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OIL RECOVERY BY CARBON DIOXIDE INJECTION

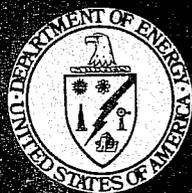
Quarterly Report, July–September 1977

By
George P. SanFilippo

December 1977
Date Published

Work Performed Under Contract No. EF-76-C-05-5301

Pennzoil Company
Vienna, West Virginia



U. S. DEPARTMENT OF ENERGY

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**Quarterly Report for the
Period July-September 1977**

George P. SanFilippo

**PENNZOIL COMPANY
Vienna, West Virginia 26105**

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**PREPARED FOR THE UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION**

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INTRODUCTION

This report is the twenty-first report on the progress of the Rock Creek carbon dioxide project in Roane County, West Virginia.

Designed, developed, and operated by Pennzoil Company, this project will demonstrate the feasibility of miscible carbon dioxide oil recovery in the Rock Creek Big Injun Field. A successful demonstration of this process will lead to a field wide commercial development. Also, the technical success of this project would be utilized in the development of other miscible carbon dioxide oil recovery projects in numerous fields within the Appalachian area.

SUMMARY

No significant delays in the project were incurred during the third quarter of 1977. A delay in the delivery of materials needed to complete construction of the carbon dioxide handling system necessitated the completion date of this phase of the project to be extended to the end of the fourth quarter of 1977. This delay has no effect on the remaining phases of the project.

During the past quarter, it was discovered that communication

between E. Lewis WIW No. 17 and L. W. Shaffer No. 1 exists via a permeable streak in the Big Lime. Attempts will be made to eliminate this problem. With the exception of this water problem in Shaffer No. 1, no major change in fluid production occurred in the producing wells.

The water supply and water handling system performed trouble-free throughout the quarter. T. Henderson WSW No. 1 has proven to be a formidable water source by experiencing little drawdown at an average producing rate of approximately 2,900 barrels per day.

Water injection continued on schedule into all of the injection wells with the exception of three wells experiencing some problem. Slight casing leaks appeared in two injection wells while a packer failure occurred in the third well. The packer failure has been rectified and the casing leaks will be dealt with in the near future.

The progress of the project and the corresponding cash outlay is depicted pictorially on Figure No. 1. Figure No. 2 is a map of the project area.

CIL RECOVERY BY CARBON DIOXIDE INJECTION
 ROCK CREEK FIELD, ROMAHE COUNTY, WEST VIRGINIA

As of October 1, 1977

PROJECT SCHEDULE

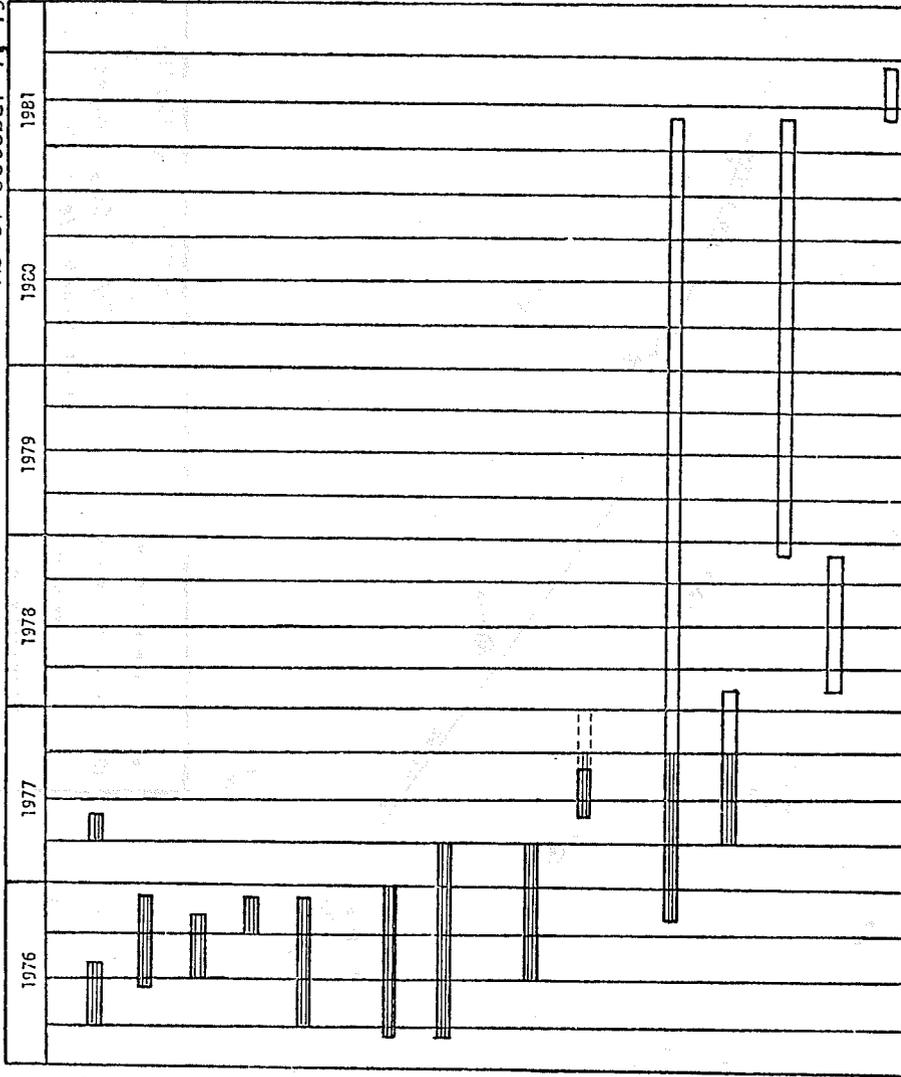


Figure 1

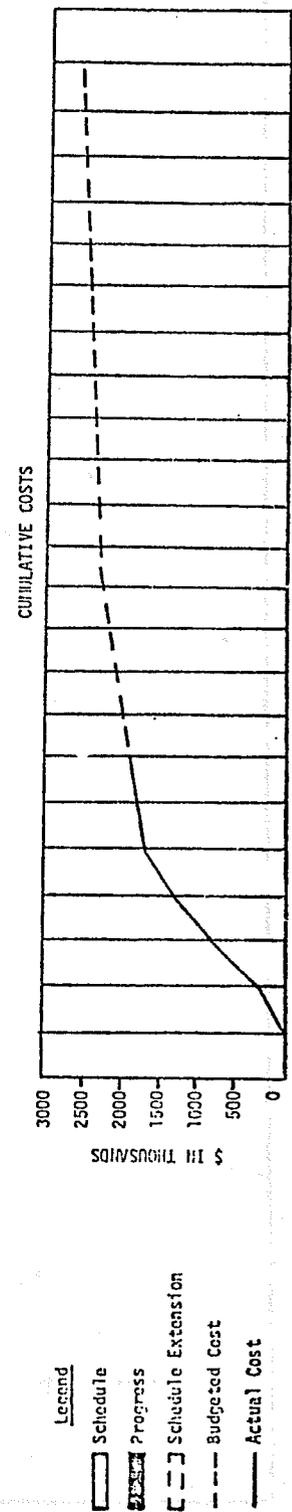
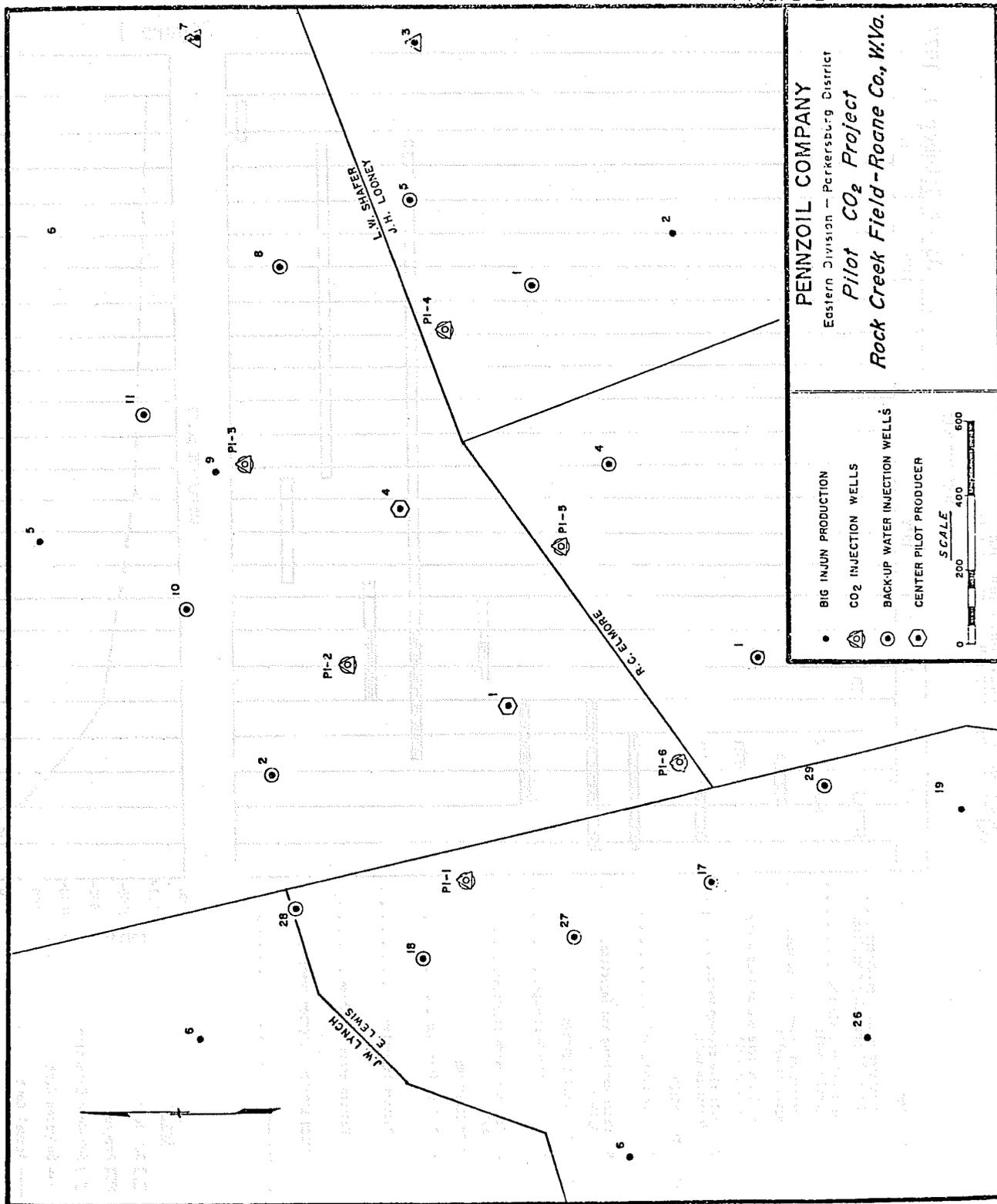


Figure 2



Producing Wells - History

The water production from Shaffer No. 1 increased significantly during this quarter. The low gravity water being produced from Shaffer No. 1 indicated premature injection water breakthrough. When a packer failure occurred in E. Lewis WIW No. 17 on July 24, 1977, necessitating the well being shut-in for an extended period, the water production from Shaffer No. 1 decreased. Subsequent tests verified the source of water from Shaffer No. 1 as originating at Lewis WIW No. 17. It has been determined that this water breakthrough is attributable to a permeable streak that exists in the Big Lime approximately ten feet above the Big Injun Sand. This increase in water production was cause for the decrease in oil production from Shaffer No. 1.

The oil production from Shaffer No. 4 increased slightly, corresponding to a decrease in water production. The monthly production for this quarter is listed below and graphically shown in Appendix A.

