OILFIELD RESEARCH LABORATORIES

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

September 26, 1966

CRA, Incorporated
P. O. Box 98
Wellington, Kansas

Gentlemen:

Enclosed herewith is the report of the analysis of the Rotary core taken from the Holeman Lease, Well No. 2, Bourbon County, Kansas, and submitted to our laboratory on September 21, 1966.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Carl L. Pate

CLP:rf

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

Oilfield Research Laboratories

GENERAL INFORMATION & SUMMARY

Company CRA, Inc. Lease Holeman Well No. 2

Location 150' WEL & 1000' NSL, SW¼

Section 1 Twp. 25S Rge. 21E County Bourbon State Kansas

Name of Sand	Bartlesville
Top of Core	659.0
Bottom of Core	680.0
Top of Sand	664.0
Bottom of Sand/pay	674.6
Total Feet of Permeable Sand (Analyzed)	13.3
Total Feet of Floodable Sand	10.6

Distribution of Permeable Sand:

Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 10	1.6	1.6
10 - 20	4.7	6.3
20 - 50	2.0	8.3
50 - 70	3.0	11.3
70 & above	2.0	13.3

Average Permeability Millidarcys	34.0
Average Percent Porosity	19.7
Average Percent Oil Saturation	42.2
Average Percent Water Saturation	35.9
Average Oil Content, Bbls./A. Ft.	652.
Total Oil Content, Bbls./Acre	8,665.
Average Percent Oil Recovery by Laboratory Flooding Tests	18.2
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	288.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	2,908.
Total Calculated Oil Recovery, Bbls./Acre (Primary & Secondary)	3,880.
Packer Setting, Feet	
Viscosity, Centipoises @	
A. P. I. Gravity, degrees @ 60 °F	
Elevation, Feet	

A fresh water mud was used as a circulating fluid in the coring of the sand in this well. This well was drilled in a virgin area. The core was sampled by an employee of Oilfield Research Laboratories.

FORMATION CORED

The detailed log of the formation cored is as follows:

Depth Interval, Feet	Description
659.0 - 663.0	Laminated sandy shale.
663.0 - 664.0	Laminated sandstone and shale.
664.0 - 674.6	Brown, slightly laminated, slightly shaly sandstone.
674.6 - 676.8	Dark carbonaceous sandstone.
676.8 - 680.0	Shale.

Coring was started at a depth of 659.0 feet in laminated sandy shale and completed at 680.0 feet in shale. This core shows a total of 12.8 feet of sandstone. The pay is made up of brown, slightly laminated, 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 38.4 and 11.5 millidarcys respectively; the overall average being 34.0 (See Table III). By observing the data given on the core-graph, it is noticeable that the sand has a very irregular permeability profile. The permeability of the sand varies from 6.3 to a maximum of 71. millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a good weighted average percent oil saturation, namely, 42.2. The weighted average percent oil saturation of the upper and lower sections is 44.4 and 31.4 respectively. The weighted average percent water saturation of the upper and lower sections is 36.1 and 34.9 respectively; the overall average being 35.9 (See Table III). This gives an overall weighted average total fluid saturation of 78.1 percent. This low total fluid saturation indicates considerable fluid was lost during coring which was probably oil.

The weighted average oil content of the upper and lower sections is 682 and 496 barrels per acre foot respectively; the overall average being 652. The total oil content, as shown by this core, is 8,665 barrels per acre of which 7,575 barrels are in the pay sand section (See Table III).

LABORATORY FLOODING TESTS

The sand in this core responded very well to laboratory flooding tests, as a total recovery of 2,908 barrels of oil per acre was obtained from 10.1 feet of sand. The weighted average percent oil saturation was reduced from 46.3 to 28.1, or represents an average recovery of 18.2 percent. The weighted average effective permeability of the samples is 4.39 millidarcys, while the average initial fluid production pressure is 24.2 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 14 samples tested, 11 produced water and oil. This indicates that approximately 79 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.

