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TERTIARY OIL RECOVERY BY CARBON DIOXIDE INJECTION GRANNY'S CREEK FIELD, WEST VIRGINIA

Annual Report for July 1977—June 1978

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Annual Report for July 1977-June 1978

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ABSTRACT

OBJECTIVE

The objective of this field test is to evaluate and demonstrate the effectiveness of using CO_2 injection to recover high gravity crude oil from shallow watered-out reservoirs. The estimated recovery potential from the flood pattern of six (6) acres is approximately 50,000 barrels. The work will be conducted in five (5) phases as follows:

Phase 1--Preliminary Testing and Construction, Water Injection, and Plant Construction

Phase 2--Natural Gasoline Injection

Phase 3--CO_2 Injection

Phase 4--Carbonated Water Injection

Phase 5--Water Injection

SUMMARY

The year's activity can best be described as disappointing. With the conclusion of CO_2 injection in June 1977, the fifth phase of the project, water injection, began. While we did not reach the required injection rate of 50 barrels per well per day, we were able to maintain a reasonable rate due to the many changes made in the injection system during the summer of 1977. Total injection for the period was 64,535 barrels or 44.2 barrels per well per day. In addition to mechanical changes in the injection system, it was also necessary to treat the injection wells to relieve the high reservoir pressures encountered.

While injection was about as expected, production was another story. Peak oil production was reached in June 1977 at 2440 barrels. When water injection was resumed during the month, oil production began a decline that continued throughout the period. By June 1978, production had declined to 1340 barrels. Water production throughout the period continued to increase. During the winter and spring of 1978, discussions were held with D.O.E. to determine what steps could be taken to obtain further data to

evaluate the project. As of June the problem had not been resolved.

Through June 30, 1978, approximately 8,560 barrels of oil had been produced as a result of CO_2 injection.

INTRODUCTION AND REVIEW

The Granny's Creek Field was drilled in the period from 1916 to 1944 and at present is being waterflooded by Columbia on the southern 350 acres and by Pennzoil in the northern part of the field.

The waterflood was initiated in 1964 by, a then subsidiary of Columbia Gas System, Preston Oil Company, with a 10 acre pilot project consisting of 6 water injection wells and 3 producers. Approximately 4000 barrels per acre of secondary oil was recovered with an approximate response time of 2 1/2 years.

Subsequently, in early 1975, the Columbia Gas Transmission Corporation, acting in conjunction with the Morgantown Energy Research Center and the Pennzoil Company, drilled an additional well inside the pilot area as part of the Energy Research and Development Administration's continuing program for furthering the use of fracture systems for secondary recovery. In addition, residual oil saturation was determined and the feasibility of initiating a miscible flood process to recover additional oil was investigated.

Upon completion of the core analysis, log analysis, miscibility studies, fracture orientation determination and other important considerations, the reservoir conditions appeared to be favorable for a tertiary recovery project utilizing a miscible flood technique.

During the preliminary testing and design phase of the project, three basic questions arose:

1. Is the residual oil saturation after waterflood high enough to warrant an attempt for tertiary oil?

2. How big a "slug" of CO_2 should be injected?

3. Should it be injected in one mass or in stages?

The first of these questions was answered by core analysis from a test well in the proposed pilot area as discussed above (an indicated 35%). On question #2 - based on the "state of the art" at the time, it was determined that a minimum of 4000 tons of CO_2 and a maximum of 8000 tons of CO_2 could be injected and give satisfactory results. This maximum and minimum was determined using the two prevailing methods of calculation, i.e., 200 scf/bbl. of oil, or 5% of the pore volume. The actual slug size was to be determined by observing and analyzing data as it was collected. On #3 - the "state of the art" also indicated that the CO_2 slug should be injected in one mass followed by alternate slugs of "carbonated" water.

Columbia began construction of the project in August, 1975 with the resumption of water injection into the 6 original pilot input wells in an attempt to repressure the reservoir to 1000 psi. Periodic bottom hole pressure tests were run on the inside producers to determine if this were being achieved. During the period from August, 1975, to June 1, 1976, wells were reworked and CO_2 storage and injection equipment was ordered and installed.

CO_2 AND WATER INJECTION

On June 1, 1976, approximately 300 barrels of gasoline was injected to promote miscibility and on June 2, 1976, CO_2 injection began.

While original plans called for the injection of 36 tons per day, the actual injection averaged 45-50 tons per day. During the latter part of July and early August, CO_2 was detected in the produced gas of both the inside and outside producers. After extensive testing and study, it was decided that enough CO_2 had been injected so that water could be injected without an adverse effect on the CO_2 slug. Subsequent to the injection of 1000 barrels of water per well, it was decided to alternate future injection of CO_2 with water, so that each well would follow the overall schedule listed below:

1) 800 Tons CO_2
2) 1000 Barrels Water
3) 500 Tons CO_2
4) 850 Barrels Water
5) 400 Tons CO_2
6) 680 Barrels Water
7) 300 Tons CO_2
8) 510 Barrels Water

This schedule was followed with little difficulty until mid-December when the worst winter on record set in. From mid-December, 1976 to mid-March 1977, CO_2 was virtually non-existant in Appalachia due to the natural gas crisis in the area. An attempt was made to inject water during this period, however, this was extremely difficult due to constant freeze-ups. As a result, reservoir pressure declined 400-500 pounds.

In mid-March, CO_2 began to be available although it was necessary to bring it in from northwestern Ohio. Due to the distance involved, and the expense, we resumed injection with about 1/2 to 2/3 of the daily requirements of the project. However, this did arrest the decline in pressure and even increased it slightly.

When CO_2 became available again locally in April, it was decided that the remaining CO_2 would be injected in one slug rather than resuming the various cycles of the wells. It was also decided to add an additional 1000 tons of CO_2 after the 8800 tons in the original proposal had been injected.

CO_2 injection was completed on June 14, 1977, and water injection resumed. Cumulative injection of CO_2 per well is as follows:

#2020	#2022	#2023	#2025
2,364 Tons	2,794 Tons	2,264 Tons	2,456 Tons

Total: 9,878 Tons

With the conclusion of CO_2 Injection, Phase V, or the water injection phase of the project began. Although this phase called for the injection of 50 barrels per well per day for a total of 200 barrels per day for the project, we actually reached this total on few occasions. The reasons for this were mainly high reservoir pressures and down time caused by power outages and maintainence. However, we were able to maintain a reasonable injection rate even throughout the winter of '77-78. This was accomplished by treating the wells to increase injection, re-burying the lines and rebuilding the water plant to prevent freeze-ups, and re-vamping the water system to provide for additional water supply. Except as discussed above, the water injection phase during the period July 1977-June 1978 was fairly routine.

Total water injected during the period is as follows:

Well No.	Annual Inj.(bbls)	Daily Av.
2020	14,720	40.33
2021	13,779	37.75
2023	18,930	51.86
2025	17,106	46.86
Total	64,535	176.81

During the spring of 1978 adjustments were made on the injection rates of 2025 and 2023 in order to improve the balance of the flood, however it occurred too late in the period to be noticeable.

PRODUCTION

Prior to June 15, 1976, all wells in the field except the 4 wells inside the pattern were pumped into a central tank battery and production allocated on the basis of pumping time. The 4 wells inside the pattern were shut-in for periodic B.H.P. testing. On June 15, construction of lines and tank sites had been completed and the 12 wells involved in the project began producing into an individual tank for each well. Flow testing for different periods of time was initiated on the inside producers June 3, 1976, and continued until July 1, 1976.

From July 1, 1976 until August 30, 1976, these wells flowed 24 hours per day. On August 30, 1976, all of the inside producers, except Well No. 4254 had been shut-in and since that time have been used for reservoir testing only. During the fall of 1976, bottom hole pressure tests indicated a higher productive capacity in Well No. 4254 than the well was actually producing, although increases in production had been noted.

The well was therefore treated with carbon bisulfide, reconditioned and given a light fracture treatment in an effort to stimulate production. Production then increased from approximately 30 barrels per week to 60 barrels per week and was steadily climbing when winter arrived.

As pressure declined due to lack of sufficient injection media, production in the well declined to approximately 20 barrels per week. The cycle was repeated with the resumption of CO_2 injection and the well again reached a peak production of approximately 60 barrels per week. Since all indications pointed to a higher productive capacity for the well, the decision was made to pump the well instead of allowing it to flow.

Almost immediately after pumping operations were started, oil production began an almost steady decline and water production began a steady increase. At the end of the period, the well was producing approximately 1 barrel of oil per day and 36 barrels of water per day.

The test well inside the pattern (20274) also began to give us problems during the winter of '77-78. A casing leak developed on the outside of the 4 1/2". During the winter while the leak was small, it was necessary to flow the well periodically to relieve the pressure. By spring the leak had developed to the point where it was necessary to flow the well continuously. While the well did contribute to the oil production, it caused a pressure drop in the pattern and thus "unbalanced" pressure in the reservoir. Since by spring of 1978 it was obvious that the project was beset with too many problems to be successful, repair of the casing leak was deferred until a decision was made regarding future operations.

While production increases were noted in the wells outside the pattern, the most significant one was in Well No. 2046. Throughout 1976, this well had a bottom hole pressure in excess of 950 psi, yet flowed only 1-2 barrels per day. The well was tested and treated with carbon bisulfide to relieve paraffin blocks, to no avail. In May of this year, the well was tubed and started to pump. Since that time production increased to a peak of approximately 23 barrels per day, before declining to about 10 barrels per day.

The original proposal called for flowing the producing wells in order to maintain better reservoir control such as miscibility sweep efficiency, reduce corrosion and prevent paraffin deposition.

By the summer of 1977, it was realized that pumping would be necessary if the production goal was to be reached or even reasonably approached. Through June 30, 1978 total oil produced from all wells due to CO_2 injection was 8562 barrels with approximately 4540 coming from inside the pattern.

One of the most interesting and, in retrospect, discouraging aspects of this project, has been the relationship between oil and water production and CO_2 and water injection.

Since the project was installed in a "watered-out" section of our waterflood, it was expected that water production would come first, especially inside the pattern. This was not the case. Increases in oil production began almost immediately with the injection of CO_2. This was accompanied with very little increase in water. As long as CO_2 was being injected, oil production increased and water production remained fairly constant. As soon as CO_2 injection was completed and water injection resumed, the production cycle reversed; oil production declined and water production increased. This would seem to indicate that the CO_2 entered a previously untouched zone and that the water entered the zones it had during the waterflood. The early arrival of CO_2 at the producing wells is typical of current CO_2 injection projects and to date seems to be unpreventable.

BOTTOM HOLE PRESSURE TESTS

Bottom hole pressure tests were initiated in 1975 when the former water injection wells were returned to service to repressure the reservoir. As can be seen on the enclosed graphs, this was accomplished prior to the commencement of CO_2 injection. These tests have been continued periodically throughout the life of the project and illustrate the various phases in the injection and production cycles described previously. Bottom hole pressure data, in addition to that shown on the graphs, is enclosed on the data sheets in the enclosed quarterly reports.

GAS SAMPLES

Gas samples were taken monthly beginning in August 1976 from wells within the project as well as other selected wells in the field. These samples were analyzed for CO_2 content and measured for volume. This data is also shown in the attached quarterly reports.

Gas separation and metering equipment was installed on Well 2044 in an effort to measure produced gas along with the oil. This was done in 1976 and reported on previously. However, the equipment was plagued with continual problems

of fluid accumulation in the meter and its use was discontinued during the summer of 1977. Two separate metering and separation stations were installed on the test tank batteries and were manifolded in such a manner as to allow each well in the project to be tested. The wells were tested throughout the reporting period and the data is shown in the attached quarterly reports.

WATER SAMPLES

Water samples were taken periodically throughout the year from those wells producing water. The results of analysis of these samples for pH and chloride content are shown on the data sheets in the accompanying quarterly reports.

PROBLEMS

From an operational standpoint, three problems have occurred: 1) the high pressure injection pump; 2) metering the liquid CO_2; and 3) the change over from CO_2 to water during injection cycles.

1. Although technically we were handling a liquid, the CO_2 had a tendency to vapor lock the pump, particularly in hot weather. Changes in insulation and piping design was the solution. Packing adjustment and the proper lubricating oil were critical due to the $0^{\circ}F$ operating temperature. Unlike a water pump, the packing on a CO_2 pump cannot be allowed to leak or ice will form, and the packing will blow out. The proper lube oil must be used to keep vapor entrapment to a minimum, and in general the plungers must be over lubricated or packing blow-outs will result.

2. The meters originally installed were water meters converted for CO_2 usage. However, these proved inaccurate and turbine meters were substituted with much better results.

3. While the water injection system was satisfactory during the life of the pilot waterflood, it proved unsatisfactory when the wells were

periodically changed from CO_2 injection to water injection as outlined previously. This was due to the higher pressure necessary to inject water once the reservoir was pressured up.

This was especially true during the winter of '76-77 when leaks and freeze-ups were a daily occurrence. However, when CO_2 injection was completed, these lines were tied into the water plant and the problem solved. We have added to the water supply system and replaced the filters and associated equipment in the water plant, and have been able to operate relatively trouble-free.

One problem that has not occurred is corrosion due to CO_2 injection. While outside corrosion has occurred due to weathering, no evidence of internal corrosion has been found. We have inspected various pieces of surface equipment and subsurface equipment, and found no evidence of CO_2 corrosion. We believe this is because of the relatively low temperature of the reservoir (approx. 70°F).

We have had paraffin problems in certain wells and it has been necessary to steam the tubing when it gets serious enough to restrict production.

The biggest single problem has not been one of mechanical operation of the project, but of interpreting the results from the data obtained. Since the project was essentially "watered-out" or at least fast approaching that point by January 1978, meetings were held with D.O.E. to discuss what steps, if any, could be taken to determine what had happened in the reservoir. D.O.E. proposed drilling, coring, logging and drill stem testing of a well inside the pattern. Columbia investigated that cost and feasibility of taking a pressure core as the best method of obtaining a representative reservoir sample. After much analysis and debate, it was decided that additional drilling and coring would not obtain the desired information. As of June 30, 1978 the problem had still not been resolved.

CONCLUSIONS

After two years of operation, the following conclusions can be drawn from the project:

1. Reservoirs of this type can be repressured to a point where miscibility can be achieved.

2. Handling liquid CO_2 on the surface presents few operating difficulties, although the equipment does require constant attention.

3. CO_2 moves through the reservoir much faster than conventional injection media, as shown by the almost immediate response when injection was originally started and again after the three-month shut-down during the winter of '76-77. Premature CO_2 breakthrough is a problem that has not yet been solved.

4. While this particular project has not lived up to expectations, CO_2 will recover additional oil.

5. Considering the advances in the "state of the art" in the past few years, a larger volume of CO_2 will be required in future projects.

6. CO_2 related corrosion is not a problem in shallow, low temperature reservoirs.

7. CO_2 can be injected at much higher rates than had been originally calculated.

8. It is still believed that much more basic research concerning the interaction of CO_2 and rock and fluid characteristics of the reservoir is necessary before accurate predictions as to reservoir response can be made.

PUBLICATIONS PREVIOUSLY ISSUED UNDER CONTRACT EF-76-C-05-5302

Title	Description
Tertiary Oil Recovery by CO_2 Injection	Monthly Report - July 1977 ORO-5302-13
Tertiary Oil Recovery by CO_2 Injection	Monthly Report - August 1977 ORO-5302-14
Tertiary Oil Recovery by CO_2 Injection	Oral Presentation: D.O.E. Symposium, Tulsa, OK August 31, 1977
Tertiary Oil Recovery by CO_2 Injection	Monthly Report - September 1977 ORO-5302-17
Tertiary Oil Recovery by CO_2 Injection	Oral Presentation: State Well Scout Meeting, Pipestem, WV September 27, 1977
Tertiary Oil Recovery by CO_2 Injection	Quarterly Report July - September 1977 ORO-5302-18
Tertiary Oil Recovery by CO_2 Injection	Monthly Report - October 1977 ORO-5302-19
Tertiary Oil Recovery by CO_2 Injection	Monthly Report - November 1977 ORO-5302-20
Tertiary Oil Recovery by CO_2 Injection	Monthly Report - December 1977 ORO-5302-21
Tertiary Oil Recovery by CO_2 Injection	Quarterly Report October - December 1977 ORO-5302-22
Tertiary Oil Recovery by CO_2 Injection	Monthly Report - January 1978 ORO-5302-23
Tertiary Oil Recovery by CO_2 Injection	Monthly Report - February 1978 ORO-5302-24
Tertiary Oil Recovery by CO_2 Injection	Monthly Report - March 1978 ORO-5302-25

PUBLICATIONS (Con'd)

Title	Description
Tertiary Oil Recovery by CO_2 Injection	Quarterly Report January - March 1978 ORO-5302-26
Tertiary Oil Recovery by CO_2 Injection	Monthly Report - April 1978 ORO-5302-27
Tertiary Oil Recovery by CO_2 Injection	Monthly Report - May 1978 ORO-5302-28
Tertiary Oil Recovery by CO_2 Injection	Monthly Report - June 1978 ORO-5302-29
Tertiary Oil Recovery by CO_2 Injection	Quarterly Report April - June 1978 ORO-5302-30

APPENDIX A

ABSTRACT

OBJECTIVE

The objective of this field test is to evaluate and demonstrate the effectiveness of using CO_2 injection to recover high gravity crude oil from shallow watered-out reservoirs. The estimated recovery potential from the flood pattern of six (6) acres is approximately 50,000 barrels. The work will be conducted in five (5) phases as follows:

Phase 1--Preliminary Testing and Construction, Water Injection and Plant Construction

Phase 2--Natural Gasoline Injection

Phase 3--CO_2 Injection

Phase 4--Carbonated Water Injection

Phase 5--Water Injection

SUMMARY

Total water injection for the quarter was 17,370, an increase of approximately 2700 barrels over the previous period. The increase was due to remedial work on the input wells that was completed during March. The only problems occurred during June, when excessive shut-downs resulted from line plugging after moving the water tanks. This problem was subsequently solved.

Oil production for the period was 4314 barrels, an increase of approximately 660 barrels over the previous quarter. Although increases in production were experienced in wells outside the pattern, the central producer continued at about 1 barrel per day with increasing water production. Total production attributable to CO_2 injection is 8562 barrels.

WATER INJECTION

Water injection for the quarter totaled 17,370 barrels compared to 14,663 for the previous period. Daily average injection per well amounted to 47.72 barrels; an increase of 7 barrels per day over that of the January-March quarter. This was largely due to remedial work performed on the wells during the latter part of March. Injection rates for each well during the quarter is shown below.

Well No.	Quarterly Inj.(bbls)	Cum. Inj.(bbls)
2020	4,452	15,157
2022	3,378	14,651
2023	5,226	19,945
2025	4,314	17,903
Total	17,370	67,656

Down time for the period was 118 hours or approximately 5% of the total operating time. The down time was due to power outages and shut-downs due to high pressure. Considerable trouble was experienced with the system during June. After moving the water tanks that supply the injection plant, line plugging occurred, apparently due to foreign matter, and caused shut-downs due to high pressure. This problem has been corrected.

Water production for the project since its inception is shown on the enclosed graph.

OIL AND WATER PRODUCTION

Total oil and water production for the quarter is listed in the table below. That attached charts and graphs indicate the production for each well in the project along with a summary of production for wells both inside and outside the pattern.

Month	Oil Prod.(bbls)	Water Prod.(bbls)
April	1,384	3,465
May	1,584	4,351
June	1,346	4,188
Total	4,314	12,004

While oil production increased approximately 660 barrels during the quarter, water production increased 3,560 barrels. It should be noted that water production increased at about the same time as injection increased. Flow tests were run on most of the wells in the project. The results along with the associated gas volumes are shown on the accompanying data sheets.

Cumulative oil production through June 1978 that has been attributed to CO_2 injection is 8562 barrels. The watercut is currently 75%.

BOTTOM HOLE PRESSURE TESTS

Bottom hole pressure tests were run on selected wells in the project during April and June. They were not run during May since the service company's tool was not available. Results of the tests are as follows:

	B.H.P.(psi)	
Well No.	April	June
2024	1,178	1,235
20274	810	957
2021	1,608	1,537
2020	2,180	2,081
2022	1,997	1,929
4562	1,106	935
2025	1,815	1,898
2023	2,180	2,098

GAS SAMPLES

Gas samples were taken from selected wells in the field and were analyzed for CO_2 content and the wells were tested for open flows. The results of these tests are listed on the accompanying table. Samples from several wells were also sent to the Morgantown Energy Research Center for a more complete analysis. The results of these tests are also included.

WATER SAMPLES

Water samples were obtained from certain wells in the project and analyzed for chloride content and pH. The results of these tests are listed on the attached chart.

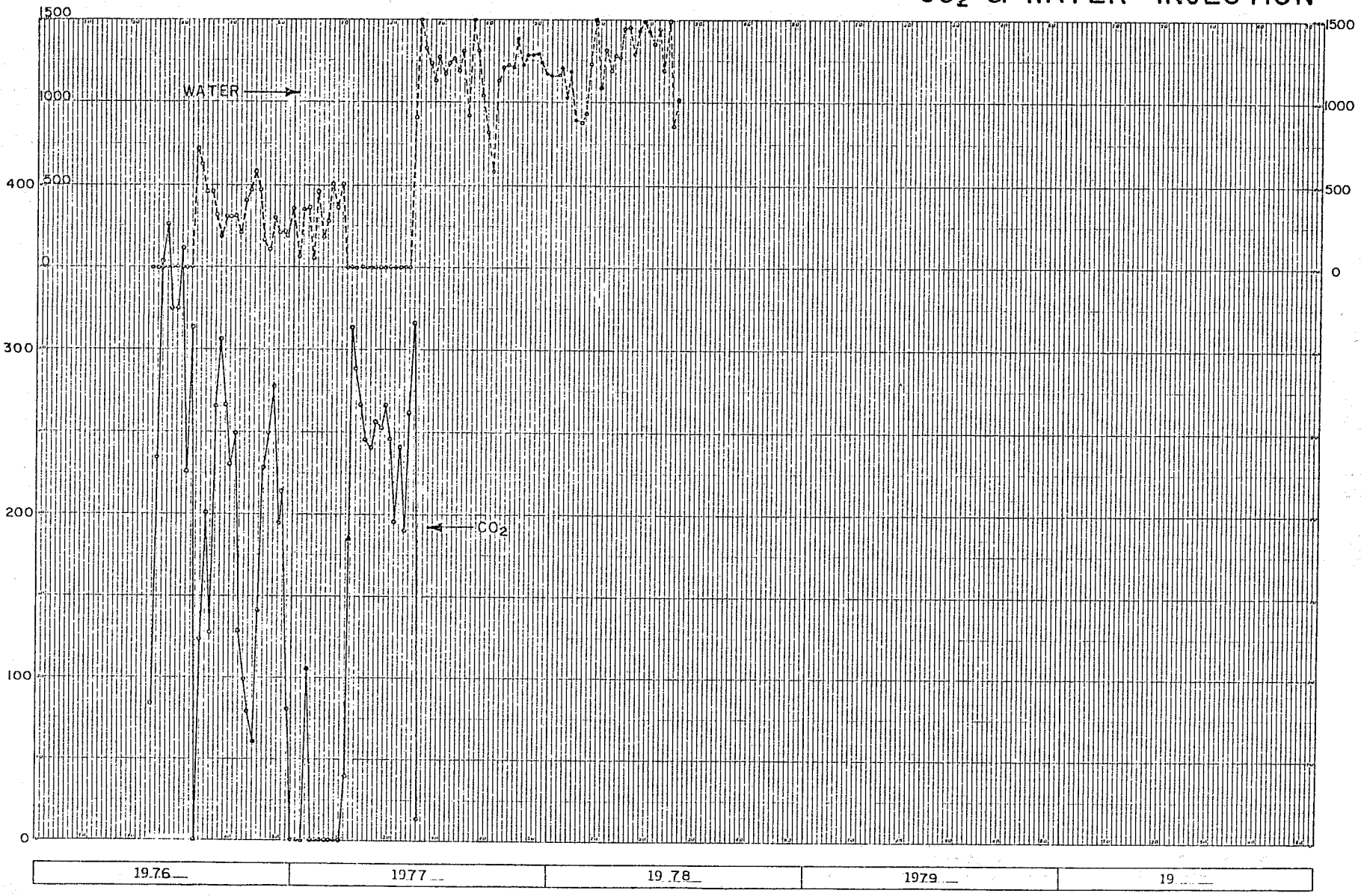
EVALUATION PROCEDURES

During the quarter meetings and disucssions were held with consultants and the Department of Energy to determine the best procedure to follow in evaluating the project. As of June 30, these procedures were still in the development stage.

PROJECT SCHEDULE

The attached Milestone Chart shows the original schedule for the project and the progress to date. As can be seen, a delay of approximately one month occurred due to winter shut-downs, and the additional 1000 tons of CO_2 injected. Although water injection rates have been somewhat lower than anticipated, it is believed that the project will be completed on schedule.

CO_2 & WATER INJECTION



NO. 411-21. FIVE YEARS 8½" WEEKS X 100 DIVISIONS.
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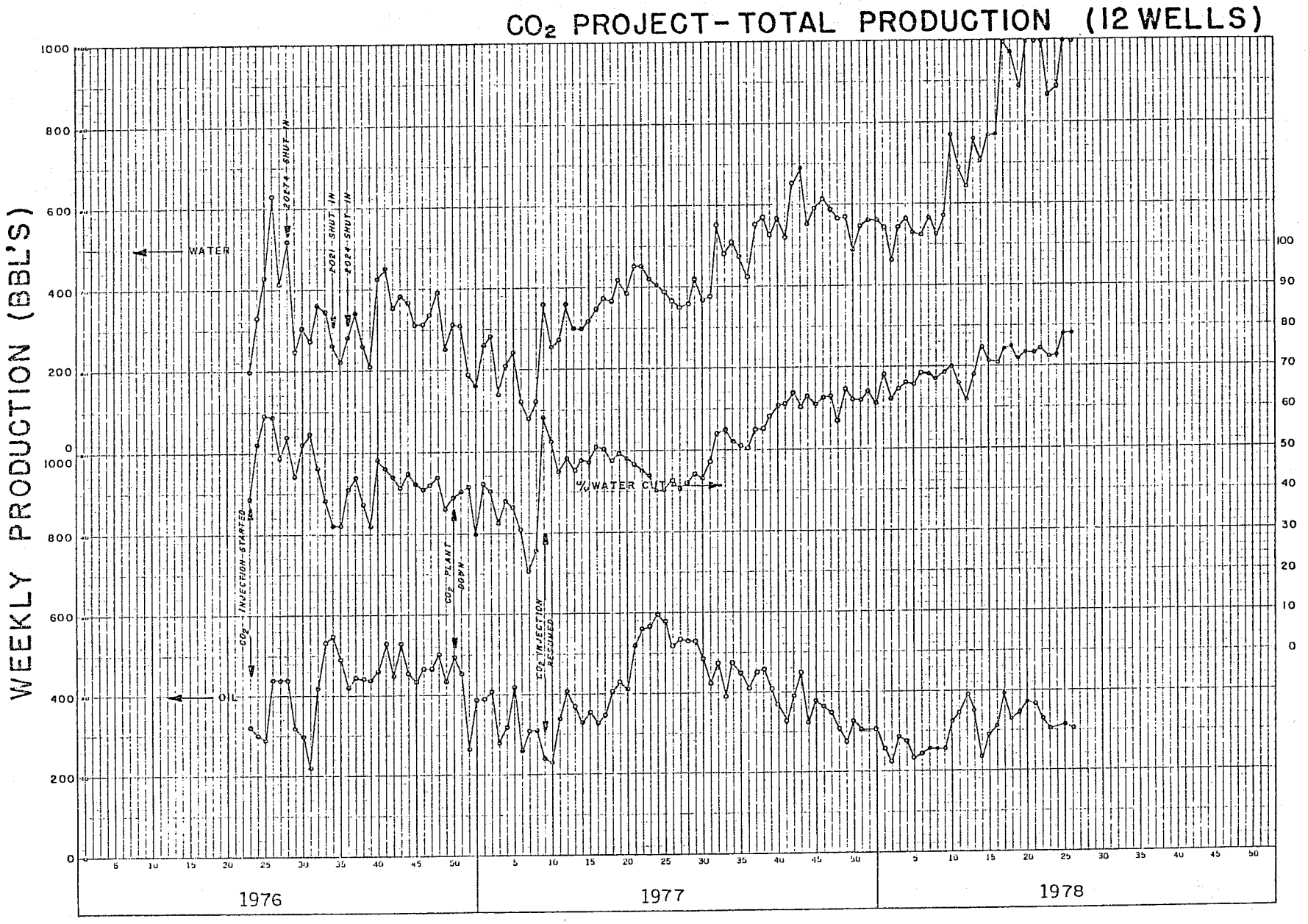