TABLE I

Pattern Production History

	L. W. Shaffer No. 1					
	<u>BO</u>	<u>BW</u>	<u>MMCF</u>	<u>Hrs.</u>	<u>WOR</u>	<u>GOR, CFPB</u>
July	56	78	0.1224	88	1.39	2,186
August	33	56	0.1929	93	1.70	5,845
September	30	10	0.1650	93	0.33	5,500
Cumulative*	559	156	1.4094		0.28	2,521

	L. W. Shaffer No. 4					
	<u>BO</u>	<u>BW</u>	<u>MMCF</u>	<u>Hrs.</u>	<u>WOR</u>	<u>GOR, CFPB</u>
July	43	7	0.2083	70	0.16	4,844
August	43	3	0.2239	62	0.07	5,207
September	36	2	0.2100	62	0.06	5,833
Cumulative*	233	236	1.5371		1.01	6,597
Project Cum.	792	392	2.9465		0.49	3,720

*As of October 1, 1976

Producing Wells - Future

Both wells will continue to pump regularly unless it is decided to shut the wells in to accelerate the increase in reservoir pressure.

Carbon Dioxide Injection Wells - History

Cumulative injection into these six wells as of October 1, 1977 was 121,073 barrels of water. Of this total, 72,473 barrels were injected during the third quarter of 1977. The average rate during

this period was 738 BPD or 131 BPD per well at an average wellhead pressure of 732 psig. During September, it was discovered that communication between the 4-1/2" and 8-5/8" casing of E. Lewis P.I. No. 1 existed. This problem will be rectified in the near future. Surface pressure fall-off tests were conducted in September. Sufficient fall-off periods were not obtained for proper extrapolation.

The injection history for these wells is listed in Table II and graphically presented in Appendix B.

Carbon Dioxide Injection Wells - Future

Water injection will continue as scheduled. The source of the communication problem in Lewis P.I. No. 1 will be found and corrected. Bottom hole pressure fall-off tests will be run in order to evaluate injection performance.

Back-up Water Injection Wells - History

Cumulative injection into these thirteen wells as of October 1, 1977 was 542,957 barrels of water. Of this total, 191,738 barrels were injected during the third quarter of 1977. The average rate during this period was 2,084 BPD or 160 BPD per well at an average wellhead pressure of 798 psig. During September, it was discovered that communication between the 4-1/2" and 8-5/8" casing of E. Lewis

No. 28 existed. This problem will be corrected in the near future. Surface pressure fall-off tests were conducted in September. Sufficient fall-off periods could not be obtained by surface fall-offs for proper evaluation. Table II lists the injection history for these thirteen wells. Well histories are graphically presented in Appendix C.

TABLE II

Water Injection History

	Injection, BW			Avg. WHP* PSIG	Cum. Inj. 10/1/77
	July	August	September		
Carbon Dioxide Injection Wells					
E. Lewis P.I. No. 1	3,701	4,104	3,977	625	18,126
L. W. Shaffer P.I. No. 2	3,205	3,777	3,844	900	21,926
L. W. Shaffer P.I. No. 3	3,773	3,851	2,967	985	14,598
J. H. Looney P.I. No. 4	4,363	5,053	4,172	545	19,011
R. C. Elmore P.I. No. 5	4,080	3,883	4,097	765	23,663
L. W. Shaffer P.I. No. 6	3,441	4,746	5,439	405	23,749
Sub-total	22,563	25,414	24,496	705	121,073
Back-up Water Injection Wells					
R. C. Elmore No. 1	7,601	6,415	10,332	0	79,125
R. C. Elmore No. 4	2,876	3,068	2,936	1005	29,405
E. Lewis No. 17	4,145	0	226	645	30,856
E. Lewis No. 18	3,329	3,444	3,071	1005	34,513
E. Lewis No. 27	4,987	5,178	4,352	1015	38,100
E. Lewis No. 28	5,274	5,776	4,381	940	40,635
E. Lewis No. 29	2,759	4,524	3,655	960	20,180
J. H. Looney No. 1	6,487	6,494	5,932	975	64,232
J. H. Looney No. 5	5,480	6,169	5,918	770	34,750
L. W. Shaffer No. 2	8,393	6,236	7,456	0	71,722
L. W. Shaffer No. 8	4,918	5,260	5,056	980	49,144
L. W. Shaffer No. 10	5,354	5,204	4,411	995	24,684
L. W. Shaffer No. 11	4,601	5,215	4,825	1010	25,611
Sub-total	66,204	62,983	62,551	790	542,957
TOTAL	88,767	88,397	87,047	765	664,030

Back-up Water Injection Wells - Future

Water injection will continue as scheduled. Tubing and packer will be run in E. Lewis No. 28 to eliminate the communication problem. Bottom hole pressure fall-offs will be measured in order to evaluate the pressure build-up.

Observation Well

The bottom hole pressure of L. W. Shaffer No. 9 was taken on August 24, 1977 and recorded as 359.4 psia. The pressure gradient of the well fluid was 0.49 psi/ft. which equals a specific gravity of 1.132.

WATER SYSTEM

To date, approximately 439,430 barrels of water have been produced from T. Henderson WSW No. 1 and used in this project. Approximately 265,400 barrels were used from the Henderson well during the third quarter of 1977 of which 265,411 barrels were injected. The average daily producing rate of the Henderson water supply well was 2,885 BPD. A fluid level of approximately 33 ft. was maintained in the water well throughout this period.

CARBON DIOXIDE SYSTEM

Carbon Dioxide Handling - History

The final construction of this system was begun but not completed due to delays in equipment procurement.

Carbon Dioxide Handling - Future

If all the necessary equipment arrives and favorable weather conditions exist, construction of this system will be completed by the end of 1977.

CONCLUSION

The project proceeded as outlined in the project schedule with the exception of the delay in completing the carbon dioxide handling system. The water supply and water injection phases of the project proceeded on schedule with minor problems occurring in the injection phase. The source of premature water breakthrough in L. W. Shaffer No. 1 has been located and will be corrected. Communication between the 4-1/2" and 8-5/8" casing in two injection wells was recognized and will be rectified. Pressure fall-off tests were not successful in that surface fall-offs did not provide

sufficient data for proper evaluation, therefore, bottom hole fall-offs will be necessary.

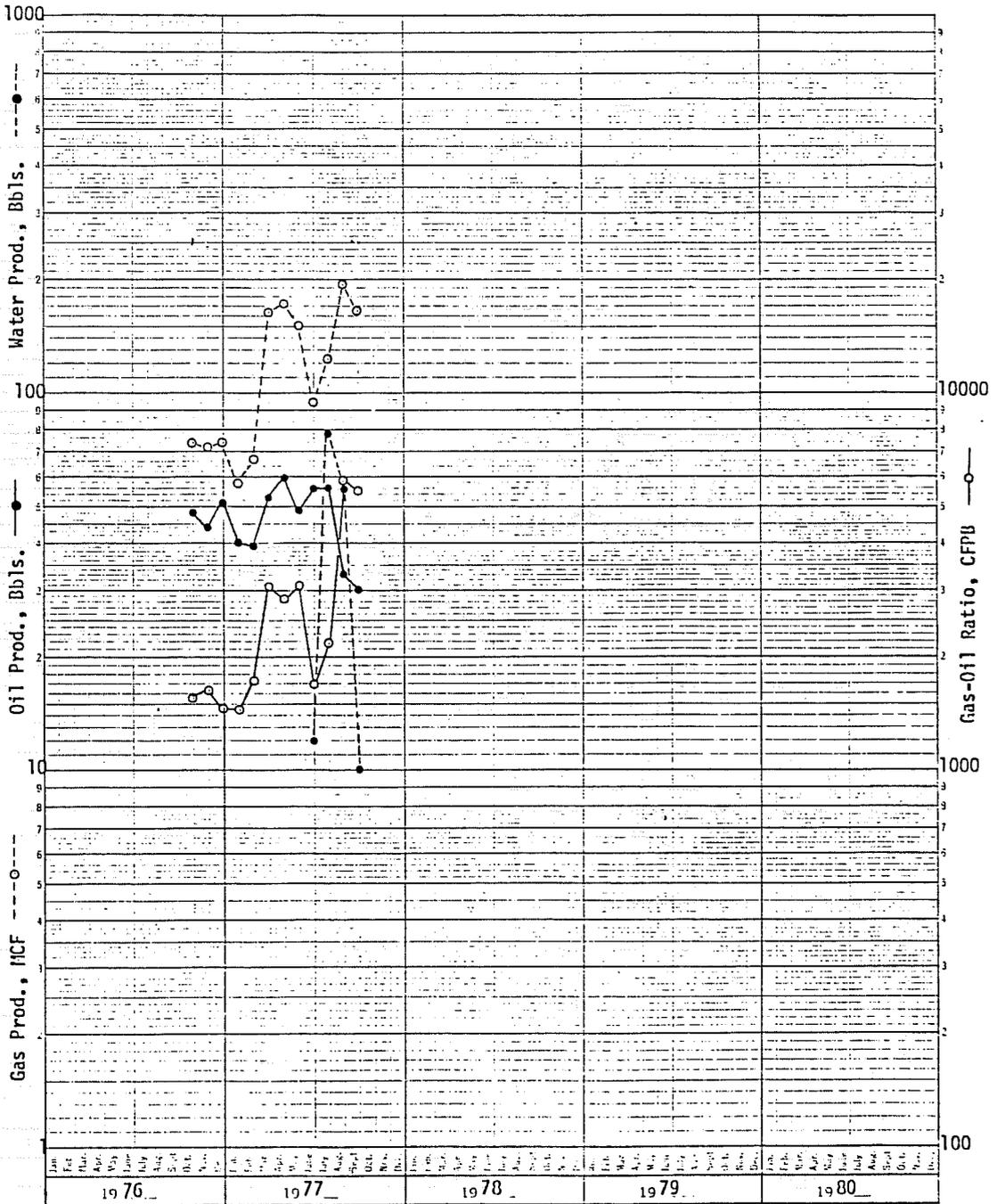
To date, no known problems should adversely affect the success of the project.

APPENDIX A

Producing Well History

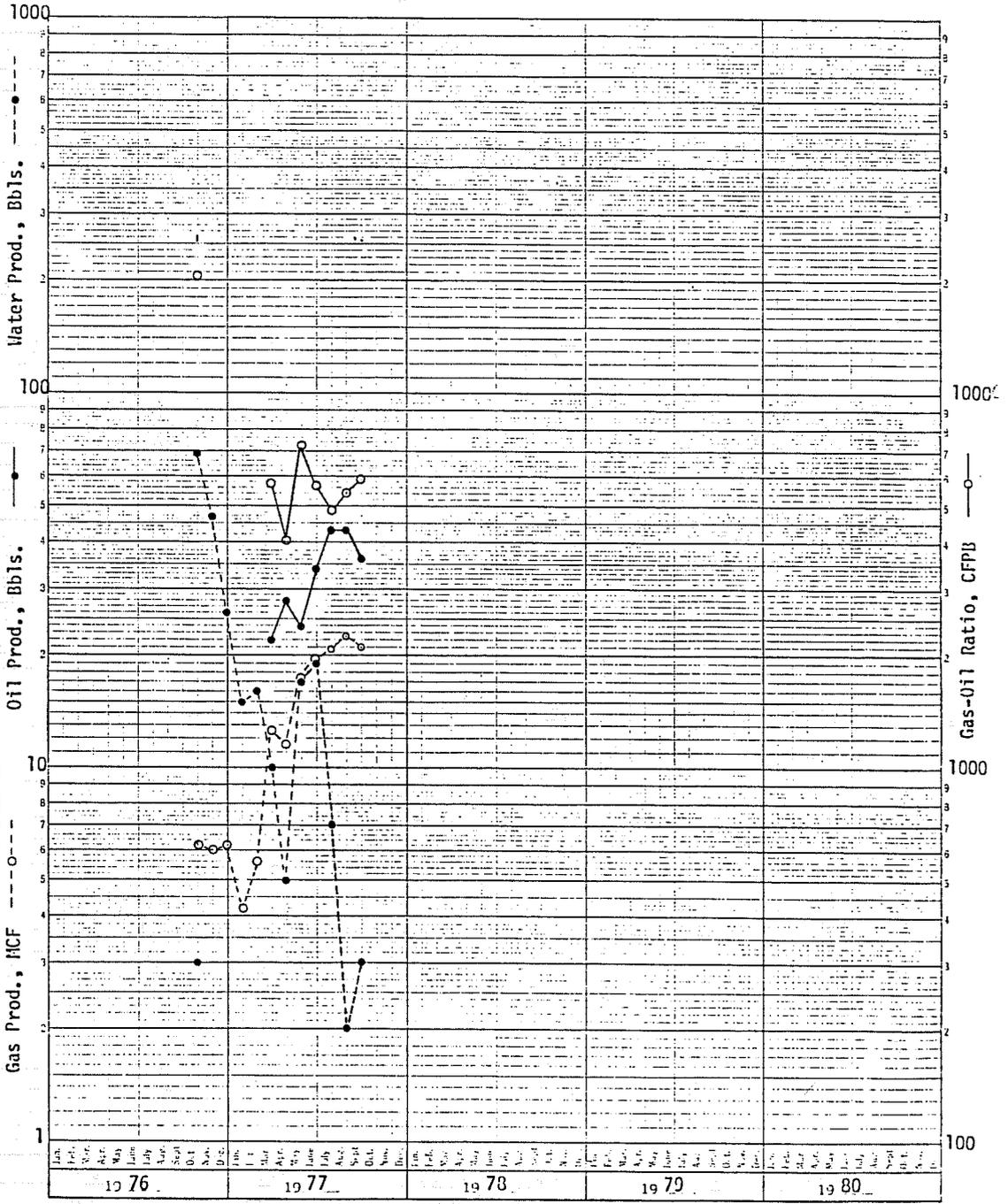
L. W. Shaffer No. 1

1 1/2 YEARS BY MONTHS 46 6690
 1 1/2 X 3 LOG CYCLES
 HUFFILL & EVILL CO.



