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

Final Report

Work Performed for the Department of Energy
Under Contract No. DE-AC05-76ET12015

Date Published—October 1983

Columbia Gas Transmission Corporation
Charleston, West Virginia

National Petroleum Technology Office
U.S. DEPARTMENT OF ENERGY
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Final Report

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UNITED STATES DEPARTMENT OF ENERGY

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ABSTRACT

During the period June 1976 through June 30, 1980, Columbia Gas Transmission Corporation, in conjunction with the Department of Energy, conducted a field demonstration of oil recovery by CO_2 injection in Clay County, West Virginia. The objective of this test was to demonstrate and evaluate the effectiveness of using CO_2 injection to recover high gravity crude oil from shallow watered-out reservoirs. The project eventually developed into two distinct phases: the first being CO_2 injection into four corner wells in a conventional five-spot, with a central producing well and three interior test/observation wells. The second phase of the project consisted of a mini-flood within the original pattern.

The reservoir was repressured to approximately 1000 psi with water prior to CO_2 injection. The injection plant and facilities were completed and injection of CO_2 began on June 2, 1976. A total of 9800 tons of CO_2 was injected into the five-spot in several stages, alternating with water periodically for mobility control and better sweep efficiency. Injection of the CO_2 slug was completed on June 16, 1977. Water injection followed the CO_2 slug until the pattern was effectively watered-out.

Oil production from the central producer peaked shortly after cessation of CO_2 injection and water production increased to about the same as before the project started.

Since it was felt that the project lacked confinement as evidenced by extensive CO_2 migration outside the pattern and the low recoveries, a series of reservoir interference tests were run to help determine the best course of action to follow. The mini-test resulted. Approximately 1600 tons of CO_2 were injected during this phase. Oil production within the pattern during the first phase amounted to approximately 4000 bbls. while during the mini-flood an additional 1345 bbls. of oil was produced.

It has been extremely difficult to evaluate this project due to the extremely complex heterogeneity of the reservoir. The problem has been compounded by the many workovers experienced by the wells over the years, and the resultant damage to the reservoir.

INTRODUCTION & REVIEW

The Granny's Creek field is located in western Clay and southeastern Roane Counties, West Virginia, approximately 25 miles northeast of the city of Charleston, West Virginia. The field is approximately five miles long and two miles wide and contains approximately 3000 acres. Columbia has under lease approximately 1200 acres in the field and has produced approximately 3,000,000 barrels of oil from its leases.

The producing horizon in the Granny's Creek field is the Upper Pocono Big Injun Sand of Lower Mississippian Age, according to W. D. Bagnall. Production is primarily from three usually separate porous and permeable intervals that he has designated zones A, B and C. The A and B horizons are developed in the upper, coarse-grained part of the Injun sand and generally exhibit low to medium porosities and medium to high permeabilities. The C zone, on the other hand, is developed in the fine-grained, argillaceous sandstone that characterizes the lower part of the Injun sand in the Granny's Creek area; and generally shows very high porosity and low permeability. Oil production is controlled by both the structure of the field and by intraformational permeability and porosity pinch-outs.

The field was drilled in the period from 1916 to 1944 and at present is being waterflooded by Columbia on the southern 610 acres and in a waterflood by Pennzoil in the northern part of the field.

The waterflood was initiated in 1964 by, a then subsidiary of Columbia Gas System, The 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. Expansion of the waterflood, which is still being operated, took place between 1968 and 1972.

Subsequently, in early 1975 the Columbia Gas System, 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.

Columbia began construction on the project in August 1975, with the resumption of water injection into the 6 original pilot water 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 was being achieved. During the period from August 1975 to June 1, 1976, wells were reworked with a small fracture treatment and CO_2 storage and injection equipment was ordered and installed.

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% - subsequent log-inject-log tests have confirmed this). 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 water.

CO_2 INJECTION - PHASE I

On June 1, 1976 approximately 300 barrels of natural 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 40-45 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 1,000 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 arrived. From mid December 1976 to mid March 1977, CO_2 was virtually nonexistent 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 PSI.

In mid March, CO_2 again became 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 was resumed and continued until January, 1980.

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

PRODUCTION - PHASE I

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 BHP testing. On June 15, construction of lines and tank sites had been completed and the 12 wells involved in the project began producing into individual tanks. 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 number 4254 were shut-in and since that time used for reservoir testing only. During the fall of 1976, bottom hole pressure tests indicated a higher productive capacity in well number 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. 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. Pumping equipment was installed in August of 1977.

Coincidentally, with the installation of pumping equipment and the resumption of water injection, oil production began declining and water production increased. This trend, with minor fluctuations, continued until the mini-flood began.

While production increases were noted early in the wells outside the pattern, the most interesting one was well number 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 1977, the well was tubed and started to pump. Production then increased to approximately 23 barrels of oil per day, again peaking in June and declining with the resumption of water injection.

The original proposal called for flowing the producing wells in order to maintain better control over miscibility, sweep efficiency, corrosion and prevention of paraffin deposition. However, production tests soon proved this method to be inadequate for producing the wells to their capacity.

One of the most interesting aspects of the project was the low initial water volumes produced. In almost all wells, increases in initial oil production were noted with very little or no water production.

Since this project was installed in a "watered-out" section of the reservoir, it was expected that water production would come first, especially inside the pattern. This was not the case. Oil came first and only after CO_2 injection was completed did water production become significant.

Production in general has followed the same pattern. Increases in oil production with no increase in water followed by the reverse (decrease in oil production and increase in water production), when the CO_2 slug was complete and water injection resumed.

PROBLEMS

From an operational standpoint, problems have occurred in these areas: 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. A change in insulation and piping design was the solution. Packing adjustment and the proper lubricating oil were critical due to the $0^{o}F$ 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. The problem was due to the higher pressure necessary to inject water once the reservoir was pressured up. This was especially true during the winter of 1976-77 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. Since these lines were all new, welded, coated and wrapped, it was felt that they were more than adequate for the life of the project. We added to the water supply system and replaced the filters, and associated equipment in the water plant in order to insure a more reliable water supply and injection system.

One major problem was that of corrosion. While leaks were frequent, it has not been determined whether they were caused by CO_2. The repairs have been no more frequent than when waterflooding.

Paraffin problems occurred in certain wells and it was necessary to steam the tubing when it was serious enough to restrict production.

From a reservoir standpoint, the major problem was that of evaluating the project. It has been calculated that only 3%-6% of the injected CO_2 entered the pattern. If true, then oil recovery based on this volume is reasonable.

As a result of the many problems involved, mainly lack of confinement and the resultant loss of CO_2 outside the pattern, most of 1978 was spent trying to determine the best procedure to follow to obtain the data necessary to evaluate the project, and the process to attain the original objective. It was finally decided to attempt to conduct a series of interference tests, the primary objective being to determine the degree of communication between wells within the pilot area.

These tests consisted of (1) observing the effects on the three interior wells by closing six injection wells (2) interference on one producing well caused by producing two of the other wells, and (3) observing the effects of injecting water into well 20274 on the other two (4254 and 2024) interior wells. Results of this test indicated good communication between well 2024 and 4254 but poor between 20274 and 4254 and 2024. Based on all available data, four years of experience, a better knowledge of the process and the above discussed testing, the mini-flood was initiated in January 1980.

THE MINI-FLOOD - PHASE II

The area swept by the mini-flood was estimated to be approximately 2.2 acres within the original CO_2 pilot. This phase consisted of injecting CO_2 into well 20274 and utilizing wells 2024 and 4254 as producers. In May of that year well 2025 was converted from injection to production. This well had been a water injection well from 1964 until 1974 and a CO_2 injector during Phase I of the

CO_2 pilot. Water was injected into the remaining CO_2 injectors and all producers were shut in outside of the original pattern. All producing wells in the test area were flowed with 100-200 psi back pressure. All production was measured for oil, water and gas.

CO_2 injection ranged from 5 to approximately 14 tons per day from January thru June 1980. Cumulative injection amounted to approximately 1546 tons. Oil production response occurred almost immediately with resultant CO_2 breakthrough to well 4254. Since the injection string (2" tubing) was set on a packer above all three zones (A, B and C), it was felt that injection was entering A and B zones. Noise logs run in the well confirmed these suspicions. The 2" tubing was then lowered and the packer set between zones B and C so that injection could enter only zone C. Through the life of the project, the annulus was monitored to determine communication around the packer and noise logs were run periodically. Small annulus pressure increases were noted. Oil production, as in Phase I, was directly related to CO_2 injection and peaked during June at 406 bbl/month. After CO_2 injection stopped (after expiration of the contract) production steadily declined. Cumulative oil production was 1345 barrels.

DISCUSSION & EVALUATION

Description of the operational and mechanical problem solving aspects of the project is a relatively simple matter since all equipment and products are visible. Evaluation of the reservoir performance was extremely difficult, particularly during Phase I of the project. With all of the advantages of hindsight, many factors contributed to this difficulty. Among these are, primarily, (1) pumping producers outside of the original pattern and (2) the lack of proper gas measurement facilities to account for gas migration outside of the pattern.

The decision was made early in the project to pump the outside wells since this was the manner in which the original pilot waterflood was operated. Also it was felt that there were enough water injectors to confine the CO_2.

Several attempts were made to meter gas production inside the pattern, but this proved impossible to do with any degree of success. The wells surged causing wide variations in production rates. In addition, fluid carryover was a constant problem, especially during the winter. Gas (CO_2) was detected in such a large number of wells outside the pattern that metering was impossible. There can be no doubt that CO_2 channeled through some type of fracture system. This was also confirmed by the quick response (approximately 2 weeks) of the producers within the pattern, to CO_2 injection.

Whether the oil production during the life of the project was the result of miscible displacement is open for debate. However, it can be assumed that it resulted from one or more of several mechanisms: oil swelling, viscosity reduction and miscible displacement. Channeling and viscous fingering presented serious problems.

Another problem that became evident early in the life of the project was the geology of the Injun sand in the area. While the geology appeared to be adequately known for waterflooding, this was certainly not the case for a tertiary project. As a result, a continual geologic update was conducted during the life of the project.

As has been stated previously, reservoir and recovery factors are difficult to calculate. However, one calculation is difficult to avoid and seems to hold true for both phases of the project and that is the amount of oil produced per ton of CO_2 injected. If one considers the amount of oil produced from all wells involved in Phase I, the ratio is 19,390 SCF of CO_2 injected for each barrel produced. For Phase II the ratio is 20,438 SCF per barrel, very close. The basic data, historical production and injection graphs and results calculated by Columbia's engineers are shown in the attached tables and figures.