CONCLUSION

From a study of the above data, we estimate that approximately 1,060 barrels of oil per acre can be recovered from the area, represented by this core, by efficient primary production methods. An additional recovery of 2,820 barrels of oil per acre or an average of 266 barrels per acre foot can be expected from efficient waterflooding. The following data and assumptions were used in calculating the above oil recovery values:

Original formation volume factor	1.06
Irreducible water saturation, percent	26.0
Primary recovery, estimated, percent	None
Present oil saturation, percent	63.5
Average porosity, percent	19.6
Oil saturation after flooding, percent	28.1
Performance factor	0.50
Net floodable pay sand, feet	10.6

This core shows a rather clean sand section having a good oil saturation, a moderate water saturation and a fairly good permeability. The pay zone extends from a depth of 664.0 to 674.6 feet.

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company CRA, Inc. Lease Holeman Well No. 2

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	663.1	15.1	26	56	82	304	0.52	1.0	1.0	304	0.52
2	664.1	21.6	45	32	77	754	6.3	0.6	1.6	452	3.78
P-3	665.0	-	-	-	-	-	18.	0.5	2.1	-	9.00
3	665.2	22.6	51	28	79	893	-	0.5	2.6	446	-
4	666.1	21.0	47	31	78	766	70.	1.0	3.6	766	70.00
5	667.1	21.1	54	27	81	883	67.	1.0	4.6	883	67.00
6	668.1	20.6	54	31	85	862	71.	1.0	5.6	862	71.00
7	669.1	16.6	43	47	90	554	12.	1.0	6.6	554	12.00
8	670.1	18.5	45	44	89	645	11.	1.0	7.6	645	11.00
9	671.1	16.9	40	39	79	524	27.	1.0	8.6	524	27.00
10	672.1	21.6	44	28	72	736	53.	1.0	9.6	736	53.00
11	673.1	21.8	46	28	74	777	61.	1.0	10.6	777	61.00
12	674.1	19.7	41	36	77	626	41.	1.0	11.6	626	41.00
13	675.1	21.5	38	30	68	633	11.	1.0	12.6	633	11.00
14	676.1	18.9	26	39	65	381	12.	1.2	13.8	457	14.40

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SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company CRA, Inc. Lease Holeman Well No. 2

Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.
663.0 - 674.6	11.1	38.4	426.30
674.6 - 676.8	2.2	11.5	25.40
663.0 - 676.8	13.3	34.0	451.70

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
663.0 - 674.6	11.1	19.6	44.4	36.1	682	7,575
674.6 - 676.8	2.2	20.1	31.4	34.9	496	1,090
663.0 - 676.8	13.3	19.7	42.2	35.9	652	8,665

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RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company CRA, Inc. Lease Holeman Well No. 2

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	663.1	15.4	23	275	0	0	23	62	275	0	Imp.	-
2	664.1	21.1	45	737	21	344	24	67	393	12	0.300	40
3	665.2	22.4	51	887	28	487	23	71	400	484	11.80	20
4	666.1	21.5	47	784	23	384	24	76	400	460	11.60	10
5	667.1	20.7	54	868	28	450	26	72	418	173	5.10	20
6	668.1	20.2	54	846	26	407	28	70	439	125	3.40	20
7	669.1	17.1	43	571	6	80	37	62	491	6	0.200	50
8	670.1	18.9	45	659	11	161	34	66	498	38	0.900	30
9	671.1	17.4	40	581	10	135	30	67	446	26	0.700	30
10	672.1	21.3	44	727	21	347	23	76	380	390	9.00	10
11	673.1	21.2	46	756	21	345	25	74	411	230	5.80	10
12	674.1	19.3	41	614	10	150	31	65	464	55	1.70	30
13	675.1	21.1	35	573	0	0	35	38	573	0	Imp.	-
14	676.1	18.6	24	346	0	0	24	47	346	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.

