Joint Report

on

UNIVERSITY and STATE LANDS

in

THE BIG MUDDY OIL FIELD

to the

State Board of Land Commissioners
and the
Board of Trustees, University of Wyoming,

by

E. O. Fuller, Fiscal Agent,
and
G. B. Morgan, State Geologist.

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November 19, 1919.

INDEX.

Cheyenne, Wyoming.
November 19, 1919.

The State Board of Land Commissioners
The Board of Trustees, University of Wyoming.

Gentlemen:

Pursuant to instructions received from the Executive Committee, the then acting Secretary of the Board of Trustees of the University of Wyoming, under date of August 15, 1919, directed the undersigned Fiscal Agent of the University of Wyoming (Board of Trustees) to accompany the State Geologist to the Big Muddy oil field for the purpose of obtaining knowledge of the University interests there. By letter of August 18, 1919, the President of the State Board of Land Commissioners directed the undersigned State Geologist to make such examination of the oil field named and to submit report to the Board of Trustees of the University and to the State Board of Land Commissioners on the drilling and operations of the oil wells on the said lands and the reason for the falling off in production and the measures or steps which should be taken to relieve the situation. Such field examination was made by the writers from September 9 to 14, inclusive, 1919. The writers also instituted such inquiry of the residents of the vicinity and of practical and experienced oil men of Glenrock and Casper, Wyoming, as the facts seemed to warrant. During the course of the field examination the writers also made a personal inspection of each of the five tracts of University lands in this field, which are oil-bearing. We also examined other producing lands in this field from which the State is receiving oil royalties as follows:

Sections 15, 16, and 21, T. 33 N., R. 76 W.

We also examined other State lands in the vicinity of this oil field

which are not now producing oil, for the purpose of determining their value as prospective oil-bearing lands, as follows:

Section 1, T. 33 N., R. 76 W.
Section 8, T. 33 N., R. 75 W.

During the course of the investigation we were with, and observed the methods of, the gaugers of the Illinois Pipe Line Company to determine how they gauged and tested the oil in the tanks in this field, and we were also at practically all of the oil wells on the State and University lands. We checked up their locations not only in the field but also on the records of the producing oil companies, and we also noted the improvements on the lands and observed the operating methods of the companies producing oil from these lands. We also examined the records of the two pro-ducing companies to ascertain the location of the wells on the lands under investigation with reference to off-set wells and also with reference to current and past production. While making the field examination, we noted the methods of drilling and the methods of producing oil, either by allowing the well to flow when there was sufficient gas pressure or by different methods of pumping. Inquiry was also made of the officials of the Texas Company as to the location of the off-set wells on the land controlled by this Company in this field adjacent to State lands. Upon inquiry of the officials of the Illinois Pipe Line Company and others, it was ascertained by us that there are no means of transmitting oil from this field, either by rail or by pipe line, other than through the pipe line of the Illinois Pipe Line Company.

Accompanying this report is a map, marked Exhibit A, showing the various wells on the State and University lands here-tofore referred to and the location of all of the oil wells thereon,

which were in existence at the time of our investigation. The map also shows the location of the C. B. & Q. Railroad, the North Platte River, and the Midwest Refining Company's camp. This map is as accurate and complete as it is possible to make it on this scale.

DESCRIPTION OF THE LANDS AND LEASES INVOLVED.

The following described lands were the ones that were investigated by us and upon which this report is based. They constitute all of the oil producing lands in the Big Muddy field from which the State or University derives an income. They are all located in T. 33 N., R. 76 W., and are enumerated as follows:

Kinney Lease
University Land.

Section 4, Lots 1, 2, 3, SW$\frac{1}{4}$NE$\frac{1}{4}$, SE$\frac{1}{4}$NW$\frac{1}{4}$, W$\frac{1}{2}$SE$\frac{1}{4}$, E$\frac{1}{2}$SW$\frac{1}{4}$, containing 362.32 acres. (The proved oil-bearing area is confined to the W$\frac{1}{2}$SE$\frac{1}{4}$ & E$\frac{1}{2}$SW$\frac{1}{4}$).

Prospector's Lease No. 21144 was granted on this tract to William Marley on May 10, 1916. The same was assigned to J. C. Kinney on June 22, 1916. An Oil Operator's Lease No. 21686 was granted to J. C. Kinney on September 1, 1916, who on November 21, 1916, assigned one half interest in said lease to the Ohio Oil Company. The remaining one-half interest was assigned by J. C. Kinney to the Kinney Oil Company on December 8, 1916, which in turn was assigned by the Kinney Oil Company to the Kinney Oil and Refining Company on April 4, 1917. The Kinney lease was granted for fifteen years. The operations on this land are entirely in the hands of the Ohio Oil Company.

Information is given in the following table regarding the wells drilled on the Kinney lease.

Shannon Sand Wells.

No.	Depth to Top of Sand	Date Completed	Remarks.
1	927 ft.	Not known	Total depth
2	966 "	" "	" "
3	996 "	" "	" "
4	980 "	Dec. 16, 1916	" "
5	1005 "	Jan. 19, 1917	Dry
6	883 "	Feb. 2, 1917	
7	912 "	Feb. 21, 1917	
8	891 "	Mar. 10, 1917	
10	890 "	Apr. 20, 1917	Dry
11	960 "	Aug. 4, 1917	
16	953 "	Nov. 8, 1917	
19	956 "	Dec. 22, 1917	
21	964 "	Jan. 17, 1918	

Note: All Shannon wells are pumping.

Wall Creek Sand Wells.

9	2993	Aug. 31, 1917	Flowing	
12	2984	Dec. 14, 1917	Pumping	
13	3015	Mar. 26, 1918	Flowing	
14	2992	Dec. 22, 1917	Flowing	
17	3179	June 17, 1918	Pumping	
18	3085	Sept. 4, 1918	Flowing	Total depth.
20	2950	Apr. 15, 1918	Flowing	
22	3067	Oct. 16, 1918	Pumping	Total depth
23	3024	July 24, 1919	Pumping	
24				

Stray Sand Well.

15	1530	Sept. 24, 1917	Pumping

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The monthly production of oil in barrels from the Kinney lease is given in the following table:

Month	1916	1917	1918	1919.
January		239.00	36,348.34	31,409.29
February		2,726.28	33,082.77	29,233.29
March		4,480.94	43,861.02	29,640.72
April		4,612.64	53,409.78	23,874.54
May		6,705.54	55,406.02	24,064.99
June		4,886.11	54,960.15	23,041.50
July		6,135.67	48,792.00	22,842.98
August		7,134.61	39,678.62	19,778.07
September		16,598.48	40,192.91	16,865.56
October		14,297.12	40,754.28	
November		13,800.46	37,470.86	
December	1,144.33	29,247.46	38,366.74	

Elkhorn Lease.
University Land.

Section 4, Lot 4, $SW\frac{1}{4}NW\frac{1}{4}$, $W\frac{1}{2}SW\frac{1}{4}$,
Section 5, Lots 1 and 2, $S\frac{1}{2}NE\frac{1}{4}$, $N\frac{1}{2}SE\frac{1}{4}$, containing 401 acres altogether. (The proved oil-bearing area is confined to the $W\frac{1}{2}SW\frac{1}{4}$ of Section 4.)

Prospector's Lease No. 21148 was granted on this tract to G. R. Hagens and J. F. Leeper on May 10, 1916, which was assigned to the Elkhorn Oil Company on July 8, 1916. Operator's Lease No. 21945 was granted to the Elkhorn Oil Company on September 1, 1916, for a term of fifteen years. This lease is operated entirely by the Midwest Refining Company.

Information is given in the following table regarding the wells drilled on the Elkhorn lease:

Shannon Wells.

No.	Depth to Top of Sand	Date Completed.	Remarks
1	946 ft.	Sept. 10, 1916.	
2	938 "	Oct. 20, 1916	
3	953 "	Nov. 26, 1916	Dry
4	993 "	Nov. 21, 1916	Dry
5	1037 "	Jan. 2, 1917	Dry
7	939 "	Feb. 3, 1917	Dry

Wall Creek Wells.

6	3075	Oct. 1, 1917
10	3065	July 30, 1918
11	2961	May 23, 1919
12	3095	Sept. 30, 1918
13	3090	Feb. 22, 1919

Stray Sand.

8	2373	Oct. 3, 1918
9	2353	June 19, 1918

Note: All producing wells on the Elkhorn lease are pumpers.

The monthly production of oil in barrels from the Elkhorn lease is given in the following table:

Month	1916	1917	1918	
January		2,873.76	24,123.55	12,571.92
February		2,398.63	20,504.29	10,642.47
March		937.96	22,231.35	46,546.71
April		3,132.75	21,453.27	39,657.37
May		1,365.15	23,901.21	22,429.03
June		896.49	25,951.50	8,418.53
July		1,359.26	22,436.04	8,350.68
August		1,649.97	25,627.86	8,709.96
September	297.99	9,319.85	23,021.80	8,240.92
October	2945.58	28,478.71	17,960.83	
November	2882.12	26,066.98	17,189.48	
December	2887.49	23,750.56	12,850.15	

A. E. Humphreys Lease
University Land.

Section 8, $S\frac{1}{2}$, $NW\frac{1}{4}$, $S\frac{1}{2}NE\frac{1}{4}$, containing 560 acres.

Prospector's Lease No. 19692 was granted on this tract to Charles A. Mau on May 5, 1915, which was assigned to A. E. Humphreys on June 26, 1915. Oil Operator's Lease No. 22188 was granted on January 25, 1917, to A. E. Humphreys for a term of fifteen years. This lease is operated by the Midwest Refining Company.

Information is given in the following table regarding the wells drilled on the A. E. Humphreys lease:

Shannon Sand Wells.

No. of Well	Depth to top of Sand	Date Completed	Remarks.
1	935 ft.		Dry
2	896 "		
3	895 "		
4	895 "		
6	895 "	June 24, 1917	
8	895 "	July 14, 1917	
9	895 "		
10	894 "	Aug. 15, 1917	
11	890 "	Sept. 2, 1917	
12	888 "	Oct. 1, 1917	
15	950 "		
16	1023 "	Nov. 23, 1917	Not now producing
17	930 "	Dec. 13, 1917	Dry
23	895 "	Apr. 28, 1918	
24	904 "	June 4, 1918	Dry
25	912 "	June 20, 1918	
26	905 "	June 16, 1919	
27	909 "	Sept. 16, 1918	
28	905 "	Nov. 5, 1918	
31	945 "	Oct. 21, 1919.	Dry

Note: All producing Shannon wells are pumping.

Wall Creek Sand Wells.

5	3170	Oct. 16, 1919	Pumping
7	3035	Jan. 31, 1918	Flowing
13	3100	Apr. 15, 1918	Flowing
14	3266	Nov. 23, 1918	Pumping
18	2995	July 16, 1918	Flowing
19	3116	Feb. 11, 1919	Pumping
20	3065	Nov. 14, 1918	Flowing
21	3003	Feb. 13, 1919	Flowing
22	3047	May 26, 1919	Flowing
29			Drilling
30			"

Note: No. 4 was abandoned at 1600 feet as a Wall Creek sand well and reported dry. Later it was plugged and is now a Shannon producer.

Totals.

9 Wall Creek wells
2 Wall Creek wells drilling, Nos. 29 and 30.
5 Shannon wells dry
15 Shannon producers
31 Total Number

The monthly production of oil in barrels from the A. E. Humphreys lease is given in the following table:

Month	1916	1917	1918	1919
January		420.00	1,423.56	19,380.37
February		250.00	5,948.27	21,202.92
March		380.83	7,867,62	28,179.12
April		286.76	7,982.21	36,874.88
May		851.46	12,372.44	35,262.63
June		487.27	13,558.25	38,843.97
July		600.23	14,609.30	34,173.79
August		992.06	13,346.19	35,457.02
September		1,094.14	12,459.87	31,086.92
October		860.87	12,262.40	
November		1,897.40	18,659.22	
December	862.10	2,310.39	21,118.52	

R. B. Whiteside Lease.
University Land.

Section 9, $S\frac{1}{2}$, $S\frac{1}{2}N\frac{1}{2}$, $NE\frac{1}{4}NW\frac{1}{4}$, $NW\frac{1}{4}NE\frac{1}{4}$, containing 560 acres.

