OILFIELD RESEARCH LABORATORIES

536 NORTH HIGHLAND - CHANUTE, KANSAS - PHONE HE1-2650

Chanute, Kansas

November 26, 1965

CRA, Incorporated
Box 445
Wellington, Kansas

Gentlemen:

Enclosed herewith is the report of the analysis of the Rotary core taken from the Woodward Lease, Well No. 8, Bourbon County, Kansas, and submitted to our laboratory on November 18, 1965.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Benjamin R. Pearman

Benjamin R. Pearman

BRP:rf

2 c. - Wellington, Kansas
2 c. - Muskogee, Oklahoma
1 c. - Roy Wood

Oilfield Research Laboratories

GENERAL INFORMATION & SUMMARY

Company CRA, Inc. Lease Woodward Well No. 8

Location 340' WEL & 1650' NSL SW

Section 12 Twp. 25S Rge. 21E County Bourbon State Kansas

Name of Sand	Bartlesville
Top of Core	619.0
Bottom of Core	660.0
Top of Sand	620.0
Bottom of Sand	656.0
Total Feet of Permeable Sand	33.9
Total Feet of Floodable Sand	21.9

Distribution of Permeable Sand:

Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 10	5.0	5.0
10 - 50	12.9	17.9
50 - 100	5.0	22.9
100 - 300	10.0	32.9
300 & above	1.0	33.9

Average Permeability Millidarcys	80.6
Average Percent Porosity	20.2
Average Percent Oil Saturation	35.4
Average Percent Water Saturation	33.6
Average Oil Content, Bbls./A. Ft.	551.
Total Oil Content, Bbls./Acre	19,209.
Average Percent Oil Recovery by Laboratory Flooding Tests	12.5
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	198.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	4,340.
Total Calculated Oil Recovery, Bbls./Acre (Primary & Secondary)	8,470.
Packer Setting, Feet	1754'
Viscosity, Centipoises @	
A. P. I. Gravity, degrees @ 60 °F	
Elevation, Feet	

Fresh water mud was used as the circulating fluid while taking this core. The core was sampled and the samples sealed in plastic bags by an employee of Oilfield Research Laboratories. The well was drilled in virgin territory.

FORMATION CORED

The detailed log of the formation cored is as follows:

Depth Interval, Feet	Description
619.0 - 620.0	Sandy shale.
620.0 - 633.0	Light brown, shaly sandstone.
633.0 - 633.6	Sandy shale.
633.6 - 637.6	Brown, slightly shaly sandstone.
637.6 - 638.1	Sandy shale.
638.1 - 652.0	Dark brown, slightly laminated, slightly shaly sandstone.
652.0 - 656.0	Brown to dark, laminated, carbonaceous sandstone.
656.0 - 660.0	Sandy shale.

Coring was started at a depth of 619.0 feet in sandy shale and completed at 660.0 feet also in sandy shale. This core shows a total of 34.9 feet of sandstone. For the most part, the pay is made up of brown to dark brown, slightly shaly sandstone.

PERMEABILITY

For the sake of distribution, the core was divided into two sections. The weighted average permeability of the upper and lower sections is 123.7 and 53.8 millidarcys respectively; the overall average being 80.6 (See Table III). By observing the data given on the coregraph, it

is noticeable that the sand has an irregular permeability profile. The permeability of the sand varies from impermeable to a maximum of 384. millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a good weighted average percent oil saturation, namely, 35.4. The weighted average percent oil saturation of the upper and lower sections is 22.3 and 43.0 respectively. The weighted average percent water saturation of the upper and lower sections is 38.6 and 30.6 respectively; the overall average being 33.6 (See Table III). This gives an overall weighted average total fluid saturation of 69.0 percent.

The weighted average oil content of the upper and lower sections is 348 and 670 barrels per acre foot respectively; the overall average being 551. The total oil content, as shown by this core, is 19,209 barrels per acre (See Table III).