Several positive conclusions can be made from the project:

1. Substantial amounts of crude oil can be produced from reservoirs of this type; i.e., shallow, watered-out, low temperature reservoirs.

2. Physical handling of liquid CO_2 does not present problems not easily solved.

3. Corrosion of equipment was not a serious problem.

4. It is not necessary to purchase stainless or other special metallurgical steel for the pipes or equipment.

5. The key to economic recovery is to obtain CO_2 at the lowest price possible and possibly to recycle it to further reduce costs.

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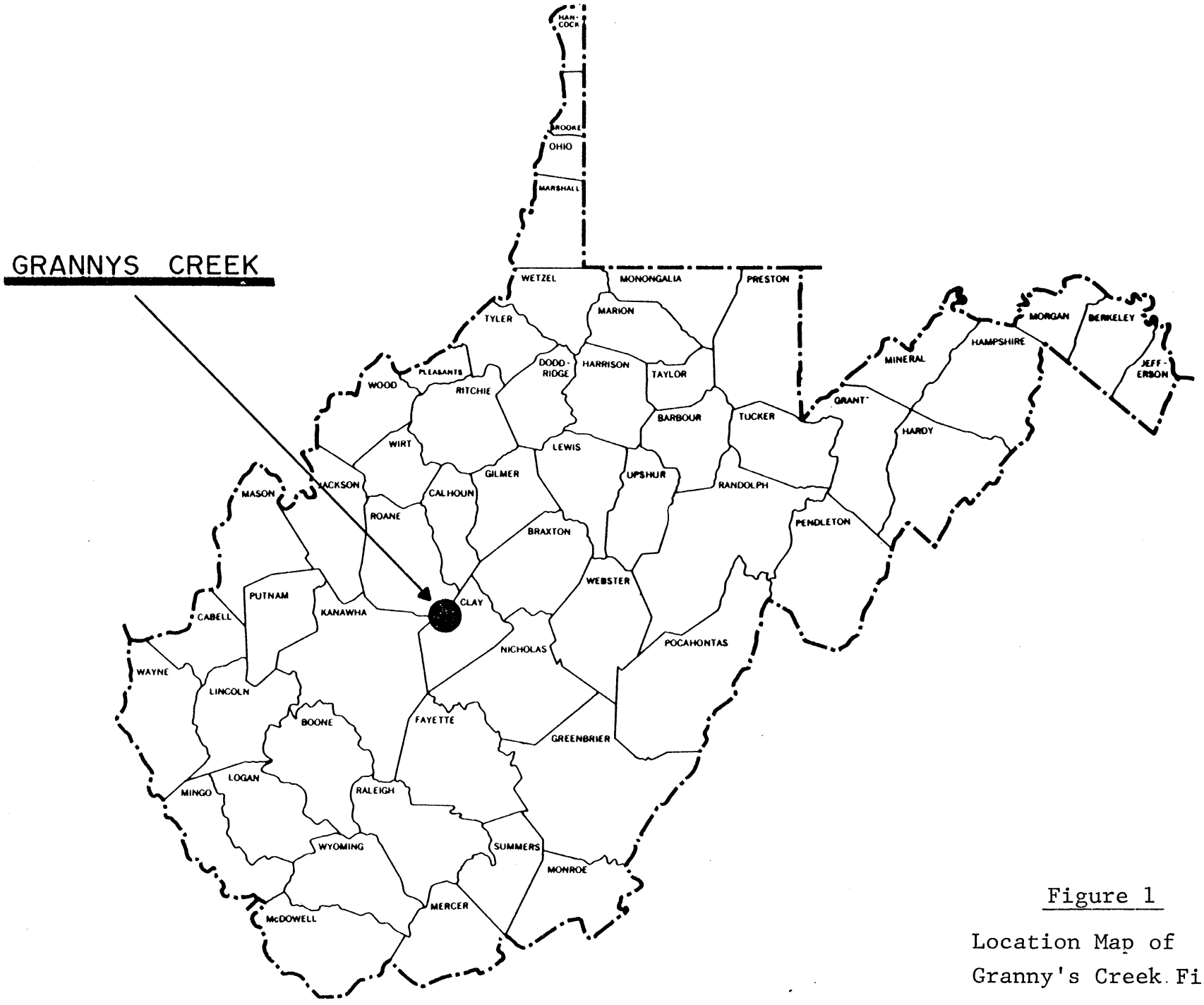

