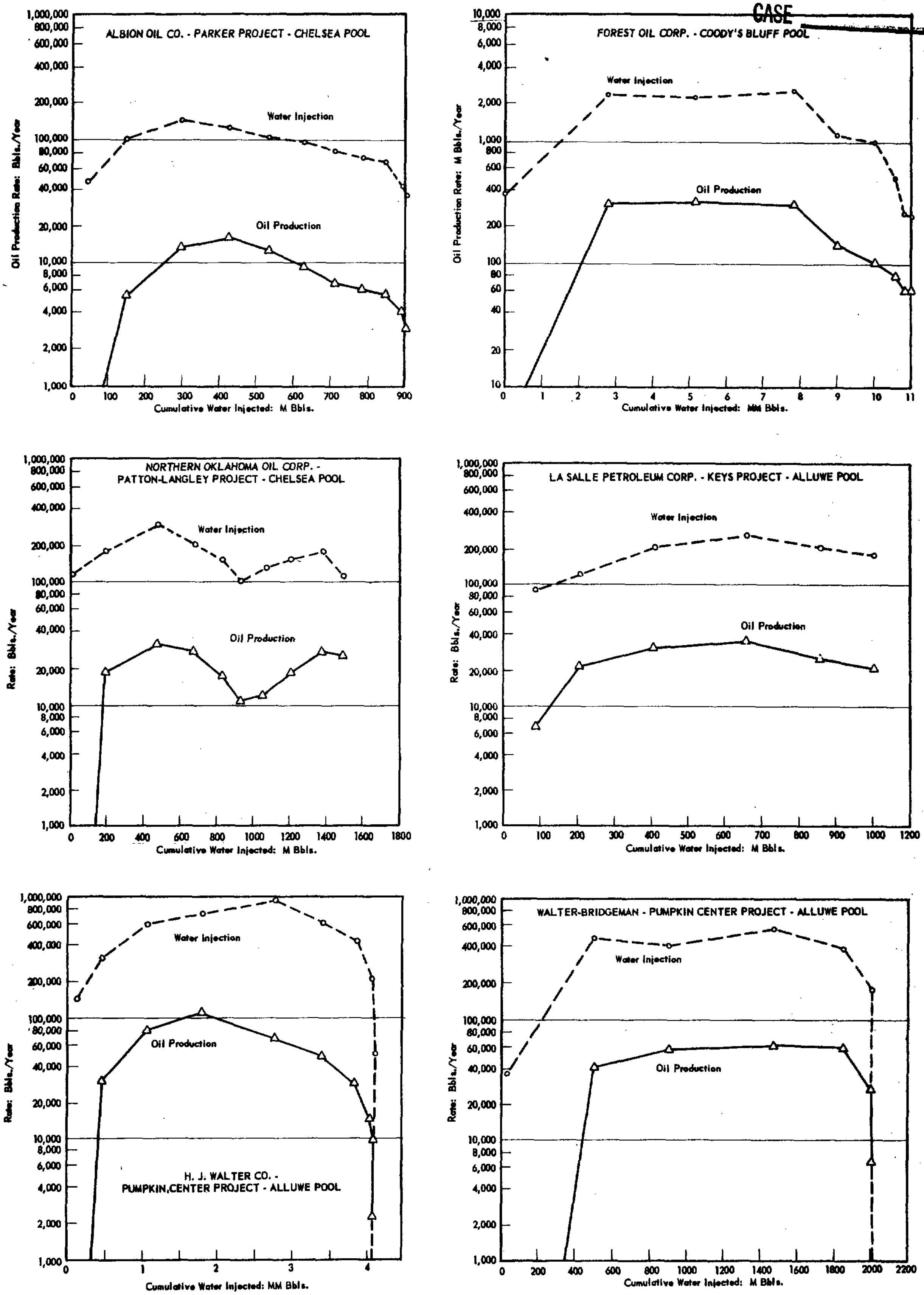
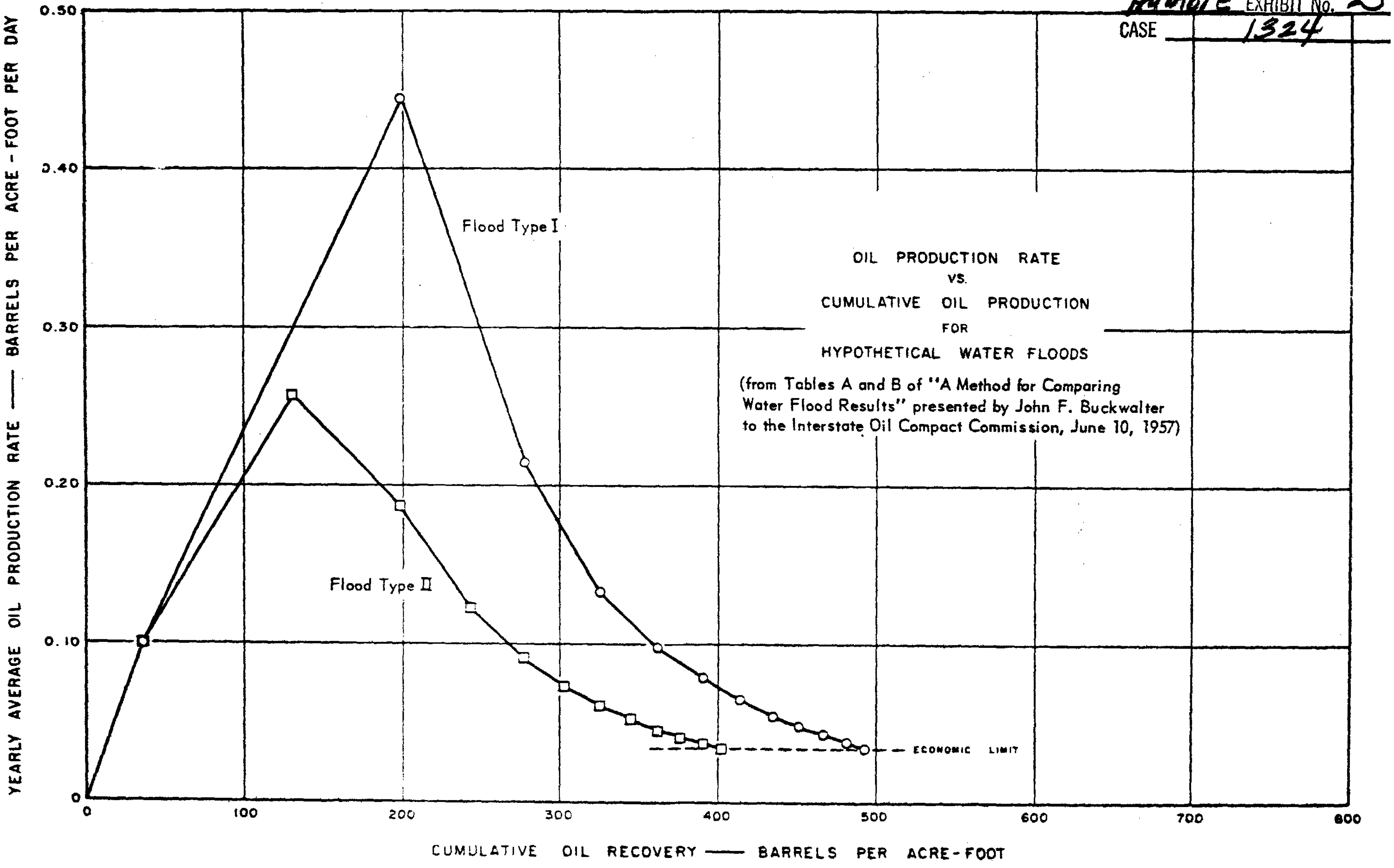
BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO
Humble EXHIBIT No. 1
CASE 1324



RELATION BETWEEN OIL PRODUCTION AND WATER INJECTION FOR SEVERAL WATER FLOOD PROJECTS IN OKLAHOMA
(Data from Bureau of Mines RI 4831)