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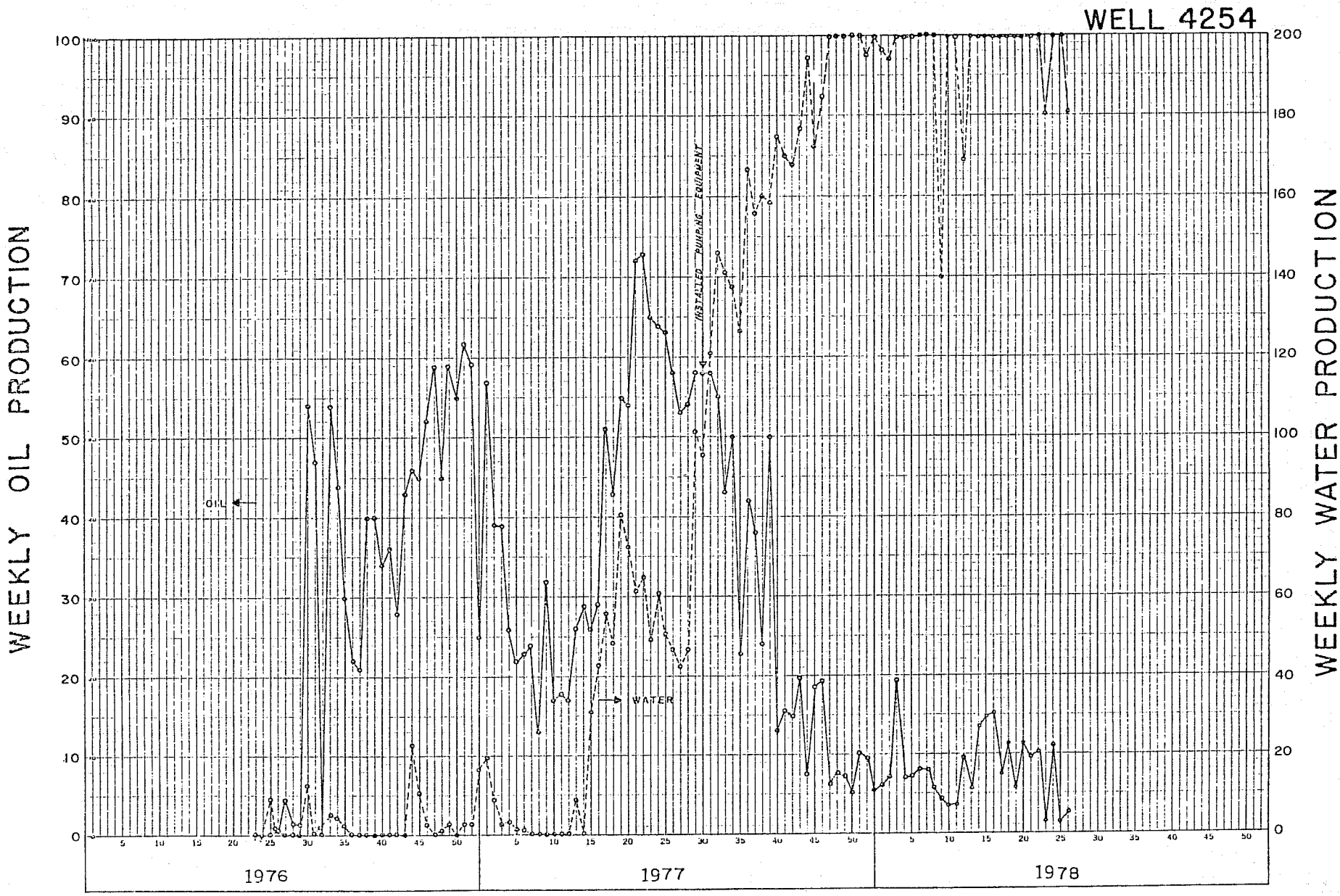

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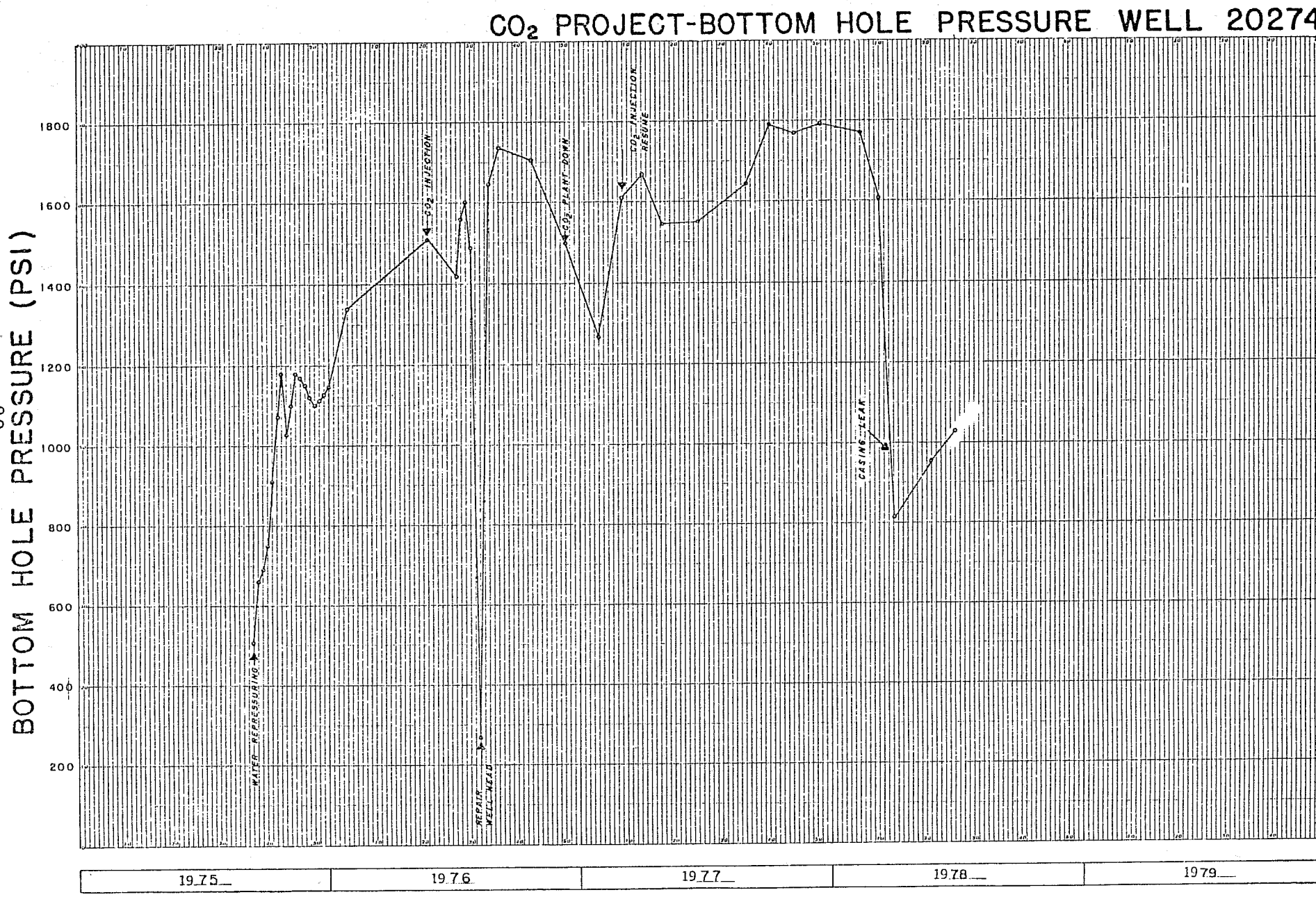

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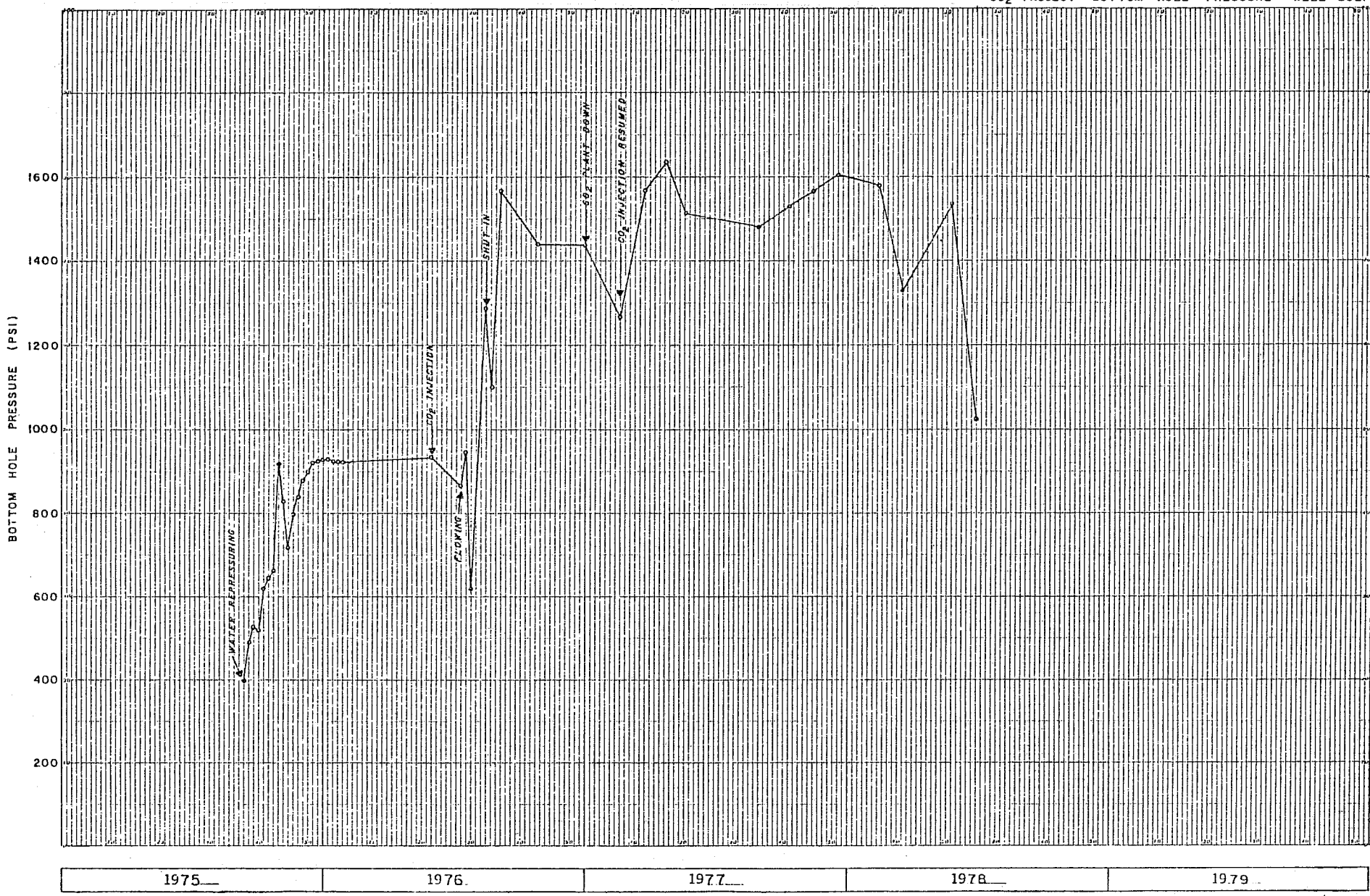
CO_2 PROJECT — BOTTOM HOLE PRESSURE WELL 2021



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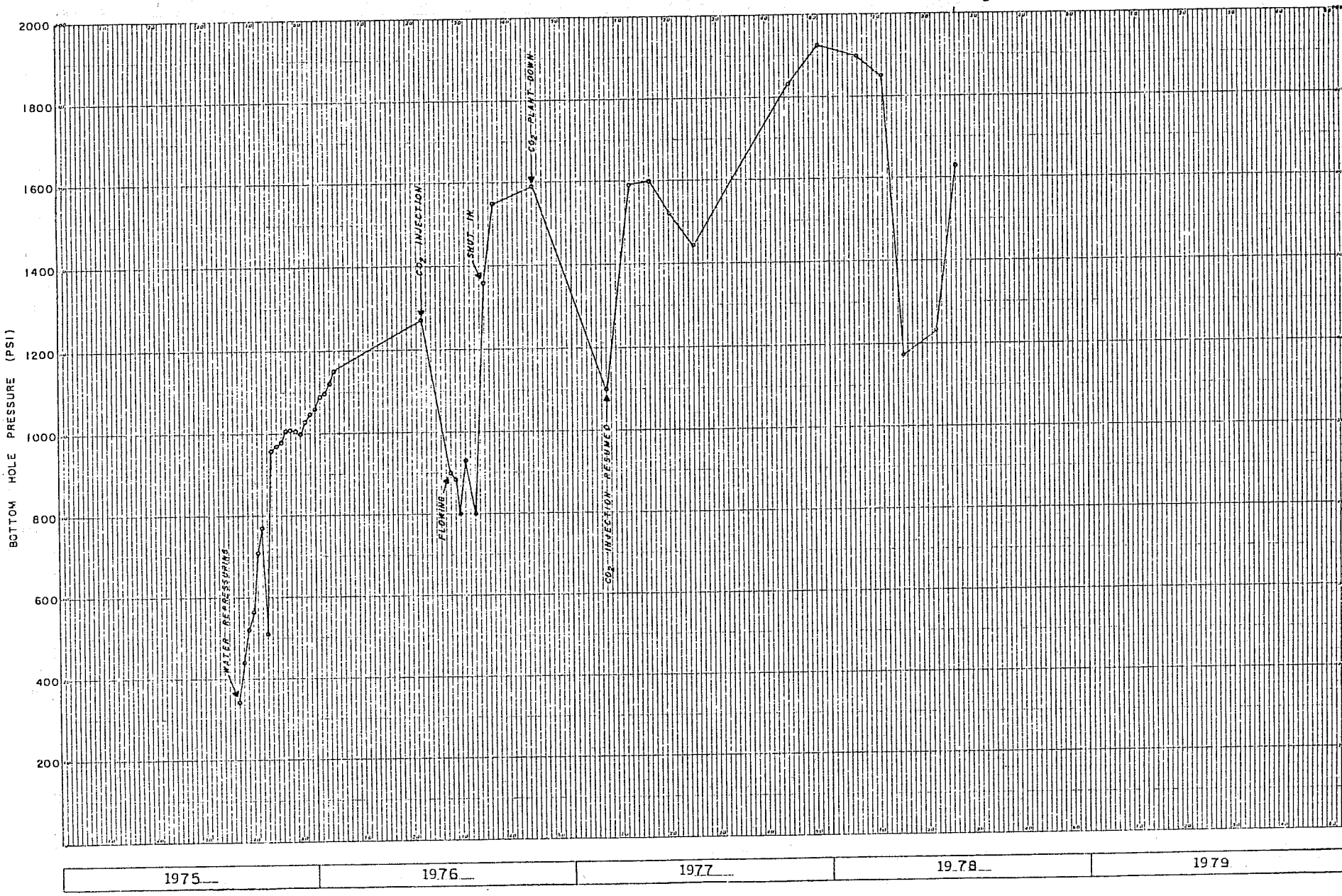
CO_2 PROJECT— BOTTOM HOLE PRESSURE WELL 2024



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CO_2 PROJECT
MONTHLY WATER INJECTION
(After CO_2 Injection)

	Month	2020 Monthly Total	2020 Cum. Total	2022 Monthly Total	2022 Cum. Total	2023 Monthly Total	2023 Cum. Total	2025 Monthly Total	2025 Cum. Total	Monthly Total	Total Cum.Inj.	Daily Av./ Well	Remarks
1977	June	437	437	872	872	1015	1015	797	797	3121	3121	52	Plant down -0-
	July	988	1425	1414	2286	1685	2700	1498	2295	5585	8706	45	Plant down 49 hrs
	August	1103	2528	1179	3465	1708	4408	1590	3885	5580	14286	45	Plant down 58 hrs
	September	1107	3635	1079	4544	1607	6015	1447	5332	5240	19526	43	Plant down 91 hrs
	October	1389	5024	1072	5616	1598	7613	1384	6716	5443	24969	44	Plant down 52 hrs
	November	1312	6336	1492	7108	1501	9114	1230	7946	5535	30504	46	Plant down 24 hrs
	December	1232	7568	1283	8391	1423	10537	1181	9127	5119	35623	41	Plant down 18.5 h
1978	January	1123	8691	1118	9509	1242	11779	959	10086	4442	40065	36	Plant down 36.5 h
	February	728	9419	910	10419	1262	13041	1168	11254	4068	44133	36	Plant down 14 hrs
	March	1286	10705	854	11273	1678	14719	2335	13589	6153	50286	49.6	Plant down 70 hrs
	April	1641	12346	945	12218	1824	16543	1444	15033	5854	56140	48.8	Plant down 1 hr.
	May	1615	13961	1214	13432	1745	18288	1619	16652	6193	62333	49.9	Plant down 56 hrs
	June	1196	15157	1219	14651	1657	19945	1251	17903	5323	67656	44.4	Plant down 61 hrs

CO_2 INJECTION PROJECT
TOTAL PRODUCTION

	Month	Total Oil	Add'l Oil (1363 Bbls) Base	Cum. Oil	Cum. Add'l Oil	Total Water	Add'l Water (1393 Bbls) Base	Cum. Water	Cum. Add'l Water	Total Fluid	% Water Cut	Remarks
1976	June	1412	49	1412	49	1468	75	1468	75	2880	51	
	July	1584	221	2996	270	1622	229	3090	304	3206	51	
	August	2157	794	5153	1064	1338	-	4428	304	3495	38	
	September	1882	519	7035	1583	1254	-	5682	304	3136	40	
	October	2196	833	9231	2416	1724	331	7406	635	3920	44	
	November	1946	583	11177	2999	1417	24	8823	659	3363	42	
	December	1857	494	13034	3493	1199	-	10022	659	3056	39	
1977	January	1590	227	14624	3720	943	-	10965	659	2533	37	
	February	1323	-	15947	3720	578	-	11543	659	1901	30	
	March	1396	33	17343	3753	1371	-	12914	659	2767	50	
	April	1477	114	18820	3867	1452	59	14366	718	2929	50	
	May	1969	606	20789	4473	1812	419	16178	1137	3781	48	
	June	2444	1081	23233	5554	1780	387	17958	1524	4224	42	
	July	2320	957	25553	6511	1686	293	19644	1817	4006	42	
	August	1954	591	27507	7102	2108	715	21752	2532	4062	52	
	September	1881	518	29388	7620	2196	803	23948	3335	4077	54	
	October	1732	369	31120	7989	2700	1307	26648	4642	4432	61	
	November	1525	162	32645	8151	2499	1106	29147	5748	4024	62	
	December	1367	4	34012	8155	2389	996	31563	6744	3756	63	
1978	January	1152	-	35164	8155	2230	837	33793	7581	3382	66	
	February	990	-	35154	8155	2161	768	35954	8349	3151	68	
	March	1511	148	37665	8303	3052	1659	39006	10008	4563	67	
	April	1384	21	39049	8324	3465	2072	42471	12080	4849	71	
	May	1584	221	40633	8545	4351	2958	46822	15038	5935	73	
	June	1346	17	41979	8562	4188	2795	51010	19226	5534	75	

CO_2 PROJECT
OIL & WATER PRODUCTION
SUMMARY

	MONTH	-INSIDE PATTERN- OIL	WATER	TOTAL FLUID	CUM. OIL	CUM. WATER	-OUTSIDE PATTERN- OIL	WATER	TOTAL FLUID	CUM. OIL	CUM. WATER	REMARKS
1976	June	212	380	592	212	380	1199	1088	2288	1199	1088	
	July	553	553	1107	766	933	1030	1068	2099	2230	2157	
	August	576	344	920	1342	1278	1581	994	2575	3811	3151	
	September	146	-	146	1488	1278	1735	1254	2990	5547	4406	Inside: #4254
	October	304	58	363	1793	1337	1891	1666	3557	7438	6072	Inside: 2 Wells
	November	**225*	15	241	2019	1352	**1720	1401	3121	9159	7473	Inside: #4254
	December	224	9	234	2244	1362	1632	1189	2822	10792	8663	Inside: #4254
1977	January	222	107	330	2466	1470	1368	835	2204	12160	9499	Inside: 2 Wells
	February	87	1	88	2553	1472	1236	577	1813	13396	10076	Inside: #4254
	March	105	-	105	2659	1472	1290	1371	2661	14687	11447	Inside: #4254
	April	174	115	289	2833	1587	1303	1336	2639	15990	12784	Inside: #4254
	May	292	300	593	3126	1888	1676	1511	3188	17667	14295	Inside: #4254
	June	257	234	492	3384	2122	2186	1546	3733	19853	15842	Inside: #4254
	July	256	311	568	3640	2433	2064	1375	3439	21917	17218	Inside: #4254
	August	253	863	1117	3894	3297	1700	1245	2946	23618	18463	
	September	128	700	829	4023	3997	1752	1495	3248	25371	19959	Inside: #4254
	October	81	1059	1140	4104	5056	1651	1640	3292	27022	21600	Inside: 2 Wells
	November	42	850	893	4147	5907	1483	1649	3132	28505	23249	Inside: #4254
	December	43	907	951	4191	6814	1323	1481	2804	29828	24731	Inside: #4254
1978	January	47	887	934	4238	7702	1104	1342	2447	30933	26073	Inside: #4254
	February	43	802	845	4281	8504	947	1358	2305	31880	27431	Inside: 3 Wells
	March	68	1037	1106	4350	9542	1442	2014	3456	33322	29446	Inside: 3 Wells
	April	66	1467	1534	4416	11010	1318	2302	3620	34622	31691	Inside; 2 Wells
	May	58	1722	1781	4475	12732	1525	2628	4154	36148	34377	Inside: 3 Wells
	June	63	1700	1764	4539	14432	1282	2487	3769	37430	36865	

*Well Fractured
**Well Treated with Carbon Bisulfide

CO_2 INJECTION PROJECT
PRODUCTION FROM WELLS INSIDE PATTERN
MONTHLY TOTALS (BBLS.)

	MONTH	2021 OIL	2021 WATER	2021 TOTAL FLUID	2024 OIL	2024 WATER	2024 TOTAL FLUID	4254 OIL	4254 WATER	4254 TOTAL FLUID	20274 OIL	20274 WATER	20274 TOTAL FLUID
1976	June	-	-	-	-	136	136	4	10	15	207	232	440
	July	13	73	87	109	227	336	105	13	118	325	239	564
	August	49	85	135	327	206	533	157	15	173	41	36	78
	September	* -	-	-	* -	-	-	146	-	146	* -	-	-
	October	* -	-	-	58	36	94	**246	22	268	* -	-	-
	November	* -	-	-	* -	-	-	***225	15	241	* -	-	-
	December	* -	-	-	* -	-	-	224	9	234	* -	-	-
1977	January	* -	-	-	* -	-	-	161	50	211	61	57	118
	February	* -	-	-	* -	-	-	87	1	88	* -	-	-
	March	* -	-	-	* -	-	-	105	-	105	* -	-	-
	April	* -	-	-	* -	-	-	174	115	289	* -	-	-
	May	* -	-	-	* -	-	-	292	300	593	* -	-	-
	June	* -	-	-	* -	-	-	257	234	492	* -	-	-
	July	* -	-	-	* -	-	-	256	311	568	* -	-	-
	August	26	39	65	28	94	122	171	613	785	27	116	143
	September	* -	-	-	* -	-	-	128	700	829	* -	-	-
	October	* -	-	-	15	264	280	65	794	859	* -	-	-
	November	* -	-	-	* -	-	-	42	850	893	* -	-	-
	December	* -	-	-	* -	-	-	43	907	951	* -	-	-
1978	January	* -	-	-	* -	-	-	47	887	934	* -	-	-
	February	* -	-	-	4	84	90	26	688	714	11	29	17
	March	12	48	61	* -	-	-	****33	855	888	23	133	156
	April	-	-	-	-	-	-	47	1136	1183	19	331	351
	May	3	73	77	-	-	-	41	1244	1285	14	399	413
	June	4	58	63	6	58	65	****30	1084	1114	21	498	519

*Shut In
**Well Fractured
***Well Treated with Carbon Bisulfide
****Well Serviced

CO_2 INJECTION PROJECT
PRODUCTION FROM WELLS OUTSIDE PATTERN
MONTHLY TOTALS (BBLS.)

		2047			4049			4591			2043		
	MONTH	OIL	WATER	TOTAL FLUID	OIL	WATER	TOTAL FLUID	OIL	WATER	TOTAL FLUID	OIL	WATER	TOTAL FLUID
1976	June	35	65	101	43	250	293	53	111	165	164	66	231
	July	* 1	15	17	7	402	409	29	164	193	259	72	331
	August	333	100	434	-	252	252	82	258	340	261	38	299
	September	363	90	453	55	414	470	117	89	206	273	60	334
	October	259	53	312	107	842	949	112	135	248	324	67	391
	November	243	57	300	136	678	815	97	131	229	314	45	360
	December	221	44	266	173	615	788	142	69	212	348	51	399
1977	January	222	51	273	141	470	612	118	50	169	274	58	332
	February	172	30	203	* 52	151	204	96	41	137	210	47	257
	March	161	41	203	115	812	927	80	45	126	183	65	249
	April	150	53	203	136	582	718	61	37	98	170	77	248
	May	193	56	249	173	605	779	73	70	144	162	39	201
	June	204	52	256	169	561	730	165	63	228	212	65	278
	July	214	48	263	181	530	712	129	35	165	162	34	196
	August	145	26	171	187	488	675	107	48	156	126	55	181
	September	267	52	319	181	450	632	102	68	170	109	74	184
	October	*122	55	178	245	493	739	74	63	137	100	96	196
	November	193	78	271	154	450	605	76	104	180	90	94	184
	December	207	77	284	144	490	634	87	146	234	111	84	195
1978	January	200	86	287	109	473	582	67	137	204	105	94	200
	February	189	71	260	85	468	553	41	128	170	102	87	189
	March	194	81	275	86	527	613	32	149	181	107	123	230
	April	179	87	266	69	706	775	30	163	194	110	120	230
	May	218	83	302	75	1096	1171	29	191	221	111	134	245
	June	189	123	312	61	786	847	28	246	274	115	163	278

*Well Off Production-Pulled-Changed Pump
**Well is Off

CO_2 INJECTION PROJECT
PRODUCTION FROM WELLS OUTSIDE PATTERN
MONTHLY TOTALS (BBLS.)

	MONTH	2044 OIL	2044 WATER	2044 TOTAL FLUID	4090 OIL	4090 WATER	4090 TOTAL FLUID	2046 OIL	2046 WATER	2046 TOTAL FLUID	2048 OIL	2048 WATER	2048 TOTAL FLUID
1976	June	171	309	480	286	169	456	303	111	414	141	3	144
	July	184	160	344	*123	116	239	280	133	413	**144	4	149
	August	314	109	423	442	232	674	** 7	-	7	140	2	142
	September	409	216	625	366	380	746	4	-	4	146	2	148
	October	499	198	698	376	366	743	24	-	24	186	2	189
	November	379	133	512	324	341	666	***29	-	30	193	11	205
	December	268	116	384	252	292	544	47	-	48	178	-	178
1977	January	285	120	405	**124	79	204	28	-	29	172	4	176
	February	92	33	126	452	268	721	1	-	1	157	3	161
	March	146	175	322	***360	227	587	49	-	49	192	2	195
	April	211	166	378	339	386	726	38	29	68	195	3	198
	May	268	169	437	346	399	745	215	168	384	243	2	245
	June	306	126	433	340	387	728	684	283	967	102	6	108
	July	239	111	351	380	389	770	630	217	848	124	8	132
	August	19	55	75	386	369	756	573	192	766	153	8	161
	September	120	316	436	310	336	646	471	189	660	190	7	197
	October	172	351	523	345	346	691	427	217	645	161	17	179
	November	130	401	532	316	304	620	375	207	582	146	7	154
	December	24	228	252	200	244	444	403	207	611	144	4	148
1978	January	20	229	250	107	97	205	362	220	528	131	2	133
	February	22	295	317	*****30	73	104	318	202	520	157	1	159
	March	48	513	561	411	340	751	397	274	671	166	4	171
	April	87	447	564	303	317	620	332	220	553	204	-	204
	May	93	539	633	426	355	781	365	232	597	210	-	210
	June	62	558	620	357	395	752	265	213	478	203	1	205

*Rods Out for Testing
**Rods Out for Testing & Changing Casinghead
***Well Treated with Carbon Bisulfide
****Shut In
*****Well is Off

CO_2 INJECTION PROJECT WATER ANALYSIS

WELL NO.	12-77 pH	12-77 Total Cl.	1-78 pH	1-78 Total Cl.	2-78 pH	2-78 Total Cl.	3-78 ph	3-78 Total Cl.	5-78 pH	5-78 Total Cl.
2044	8.0	32,000	8.0	32,000	7.0	25,200	7.0	27,000	7.5	36,800
4591	7.5	100,000	7.0	100,000	-	-	6.5	75,000	7.0	77,000
2043	8.0	82,000	-	-	7.5	114,000	8.0	96,000	7.5	63,800
4090	-	-	-	-	-	-	7.5	30,000	8.0	18,400
4049	8.0	18,000	8.0	22,000	7.0	19,200	7.0	30,000	7.5	18,400
4254	7.5	71,000	7.5	60,000	7.0	80,400	7.5	76,400	7.0	48,400
2047	7.5	68,000	8.5	112,000	-	-	-	-	8.0	34,400
3985	8.0	60,000	8.0	50,000	7.0	74,400	7.0	65,000	7.0	45,200
4039	-	-	8.0	30,000	6.0	32,400	7.0	32,000	6.0	22,000
2052	8.0	72,000			7.0	126,000	7.5	120,000	6.0	60,000
1919	8.0	42,000	7.5	42,000	7.0	55,200	6.0	46,000	6.5	36,800
4029	8.5	22,000					-	-	7.5	18,400
1334	8.5	30,000	8.0	28,000	6.5	16,300	8.0	20,000	7.0	22,000
2045	8.0	56,000	8.5	50,000	7.5	24,000	7.0	30,000	6.5	55,800
1354	8.5	14,000	8.5	10,000	8.0	12,000	7.5	5,700	8.5	6,540
3905	8.0	46,000	8.0	32,000	6.0	39,600	7.0	30,600	5.5	23,800
2053	8.0	14,000	8.5	16,000	7.0	13,200	7.5	7,800	8.0	10,600
2041	8.0	41,000	-	-	6.0	45,600	7.5	47,000	6.5	45,200
1252	-	-	8.5	21,000	7.0	19,200	7.0	12,600	7.5	13,900
1265	8.0	14,000	8.0	14,000	7.0	19,200	8.0	12,600	8.5	14,000
2042	-	-	-	-	7.0	34,800	6.5	30,800	8.0	33,000
1327	8.0	20,100	-	-	7.0	21,000	7.0	15,600	7.0	15,400
1349	8.0	35,000	-	-	6.5	114,000	6.5	110,000	-	-
2040	7.5	42,000	8.5	50,000	6.0	14,400	7.0	64,600	7.5	39,400
2046										
1258	7.5	23,000								
1315	7.5	53,000								
									8.0	21,000

CO_2 INJECTION PROJECT WATER ANALYSIS

WELL NO.	6-78 pH	6-78 Total Cl.
2044	7.0	34,500
4591	6.5	72,000
2043	7.0	57,300
4090	7.0	26,700
4049	7.0	24,900
4254	6.5	48,400
2047	6.0	72,000
3985	7.0	43,500
4039	-	-
2052	6.0	55,200
1919	6.0	32,400
4029		
1334	7.0	22,600
2045	7.0	50,400
1354	8.0	5,670
3905	6.5	32,400
2053	7.5	9,000
2041	6.5	40,200
1252	7.5	12,000
1265	8.0	7,700
2042	6.5	28,800
1327	-	-
1349	-	-
2040	7.0	36,200
2046		
1258		
1315		