Prospector's Lease No. 19691 for this tract was granted to Ralph Arnold on May 5, 1915, which was assigned to R. B. Whiteside on June 26, 1915. An oil Operator's Lease No. 22187 was granted to R. B. Whiteside on January 25, 1917, for a term of fifteen years. The Midwest Refining Company is operating this tract.

Information is given in the following table regarding the wells drilled on the R. B. Whiteside lease:

Shannon Sand Wells.

No. of Well	Depth to Top of Sand ft.	Date Completed	Remarks
2	903	June 19, 1917	
3	900	June 30, 1917	
4	890	June 16, 1917	
5	900	July 31, 1917	
6	896	Aug. 12, 1917	Dry
7	900		
8	892	Sept. 2, 1917	
9	880	Sept. 9, 1917	
10			
11	910		
12			
15	905	Oct. 19,1917	
16	940	Aug. 29,1917	
17	942	Sept.16,1917	Dry
20	925	Oct. 1, 1917	
24	887	Sept.27,1917	
25	922	Oct. 16,1917	
26	910	Oct. 21,1917	
29	900	Nov. 11,1917	
30	895	Nov. 14,1917	
31	910	Dec. 3,1917	
32	890	Dec. 8 ,1917	
33	930	Dec. 30,1917	
34	930	Jan. 20,1918	
43	905	July 26,1918	
49	920	Aug. 7,1919	Dry

Note: All producing Shannon wells are pumping.

Wall Creek Sand Wells.

1	3021	Jan. 26, 1918	Flowing
13	3025	Jan. 28, 1918	Flowing
14	3042	July 30, 1918	Flowing
18	3102	May 12, 1918	Flowing
19	2995	Oct. 21, 1919	
21	3264	July 7, 1919	Pumping
23	3036	Aug. 7, 1918	Flowing
27	3040	May 6, 1918	Flowing
28	3037	July 15, 1918	Flowing
35	3010	Aug. 15, 1918	Flowing
36	3015	June 8, 1918	
37	2970	July 13, 1918	Flowing
38	2965	Dec. 8, 1918	Flowing
39	3045	Dec. 31, 1918	Flowing
40	3320	Nov. 15, 1918	Pumping
41	3260	Oct. 23, 1918	Pumping
42	3240	Oct. 19, 1918	Pumping

Wall Creek Sand Wells (Continued)

No. of Well	Depth to Top of Sand ft.	Date Completed	Remarks
44	3295	Jan. 14, 1919	Pumping
45	3264	Feb. 24, 1919	Pumping
46	3321	Feb. 22, 1919	Pumping
48	3060	Dec. 31, 1918	Flowing

Note: An attempt was made to drill Well No. 19 to the Wall Creek sand. This was abandoned and well plugged back to First Wall Creek sand, and has been producing as such since Oct. 21, 1919.
No. 21 was abandoned at 1835 feet and rig moved to new location, where well with same number was drilled to Wall Creek sand.
No. 22 is a location only.
No. 47 is a location only.
No. 50 is trying for the Second Wall Creek sand.
No. 38 encountered stray sand at 2325 to 2337 ft.

The monthly production of oil in barrels from the R. B. Whiteside lease is given in the following table:

Month	1916	1917	1918	1919
January		793.55	12,794.05	53,332.42
February		794.71	20,388.34	41,271.90
March		702.46	21,964.86	40,764.45
April		676.45	26,882.38	36,160.77
May		1,433.26	40,991.72	33,307.78
June		1,671.64	48,016.99	29,029.29
July		1,731.01	64,853.40	27.766.37
August		1,964.69	72,881.28	29,174.17
September		5,156.51	68,373.37	27,397.76
October		4,286.08	62,028.23	
November		5,405,23	50,796.46	
December	1134.34	5,001.41	55,376.04	

Merritt Lease
University Land.

Sec. 10, $S\frac{1}{2}$, $S\frac{1}{2}N\frac{1}{2}$, $N\frac{1}{2}NE\frac{1}{4}$, $NE\frac{1}{4}NW\frac{1}{4}$, containing 600 acres.

Prospector's Lease for this tract was granted to the Merritt Oil and Gas Company on May 5, 1916. Operator's Lease No. 22014 was made to the Merritt Oil and Gas Company on November

27, 1916, for a term of fifteen years. One half interest in and to the NE¼, S½NW¼, and the north sixty acres of the SW¼ (340 acres) was was assigned to the Ohio Oil Company on December 4, 1916. The Ohio Oil Company is operating in the northern portion and the Midwest Refining Company is operating in the southern portion of the said lease.

Information is given in the following table regarding the wells drilled on the Merritt lease:

North Part.

No. of Well	Depth to Top of Sand ft.	Date Completed	Remarks	
	Shannon Sand Wells.			
5	985	Oct. 1, 1917		
	Wall Creek Sand Wells.			
1	3212		Flowing	Total Depth
2	3128	July 20, 1917	Flowing	
3	3198	Oct. 16, 1917	Flowing	
4	3321	May 12, 1918	Pumping	
6	3195	Aug. 21, 1918	Flowing	
7	3308	Dec. 15, 1918	Pumping	
8	3299	Oct. 21, 1918	Pumping	Total Depth
9	3226	Oct. 10, 1918	Pumping	
10	3330	Mar. 28, 1919	Pumping	

South Part
(Midwest Refining Company, Operator)

	Wall Creek Sand Wells.			
1	3316	Nov. 11, 1918	Pumping	
2	3300	Oct. 28, 1918	Pumping	Water at 3368'. Plugged back to 3362'

The monthly production of oil in barrels from the Merritt lease is given in the following tables:

North Part
(Ohio Oil Company, Operator.)

Month	1916	1917	1918	1919
January		3,620.98	18,485.36	25,675.65
February		7,728.29	19,348.53	21,258.01
March		7,891.07	21,449.88	21,321.51
April		7,113.55	15,979.56	17,168.72
May		6,884.85	15,342.58	16,339.07
June		6,732.85	15,523.50	16,273.25
July		7,341.60	15,916.43	16,695.13
August		7,667.04	19,213.10	15,737.94
September		17,254.09	22,482.75	14,186.34
October		18,264.83	23,451.59	
November		17,600.81	25,991.62	
December	3,170.43	18,039.63	28,210.81	

South Part.
(Midwest Refining Company)

January				1,147.33
February				779.16
March				750.14
April				900.07
May				852.01
June				766.47
July				773.16
August				766.20
September				953.92
October				
November			553.77	
December			1,372.41	

James E. Whiteside Lease
Penitentiary Land

All of Section 15, containing 640 acres.

Prospector's Lease was granted to James E. Whiteside on May 5, 1917. Operator's Lease No. 25024 was made to James E. Whiteside on August 1, 1918, for fifteen years. This tract is

being developed by the Midwest Refining Company.

Section 16
School Land.

Prospector's Lease of all of Section 16 was made to William P. DeLaat on January 11, 1916. Operator's Lease No. 23576 to the E½ of Section 16 was made to James T. Hurst on September 10, 1917, for a period of five years. A five-eighths in said lease was assigned to the Ohio Oil Company on December 4, 1917.

Prospector's Lease to the SW¼ of Section 16 was made to E. J. Carlin February 24, 1917, and the same was assigned to F. W. Messimer on February 28, 1917. A Prospector's Lease to the same party was made on February 24, 1918, and another Prospector's Lease was granted to E. J. Carlin and F. W. Messimer on March 1, 1919.

On the NW¼ Section 16 a Prospector's Lease was granted to W. P. DeLaat on February 24, 1917, and on the same date the SE¼NW¼ was assigned to F. E. Hurley, which was cancelled September 10, 1917. Operator's Lease No. 25726 for the SE¼NW¼ was made to F. E. Hurley on December 1, 1918, for a term of five years. For the N½NW¼, SW¼NW¼, Section 16, a Prospector's Lease was made to Mrs. W. W. Atkinson on March 1, 1918, and renewed on March 1, 1919. Operator's Lease No. 26833 was granted to Mrs. Atkinson on June 19, 1919, for a term of five years. The Ohio Oil Company is operating on the E½, SW¼, and SE¼NW¼ Section 16, and the Midwest Refining Company is operating on the N½NW¼ and the SW¼NW¼ of the same section.

Ira B. Humphreys Lease

All of Section 21, 640 acres.

Prospector's Lease was granted to Ira B. Humphreys May 5, 1917. Operator's Lease No. 25095 was granted to the same party May 1, 1918, for a term of fifteen years. The Midwest Refining Company is operating this lease.

GENERAL DESCRIPTION OF THE BIG MUDDY FIELD.

Inasmuch as the principal object of the investigation was to inquire into the cuase of the falling off of production, a few words will suffice as a general geologic description of the field. The major axis of the Big Muddy structure or dome extends in a northeasterly and southwesterly direction across Sections 2, 3, 7, 8, and 9, the steeper dips being to the north and the lesser to the south. The average dip at the eastern end of the structure is much greater than that at the western end. The above shows that the producing area of the field, if extended at all, will be extended to the west and south rather than to the east and north. In other words the structural contours indicate that the water line is much nearer the crest of the dome to the north and to the east than in other directions, and this has also been shown by the wells drilled in this field.

The snadstones and shales of the Pierre formation (Montana) outcrop on the surface. The Shannon sand of this formation is found at an average depth of about 975 feet below the surface and the Wall Creek sandstone of the Benton formation (Colorado) is encountered at an average depth of about 3000 feet at the crest of the dome. These are the two producing sands of the Big Muddy so far discovered, with the exception of a

stray sand found in two wells in the Elkhorn lease at a depth of about 2350 feet. The Shannon sand has an average thickness of about eighty feet, and as to the thickness of the Wall Creek sand, we have no authentic information as yet in this field, although it was reported to be about 260 feet thick in one well. The average thickness of the first Wall Creek sand at the various exposures is about 150 feet. An effort is being made to go down to the Second Wall Creek sand in Well No. 50 in Section 9, which was 3028 feet deep on November 1, 1919, and was probably at that time near the top of the first Wall Creek sand.

The producing area of this field with reference to the Shannon sand is approximately 1200 acres and with reference to the Wall Creek sand it is approximately 4300 acres. As above indicated no information is yet available as to the occurrence or depth of the Second Wall Creek sand. It is believed by some that the two sands have come together in this field. It is more than likely, however, that the Second Wall Creek sand will be found at a depth of about 400 feet below the first and that it will be oil-bearing, but no estimates or predictions are based on this conjecture. If future development proves up one or more lower sands in this field, it is likewise possible that the producing area will also be materially increased as in Salt Creek, but it is not expected that the limits of the drilling territory will be extended over a mile in any direction, owing to the depth of the sands and the cost of drilling.

OPERATING COMPANIES.

There are three operating and producing companies in this field, namely, the Midwest Refining Company, the Ohio Oil Company, and the Texas Company. The first two named companies are operating on the University and State lands heretofore listed, together with other and adjacent lands. The Texas Company is operating on the following patented lands in the same township:

Section 5, S½S½,
Section 6, SE¼SE¼,
Section 7. N½NE¼,
Section 8, N½NE¼,
Section 9, NW¼NW¼

DECLINE IN PRODUCTION.

In the following table we have listed the data secured with reference to monthly production of oil from the several leases, together with the monthly completion of oil wells of the Shannon, Wall Creek, and stray sands. In this table, as will be observed, data are given for the years 1917, 1918, and to September 1, 1919.

Although a few wells were completed in this field prior to January 1, 1917, there was very little production prior to that date. Drillers were very lax in keeping logs and other records of the earlier wells in this field. In a number of instances we were unable to secure any data at all with reference to the formations passed through in drilling early wells, or as to date of completion of the wells. However, we secured complete data as to completion of wells and production since January 1, 1917. These data are given in the table on the following page, which we have designated as Plate 10.

