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LIGNITE RESOURCES OF NORTH DAKOTA

By Russell A. Brant

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W. E. Wrather, Director

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PREFACE

This report on the lignite resources of North Dakota is the ninth of a series of State summary reports prepared by the Geological Survey as part of its program of reappraising the coal reserves of the United States. Studies of the coal resources of other States are contained in the following publications of the Survey: Geology of the Deep River coal field, Chatham, Lee, and Moore Counties, N. C., Preliminary Map, 1949; and in Coal resources of Montana, Circular 53, 1949; Coal resources of Michigan, Circular 77, 1950; Coal resources of Wyoming, Circular 81, 1950; Coal resources of New Mexico, Circular 89, 1950; Lignite resources of South Dakota, Circular 159, 1952; and Coal resources of Virginia, Circular 171, 1952. A report on the coal resources of Indiana is in preparation.

W. E. Wrather,

Director

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LIGNITE RESOURCES OF NORTH DAKOTA

INTRODUCTION

This report on the lignite resources of North Dakota has been prepared in cooperation with the North Dakota Geological Survey and the North Dakota Research Foundation as part of the program of the Interior Department for the integrated development of the Missouri River Basin. The estimates are based on careful study of published reports of the U. S. Geological Survey and the North Dakota Geological Survey, supplemented by information supplied by many of the mining companies in the State. The office study was followed by a small amount of field work, consisting mostly of mine examinations.

The present report summarizes all available information on the lignite reserves of North Dakota, and the estimates are as accurate and comprehensive as can be made from the data currently available. As a considerable part of the lignite-bearing area of North Dakota has not been adequately mapped or explored, however, the estimates are subject to change as new information becomes available. For this reason the report may be regarded as primarily a conservative base on which more detailed estimates can be built as new mapping and exploration make more data available.

Acknowledgments

Among the many individuals who contributed time, information, and advice in the preparation of this report, thanks are particularly due to Dr. Wilson M. Laird, State Geologist of North Dakota, who provided working space for the staff and who assisted the author greatly in summarizing previous work on the lignites of North Dakota; and to Dr. Alex. C. Burr and Dr. Walter Oppelt of the U. S. Bureau of Mines and the North Dakota Research Foundation, who assisted in obtaining mine data and analyses of the lignite. Thanks are also due to Mr. V. A. Gilles and Mr. L. L. Schwarm of the Northern Pacific Railway Company, for supplying maps and sections of large areas in the southwestern part of the State where other information was not available; to Dr. Walter O. Kuptsh, Geologist with the Department of Conservation at Saskatoon, Saskatchewan, Canada, who provided unpublished data were used in estimating reserves for the northwestern part of North Dakota; and to Mr. Walter B. Roe, Geologist of the Truax-Traer Mining Company, who supplied detailed information on North Dakota mines.

Others to whom appreciation is expressed are Mr. Gordon Prescott, Geologist, U. S. Corps of Engineers, who provided drill-hole information for the area around Garrison Dam; Mr. W. M. Edmunds of Grand Forks, who permitted the use of drill-hole data in his possession; Mr. Daniel Jobin, Geologist, U. S. Geological Survey, who guided the author over parts of the Fort Berthold area; and Mr. Calvin Truax, a student at the University of North Dakota, who acted as guide in the region around Medora. The offices of the Ground Water Division, U. S. Geological Survey, at Grand Forks, and of the Conservation Division of the same bureau, at Billings, Montana, also provided much useful data.

SUMMARY

The original reserves of lignite in North Dakota (see table 1) are estimated at 350,910 million tons. The lignite-bearing parts of the State are west of the 100th meridian and cover an area of about 32,000 square miles, of which approximately 28,000 square miles are underlain by beds of lignite more than $2\frac{1}{2}$ feet thick, and 4,000 square miles by beds generally less than $2\frac{1}{2}$ feet thick. The boundaries of the lignite-bearing part of the State are shown in figure 1, as is the approximate extent of the areas underlain by thick and thin beds.

The geological formation that contains most of the lignite in North Dakota is the Tongue River member of the Fort Union formation of Paleocene age, although the underlying Ludlow member of the same formation contains smaller amounts of lignite. The Hell Creek formation of Upper Cretaceous age, which underlies the Fort Union, contains lignite, but the beds are generally less than $2\frac{1}{2}$ feet thick and therefore are not considered in estimating reserves.

Total production of lignite in North Dakota, from the beginning of mining to January 1, 1951, is reported as 70,751,824 short tons. As the chart (fig. 2) shows, mining activity has increased at a fairly steady rate since operations first began; for example, production for the years 1941-50 was 27,082,660 tons, or 34 percent of the all-time total. (See table 2.) This increase in production coincides substantially with a shift from underground to surface mining; it is characterized by a decrease in the number of mines and a corresponding increase in the size and efficiency of the individual operations.

METHODS OF PREPARING RESERVE ESTIMATES

In its program of reappraising the coal resources of the United States, the Geological Survey follows certain established definitions and procedures in subdividing the total reserves into several categories and groups. The principal classifications are those relating to the characteristics of the coal itself; to the abundance and reliability of the data on which the estimates are based; and to the dates to which the estimates apply, that is, whether they are of original, remaining, or recoverable reserves. These various classifications and the methods of making the reserve estimates are described in the following paragraphs.

Table 1.--Estimated original reserves of lignite in North Dakota

(in millions of short tons)

County	Measured reserves				Indicated reserves				Inferred reserves				Total in all categories			County totals
	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	
Adams	36.40	28.56	38.20	103.16	168.72	115.64	83.13	367.49	485.01	452.97	448.13	1,386.11	690.13	597.17	569.46	1,856.76
Billings	62.63	251.54	213.45	527.62	759.14	1,066.26	1,304.40	3,129.80	9,197.73	2,441.88	2,421.00	14,060.61	10,019.50	3,759.68	3,938.85	17,718.03
Bowman	47.34	52.94	166.39	266.67	310.74	472.52	444.30	1,227.56	1,055.93	1,296.92	3,173.90	5,526.75	1,414.01	1,822.38	3,784.59	7,020.98
Burke	23.57	108.78	11.05	143.40	238.07	329.70	80.56	648.33	5,513.55	275.67	29.17	5,818.39	5,775.19	714.15	120.78	6,610.12
Burleigh	....	5.66	36.20	41.86	....	89.86	76.07	165.93	44.35	865.97	39.24	949.56	44.35	961.49	151.51	1,157.35
Divide	21.24	63.41	53.85	138.50	363.76	374.48	300.08	1,038.32	6,899.39	136.56	51.36	7,087.31	7,284.39	574.45	405.29	8,264.13
Dunn	772.27	303.78	194.93	1,270.98	3,254.43	1,574.52	918.96	5,747.91	60,000.32	3,377.68	645.36	64,023.36	64,027.02	5,255.98	1,759.25	71,042.25
Golden Valley	127.20	205.77	27.62	360.59	1,507.17	979.46	76.73	2,563.36	4,695.81	690.96	8.18	5,394.95	6,330.18	1,876.19	112.53	8,318.90
Grant	94.15	180.45	21.50	296.10	689.44	457.43	10.59	1,157.46	3,054.78	149.39	....	3,204.17	3,838.37	787.27	32.09	4,657.73
Hettinger	35.63	47.96	49.02	132.61	397.91	508.56	241.74	1,148.21	8,723.38	931.74	1,716.81	11,371.93	9,156.92	1,488.26	2,007.57	12,652.75
McHenry	7.62	3.91	9.93	21.46	6.68	21.44	4.24	32.36	0.12	63.96	....	64.08	14.42	89.31	14.17	117.90
McKenzie	384.27	761.04	25.56	1,170.87	2,102.23	2,116.00	308.71	4,526.94	23,803.51	2,665.46	16.34	26,485.31	26,290.01	5,542.50	350.61	32,183.12
McLean	262.13	305.87	31.75	599.75	1,078.73	1,206.48	379.21	2,664.42	7,927.40	4,433.35	853.49	13,214.24	9,268.26	5,945.70	1,264.45	16,478.41
Mercer	248.01	425.94	649.61	1,323.56	1,741.31	2,056.17	1,621.89	5,419.37	13,738.60	5,683.27	3,747.43	23,169.30	15,727.92	8,165.38	6,018.93	29,912.23
Morton	217.04	338.64	41.82	597.50	1,435.41	1,301.75	286.21	3,023.37	11,156.01	468.35	5.54	11,629.90	12,808.46	2,108.74	333.57	15,250.77
Mountrail	148.12	67.97	79.52	295.61	356.03	368.05	233.57	957.65	13,813.88	310.64	....	14,124.52	14,318.03	746.66	313.09	15,377.78
Oliver	139.09	206.25	52.21	397.55	1,347.43	1,257.16	407.32	3,011.91	11,857.34	2,121.35	450.65	14,429.34	13,343.86	3,584.76	910.18	17,838.80
Renville	3.76	5.29	18.57	27.62	117.04	35.01	....	152.05	603.11	....	....	603.11	723.91	40.30	18.57	782.78
Sheridan	....	....	....	....	....	....	....	....	660.06	....	....	660.06	660.06	....	....	660.06
Slope	72.55	169.68	396.08	638.31	1,176.62	1,827.30	2,600.45	5,604.37	2,228.60	716.96	10,902.36	13,847.92	3,477.77	2,713.94	13,898.89	20,090.60
Stark	104.70	150.94	136.44	392.08	1,078.31	836.39	1,092.72	3,007.42	15,406.49	3,076.94	3,814.77	22,298.20	16,589.50	4,064.27	5,043.93	25,697.70
Ward	76.54	37.43	145.55	259.52	538.50	381.36	340.93	1,260.79	6,091.92	2,305.86	367.96	8,765.74	6,706.96	2,724.65	854.44	10,286.05
Williams	210.30	241.91	63.87	516.08	1,427.31	1,251.64	586.42	3,265.37	17,223.07	4,471.82	1,458.28	23,153.17	18,860.68	5,965.37	2,108.57	26,934.62
State total	3,094.56	3,963.72	2,463.12	9,521.40	20,094.98	18,627.18	11,398.23	50,120.39	224,180.36	36,937.70	30,149.97	291,268.03	247,369.90	59,528.60	44,011.32	350,909.82

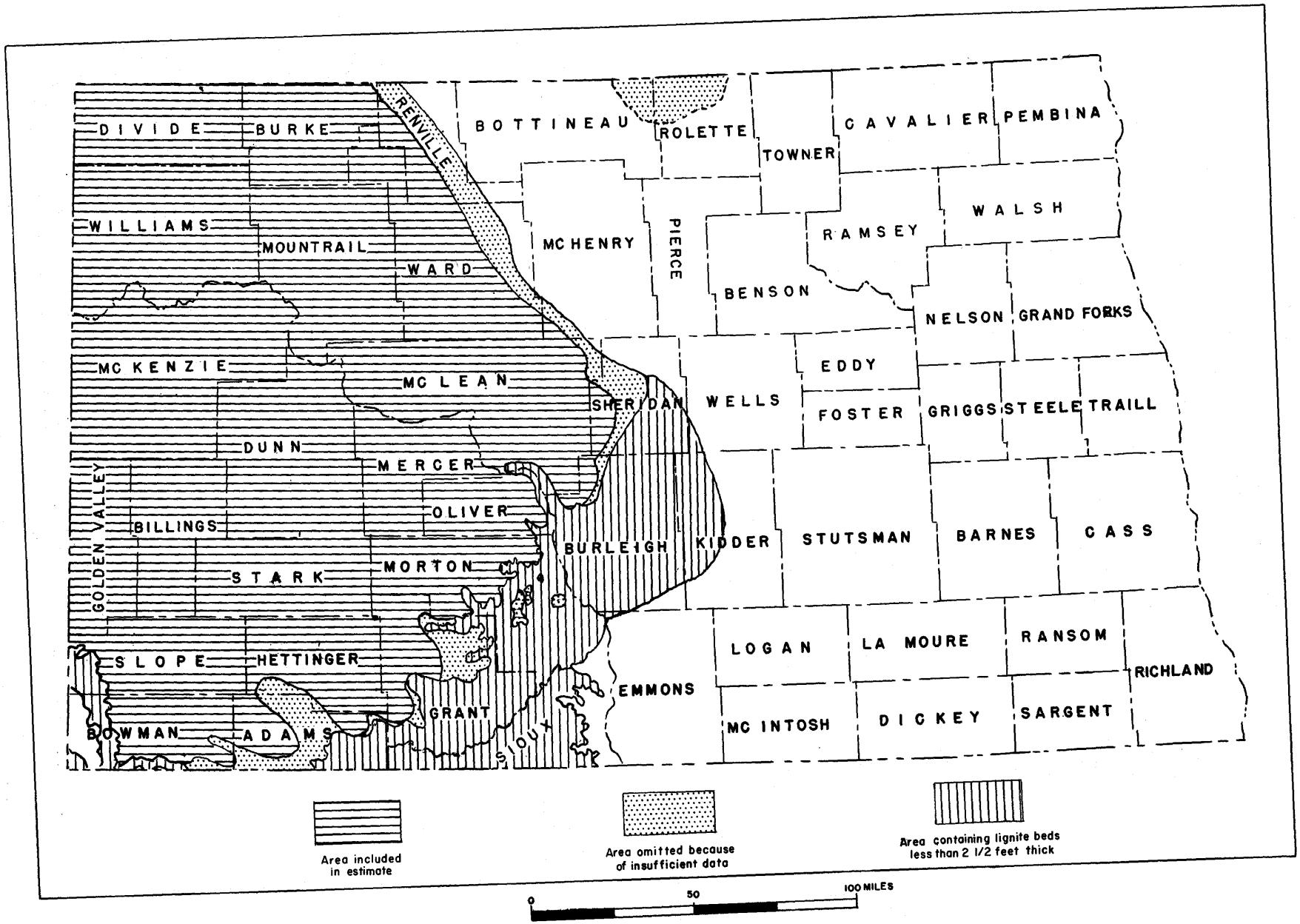


Figure 1.--Map of North Dakota showing lignite-bearing areas.

Table 2.--Production of lignite in North Dakota by county from 1941 through 1950, in short tons

County	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	Total
Adams	49,921	68,203	70,399	76,309	91,421	53,729	72,258	73,397	66,293	64,053	685,983
Billings	1,243	1,286	2,529	1,115	280	150	100	....	....	764	7,467
Bowman	9,214	10,497	11,620	10,500	5,121	6,366	7,384	5,186	5,379	11,326	82,593
Burke	267,306	277,612	378,960	365,248	418,930	393,778	348,183	344,648	385,537	450,631	3,630,833
Burleigh	264,867	290,603	327,174	336,512	245,207	165,380	6,976	3,811	9,493	17,111	1,667,134
Divide	176,532	178,243	240,210	234,455	198,174	212,926	267,922	239,406	236,628	265,883	2,250,379
Dunn	7,019	6,870	7,130	7,024	6,977	5,281	5,329	4,810	6,655	12,748	69,843
Golden Valley	8,774	9,803	8,862	7,312	4,826	4,383	2,925	3,681	3,843	3,794	58,103
Grant	25,621	30,515	30,314	15,373	22,019	22,939	26,106	27,831	24,023	23,847	248,588
Hettinger	19,201	17,346	25,930	21,218	17,586	25,090	18,810	15,566	12,775	14,261	187,783
McKenzie	5,987	7,066	8,560	6,373	6,498	7,665	5,546	2,991	5,952	7,395	64,033
McLean	146,676	147,617	108,554	38,642	36,260	42,509	124,067	278,043	325,236	406,490	1,654,094
Mercer	627,766	672,760	670,438	574,054	669,521	944,624	1,148,865	1,226,764	1,252,265	1,192,096	8,979,153
Morton	26,296	35,965	38,007	33,433	34,614	31,699	35,412	31,058	37,248	31,637	335,369
Mountrail	15,892	16,474	16,422	7,800	3,981	5,463	6,270	10,180	35	2,590	85,107
Oliver	23,697	22,515	13,917	12,199	7,597	6,411	6,589	8,421	6,640	7,938	115,954
Slope	2,182	1,790	2,192	966	500	132	560	....	225	340	8,887
Stark	113,944	137,198	106,628	95,004	94,442	86,162	99,908	90,295	100,614	117,333	1,041,528
Ward	509,624	493,394	586,856	639,397	593,873	563,121	602,541	556,478	463,211	557,102	5,565,597
Williams	45,496	48,249	39,898	32,849	27,642	32,706	32,017	31,897	28,243	25,195	344,232
Total	2,347,258	2,474,006	2,694,600	2,515,823	2,485,469	2,610,544	2,817,768	2,954,363	2,970,295	3,212,534	27,082,660

Classification according to the characteristics of the coal

Rank of coal.--All of the coal in North Dakota is ranked as lignite according to the Standard Specifications of the American Society for Testing Materials (1939) which are reproduced herein as figure 3. From this figure and from the chart (fig. 4) it will be seen that lignite is high in moisture and low in heating value as compared with coal of other ranks. A number of analyses of North Dakota lignites are given in table 3.

The rank of a coal is assigned on the basis of degree of metamorphism and is quite independent of grade. The grade of a coal is determined on the basis of quality, that is, in general by the ash and sulphur content.

Weight of lignite.--A number of specific gravity determinations of lignite from various parts of North Dakota and eastern Montana give a weight of 1,750 tons per acre-foot as the average for the area. This weight is used in calculating the reserve tonnages given in the present report.

Thickness of beds.--Coal reserve estimates made by the Geological Survey are divided into three bed-thickness ranges, designated "thin," "intermediate," and "thick." In subbituminous coal and lignite, beds $2\frac{1}{2}$ to 5 feet thick are designated as thin, those from 5 to 10 feet thick as intermediate, and those more than 10 feet thick as thick.

Thickness of overburden.--For the purpose of estimating reserves, coal is usually divided into three groups according to the thickness of overburden, the depth ranges being 0-1,000 feet, 1,000-2,000 feet, and 2,000-3,000 feet. In North Dakota, however, practically all the minable lignite is under less than 1,000 feet of cover, the exceptions being beds under some of the buttes in the southwestern part of the State, where the maximum cover is probably about 1,200 feet. Although accurate subdivision of the 0-1,000-foot depth category is not possible from available data, it is believed that 70 percent of the minable reserves in North Dakota are under less than 500 feet of overburden, 28 percent are under 500-1,000 feet, and about 2 percent are under 1,000-1,200 feet. More detailed information on the overburden of some of the thicker and more accessible beds is given in the county descriptions.

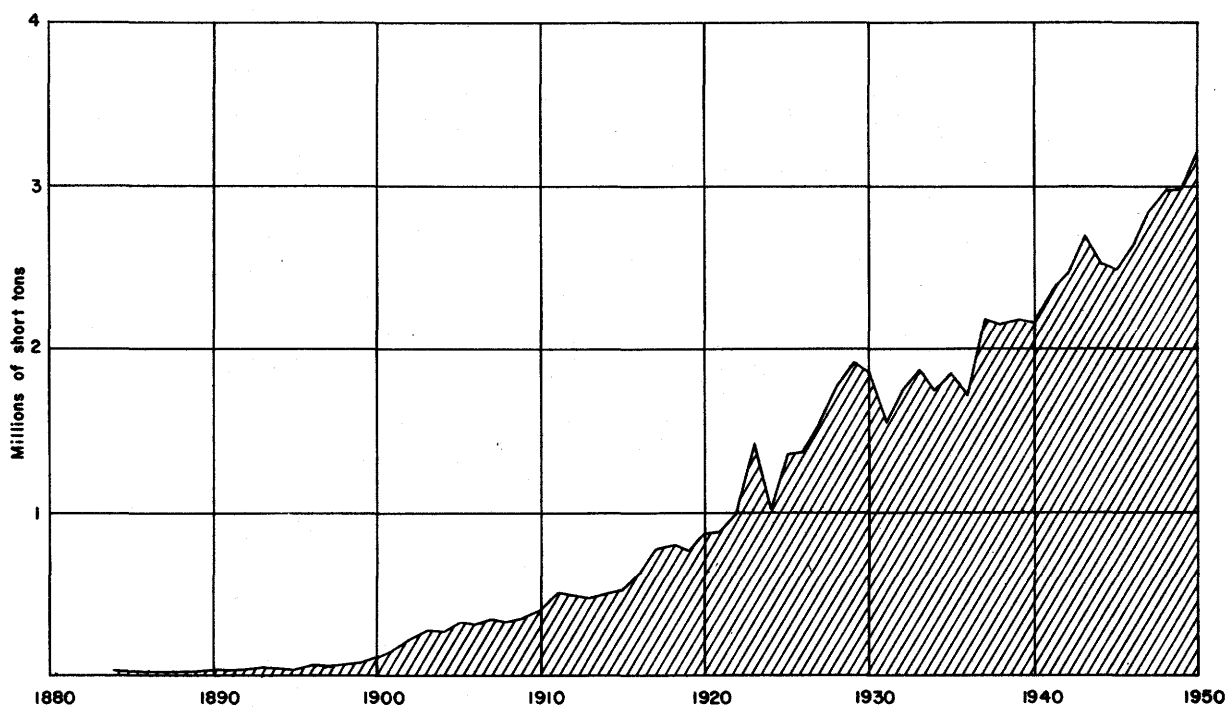


Figure 2.--Chart showing lignite production in North Dakota, 1884-1950.

Table 3.--Analysis of North Dakota lignites (on the as-received basis)

Location	Mine	Bed	Laboratory number	Proximate analysis, percent					Heating value, Btu.
				Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	
Adams County									
Sec. 16, T.129N., R.94W.	Dakota Collieries	Haynes	1/B77966	33.9	27.6	30.0	8.5	1.4	7,340
Sec. 6, T.129N., R.94W.	Ihle	Haynes	1/A42558	31.8	30.6	29.9	7.7	1.3	7,710
Sec. 10, T.130N., R.98W.	Reader	Scranton	2/ 10189	42.4	26.4	23.4	7.8	1.9	6,233
Sec. 15, T.130N., R.98W.	Haugen	Scranton	2/ 10190	39.4	27.1	24.9	8.6	1.2	6,820
Billings County									
Sec. 5, T.138N., R.100W.	Frappier	Fryburg	2/ 10065	40.3	25.2	26.4	7.6	0.5	5,975
Bowman County									
Sec. 34, T.130N., R.103W.	Durkin Prospect	T-Cross	1/ 14850	43.6	23.2	27.0	6.2	0.7	5,830
Sec. 15, T.132N., R.102W.	Halleck Mine	Harmon	3/ 5761	44.5	24.8	25.5	5.2	0.7	6,062
Burke County									
Sec. 21, T.162N., R.93W.	Kinkaid	Noonan	1/A46066	34.0	26.0	31.7	8.3	0.4	7,050
Sec. 21, T.162N., R.93W.	Bonsness	Noonan	2/ 10067	36.2	26.4	30.5	6.9	0.3	7,194
Burleigh County									
Sec. 6, T.142N., R.79W.	Burleigh	Wilton(?)	1/ 65	41.1	25.9	26.0	7.0	0.6	6,270
Sec. 8, T.142N., R.79W.	Washburn	Wilton	4/ 10253	39.0	25.6	28.1	7.4	0.5	6,245
Divide County									
Sec. 11, T.162N., R.95W.	Baukol-Noonan	Noonan	2/ 5774	30.8	29.5	31.5	8.2	0.5	7,380
Dunn County									
Sec. 32, T.144N., R.94W.	Moore Coal Co.	Dunn Center(?)	2/ 10335	37.5	28.8	28.0	5.7	0.6	6,800
Sec. 22, T.145N., R.93W.	High Carbon	Dunn Center	4/ 10063	37.4	27.2	27.4	8.0	1.0	6,092
Golden Valley County									
Sec. 5, T.139N., R.104W.	Mammoth	Sentinel Butte	2/ 10116	45.1	24.2	24.1	6.6	1.2	5,933
Sec. 16, T.141N., R.105W.	Beach Open Pit	(?)	1/ 5525	35.7	31.9	23.5	8.9	1.5	6,370
Grant County									
Sec. 35, T.132N., R.90W.	Coffin Butte	Haynes	2/ 10300	34.0	29.4	28.2	7.9	1.3	6,688
Sec. 34, T.134N., R.90W.	Davenport	Haynes	5/ 6065	34.8	29.0	29.8	6.4	0.8	7,144
Hettinger County									
Sec. 34, T.132N., R.91W.	Crary	Haynes(?)	2/ 10203	30.9	30.7	25.7	12.7	1.0	6,411
Sec. 5, T.135N., R.95W.	Walsh	Coalbank	2/ 10184	39.3	29.7	27.6	5.4	0.9	6,812
McKenzie County									
Sec. 1, T.149N., R.100W.	Bushee	(?)	2/ 10282	39.3	26.7	27.7	6.3	0.4	6,300
McLean County									
Sec. 12, T.149N., R.85W.	Minter	Minter	2/ 10247	37.0	29.2	28.6	5.2	0.5	6,596
Mercer County									
Sec. 2, T.143N., R.88W.	Thompson	Beulah Zap	2/ 10127	35.0	30.1	30.1	4.6	0.4	7,027
Sec. 23, T.144N., R.87W	Thompson	Beulah Zap	5/ 6073	36.4	26.9	31.5	5.2	0.7	7,010
Morton County									
Sec. 21, T.139N., R.85W.	Deep Mine	"A" Deep Vein	2/ 10293	37.2	26.4	28.2	8.1	0.2	6,565
Sec. 8, T.140N., R.90W.	Harnish	Harnish	2/ 10113	37.9	27.1	27.9	7.1	0.6	6,490
Mountrail County									
Sec. 19, T.152N., R.89W.	Parshall Coal	(?)	5/ 6078	40.9	25.5	27.7	5.9	0.7	6,352
Sec. 10, T.156N., R.94W.	Borger	(?)	5/ 6079	41.0	23.9	27.0	8.1	0.9	6,152
Oliver County									
Sec. 2, T.141N., R.84W.	Meyhoff	(?)	2/ 10135	31.8	31.6	30.0	6.6	1.0	7,030
Sec. 6, T.143N., R.84W.	Victor	(?)	2/ 10137	33.1	31.6	30.6	5.1	0.4	7,019
Renville County									
Sec. 34, T.158N., R.86W.	Gaylord Mandt	Burlington	2/ 10013	35.4	28.6	29.8	6.2	1.1	7,226
Sec. 29, T.158N., R.86W	Jenson Bros.	Burlington	2/ 10150	35.0	28.1	30.4	6.5	0.9	6,957
Slope County									
Sec. 1, T.133N., R.101W.	Hallenberg	Hansen	2/ 10218	42.5	27.2	24.0	6.3	1.4	5,952
Stark County									
Sec. 18, T.139N., R.97W.	Adamski	HE	2/ 10061	39.3	27.2	23.7	9.8	0.5	5,740
Sec. 15, T.139N., R.95W.	Pittsburg	Leigh	1/ 79	37.6	25.5	29.0	7.9	1.0	6,820
Ward County									
Sec. 27, T.152N., R.81W.	Velva	Coteau	1/ 117	39.4	25.6	30.0	5.0	0.2	6,620
Sec. 2, T.155N., R.84W.	Burlington Coop.	Coteau	1/B45880	36.0	22.2	30.5	11.3	0.2	6,380
Williams County									
Sec. 10, T.154N., R.100W.	Avoca Coal Co.	(?)	2/ 10092	44.6	24.3	27.4	3.7	0.3	6,245
Sec. 23, T.159N., R.99W.	Lohse	(?)	6/ 11254	38.9	27.7	27.4	6.0	0.3	6,449

1/ U. S. Bureau of Mines, Technical Paper 700, 1948

2/ Circular 8, University of North Dakota College of Engineering, 1934.

3/ Circular 2, University of North Dakota College of Engineering, 1926.

4/ Bulletin 4, North Dakota Geological Survey, 1925.

5/ Circular 5, University of North Dakota College of Engineering, 1928.

6/ Circular 11, University of North Dakota College of Engineering, 1936.

Legend: F.C. = Fixed Carbon. V.M. = Volatile Matter. Btu. = British thermal units.

Class	Group	Limits of Fixed Carbon or Btu. Mineral-Matter-Free Basis	Requisite Physical Properties
I. Anthracitic	1. Meta-anthracite	Dry F.C., 98 per cent or more (Dry V.M., 2 per cent or less)	Nonagglomerating[b]
	2. Anthracite	Dry F.C., 92 per cent or more and less than 98 per cent (Dry V.M., 8 per cent or less and more than 2 per cent)	
	3. Semianthracite	Dry F.C., 86 per cent or more and less than 92 per cent (Dry V.M., 14 per cent or less and more than 8 per cent)	
II. Bituminous[d]	1. Low volatile bituminous coal	Dry F.C., 78 per cent or more and less than 86 per cent (Dry V.M., 22 per cent or less and more than 14 per cent)	Either agglomerating or nonweathering[f]
	2. Medium volatile bituminous coal	Dry F.C., 69 per cent or more and less than 78 per cent (Dry V.M., 31 per cent or less and more than 22 per cent)	
	3. High volatile *A* bituminous coal	Dry F.C., less than 69 per cent (Dry V.M., more than 31 per cent); and moist[c] Btu., 14,000[e] or more	
	4. High volatile *B* bituminous coal	Moist[c] Btu., 13,000 or more and less than 14,000[e]	
	5. High volatile *C* bituminous coal	Moist Btu., 11,000 or more and less than 13,000[e]	
III. Subbituminous	1. Subbituminous *A* coal	Moist Btu., 11,000 or more and less than 13,000[e]	Both weathering and nonagglomerating
	2. Subbituminous *B* coal	Moist Btu., 9500 or more and less than 11,000[e]	
	3. Subbituminous *C* coal	Moist Btu., 8300 or more and less than 9500[e]	
IV. Lignitic	1. Lignite	Moist Btu., less than 8300	Consolidated
	2. Brown coal	Moist Btu., less than 8300	Unconsolidated

a This classification does not include a few coals which have unusual physical and chemical properties and which come within the limits of fixed carbon or Btu. of the high-volatile bituminous and subbituminous ranks. All of these coals either contain less than 48 per cent dry, mineral-matter-free fixed carbon or have more than 15,500 moist, mineral-matter-free Btu.

b If agglomerating, classify in low-volatile group of the bituminous class.

c Moist Btu. refers to coal containing its natural bed moisture but not including visible water on the surface of the coal.

d It is recognized that there may be noncaking varieties in each group of the bituminous class.

e Coals having 69 per cent or more fixed carbon on the dry, mineral-matter-free basis shall be classified according to fixed carbon, regardless of Btu.

f There are three varieties of coal in the high-volatile C bituminous coal group, namely, Variety 1, agglomerating and nonweathering; Variety 2, agglomerating and weathering; Variety 3, nonagglomerating and nonweathering.

Figure 3.--Classification of coals by rank.