LABORATORY FLOODING TESTS

The sand in this core responded to laboratory flooding tests, as a total recovery of 4,340 barrels of oil per acre was obtained from 21.9 feet of sand. The weighted average percent oil saturation was reduced from 42.5 to 30.0, or represents an average recovery of 12.5 percent. The weighted average effective permeability of the samples is 5.50 millidarcys, while the average initial fluid production pressure is 19.8 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 35 samples tested, 31 produced water and 22 oil. This indicates that approximately 63 percent of the sand represented by these samples is

floodable pay sand. The tests also show that the sand has a wide variation in effective permeability to water.

CONCLUSION

Based on the results of the laboratory tests, it appears that efficient primary and secondary operations in the vicinity of this well should recover approximately 8,470 barrels of oil per acre or an average of 387 barrels per acre foot from the 21.9 feet of floodable pay sand analyzed in this core. These recovery values were calculated using the following data and assumptions:

Original formation volume factor	1.06
Reservoir water saturation, percent	17.0
Average porosity, percent	20.0
Oil saturation after flooding, percent	30.0
Performance factor, percent	50.0
Net floodable pay sand, feet	21.9

This core shows a pay sand section (633.6 - 652.0) having a good oil saturation, a moderate water saturation and a wide variation in effective permeability to water.

Oilfield Research Laboratories

RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company CRA, Inc. Lease Woodward Well No. 8

Sample No.	Depth, Feet	Effective Porosity Percent	Percent Saturation			Oil Content Bbls. / A Ft.	Perm., Mill.	Feet of Sand		Total Oil Content	Perm. Capacity Ft. X md.
			Oil	Water	Total			Ft.	Cum. Ft.		
1	620.5	22.3	10	51	61	173	31.	1.0	1.0	173	31.00
2	621.5	21.9	17	31	48	288	135.	1.0	2.0	288	135.00
3	622.5	18.3	33	40	73	469	93.	1.0	3.0	469	93.00
4	623.5	19.0	23	33	56	339	17.	1.0	4.0	339	17.00
5	624.5	19.8	27	37	64	414	42.	1.0	5.0	414	42.00
6	625.5	18.7	18	33	51	261	13.	1.0	6.0	261	13.00
7	626.5	20.3	16	36	52	252	178.	1.0	7.0	252	178.00
8	627.5	23.2	20	56	76	360	109.	1.0	8.0	360	109.00
9	628.5	23.2	19	27	46	342	122.	1.0	9.0	342	122.00
10	629.5	15.0	36	59	95	419	33.	1.0	10.0	419	33.00
11	630.5	19.8	32	37	69	491	156.	1.0	11.0	491	156.00
12	631.5	24.4	17	31	48	322	296.	1.0	12.0	322	296.00
13	632.5	23.6	22	31	53	402	384.	1.0	13.0	402	384.00
14	634.5	24.3	36	23	59	679	115.	1.4	14.4	950	161.00
15	635.5	20.8	39	30	69	629	121.	1.0	15.4	629	121.00
16	636.5	23.0	46	22	68	821	89.	1.0	16.4	821	89.00
17	637.5	20.4	41	28	69	648	116.	0.6	17.0	388	69.60
18	638.5	20.8	45	23	68	726	45.	0.9	17.9	654	40.50
19	639.5	23.0	45	21	66	803	284.	1.0	18.9	803	284.00
20	640.5	20.7	44	24	68	706	8.3	1.0	19.9	706	8.30
21	641.5	20.4	51	24	75	805	67.	1.0	20.9	805	67.00
22	642.5	21.7	49	21	70	825	57.	1.0	21.9	825	57.00
23	643.5	20.5	53	25	78	842	20.	1.0	22.9	842	20.00
24	644.5	24.0	57	17	74	1,062	58.	1.0	23.9	1,062	58.00

66% Ave

79%

+401

Oilfield Research Laboratories

RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company CRA, Inc. Lease Woodward Well No. 8