Figure 1

Location Map of
Granny's Creek Field

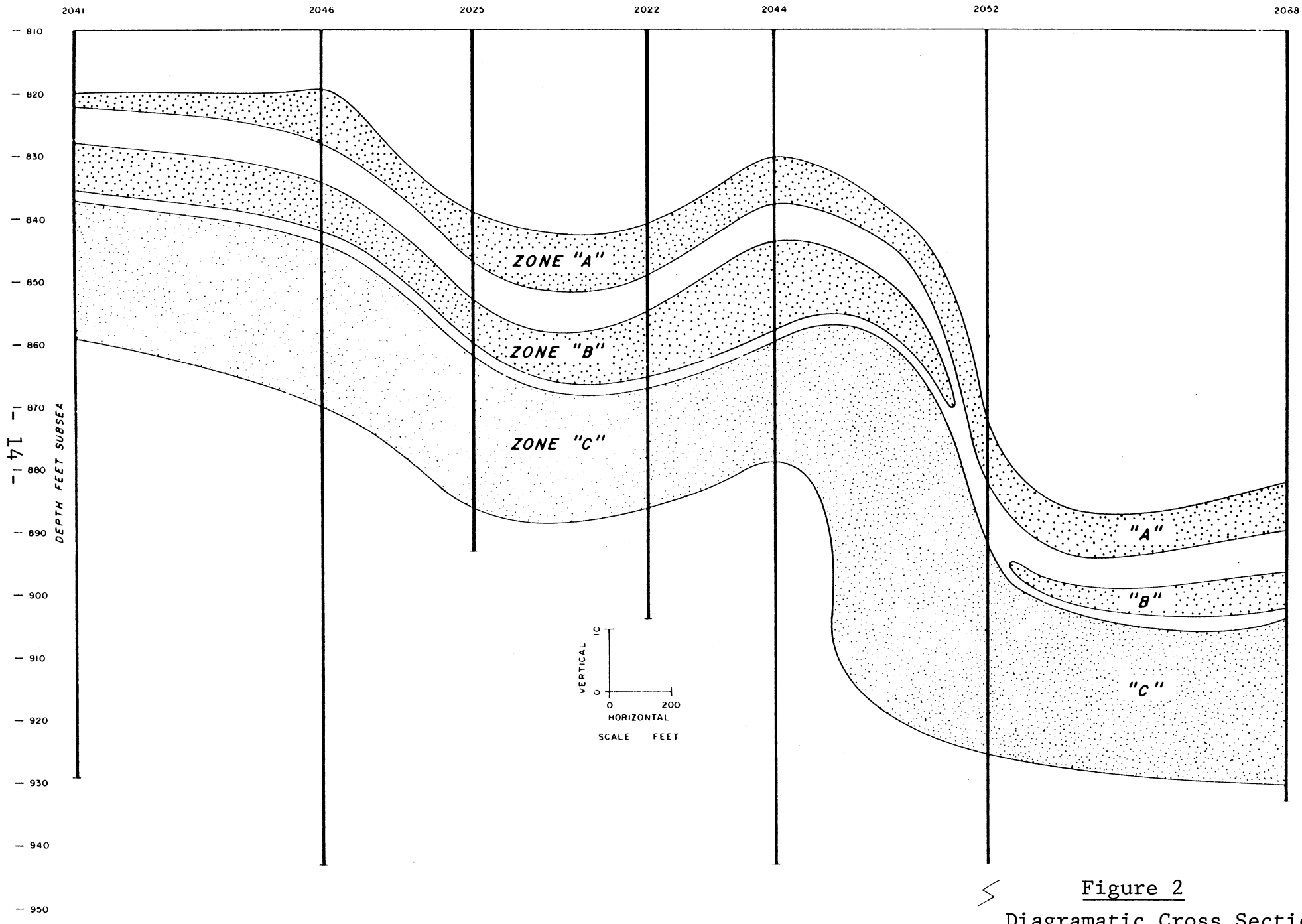

Figure 2

Diagramatic Cross Section

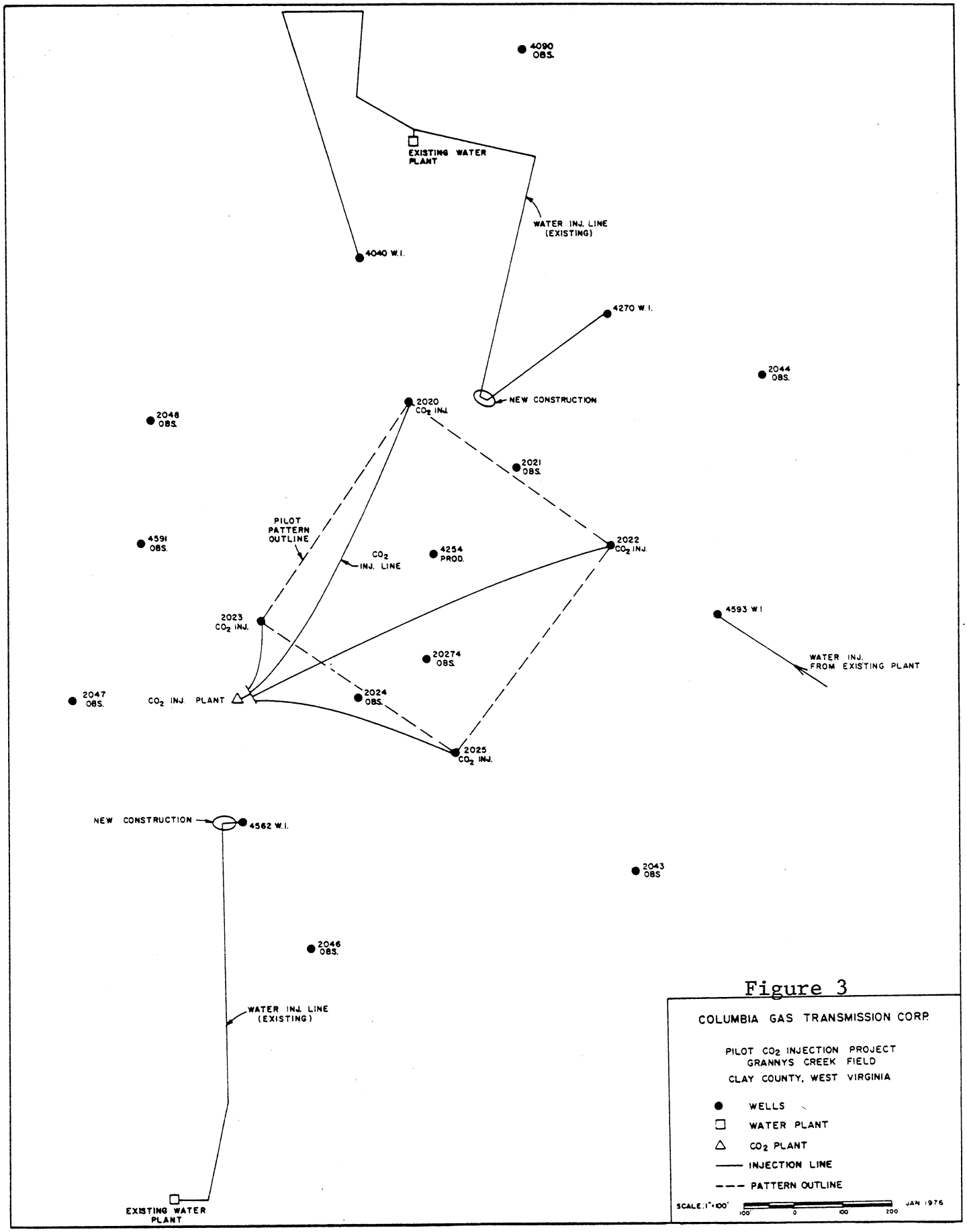

Figure 3

COLUMBIA GAS TRANSMISSION CORP.

PILOT CO_2 INJECTION PROJECT
GRANNYS CREEK FIELD
CLAY COUNTY, WEST VIRGINIA

- WELLS
- WATER PLANT
- CO_2 PLANT
- INJECTION LINE
- PATTERN OUTLINE

SCALE: 1"=100' JAN 1976

FIGURE 4

COLUMBIA GAS TRANSMISSION CORPORATION
GRANNY'S CREEK
PILOT WATERFLOOD AND CO_2 PROJECT

PROJECT	PRODUCTION	ACRES
WATERFLOOD 1965-1976	42,708	10.6
CO_2 1976-1979	4,700	6.5

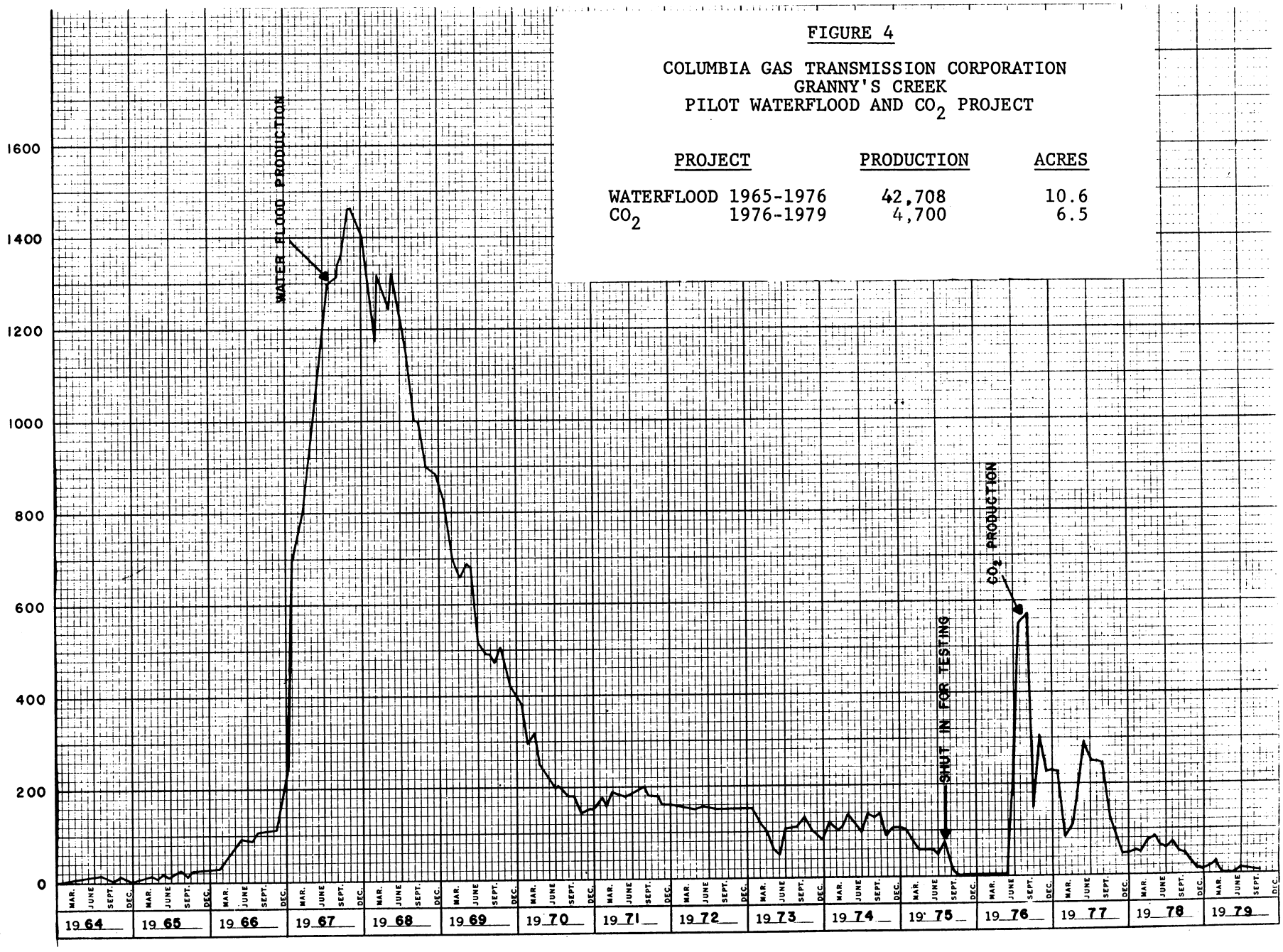

Figure 5

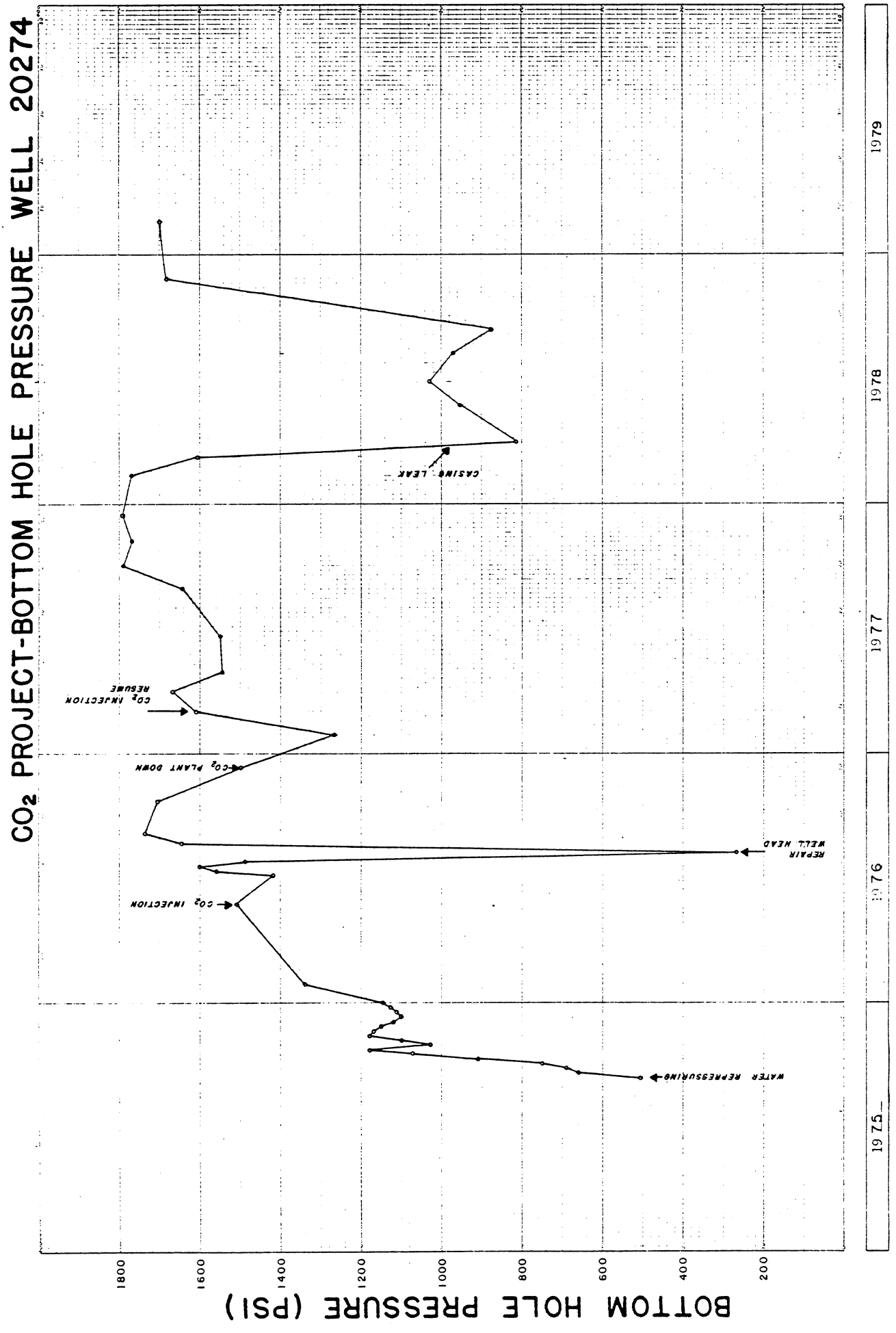
CO_2 PROJECT-BOTTOM HOLE PRESSURE WELL 20274
BOTTOM HOLE PRESSURE (PSI)
1800
1600
1400
1200
1000
800
600
400
200
1975
1976
1977
1978
1979
WATER REPRESSURING
CO_2 INJECTION
REPAIR WELL HEAD
CO_2 PLANT DOWN
CO_2 INJECTION RESUME
CASING LEAK

