OILFIELD RESEARCH LABORATORIES
536 NORTH HIGHLAND - CHANUTE, KANSAS 66720 - PHONE (316) 431-2650

May 1, 1979

Missouri Lead & Zinc Company
1128 Main
Parsons, Kansas 67357

Gentlemen:

Enclosed herewith is the report of the analysis of the rotary core taken from the Gray Lease, Well No. 12, Neosho County, Kansas, and submitted to our laboratory on April 19, 1979.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Benjamin R. Pearman

SAM:cgb
4 5 c to Parsons, Kansas

Oilfield Research Laboratories

GENERAL INFORMATION & SUMMARY

Company Missouri Lead & Zinc Co. Lease Gray Well No. 12

Location NE SE

Section 34 Twp. 30S Rge. 12E County Neosho State Kansas

Name of Sand	Bartlesville
Top of Core	172.0
Bottom of Core	243.0
Top of Sand	173.1
Bottom of Sand	239.7
Total Feet of Permeable Sand	60.0
Total Feet of Floodable Sand	23.9

Distribution of Permeable Sand: Permeability Range Millidarcys	Feet	Cum. Ft.
0 – 50	24.9	24.9
50 – 100	13.1	38.0
100 – 200	7.7	45.7
200 – 400	12.3	58.0
400 – 600	2.0	60.0

Average Permeability Millidarcys	115.7
Average Percent Porosity	22.7
Average Percent Oil Saturation	39.1
Average Percent Water Saturation	41.1
Average Oil Content, Bbls./A. Ft.	695.
Total Oil Content, Bbls./Acre	41,702.
Average Percent Oil Recovery by Laboratory Flooding Tests	9.3
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	195.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	4,670.
Total Calculated Oil Recovery, Bbls./Acre (Primary & Waterflooding)	11,950.
Packer Setting, Feet	
Viscosity, Centipoises @	
A. P. I. Gravity, degrees @ 60 °F	
Elevation, Feet	

The core was sampled and the samples sealed in plastic bags by a representative of the client. The core was reported to be from a virgin area.

FORMATION CORED

The detailed log of the formation cored is as follows:

Depth Interval, Feet	Description
172.0 - 173.1	Gray sandy shale.
173.1 - 181.8	Dark brown sandstone.
181.8 - 185.8	Gray shale.
185.8 - 187.8	Brown sandstone.
187.8 - 191.3	Light brown and gray laminated sandstone and shale.
191.3 - 194.0	Light brown slightly shaly sandstone.
194.0 - 195.1	Gray and light brown laminated shale and sandstone.
195.1 - 198.6	Brown sandstone.
198.6 - 199.4	Gray sandy shale.
199.4 - 201.1	Brown sandstone containing thin widely scattered coal partings.
201.1 - 204.0	Grayish light brown shaly sandstone.
204.0 - 205.0	Brown sandstone.

205.0 - 205.4	Grayish light brown shaly sandstone.
205.4 - 208.3	Brown sandstone.
208.3 - 220.0	Brown sandstone containing thin widely scattered coal partings.
220.0 - 222.1	Light brown sandstone containing thin widely scattered coal partings.
222.1 - 227.2	Light brown slightly carbonaceous sandstone.
227.2 - 228.0	Brown slightly carbonaceous sandstone.
228.0 - 229.4	Gray shale.
229.4 - 239.7	Brown slightly carbonaceous sandstone containing thicker widely scattered coal partings.
239.7 - 240.0	Gray sandy conglomerate.
240.0 - 243.0	Gray shale.

LABORATORY FLOODING TESTS

The sand in this core responded to laboratory flooding tests, as a total recovery of 4,670 barrels of oil per acre was obtained from 23.9 feet of sand. The weighted average percent oil saturation was reduced from 42.3 to 33.0, or represents an average recovery of 9.3 percent. The weighted average effective permeability of the samples is 16.36 millidarcys, while the average initial fluid production pressure is 13.0 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 62 samples tested, 53 produced water, and 24 oil. This indicates that approximately 39 percent of the sand represented by these samples is floodable pay sand. The tests also show that the sand has a relatively high uniform effective permeability to water in the upper zone of the core.

CALCULATED RECOVERY

It would appear from a study of the data, that efficient primary and waterflood operations in the vicinity of this well should recover approximately 11,950 barrels of oil per acre. This is an average recovery of 500 barrels per acre foot from 23.9 feet of floodable sand analyzed in this core.

