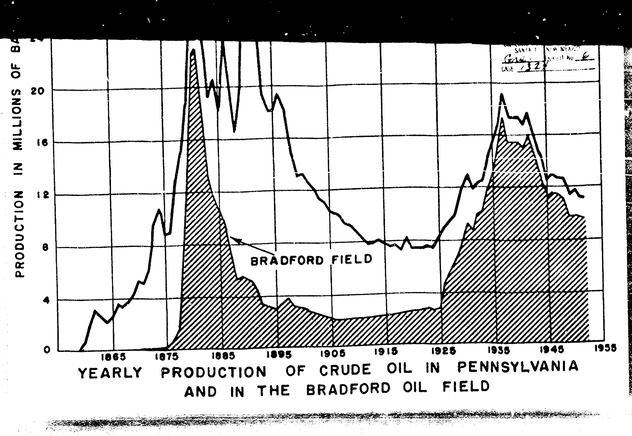
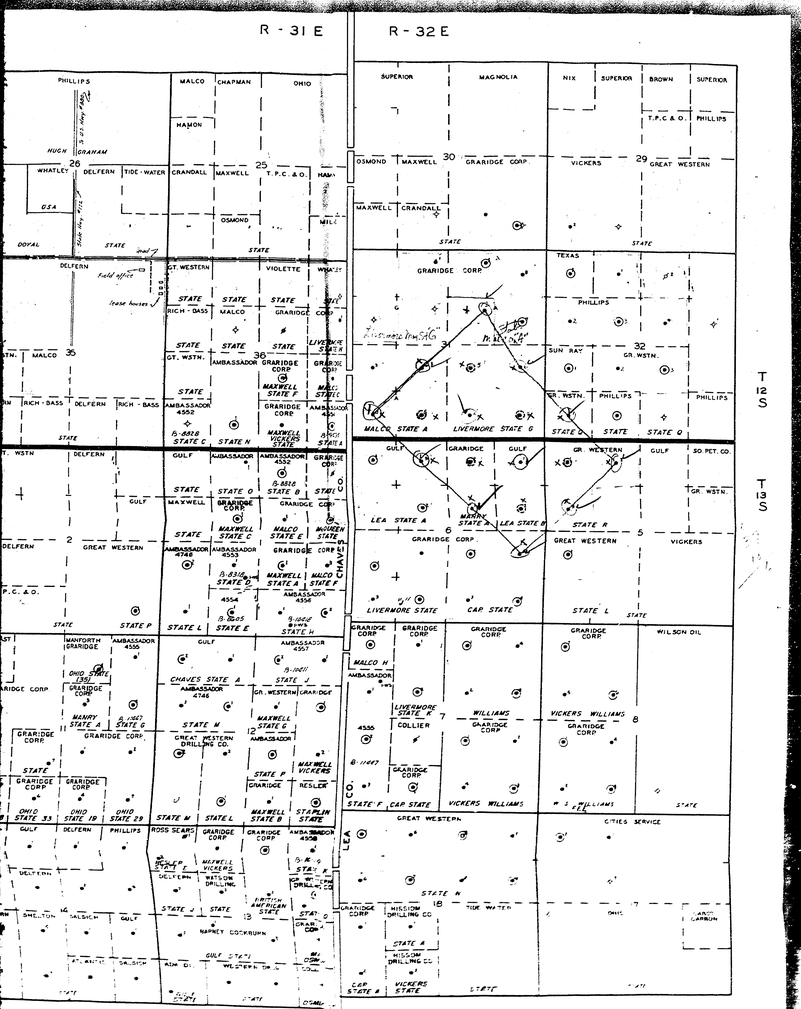
1324

Large Exhibits



YEARLY PRODUCTION OF CRUDE OIL IN PENNSYLVANIA AND IN THE BRADFORD OIL FIELD



- PILOT INJECTION WELLS
- CURRENT INJECTION WELLS IN FIELD
- FUTURE INJECTION PATTERN FOR FULL SCALE FLOOD

CAPROCK AREA
CHAVES & LEA CO'S NEW MEXICO

GRAIDGE CORPORATION Dx 4

Projected Valuations of 1760 Acres of Caprock Queen Field, Lea County, New Mexico
Valuations do not include Acquisition Costs, Depletion, Income Taxes or Salvage Values

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

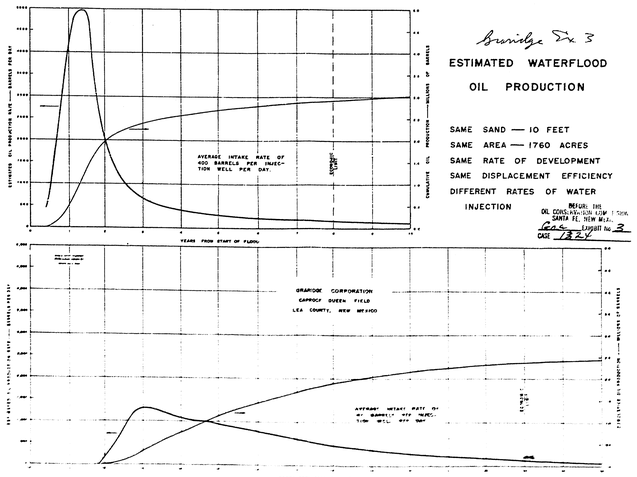
Based on Average Intake Rate of 400 Barrels per Injection Well per Day

Years from Start of Flood	Estimated Future Oil Production: Gross Barrels	Gross Barrels Per Day	Net Barrels (.82)	Income* From Oil Sales	Deduct Estimated Expenses: Production Tax	Direct Lease Expense and Overhead	Development Costs	Total	Net Value: Not Discounted	Net Value: @ Discount Factor	Net Value: Present Worth
1	504,600	1,382	413,800	$1,200,000	$ 55,700	$ 85,500	$704,000	$ 845,200	$ 354,800	.9717	$ 344,800
2	1,464,700	4,013	1,201,100	3,483,200	161,600	132,000		293,600	3,189,600	.9167	2,923,900
3	408,100	1,118	334,600	970,300	45,000	132,000		177,000	793,300	.8648	686,000
4	187,700	514	153,900	446,300	20,700	132,000		152,700	293,600	.8159	239,500
5	128,300	352	105,200	305,100	14,200	132,000		146,200	158,900	.7697	122,300
6	96,900	265	79,500	230,600	10,700	132,000		142,700	87,900	.7261	63,800
7	76,200	209	62,500	181,300	8,400	132,000		140,400	40,900	.6850	28,000
8	62,800	172	51,500	149,400	6,900	132,000		138,900	10,500	.6462	6,800
Totals	2,929,300		2,402,100	$6,966,200	$323,200	$1,009,500	$704,000	$2,036,700	$4,929,500		$4,415,100

Based on Average Intake Rate of 80 Barrels per Injection Well per Day

1	0	0	0	$ 0	$ 0	$ 24,000	$498,000	$ 522,000	($ 522,000)	.9717	($ 507,200)
2	5,100	14	4,200	12,200	600	30,000		30,600	(18,400)	.9167	(16,900)
3	295,700	810	242,500	703,300	32,600	80,000		112,600	590,700	.8648	510,800
4	442,400	1,212	362,800	1,052,100	48,800	105,600		154,400	897,700	.8159	732,400
5	372,500	1,021	305,500	886,000	41,100	105,600		146,700	739,300	.7697	569,000
6	317,300	869	260,200	754,600	35,000	105,600		140,600	614,000	.7261	445,800
7	256,000	701	209,900	608,700	28,200	105,600		133,800	474,900	.6850	325,300
8	195,400	535	160,200	464,600	21,600	105,600		127,200	337,400	.6462	218,000
9	152,500	418	125,100	362,800	16,800	105,600		122,400	240,400	.6097	146,600
10	120,000	329	98,400	285,400	13,200	105,600		118,800	166,600	.5751	95,800
11	93,200	255	76,400	221,600	10,300	105,600		115,900	105,700	.5426	57,400
12	71,500	196	58,600	169,900	7,900	105,600		113,500	56,400	.5119	28,900
13	53,900	148	44,200	128,200	5,900	105,600		111,500	16,700	.4829	8,100
Totals	2,375,500		1,948,000	$5,649,400	$262,000	$1,190,000	$498,000	$1,950,000	$3,099,400		$2,614,000