PLATE 10

Production Compared to Completions on Producing Wells
Big Muddy
(Sh - Shannon. WC - Wall Creek)

Lease	Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Totals	
Kinney	1917		Sh-3						Sh-1	Sh-1		Sh-1	Sh-1	Sh -7	WC -3
Ohio Oil Co.									WC-1				WC-2		
Sec. 4	1918	Sh-1		WC-1	WC-1		WC-1			WC-1	WC-1			Sh -1	WC -5
Prod.	1919							WC-1							WC -1
by bbls.	1917	239	2726	4481	4613	6706	4886	6136	7135	16598	14297	13800	29247	110864 bbls.	
	1918	36348	33083	43861	53410	55406	54960	48792	39679	40193	40754	37471	38367	522324 "	
	1919	31409	29233	29641	23874	24065	23042	22843						184107 "	
Elkhorn	1917										WC-1				WC -1
M. R. Co.	1918					WC-1	Stray-1	WC-1		WC-1	Stray-1			Stray-2	WC-3
Sec. 4	1919		WC-1												WC -1
	1917	2874	2399	938	3133	1365	896	1359	1650	9320	28479	26067	23751	102231 bbls.	
Prod.	1918	24124	20504	22231	21453	23901	25951	22436	25628	23022	17961	17189	12850	257250 "	
	1919	12572	10642	46547	39657	22429	8419	8351						148617 "	
A.E.Humphrey	1917						Sh-2	Sh-2	Sh-1	Sh-1	Sh-1			Sh -7	WC -1
Sec. 8	~~1918~~										WC-1				
M. R. Co.	1918	Sh-1			Sh-1		Sh-1	WC-1		Sh-1		Sh-1		Sh -5	WC -5
		WC-1			WC-1							WC-2			
Prod.	1919		WC-2			Wc-1	Sh-1							Sh -1	WC -3
	1917	420	250	381	287	851	487	600	992	1094	861	1897	2310	10430 bbls.	
Prod.	1918	1424	5948	7868	7982	12372	13558	14609	13346	12460	12262	18659	21118	141606 "	
	1919	19380	21210	28179	36875	35263	38844	34174						213925 "	
R.B.Whiteside	1917						Sh-2	Sh-2	Sh-1	Sh-7	Sh-4	Sh-2	Sh-3	Sh -21	WC -1
Sec. 9													WC-1		
	1918	Sh-1				WC-2	WC-1	Sh-1	WC-2		WC-2	WC-1	WC-3	Sh -2	WC -15
M.R.Co.		WC-1						WC-3							
	1919	WC-1	WC-2					WC-1							WC -4
	1917	794	795	702	676	1433	1672	1731	1965	5157	4286	5405	5001	29617 bbls.	
Prod.	1918	12794	20388	21965	26882	40992	48017	64853	72881	68373	62028	50796	55376	545345 "	
	1919	53332	41272	40764	36161	33308	29029	27766						261632 "	
	1917							WC-1			Sh-1			Sh-1	WC -2
Merritt											WC-1				
Sec. 10	1918					WC-1		WC-1			WC-2		WC-1		WC -5
Ohio Oil Co.	1919			WC-1											WC -1
	1917	3621	7728	7891	7114	6885	6733	7342	7667	17254	18265	17601	18040	126141 bbls.	
	1918	18485	19349	21450	15980	15343	15523	15916	19213	22483	23452	26545	29583	243322	
Prod.	1919	25676	21258	21322	17169	16339	16273	16695						134732 "	
Merritt	1917														
Sec. 10	1918										WC-1	WC-1			WC-2
M.R.Co.	1919														
	1917														
	1918											554	1372	1926	
	1919	1147	779	750	900	852	766	773						5967	

The information given in the foregoing table convinces us that the primary cause of the decline in production in this field during the past six months is the failure of the drilling companies to complete a sufficient number of wells to the Wall Creek sand to arrest the normal decline in production. In other words the normal decline in production of the deep wells has not been overcome by bringing in new wells. To present the information given in the foregoing table in graphic form, we have prepared the following curve charts, showing the production and well completions by months for each of the several tracts of University lands in this field. The close relation between these factors in oil production is clearly shown on the attached graphs.

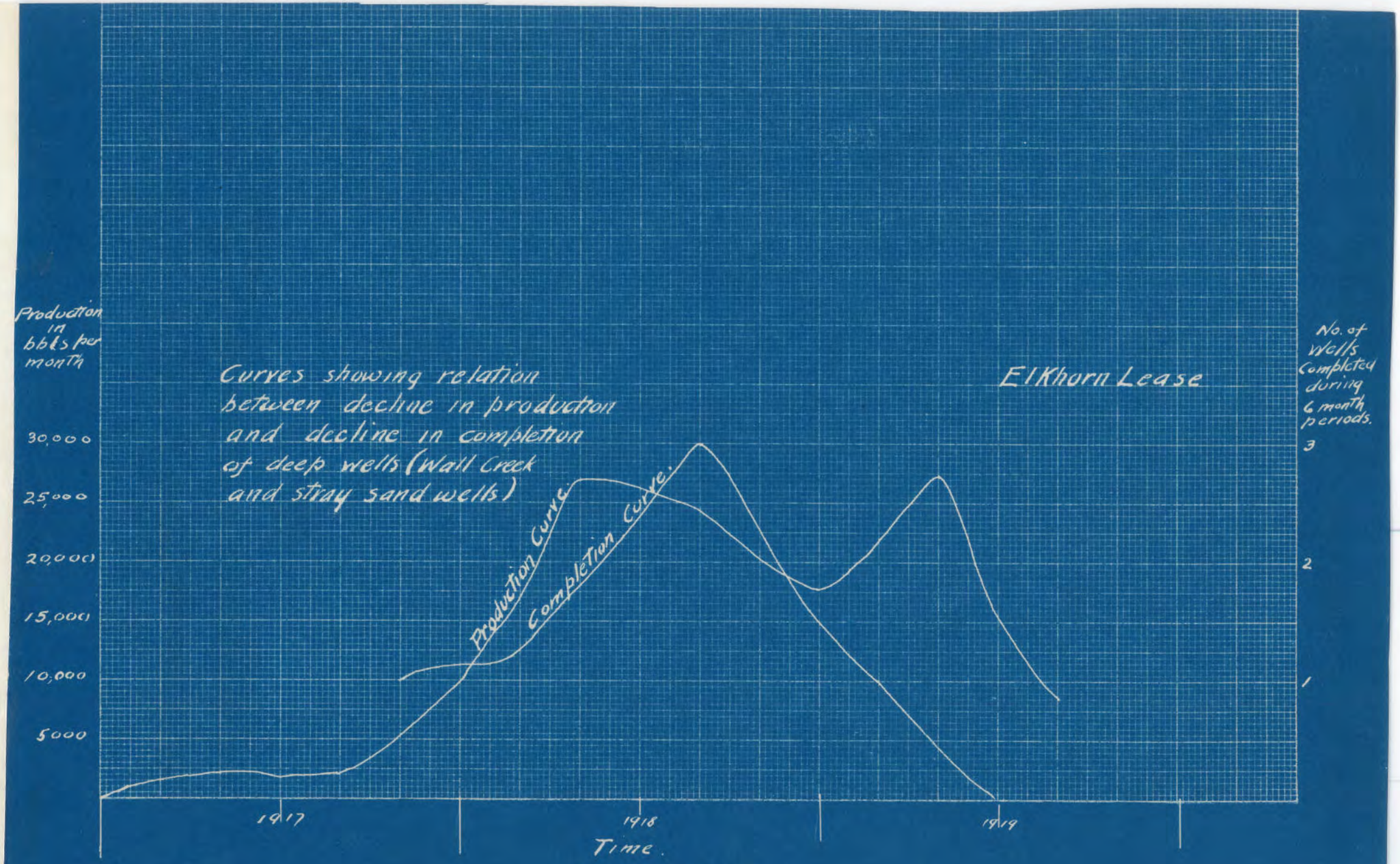
Production in bbls per month
30,000
25,000
20,000
15,000
10,000
5000
Curves showing relation between decline in production and decline in completion of deep wells (Wall Creek and stray sand wells)
Production Curve.
Completion Curve.
Elkhorn Lease
No. of Wells Completed during 6 month periods.
3
2
1
1917
1918
1919
Time.

PLATE I.

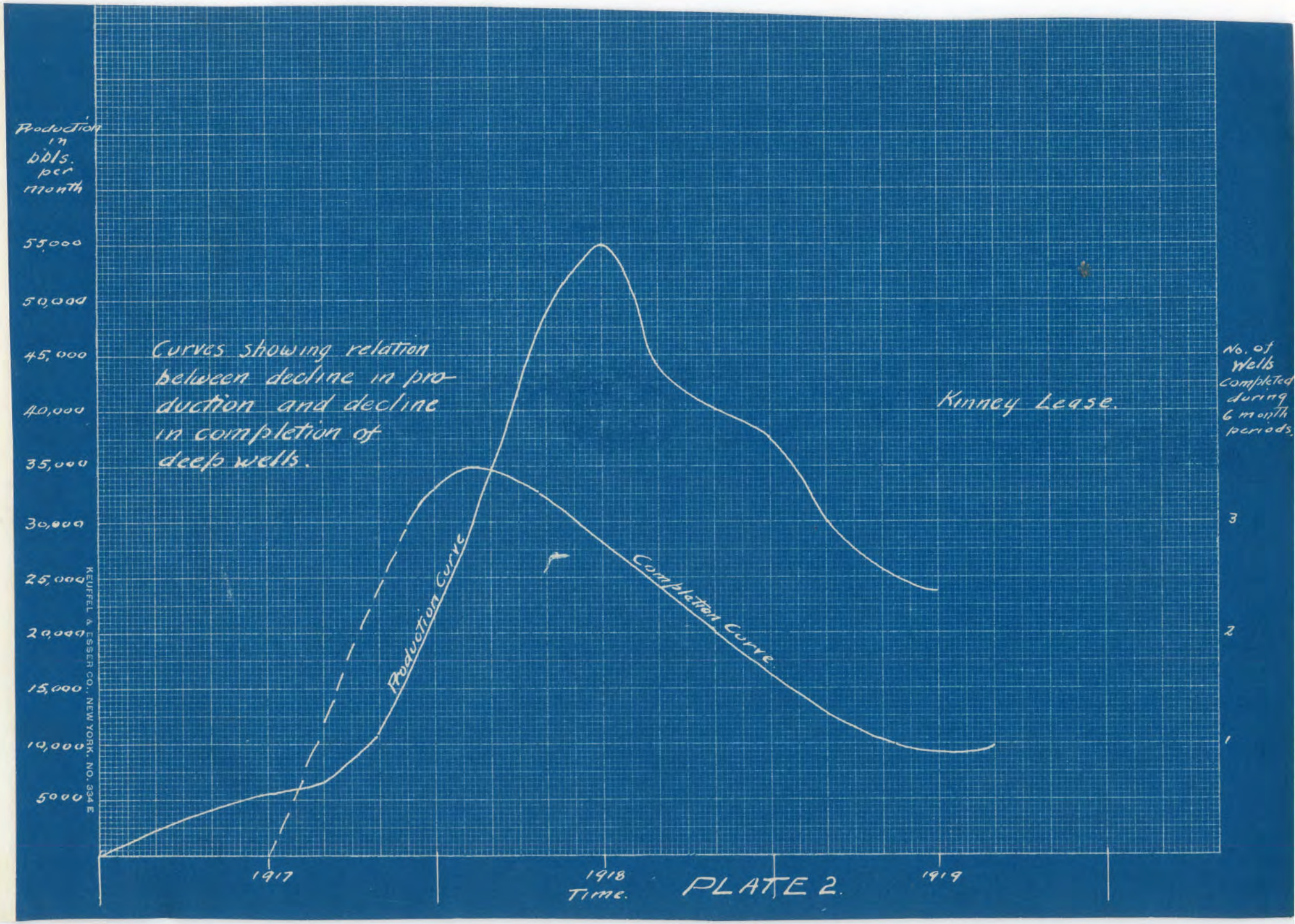
Production in bbls. per month
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5000
No. of Wells Completed during 6 month periods.
3
2
1
Curves showing relation between decline in production and decline in completion of deep wells.
Kinney Lease.
Production Curve
Completion Curve
1917
1918
1919
Time.
KEUFFEL & ESSER CO. NEW YORK. NO. 334 E

PLATE 2.