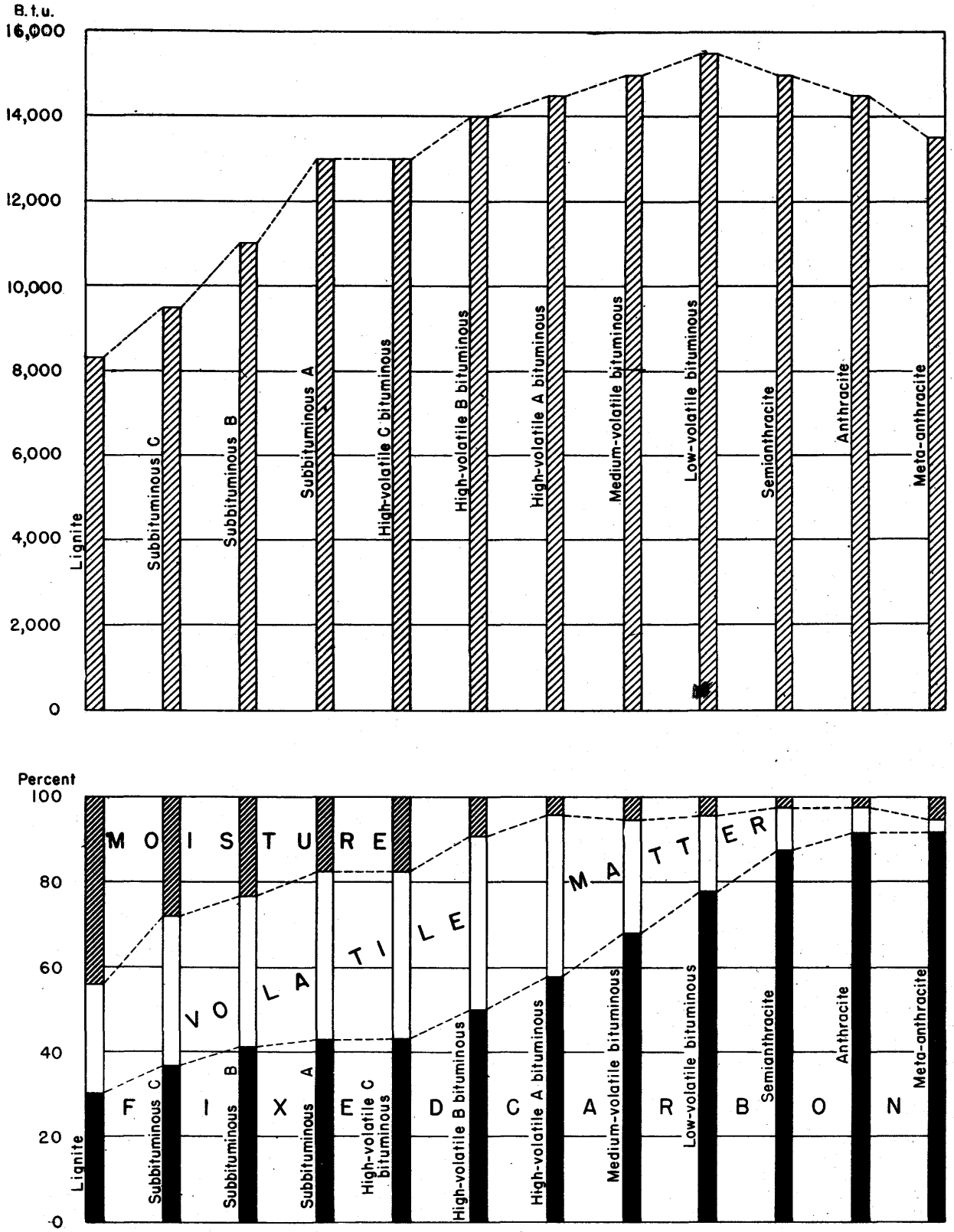


Figure 4.--Heat value of coal of different ranks compared to proximate analyses.

Classification according to abundance and reliability of data

The estimates given herein are divided into three categories, termed "measured," "indicated," and "inferred," according to the abundance and reliability of the data on which the estimates are based. These terms are defined briefly in the following sections.

Measured reserves.--Measured reserves are those for which information as to the thickness and extent of the coal beds is gained from outcrop measurements, mine workings, and drill-hole records. The points of observation and measurement must be so closely spaced that the estimated tonnage may be considered to be within 20 percent of the true tonnage. Although the distances will vary somewhat from place to place and from bed to bed, in general the points of observation should be not more than half a mile apart. The outer limit of a block of measured lignite, therefore, is usually about a quarter of a mile from the last point of observation and approximately half the distance between points of observation. Where only outcrop measurements are available but the outcrop is continuous for long distances and conditions suggest that the lignite is present at a considerable distance back of the outcrop, a smooth line drawn approximately half a mile behind the outcrop is taken as the limit of measured lignite.

Indicated reserves.--Indicated reserves are computed partly from specific measurements and partly from the projection of visible data for considerable distances on geologic evidence. Indicated lignite usually lies beyond measured lignite; for example, if drilling has proved a block of measured lignite, that category of reserves is considered to extend for a quarter of a mile on each side of the block actually drilled. If indications are that the bed is reasonably continuous, this area of measured reserves is surrounded by a belt of indicated reserves that, according to the judgment of the appraiser, may be as much as $1\frac{1}{2}$ miles wide. Where only outcrop measurements are available, but where conditions are such that the lignite may be expected to be present for considerable distances back of the outcrop, the area of indicated lignite is usually bounded by a line drawn 2 miles behind the outcrop.

Inferred reserves.--Inferred reserves are those for which estimates are based largely on broad knowledge of the geologic characteristics of the bed or region, supported by few or no measurements. In general, inferred reserves lie outside the limits defined above for indicated reserves, but only where there is good evidence for believing that lignite, in the thickness given, is actually present.

Distinction between original, remaining, and recoverable reserves.--Reserves of lignite may be estimated on the basis of original reserves in the ground before mining began, of reserves remaining as of a certain date, or of reserves considered recoverable as of a certain date. The terms as used in this report are defined below.

Original reserves.--Original reserves are defined as the reserves in the ground before any mining was done. In North Dakota, as in a majority of coal-bearing States, it was necessary to make estimates on the basis of original reserves, because information on mined-out areas was insufficient for placing them on the work maps and thus eliminating them from the areas estimated. In North Dakota, however, total cumulative production is only a small fraction of 1 percent of the coal originally in the ground, so that for practical purposes the original reserves, for the State as a whole, are essentially the same as the remaining reserves. This generalization is not applicable, of course, to certain relatively small areas in the State where mining has been intensive.

The original reserves of lignite in North Dakota, as estimated for this report, total 350,909,820,000 tons.

Remaining reserves.--As stated in the preceding section, it is not practicable to estimate the lignite reserves of North Dakota as of a certain date; to obtain the reserves as of January 1, 1951, therefore, it is necessary to subtract the all-time production of the State, plus estimated losses in mining, from the original reserves. According to production records of the North Dakota State Coal Mine Inspector (1919-50), the total reported production of lignite in North Dakota to January 1, 1951, is 70,751,824 short tons. The amount of lignite lost in mining cannot be estimated except in a general way, but for the purposes of this report it is assumed that the estimate of 50 percent mining losses given by Averitt and Berryhill (1950), is applicable to North Dakota. On this basis, lignite mined and lost in mining would total twice the reported production, or 141,503,648 short tons; this figure, subtracted from the estimated original reserves of 350,909,820,000 tons, leaves 350,768,316,000 tons as the reserves remaining as of January 1, 1951.

Recoverable reserves.--Recoverable reserves may be defined as that part of remaining reserves considered actually recoverable by mining. As recoverability varies greatly according to the mining methods employed, the thickness of the lignite, the nature of the roof and floor rocks, the skill of the operators, and numerous other factors, it is difficult to assign an average figure. On the assumption that the 50 percent estimate for mining losses, quoted above from Averitt and Berryhill (1950) applies to North Dakota, the recoverable reserves of the State as of January 1, 1951, are half the remaining reserves as of that date, or 175,384,158,000 tons. It should be stated, however, that because of the predominance of strip mining in North Dakota, coupled with the comparative thickness of the lignite beds, recovery may possibly be somewhat higher than the figure here quoted.

Methods of recording data and making calculations

The reserve estimates presented herein were computed by individual beds of lignite, the areal unit being the township. A map on the scale of 1 inch to the mile was drawn for each lignite bed in the State; the outcrop of the bed, all recorded observations of thickness, all known drill-hole information, and all known mining areas were plotted on these bed maps. After this basic information was assembled, the extent of each bed was estimated, usually by assuming that the total length of the outcrop along which the lignite was at least $2\frac{1}{2}$ feet thick established the

presence of lignite of all categories in a semi-circular area back of the outcrop, the radius of the circle being half the length of the outcrop. As thick beds of lignite have greater continuity than thinner beds, measurements of lignite more than 5 feet thick along the outcrop are assumed to establish continuity for 2 miles in each direction along the outcrop beds; less than 5 feet thick are considered to establish continuity for only ½ mile.

Where mine or drill-hole data provided proof of the continuity and thickness of a bed beyond the semi-circular area mentioned above, the arc was enlarged to include such points of information if they were not too far removed to be joined with the original area. An isolated drill hole was presumed to establish only an isolated circular area of lignite, the size of which was determined by the thickness of the lignite, as described above. Beds extending around a spur or ridge were presumed to underlie the area enclosed by the outcrop.

After the total area of lignite occurrence in each bed had been established, it was divided on the work maps into areas of measured, indicated, and inferred reserves in accordance with the definitions given in the preceding paragraphs. As nearly all the lignite in the State is under less than 1,000 feet of cover, it was not necessary to subdivide the reserves into depth-of-overburden groups. The acreage underlain by lignite in each of the categories--measured, indicated, and inferred--was then measured with a planimeter. The weighted average thickness of lignite in each thickness and reliability category was then determined, omitting all partings more than 3/8 inch thick; and reserves for each area were calculated by multiplying the average thickness in feet by the acreage, then by the weight factor of 1,750 tons per acre-foot. The estimates by township and county are shown in table 25; those for many of the individual beds, by county, in tables 4 to 24.

The estimates in the tables are given to the nearest 10,000 tons, because in many parts of the State it was necessary to estimate small areas which could not have been included had a larger unit been used. It should be pointed out, however, that the use of the 10,000-ton unit was dictated by the small areas referred to above as well as by ease in making the actual calculations, and that figures less than 1,000,000 tons should not be considered as significant; in effect, those figures to the right of the decimal point may be disregarded.

Areas excluded from the estimates.--The estimates given in this report take into consideration all known occurrences of lignite in North Dakota except those in areas where the coal is believed to be generally less than 2½ feet thick. Such areas include about 4,000 square miles in the eastern and southern margins of the lignite-bearing part of North Dakota. Although most of the lignite in these marginal areas is less than 2½ feet thick, it is known that in certain small areas it is somewhat thicker than that figure and may be suitable for local use.

Several small lignite-bearing areas, which are shown by a distinctive pattern on the map (fig. 1) are also omitted from the estimate because no data are available. These areas cover about 500 square miles, or about 1.7 percent of the total 28,000 square mile area that is considered to be underlain by lignite more than 2.5 feet thick.

Limitations of the estimate.--As this estimate is based almost entirely on outcrop data, the assumed area of occurrence of each lignite bed is restricted as described above. Further exploration would extend greatly the known area of occurrence of many of the beds; many areas have not been mapped, and the information at present available for such areas generally relates to only the most prominent bed. In the central part of the lignite-bearing area, also, there is a considerable thickness of lignite-bearing rocks that has not been explored, but that ultimately may be found to contain large reserves.

The estimate presented herein is conservative and is based only on the data currently available. It is certain that further mapping and exploration will make possible a larger estimate in the future.

PREVIOUS ESTIMATES

It is interesting to note that previous estimates of the total original reserves of lignite in North Dakota, which were based on broad, general assumptions as to the thickness, continuity, and number of the beds, are not conspicuously larger than the present estimate, if statistical allowance is made for possible reserves in unmapped and unexplored areas. Leonard (1926, p. 23) estimated the reserves as 516 billion tons, and the estimate of Campbell (1926, p. 3) was 600 billion tons, as compared to the present estimate of 351 billion tons.

Leonard assumed the lignite-bearing area to be 28,000 square miles, taking into account only lignite in the upper 300-400 feet of the lignite-bearing part of the Tongue River member of the Fort Union formation. Campbell considered the lignite-bearing area to cover 32,500 square miles, taking into account all the lignite-bearing rocks. The lignite-bearing area covered by this report includes 28,000 square miles, but only mapped lignite beds for which data on the thickness and continuity of the beds are now available are included in the estimates. Although not strictly comparable, the three estimates stand in proper relationship.

THE NORTH DAKOTA LIGNITE FIELD

Geography

Throughout most of the lignite-bearing parts of North Dakota the land surface is a flat or gently rolling plain that has been dissected somewhat by the Missouri River and its tributaries, and by the Souris River. The highest altitudes are in Slope and Bowman Counties in the southwestern part of the State, where the land surface is approximately 3,000 feet above sea level. HT Butte in Slope County rises to an altitude of 3,474 feet, the highest point in North Dakota. From this area the surface slopes eastward to elevations of 1,650 to 1,800 feet near Bismarck, and northward to altitudes of about 1,800 feet in Ward, Burke, and Divide Counties.

The northern part of the lignite field, north of the Missouri River, is covered by glacial deposits ranging in thickness from a few feet to several hundred feet. These deposits conceal the lignite-bearing rocks everywhere in this area except along the major streams, notably the Missouri River, Little Muddy Creek in

Williams County, Shell Creek in Mountrail County, Scoria Creek in northern Williams County, and the Souris and Des Lacs Rivers in Burke, Renville, Ward, and McHenry Counties. These streams have cut through the glacial cover into the underlying lignite-bearing formations.

The bedrock topography under the glacial deposits had somewhat greater relief than the present surface, and locally the glacial deposits fill the channels of ancient streams. Several of these buried channels are known in Burke and Ward Counties, and a few cut out the lignite beds over considerable areas.

South of the Missouri River the glacial deposits are thin or absent. In this area the relief is more pronounced than in the glaciated region to the north, and the Badlands, in Golden Valley, McKenzie, Dunn, Bowman, Slope, and Billings Counties, are the most striking geographic feature of the State.

The physiography and geography of North Dakota are discussed in detail in reports by Alden (1924) and Simpson (1929). Areas covered by lignite reports are shown in figure 5.

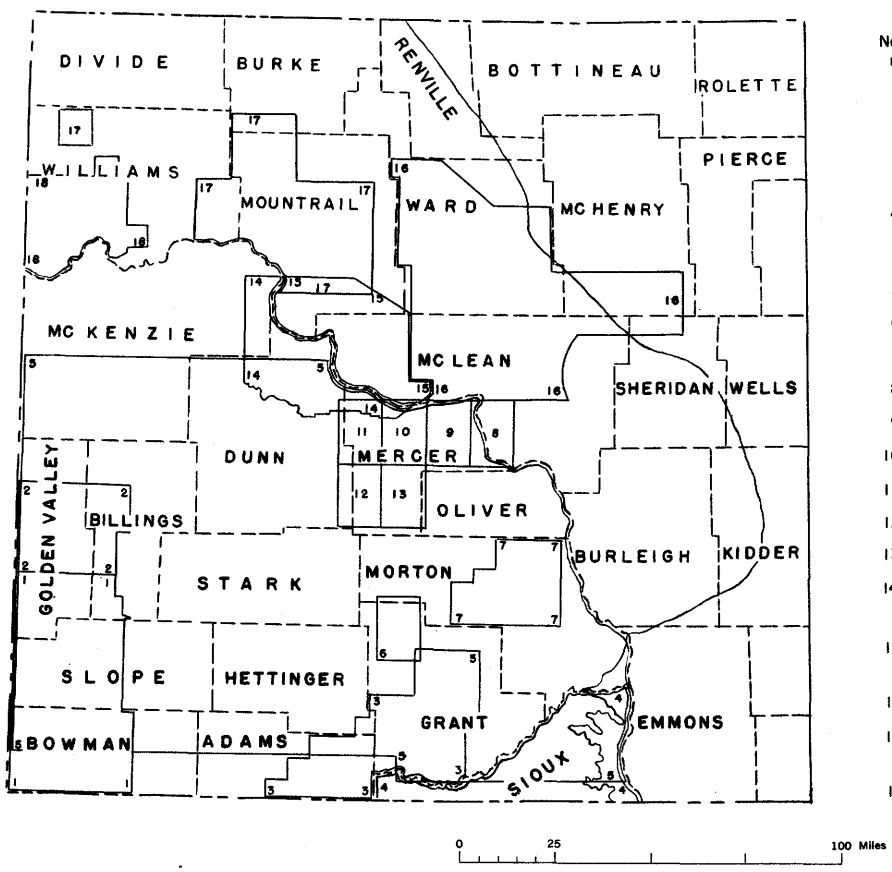
Water supply.--The Missouri River is the only reliable source of surface water in large quantity in the lignite field. At Williston, North Dakota, the average flow of the Missouri River over a 19-year period ending in September 1947, was 18,690 second-feet, and the minimum flow during the period was 1,320 second-feet. At Bismarck, North Dakota, the average flow of the Missouri during approximately the same period was 19,820 second-feet, the minimum flow 2,800 second-feet (U. S. Geological Survey, 1950, pp. 30, 32).

The supply of palatable subsurface water in the lignite-bearing part of North Dakota is meager, and most of the towns and cities are considerably handicapped by the shortage of good water. Even where large amounts of water can be obtained, most of it is highly mineralized and is unsuited for most industrial and domestic purposes. Palatable water is obtained from the Fort Union formation and, in certain areas, from glacial deposits. In many places ground water is obtained in moderate quantities from the lignite beds.

Climate.--The lignite-bearing parts of North Dakota are in the so-called short grass prairie region, which is characterized by an average annual rainfall of less than 15 inches. Typical temperatures range from 90°F in summer to -30° in winter, the extreme recorded temperatures being 124° and -59°.

Land use.--The economy of the lignite-bearing region is predominantly agricultural. Large tracts of land are suitable for the raising of wheat and other grains, but other areas can support only grazing.

Towns.--Minot, with a population in 1950 of 21,924, and Bismarck, with 18,544 inhabitants, are the largest cities in the lignite-bearing portion of North Dakota. Only three other cities--Dickinson,



EXPLANATION

No. on map	Mapped Area
1	Marmarth region (Hares, 1928)
2	Sentinel Butte region (Leonard and Smith, 1909)
3	Cannonball River region (Lloyd, 1914)
4	Standing Rock and Cheyenne River Indian Reservation (Calvert and others 1914)
5	Northern Pacific Railway map (1923–25)
6	Heart Butte (Tisdale, 1941)
7	New Salem region (Hancock, 1921)
8	Stanton quadrangle (Benson, 1951)
9	Hazen quadrangle (Benson, 1951)
10	Beulah quadrangle (Benson, 1951)
11	Golden Valley quadrangle (Benson, 1951)
12	Broncho quadrangle (Benson, 1951)
13	Medicine Butte quadrangle (Benson, 1951)
14	Fort Berthold Indian Reservation (Bauer and Herald, 1921)
15	Fort Berthold Indian Reservation (Pishel, 1912)
16	Minot region (Andrews, 1939)
17	Williams and Mountrail Counties (Leonard, Dove, and Eaton, 1925)
18	Williston region (Herald, 1913)

Figure 5.--Index map showing areas in North Dakota covered by lignite reports.

Williston, and Mandan--contain more than 5,000 inhabitants: In recent years the urban population of the region has increased slightly but the rural population has decreased to a greater degree, resulting in a net loss for the region as a whole. However, commercial oil discoveries in 1951 have brought an influx of people to the area.

Transportation facilities.--Railroad transportation in the lignite-bearing area is provided by four roads: the Great Northern Railway and the Minneapolis, St. Paul, & Sault Ste. Marie Railroad, usually known as the "Soo Line," which serves the area north of the Missouri River with lines that go into every county in that area; the Northern Pacific Railway, which crosses the region from Bismarck west; and the Chicago, Milwaukee, St. Paul and Pacific Railroad, which cuts across the southwestern corner of the State. In the area south of the Missouri River which is served by the two last-named roads, branch lines are few and large areas are remote from rail transportation of any kind. North-south rail transportation, in particular, is poor.

The principal highways are U. S. Routes 2 and 52, which serve east and west traffic north of the Missouri River; U. S. Route 10, which parallels the Northern Pacific Railway from Bismarck west; U. S. 12, which parallels the Chicago, Milwaukee, St. Paul and Pacific Railroad; and U. S. 83 and U. S. 85, which provide north-south transportation across the region. All of these Federal highways are hard-surfaced at most places, but several of them still have stretches of gravel surface. A number of State highways help to cover the area north of the Missouri River with a fairly good network of roads, but such roads are fewer south of the river. County roads are hard-surfaced near some of the towns, but as a rule they are gravelled or merely graded. Travel over such roads is not difficult in dry weather but is difficult or impossible when the ground is wet.

Most of the lignite mined in North Dakota is shipped by rail; trucks carry only small amounts of the fuel, mostly for local use.

Stratigraphy

The lignite field of North Dakota covers about 32,000 square miles in approximately the western half of the State. (See fig. 1.) Of this area only about 28,000 square miles contain lignite in commercial grades and quantity; the remaining 4,000 square miles, which lie on the eastern edge of the area, contain beds that are generally less than 2½ feet thick and hence are not included in the area covered by the estimate. All of the lignite-bearing portion of North Dakota is part of the Fort Union lignite region, which extends northward, southward, and westward from the State into Canada, Montana, Wyoming, and South Dakota.

General section.--The sediments exposed in the lignite-bearing region of North Dakota range in age from Late Cretaceous to Oligocene.(See fig. 6.) The oldest beds, the Pierre shale and the overlying Fox Hills sandstone of Late Cretaceous age, are exposed only along the western edge of Bowman County and in the eastern part of Sioux County and adjacent parts of Morton and Emmons Counties. Overlying the Fox Hills is the Hell Creek formation, also of Late Cretaceous age, which was formerly included in the Lance formation. The Hell Creek is exposed in a narrow outcrop belt in western Bowman and Slope Counties, and over a considerably larger area along the Cannonball River, in Morton, Grant, and Sioux Counties. (See pl. 1.)

Nearly all of the minable lignite in North Dakota is in the Fort Union formation of Paleocene age, which directly overlies the Hell Creek. The Fort Union consists of three members: the Ludlow member, which

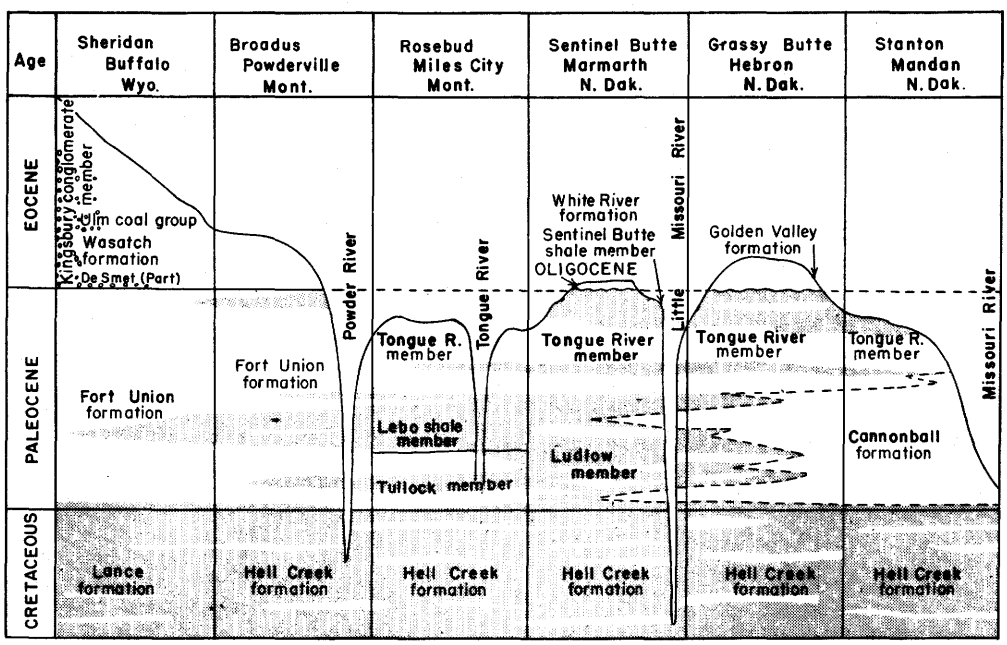


Figure 6.--Diagrammatic section through the Fort Union region. Stippled parts indicate dark zones of strata of all kinds; unstippled parts are light-colored zones (after Brown, 1948, p. 1266).

merges laterally eastward into the Cannonball formation; the Tongue River member, and the Sentinel Butte shale member. The Fort Union is overlain, in the buttes and mesas in the central part of the region, by the Golden Valley formation of Eocene age and the White River formation of Oligocene age. Pleistocene deposits cover most of the area north of the Missouri River.

All the rock units which crop out in the lignite-bearing region of North Dakota, except the Pierre shale and the Fox Hills sandstone, which contain no lignite, are discussed briefly below.

Hell Creek formation.--The Hell Creek formation of Late Cretaceous age consists, at its eastern exposures in Sioux and adjoining counties, of alternating beds of sandstone, shale, bentonitic clay, and thin lignite beds that are not of major importance. The total thickness of the unit is 250 to 300 feet (Denson, 1950, p. 5). In the Marmarth lignite field in western Bowman County its thickness, as determined by Hares (1928, p. 47), is 575 feet. In that area it contains some lignite, but most of the beds are too thin or too impure for commercial exploitation.

Fort Union formation.--The Fort Union formation of Paleocene age is composed of the Ludlow, Tongue River, and Sentinel Butte members (Brown, 1948, pp. 1270-72). The lowest member, the Ludlow, is the equivalent of the Tullock member and Lebo shale member of the lignite fields of southeastern Montana; in North Dakota its outcrop area is limited to a band averaging less than 10 miles wide that extends southeasterly from southern Golden Valley County across Slope and Bowman Counties into Adams County. In the southeastern part of the lignite-bearing area the Ludlow member grades laterally into the non-coal-bearing marine Cannonball formation.(See fig. 6.)

The best exposures and thickest sections of the Ludlow member of the Fort Union are in the Marmarth lignite field, where it consists of 250 feet of alternating shale, sandstone, and lignite beds. The member thins to the east and interfingers with the Cannonball formation over a considerable area before it disappears entirely. The aggregate thickness of the lignite beds in the member, in sec. 10, T. 135 N., R. 105 W., in Bowman County, is 39 feet 11 inches (Hares, 1928, pp. 25-26, 47). Largely because of the small area in which the Ludlow is exposed, the total estimated reserves of lignite in the member are comparatively small.

The Tongue River member of the Fort Union crops out over more than nine-tenths of the lignite-bearing portion of North Dakota. At most places the upper part of the unit has been removed by erosion, but in areas such as the Blue Buttes in McKenzie County, the Killdeer Mountains in Dunn County, Sentinel Butte in Golden Valley County, and other localities in drainage divides, all or nearly all of the original thickness of the Tongue River is preserved, though it is not usually well exposed. The member consists of a series of alternating beds of sandstone, shale, and lignite. Characteristically it is light in color, contrasting in this respect with the dusky, bluish-gray color of the underlying Ludlow member.

The thickness of the Tongue River member in the Sentinel Butte area in the southwestern part of the State is given as 1,100 feet (Leonard and Smith, 1909), and it is possibly somewhat greater near Dickinson (Brown, 1948, p. 1270). The member thins eastward to about 500 feet in the Knife River area (Benson, in preparation).

The lower part of the Tongue River member contains numerous thick and widespread beds of lignite, and nearly all of the estimated reserves of the State are in that member.

Lying above the Tongue River member, and grading into it both laterally and vertically, is the dark-colored Sentinel Butte shale member (Brown, 1948, pp. 1265-74), which is exposed in the higher parts of the lignite-bearing region south of the Missouri River. The Sentinel Butte contains beds of lignite, but the total tonnage is small as compared with that in the underlying Tongue River member.

Golden Valley formation.--The Golden Valley formation of Eocene age, as defined by Benson and Laird (1947, pp. 1166-67), is exposed in buttes and synclines and in interstream divide areas; the largest occurrences are in southwestern Stark County, and eastern Dunn and western Mercer Counties. The formation is composed of two members. The lower member, 20 to 30 feet thick, is composed of purplish-gray carbonaceous shales interbedded with white, sandy kaolinitic clays commonly stained yellow-orange at outcrop surfaces. Locally it contains small quantities of lignite (Benson and Laird, 1947, p. 1166). The upper portion of the formation contains fine to coarse-grained micaceous sands and silts, and small lenses of clay. At the type locality of the formation, near the town of Golden Valley in Mercer County, the unit is about 170 feet thick.

White River formation.--The White River formation of Oligocene age consists of interbedded fresh water limestone, calcareous clay, and sandstone beds. It is exposed only in small areas that are confined to the southwestern one-fourth of the lignite-bearing part of North Dakota. (See pl. 1.) The formation, which contains no lignite, has been described by Leonard (1922, pp. 218-228).

Pleistocene deposits.--Nearly all of the lignite-bearing area north and east of the Missouri River is covered by glacial drift to depths of 50 feet or more, except where it has been removed by erosion. The thickest deposits are in buried valleys in Divide, Burke, and northern Williams Counties; one such valley in the southwestern part of Divide County contains more than 400 feet of glacial material. This valley trends north along the edges of Ranges 97 and 98. Another valley in the north central part of Burke County trends west from near Bowbells across the entire County.

South and west of the Missouri River the glacial deposits consist of terraces and thin deposits of till, which may be of pre-Wisconsin or possibly very early Wisconsin age. In this region most of the till has been removed by erosion and only the larger and more resistant boulders and cobbles remain on the surface.

Structure

The lignite-bearing rocks of North Dakota are essentially flat-lying and the broad folds that are present are usually not discernible except by careful observation. The recorded regional dip is northward to northeastward at rates of from less than 10 feet to as much as 180 feet to the mile, but many reversals are present. Unusually steep dips are reported for small areas. An example is the Hanks district in Williams County, where the beds dip locally as much as 33° (Leonard and others, 1925, p. 80). Another area of unusually steep dips is near the town of Lignite in Burke County (Townsend, 1950, pp. 1552-64). The sides of the valleys of many of the larger streams contain large slump blocks that may be confused with orogenic structures, so that caution is necessary in interpreting unusual dips in such areas.

Among the major structures exposed in the State is the Glendive anticline, which extends into the western parts of Slope and Bowman Counties. In this area Fort Union deposits have been eroded, exposing the Pierre shale. (See pl. 1.) Other structures are the Nesson anticline in Williams County (Collier, 1918), and the Keene dome, a southern extension of the anticline into McKenzie County, (Nevin, 1946; Laird, 1946). The dips in these structures are as great as 80 feet per mile. East of the Keene dome and the Nesson anticline, a syncline trends north-northwest in the western part of the Fort Berthold Indian Reservation and adjacent territory. A small north-trending syncline has been mapped east of Dickinson in Stark County, and other synclines in northern Billings County are noted.

COUNTY DESCRIPTIONS

In the following sections the reserves of each county in the lignite-bearing portion of North Dakota are discussed, the text being supplemented by maps showing outcrops and mine locations. In the discussion the counties are arranged in geographical order, beginning with the northwesternmost county, Divide, and working east and south until all counties north and east of the Missouri River have been covered; following these the counties south and west of the river are discussed.

Divide County

Geography and geology. --Divide County is in northwestern corner of North Dakota. The population of the county in 1950 was 5, 977; nearly all the people are directly or indirectly supported by farming. The largest town is Crosby, the county seat, which has 1, 404 inhabitants; other large towns, all with fewer than 1, 000 inhabitants, are Noonan, Fortuna, and Paulson. Branch lines of the Great Northern Railway and the Minneapolis, St. Paul & Sault Ste. Marie Railroad serve the county.