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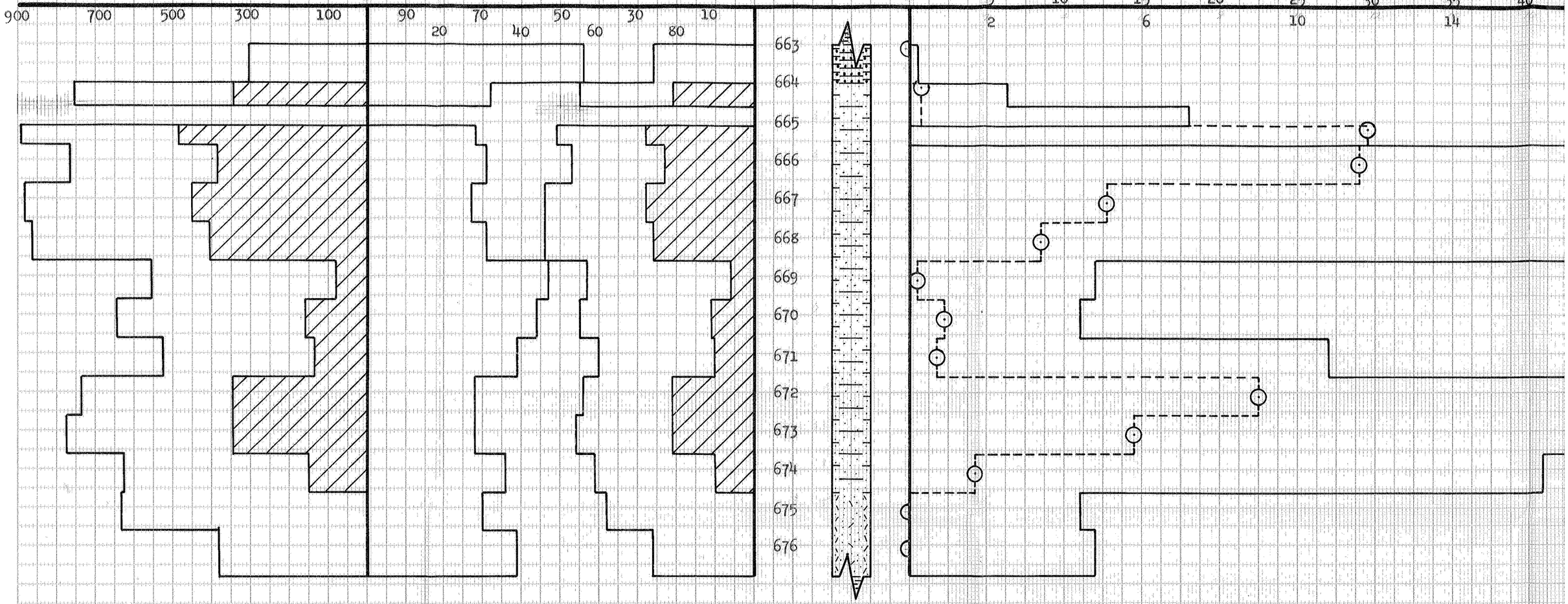
SUMMARY OF LABORATORY FLOODING TESTS

TABLE V

Company CRA, Inc. Lease Holeman Well No. 2

Depth Interval, Feet	664.0 - 674.6
Feet of Core Analyzed	10.1
Average Percent Porosity	19.5
Average Percent Original Oil Saturation	46.3
Average Percent Oil Recovery	18.2
Average Percent Residual Oil Saturation	28.1
Average Percent Residual Water Saturation	69.6
Average Percent Total Residual Fluid Saturation	97.7
Average Original Oil Content, Bbls./A. Ft.	722.
Average Oil Recovery, Bbls./A. Ft.	288.
Average Residual Oil Content, Bbls./A. Ft.	434.
Total Original Oil Content, Bbls./Acre	7,291.
Total Oil Recovery, Bbls./Acre	2,908.
Total Residual Oil Content, Bbls./Acre	4,383.
Average Effective Permeability, Millidarcys	4.39
Average Initial Fluid Production Pressure, p.s.i.	24.2