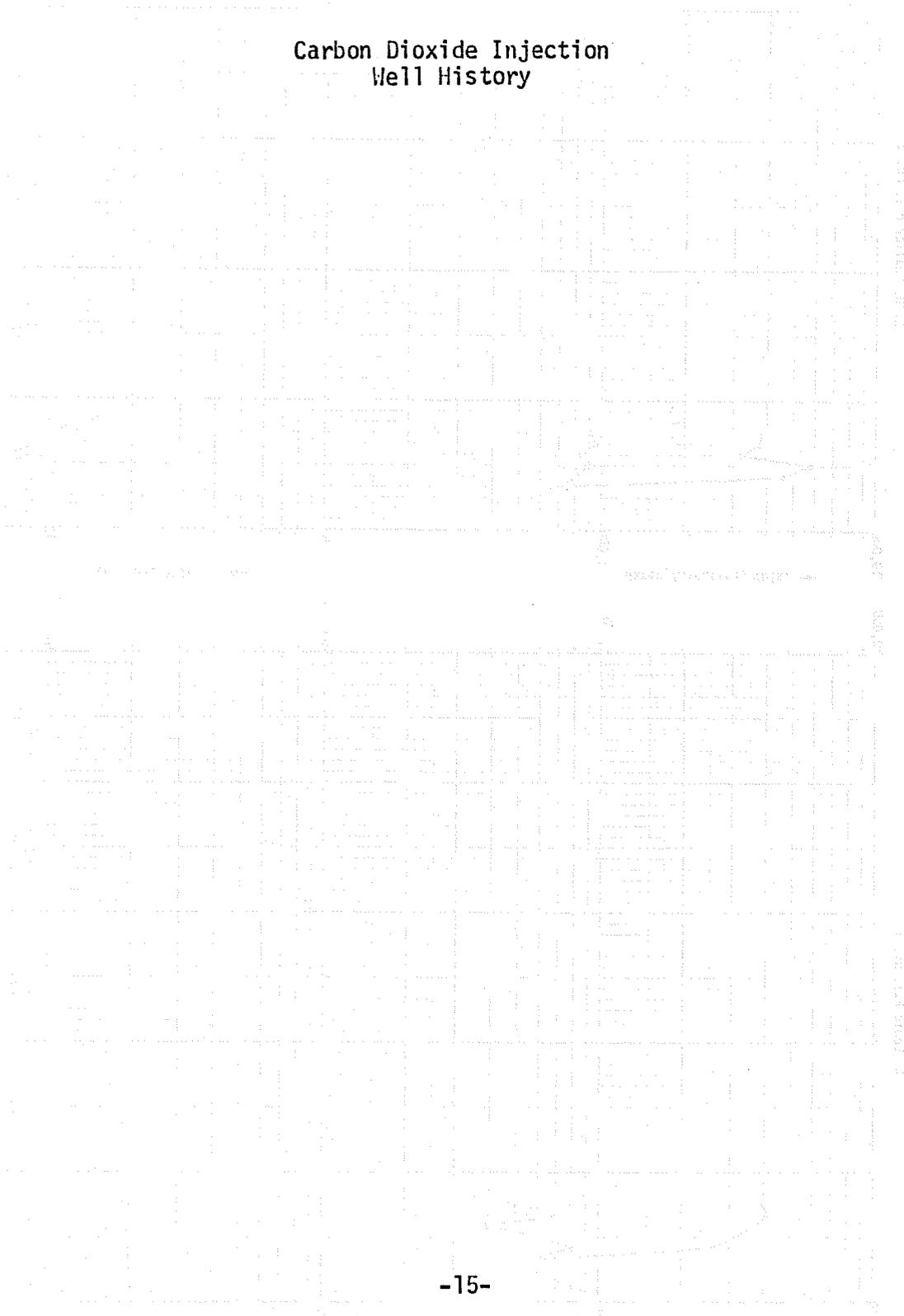
L. W. Shaffer No. 4

1/2 SEC. 5 YEARS BY MONTHS 46 6690
 1/2 SEC. X 3 LOG CYCLES
 NEVILL & LUSH CO.