CO_2 INJECTION
GAS OPEN FLOWS & CO_2 ANALYSIS

Well No.	3-30-78 MCF	3-30-78 %CO_2	4-30-78 MCF	4-30-78 %CO_2	5-30-78 MCF	5-30-78 %CO_2	6-30-78 MCF	6-30-78 %CO_2
1327	3.8	.10	3.8	.10	3.8	.05	4.25	.05
1265	3.8	.40	-	.70	3.3	.35	.79	.55
1282	10.2	.10	5.38	.06	13.1	.10	11.7	.10
1285	36.5	.10	29.66	.10	36.2	.10	29.7	.10
20325	3.8	.35	1.11	.35	2.8	.40	2.7	.30
1258	2.8	2.40	2.7	1.05	3.8	6.0	1.47	2.0
2040	.79	1.8	.79	1.75	.79	1.50	-	.10
3985	2.6	.15	1.11	.15	1.57	.15	1.76	.10
4258	.79	.20	.79	.20	.56	.15	.79	.15
4049								
4090								
2048								
4591								
2053	1.1	.05	-	.20	.55	.50	.55	.85
2045	1.3	5.0	1.11	2.75	.96	2.0	1.1	2.25
1252	1.1	1.75	1.11	1.30	1.36	1.40	1.57	1.20
2042	-	.30	.56	2.25	-	2.25	.55	2.0
2043								
2046								
4050			25.84	.10	25.8	.10	22.3	.10
4039	.78	.30			3.8	2.75	3.3	1.10
1871	.79	.10	-	.15	-	.15	-	.10
1919	-	.40	-	.75	-	.65	.55	.60
20327	25.8	.10	29.68	.10	25.8	.10	22.4	.10
1247	1.1	.20	.79	.10	1.1	.10	.96	.10
2047	-	-						
2041	1.1	.40	1.11	.35	.96	.45	1.24	.45
1324	41.8	.10	11.0	.10	11.0	.10	5.91	.50
1315	51.28	.10	18.3	.10	11.0	.10	13.5	.10
1284	1.1	.10	.79	.10	.55	.10	.55	.10
1349	8.5	.06	10.1	.10	8.3	.10	5.7	.10
1297	1.1	.10	.79	.10	.789	.10	.96	.10
1323	.79	6.0	.79	2.00	-	.15	.79	2.0
1318	8.3	.10	8.3	.10	11.0	.10	8.34	.10
2072	22.8	.10	22.4	.10	13.49	.10	19.08	.10
1279	4.6	.06	11.0	.10	5.37	.10	4.66	.05

CO_2 INJECTION
GAS OPEN FLOWS & CO_2 ANALYSIS

	3-30-78		4-30-78		5-30-78		6-30-78	
Well No.	MCF	%CO_2	MCF	%CO_2	MCF	%CO_2	MCF	%CO_2
1347	11.7	.25	19.1	.10	18.30	.10	4.66	.05
3905	-	.40	-	.20	-	.20	-	.20
1334	-	.80	-	1.50			-	1.25
4029	3.8	1.00	1.11	1.20	1.1	.75	1.37	.90
2052	0	.60	.79	.15	.55	.25	.55	.15
1354	-	1.4	-	1.75	-	1.30	-	.90
3904	1.1	12.	2.23	12.0	2.36	12.0	3.80	12.0

A12-06

SAMPLE COLLECTER:	MORGANTOWN ENERGY RESEARCH CENTER GAS ANALYSIS ANALYTICAL LABORATORY	DATE RECEIVED: 4-12-78
SEND REPORT TO: C. D. Locke		DATE REPORTED:

NUMBER IDENTIFICATION	SAMPLE NO. 1	LAB. NO. 1514	SAMPLE NO. 2	LAB. NO. 1515	SAMPLE NO. 3	LAB. NO. 1516	SAMPLE NO. 4	LAB. NO. 151
COLLECTING	DATE 3-8-78	TIME	DATE 3-14-78	TIME	DATE 3-15-78	TIME	DATE 3-21-78	TIME
SAMPLE DESCRIPTION	Columbia Gas Trans. Well #2021		Columbia Gas Trans. Well #2044		Columbia Gas Trans. Well #2047		Columbia Gas Trans Well #425	
ANALYSES WANTED (OR PLACE "X" BELOW IN FRONT OF CONSTITUENT DESIRED. INCLUDE ONLY THOSE OF INTEREST)	LIST: HiCO2 ∞		LIST: CO2 25-50		LIST: CO2 25-50		LIST: CO2 80-9	

	CONSTITUENT					
✓	HYDROGEN	H_2				
✓	OXYGEN	O_2	1.72	9.16	21.02	15.60
✓	NITROGEN	N_2	6.30	33.52	76.16	55.28
✓	CARBON MON	CO				
✓	METHANE	CH_4	2.27	1.32		.16
✓	ETHANE	C_2H_6	2.83	1.67	.24	.16
✓	CARBON DIOX	CO_2	76.69	51.42	.87	27.77
✓	ETHYLENE	C_2H_4				
✓	PROPANE	C_3H_8	4.32	1.23	.56	.14
✓	ISO-BUTANE	iC_4H_{10}	1.30	.35	.19	.03
✓	BUTANE	C_4H_{10}	3.11	1.00	.42	.08
✓		H_2S				

ANALYSTS: DATE: CHECKED BY:

A12-066

SAMPLE COLLECTER:

SEND REPORT TO: C. D. Locke

MORGANTOWN ENERGY RESEARCH CENTER
GAS ANALYSIS
ANALYTICAL LABORATORY

DATE RECEIVED:

DATE REPORTED:

NUMBER IDENTIFICATION	SAMPLE NO. 5	LAB. NO. R 1518	SAMPLE NO. 6	LAB. NO. R 1519	SAMPLE NO.	LAB. NO.	SAMPLE NO.	LAB. N
COLLECTING	DATE 3-28-78	TIME	DATE 3-28-78	TIME	DATE	TIME	DATE	TIME
SAMPLE DESCRIPTION	Columbia Gas Trans. Well #2046		Columbia Gas Trans. Well #2048					
ANALYSES WANTED (OR PLACE "X" BELOW IN FRONT OF CONSTITUENT DESIRED. INCLUDE ONLY THOSE OF INTEREST)	LIST: CO_2 10-50		LIST: Mix nat and CO_2 CO_2 10-50		LIST:		LIST:	

	CONSTITUENT					
✓	HYDROGEN	H_2				
✓	OXYGEN	O_2	1.87	9.13		
✓	NITROGEN	N_2	7.68	32.72		
✓	CARBON MON	CO				
✓	METHANE	CH_4	10.48	7.06		
✓	ETHANE	C_2H_6	21.00	11.02		
✓	CARBON DIOX	CO_2	26.95	23.21		
✓	ETHYLENE	C_2H_4				
✓	PROPANE	C_3H_8	18.17	8.49		
✓	ISO-BUTANE	iC_4H_{10}	4.10	2.09		
✓	BUTANE	C_4H_{10}	8.32	4.76		
✓		H_2S				

ANALYSTS: DATE: CHECKED BY:

SAMPLE COLLECTOR COLUMBIA GAS	MORGANTOWN ENERGY RESEARCH CENTER GAS ANALYSIS ANALYTICAL LABORATORY	DATE RECEIVED: A12-057
SEND REPORT TO: R. J. WATTS		DATE REPORTED: 6-2-78

NUMBER IDENTIFICATION	SAMPLE NO. WELL #4049	LAB. NO. C 1520	SAMPLE NO. WELL #2043	LAB. NO. C 1521	SAMPLE NO.	LAB. NO.	SAMPLE NO.	LAB. NO.
COLLECTING	DATE	TIME	DATE	TIME	DATE	TIME	DATE	TIME
SAMPLE DESCRIPTION								
ANALYSES WANTED (OR PLACE "X" BELOW IN FRONT OF CONSTITUENT DESIRED. INCLUDE ONLY THOSE OF INTEREST)	LIST: Note Samples S.S Bombs supposed to be found them to		LIST: received in 40#		LIST:		LIST:	

	CONSTITUENT		%	%		
	HYDROGEN	H_2				
✓	OXYGEN	O_2	6.56	1.30		
✓	NITROGEN	N_2	21.64	5.15		
✓	CARBON MON	CO				
✓	METHANE	CH_4	7.10	2.81		
✓	ETHANE	C_2H_6	20.80	14.35		
✓	CARBON DIOX	CO_2	1.61	20.39		
✓	ETHYLENE	C_2H_4				
✓	PROPANE	C_3H_8	20.17	23.38		
✓	ISO-BUTANE	iC_4H_{10}	4.28	6.70		
✓	BUTANE	C_4H_{10}	8.63	15.39		
	Bal		Undetermined →			

ANALYSTS: J T C DATE: _____ CHECKED BY: _____

CO_2 PROJECT
FLOW TESTS

April 1978

Date	2044 Oil (bbls)	2044 Water (bbls)	2044 Gas (cu.ft.)	4591 Oil (bbls)	4591 Water (bbls)	4591 Gas (cu.ft.)	2043 Oil (bbls)	2043 Water (bbls)	2043 Oil (cu.ft.)
4-4	.83	15.77	13,089	.83	4.98	278			
4-5	3.32	19.92	12,715	1.66	4.15	409			
4-6	2.49	20.75	8,989	.83	5.81	478			
4-11							4.15	4.98	1,467
4-12							3.32	4.98	638
4-13							1.66	-	4,352

Date	4049 Oil (bbls)	4049 Water (bbls)	4049 Gas (cu.ft.)	4090 Oil (bbls)	4090 Water (bbls)	4090 Gas (cu.ft.)	2047 Oil (bbls)	2047 Water (bbls)	2047 Oil (cu.ft.)
4-11	3.32	19.09	646						
4-12	2.49	16.60	550						
4-13	4.15	17.43	744						
4-25				10.79	12.45	3,366	8.30	3.32	8,110
4-26				29.88	14.94	4,352	8.30	3.32	10,260
4-27				16.60	7.47	2,153	6.64	2.49	7,242

CO_2 PROJECT
FLOW TESTS

May 1978

Date	2021 Oil (bbls)	2021 Water (bbls)	2021 Gas (cu.ft.)	4049 Oil (bbls)	4049 Water (bbls)	4049 Gas (cu.ft.)	2046 Oil (bbls)	2046 Water (bbls)	2046 Gas (cu.ft.)
5-2	.83	29.05	5,383						
5-3	.83	14.94	2,482						
5-4	.83	17.43	2,591	4.98	33.20	100			
5-5				1.66	24.90	566			
5-6				1.60		100			
5-9							15.77	8.30	27,079
5-10							8.30	18.26	23,650
5-11							11.62	5.81	23,130

Date	2048 Oil (bbls)	2048 Water (bbls)	2048 Gas (cu.ft.)	4254 Oil (bbls)	4254 Water (bbls)	4254 Gas (cu.ft.)	4090 Oil (bbls)	4090 Water (bbls)	4090 Gas (cu.ft.)
5-9	6.64	-	100						
5-10	8.30	-	100						
5-11	7.47	-	100						
5-16				.83	36.52	20,100			
5-17				.83	45.65	21,000			
5-18				-	40.67	21,000			
5-23							14.94	11.62	4,113
5-24							14.94	14.11	5,921
5-25							14.94	9.96	5,380

CO_2 PROJECT
FLOW TESTS

June 1978

Date	2043 OIL (bbls)	2043 WATER (bbls)	2043 GAS (cu.ft.)	2048 OIL (bbls)	2048 WATER (bbls)	2048 GAS (cu.ft.)	2047 OIL (bbls)	2047 WATER (bbls)	2047 GAS (cu.ft.)
6-1	3.32	4.98	3,687	4.15	-	8,725			
6-2	4.98	4.15	638	3.32	-	5,521			
6-3	4.15	-	374						
		2024							
6-6	5.81	27.39	24,000				6.64	2.49	1,011
6-7	-	23.24	300				9.96	1.66	2,277
6-8	.83	8.30	400				5.81	2.49	5,210
		2021			4049			4591	
6-13	-	29.05	9,138	2.49	25.73	100			
6-14	.83	18.26	-	1.66	27.39	100			
6-15	4.15	11.62	-	1.66	30.71	100			
		2044							
6-21							.83	5.81	1,901
6-22							2.49	19.92	1,961
6-23	1.66	39.01	11,208				3.32	29.88	2,183
6-24	7.47	18.06	11,970						
		2043			2047				
6-28	4.98	5.81	203						
6-29	-	-	1,145	5.81	3.32	14,899			
6-30	2.49	.83	3,125	8.30	23.24	4,486			

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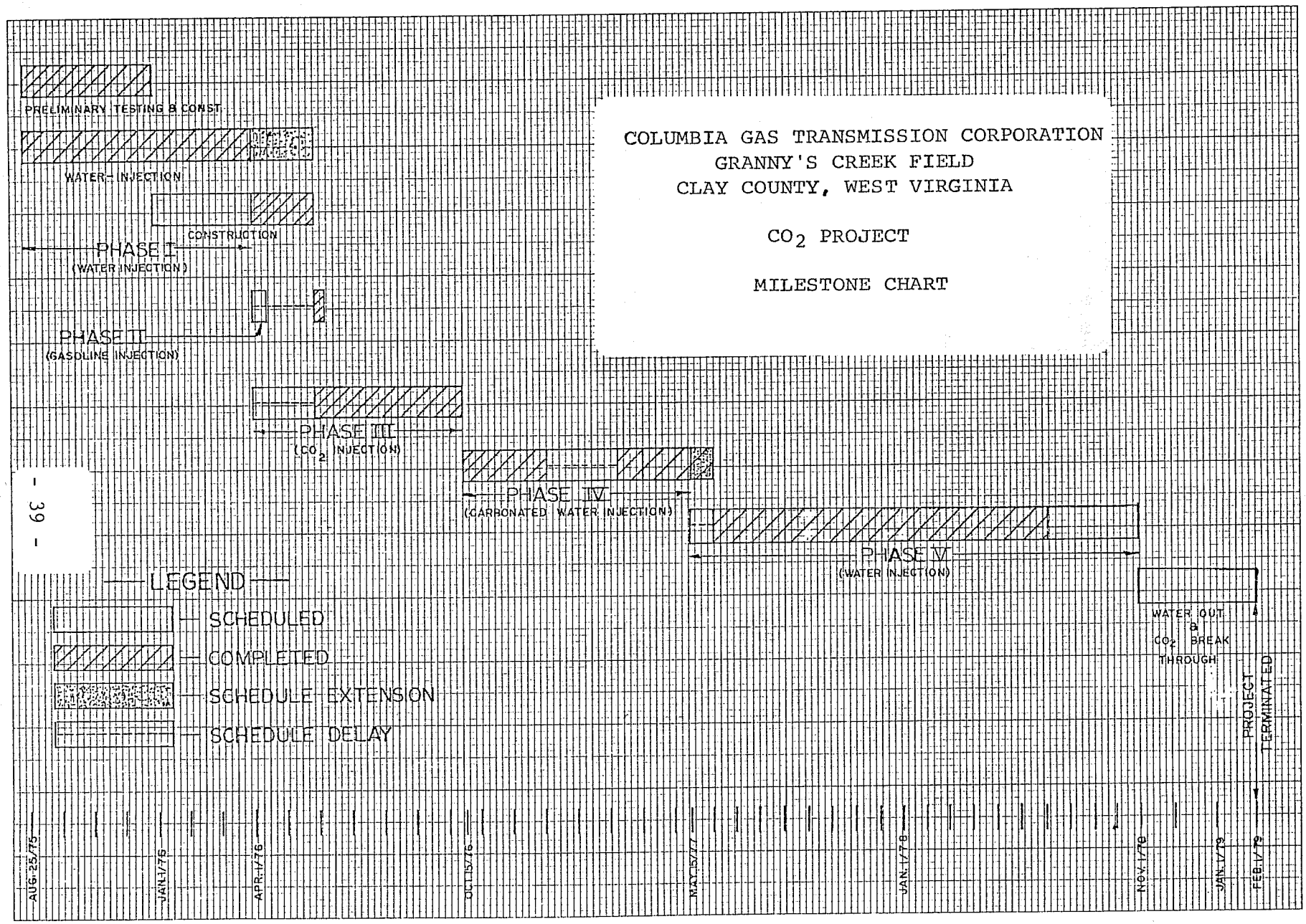

APPENDIX B

ABSTRACT

OBJECTIVE

The objective of this field test is to evaluate and demonstrate the effectiveness of using CO_2 injection to recover high gravity crude oil from shallow watered-out reservoirs. The estimated recovery potential from the flood pattern of six (6) acres is approximately 50,000 barrels. The work will be conducted in five (5) phases as follows:

Phase 1--Preliminary Testing and Construction Water Injection, and Plant Construction

Phase 2--Natural Gasoline Injection

Phase 3--CO_2 Injection

Phase 4--Carbonated Water Injection

Phase 5--Water Injection

SUMMARY

Total water injection for the quarter was 14,663 barrels. Although this was approximately 1750 barrels less than previously, three of the four injection wells were acidized during the period and injection was much higher during March. To date no serious injection problems have occurred and the water supply remains adequate.

Oil production for the period, while indicating a decline of 971 barrels for the quarter, showed a substantial increase during March. While 4254 (the center producer) continued at about the same rate, increases in both oil and water production occurred in most of the outside producers, particularly well numbers 2046 and 4090. Total oil production that has been attributed to CO_2 injection is currently 8303 barrels.

WATER INJECTION

Total water injection for the quarter amounted to 14,663 barrels compared to 16,405 for the previous period. The daily average injection per well was 40.73 barrels. While injection was somewhat lower on a quarterly basis, three of the four injection wells were acidized during the last half of the period and as a result, injection was substantially increased during March. Injection for each well during the quarter is listed below:

Well No.	Quarterly Inj. (bbls)	Cum. Inj. (bbls)
2020	3,137	10,705
2022	2,882	11,273
2023	4,182	14,719
2025	4,462	13,589
Total	14,663	50,286

While the injection rate per well is substantially below the 50 barrels called for in the contract, the remedial work performed during March will alleviate the problem. March rates were 49.6 barrels.

Down time for the period was 120.5 hours or approximately 5% of total operating time. Approximately 70 hours of this was due to necessary maintenance of the high pressure pumping equipment. The remainder occurred during the first half of the quarter and was due to shut down by the high pressure safety switch and power outages and resulting freeze-ups of surface equipment.

Water injection for the project since its inception is shown on the accompanying graph.

OIL AND WATER INJECTION

Total oil and water production for the period is shown in the table below. The attached charts and graphs indicate the production for each well in the project along with a summary of the production both inside and outside the pattern.

Month	Oil Prod.(bbls)	Water Prod.(bbls)
January	1,152	2,230
February	990	2,161
March	1,511	3,052
Total	3,653	8,443

As can be seen in the above table, production continued the previous decline until March when it increased rather dramatically. Although production from the center producer showed little or no change during the period, most of the producers outside the pattern increased during March. The largest increases were from 2046 and 4090. In view of the increased water injection at this time, it is apparent that the injection media, either water or the CO_2 slug, has moved outside the pattern.

The gas metering and separation equipment was installed during February and flow tests were started on all wells in the project. The results of the tests run during the quarter are shown on the attached data sheet. It is intended to run three day tests on all wells in the project and have a sample of the gas analyzed.

Cumulative oil production through March 1978 that has been attributed to CO_2 injection is 8303 barrels, and the water cut is currently 67%.

BOTTOM HOLE PRESSURE TESTS

Bottom hole pressure tests were not run in January due to the unavailability of the service company's instrument. However, the instrument became available in February and tests were run during the last two months of the quarter. We also rebuilt the wellheads on the input wells during the quarter and were thus able to run B.H.P.'s on these also. Results of the tests are as follows:

Well No.	B.H.P.(psi) February	March
2024	1,902	1,854
20274	1,737	1,602
2021	1,580	1,337
2020	2,037	2,028
2022	1,941	1,971
4562	1,463*	1,229
2025		1,967*
2023		2,080*

*First test taken

As shown above, reservoir pressure has declined somewhat, however, it is still substantially above miscibility pressure.

GAS SAMPLES

Gas samples were taken from certain wells in the field and were analyzed for CO_2 content and the wells were tested for open flows. The results of these tests are shown on the accompanying table. Samples from two wells (2024 and 20274) were also sent to the Morgantown Energy Research Center for a more complete analysis. The results of these tests are also attached.

WATER SAMPLES

Water samples were obtained from selected wells in the project and analyzed for chloride and pH. The results of those tests are listed on the attached chart.

ADMINISTRATIVE MATTERS

A representative of the U.S. Department of Agriculture visited the project on January 23rd. This visit was a follow-up of the December inspection of representatives from the Oak Ridge National Laboratories. To date Columbia has had no further formal contact with either parties.

Considering the many unusual aspects of this project, particularly the disappointing production performance, the Morgantown Energy Research Center has proposed a modification of the contract. The proposal would entail the drilling, coring and logging of a well inside the pattern and a complete analysis by reservoir simulation of the project. Columbia has responded to the proposal and, at this writing, is waiting on a reply.

PROJECT SCHEDULE

The attached Milestone Chart shows the original schedule and progress to date. As can be seen, completion of the CO_2 Phase (Phases 3 and 4) were delayed approximately one month due to the shut-down of last winter and the additional 1000 tons injected. Although water injection rates have been slightly lower than anticipated, it is believed that the project will be completed on schedule.