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



FLOOD POT RECOVERY

CARBONACEOUS SANDSTONE

SHALY SANDSTONE

LAMINATED SANDSTONE & SHALE

SANDY SHALE

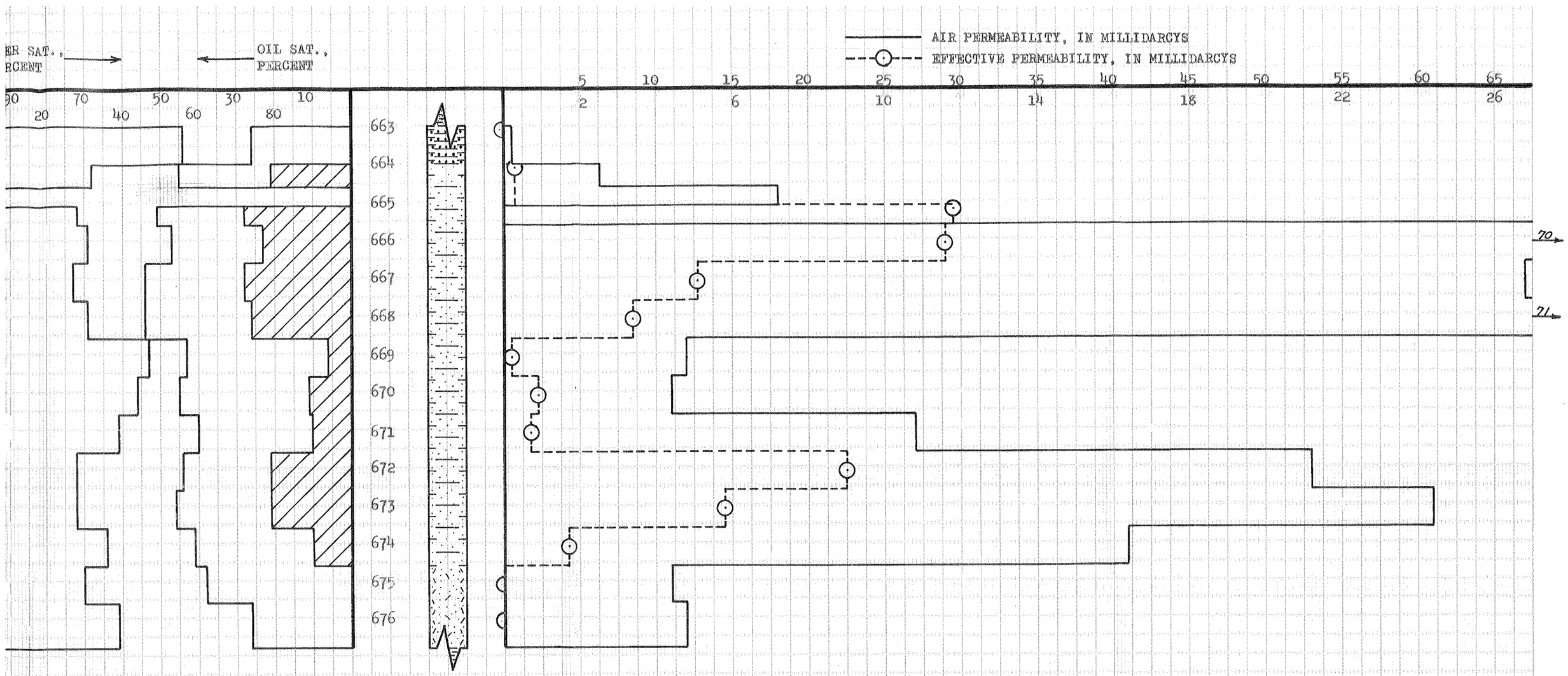
SHALE

C. R. A. INC.

HOLEMAN LEASE WELL NO. 2

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
663.0 - 674.6	11.1	19.6	44.4	36.1	682	7,575	38.4	
674.6 - 676.8	2.2	20.1	31.4	34.9	496	1,090	11.5	
663.0 - 676.8	13.3	19.7	42.2	35.9	652	8,665	34.0	3,880 (Primary &



C. R. A. INC.

HOLEMAN LEASE WELL NO. 2

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
663.0 - 674.6	11.1	19.6	44.4	36.1	682	7,575	38.4	
674.6 - 676.8	2.2	20.1	31.4	34.9	496	1,090	11.5	
663.0 - 676.8	13.3	19.7	42.2	35.9	652	8,665	34.0	3,880 (Primary & Secondary)