Sample No.	Depth, Feet	Effective Porosity Percent	Percent Saturation			Oil Content Bbls. / A Ft.	Perm., Mill.	Feet of Sand		Total Oil Content	Perm. Capacity Ft. X md.
			Oil	Water	Total			Ft.	Cum. Ft.		
25	645.5	17.9	41	33	74	569	11.	1.0	24.9	569	11.00
26	646.5	17.8	39	35	74	538	14.	1.0	25.9	538	14.00
27	647.5	20.3	43	29	72	676	22.	1.0	26.9	676	22.00
28	648.5	20.8	46	22	68	741	29.	1.0	27.9	741	29.00
29	649.5	19.6	44	24	68	668	49.	1.0	28.9	668	49.00
30	650.5	16.2	42	42	84	527	9.4	1.0	29.9	527	9.40
31	651.5	16.5	50	41	91	639	12.	1.0	30.9	639	12.00
32	652.5	19.0	45	26	71	664	2.0	1.0	31.9	664	2.00
33	653.5	16.7	43	40	83	556	0.84	1.0	32.9	556	0.84
34	654.5	14.2	29	68	97	319	Imp.	1.0	33.9	319	0.00
35	655.5	17.3	22	57	79	295	0.57	1.0	34.9	295	0.57
								Total-------		19,209	

Oilfield Research Laboratories

SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company CRA, Inc. Lease Woodward Well No. 8

Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.
620.0 - 633.0	13.0	123.7	1,609.00
633.6 - 656.0	20.9	53.8	1,125.21
620.0 - 656.0	33.9	80.6	2,734.21

Depth Interval, Feet	Feet of Core Analyzed	Average Percent Porosity	Average Percent Oil Saturation	Average Percent Water Saturation	Average Oil Content Bbl./A. Ft.	Total Oil Content Bbls./Acre
620.0 - 633.0	13.0	20.7	22.3	38.6	348	4,532
633.6 - 656.0	21.9	19.9	43.0	30.6	670	14,677
620.0 - 656.0	34.9	20.2	35.4	33.6	551	19,209

Oilfield Research Laboratories

RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company CRA, Inc. Lease Woodward Well No. 8

Sample No.	Depth, Feet	Effective Porosity Percent	Original Oil Saturation		Oil Recovery		Residual Saturation			Volume of Water Recovered cc*	Effective Permeability Millidarcys**	Initial Fluid Production Pressure Lbs./Sq./In.
			%	Bbls./A. Ft.	%	Bbls./A. Ft.	% Oil	% Water	Bbls./A. Ft.			
1	620.5	22.0	12	204	0	0	12	84	204	222	13.00	10
2	621.5	22.1	17	291	0	0	17	73	291	524	37.60	10
3	622.5	18.6	33	476	6	87	27	69	389	181	4.64	10
4	623.5	18.9	23	337	0	0	23	68	337	185	7.40	10
5	624.5	20.0	27	419	2	31	25	60	388	178	6.80	10
6	625.5	18.2	17	240	0	0	17	65	240	45	1.25	10
7	626.5	20.7	17	273	0	0	17	71	273	757	50.00	10
8	627.5	22.9	20	355	0	0	20	73	355	139	3.38	10
9	628.5	23.0	20	356	0	0	20	68	356	295	14.00	10
10	629.5	15.4	36	430	10	119	26	70	311	331	27.80	10
11	630.5	20.1	32	499	4	62	28	67	437	210	21.25	10
12	631.5	24.0	18	335	0	0	18	73	335	578	66.60	10
13	632.5	22.6	22	386	0	0	22	65	386	250	24.40	10
14	634.5	24.0	36	670	18	335	18	65	335	276	11.21	10
15	635.5	20.5	39	620	9	143	30	66	477	101	3.89	10
16	636.5	22.7	46	810	13	229	33	66	581	229	11.21	15
17	637.5	20.8	41	661	17	274	24	66	387	122	4.60	10
18	638.5	20.3	45	708	15	236	30	67	472	11	0.300	30
19	639.5	22.6	45	788	18	315	27	65	473	176	6.10	10
20	640.5	20.5	44	700	15	238	29	61	462	16	0.600	20
21	641.5	20.7	51	819	17	272	34	64	547	106	4.20	10
22	642.5	21.4	49	813	17	282	32	64	531	81	2.80	10
23	643.5	20.0	53	821	19	294	34	65	527	98	3.10	10
24	644.5	23.8	57	1,052	17	314	40	58	738	98	3.80	10

Note: cc—cubic centimeter.