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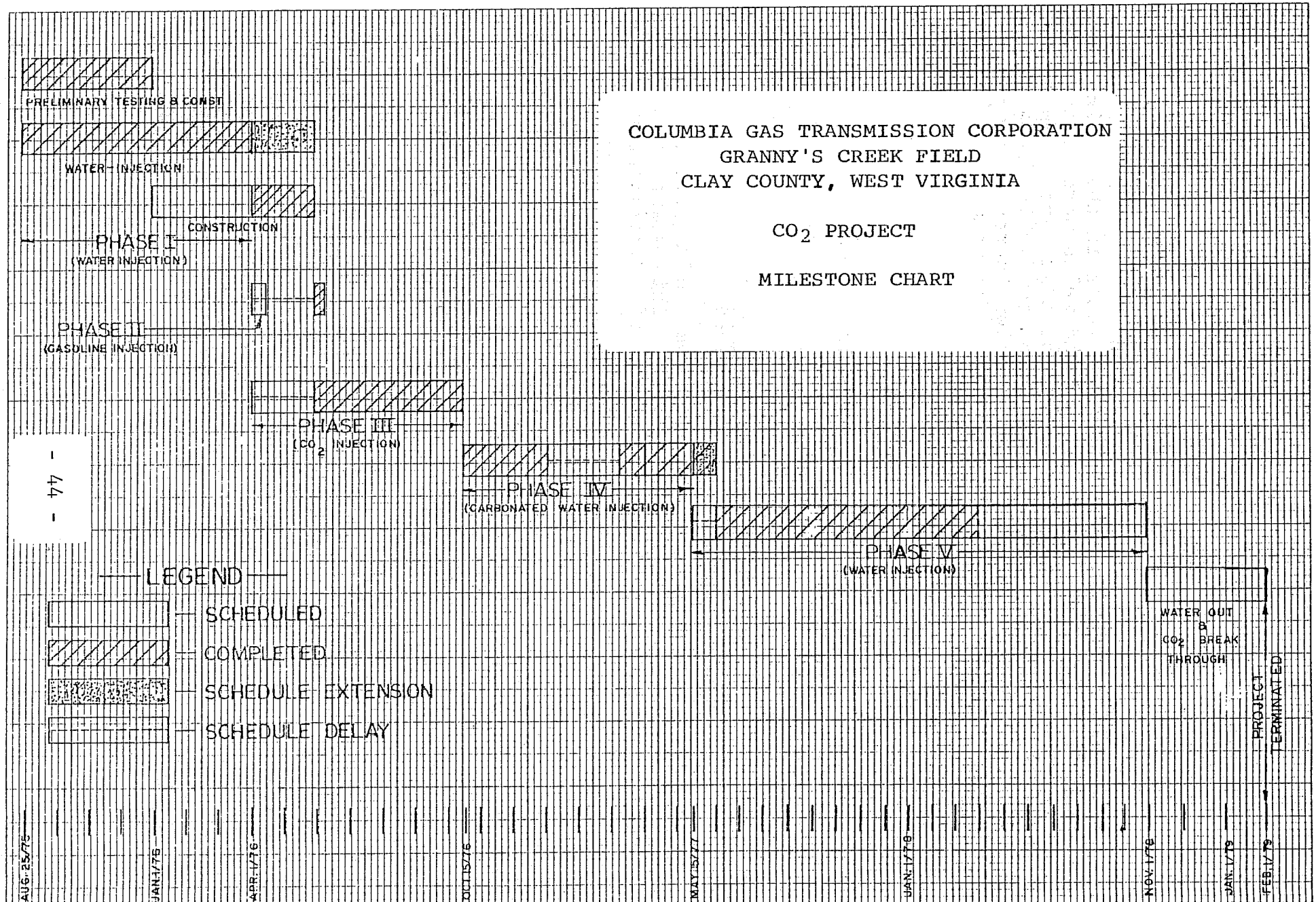
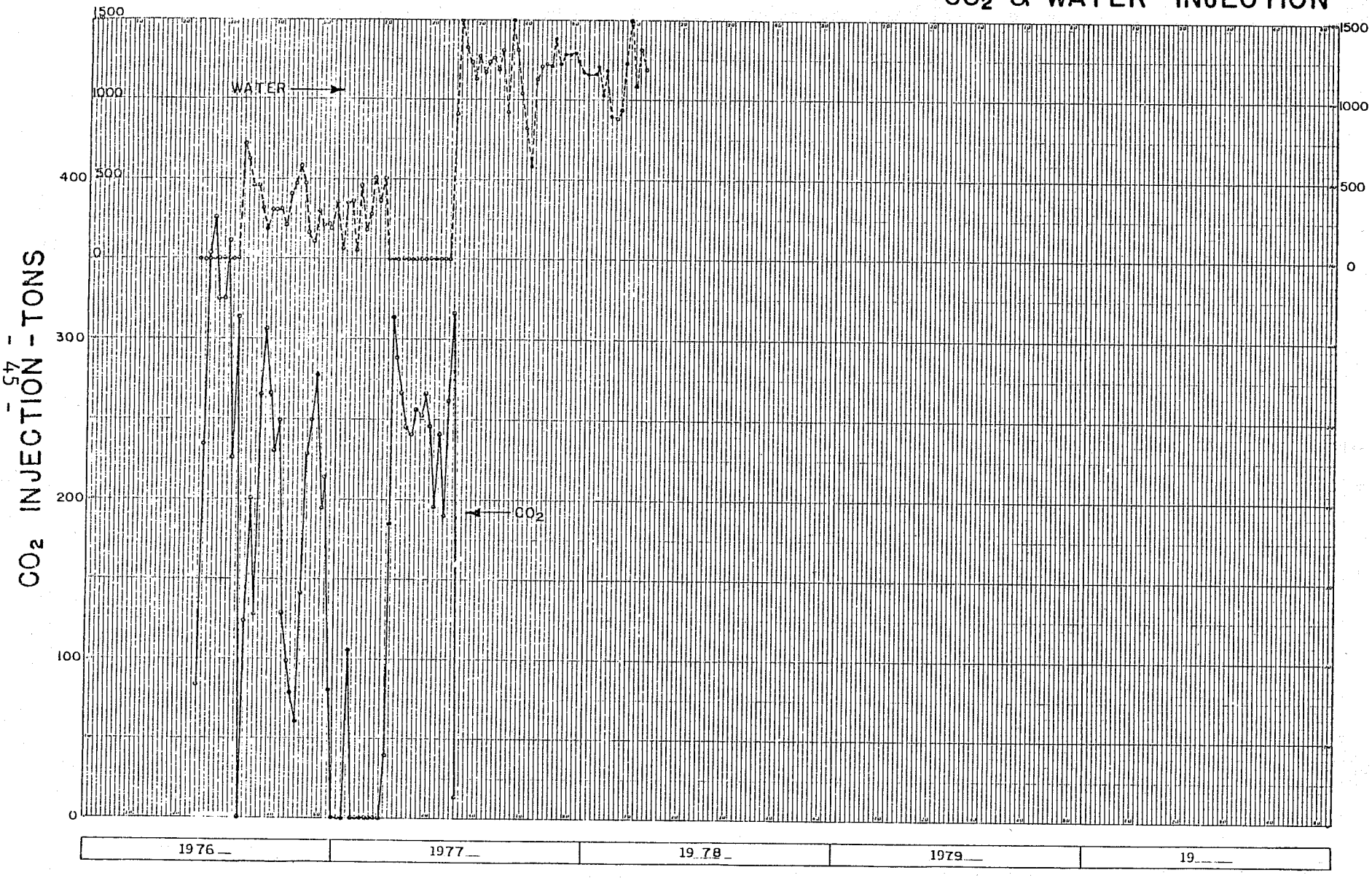
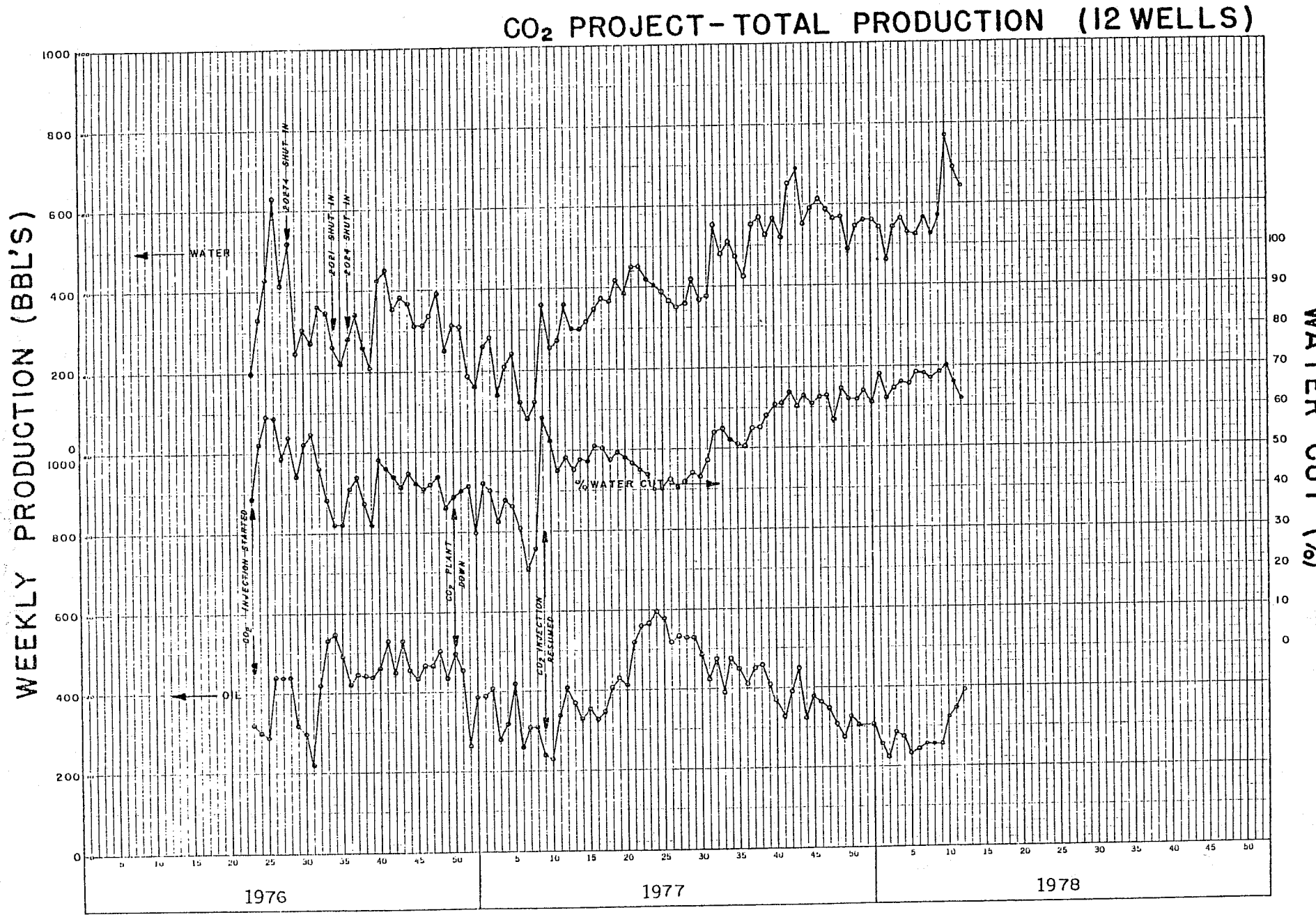
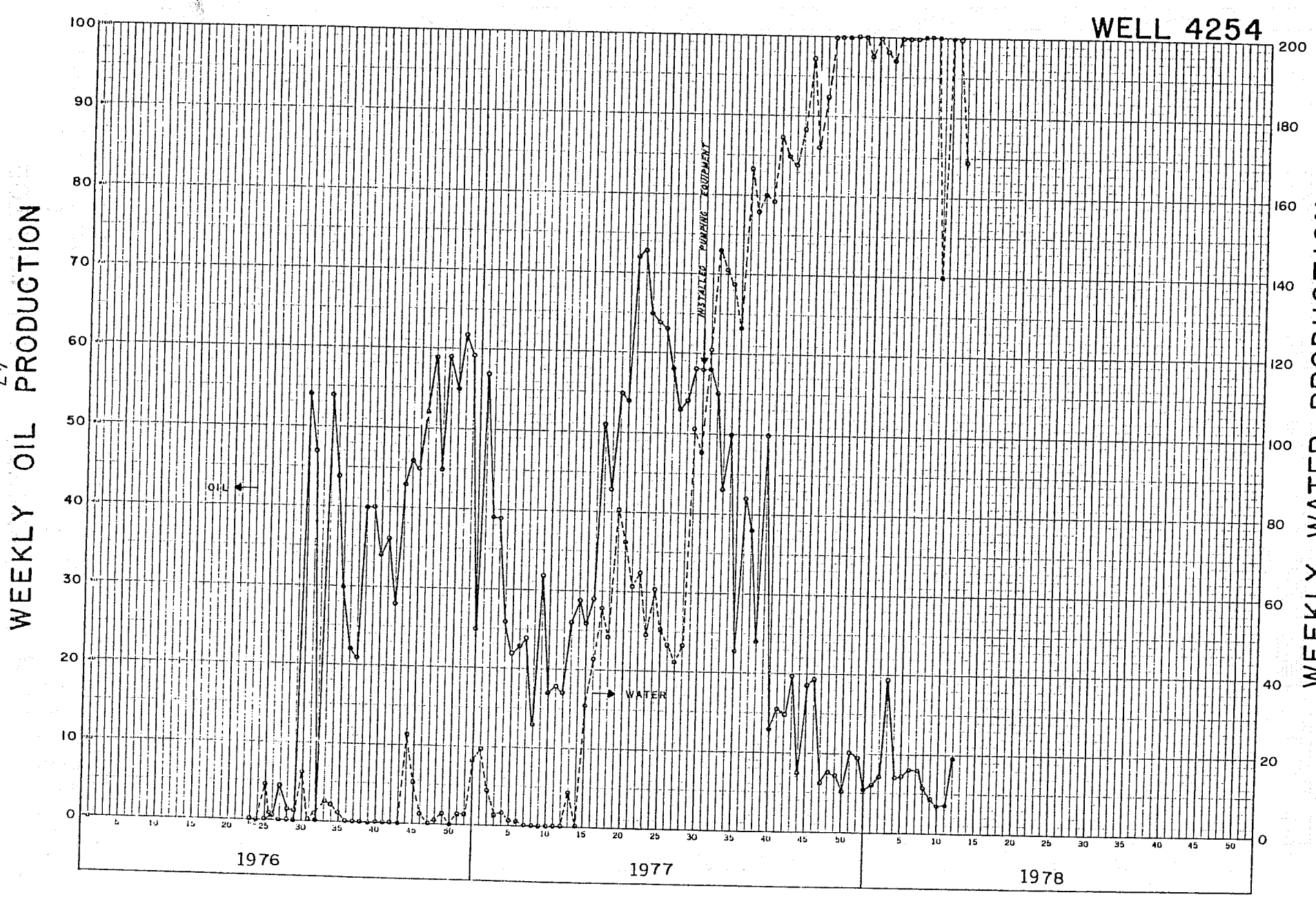
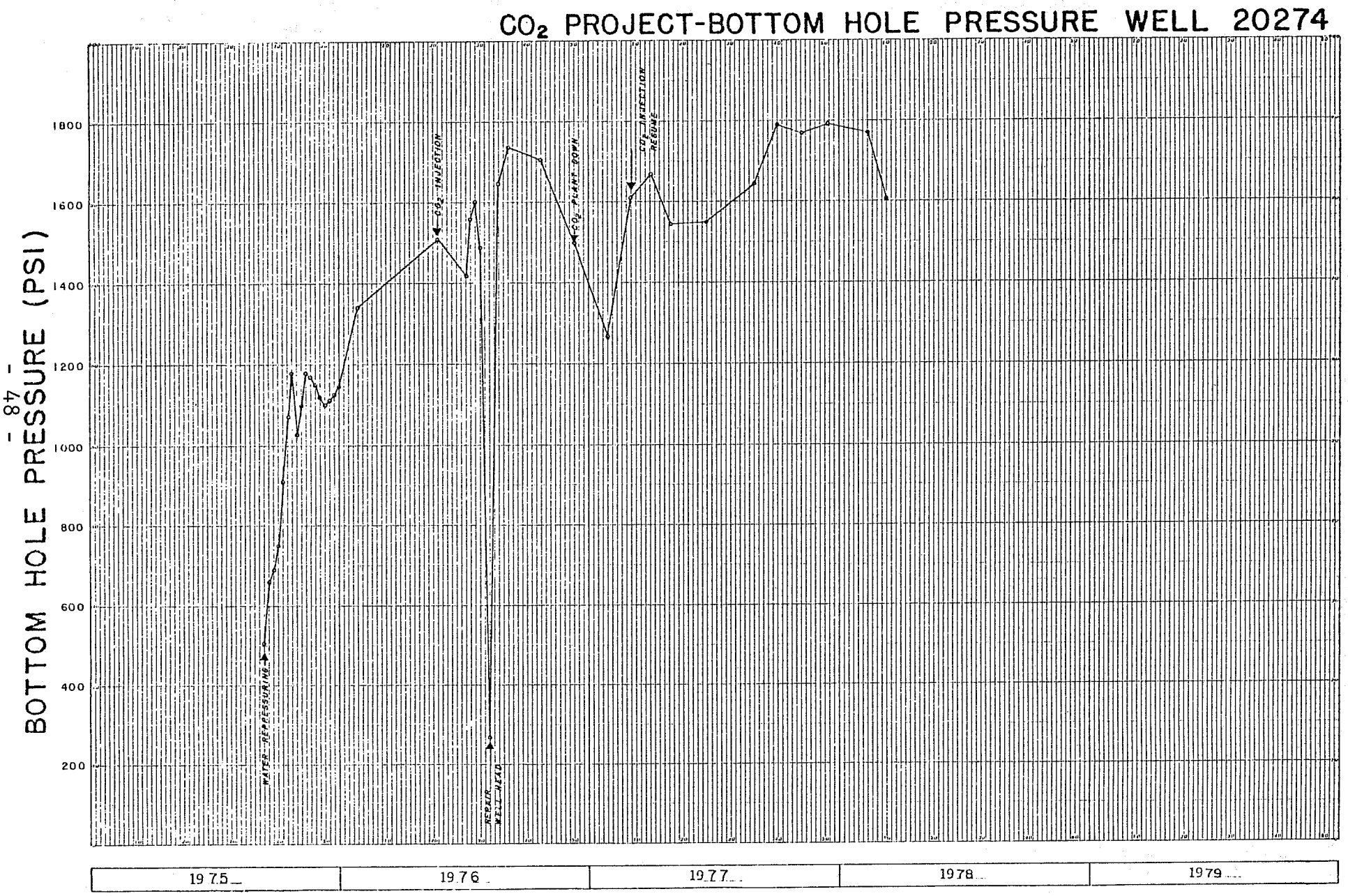


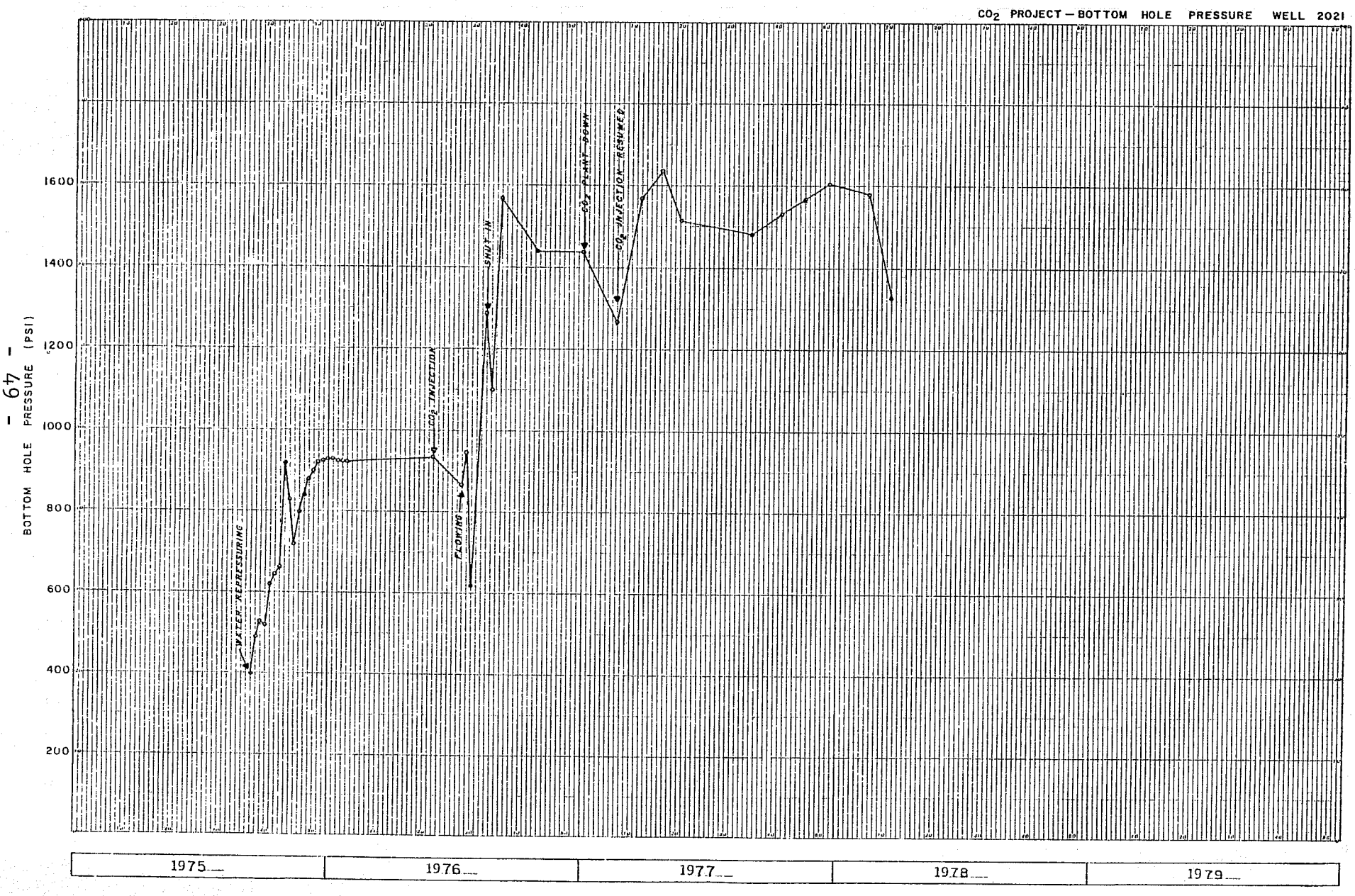
CO_2 & WATER INJECTION




CO2 PROJECT-TOTAL PRODUCTION (12 WELLS)
WEEKLY PRODUCTION (BBL'S)
WATER CUT (%)
WATER
OIL
% WATER CUT
CO2 INJECTION STARTED
2021-SHUT-IN
2024-SHUT-IN
2024-SHUT-IN
CO2 PLANT DOWN
CO2 INJECTION RESUMED
1976
1977
1978


WELL 4254
WEEKLY OIL PRODUCTION
WEEKLY WATER PRODUCTION
OIL
WATER
INSTALLED PUMPING EQUIPMENT
1976
1977
1978


CO2 PROJECT-BOTTOM HOLE PRESSURE WELL 20274
BOTTOM HOLE PRESSURE (PSI)
1800
1600
1400
1200
1000
800
600
400
200
WATER REPRESSURING
CO2 INJECTION
REPAIR WELL HEAD
CO2 PLANT DOWN
CO2 INJECTION RESUME
1975
1976
1977
1978
1979



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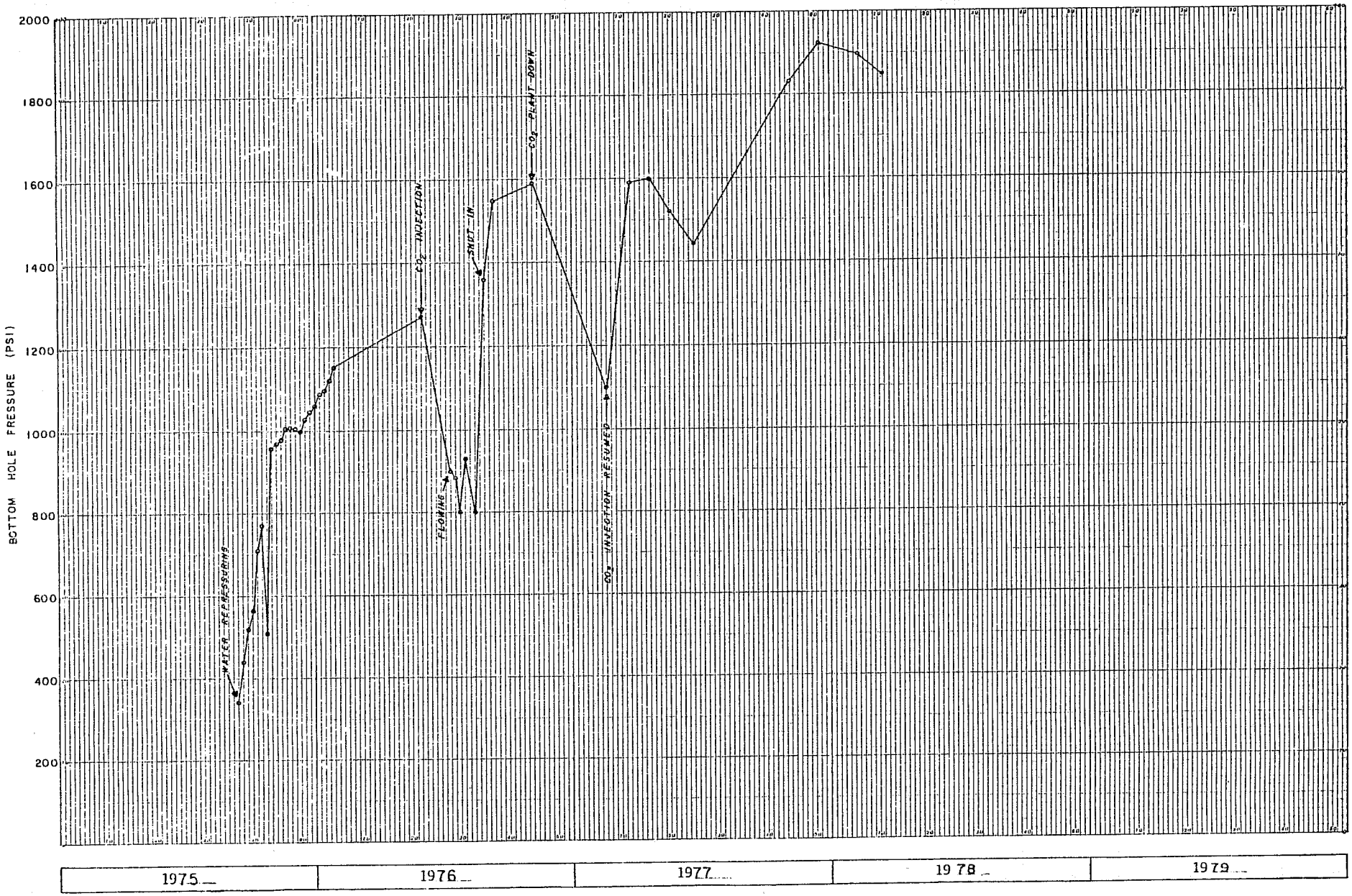
CO_2 PROJECT— BOTTOM HOLE PRESSURE WELL 2024



CO_2 PROJECT
MONTHLY WATER INJECTION
(After CO_2 Injection)

	Month	2020 Monthly Total	2020 Cum. Total	2022 Monthly Total	2022 Cum. Total	2023 Monthly Total	2023 Cum. Total	2025 Monthly Total	2025 Cum. Total	Monthly Total	Total Cum. Inj.	Daily Av./ Well	Remarks
1977	June	437	437	872	872	1015	1015	797	797	3121	3121	52	Plant down -0-
	July	988	1425	1414	2286	1685	2700	1498	2295	5585	8706	45	Plant down 49 hrs.
	August	1103	2528	1179	3465	1708	4408	1590	3885	5580	14286	45	Plant down 58 hrs.
	September	1107	3635	1079	4544	1607	6015	1447	5332	5240	19526	43	Plant down 91 hrs.
	October	1389	5024	1072	5616	1598	7613	1384	6716	5443	24969	44	Plant down 52 hrs.
	November	1312	6336	1492	7108	1501	9114	1230	7946	5535	30504	46	Plant down 24 hrs.
	December	1232	7568	1283	8391	1423	10537	1181	9127	5119	35623	41	Plant down 18.5 hrs
1978	January	1123	8691	1118	9509	1242	11779	959	10086	4442	40065	36	Plant down 36.5 hrs
	February	728	9419	910	10419	1262	13041	1168	11254	4068	44133	36	Plant down 14 hrs.
	March	1286	10705	854	11273	1678	14719	2335	13589	6153	50286	49.6	Plant down 70 hrs.

CO_2 INJECTION PROJECT
TOTAL PRODUCTION

	Month	Total Oil	Add'l Oil (1363 Bbls) Base	Cum. Oil	Cum. Add'l Oil	Total Water	Add'l Water (1393 Bbls) Base	Cum. Water	Cum. Add'l Water	Total Fluid	% Water Cut	Remarks
1976	June	1412	49	1412	49	1468	75	1468	75	2880	51	
	July	1584	221	2996	270	1622	229	3090	304	3206	51	
	August	2157	794	5153	1064	1338	-	4428	304	3495	38	
	September	1882	519	7035	1583	1254	-	5682	304	3136	40	
	October	2196	833	9231	2416	1724	331	7406	635	3920	44	
	November	1946	583	11177	2999	1417	24	8823	659	3363	42	
	December	1857	494	13034	3493	1199	-	10022	659	3056	39	
1977	January	1590	227	14624	3720	943	-	10965	659	2533	37	
	February	1323	-	15947	3720	578	-	11543	659	1901	30	
	March	1396	33	17343	3753	1371	-	12914	659	2767	50	
	April	1477	114	18820	3867	1452	59	14366	718	2929	50	
	May	1969	606	20789	4473	1812	419	16178	1137	3781	48	
	June	2444	1081	23233	5554	1780	387	17958	1524	4224	42	
	July	2320	957	25553	6511	1686	293	19644	1817	4006	42	
	August	1954	591	27507	7102	2108	715	21752	2532	4062	52	
	September	1881	518	29388	7620	2196	803	23948	3335	4077	54	
	October	1732	369	31120	7989	2700	1307	26648	4642	4432	61	
	November	1525	162	32645	8151	2499	1106	29147	5748	4024	62	
	December	1367	4	34012	8155	2389	996	31563	6744	3756	63	
1978	January	1152	-	35164	8155	2230	837	33793	7581	3382	66	
	February	990	-	35154	8155	2161	768	35954	8349	3151	68	
	March	1511	148	37665	8303	3052	1659	39006	10008	4563	67	

CO_2 PROJECT
OIL & WATER PRODUCTION
SUMMARY

		-INSIDE PATTERN-					-OUTSIDE PATTERN-					
	MONTH	OIL	WATER	TOTAL FLUID	CUM. OIL	CUM. WATER	OIL	WATER	TOTAL FLUID	CUM. OIL	CUM. WATER	REMARKS
1976	June	212	380	592	212	380	1199	1088	2288	1199	1088	
	July	553	553	1107	766	933	1030	1068	2099	2230	2157	
	August	576	344	920	1342	1278	1581	994	2575	3811	3151	
	September	146	-	146	1488	1278	1735	1254	2990	5547	4406	Inside: #4254
	October	304	58	363	1793	1337	1891	1666	3557	7438	6072	Inside: 2 Wells
	November	**225*	15	241	2019	1352	**1720	1401	3121	9159	7473	Inside: #4254
	December	224	9	234	2244	1362	1632	1189	2822	10792	8663	Inside: #4254
1977	January	222	107	330	2466	1470	1368	835	2204	12160	9499	Inside: 2 Wells
	February	87	1	88	2553	1472	1236	577	1813	13396	10076	Inside: #4254
	March	105	-	105	2659	1472	1290	1371	2661	14687	11447	Inside: #4254
	April	174	115	289	2833	1587	1303	1336	2639	15990	12784	Inside: #4254
	May	292	300	593	3126	1888	1676	1511	3188	17667	14295	Inside: #4254
	June	257	234	492	3384	2122	2186	1546	3733	19853	15842	Inside: #4254
	July	256	311	568	3640	2433	2064	1375	3439	21917	17218	Inside: #4254
	August	253	863	1117	3894	3297	1700	1245	2946	23618	18463	
	September	128	700	829	4023	3997	1752	1495	3248	25371	19959	Inside: #4254
	October	81	1059	1140	4104	5056	1651	1640	3292	27022	21600	Inside: 2 Wells
	November	42	850	893	4147	5907	1483	1649	3132	28505	23249	Inside: #4254
	December	43	907	951	4191	6814	1323	1481	2804	29828	24731	Inside: #4254
1978	January	47	887	934	4238	7702	1104	1342	2447	30933	26073	Inside: #4254
	February	43	802	845	4281	8504	947	1358	2305	31880	27431	Inside: 3 Wells
	March	68	1037	1106	4350	9542	1442	2014	3456	33322	29446	Inside: 3 Wells

*Well Fractured
**Well Treated with Carbon Bisulfide

CO_2 INJECTION PROJECT
PRODUCTION FROM WELLS INSIDE PATTERN
MONTHLY TOTALS (BBLS.)

	MONTH	2021 OIL	2021 WATER	2021 TOTAL FLUID	2024 OIL	2024 WATER	2024 TOTAL FLUID	4254 OIL	4254 WATER	4254 TOTAL FLUID	20274 OIL	20274 WATER	20274 TOTAL FLUID
1976	June	-	-	-	-	136	136	4	10	15	207	232	440
	July	13	73	87	109	227	336	105	13	118	325	239	564
	August	49	85	135	327	206	533	157	15	173	41	36	78
	September	* -	-	-	* -	-	-	146	-	146	* -	-	-
	October	* -	-	-	58	36	94	**246	22	268	* -	-	-
	November	* -	-	-	* -	-	-	***225	15	241	* -	-	-
	December	* -	-	-	* -	-	-	224	9	234	* -	-	-
1977	January	* -	-	-	* -	-	-	161	50	211	61	57	118
	February	* -	-	-	* -	-	-	87	1	88	* -	-	-
	March	* -	-	-	* -	-	-	105	-	105	* -	-	-
	April	* -	-	-	* -	-	-	174	115	289	* -	-	-
	May	* -	-	-	* -	-	-	292	300	593	* -	-	-
	June	* -	-	-	* -	-	-	257	234	492	* -	-	-
	July	* -	-	-	* -	-	-	256	311	568	* -	-	-
	August	26	39	65	28	94	122	171	613	785	27	116	143
	September	* -	-	-	* -	-	-	128	700	829	* -	-	-
	October	* -	-	-	15	264	280	65	794	859	* -	-	-
	November	* -	-	-	* -	-	-	42	850	893	* -	-	-
	December	* -	-	-	* -	-	-	43	907	951	* -	-	-
1978	January	* -	-	-	* -	-	-	47	887	934	* -	-	-
	February	* -	-	-	4	84	90	26	688	714	11	29	17
	March	12	48	61	* -	-	-	****33	855	888	23	133	156

*Shut In
**Well Fractured
***Well Treated with Carbon Bisulfide
****Well Serviced

CO_2 INJECTION PROJECT
PRODUCTION FROM WELLS OUTSIDE PATTERN
MONTHLY TOTALS (BBLS.)

	MONTH	2047 OIL	2047 WATER	2047 TOTAL FLUID	4049 OIL	4049 WATER	4049 TOTAL FLUID	4591 OIL	4591 WATER	4591 TOTAL FLUID	2043 OIL	2043 WATER	2043 TOTAL FLUID
1976	June	35	65	101	43	250	293	53	111	165	164	66	231
	July	* 1	15	17	7	402	409	29	164	193	259	72	331
	August	333	100	434	-	252	252	82	258	340	261	38	299
	September	363	90	453	55	414	470	117	89	206	273	60	334
	October	259	53	312	107	842	949	112	135	248	324	67	391
	November	243	57	300	136	678	815	97	131	229	314	45	360
	December	221	44	266	173	615	788	142	69	212	348	51	399
1977	January	222	51	273	141	470	612	118	50	169	274	58	332
	February	172	30	203	* 52	151	204	96	41	137	210	47	257
	March	161	41	203	115	812	927	80	45	126	183	65	249
	April	150	53	203	136	582	718	61	37	98	170	77	248
	May	193	56	249	173	605	779	73	70	144	162	39	201
	June	204	52	256	169	561	730	165	63	228	212	65	278
	July	214	48	263	181	530	712	129	35	165	162	34	196
	August	145	26	171	187	488	675	107	48	156	126	55	181
	September	267	52	319	181	450	632	102	68	170	109	74	184
	October	*122	55	178	245	493	739	74	63	137	100	96	196
	November	193	78	271	154	450	605	76	104	180	90	94	184
	December	207	77	284	144	490	634	87	146	234	111	84	195
1978	January	200	86	287	109	473	582	67	137	204	105	94	200
	February	189	71	260	85	468	553	41	128	170	102	87	189
	March	194	81	275	86	527	613	32	149	181	107	123	230

*Well Off Production-Pulled-Changed Pump
**Well is Off

CO_2 INJECTION PROJECT
PRODUCTION FROM WELLS OUTSIDE PATTERN
MONTHLY TOTALS (BBLS.)

