

PLAN OF WATERFLOOD OPERATIONS

FOR
MALAGA UNIT

EDDY COUNTY, NEW MEXICO

Submitted by:

MORRIS R. ANTWEIL
Unit Operator

May 1, 1967

I. HISTORY

The field discovery well, Southern California Petroleum Corporation's Valley Land Company No. 1-F, located in Unit F, SE/4 NW/4 Sec. 7, T-24-S, R-29-E, (now Reserve Oil and Gas Company's Valley Land No. 1) was completed on June 19, 1951, for 30 BOPD. By the close of 1952, a total of twenty (20) active wells and one (1) temporarily abandoned well were drilled and completed. The productive acreage in this field lies within Section 12 and 13, T-24-S, R-28-E and Section 7 and 18, T-24-S, R-29-E, both in Eddy County, New Mexico.

The drilling method used to develop the field consisted of cable tools to total depth with production casing set on top of the pay zone and hydraulic fractive treatment in the open hole. The casing program normally consisted of 8-5/8" or 10-3/4" OD surface casing to approximately 300 feet and approximately 2,740 feet of 5-1/2" or 7" OD casing as a production string. Table I presents other pertinent well completion data.

Initial production rates ranged from 26 to 94 BOPD following fracture treatment, with the average being 40 to 50 BOPD. Production followed the normal decline of a solution gas drive mechanism. Wells completed below +230 datum normally produced some water; however, no active water drive appears to have been present.

II. GEOLOGY

The producing horizon in the Malaga Field is the Delaware sand of the Guadalupe Series, Bell Canyon Group of the Permian System. The reservoir consists of a stratigraphic accumulation trending northeast-southwest along a local structural nose. The pay zone exists as a general blanket sand which is gray to green, fine to uniform grained, well sorted, calcareous cemented sandstone highly laminated into randomly alternating intervals of high oil saturation to low oil saturation, with accompanying high water saturation. The sand is encountered at an average depth of 2739 feet from the surface, some 10 to 15 feet below the Delaware limestone. Enclosed is a typical radioactivity well log for correlation purposes.

The average net oil pay thickness is estimated at 10 feet. The oil pay occurs in the middle zone of the Delaware sand, with the upper zone being a barren or low-pressure gas-bearing sand, which may conduct injected water under the proposed waterflood program. If this upper zone member proves to present an injection problem, it is proposed to control the injection into the oil pay by cementing liners through the open hole section and selectively perforating the oil zone. This method has been successfully employed in nearby Delaware sand floods.

III. ROCK AND FLUID CHARACTERISTICS

Average rock and fluid properties were reported in the New Mexico Geological Symposium Book, as follows:

Avg. Porosity	24%
Avg. Permeability	55 md (horizontal)
Saturations:	
Connate Water	38%
Remaining Oil	48%
Formation Volume	
Factor	1.10 est.
Pay Thickness, Avg.	10 ft.
Depth to Pay	2,730 ft.
Oil Gravity	42° API Sweet
Original Gas in	
Solution	420 SCF/bbl. est.

IV. PRIMARY RECOVERY AND PREDICTED SECONDARY RECOVERY

The cumulative primary oil production from the wells within the proposed Unit area as of January 1, 1967 has been 641,091 barrels. The solution gas drive reservoir energy has been depleted and the primary recovery is virtually complete with the majority of the wells operating near their economic limit.

The twenty (20) active wells in the field produced 942 barrels of oil during February, 1967, which is an average of 1.68 barrels per well per day, with a range from 0.04 to 6.2 barrels per well per day.

Predicted secondary oil recovery resulting from a successful waterflood venture is 591,000 barrels, based on an average secondary recovery for similar waterfloods of approximately 0.9 times primary recovery.

V. UNIT PARTICIPATION FORMULA

The Operator's Committee unanimously agreed that the most valid criterion for a participation formula for the Unit would be a formula based 100% on accumulative primary recovery to July 1, 1963. Primary recovery is the most revealing factor in ascertaining reservoir capacity and remaining reserves since few good primary producing fields, which were produced by solution gas drive, have failed under a waterflood program.

A volumetric type formula was discarded due to the peculiar productive nature of the Delaware Sand. Even where excellent log control is existent, leading reservoir analyst agree that net pay determinations are virtually impossible or at the best inconclusive. This basically is because of the noncorrelatable situation between porosity, permeability, and occurrence of commercial oil production. One authority, Core Laboratories, contends that net pay determinations are almost impossible to make and if so, are of questionable validity.

VI. UNIT AREA DESIGNATION

The attached map, Exhibit "A", depicts the limits of the proposed unit. The unit is contained partially in Sections 12 and 13, T-24-S, R-28-E and Sections 7 and 18, T-24-S, R-29-E, of Eddy County, New Mexico. All of the productive acreage in the Malaga Field is included in the proposed area.

VII. UNDEVELOPED TRACTS

The only undeveloped tract in the Unit, Tract 3, originally had a well drilled on it and produced oil from the subject Delaware Sand. It was a small commercial well and was plugged and abandoned in 1952. The tract has been included in the Unit since it could serve as an injection well under successful flood operations.

The participation formula appropriately accommodates the fact that no well currently exists and that only a small volume of primary oil was recovered from the well.

VIII. WATER SOURCE

Water for injection purposes will be obtained from the shallow water sands underlying the Unit area which produce for agricultural use in the local area. A water lease authorizing withdrawal from these sands, contained in the Carlsbad Underground Water Basin, has been obtained and a water supply well has been drilled.

When produced water from the pay zone commences, it will be re-injected along with the above water.

IX. WATER STATION AND INJECTION EQUIPMENT

Development of the injection system and water station will be completed in one stage, at flood initiation. It is planned to utilize only one pressure pump for the project. Distribution of injection water is planned through a system of buried lines which will be internally and externally coated to control corrosion.