*—Volume of water recovered at the time of maximum oil recovery.

**—Determined by passing water through sample which still contains residual oil.

RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company CRA, Inc. Lease Woodward Well No. 8

Sample No.	Depth, Feet	Effective Porosity Percent	Original Oil Saturation		Oil Recovery		Residual Saturation			Volume of Water Recovered cc*	Effective Permeability Millidarcys**	Initial Fluid Production Pressure Lbs./Sq./In.
			%	Bbls./A. Ft.	%	Bbls./A. Ft.	% Oil	% Water	Bbls./A. Ft.			
25	645.5	17.6	41	559	7	96	34	63	463	8	0.200	40
26	646.5	17.4	39	526	10	135	29	66	391	10	0.300	40
27	647.5	19.9	43	663	16	246	27	69	417	10	0.400	40
28	648.5	20.5	46	731	10	159	36	60	572	56	1.60	20
29	649.5	19.1	44	651	15	222	29	67	429	90	2.70	20
30	650.5	16.1	42	524	14	175	28	67	349	15	0.500	40
31	651.5	16.3	50	632	6	76	44	50	556	8	0.200	50
32	652.5	18.9	46	674	0	0	46	27	674	0	Imp.	-
33	653.5	16.7	45	582	0	0	45	41	582	0	Imp.	-
34	654.5	14.4	30	335	0	0	30	67	335	0	Imp.	-
35	655.5	17.0	22	290	0	0	22	59	290	0	Imp.	-

Notes: cc—cubic centimeter.

*—Volume of water recovered at the time of maximum oil recovery.