FIGURE 6

PHASE I
CO_2 PROJECT
MONTHLY CO_2 & WATER INJECTION

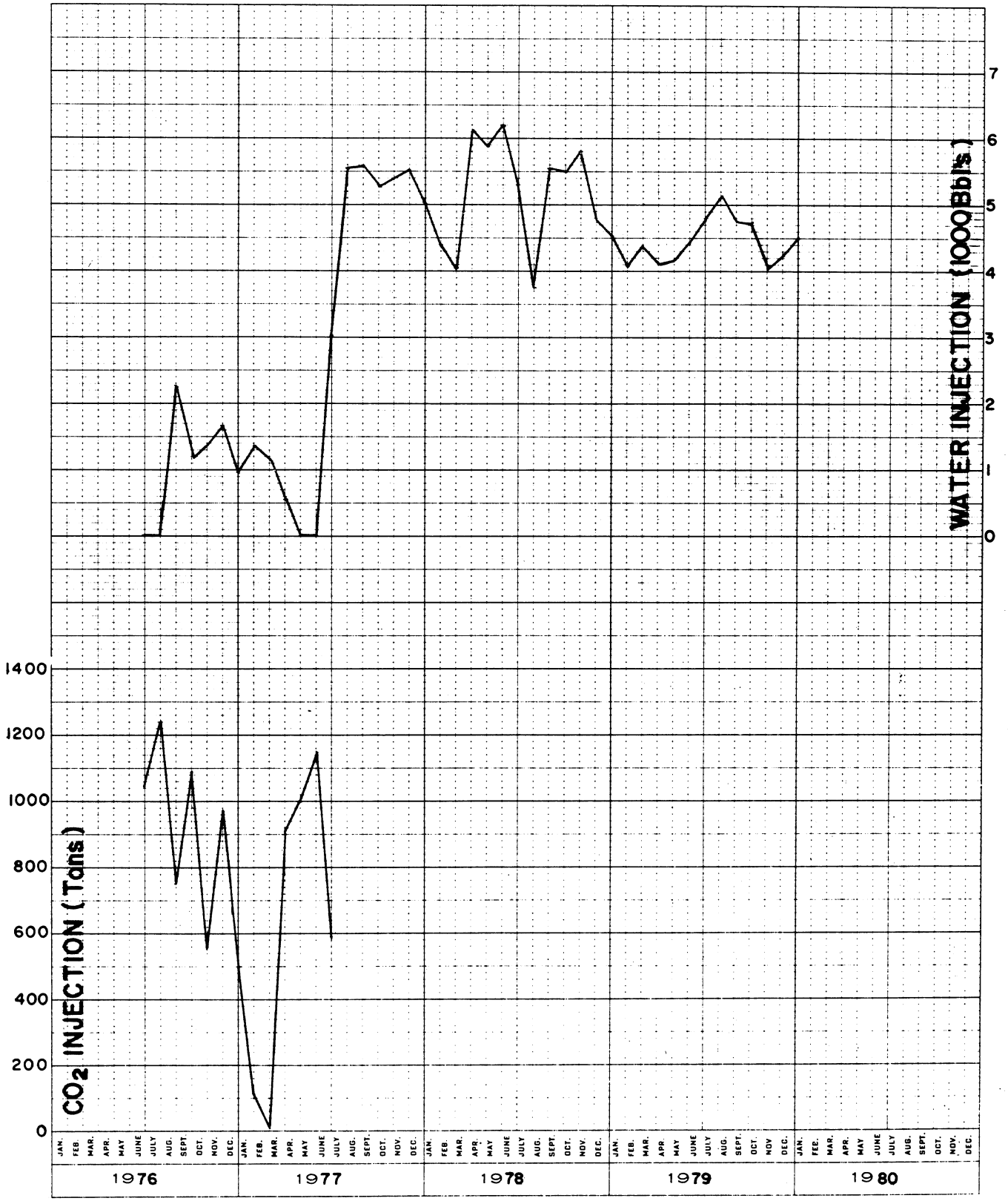

Figure 7

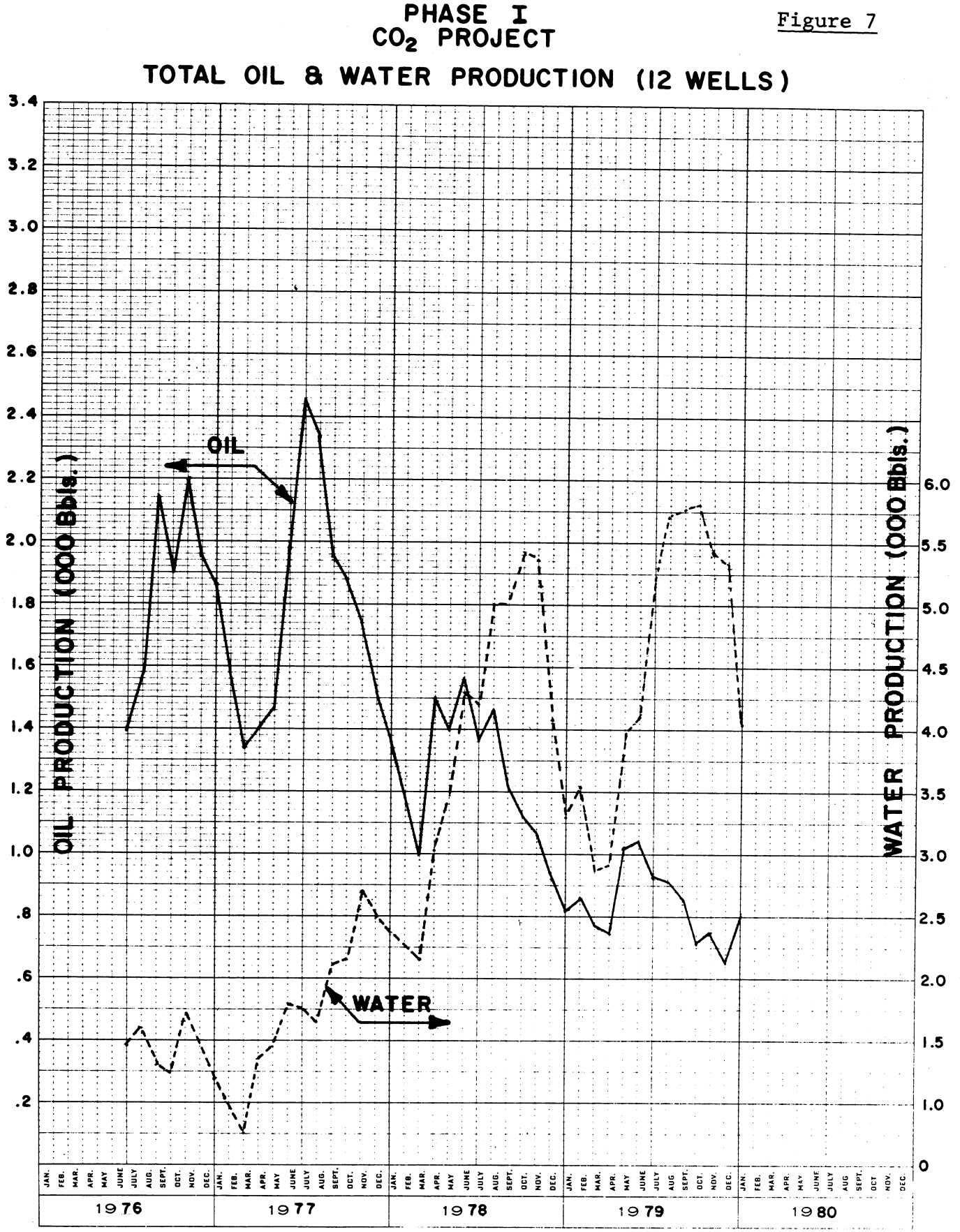
PHASE I
CO2 PROJECT
TOTAL OIL & WATER PRODUCTION (12 WELLS)
OIL PRODUCTION (000 Bbls.)
WATER PRODUCTION (000 Bbls.)
OIL
WATER
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
1976
1977
1978
1979
1980

Figure 8

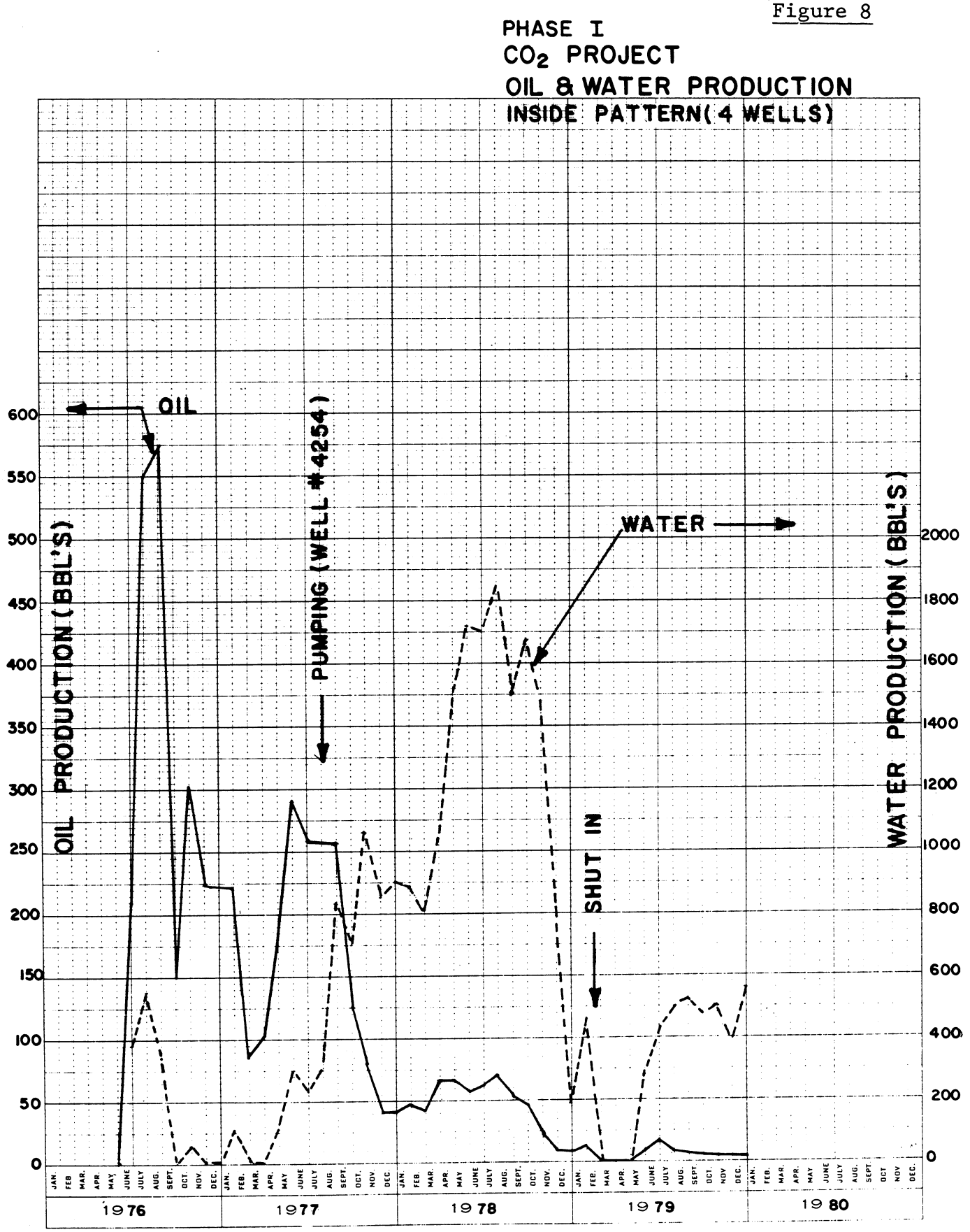
PHASE I
CO2 PROJECT
OIL & WATER PRODUCTION
INSIDE PATTERN(4 WELLS)
OIL
WATER
PUMPING (WELL #4254)
SHUT IN
OIL PRODUCTION (BBL'S)
WATER PRODUCTION (BBL'S)
0
50
100
150
200
250
300
350
400
450
500
550
600
0
200
400
600
800
1000
1200
1400
1600
1800
2000
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
1976
1977
1978
1979
1980