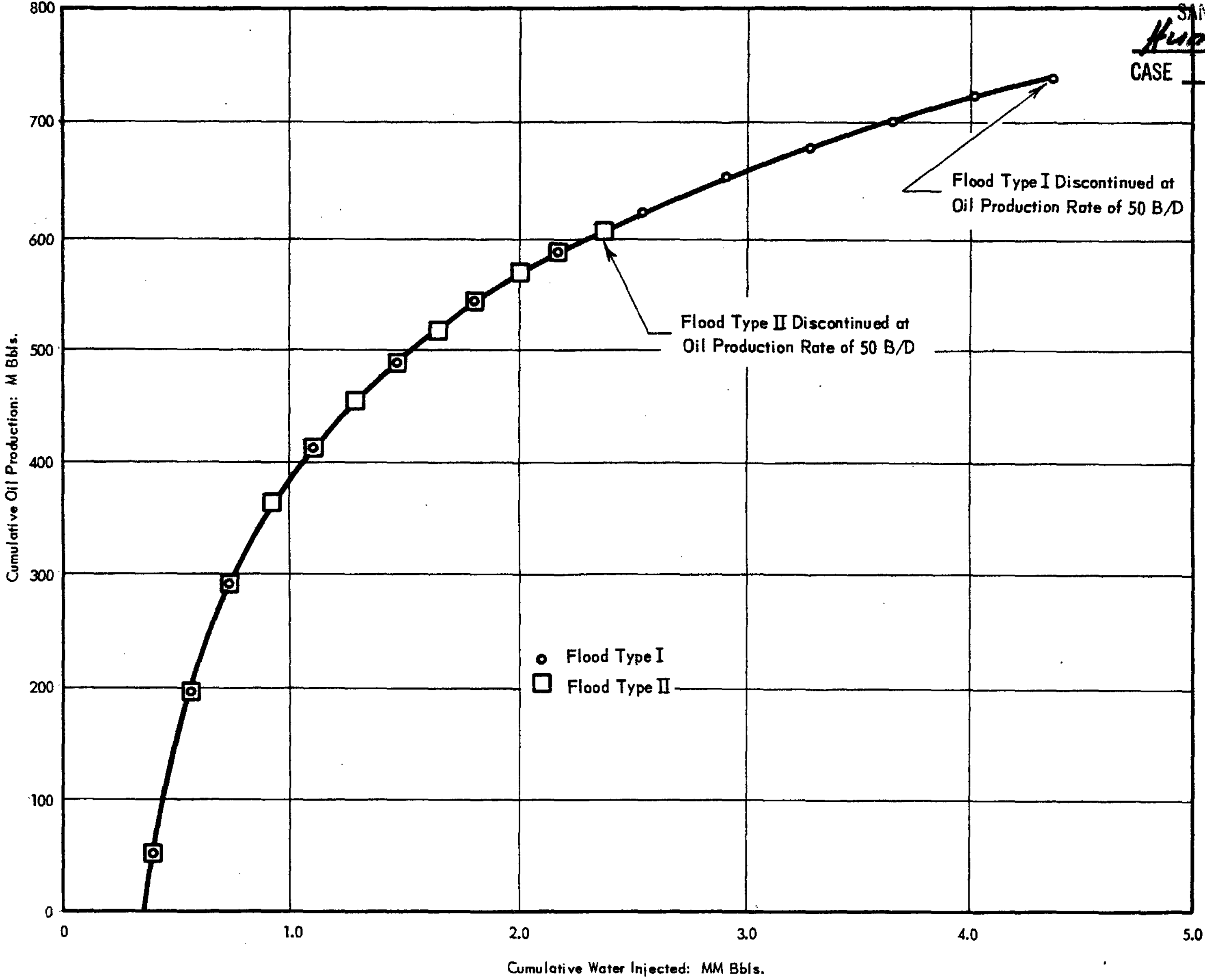
BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO
Humble EXHIBIT No. 2
CASE 1324



OIL PRODUCTION RATE
VS.
CUMULATIVE OIL PRODUCTION
FOR
HYPOTHETICAL WATER FLOODS

(from Tables A and B of "A Method for Comparing Water Flood Results" presented by John F. Buckwalter to the Interstate Oil Compact Commission, June 10, 1957)

BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO
Humble EXHIBIT No. 3
CASE 1324