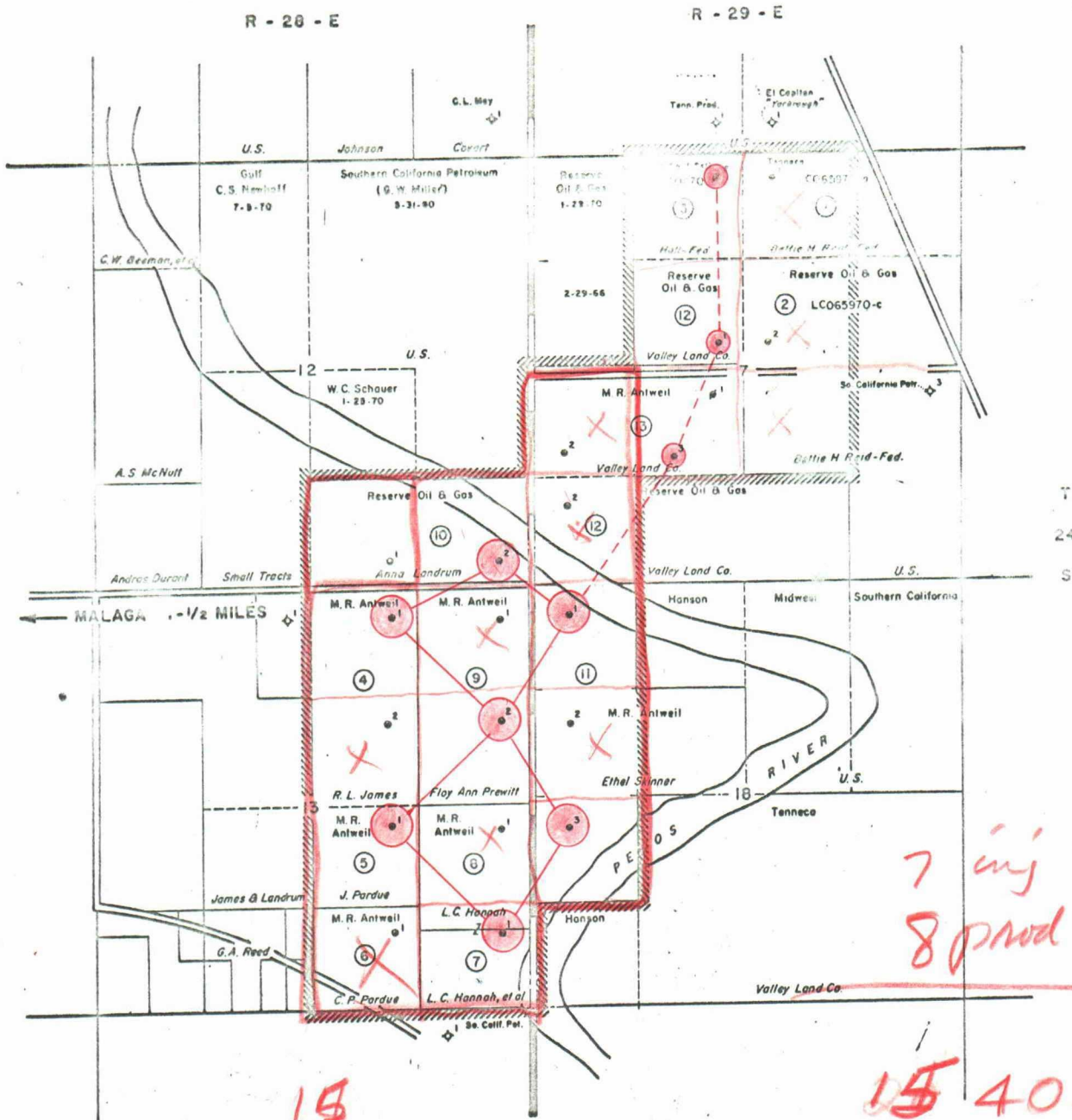
X. INJECTION PATTERN

A basic five-spot injection pattern has been selected for the Malaga Unit waterflood project. Such a pattern conforms well with the development configuration in the southern portion of the Unit area, but requires modification to meet the less extensive development in the northern portion of the Unit. The proposed injection pattern is shown on the attached map, Exhibit "A".

It is planned to initiate the waterflood with injection into the seven wells in the southern portion of the Unit shown on Exhibit "A" as proposed injection wells. The waterflood program will be expanded to the wells shown as future injection wells after results are obtained to indicate the waterflood program is successful in stimulating oil production.

XI. PRODUCTION EQUIPMENT

Pumping equipment, surface and subsurface, will be enlarged as necessary to adequately handle the production generated. Consolidation of individual tank batteries into a central location to facilitate and expedite handling of the produced fluids will be considered when a production response is realized. Provisions will be made to allow periodic production testing of all producing wells.



LEGEND

- Oil Well
- Plugged & Abandoned
- Dry & Abandoned
- County Roads
- Tract No.
- Unit Boundary

- Proposed injection well
- Future injection well

MORRIS R. ANTWEIL

MALAGA UNIT
EDDY COUNTY, NEW MEXICO

EXHIBIT "A"