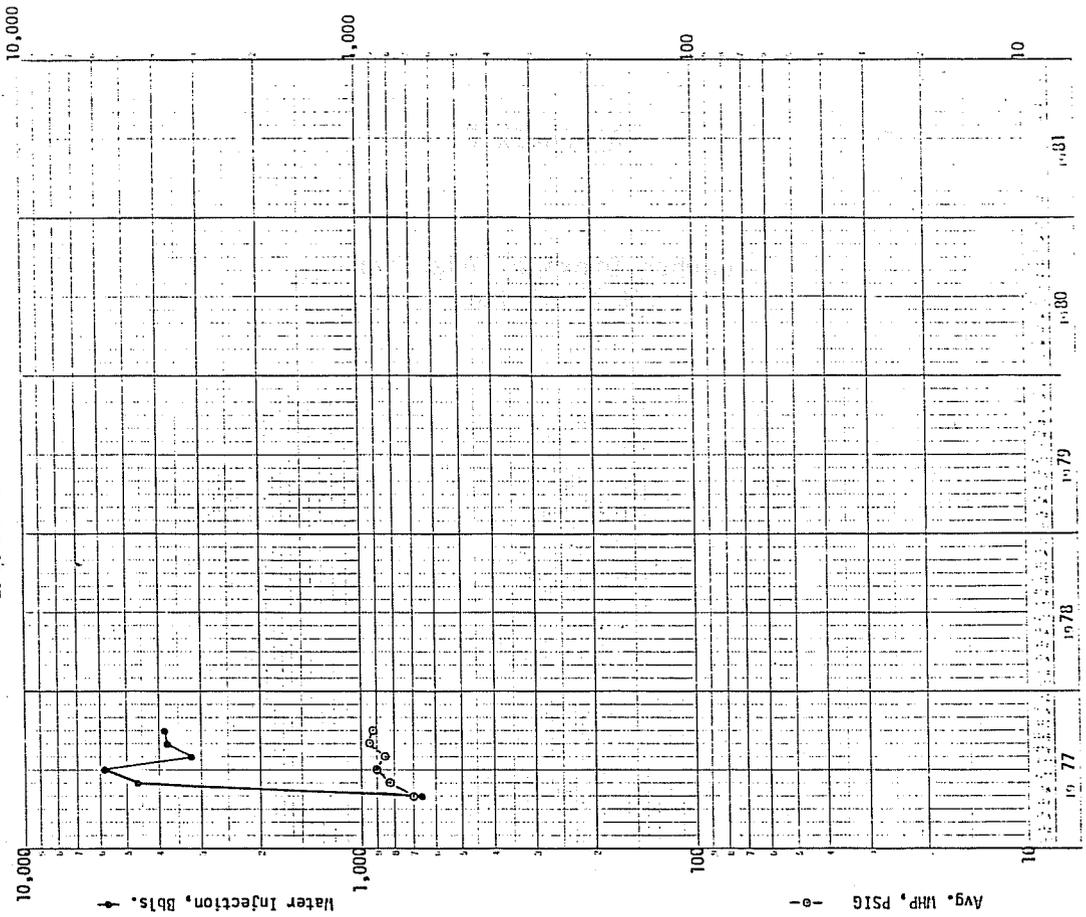


APPENDIX B

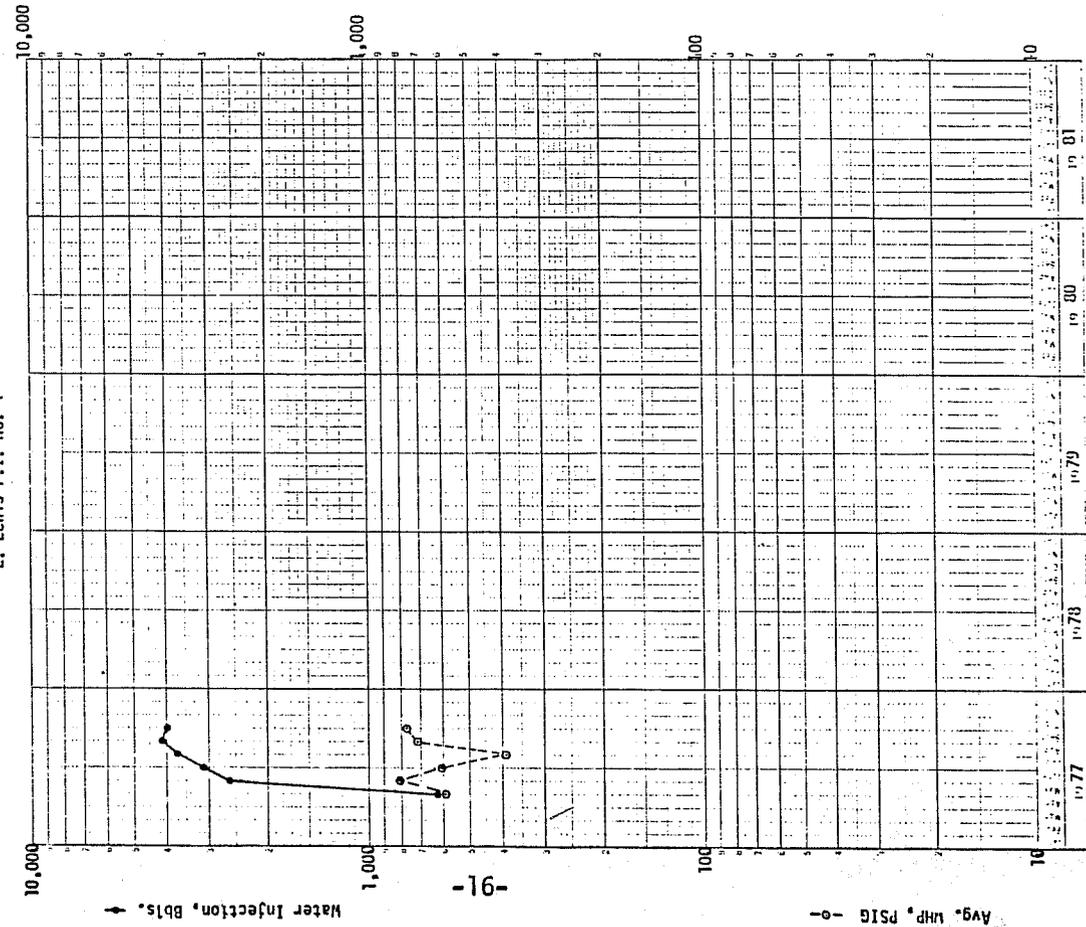
Carbon Dioxide Injection
Well History



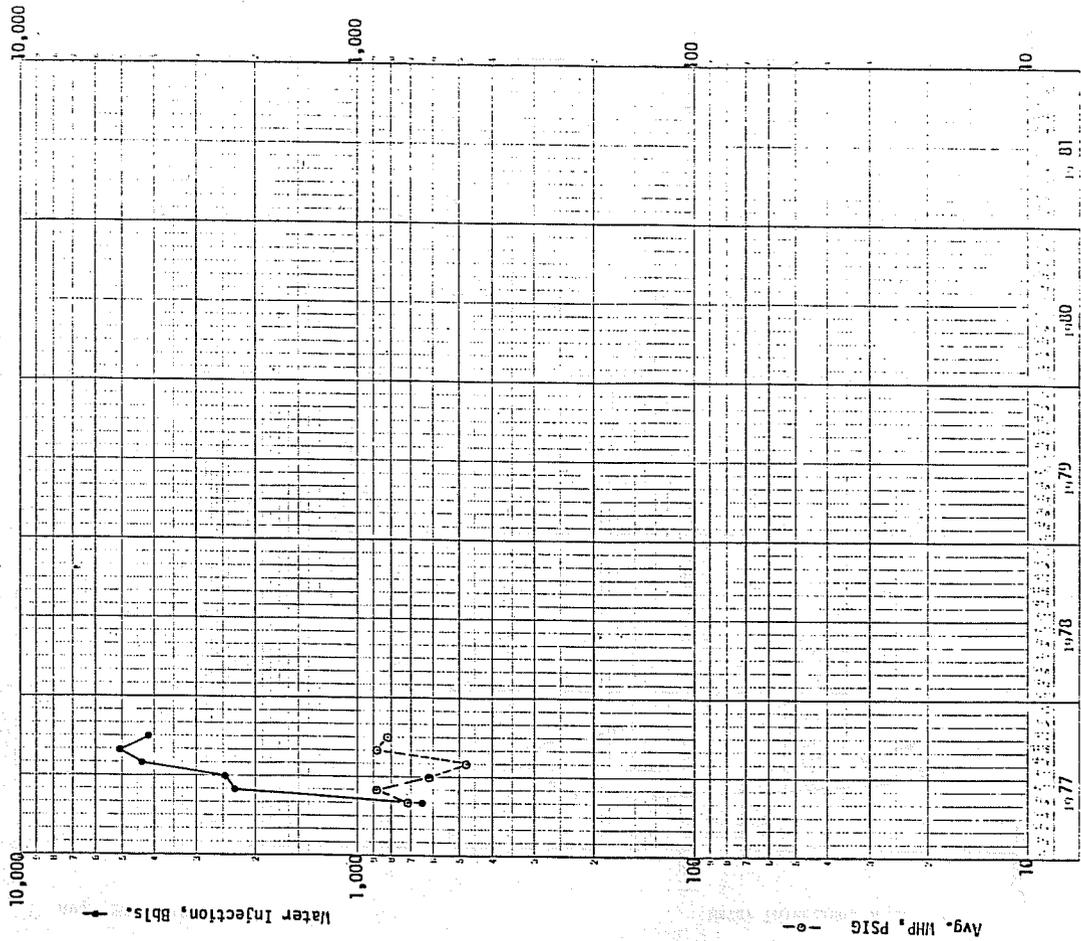
L. H. Shaffer P.I. No. 2



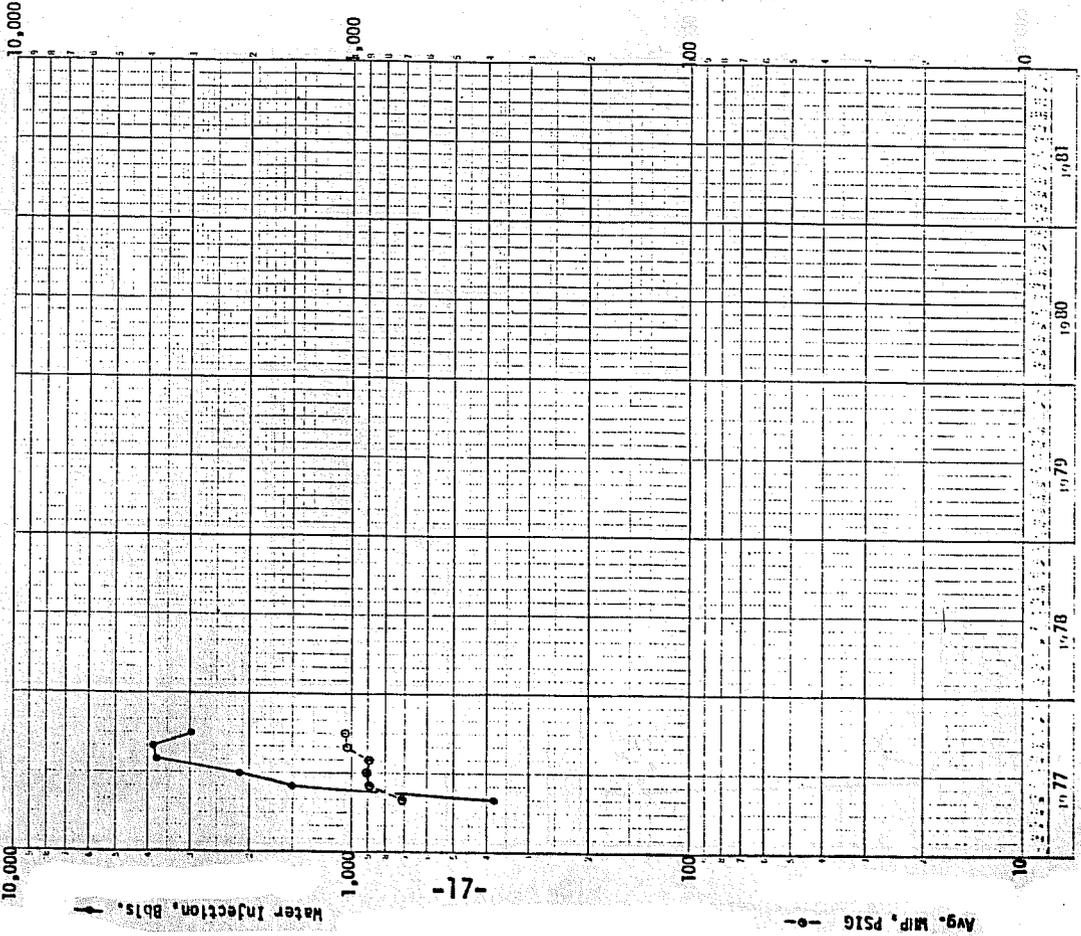
E. Lewis P.I. No. 1



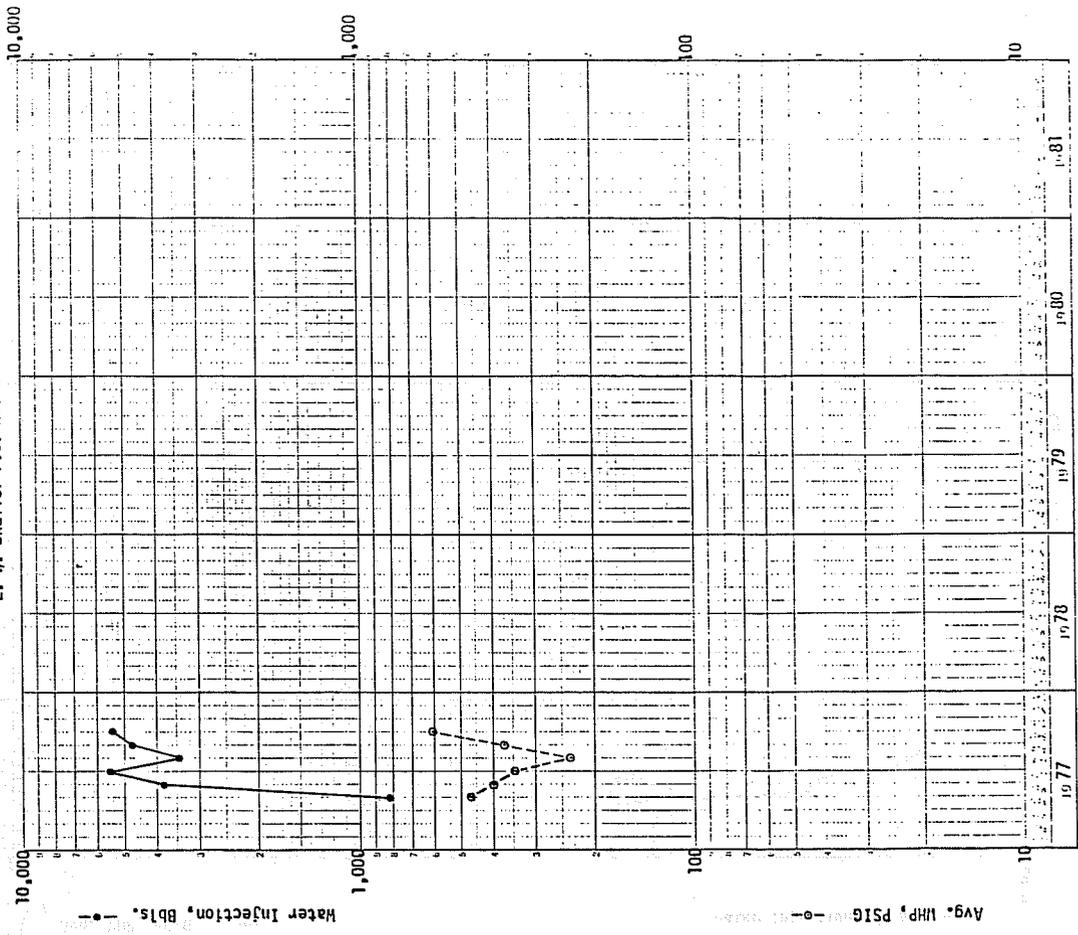