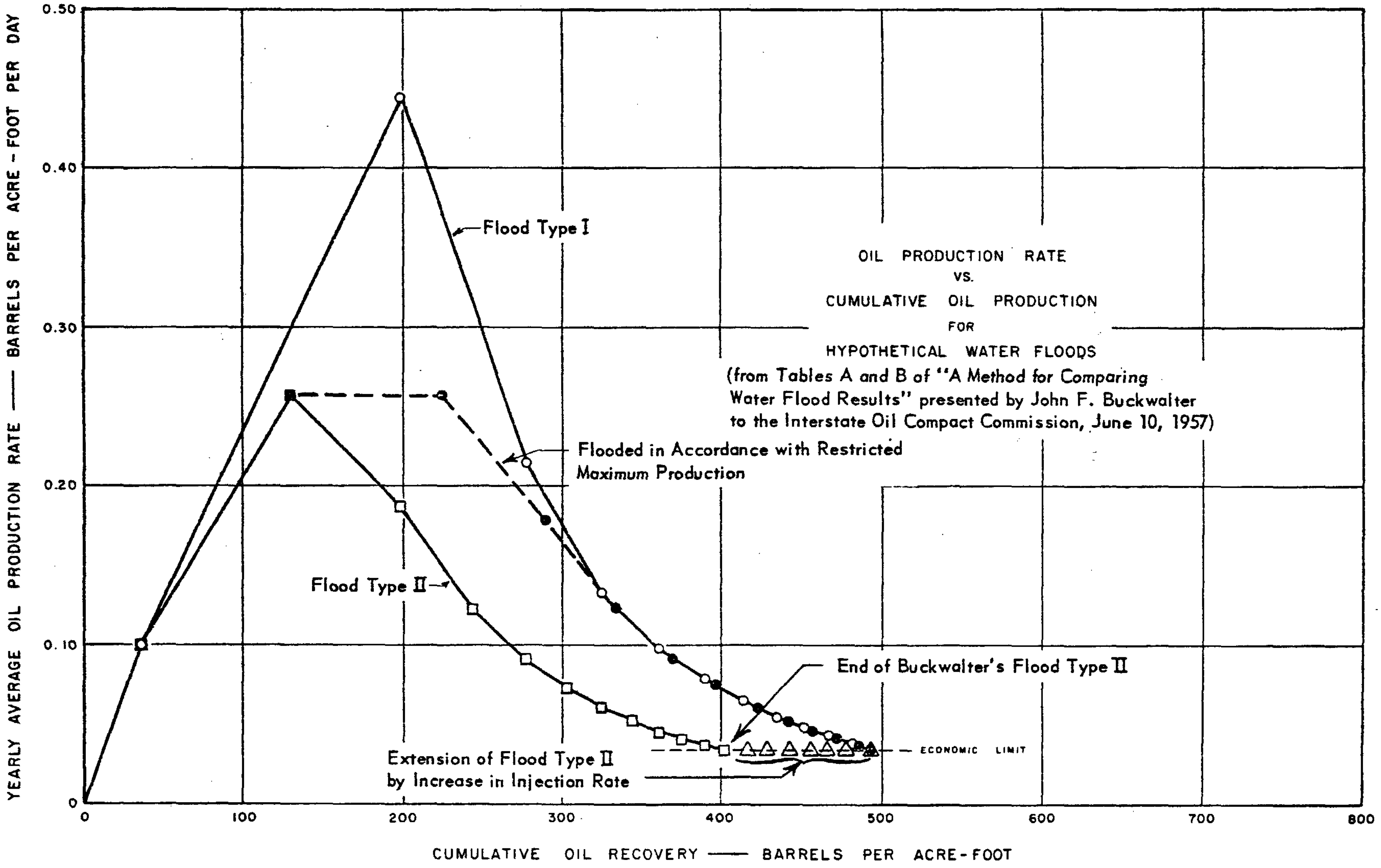


CUMULATIVE OIL PRODUCTION VS CUMULATIVE WATER INJECTED HYPOTHETICAL FLOODS TYPE I and II

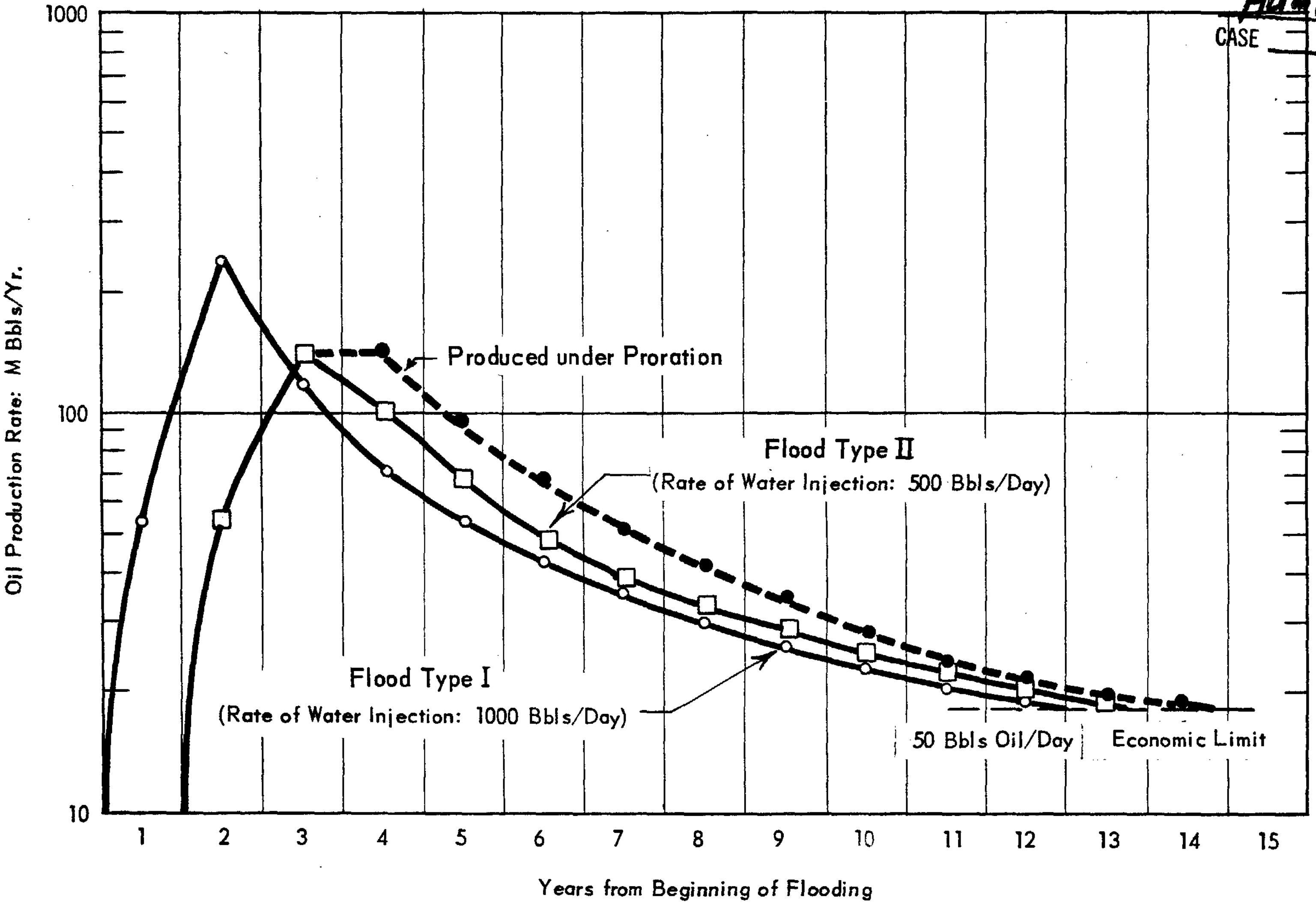
(from Tables A and B of "A Method for Comparing Water Flood Results"
presented by John F. Buckwalter to the Interstate Oil Compact Commission,
June 10, 1957)

BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO
Humble EXHIBIT No. 4
CASE 1324

# COMPARISON OF BUCKWALTERS FLOOD TYPES I and II WHEN CONDUCTED TO IDENTICAL CONDITIONS OF ABANDONMENT WITH FLOOD PRODUCED SUBJECT TO RESTRICTED PRODUCING RATES



BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO
Humble EXHIBIT No. 5
CASE 1324



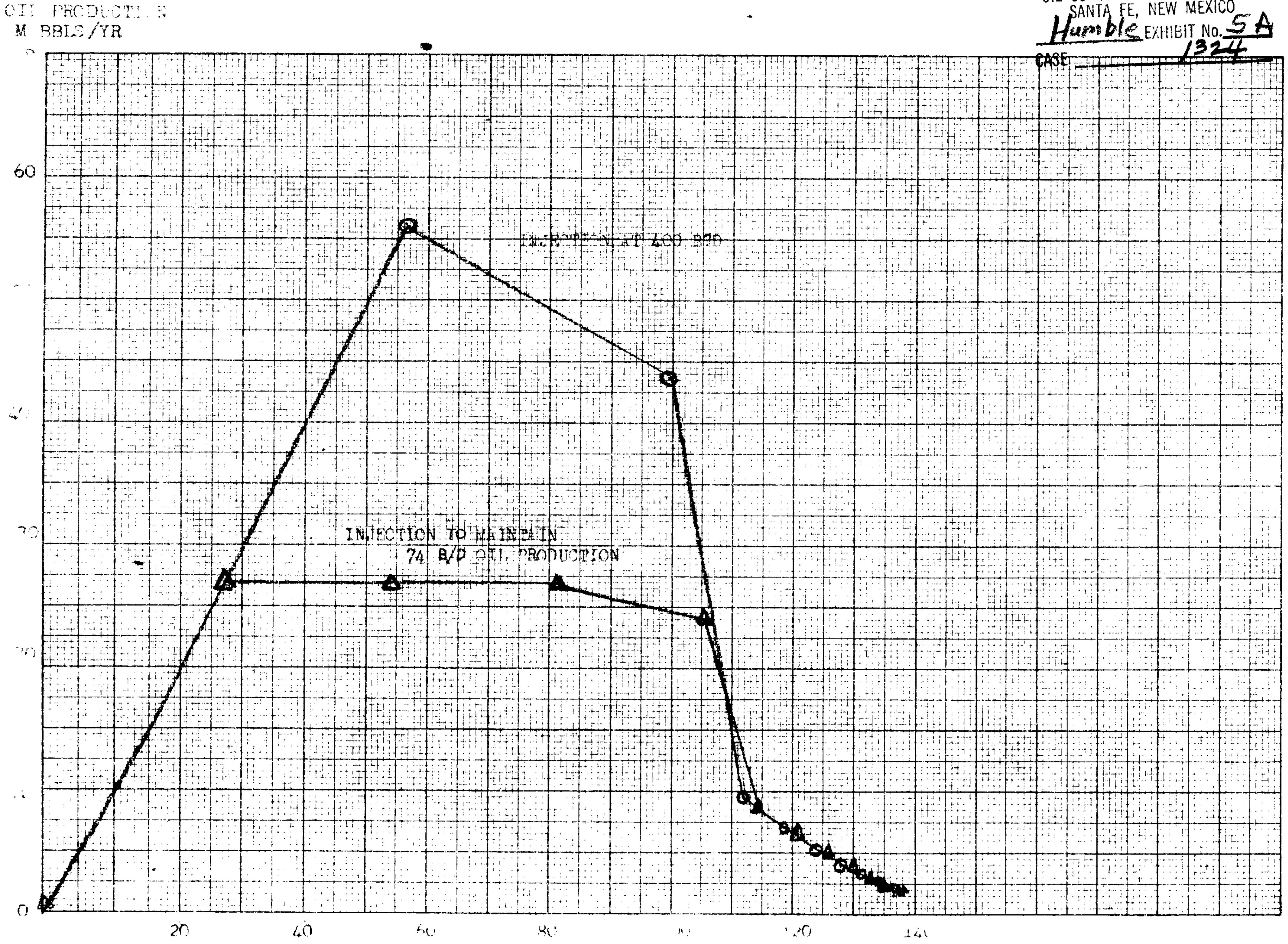
OIL PRODUCTION RATE VS TIME HYPOTHETICAL FLOODS TYPE I AND II

(from Tables A and B of "A Method for Comparing Water Flood Results" presented by John F. Buckwalter to the Interstate Oil Compact Commission, June 10, 1957)