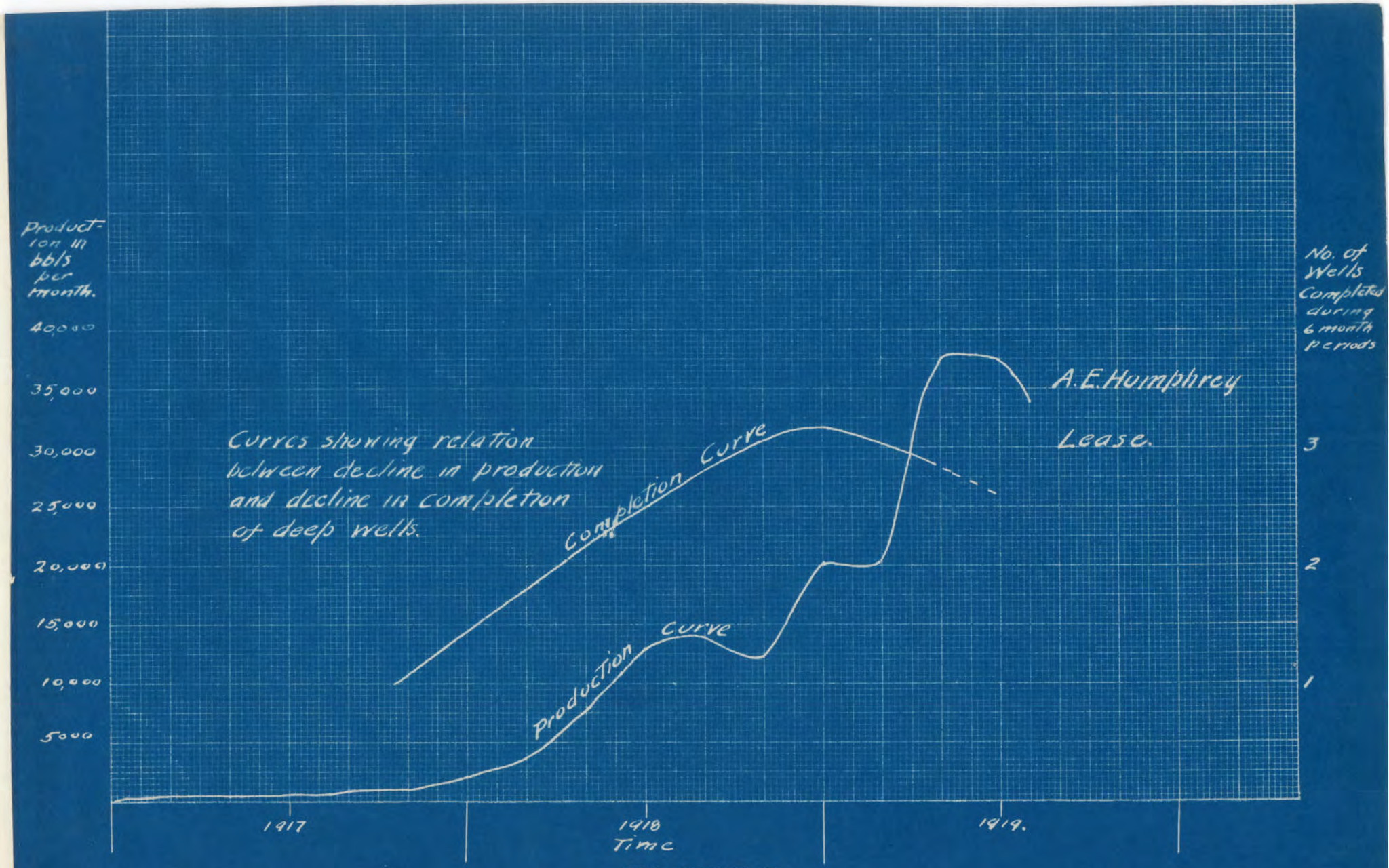
Production in bbls per month.
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5000
No. of Wells Completed during 6 month periods
3
2
1
Curves showing relation between decline in production and decline in completion of deep wells.
Completion Curve
Production Curve
A.E. Humphrey Lease.
1917
1918
1919.
Time

PLATE 3.

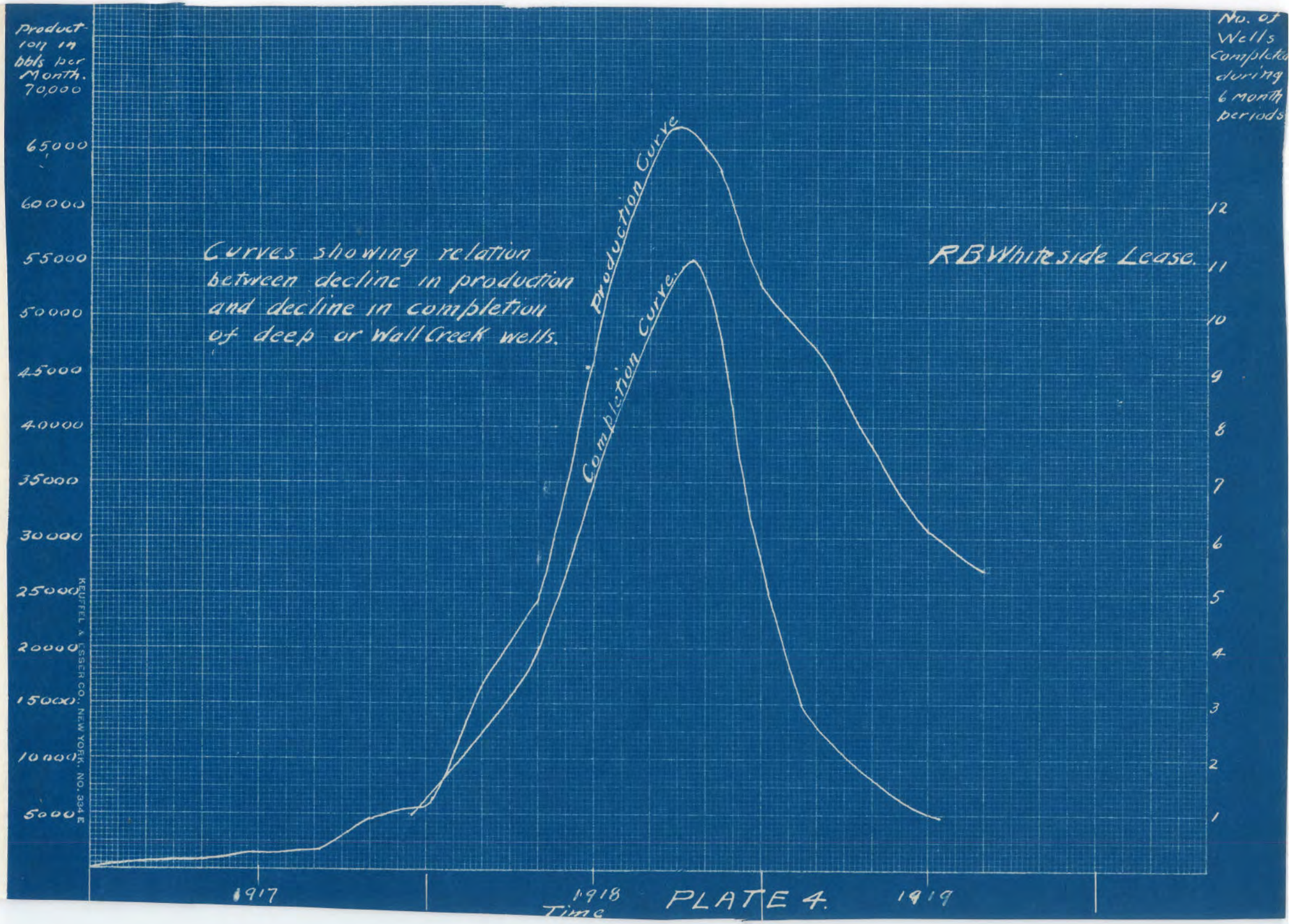
Production in bbls per Month.
70,000
65000
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
No. of Wells Completed during 6 month periods
12
11
10
9
8
7
6
5
4
3
2
1
Curves showing relation between decline in production and decline in completion of deep or Wall Creek wells.
Production Curve
Completion Curve.
R B Whiteside Lease.
1917
1918
1919
Time
KEUFFEL & ESSER CO. NEW YORK. NO. 334 E

PLATE 4.

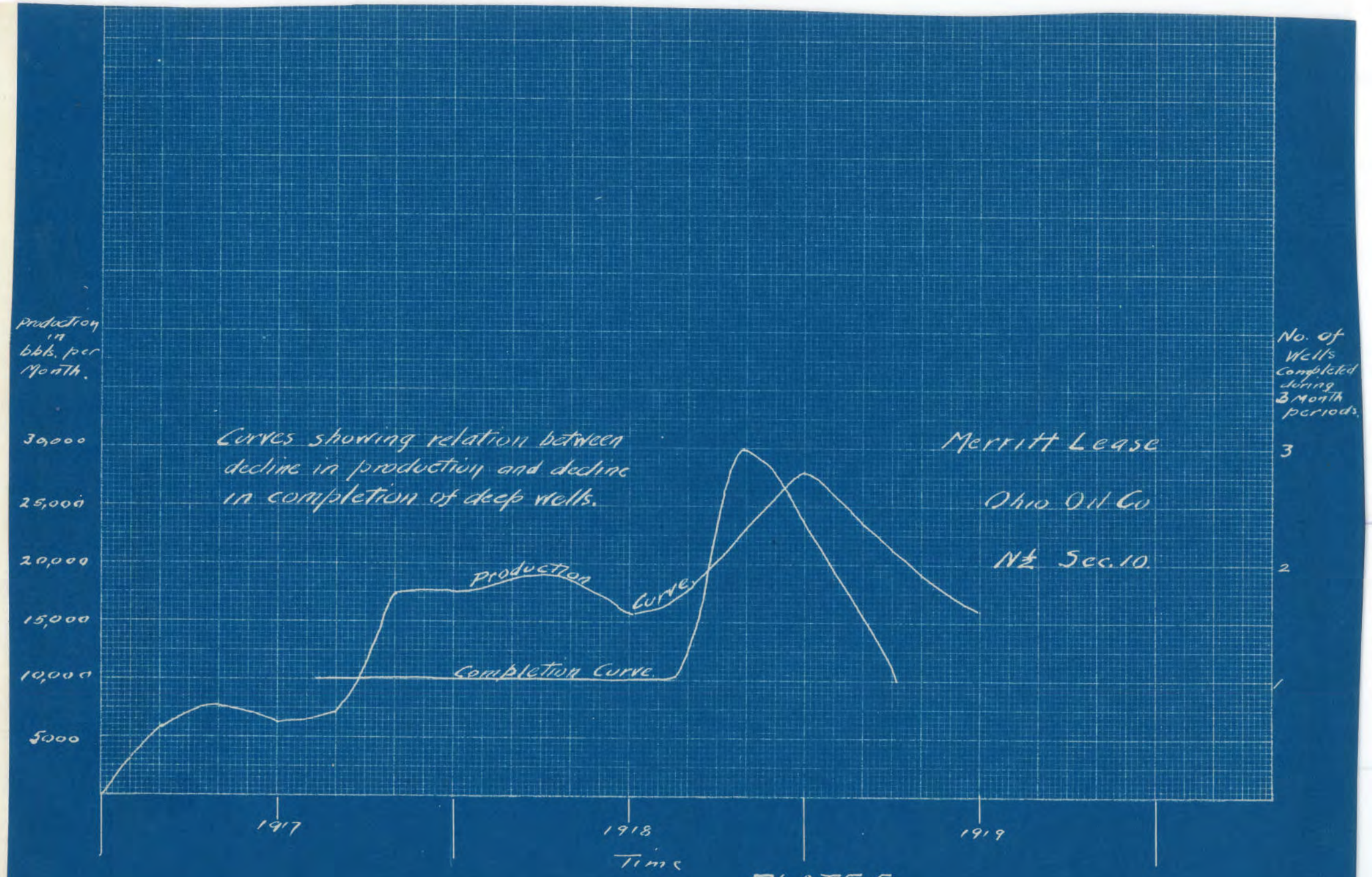
Production in bbls. per Month.
30,000
25,000
20,000
15,000
10,000
5000
No. of Wells Completed during 3 Month periods.
3
2
1
Curves showing relation between decline in production and decline in completion of deep wells.
Merritt Lease
Ohio Oil Co
N½ Sec. 10.
Production Curve
Completion Curve
1917
1918
1919
Time

PLATE 5.