Most of Divide County is in the glaciated Missouri Plateau section of the Great Plains province; a small area in the northeastern corner is in the Drift Prairie area of the Central Lowland province. The relief is approximately 450 feet, surface altitudes ranging from about 1, 950 to 2, 400 feet. Small intermittent ponds and lakes, and irregular drainage patterns throughout the country emphasize the glacial genesis of the terrane.

Lignite beds. --Seven lignite beds, no one of which underlies the entire county, have been recognized in Divide County. Correlations of the beds are based largely on altitudes above sea level.

The lowest bed recognized in the county is the Paulson no. 1 bed, which is identified on the basis of two well records that penetrated 6 feet of lignite at depths of about 400 feet near the town of Paulson. The Paulson no. 1 bed is believed to underlie T. 163 N., R. 96 W., and small portions of the adjoining townships on the east, west, and south, at an average altitude above sea level of about 1, 500 feet.

The next higher bed, the Paulson no. 2, is about 100 feet above the Paulson no. 1 and underlies the northeastern part of Divide County. A thickness of more than 11 feet near Paulson is indicated by well logs; other logs from Burke County and from Canada, which do not give exact thicknesses, have been used to delimit the areal extent of the bed.

A lignite bed known in Williams County as bed A is projected into the south-central part of Divide County on the basis of data noted in the Williston lignite field. The assigned thicknesses in Divide County range up to 3. 5 feet, though in the mapped area in Williams County (see fig. 7) thicknesses up to 12. 5 feet are recorded. Throughout most of its estimated area of occurrence in Divide County the A bed is under 300 to 400 feet of overburden.

The Des Lacs bed, named by Leonard and Eaton (Leonard and others, 1925, p. 146) for its outcrop in the Des Lacs River valley in Burke County, is not known to crop out in Divide County but on the basis of well logs is believed to be present from 100 to 200 feet below the surface in the eastern part of the county, at about 1, 850 feet above sea level. Its thickness ranges up to 12 feet. It is believed to be terminated on the west by a deep glacial channel trending north in the border region of Tps. 160-162 N., Rs. 97-98 W; no data are available as to the presence of the bed west of the channel.

Bed 2 is projected from Mountrail and Williams Counties into a small area in the southeastern part of Divide County, where it occurs approximately 1, 900 feet above sea level and has an estimated average thickness of 2. 5 to 3. 5 feet.

Portions of Tps. 160-162 N., R. 95 W., are underlain at altitudes above sea level of 1, 950 to 2, 000 feet by the Noonan bed, named by Leonard and Eaton (Leonard and others, 1925, p. 79) for the town of Noonan, near which it is being mined. The bed reaches a thickness of 7. 5 feet, but the outcrop is nearly everywhere buried by glacial deposits and is exposed in only a few coulees where the glacial debris has been removed by erosion. (See fig. 7.) The best exposures of the bed are in the strip mines south of Noonan, where the overburden is from 30 to 100 feet over an area of several square miles. In some areas near Noonan the bed is split into benches (Leonard and others, 1925, p. 79).

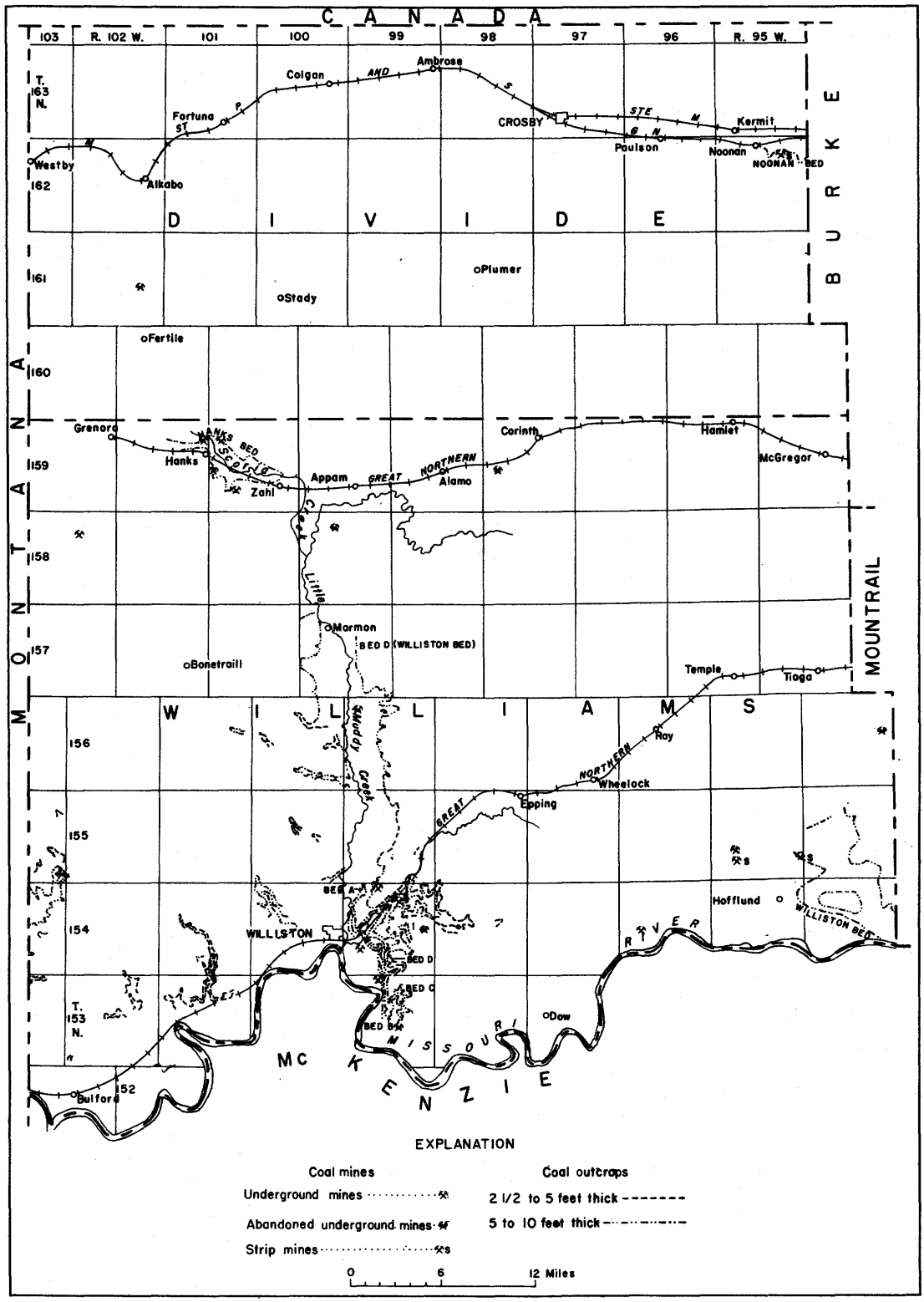


Figure 7.--Lignite outcrops in Divide and Williams Counties, North Dakota.

The Hanks bed underlies approximately the western half of Divide County, at altitudes of 2,000 to 2,100 feet. In the Fortuna-Alkabo area the thickness is from 4 to 6 feet, and in this same area local dips of as much as 45° are reported in mines. The Hanks bed is thought to be cut off to the east by a buried valley trending north along the approximate line between ranges 97 and 98W.

Reserves and production.--The estimated original reserves of lignite in Divide County are given in table 25; a summary is given below:

Estimated original reserves of lignite in Divide County
(in millions of short tons)

Thickness of beds (ft.)	Category of reserves			
	Measured	Indicated	Inferred	Total
2½-5	21	364	6,899	7,284
5-10	64	374	137	575
10+	54	300	51	405
Total	139	1,038	7,087	8,264

Estimated reserves for the Noonan bed in Divide County are given in table 4.

The only two lignite beds that have been developed commercially in Divide County are the Hanks bed in the western part and the Noonan bed in the eastern portion. No mining in the Hanks bed has been reported since 1945; one operation in the Noonan bed is now active. In past years, however, 37 mines have been opened in Divide County; both underground and strip mines are included in the total reported operations.

The all-time recorded production of lignite in Divide County is 4,634,961 short tons, of which nearly half has been recovered since 1940. The greatest output for any one year was 267,922 tons in 1947; present annual production is at substantially that level.

The only operating mine in Divide County in 1950 was the Baukol-Noonan strip mine in the Noonan bed in secs. 2, 3, 10, and 13, T. 162 N., R. 95 W.

Williams County

Geography and geology.--Williams County is on the western border of North Dakota, south of Divide County, and north of the Missouri River. (See fig. 7.) The population of the county in 1950 was 16,402. The principal city of the county and surrounding region is Williston, which has a population of 7,353. The chief income is from farming, but in the Williston area there has been considerable activity in oil in 1951 and 1952.

Rail transportation for the county is supplied by the Great Northern Railway. The main line passes through Williston, Epping, and Tioga, and a spur line serves the towns of Corinth, Appam, Zahl, Hanks, and Grenora.

Most of Williams County is a broad rolling upland covered by glacial drift that is deeply incised in the southern portion by the valley of the Missouri River and its tributary, Little Muddy Creek, in the east-central part of the county. Farther northwest, Scoria Creek has cut a moderate depression in the plain. Elevations in the county range from about 1,800 feet in the Missouri River valley to a maximum of 2,400 feet in the east-central part of the county; the general altitude of the upland surface is about 2,200 to 2,300 feet.

Lignite beds.--Six lignite beds of wide areal extent, as well as several minor beds, are known to underlie parts of Williams County. The lowest of these is the Des Lacs bed, which crops out in Burke County and is inferred to underlie the northeastern part of Williams County.

The next bed above the Des Lacs horizon is bed A, which crops out in the valley of Little Muddy Creek. Its thickness ranges from less than 2 1/2 feet in sec. 18, T. 153 N., R. 102 W., to 14 feet in sec. 29, T. 155 N., R. 96 W. The bed is 2.5 to 9 feet thick in the vicinity of Williston and appears to thicken north and east of that city. It probably underlies most of the county at depths of 400 to 500 feet, except for narrow areas in the eastern and western parts of the county and in the valleys of Little Muddy Creek and the Missouri River.

Bed B (Herald, 1913), the next bed above bed A, is 5.8 to 9.5 feet thick along its outcrop in Tps. 153-154 N., R. 100 W., and reaches a maximum known thickness of 14 feet in a well in sec. 35, T. 155 N., R. 99 W. The bed probably underlies all of the eastern and southeastern portions of the county except where it has been removed by erosion. In Tps. 153-154 N., Rs. 102-103 W., west of Williston, where the bed is as much as 400 feet below the surface, it averages less than 5 feet thick, and westward from that area it thins to less than 2 1/2 feet. In T. 154 N., R. 97 W., the bed dips west at the rate of 20 to 40 feet per mile; still farther west, the beds are almost horizontal. Bed B is correlated with bed 2 of Collier (1918) and bed 2 of the Fort Berthold area (Pishel, 1912). These beds have been correlated over about one-third of Williams County and over large areas in the counties to the east.

Bed C (F. A. Herald, 1913) crops out on the east side of the valley of Little Muddy Creek. It is about 7 1/2 feet thick throughout most of its outcrop area but is believed to be of relatively small areal extent.

Bed D is the same as the Williston bed, as Collier (1918, p. 212) uses the term. It is correlated also with bed 3 of the Fort Berthold Indian Reservation. It reaches a thickness of 8 feet on the east side of Little Muddy Creek in sec. 3, T. 154 N., R. 100 W., and

Table 4.--Estimated original reserves of lignite in Noonan bed, Divide County, North Dakota
(in millions of short tons)

Location	Measured reserves			Indicated reserves			Inferred reserves			Total reserves
	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	
T.162N., R.95W.	6.0	2,719	28.55	4.9	4,998	45.40	4.9	11,662	80.77	154.72
T.162N., R.96W.	...	...	...	...	...	...	3.8	974	6.40	6.40
T.161N., R.95W.	...	...	...	...	...	...	3.8	20,858	136.88	136.88
T.161N., R.96W.	...	...	...	...	...	...	3.8	253	1.66	1.66
T.160N., R.95W.	...	...	...	...	...	...	3.8	14,148	92.85	92.85
T.160N., R.96W.	...	...	...	...	...	...	3.8	350	2.30	2.30
Total		2,719	28.55		4,998	45.40		48,245	320.86	394.81

11 to 12 feet in sec. 11, same township and range. The bed thins locally to 2.6 feet in sec. 34, T. 155 N., R. 100 W., but thickens again north of that area. A bed of lignite 15 feet thick in a well in sec. 35, T. 154 N., R. 99 W., is correlated with bed D. In general the lignite thickens toward the north and east and pinches out toward the west; and a persistent parting, ranging in thickness from 1 1/2 to 3 feet, is characteristic of the bed at nearly all exposures. Bed D probably is covered by as much as 300 feet of overburden.

The Marmon bed, higher stratigraphically than bed D, is confined to the southeastern part of Williams County. Its maximum thickness, about 11 feet, is reported in a well in T. 155 N., R. 99 W. Several mines have been opened in this bed.

The Hanks bed crops out in the northwestern part of the county, where it underlies a considerable area at about 2,100 to 2,250 feet above sea level. In the Hanks-Zahl district (fig. 7) the bed is as much as 8 feet thick. In the valley of Scoria Creek the horizon of the Hanks bed is marked by clinker resulting from the burning of the coal.

Several beds in the western part of Williams County have been mapped but do not appear to be correlatable with the more widespread beds and hence are treated individually in the estimate of reserves. A number of local beds occur throughout the coal section described above. In most places these beds are either less than 2 1/2 feet thick or are too poorly described to permit an estimate.

Reserves and production.--The estimated original reserves of lignite in Williams County are given in table 25; a summary follows:

Estimated original reserves of lignite in Williams County
(in millions of short tons)

Thickness of beds (ft.)	Category of reserves			
	Measured	Indicated	Inferred	Total
2½-5	210	1,427	17,223	18,860
5-10	242	1,252	4,472	5,966
10+	64	586	1,458	2,108
Total	516	3,265	23,153	26,934

Reported all-time production of lignite from Williams County to January 1, 1951, is 2,010,051 tons, of which only 344,232 tons have been mined from 1941 to 1950. The annual reports of the State Coal Mine Inspector list more than 125 mines as having been operated at one time or another in the county; most of these mines were of the slope or drift type. Of the 12 mines operating in 1950, nine were underground operations and only two were strip mines. These mines are listed below:

Operating mines in Williams County in 1950

Name of mine	Location			Type	Bed
	sec.	T.	R.		
Holland	9	153N	100W	Drift-	C or D
Black Diamond	4	153N	100W	--do---	D
Van Allen	20	154N	97W	Slope-	D?

Operating mines in Williams County in 1950--Continued

Name of mine	Location			Type	Bed
	sec.	T.	R.		
Cedar Coulee No. 2	20	154N	97W	Drift-	D?
Star	24	154N	100W	Slope-	D
Williston View	4	154N	100W	Drift-	D
Standard Coal Co.	20	154N	100W	--do---	C
Ledahl Coal Co.	10	154N	100W	Strip-	D
Ray's	22	154N	100W	Slope-	C or D
Granly	25	155N	96W	Strip-	B
M & M Coal Co.	29	155N	96W	--do---	B?
Sorenson	7	159N	101W	Drift-	Hanks

Mountrail County

Geography and geology.--Mountrail County is in the north central part of the lignite-bearing region of North Dakota. It is bounded by Burke County on the north, McLean County and the Missouri River on the south, and Williams County on the west. The population in 1950 was 9,399 and is supported mostly by farming. Stanley, the county seat, with a population of about 1,000, is the largest town. The main line of the Great Northern Railway passes through Tagus, Stanley, and White Earth (fig. 8) and a branch line of the same system runs northwest from Stanley into southern Burke and Williams Counties. A branch line of the Minneapolis, St. Paul & Sault Ste. Marie Railroad crosses the southern part of the county, terminating at Sanish on the Missouri River.

Approximately the two southern tiers of townships in Mountrail County are within the original limits of the Fort Berthold Indian Reservation. The area covered by the reservation is indicated on the map (fig. 8), and is important in the study of lignite in the county because the reservation was mapped earlier and in more detail than other parts of the county, and because the designations of the beds are different from those used in adjacent areas.

Most of the surface of Mountrail County is covered by till. In the northeastern part, the surface is gently rolling; the southwestern portion, along the valleys of the Missouri River and its tributaries, is in most areas highly dissected. Beneath the glacial material the exposed bedrock is the Tongue River member of the Fort Union formation.

Lignite beds.--Three outcropping beds of lignite have been mapped in Mountrail County, all in the original Fort Berthold reservation. In addition, two beds are inferred to underlie parts of the county on the basis of outcrops in adjoining counties. The lowest of the mapped beds is bed 1, which crops out in the southwestern part of the county in the Missouri River valley, where its elevation above sea level averages about 1,780 feet. Its maximum thickness is reported to be 10.2 feet in T. 151 N., R. 93 W., and the lignite is reported to be of high quality. It contains, however, numerous partings, which increase in number and thickness to the east and west. To the north, the bed thins and the partings are fewer.

Bed 2 underlies the major portion of southern Mountrail County and crops out in the Missouri River valley. It is correlated with bed B of Williams County and with the Minter bed of McLean County on the basis

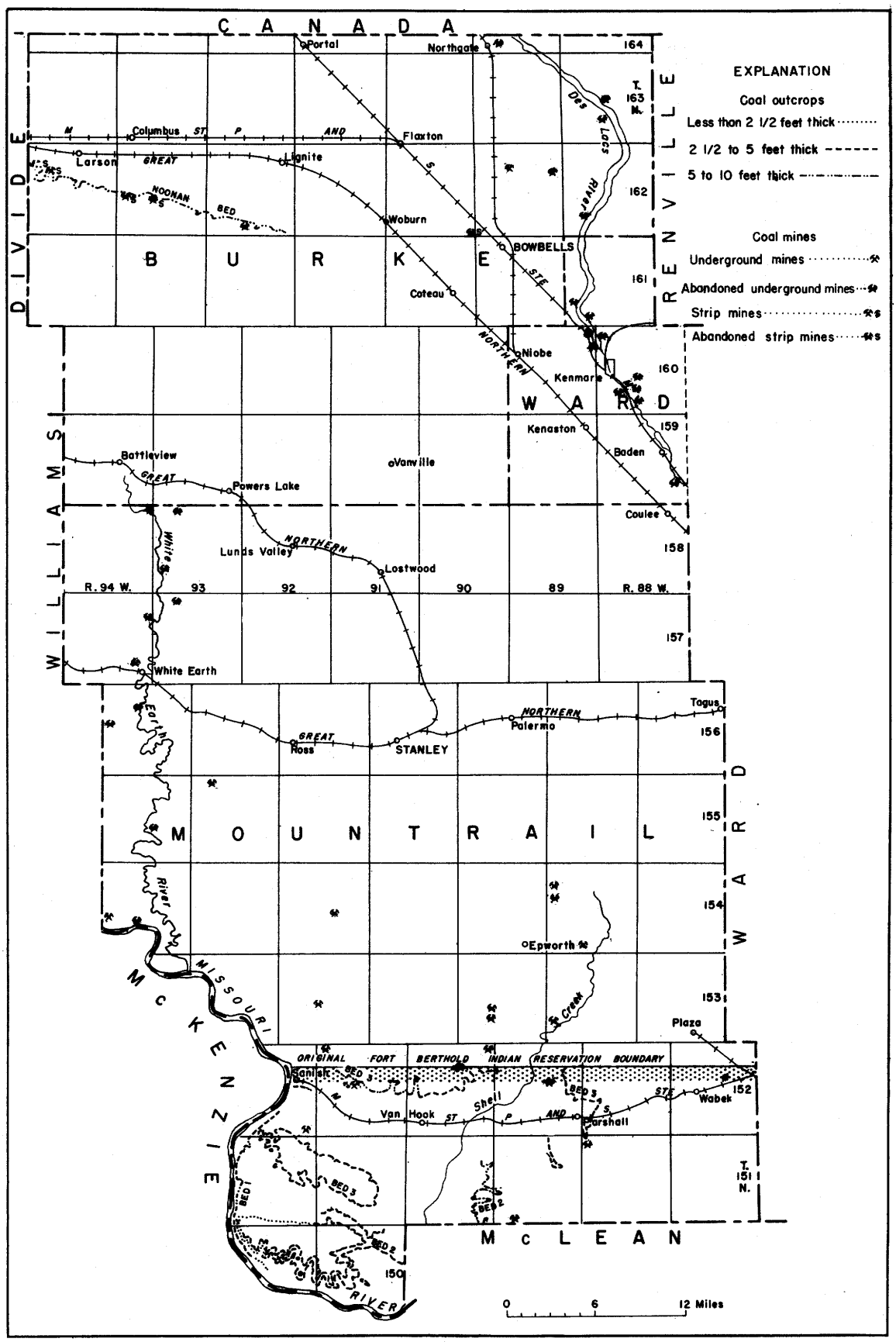


Figure 8.--Lignite outcrops in Burke and Mountrail Counties and part of Ward County, North Dakota.

of the elevations of the outcrops and known structure. Bed 2 reaches a maximum thickness of 5 feet. In places the lignite is of good quality, but in areas it is impure and in T. 151 N., R. 93 W., is replaced by clay.

Bed 3 (Pishel, 1912) is believed to underlie nearly all of the county except the most southern part. It stands at about 2,000 to 2,100 feet above sea level and on the basis of altitude is tentatively correlated with bed D of Williams County. The maximum known thickness, as indicated by well-log data from T. 151 N., R. 92 W., is 14 feet, though the average for the outcrop area is only 4 to 6 feet.

From data in adjacent Ward and Burke Counties, the Des Lacs bed is inferred to underlie the northeastern part of the county about 500 to 600 feet below the surface, at altitudes of about 1,800 to 1,850 feet. In the southeastern part of the county the 1-A or Garrison Creek bed of McLean County is inferred to underlie a considerable area at 1,850 to 1,900 feet above sea level. The bed is estimated to be about 3 1/2 feet thick.

Reserves and production.--The total estimated reserves for Mountrail County are summarized below; the reserves by townships are given in table 25.

Estimated original reserves of lignite
Mountrail County
(in millions of short tons)

Thickness of beds (ft.)	Category of reserves			
	Measured	Indicated	Inferred	Total
2½-5	148	356	13,814	14,318
5-10	68	368	311	747
10+	79	234	---	313
Total	295	958	14,125	15,378

Recorded production of Mountrail County since 1920 has been only 218,638 tons; no figures prior to 1920 are available. The peak production was in 1942, when 16,474 tons was mined; 1950 production is listed as 2,590 tons.

As many as 40 mines have operated in Mountrail County, 25 having been reported for a single year. For 1950, however, only two mines were reported in operation. These are listed below:

Operating mines in Mountrail County in 1950

Name of mine	Location			Type	Bed
	sec.	T.	R.		
Timmel	19	154N	94W	Drift	3
Hansen	6	152N	92W	Strip	3

Burke County

Geography and geology.--Burke County is bounded on the north by Canada, on the east by Renville and Ward Counties, on the south by Mountrail County, and on the west by Williams and Divide Counties. Agriculture and related industries supported a population of 6,597 in 1950. The principal towns are Bowbells, Flaxton, and Columbus, none of which has as many as 1,000 inhabitants. These towns are served by a branch line of the Minneapolis, St. Paul & Sault Ste. Marie Railroad; two branches of the Great Northern Railway serve other parts of the county.

The northern part of Burke County, in the Drift Prairie area, is separated from the southwestern part, in the glaciated Missouri Plateau, by the Missouri escarpment. Elevation of the prairie is about 1,900 to 2,000 feet, and the plateau is approximately 200 feet higher. The topography of the entire county is rolling except in the eastern part, where the Des Lacs River and its tributaries have cut into the general plain level to depths of 100 to 150 feet. Beneath the glacial till that forms the surface of most of the county, the bedrock is the Tongue River member of the Fort Union formation.

Lignite beds.--Of the five extensive lignite beds known in Burke County, it is probable that only one underlies more than half the county. The lowest bed, the Paulson no. 1, is projected from Divide County and underlies about 2 square miles in the northwestern part of Burke County at an elevation above sea level of about 1,550 feet. The bed is estimated to be about 3.0 feet thick on the basis of well information from Divide County, and lies under about 500 feet of overburden.

The Paulson no. 2 bed, also projected from Divide County, underlies approximately two townships in the northwestern part of the county and attains a thickness of 7.5 feet. Its altitude is about 1,650 feet, and it is under 400 to 500 feet of overburden. Three local beds penetrated by water wells in parts of Tps. 160-162 N., Rs. 90-91 W., are estimated with the Paulson no. 2 bed, as they are at approximately the same horizon.

The Des Lacs bed is exposed at outcrops and in mines in the valley of the Des Lacs River, at altitudes of about 1,800 to 1,850 feet. The bed is not mapped, but it is reported by Leonard and Eaton (Leonard and others, 1925, p. 146). The overburden ranges from about 100 feet in the northern part of the county to about 300 to 400 feet in the southwestern part. In western Burke and eastern Divide Counties the bed, as correlated on the basis of water-well information, is a maximum of 12 feet thick; but at abandoned mines in the Des Lacs River valley the thickness is only 4 to 6 feet. The bed probably underlies all of the county except where it has been cut out by buried valleys, the principal one of which trends northwest from T. 161 N., R. 88 W., to the extreme northwestern corner of the county. A tributary valley appears, on the basis of recent drilling, to cut out the coal in an area south of Bowbells, and to join the principal valley about 6 miles northwest of that town. The estimated width of these buried valleys is about 2 miles, and in places they are cut as much as 350 feet below the present surface.

Bed 2 of Mountrail County probably underlies the two southern tiers of townships in Burke County. It is possible that the abandoned Schult mine 2 miles west of Bowbells is in this bed, at an altitude of about 1,900 feet.

The Noonan bed, the only bed now being mined commercially in Burke County, underlies the west-central portion of the county. The lignite is as much as 8 feet thick at outcrops and in mine cuts; in places, however, as reported by Leonard and Eaton (Leonard and others, 1925, pp. 78-79) it apparently splits into three benches. The Noonan lignite crops out at about 1,950 feet elevation; and in a band about 1 1/2 miles

wide back of its outcrop, which extends about 20 miles in Burke County, it is under relatively light cover. In large parts of Tps. 161-162 N., Rs. 91-94 W., the lignite is under less than 100 feet of overburden.

Bed 3 of Mountrail County is inferred to underlie a small area in the southernmost tier of townships in Burke County.

Reserves and production.--The estimated original reserves of lignite in Burke County are summarized below; reserves by townships are given in table 25.

Estimated original lignite reserves of Burke County
(in millions of short tons)

Thickness of beds (ft.)	Category of reserves			
	Measured	Indicated	Inferred	Total
2½-5	24	238	5,513	5,775
5-10	109	330	275	714
10+	11	81	29	121
Total	144	649	5,817	6,610

The estimated reserves of the Noonan bed, which is being extensively mined at present, are given in table 5.

In all, 44 mines have been reported at different times in Burke County, but only 2 are now in operation. Past and present activity is concentrated largely in the vicinity of Columbus, though one mine was operated west of Bowbells in the 1930's, and an operation about 6 miles north of Columbus is also recorded. Both of the mines now operating are strip mines.

The total all-time production of Burke County through 1950 is reported as 8,730,000 tons. Nearly half of this production was mined between 1941 and 1950, the peak year being 1950, when 450,000 tons was produced.

Mines operating in 1950 are listed below:

Operating mines in Burke County in 1950

Name of mine	Location sec.	T.	R.	Type	Bed
Bonsness Coal Mine---	21	162N	93W	Strip-	Noonan
Truax-Traer Coal Co.--	19	162N	93W	--do---	Do.

Renville County

Geography and geology.--Renville County is bounded on the north by Canada, on the south by Ward County, and on the west by Ward and Burke Counties. The population in 1950 was 5,388 and is supported chiefly by agriculture. The Great Northern Railway and the Minneapolis, St. Paul & Sault Ste. Marie Railroad serve the county.

The topography is generally rolling, the principal features being the valleys of the Souris and Des Lacs Rivers. The former stream flows south-southeast across the county, entering it from Canada near the northwestern corner; the latter cuts across only the southwestern corner. The lignite-bearing portion of the county is generally west of the Souris River, where the plain stands at elevations above sea level of 1,725 to 1,950 feet; the terrane east of the river, where no lignite is known but where a small amount may be present, is about 125 to 200 feet lower. The bed of the Souris River stands at about 1,600 feet at the southern boundary line of the county, rising to 1,623 feet at the Canadian border.

Lignite beds.--The lowest bed for which reserves are calculated is the Mattson bed, named for the Mattson mine, 2 miles from Tolley. (See fig. 9.) In that area the bed is reported to be 12 feet thick and lies under about 300 feet of overburden at an elevation above sea level of about 1,550 feet.

The Burlington bed underlies a small part of Renville County at elevations of 1,650 to 1,700 feet. No mining activity in this bed has been reported. The next highest bed is the Des Lacs bed, which underlies the southwestern portion of the county, at about 1,800 feet elevation. In the extreme southwestern township, the Coteau bed of Ward County, or a bed at very nearly the same horizon, is present at an elevation above sea level of about 1,850 feet.

Reserves and production.--The estimated reserves of Renville County are summarized below; reserves by townships are given in table 25.