These recovery values were calculated using the following data and assumptions:

Original formation volume factor	1.01
Reservoir water saturation, percent	15.0
Average porosity, percent	25.2
Oil saturation after flooding, percent	33.0
Performance factor, percent	50.0
Net floodable pay sand, feet	23.9

Oilfield Research Laboratories

RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company Missouri Lead & Zinc Company Lease Gray Well No. 12

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	173.7	26.3	51	15	66	1041	253.	0.9	0.9	937	227.70
2	174.4	29.2	55	9	64	1246	296.	1.0	1.9	1246	296.00
3	175.5	28.3	60	1	61	1317	467.	1.0	2.9	1317	467.00
4	176.4	29.4	56	10	66	1277	190.	1.0	3.9	1277	190.00
5	177.5	29.8	55	8	63	1272	399.	1.0	4.9	1272	399.00
6	178.5	29.5	50	8	58	1144	296.	1.0	5.9	1144	296.00
7	179.4	29.5	50	9	59	1144	293.	1.0	6.9	1144	293.00
8	180.4	27.2	46	16	62	992	415.	1.0	7.9	992	415.00
9	181.4	29.4	40	19	59	912	242.	0.8	8.7	730	193.60
10	186.5	27.9	48	10	58	1039	58.	1.2	9.9	1247	69.60
11	187.5	25.9	36	29	65	723	75.	0.8	10.7	578	60.00
12	188.3	24.4	36	30	66	682	29.	1.2	11.9	818	34.80
13	189.4	24.1	36	30	66	673	31.	1.0	12.9	673	31.00
14	190.3	25.0	30	30	60	582	67.	1.3	14.2	757	87.10
15	191.5	24.8	35	29	64	673	21.	0.7	14.9	471	14.70
16	192.4	25.9	36	26	62	723	44.	1.0	15.9	723	44.00
17	193.3	19.9	32	44	76	494	22.	1.0	16.9	494	22.00
18	194.3	17.8	39	46	85	539	4.5	1.1	18.0	593	4.95
19	195.3	18.6	51	43	94	736	49.	0.9	18.9	662	44.10
20	196.5	20.9	47	39	86	762	35.	1.0	19.9	762	35.00
21	197.5	22.5	36	51	87	628	63.	1.0	20.9	628	63.00
22	198.5	12.4	44	50	94	423	172.	0.6	21.5	381	103.20
23	199.5	20.9	31	45	76	503	7.2	0.6	22.1	302	4.32
24	200.5	25.1	49	37	86	954	197.	1.1	23.2	1049	216.70
25	201.5	18.6	43	48	91	621	42.	0.9	24.1	559	37.80
26	202.5	11.8	50	39	89	458	3.1	1.0	25.1	458	3.10
27	203.5	14.8	37	50	87	425	6.5	1.0	26.1	425	6.50
28	204.6	23.6	36	50	86	659	324.	1.0	27.1	659	324.00
29	205.6	24.1	43	50	93	804	247.	0.6	27.7	482	148.20
30	206.4	25.1	37	49	86	721	163.	1.0	28.7	721	163.00

Oilfield Research Laboratories

RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company Missouri Lead & Zinc Company Lease Gray Well No. 12

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.		
31	207.5	23.4	35	54	89	635	208.	1.3	30.0	826	270.40
32	208.5	24.9	36	52	88	695	241.	0.7	30.7	487	168.70
33	209.8	26.2	36	53	89	732	200.	1.0	31.7	732	200.00
34	210.5	23.7	34	52	86	625	49.	1.0	32.7	625	49.00
35	211.5	25.8	33	55	88	661	102.	1.0	33.7	661	102.00
36	212.5	26.3	36	52	88	735	230.	1.0	24.7	735	230.00
37	213.4	26.4	28	53	81	574	206.	1.0	35.7	574	206.00
38	214.4	21.5	30	54	84	500	51.	1.0	36.7	500	51.00
39	215.5	23.6	29	59	88	531	95.	1.0	37.7	531	95.00
40	216.5	21.5	33	59	92	550	272.	1.0	38.7	550	272.00
41	217.5	23.2	31	49	80	558	31.	1.0	39.7	558	31.00
42	218.5	18.1	34	58	92	477	38.	1.0	40.7	477	38.00
43	219.5	23.8	35	45	80	646	105.	1.0	41.7	646	105.00
44	220.5	24.3	24	53	77	452	118.	1.0	42.7	452	118.00
45	221.5	20.1	27	57	84	421	77.	1.1	43.8	463	84.70
46	222.5	22.3	25	68	93	433	92.	0.9	44.7	390	82.80
47	223.5	19.5	27	67	94	409	76.	1.0	45.7	409	76.00
48	224.5	19.1	36	60	96	533	31.	1.0	46.7	533	31.00
49	225.3	19.0	27	69	96	398	58.	1.0	47.7	398	58.00
50	226.4	22.3	31	64	95	536	91.	1.2	48.9	643	109.20
51	227.4	23.9	40	37	77	742	31.	0.8	49.7	594	24.80
52	229.7	24.2	50	29	79	939	60.	0.6	50.3	563	36.00
53	230.6	20.6	31	39	70	495	39.	1.0	51.3	495	39.00
54	231.5	22.8	44	37	81	778	63.	1.0	52.3	778	63.00
55	232.5	21.4	51	31	82	847	6.2	1.0	53.3	847	6.20
56	233.5	12.8	45	50	95	447	24.	1.0	54.3	447	24.00
57	234.5	20.6	39	46	85	623	38.	1.0	55.3	623	38.00
58	235.7	18.7	26	50	76	377	2.4	1.0	56.3	377	2.40
59	236.5	15.9	45	50	95	555	10.	1.0	57.3	555	10.00
60	237.4	8.9	49	43	92	338	13.	1.0	58.3	338	13.00

