OILFIELD RESEARCH LABORATORIES
536 NORTH HIGHLAND - CHANUTE, KANSAS - PHONE HE1-2650

February 7, 1966

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. 17, Bourbon County, Kansas, and submitted to our laboratory on February 1, 1966.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Benjamin R. Pearman

BRP:rf

3 c. - Wellington, Kansas
1 c. - Muskogee, Oklahoma
1 c. - Independence, Kansas

Oilfield Research Laboratories

GENERAL INFORMATION & SUMMARY

Company CRA, Inc. Lease Woodward Well No. 17

Location 1220' NSL & 2465' EWL, NW

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

Name of Sand	Bartlesville
Top of Core	636.0
Bottom of Core	685.0
Top of Sand (Analyzed)	636.0
Bottom of Sand (Analyzed)	684.5
Total Feet of Permeable Sand	45.6
Total Feet of Floodable Sand	28.5

Distribution of Permeable Sand: Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 10	6.9	6.9
10 - 20	3.0	9.9
20 - 50	20.0	29.9
50 - 100	15.7	45.6

Average Permeability Millidarcys	41.6
Average Percent Porosity	21.2
Average Percent Oil Saturation	41.4
Average Percent Water Saturation	33.0
Average Oil Content, Bbls./A. Ft.	679.
Total Oil Content, Bbls./Acre	30,900.
Average Percent Oil Recovery by Laboratory Flooding Tests	15.4
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	257.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	7,334.
Total Calculated Oil Recovery, Bbls./Acre (Primary & Secondary)	11,000.
Packer Setting, Feet	
Viscosity, Centipoises @	
A. P. I. Gravity, degrees @ 60 °F	
Elevation, Feet	1049.

Fresh water mud was used as the circulating fluid while taking this core. The core was sampled and the samples sealed in cans by a representative 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
636.0 - 647.0	Light brown, laminated, shaly sandstone.
647.0 - 647.5	Sandy shale.
647.5 - 681.0	Brown, laminated, slightly shaly sandstone.
681.0 - 683.0	Dark, carbonaceous, slightly shaly sandstone.
683.0 - 685.0	Dark, carbonaceous, calcareous sandstone.

Coring was started at a depth of 636.0 feet in laminated, shaly sandstone and completed at 685.0 feet in carbonaceous sandstone. This core shows a total of 45.6 feet of sandstone. For the most part, the pay is made up of brown, laminated, 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 50.4 and 39.6 millidarcys respectively; the overall average being 41.6 (See Table III). By observing the data given on the coregraph, it is noticeable that the sand has a rather uniform permeability profile. The permeability of the sand varies from 0.98 to a maximum of 98. millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a good weighted average percent oil saturation, namely, 41.4. The weighted average percent oil saturation of the upper and lower sections is 23.4 and 45.5 respectively. The weighted average percent water saturation of the upper and lower sections is 43.8 and 30.2 respectively; the overall average being 33.0 (See Table III). This gives an overall weighted average total fluid saturation of 74.4 percent. This low total fluid saturation indicates considerable fluid was lost during coring most of which was probably oil.

The weighted average oil content of the upper and lower sections is 404 and 742 barrels per acre foot respectively; the overall average being 679. The total oil content, as shown by this core, is 30,900 barrels per acre of which 21,642 barrels are in the pay sand section (See Table III).

LABORATORY FLOODING TESTS

The sand in this core responded to laboratory flooding tests, as a total recovery of 7,334 barrels of oil per acre was obtained from 28.5 feet of sand. The weighted average percent oil saturation was reduced from 45.8 to 30.4, or represents an average recovery of 15.4 percent. The weighted average effective permeability of the samples is 2.34 millidarcys, while the average initial fluid production pressure is 24.8 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 46 samples tested, 39 produced water and 28 oil. This indicates approximately 61 percent of the sand represented by these samples is floodable pay sand. The tests also show that the sand has a fairly uniform effec-

tive permeability to water.

CONCLUSION

Based on the results of the laboratory tests, it appears that approximately 11,000 barrels of oil per acre or an average of 387 barrels per acre foot can be recovered from the vicinity of this well by efficient primary and secondary operations. These recovery values were calculated using the following data and assumptions:

Original formation volume factor	1.06
Reservoir water saturation, percent	20.0
Average porosity, percent	21.3
Oil saturation after flooding, percent	30.4
Performance factor, percent	50.0
Net floodable pay sand, feet	28.5

This core shows a pay sand section having a good oil saturation, a moderate water saturation and a fairly uniform effective permeability to water.