Estimated original lignite reserves of Renville County
(in millions of short tons)

Thickness of beds (ft.)	Category of reserves			
	Measured	Indicated	Inferred	Total
2½-5	4	117	603	724
5-10	5	35	---	40
10+	19	---	---	19
Total	28	152	603	783

Only four mines are listed as having operated in Renville County from 1918 through 1950. The best known of these was the Mattson mine, a shaft mine about 300 feet deep which was active in 1926 but had

Table 5.--Estimated original reserves of lignite in Noonan bed, Burke County, North Dakota
(in millions of short tons)

Location	Measured reserves			Indicated reserves			Inferred reserves			Total reserves
	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	
T.162N., R.92W.	5.4	1,171	11.94	5.5	1,126	13.66	...	...	...	25.60
T.162N., R.93W.	7.5	3,808	47.35	7.5	783	62.78	7.5	136	1.79	111.92
T.162N., R.94W.	7.5	2,109	27.68	7.5	5,796	76.07	5.4	6,029	73.12	176.87
T.161N., R.91W.	5.4	1,131	11.65	5.4	5,488	60.23	6.9	20,363	135.74	207.62
T.161N., R.92W.	3.3	655	3.78	5.4	5,328	34.39	3.3	16,855	97.34	135.51
T.161N., R.93W.	...	...	...	5.4	1,023	14.08	5.4	21,956	145.87	159.95
T.161N., R.94W.	...	...	...	...	...	...	5.4	23,039	141.63	141.63
T.160N., R.92W.	...	...	...	...	...	...	3.3	11,046	63.84	63.84
T.160N., R.93W.	...	...	...	...	...	...	3.3	22,585	130.43	130.43
T.160N., R.94W.	...	...	...	...	...	...	3.3	22,910	132.31	132.31
T.159N., R.93W.	...	...	...	...	...	...	3.3	1,103	6.37	6.37
T.159N., R.94W.	...	...	...	...	...	...	3.3	1,512	8.73	8.73
Total		8,674	102.40		19,544	261.21		147,534	937.17	1,300.78

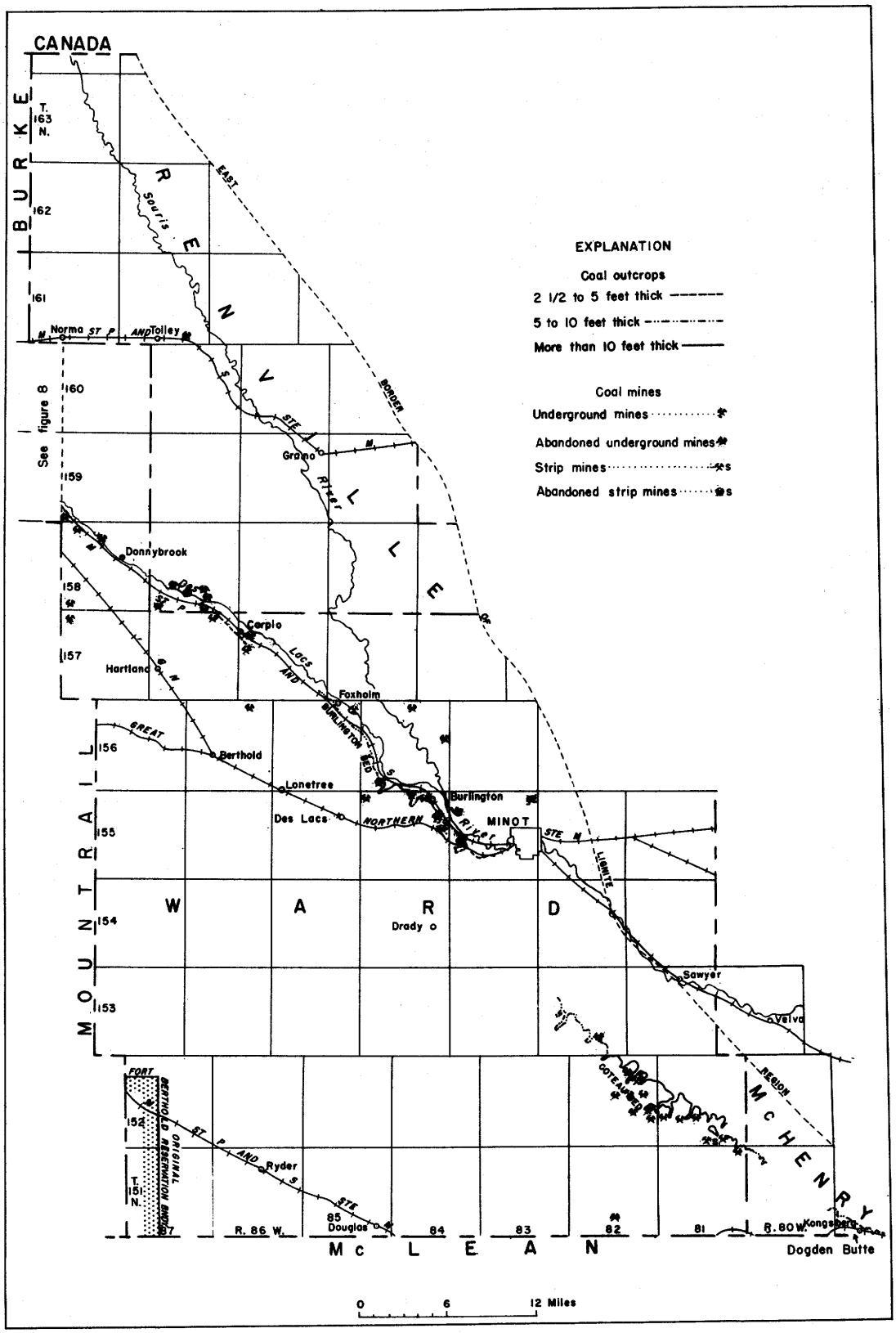


Figure 9.--Lignite outcrops in Renville, Ward, and McHenry Counties, North Dakota.

only a short life. In the late 1930's three short-lived slope mines were reported, the last production having been in 1940. The total all-time production for the county is less than 3,000 tons, all obtained from underground mines.

Ward County

Geography and geology.--Ward County is bounded on the north by Renville County, on the east by McHenry County, on the south by McLean County, and on the west by Mountrail and Burke Counties. (See figs. 8, 9.) The population in 1950 was 34,631, of whom 21,924 were in the city of Minot, the trading center for a large farming area in central and northern North Dakota. The main line of the Great Northern Railway passes through Minot and Berthold, and a branch of the same line runs northwest from Berthold. The southern part of the county is served by a branch of the Minneapolis, St. Paul & Sault Ste. Marie Railroad that terminates at Sanish in Mountrail County, and another branch of the same system that parallels the Des Lacs River northwest of Minot.

The surface elevation in the northeastern part of the county is about 1,800 feet; in the southwestern part it is about 2,400 feet. The valleys of the Des Lacs and Souris Rivers cut about 150 to 200 feet into the general level of the plains. The entire area except the stream valleys is overlain by glacial till; the bedrock is mostly the Tongue River member of the Fort Union formation, though it is probable that in the northeastern part of the county Cretaceous strata may crop out.

Lignite beds.--The lowest lignite bed identified in Ward County is the Burlington bed, which stands at an elevation of about 1,620 feet at most of its observed exposures in the valleys of the Des Lacs and Souris Rivers northwest of Minot. The known length of outcrop of the bed is about 20 miles, between a point about 1 1/2 miles west of Minot and a point 2 miles northwest of Carpio. (See fig. 9.) Andrews (1939, p. 69) records a thickness of 10 feet 10 inches about 1/2 mile southeast of Burlington. In this vicinity the bed is free from partings, but to both the northwest and southeast it thins and the partings increase in number and thickness. About 3 miles west of Minot the lower half of the bed is bony.

Outcrop information and mine data have been used in inferring the presence of the Burlington bed in an isolated block between the Souris and Des Lacs Rivers. It is estimated that most of the lignite in this bed is overlain by 200 feet of cover, but in the valley sides the cover ranges from a few inches to 100 feet. Although a number of old mines may be seen in the Des Lacs River valley, no mines are now operating in this bed.

The Des Lacs bed underlies part of northwestern Ward County at elevations above sea level of 1,830 to 1,860 feet, as determined from mines in the valley of the Des Lacs River. It is 4 to 6 feet thick (Leonard and others, 1925, p. 146); its overburden is about 200 feet over a large area, thinning near the Des Lacs River. The dip of the bed has not been determined. It has been mined fairly extensively in the past, but at present only one mine, near Kenmare (fig. 8), is operating.

The Coteau bed, which is correlated with the Garrison Creek bed of McLean County in the Missouri River Valley, crops out over relatively extensive areas. Its elevation ranges from approximately 1,820 to 1,900 feet in the Velva area in Ward and western McHenry Counties. It attains thicknesses of as much as 16 feet in the Truax-Traer Company's Velva mine, and is strip-mined at a number of places near its outcrop. In this area the overburden is thin, but it thickens to the southwest. In T. 152 N., Rs. 81-82 W., and in T. 151 N., R. 81 W., a belt from 1/2 mile to 1 1/2 miles wide appears to have 100 feet or less of cover over the lignite. At present four mines are operating along the northeast outcrop of the Coteau bed.

Drill holes indicate presence of the Minter bed of McLean County in the southern part of Ward County. Accurate thickness measurements are not available, but it is thought that the bed is of minable thickness.

Reserves and production.--The estimated reserves of lignite in Ward County are given by townships in table 25 and summarized below.

Estimated original reserves of lignite in Ward County
(in millions of short tons)

Thickness of beds (ft.)	Category of reserves			
	Measured	Indicated	Inferred	Total
2½-5	77	538	6,092	6,707
5-10	37	381	2,306	2,724
10+	146	341	368	855
Total	260	1,260	8,766	10,286

The estimated reserves of the Coteau and Burlington beds, in which most of the mining in Ward County has been carried on, are given in tables 6 and 7, respectively.

More than 70 mines have been opened in Ward County from the beginning of mining to January 1, 1951, according to the reports of the State Coal Mine Inspector. The first mining was in the northwestern part of the county, largely by underground methods, in the Burlington bed. In recent years a number of large-scale stripping operations have been opened in the Coteau bed in the southeastern part of the county. The all-time production from Ward County is reported as 13,034,202 tons, of which more than 5 million tons were produced in the years 1941-50. In 1950 the total reported production was 550,102 tons, of which 7,700 tons was from two slope mines and 542,402 tons from four strip mines.

The mines now operating in Ward County are listed below:

Operating mines in Ward County in 1950

Name of mine	Location			Type	Bed
	sec.	T.	R.		
Ankenbauer	12	160N	89W	Slope	Des Lacs?
Miller	11	152N	82W	Strip	Coteau.
Quality Lignite Co.	24	152N	82W	--do--	Do.
Vix	24,25	152N	82W	Slope	Do.
West Side	23	152N	82W	Strip	Do.
Truax-Traer, Velva.	34	152N	81W	--do--	Do.

Table 6.--Estimated original reserves of lignite in Coteau bed, Ward County, North Dakota

(in millions of short tons)

Location	Measured reserves			Indicated reserves			Inferred reserves			Total reserves
	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	
T.158N., R.87W.	...	...	...	...	...	...	2.6	20,386	91.41	91.41
T.157N., R.86W.	...	...	...	...	...	...	2.6	8,871	40.36	40.36
T.157N., R.87W.	...	...	...	...	...	...	2.6	23,040	104.83	104.83
T.156N., R.86W.	...	...	...	...	...	...	2.6	10,433	47.47	47.47
T.156N., R.87W.	...	...	...	...	...	...	2.6	23,040	104.83	104.83
T.155N., R.84W.	...	...	...	...	...	...	2.6	214	0.97	0.97
T.155N., R.85W.	...	...	...	..	...	...	2.6	10,906	49.62	49.62
T.155N., R.86W.	...	...	...	...	...	...	2.7	22,472	106.18	106.18
T.155N., R.87W.	...	...	...	...	...	...	2.7	23,040	108.86	108.86
T.154N., R.83W.	...	...	...	...	...	...	3.0	1,452	7.62	7.62
T.154N., R.84W.	...	...	...	...	...	...	3.0	15,973	83.86	83.86
T.154N., R.85W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.154N., R.86W.	...	...	...	...	...	...	2.7	23,040	108.86	108.86
T.154N., R.87W.	...	...	...	...	...	...	2.7	23,040	108.86	108.86
T.153N., R.82W.	7.5	927	12.17	5.5	1,963	18.10	3.5	3,350	20.52	50.79
T.153N., R.83W.	...	...	...	...	...	...	3.5	19,375	118.67	118.67
T.153N., R.84W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.153N., R.85W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.153N., R.86W.	...	...	...	...	...	...	2.7	23,040	108.86	108.86
T.153N., R.87W.	...	...	...	...	...	...	2.7	23,040	108.86	108.86
T.152N., R.81W.	12.5	4,504	98.53	12.5	2,922	63.92	...	...	...	162.45
T.152N., R.82W.	10.0	4,523	96.38	10.0	8,003	157.46	10.0	7,977	126.76	380.60
T.152N., R.83W.	...	...	...	5.5	240	2.80	5.5	22,810	150.74	153.54
T.152N., R.84W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.152N., R.85W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.152N., R.86W.	...	...	...	...	...	...	2.7	23,040	108.86	108.86
T.152N., R.87W.	...	...	...	...	...	...	2.7	23,040	108.86	108.86
T.151N., R.81W.	12.5	505	11.05	10.0	3,590	76.72	10.0	18,981	303.42	391.19
T.151N., R.82W.	...	...	...	...	...	...	6.8	23,040	273.85	273.85
T.151N., R.83W.	...	...	...	...	...	...	3.5	23,040	141.12	141.12
T.151N., R.84W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.151N., R.85W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.151N., R.86W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.151N., R.87W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
Total		10,459	218.13		16,718	319.00		624,000	3,574.53	4,111.66

Table 7.--Estimated original reserves of lignite in Burlington bed, Ward County, North Dakota

(in millions of short tons)

Location	Measured reserves			Indicated reserves			Inferred reserves			Total reserves
	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	
T.157N., R.84W.	4.9	52	0.46	4.0	2,966	20.76	4.0	2,215	15.51	36.73
T.157N., R.85W.	3.9	1,589	8.46	4.4	9,152	50.94	3.9	4,407	30.46	89.86
T.157N., R.86W.	3.0	356	1.87	3.0	3,938	20.67	3.0	1,922	10.09	32.63
T.156N., R.83W.	...	...	...	5.6	1,080	9.43	...	...	...	9.43
T.156N., R.84W.	4.4	1,353	8.56	5.0	4,309	36.68	5.1	1,378	12.30	57.54
T.156N., R.85W.	5.8	...	2.29	4.6	8,865	81.12	4.4	12,979	95.09	178.50
T.156N., R.86W.	...	...	...	...	...	...	3.0	14,926	78.36	78.36
T.155N., R.83W.	4.2	1,287	10.13	4.7	4,050	32.56	...	...	...	42.69
T.155N., R.84W.	4.8	2,368	13.33	4.8	10,358	55.07	3.0	7,783	40.86	109.26
T.155N., R.85W.	...	...	...	3.0	1,740	9.14	3.0	14,991	78.70	87.84
T.155N., R.86W.	...	...	...	...	...	...	3.0	2,200	11.55	11.55
Total		7,000	45.10		46,458	316.37		62,801	372.92	734.39

McHenry County

The Coteau bed crops out in two townships in the southwestern corner of McHenry County, the principal exposure being north of Dogden Butte, not far from the town of Kongsberg. (See fig. 9.) The lignite in McHenry County, which is estimated at 118 million tons, is essentially a southeastern continuation of the outcrop of the Coteau bed of Ward County.

Sheridan County

Sheridan County, which borders McHenry County on the south, probably contains, in a small area, the Wilton bed, which crops out in the adjacent counties. No mining from the county has been reported, but a small reserve of minable lignite is estimated on the basis of the nearby outcrops.

McLean County

Geography and geology.--McLean County is bounded on the north by McHenry, Ward, and Mountrail Counties, on the east by Sheridan County, on the south by Burleigh and Mercer Counties, and on the west by Dunn County. In 1950 the population of 18,770 was supported principally by agriculture. The principal towns are Washburn, the county seat, Riverdale, and Garrison; no other towns in the county contain as many as 1,000 inhabitants. The Minneapolis, St. Paul & Sault Ste. Marie Railroad runs north and south through the county, and a branch of the same railroad runs east and west near the northern border. A spur of the Northern Pacific Railway enters the county from the east, ending at Turtle Lake. (See fig. 10.)

At the present time a large force is based at Riverdale for construction of Garrison Dam on the Missouri River. The western part of the county is within the original boundaries of the Fort Berthold Indian reservation.

Surficially, most of McLean County is a fairly smooth plain, into which the Missouri River and its larger tributaries have cut broad valleys, usually 1 to 2 miles wide and bordered by bluffs. Most of the exposed rock is the Tongue River member of the Fort Union formation, though in some areas, particularly in the northern part of the county, there is a comparatively thin veneer of glacial drift. Altitudes range from 1,640 feet to 2,100 feet in the southern part of the county and from 1,700 feet to 2,300 feet in the western part.

Lignite beds.--Information on the lignite beds of McLean County is much more abundant for the western two-thirds of the county, which has been mapped by Pishel (1912) and Andrews (1939), than for the eastern portion, where dependence must be placed largely on sketch maps, mine data, well information, and the annual reports of the State Coal Mine Inspector.

The lowest lignite bed cropping out in McLean County is the Wolf Creek bed, which has been mapped near the Missouri River in T. 147 N., R. 86 W., where the thickness of the lignite average 5.5 feet, and in the east bank of the river south of Riverdale. (See fig. 10.) In its outcrops in T. 147 N., R. 84 W., the bed ranges in thickness from 4.2 to 9.7 feet, and characteristically contains a parting 1 to 5 feet thick. South of that township the bed thins to less than 2 1/2 feet in the southern part of T. 146 N., R. 84 W., and the northern part of T. 145 N., R. 84 W.; but farther south, in secs. 26 and 35, T. 144 N., R. 84 W., its average thickness is 7 feet, including in some places a parting 1.0 to 1.8 feet thick. The bed has been traced into T. 144 N., R. 83 W., but no thicknesses in that township are given. Throughout most of its area of occurrence south of Riverdale the bed is under 300 to 400 feet of overburden.

The Wolf Creek bed may possibly be correlated with a bed about 30 to 40 feet below bed 1-A, which has been mapped in the Fort Berthold Reservation. It is also believed that the Knoop bed is equivalent to the Wolf Creek bed in T. 145 N., R. 84 W.

The next minable lignite above the Wolf Creek bed is the Garrison Creek bed, which is mapped as bed 1-A in that part of the county formerly within the Fort Berthold Indian Reservation, and which is correlate with the Coteau bed of Ward County and the Dogden Butte area of McHenry County. The Garrison Creek bed crops out in the coulees tributary to the Missouri River in the southwestern part of McLean County, generally at about 1,800 to 1,850 feet above sea level. The maximum known thickness of the bed, in sec. 35, T. 148 N., R. 85 W., is 10 feet; and in the Custer mine, 5 miles east of Garrison, the lignite is 5 to 6 feet thick and lies under only 35 to 50 feet of cover. The bed thickens to the north, and probably underlies a very large area in the northern and central parts of the county. It has been mined on a fairly large scale in the vicinity of Garrison.

The bed can be traced south of Riverdale to sec. 35, T. 146 N., R. 84 W., where the thickness is about 4.0 feet. South of this point it is believed to be generally thin or absent.

The Minter bed, which is equivalent to bed 2 of the Fort Berthold Indian Reservation, is mapped in tributary coulees of the Missouri River and probably underlies a large area in the western portion of McLean County, extending into parts of Ward, Mountrail, and Williams Counties. Lignite thicknesses up to 13 feet are reported in well borings in T. 149 N., R. 85 W. Thicknesses of 9 to less than 2 1/2 feet are recorded in the Missouri River valley west of Garrison. In the Fort Berthold Reservation the bed ranges from 2.5 to 5.5 feet in thickness in T. 147 N., Rs. 85-90 W. In parts of Tps. 148-149 N., Rs. 90-91 W., the bed is less than 2 1/2 feet thick.

It is believed that a bed south of Riverdale known as the Kruckenberg is equivalent to the Minter bed. In this area it is generally less than 2 1/2 feet thick.

The Stanton bed crops out in Tps. 144-145 N., Rs. 83-84 W., and ranges up to about 6.0 feet of good lignite. However, most of the sections of the exposed outcrop reveal between 2.5 to 5.0 feet of lignite. Although this bed underlies a large area west of the Missouri River in Oliver County little is known about its extent in McLean County.

In the southeastern part of McLean County the Fairman bed, which is at approximately the same horizon as the Garrison Creek bed, probably underlies

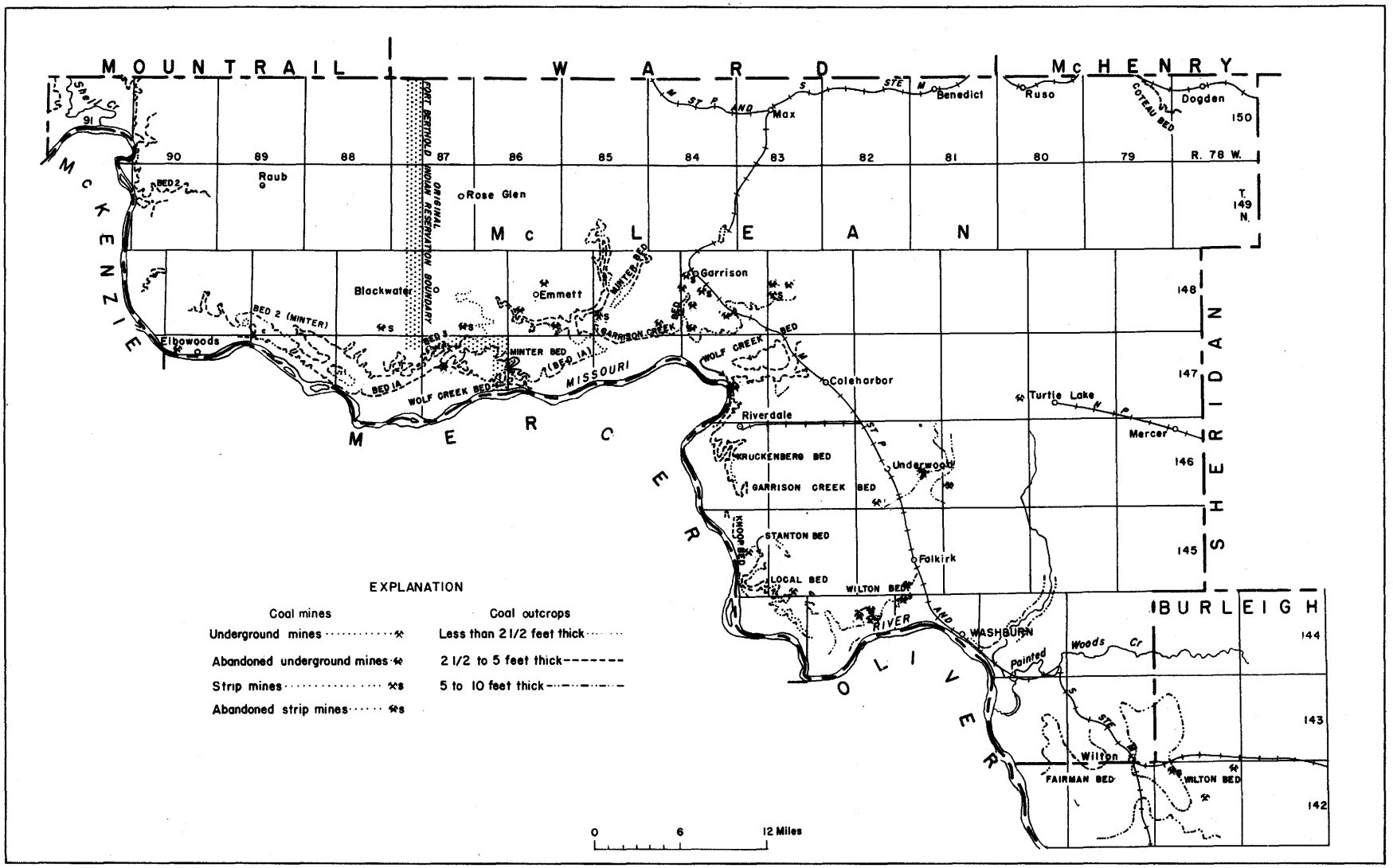


Figure 10.--Lignite outcrops in McLean and Burleigh Counties, North Dakota.

a relatively small area in the vicinity of Washburn. Lignite thicknesses of as much as 11 feet are reported for this bed, which is about 1,800 to 1,830 feet above sea level.

The Wilton bed, of the southeastern part of the county, which may be equivalent to the Stanton bed, is included in the reserve estimates largely on the basis of mine information. It is approximately 1,900 to 2,000 feet above sea level and ranges up to 10 feet thick east of the town of Wilton. The bed is believed to be more than 5 feet thick underlying parts of Tps. 143-144 N., Rs. 79-80 W., and adjacent parts of Burleigh County. It has been mined on a fairly large scale in the past, but present production is small.

Reserves and production.--Reserves of lignite in McLean County by townships are given in table 25, and summarized below:

Estimated original reserves of lignite in McLean County
(in millions of short tons)

Thickness of beds (ft.)	Category of reserves			
	Measured	Indicated	Inferred	Total
2½-5	262	1,079	7,927	9,268
5-10	306	1,206	4,433	5,945
10+	32	379	854	1,265
Total	600	2,664	13,214	16,478

Estimated reserves in the Garrison Creek bed (including lignite mapped as bed 1-A of the Fort Berthold Reservation) are given in table 8.

Of the approximately 70 mines that have been listed in the State Coal Mine Inspectors' reports for McLean County since mining began, only four now remain active. Of this number, one is an underground operation, the others, strip mines. A number of small operations not listed include some in the reservation that serve the local trade. The total reported all-time production from the county has been 4,065,929 tons, of which 1,654,094 tons has been removed during the years 1941-50. Mines reported as operating in 1950 follow:

Operating mines in McLean County in 1950

Name of mine	Location			Type	Bed
	sec.	T.	R.		
Burns & Wretling.	30	148N	85W	Strip-	Garrison Creek.
Truax-Traer (Custer).	19	148N	83W	--do--	Do.
Underwood Coal Co.	23	146N	82W	--do--	Stanton.
Pfister-----	11	144N	83W	Slope-	Do.

Burleigh County

Geography and geology.--Burleigh County is south of Sheridan County and is bounded on the south by Emmons County, and on the west by McLean, Oliver, and Morton Counties. The population in 1950 was 25,252 of which number 18,544 lived in Bismarck, the State capital. The main line of the Northern Pacific Railway passes through Bismarck, as does a line of the Minneapolis, St. Paul & Sault Ste. Marie Railroad that serves the lignite-bearing area in the northwestern corner of the county. (See fig. 10.)

The surface of the county is rolling, but in the western part it is deeply incised by the valleys of the Missouri River and its tributaries. The elevations range from about 1,650 feet on the Missouri River flats to about 2,200 feet on the upland surface. The lignite beds are restricted to about eight townships in the northwestern part of the county, where the Tongue River member of the Fort Union formation is the bedrock.

Lignite beds.--Two beds of lignite are known to underlie the northwestern part of Burleigh County. The lower or Fairman bed crops out in T. 143 N., R. 81 W., where it measures 6 to 9 feet in thickness and has been mined at a number of places. Apparently it stands at about 1,830 feet above sea level. In some mines the bed is as much as 8 feet thick; in the abandoned Fairman mine in sec. 27, T. 143 N., R. 81 W., the lignite is 7.0 feet thick and contains two prominent clay partings 3 to 6 inches thick.

The Wilton bed underlies parts of three townships at elevations of about 1,900 to 2,000 feet. It attains a thickness of 11 feet east of Wilton and crops out over limited areas near that town. Relatively large areas of this bed are overlain by 50 to 100 feet of overburden, and the bed has been mined on a large scale in the Wilton district.

Reserves and production.--The lignite reserves of Burleigh County are summarized below:

Estimated original reserves of lignite in Burleigh County
(in millions of short tons)

Thickness of beds (ft.)	Category of reserves			
	Measured	Indicated	Inferred	Total
2½-5	---	---	44	44
5-10	6	90	866	962
10+	36	76	39	151
Total	42	166	949	1,157

Reserves in the Fairman bed are given separately in table 9.

Of the 40 mines listed in the reports of the State Coal Mine Inspector in the area east of Wilton, only two were active in 1950. A large development in the past is shown by the all-time production of 9,305,218 tons through 1950; but in the years 1941-50 production has declined, being reported as 1,667,134 tons for the 10-year period but only slightly more than 17,000 tons in 1950.

Mines operating in Burleigh County in 1950 were:

Operating mines in Burleigh County in 1950

Name of mine	Location			Type	Bed
	sec.	T.	R.		
Ecklund Taplin--	7	142N	79W	Strip-	Wilton.
Engstrom---------	15	142N	79W	Slope-	Wilton(?)

Table 8.--Estimated original reserves of lignite in Garrison Creek bed, McLean County, North Dakota

(in millions of short tons)

Location	Measured reserves			Indicated reserves			Inferred reserves			Total reserves
	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	
T.150N., R.78W.	3.0	227	1.19	3.0	1,147	6.02	3.0	1,361	7.15	14.36
T.150N., R.79W.	3.5	1,759	10.77	3.5	6,625	40.58	3.5	12,975	79.47	130.82
T.150N., R.80W.	...	...	...	4.5	462	3.64	6.0	22,560	187.07	190.71
T.150N., R.81W.	...	...	...	...	...	...	6.0	23,022	203.21	203.21
T.150N., R.82W.	...	...	...	7.5	96	1.26	3.5	22,926	140.42	141.68
T.150N., R.83W.	...	...	...	...	...	...	3.2	23,040	129.02	129.02
T.150N., R.84W.	...	...	...	...	...	...	3.0	23,040	124.99	124.99
T.150N., R.85W.	...	...	...	...	...	...	2.9	23,040	116.93	116.93
T.150N., R.86W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.150N., R.87W.	...	...	...	...	...	...	2.7	9,065	42.83	42.83
T.150N., R.88W.	...	...	...	...	...	...	2.7	23,040	108.86	108.86
T.150N., R.89W.	...	...	...	...	...	...	2.6	7,922	32.82	32.82
T.150N., R.90W.	...	...	...	...	...	...	2.8	3,164	15.42	15.42
T.149N., R.79W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.149N., R.80W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.149N., R.81W.	...	...	...	...	...	...	3.5	23,040	141.12	141.12
T.149N., R.82W.	...	...	...	...	...	...	3.5	23,040	141.12	141.12
T.149N., R.83W.	...	...	...	...	...	...	3.5	23,040	141.12	141.12
T.149N., R.84W.	...	...	...	3.5	712	4.36	3.5	22,117	135.47	139.83
T.149N., R.85W.	3.5	854	5.23	3.5	5,463	33.46	3.5	16,865	103.30	141.99
T.149N., R.86W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.149N., R.87W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.149N., R.88W.	...	...	...	...	...	...	2.7	23,040	108.86	108.86
T.149N., R.89W.	...	...	...	...	...	...	2.6	13,744	62.53	62.53
T.149N., R.90W.	...	...	...	...	...	...	2.8	3,833	18.78	18.78
T.148N., R.79W.	...	...	...	...	...	...	2.7	10,073	47.59	47.59
T.148N., R.80W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.148N., R.81W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.148N., R.82W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.148N., R.83W.	4.6	3,351	25.72	4.6	8,410	52.31	3.5	6,208	38.02	116.05
T.148N., R.84W.	4.7	6,150	48.32	4.8	3,281	22.40	3.5	9,906	60.67	131.39
T.148N., R.85W.	5.0	5,451	42.63	5.0	12,577	79.37	3.5	3,351	20.53	142.53
T.148N., R.86W.	4.4	5,264	33.66	4.4	8,218	50.61	3.5	6,144	37.63	121.90
T.148N., R.87W.	4.8	3,954	24.60	3.5	12,968	79.43	3.5	4,642	28.43	132.46
T.148N., R.88W.	...	...	...	3.0	193	1.01	3.0	22,823	119.82	120.83
T.148N., R.89W.	3.0	51	0.27	4.5	2,857	15.57	3.0	22,675	119.04	134.88
T.148N., R.90W.	2.8	103	0.50	2.8	507	2.49	2.8	1,412	6.92	9.91
T.147N., R.79W.	...	...	...	...	...	...	2.6	308	1.40	1.40
T.147N., R.80W.	...	...	...	...	...	...	2.7	14,612	69.04	60.04
T.147N., R.81W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.147N., R.82W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.147N., R.83W.	4.4	3,704	24.48	4.5	9,476	60.61	3.5	7,884	48.29	133.38
T.147N., R.84W.	4.8	2,606	20.04	4.5	2,819	17.24	3.5	71	0.44	37.72
T.147N., R.85W.	3.5	462	2.83	...	...	...	...	...	...	2.83
T.147N., R.86W.	4.8	2,787	20.99	4.8	3,768	24.48	...	...	...	45.47
T.147N., R.87W.	5.0	937	7.32	5.0	7,543	55.37	4.0	1,380	9.66	72.35
T.147N., R.88W.	6.0	244	2.56	5.0	3,211	24.16	4.0	10,953	76.67	103.39
T.147N., R.89W.	5.0	1,676	14.12	5.0	4,231	31.25	4.0	1,079	7.55	52.92
T.147N., R.90W.	4.0	77	0.54	...	...	...	...	...	...	0.54
T.146N., R.81W.	...	...	...	...	...	...	2.7	4,963	23.45	23.45
T.146N., R.82W.	...	...	...	...	...	...	2.7	12,461	58.88	58.88
T.146N., R.83W.	...	...	...	2.8	58	0.28	2.8	17,565	86.07	86.35
T.146N., R.84W.	3.5	841	5.15	3.5	20,621	126.30	3.5	1,233	7.55	139.00
Total		40,498	290.92		115,243	732.20		730,184	4,077.44	5,100.56

Table 9.--Estimated original reserves of lignite in Fairman bed, Burleigh County, North Dakota

(in millions of short tons)

Location	Measured reserves			Indicated reserves			Inferred reserves			Total reserves
	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	
T.144N., R.79W.	...	...	...	...	...	...	6.5	12,983	156.43	156.43
T.143N., R.79W.	...	...	...	...	...	...	6.5	18,298	208.14	208.14
T.142N., R.79W.	...	...	...	...	...	...	6.5	14,693	167.13	167.13
T.142N., R.80W.	6.5	252	2.87	6.5	5,642	64.18	6.5	11,725	133.37	200.42
T.142N., R.81W.	6.5	245	2.79	6.5	2,250	25.68	6.5	1,113	17.66	46.13
Total		497	5.66		7,892	89.86		58,812	682.73	778.25

Mercer County

Geography and geology.--Mercer County is in the east-central part of the lignite-bearing area of North Dakota, west and south of the Missouri River. The population in 1950 was 8,686, and about one-third lived in the principal towns: Stanton, the county seat; Beulah; Golden Valley; Hazen; and Zap. The principal industries are wheat growing and lignite mining. The county has adequate rail transportation over a branch line of the Northern Pacific Railway. (See fig. 11.) The Fort Berthold Indian Reservation extends a short distance into the northwestern corner of the county.