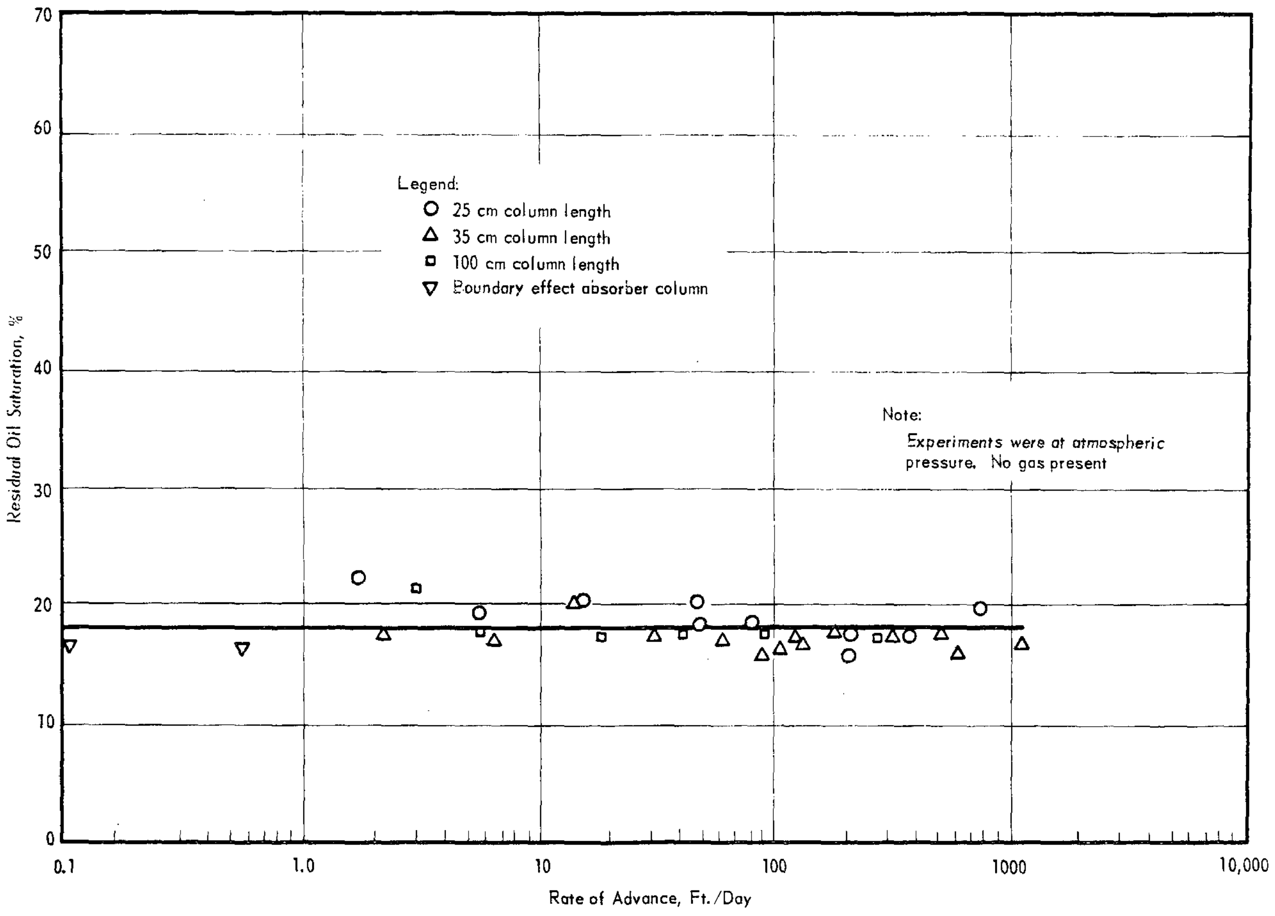
5

K+E 10 X 10 TO THE ½ INCH 359-11
KEUFFEL & ESSER CO. MADE IN U.S.A.

BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO
Humble EXHIBIT No. 5A
CASE 1324

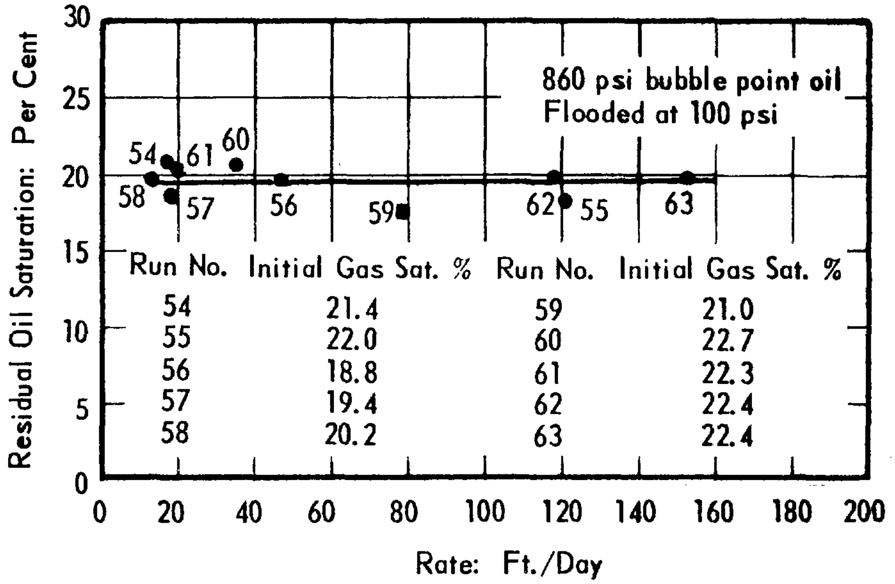


BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO
Humble EXHIBIT No. 6
CASE 1324



THE EFFECT OF RATE ON RECOVERY BY WATER FLOODING

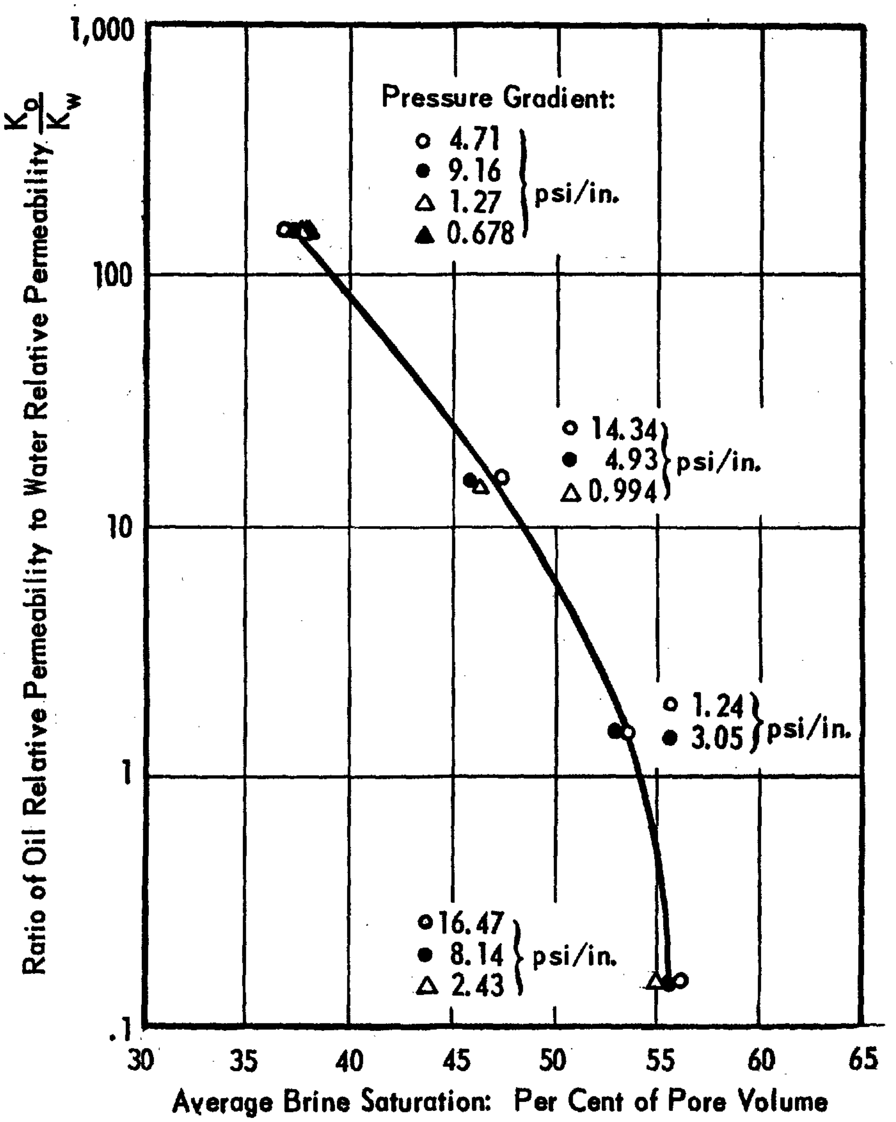
BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO
Humble EXHIBIT No. 6A
CASE 1324



| Run No. | Initial Gas Sat. % | Run No. | Initial Gas Sat. % |
|---|---|---|---|
| 54 | 21.4 | 59 | 21.0 |
| 55 | 22.0 | 60 | 22.7 |
| 56 | 18.8 | 61 | 22.3 |
| 57 | 19.4 | 62 | 22.4 |
| 58 | 20.2 | 63 | 22.4 |

THE EFFECT OF RATE ON OIL RECOVERY BY WATER FLOODING IN PRESENCE OF A 22% FREE GAS SATURATION
(Homogeneous Sand)

BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO
Humble EXHIBIT No. 7
CASE 1324

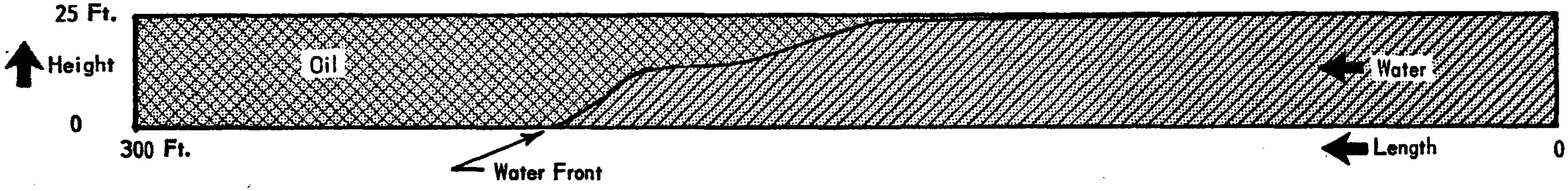


RELATIVE PERMEABILITY AS A FUNCTION OF BRINE SATURATION: MEASUREMENTS AT DIFFERENT PRESSURE GRADIENTS

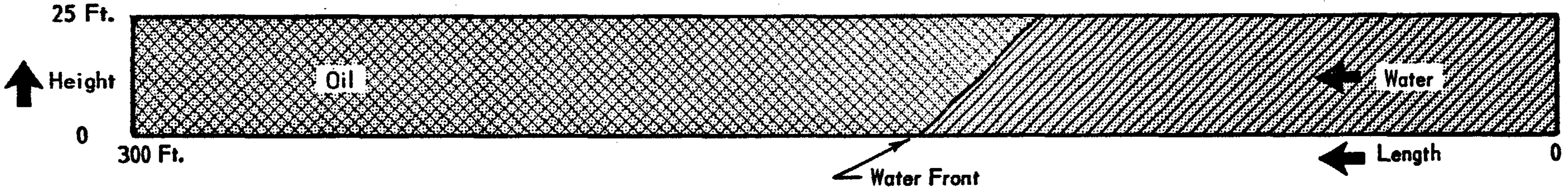
(From Data of Geffen, Owens, Parrish & Morse )