	MONTH	2044 OIL	2044 WATER	2044 TOTAL FLUID	4090 OIL	4090 WATER	4090 TOTAL FLUID	2046 OIL	2046 WATER	2046 TOTAL FLUID	2048 OIL	2048 WATER	2048 TOTAL FLUID
1976	June	171	309	480	286	169	456	303	111	414	141	3	144
	July	184	160	344	*123	116	239	280	133	413	**144	4	149
	August	314	109	423	442	232	674	** 7	-	7	140	2	142
	September	409	216	625	366	380	746	4	-	4	146	2	148
	October	499	198	698	376	366	743	24	-	24	186	2	189
	November	379	133	512	324	341	666	***29	-	30	193	11	205
	December	268	116	384	252	292	544	47	-	48	178	-	178
1977	January	285	120	405	**124	79	204	28	-	29	172	4	176
	February	92	33	126	452	268	721	1	-	1	157	3	161
	March	146	175	322	****360	227	587	49	-	49	192	2	195
	April	211	166	378	339	386	726	38	29	68	195	3	198
	May	268	169	437	346	399	745	215	168	384	243	2	245
	June	306	126	433	340	387	728	684	283	967	102	6	108
	July	239	111	351	380	389	770	630	217	848	124	8	132
	August	19	55	75	386	369	756	573	192	766	153	8	161
	September	120	316	436	310	336	646	471	189	660	190	7	197
	October	172	351	523	345	346	691	427	217	645	161	17	179
	November	130	401	532	316	304	620	375	207	582	146	7	154
	December	24	228	252	200	244	444	403	207	611	144	4	148
1978	January	20	229	250	107	97	205	362	220	528	131	2	133
	February	22	295	317	*****30	73	104	318	202	520	157	1	159
	March	48	513	561	411	340	751	397	274	671	166	4	171

*Rods Out for Testing
**Rods Out for Testing & Changing Casinghead
***Well Treated with Carbon Bisulfide
****Shut In
*****Well is Off

CO_2 PROJECT
FLOW TESTS
First Quarter 1978

Date	2024 Oil (bbls)	2024 Water (bbls)	2024 Gas (cu.ft.)	20274 Oil (bbls)	20274 Water (bbls)	20274 Gas (cu.ft.)	2021 Oil (bbls)	2021 Water (bbls)	2021 Gas (cu.ft.)
2-23	4.15	39.01	24,000						
2-24	-	26.56	4,535						
2-25	.83	19.92	4,525						
2-28				11.62	29.05	68,705			
3-1				7.47	13.28	18,842			
3-2				3.32	22.41	12,128			
3-7							3.32	24.07	5,260
3-8							7.47	10.79	757
3-9							1.66	14.11	1,295
	2044			2047			4254		
3-14	-	19.92	58,300*						
3-15	.83	25.75	12,310						
3-16	.83	24.07	8,075						
3-21				4.15	4.98	7,819	-	30.71	2,553
3-22				9.94	-	11,555	.83	34.86	2,553
3-23				7.47	3.32	11,484	-	33.20	2,553
	2046			2048					
3-28	19.09	9.96	1,296*	6.64	.83	16,855			
3-29	17.43	9.13	28,532	6.64	-	21,770			
3-30	17.43	5.81	29,071	6.64	-	24,688			
3-31	18.26	9.96	29,609						

*Questionable Data

A12-067

SAMPLE COLLECTOR	MORGANTOWN ENERGY RESEARCH CENTER GAS ANALYSIS ANALYTICAL LABORATORY	DATE RECEIVED:
SEND REPORT TO: KI KAMATH		DATE REPORTED:

NUMBER IDENTIFICATION	SAMPLE NO.	LAB. NO.	SAMPLE NO.	LAB. NO.	SAMPLE NO.	LAB. NO.	SAMPLE NO.	LAB. NO.
	—	R 1502		R 1503				
COLLECTING	DATE 2/23/78	TIME	DATE 2/28/78	TIME	DATE	TIME	DATE	TIME
SAMPLE DESCRIPTION	Well 2024 in SS Bottles * Pressure unknown		Well 20274 in SS Bottles * Pressure unknown					
ANALYSES WANTED (OR PLACE "X" BELOW IN FRONT OF CONSTITUENT DESIRED. INCLUDE ONLY THOSE OF INTEREST)	LIST: 17.9E		LIST: 9.82		LIST:		LIST:	

	CONSTITUENT					
✓	HYDROGEN	H_2	-0-	-0-		
✓	OXYGEN	O_2	0.39	0.17		
✓	NITROGEN	N_2	1.49	0.66		
✓	CARBON MON	CO	-0-	-0-		
✓	METHANE	CH_4	2.80	2.78		
✓	ETHANE	C_2H_6	3.87	2.52		
✓	CARBON DIOX	CO_2	Balance 82.02	Balance 90.18		
✓	ETHYLENE	C_2H_4				
✓	PROPANE	C_3H_8	4.49	1.97		
✓	ISO-BUTANE	iC_4H_{10}	1.43	0.53		
✓	BUTANE	C_4H_{10}	3.71	1.19		
✓	H_2S		-0-	-0-		
✓	COS		-0-	-0-		

ANALYSTS: _____ DATE: _____ CHECKED BY: _____

* Sample at atm P
** " " about 4psi

CO_2 INJECTION PROJECT
GAS OPEN FLOWS & CO_2 ANALYSIS

WEEK ENDING

WELL NO.	2-25-77 MCF	2-25-77 %CO_2	3-9-77 MCF	3-9-77 %CO_2	3-30-77 MCF	3-30-77 %CO_2	5-4-77 MCF	5-4-77 %CO_2	5-31-77 MCF	5-31-77 %CO_2	6-14-77 MCF	6-14-77 %CO_2	1-15-78 MCF	1-15-78 % CO_2
1327			7.1	0.0	8.9	0.0	8.5	0.0	8.5	0.0	8.5	1.0	3.8	.25
1265			3.1	15.0	2.7	6.0	Tr.	0.0	4.5	2.0	4.3	14.0	1.6	.25
1282			21.0	0.0	36.1	0.0	41.5	0.0	26.4	0.0	30.0	1.5	10.2	.25
1285			41.0	0.0	22.8	0.0	43.0	0.0	37.3	0.0	43.7	0.0	31.6	.25
20325			3.8	2.5	2.6	0.0	5.8	0.0	8.5	0.0	4.5	0.0	6.0	.50
1258			3.2	13.5	2.9	15.0	3.3	6.5	3.3	6.5	3.3	9.0	2.7	.25
2040	-	4.5			Tr.	8.0	1.0	6.5	1.1	8.0	0.8	11.5	.78	1.75
3985	Tr.	0.0			2.5	0.0	2.4	0.0	2.7	0.0	2.8	0.0	1.9	.25
4258	1.0	11.0			1.1	11.0	1.0	4.5	0.8	7.5	1.1	4.5	.79	.25
4049					1.1	10.5	1.4	4.5	1.1	10.0			63.3	2.5
4090	-	13.5			-	5.5	Tr.	4.5	Tr.	3.5	Tr.	10.5		
2048			2.8	>20.0	4.3	>20.0	7.8	>20.0	1.8	>20.0	.6	>20.0	13.2	12.0
4591			6.0	>20.0	1.6	>20.0	6.9	>20.0	6.3	>20.0	32.0	>20.0	10.2	12.0
2053			2.9	0.0	Tr.	0.0	1.0	1.0	Tr.	2.0	Tr.	0.0	1.6	1.0
2045	2.9	6.5			2.2	5.5	1.8	4.0	2.5	9.5	2.3	10.0	1.4	6.0
1252	1.2	1.0			-	-	SHUT	IN	0.6	0.0	Tr.	0.0	1.36	2.0
2042			0.6	6.5	1.0	8.5	1.1	9.5	Tr.	1.0	Tr.	0.0	-	.75
2043			8.5	>20.0	11.8	>20.0	28.0	>20.0	42.6	>20.0	18.1	>20.0	19.1	12.0
2046							FLOWING						26.9	12.0
4050			24.5	0.0	30.2	0.0	25.7	0.0	28.0	0.0	28.0	0.0		
4039					Tr.	0.0	0.6	0.0	0.8	0.0	0.6	0.0	.79	.50
1871	0.8	13.0			Tr.	0.0	Tr.	9.0	Tr.	4.5	Tr.	4.5	-	.25
1919	0.6	4.5			0.6	0.0	0.8	0.0	0.8	0.0	0.6	0.0	-	.75
20327			26.4	>20.0	29.5	0.0			30.0	0.0	34.9	0.0	21.9	.25
1347			2.9	8.0	3.0	4.5	3.1	2.5	3.1	5.5	2.8	1.0	1.3	.25
2047			8.0	>20.0	6.0	>20.0	4.8	>20.0	5.8	>20.0	8.5	>20.0	18.3	12.0
2041	1.6	14.5			2.4	8.0	2.2	0.5	2.7	0.0	2.6	9.0	.78	.50
1324	31.0	0.0			29.5	0.0	8.5	0.0	34.0	0.0	35.0	0.0	22.8	.25
1315	22.8	0.0			14.7	0.0	16.5	0.0	18.0	0.0	18.5	0.0	-	-
1284	4.5	7.0			3.0	3.5	42.6	7.0	2.9	4.5	2.1	3.0	-	.25
1349	17.7	0.0			17.6	0.0	17.0	3.5	4.9	0.0	20.0	0.0	8.9	.25
1297			2.7	5.0	2.7	5.5	1.0	0.0	0.8	0.0	2.6	4.0	6.0	.25
1323			9.3	0.0	10.2	0.0	7.9	0.0	7.6	1.0	7.1	0.0	-	0.0
1318							8.9	0.0	8.5	0.0	10.0	0.0	7.6	.25
2072			20.4	0.0	19.6	0.0	18.1	0.0	16.0	0.0	17.0	0.0	10.4	.25
1279	11.1	0.0			12.0	0.0	9.1	0.0	9.7	0.0	8.5	0.0	11.1	.25

CO_2 INJECTION PROJECT
GAS OPEN FLOWS & CO_2 ANALYSIS

WELL NO.	WEEK ENDING 2-25-77 MCF	2-25-77 %CO_2	3-9-77 MCF	3-9-77 %CO_2	3-30-77 MCF	3-30-77 %CO_2	5-4-77 MCF	5-4-77 %CO_2	5-31-77 MCF	5-31-77 %CO_2	6-14-77 MCF	6-14-77 %CO_2	1-15-78 MCF	1-15-78 % CO_2
1347	22.1	0.0			9.3	0.0	38.2	0.0	3.8	0.0	26.0	4.0	23.6	0.0
3905	1.1	3.0			Tr.	2.5	0.6	6.5	0.8	3.0	0.6	3.5	-	.25
1334	Tr.	4.0			Tr.	0.0	Tr.	0.0	Tr.	6.0	Tr.	0.0	-	.25
4029	2.8	1.0			-	-	2.7	8.5	2.8	2.0	2.4	4.0	1.1	1.9
2052	Tr.	0.0			Tr.	4.0	1.0	6.0	0.8	3.0	Tr.	5.0		
1354	-	0.0			-	0.0	Tr.	0.0	Tr.	0.0	Shut	In	-	0.0
3904	2.7	5.5			3.5	2.5	3.7	0.0	1.8	1.0	-	-	1.1	12.0

CO_2 INJECTION
GAS OPEN FLOWS & CO_2 ANALYSIS

Well No.	3-30-78 MCF	3-30-78 %CO_2
1327	3.8	.10
1265	3.8	.40
1282	10.2	.10
1285	36.5	.10
20325	3.8	.35
1258	2.8	2.40
2040	.79	1.8
3985	2.6	.15
4258	.79	.20
4049		
4090		
2048		
4591		
2053	1.1	.05
2045	1.3	5.0
1252	1.1	1.75
2042	-	.30
2043		
2046		
4050		
4039	.78	.30
1871	.79	.10
1919	-	.40
20327	25.8	.10
1247	1.1	.20
2047	-	-
2041	1.1	.40
1324	41.8	.10
1315	51.28	.10
1284	1.1	.10
1349	8.5	.06
1297	1.1	.10
1323	.79	6.0
1318	8.3	.10
2072	22.8	.10
1279	4.6	.06

CO_2 INJECTION
GAS OPEN FLOWS & CO_2 ANALYSIS

Well No.	3-30-78 MCF	3-30-78 $\%CO_2$
1347	11.7	.25
3905	-	.40
1334	-	.80
4029	3.8	1.00
2052	0	.60
1354	-	1.4
3904	1.1	12.

APPENDIX C

ABSTRACT

OBJECTIVE

The objective of this field test is to evaluate and demonstrate the effectiveness of using CO_2 injection to recover high gravity crude oil from shallow watered-out reservoirs. The estimated recovery potential from the flood pattern of six (6) acres is approximately 50,000 barrels. The work will be conducted in five (5) phases as follows:

Phase 1--Preliminary Testing and Construction Water Injection, and Plant Construction

Phase 2--Natural Gasoline Injection

Phase 3--CO_2 Injection

Phase 4--Carbonated Water Injection

Phase 5--Water Injection

SUMMARY

Water injection during the 5th phase of the project continued throughout the quarter. This phase will continue until terminated by the Technical Committee. Total injection of 16,097 barrels was approximately 300 barrels less than the previous period, although down time was 100 hours less and operating days were the same. The lower rate is directly attributable to the continually increasing reservoir pressures encountered as shown by the bottom hole pressure tests. To date no serious injection problems have occurred and the water supply continues to be adequate.

Oil production continues to decline particularly in the center producer (well 4254). Total oil production for the period was 4624 barrels, bringing the total to date due to CO_2 injection to 8,155 barrels. Increases in water production along with the decline in oil production has brought the total water cut up to 63%. Other than routine servicing, no particular problems were encountered with the producing wells.

WATER INJECTION

Total water injection for the quarter amounted to 16,097 barrels. This compares with 16,405 barrels for the previous quarter. The daily average injection per well declined approximately .8 bbl/well/day. Although down time for the quarter was about 100 hours less than previously, and the number of operating days were the same, injection rates were lower due to continual high pressure. Most of the shut-downs, particularly in November and December were due to high pressure safety shut-downs. We have, therefore, found it necessary to adjust the safeties on the pump to about 1450 psi or about 100 psi over current operating pressure. There is also the possibility of well bore damage. This will be investigated and corrected if necessary. Overall, the injection has been higher than that experienced before the work done this past summer to relieve the supply and injection problems discussed in previous reports.

Water injection for each well in the project along with cumulatives for Phase 5 is listed below and is shown on the accompanying graph.

Well No.	Quarterly Inj.(bbls)	Cum. Inj.(bbls)
2020	3,933	7,568
2022	3,847	8,391
2023	4,522	10,537
2025	3,795	9,127
Total	16,097	35,623

OIL AND WATER PRODUCTION

Total oil and water production for the period is shown in the table below. The attached charts and graphs indicate the production for each well in the project along with a summary of the production both inside and outside the pattern.

Month	Oil Prod.(bbls)	Water Prod.(bbls)
October	1,732	2,700
November	1,525	2,499
December	1,367	2,389
Total	4,624	7,588

The production, shown above, is approximately 1500 barrels lower than the previous quarter for both oil and water. While oil production continues a steady downward trend that started with the cessation of CO_2 injection, water production seems to fluctuate both up and down. Oil production from well 4254 has steadily declined until the December production of 44 barrels approximately equals that at the start of the project. It is becoming apparent that the water is being injected in an area of the reservoir that the CO_2 was not. It is interesting to note that production has declined or at best leveled off in all of the wells except those to the west. These seem to be unaffected.

Although the gas metering equipment has not been installed, construction of the manifolding did continue and production tests were run on observation well #2024 in October. The results are as follows:

Date	Oil(bbls)	Water(bbls)
10-7	1.66	29.88
10-8	2.49	26.56
10-9	1.66	19.09
10-10	-	22.41
10-11	.83	19.92
10-12	1.66	16.60
10-13	.83	-
10-22	-	14.11
10-23	.83	22.41
10-24	.83	14.11
10-25	-	23.24
10-26	1.66	24.07
10-28	1.66	19.92
10-29	1.66	12.45

Cumulative production to date due to CO_2 injection is 8155. The total water cut is approximately 63%.

BOTTOM HOLE PRESSURE TESTS

Bottom hole pressure testing was resumed in September after repairs to the instrument were made. Work was started during the quarter to re-build the wellheads on the input wells so that B.H.P.'s could be run in these wells also. The results of the testing during the quarter are as follows:

Well No.	Oct.	Nov.	Dec.
2024		1,733	1,937
20274	1,793	1,737	1,794
2021	1,530	1,563	1,602
2020	>2,400*	2,171	2,124
2022			2,124

*Off chart - range of gauge too low

As can be seen from the above, reservoir pressure continues to increase and has about reached the limit if fracturing is to be avoided. We will continue re-working the remaining wellheads and should have them complete next month.

WATER SAMPLES

Arrangements were made to relieve the manpower situation, somewhat, and we were able to resume the water sampling that had been discontinued during August and September. The results of the water analysis are shown on the attached chart.

GAS SAMPLES

Personnel was still not available to obtain and analyze gas samples during the quarter.

ENVIRONMENTAL ASSESSMENT

In late November a request was made by the Morgantown Energy Research Center (MERC) to conduct an inspection of the project with an environmental group from the Oak Ridge National Laboratory. The request was granted and on December 7th the inspection was made, and hopefully their questions were answered satisfactorily.

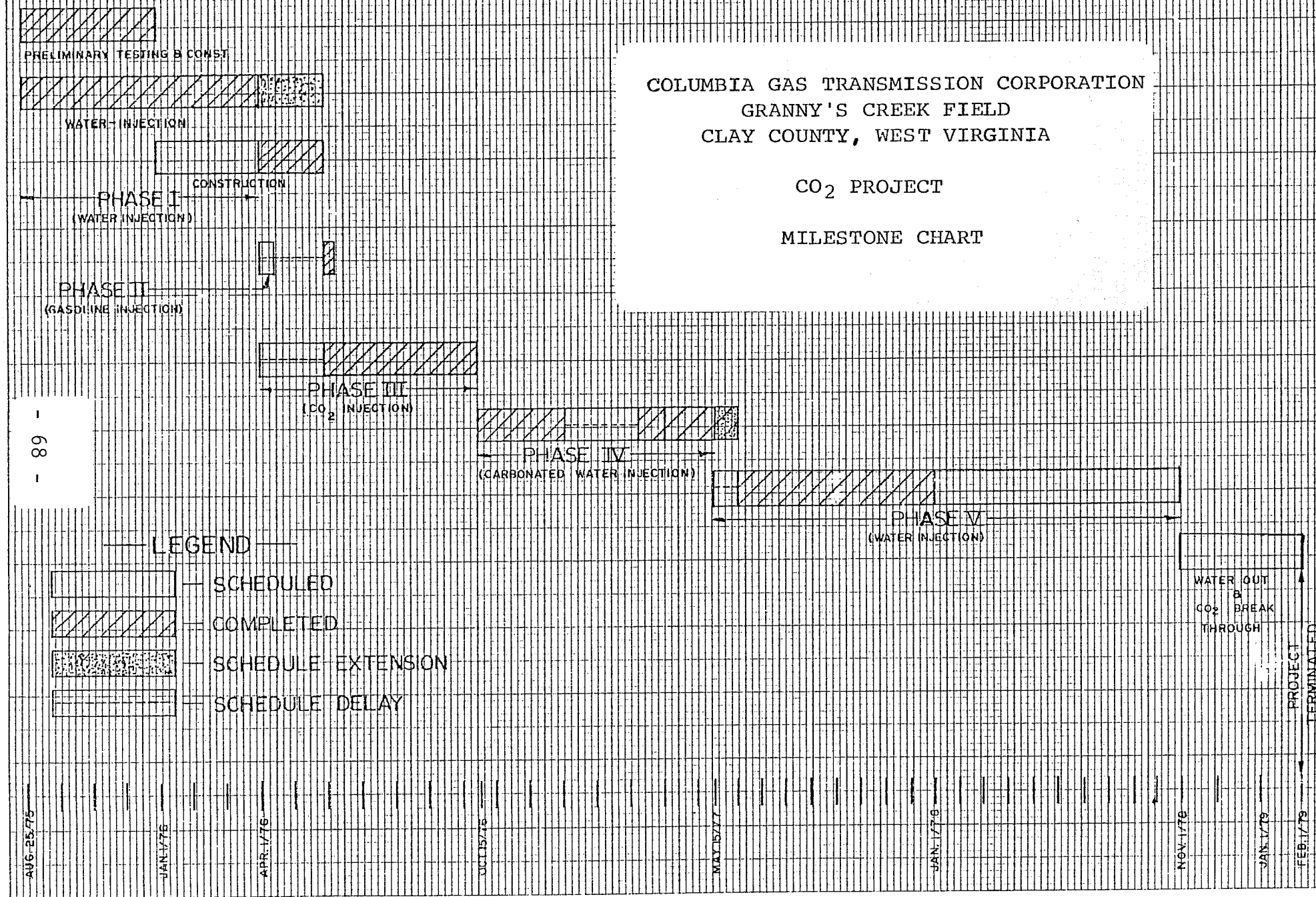
PROJECT SCHEDULE

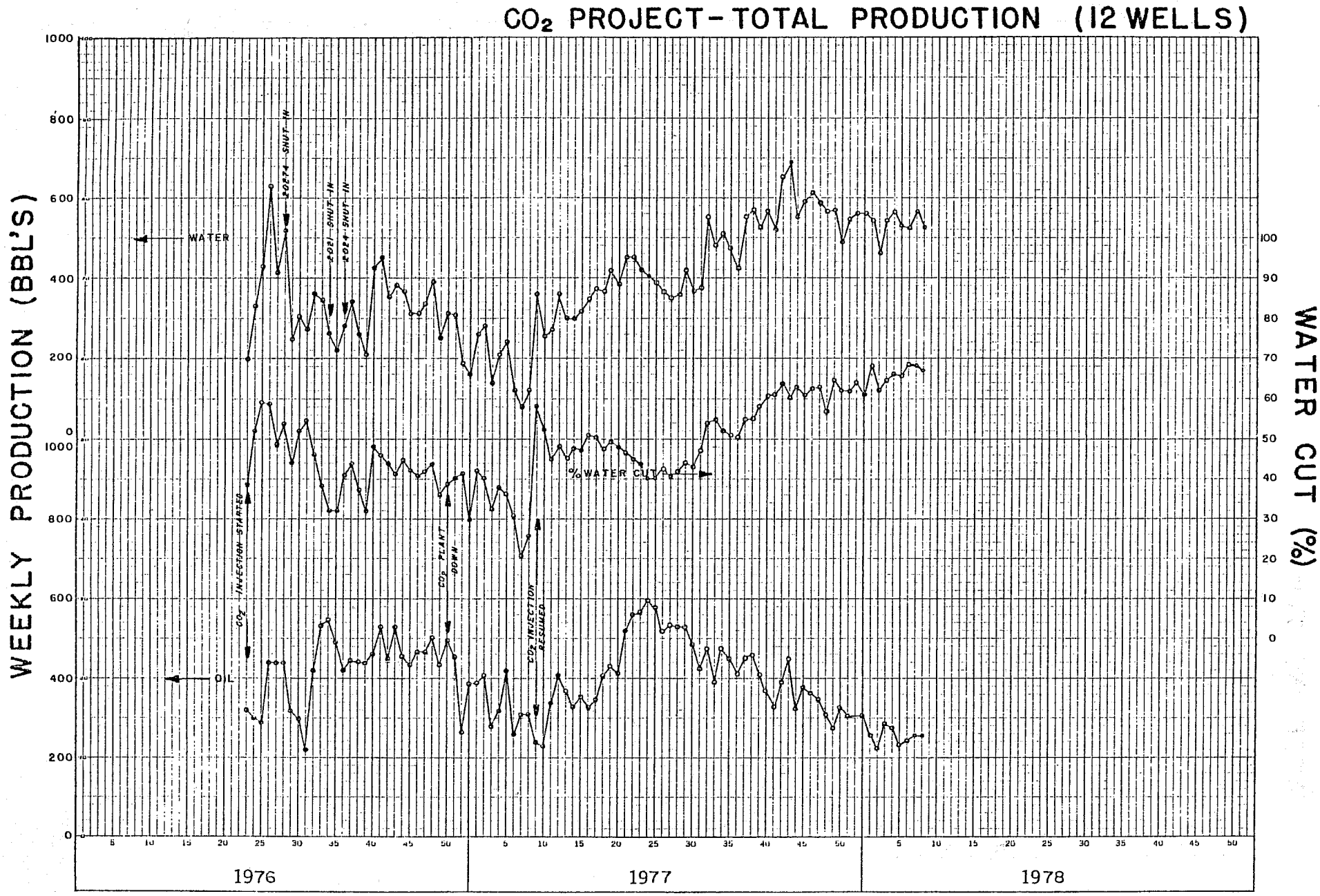
The attached Milestone Chart shows the original schedule and progress to date. As can be seen, completion of the CO_2 phase (phases 3 and 4) were delayed approximately one month due to the shut-down of last winter and the additional 1000 tons injected. Although water injection rates have been slightly lower than anticipated, it is believed that the project will be completed on schedule.

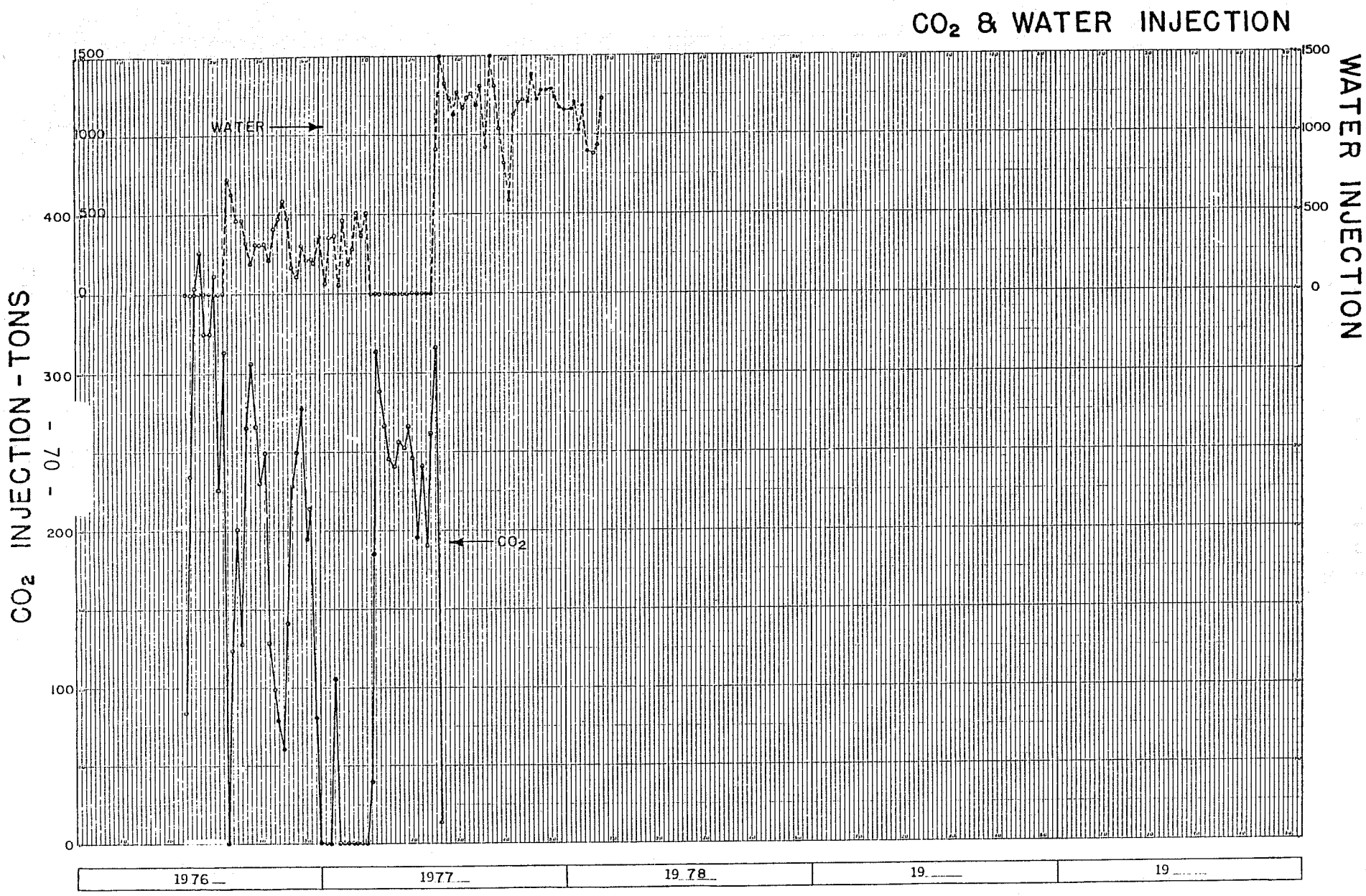
COLUMBIA GAS TRANSMISSION CORPORATION
GRANNY'S CREEK FIELD
CLAY COUNTY, WEST VIRGINIA