0 500 1000 2000 3000 4000
SCALE - FEET

DATE: 2-21-66

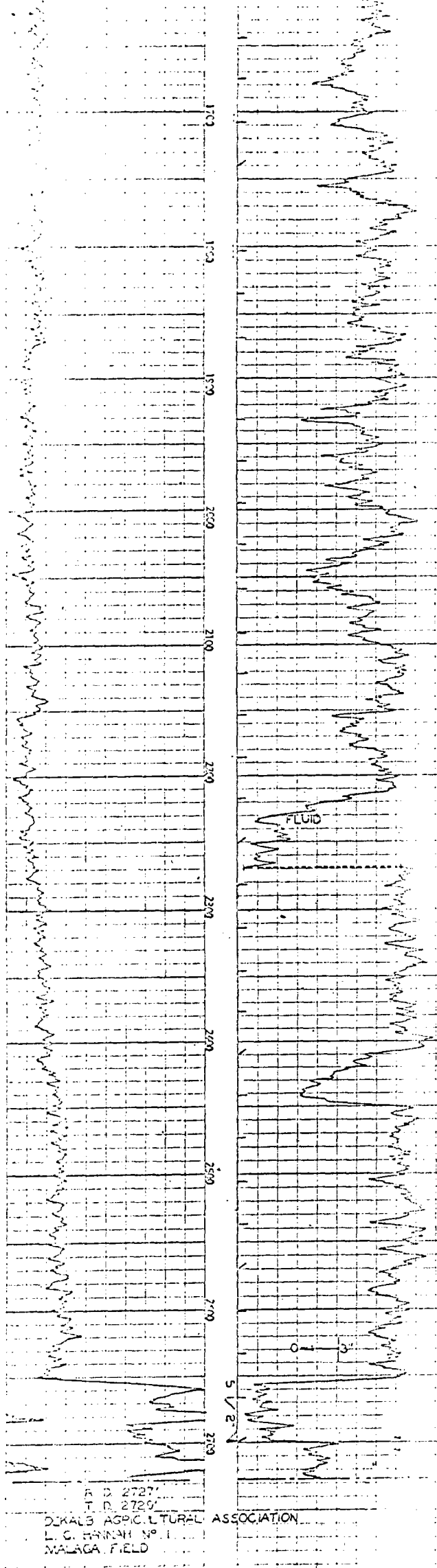
TABLE 1 -
MALAGA DELAWARE SAND UNIT - EDDY COUNTY, NEW MEXICO
WELL COMPLETION DATA

Company & Lease Name Reserve Oil & Gas Landrum	Well No.	Comp. Date	Elev.	T.D.	C A S I N G			Delaware Pay Section	Stimu- lation	Current Status
					Size	Depth	Cement			
Morris R. Antweil	1	4/9/52	2953	2754	10-3/4	275	58	2747-54	Frac	Producing
	2	5/29/52	2948	2756	10-3/4	294	200	2752-56	Frac	Producing
L. C. Hannah	1	7/28/52	2949	2727	6-5/8	316	125	2718-27	Frac	Producing
	1	9/11/52	2942	2739	5-1/2	2694	50	2731-2939	Frac	Producing
L. C. Hannah et al	1	9/11/52	2942	2739	8-5/8	324	150	2731-2939	Frac	Producing
	1	3/7/52	2963	2748	5-1/2	2694	75	2740-48	Frac	Producing
R. L. James	1	3/7/52	2963	2748	10-3/4	280	180	2740-48	Frac	Producing
	2	4/24/52	2966	2757	5-1/2	2700	100	2748-57	Frac	Producing
James & Pardue	1	8/16/52	2965	2742	8-5/8	299	100	2748-57	Frac	Producing
	1	8/16/52	2965	2742	5-1/2	2730	100	2734-42	Frac	Producing
C. P. Pardue	1	3/7/53	2937	2726	8-5/8	301	125	2734-42	Frac	Producing
	1	3/7/53	2937	2726	5-1/2	2683	75	2716-26	Frac	Producing
Floy Prewitt	1	5/28/52	2962	2754	8-5/8	306	125	2716-26	Frac	Producing
	2	6/23/52	2956	2742	5-1/2	2701	50	2744-54	Frac	Producing
Floy Prewitt	1	5/28/52	2962	2754	8-5/8	289	100	2744-54	Frac	Producing
	2	6/23/52	2956	2742	5-1/2	2739	100	2731-42	Frac	Producing
Valley Land	2	9/17/52	2955	2752	8-5/8	312	125	2731-42	Frac	Producing
	3	1/ 9/52	2942	2797	5-1/2	2734	200	2731-42	Frac	Producing
Valley Land	3	1/ 9/52	2942	2797	4-1/2	2734	200	2731-42	Frac	Producing
	3	1/ 9/52	2942	2797	Liner-2665-2746	332	200	2750-52	Frac	Producing
Valley Land	3	1/ 9/52	2942	2797	8-5/8	2712	500	2750-52	Frac	Producing
	3	1/ 9/52	2942	2797	8-5/8	313	200	2755-66	Frac	Producing
Valley Land	3	1/ 9/52	2942	2797	5-1/2	2796	100	2755-66	Frac	Producing
	3	1/ 9/52	2942	2797	P.B.	2774	100	2755-66	Frac	Producing
Valley Land	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
Valley Land	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
Valley Land	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
Valley Land	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
Valley Land	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
Valley Land	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
Valley Land	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
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Valley Land	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
Valley Land	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
Valley Land	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
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Valley Land	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
Valley Land	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
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Valley Land	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
Valley Land	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
Valley Land	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
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	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
Valley Land	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
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Valley Land	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	Producing
	1	9/ 4/57	2970	2796	8-5/8	1465	450	2765-96	Frac	

TABLE 1. (Cont'd)

Company & Lease Name Reserve Oil & Gas	Well Comp. No.	Date	Elev.	T.D.	C A S I N G			Pay Section	Stimu- lation	Current Status
					Size	Depth	Cement			
Valley Land	1	5/16/51	2962	2779	10-3/4	127-	250	2774-79	Frac 750 g.	Producing
					8-5/8	1008-	0			
					7	484-				
						1293				
						2555	40			
					5-1/2	2728	280			
Valley Land	2	6/ 8/52	2950	2737	10-3/4	294	350	2735-37	Frac 1500 g.	Producing
					5-1/2	2737	200			
Bettie H. Reid	1	8/23/51	2980	2792	13-3/8	152	98	2782-92	Frac 750 g.	Producing
					8-5/8	982	125			
					5-1/2	2765	147			
Bettie H. Reid	2	10/3/	2781	2791	13-3/8	173	96	2783-91	Frac 750 g.	Producing
					5-1/2	2775	280			
(Southern California)										
Hall-Federal	1	6/ 1/52	2979	2817	10-3/4	314	250	2813-17	Frac 1500 g.	P & A
(Now E.A.Hanson)					5-1/2	2793	550			
Manana Gas Company										
Ethel Skinner	1	6/18/52	2963	2755	9-5/8	275	400	2754-55	Frac 1500 g.	Producing
					5-1/2	2736	125			
Ethel Skinner	2	8/ 4/52	2951	2720	9-5/8	290	400	2715-20	Frac 3000 g.	Producing
					5-1/2	2712	125			
Ethel Skinner	3	8/19/52	2946	2734	10-3/4	278	300	2728-34	Frac 1500 g.	Producing
					7	2716	125			