Figure 9

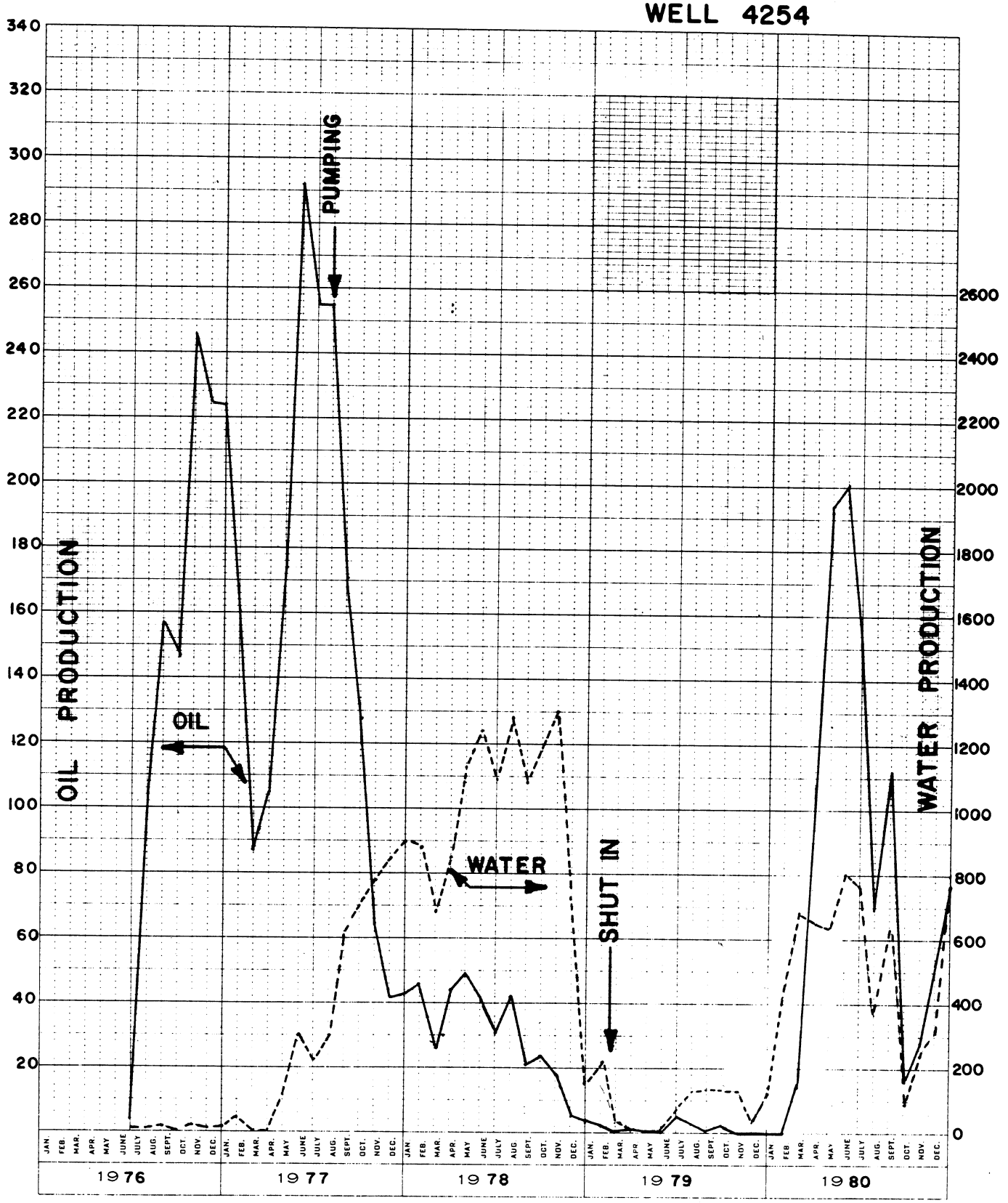
MONTHLY PRODUCTION
WELL 4254
OIL PRODUCTION
WATER PRODUCTION
PUMPING
OIL
WATER
SHUT IN
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
1976
1977
1978
1979
1980

Figure 10

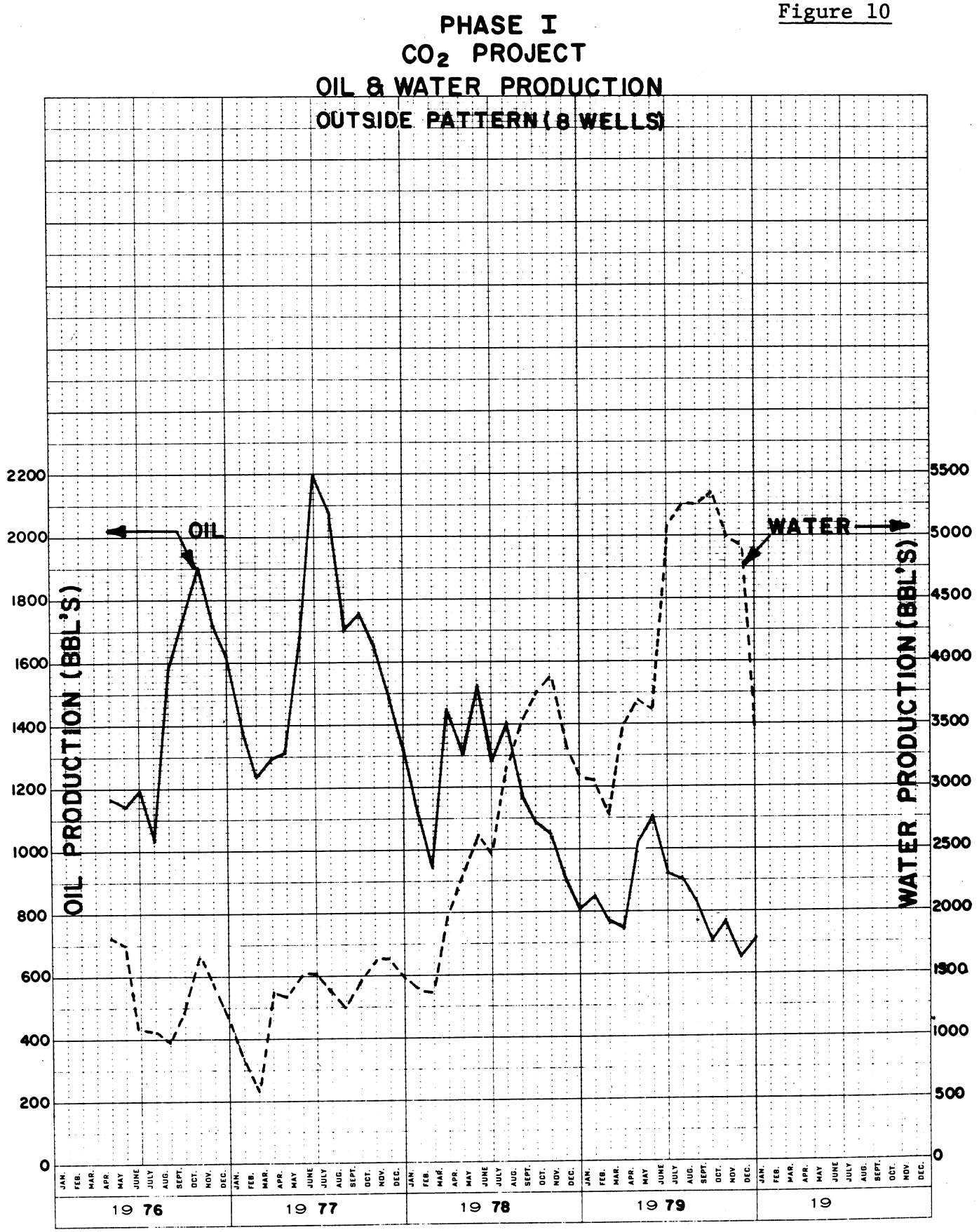
PHASE I
CO2 PROJECT
OIL & WATER PRODUCTION
OUTSIDE PATTERN (8 WELLS)
OIL
WATER
OIL PRODUCTION (BBL'S)
WATER PRODUCTION (BBL'S)
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
19 76
19 77
19 78
19 79
19

Figure 11

MONTHLY CO_2 INJECTION
"MINI - FLOOD"