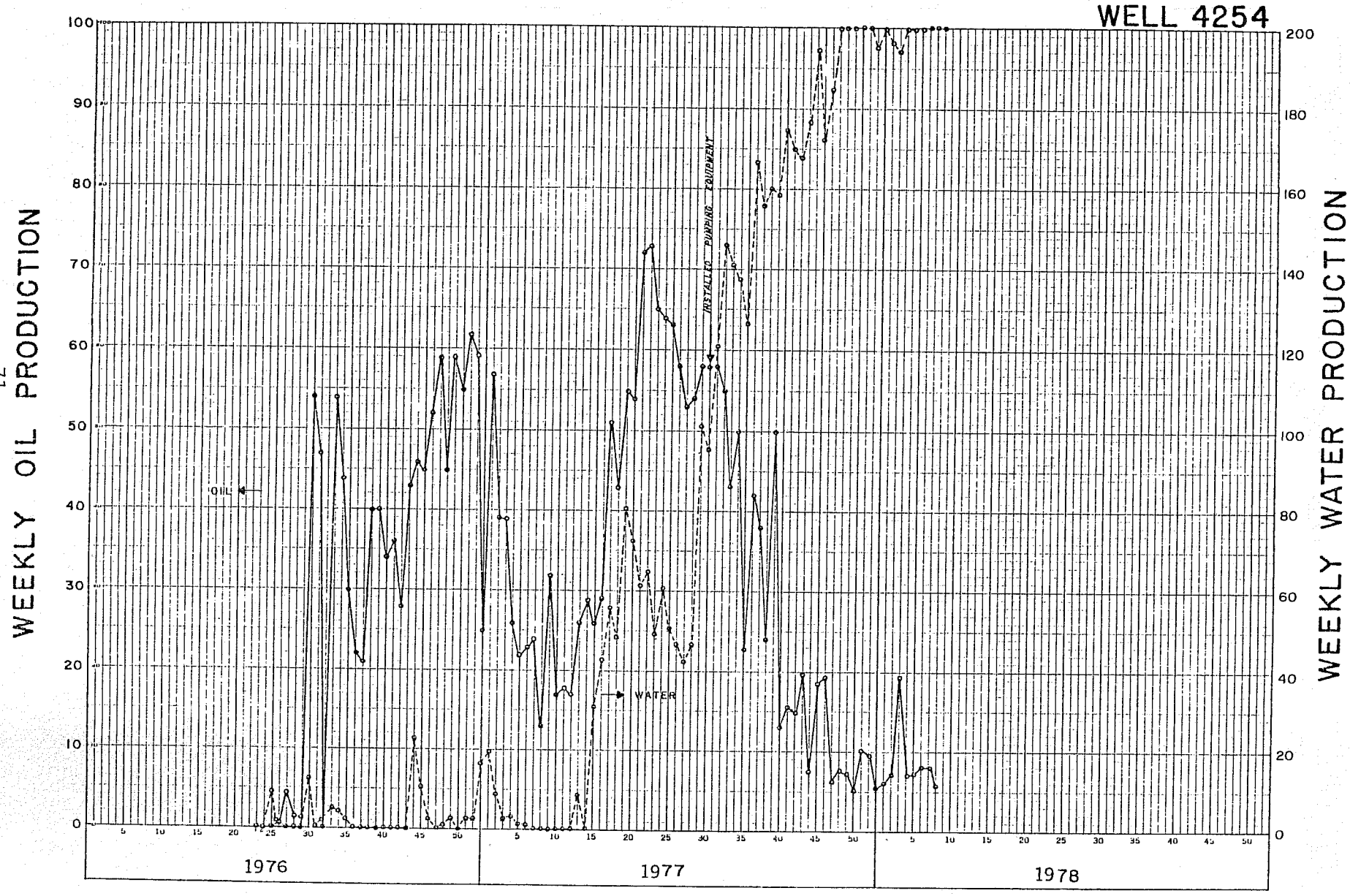
CO_2 PROJECT

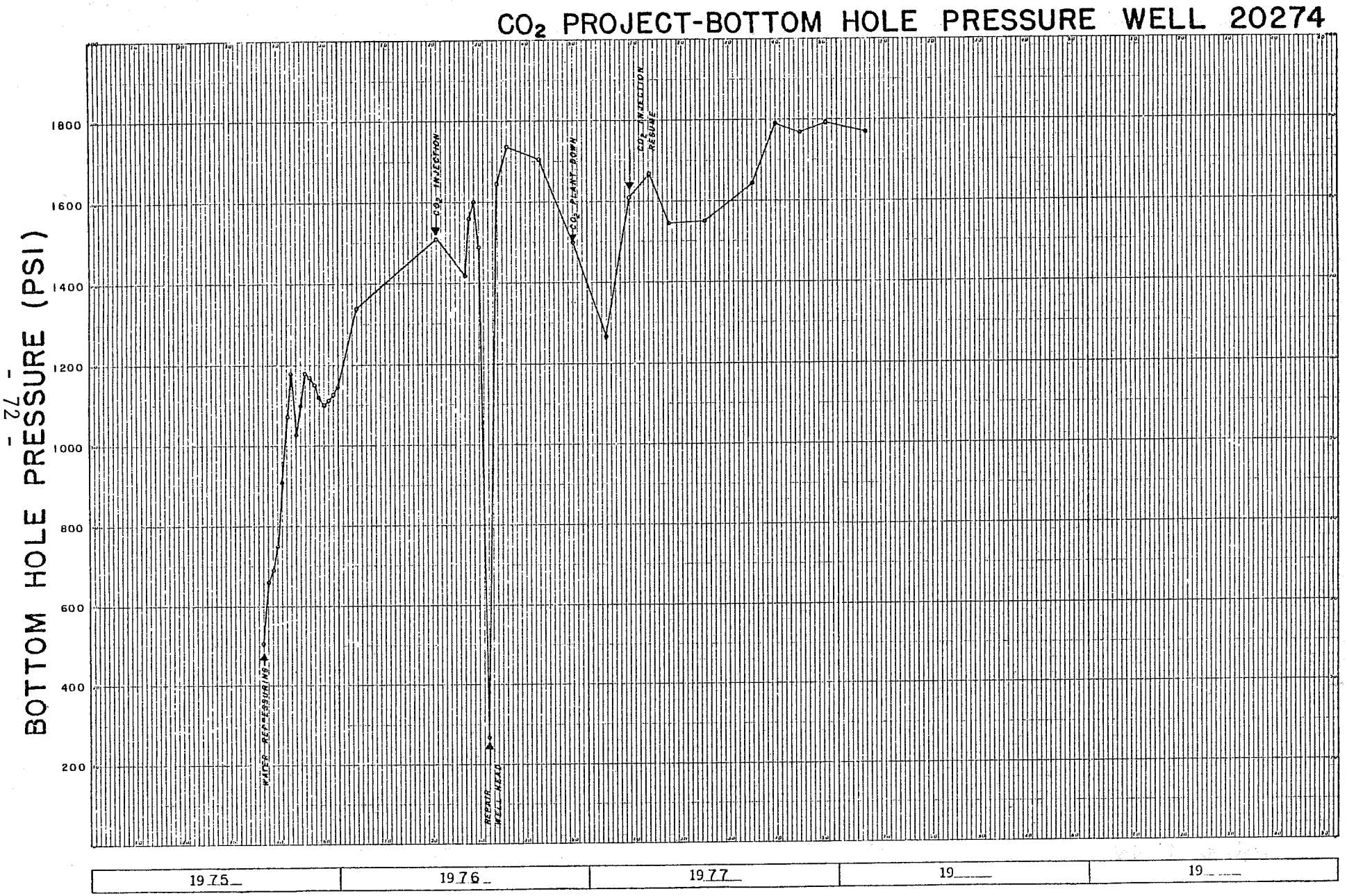
MILESTONE CHART

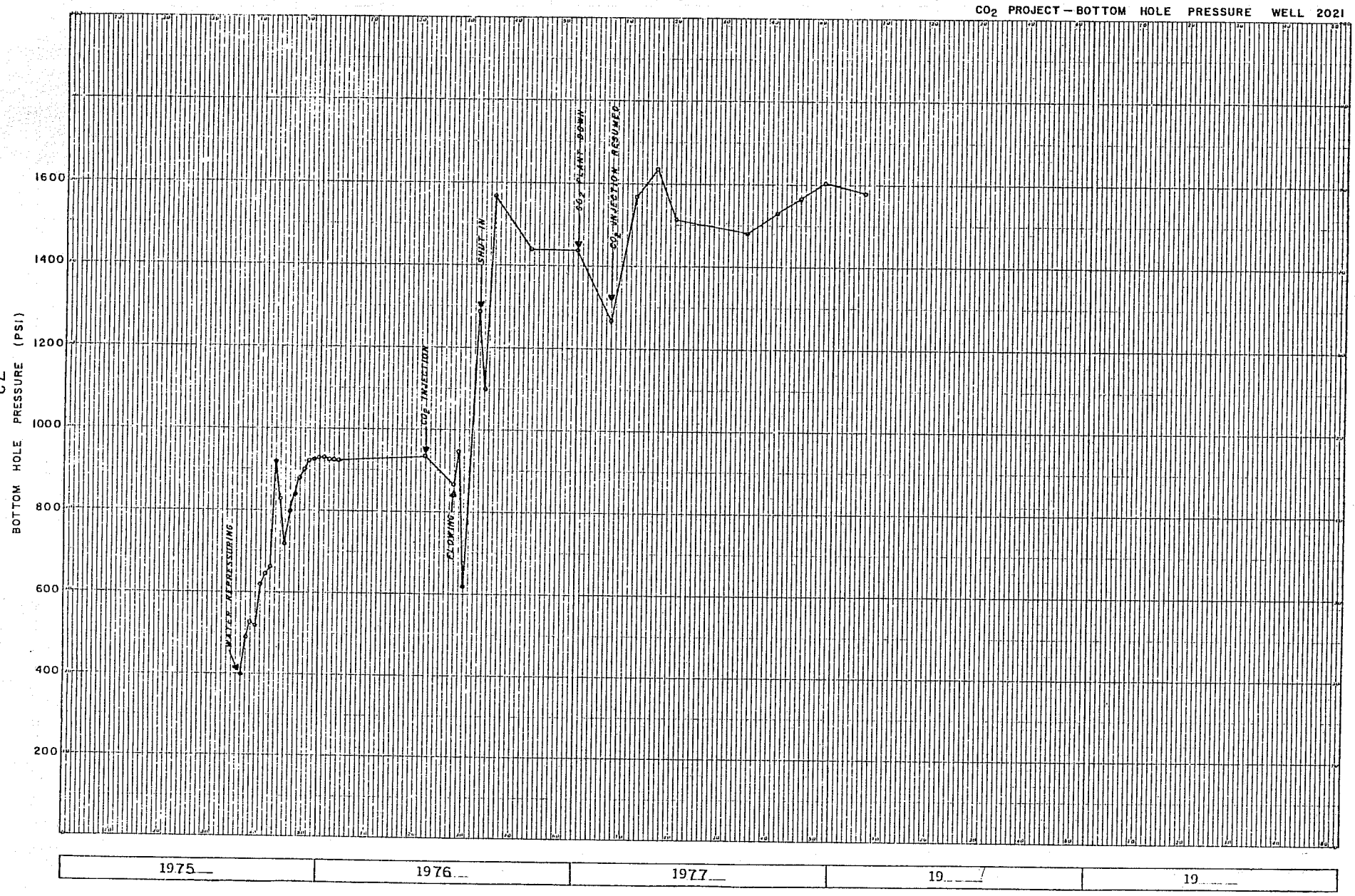


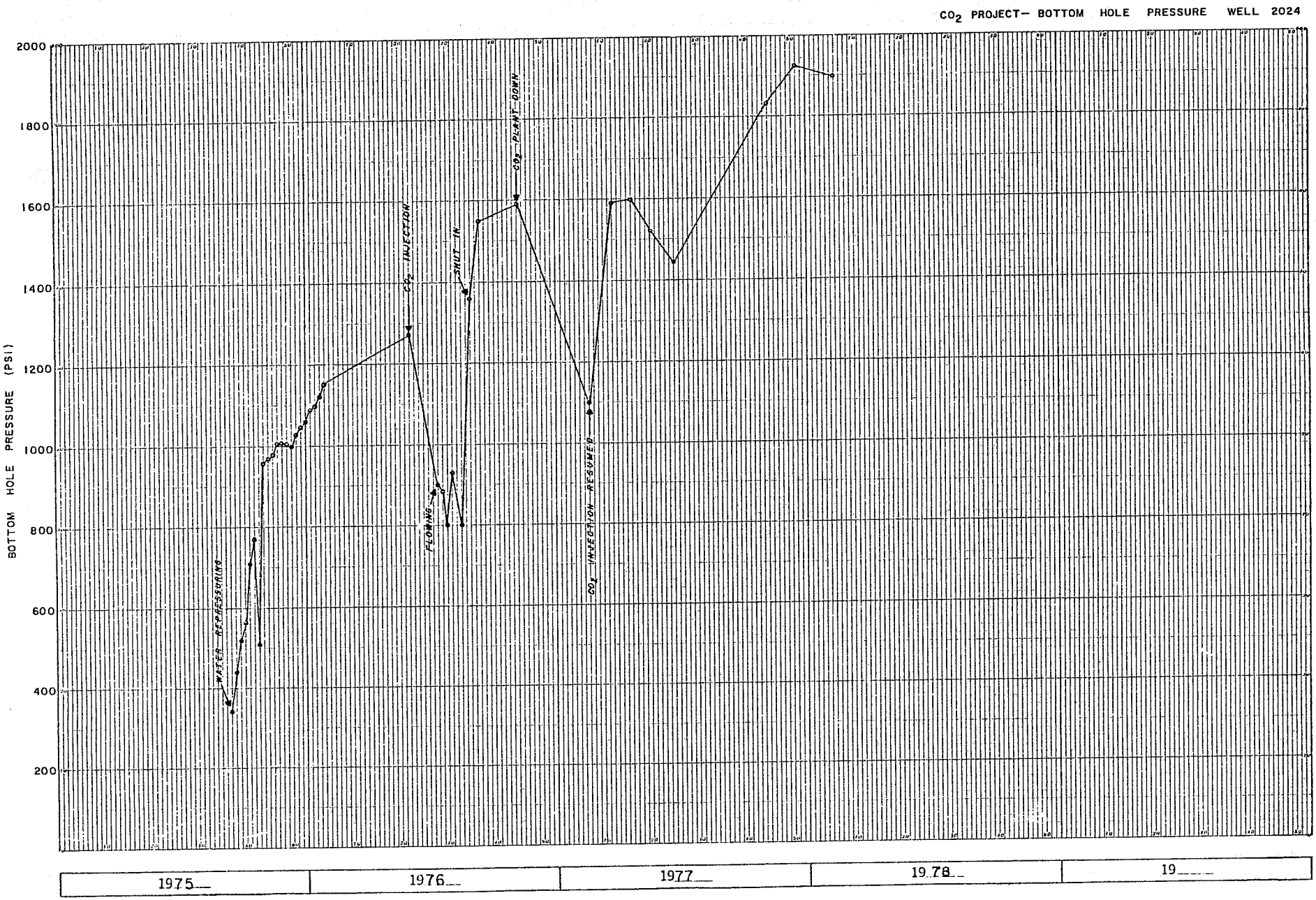

CO2 PROJECT-TOTAL PRODUCTION (12 WELLS)
WEEKLY PRODUCTION (BBL'S)
WATER CUT (%)
WATER
OIL
% WATER CUT
CO2 INJECTION STARTED
2024 SHUT-IN
2021 SHUT-IN
2024 SHUT-IN
CO2 PLANT DOWN
CO2 INJECTION RESUMED
1976
1977
1978


CO2 & WATER INJECTION
CO2 INJECTION - TONS
WATER INJECTION
WATER
CO2
1500
1000
500
0
400
300
200
100
0
1976
1977
1978
19
19


WELL 4254
WEEKLY OIL PRODUCTION
WEEKLY WATER PRODUCTION
OIL
WATER
INSTALLED PUMPING EQUIPMENT
1976
1977
1978


CO2 PROJECT-BOTTOM HOLE PRESSURE WELL 20274
BOTTOM HOLE PRESSURE (PSI)
1800
1600
1400
1200
1000
800
600
400
200
WATER REPRESSURING
REPAIR WELL HEAD
CO2 INJECTION
CO2 PLANT DOWN
CO2 INJECTION RESUME
1975
1976
1977
19
19


CO2 PROJECT — BOTTOM HOLE PRESSURE WELL 2021
BOTTOM HOLE PRESSURE (PSI)
1600
1400
1200
1000
800
600
400
200
WATER REPRESSURING
CO2 INJECTION
SHUT-IN
CO2 PLANT DOWN
CO2 INJECTION RESUMED
1975
1976
1977
19
19


CO_2 PROJECT— BOTTOM HOLE PRESSURE WELL 2024
BOTTOM HOLE PRESSURE (PSI)
2000
1800
1600
1400
1200
1000
800
600
400
200
WATER DEPRESSURING
CO_2 INJECTION
FLOWING
SHUT IN
CO_2 PLANT DOWN
CO_2 INJECTION RESUMED
1975
1976
1977
1978
19

CO_2 PROJECT
MONTHLY WATER INJECTION
(After CO_2 Injection)

	Month	2020 Monthly Total	2020 Cum. Total	2022 Monthly Total	2022 Cum. Total	2023 Monthly Total	2023 Cum. Total	2025 Monthly Total	2025 Cum. Total	Monthly Total	Total Cum.Inj.	Daily Av./ Well	Remarks
1977	June	437	437	872	872	1015	1015	797	797	3121	3121	52	Plant down -0-
	July	988	1425	1414	2286	1685	2700	1498	2295	5585	8706	45	Plant down 49 hrs.
	August	1103	2528	1179	3465	1708	4408	1590	3885	5580	14286	45	Plant down 58 hrs.
	September	1107	3635	1079	4544	1607	6015	1447	5332	5240	19526	43	Plant down 91 hrs.
	October	1389	5024	1072	5616	1598	7613	1384	6716	5443	24969	44	Plant down 52 hrs.
	November	1312	6336	1492	7108	1501	9114	1230	7946	5535	30504	46	Plant down 24 hrs.
	December	1232	7568	1283	8391	1423	10537	1181	9127	5119	35623	41	Plant down 18.5 hrs
1978	January	1123	8691	1118	9509	1242	11779	959	10086	4442	40065	36	Plant down 36.5 hrs
	February	728	9419	910	10419	1262	13041	1168	11254	4068	44133	36	Plant down 14 hrs.

CO_2 INJECTION PROJECT
TOTAL PRODUCTION

	Month	Total Oil	Add'l Oil (1363 Bbls) Base	Cum. Oil	Cum. Add'l Oil	Total Water	Add'l Water (1393 Bbls) Base	Cum. Water	Cum. Add'l Water	Total Fluid	% Water Cut	Remarks
1976	June	1412	49	1412	49	1468	75	1468	75	2880	51	
	July	1584	221	2996	270	1622	229	3090	304	3206	51	
	August	2157	794	5153	1064	1338	-	4428	304	3495	38	
	September	1882	519	7035	1583	1254	-	5682	304	3136	40	
	October	2196	833	9231	2416	1724	331	7406	635	3920	44	
	November	1946	583	11177	2999	1417	24	8823	659	3363	42	
	December	1857	494	13034	3493	1199	-	10022	659	3056	39	
1977	January	1590	227	14624	3720	943	-	10965	659	2533	37	
	February	1323	-	15947	3720	578	-	11543	659	1901	30	
	March	1396	33	17343	3753	1371	-	12914	659	2767	50	
	April	1477	114	18820	3867	1452	59	14366	718	2929	50	
	May	1969	606	20789	4473	1812	419	16178	1137	3781	48	
	June	2444	1081	23233	5554	1780	387	17958	1524	4224	42	
	July	2320	957	25553	6511	1686	293	19644	1817	4006	42	
	August	1954	591	27507	7102	2108	715	21752	2532	4062	52	
	September	1881	518	29388	7620	2196	803	23948	3335	4077	54	
	October	1732	369	31120	7989	2700	1307	26648	4642	4432	61	
	November	1525	162	32645	8151	2499	1106	29147	5748	4024	62	
	December	1367	4	34012	8155	2389	996	31563	6744	3756	63	
1978	January	1152	-	35164	8155	2230	837	33793	7581	3382	66	
	February	990	-	35154	8155	2161	768	35954	8349	3151	68	

CO_2 PROJECT
OIL & WATER PRODUCTION
SUMMARY

		-INSIDE PATTERN-					-OUTSIDE PATTERN-					
	MONTH	OIL	WATER	TOTAL FLUID	CUM. OIL	CUM. WATER	OIL	WATER	TOTAL FLUID	CUM. OIL	CUM. WATER	REMARKS
1976	June	212	380	592	212	380	1199	1088	2288	1199	1088	
	July	553	553	1107	766	933	1030	1068	2099	2230	2157	
	August	576	344	920	1342	1278	1581	994	2575	3811	3151	
	September	146	-	146	1488	1278	1735	1254	2990	5547	4406	Inside: #4254
	October	304	58	363	1793	1337	1891	1666	3557	7438	6072	Inside: 2 Wells
	November	**225*	15	241	2019	1352	**1720	1401	3121	9159	7473	Inside: #4254
	December	224	9	234	2244	1362	1632	1189	2822	10792	8663	Inside: #4254
1977	January	222	107	330	2466	1470	1368	835	2204	12160	9499	Inside: 2 Wells
	February	87	1	88	2553	1472	1236	577	1813	13396	10076	Inside: #4254
	March	105	-	105	2659	1472	1290	1371	2661	14687	11447	Inside: #4254
	April	174	115	289	2833	1587	1303	1336	2639	15990	12784	Inside: #4254
	May	292	300	593	3126	1888	1676	1511	3188	17667	14295	Inside: #4254
	June	257	234	492	3384	2122	2186	1546	3733	19853	15842	Inside: #4254
	July	256	311	568	3640	2433	2064	1375	3439	21917	17218	Inside: #4254
	August	253	863	1117	3894	3297	1700	1245	2946	23618	18463	
	September	128	700	829	4023	3997	1752	1495	3248	25371	19959	Inside: #4254
	October	81	1059	1140	4104	5056	1651	1640	3292	27022	21600	Inside: 2 Wells
	November	42	850	893	4147	5907	1483	1649	3132	28505	23249	Inside: #4254
	December	43	907	951	4191	6814	1323	1481	2804	29828	24731	Inside: #4254
1978	January	47	887	934	4238	7702	1104	1342	2447	30933	26073	Inside: #4254
	February	43	802	845	4281	8504	947	1358	2305	31880	27431	Inside: 3 Wells

*Well Fractured
**Well Treated with Carbon Bisulfide

CO_2 INJECTION PROJECT
PRODUCTION FROM WELLS INSIDE PATTERN
MONTHLY TOTALS (BBLS.)

	MONTH	2021 OIL	2021 WATER	2021 TOTAL FLUID	2024 OIL	2024 WATER	2024 TOTAL FLUID	4254 OIL	4254 WATER	4254 TOTAL FLUID	20274 OIL	20274 WATER	20274 TOTAL FLUID
1976	June	-	-	-	-	136	136	4	10	15	207	232	440
	July	13	73	87	109	227	336	105	13	118	325	239	564
	August	49	85	135	327	206	533	157	15	173	41	36	78
	September	* -	-	-	* -	-	-	146	-	146	* -	-	-
	October	* -	-	-	58	36	94	**246	22	268	* -	-	-
	November	* -	-	-	* -	-	-	***225	15	241	* -	-	-
	December	* -	-	-	* -	-	-	224	9	234	* -	-	-
1977	January	* -	-	-	* -	-	-	161	50	211	61	57	118
	February	* -	-	-	* -	-	-	87	1	88	* -	-	-
	March	* -	-	-	* -	-	-	105	-	105	* -	-	-
	April	* -	-	-	* -	-	-	174	115	289	* -	-	-
	May	* -	-	-	* -	-	-	292	300	593	* -	-	-
	June	* -	-	-	* -	-	-	257	234	492	* -	-	-
	July	* -	-	-	* -	-	-	256	311	568	* -	-	-
	August	26	39	65	28	94	122	171	613	785	27	116	143
	September	* -	-	-	* -	-	-	128	700	829	* -	-	-
	October	* -	-	-	15	264	280	65	794	859	* -	-	-
	November	* -	-	-	* -	-	-	42	850	893	* -	-	-
	December	* -	-	-	* -	-	-	43	907	951	* -	-	-
1978	January	* -	-	-	* -	-	-	47	887	934	* -	-	-
	February	* -	-	-	4	84	90	26	688	714	11	29	17

*Shut In
**Well Fractured
***Well Treated with Carbon Bisulfide

CO_2 INJECTION PROJECT
PRODUCTION FROM WELLS OUTSIDE PATTERN
MONTHLY TOTALS (BBLS.)

	MONTH	2047 OIL	2047 WATER	2047 TOTAL FLUID	4049 OIL	4049 WATER	4049 TOTAL FLUID	4591 OIL	4591 WATER	4591 TOTAL FLUID	2043 OIL	2043 WATER	2043 TOTAL FLUID
1976	June	35	65	101	43	250	293	53	111	165	164	66	231
	July	* 1	15	17	7	402	409	29	164	193	259	72	331
	August	333	100	434	-	252	252	82	258	340	261	38	299
	September	363	90	453	55	414	470	117	89	206	273	60	334
	October	259	53	312	107	842	949	112	135	248	324	67	391
	November	243	57	300	136	678	815	97	131	229	314	45	360
	December	221	44	266	173	615	788	142	69	212	348	51	399
1977	January	222	51	273	141	470	612	118	50	169	274	58	332
	February	172	30	203	* 52	151	204	96	41	137	210	47	257
	March	161	41	203	115	812	927	80	45	126	183	65	249
	April	150	53	203	136	582	718	61	37	98	170	77	248
	May	193	56	249	173	605	779	73	70	144	162	39	201
	June	204	52	256	169	561	730	165	63	228	212	65	278
	July	214	48	263	181	530	712	129	35	165	162	34	196
	August	145	26	171	187	488	675	107	48	156	126	55	181
	September	267	52	319	181	450	632	102	68	170	109	74	184
	October	*122	55	178	245	493	739	74	63	137	100	96	196
	November	193	78	271	154	450	605	76	104	180	90	94	184
	December	207	77	284	144	490	634	87	146	234	111	84	195
1978	January	200	86	287	109	473	582	67	137	204	105	94	200
	February	189	71	260	85	468	553	41	128	170	102	87	189

*Well Off Production-Pulled-Changed Pump
**Well is Off

CO_2 INJECTION PROJECT
PRODUCTION FROM WELLS OUTSIDE PATTERN
MONTHLY TOTALS (BBLS.)

	MONTH	2044 OIL	2044 WATER	2044 TOTAL FLUID	4090 OIL	4090 WATER	4090 TOTAL FLUID	2046 OIL	2046 WATER	2046 TOTAL FLUID	2048 OIL	2048 WATER	2048 TOTAL FLUID
1976	June	171	309	480	286	169	456	303	111	414	141	3	144
	July	184	160	344	*123	116	239	280	133	413	**144	4	149
	August	314	109	423	442	232	674	** 7	-	7	140	2	142
	September	409	216	625	366	380	746	4	-	4	146	2	148
	October	499	198	698	376	366	743	24	-	24	186	2	189
	November	379	133	512	324	341	666	***29	-	30	193	11	205
	December	268	116	384	252	292	544	47	-	48	178	-	178
1977	January	285	120	405	**124	79	204	28	-	29	172	4	176
	February	92	33	126	452	268	721	1	-	1	157	3	161
	March	146	175	322	***360	227	587	49	-	49	192	2	195
	April	211	166	378	339	386	726	38	29	68	195	3	198
	May	268	169	437	346	399	745	215	168	384	243	2	245
	June	306	126	433	340	387	728	684	283	967	102	6	108
	July	239	111	351	380	389	770	630	217	848	124	8	132
	August	19	55	75	386	369	756	573	192	766	153	8	161
	September	120	316	436	310	336	646	471	189	660	190	7	197
	October	172	351	523	345	346	691	427	217	645	161	17	179
	November	130	401	532	316	304	620	375	207	582	146	7	154
	December	24	228	252	200	244	444	403	207	611	144	4	148
1978	January	20	229	250	107	97	205	362	220	528	131	2	133
	February	22	295	317	*****30	73	104	318	202	520	157	1	159

*Rods Out for Testing
**Rods Out for Testing & Changing Casinghead
***Well Treated with Carbon Bisulfide
****Shut In
*****Well is Off

CO_2 INJECTION PROJECT
GAS OPEN FLOWS & CO_2 ANALYSIS

WEEK ENDING

WELL NO.	2-25-77 MCF	2-25-77 %CO_2	3-9-77 MCF	3-9-77 %CO_2	3-30-77 MCF	3-30-77 %CO_2	5-4-77 MCF	5-4-77 %CO_2	5-31-77 MCF	5-31-77 %CO_2	6-14-77 MCF	6-14-77 %CO_2	1-15-78 MCF	1-15-78 % CO_2
1327			7.1	0.0	8.9	0.0	8.5	0.0	8.5	0.0	8.5	1.0	3.8	.25
1265			3.1	15.0	2.7	6.0	Tr.	0.0	4.5	2.0	4.3	14.0	1.6	.25
1282			21.0	0.0	36.1	0.0	41.5	0.0	26.4	0.0	30.0	1.5	10.2	.25
1285			41.0	0.0	22.8	0.0	43.0	0.0	37.3	0.0	43.7	0.0	31.6	.25
20325			3.8	2.5	2.6	0.0	5.8	0.0	8.5	0.0	4.5	0.0	6.0	.50
1258			3.2	13.5	2.9	15.0	3.3	6.5	3.3	6.5	3.3	9.0	2.7	.25
2040	-	4.5			Tr.	8.0	1.0	6.5	1.1	8.0	0.8	11.5	.78	1.75
3985	Tr.	0.0			2.5	0.0	2.4	0.0	2.7	0.0	2.8	0.0	1.9	.25
4258	1.0	11.0			1.1	11.0	1.0	4.5	0.8	7.5	1.1	4.5	.79	.25
4049					1.1	10.5	1.4	4.5	1.1	10.0			63.3	2.5
4090	-	13.5			-	5.5	Tr.	4.5	Tr.	3.5	Tr.	10.5		
2048			2.8	>20.0	4.3	>20.0	7.8	>20.0	1.8	>20.0	.6	>20.0	13.2	12.0
4591			6.0	>20.0	1.6	>20.0	6.9	>20.0	6.3	>20.0	32.0	>20.0	10.2	12.0
2053			2.9	0.0	Tr.	0.0	1.0	1.0	Tr.	2.0	Tr.	0.0	1.6	1.0
2045	2.9	6.5			2.2	5.5	1.8	4.0	2.5	9.5	2.3	10.0	1.4	6.0
1252	1.2	1.0			-	-	SHUT	IN	0.6	0.0	Tr.	0.0	1.36	2.0
2042			0.6	6.5	1.0	8.5	1.1	9.5	Tr.	1.0	Tr.	0.0	-	.75
2043			8.5	>20.0	11.8	>20.0	28.0	>20.0	42.6	>20.0	18.1	>20.0	19.1	12.0
2046							FLOWING						26.9	12.0
4050			24.5	0.0	30.2	0.0	25.7	0.0	28.0	0.0	28.0	0.0		
4039					Tr.	0.0	0.6	0.0	0.8	0.0	0.6	0.0	.79	.50
1871	0.8	13.0			Tr.	0.0	Tr.	9.0	Tr.	4.5	Tr.	4.5	-	.25
1919	0.6	4.5			0.6	0.0	0.8	0.0	0.8	0.0	0.6	0.0	-	.75
20327			26.4	>20.0	29.5	0.0			30.0	0.0	34.9	0.0	21.9	.25
1347			2.9	8.0	3.0	4.5	3.1	2.5	3.1	5.5	2.8	1.0	1.3	.25
2047			8.0	>20.0	6.0	>20.0	4.8	>20.0	5.8	>20.0	8.5	>20.0	18.3	12.0
2041	1.6	14.5			2.4	8.0	2.2	0.5	2.7	0.0	2.6	9.0	.78	.50
1324	31.0	0.0			29.5	0.0	8.5	0.0	34.0	0.0	35.0	0.0	22.8	.25
1315	22.8	0.0			14.7	0.0	16.5	0.0	18.0	0.0	18.5	0.0	-	-
1284	4.5	7.0			3.0	3.5	42.6	7.0	2.9	4.5	2.1	3.0	-	.25
1349	17.7	0.0			17.6	0.0	17.0	3.5	4.9	0.0	20.0	0.0	8.9	.25
1297			2.7	5.0	2.7	5.5	1.0	0.0	0.8	0.0	2.6	4.0	6.0	.25
1323			9.3	0.0	10.2	0.0	7.9	0.0	7.6	1.0	7.1	0.0	-	0.0
1318							8.9	0.0	8.5	0.0	10.0	0.0	7.6	.25
2072			20.4	0.0	19.6	0.0	18.1	0.0	16.0	0.0	17.0	0.0	10.4	.25
1279	11.1	0.0			12.0	0.0	9.1	0.0	9.7	0.0	8.5	0.0	11.1	.25

CO_2 INJECTION PROJECT
GAS OPEN FLOWS & CO_2 ANALYSIS

WEEK ENDING

WELL NO.	2-25-77 MCF	2-25-77 %CO_2	3-9-77 MCF	3-9-77 %CO_2	3-30-77 MCF	3-30-77 %CO_2	5-4-77 MCF	5-4-77 %CO_2	5-31-77 MCF	5-31-77 %CO_2	6-14-77 MCF	6-14-77 %CO_2	1-15-78 MCF	1-15-78 % CO_2
1347	22.1	0.0			9.3	0.0	38.2	0.0	3.8	0.0	26.0	4.0	23.6	0.0
3905	1.1	3.0			Tr.	2.5	0.6	6.5	0.8	3.0	0.6	3.5	-	.25
1334	Tr.	4.0			Tr.	0.0	Tr.	0.0	Tr.	6.0	Tr.	0.0	-	.25
4029	2.8	1.0			-	-	2.7	8.5	2.8	2.0	2.4	4.0	1.1	1.9
2052	Tr.	0.0			Tr.	4.0	1.0	6.0	0.8	3.0	Tr.	5.0		
1354	-	0.0			-	0.0	Tr.	0.0	Tr.	0.0	Shut	In	-	0.0
3904	2.7	5.5			3.5	2.5	3.7	0.0	1.8	1.0	-	-	1.1	12.0