J. H. Looney P.I. Ilo. 4



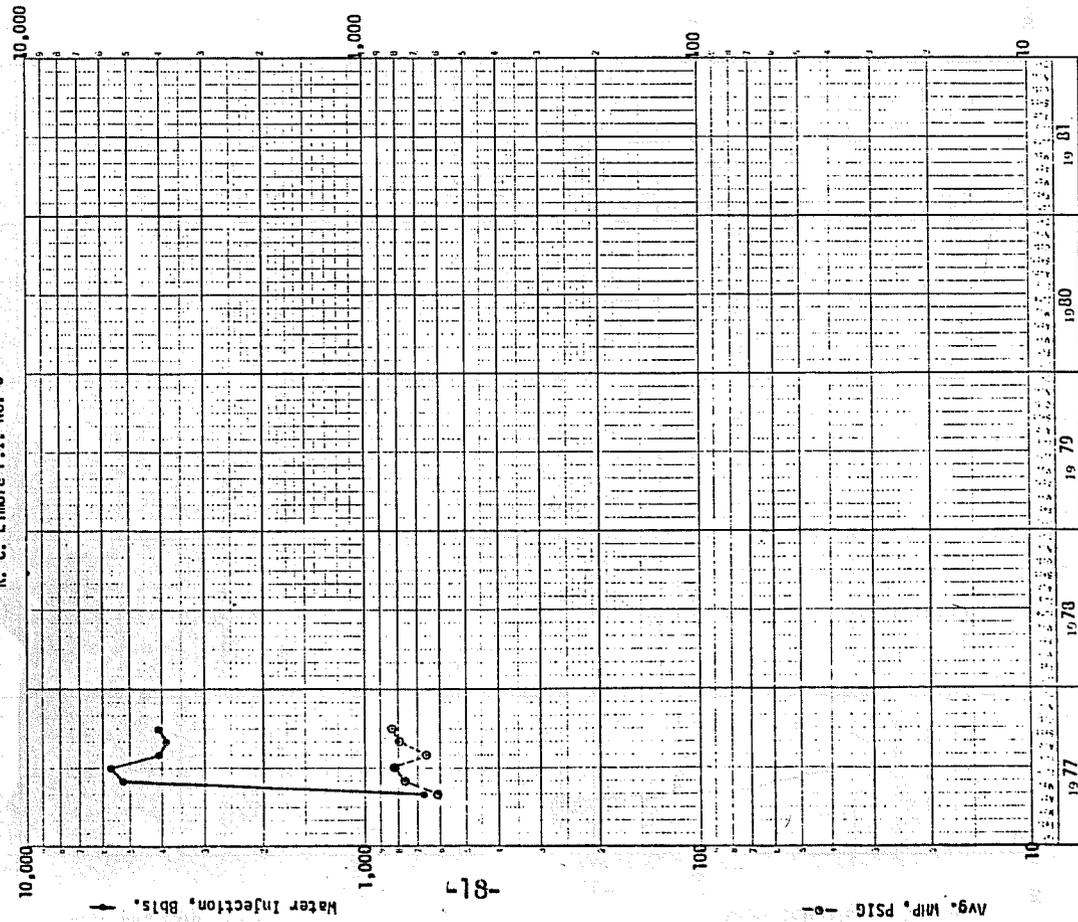
L. H. Shaffer P.I. Ilo. 3



L. J. Shaffer P. I. Ilo. 6

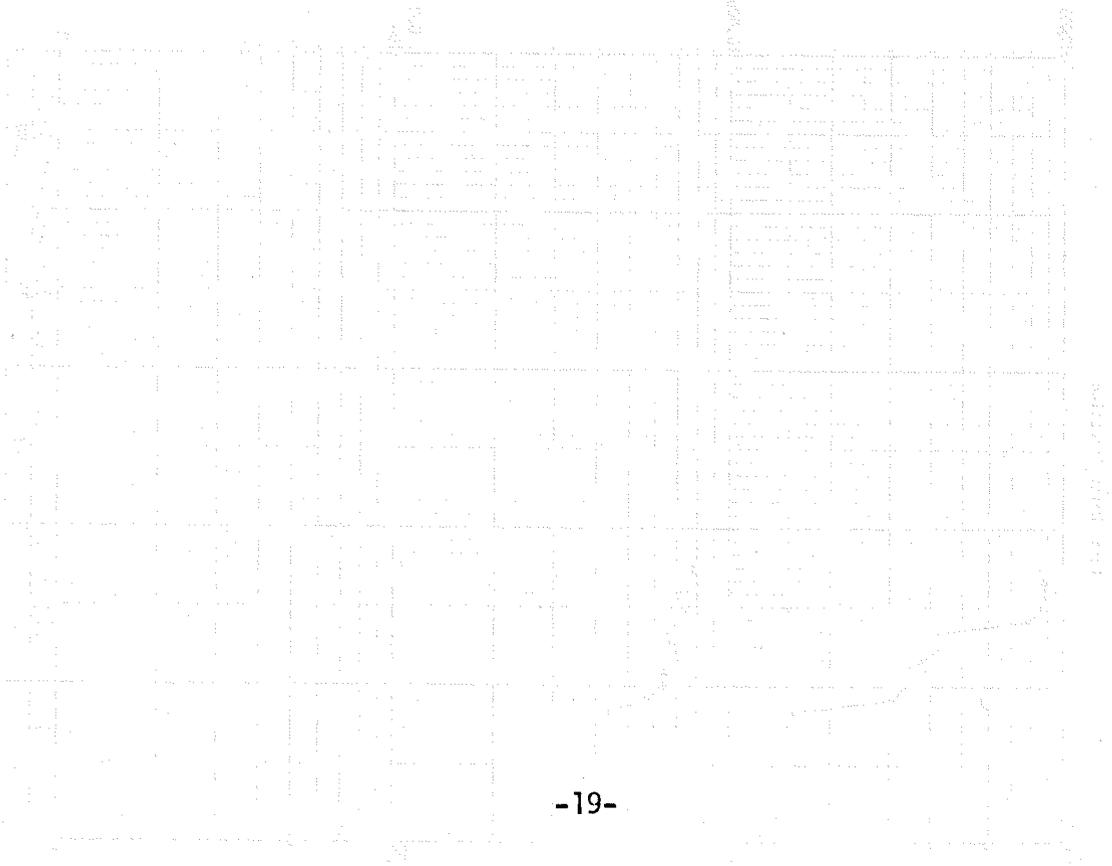
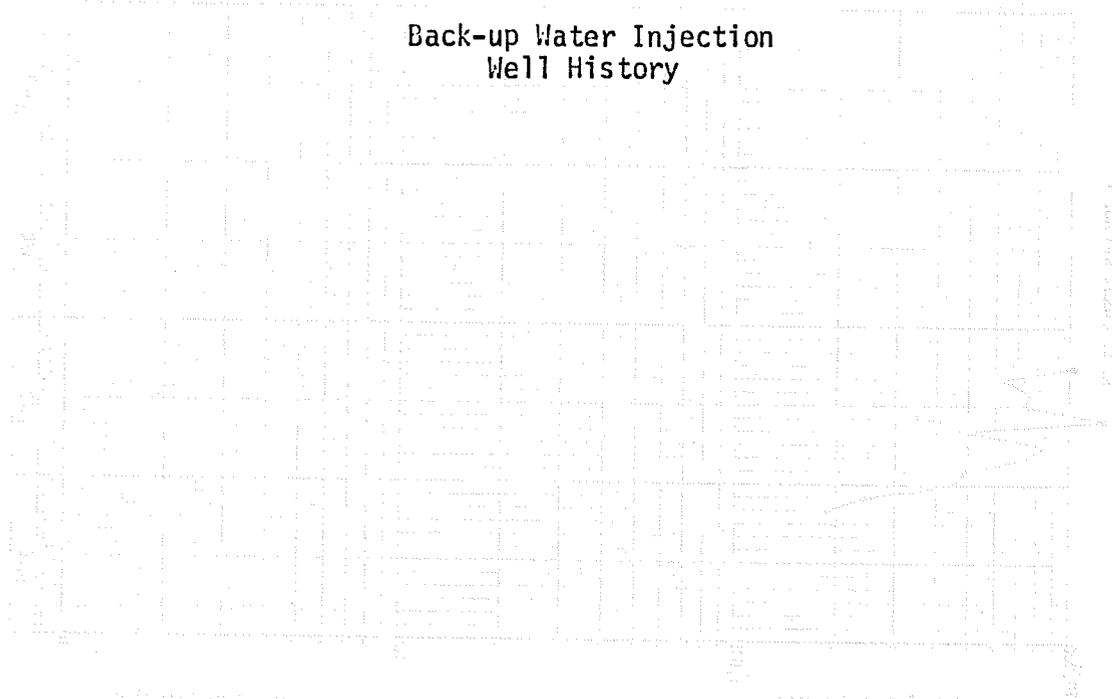


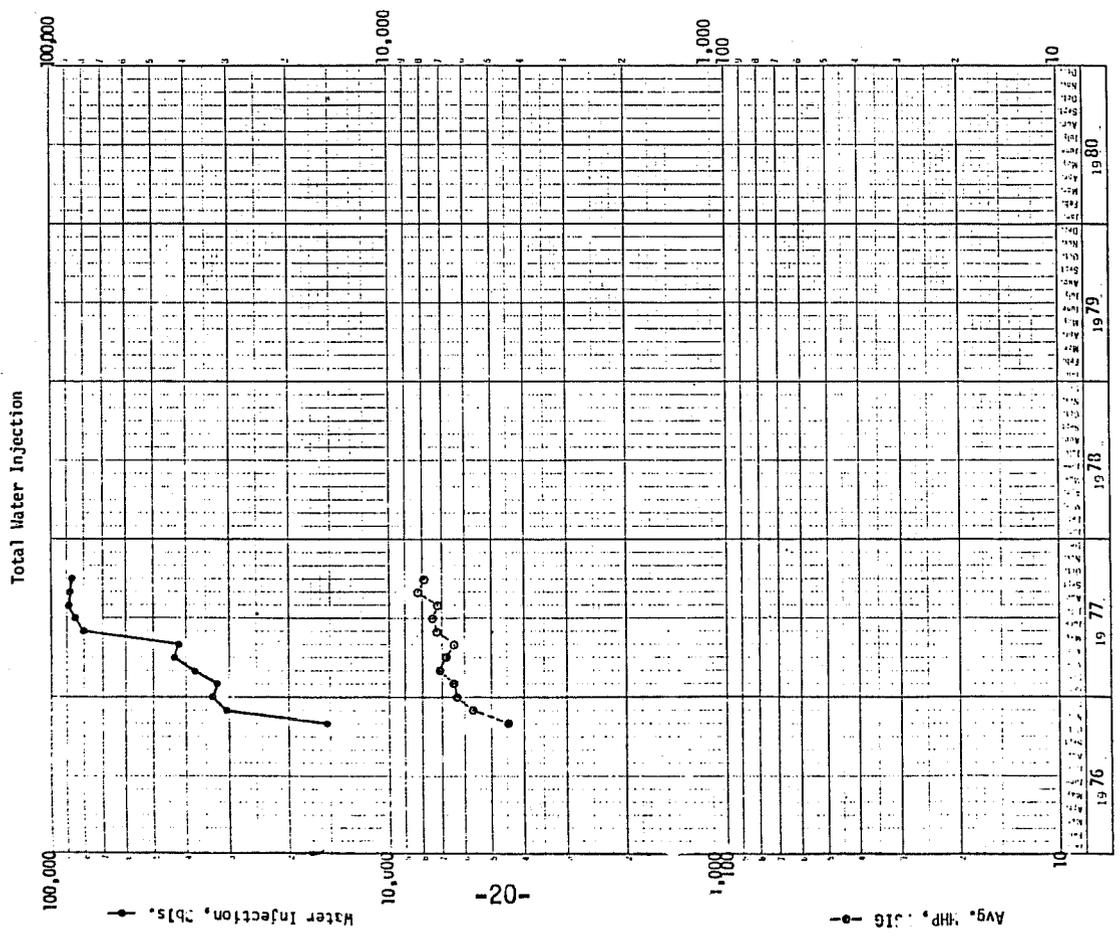
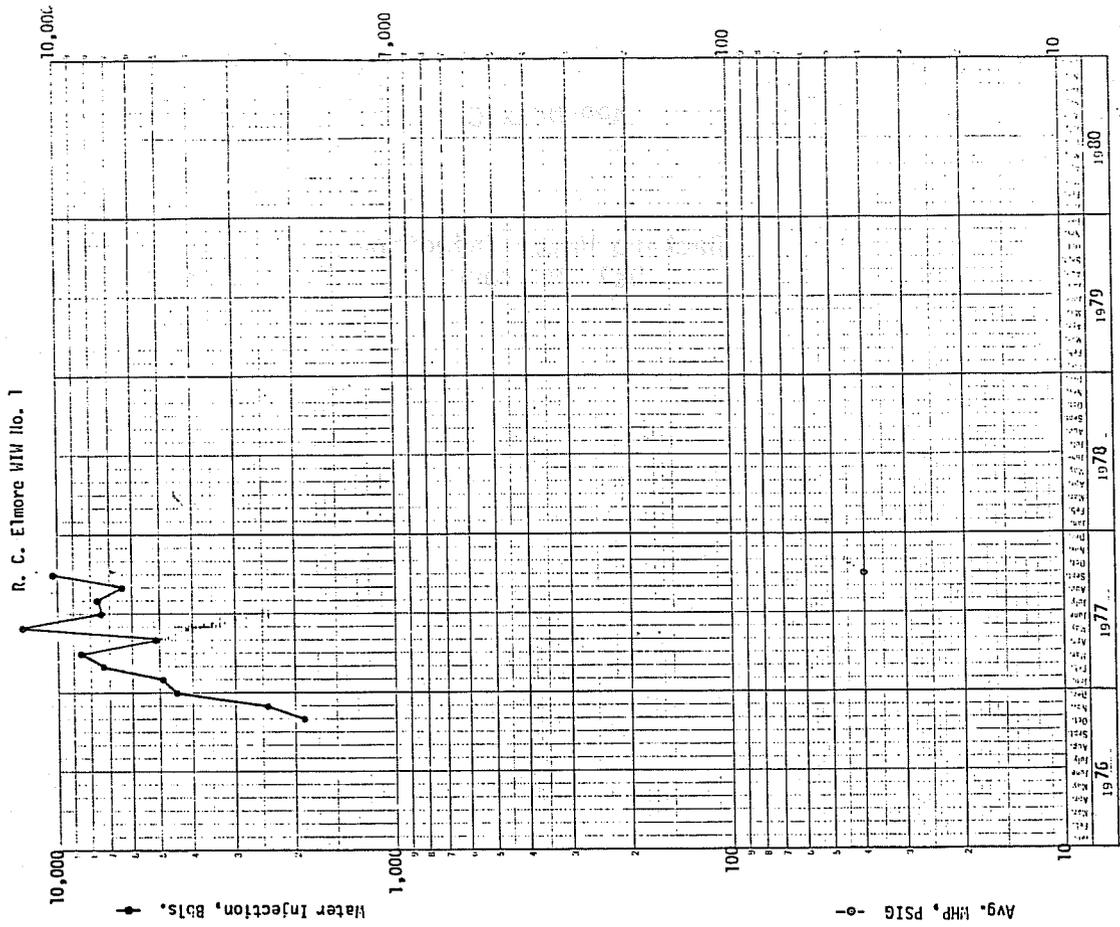
R. C. Elmore P. I. Ilo. 5