BEFORE THE
OIL CONS·.V.·.ION COMMISSION
SANTA FE, NEW MEXICO
Humble EXHIBIT No. 8
CASE 1324

No gas
Rate of advance – 0.047 Ft./Day
Recovery at water breakthrough = 62.0% pore volume



No gas
Rate of advance – 0.10 Ft./Day
Recovery at water breakthrough = 64.1% pore volume



THE EFFECT OF RATE ON THE FLOODING CONFORMANCE OF
A UNIFORM SAND WHERE GRAVITATIONAL SEGREGATION IS IMPORTANT

8

BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO
Humble EXHIBIT No. 9
CASE 1324

# CAN PRODUCTION AND INJECTION BE TEMPORARILY HALTED WITHOUT DAMAGING FLOOD?

**Data From:**

"A Laboratory Study of Gravity Segregation in Frontal Drives"
F. I. Craig, Jr., J. L. Sanderlin, D. W. Moore, T. M. Geffen, Pan American Prod. Corp.
Presented at 31st Annual Meeting of the Petroleum Branch of the AIME, Oct., 1956

**Reservoir Simulated:**

| | |
|---|---|
| 10-Acre | 5-Spot Pattern |
| 50 mds | Permeability |
| 55 Feet | Formation Thickness |
| 1.55 cp | Oil Viscosity |
| 40° API | Oil Density |

**Operation Schedules Studied:**

1 – Continuous Injection and Production – at 143 Bbl/Day Per Well
2 – Intermittent Operation – Alternate Days of Operation and Shutdown
286 Bbl/Day Per Well Each Day of Operation
3 – Intermittent Operation – 15 Days Operating Followed by 15 Days Shutdown
286 Bbl/Day Per Well Each Day of Operation

**Observation:**

"The Oil Recovery Performances of All Three Water Floods Were Identical" – page 6.

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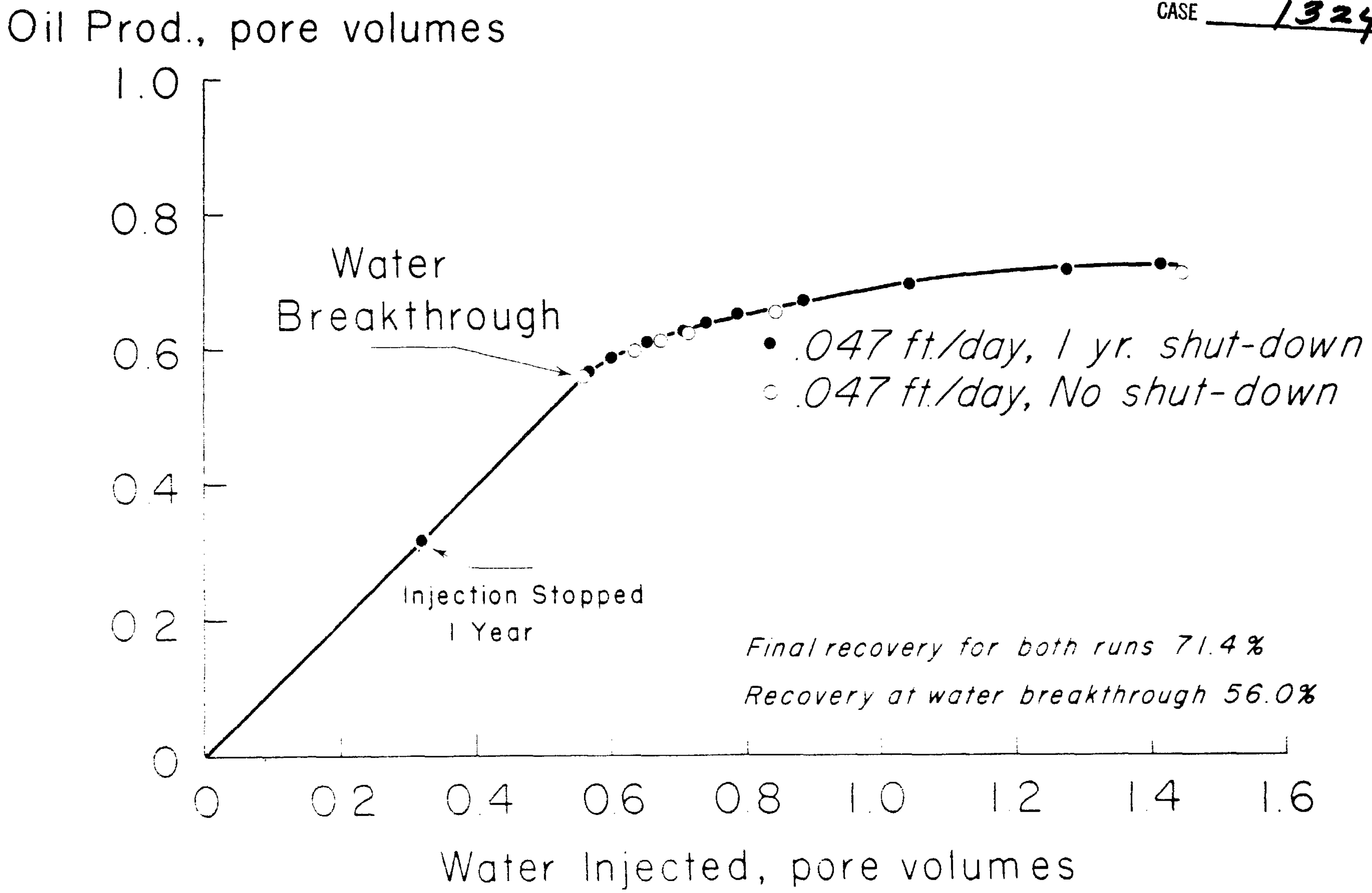
CASE 1324



*Final recovery for both runs 71.4%*

*Recovery at water breakthrough 56.0%*

10.

BEFORE THE
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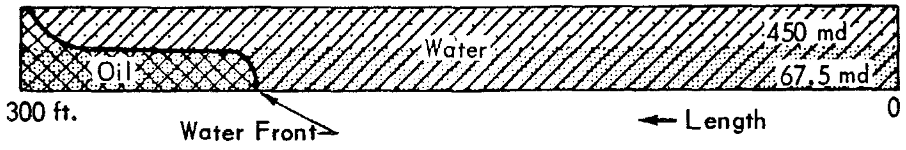
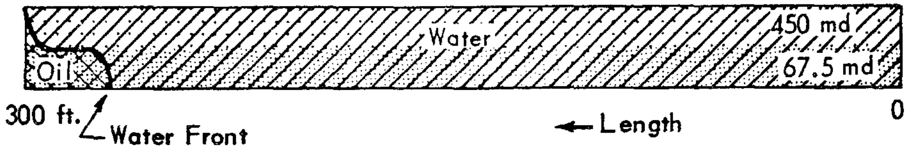
CASE 1324

*No gas*
*Rate = 0.51 ft./day*
*Recovery at water breakthrough = 53.0% pore volume*



*No gas*
*Rate = 0.186 ft./day*
*Recovery at water breakthrough = 60.5% pore volume*