CO_2 INJECTION PROJECT WATER ANALYSIS

WELL NO.	7-1-77 pH	7-1-77 Total Cl.	7-8-77 pH	7-8-77 Total Cl.	10-17-77 pH	10-17-77 Total Cl.	10-26-77 pH	10-26-77 Total Cl.	11-77 pH	11-77 Total Cl.
2044	6.5	61,000					8.5	33,000	8.0	32,000
4591	6.5	68,000	6.5	72,000			8.2	100,000	8.5	86,000
2043							8.0	55,000	8.0	84,000
4090	7.0	25,000	7.0	27,000			8.0	30,000	8.0	32,000
4049	7.5	17,500	7.5	17,500			8.0	20,000	8.5	22,000
4254	6.5	68,000	6.5	73,000			8.2	70,000	8 0	64,000
2047	6.0	120,000	6.7	125,000					7.0	120,000
3985					8.5	30,000			8.0	52,000
4039					8.0	25,500			8.0	30,000
2052					8.0	57,500			8.0	70,000
1919					8.0	41,000			8.0	42,000
4029					8.5	15,000				
1334					8.0	22,500			9.0	25,000
2045					8.0	50,000			7.5	52,000
1354					8.0	12,500			8.0	14,000
3905					8.0	30,000			8.0	36,000
2053					8.5	10,000			-	-
2041									8.0	49,000
1252					8.0	18,000			-	-
1265					8.5	10,000			8.0	16,000
2042									8.5	39,000
1327									8.0	22,000
1349									8.0	82,000
2040					7.0	39,000			8.0	46,000
2046	6.5	65,000	6.5	63,500						
1258					8.7	26,000				
1315										

CO_2 INJECTION PROJECT WATER ANALYSIS

WELL NO.	12-77 pH	12-77 Total Cl.	1-78= pH	1-78= Total Cl.	2-78 pH	2-78 Total Cl.	3-78 ph	3-78 Total Cl.	4-78 pH	4-78 Total Cl.
2044	8.0	32,000	8.0	32,000	7.0	25,200				
4591	7.5	100,000	7.0	100,000	-	-				
2043	8.0	82,000	-	-	7.5	114,000				
4090	-	-	-	-	-	-				
4049	8.0	18,000	8.0	22,000	7.0	19,200				
4254	7.5	71,000	7.5	60,000	7.0	80,400				
2047	7.5	68,000	8.5	112,000	-	-				
3985	8.0	60,000	8.0	50,000	7.0	74,400				
4039	-	-	8.0	30,000	6.0	32,400				
2052	8.0	72,000			7.0	126,000				
1919	8.0	42,000	7.5	42,000	7.0	55,200				
4029	8.5	22,000								
1334	8.5	30,000	8.0	28,000	6.5	16,300				
2045	8.0	56,000	8.5	50,000	7.5	24,000				
1354	8.5	14,000	8.5	10,000	8.0	12,000				
3905	8.0	46,000	8.0	32,000	6.0	39,600				
2053	8.0	14,000	8.5	16,000	7.0	13,200				
2041	8.0	41,000	-	-	6.0	45,600				
1252	-	-	8.5	21,000	7.0	19,200				
1265	8.0	14,000	8.0	14,000	7.0	19,200				
2042	-	-	-	-	7.0	34,800				
1327	8.0	20,100	-	-	7.0	21,000				
1349	8.0	35,000	-	-	6.5	114,000				
2040	7.5	42,000	8.5	50,000	6.0	14,400				
2046										
1258	7.5	23,000								
1315	7.5	53,000								

APPENDIX D

ABSTRACT

OBJECTIVE

The objective of this field test is to evaluate and demonstrate the effectiveness of using CO_2 injection to recover high gravity crude oil from shallow watered-out reservoirs The estimated recovery potential from the flood pattern of six (6) acres is approximately 50,000 barrels. The work will be conducted in five (5) phases as follows:

Phase 1--Preliminary Testing and Construction Water Injection, and Plant Construction

Phase 2--Natural Gasoline Injection

Phase 3--CO_2 Injection

Phase 4--Carbonated Water Injection

Phase 5--Water Injection

SUMMARY

The 5th Phase of the project, water injection, began on June 16, 1977, with the completion of CO_2 injection, and continued throughout the current quarter. It is planned to continue this phase until terminated by the Technical Committee. Total water injection for the period was 16,405 barrels for an average of 44.5 barrels of water per well per day. While the current rate is somewhat below that planned, it is expected that the project will be completed as scheduled. Although there were 198 hours of down time, only 30 of it was planned and that was to install a new filter system and clean the water storage tanks. The remainder of the down time was caused by power outages.

Oil production for the period amounted to 6155 barrels, bringing the total oil recovered due to CO_2 injection, to 7620 barrels. While total oil production was higher than the previous quarter, it actually peaked during June and declined slightly during July and rather drastically during August. Pumping equipment was installed in well #4254 in the latter part of July and almost immediately the oil production began declining and water production increased. Bottom hole pressures taken during the quarter indicates we continue to have high reservoir pressures inside the pattern.

WATER INJECTION

Phase 5, Water Injection, began immediately upon completion of the CO_2 injection phase and will continue until terminated by the Technical Committee. This phase of the project began on June 16 and continued throughout the quarter. Quarterly injection rates are shown below for each well along with cumulative volumes since the phase started.

Well No.	Quarterly Inj. (bbls)	Cum. Inj. (bbls)
2020	3,198	3,635
2022	3,672	4,544
2023	5,000	6,015
2025	4,535	5,332
Total	16,405	19,526

Daily average injection per well was 44.5 barrels. This is somewhat below that proposed in the contract. However, it was necessary to continually raise the injection pressure in order to maintain a satisfactory rate. Injection pressures increased from 1100 psi to 1350 during the quarter.

Since the CO_2 lines were used as water injection lines after manifolding the two plants together during the past winter, no trouble was experienced when the pressure was increased. Most of our trouble was experienced with the local power company. The 198 hours of down time was mostly due to power outages, although we were down approximately 30 hours to install new filtering equipment and clean the water storage tanks.

Also during the period additions were made to the water supply system, and a program of reburying supply lines and insulating surface equipment was started. This is being done in order to avoid the problems of winter.

A monthly break-down of injection to date for each well is shown in the attached table. The enclosed graph shows weekly injection of CO_2 and water since the project was started.

OIL AND WATER PRODUCTION

Total oil and water production for the quarter was as follows:

Month	Oil(bbls)	Water(bbls)
July	2,320	1,686
August	1,954	2,108
September	1,881	2,196
Total	6,155	5,990

This compares with oil production of 5888 barrels and 5008 barrels of water for the preceding quarter, or an increase of 267 barrels of oil and 982 barrels of water. However, these comparisons are somewhat misleading in that oil production as shown on the attached graphs and chart actually peaked during June and has subsequently declined.

While the production characteristics of most of the wells after June seem to be reversing themselves, the most marked change has been in 4254, the central producer. Since the well did not produce to its potential by flowing, pumping equipment was installed during the latter part of July. Almost immediately, water production increased and during August and September oil production dropped substantially. Other than routine servicing, no serious problems were encountered with production equipment.

During August flow tests were made on wells 2021, 2024 and 20274 with the following results:

	2021		2024		20274	
Date	Oil	Water	Oil	Water	Oil	Water
8-10	12.45	8.30				
8-11	4.98	10.79				
8-12	.83	3.32	10.79	19.09		
8-13			6.64	18.26		
8-14			8.30	22.41		
8-15			-	19.09		
8-16			-	2.49	13.28	27.39
8-17					3.32	25.73
8-18					4.98	14.98
8-19					1.66	25.73
Total	18.26	22.41	25.73	81.34	23.24	93.83

Through September 30, 1977, cumulative oil production directly attributable to CO_2 injection is 7620 barrels. Monthly totals of oil and water production for each well in the project, along with a summary sheet for the project as a whole, are shown on the attached data sheets.

BOTTOM HOLE PRESSURE TESTS

An attempt was made to run B.H.P.'s in July. However, the instrument became stuck in well 2024, the first well scheduled to be tested. During fishing operations, that consumed approximately 10 days, the instrument suffered some damage and was sent in for repairs and recalibration. Since the service company did not get the tool back until early in September, no B.H.P.'s were run in either July or August. They were run on 3 wells on September 8, 1977, with the following results:

Well No.	B.H.P.(psi)
20274	1,641
2021	1,479
2044	883

As indicated on the graphs, we continue to have high reservoir pressure within the pattern.

GAS SAMPLES

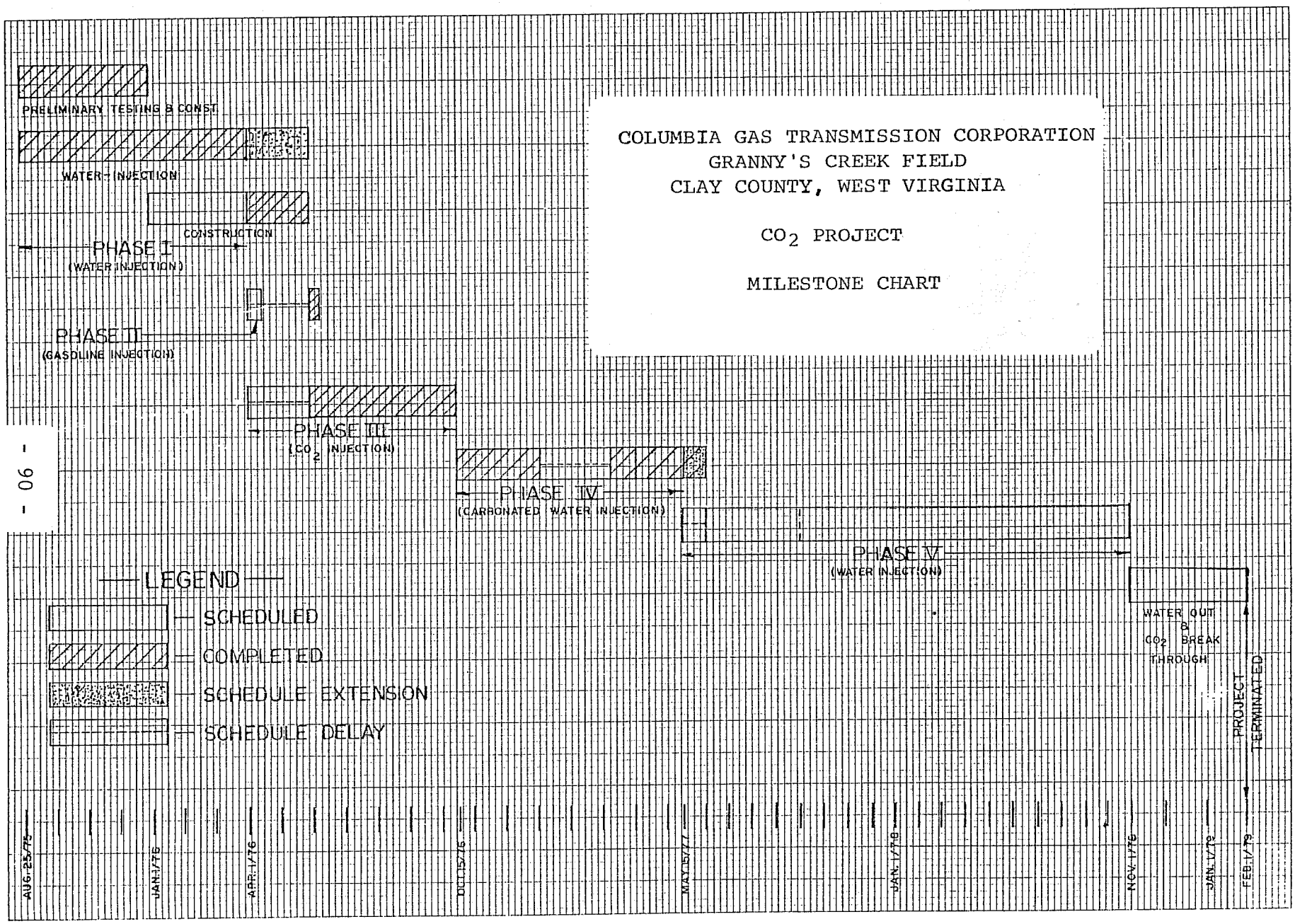
Due to changes in the organization, manpower was not available to obtain and analyze gas samples. However, the gas separation and metering equipment was in service on well 2044. During July, gas production from this well averaged 13,819 cu.ft. per day. During August the meter was sent in for repairs and had not been returned by the end of the quarter. Work was started during the quarter to move the separation equipment to the tank batteries and construct manifolding, so that all wells in the project can be tested for gas production, instead of only the one (2044).

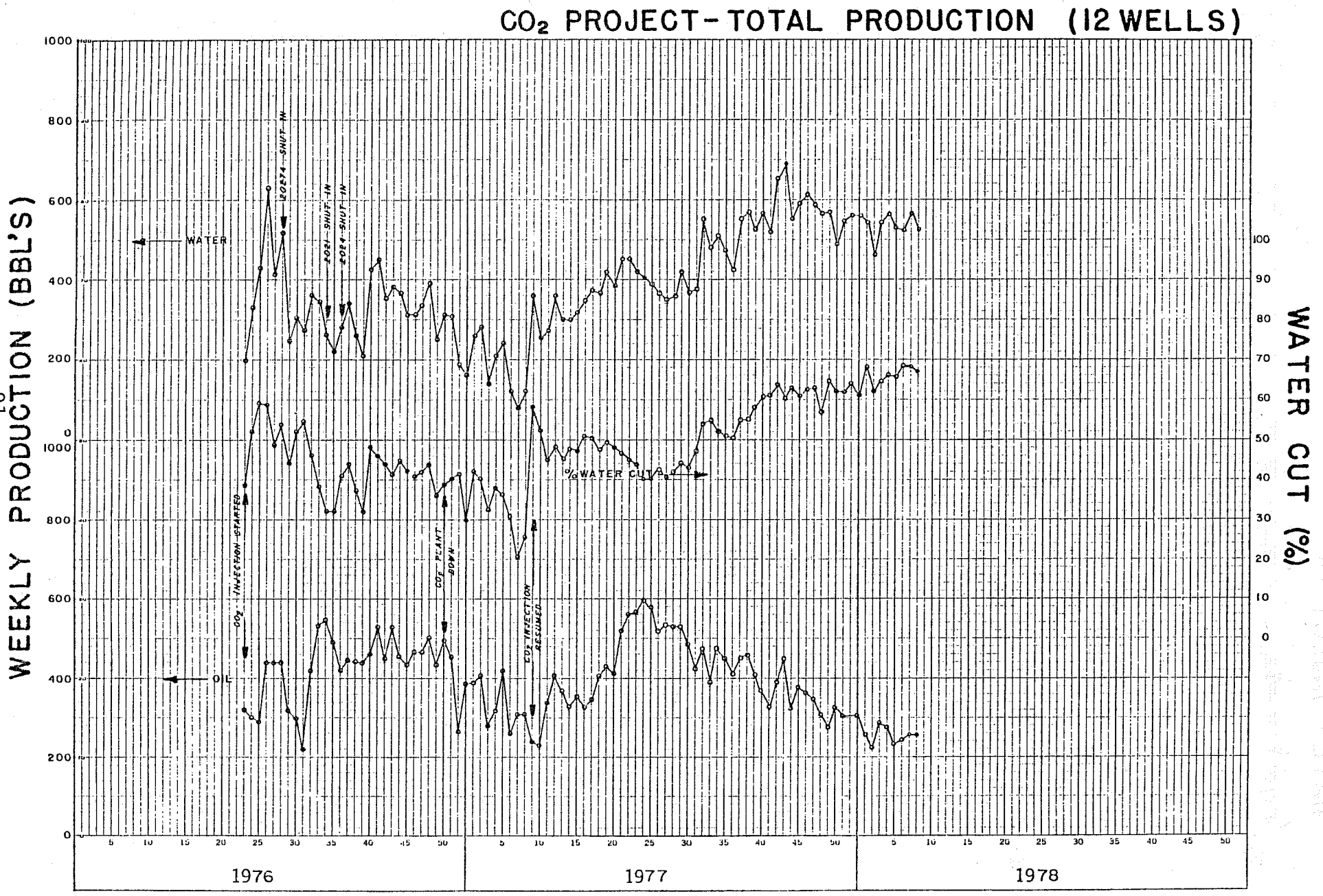
WATER ANALYSIS

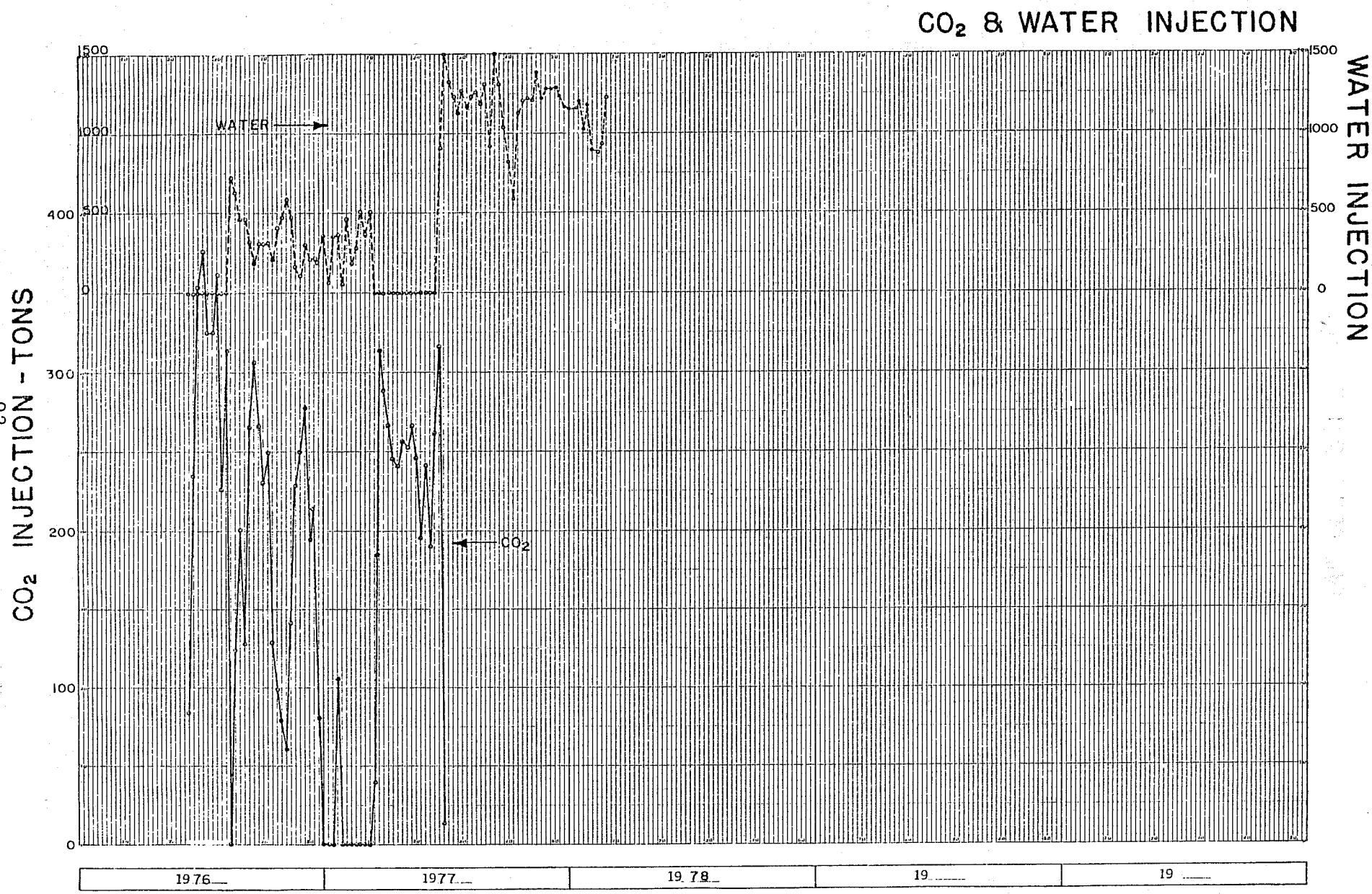
Water samples from those wells having water production were taken in July and analyzed for pH and chloride content. During August samples were sent to Halliburton for analysis and no samples were taken during September since personnel was not available for this work.

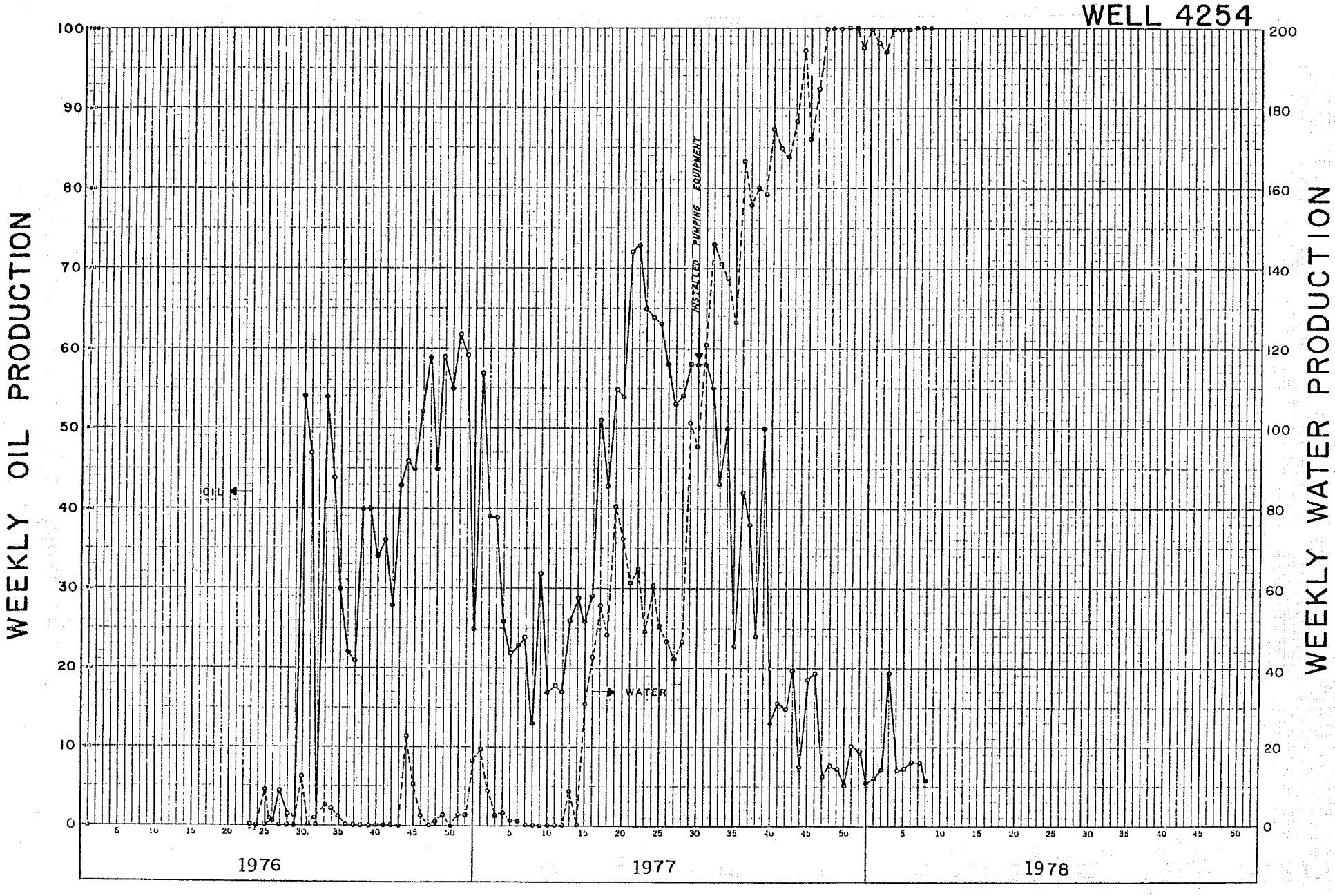
PROJECT SCHEDULE

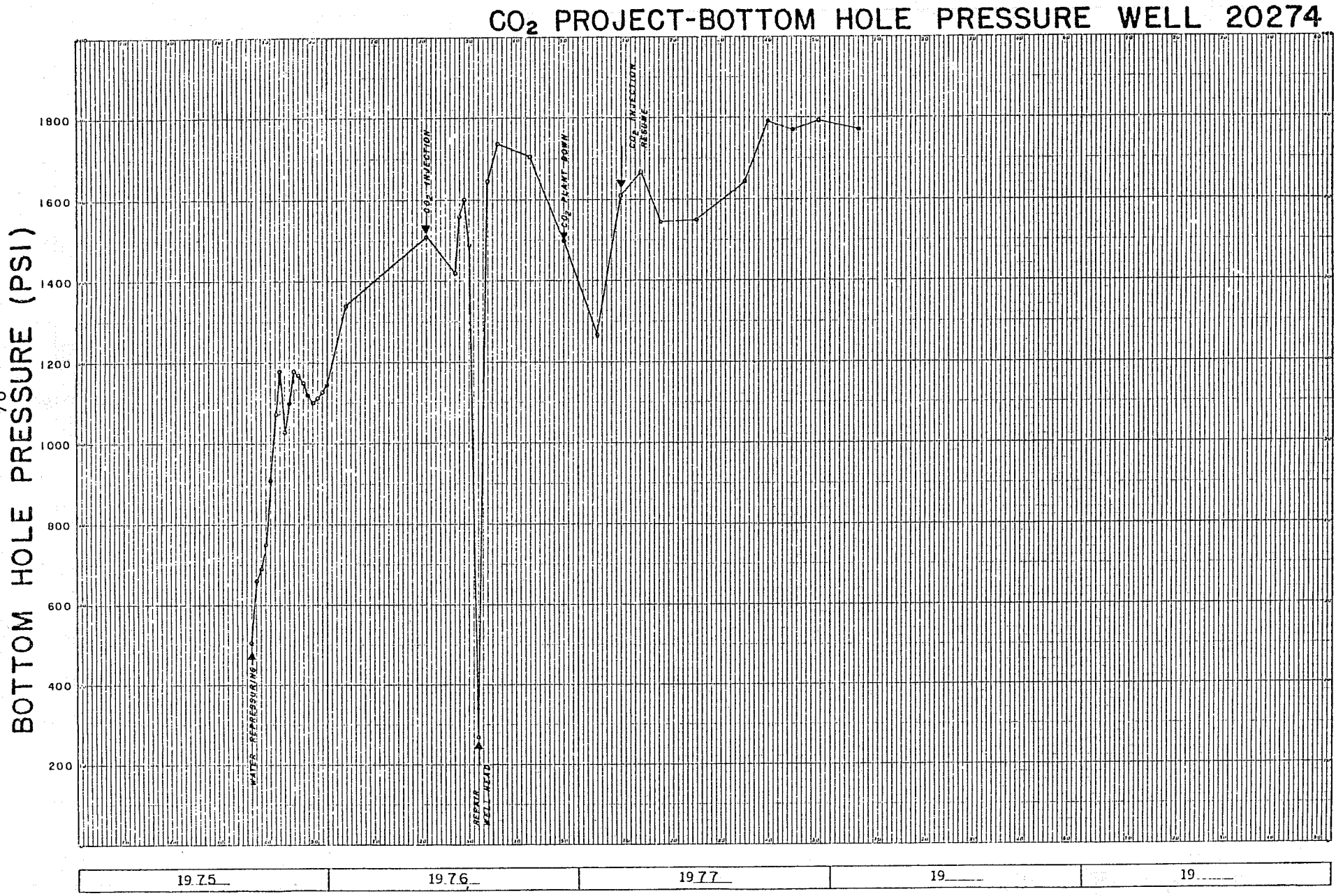
The attached Milestone Chart shows the original schedule and progress to date. As can be seen, completion of the CO_2 phase (phases 3 and 4) were delayed approximately one month due to the shut-down of last winter and the additional 1000 tons injected. Although water injection rates have been slightly lower than anticipated, it is beieved that the project will be completed on schedule.