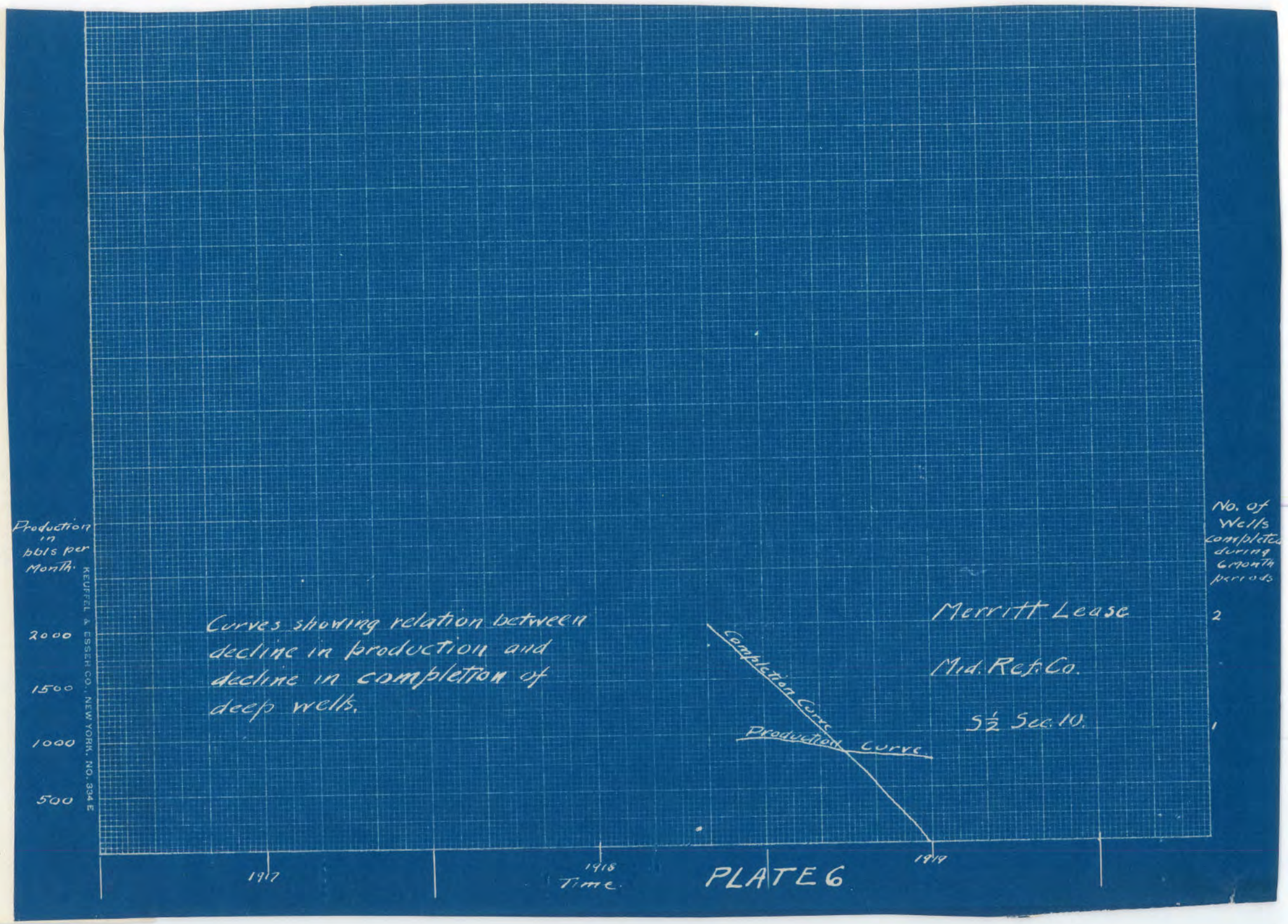
Production in bbls per Month.
2000
1500
1000
500
KEUFFEL & ESSER CO. NEW YORK. NO. 334 E
Curves showing relation between decline in production and decline in completion of deep wells.
Completion Curve
Production Curve
Merritt Lease
Mid. Ref. Co.
S½ Sec. 10.
No. of Wells completed during 6 month periods
2
1
1917
1918
Time
1919

PLATE 6

The rule that the initial production of an oil well is greater than subsequent and later production is practically universal. The few minor exceptions are hardly sufficient in number to prove the rule. So universal is this rule that petroleum engineers of note, after investigation of thousands of oil wells in scores of oil fields and under widely varying conditions, have formulated a rule applicable to the expected future production of producing oil wells, known as "The Law of Equal Expectation". This rule is stated in Bulletin No. 152 of the American Institute of Mining and Metallurgical Engineers, August 1919, edition, page 1237, in the following language:

"If two wells under similar conditions produce equal amounts during any given year, the amounts they will produce thereafter, on the average, will be approximately equal, regardless of their relative ages."

In the same publication, in discussing the application of this rule, the following language is used:

"The law of equal expectation means that each individual of a group of wells producing under similar conditions will decline along approximately the same type of curve, the rapidity of decline varying with the output of the well. For instance, if the first year's production of a well is very large, its decline will be much more rapid that that of a well having a smaller output. Furthermore, the second well will produce oil at the same rate as the first well after the latter has declined to the same output as the second".

A bulletin has been issued by the U. S. Bureau of Mines, No. 177, edition of April, 1919, entitled, "The Decline and Ultimate Production of Oil Wells", in which the subject is treated very exhaustively. This bulletin gives information based upon an investigation by the Government of some 20,000 oil wells in the oil fields of California, West Virginia, Kentucky, Texas, Wyoming, Illinois, and Oklahoma, and other oil fields of the United States.

An interesting fact is developed and shown by this publication with reference to the Salt Creek oil field of this State, which is, that based upon past results of producing oil wells in this field, the second year daily production is only 70 per cent of the daily production for the first year. In other words, the decline in production during the first year in the Salt Creek field is 30 per cent, and this has been the experience of the past notwithstanding that only a fraction of the field has been drilled, and due to this fact the decline in production would be much less than in a field which is more fully developed.

Tables are given in this publication from scores of other oil fields, all of which show a decline in production from the mazimum first year's production. On page 189 of this bulletin, a decline curve is given for the Oil City district, Pennsylvania, which shows that the production for the second year was approximately 62 per cent of that of the first year. Certain oil fields in West Virginia, comprising the Rock Creek, Spencer, and Duvall oil districts, are listed on page 186 in the same manner, which show a decline of 50 per cent, or thereabouts, of the first year's production during the second year. In Ohio (page 178), the decline curves are given for nineteen properties in two oil fields, which show a percentage of decline of 40 per cent to 50 per cent during the first year. On page 176, decline curves are given for the Carlyle and San Doval oil fields in Illinois. The rate of decline from the first year's production is 50 per cent in the San Doval field, and for the Carlyle field the daily rate of production during the second year is 80 per cent of the first year's production. In the Oklahoma fields, a higher rate of decline is the rule. This apparently is due to the fact that generally the wells in Oklahoma have a greater rate of initial production. The following

Oklahoma fields are described on pages 113-147 of the publication named:

Oil Field	Page.	Second Year's Production Percentage of first Year's Production.
Bartlesville	113	50%
Bird Creek	124	60
Nowata	124	50
Glenn Pool	137	51
Cushing	143	30
Ponca City	146	60
Okmulgee	147	53
Muskogee	147	43

The foregoing figures are not complete and are not intended to cover all of the oil fields, but are taken at random to illustrate the point.

To show that the same rule holds with reference to other oil fields in Wyoming, we are giving herewith the production from two tracts of eighty acres each in Section 19, T. 46 N., R. 98 W., Grass Creek field, Wyoming. These figures were secured from the State Land Commissioner, Cheyenne, Wyoming.

Month Produced	Total Bbls. Oil
1918	
June	45,177.67
July	48674.19
August	41,086.73
September	37,650.37
October	38,924.61
November	34,733.80
December	36,813.81
1919	
January	35,841.13
February	31,442.56
March	31,251.44
April	31,571.74
May	31,665.24
June	26,273.44
July	27,766.00
August	27,029.70
September	23,882.52

The production for September, 1918, is 37,630 barrels, and for September, 1919, it is 23,882 barrels, a decline of approximately 37 per cent during the past year.

We have to-day received a statement from the Texas Company, which is operating on lands adjoining the University lands in the Big Muddy field, on lands described on page 16 hereof, from which it appears that the average monthly production from the Texas Company wells in this field in 1918 was 2885 barrels per well per month, while the average production for the year, 1919, to September 30th, has been 1610 barrels per well per month, thus showing a decline for the year from 2885 barrels to 1610 barrels per well per month, a decrease of 1275 barrels per well per month, or forty-four per cent. This shows that the experience of the Texas Company with reference to production in the Big Muddy field has been practically identical with that of the two companies which are producing from University land in this field.

The October 24, 1919, edition of the Oil and Gas Journal (pages 56-58) gives a list of the oil wells in the Eastland, Texas, oil field with dates of completion, initial production, present production, and other data. The information regarding the first fifty wells listed in this article shows the following:

Eastland County Production Report, August 31, 1919.

Company	Date of Completion	Initial Production	Present Production
Cullinan et al	July, 1919	4,000	55
"	October, 1918	1,210	45
"	January, 1919	40	15
"	May 1919	20	10
"	April, 1919	25	15
"	February, 1919	50	5
"	February, 1919	200	15
"	April, 1919	90	90
"	May, 1919	605	90
Gulf Production	May, 1919	500	318
"	August, 1919	3,495	1,105
"	August, 1919	250	140
"	January, 1919	55	10
"	May, 1919	35	6
"	July, 1919	30	6
"	March, 1919	40	8
"	August, 1919	20	10
"	June, 1919	55	15
"	January, 1919	1,000	100
"	May, 1919	20	20
"	July, 1919	500	180
"	August, 1919	20	5
"	October, 1918	1,220	130
"	January, 1919	1,497	122
"	January, 1919	400	122
"	April, 1919	202	60
"	April, 1919	300	110
"	March, 1919	302	40
"	June, 1919	100	47
"	May, 1919	205	59
"	June 1919	1,162	200
"	May, 1919	400	105
"	June, 1919	42	20
"	August, 1919	240	100
Hamon, Jake	June, 1919	352	120
"	August, 1919	70	45
"	February, 1919	1,200	100
"	January, 1919	1,455	110
"	March, 1919	2,502	104
Hennen & Coe	July, 1919	152	0
"	October, 1919	10	0
"	November, 1918	1,800	35
"	December, 1918	1,000	30
"	March, 1919	702	38
"	August, 1919	290	142
Magnolia Hogg Creek	August, 1919	13	10
"	June, 1919	74	20
Magnolia Petroleum	May, 1919	22	2
"	October, 1918	32	0
"	February, 1919	2	0

In the preceding table, we have not given all the wells listed in the article referred to, since in a general way they all show the same state of facts with reference to the decline in production. Other fields in Texas, relative to which we have secured information, show even a greater rate in decline than the Eastland field.

In view of all the foregoing, we are of the opinion that the decline in production in the Big Muddy field has been no greater than normal, and in fact has not been as great as might be expected in the average field where drilling has not been restricted. In our opinion, there is no doubt but that the chief cause of the decline in production in this field has been due to insufficient drilling. About a year ago in an effort to forestall the Government withdrawal in the Lance Creek oil field, a large number of drilling rigs were moved from the Big Muddy field to the Lance Creek field. Due to this fact, completions have declined very materially in the Big Muddy field during the past year. Attention is directed to the table heretofore referred to (Plate 10), in which it is shown that in all of the wells on University lands in the Big Muddy field there have been only ten completions to the Wall Creek sand during the year, 1919, to September 1st. During 1918, there were thirty-five completions to the Wall Creek sand on University lands in this field. In 1917, there were eight completions to this sand on University lands, making in all fifty-three Wall Creek sand wells in this field on University lands, and it might be mentioned in passing that all of these wells are producing.

It is apparent from the foregoing that the completions of wells to the Wall Creek sand on University lands during the past year have not been sufficient to arrest the decline of production. In

BIG MUDDY FIELD

Status of Wells on University Lands, T. 33 N., R. 76 W.--Sept. 20, 1919.