***The effect of rate on the flooding conformance of a stratified reservoir.***

11

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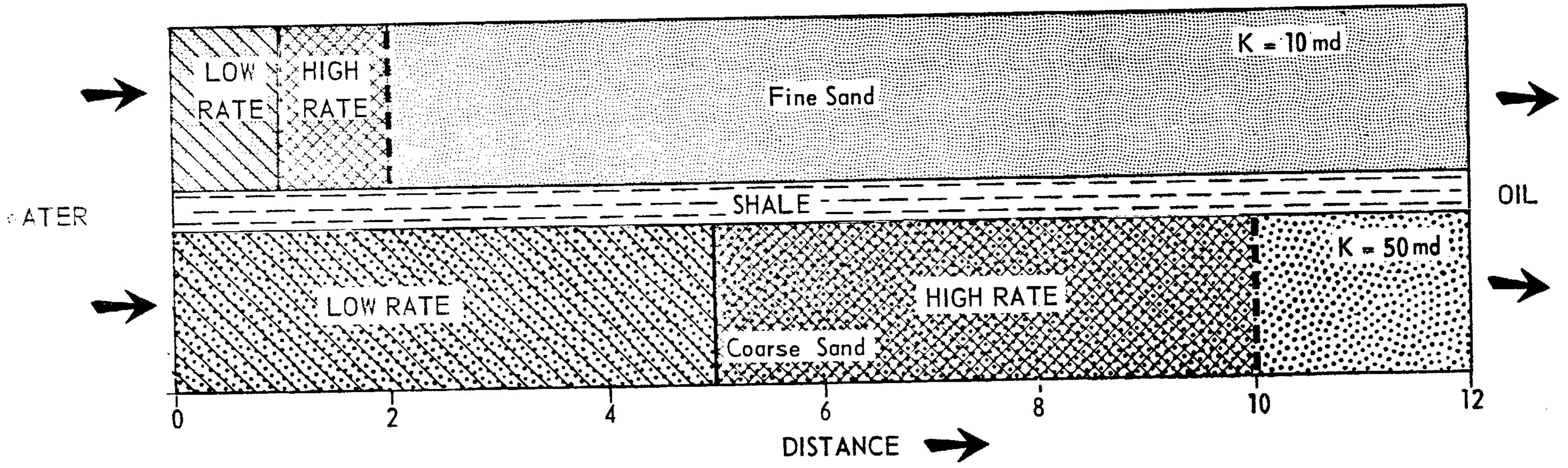
CASE 1324

AT EQUIVALENT TIMES



$$\boxed{q = \frac{KA\Delta P}{\mu L}}$$

RELATIVE MOVEMENT OF WATER THROUGH STRATIFIED, NON-COMMUNICATING SANDS OF DIFFERENT PERMEABILITIES

12.

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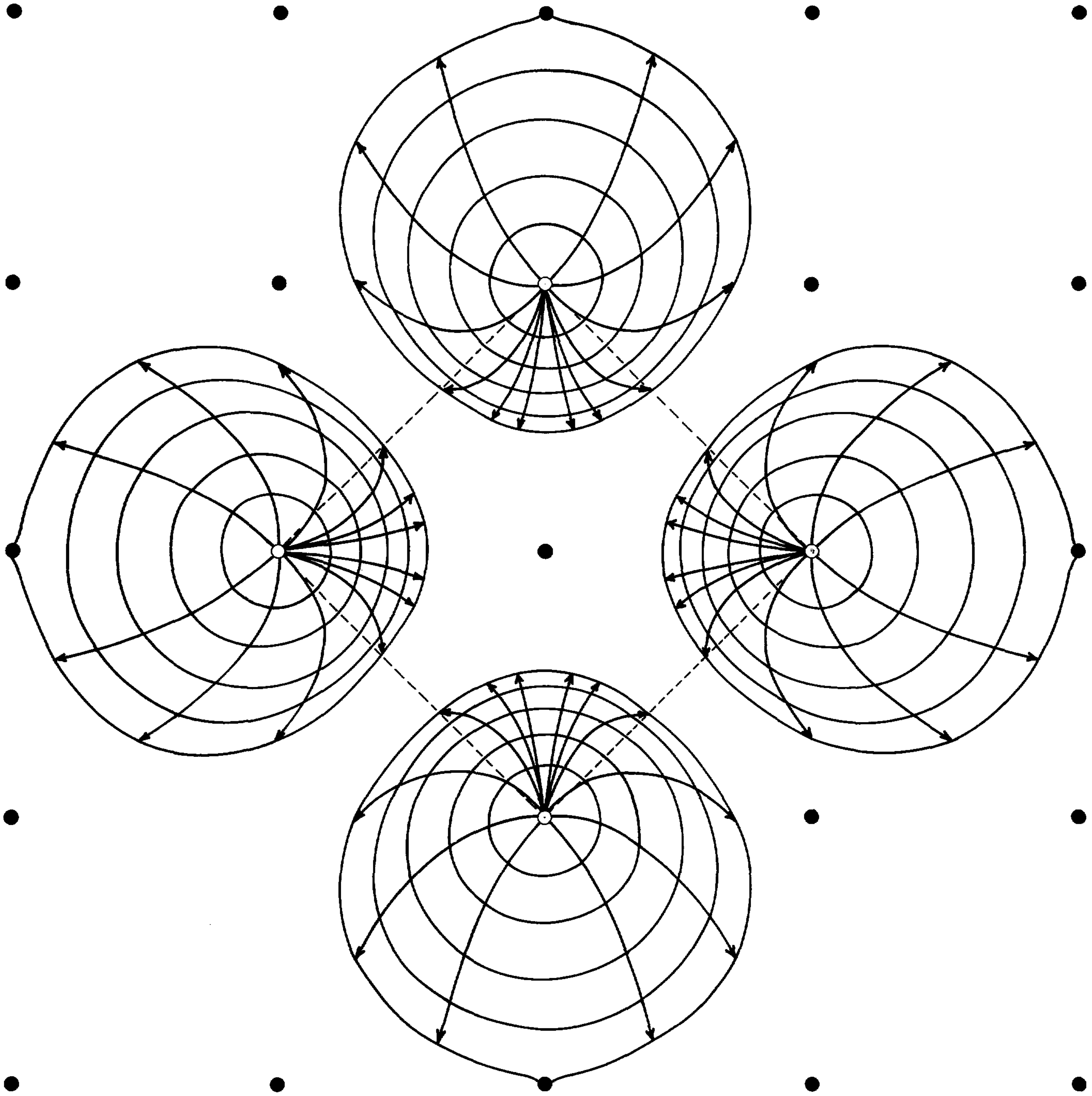
Injection Rate 1000 b/d/w

Production Rate 200 b/d



AT BREAKTHROUGH:
% Of Injected
Water Entering
5-Spot = 13.6%

Oil Lost 190,639 bbls.
=172% Of Oil Produced

13.

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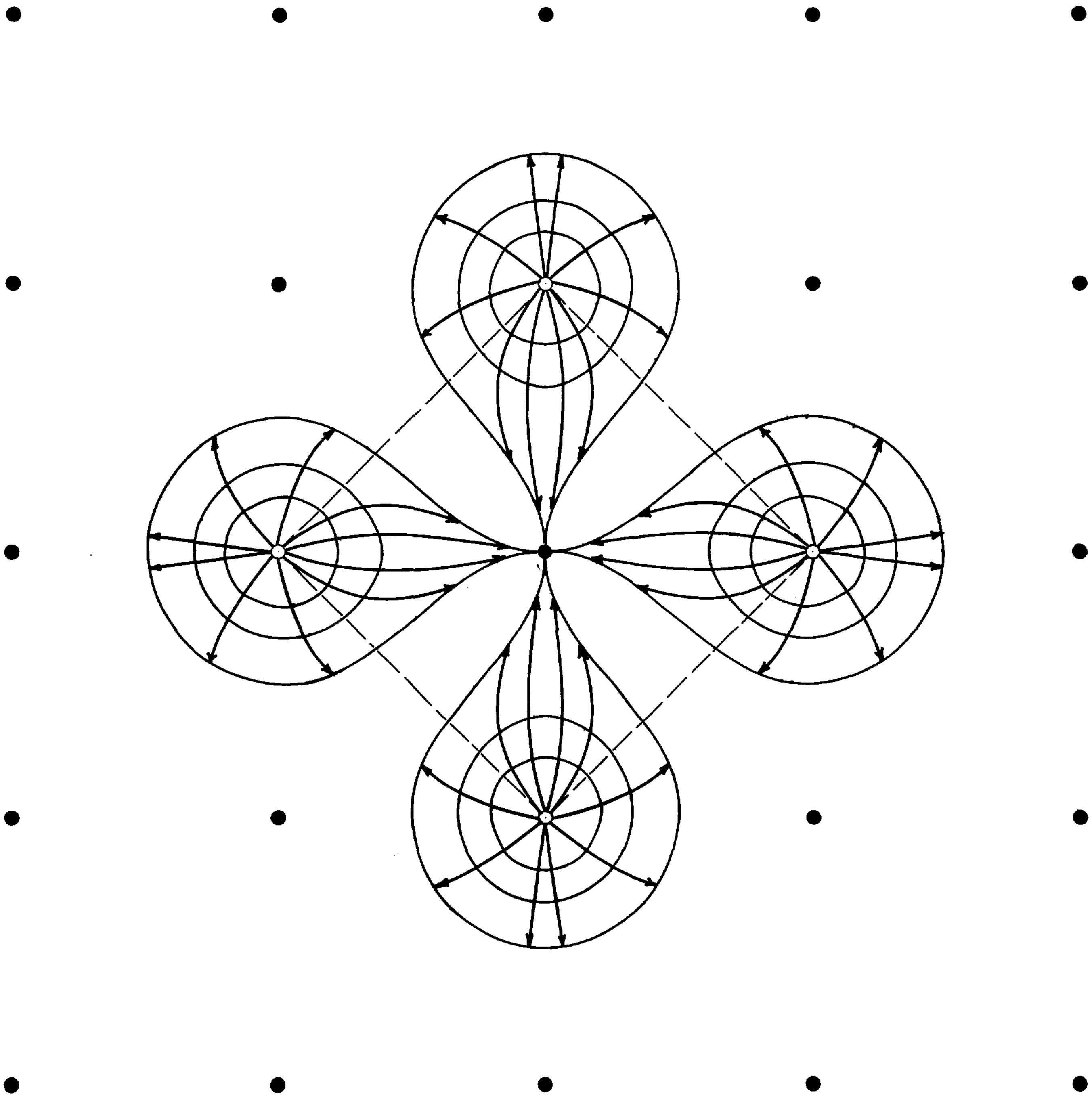
Injection Rate 100 B/D/W