The surface is generally rolling except in the valleys of the Missouri and Knife Rivers and their principal tributaries. Elevations range from about 1,680 feet in the Missouri River valley to about 2,200 feet on the upland surface. The exposed rock in most of the county is the Tongue River member of the Fort Union formation of Paleocene age; however, the Golden Valley formation of Eocene age (Benson and Laird, 1947, p. 1166) is exposed in the western part of the county.

Lignite beds.--As the lignite beds in Mercer County were not mapped at the same time, most of them are known by different names in different areas. In the discussion below, the basic nomenclature is that used in the Fort Berthold Indian Reservation south and west of the Missouri River (Bauer and Herald, 1921), but as far as possible beds have been correlated throughout the county and the names used in other sections are given.

The lowest bed cropping out in Mercer County is bed A, known in the eastern part of the county as the Wolf Creek bed. This bed is 4.1 to 9.0 feet thick, the latter figure measured in a well in Sec. 19, T. 146 N., R. 87 W. In T. 145 N., R. 86 W., the bed contains partings 4 feet thick. In the eastern part of the Fort Berthold Reservation, bed A is slightly above the water level of the Missouri River, at altitudes of 1,680 to 1,700 feet, and is believed to underlie most of Mercer County at minable thickness. Bed A is not exposed in the northwest part of the county.

Bed B, or the Garrison Creek bed (Andrews, 1939) is exposed in the northern and southeastern parts of the county, its thickness ranging from 2.7 to 8.4 feet. Apparently this bed thickens westward from its outcrop in T. 147 N., Rs. 84-85 W. The Garrison Creek bed is also believed to be equivalent to the Coal Creek bed which crops out in the southeastern part of the county near Stanton. The Coal Creek bed ranges in thickness from less than 2.5 feet to more than 3.4 feet in T. 145 N., R. 85 W.

Bed CC, which reaches a maximum thickness of 6.5 feet in the Fort Berthold Reservation, is known by the Northern Pacific Railway Co. (1923) as bed C and in the eastern part of the county as the Kruckenberg bed (Benson, 1951). In T. 146 N., R. 85 W., the bed probably averages less than 2 1/2 feet thick, but along a line extending from the mouth of the Knife River to the Fort Berthold Reservation it is relatively thick, thinning from that area to both the northeast and the southwest. Near the mouth of the Knife River a bed known as the Stanton bed crops out at approximately the bed C or Kruckenberg horizon and probably may be correlated with that bed.

Bed CC is also correlated with bed 1-A (Bauer and Herald, 1921, p. 127) north of the Missouri River.

Bed DD of the Fort Berthold Reservation is possibly equivalent to the Spaer, Hazen A, and other local beds of the Knife River area. It is 6.7 feet thick at one place in the southeastern part of the Reservation and about 10 feet thick at one locality in T. 145 N., R. 85 W. (N. P. Ry. Co., 1923). It probably thins generally south and southwest from the Missouri River valley. In the area around the town of Hazen, the bed is generally thin and at many places such as Tps. 142-143 N., Rs. 88-89 W., it is less than 2 1/2 feet thick.

Bed EE, best known as the Beulah-Zap bed, underlies a large area in Mercer County, where it is the key bed from which the stratigraphic positions of other lignite beds are determined. It reaches its maximum thickness in a north-south strip running through Tps. 142-146 N., Rs. 87-88 W., the greatest measured thickness being 22 feet in sec. 18, T. 145 N., R. 87 W. From this area the bed thins rather uniformly to the east, west, and south. In a few areas in Tps. 142-143 N., R. 90 W., and throughout T. 141 N., R. 90 W., it is probably of less than minable thickness. However, farther to the west in Dunn and McKenzie Counties the bed thickens to more than 5 feet.

Bed F of the Fort Berthold area is probably equivalent to the School House bed of Benson (1951) in the western and southern parts of the county. The maximum known thickness of the bed is 6 feet in sec. 25, T. 144 N., R. 90 W.; it thins in all directions from that area. In the Fort Berthold Reservation the bed is about 3 1/2 feet thick.

Bed G, or the Twin Buttes bed, crops out in the drainage divides in the western part of the county. It reaches a maximum thickness of about 5 feet in T. 143 N. R. 90 W., and in scattered localities north and south of that area.

The lignite beds in Mercer County through bed G are in the Tongue River member of the Fort Union formation. The next succeeding beds, H and I, are in the Golden Valley formation, and are confined to the high land in the western part of the county. Bed H or the Alamo Bluff bed of Benson (1951) reaches a maximum thickness of 10.1 feet in Tps. 143-144 N., R. 90 W. (N. P. Ry. Co., 1923). The bed crops out in the Fort Berthold Reservation, but in that area it is thin and the lignite is of poor quality.

Bed I occurs in isolated erosional remnants in western Mercer and eastern Dunn Counties; it is also known as the Schafner bed. It contains only small reserves.

Beds J, K, L, and O crop out over small areas in extreme southern Mercer County and cannot be correlated with beds in the northern part of the county from data at present available. It is believed that these beds are in the Tongue River member of the Fort Union formation. Bed J ranges from 3.9 to 9.4 feet thick and is mostly in T. 141 N., R. 88 W. The other beds are thinner and of little economic importance.

Reserves and production.--The reserves of lignite in Mercer County are estimated at

29,912 million tons. Estimates by townships are given in table 25 and are summarized below.

Estimated original reserves of lignite in Mercer County
(in millions of short tons)

Thickness of beds (ft.)	Category of reserves			
	Measured	Indicated	Inferred	Total
2½-5	248	1,741	13,739	15,728
5-10	426	2,056	5,683	8,165
10+	650	1,622	3,747	6,019
Total	1,324	5,419	23,169	29,912

The estimated original reserves of the Beulah-Zap bed, which contains the largest reserves in the county and in which most of the present-day mining is concentrated, are given in table 10.

Reported production of lignite in Mercer County from the beginning of mining through December 31, 1950 is 17,630,902 tons, of which 9,034,153 tons was produced from 1941 to 1950. For the years 1947-50 production has averaged more than a million tons annually and the county produces more lignite by far than any other in the State. (See table 2.) Most of the properties now being operated are strip mines, although a moderate percentage of the production was from the underground mine of the Knife River Coal Company which recently began stripping operations. Of the 92 mines that have been reported as operating in Mercer County, the 13 that were active in 1950 are listed below.

Mines operating in Mercer County in 1950

Name of mine	Location			Type	Bed
	sec.	T.	R.		
Krause	30	146N	88W	Strip	Beulah-Zap.
Link	8	146N	89W	--do	Do.
Walker	13	146N	89W	--do	Do.
Mittlesteadt.	31	145N	85W	--do	Coal Creek.
Dakota Star	21	145N	86W	--do	Beulah-Zap.
Bauer's	26	145N	88W	Slope	Do.
Moxley & Erickson.	24	145N	88W	--do	Do.
Knife River Coal Co.	18	144N	87W	Drift and Strip.	Do.
Beick	4	144N	88W	Drift	Do.
Dakota Collieries.	24	144N	89W	Strip	Do.
Grishkowsky	11	143N	88W	--do	Do.
Voegele	18	141N	88W	--do	Do.
Elder	24	141N	89W	--do	Do.

Oliver County

Geography and geology.--Oliver County is south and east of Mercer County and west of the Missouri River, in the east-central part of the lignite-bearing area of North Dakota. The population in 1950 was 3,077; most of the people are supported by farms or ranches; only about 500 live in the towns. The county is served by a branch line of the Northern Pacific Railway paralleling the Missouri River.

Oliver County is part of the Missouri Plateau with a gently rolling topography except in the eastern part, which is deeply dissected by the Missouri River and its tributaries. Altitudes range from about 1,650 feet in the valley of the Missouri River to about 2,300 feet in the western part of the county. The outcropping rocks are mostly the Tongue River member of the Fort Union formation, though the underlying Cannonball formation is exposed in the Missouri River valley. All of the lignite estimated is in the Tongue River member.

Lignite beds.--Of the 15 lignite beds for which reserves are estimated in Oliver County, ten are comparatively extensive and seven are shown on the map (fig. 11). The other five beds are local in nature or are projected into Oliver County from adjacent Mercer and Morton Counties. The bed designations are those of the Northern Pacific Railway Co. (1923), which did the only extensive mapping of lignite in the county.

The lowest important bed is bed B, which is exposed in Tps. 142-143 N., R. 83 W., and reaches its maximum measured thickness of 14 feet in sec. 24, T. 143 N., R. 83 W. The bed probably underlies most of the county at minable thickness, but thins toward the west.

Bed C, equivalent to the Stanton bed of Mercer County (Benson, 1951) is exposed in T. 143 N., Rs. 82, 83, and 87 W. In the last-named township the lignite is more than 6 feet thick, but it thins locally in secs. 12-14, T. 143 N., R. 84 W.

Bed D crops out in the northeastern part of the county in T. 143 N., Rs. 83-84 W., where it reaches thicknesses of 6.0 to 7.5 feet. In the valley of Square Butte Creek, southeast of Center, the lignite in this bed is 11 feet thick, and its average thickness over its outcrop area appears to be about 5 feet.

Bed E crops out over wide areas in Tps. 141-143 N., Rs. 83-84 W., and T. 143 N., R. 87 W. In the southeastern part of the county the lignite is 5 feet or more thick, reaching a maximum of 12 feet in sec. 2, T. 141 N., R. 84 W. The bed thins generally in the central portion of the county but thickens westward; from measurements in Mercer County it is believed that it may be as much as 14 feet thick in the western half of Tps. 141-142 N., R. 87 W.

Little is known of bed F, which possibly underlies the western half of the county. It is probably thin throughout most of its extent.

Bed G crops out in the valley of Otter Creek in Tps. 141-143 N., Rs. 86-87 W., where it is as much as 7.2 feet thick (N. P. Ry. Co., 1923). The bed probably averages about 5 feet in thickness over a considerable area in the central part of the county.

Outcrops of bed H have been mapped in T. 143 N., R. 86 W., where it reaches a maximum thickness of 7 feet; most of the measured sections, however, are less than 5 feet thick, and the bed probably averages about 4 feet.

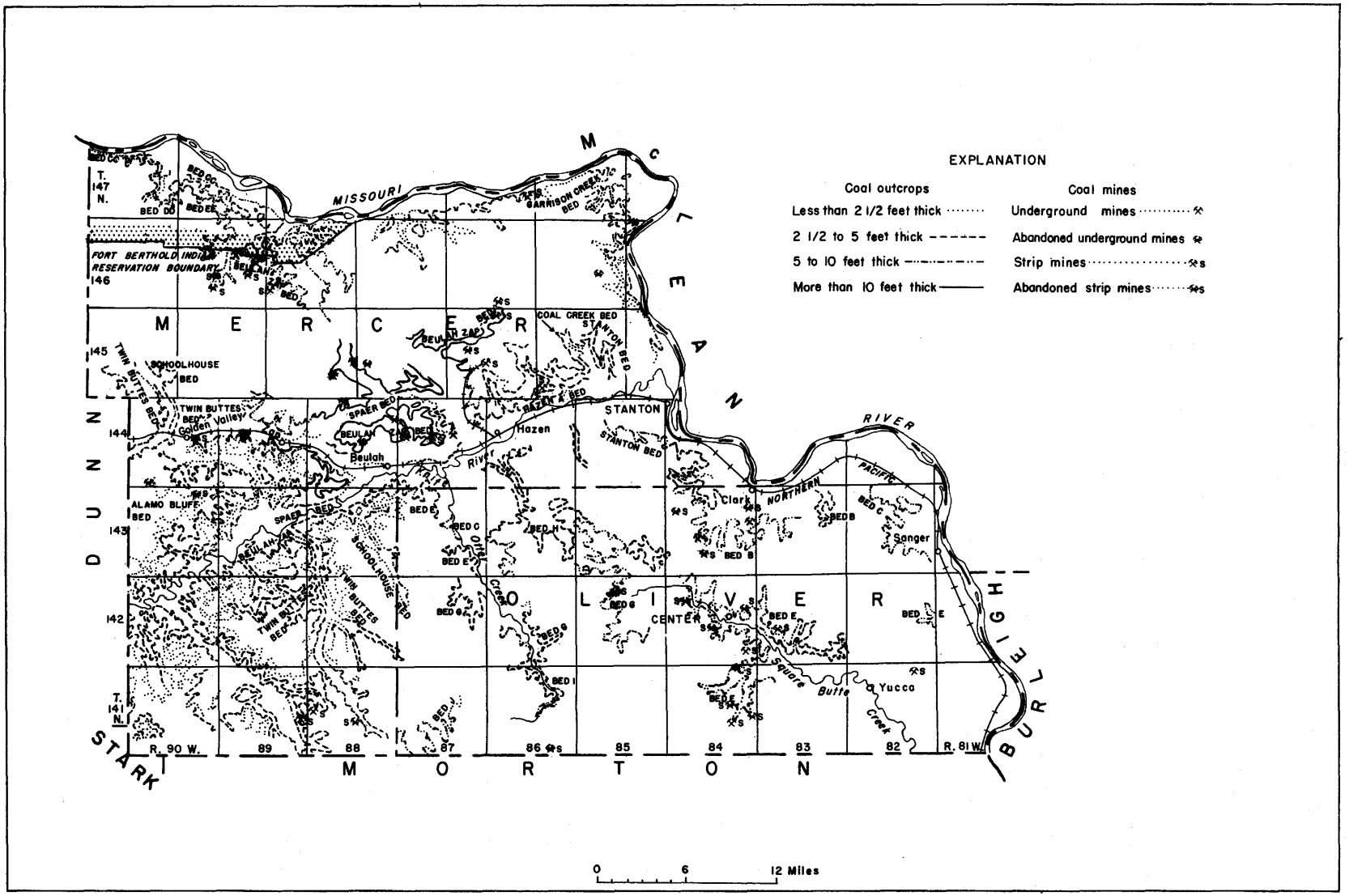


Figure 11.--Lignite outcrops in Mercer and Oliver Counties, North Dakota.

Table 10.--Estimated original reserves of lignite in Beulah-Zap bed (bed E), Mercer County, North Dakota

(in millions of short tons)

Location	Measured reserves			Indicated reserves			Inferred reserves			Total reserves
	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	
T.147N., R.85W.	...	...	...	...	...	...	4.0	1,932	13.52	13.52
T.147N., R.89W.	5.3	1,408	13.84	5.3	2,293	20.48	...	...	...	34.32
T.147N., R.90W.	3.0	1,769	9.29	3.0	9,177	48.18	3.0	2,692	14.13	71.60
T.146N., R.85W.	...	...	...	...	...	...	5.5	14,017	135.00	135.00
T.146N., R.86W.	9.0	596	9.26	7.5	5,135	67.40	7.5	12,596	165.30	241.96
T.146N., R.87W.	5.2	1,408	17.46	8.4	8,704	190.07	11.3	3,668	94.30	301.83
T.146N., R.88W.	11.1	1,932	43.01	11.1	5,483	144.41	...	...	...	187.42
T.146N., R.89W.	5.5	485	4.67	5.1	7,937	74.86	5.1	10,369	95.84	175.37
T.146N., R.90W.	...	...	...	4.5	910	7.17	4.5	22,185	174.71	181.88
T.145N., R.85W.	...	...	...	...	...	...	6.0	1,834	19.60	19.60
T.145N., R.86W.	9.8	845	12.73	9.8	7,932	121.89	9.8	5,102	73.06	207.68
T.145N., R.87W.	19.0	3,360	111.72	19.0	8,109	269.62	19.0	66	2.19	383.53
T.145N., R.88W.	11.8	1,238	28.59	12.2	11,076	213.18	10.5	6,032	98.54	340.31
T.145N., R.89W.	7.5	130	1.71	7.5	3,686	43.38	6.1	19,046	236.76	281.85
T.145N., R.90W.	...	...	...	5.1	13	0.12	4.8	23,089	189.15	189.27
T.144N., R.85W.	...	...	...	...	...	...	4.0	6,360	44.52	44.52
T.144N., R.86W.	...	...	...	...	...	...	4.3	3,196	24.98	24.98
T.144N., R.87W.	12.3	1,848	53.10	12.3	491	12.43	5.0	164	1.55	67.08
T.144N., R.88W.	9.7	5,096	293.22	9.7	2,260	36.50	...	...	...	329.72
T.144N., R.89W.	7.8	4,494	52.31	7.8	10,422	47.72	...	...	...	100.03
T.144N., R.90W.	5.5	2,810	27.05	5.5	13,021	125.33	5.2	2,770	26.52	178.90
T.143N., R.88W.	9.8	2,123	54.86	11.8	8,724	243.69	16.0	3,642	101.98	400.53
T.143N., R.89W.	7.5	2,849	35.34	9.2	7,285	118.84	...	...	...	154.18
T.143N., R.90W.	4.3	1,316	7.02	4.3	8,922	52.35	4.3	9,596	63.07	122.44
T.142N., R.88W.	12.0	688	14.45	12.0	5,587	117.33	7.8	15,864	283.32	415.10
T.142N., R.89W.	5.5	2,543	25.52	10.0	10,697	176.78	10.0	4,117	82.51	284.81
T.142N., R.90W.	3.0	4,978	26.13	3.0	8,738	45.87	...	...	...	72.00
T.141N., R.88W.	...	...	...	6.0	3,773	32.13	6.0	19,329	174.54	206.67
T.141N., R.89W.	3.8	1,081	7.86	5.0	14,836	96.73	7.5	7	0.09	104.68
T.141N., R.90W.	2.7	328	1.55	2.7	4,232	19.53	2.6	2,332	10.61	31.69
Total		43,334	850.69		169,443	2,325.99		190,005	2,125.79	5,302.47

Bed I crops out in the upper part of the Otter Creek valley and underlies the higher land in the central and southwestern parts of the county. The maximum thickness of the bed, about 10 feet, is measured in sec. 35, T. 141 N., R. 86 W.; the average over the outcrop area is about 4 to 5 feet.

Bed J crops out in a small area in the southwestern corner and in a narrow belt in the south-central part of the county. It appears to be thin, of an average thickness of 2.5 to 3.0 feet.

Bed K crops out in Tps. 142-143 N., R. 85 W., in the highest part of the divide between Otter Creek and Square Butte Creek. Its greatest known thickness is 8 feet, its average about 4 feet.

Beds L, M, N, and O are believed to underlie small areas in Oliver County, as they crop out in adjacent Morton and Mercer Counties near the boundary lines.

Reserves and production.--The reserves of lignite in Oliver County are estimated at 17,838 million tons, as summarized below. The estimates by townships are given in table 25.

Estimated original reserves of lignite in Oliver County
(in millions of short tons)

Thickness of beds (ft.)	Category of reserves			
	Measured	Indicated	Inferred	Total
2½-5	139	1,348	11,857	13,344
5-10	206	1,257	2,121	3,584
10+	52	407	451	910
Total	397	3,012	14,429	17,838

Estimated reserves of bed E, the most widespread bed in the county, are given in table 11.

Total all-time production of lignite in Oliver County through Dec. 31, 1950, is 321,158 tons, of which 115,954 tons was mined in the years 1941-50. Most of the production has been from beds D and E. In 1950 six mines were active, producing 7,938 tons. These mines are listed below:

Mines operating in Oliver County in 1950

Name of mine	Location			Type	Bed
	sec.	T.	R.		
Hagel--------	2	141N	82W	Strip--	E?
Kuether------	23	141N	84W	--do----	E
Light--------	22	142N	84W	--do----	E
Schenk-------	25	142N	84W	--do----	E
Schmidt------	13	143N	84W	--do----	A
Yaeger-------	21	143N	84W	--do----	B

Dunn County

Geography and geology.--Dunn County is in the approximate center of the lignite-bearing portion of North Dakota, south of the Missouri River and west of Mercer County. The population in 1950 was 7,212; most of the people are supported by small-grain farming and cattle grazing. The principal towns are Killdeer, Dunn Center, Werner, and Halliday, none of which has as many as 1,000 inhabitants, and all of which are on a branch line of the Northern Pacific Railway which terminates at Killdeer.

Most of Dunn County is about 2,300 to 2,500 feet above sea level. The surface is gently rolling except where the Missouri and Little Missouri Rivers have cut valleys as much as 500 to 600 feet below the upland level. The Killdeer Mountains are about 3,100 feet above sea level over 5 or 6 square miles in the western part of the county.

The northern part of Dunn County is part of the Fort Berthold Indian Reservation, which also includes parts of Mercer, McLean, Mountrail, and McKenzie Counties.

Most of the exposed bedrock is in the Tongue River member of the Fort Union formation, but the

Table 11.--Estimated original reserves of lignite in bed E, Oliver County, North Dakota

(in millions of short tons)

Location	Measured reserves			Indicated reserves			Inferred reserves			Total reserves
	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	
T.143N., R.82W.	...	...	...	...	...	...	3.5	2,562	15.69	15.69
T.143N., R.83W.	...	...	...	4.0	374	2.62	4.0	4,704	32.93	35.55
T.143N., R.84W.	4.0	256	1.79	4.0	3,357	23.50	4.0	3,797	26.58	51.87
T.143N., R.85W.	...	...	...	...	...	...	3.2	22,837	127.89	127.89
T.143N., R.86W.	3.5	565	3.46	3.5	9,382	57.46	3.5	11,938	73.12	134.04
T.143N., R.87W.	5.8	1,442	10.61	8.2	8,305	85.82	8.2	4,192	60.43	156.86
T.142N., R.82W.	...	...	...	3.5	565	3.46	3.5	8,541	52.31	55.77
T.142N., R.83W.	5.5	2,240	22.22	7.0	10,411	96.24	4.5	4,126	32.49	150.95
T.142N., R.84W.	8.0	1,399	21.53	7.0	14,894	211.66	5.3	1,892	19.83	252.02
T.142N., R.85W.	...	...	...	4.5	499	3.24	4.5	22,541	118.55	121.79
T.142N., R.86W.	3.0	493	2.59	3.0	4,172	21.90	3.0	18,140	95.24	119.73
T.142N., R.87W.	4.0	210	1.47	4.0	4,126	28.88	7.8	18,553	153.12	183.47
T.141N., R.82W.	...	...	...	...	...	...	3.0	125	0.66	0.66
T.141N., R.83W.	4.1	2,162	12.61	4.1	10,499	66.61	3.0	841	4.43	83.65
T.141N., R.84W.	7.5	2,411	32.44	7.5	10,230	117.25	4.0	6,419	44.93	194.62
T.141N., R.85W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.141N., R.86W.	...	...	...	...	...	...	2.7	23,040	108.86	108.86
T.141N., R.87W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
Total		11,178	108.72		76,817	718.64		200,328	1,207.98	2,035.34

Golden Valley formation is exposed in some of the buttes, and the Killdeer Mountains are capped by rocks of the White River formation. Most of the minable lignite is in the Tongue River member, the remainder in the Golden Valley formation. Remnants of till, which exist at most places as conspicuous boulders, cover much of the county.

Lignite beds.--The lignite reserves of Dunn County are contained in 14 extensive beds and 10 local beds. The nomenclature is that of Bauer and Herald, who mapped the Fort Berthold Reservation in 1921, and of Gilles, who mapped for the Northern Pacific Railway Co. (1923). Except for the doubling of some of the letters in the Fort Berthold Reservation, and the carrying over of a few bed names from Mercer County into the southeastern part of Dunn County, the same bed designations are used throughout. The outcrops of the more extensive beds are shown in figure 12, which covers the entire county, and in figures 13 and 14, which show in detail beds in parts of the Fort Berthold Indian Reservation. A number of local beds, designated by letters and numbers, have not been fitted into the stratigraphic sequence and are not shown on the maps.

The lowest bed for which reserves are estimated in Dunn County is bed A, which is inferred from data projected from McKenzie and Mercer Counties, where its average thickness over large areas is about 8 feet. It is probably present under a large part of Dunn County. The same is true of beds B, C, and D, which have been identified in McKenzie County on the west and Mercer County on the east.

Bed E or EE is correlated with the Beulah-Zap bed of Mercer and southeastern Dunn Counties. It crops out along both banks of the Little Missouri River, where 14 feet of lignite are reported in secs. 3 and 4, T. 147 N., R. 95 W. To the north, in the valley of the Missouri River, the bed thins to about 5 feet at outcrops in Tps. 149-150 N., Rs. 92-93 W. In T. 142 N., Rs. 91-92 W., in the east-central part of the county, it has a maximum thickness of 11 feet and averages about 7 feet. The bed is free from partings and is believed to be of minable thickness under most of Dunn County; the only known area of thin coal is in secs. 1-3, T. 149 N., R. 93 W.

Bed F crops out in the valleys of the Missouri and Knife Rivers and of Spring Creek. The thickest known exposure is 6 feet, in sec. 9, T. 142 N., R. 93 W. The average thickness in the northern part of the county is about 3.5 feet. Although bed F nowhere attains great thickness, it appears to be uniform and continuous over large areas.

Bed G, or GG, crops out in the valleys of the Missouri and Knife Rivers and of Spring Creek. The bed is thin in the northern part of the county where the maximum known thickness is 3.2 feet in sec. 6, T. 149 N., R. 91 W. In the valley of Spring Creek (see fig. 12) it is 5.3 feet thick in sec. 28, T. 145 N., R. 93 W. It thins locally in T. 147 N., Rs. 91-93 W., but is 12 feet thick in the Knife River area in sec. 33, T. 143 N., R. 93 W., and east of that locality apparently is about 9 feet thick for several miles.

Bed H, or HH, crops out in the valley of the Little Missouri River, where it is 2.5 to 6.5 feet thick. In the southern part of the county, in Tps. 141-142 N., Rs. 93-94 W., it is 5 to 8 feet thick. The bed thins toward the north and west, and in T. 141 N., R. 96 W., the thickness range is 1.5 to 4.5 feet.

Bed I, or II, crops out in the Fort Berthold Reservation in the northern part of the county and in the south-central and southwestern parts, where it is known locally as the Dunn Center bed. Over most of its outcrop area the bed is 3 to 5 feet thick; in T. 147 N., R. 94 W., however, the range is 8 to 13 feet. East of Dunn Center in secs. 27-30, T. 145 N., R. 93 W., the bed is 14 to 23 feet thick. At the only active mine in the bed in this area, in sec. 30, 12 feet of clean coal is overlain by only 16 feet of cover. In southwestern Dunn County in T. 141 N., Rs. 92-93 W., the bed is 5 to 7 feet thick. Generally speaking, it thins north and south from the Dunn Center area.

Bed J crops out in Tps. 141-142 N., R. 94 W., in T. 145 N., R. 94 W., and in T. 147 N., Rs. 93-94 W. It ranges from 4.2 feet to 5.0 feet in thickness and probably underlies the western and central portions of the county.

Bed K probably underlies only the drainage divide areas. Its greatest measured thickness is 12 feet in sec. 1, T. 145 N., R. 94 W. In the valley of the Little Missouri River, in Tps. 146-149 N., Rs. 92-93 W., the maximum thickness of the bed is 4.9 feet.

Bed L, estimated from a few scattered mines and measured sections in the western part of the county, ranges from 2.5 to 6.8 feet in thickness, with an average of about 4 feet.

Bed M averages about 3.0 to 3.5 feet in thickness in a series of outliers in Tps. 144-149 N., Rs. 92-93 W. Southwest of Emerson, in Tps. 142-143 N., Rs. 96-97 W., the bed is 5.5 to 12.0 feet thick. It probably underlies the southwestern part of the county.