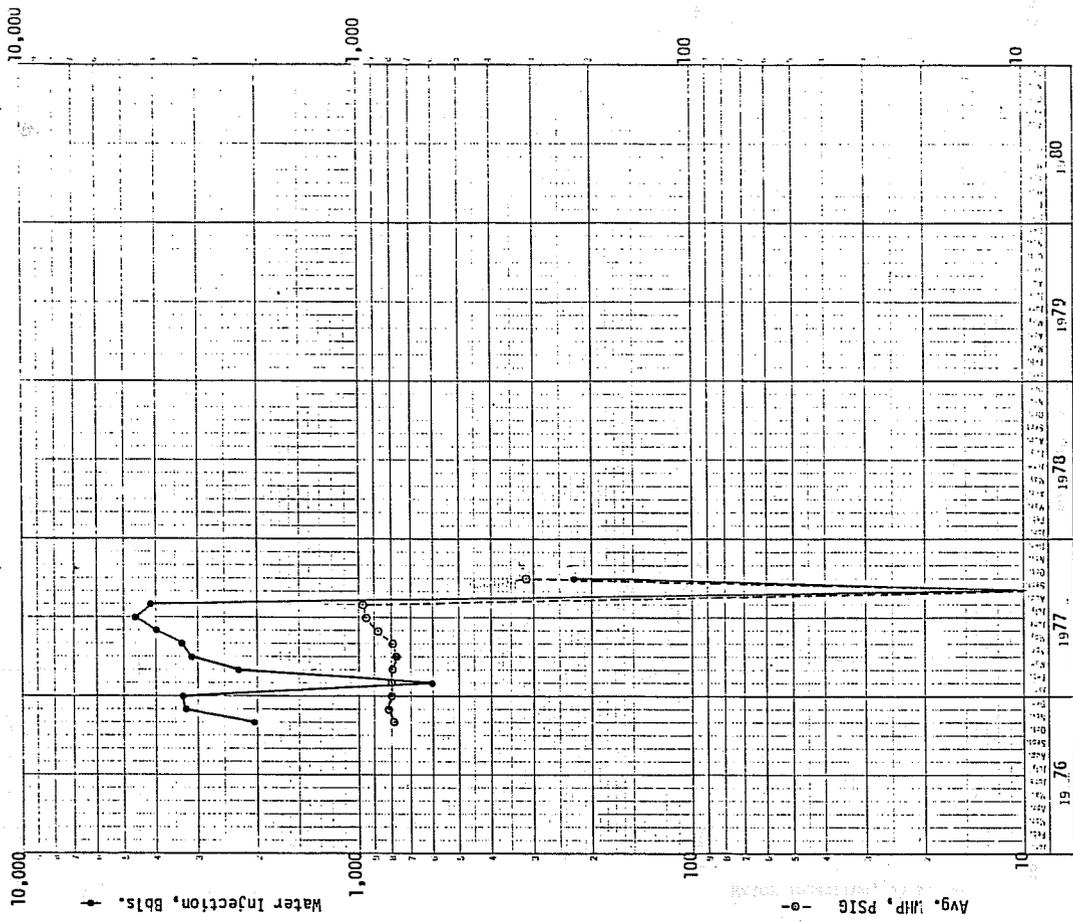
APPENDIX C

Back-up Water Injection
Well History

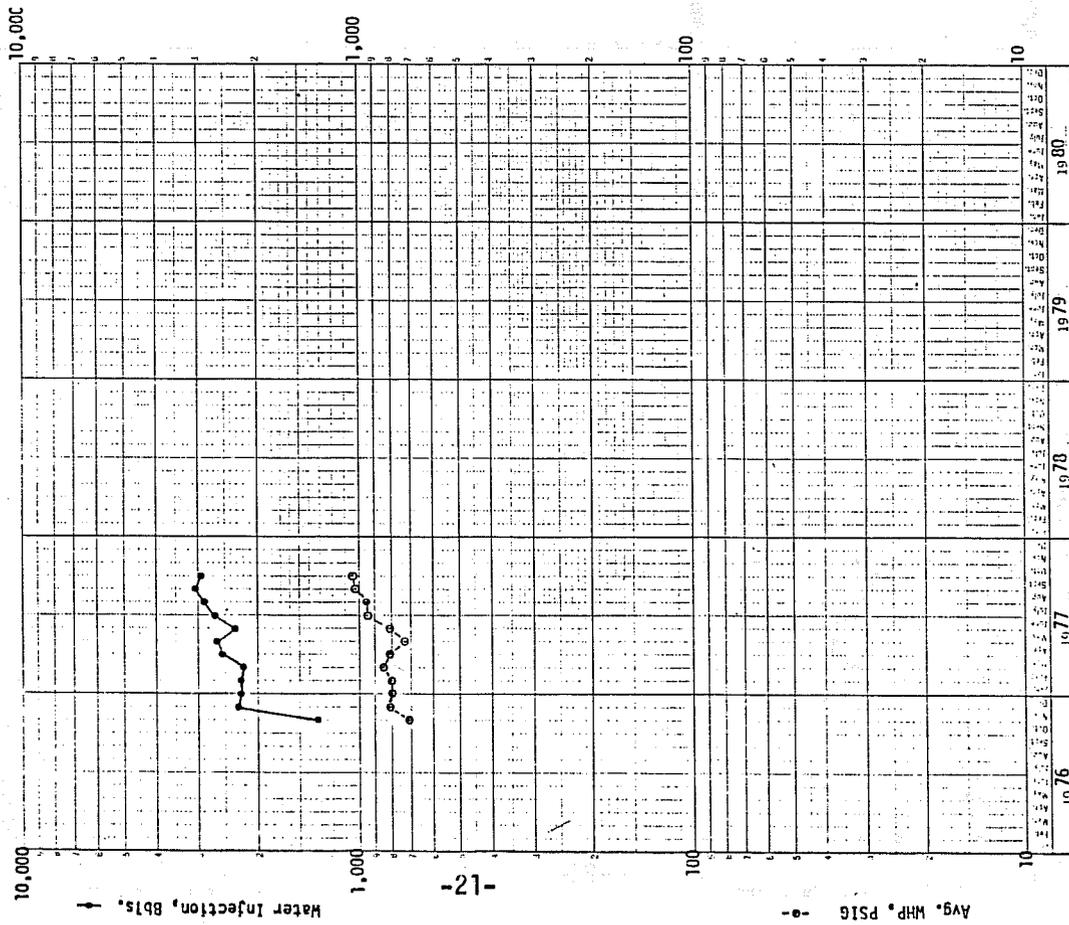




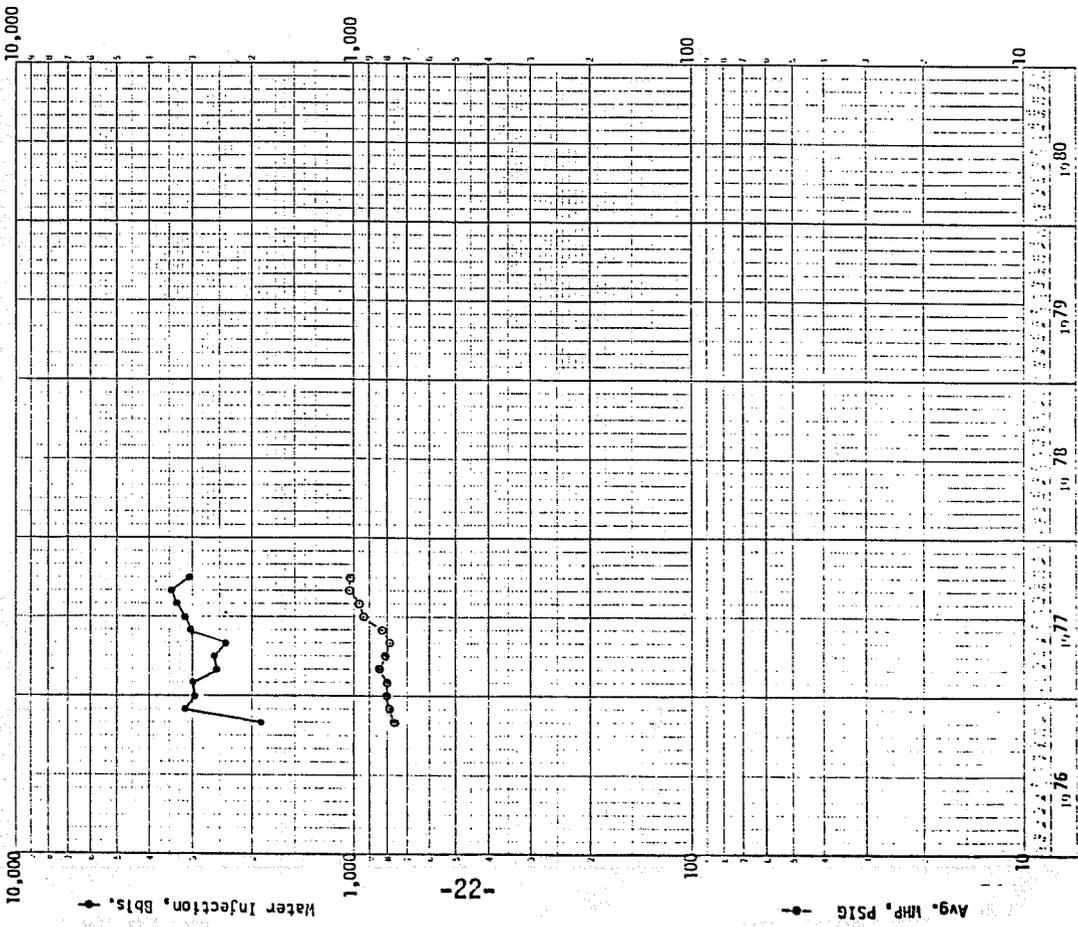
E. Lev's Well No. 17



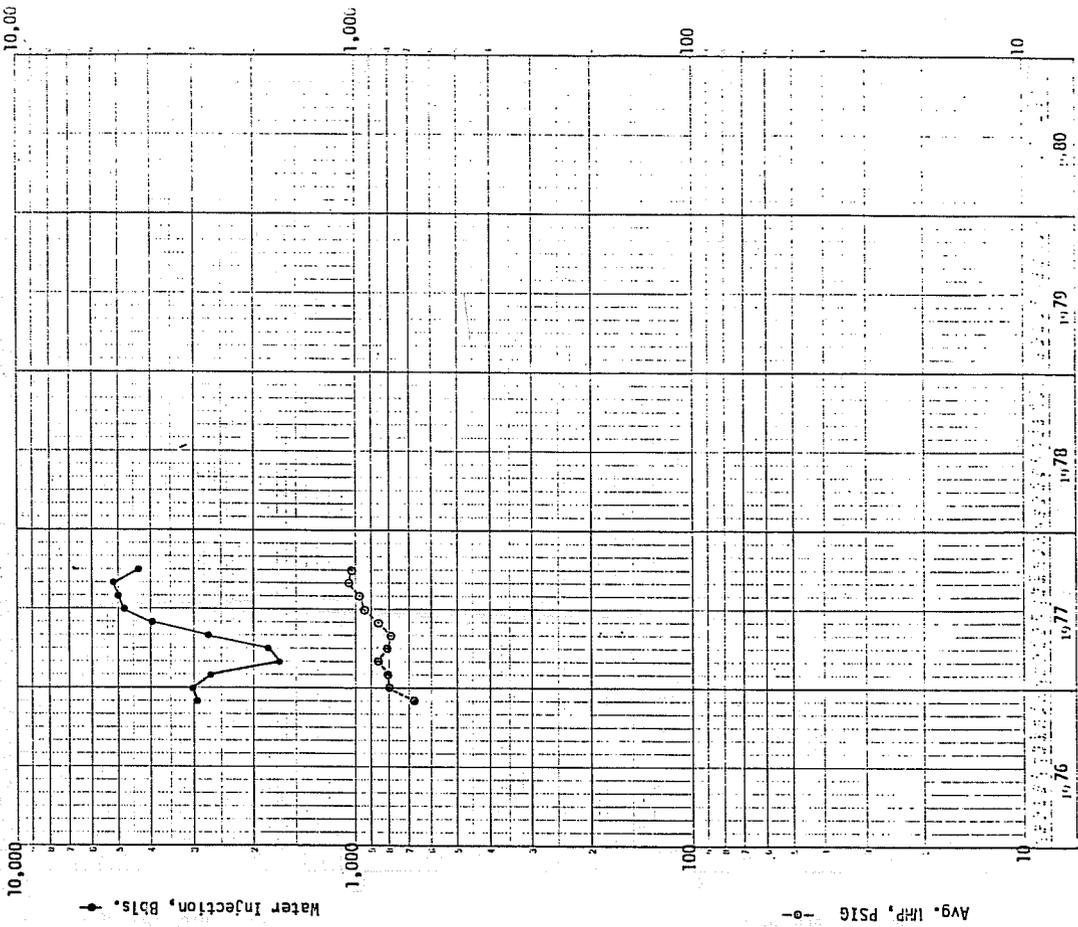
R. C. Elmore Well No. 4