Lease	Location	Operating COmpany	Estimated Shannon Acreage	Estimated Wall Creek Acreage	No. Wells drilling	Drilled not producing	Wall Creek producing Wells.	Shannon producing Wells.	Dry or abandoned	Well Location	Total
	Sec.										
Kinney	4	Ohio Oil Co.	40 A.	100 A.	--	1	9	12	2	--	24
Merritt	N½10	"	120 "	340 A.	--	2	8	1	--	--	11
A.E.Humphrey	8	Midwest Ref.Co.	240 A.	560 A.	3	--	9	15	4	--	31
R.B.Whiteside	9	"	240 "	560 A.	2	--	20	23	3	2	50
Merritt	10	"	--	200 A.	1	--	2	--	--	--	3
Elkhorn	4	"	20 "	50 A.	--	--	5	2 2(stray sand)	4	--	13
Total			660 A.	1810 A.	6	3	53	55	13	2	132

Note: All Shannon wells are pumping. Two stray sand wells are pumping.
Wall Creek wells -- 25 are flowing, 28 are pumping.

State Land.

Hurst	16	Ohio Oil Co.	--	280 A.	--	--	5	--	--	1	6
DeLaat	"	"	--	40 "	--	--	1	--	--	--	1
Atkinson	"	Mid. Ref. Co.	--	120 "	--	--	1	--	2	--	3
J.E.Whiteside	15	"	--	120 "	--	--	2	--	--	1	3
I.B.Humphrey	21	"	--	60 "	1	--	1	--	--	--	2

PLATE 9

Estimated Remaining Available Supply of Oil in State and University Lands.

In connection with the past production and the decline in production in the Big Muddy field, it was deemed advisable and important to investigate the probable future oil production of the tracts belonging to the State and University. The following known facts are set out as a preliminary to this discussion.

First, there is a certain fixed quantity of oil in a reservoir, or pool, generally a sand, which cannot be increased by the forces of nature.

Second, with a given quantity of oil, the amount which can be extracted from a reservoir or sand depends entirely upon the percentage of extraction, which in turn is dependent upon the nature and condition of the oil and the condition of the sand, rock pressure, the gas in the sand, the encroaching water, and the methods of drilling and pumping.

Third, other things being equal, the life of an oil field varies inversely with the rate of production. In other words, the same quantity of oil may be extracted from a given pool in five or ten years, dependent upon the rate of development and upon the rate at which the wells flow. It is a well known fact that fields with a great initial production are shorter lived than those with smaller initial production.

Fourth, the past production of a group of wells or all of the wells in the field is the most reliable basis upon which to estimate future production and the total production of the field.

Prior to 1918, the usual method of estimating the reserves of an oil field was the saturation method. With the use of this method it was necessary to know the thickness of the containing sand, the percentage of oil saturation in the sand, and the probable extraction from the sand. In the case of the Big Muddy field,

this method would be impracticable, for it would entail the use of three unknown factors. We do not know the exact thickness of the Wall Creek sand in the Big Muddy field, and we would be compelled to guess at the saturation and extraction percentages. Another point which militates against the use of the saturation method is that in no field is the saturation equal throughout the producing area. This is especially true of the Wall Creek sand in the Big Muddy field.

The past production, or production curve method, has been developed and is used by such petroleum engineers as Beal, Arnold, Lewis, Fisher, and others, and is also used by the experts of the Internal Revenue Office for the appraisal of oil lands that have been partially developed. By this method, a curve is plotted called the decline curve. This curve represents the decline in production for any property or lease and is made by taking the average production in barrels per well per month and plotting these figures vertically against the time element in months, which is plotted horizontally on the chart. This cannot be done in the first instance on the ordinary co-ordinate paper, but must be done on the logarithmic co-ordinate paper upon which the curve can be extended into the future. This curve is then re-plotted on the common co-ordinate paper and it will then show the rate of production per month for the average well at any given time in the life of the property, and it also shows the period during which the lease can be worked at a profit, i. e., the curve can be extended into the future until it shows a rate of production too low to be commercial. Two illustrations of the decline curve

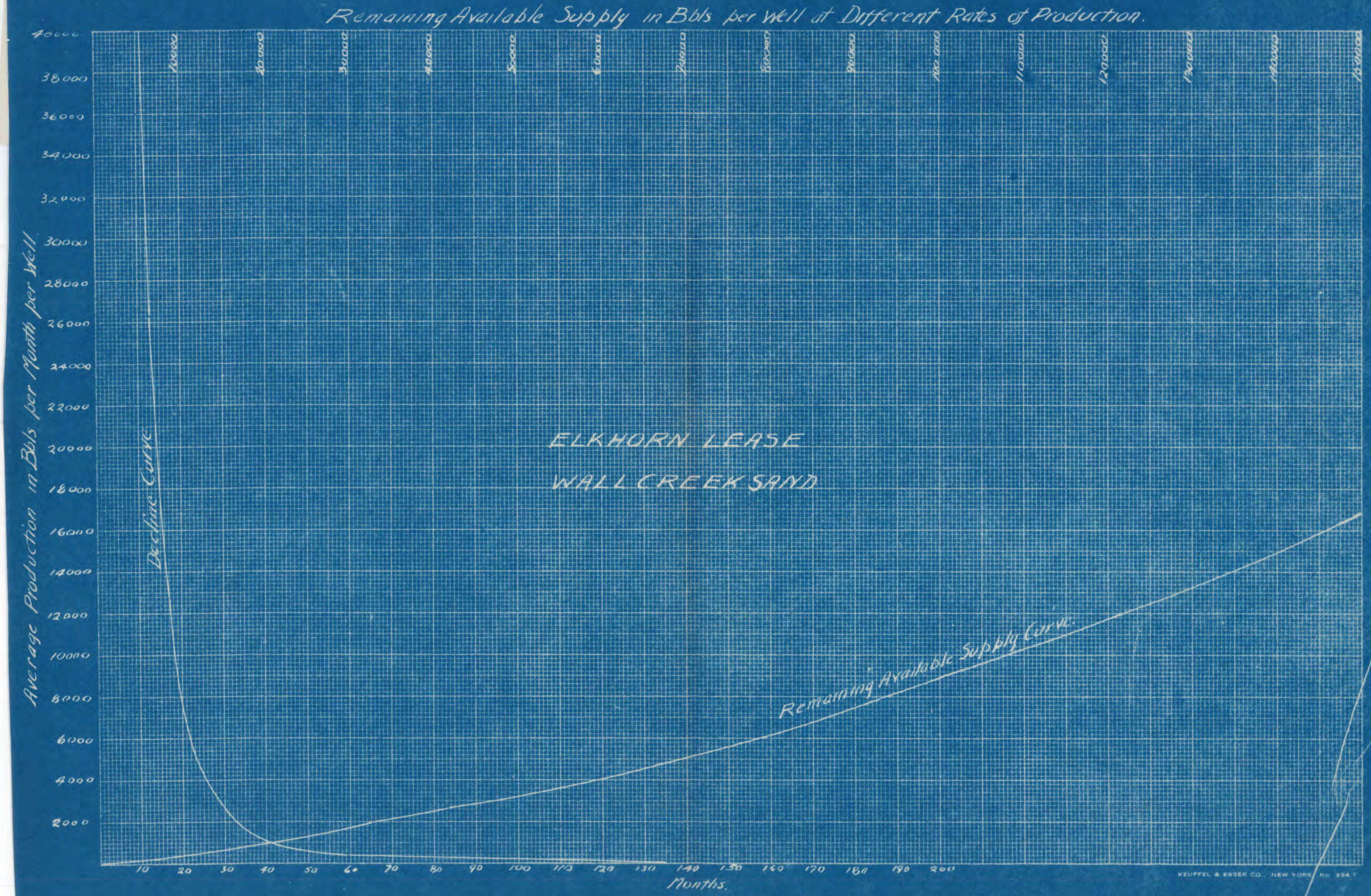
Remaining Available Supply in Bbls per Well at Different Rates of Production.
Average Production in Bbls per Month per Well
40000
38000
36000
34000
32000
30000
28000
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
10000
20000
30000
40000
50000
60000
70000
80000
90000
100000
110000
120000
130000
140000
150000
Decline Curve
ELKHORN LEASE
WALL CREEK SAND
Remaining Available Supply Curve.
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Months.
KEUFFEL & ESSER CO., NEW YORK No. 334-T

PLATE 7

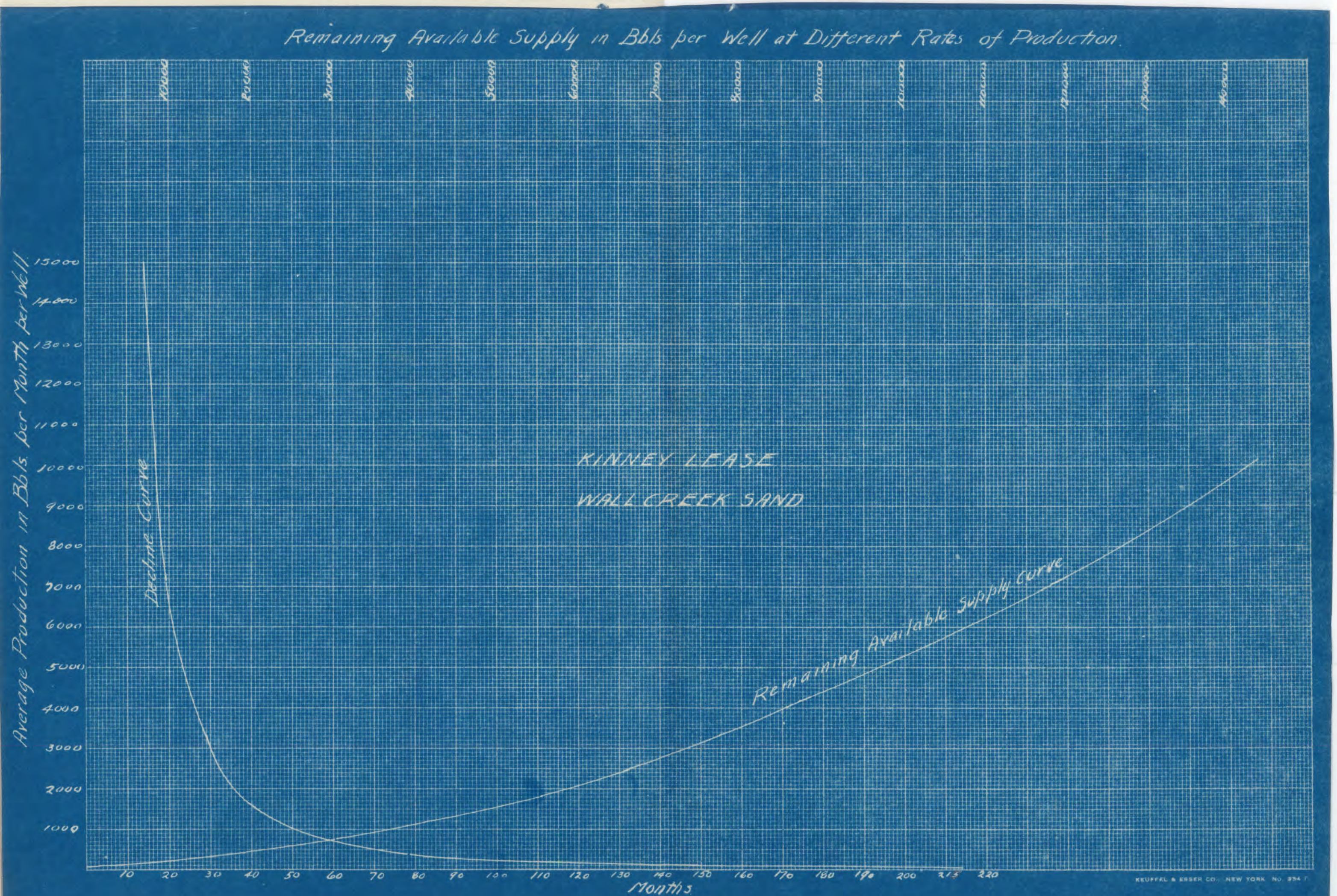
Remaining Available Supply in Bbls per Well at Different Rates of Production.
Average Production in Bbls. per Month per Well.
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
Decline Curve
KINNEY LEASE
WALL CREEK SAND
Remaining Available Supply Curve
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
215
220
Months
KEUFFEL & ESSER CO., NEW YORK NO. 354 F

PLATE 8

are shown on Plates 7 and 8 of this report. These are the decline curves for the Elkhorn and Kinney leases. For the Elkhorn lease, the curve terminates at the 135th month, which shows that the life of the lease will be about eight and one half years from the present, at which time the production will be too low for commercial operation. For the Kinney lease, the life is much longer, being fifteen years from the present time. It must be remembered, however, that the monthly production will be very small for the last five or six years in each case.