* $2.90 per barrel

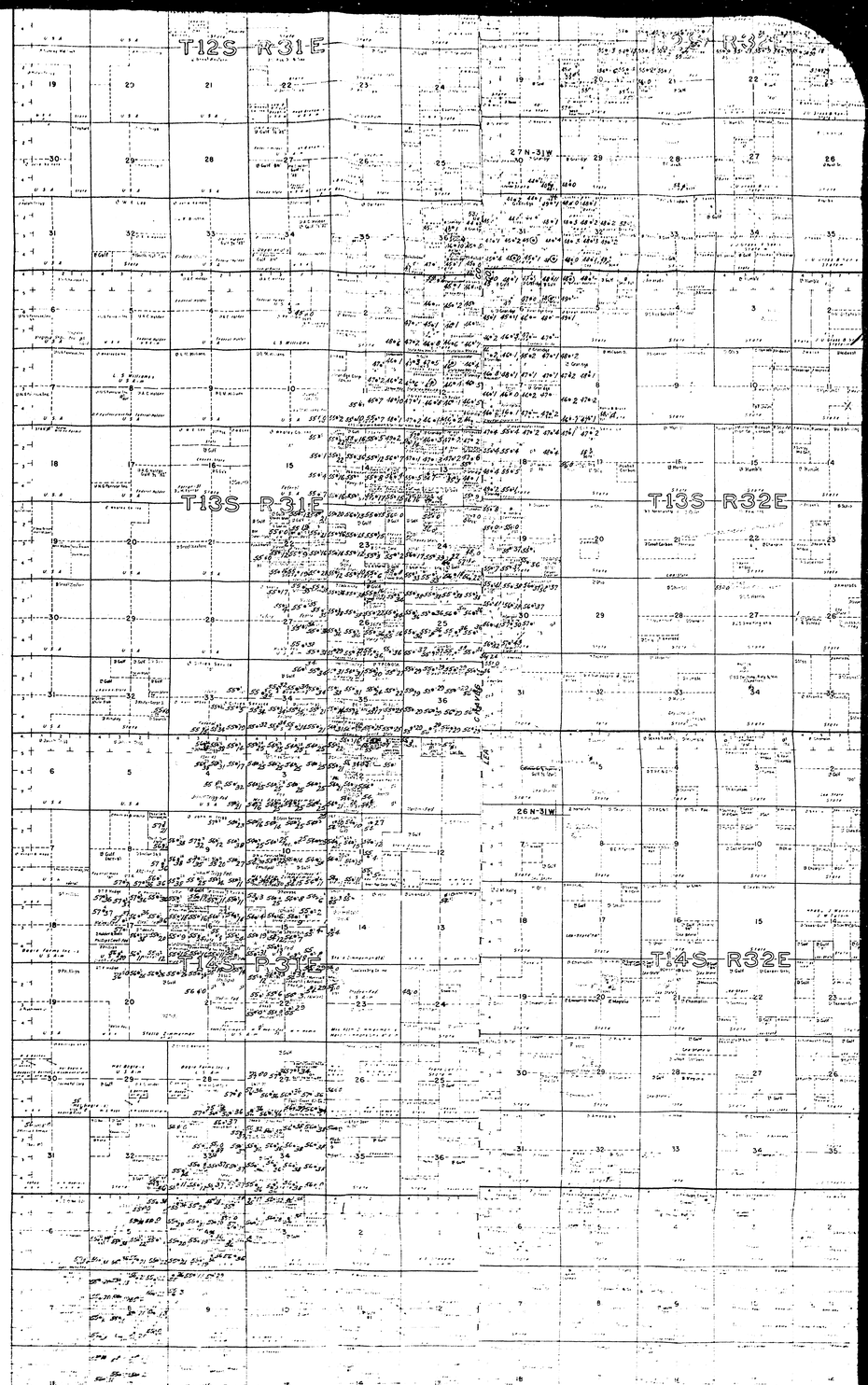


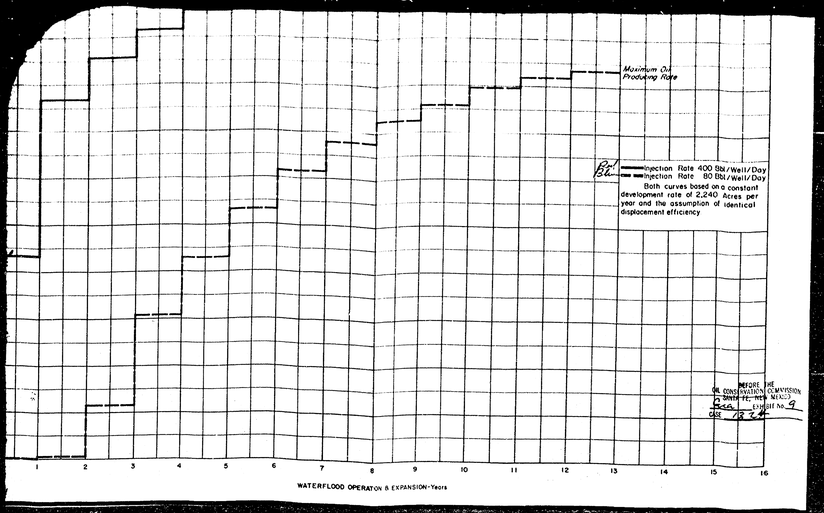
Graidge Dx 3

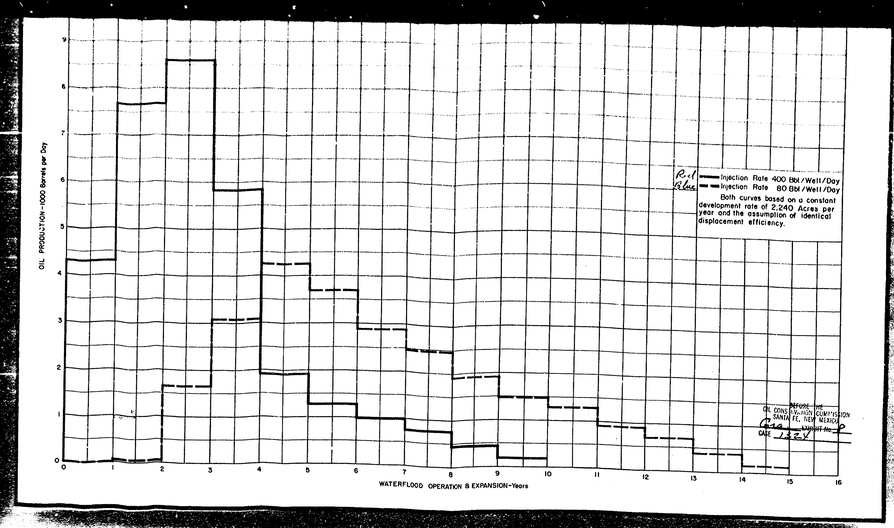
ESTIMATED WATERFLOOD OIL PRODUCTION

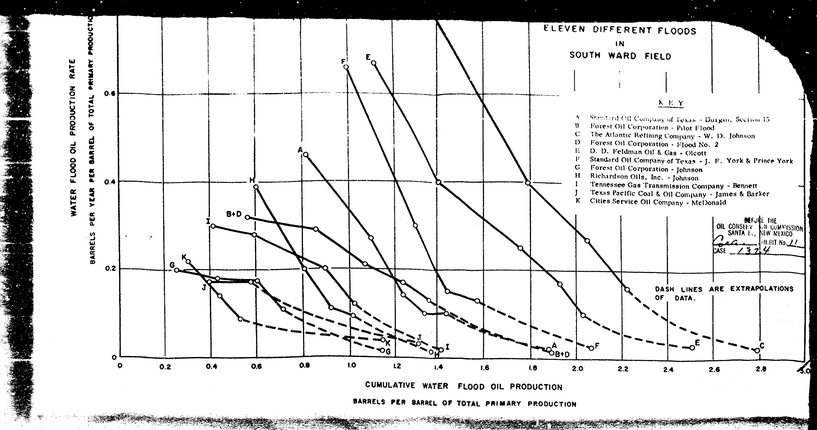
SAME SAND — 10 FEET
SAME AREA — 1760 ACRES
SAME RATE OF DEVELOPMENT
SAME DISPLACEMENT EFFICIENCY
DIFFERENT RATES OF WATER INJECTION

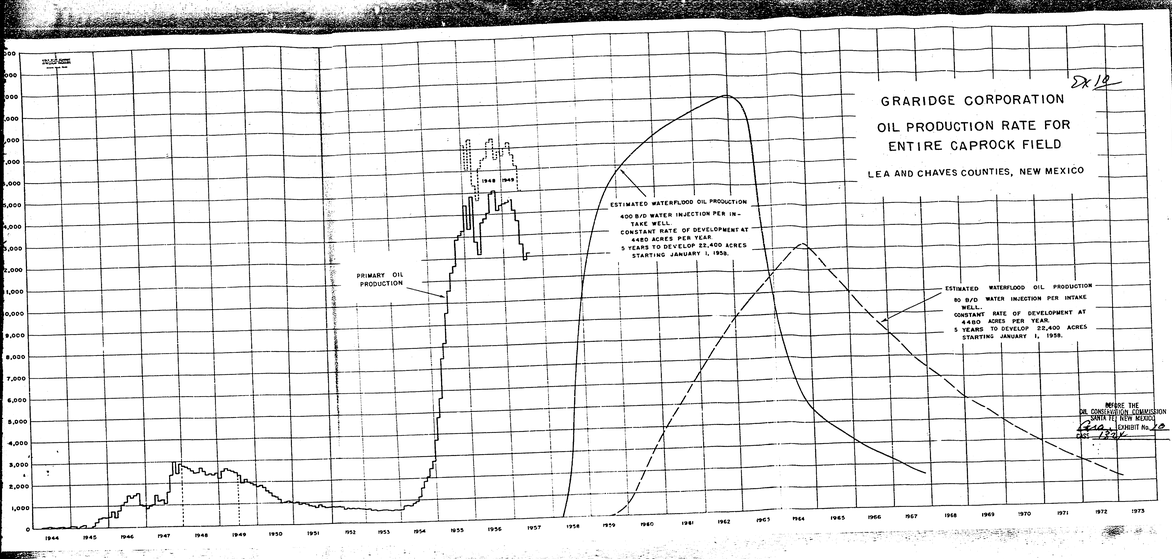
BEFORE THE OIL CONSERVATION COMMISSION SANTA FE, NEW MEX. Case 1324 EXHIBIT No. 3

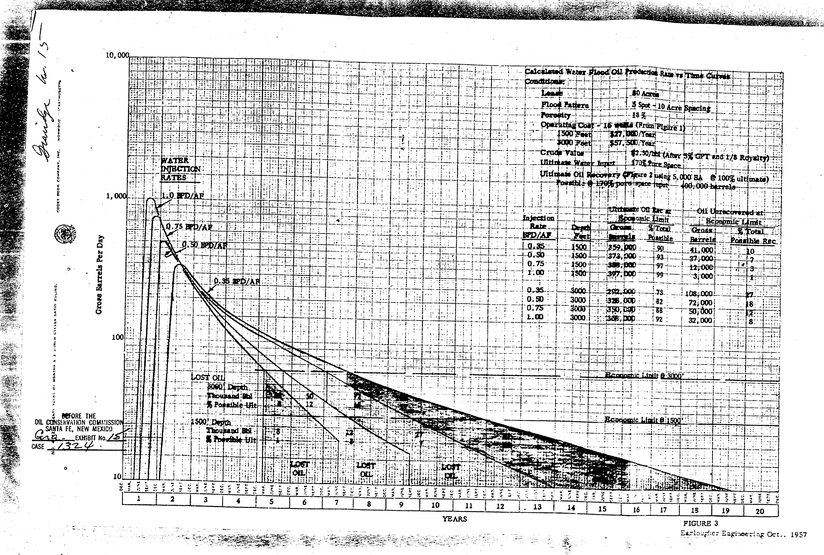