Oilfield Research Laboratories

RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company Missouri Lead & Zinc Company Lease Gray Well No. 12

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.		
61	238.5	22.6	51	33	84	894	8.0	1.0	59.3	894	8.00
62	239.5	21.9	42	48	90	714	4.7	0.7	60.0	500	3.29

Oilfield Research Laboratories

SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company Missouri Lead & Zinc Company Lease Gray Well No. 12

Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.
173.1 - 181.8	8.7	319.2	2777.30
185.8 - 220.0	33.0	101.1	3335.17
220.0 - 239.7	18.3	45.2	827.39
173.1 - 239.7	60.0	115.7	6939.86

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
173.1 - 181.8	8.7	28.8	51.7	10.3	1,156	10,059
185.8 - 220.0	33.0	22.6	37.0	44.4	647	21,344
220.0 - 239.7	18.3	19.9	36.9	49.7	563	10,299
173.1 - 239.7	60.0	22.7	39.1	41.1	695	41,702

Oilfield Research Laboratories

RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company Missouri Lead & Zinc Company Lease Gray Well No. 12

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	173.7	25.8	51	1021	20	400	31	58	621	257	18.74	15
2	174.4	28.8	55	1229	21	469	34	54	760	145	27.18	10
3	175.5	27.8	60	1294	26	561	34	56	733	155	29.05	10
4	176.4	29.0	56	1260	25	562	31	59	698	430	26.98	5
5	177.5	29.4	55	1254	25	570	30	61	684	173	26.24	5
6	178.5	29.1	50	1129	22	497	28	62	632	292	31.49	10
7	179.4	29.1	50	1129	15	339	35	56	790	290	29.99	10
8	180.4	26.9	46	960	11	230	35	55	730	130	24.37	10
9	181.4	28.9	40	897	12	269	28	59	628	364	38.98	10
10	186.5	27.6	48	1028	10	214	38	53	814	186	9.74	20
11	187.5	25.7	36	718	5	100	31	62	618	206	9.46	20
12	188.3	24.4	35	663	0	0	35	59	663	0	Imp.	-
13	189.4	23.8	36	665	0	0	36	61	665	8	0.15	35
14	190.3	24.7	31	594	0	0	31	61	594	9	0.15	35
15	191.5	24.7	35	671	0	0	35	61	671	55	1.65	25
16	192.4	25.6	36	715	2	40	34	61	675	50	1.57	25
17	193.3	20.1	32	499	3	47	29	67	452	230	6.30	20
18	194.3	18.0	38	531	0	0	38	57	531	0	Imp.	-
19	195.3	19.0	51	752	5	74	46	49	678	144	4.50	20
20	196.5	21.1	47	770	0	0	47	50	770	171	4.89	20
21	197.5	22.0	36	614	3	0	33	62	614	227	6.60	20
22	198.5	12.9	44	441	0	0	44	50	441	73	1.72	20
23	199.5	21.1	31	507	0	0	31	67	507	249	8.50	10
24	200.5	24.7	49	939	0	0	49	46	939	130	2.92	15
25	201.5	19.0	42	619	0	0	42	56	619	124	2.70	15
26	202.5	11.6	49	441	0	0	49	46	441	0	Imp.	-
27	203.5	14.7	39	445	0	0	39	58	445	4	0.07	40
28	204.6	24.0	36	670	3	56	33	62	614	426	21.55	5
29	205.6	24.0	42	782	0	0	42	53	782	0	Imp.	-
30	206.4	24.7	37	709	2	38	35	62	671	170	22.49	5