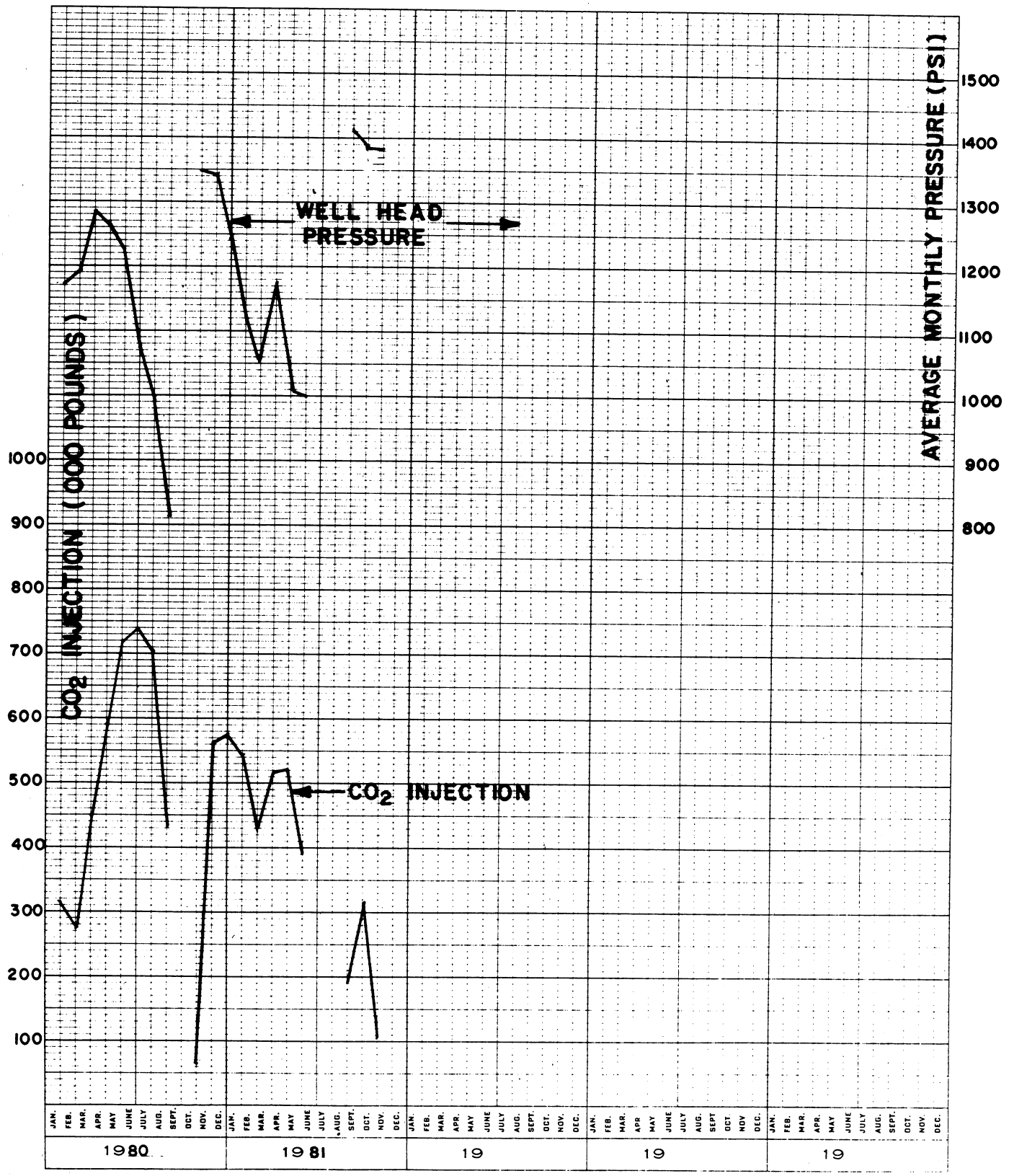

Figure 12

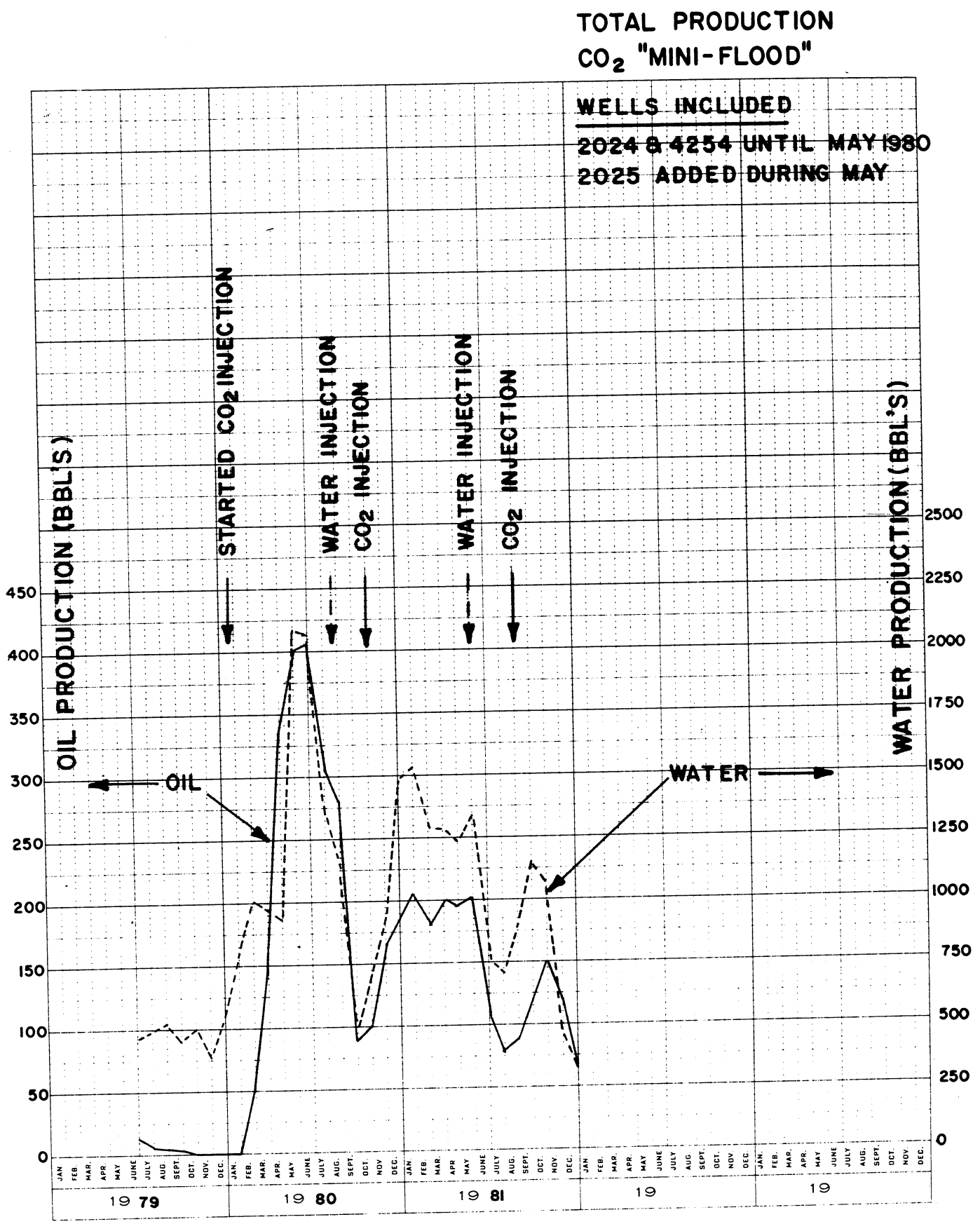
TOTAL PRODUCTION
CO_2 "MINI-FLOOD"
WELLS INCLUDED
2024 & 4254 UNTIL MAY 1980
2025 ADDED DURING MAY
STARTED CO_2 INJECTION
WATER INJECTION
CO_2 INJECTION
WATER INJECTION
CO_2 INJECTION
OIL PRODUCTION (BBL'S)
WATER PRODUCTION (BBL'S)
OIL
WATER
450
400
350
300
250
200
150
100
50
0
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV DEC
19 79
19 80
19 81
19
19

TABLE 1

MONTHLY CO_2 INJECTION (POUNDS)

PHASE I

Month	2020	2022	2023	2025	Total Inj. (lbs)	Total Inj. (tons)
June 1976	276,272	605,593	499,600	707,955	2,089,420	1,044.71
July	426,826	694,823	622,072	736,799	2,480,520	1,240.26
Aug.	550,343	122,029	616,640	219,709	1,508,721	754.36
Sept.	379,213	810,665	-	978,862	2,168,740	1,084.37
Oct.	-	472,948	383,525	245,627	1,102,100	551.05
Nov.	271,541	182,541	645,163	823,875	1,923,120	961.56
Dec.	280,277	383,427	-	314,636	978,340	489.17
Jan. 1977	38,140	93,828	82,492	-	214,460	107.23
Feb.	-	-	-	-	-	-
Mar.	640,423	750,058	345,388	84,431	1,820,300	910.15
Apr.	872,050	513,933	490,749	122,628	1,999,360	999.68
May	657,450	648,972	576,163	404,155	2,286,740	1,143.37
June	335,835	310,641	266,232	273,512	1,186,220	593.11
Total	4,728,370	5,589,458	4,528,024	4,912,189	19,758,041	9,879.02

MONTHLY WATER INJECTION (BBLS)

(Slugs during CO_2 Inj.)

June 1976	-	-	-	-	-
July	-	-	-	-	-
Aug.	121	640	428	1,088	2,277
Sept.	207	28	879	20	1,134
Oct.	501	244	162	472	1,379
Nov.	334	611	317	402	1,664
Dec.	113	92	451	310	966
Jan. 1977	205	268	353	482	1,308
Feb.	329	72	550	232	1,183
Mar.	142	98	180	90	510
Apr.	-	-	-	-	-
May	-	-	-	-	-
Total	1,952	2,053	3,320	3,096	10,421

TABLE 2

PHASE I
CO_2 PROJECT
MONTHLY WATER INJECTION
(After CO_2 Inj.(bbls)

Year	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.
	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.
	July	609	15766	1160	15811	1346	21291	657	18560	3772	71428	30.0	Plant down 141 hrs.
	August	1561	17327	1202	17013	1474	22765	1321	19881	5558	76986	44.8	Plant down 43.5 hrs.
	September	1796	19123	1215	18228	1552	24317	940	20821	5503	82489	45.8	Plant down 21 hrs.
	October	1354	20427	1256	19484	1830	26147	1425	22246	5865	88354	47.3	Plant down 39 hrs.
	November	1050	21527	1281	20765	951	27098	1485	23731	4767	93121	39.7	Plant down 16 hrs.
	December	884	22411	1609	22374	857	27955	1292	25023	4642	97763	37.4	Plant down 4 hrs.
1979	January	932	23343	1291	23665	794	28749	1073	26096	4090	101853	32.9	Plant down 1 hr.
	February	802	24145	1315	24980	836	29585	1410	27506	4363	106216	38.95	Plant down 17 hrs.
	March	835	24980	1416	26396	736	30321	1333	28839	4320	110536	34.84	Plant down 32 hrs.
	April	780	25760	1400	27796	730	31051	1231	30070	4141	114677	34.5	Plant down -0-
	May	864	26624	1090	28886	642	31693	1272	31342	3868	118545	31.2	Plant down 31 hrs.
	June	760	27384	1336	30222	549	32242	1274	32616	3919	122464	32.6	Plant down 47.5 hrs
	July	767	28151	1447	31669	906	33148	1125	33741	4245	126709	34.2	Plant down 4 hrs.
	August	764	28915	1544	33213	766	33914	759	34500	3833	130542	30.9	Plant down 18 hrs.
	September	752	29667	1496	34709	750	34664	837	35337	3835	134377	31.9	Plant down 2.5 hrs
	October	1009	30676	1658	36367	768	35432	644	35981	4079	138456	32.9	Plant down 12 hrs.
	November	1243	31919	1514	37881	941	36373	562	36543	4260	142716	35.5	Plant down 20 hrs.
	December	1120	33039	1590	39471	1022	37395	811	37354	4543	147259	36.7	Plant down 23 hrs.