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company CRA, Inc. Lease Woodward Well No. 17

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	636.1	21.4	11	51	62	183	55.	0.6	0.6	110	33.00
2	638.1	21.7	14	45	59	236	14.	1.0	1.6	236	14.00
3	639.1	24.0	23	48	71	428	62.	1.0	2.6	428	62.00
4	640.1	23.4	26	43	69	471	60.	1.0	3.6	471	60.00
5	641.1	22.5	21	44	65	366	38.	1.0	4.6	366	38.00
6	642.1	21.6	23	42	65	385	30.	1.0	5.6	385	30.00
7	643.1	20.8	28	43	71	451	35.	1.0	6.6	451	35.00
8	644.1	23.0	33	42	75	588	96.	1.0	7.6	588	96.00
9	646.1	21.2	27	39	66	444	64.	1.0	8.6	444	64.00
10	648.1	23.7	51	28	79	936	54.	1.1	9.7	1,030	59.40
11	649.1	22.7	50	27	77	879	46.	1.0	10.7	879	46.00
12	650.1	22.2	36	33	69	619	28.	1.0	11.7	619	28.00
13	651.1	21.1	44	35	79	719	38.	1.0	12.7	719	38.00
14	652.1	21.8	42	35	77	709	32.	1.0	13.7	709	32.00
15	653.1	20.2	49	29	78	766	45.	1.0	14.7	766	45.00
16	654.1	19.4	42	31	73	631	42.	1.0	15.7	631	42.00
17	655.1	22.5	48	30	78	836	39.	1.0	16.7	836	39.00
18	656.1	20.5	45	36	81	716	42.	1.0	17.7	716	42.00
19	657.1	23.5	53	32	85	965	62.	1.0	18.7	965	62.00
20	658.1	23.0	39	35	74	696	72.	1.0	19.7	696	72.00
21	659.1	22.4	58	29	87	1,008	81.	1.0	20.7	1,008	81.00
22	660.1	19.7	23	37	60	351	23.	1.0	21.7	351	23.00
23	661.1	24.1	52	27	79	971	74.	1.0	22.7	971	74.00
24	662.1	19.9	26	38	64	401	16.	1.0	23.7	401	16.00

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company CRA, Inc. Lease Woodward Well No. 17

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	663.1	22.9	37	29	66	656	62.	1.0	24.7	656	62.00
26	664.1	22.5	48	21	69	836	82.	1.0	25.7	836	82.00
27	665.1	21.7	41	30	71	690	98.	1.0	26.7	690	98.00
28	666.1	22.4	43	31	74	747	78.	1.0	27.7	747	78.00
29	667.1	20.8	45	34	79	726	44.	1.0	28.7	726	44.00
30	668.1	19.1	49	34	83	725	24.	1.0	29.7	725	24.00
31	669.1	23.2	42	25	67	756	48.	1.0	30.7	756	48.00
32	670.1	21.2	40	29	69	657	57.	1.0	31.7	657	57.00
33	671.1	19.6	38	35	73	577	30.	1.0	32.7	577	30.00
34	672.1	22.7	44	27	71	774	62.	1.0	33.7	774	62.00
35	673.1	21.0	43	29	72	700	21.	1.0	34.7	700	21.00
36	674.1	19.7	42	28	70	641	8.3	1.0	35.7	641	8.30
37	675.1	20.2	50	37	87	782	24.	1.0	36.7	782	24.00
38	676.1	16.5	41	40	81	524	8.8	1.0	37.7	524	8.80
39	677.1	18.3	59	35	94	837	39.	1.0	38.7	837	39.00
40	678.1	21.6	50	30	80	838	34.	1.0	39.7	838	34.00
41	679.1	20.7	45	29	74	721	9.9	1.0	40.7	721	9.90
42	680.1	20.2	47	29	76	736	10.	1.4	42.1	1,030	14.00
43	681.1	19.3	49	28	77	739	5.2	1.0	43.1	739	5.20
44	682.1	19.9	50	27	77	771	12.	1.0	44.1	771	12.00
45	683.1	18.1	65	14	79	911	1.7	1.0	45.1	911	1.70
46	684.1	19.9	63	16	79	971	0.98	0.5	45.6	486	0.49
								Total------		30,900	

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SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company CRA, Inc. Lease Woodward Well No. 17

Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.
636.0 - 646.6	8.6	50.4	432.00
646.6 - 684.5	37.0	39.6	1,462.79
636.0 - 684.5	45.6	41.6	1,894.79

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
636.0 - 646.6	8.6	22.2	23.4	43.8	404	3,479
646.6 - 684.5	37.0	21.0	45.5	30.2	742	27,421
636.0 - 684.5	45.6	21.2	41.4	33.0	679	30,900

Oilfield Research Laboratories

RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company CRA, Inc. Lease Woodward Well No. 17