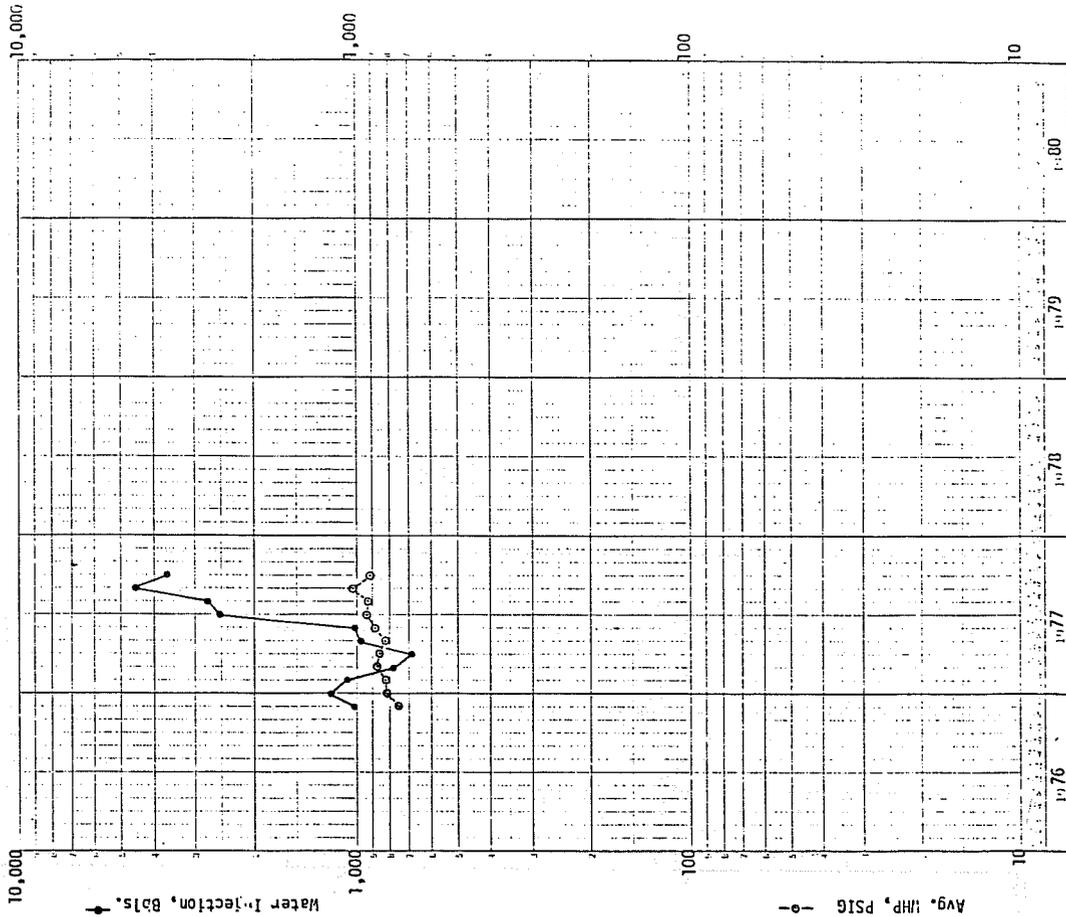
E. Lewis WIV No. 18



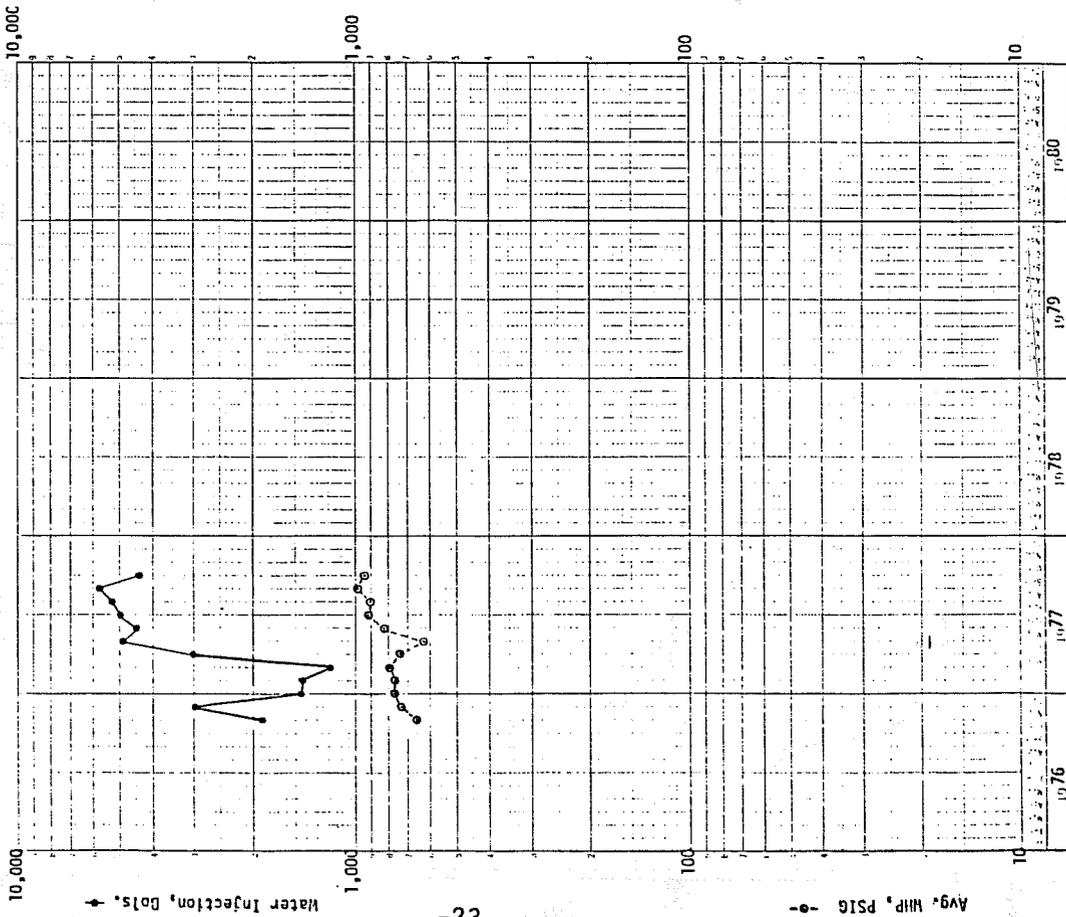
E. Lewis WIV No. 27



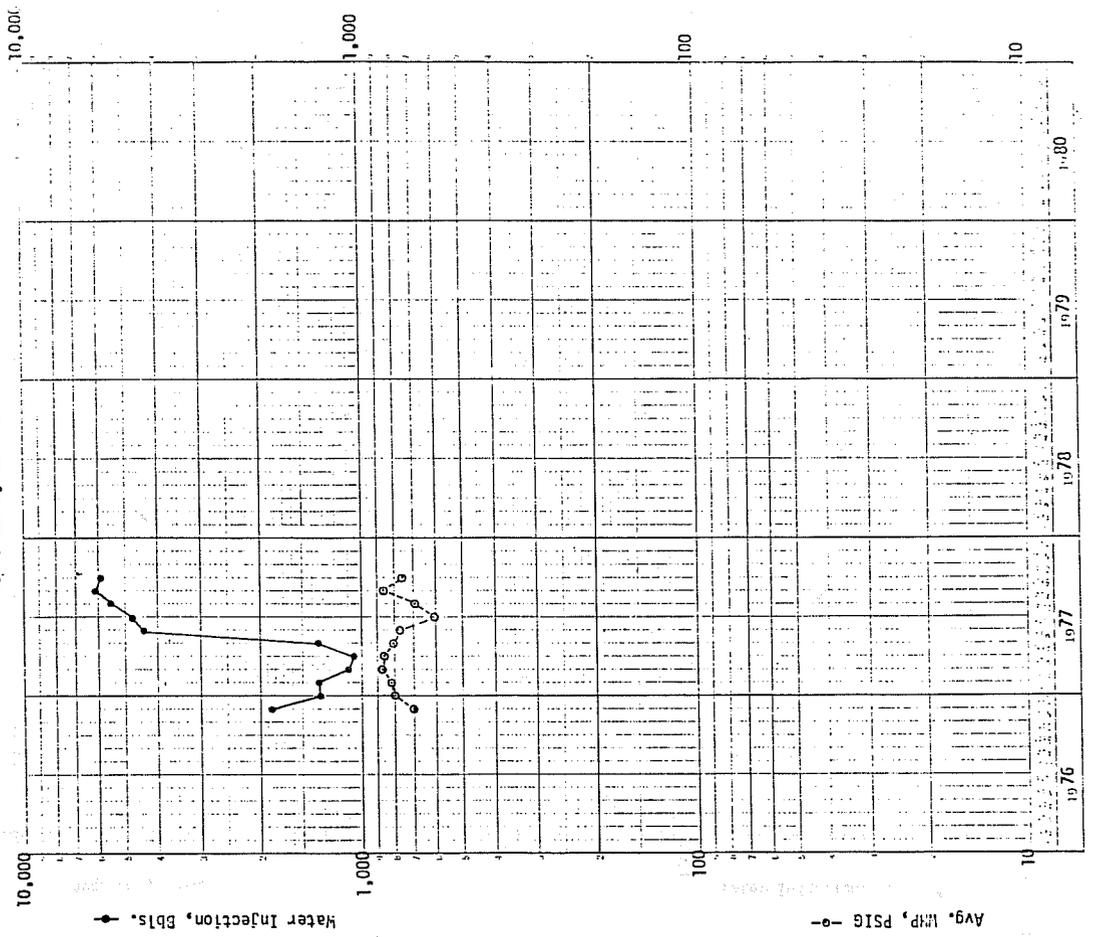
E. Lewis III Ito. 29



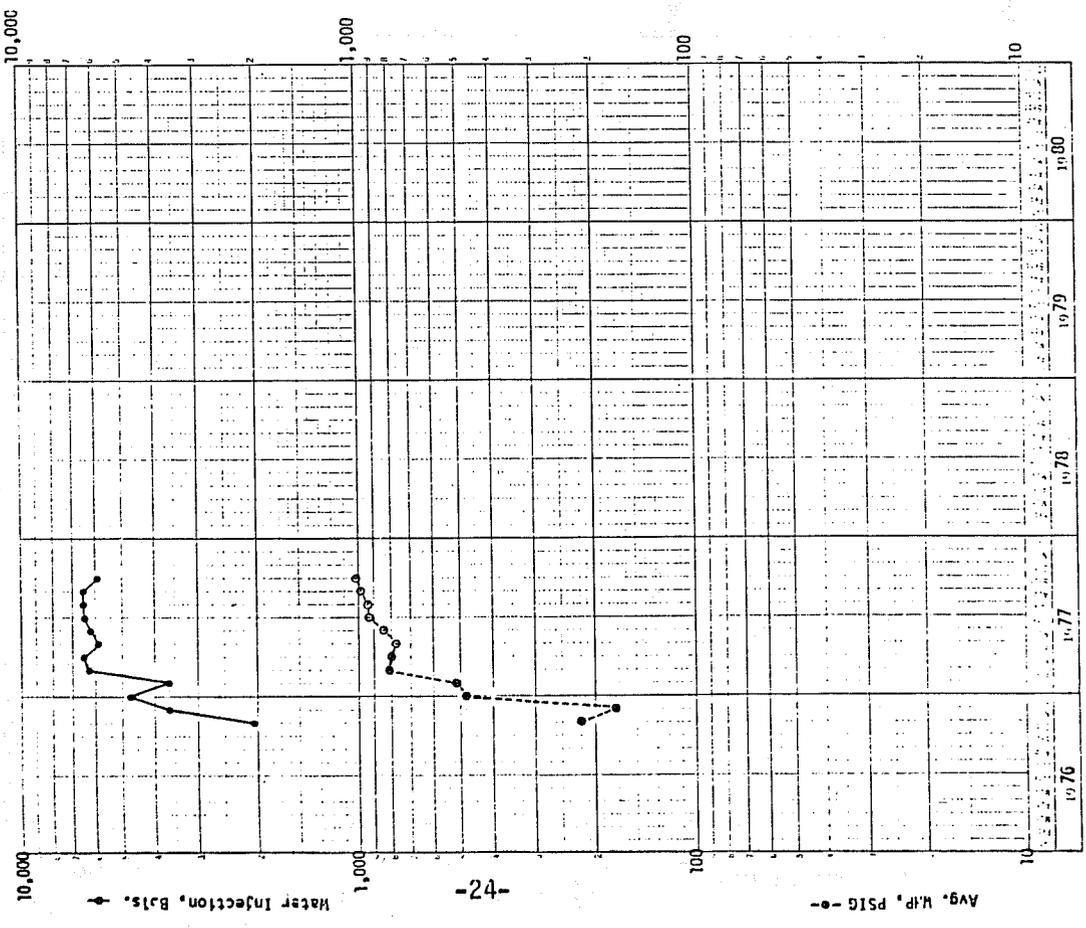
E. Lewis III Ito. 28