now
Morris R.
Antweil



TYPE LOG

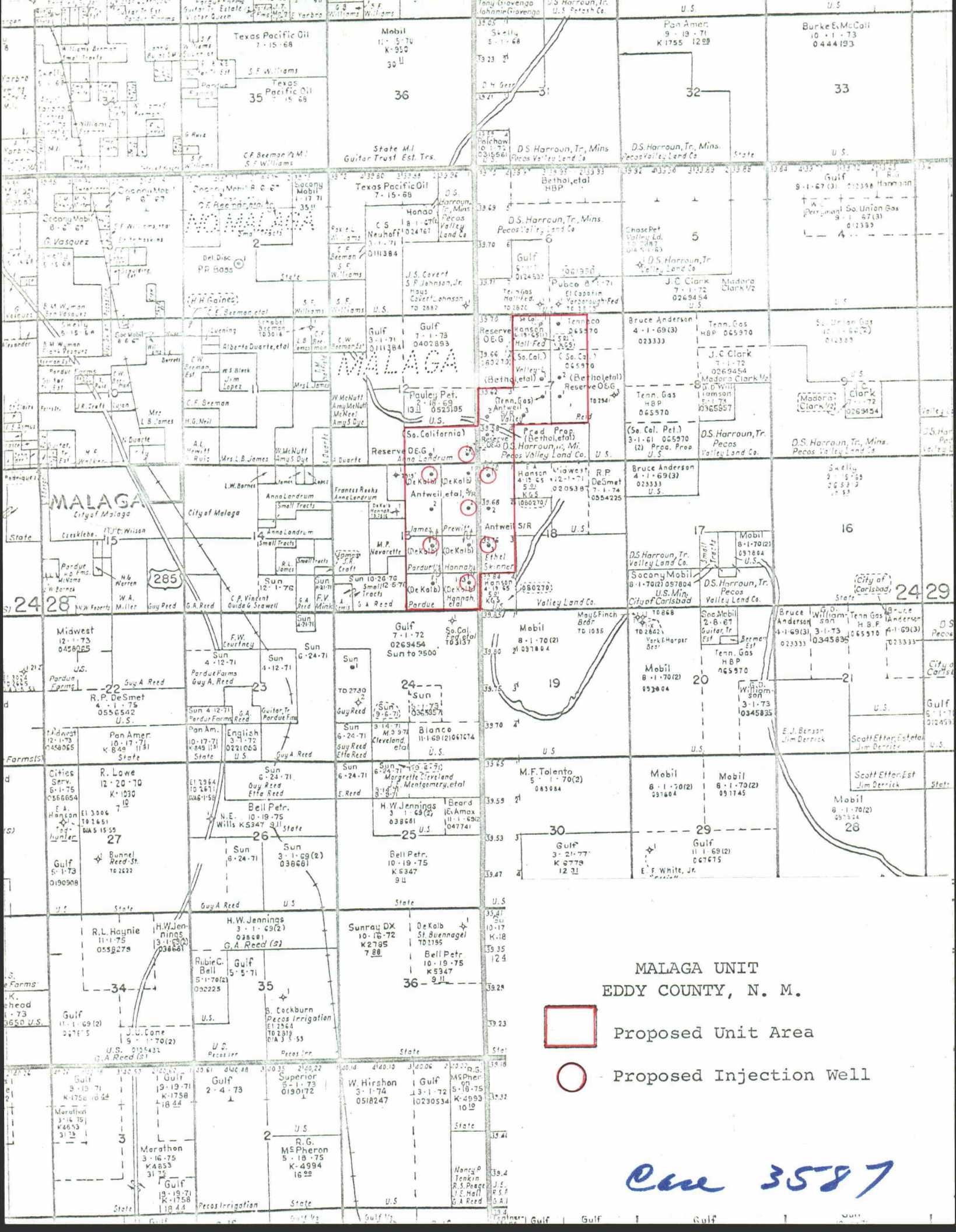
DeKalb (now Morris R. Antweil)
L. C. Hannah #1

Located 330 fcl and 2970 fnl
Section 13-24S-28E



Elevation 2449'

Delaware Sand
2710' - 2720'

R.D. 2727
T.D. 2729
DEKALB AGRICULTURAL ASSOCIATION
L. C. HANNAH NO. 1
MALAGA FIELD



MALAGA UNIT
EDDY COUNTY, N. M.