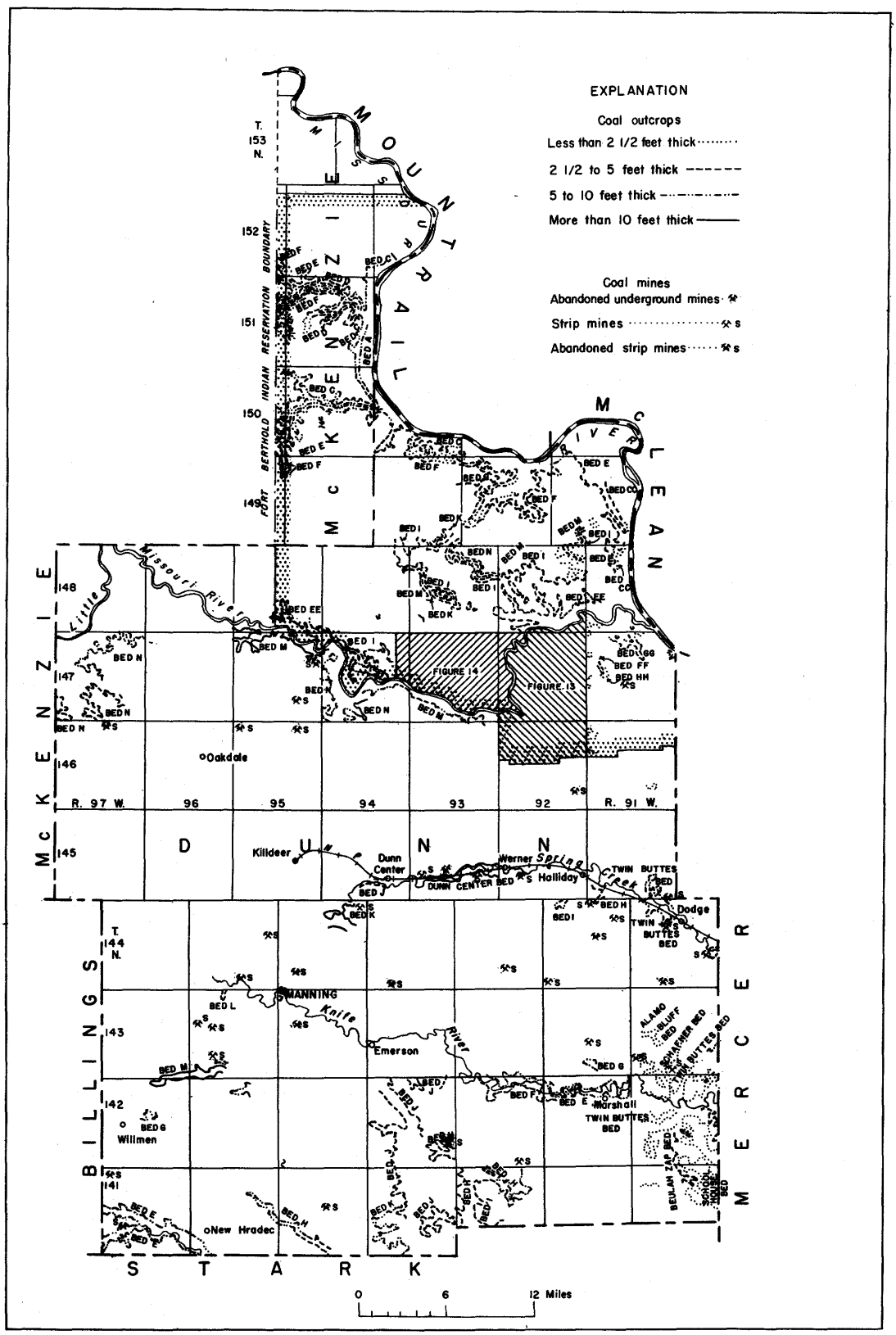


Figure 12.--Lignite outcrops in Dunn County and part of McKenzie County, North Dakota.

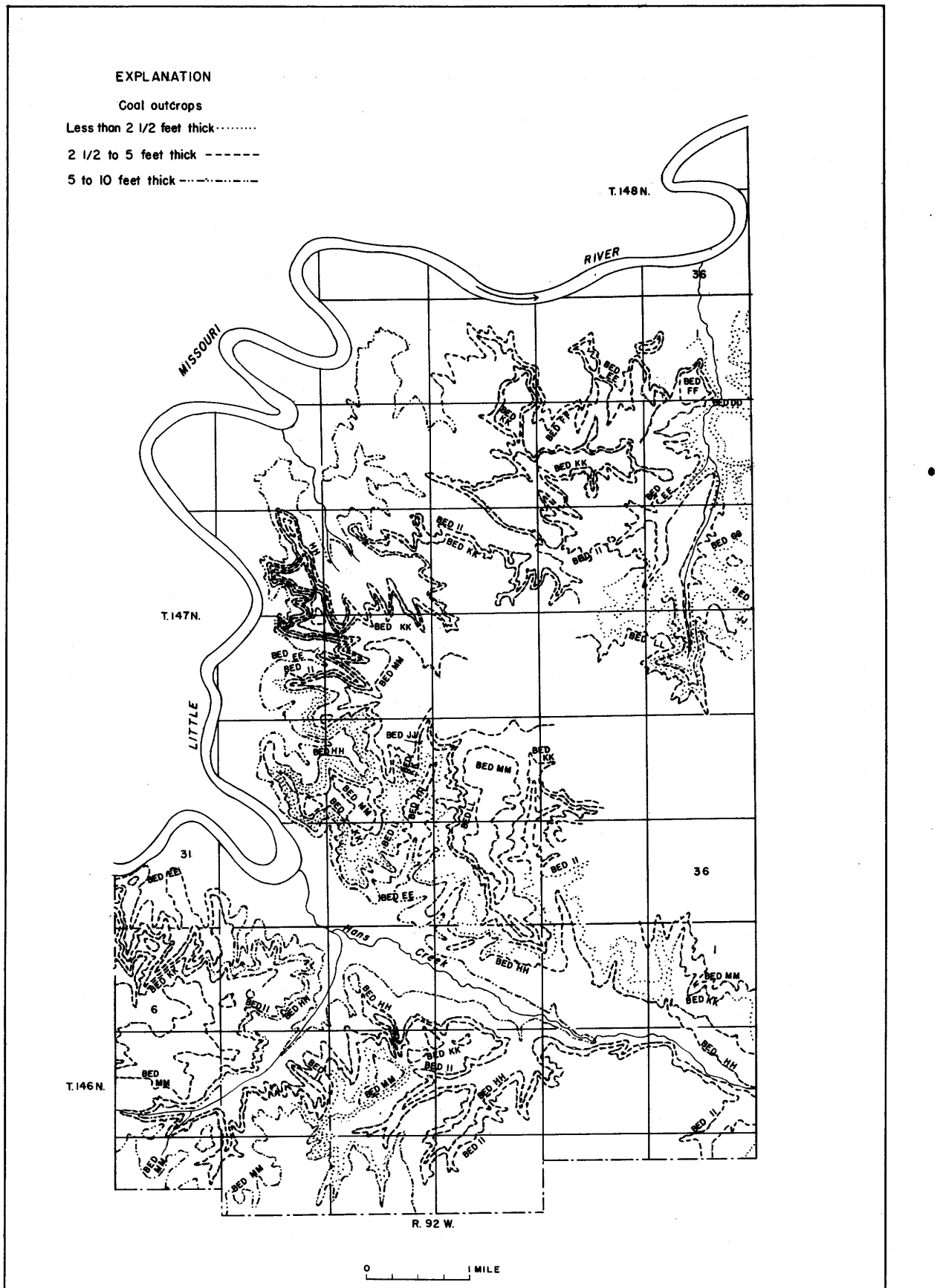


Figure 13.--Lignite outcrops in Tps. 146-148 N., R. 92 W., Dunn County, North Dakota.

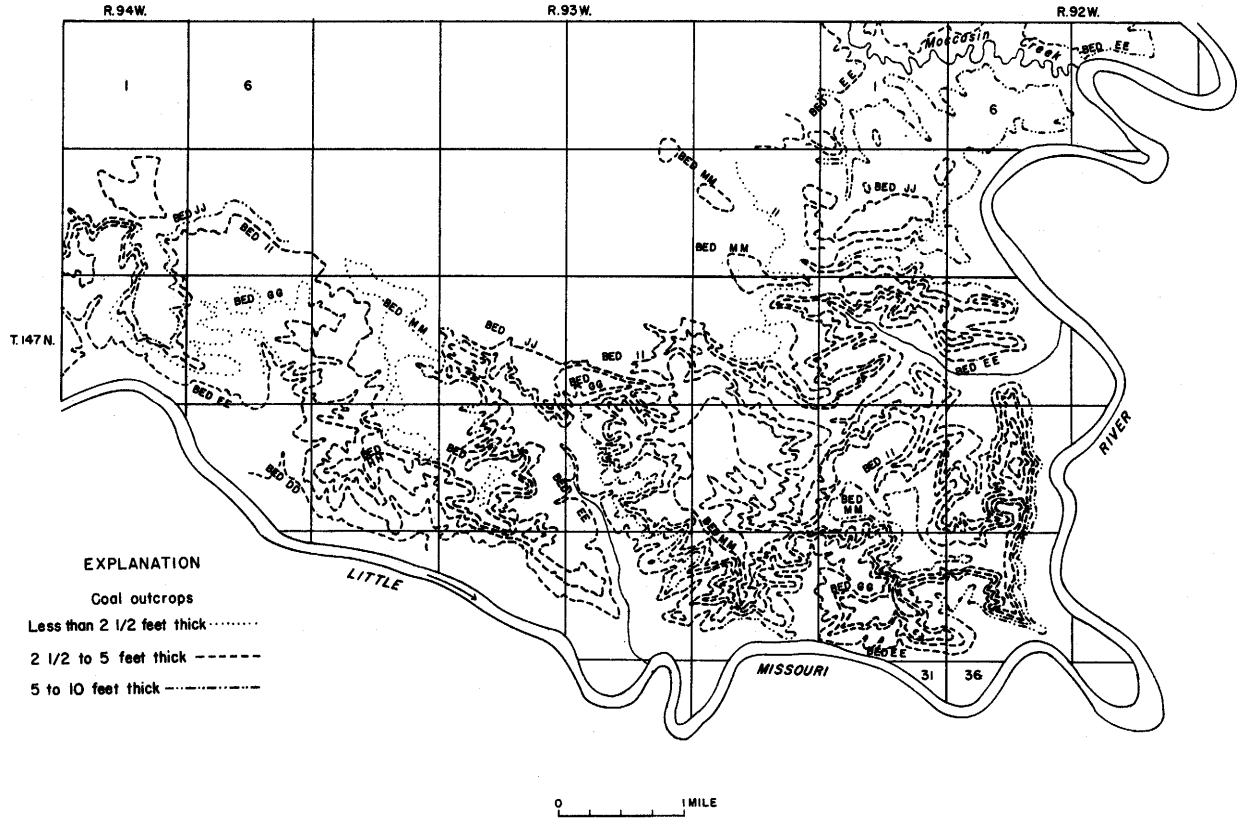


Figure 14.--Lignite outcrops in T. 147 N., Rs. 92-94 W., Dunn County, North Dakota.

Bed N crops out in T. 147 N., R. 97 W., where it is 4 to 6 feet thick, and probably underlies the west-central portion of the county. It thins to the south and in T. 143 N., R. 96 W., is only 3.0 to 3.2 feet thick.

Bed O occurs in the same general areas as bed N, and is from 2.5 to 8.0 feet thick.

The highest beds in Dunn County, beds P, Q, R, and S, crop out in a low butte in T. 143 N., R. 97 W. The average thickness of the group is 2.8 to 3.5 feet, and the area of occurrence is small.

Local beds are designated beds A-1, B-1, D-1, E-1, and G-1. Bed A-1 crops out in Tps. 142-143 N., R. 96 W., where it is 5 to 10 feet thick, probably averaging 7 feet. Bed B-1, exposed in Tps. 147-148 N., R. 94 W., averages about 2.7 feet in thickness. Bed D-1, in parts of T. 142 N., Rs. 96-97 W., has an average in thickness of 6.5 feet. Cropping out in the same general area as bed D-1 is bed E-1, about 3 feet thick. The average thickness of bed G-1, which crops out in the northern half of T. 142 N., R. 97 W., is 2.8 feet.

In the extreme southeastern corner of the county, in Tps. 141-143 N., R. 91 W., the Beulah-Zap, School House, Twin Buttes, Schafner, and Alamo Bluff beds are mapped under the names by which they are known in adjacent Mercer County.

Reserves and production. — The lignite reserves of Dunn County are estimated at 71,042 million tons. The figures by townships are given in table 25, and are summarized below:

Estimated original reserves of lignite in Dunn County
(in millions of short tons)

Thickness of beds (ft.)	Category of reserves			
	Measured	Indicated	Inferred	Total
2½-5	772	3,255	60,000	64,027
5-10	304	1,575	3,377	5,256
10+	194	919	646	1,759
Total	1,270	5,749	64,023	71,042

The estimated reserves of the Dunn Center bed and of bed E are given in tables 12 and 13, respectively.

The all-time reported production of lignite in Dunn County, through December 31, 1950, is 278,851 tons, of which 69,843 tons was mined in the years 1941-50. Recent production has been sporadic, ranging from 25,000 tons in 1922 to 3,000 tons in 1937. (See table 2.) More than 70 mines have been opened in Dunn County since 1920, but only five, three of which were new operations, were active in 1950. Practically all the county's production has been from strip mines. Those operating in 1950 follow:

Mines operating in Dunn County in 1950

Name of mine	Location			Type	Bed
	sec.	T.	R.		
Pelton	30	145N	93W	Strip-	[a]I
Sampson	34	144N	96W	--do--	L
Schollmeyer	1	144N	95W	--do--	K
Skalsky	11	144N	92W	--do--	H
Semerad	29	143N	96W	--do--	M

[a] Dunn Center.

McKenzie County

Geography and geology. --McKenzie County is in the western part of North Dakota, south of the Missouri River and between Dunn County on the east and the State of Montana on the west. The county population in 1950 was 6,840; most of the people are engaged in farming and cattle raising. The largest town is Watford City, the county seat, which had a population in 1950 of 1,370 and is the terminus of the branch line of the Great Northern Railway that passes through the towns of Charbonneau, Arnegard, and Cartwright.

The county is in the Missouri Plateau, and the upland surface is deeply dissected by the Missouri, Yellowstone, and Little Missouri Rivers. These rivers have cut wide valleys which, particularly along the Little Missouri, are bordered by belts of badland topography extending 2 to 3 miles on each side of the stream. Altitudes range from about 1,840 feet in the Missouri River valley to about 2,400 feet on the plateau and 2,600 feet in the Blue Buttes, a striking topographic feature of the eastern part of the county.

The exposed bedrock is the Tongue River member of the Fort Union formation except for some of the higher buttes, which are capped by the Golden Valley formation of Eocene age. In the northern part of the county a thin cover of pre-Wisconsin drift remains in some areas, but elsewhere it has been almost completely removed by erosion.

Lignite beds. --The eastern tier of townships in the county (Tps. 149-154 N., R. 94 W.) is partly in the Fort Berthold Indian Reservation, in which the lignite beds were mapped by Bauer and Herald (1921). The southern part of the county (Tps. 145-148 N., Rs. 98-105 W.) was mapped by the Northern Pacific Railway Co. (1923). The remainder of the county has not been mapped, and data for reserve calculations are taken from mine information and from sections in the Bulletins of the North Dakota Geological Survey. Because of the large unmapped area west of the Fort Berthold Reservation in the northern part of the county no attempt has been made to correlate the beds in one area with those in the other. The beds, with their outcrop areas, are listed in table 14, and are discussed only briefly below, as most of the essential information is embodied in the table.

Of the beds in the Fort Berthold Reservation (fig. 12), beds A, B, and C appear to be relatively extensive. Bed A is fairly uniform in its thickness range of 5.7 to 10 feet, and contains only thin clay partings. Bed B is variable in thickness, the range being 2.8 to 9.5 feet; 3.3 feet are measured in T. 151 N., R. 94 W., where the lignite contains clay partings. Bed C is also variable in thickness; in sec. 11, T. 150 N. R. 94 W., it is split into three benches, each of which is almost 4 feet thick, but in other localities in the same general vicinity the lignite is largely replaced by shale.

Bed D of the Fort Berthold Reservation is about 4 feet thick throughout most of its outcrop and usually contains a thin parting of carbonaceous shale near the

Table 12.--Estimated original reserves of lignite in Dunn Center bed (bed I), Dunn County, North Dakota

(in millions of short tons)

Location	Measured reserves			Indicated reserves			Inferred reserves			Total reserves
	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	
T.149N., R.91W.	2.7	612	2.89	2.7	1,704	8.05	2.7	2,070	9.78	20.72
T.149N., R.92W.	...	...	...	2.8	2,253	11.04	2.8	650	3.19	14.23
T.149N., R.93W.	3.0	877	4.60	3.0	5,635	29.58	3.0	4,915	25.80	59.98
T.148N., R.92W.	3.5	3,155	19.33	3.5	3,288	20.14	...	...	...	39.47
T.148N., R.93W.	3.2	3,376	20.46	3.5	4,354	26.67	3.5	1,559	9.55	56.68
T.148N., R.94W.	3.0	795	4.17	3.0	13,794	72.42	3.0	14,021	73.61	150.20
T.148N., R.95W.	3.0	1,010	5.30	3.0	3,142	16.50	3.0	11,043	57.98	79.78
T.148N., R.96W.	...	...	...	...	...	...	2.9	11,137	55.40	55.40
T.148N., R.97W.	...	...	...	...	...	...	2.8	18,936	92.79	92.79
T.147N., R.91W.	3.0	126	0.66	3.0	4,026	21.14	3.0	7,010	36.80	58.60
T.147N., R.92W.	3.8	6,209	38.11	3.5	2,227	13.64	...	...	...	51.75
T.147N., R.93W.	3.5	4,733	28.99	5.3	6,323	39.70	5.3	1,943	17.89	86.58
T.147N., R.94W.	8.1	2,751	34.89	7.4	4,979	57.20	7.8	1,236	16.43	108.52
T.147N., R.95W.	...	...	...	7.0	1,729	21.18	5.8	13,207	111.59	132.77
T.147N., R.96W.	...	...	...	...	...	...	3.5	21,915	134.23	134.23
T.147N., R.97W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.146N., R.91W.	5.2	373	2.38	5.2	6,512	47.33	5.2	15,624	93.50	143.21
T.146N., R.92W.	5.5	4,815	36.61	5.5	10,286	104.26	7.5	4,783	62.78	203.65
T.146N., R.93W.	3.5	183	1.12	5.5	2,543	28.16	10.0	19,864	281.77	311.05
T.146N., R.94W.	12.0	63	1.32	9.7	3,073	51.32	9.0	2,026	27.52	80.16
T.146N., R.95W.	...	...	...	7.0	442	5.41	5.8	23,076	227.28	232.69
T.146N., R.96W.	...	...	...	...	...	...	3.5	23,040	141.12	141.12
T.146N., R.97W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.145N., R.91W.	...	...	...	7.0	63	0.77	5.3	14,002	116.26	117.03
T.145N., R.92W.	7.5	6	0.08	10.0	1,186	16.78	10.0	12,683	187.06	203.92
T.145N., R.93W.	15.0	1,262	33.13	15.0	11,181	293.50	11.5	8,632	225.89	552.52
T.145N., R.94W.	...	...	...	12.5	429	9.39	8.2	22,192	361.58	370.97
T.145N., R.95W.	...	...	...	...	...	...	5.5	23,038	198.71	198.71
T.145N., R.96W.	...	...	...	...	...	...	3.5	23,040	141.12	141.12
T.145N., R.97W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.144N., R.91W.	...	...	...	...	...	...	3.0	8,222	43.17	43.17
T.144N., R.92W.	7.0	297	3.64	5.3	3,338	35.06	5.3	17,314	107.09	145.79
T.144N., R.93W.	...	...	...	10.0	871	15.52	7.8	22,325	219.03	234.55
T.144N., R.94W.	...	...	...	13.0	618	14.06	8.2	22,697	217.38	231.44
T.144N., R.95W.	...	...	...	...	...	...	5.5	23,038	164.24	164.24
T.144N., R.96W.	...	...	...	...	...	...	3.5	23,040	141.12	141.12
T.144N., R.97W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.143N., R.91W.	...	...	...	...	...	...	2.8	18,394	90.13	90.13
T.143N., R.92W.	...	...	...	...	...	...	3.0	18,217	95.64	95.64
T.143N., R.93W.	...	...	...	...	...	...	3.2	14,772	82.72	82.72
T.143N., R.94W.	...	...	...	...	...	...	3.1	9,907	155.13	155.13
T.143N., R.95W.	...	...	...	...	...	...	3.5	17,904	109.66	109.66
T.143N., R.96W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.143N., R.97W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.142N., R.92W.	...	...	...	3.5	353	2.04	3.5	4,089	25.05	27.09
T.142N., R.93W.	5.5	88	0.85	4.8	1,408	10.21	4.1	1,332	7.36	18.42
T.142N., R.94W.	...	...	...	...	...	...	3.3	17,732	91.47	91.47
T.142N., R.95W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.142N., R.96W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.142N., R.97W.	...	...	...	...	...	...	2.7	23,040	108.86	108.86
T.141N., R.92W.	...	...	...	4.0	366	2.56	4.0	10,904	76.33	78.89
T.141N., R.93W.	6.0	745	7.82	5.3	7,175	68.51	5.3	1,162	10.44	86.77
T.141N., R.94W.	...	...	...	4.3	1,275	7.46	4.3	20,628	113.10	120.56
T.141N., R.95W.	...	...	...	...	...	...	2.9	17,788	90.27	90.27
T.141N., R.96W.	...	...	...	...	...	...	2.7	7,181	33.93	33.93
T.141N., R.97W.	...	...	...	...	...	...	2.7	4,297	20.30	20.30
Total		31,476	246.35		104,553	1,049.60		789,925	5,647.49	6,943.44

Table 13.--Estimated original reserves of lignite in Bed E, Dunn County, North Dakota

(in millions of short tons)

Location	Measured reserves			Indicated reserves			Inferred reserves			Total reserves
	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	
T.150N., R.91W.	2.8	235	1.15	...	...	...	...	...	...	1.15
T.150N., R.93W.	2.7	767	3.62	2.7	209	0.99	...	...	...	4.61
T.149N., R.91W.	3.5	4,051	24.81	3.5	14,530	94.08	3.5	61	0.37	119.26
T.149N., R.92W.	3.2	8,401	47.05	3.2	7,469	41.83	...	...	...	88.88
T.149N., R.93W.	2.7	1,243	5.87	2.7	7,462	35.26	2.7	13,054	61.68	102.81
T.148N., R.91W.	3.0	2,130	11.18	3.0	3,633	19.07	...	...	...	30.25
T.148N., R.92W.	4.6	3,303	23.27	4.6	9,029	58.96	3.7	5,015	32.47	114.70
T.148N., R.93W.	3.5	431	2.64	3.5	3,867	23.69	3.5	18,500	113.31	139.64
T.148N., R.94W.	7.0	25	0.31	7.0	1,686	20.65	5.4	21,328	154.97	175.93
T.148N., R.95W.	5.8	8,051	8.55	5.8	5,351	47.99	5.8	14,880	104.28	160.82
T.148N., R.96W.	4.0	32	0.22	4.0	1,014	7.10	4.0	20.611	144.28	151.60
T.148N., R.97W.	...	...	...	...	...	...	3.5	23,040	141.12	141.12
T.147N., R.91W.	2.6	1,908	8.68	2.6	9,764	44.43	2.6	10,949	49.82	102.93
T.147N., R.92W.	4.9	4,121	30.53	3.8	8,768	67.56	4.8	1,395	11.59	109.68
T.147N., R.93W.	5.2	3,385	27.06	5.4	13,840	100.19	4.0	2,511	17.58	144.83
T.147N., R.94W.	8.8	2,225	32.70	7.3	10,962	140.99	6.0	5,490	68.80	242.49
T.147N., R.95W.	8.0	2,850	53.16	9.8	7,594	103.09	8.0	10,258	135.55	291.80
T.147N., R.96W.	5.5	615	6.20	5.5	3,233	29.29	5.5	20,016	146.64	182.13
T.147N., R.97W.	...	...	...	...	...	...	3.5	23,040	141.12	141.12
T.146N., R.91W.	...	...	...	...	.....	. ...	3.5	23,040	141.12	141.12
T.146N., R.92W.	5.6	571	5.60	5.6	4,425	43.37	5.1	17,460	143.71	192.68
T.146N., R.93W.	...	...	...	4.8	3,227	25.19	4.8	19,128	135.87	161.06
T.146N., R.94W.	...	...	...	...	...	...	5.8	23,039	194.27	194.27
T.146N., R.95W.	...	...	...	...	...	...	5.8	23,040	197.81	197.81
T.146N., R.96W.	...	...	...	...	...	...	4.5	23,040	181.44	181.44
T.146N., R.97W.	...	...	...	...	...	...	3.5	23,040	141.12	141.12
T.145N., R.91W.	...	...	...	...	...	...	3.5	23,040	141.12	141.12
T.145N., R.92W.	...	...	...	...	...	...	4.0	23,040	161.28	161.28
T.145N., R.93W.	...	...	...	...	...	...	3.5	23,040	141.12	141.12
T.145N., R.94W.	...	...	...	...	...	...	4.0	23,040	161.28	161.28
T.145N., R.95W.	...	...	...	...	...	...	3.5	23,040	141.12	141.12
T.145N., R.96W.	...	...	...	...	...	...	4.0	23,040	161.28	161.28
T.145N., R.97W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.144N., R.91W.	...	...	...	4.8	4,413	32.86	4.0	18,583	130.08	162.94
T.144N., R.92W.	...	...	...	...	...	...	3.5	23,040	141.12	141.12
T.144N., R.93W.	...	...	...	...	...	...	3.2	23,040	129.02	129.02
T.144N., R.94W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.144N., R.95W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.144N., R.96W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.144N., R.97W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.143N., R.91W.	11.0	89	1.71	7.2	1,921	16.51	3.0	21,030	110.41	128.63
T.143N., R.92W.	9.3	120	2.08	5.7	4,223	26.95	2.8	18,697	91.62	120.65
T.143N., R.93W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.143N., R.94W.	...	...	...	...	...	...	3.5	23,040	141.12	141.12
T.143N., R.95W.	...	...	...	...	...	...	3.5	23,040	141.12	141.12
T.143N., R.96W.	...	...	...	...	...	....	3.5	23,040	141.12	141.12
T.143N., R.97W.	...	...	...	...	...	...	3.5	23,040	141.12	141.12
T.142N., R.91W.	6.7	1,712	8.82	6.8	4,032	21.74	2.8	1,744	8.55	39.11
T.142N., R.92W.	7.2	2,303	17.96	5.8	8,908	55.01	3.0	8,927	46.87	119.84
T.142N., R.93W.	...	...	...	3.0	1,870	9.82	3.0	21,169	111.14	120.96
T.142N., R.94W.	...	...	...	...	...	...	3.5	23,040	141.12	141.12
T.142N., R.95W.	...	...	...	...	...	...	4.0	23,040	161.28	161.28
T.142N., R.96W.	...	...	...	...	...	...	4.0	23,040	161.28	161.28
T.142N., R.97W.	...	...	...	...	...	...	4.0	23,040	161.28	161.28
T.141N., R.91W.	...	...	...	2.5	1,204	5.27	2.5	5,668	24.80	30.07
T.141N., R.92W.	...	...	...	...	...	...	2.6	15,349	69.83	69.83
T.141N., R.93W.	...	...	...	...	...	...	3.0	15,360	80.64	80.64
T.141N., R.94W.	...	...	...	...	...	...	4.0	23,040	161.28	161.28
T.141N., R.95W.	...	...	...	...	...	...	5.3	23,040	184.17	184.17
T.141N., R.96W.	14.0	716	17.54	10.8	3,354	73.09	6.0	16,218	204.44	295.07
T.141N., R.97W.	10.3	4,795	76.31	6.0	10,561	160.25	6.0	4,000	34.26	270.82
Total		54,078	417.02		156.549	1,305.23		1,041,640	6,809.55	8,531.80

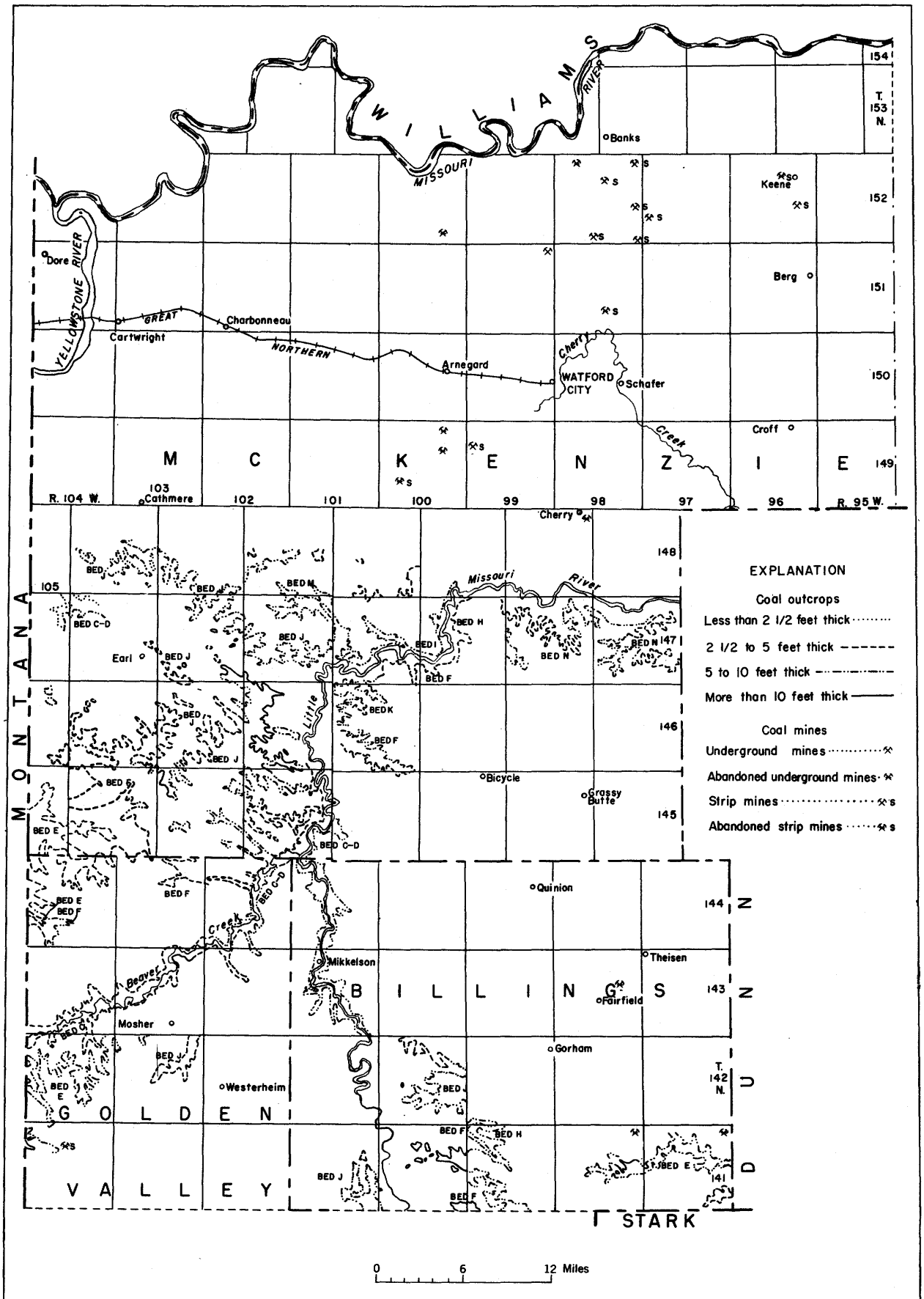


Figure 15.--Lignite outcrops in McKenzie County and parts of Golden Valley and Billings Counties, North Dakota.

top. Bed E, approximately 40 feet above bed D, is 6 feet thick in sec. 9, T. 151 N., R. 94 W., but is irregular in thickness, and a general thinning and development of splits and bone partings is evident in T. 150 N., R. 94 W. Leonard (Leonard and others, 1925, pp. 81, 104) recognized bed E as the Reservation bed for a long distance in the Little Missouri River valley. Bed F, though thin at most of its outcrops, reaches 6.5 feet in thickness in sec. 36, T. 152 N., R. 95 W. Bed G is exposed in only a small area in McKenzie County. In sec. 18, T. 151 N., R. 94 W., it contains about 3 feet of lignite with a 1-foot parting near the base; its maximum known thickness is 6.5 feet, but the average is not more than 4 feet.