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	636.1	21.2	12	197	0	0	12	76	197	573	9.30	10
2	638.1	21.8	11	186	0	0	11	80	186	335	13.80	10
3	639.1	23.7	24	441	0	0	24	74	441	322	17.12	10
4	640.1	23.0	24	428	0	0	24	75	428	201	13.27	20
5	641.1	22.0	23	392	0	0	23	75	392	280	12.00	20
6	642.1	21.4	23	382	0	0	23	76	382	274	15.78	10
7	643.1	20.3	26	409	0	0	26	70	409	320	10.80	20
8	644.1	22.6	30	526	0	0	30	68	526	379	8.40	10
9	646.1	21.6	26	436	0	0	26	70	436	302	8.50	10
10	648.1	23.2	51	916	23	414	28	71	502	98	2.70	20
11	649.1	22.2	50	860	17	292	33	63	568	290	8.40	20
12	650.1	22.0	36	614	16	273	20	70	341	118	3.00	20
13	651.1	20.7	44	706	17	273	27	70	433	71	1.70	20
14	652.1	21.5	42	700	11	183	31	68	517	172	4.50	20
15	653.1	20.0	49	759	24	372	25	70	387	62	1.40	20
16	654.1	19.9	42	648	16	247	26	69	401	68	1.70	20
17	655.1	22.0	48	819	21	358	27	71	461	78	2.10	20
18	656.1	20.4	45	711	15	237	30	68	474	44	1.10	20
19	657.1	23.1	53	948	18	322	35	63	626	63	1.70	20
20	658.1	22.7	39	686	16	282	23	65	404	161	4.50	10
21	659.1	22.9	58	1,029	22	390	36	63	639	101	2.50	20
22	660.1	19.4	25	376	0	0	25	68	376	19	0.500	30
23	661.1	23.8	52	959	24	442	28	64	517	52	1.30	20
24	662.1	19.5	26	393	0	0	26	58	393	27	0.700	30

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

RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company CRA, Inc. Lease Woodward Well No. 17

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	663.1	22.4	37	641	15	260	22	74	381	186	5.50	20
26	664.1	22.1	48	820	24	410	24	73	410	273	11.00	20
27	665.1	21.4	41	680	10	166	31	66	514	110	2.40	20
28	666.1	22.0	43	733	16	273	27	70	460	61	1.70	20
29	667.1	20.4	45	711	14	221	31	67	490	41	1.00	30
30	668.1	19.6	49	744	19	288	30	61	456	45	1.10	30
31	669.1	23.0	42	749	11	196	31	63	553	43	1.20	30
32	670.1	21.2	40	657	10	164	30	64	493	52	1.40	20
33	671.1	19.4	38	571	12	181	26	71	390	17	0.571	20
34	672.1	22.3	44	760	12	207	32	65	553	24	0.700	30
35	673.1	20.5	43	683	12	191	31	55	492	14	0.400	35
36	674.1	19.4	42	631	0	0	42	30	631	0	Imp.	-
37	675.1	19.8	50	767	10	153	40	58	614	6	0.200	50
38	676.1	16.7	41	531	0	0	41	42	531	0	Imp.	-
39	677.1	18.6	59	850	15	216	44	50	634	18	0.500	40
40	678.1	21.2	50	821	12	197	38	55	624	29	1.00	40
41	679.1	20.2	47	735	0	0	47	30	735	0	Imp.	-
42	680.1	19.8	47	721	4	61	43	50	660	27	0.875	40
43	681.1	19.0	50	736	0	0	50	29	736	0	Imp.	-
44	682.1	19.4	50	752	0	0	50	27	752	0	Imp.	-
45	683.1	18.3	66	936	0	0	66	12	936	0	Imp.	-
46	684.1	20.0	63	976	0	0	63	18	976	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