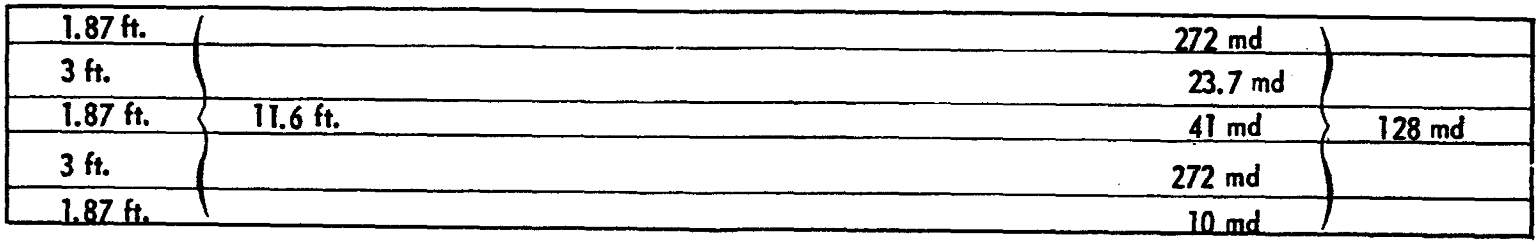
Production Rate 200 B/D



AT BREAKTHROUGH
% of Injected
Water Entering
5-Spot = 35.0%

Oil Gained 164,833 bbls.
= 30.0% of Oil Produced

## RECOVERY OF OIL AT DIFFERENT RATES OF FLOODING



Length = 432 feet

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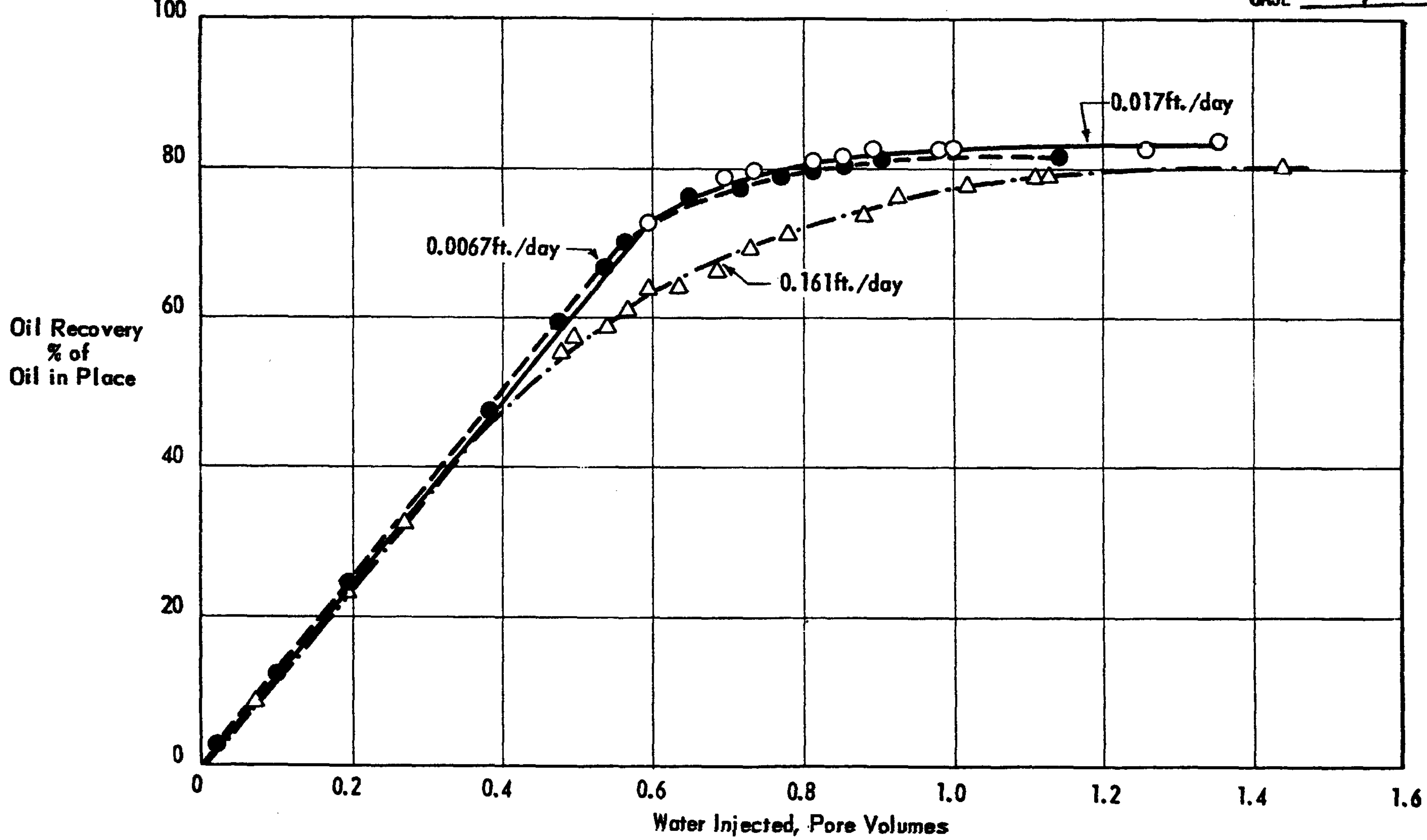
CASE 1324



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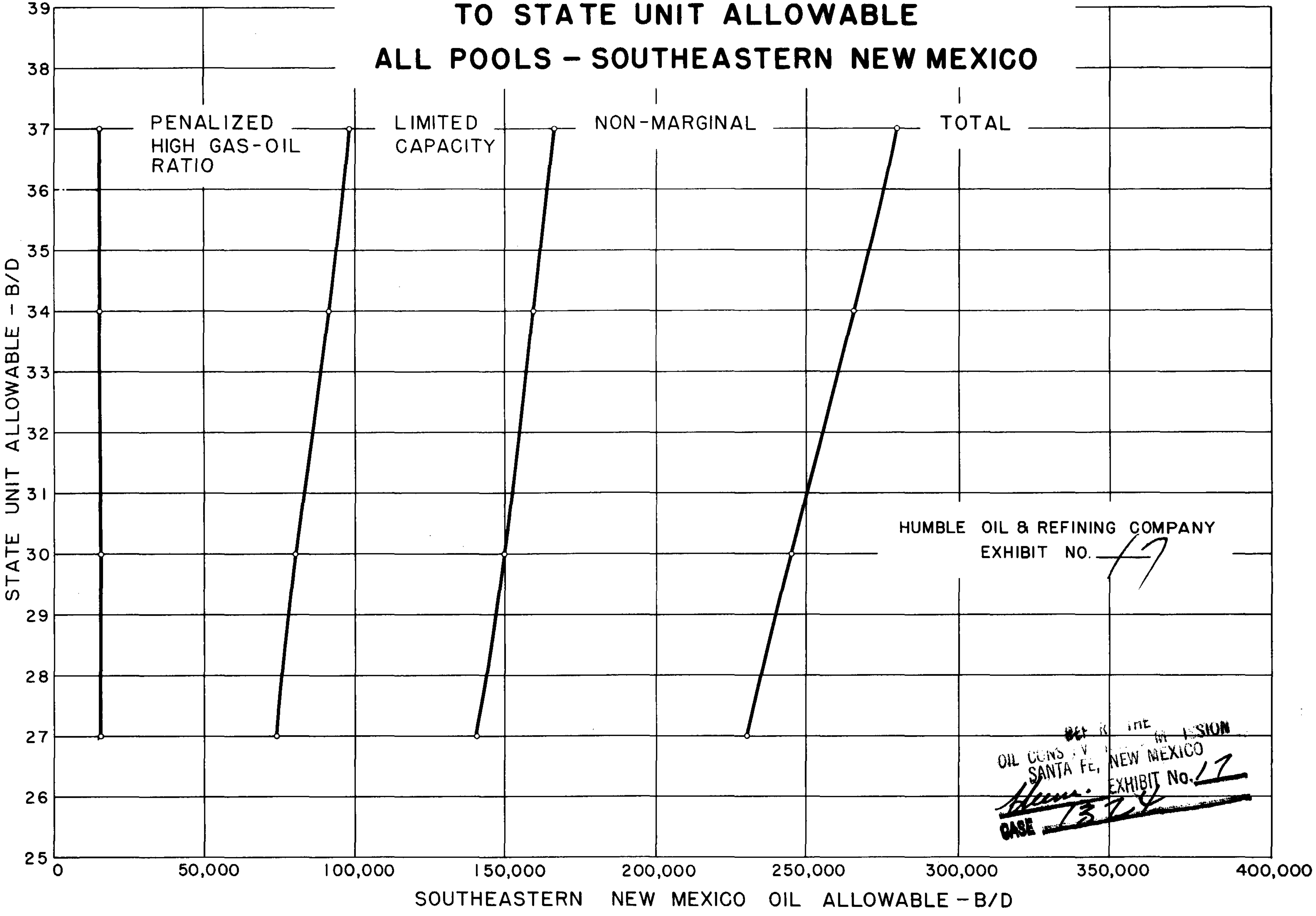
CASE 1324