Calculated Water Flood Oil Production Rate vs Time Curves

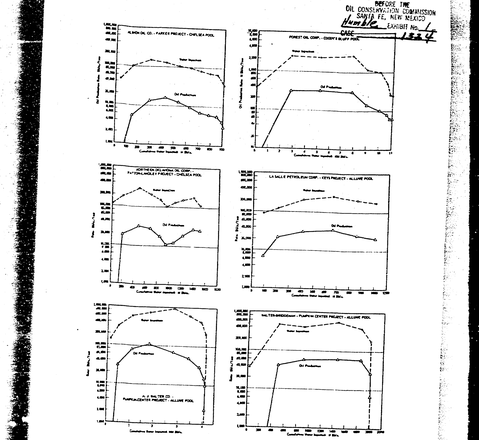
Conditions:

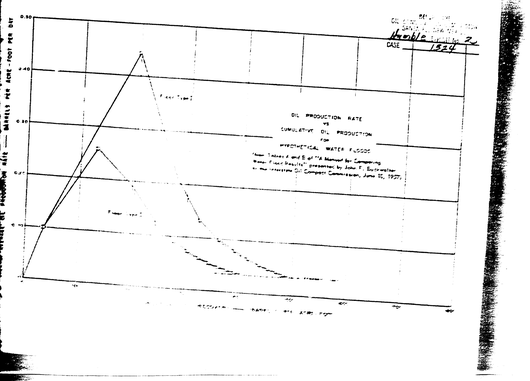
Lease	80 Acres
Flood Pattern	5 Spot - 10 Acre Spacing
Porosity	18 %
Operating Cost - 16 wells (From Figure 1)	
1500 Feet	$27,000/Year
3000 Feet	$57,500/Year
Crude Value	$2.30/bbl (After 5% CPT and 1/8 Royalty)
Ultimate Water Input	570% Pore Space

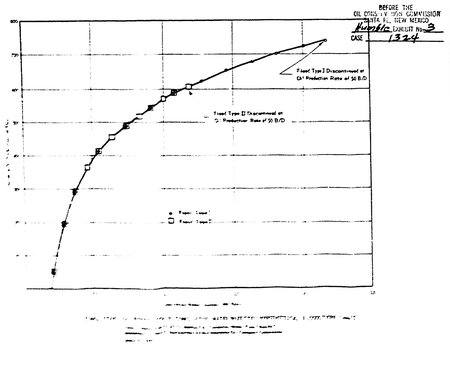
Ultimate Oil Recovery (Pattern 2 using 5,000 BA @ 100% ultimate)
Possible @ 1095 pore space input - 400,000 barrels