The remaining available supply curve is illustrated on the plates above referred to. This curve is formed by plotting the results of a complicated series of calculations and shows the remaining available supply in the average well of the lease at any given rate of production or at any given time. For instance, it being desirable to determine the remaining available supply of oil in a lease at the present time, we would first ascertain how many months the lease has been producing. Suppose the figure to be twenty months, we would then locate twenty months on the scale at the bottom of the sheet, from that point going up vertically to the decline curve, and at this intersection proceeding horizontally until we intersect the remaining available supply curve, at which point we would again arise vertically to the top of the sheet, and that scale would show us the number of barrels of oil remaining in the average well on this lease. By multiplying these figures by the number of wells the lease can sustain, we would arrive at the estimated remaining available supply of oil in the lease.

This work has been done for all of the leases involved in this report and the results are shown on the following table marked Plate 11. It will be noted that on some of the leases the estimates were made by Mr. C. A. Fisher, petroleum engineer

PLATE 11.

BIG MUDDY FIELD
Estimated Reserves on University and State Lands, Aug. 1, 1919.
Based on Shannon, Stray, and First Wall Creek Sands.

Lease & Section	Operating Company	Productive Acreage Acres	Total Production per Acre. Bbls.	Total Production per Lease Bbls.	Production to Aug. 1, 1919. Bbls.	Remaining Available Supply. Bbls.	
Kinney Sec. 4	Ohio Oil Co.	100	13,564	1,356,383	696,383	660,000	Morgan's estimate
Elkhorn Sec. 4	Mid. R. Co.	50	13,840	692,000	517,000	175,000	" "
A.E.Humphrey Sec. 8	Mid. R. Co.	560	10,000	5,600,000	366,823	5,233,173	A.A. Fisher's "
R.B.Whiteside Sec. 9	Mid. R. Co.	560	9,500	5,320,000	837,728	4,482,272	" "
Merritt Sec. 10	Ohio Oil Co.	340	9,300	3,162,000	507,365	2,654,635	" "
Merritt Sec. 10	Mid. R. Co.	200	5,000	1,000,000	7,893	992,107	" "
J. E.Whiteside Sec. 15	Mid. R. Co.	120	3,500	420,000	26,435	393,565	Morgan's "
I. B. Humphrey Sec. 21	Mid. R. Co.	60	3,000	180,000	6,208	173,792	" "
Hurst Sec. 16, E½	Ohio Oil Co.	280	3,750	1,050,000	64,546	985,454	" "
Totals		2270	8,273.3	18,780,383	3030,381	15,749,998	" "

Note: The W½ of Section 16, including the Atkinson, DeLaat, and Carlin leases, has practically the same status as to possible oil production as the E½ (Hurst lease).

for the Merritt Company, and on the other leases they were made by the State Geologist. Mr. Fisher had already worked up his estimates on the Merritt leases, including Sections 8, 9, and 10, in his report to the Merritt Company, which he kindly let us use with the consent of the aforesaid Company, and it was thought that we might avail ourselves of his estimates, thereby saving considerable time and work. Plate 11 is self-explanatory, and is the result of a very careful working up of all the available data on production, etc. At first glance, it might appear that Mr. Fisher's estimates were lower than Mr. Morgan's, but it must be borne in mind that Sections 8, 9, and 10 cover a large area, only portions of which are on the crest of the dome, while the producing areas of the Kinney and Elkhorn leases are on or very close to the crest. By this table one can arrive at a very fair estimate of the life of the Big Muddy field and the amount of oil which can be produced from the State and University lands therein.

GAUGING.

As heretofore stated, the writers observed the methods used in measuring, or gauging, oil in this field.

The oil from the wells is first conducted to a supply tank. As a rule, this is a large tank, called a "gun barrel", placed near the smaller tanks in which the oil is finally gauged. It is necessary to run the oil into the larger settling tank first because the oil, as it comes from the wells, carries more or less water which it is necessary to drain away before the oil will be accepted for transportation by the pipe line company. The water, being heavier than oil, settles to the bottom of the tank and is drained away from the bottom of the settling tank, after which the oil is conducted to the other tanks for final inspection by the pipe line gaugers.

The smaller tanks in which the oil is gauged are first measured, or as it is termed by the gaugers, "strapped". This consists of taking measurements of the outside circumference of the tanks eighteen inches apart from the bottom to the top of the tank. The width of the material of which the tank is constructed is also taken, as well as the measurement of ladders, braces, steam coils, and other objects in the tank which reduce its capacity for carrying oil, and the total volume of these objects are deducted from the total carrying capacity of the tanks. These figures are forwarded to the officials of the pipe line company, who thereupon give the tank a number and compute the capacity of the tank for each quarter of an inch in height, and from these figures is prepared what is known as a tank table for any particular tank, showing its capacity at successive heights of quarters of an inch. Preparatory to running the oil from the tank, the gauger first takes the temperature of the oil and secures a sample of the oil from the bottom of the tank in what is known as a "thief". This is done in order to determine whether the oil is of the proper standard of purity. If the oil meets the requirements of the gauger as to purity, it is then turned into the pipes and conducted to the main pipe line.. At the bottom of each tank there is a valve in the pipe, which leads from that tank, which valve is closed after the oil is run from the tank, and the valve is sealed by the gauger, so that it can not be tampered with during his absence without his knowledge. After the gauger closes the valve and seals it, he takes the measurement of the oil remaining in the tank, if any, in order that the remaining amount may be deducted from the total amount of oil which was found by the gauger to be in the tank at the time of his first measurement. All of this is done in the presence of a witness for the owner or operator of the wells and a ticket is given to this witness,

a duplicate of which is forwarded by the gauger to the office of the pipe line company.

In this system of accepting oil and accounting for it, it is seen that the pipe line company cannot make separate runs of oil for the several individual operators in the main pipe line. As a matter of fact, the oil from the several leases is all run together after leaving the tank and the quantity of oil measured, or gauged, at the tanks in the field is delivered to the consignee at the other end of the pipe line, less a deduction of one per cent to cover loss of shrinkage and evaporation. The oil from the Big Muddy field is all handled by the Illinois Pipe Line Company. In its printed regulations, the Illinois Pipe Line Company reserves the right to reject all crude petroleum offered for transportation, which is not up to its standard of purity, and Section 4 of its regulations provides that "Crude petroleum will be accepted for transportation only on condition that it be subject to such changes in gravity or quality while in transit as may result from the mixture of said crude petroleum with other crude petroleum in the pipe lines or tanks of this Co Company".

OFF-SET WELLS.

After considerable difficulty, the writers have secured from the several operating companies in this field statements showing the location of the wells on the University and other State lands, together with the location of the off-set wells on the adjoining lands. A part of this data was secured from the records of the operating companies in the field at Parkerton, Wyoming; a part from the office records of the companies at Casper, Wyoming; and the remainder from the company records at Denver, Colorado. So far as is known, this information has

never before been assembled in one report. After securing the information, the writers spent considerable time and care in compiling and platting the data so that it could be available for use.

The attached plat, Plate 12, shows the location of the several University and other State wells, together with the off-set wells on the adjoining lands. No attempt has been made to plat the off-set wells between the different leases on University lands, since it is apparent that the failure of one lessee to off-set the well of another lessee on an adjoining tract of University land would not adversely affect the University's interests. The plat is drawn to scale. As will be noted, the deep, or Wall Creek, wells are indicated by the solid circles and the shallow, or Shannon, wells are the open circles. Locations for wells are indicated by the cross marks. It is necessary to show by distinctive markings the deep and the shallow wells, since it takes a Shannon well to off-set a Shannon well and a Wall Creek well to off-set a Wall Creek well. In other words, a Shannon well will not off-set a Wall Creek well, and the reverse is also true.

Attention is called to Well No. 16, O. B. Barber, Oil Placer Claim, on the SW¼SE¼ Section 3, which is a well to the Shannon sand. This well is not off-set by a well to the Shannon sand on Section 10 to the south, which is University land. This well is only 189 feet from the University land in Section 10.

The well known as No. 4, Jones Oil Placer Claim, on the NE¼NE¼ Section 9, is a well to the Shannon sand. This well is not off-set by a Shannon well on University land in Section 9 to the west. It is only 200 feet from the University land.

The well known as No. 6 on the Jones Placer Claim No. 1 in the NE¼NE¼ Section 9, is a well to the Shannon sand. This

from the bottom of the tank in what is known as a "thief". This

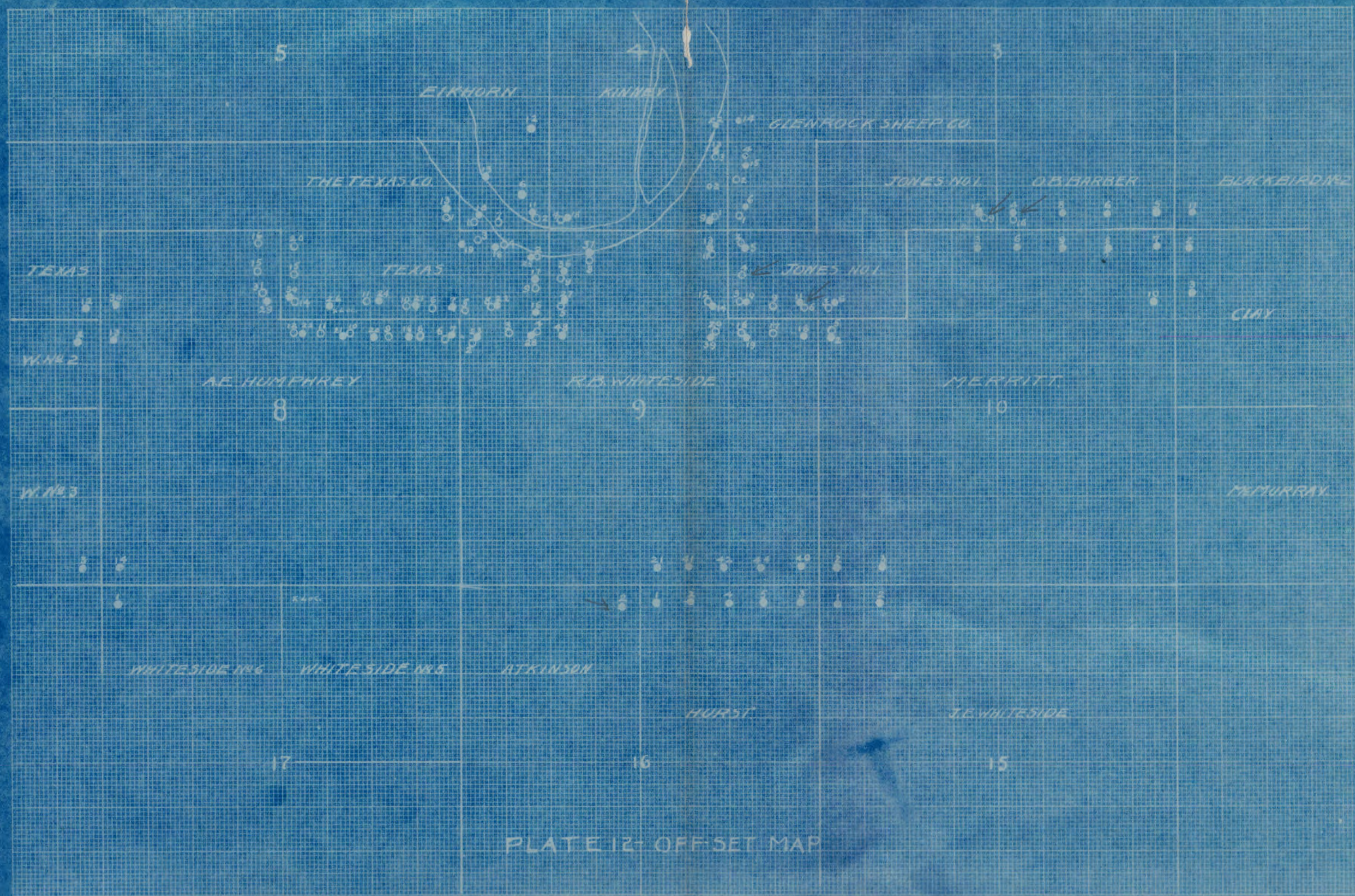

PLATE 12 OFFSET MAP

well is not off-set by a well to the Shannon sand on the University lands to the south. The said well is only 200 feet from the northern boundary of the University land.