**—Determined by passing water through sample which still contains residual oil.

Oilfield Research Laboratories

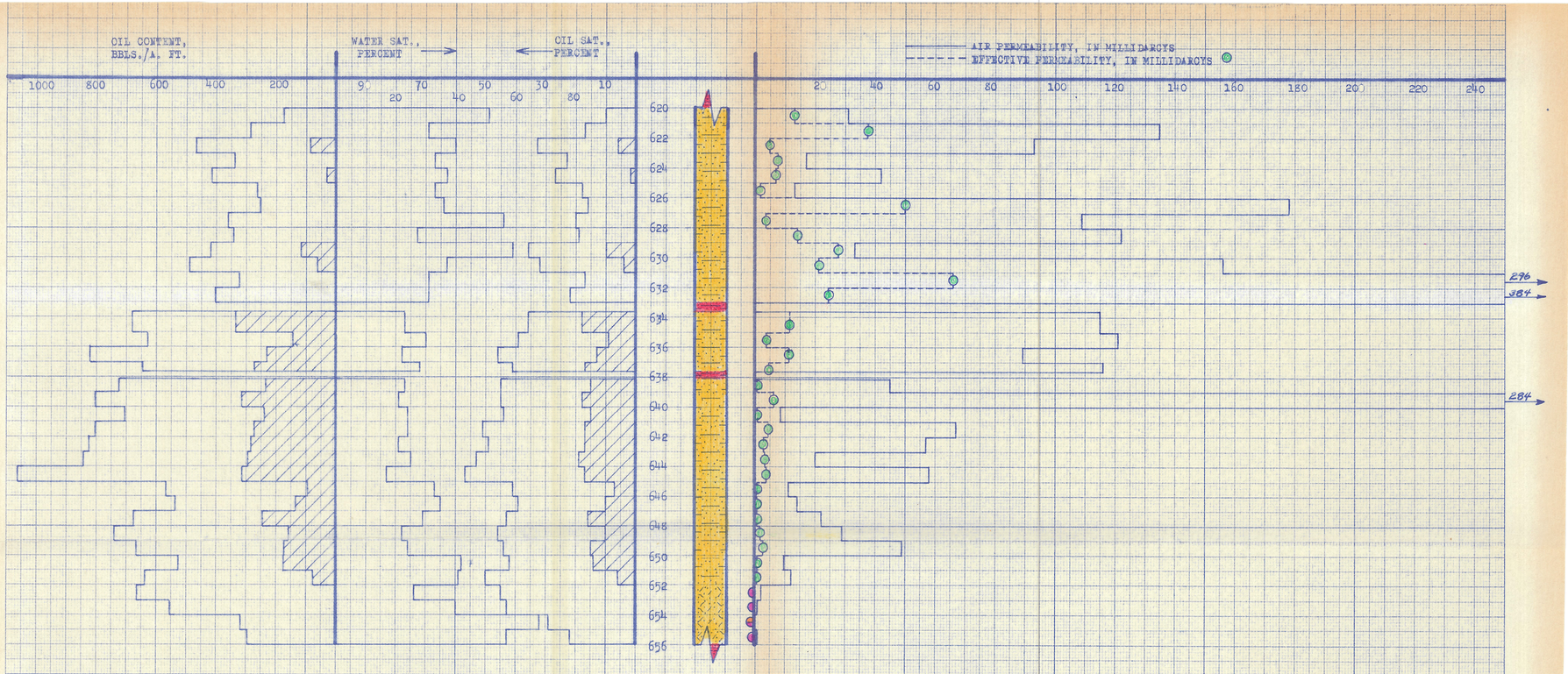
SUMMARY OF LABORATORY FLOODING TESTS

TABLE V

Company CRA, Inc. Lease Woodward Well No. 8

Depth Interval, Feet	620.0 - 633.0	633.6 - 656.0	620.0 - 656.0
Feet of Core Analyzed	4.0	17.9	21.9
Average Percent Porosity	18.5	20.3	20.0
Average Percent Original Oil Saturation	32.0	44.9	42.5
Average Percent Oil Recovery	5.5	14.1	12.5
Average Percent Residual Oil Saturation	26.5	30.8	30.0
Average Percent Residual Water Saturation	66.5	63.9	64.1
Average Percent Total Residual Fluid Saturation	93.0	94.7	94.1
Average Original Oil Content, Bbls./A. Ft.	456.	707.	662.
Average Oil Recovery, Bbls./A. Ft.	75.	226.	198.
Average Residual Oil Content, Bbls./A. Ft.	381.	481.	464.
Total Original Oil Content, Bbls./Acre	1,824.	12,680.	14,504.
Total Oil Recovery, Bbls./Acre	299.	4,041.	4,340.
Total Residual Oil Content, Bbls./Acre	1,525.	8,639.	10,164.
Average Effective Permeability, Millidarcys	15.11	3.36	5.50
Average Initial Fluid Production Pressure, p.s.i.	10.0	22.0	19.8

NOTE: Only those samples which recovered oil were used in calculating the above averages.



CRA, INC.

WOODWARD LEASE WELL NO. 6
BOURBON COUNTY, KANSAS

DEPTH INTERVAL, FEET	FEET OF CORE ANALYZED	AVERAGE POROSITY, PERCENT	AVG. OIL SATURATION PERCENT	AVG. WATER SATURATION PERCENT	AVG. OIL CONTENT BBLS./A.FT.	TOTAL OIL CONTENT BBLS./ACRE	AVG. AIR PERMEABILITY, MILLIDARCYS	CALCULATED OIL RECOVERY, BBLS./ACRE
620.0 - 633.0	13.0	20.7	22.3	38.6	348	4,532	123.7	
633.6 - 656.0	21.9	19.9	43.0	30.6	670	14,677	53.8	
620.0 - 656.0	34.9	20.2	35.4	33.6	551	19,209	80.6	8,470(Primary & Secondary)

OILFIELD RESEARCH LABORATORIES
CHANUTE, KANSAS
NOVEMBER, 1965