## Characteristics of Stratified Model as Reservoir

| Property | Model | Reservoir |
|---|---|---|
| Oil Density, $\rho_o$ | 0.827 g/cc | 0.821 g/cc |
| Water Density, $\rho_w$ | 1.098 g/cc | 0.993 g/cc |
| Density Difference, $\rho_w - \rho_o$ | 0.271 g/cc | 0.172 g/cc |
| Permeability, $K_1$ | 109,000 md | 272 md |
| $K_2$ | 9,500 | 23.7 |
| $K_3$ | 16,400 | 41 |
| $K_4$ | 109,000 | 272 |
| $K_5$ | 4,000 | 10 |
| Overall | 51,400 | 128.4 |
| Porosity, $\phi$ | 44% | 22% |
| Height, $H_1$ | .312 inches | 1.87 feet |
| $H_2$ | .500 inches | 3.00 feet |
| $H_3$ | .312 inches | 1.87 feet |
| $H_4$ | .500 inches | 3.00 feet |
| $H_5$ | .312 inches | 1.87 feet |
| Overall | 1.936 inches | 11.61 feet |
| Length, L | 72 inches | 432 feet |
| $\frac{\text{Length}}{\text{Height}} = \frac{L}{H}$ | 37.2 | 37.2 |
| Oil Viscosity, $\mu_o$ | 6.3 cp | 3.6 cp |
| Water Viscosity, $\mu_w$ | 1.19 cp | 0.68 cp |
| $\frac{\text{Viscosity Oil}}{\text{Viscosity Water}} = \frac{\mu_o}{\mu_w}$ | 5.3 | 5.3 |
| Interfacial Tension, $\gamma$ | 33.8 dynes/cm | 33.8 dynes/cm |
| Flood Rate 1, $q_1$ | 7.87 ft/day | 0.00668 ft/day |
| Flood Rate 2, $q_2$ | 20 | 0.017 |
| Flood Rate 3, $q_3$ | 189 | 0.161 |
| $\frac{\text{Gravitational Pressure}}{\text{Capillary Pressure}} = \frac{(\rho_w - \rho_o)gH}{\gamma\sqrt{\frac{\phi}{K}}}$ | 0.0415 | 0.134 |
| $\frac{\text{Viscous Pressure}}{\text{Capillary Pressure}} = \frac{\frac{q}{K}\mu_w L}{\gamma\sqrt{\frac{\phi}{K}}}$ Rate 1 | 0.375 | 0.375 |
| Rate 2 | 0.955 | 0.955 |
| Rate 3 | 9.05 | 9.05 |
| $\frac{\text{Viscous}}{\text{Gravitational}} = \frac{\frac{q}{K}\mu_w L}{(\rho_w - \rho_o)gH}$ Rate 1 | 9.04 | 2.8 |
| Rate 2 | 23 | 7.12 |
| Rate 3 | 218 | 67.5 |

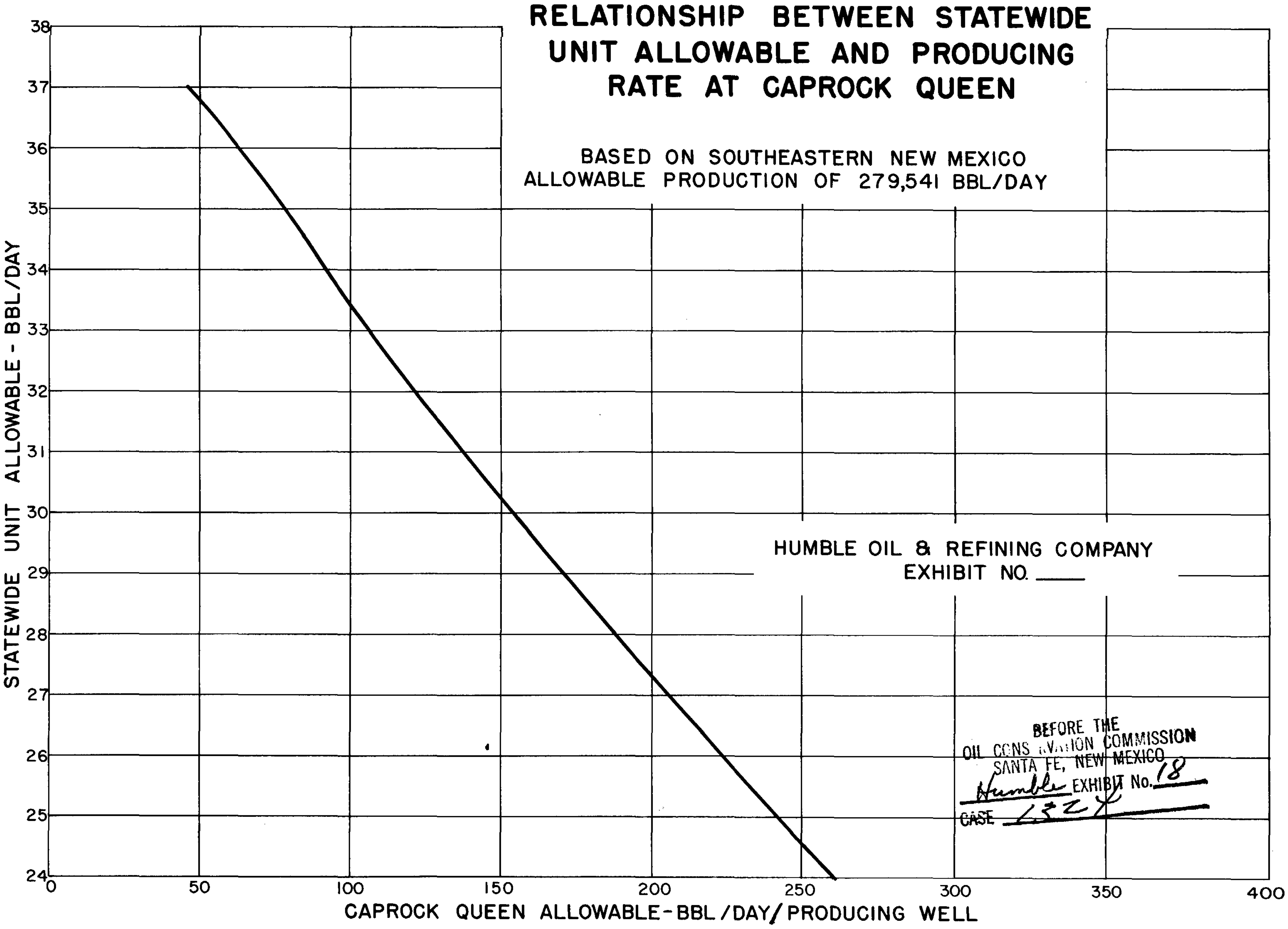
# RELATION OF TOTAL OIL ALLOWABLE TO STATE UNIT ALLOWABLE

## ALL POOLS – SOUTHEASTERN NEW MEXICO



HUMBLE OIL & REFINING COMPANY
EXHIBIT NO. 17

BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO
EXHIBIT No. 17
Hum.
CASE 1324



# RELATIONSHIP BETWEEN STATEWIDE UNIT ALLOWABLE AND PRODUCING RATE AT CAPROCK QUEEN

BASED ON SOUTHEASTERN NEW MEXICO
ALLOWABLE PRODUCTION OF 279,541 BBL/DAY

HUMBLE OIL & REFINING COMPANY
EXHIBIT NO. ____

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OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO
Humble EXHIBIT No. 18
CASE 1324