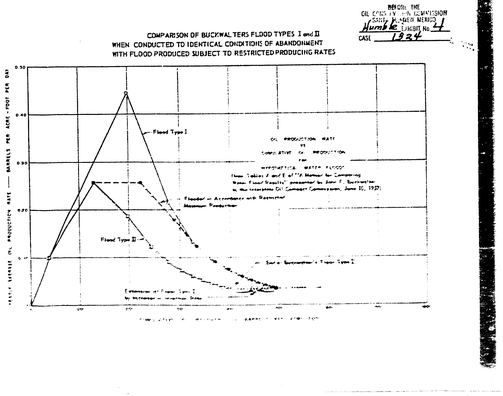
Injection Rate BPD/AF	Depth Feet	Ultimate Oil Rec at Economic Limit Gross Barrels	% Total Possible	Oil Unrecovered at Economic Limit Gross Barrels	% Total Possible Rec.
0.35	1500	359,000	90	41,000	10
0.50	1500	373,000	93	27,000	7
0.75	1500	388,000	97	12,000	3
1.00	1500	397,000	99	3,000	1
0.35	3000	302,000	73	108,000	27
0.50	3000	328,000	82	72,000	18
0.75	3000	350,000	88	50,000	12
1.00	3000	368,000	92	32,000	8

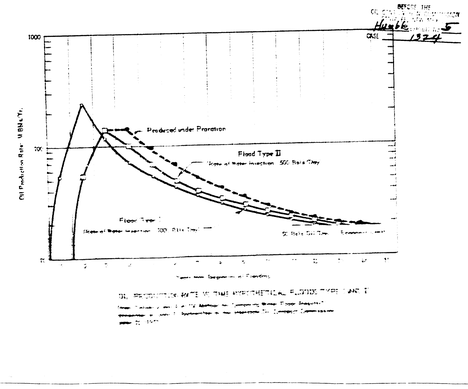
FIGURE 3
Earlougher Engineering Oct., 1957

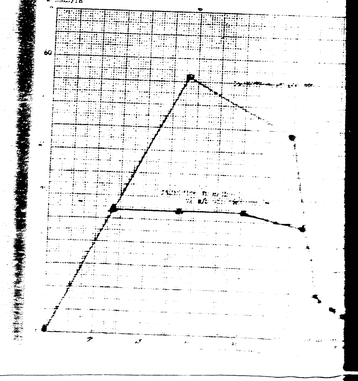


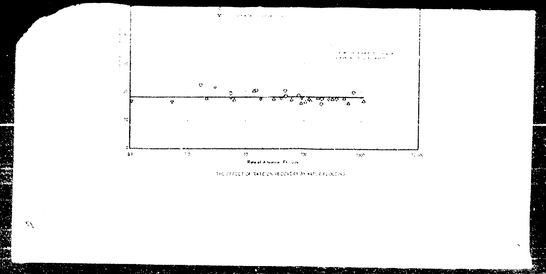




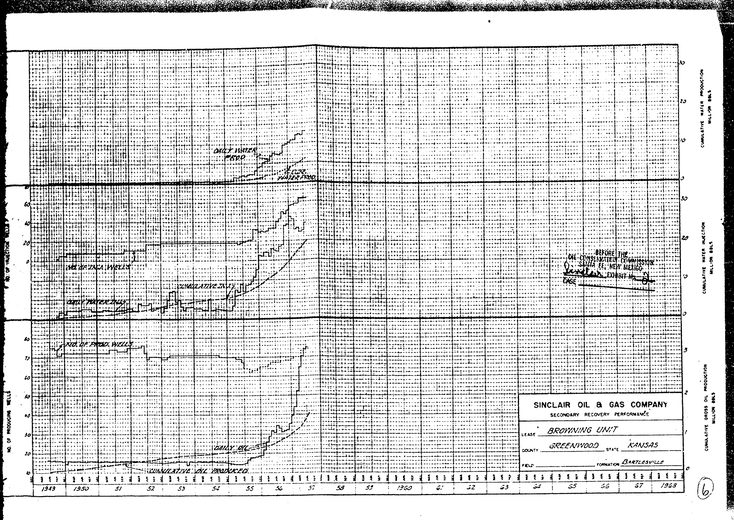








THE EFFECT OF RATE ON RECOVERY BY WATER FLOODING



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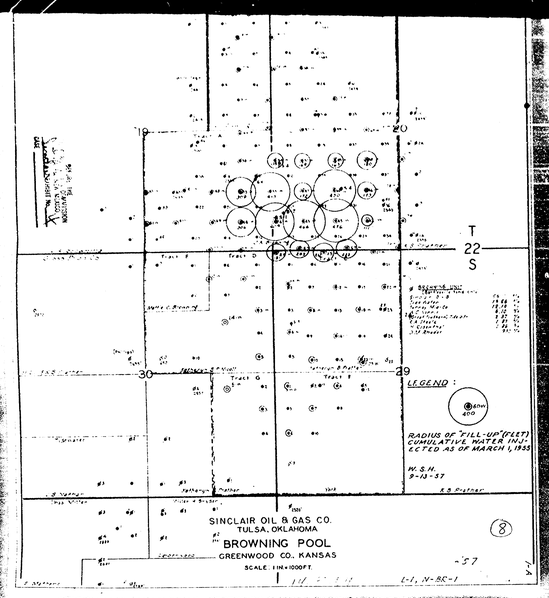

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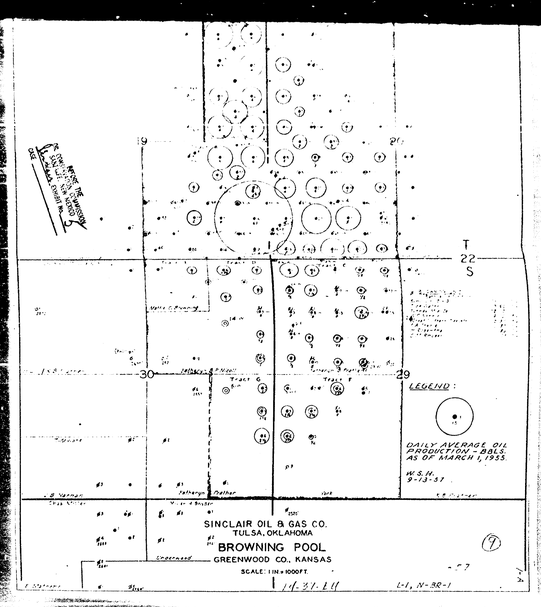

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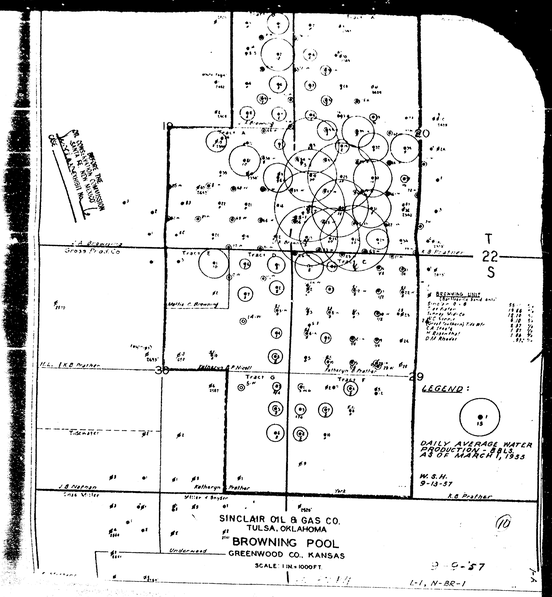