TABLE 3

PHASE I
CO_2 INJECTION PROJECT
TOTAL PRODUCTION

(Barrels)

Year	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	
	July	1482	119	43461	8681	5010	3617	56020	22883	6492	77	
	August	1226	-	44687	8681	5034	3641	61054	26524	6261	80	
	September	1132	-	45819	8681	5437	4044	66991	30568	6569	82	
	October	1076	-	46895	8681	5358	3965	71849	34533	6434	83	
	November	926	-	47821	8681	4088	2695	74544	37228	5015	81	
	December	814	-	48635	8681	3275	1882	77819	39110	4090	80	
1979	January	869	-	49504	8681	3522	2179	81341	41289	4391	80	
	February	769	-	50273	8681	2865	1472	84206	42761	3634	78	
	March	742	-	51015	8681	3489	2096	87695	44857	4231	82	
	April	1022	-	52037	8681	3696	2303	91391	47160	4718	78	
	May	1124	-	53161	8681	3901	2508	95292	49668	5025	77	
	June	935	-	54096	8681	5503	4110	100795	53778	6438	85	
	July	917	-	55014	8681	5736	4343	106531	58121	6654	86	
	August	846	-	55860	8681	5765	4372	110903	62493	6611	87	
	September	706	-	56566	8681	5810	4417	115320	66910	6516	89	
	October	774	-	57340	8681	5430	4037	120750	70947	6204	87.5	
	November	655	-	57995	8681	5331	3938	126081	76278	5986	89.1	
	December	719	-	58714	8681	4032	2639	130113	80310	4751	84.9	

TABLE 4

PHASE I
CO_2 PROJECT
OIL & WATER PRODUCTION
SUMMARY

(Barrels)

		-INSIDE PATTERN-					-OUTSIDE PATTERN-					
YEAR	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
	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	Inside: 4 Wells
	July	73	1857	1931	4613	16290	1408	3152	4560	38838	40017	3 Wells
	August	53	1493	1547	4666	17784	1172	3540	4712	40010	43557	3 Wells
	September	46	1676	1722	4713	19461	1085	3760	4846	41096	47317	3 Wells
	October	21	1465	1487	4734	20926	1054	3892	4946	42151	51209	3 Wells
	November	9	788	798	4743	21715	916	3299	4215	43068	54508	2 Wells
	December	5	195	201	4749	21911	808	3079	3887	43876	57587	2 Wells
1979	January	14	460	475	4763	22372	854	3061	3915	44731	60648	2 Wells
	February	-	72	72	4763	22444	769	2792	3561	45500	63441	2 wells
	March	-	-	-	4763	22444	742	3489	4231	46242	66930	0 wells
	April	-	-	-	4763	22444	1022	3696	4718	47266	76626	0 wells
	May	10	267	278	4774	22712	1113	3663	4746	48379	80260	
	June	14	437	452	4789	23149	920	5065	5985	49299	85325	
	July	6	508	514	4796	23657	911	5227	6138	50210	90553	
	August	6	526	523	4802	24183	839	5239	6078	51049	95792	
	September	4	469	474	4807	24652	701	5340	6041	51750	101133	

*Well Fractured
**Well Treated with Carbon Bisulfide

TABLE 5

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

		2021			2024			4254			20274		
YEAR	MONTH	OIL	WATER	TOTAL FLUID	OIL	WATER	TOTAL FLUID	OIL	WATER	TOTAL FLUID	OIL	WATER	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
	July	1	95	97	-	-	-	42	1292	1334	29	469	499
	August	-	-	-	-	9	10	21	1095	1116	31	388	420
	September	1	59	60	-	-	-	24	1126	1150	20	490	511
	October	-	-	-	-	24	24	19	1337	1357	-	104	105
	November	3	49	52	-	-	-	5	739	745	-	-	-
	December	-	-	-	1	35	37	4	160	164	-	-	-
1979	January	-	-	-	10	248	259	3	212	216	-	-	-
	February	-	-	-	-	36	36	-	35	35	-	-	-
	March	-	-	-	-	-	-	-	-	-	-	-	-
	April	-	-	-	-	-	-	-	-	-	-	-	-
	May	-	-	-	4	249	253	6	17	24	-	-	-
	June	-	-	-	4	369	374	9	68	78	-	-	-
	July	-	-	-	4	381	385	2	126	128	-	-	-
	August	-	-	-	5	388	393	-	138	138	-	-	-
	September	-	-	-	2	332	334	2	137	139	-	-	-
	October	-	-	SI	-	333	333	-	168	168	-	-	-
	November	-	-	SI	-	353	353	-	35	35	-	-	-
	December	-	-	SI	-	395	395	-	163	163	-	-	-

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

TABLE 6

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

		2047			4049			4591			2043		
YEAR	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
	July	219	132	352	53	1470	1523	27	190	218	154	163	317
	August	217	177	395	2	1685	1688	19	200	219	165	156	322
	September	223	94	317	30	1599	1630	37	224	262	117	161	278
	October	207	91	298	-	1389	1390	20	207	228	116	190	306
	November	190	81	272	-	1680	1681	18	262	280	99	228	327
	December	161	92	254	-	1710	1710	27	172	200	99	219	319
1979	January	202	85	287	-	1788	1788	-	-	SI	103	228	332
	February	185	79	265	-	1618	1618	-	-	SI	88	241	330
	March	193	92	285	-	1789	1789	-	-	SI	95	245	340
	April	184	100	284	-	1536	1536	-	-	SI	98	222	321
	May	183	97	281	55	1602	1657	-	-	SI	93	239	333
	June	171	97	268	-	3000	3000	-	-	SI	79	243	322
	July	199	97	296	-	3100	3100	-	-	SI	79	244	323
	August	190	112	302	-	3070	3070	-	-	SI	87	258	345
	September	147	138	285	-	3000	3000	-	-	SI	56	221	277
	October	180	102	283	-	2400	2400	-	-	SI	54	145	199
	November	32	80	112	-	2700	2700	-	-	SI	115	300	415
	December	127	224	352	-	1000	1000	-	-	SI	25	154	180

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

TABLE 6 (cont)

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

YEAR	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
	July	68	554	623	350	488	839	312	213	525	221	39	261
	August	38	556	594	257	644	901	273	193	467	203	13	216
	September	45	421	466	131	1049	1181	306	196	503	201	12	214
	October	65	513	579	121	830	952	312	230	543	209	43	253
	November	81	540	621	-	-	SI	314	224	539	211	24	235
	December	54	521	576	-	-	-	268	299	567	196	63	259
1979	January	53	596	649	-	-	-	259	315	575	235	47	283
	February	79	497	576	-	-	SI	209	323	533	205	32	238
	March	34	542	577	27	136	163	182	631	831	208	52	260
	April	30	528	559	280	445	726	249	805	1054	178	57	235
	May	39	566	605	280	415	695	275	790	1065	185	69	254
	June	20	587	608	244	394	638	246	695	941	157	48	205
	July	29	619	648	219	317	536	227	744	971	156	53	209
	August	19	634	653	179	327	506	216	778	994	146	58	204
	September	27	659	686	134	528	662	190	752	942	144	39	183
	October	25	744	769	155	764	919	180	746	926	180	25	205
	November	24	720	744	146	372	518	171	746	917	165	24	190
	December	25	642	668	205	372	577	205	874	1080	128	205	334

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

TABLE 7

CO_2 PROJECT - PHASE II

"MINI-FLOOD"

MONTHLY INJECTION DATA

	Month	Monthly Injection (lbs CO_2)	Cumulative Injection (lbs)	Liquid
Start -	January 1980	312,600	312,600	CO_2
	February	274,560	578,160	CO_2
	March	458,584	1,045,744	CO_2
	April	590,030	1,635,774	CO_2
	May	718,752	2,354,526	CO_2
	June	739,089	3,093,615	CO_2
	July	707,280	3,800,895	CO_2
	August	435,165	4,236,060	CO_2
	August	492 Bbls.	492	Water
	September	791 Bbls.	1,283	Water
	October	519 Bbls.	1,802	Water
	October	62,370	62,370	CO_2
	November	568,000	630,370	CO_2
	December	577,660	1,208,030	CO_2
	January 1981	541,320	1,749,350	CO_2
	February	427,140	2,176,490	CO_2
	March	518,800	2,695,290	CO_2
	April	521,660	3,216,950	CO_2
	May	398,520	3,615,470	CO_2
	May	236 Bbls.	236	Water
	June	453 Bbls.	689	Water
	July	305 Bbls.	994	Water
	August	42 Bbls.	1,036	Water
	August	196,440	196,440	CO_2
	September	313,060	509,500	CO_2
	October	106,380	615,880	CO_2
	October	499 Bbls.	499	Water
	November	649 Bbls.	1,148	Water
	December	631 Bbls.	1,779	Water

Total CO_2 Injected 8,467,410 lbs.

Total Water Injected 4,617 bbls.