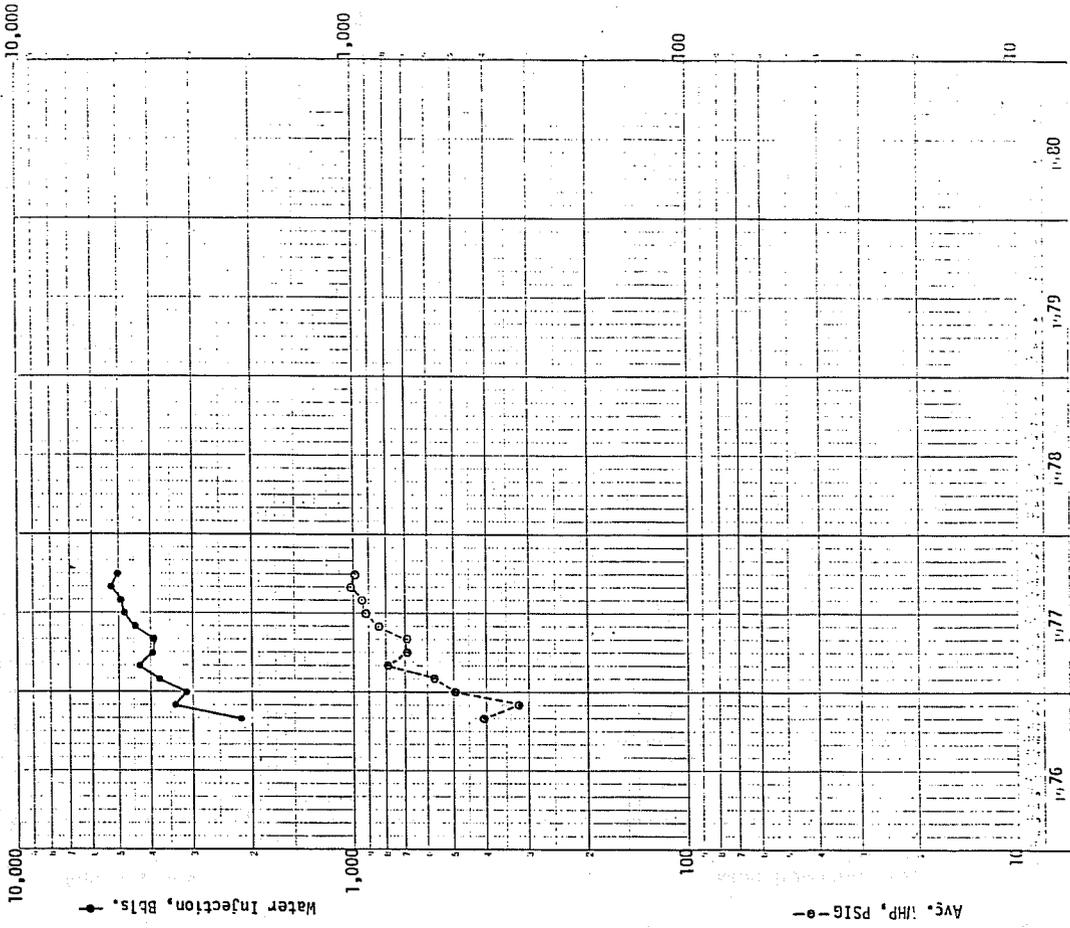
J. II. Looney III No. 5



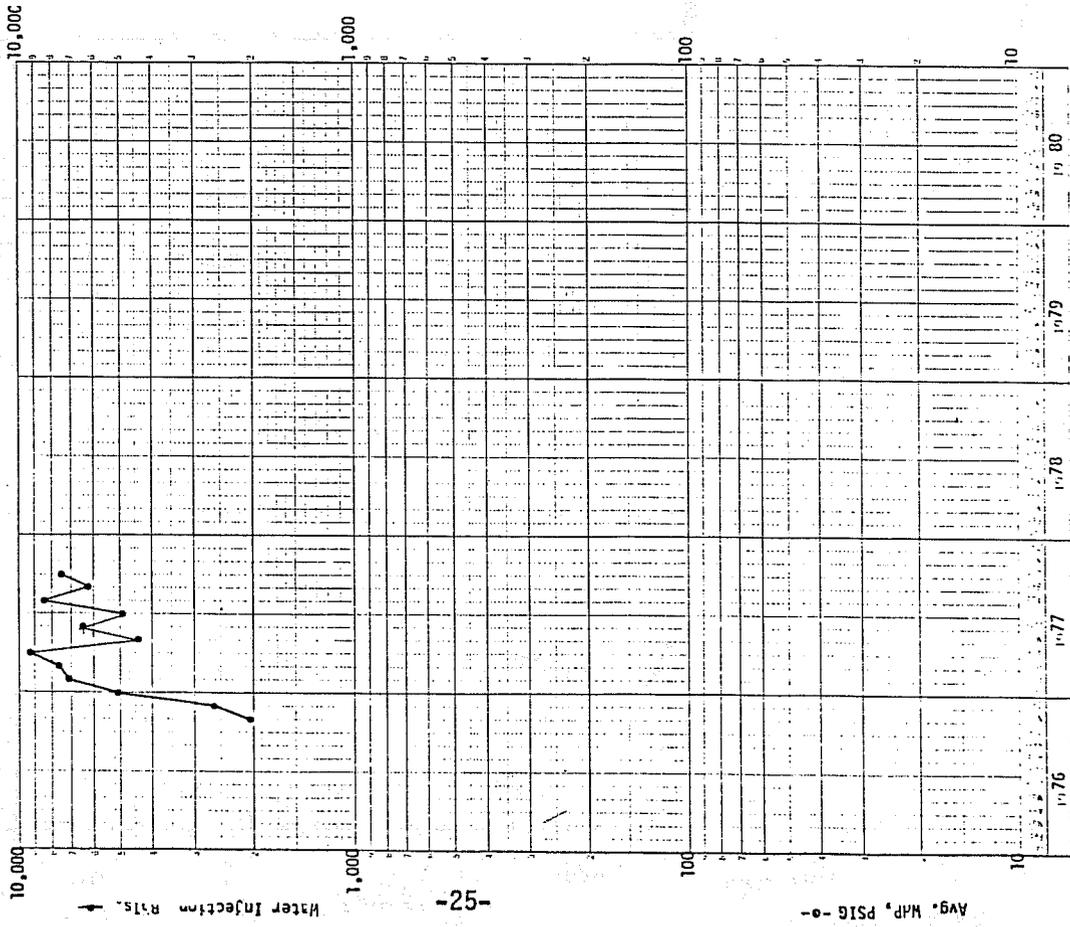
J. II. Looney III No. 1



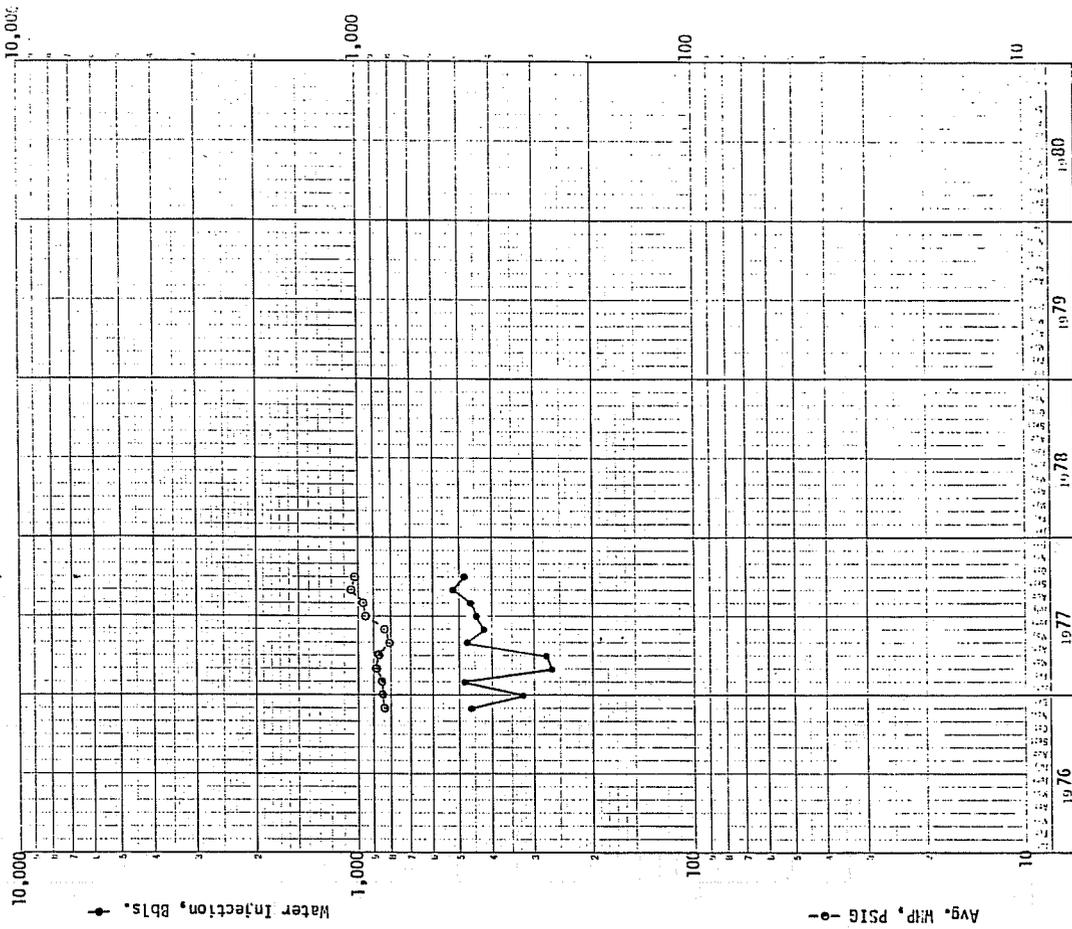
L. M. Shaffer VIII flo. B



L. U. Shaffer VIII flo. 2



L. W. Shaffer VIII Ilo. 11



L. W. Shaffer VIII Ilo. 10