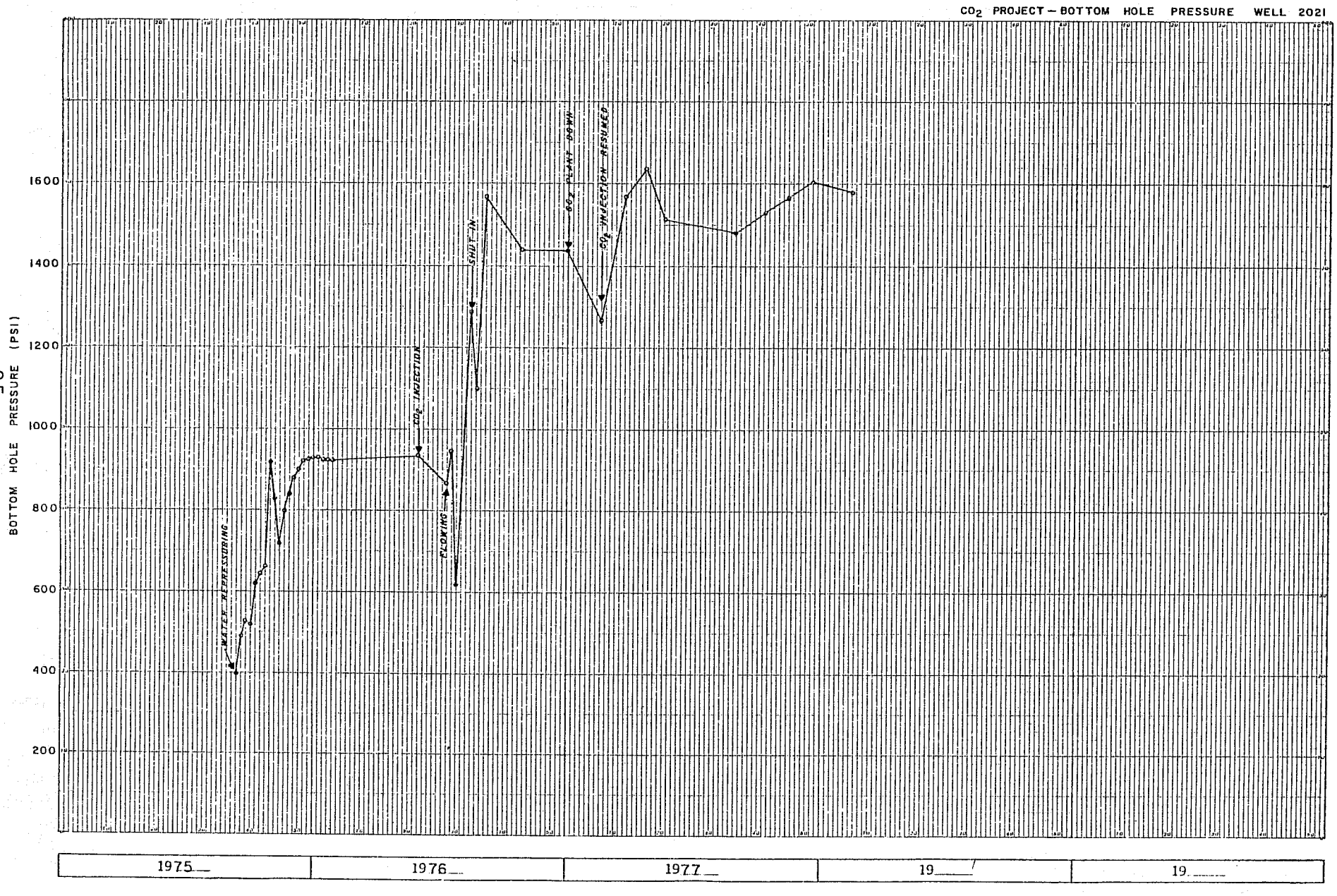

COLUMBIA GAS TRANSMISSION CORPORATION
GRANNY'S CREEK FIELD
CLAY COUNTY, WEST VIRGINIA
CO_2 PROJECT
MILESTONE CHART
PRELIMINARY TESTING & CONST.
WATER INJECTION
CONSTRUCTION
PHASE I
(WATER INJECTION)
PHASE II
(GASOLINE INJECTION)
PHASE III
(CO_2 INJECTION)
PHASE IV
(CARBONATED WATER INJECTION)
PHASE V
(WATER INJECTION)
WATER OUT & CO_2 BREAK THROUGH
PROJECT TERMINATED
LEGEND
SCHEDULED
COMPLETED
SCHEDULE EXTENSION
SCHEDULE DELAY
AUG. 25/75
JAN. 1/76
APR. 1/76
OCT. 15/76
MAY 25/77
JAN. 1/78
NOV. 1/78
JAN. 1/79
FEB. 1/79

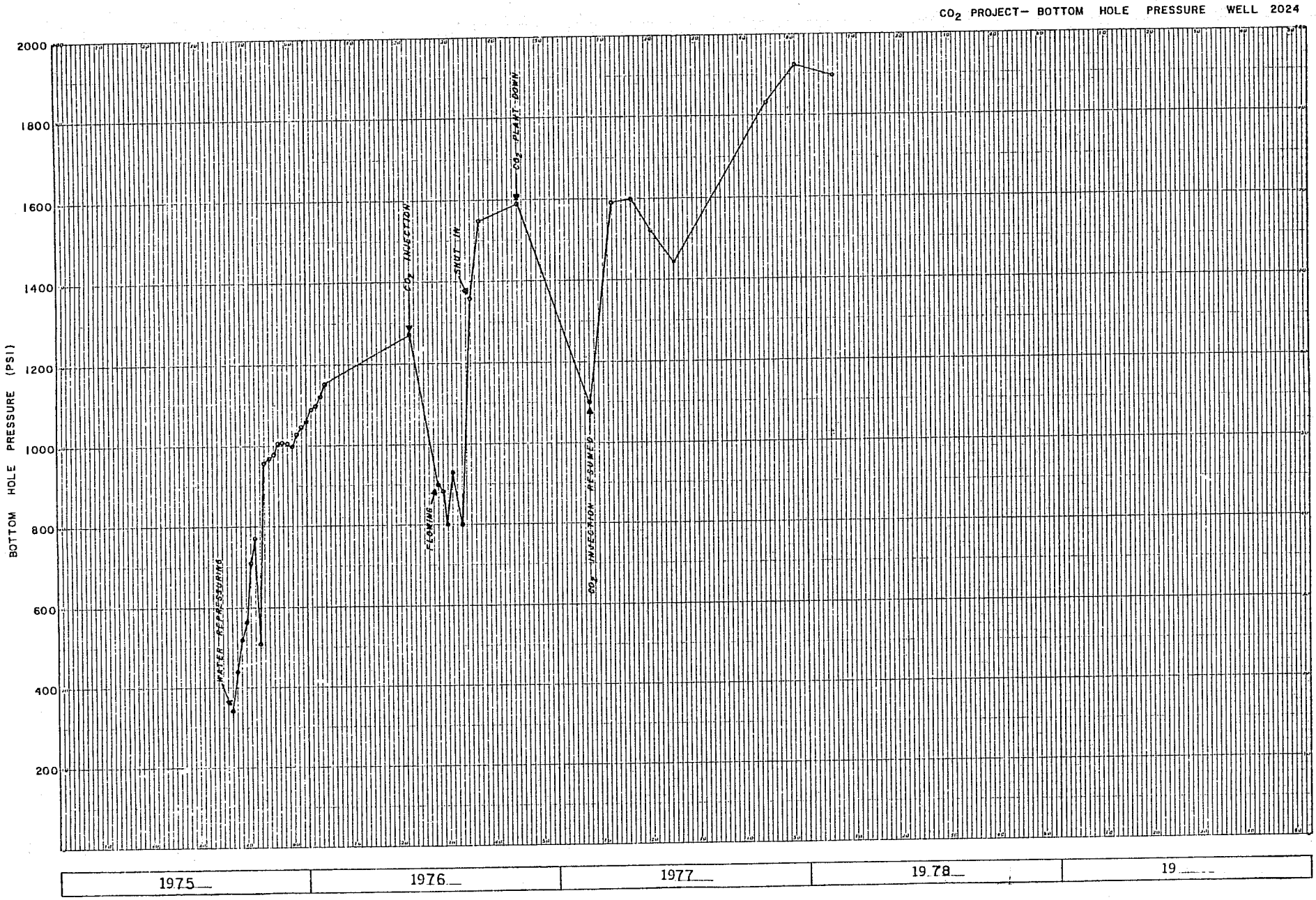

CO2 PROJECT-TOTAL PRODUCTION (12 WELLS)
WEEKLY PRODUCTION (BBL'S)
WATER CUT (%)
WATER
OIL
% WATER CUT
CO2 INJECTION STARTED
2021 SHUT-IN
2024 SHUT-IN
2024 SHUT-IN
CO2 PLANT DOWN
CO2 INJECTION RESUMED
1976
1977
1978


CO2 & WATER INJECTION
WATER INJECTION
CO2 INJECTION - TONS
WATER
CO2
1500
1000
500
0
400
300
200
100
0
1976
1977
1978
19
19


WELL 4254
WEEKLY OIL PRODUCTION
WEEKLY WATER PRODUCTION
OIL
WATER
INSTALLED PUMPING EQUIPMENT
1976
1977
1978


CO2 PROJECT-BOTTOM HOLE PRESSURE WELL 20274
BOTTOM HOLE PRESSURE (PSI)
1800
1600
1400
1200
1000
800
600
400
200
WATER REPRESSURING
CO2 INJECTION
REPAIR WELL HEAD
CO2 PLANT DOWN
CO2 INJECTION RESUME
1975
1976
1977
19
19


CO_2 PROJECT – BOTTOM HOLE PRESSURE WELL 2021
BOTTOM HOLE PRESSURE (PSI)
1600
1400
1200
1000
800
600
400
200
WATER REPRESSURING
CO_2 INJECTION
CLOSING
SHUT-IN
SO_2 PLANT DOWN
CO_2 INJECTION RESUMED
1975
1976
1977
19
19


CO_2 PROJECT— BOTTOM HOLE PRESSURE WELL 2024
BOTTOM HOLE PRESSURE (PSI)
2000
1800
1600
1400
1200
1000
800
600
400
200
WATER REPRESSURING
CO_2 INJECTION
FLOWING
SHUT IN
CO_2 PLANT DOWN
CO_2 INJECTION RESUMED
1975
1976
1977
1978
19

CO_2 PROJECT
MONTHLY WATER INJECTION
(After CO_2 Injection)

	Month	2020 Monthly Total	2020 Cum. Total	2022 Monthly Total	2022 Cum. Total	2023 Monthly Total	2023 Cum. Total	2025 Monthly Total	2025 Cum. Total	Monthly Total	Total Cum. Inj.	Daily Av./ Well	Remarks
1977	June	437	437	872	872	1015	1015	797	797	3121	3121	52	Plant down -0-
	July	988	1425	1414	2286	1685	2700	1498	2295	5585	8706	45	Plant down 49 hrs.
	August	1103	2528	1179	3465	1708	4408	1590	3885	5580	14286	45	Plant down 58 hrs.
	September	1107	3635	1079	4544	1607	6015	1447	5332	5240	19526	43	Plant down 91 hrs.
	October	1389	5024	1072	5616	1598	7613	1384	6716	5443	24969	44	Plant down 52 hrs.
	November	1312	6336	1492	7108	1501	9114	1230	7946	5535	30504	46	Plant down 24 hrs.
	December	1232	7568	1283	8391	1423	10537	1181	9127	5119	35623	41	Plant down 18.5 hrs
1978	January	1123	8691	1118	9509	1242	11779	959	10086	4442	40065	36	Plant down 36.5 hrs
	February	728	9419	910	10419	1262	13041	1168	11254	4068	44133	36	Plant down 14 hrs.

CO_2 INJECTION PROJECT
TOTAL PRODUCTION

	Month	Total Oil	Add'l Oil (1363 Bbls) Base	Cum. Oil	Cum. Add'l Oil	Total Water	Add'l Water (1393 Bbls) Base	Cum. Water	Cum. Add'l Water	Total Fluid	% Water Cut	Remarks
1976	June	1412	49	1412	49	1468	75	1468	75	2880	51	
	July	1584	221	2996	270	1622	229	3090	304	3206	51	
	August	2157	794	5153	1064	1338	-	4428	304	3495	38	
	September	1882	519	7035	1583	1254	-	5682	304	3136	40	
	October	2196	833	9231	2416	1724	331	7406	635	3920	44	
	November	1946	583	11177	2999	1417	24	8823	659	3363	42	
	December	1857	494	13034	3493	1199	-	10022	659	3056	39	
1977	January	1590	227	14624	3720	943	-	10965	659	2533	37	
	February	1323	-	15947	3720	578	-	11543	659	1901	30	
	March	1396	33	17343	3753	1371	-	12914	659	2767	50	
	April	1477	114	18820	3867	1452	59	14366	718	2929	50	
	May	1969	606	20789	4473	1812	419	16178	1137	3781	48	
	June	2444	1081	23233	5554	1780	387	17958	1524	4224	42	
	July	2320	957	25553	6511	1686	293	19644	1817	4006	42	
	August	1954	591	27507	7102	2108	715	21752	2532	4062	52	
	September	1881	518	29388	7620	2196	803	23948	3335	4077	54	
	October	1732	369	31120	7989	2700	1307	26648	4642	4432	61	
	November	1525	162	32645	8151	2499	1106	29147	5748	4024	62	
	December	1367	4	34012	8155	2389	996	31563	6744	3756	63	
1978	January	1152	-	35164	8155	2230	837	33793	7581	3382	66	
	February	990	-	35154	8155	2161	768	35954	8349	3151	68	

CO_2 PROJECT
OIL & WATER PRODUCTION
SUMMARY

		-INSIDE PATTERN-					-OUTSIDE PATTERN-					
	MONTH	OIL	WATER	TOTAL FLUID	CUM. OIL	CUM. WATER	OIL	WATER	TOTAL FLUID	CUM. OIL	CUM. WATER	REMARKS
1976	June	212	380	592	212	380	1199	1088	2288	1199	1088	
	July	553	553	1107	766	933	1030	1068	2099	2230	2157	
	August	576	344	920	1342	1278	1581	994	2575	3811	3151	
	September	146	-	146	1488	1278	1735	1254	2990	5547	4406	Inside: #4254
	October	304	58	363	1793	1337	1891	1666	3557	7438	6072	Inside: 2 Wells
	November	**225*	15	241	2019	1352	**1720	1401	3121	9159	7473	Inside: #4254
	December	224	9	234	2244	1362	1632	1189	2822	10792	8663	Inside: #4254
1977	January	222	107	330	2466	1470	1368	835	2204	12160	9499	Inside: 2 Wells
	February	87	1	88	2553	1472	1236	577	1813	13396	10076	Inside: #4254
	March	105	-	105	2659	1472	1290	1371	2661	14687	11447	Inside: #4254
	April	174	115	289	2833	1587	1303	1336	2639	15990	12784	Inside: #4254
	May	292	300	593	3126	1888	1676	1511	3188	17667	14295	Inside: #4254
	June	257	234	492	3384	2122	2186	1546	3733	19853	15842	Inside: #4254
	July	256	311	568	3640	2433	2064	1375	3439	21917	17218	Inside: #4254
	August	253	863	1117	3894	3297	1700	1245	2946	23618	18463	
	September	128	700	829	4023	3997	1752	1495	3248	25371	19959	Inside: #4254
	October	81	1059	1140	4104	5056	1651	1640	3292	27022	21600	Inside: 2 Wells
	November	42	850	893	4147	5907	1483	1649	3132	28505	23249	Inside: #4254
	December	43	907	951	4191	6814	1323	1481	2804	29828	24731	Inside: #4254
1978	January	47	887	934	4238	7702	1104	1342	2447	30933	26073	Inside: #4254
	February	43	802	845	4281	8504	947	1358	2305	31880	27431	Inside: 3 Wells

*Well Fractured
**Well Treated with Carbon Bisulfide

CO_2 INJECTION PROJECT
PRODUCTION FROM WELLS INSIDE PATTERN
MONTHLY TOTALS (BBLS.)

	MONTH	2021 OIL	2021 WATER	2021 TOTAL FLUID	2024 OIL	2024 WATER	2024 TOTAL FLUID	4254 OIL	4254 WATER	4254 TOTAL FLUID	20274 OIL	20274 WATER	20274 TOTAL FLUID
1976	June	-	-	-	-	136	136	4	10	15	207	232	440
	July	13	73	87	109	227	336	105	13	118	325	239	564
	August	49	85	135	327	206	533	157	15	173	41	36	78
	September	* -	-	-	* -	-	-	146	-	146	* -	-	-
	October	* -	-	-	58	36	94	**246	22	268	* -	-	-
	November	* -	-	-	* -	-	-	***225	15	241	* -	-	-
	December	* -	-	-	* -	-	-	224	9	234	* -	-	-
1977	January	* -	-	-	* -	-	-	161	50	211	61	57	118
	February	* -	-	-	* -	-	-	87	1	88	* -	-	-
	March	* -	-	-	* -	-	-	105	-	105	* -	-	-
	April	* -	-	-	* -	-	-	174	115	289	* -	-	-
	May	* -	-	-	* -	-	-	292	300	593	* -	-	-
	June	* -	-	-	* -	-	-	257	234	492	* -	-	-
	July	* -	-	-	* -	-	-	256	311	568	* -	-	-
	August	26	39	65	28	94	122	171	613	785	27	116	143
	September	* -	-	-	* -	-	-	128	700	829	* -	-	-
	October	* -	-	-	15	264	280	65	794	859	* -	-	-
	November	* -	-	-	* -	-	-	42	850	893	* -	-	-
	December	* -	-	-	* -	-	-	43	907	951	* -	-	-
1978	January	* -	-	-	* -	-	-	47	887	934	* -	-	-
	February	* -	-	-	4	84	90	26	688	714	11	29	17

*Shut In
**Well Fractured
***Well Treated with Carbon Bisulfide

CO_2 INJECTION PROJECT
PRODUCTION FROM WELLS OUTSIDE PATTERN
MONTHLY TOTALS (BBLS.)

	MONTH	2047 OIL	2047 WATER	2047 TOTAL FLUID	4049 OIL	4049 WATER	4049 TOTAL FLUID	4591 OIL	4591 WATER	4591 TOTAL FLUID	2043 OIL	2043 WATER	2043 TOTAL FLUID
1976	June	35	65	101	43	250	293	53	111	165	164	66	231
	July	* 1	15	17	7	402	409	29	164	193	259	72	331
	August	333	100	434	-	252	252	82	258	340	261	38	299
	September	363	90	453	55	414	470	117	89	206	273	60	334
	October	259	53	312	107	842	949	112	135	248	324	67	391
	November	243	57	300	136	678	815	97	131	229	314	45	360
	December	221	44	266	173	615	788	142	69	212	348	51	399
1977	January	222	51	273	141	470	612	118	50	169	274	58	332
	February	172	30	203	* 52	151	204	96	41	137	210	47	257
	March	161	41	203	115	812	927	80	45	126	183	65	249
	April	150	53	203	136	582	718	61	37	98	170	77	248
	May	193	56	249	173	605	779	73	70	144	162	39	201
	June	204	52	256	169	561	730	165	63	228	212	65	278
	July	214	48	263	181	530	712	129	35	165	162	34	196
	August	145	26	171	187	488	675	107	48	156	126	55	181
	September	267	52	319	181	450	632	102	68	170	109	74	184
	October	*122	55	178	245	493	739	74	63	137	100	96	196
	November	193	78	271	154	450	605	76	104	180	90	94	184
	December	207	77	284	144	490	634	87	146	234	111	84	195
1978	January	200	86	287	109	473	582	67	137	204	105	94	200
	February	189	71	260	85	468	553	41	128	170	102	87	189

*Well Off Production-Pulled-Changed Pump
**Well is Off

CO_2 INJECTION PROJECT
PRODUCTION FROM WELLS OUTSIDE PATTERN
MONTHLY TOTALS (BBLS.)

	MONTH	2044 OIL	2044 WATER	2044 TOTAL FLUID	4090 OIL	4090 WATER	4090 TOTAL FLUID	2046 OIL	2046 WATER	2046 TOTAL FLUID	2048 OIL	2048 WATER	2048 TOTAL FLUID
1976	June	171	309	480	286	169	456	303	111	414	141	3	144
	July	184	160	344	*123	116	239	280	133	413	**144	4	149
	August	314	109	423	442	232	674	** 7	-	7	140	2	142
	September	409	216	625	366	380	746	4	-	4	146	2	148
	October	499	198	698	376	366	743	24	-	24	186	2	189
	November	379	133	512	324	341	666	***29	-	30	193	11	205
	December	268	116	384	252	292	544	47	-	48	178	-	178
1977	January	285	120	405	**124	79	204	28	-	29	172	4	176
	February	92	33	126	452	268	721	1	-	1	157	3	161
	March	146	175	322	***360	227	587	49	-	49	192	2	195
	April	211	166	378	339	386	726	38	29	68	195	3	198
	May	268	169	437	346	399	745	215	168	384	243	2	245
	June	306	126	433	340	387	728	684	283	967	102	6	108
	July	239	111	351	380	389	770	630	217	848	124	8	132
	August	19	55	75	386	369	756	573	192	766	153	8	161
	September	120	316	436	310	336	646	471	189	660	190	7	197
	October	172	351	523	345	346	691	427	217	645	161	17	179
	November	130	401	532	316	304	620	375	207	582	146	7	154
	December	24	228	252	200	244	444	403	207	611	144	4	148
1978	January	20	229	250	107	97	205	362	220	528	131	2	133
	February	22	295	317	*****30	73	104	318	202	520	157	1	159

*Rods Out for Testing
**Rods Out for Testing & Changing Casinghead
***Well Treated with Carbon Bisulfide
****Shut In
*****Well is Off

CO_2 INJECTION PROJECT
GAS OPEN FLOWS & CO_2 ANALYSIS

WEEK ENDING

WELL NO.	2-25-77 MCF	2-25-77 %CO_2	3-9-77 MCF	3-9-77 %CO_2	3-30-77 MCF	3-30-77 %CO_2	5-4-77 MCF	5-4-77 %CO_2	5-31-77 MCF	5-31-77 %CO_2	6-14-77 MCF	6-14-77 %CO_2	1-15-78 MCF	1-15-78 % CO_2
1327			7.1	0.0	8.9	0.0	8.5	0.0	8.5	0.0	8.5	1.0	3.8	.25
1265			3.1	15.0	2.7	6.0	Tr.	0.0	4.5	2.0	4.3	14.0	1.6	.25
1282			21.0	0.0	36.1	0.0	41.5	0.0	26.4	0.0	30.0	1.5	10.2	.25
1285			41.0	0.0	22.8	0.0	43.0	0.0	37.3	0.0	43.7	0.0	31.6	.25
20325			3.8	2.5	2.6	0.0	5.8	0.0	8.5	0.0	4.5	0.0	6.0	.50
1258			3.2	13.5	2.9	15.0	3.3	6.5	3.3	6.5	3.3	9.0	2.7	.25
2040	-	4.5			Tr.	8.0	1.0	6.5	1.1	8.0	0.8	11.5	.78	1.75
3985	Tr.	0.0			2.5	0.0	2.4	0.0	2.7	0.0	2.8	0.0	1.9	.25
4258	1.0	11.0			1.1	11.0	1.0	4.5	0.8	7.5	1.1	4.5	.79	.25
4049					1.1	10.5	1.4	4.5	1.1	10.0			63.3	2.5
4090	-	13.5			-	5.5	Tr.	4.5	Tr.	3.5	Tr.	10.5		
2048			2.8	>20.0	4.3	>20.0	7.8	>20.0	1.8	>20.0	.6	>20.0	13.2	12.0
4591			6.0	>20.0	1.6	>20.0	6.9	>20.0	6.3	>20.0	32.0	>20.0	10.2	12.0
2053			2.9	0.0	Tr.	0.0	1.0	1.0	Tr.	2.0	Tr.	0.0	1.6	1.0
2045	2.9	6.5			2.2	5.5	1.8	4.0	2.5	9.5	2.3	10.0	1.4	6.0
1252	1.2	1.0			-	-	SHUT	IN	0.6	0.0	Tr.	0.0	1.36	2.0
2042			0.6	6.5	1.0	8.5	1.1	9.5	Tr.	1.0	Tr.	0.0	-	.75
2043			8.5	>20.0	11.8	>20.0	28.0	>20.0	42.6	>20.0	18.1	>20.0	19.1	12.0
2046							FLOWING						26.9	12.0
4050			24.5	0.0	30.2	0.0	25.7	0.0	28.0	0.0	28.0	0.0		
4039					Tr.	0.0	0.6	0.0	0.8	0.0	0.6	0.0	.79	.50
1871	0.8	13.0			Tr.	0.0	Tr.	9.0	Tr.	4.5	Tr.	4.5	-	.25
1919	0.6	4.5			0.6	0.0	0.8	0.0	0.8	0.0	0.6	0.0	-	.75
20327			26.4	>20.0	29.5	0.0			30.0	0.0	34.9	0.0	21.9	.25
1347			2.9	8.0	3.0	4.5	3.1	2.5	3.1	5.5	2.8	1.0	1.3	.25
2047			8.0	>20.0	6.0	>20.0	4.8	>20.0	5.8	>20.0	8.5	>20.0	18.3	12.0
2041	1.6	14.5			2.4	8.0	2.2	0.5	2.7	0.0	2.6	9.0	.78	.50
1324	31.0	0.0			29.5	0.0	8.5	0.0	34.0	0.0	35.0	0.0	22.8	.25
1315	22.8	0.0			14.7	0.0	16.5	0.0	18.0	0.0	18.5	0.0	-	-
1284	4.5	7.0			3.0	3.5	42.6	7.0	2.9	4.5	2.1	3.0	-	.25
1349	17.7	0.0			17.6	0.0	17.0	3.5	4.9	0.0	20.0	0.0	8.9	.25
1297			2.7	5.0	2.7	5.5	1.0	0.0	0.8	0.0	2.6	4.0	6.0	.25
1323			9.3	0.0	10.2	0.0	7.9	0.0	7.6	1.0	7.1	0.0	-	0.0
1318							8.9	0.0	8.5	0.0	10.0	0.0	7.6	.25
2072			20.4	0.0	19.6	0.0	18.1	0.0	16.0	0.0	17.0	0.0	10.4	.25
1279	11.1	0.0			12.0	0.0	9.1	0.0	9.7	0.0	8.5	0.0	11.1	.25

CO_2 INJECTION PROJECT
GAS OPEN FLOWS & CO_2 ANALYSIS

WELL NO.	WEEK ENDING 2-25-77 MCF	2-25-77 %CO_2	3-9-77 MCF	3-9-77 %CO_2	3-30-77 MCF	3-30-77 %CO_2	5-4-77 MCF	5-4-77 %CO_2	5-31-77 MCF	5-31-77 %CO_2	6-14-77 MCF	6-14-77 %CO_2	1-15-78 MCF	1-15-78 % CO_2
1347	22.1	0.0			9.3	0.0	38.2	0.0	3.8	0.0	26.0	4.0	23.6	0.0
3905	1.1	3.0			Tr.	2.5	0.6	6.5	0.8	3.0	0.6	3.5	-	.25
1334	Tr.	4.0			Tr.	0.0	Tr.	0.0	Tr.	6.0	Tr.	0.0	-	.25
4029	2.8	1.0			-	-	2.7	8.5	2.8	2.0	2.4	4.0	1.1	1.9
2052	Tr.	0.0			Tr.	4.0	1.0	6.0	0.8	3.0	Tr.	5.0		
1354	-	0.0			-	0.0	Tr.	0.0	Tr.	0.0	Shut	In	-	0.0
3904	2.7	5.5			3.5	2.5	3.7	0.0	1.8	1.0	-	-	1.1	12.0

HALLIBURTON DIVISION LABORATORY

HALLIBURTON SERVICES, A DIVISION OF HALLIBURTON COMPANY

LABORATORY REPORT

No.

To [illegible]

[illegible]

[illegible]

Date [illegible]/77

This report is the property of Halliburton Services, A Division of Halliburton Company and neither it nor any part thereof nor a copy thereof is to be published or disclosed without first securing the express written approval of laboratory management; it may however, be used in the course of regular business operations by any person or concern and employees thereof receiving such report from Halliburton Services, A Division of Halliburton Company.

We give below results of our examination of [illegible]

Submitted by [illegible]

Marked

Well #	Chloride (mgl)
1327	20,000
2043	53,000
1919	36,000
252	14,000
4039	15,000
3042	28,000
3241	41,000
2052	44,000
1334	22,000

Well #	Chloride (mgl)
2053	10,000
4039	34,000
3483	5,000
1354	8,000
1225	9,400
2040	49,000
3125	22,000
1253	34,000

Respectfully submitted,

Laboratory Analyst

[illegible]

HALLIBURTON SERVICES, A DIVISION OF HALLIBURTON COMPANY

By J. Gaylor Dist Engr.

NOTICE: This report is limited to the described sample tested. Any person using or relying on this report agrees that Halliburton shall not be liable for any loss or damage whether due to act or omission resulting from such report or its use.

CO_2 INJECTION PROJECT WATER ANALYSIS

WELL NO.	7-1-77 pH	7-1-77 Total Cl.	7-8-77 pH	7-8-77 Total Cl.	10-17-77 pH	10-17-77 Total Cl.	10-26-77 pH	10-26-77 Total Cl.	11-77 pH	11-77 Total Cl.
2044	6.5	61,000					8.5	33,000	8.0	32,000
4591	6.5	68,000	6.5	72,000			8.2	100,000	8.5	86,000
2043							8.0	55,000	8.0	84,000
4090	7.0	25,000	7.0	27,000			8.0	30,000	8.0	32,000
4049	7.5	17,500	7.5	17,500			8.0	20,000	8.5	22,000
4254	6.5	68,000	6.5	73,000			8.2	70,000	8 0	64,000
2047	6.0	120,000	6.7	125,000					7.0	120,000
3985					8.5	30,000			8.0	52,000
4039					8.0	25,500			8.0	30,000
2052					8.0	57,500			8.0	70,000
1919					8.0	41,000			8.0	42,000
4029					8.5	15,000				
1334					8.0	22,500			9.0	25,000
2045					8.0	50,000			7.5	52,000
1354					8.0	12,500			8.0	14,000
3905					8.0	30,000			8.0	36,000
2053					8.5	10,000			-	-
2041									8.0	49,000
1252					8.0	18,000			-	-
1265					8.5	10,000			8.0	16,000
2042									8.5	39,000
1327									8.0	22,000
1349									8.0	82,000
2040					7.0	39,000			8.0	46,000
2046	6.5	65,000	6.5	63,500						
1258					8.7	26,000				
1315										

CO_2 INJECTION PROJECT WATER ANALYSIS

WELL NO.	12-77 pH	12-77 Total Cl.	1-78= pH	1-78= Total Cl.	2-78 pH	2-78 Total Cl.	3-78 ph	3-78 Total Cl.	4-78 pH	4-78 Total Cl.
2044	8.0	32,000	8.0	32,000	7.0	25,200				
4591	7.5	100,000	7.0	100,000	-	-				
2043	8.0	82,000	-	-	7.5	114,000				
4090	-	-	-	-	-	-				
4049	8.0	18,000	8.0	22,000	7.0	19,200				
4254	7.5	71,000	7.5	60,000	7.0	80,400				
2047	7.5	68,000	8.5	112,000	-	-				
3985	8.0	60,000	8.0	50,000	7.0	74,400				
4039	-	-	8.0	30,000	6.0	32,400				
2052	8.0	72,000			7.0	126,000				
1919	8.0	42,000	7.5	42,000	7.0	55,200				
4029	8.5	22,000								
1334	8.5	30,000	8.0	28,000	6.5	16,300				
2045	8.0	56,000	8.5	50,000	7.5	24,000				
1354	8.5	14,000	8.5	10,000	8.0	12,000				
3905	8.0	46,000	8.0	32,000	6.0	39,600				
2053	8.0	14,000	8.5	16,000	7.0	13,200				
2041	8.0	41,000	-	-	6.0	45,600				
1252	-	-	8.5	21,000	7.0	19,200				
1265	8.0	14,000	8.0	14,000	7.0	19,200				
2042	-	-	-	-	7.0	34,800				
1327	8.0	20,100	-	-	7.0	21,000				
1349	8.0	35,000	-	-	6.5	114,000				
2040	7.5	42,000	8.5	50,000	6.0	14,400				
2046										
1258	7.5	23,000								
1315	7.5	53,000								

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