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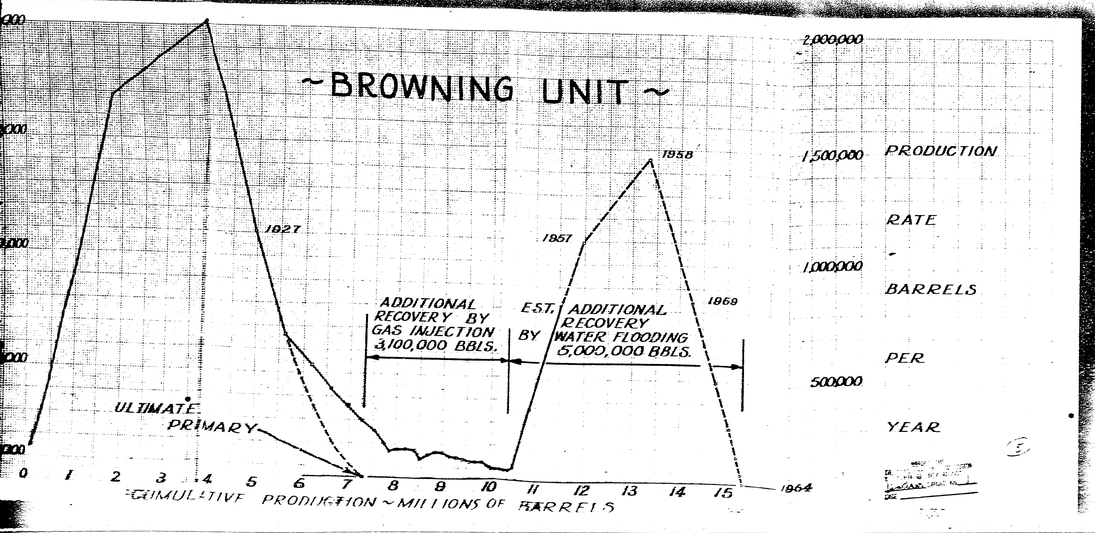

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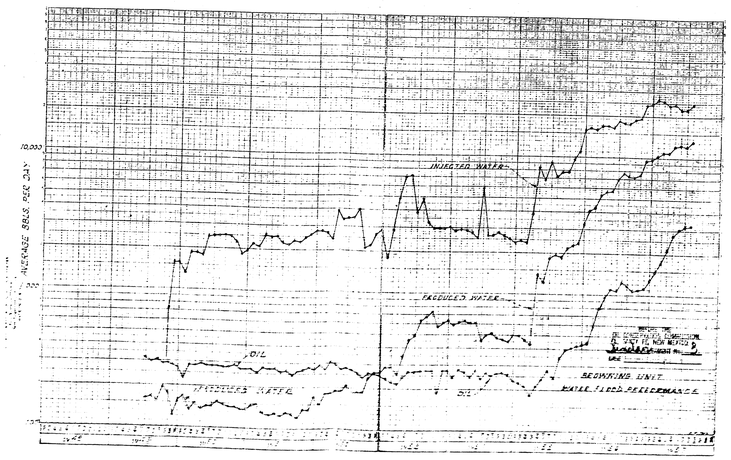
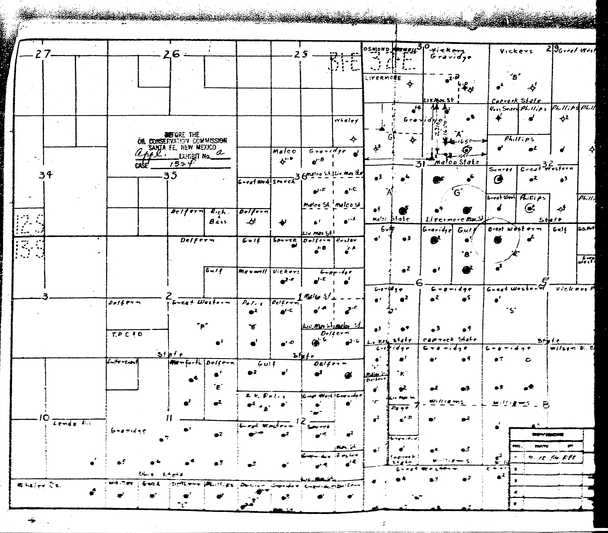
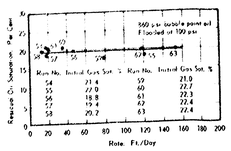
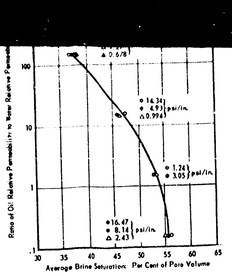


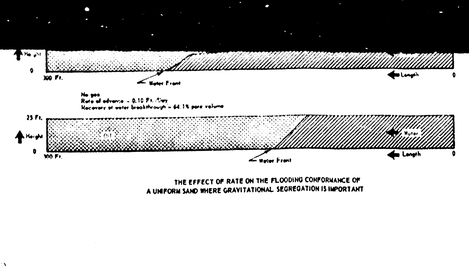




THE EFFECT OF RATE ON OIL RECOVERY BY WATER FLOODING IN PRESENCE OF A 22% FREE GAS SATURATION
(Homogeneous Sand)



RELATIVE PERMEABILITY AS A FUNCTION OF BRINE SATURATION MEASUREMENTS AT DIFFERENT PRESSURE GRADIENTS
(From Date of Gelfan, Owens, Parrish & Morse)

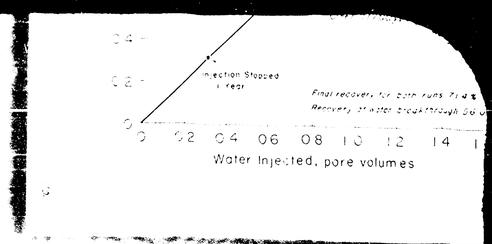


THE EFFECT OF RATE ON THE FLOODING CONFORMANCE OF A UNIFORM SAND WHERE GRAVITATIONAL SEGREGATION IS IMPORTANT

55 Feet Formation Thickness
1.55 cp Oil Viscosity
40° API Oil Density

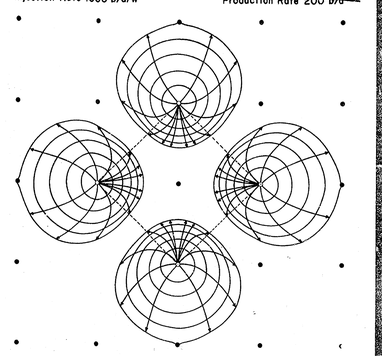
Operation Schemes Studied:
1 – Continuous Injection and Production – at 143 Bbl/Day Per Well
2 – Intermittent Operation – Alternate Days of Operation and Shutdown
286 Bbl/Day Per Well Each Day of Operation
3 – Intermittent Operation – 15 Days Operating Followed by 15 Days Shutdown
286 Bbl/Day Per Well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

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



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

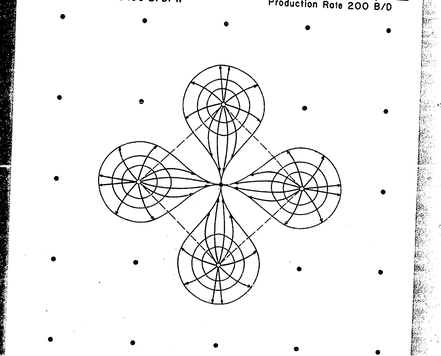
RELATIVE MOVEMENT OF WATER THROUGH STRATIFIED, NON-COMMUNICATING SANDS OF DIFFERENT PERMEABILITIES



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

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

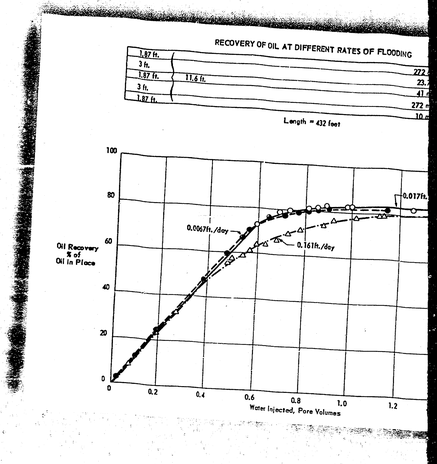
13.