-  Proposed Unit Area
-  Proposed Injection Well

See 3587

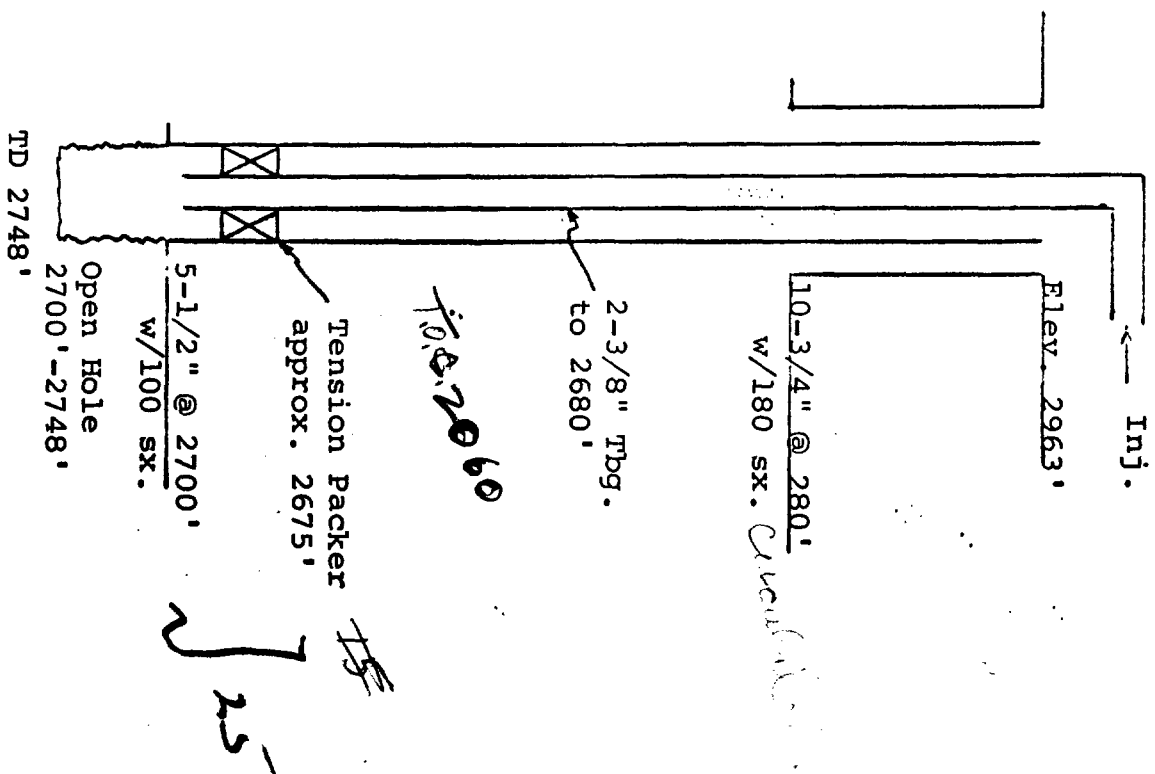
PROPOSED WATER INJECTION WELLS
MALAGA UNIT, EDDY COUNTY, NEW MEXICO

Malaga unit. - 4-1/2

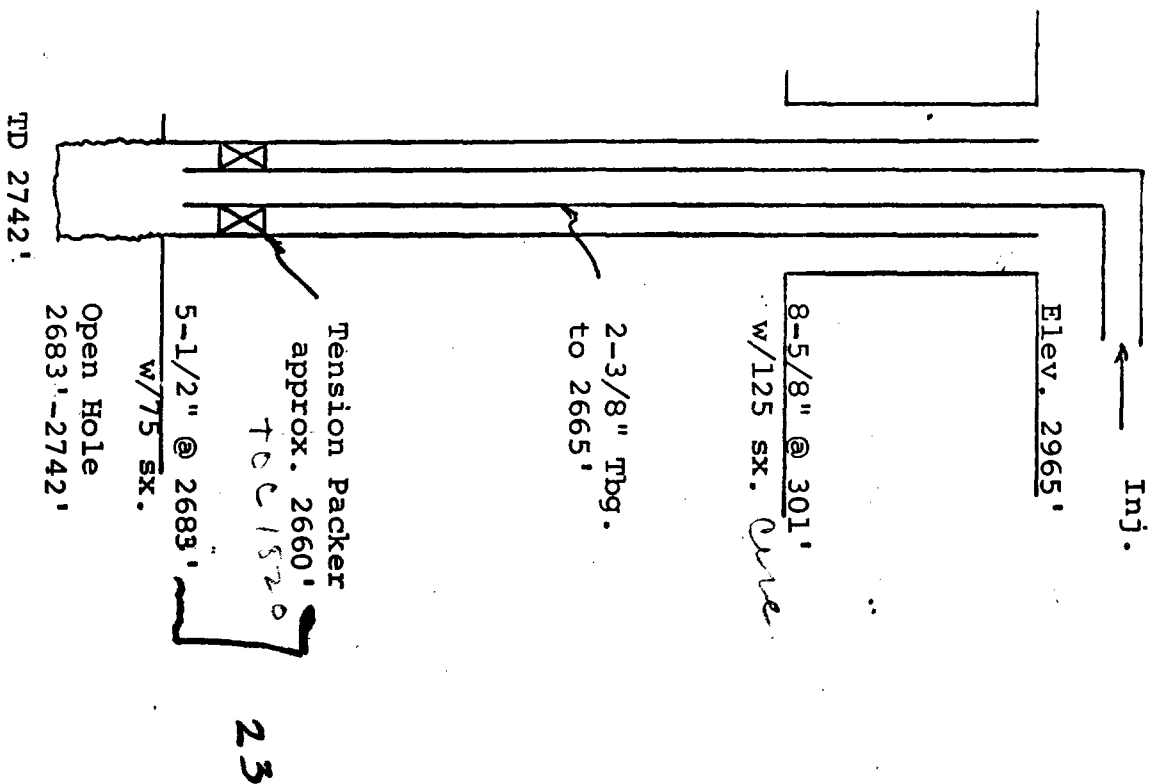
- WELL 4-1 formerly Morris R. Antweil - R. L. James 1
located in Unit B, Sec. 13-24S-28E
- WELL 5-1 formerly Morris R. Antweil-James Pardue 1
located in Unit J, Sec. 13-24S-28E
- WELL 7-1 formerly Morris R. Antweil-L. C. Hannah, et al 1
located in Unit P, Sec. 13-24S-28E
- WELL 9-2 formerly Morris R. Antweil-Floy Prewitt 2
located in Unit H, Sec. 13-24S-28E
- WELL 10-2 formerly Reserve Oil & Gas Company-Landrum 2
located in Unit P, Sec. 12-24S-28E
- WELL 11-1 formerly Morris R. Antweil-Ethel Skinner 1
located in Unit, D, Sec. 18-24S-29E
- WELL 11-3 formerly Morris R. Antweil-Ethel Skinner 3
located in Unit L, Sec. 18-24S-29E