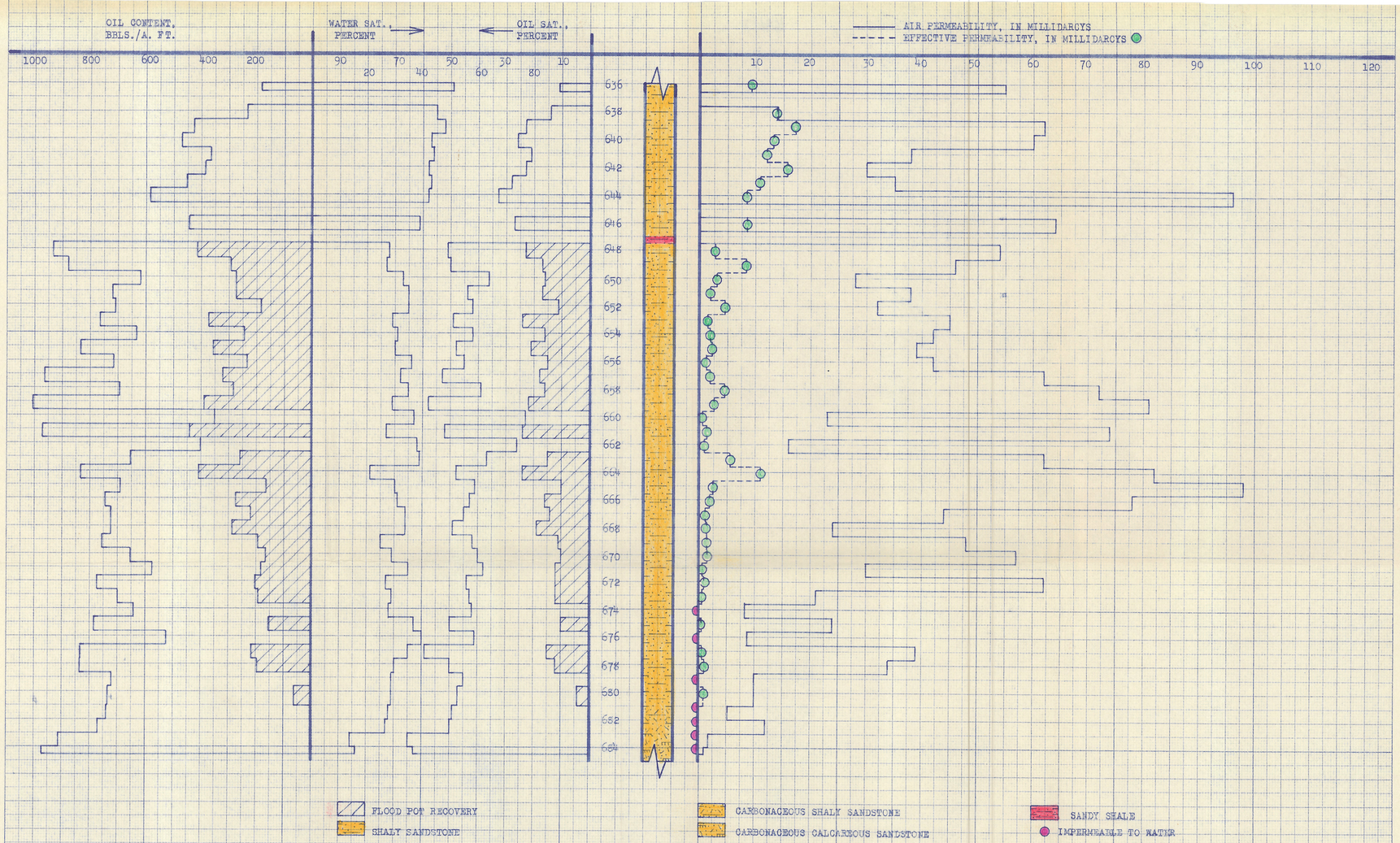
SUMMARY OF LABORATORY FLOODING TESTS

TABLE V

Company CRA, Inc. Lease Woodward Well No. 17

Depth Interval, Feet	647.5 - 684.5
Feet of Core Analyzed	28.5
Average Percent Porosity	21.3
Average Percent Original Oil Saturation	45.8
Average Percent Oil Recovery	15.4
Average Percent Residual Oil Saturation	30.4
Average Percent Residual Water Saturation	64.7
Average Percent Total Residual Fluid Saturation	95.1
Average Original Oil Content, Bbls./A. Ft.	759.
Average Oil Recovery, Bbls./A. Ft.	257.
Average Residual Oil Content, Bbls./A. Ft.	502.
Total Original Oil Content, Bbls./Acre	21,642.
Total Oil Recovery, Bbls./Acre	7,334.
Total Residual Oil Content, Bbls./Acre	14,308.
Average Effective Permeability, Millidarcys	2.34
Average Initial Fluid Production Pressure, p.s.i.	24.8

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



CRA, INC.

WOODWARD LEASE WELL NO. 17
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./AC.	AVG. AIR PERMEABILITY, MILLIDARCYS	CALCULATED OIL RECOVERY, BBLS./ACRE
636.0 - 646.6	8.6	22.2	23.4	43.8	404	3,479	50.4	
646.6 - 684.5	37.0	21.0	45.5	30.2	742	27,421	39.6	
636.0 - 684.5	45.6	21.2	41.4	33.0	679	30,900	41.6	11,000 (Primary & Secondary)

OILFIELD RESEARCH LABORATORIES
CHANUTE, KANSAS
FEBRUARY, 1966