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

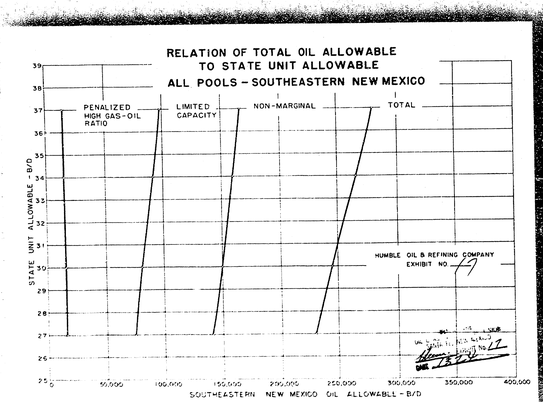
Oil Gained 164,833 bbls.
= 30.0% of Oil Produced

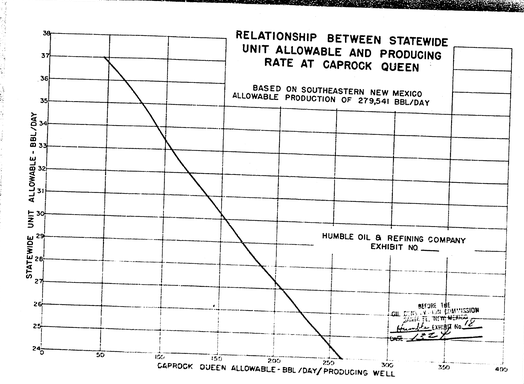
14.

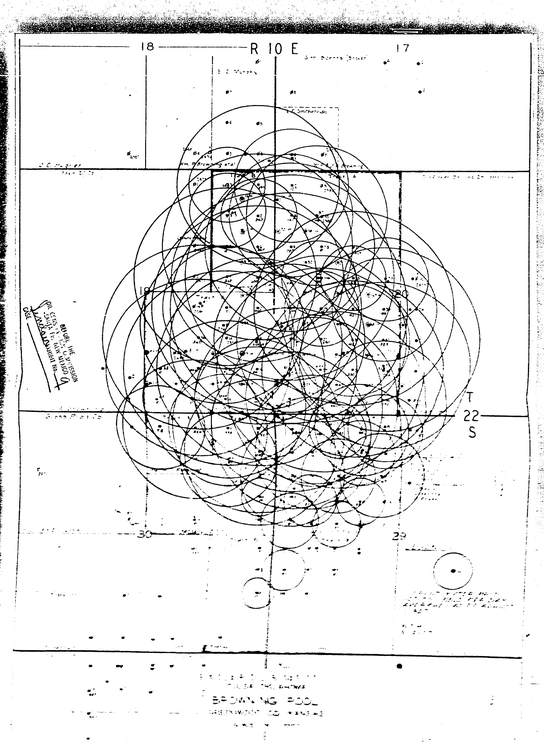


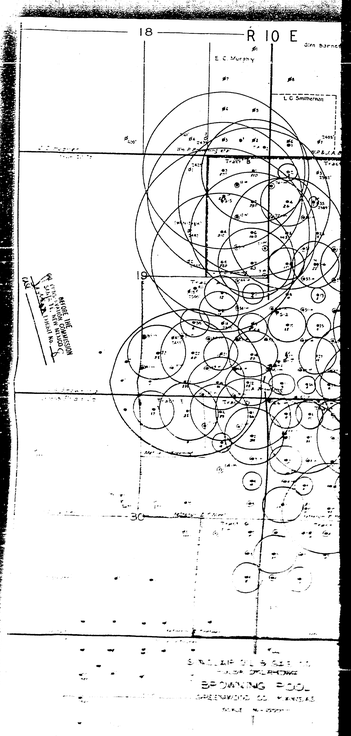
Characteristics of Stratified Model as Reservoir