Malaga - Delaware

INJECTION WELL 4-1
NW/4 NE/4 Sec. 13

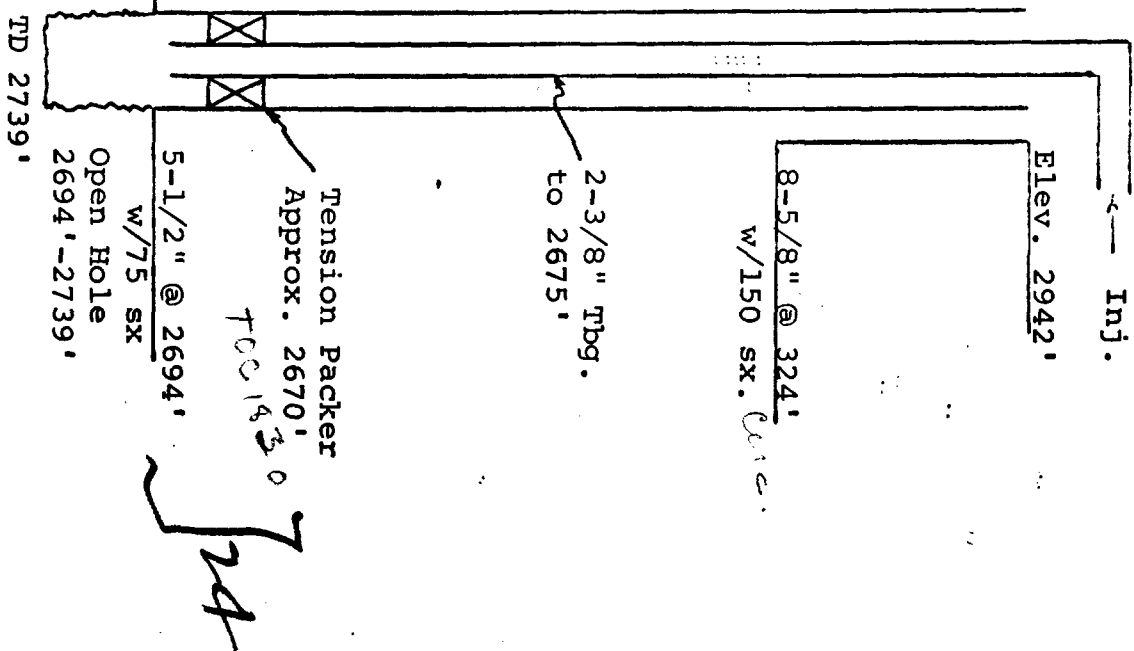


INJECTION WELL 5-1
NW/4 SE/4 Sec. 13



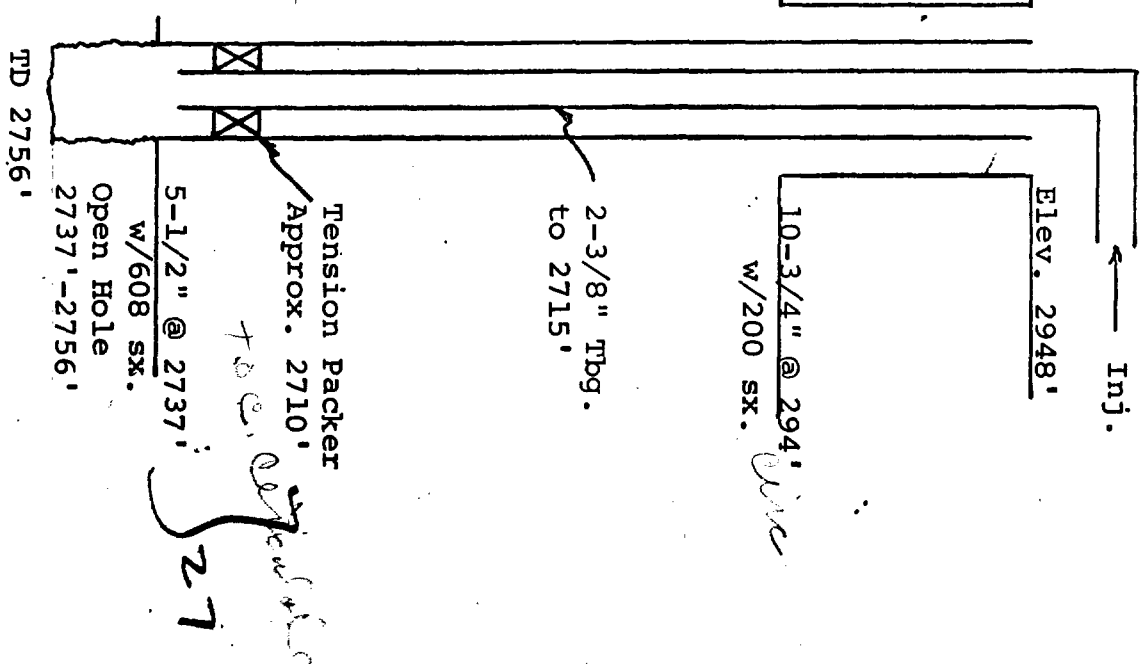
DIAGRAMMATIC SKETCH
INJECTION WELLS
MALAGA UNIT