TABLE 8

CO_2 PROJECT - PHASE II

"MINI-FLOOD"

TOTAL PRODUCTION

(Barrels)

	Oil	Cum. Oil	Water	Cum. Water	Remarks
January 1980	0.0	0.0	819.13	819.13	
February	54.62	54.62	1,014.97	1,834.10	Lowered packer-20274
March	145.88	200.50	978.04	2,812.14	
April	336.82	537.32	929.38	3,741.52	
May	401.73	939.05	2,099.21	5,840.73	Added 2025
June	406.43	1,345.48	1,940.57	7,781.30	
July	306.08	1,651.56	1,436.28	9,217.58	
August	280.59	1,932.15	1,108.89	10,398.47	
September	83.47	2,015.62	442.29	10,840.76	
October	100.42	2,116.04	682.38	11,523.14	
November	161.49	2,277.53	925.01	12,448.15	
December	186.22	2,463.75	1,475.29	13,923.44	
January 1981	207.54	2,671.29	1,537.36	15,504.36	
February	167.67	2,838.96	1,291.13	16,795.49	
March	202.46	3,041.42	1,278.14	18,073.63	
April	196.66	3,238.08	1,235.75	19,308.86	
May	203.27	3,441.35	1,340.23	20,649.09	
June	110.39	3,551.74	756.22	21,405.31	
July	77.19	3,628.93	669.14	22,074.45	
August	88.81	3,717.74	902.98	22,977.43	
September	120.84	3,838.58	1,133.42	24,110.85	
October	150.23	3,988.81	1,034.42	25,145.27	
November	116.20	4,105.01	473.46	25,618.73	
December	68.89	4,173.90	283.86	25,902.59	

TABLE 9

CO_2 PROJECT

"Mini-Flood"

MONTHLY PRODUCTION

(Barrels)

		Well #2024					Well #4254					
Year	Month	Oil	Cum. Oil	Water	Cum. Water	Total Fluid	Oil	Cum. Oil	Water	Cum. Water	Total Fluid	Remarks
1980	January	0.00	0.00	390.84	390.84	390.84	0.00	0.00	428.29	428.29	428.29	Start CO_2 Inj. 1-9-80
	February	40.51	40.51	330.34	721.18	370.85	14.11	14.11	684.63	1,112.92	698.74	Lowered packer in 20274 - 2-15-80
	March	38.31	78.82	327.85	1,049.03	366.16	107.57	121.68	650.19	1,743.11	757.76	
	April	142.09	220.91	289.25	1,338.28	431.34	194.73	316.41	640.13	2,403.24	834.56	
	May	165.79	386.70	282.41	1,620.69	448.20	203.69	520.10	804.06	3,207.30	1,007.75	
	June	168.22	554.92	286.31	1,907.00	454.53	154.82	674.92	770.41	3,977.71	925.23	
	July	142.62	697.54	461.49	2,368.49	604.11	70.65	745.57	363.21	4,340.92	433.86	4254 Shut in 15 days
	August	97.93	795.47	197.07	2,565.56	295.00	112.08	857.65	635.04	4,975.96	747.12	Start water injection
	September	19.92	815.39	34.03	2,599.59	53.95	16.60	874.25	97.94	5,073.90	114.54	
	October	27.38	842.77	96.88	2,696.47	124.26	26.56	900.81	252.64	5,326.54	279.20	Start CO_2 injection
	November	34.63	877.40	200.00	2,896.47	234.63	53.82	954.63	306.51	5,633.05	360.33	
	December	35.69	913.09	246.10	3,142.57	281.79	77.74	1,032.37	800.95	6,484.05	878.69	
1981	January	35.69	948.78	224.10	3,366.67	259.79	79.68	1,112.06	952.95	7,437.00	1,032.63	
	February	25.67	974.45	225.58	3,592.25	251.25	49.80	1,161.86	758.41	8,195.41	808.21	
	March	28.22	1,002.67	216.65	3,808.90	244.87	63.08	1,224.94	774.31	8,969.72	837.39	
	April	29.05	1,031.72	200.03	4,008.93	229.08	68.01	1,292.95	785.89	9,755.61	853.90	
	May	25.73	1,057.45	212.98	4,221.91	238.71	80.31	1,373.26	904.84	10,660.45	985.15	Start water injection
	June	13.28	1,070.73	184.06	4,405.97	197.34	34.03	1,407.29	360.51	11,020.96	394.54	
	July	7.47	1,078.20	195.87	4,601.84	203.34	21.58	1,428.87	289.67	11,310.63	311.25	
	August	6.64	1,084.84	225.67	4,827.51	232.31	23.24	1,452.11	486.43	11,797.06	509.67	Start CO_2 injection
	September	12.46	1,097.30	232.47	5,059.98	244.93	31.54	1,483.65	723.33	12,520.39	754.87	
	October	21.58	1,118.88	222.47	5,282.45	244.05	43.99	1,527.64	623.33	13,143.72	667.32	Start water injection
	November	17.43	1,136.31	156.04	5,438.49	173.47	27.39	1,555.03	145.59	13,289.31	172.98	
	December	5.81	1,142.12	139.44	5,577.93	145.25	4.98	1,560.01	.83	13,290.14	5.81	

TABLE 9 (cont)

CO_2 PROJECT

"Mini-Flood"

MONTHLY PRODUCTION

(Barrels)

		Well #2025					
Year	Month	Oil	Cum. Oil	Water	Cum. Water	Total Fluid	Remarks
1980	January	-	-	-	-	-	
	February	-	-	-	-	-	
	March	-	-	-	-	-	
	April	-	-	-	-	-	
	May	32.25	32.25	1,012.74	1,012.74	1,044.99	Former Inj. Well - Started Prod. Test
	June	83.39	115.64	883.85	1,896.59	967.24	
	July	92.81	208.45	611.58	2,508.17	704.39	
	August	70.58	279.03	348.78	2,856.95	419.36	
	September	46.95	325.98	310.32	3,167.27	357.27	
	October	46.48	372.46	332.86	3,500.13	379.34	
	November	73.04	445.50	433.35	3,933.48	506.39	
	December	72.79	518.29	347.76	4,281.24	420.55	
1981	January	92.17	610.46	360.31	4,641.55	452.48	
	February	92.20	702.66	307.14	4,948.69	399.34	
	March	111.16	813.82	287.18	5,235.87	398.34	
	April	99.60	919.42	249.83	5,485.70	349.43	
	May	97.23	1,010.65	222.41	5,708.11	319.64	
	June	63.08	1,073.73	211.65	5,919.76	274.73	
	July	48.14	1,121.87	183.60	6,103.36	231.74	
	August	58.93	1,180.80	190.88	6,294.24	249.81	
	September	76.84	1,257.74	177.62	6,471.86	254.46	
	October	84.66	1,342.40	188.41	6,660.27	273.07	
	November	71.38	1,413.78	171.83	6,832.10	243.21	
	December	58.10	1,471.88	143.59	6,975.69	201.69	

TABLE 10

CO_2 MINI-FLOOD

GAS PRODUCTION

Week Ending	2024 Av. Mcf Per Day	4254 Av. Mcf Per Day	2025 Av. Mcf Per Day
2-27-80	0.00	1.90	
3-5-80	1.26	9.48	
3-12-80	2.45	9.48	
3-19-80	2.53	11.03	
3-26-80	3.79	15.17	
4-2-80	3.97	14.76	
4-9-80	4.69	-	
4-16-80	6.63	13.12	
4-23-80	8.47	15.70	
4-30-80	7.94	16.82	
5-7-80	9.53	-	
5-14-80	12.40	67.28	
5-21-80	11.60	-	
5-24-80	13.12	-	9.36
5-30-80	11.61	-	11.47
6-6-80	11.73	-	13.95
6-13-80	13.40	-	15.47
6-20-80	21.11	54.90	15.57
6-27-80	25.41	62.79	-

TABLE 11

GRANNY'S CREEK FIELD

RESERVOIR FLUID PROPERTIES

Initial Gas - Oil Ratio	155 SCF/STB
Saturation Pressure	492 Psig
Formation Volume Factor	1.113 Res. Bbls/STB at 492 Psig and 75°F
Viscosity at 492 Psig and 75°F	1.94 CP
Viscosity at 0 Psig and 75°F	3.14 CP
Stock Tank Liquid Gravity at 60°F	45.4° API

TABLE 12

SUMMARY OF CORE ANALYSIS

WELL NO.	ZONE	DEPTH, FEET	PERMEABILITY, MILLIDARCY	POROSITY PERCENT	OIL SATURATION PERCENT
2022	A	1999-2004	100.0	18.8	18.3
	B	2013-2020	31.8	13.1	12.3
	C	2024-2041	5.3	19.8	14.8
2020	A	2047-2060	5.3	13.1	51.7
	B	2063-2069	88.2	13.6	50.8
	C	2071-2088	6.2	20.1	37.9
20,274	A	1980-1986	6.8	12.2	9.4
	B	1992-1997	4.6	7.2	19.6
	C	2002-2022	4.5	16.4	13.7

TABLE 13

SUMMARY OF RESERVOIR AND PRODUCTION DATA
Granny's Creek Field
CO_2 PILOT PROJECT

Formation - Big Injun
Net Thickness - 18.3 Ft. ("C" Zone only)
Ave. Porosity - 18.9% ("C" Zone only)
Geometric Perm. - 4.5 Md
Reservoir Depth - 2000 Ft.
Reservoir Temp. - 73°F
Original Oil in Place - 99,358 STB - 6.5 Acres (Phase I)
Original Oil in Place per Acre - 15,286 - 6.5 Acres (Phase I)
Primary Recovery - 6458 STB - 6.5 Acres (Phase I)
Primary Recovery - 994 B/A - 6.5 Acres (Phase I)
Oil Saturation Prior to Waterflood - 55%
Formation Volume Factor after Primary Prod. - 1.032
Secondary Production Waterflood - 4029 B/Ac
Oil Produced Inside Pattern - Phase I - 4000 Bbl
Oil Recovery per Acre - Phase I - 615 B/A
Original HCPV - 113,367 Bbls.
CO_2 Injected - Total - Phase I - 9878 Tons
Tons of CO_2 Injected per Barrel of Oil Rec. - Total - 19,596 SCF/Bbl
Original Oil in Place - Phase II - Miniflood - 33630 STB
Oil Produced via CO_2 Jan. 1980-Oct. 1981 - 4166 STB
Oil Produced - via CO_2 Jan. 1980-Oct. 1981 - 1894 Bbls/Acre
Percent Oil in Place Prod. via CO_2 - 12.4%
CO_2 Injected - Phase II - 4244 Tons
CO_2 Injected - % HPVC - 62%
CO_2/Oil Ratio - 17514 SCF/Bbl
Ave. GOR Produced - 3259 SCF/Bbl

Note: Mini-Flood data calculated to completion (10-81)

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