Bed H also crops out in sec. 18, T. 151 N., R. 94 W. It is thin, but apparently extensive, and has been burned over much of its outcrop. Bed I is thin, but is probably continuous over a moderate area in the eastern part of McKenzie County. Beds J, K, L, M, and O, although not known to appear at the surface, are considered to underlie parts of the county on the basis of outcrops in Dunn County. Bed N is exposed south of the Little Missouri River in T. 147 N., R. 98 W., where its greatest measured thickness is 6.3 feet, its minimum thickness 2.7 feet, and its average thickness about 4 to 5 feet.

Of the beds that are mapped in the southern part of McKenzie County (fig. 15), beds F, G, I, and J are most important. The lowest bed, E, is projected into the southern part of McKenzie County from outcrops in Dunn County. The other beds, C through M, are all apparently of minable thickness over considerable areas. The thickest are beds I and J. Since these beds are in the upland area, they may be covered with only thin or moderate overburden.

The designations of the beds in the unmapped northwestern part of McKenzie County, U to Z (table 14), are used for convenience only and do not represent a regular sequence. The lowest extensive bed in the group is bed Y, which is about 70 feet above the water level of the Missouri River. Bed X is exposed in mines and outcrops in the valleys of the Yellowstone River and its tributaries, from water level to about 60 feet above. The bed is minable wherever reported, but does not exceed 6 feet in thickness. Bed Z is about 200 to 250 feet above bed Y and appears to underlie a considerable area in the northern part of the county. The uppermost group, beds U, V, and W, are possibly the same bed, but data are too incomplete to make a definite statement to that effect.

Reserves and production.--The lignite reserves of McKenzie County are estimated at 32,183 million tons, as summarized below. Figures by townships are given in table 25.

Estimated original reserves of lignite in McKenzie County
(in millions of short tons)

Thickness of beds (ft.)	Category of reserves			
	Measured	Indicated	Inferred	Total
2½-5	384	2,102	23,804	26,290
5-10	761	2,116	2,665	5,542
10+	26	309	16	351
Total	1,171	4,527	26,485	32,183

The all-time production of lignite in McKenzie County from the beginning of mining through 1950 is about 117,000 tons, of which 70,000 tons was produced from 1941 through 1950. The present annual production averages about 7,000 tons, most of which is recovered by stripping. In 1950 there were 11 active mines in the county, as listed below.

Mines operating in McKenzie County in 1950

Name of mine	Location			Type	Bed
	sec.	T.	R.		
Shelley	33	152N	98W	Strip-	U
Skogheim	24	152N	98W	--do--	U
Wold	1	152N	98W	--do--	U
Aagvik Bros.	24	152N	98W	--do--	U
Nygard	36	152N	98W	--do--	U
Pederson	10	152N	98W	--do--	U
Bond	30	152N	97W	--do--	U
Edwardson	23	152N	96W	--do--	G?
Northfork Community	19	150N	97W	--do—	V
O'Kay	7	149N	99W	--do--	W
Johnson	1	148N	99W	Drift-	W

Golden Valley County

Geography and geology.--Golden Valley County is south of McKenzie County, along the western border of North Dakota. The population in 1950 was 3,487; most of the people are supported by farming or farm service industries. The largest town is Beach, which has a population of 1,457. Other towns are Sentinel Butte and Golva. The county is served by the main line of the Northern Pacific Railway.

Most of Golden Valley County is a rolling plain standing about 2,900 to 3,000 feet above sea level, although the eastern part of the area bordering the Little Missouri River is deeply dissected into badland topography. Several buttes stand about 500 feet above the plain; the most prominent are Sentinel Butte, Square Butte, and Camels Hump Butte in the central part, and part of the western edge of Bullion Butte in the southeastern corner of the county. Elevations in the valley of the Little Missouri River range from 2,200 feet in the northern part of the county to 2,500 feet in the southern part.

The lowest outcropping bedrock unit is the Ludlow member of the Fort Union formation, which contains four minable beds of lignite. Above the Ludlow is the Tongue River member of the Fort Union, which contains most of the estimated reserves. Overlying the Tongue River is the Sentinel Butte shale member of the Fort Union, which contains a small amount of lignite. It is not known whether any Eocene deposits remain in the county; but the highest buttes are capped by the White River formation of Oligocene age, which contains no lignite.

Lignite beds.--The central part of Golden Valley County was described by Leonard (1908), and the southern portion by Hares (1928). The entire area was mapped by the Northern Pacific Railway in 1923, using the same bed designations as those employed in southern McKenzie County. As different designations were used in the mapping of different parts of Golden Valley County,

Table 14.--Lignite beds in McKenzie County, North Dakota

Bed	Outcrop locations	Thickness at outcrop (in feet)			Approximate area (in square miles)
		Max.	Min.	Ave.	
	Beds in northeastern part of county				
O	(1)	...	...	...	110
N	T. 147.N., R. 98-99 W.	6.3	2.7	4.5	140
M	(1)	...	...	...	180
L	(1)	...	...	...	70
K	(1)	...	...	...	70
J	(1)	...	...	...	150
I	T. 151 N., R. 94 W.	2.9	2.6	2.7	250
H	T. 151 N., R. 94 W.	4.1	2.6	3.3	250
G	T. 151 N., R. 94 W.	4.7	4.0	4.3	600
F	T. 149-152 N., R. 94 W.	6.5	2.5	4.5	400
E	T. 150-152 N., R. 94-95 W.	6.0	2.2	4.1	500
D	T. 149-151 N., R. 94-95 W.	4.0	2.0	3.0	400
C	T. 150-151 N., R. 94 W.	11.2	2.8	7.0	450
B	T. 150-151 N., R. 94 W.	9.5	2.8	6.2	450
A	T. 151 N., R. 94 W.	10.0	5.7	7.8	450
	Beds in southwestern part of county				
M	T. 148 N., R. 100-104 W.	9.3	3.1	6.2	50
L	T. 147-148 N., R. 102-103 W.	5.2	3.0	4.1	10
K	T. 145-148 N., R. 102-104 W.	5.1	3.0	4.0	24
J	T. 145-148 N., R. 100-105 W.	14.5	1.5	8.0	300
I	T. 147 N., R. 100-102 W.	13.4	7.0	10.2	80
H	T. 146-147 N., R. 100-101 W.	4.5	2.6	3.5	10
G	T. 147 N., R. 101 W.	9.5	2.0	5.7	3
F	T. 145-146 N., R. 100-104 W.	11.0	2.5	6.7	45
E	T. 145-146 N., R. 100-103 W.	6.0	4.0	5.0	10
D	T. 145 N., R. 100-103 W.	3.9	2.6	3.3	400
C	T. 145-147 N., R. 101-104 W.	8.3	2.8	5.6	400
B	(1)	...	...	...	20
	Unmapped and uncorrelated beds				
Z	T. 151-153 N., R. 97-101 W.	8.6	4.0	6.3	400
Y	T. 152-153 N., R. 95-100 W.	11.8	6.3	9.0	300
X	T. 150-151 N., R. 101-104 W.	6.0	3.0	4.5	250
V	T. 152-153 N., R. 97-98 W.	5.2	5.1	5.1	4
W	T. 151-153 N., R. 97-99,95 W.	5.2	2.7	3.9	30
U	T. 150 N., R. 100 W.	...	...	3.0	3

1/ Projected into McKenzie County from outcrops in Dunn County.

a certain amount of correlation is necessary in discussing the beds. The areas covered by the different maps are shown in figure 5; the outcrops in Golden Valley County in figure 15 (northern part) and figure 16 (southern part).

The lowest exposed lignite in the county is the Yule group (Leonard, 1908, pp. 77-80). Bed C of this group (Hares, 1928) crops out in the southern part of T. 136 N., R. 105 W. (fig. 16). Although in that township it is too thin to mine, it apparently thickens to the south. Bed C', about 3.7 feet thick, crops out in the same township. The Yule bed, or bed E, is 3.0 to 10.5 feet thick, probably averaging 5 feet, in T. 136 N., Rs. 105-106 W. The Yule bed is the highest known minable lignite in the Ludlow member of the Fort Union formation in Golden Valley County.

The lowest bed in the Tongue River member of the Fort Union is bed H, which crops out in the southern part of the county, where it is 2.3 to 9.0 feet thick but contains a persistent parting 0.8 to 2.0 feet thick. The next higher bed is the Harmon bed, which crops out over large areas in T. 137 N., Rs. 103-104 W. It ranges in thickness from 2.7 feet in sec. 19, T. 137 N., R. 103 W., to 9.0 feet in sec. 11 of the same township; from that area it thickens to the southeast and to a less extent to the northeast and southwest. It probably underlies a large area in the southern part of the county.

The Burkey bed is mapped in Tps. 137-138 N., Rs. 105-106 W., where it is 3.8 to 7.8 feet thick and is relatively free from partings. It is possibly equivalent to the Garner Creek bed, or possibly to a bed lower than the Garner Creek (Hares, 1928, pp. 47, 63).

The Garner Creek bed probably underlies most of Golden Valley County. In the southeastern part of the county it is about 4 feet thick except in secs. 2 and 3, T. 138 N., R. 104 W., where it thickens to 7.0 feet. It is correlated with bed K of Leonard (Leonard and others, 1925, p. 45) which crops out in T. 139 N., R. 102 W., and Tps. 139-140 N., R. 93 W., and with bed C of the northern part of the county (N. P. Ry. Co., 1923) and of the Beaver Creek area (Leonard and Smith, 1909). Bed C in the northern part of the county averages about 5 feet thick and the lignite contains few partings.

Much of the northeastern part of the county is underlain by bed B (N. P. Ry. Co., 1923), which is possibly the equivalent of bed J of Leonard (Leonard and others, 1925). Bed B, as estimated from outcrops in Billings County, is probably about 5 feet thick.

Bed D (fig. 15) crops out in the valley of Beaver Creek, where its average thickness is 3.0 to 3.5 feet. In at least one outcrop, between sec. 25, T. 143 N., R. 105 W., and sec. 1, T. 142 N., R. 105 W., its average thickness is more than 5 feet.

Bed E crops out in the valley of Beaver Creek not far above bed D. Its thickness ranges from 4.0 to 6.5 feet and is fairly uniform over large areas. Bed E is possibly the bed formerly mined at Beach.

Bed F crops out mostly in T. 144 N., R. 105 W. It is only 2.6 to 5.5 feet thick in Golden Valley County, though to the north in McKenzie County it is as much as 11 feet thick locally.

The highest known commercial lignite bed in the county is the Sentinel Butte bed, or bed G, which is best exposed in Sentinel Butte in secs. 5-8, T. 139 N., R. 104 W., and in Bullion Butte in the northeast part of T. 137 N., R. 103 W. In Sentinel Butte the lignite has an average thickness of about 20 feet; in Bullion Butte, about 10 to 15 feet.

Reserves and production.--The lignite reserves of Golden Valley County are estimated at 8,319 million tons, as summarized below. For reserves by townships, see table 25.

Estimated original reserves of lignite in Golden Valley County
(in millions of short tons)

Thickness of beds (ft.)	Category of reserves			
	Measured	Indicated	Inferred	Total
2½-5	127	1,507	4,696	6,330
5-10	206	979	691	1,876
10+	28	77	8	113
Total	361	2,563	5,395	8,319

The estimated reserves of the Garner Creek bed are given in table 15.

Reported production of lignite in Golden Valley County through 1950 totals 141,409 tons, of which 58,103 tons were mined in the years 1941-50. Present production is about 3,500 tons annually. Most of the mining has been by underground methods, and comparatively little strip-mining has been done. The only mine operating in the county in 1950 was the Mammoth Coal Mine, located in sec. 5, T. 139 N., R. 104 W., in the Sentinel Butte bed.

Billings County

Geography and geology.--Billings County is east of Golden Valley County and south of McKenzie County. The population in 1950 was 1,769 persons, most of whom are supported by agriculture. Medora, the county seat, is in the midst of the spectacular Badlands of the Little Missouri River. The main line of the Northern Pacific Railway crosses the county via Fryburg and Medora.

The western part of Billings County is deeply dissected into badlands by the Little Missouri River, which runs north near the county line. Elevations above sea level range from about 2,200 feet in the Little Missouri River valley to about 2,900 feet on the general plateau surface; the highest point in the county is Bullion Butte, the altitude of which is 3,376 feet. In the eastern part of the county the drainage is eastward, and the terrane is deeply dissected by the Heart and Cannonball Rivers.

The oldest rocks exposed in Billings County are in the Tongue River member of the Fort Union formation. Overlying this member is the Sentinel Butte shale member, which is present in Bullion Butte. The higher buttes are capped by the White River formation of Oligocene age. All of the known minable lignite is in the Tongue River member of the Fort Union, though it is possible that detailed exploration might show that

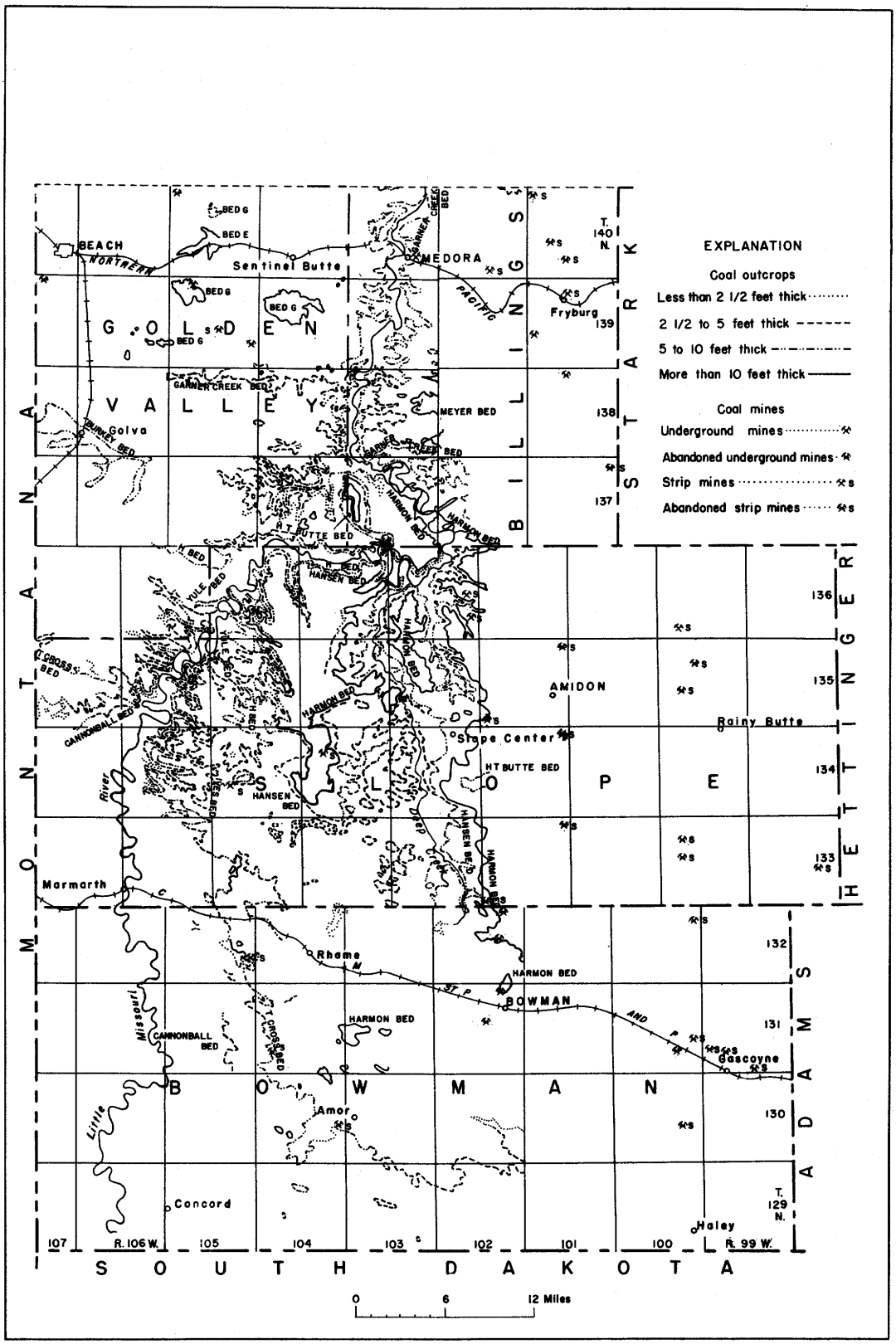


Figure 16.--Lignite outcrops in Slope and Bowman Counties, and parts of Billings and Golden Valley Counties, North Dakota.

Table 15.--Estimated original reserves of lignite in Garner Creek bed, Golden Valley County, North Dakota

(in millions of short tons)

Location	Measured reserves			Indicated reserves			Inferred reserves			Total reserves
	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	
T.144N., R.103W.	4.1	4,007	36.29	4.1	14,259	123.37	4.6	1,536	10.88	170.54
T.144N., R.104W.	3.0	237	1.24	3.0	4,205	22.08	3.0	19,411	101.91	125.23
T.144N., R.105W.	...	...	...	2.9	2,304	11.69	2.9	20,454	103.80	115.49
T.143N., R.103W.	4.9	2,792	26.54	4.9	11,632	108.06	4.9	6,894	59.72	194.32
T.143N., R.104W.	5.0	3,795	29.43	5.0	11,903	93.26	5.0	4,711	36.02	158.71
T.143N., R.105W.	5.0	1,510	13.97	5.0	9,024	53.38	3.0	9,382	49.26	116.61
T.142N., R.103W.	...	...	...	6.0	38	0.40	5.2	22,940	205.12	205.52
T.142N., R.104W.	6.0	166	1.74	6.0	2,394	25.14	5.0	20,768	159.89	186.77
T.142N., R.105W.	4.4	531	5.37	4.4	3,725	27.86	4.4	17,510	88.78	122.01
T.141N., R.103W.	...	...	...	...	...	...	4.5	23,040	157.75	157.75
T.141N., R.104W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.141N., R.105W.	...	...	...	...	...	...	2.7	23,040	108.86	108.86
T.140N., R.103W.	...	...	...	6.3	12,745	140.51	4.0	9,431	66.02	206.53
T.140N., R.104W.	...	...	...	...	...	...	3.1	23,040	124.99	124.99
T.140N., R.105W.	...	...	...	...	...	...	2.9	23,040	116.93	116.93
T.140N., R.106W.	...	...	...	...	...	...	2.7	10,811	51.08	51.08
T.139N., R.103W.	3.5	191	1.17	4.9	4,553	32.39	4.9	17,552	146.93	180.49
T.139N., R.104W.	4.3	304	1.64	3.0	5,880	30.87	3.0	16,396	86.08	118.59
T.139N., R.105W.	...	...	...	2.9	1,911	9.70	2.9	20,949	106.32	116.02
T.139N., R.106W.	...	...	...	...	...	...	2.8	11,144	54.61	54.61
T.138N., R.103W.	4.5	2,701	18.62	4.5	12,672	82.36	...	...	...	100.98
T.138N., R.104W.	5.0	998	8.11	5.0	12,057	93.50	4.0	8,762	61.33	162.94
T.138N., R.105W.	...	...	...	3.5	3,258	19.96	3.5	19,373	118.66	138.62
T.138N., R.106W.	...	...	...	...	...	...	3.0	3,594	18.87	18.87
T.137N., R.103W.	4.9	2,355	15.30	6.3	410	4.52	3.5	6,010	36.81	56.63
T.137N., R.104W.	3.3	333	1.92	3.3	7,954	45.93	3.3	8,128	46.94	94.79
T.137N., R.105W.	...	...	...	...	...	...	3.3	5,171	29.86	29.86
Total		19,920	161.34		120,924	924.98		376,127	2,268.38	3,354.70

the underlying Ludlow member contains lignite beds of minable thickness.

Lignite beds.--Of the 18 beds in Billings County for which reserves are estimated, six apparently underlie large areas. The lowest known lignite is the Harmon bed, which crops out in the valley of the Little Missouri River in Tps. 137-138 N., Rs. 101-102 W. (See fig. 16.) The bed in that area ranges in thickness from 7.0 to 20.5 feet and probably averages more than 10 feet. It disappears beneath the river in the southern part of T. 139 N., R. 101 W., and has not been identified in the northern part of the county.

The Hansen bed crops out along the Little Missouri River in the most southern part of the county; the thickest exposure is in sec. 33, T. 137 N., R. 102 W., where the bed is more than 20 feet thick but is separated into benches 5.0 and 15.5 feet thick respectively, by a parting 17 feet thick. North and west of this exposure the bed thins, but it probably has an average thickness of more than 10 feet thick in its outcrop area in Billings County.

The Garner Creek bed which, as discussed under Golden Valley County, is correlated with bed C of Leonard and Smith (1909) and bed K of Leonard (Leonard and others, 1925), crops out near water level in the valley of the Little Missouri River and disappears beneath the water in sec. 32, T. 139 N., R. 101 W. A bed which may be the same reappears, however, in sec. 35, T. 143 N., R. 102 W. The Garner Creek bed, which contains a few thin partings, thins eastward and northeastward from this area.

The Meyer bed is exposed in the lower parts of Bullion Butte in T. 137 N., R. 102 W., about 200 feet above the Garner Creek bed (Hares, 1928, p. 14). It has also been mapped in a few places north of that area. The bed ranges in thickness from 3.0 to 5.9 feet, but the quality of the lignite is said to be poor (Hares, 1928, p. 66).

The HT Butte bed is exposed in Bullion Butte, about 25 feet above the Meyer bed. It reaches a thickness of 11 feet, but its area of occurrence is so small that it has little commercial value.

The Bullion Butte bed is found only in Bullion Butte, which is mostly in T. 137 N., R. 102 W., but extends a short distance into R. 103 W., in Golden Valley County. One measured section shows the bed to be 11.9 feet thick, but, like the HT Butte bed, it underlies only a small area.

In the northern part of Billings County, bed C, the equivalent of the Garner Creek bed, crops out in the valley of the Little Missouri River. (See fig. 15.) A lower bed, bed J, was recognized by Leonard and others (1925) in this part of the county. It crops out in the valleys of the Little Missouri River and Beaver Creek in T. 139 N., R. 102 W., where it is as much as 7.5 feet thick. Bed J may be correlated with a bed at the same general horizon that crops out in Tps. 143-144 N., R. 102 W., at thicknesses ranging from 2.7 to 6.0 feet.

Bed D of Leonard and Smith (1909) and of the Northern Pacific Railway Co. (1923), which is probably equivalent to bed L of Leonard (Leonard and others, 1925), is generally thin at its exposures in the Little Missouri River valley. Bed E (N. P. Ry. Co., 1923), which may be equivalent to bed M of Leonard, crops out in T. 141 N., Rs. 98-99 W., in the southeastern part of Billings County. It is 4.0 to 10.0 feet thick along its outcrop in Billings County, and even thicker to the east in Stark County. Small isolated areas of lignite that may be equivalent to bed E have been mapped in the lower part of the Little Missouri River valley.

Bed F of Leonard and Smith (1909) and the Northern Pacific Railway Co. (1923) is exposed in the northern part of the county, where the maximum thickness of the bed is 16 feet in sec. 12, T. 141 N., R. 101 W. In several buttes within two or three miles of that locality the bed is 10 to 12 feet thick. It probably underlies most of the northeastern portion of the county and thins northward and southward.

Bed G probably underlies 3 or 4 square miles in T. 142 N., Rs. 101-102 W., at thicknesses ranging from 4.5 to 6.0 feet. On the basis of data from Dunn and Stark Counties, the same bed possibly underlies a considerable area in the northeastern part of the county.

Beds H, I, and J, which are mapped in Dunn and Stark Counties, probably underlie a part of the northeastern portion of Billings County.

Reserves and production.--The lignite reserves of Billings County are estimated at 17,718 million tons, as summarized below. Reserves by townships are given in table 25.

Estimated original reserves of lignite in Billings County
(in millions of short tons)

Thickness of beds (ft.)	Category of reserves			
	Measured	Indicated	Inferred	Total
2½-5	63	759	9,198	10,020
5-10	252	1,066	2,442	3,760
10+	213	1,304	2,421	3,938
Total	528	3,129	14,061	17,718

The estimated reserves of the Garner Creek bed are given in table 16.

The all-time production of lignite in Billings County from 1914 through 1950 is reported as 313,000 tons. Largest annual production was 44,773 tons in 1922; since that year production has dropped steadily until in the late 1940's little or no lignite was mined in the county. The 1950 production was 754 tons, from the Garner Creek bed at the Little Missouri mine in sec. 26, T. 140 N., R. 102 W. Most of the production from Billings County has been by underground methods.

Slope County

Geography and geology.--Slope County is south of Golden Valley and Billings Counties and is bounded on the west by the State of Montana. The population in 1950 was 2,308; 102 lived in Amidon, the county seat, and 626 in Marmarth. The Chicago, Milwaukee, St. Paul, and Pacific Railroad crosses the southwestern part of the county. The principal industry is cattle raising.

The eastern part of Slope County is a rolling plateau on which a few buttes stand above the general level of 2,900 to 3,000 feet. The highest of these, HT Butte, is located about 12 miles southwest of Amidon, and stands 3,474 feet above sea level. Approximately the western half of the county is in the drainage area of the Little Missouri River and over large areas is deeply dissected into badlands.

The lowest exposed formation is the Pierre shale of Upper Cretaceous age, which crops out in a relatively small area in the western part of the county. (See pl. 1.) The Pierre is overlain by the Fox Hills sandstone, and the Fox Hills by the Hell Creek formation, both of Upper Cretaceous age; these formations are exposed in the low land in the western part of the county. Above the Hell Creek formation is the Fort Union formation of Paleocene age, which in this area is composed of three members; the lowest or Ludlow, the Tongue River, and the Sentinel Butte shale (Hares, 1928, pl. 14). It is possible that Eocene sediments lie over the Fort Union, though none have as yet been identified; the highest formation in the county is the White River formation of Oligocene age, which caps HT Butte. Most of the lignite in the county is in the Tongue River member of the Fort Union formation, though the underlying Ludlow member also contains fairly large reserves.

Lignite beds.--Four of the 24 known lignite beds in Slope County (see fig. 16) underlie fairly large areas. The lowest is the Cannonball bed, which crops out at minable thickness along Cannonball Creek in T. 135 N., Rs. 105-106 W. In sec. 25, T. 135 N., R. 106 W., it is more than 5 feet thick, but 2 miles west it thins to less than 2 feet. To the east it disappears below the stream level and its thickness is not known.

The next higher bed, the Beta bed, crops out in T. 134 N., R. 105 W. It has a maximum known thickness of 4.0 feet but over most of its outcrop area is of less than minable thickness.

The T Cross bed, which underlies large parts of Slope and Bowman Counties, crops out in the east side of the Little Missouri River Valley. Its thickness

Table 16.--Estimated original reserves of lignite in Garner Creek bed, Billings County, North Dakota
(in millions of short tons)

Location	Measured reserves			Indicated reserves			Inferred reserves			Total reserves
	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	
T.144N., R.98W.	...	...	...	...	...	...	4.5	23,040	181.44	181.44
T.144N., R.99W.	...	...	...	...	...	...	4.5	23,040	181.44	181.44
T.144N., R.100W.	...	...	...	...	...	...	4.8	23,040	193.54	193.54
T.144N., R.101W.	...	...	...	...	...	...	6.2	23,039	218.81	218.81
T.144N., R.102W.	5.3	4,398	50.12	5.3	9,400	105.72	5.7	4,546	49.69	205.53
T.143N., R.98W.	...	...	...	...	...	...	4.5	23,040	181.44	181.44
T.143N., R.99W.	...	...	...	...	...	...	4.5	23,040	181.44	181.44
T.143N., R.100W.	...	...	...	...	...	...	5.9	23,038	198.14	198.14
T.143N., R.101W.	...	...	...	9.0	1,324	17.36	6.2	21,926	277.94	295.34
T.143N., R.102W.	9.5	7,086	111.90	9.5	10,198	144.40	7.0	1,903	23.31	279.61
T.142N., R.98W.	...	...	...	...	...	...	4.5	23,040	181.44	181.44
T.142N., R.99W.	...	...	...	...	...	...	4.5	23,040	181.44	181.44
T.142W., R.100W.	...	...	...	...	...	...	5.9	23,038	231.59	231.59
T.142N., R.101W.	...	...	...	9.3	534	9.57	9.3	22 415	306.87	306.44
T.142N., R.102W.	12.5	540	11.81	10.0	8,661	169.93	10.0	13,728	182.55	364.29
T.141N., R.98W.	...	...	...	...	...	...	4.5	23,040	181.44	181.44
T.141N., R.99W	...	...	...	...	...	...	4.5	23,040	181.44	181.44
T.141N., R.100W	...	...	...	...	...	...	5.8	23,039	253.47	253.47
T.141N., R.101W.	...	...	...	7.3	849	10.85	7.3	22,190	283.48	294.33
T.141N., R.102W.	...	...	...	...	...	...	7.5	23,040	302.40	302.40
T.140N., R.100W.	...	...	...	...	...	...	5.8	23,037	213.02	213.02
T.140N., R.101W.	...	...	...	7.0	2,664	32.63	7.0	19,580	239.86	272.49
T.140N., R.102W.	7.0	1,075	13.17	7.0	10,524	128.92	7.0	6,576	80.56	222.65
T.139N., R.100W.	...	...	...	...	...	...	5.4	23,038	193.55	193.55
T.139N., R.101W.	...	...	...	9.3	275	5.23	7.8	22,942	270.25	275.48
T.139N., R.102W.	5.3	902	15.61	7.8	7,973	128.65	9.2	4,693	53.52	197.78
T.138N., R.100W.	...	...	...	...	...	...	4.5	23,040	181.44	181.44
T.138N., R.101W.	4.8	96	0.81	5.9	3,362	28.79	5.9	19,579	164.84	194.44
T.138N., R.102W.	6.3	4,353	44.14	5.4	10,856	101.46	...	...	...	145.60
T.137N., R.100W.	...	...	...	...	...	...	4.5	12,819	100.95	100.95
T.137N., R.101W.	4.8	32	0.27	4.8	250	2.10	...	...	...	2.37
T.137N., R.102W.	4.2	791	6.23	4.2	1,235	10.21	...	...	...	16.44
Total		19,273	254.06		67,305	895.82		564,566	5,461.27	6,611.15

is notably irregular from place to place, ranging from 2.5 to 24 feet. In T. 134 N., R. 105 W. the general thickness range is 3.0 to 9.0 feet, but at one locality, in sec. 25, the bed measures 14.7 feet thick. North of that township it appears to thin. To the southeast, in T. 133 N., R. 104 W., the maximum thickness of 24 feet is reached, with an average thickness of 15 feet over a considerable area.

Beds C, C', and D are apparently of local extent only. Bed C is largely confined to T. 135 N., R. 105 W., where it thickens rapidly from 3.0 feet in the southern part of the township to as much as 13.8 feet in the central part. Bed C' covers a somewhat larger area than bed C, at a relatively uniform thickness of about 4 feet. Bed D crops out in approximately the same area as beds C and C' and is irregular in thickness; the maximum is 7.5 feet, but only a few localities show as much as 5 feet, and at some outcrops this lignite bed is of less than minable thickness.

The Yule bed crops out in the northwestern part of the county, in Tps. 135-136 N., Rs. 104-105 W. In general the bed thickens from 2.5 to 3.0 feet in the southern part of its outcrop area, to 5.5 to 8.1 feet in the northern part, in T. 136 N., R. 104 W. Farther south, in T. 134 N., Rs. 104-105 W., a bed named the Ives bed, which is possibly equivalent to the Yule bed, averages about 3.0 feet thick, and in T. 133 N., R. 104 W., the thickness increases to 4.5 feet. The Yule and Ives are the highest known lignite beds in the Ludlow member of the Fort Union formation in Slope County.