Well designated as Well No. 9, on the Jones No. 1 Placer Claim, in the Se$\frac{1}{4}$SW$\frac{1}{4}$ Section 3, is a well to the Shannon sand. There is no well to the Shannon sand on the University land to the south (Section 10) to off-set this well . This well is only 200 feet from the University land to the south.

Recently at our request, the Ohio Oil Company made a special test to ascertain the daily production of the several wells operated by it on the University lands in this field. This test disclosed that an average daily production of the Shannon wells is six and one-third barrels -- the total production being 76 barrels daily from 12 Shannon wells.

It is shown in the foregoing that there are four Shannon wells in this field for which there are no off-set wells on the University lands. At the present average rate of production, these four wells would produce 25 barrels of oil daily, the royalty from which would amount to $3.75 per day, which is the probable daily loss to the University by reason of the failure to drill the off-set wells.

Well No. 2 on the Atkinson Lease (State Land(on the NE$\frac{1}{4}$NW$\frac{1}{4}$ Section 16 is a Wall Creek well. This well is not off-set on the University land to the north in Section 9. It is only 328 feet south of Section 9.

There is a location for a well to the Wall Creek sand on the NW$\frac{1}{4}$NE$\frac{1}{4}$ Section 17, designated as No. 2, on the Whiteside Oil Placer Claim No. 5. This is merely a location on which no drilling had been done at the time of our field examination in the early part of September. The fact that the location of the well has been made would indicate that the operating company contemplates

drilling there at an early date. No corresponding location for an offset well on the University lands of Section 8 to the north had been made at that time.

There are some wells on University lands which do not have corresponding offset wells on the adjoining lands. For instance, No. 13 of the Elkhorn lease is a Wall Creek well with no corresponding offset on the Texas Company's lands to the west. On Section 9, University land, there are two wells to the Shannon sand, Numbers 4 and 5, which have no corresponding offsets on the Texas Company's land to the north and west.

It is thus seen that some of the wells on University lands do not have offsets on the adjoining lands and on the other hand that the University lands in some instances do not have corresponding offsets against wells on the adjoining lands.

Under the terms of our leases, the lessees are required to drill offset wells on University lands, and it is believed that the operating companies should be notified of their failure to drill the offset wells, as listed herein, and if they fail to take speedy action to remedy the situation that proper steps should be taken to enforce the offset clause in the leases.

DRILLING REQUIREMENTS.

A provision was inserted in the Merritt, Whiteside Section 9 and Humphreys Section 8 leases, requiring the drilling of not less than two wells to the Wall Creek sand each year during the first five years of the lease, which requirement is cumulative. This means in substance that if any company drills more than two wells to the Wall Creek sand in any one year that it will not have to drill the full number of wells the following year. In other words, if any company drilled ten Wall Creek wells the first year, it would not, under the terms of the lease, have to drill

any wells to this sand the succeeding four years. It may be mentioned at this time that all of the above named lessees have exceeded these drilling requirements. No requirements as to the drilling of any certain number of wells was inserted in the Elkhorn or Kinney leases. They are only required by the terms of the lease to drill offset wells and "a sufficient number of wells to thoroughly and completely drain the oil from the said land", and there is no time limit set in which to comply with this requirement. In our opinion, there is sufficient undrilled area of the Wall Creek sand on the land embraced in the Kinney lease for one or more additional wells and there is sufficient undrilled area on the Elkhorn lease for a Wall Creek well between Wells Nos. 12 and 13. One peculiar and rather unusual thing is noted in connection with Well No. 12 on the Elkhorn lease. The top of the Wall Creek sand was found at 3095 feet below the surface in this well. The said well is on the northern dip or slope of the structure. On the opposite side of the structure in Sections 21, the Wall Creek sand has been found productive at a depth of 3418 feet. This would indicate that there is a possibility of extending the productive are of the Wall Creek sand to the north of Elkhorn Well No. 12, since the difference in surface elevation between this well and the well on Section 21 will probably account for not more than 50 feet of the difference in depth between these wells. The log of this well would indicate that the water line is some distance to the north of this well, but this cannot always be taken as a basis to follow, since the water line does not always follow the same contour line on both sides of a structure. The officials of the operating companies have informed us that considerable water is coming with the oil from this well. Assuming

that the water comes from the Wall Creek sand, this indicates that the water line is near the well and also that the water line is higher up on the north side than on the south side. On the other hand, there is a possibility that the water in this well is not coming from the Wall Creek sand. If this is true, then it is quite probable that the productive area of the Wall Creek sand really extends some distance north of the Elkhorn Well No. 12.

GAS USED.

There is comparatively little gas coming with the oil, for gas pressure is low in the Big Muddy field. After the oil is conducted to the settling tanks, some gas escapes from the oil. This is a feature which is not peculiar to this field or to crude oil alone.

Both of the operating companies in this field on University lands, i.e., the Ohio Company and the Midwest Refining Company, have installed gas traps on the top of some of the settling tanks for the purpose of conserving the gas and preventing its escape. The gas trapped in this way is used by the companies for running their pumping and other engines. Some of the gas is sold by the Ohio Oil Company to its employees who reside in the field. In the month of September last, the Ohio Oil Company furnished fifteen of its employees with gas at the rate of three dollars per month, for which it received a total of $45 during the month. The Company has accounted for this amount of gas from the Kinney lease and paid ten per cent of $45, or $4.50, as royalty for the gas that was sold during the month. This Company also accounted for gas sold from the north part of Section 10 during September, the royalty from which amounted to $6.82.

An attempt has been made to estimate the amount of gas used by these two companies in their engines. To pump the oil from a Wall Creek well a twenty-five horse power engine is required. On the Kinney lease and that part of the Merritt lease operated by the Ohio Oil Company, there are nine Wall Creek wells from which the oil is pumped. This requires 9 times 25, or 225 horse power. The company also has thirteen Shannon wells on these two leases from which oil is pumped, which require engines of a total of seventy-five horse power to operate. This makes in all 300 horse power to operate the pumping engines of the Ohio Oil Company on the two leases named. Assuming that the other engines used by this Company require 100 additional horse power (admittedly an estimate), this would make 400 horse power in all used by the Ohio Oil Company. Apparently reliable information indicated that the engines of the type used in this field consume about eleven cubic feet of gas per horse power hour. For a twelve hour day this indicates a total gas consumption by the Ohio Oil Company in this field of approximately 60,000 cubic feet daily. At five cents per thousand cubic feet, this amounts to three dollars per day.

The leases in this field provide for the payment of a royalty of ten per cent of the oil or gas produced at the mouth of the well, or in lieu thereof, at the option of the lessor, ten per cent of the market value of the crude oil and gas produced.

Aside from the fact that it would be extremely difficult to establish by satisfactory proof the market price for the gas in this field, there is a doubt in our minds whether the royalty can be collected for this gas, as the companies are merely trapping the gas which would otherwise escape from their tanks and be wasted.

The Midwest Refining Company used a somewhat greater quantity of gas than the Ohio Oil Company, since it has a greater number of engines in this field than the latter Company. However,

INITIAL PROD. CURVE
DAILY PROD. CURVE
DECLINE IN PROD. IN WALLACER, SHOD
FLATS
INITIAL PRODUCTION IN BBLS PER DAY
BBLS
400
300
200
100
10
20
30
40
50
60
70
80
90
100
FEET
KEUFFEL & ESSER CO. NEW YORK No. 359 F.

the Midwest Refining Company does not secure a sufficient supply of gas to operate all its engines. Due to this fact, the said company has to ship in from Casper fuel or residue oil to operate some of its engines.

INCREASE OF PRODUCTION WITH DEPTH INTO WALL CREEK SAND.

By making a tabulation of the various deep wells on the different State lands, together with their initial and daily production and their depth into the Wall Creek sand, it was discovered that there was a slight but distinct relation between the initial and daily production of the wells and their relative depth into the sand. As a general rule, the deeper the penetration into the sand the greater the initial and daily production, and eventually the ultimate production of the well. Two curves were plotted on this proposition and they indicate that there is a moderate increase of production with depth into the sand, for the average well. (See Plate 13 for the curves above referred to.) For instance, a well with a ten foot penetration and having an initial production of 150 barrels per day would have a 200 barrel initial capacity at a thirty foot penetration, and so on. The same is true to a lesser extent in regard to the daily production of the well. A well having an average daily production of 75 barrels at a ten foot penetration would have a capacity of 110 barrels per day with a 30 foot penetration. This, of course, does not refer to any particular well, but to the average of all the wells. It is believed, therefore, that greater penetration should be encouraged inthe future drilling of Wall Creek wells and that many of the present producing wells should, if possible, be drilled deeper. In cases where the rigs are still standing, it is thought that the increase in production

would more than offset the expense of deeper drilling. Naturally, there are limits to such drilling, and it is realized that in certain wells especially near the outer limits of production, there is danger of drilling into water in the deeper portions of the sand.

GENERAL OBSERVATIONS.

During the course of the investigation, the writers interviewed Charles Orchard, the active manager of the Kinney Oil Company. Mr. Orchard stated that the Kinney Company for a time kept a gauger in this field for the purpose of keeping a check on the gauging and other operations of the producing company on its lease in this field. After a thorough trial, however, it was decided that the company was not warranted in going to the expense of keeping an observer and gauger in the field, and for some time past this company has had no one permanently in the field to oversee its holdings there. Mr. Orchard informed us, however, that his Company has its field superintendent make occasional visits to the field for the purpose of observing the progress of operations there, and that it would continue to follow this practice in the future.

For a time the Glenrock Petroleum Company and other companies kept one Maurice Flavin in this field to oversee the interests of these companies there. It was decided that the companies were not justified in keeping a man in the field for this purpose. We were also informed that the University has heretofore tried the experiment of having a permenent representative in this field. So far as known to us, none of the companies which

have interests in this field, other than the operating companies, have a permenent representative in the field at the present time, although they have had such representative therein the past. We believe that experience has demonstrated that the keeping of a permanent representative in this field is not a justifiable expense. We believe, however, that an occasional investigation of the field should be made by some one representating the University. Some of the oil companies follow this procedure and in view of the magnitude of its interests there, we believe that the University should follow the same practice.

It is the belief of the writers that the production from this field can be increased somewhat by more systematic and more diligent effort in cleaning the oil wells. The companies are making a more or less unsystematic effort to keep the wells cleaned, but they are having some difficulty in securing sufficient labor to keep the wells clean, as they should be, because it is a kind of work which most well drillers are very reluctant to do.

It is apparent from the foregoing that the operating companies have not been at all diligent in drilling wells to the Wall Creek sand. These companies possess ample resources and they have facilities for drilling any number of wells should they chose to do so. However, in view of the very liberal terms in the leases with reference to drilling, it is evident that we cannot force the issue with the companies with respect to drilling. The only thing we can do is to suggest to the companies that they drill a greater number of wells, but, of course, we cannot force them to do so except in cases where they have failed to drill

offset wells. We also think it advisable to suggest to the companies that they drill deeper into the Wall Creek sand and that they be more diligent in cleaning the wells, as we believe that production can be stimulated somewhat by this means. Failure to clean a well, however, or to deepen it, does not mean that any permanent loss accrues to the University. It merely means that production is deferred somewhat.

Very respectfully submitted,

E. O. Fuller
Fiscal Agent

L. B. Morgan
State Geologist.

T 33 N R 76 W

BIG MUDDY FIELD

Map Showing University and State Lands and Oil Wells thereon.

Exhibit A

LEGEND

- ● Oil Well-Shallow
- ●D " " -Deep
- ○ " " -Drilling
- ⊕ Dry Hole.
- ◎ Abandoned