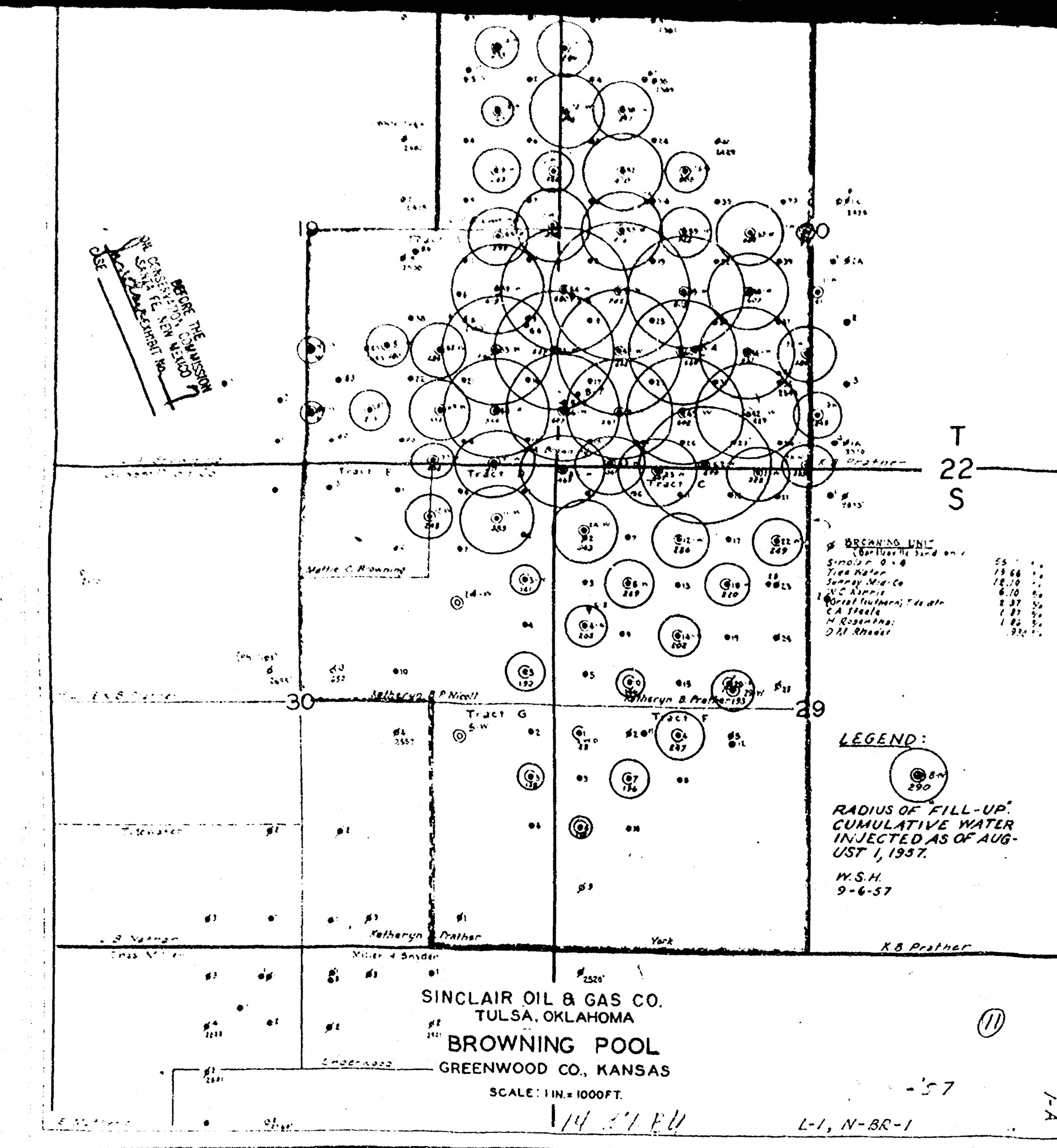
Property		Model	Reservoir
Oil Density, ρ_o		0.827 g/cc	0.821 g/cc
Water Density, ρ_w		1.098 g/cc	0.993 g/cc
Density Difference, $\rho_w - \rho_o$		0.271 g/cc	0.172 g/cc
Permeability, K		139,500 md	272 md
	K1	9,500	23.7
	K2	16,400	41
	K3	109,000	272
	K4	4,000	10
	K5		
	Overall	51,400	128.4
Porosity, ϕ		44%	22%
Height, H_1		.312 inches	1.87 feet
	H_2	.500 inches	3.90 feet
	H_3	.312 inches	1.87 feet
	H_4	.560 inches	3.33 feet
	H_5	.312 inches	1.87 feet
	Overall	1.936 inches	11.61 feet
Length, L		72 inches	432 feet
Length $\frac{L}{H}$		37.2	37.2
Height $\frac{H}{H}$		6.3	3.6
Oil Viscosity, μ_o		1.19 cp	0.68 cp
Water Viscosity, μ_w			
Viscosity Oil $\frac{\mu_o}{\mu_w}$		5.3	5.3
Viscosity Water $\frac{\mu_w}{\mu_w}$			
Interfacial Tension, γ		33.8 dynes/cm	33.8 dynes/cm
Flood Rate 1, q_1		7.87 ft/day	0.03668 ft/day
Flood Rate 2, q_2		.70	0.017
Flood Rate 3, q_3		189	0.161
Gravitational Pressure / Capillary Pressure	$\frac{(\rho_w - \rho_o) gH}{\gamma \sqrt{\frac{\phi}{K}}}$	0.0415	0.134
Viscous Pressure / Capillary Pressure	$\frac{\frac{q}{K} \mu_o L}{\gamma \sqrt{\frac{\phi}{K}}}$ Rate 1	0.375	0.375
	Rate 2	0.955	0.955
	Rate 3	9.55	9.05
Viscous / Gravitational	$\frac{\frac{q}{K} \mu_o L}{(\rho_w - \rho_o) gH}$ Rate 1	9.64	2.8
	Rate 2	21	7.12
	Rate 3	238	67.5