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 Missouri Lead & Zinc Company Lease Gray Well No. 12

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.			
31	207.5	23.4	35	635	2	36	33	63	599	322	24.98	5
32	208.5	24.9	36	695	0	0	36	58	695	20	0.60	35
33	209.8	26.0	36	726	0	0	36	61	726	222	13.49	5
34	210.5	23.4	34	618	2	36	32	62	582	184	3.60	20
35	211.5	25.5	33	653	2	40	31	64	613	272	4.89	20
36	212.5	26.0	36	726	3	61	33	60	665	345	10.77	5
37	213.4	26.1	28	567	0	0	28	69	567	453	5.85	5
38	214.4	21.6	29	486	0	0	29	69	486	212	2.50	10
39	215.5	24.0	27	503	0	0	27	69	503	371	6.00	5
40	216.5	21.9	33	561	2	34	31	63	527	395	7.35	5
41	217.5	22.8	32	566	0	0	32	66	566	107	1.57	10
42	218.5	18.6	34	490	2	29	32	60	461	134	2.47	10
43	219.5	23.7	35	644	2	36	33	63	608	331	4.27	10
44	220.5	24.5	23	438	0	0	23	73	438	323	4.16	5
45	221.5	20.4	27	427	0	0	27	62	427	80	1.42	10
46	222.5	22.0	23	393	0	0	23	73	393	381	5.25	5
47	223.5	19.7	26	397	0	0	26	67	397	247	4.12	10
48	224.5	19.6	36	548	0	0	36	57	548	120	2.02	10
49	225.3	18.8	26	379	0	0	26	70	379	148	3.07	10
50	226.4	22.4	31	538	0	0	31	66	538	330	9.00	5
51	227.4	23.9	38	704	0	0	38	55	704	118	2.77	15
52	229.7	23.7	50	919	0	0	50	43	919	11	0.22	30
53	230.6	20.4	32	507	0	0	32	65	507	27	0.60	20
54	231.5	22.3	46	796	0	0	46	43	796	7	0.15	30
55	232.5	21.2	50	822	0	0	50	46	822	0	Imp.	-
56	233.5	13.0	44	444	0	0	44	50	444	0	Imp.	-
57	234.5	20.6	39	623	0	0	39	57	623	97	2.10	20
58	235.7	19.0	26	531	0	0	26	66	531	64	1.27	20
59	236.5	16.0	44	546	0	0	44	51	546	0	Imp.	-
60	237.4	9.0	47	328	0	0	47	50	328	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

RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company Missouri Lead & Zinc Company Lease Gray Well No. 12

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.			
61	238.5	22.9	51	906	0	0	51	45	906	5	0.15	40
62	239.5	21.9	42	714	0	0	42	53	714	0	Imp.	-

Notes: cc—cubic centimeter.

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

Oilfield Research Laboratories

SUMMARY OF LABORATORY FLOODING TESTS

TABLE V

Company Missouri Lead & Zinc Company Lease Gray Well No. 12

Depth Interval, Feet	173.1 - 181.8	185.8 - 220.0	173.1 - 220.0
Feet of Core Analyzed	8.7	15.2	23.9
Average Percent Porosity	28.3	23.5	25.2
Average Percent Original Oil Saturation	51.7	36.8	42.3
Average Percent Oil Recovery	19.8	3.2	9.3
Average Percent Residual Oil Saturation	31.9	33.6	33.0
Average Percent Residual Water Saturation	57.8	56.8	57.1
Average Percent Total Residual Fluid Saturation	89.7	90.4	90.1
Average Original Oil Content, Bbls./A. Ft.	1,137.	631.	815.
Average Oil Recovery, Bbls./A. Ft.	437.	57.	195.
Average Residual Oil Content, Bbls./A. Ft.	700.	574.	620.
Total Original Oil Content, Bbls./Acre	9,891.	9,595.	19,486.
Total Oil Recovery, Bbls./Acre	3,803.	867.	4,670.
Total Residual Oil Content, Bbls./Acre	6,088.	8,728.	14,816.
Average Effective Permeability, Millidarcys	27.97	9.71	16.36
Average Initial Fluid Production Pressure, p.s.i.	8.3	16.2	13.0

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