INJECTION WELL 7-1
SE/4 SE/4 Sec. 13

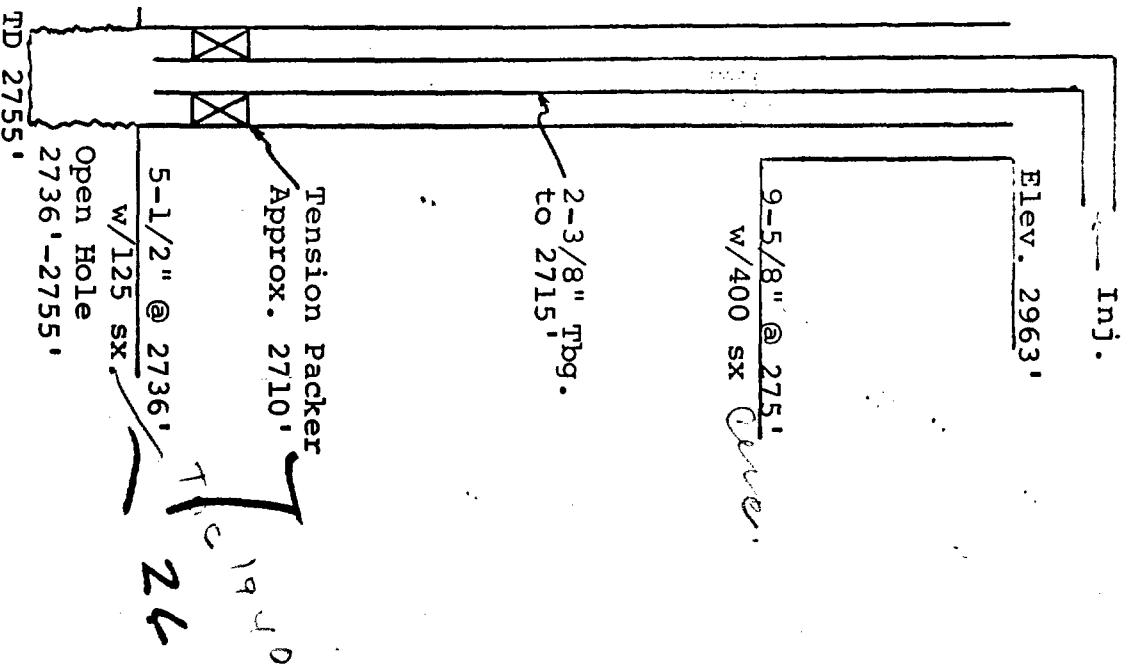


DIAGRAMMATIC SKETCH
INJECTION WELLS
MALAGA UNIT

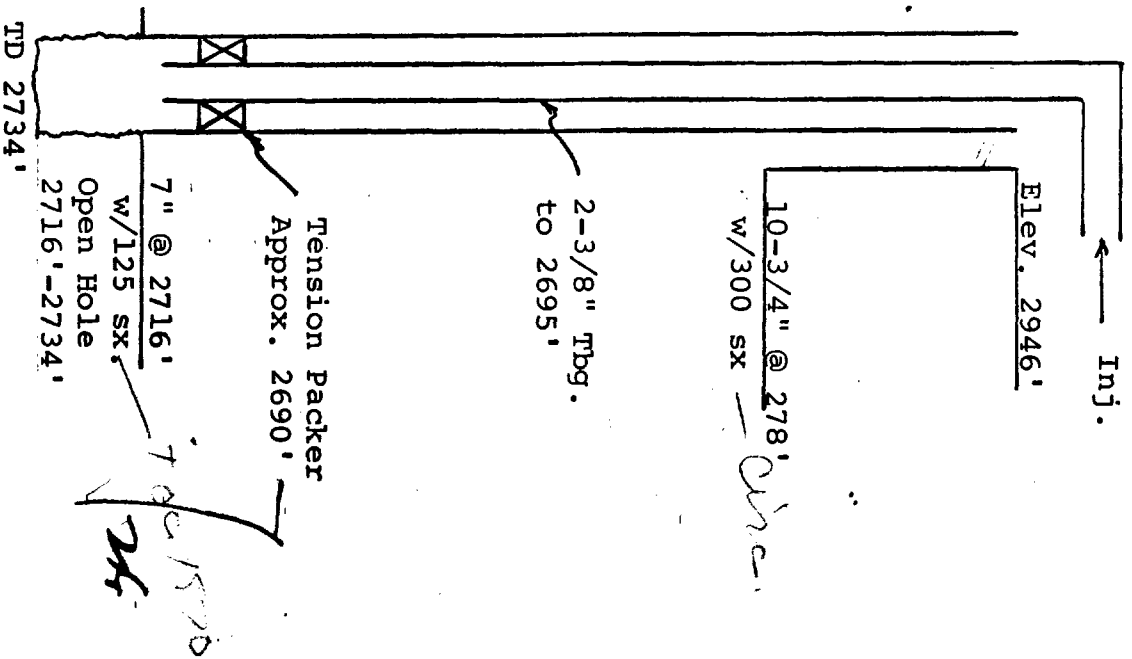
INJECTION WELL 10-2
SE/4 SE/4 Sec. 12



INJECTION WELL 11-1
NW/4 NW/4 Sec. 18

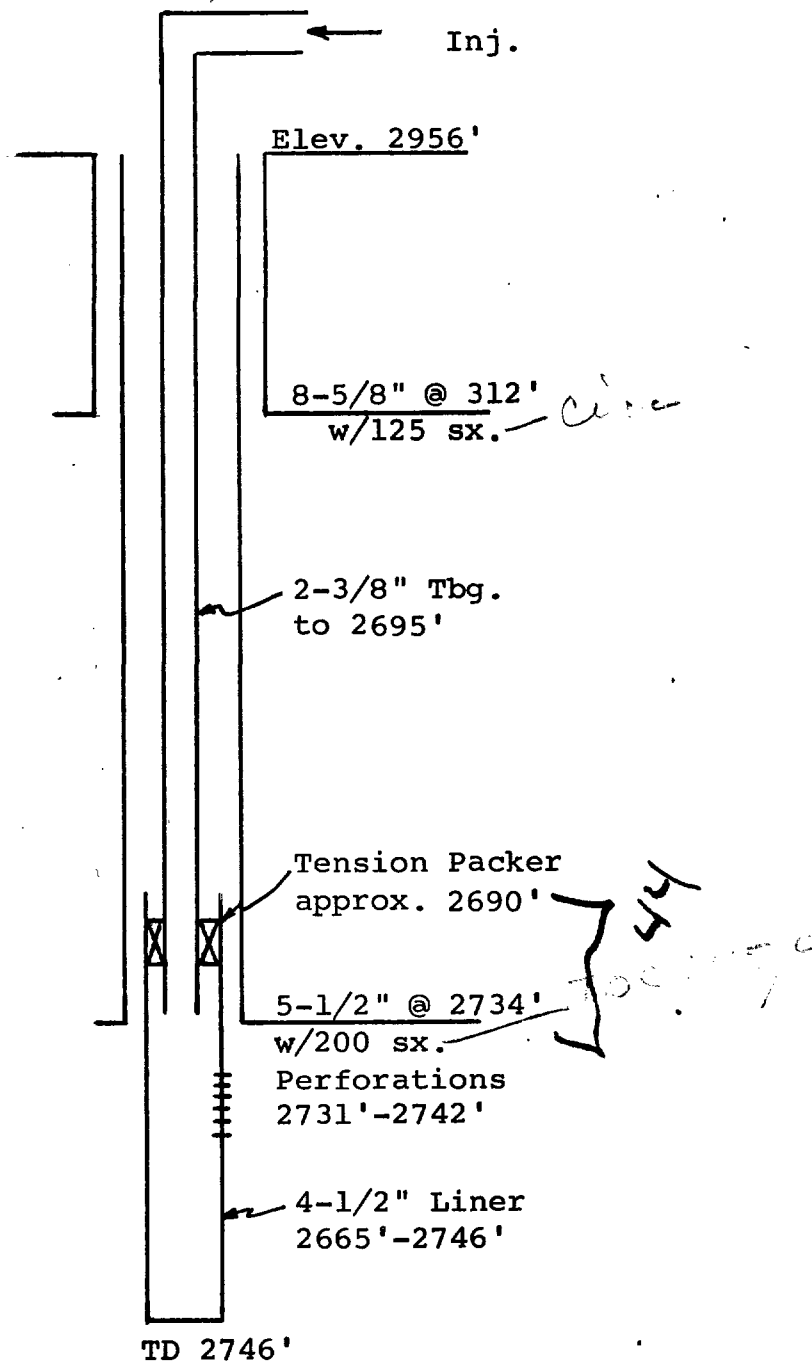


INJECTION WELL 11-3
NW/4 SW/4 Sec. 18

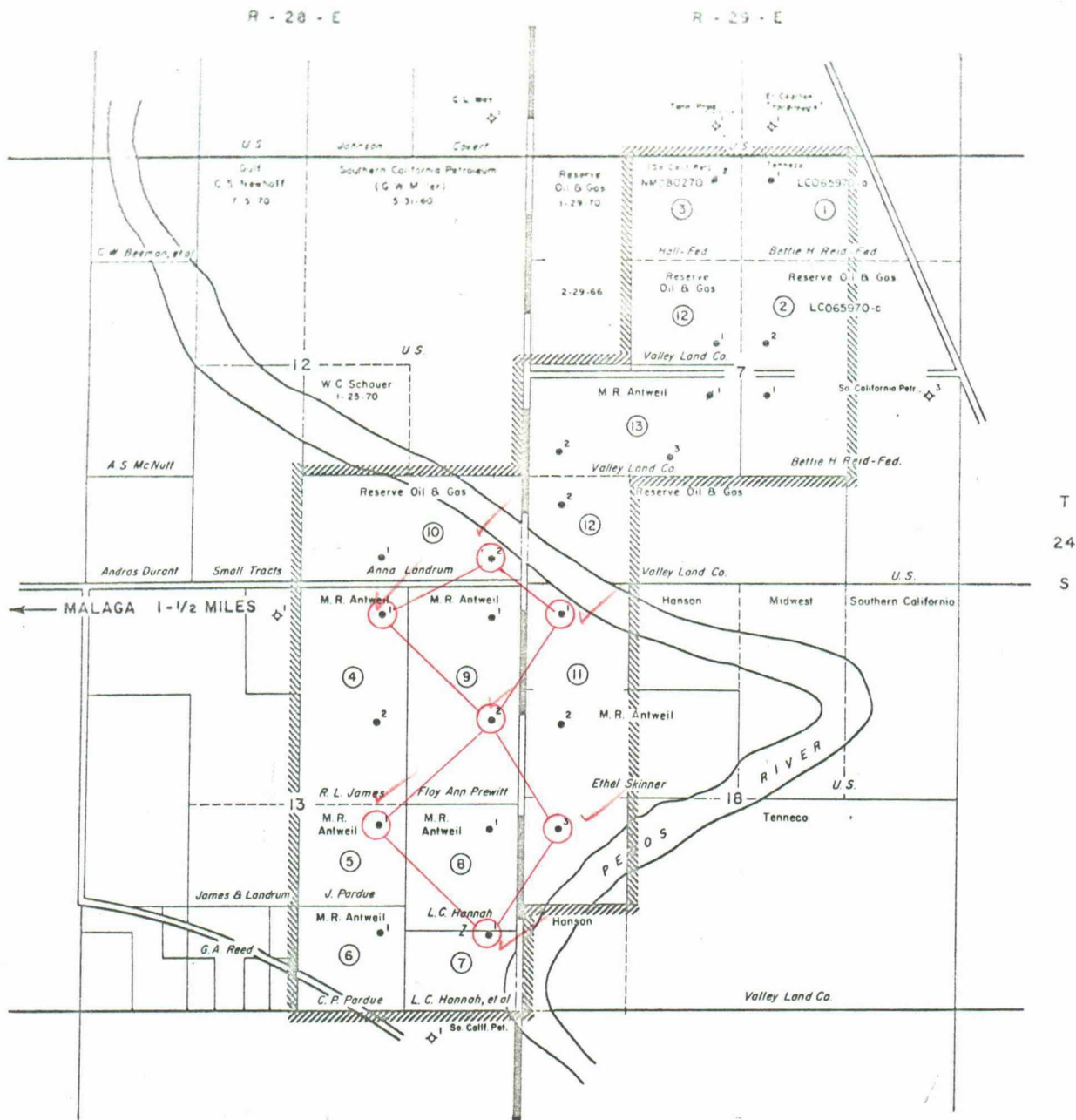


DIAGRAMMATIC SKETCH
INJECTION WELLS
MALAGA UNIT

INJECTION WELL 9-2
SE/4 NE/4 Sec.13



DIAGRAMMETIC SKETCH
INJECTION WELLS
MALAGA UNIT



LEGEND

- Oil Well
- ⦿ Plugged & Abandoned
- ◇ Dry & Abandoned
- County Roads
- Tract No
- /// Unit Boundary

○ PROPOSED INJECTION WELL

MORRIS R. ANTWEIL

MALAGA UNIT
EDDY COUNTY, NEW MEXICO

EXHIBIT "A"

0 500 1000 2000 3000 4000
SCALE - FEET

DATE: 2-21-66