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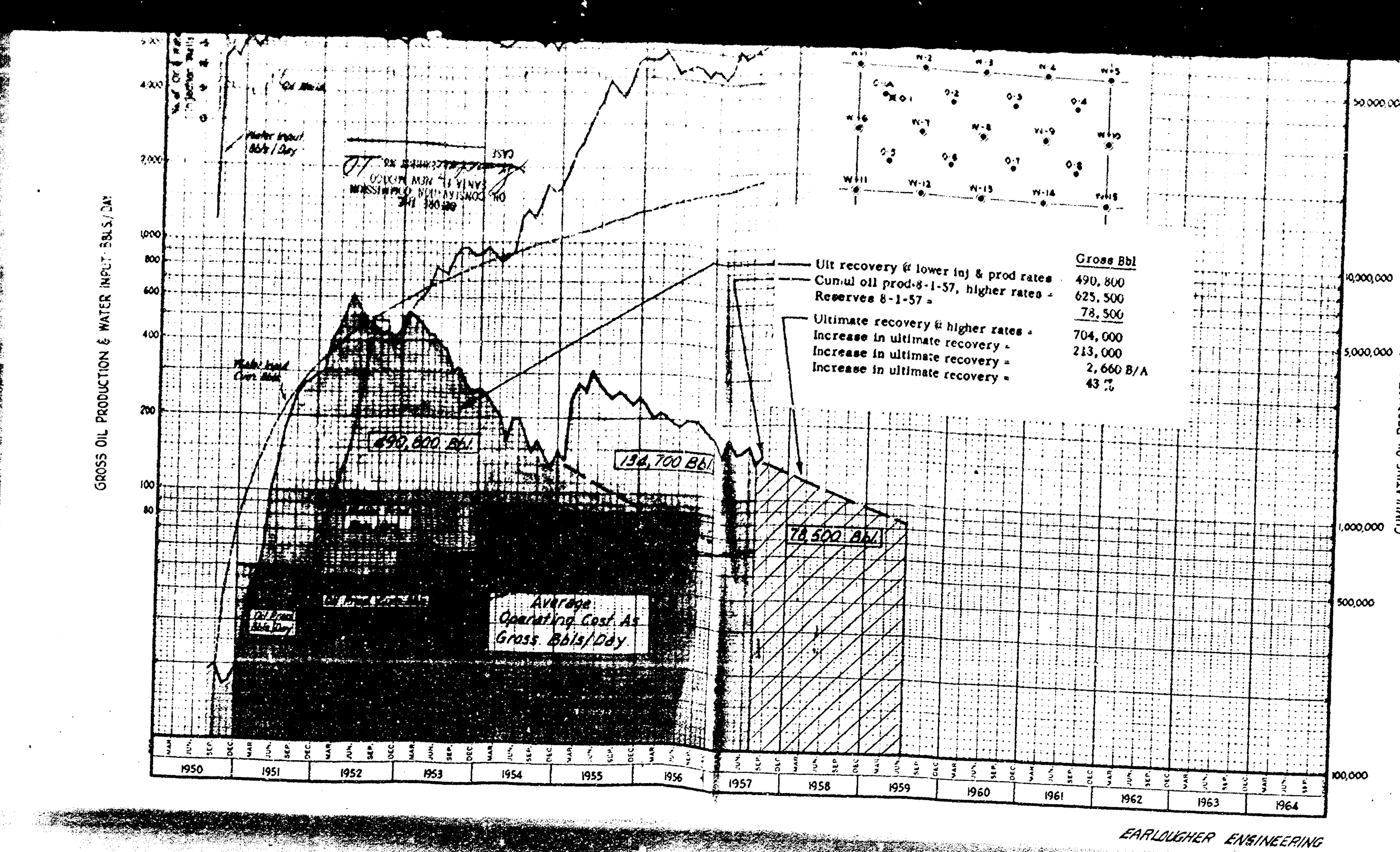
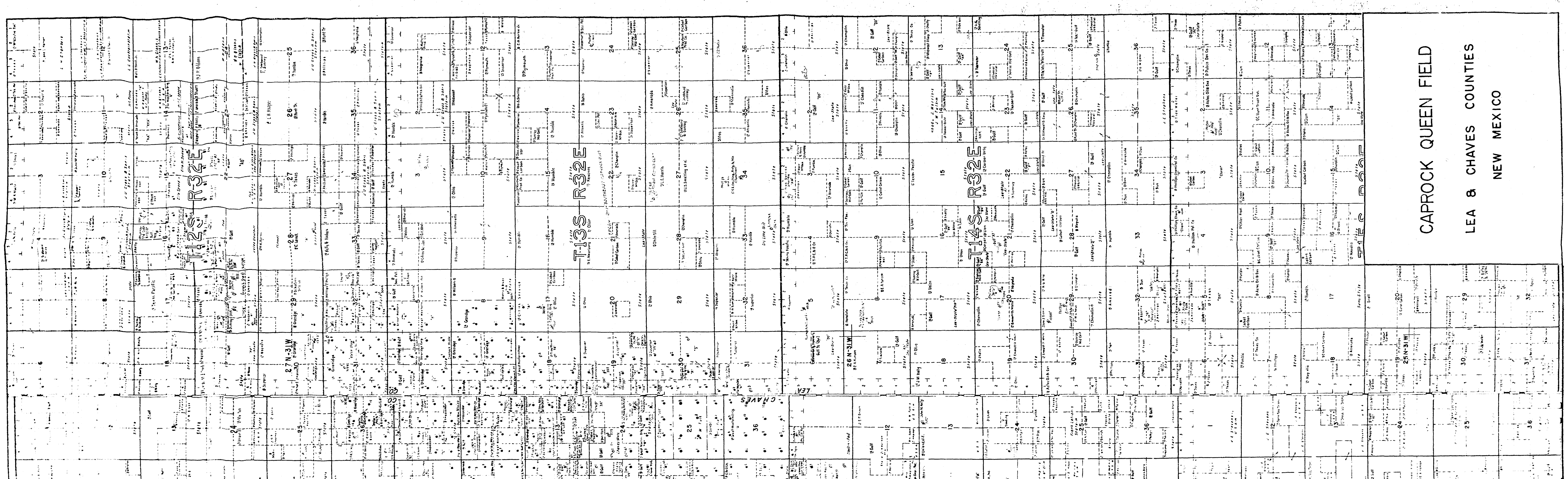
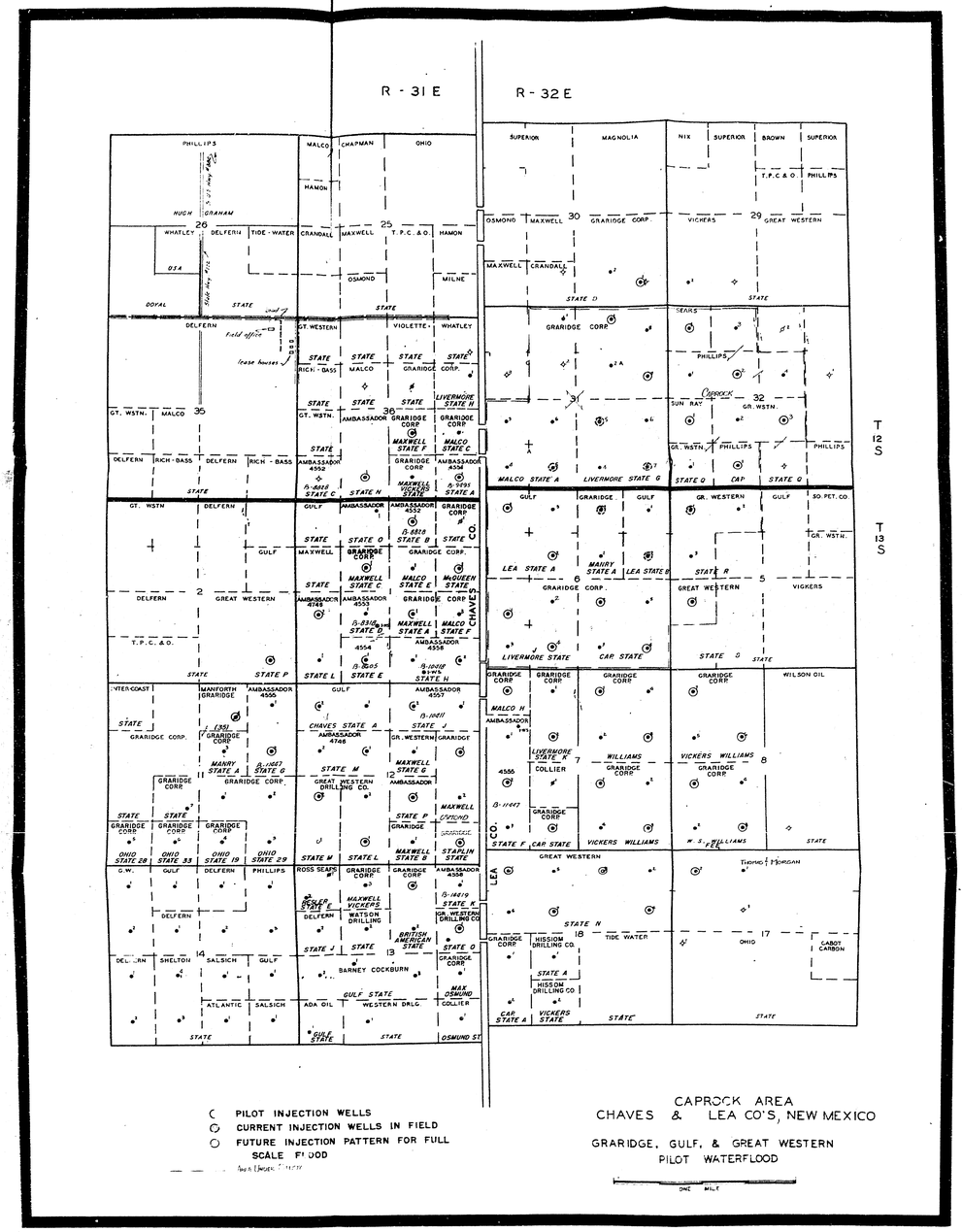
LEGEND:
RADIUS OF "FILL-UP" CUMULATIVE WATER INJECTED AS OF AUGUST 1, 1957.
SINCLAIR OIL & GAS CO.
TULSA, OKLAHOMA
BROWNING POOL
GREENWOOD CO., KANSAS


Gross Bbl
Ult recovery @ lower inj & prod rates 490,800
Cumul oil prod 8-1-57, higher rates = 625,500
Reserves 8-1-57 = 78,500
Ultimate recovery @ higher rates = 704,000
Increase in ultimate recovery = 213,000
Increase in ultimate recovery = 2,660 B/A
Increase in ultimate recovery = 43 %
134,700 Bbl.
78,500 Bbl.
Average Operating Cost As Gross Bbls/Day
GROSS OIL PRODUCTION & WATER INPUT BBLS/DAY
CUMULATIVE OIL PRODUCTION & WATER INPUT BBLS
EARLOUGHER ENGINEERING


CAPROCK QUEEN FIELD
LEA & CHAVES COUNTIES
NEW MEXICO
T12S R32E
T13S R32E
T14S R32E
T13S R31E
T14S R31E
T15S R31E
LEA
CHAVES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R - 32 E
T 12 S
T 13 S
CHAVES CO.
LEA CO.
PILOT INJECTION WELLS
CURRENT INJECTION WELLS IN FIELD
FUTURE INJECTION PATTERN FOR FULL SCALE FLOOD
CAPROCK AREA
CHAVES & LEA CO'S, NEW MEXICO
GRARIDGE, GULF, & GREAT WESTERN
PILOT WATERFLOOD
ONE MILE