The lowest bed in the Tongue River member is bed H, which crops out in the western part of the county. It is 2.0 to 8.0 feet thick, and east of the Little Missouri River it maintains a fairly uniform thickness of about 6.0 feet. It crops out in Tps. 134-136 N., Rs. 102-105 W., and thins to the east and southeast.

The Hansen bed crops out in two areas, separated by a belt about 8 or 10 miles wide in which the lignite has been removed by erosion. The western outcrops are in Tps. 133-136 N., R. 104 W. There the average thickness of the lignite is more than 5 feet. The minimum thickness, in sec. 25, T. 135 N., R. 104 W., is 4.1 feet, but the bed is thicker in nearly all known exposures and in sec. 2 of the same township reaches 13.7 feet. The eastern outcrop of the bed is in the vicinity of Deep Creek and southward in Tps. 133-136 N., R. 102 W. The thickness range in this area is commonly 3.0 to 6.0 feet, and the maximum measured thickness is 10.6 feet. This bed thins to the southwest, but in an irregular manner. In the southern part of the county it crops out in small isolated buttes in the divide areas at thicknesses ranging from 2.5 to 8.0 feet. The bed is probably present at minable thickness in large areas in the west-central part of Slope County.

The Harmon bed underlies large areas in Slope County at thicknesses of 10 feet or more. It is exposed in outliers in the northwestern part of the county, in Tps. 135-136 N., Rs. 103-104 W.; in these outliers the lignite is 4.0 to 12.7 feet thick along the western side and 5.0 to 18.2 feet on the east side. East of the area mentioned above, in Tps. 133-137 N., R. 102 W., the bed is exposed for long distances at thicknesses of 10.5 to 38 feet, usually 20 feet or more. In sec. 19, T. 133 N., R. 101 W., the bed is only 5.5 feet thick, but this measurement apparently represents only a local thinning.

The highest bed in Slope County is the HT bed, which crops out in HT Butte in the east-central part of T. 134 N., R. 102 W. This bed is in the base of the Sentinel Butte shale member of the Fort Union (Hares, 1928, pl. 14.)

As only the western part of Slope County has been mapped in detail, it is probable that additional mapping, particularly in the eastern part of the county, would disclose additional beds of lignite and increase the reserve estimates of the mapped beds.

Reserves and production.--The estimated original reserves of lignite in Slope County are 20,091 million tons, which are listed by townships in table 25 and summarized below. The reserves are unusual in that about two-thirds of the total tonnage is in beds more than 10 feet thick.

Estimated original reserves of lignite in Slope County
(in millions of short tons)

Thickness of beds (ft.)	Category of reserves			
	Measured	Indicated	Inferred	Total
2½-5	72	1,177	2,229	3,478
5-10	170	1,827	717	2,714
10+	396	2,601	10,902	13,899
Total	638	5,605	13,848	20,091

Estimated reserves of the Harmon bed in Slope County are given in table 17.

The total reported production of coal in Slope County through 1950 is only 23,591 tons, of which 8,887 tons were mined in the years 1941-50. In the past, 30 or more mines have been opened in the county, but in 1950 only the Gress mine in sec. 24, T. 136 N., R. 102 W. was active. In that year it recovered 340 tons of lignite from the Harmon bed by stripping.

Bowman County

Geography and geology.--Bowman County is south of Slope County, in the southwestern corner of North Dakota. Its population in 1950 was 3,998, supported mostly by grain farming or cattle grazing. The largest towns are Bowman, the county seat (1950 pop. 967), Gascoyne, and Rhame, all of which are on the main line of the Chicago, Milwaukee, St. Paul, and Pacific Railroad.

The county is part of the Missouri Plateau and the surface is generally rolling except in the western part, where the Little Missouri River has dissected a wide area into badlands. A few buttes, notably the Twin Buttes north of Bowman, rise 300 to 400 feet above the plains surface. The exposed geological formations are, in order, the Pierre shale, the Fox Hills sandstone, and the Hell Creek formations of Upper Cretaceous age, which crop out in the valleys in the western part of the county; the Fort Union formation of Paleocene age, which is exposed in most of

Table 17.--Estimated original reserves of lignite in Harmon bed, Slope County, North Dakota
(in millions of short tons)

Location	Measured reserves			Indicated reserves			Inferred reserves			Total reserves
	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	
T.136N., R.98W.	...	...	...	...	...	...	12.4	23,437	508.58	508.58
T.136N., R.99W.	...	...	...	...	...	...	14.1	23,782	586.82	586.82
T.136N., R.100W.	...	...	...	...	...	...	15.8	23,983	643.77	643.77
T.136N., R.101W.	17.5	1,640	51.76	17.5	9,037	276.76	17.5	13,275	375.92	704.44
T.136N., R.102W.	17.0	4,693	139.56	17.0	4,896	143.57	...	...	...	283.13
T.136N., R.103W.	8.4	2,086	33.68	8.4	11,667	202.43	...	...	...	236.11
T.136N., R.104W.	7.5	2,598	38.47	7.5	5,165	65.86	...	...	...	104.33
T.135N., R.98W.	...	...	...	...	...	...	15.9	23,014	540.37	540.37
T.135N., R.99W.	...	...	...	...	...	...	16.7	23,206	800.03	800.03
T.135N., R.100W.	...	...	...	...	...	...	23.5	23,714	934.11	934.11
T.135N., R.101W.	27.3	672	32.11	27.3	7,341	350.77	27.3	14,048	671.14	1,053.97
T.135N., R.102W.	28.0	294	14.41	28.0	5,235	256.52	...	...	...	270.93
T.135N., R.103W.	13.1	2,074	47.55	5.1	8,601	169.11	...	...	...	216.66
T.135N., R.104W.	7.3	1,530	16.77	7.3	3,368	46.02	...	...	...	62.79
T.134N., R.98W.	...	...	...	...	...	...	15.1	21,333	558.44	558.44
T.134N., R.99W.	...	...	...	...	...	...	18.5	21,670	701.57	701.57
T.134N., R.100W.	...	...	...	...	...	...	21.9	21,824	836.41	836.41
T.134N., R.101W.	...	...	...	26.3	6,298	298.86	26.3	15,942	733.73	1,032.59
T.134N., R.102W.	26.8	371	17.40	26.8	4,621	216.73	...	...	...	234.13
T.134N., R.103W.	10.5	717	13.18	10.5	3,853	70.80	...	...	...	83.98
T.134N., R.104W.	...	...	...	9.5	832	14.12	...	...	...	14.12
T.133N., R.98W.	...	...	...	...	...	...	14.2	23,066	573.19	573.19
T.133N., R.99W.	...	...	...	...	...	...	18.5	23,181	750.49	750.49
T.133N., R.100W.	...	...	...	...	...	...	22.7	23,200	921.62	921.62
T.133N., R.101W.	27.0	256	12.10	27.0	8,344	396.14	27.0	13,555	640.47	1,048.71
T.133N., R.102W.	...	...	...	26.9	410	19.30	...	...	...	19.30
Total		16,979	416.99		79,638	2,526.94		329,330	10,876.66	13,820.59

the county; and the Golden Valley formation of Eocene age, which overlies the Fort Union in the eastern part. The Fort Union formation is divided into the Ludlow and Tongue River members; the latter contains most of the lignite reserves.

Lignite beds.--Most of the data used in estimating reserves for Bowman County are taken from the report on the Marmarth lignite field (Hares, 1928), which includes the western part of the county. In all, 17 lignite beds are included in the estimates; of these, five are fairly extensive. (See fig. 16.) The Tongue River member in Bowman County is thinner than in Slope and the other counties to the north, and the reserves are correspondingly smaller; this situation reflects the location of the county, which is not far north of the southern limit of the Fort Union region in South Dakota.

The lowest mapped lignite in the county is the Cannonball bed, at the base of the Ludlow member of the Fort Union in T. 131 N., R. 105 W. In that township the bed is 2.2 to 3.2 feet thick, with an average of about 2.7 feet. The next widespread bed, the T Cross, crops out over wide areas east of the Little Missouri River. It is 2.7 to 10 feet thick, and local variations are probably present. In Tps. 129-130 N., Rs. 102-104 W., the bed is generally about 5.5 feet thick along the outcrop, though in secs. 24 and 25, T. 130 N., R. 104 W., it is thin and impure. In T. 132 N., R. 105 W., it reaches a thickness of 8.0 feet. In secs. 6, 7, and 18, T. 131 N., R. 104 W., a split divides the bed into two benches, the lower of which is less than 2.5 feet thick.

The Ives bed crops out in the northern part of T. 132 N., R. 104 W., at an average thickness of 6 feet thick. It is believed to underlie only a small area in Bowman County.

The Hansen bed is probably present only in the northern parts of T. 132 N., R. 102 W., where it is 3.5 to 7.0 feet thick. South of that area most of the bed has been removed by erosion.

The Scranton bed (Leonard and others, 1925, pp. 59-62), is exposed in mines and outcrops in the eastern part of the county. In sec. 29, T. 131 N., R. 99 W., 12 feet of lignite has been measured. The bed thickens to the east and in mines in secs. 25 and 26, T. 131 N., R. 100 W., is reported to be 20 to 21 feet thick. It probably underlies a large area in the eastern and northeastern parts of the county.

The Harmon bed, known also in Bowman County as the Bowman bed, reaches its maximum thickness of 24 to 32 feet in T. 132 N., R. 102 W. It underlies relatively small areas in the northern part of the county in Tps. 130-131 N., Rs. 99-102 W. The bed occurs also in isolated buttes in T. 131 N., R. 103 W., and in Twin Buttes north of the town of Bowman.

Several uncorrelated local beds are known in the county. One of these is about 6 feet thick in T. 129 N., R. 100 W.; other local beds are inferred from exposures in northwestern South Dakota.

Reserves and production.--The estimated lignite reserves of Bowman County, totalling 7,021 million tons, are listed by townships in table 25 and summarized below:

Estimated original reserves of lignite in Bowman County
(in millions of short tons)

Thickness of beds (ft.)	Category of reserves			
	Measured	Indicated	Inferred	Total
2½-5	47	311	1,056	1,414
5-10	53	472	1,297	1,822
10+	167	444	3,174	3,785
Total	267	1,227	5,527	7,021

Estimated reserves of the T Cross and Harmon beds are given in tables 18 and 19, respectively. These beds probably contain large strippable reserves.

The total all-time production of lignite from Bowman County through 1950 is reported as 692,168 tons. Peak production was 60,346 tons in 1927; since that year recovery has decreased and for the years 1941-50 the annual average was only 8,259 tons. Production in 1950 was 11,366 tons. Most of the mining was formerly done by underground methods, but the only two active mines in the county in 1950 were strip mines.

Table 18.--Estimated original reserves of lignite in T Cross bed, Bowman County, North Dakota

(in millions of short tons)

Location	Measured reserves			Indicated reserves			Inferred reserves			Total reserves
	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	
T.132N., R.100W.	...	...	...	...	...	...	2.6	851	3.87	3.87
T.132N., R.101W.	...	...	...	...	...	...	3.3	20,275	117.09	117.09
T.132N., R.102W.	...	...	...	...	...	...	4.8	19,590	158.44	158.44
T.132N., R.103W.	...	...	...	...	...	...	5.2	19,450	177.00	177.00
T.132N., R.104W.	9.2	787	13.09	9.2	5,337	77.01	9.7	12,979	167.82	257.92
T.132N., R.105W.	7.6	1,004	13.24	7.6	3,085	50.00	...	...	...	63.24
T.131N., R.101W.	...	...	...	...	...	...	3.3	19,507	112.65	112.65
T.131N., R.102W.	...	...	...	...	...	...	4.8	22,835	190.99	190.99
T.131N., R.103W.	...	...	...	...	...	...	5.4	22,829	215.73	215.73
T.131N., R.104W.	4.4	2,611	20.73	5.0	8,557	86.67	5.7	9,754	97.30	204.70
T.131N., R.105W.	...	...	...	5.5	211	2.04	...	...	...	2.04
T.130N., R.101W.	3.0	736	3.86	3.0	1,299	6.82	3.0	3,482	18.28	28.96
T.130N., R.102W.	4.9	774	5.91	4.8	15,443	119.86	4.9	5,197	45.42	171.19
T.130N., R.103W.	5.6	1,331	13.86	5.6	9,330	96.44	6.0	10,163	106.71	217.01
T.130N., R.104W.	5.1	1,261	11.53	4.8	7,009	62.29	6.0	179	1.88	75.70
T.129N., R.101W.	...	...	...	3.0	320	1.68	...	...	...	1.68
T.129N., R.102W.	4.9	800	6.85	4.9	1,542	12.94	...	...	...	19.79
T.129N., R.103W.	4.8	294	2.47	4.8	1,101	9.25	...	...	...	11.72
T.129N., R.104W.	8.0	186	2.60	...	...	...	...	...	...	2.60
Total		9,784	94.14		53,204	525.00		167,091	1,413.18	2,032.32

Table 19.--Estimated original reserves of lignite in Harmon bed, Bowman County, North Dakota

(in millions of short tons)

Location	Measured reserves			Indicated reserves			Inferred reserves			Total reserves
	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	
T.132N., R.99W.	...	...	...	...	...	...	16.5	19,277	556.62	556.62
T.132N., R.100W.	...	...	...	...	...	...	21.0	19,091	701.59	701.59
T.132N., R.101W.	25.0	518	22.66	25.0	3,296	144.20	25.0	14,336	627.20	794.06
T.132N., R.102W.	27.0	1,638	77.40	27.0	1,760	83.16	...	...	...	160.56
T.131N., R.99W.	...	...	...	...	...	...	18.1	11,846	375.22	375.22
T.131N., R.100W.	...	...	...	...	...	...	21.0	11,219	412.30	412.30
T.131N., R.101W.	...	...	...	...	...	...	24.1	1,722	72.63	72.63
T.131N., R.102W.	...	...	...	25.0	205	8.97	...	...	...	8.97
T.131N., R.103W.	20.5	164	5.88	20.5	960	34.44	...	...	...	40.32
T.131N., R.104W.	...	...	...	10.3	256	5.34	...	...	...	5.34
T.130N., R.104W.	...	...	...	5.5	179	1.72	...	...	...	1.72
Total		2,320	105.94		6,656	277.83		77,491	2,745.56	3,129.33

Mines operating in Bowman County in 1950

Name of mine	Location sec.	T.	R.	Type	Bed
Gascoyne (now Peerless).	34	131N	99W	Strip	Scranton.
Lamb	25	132N	105W	--do--	T Cross.

Adams County

Geography and geology.--Adams County is in the southwestern part of North Dakota, east of Bowman County; it touches South Dakota on the south. The county population in 1950 was 4,891, principally supported by farming and stock raising. The principal towns are Hettinger, the county seat (1950 pop. 1,755), Bucyrus, Reeder, and Haynes, all of which are on the main line of the Chicago, Milwaukee, St. Paul, and Pacific Railroad. (See fig. 17)

The surface of the county is mostly rolling upland, from which a few scattered buttes rise, and into which Cedar Creek, a tributary of the Cannonball River, has cut a deep valley across the central part of the county. The general slope of the terrane is toward the east. The oldest exposed rock unit is the Cannonball formation of Paleocene age, the approximate marine equivalent of the Ludlow member of the Fort Union formation, which crops out in the stream valleys in the eastern part of the county. The Tongue River member of the Fort Union, which contains all the known minable lignite reserves, overlies the Cannonball and forms the surface rock over most of the county.

Lignite beds.--The lowest important lignite bed in Adams County is the Haynes bed (Lloyd, 1914, pp. 252-253; Leonard and others, 1925, pp. 31-34), which has an average thickness of 3.0 feet at its outcrops in the northeastern part of the county in Tps. 130-131 N., Rs. 91-93 W. It is much thicker in buttes to the southeast; north of Haynes, in T. 129 N., R. 94 W., the bed underlies about 2 1/2 square miles (fig. 17) at thicknesses of 10 to 13 feet. In other small buttes the thickness ranges from 9.6 to 12.0 feet.

Bed D (N. P. Ry. Co., 1923) crops out in Tps. 130-131 N., Rs. 91-93 W. It is irregular in thickness, the maximum being about 5 feet; over large areas it is too thin to mine.

Bed E (N. P. Ry. Co., 1923) crops out in the higher land in the northeastern part of the county, in T. 131 N., Rs. 91-93 W.; the total area known to be underlain by the bed is less than 1,000 acres.

The Scranton bed in Adams County averages 8.0 feet thick in mines and exposures between Reed and Bucyrus in T. 130 N., Rs. 97-98 W.

The Harmon bed probably underlies the northwest corner of the county; its extent and thickness are inferred from outcrop information in Bowman and Slope Counties.

Reserves and production.--The lignite reserves of Adams County are estimated as 1,856 million tons, as summarized below and given by townships in table 25.

Estimated original reserves of lignite in Adams County
(in millions of short tons)

Thickness of beds (ft.)	Category of reserves: Measured	Indicated	Inferred	Total
2½-5	36	169	485	690
5-10	29	115	453	597
10+	38	83	448	569
Total	103	367	1,386	1,856

The estimated reserves of the Scranton bed are given in table 20.

From the beginning of mining through December 31, 1950, reported production of lignite from Adams County is 1,864,552 tons. Since 1920 production had been comparatively uniform; the peak year was 1922, when 83,435 tons was mined; production in the years 1941-50 was 657,965 tons, and in 1950, 64,053 tons. Until 1940 most of the production was from underground mines; but at present 94 percent of the lignite is taken from strip mines. Two mines operated in the county in 1950:

Mines operating in Adams County in 1950

Name of mine	Location sec.	T.	R.	Type	Bed
Dakota Collieries Co.	9	129N	94W	Strip	Haynes.
Ihle	6	129N	94W	Slope	Do.

Hettinger County

Geography and geology.--Hettinger County is in the south-central part of the lignite-bearing region north of Adams County. The population in 1950 was 7,086 persons, most of whom were supported by farming. The principal towns are Mott, the county seat (1950 pop. 1,574), and New England (pop. 895), the terminus of a branch line of the Chicago, Milwaukee, St. Paul, and Pacific Railroad, which serves the county. A branch of the Northern Pacific Railway also enters the county from the east, terminating at Mott. (See fig. 17)

The county is part of the Missouri Plateau and is generally a rolling upland deeply incised by the Cannonball River and Thirtymile Creek. A few isolated buttes rise above the general land surface. Most of the exposed bedrock is the Tongue River member of the Fort Union formation, which probably contains all the lignite in the county.

Lignite beds.--The reserve estimates for Hettinger County are based largely on the maps of the Northern Pacific Railway (1923). The lowest bed is bed C, or the Haynes bed, which probably underlies the eastern one-third of the county, although the nearest known outcrops are in Morton and Grant Counties to the north and east. The next higher bed, bed D, crops out in Tps. 132-133 N., Rs. 91-94 W., and possibly underlies

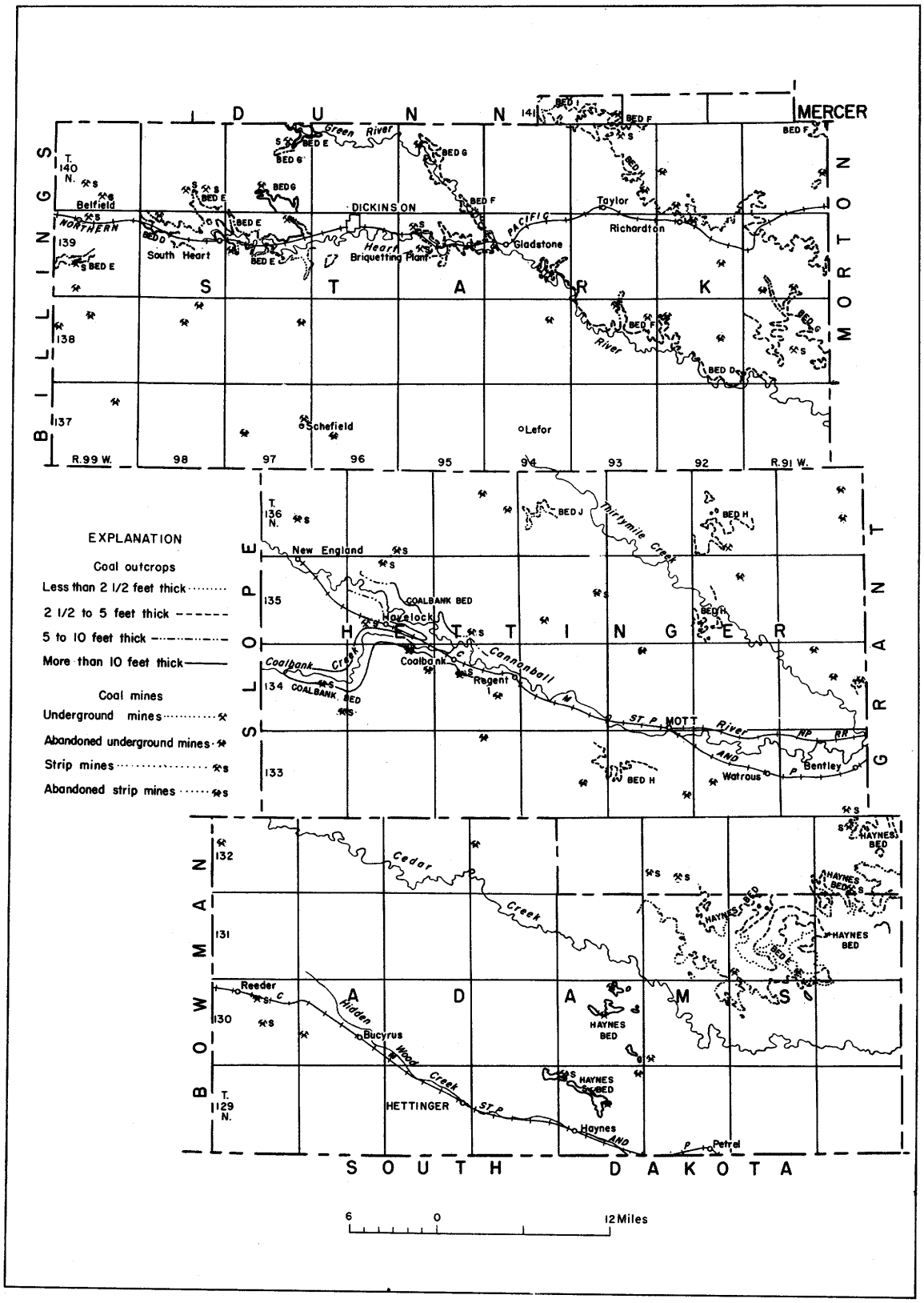


Figure 17.--Lignite outcrops in Adams, Hettinger, and Stark Counties, North Dakota.

Table 20.--Estimated original reserves of lignite in Scranton bed, Adams County, North Dakota

(in millions of short tons)

Location	Measured reserves			Indicated reserves			Inferred reserves			Total reserves
	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	
T.132N., R.97W.	...	...	...	...	...	...	3.0	1,281	6.73	6.73
T.132N., R.98W.	...	...	...	...	...	...	7.9	6,479	71.58	71.58
T.131N., R.95W.	...	...	...	...	...	...	2.8	488	2.39	2.39
T.131N., R.96W.	...	...	...	...	...	...	3.3	9,713	56.09	56.09
T.131N., R.97W.	...	...	...	...	...	...	5.4	20,021	188.46	188.46
T.131N., R.98W.	...	...	...	10.5	2,511	52.58	8.6	20,148	341.56	394.14
T.130N., R.95W.	...	...	...	...	...	...	3.0	3,348	17.58	17.58
T.130N., R.96W.	...	...	...	...	...	...	3.8	22,951	152.62	152.62
T.130N., R.97W.	6.5	266	3.03	6.5	3,639	41.39	5.4	16,547	157.93	202.35
T.130N., R.98W.	9.8	2,054	38.94	8.1	6,175	95.02	6.0	311	3.30	137.26
T.129N., R.96W.	...	...	...	...	...	...	3.0	1,959	5.86	5.86
T.129N., R.97W.	...	...	...	...	...	...	3.0	192	1.00	1.00
T.129N., R.98W.	2.8	241	1.18	2.8	2,492	12.21	2.8	1,763	8.64	22.03
Total		2,561	43.15		14,817	201.20		104,299	1,013.44	1,257.79

the northeastern three-quarters of the county. It is 10 feet thick in a mine in sec. 35, T. 132 N., R. 93 W.; and to the east in sec. 33, T. 132 N., R. 91 W., its thickness ranges up to 6.4 feet.

Bed E also probably underlies a large part of the county. Its outcrop in T. 134 N., R. 91 W. has a maximum thickness of 6.1 feet and averages about 5 feet.

Bed H, which is probably equivalent to the Coalbank bed of Leonard (Leonard and others, 1925, p. 92) crops out in the eastern part of the county and in adjacent Grant County. The bed is 4.0 to 5.0 feet thick in the southeastern part of T. 136 N., R. 92 W., and about 6 miles to the south, near the Cannonball River in sec. 35, T. 135 N., R. 92 W., it is 4.5 to 6.0 feet thick. At another outcrop in sec. 24, T. 135 N., R. 94 W., the average thickness of the bed is 4.3 feet. Where it is known as the Coalbank bed, in the valley of the Cannonball River between New England and Regent and in the valley of Coalbank Creek in Tps. 134-135 N., Rs. 96-97 W., it is more than 10 feet thick close to the junction of the four townships listed.

Bed J, which crops out in T. 136 N., Rs. 94-95 W., probably underlies an area of only about 20 square miles. Its thickness ranges from 4.0 to 8.0 feet in secs. 7 and 8, T. 136 N., R. 94 W.

Reserves and production.--The lignite reserves of Hettinger County are 12,653 million tons, as summarized below. Figures by townships are given in table 25.

Estimated original reserves of lignite in Hettinger County
(in millions of short tons)

Thickness of beds (ft.)	Category of reserves			
	Measured	Indicated	Inferred	Total
2½-5	36	398	8,723	9,157
5-10	48	508	932	1,488
10+	49	242	1,717	2,008
Total	133	1,148	11,372	12,653

The estimated reserves of the Coalbank bed are given in table 21.

Recorded all-time production of lignite in Hettinger County is 716,003 tons, of which 187,783 tons were mined from 1941 to 1950. Most past and present mining is from strip mines. Mines operating in the county in 1950 are listed below:

Mines operating in Hettinger County in 1950

Name of mine	Location sec.	T.	R.	Type	Bed
New England Coal Co.	28	135N	96W	Strip-Coal bank.	
Regent	9	134N	95W	---do--	Do.
Watson	28	132N	93W	--do--	C?
Lambie	33	132N	91W	--do--	C

Stark County

Geography and geology.--Stark County is north of Hettinger County and south of Dunn County, in the central part of the lignite-bearing area of North Dakota. The population in 1950 was 16,121, of whom 7,467 lived in Dickinson, the county seat. The main line of the Northern Pacific Railway crosses the county via Dickinson, Richardton, Taylor, Gladstone, South Heart, and Belfield. The railroad follows the valley of the Heart River west of Gladstone. (See fig. 17.)

The county is in the Missouri Plateau. The valleys are broad and in some places show badland topography, though not to the extent that prevails farther west in the Little Missouri River valley. Surface elevations range from about 2,100 to 2,700 feet, the higher land being in the western part of the county.

Lignite beds.--Of the 10 beds of lignite in Stark County for which reserves have been estimated, the seven lowest are in the Tongue River member of the Fort Union; the three highest beds, beds H, I, and J, are possibly in the Golden Valley formation, though their exact stratigraphic position has not yet been determined.

Beds A and B are believed to underlie the northeastern quarter of the county, from outcrop data in adjacent areas. Bed C is thought to be present in the eastern third of the county from data in Morton and Grant Counties. In the western part bed K or L of Leonard (Leonard and others, 1925, pp. 37-46) crops out at about the horizon of bed C of the eastern portion. It is correlated with the Garner Creek bed of Billings County, and is probably the 22-foot bed of lignite penetrated by the Northern Pacific Railway well at Dickinson.

Bed D (N. P. Ry. Co., 1923), which is correlated with the Fryburg bed of Leonard (Leonard and others,

Table 21.--Estimated original reserves of lignite in Coalbank bed, Hettinger County, North Dakota

(in millions of short tons)

Location	Measured reserves			Indicated reserves			Inferred reserves			Total reserves
	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	
T.136N., R.94W.	...	...	...	...	...	...	3.5	1,725	10.57	10.57
T.136N., R.95W.	...	...	...	...	...	...	5.5	20,500	155.31	155.31
T.136N., R.96W.	...	...	...	...	...	...	5.5	23,100	207.12	207.12
T.136N., R.97W.	...	...	...	...	...	...	6.0	11,850	95.94	95.94
T.135N., R.94W.	...	...	...	3.5	75	0.46	3.5	5,425	33.23	33.69
T.135N., R.95W.	7.5	225	2.95	5.5	7,725	98.41	5.5	14,250	160.78	262.14
T.135N., R.96W.	10.2	1,125	20.08	8.9	4,825	78.93	7.5	5,350	70.22	169.23
T.135N., R.97W.	10.5	75	1.38	9.0	2,675	40.88	5.5	15,400	142.98	185.24
T.134N., R.94W.	...	...	...	3.5	525	3.22	3.5	50	0.31	3.53
T.134N., R.95W.	5.5	575	5.97	5.5	9,125	88.10	5.5	5,100	38.24	132.31
T.134N., R.96W.	10.5	800	14.70	9.0	9,900	167.47	7.2	9,200	106.49	288.66
T.134N., R.97W.	10.5	700	12.86	9.0	5,725	83.67	5.5	9,750	82.65	179.18
T.133N., R.95W.	...	...	...	...	...	...	3.5	3,125	19.14	19.14
T.133N., R.96W.	...	...	...	...	...	...	3.5	8,900	53.90	53.90
T.133N., R.97W.	...	...	...	...	...	...	3.5	2,125	13.02	13.02
Total		3,500	57.94		40,575	561.14		135,750	1,189.90	1,808.98

1925, p. 140) is exposed in the northwestern part of T. 139 N., R. 98 W., where the maximum thickness of 12.0 feet is exposed in sec. 8. A syncline carries the bed beneath the level of the Heart River east of this area. It is possible that bed D is the same as the Lehigh bed, which averages about 11.0 feet thick near the extinct town of Lehigh, at the present site of the briquetting plant a few miles east of Dickinson.

Bed E, or the Heart River of Leonard (Leonard and others, 1925, p. 141), possibly underlies most of Stark County. The lignite is 6.0 to 11.2 feet thick in the valley of the Heart River in Tps. 139-140 N., Rs. 97-98 W. It thickens northward from that area and in sec. 6, T. 140 N., R. 96 W., is 18 feet thick. It thins to the east and south. The bed is also exposed in the eastern part of the county in Tps. 139-140 N., R. 91 W.

Bed F crops out along the lower part of the Green River, in parts of the Heart River valley, and in a small area north of Richardton. (See fig. 17.) The bed is 7 feet thick in sec. 11, T. 138 N., R. 93 W., and exceeds 5 feet throughout the northeastern part of that township. It underlies parts of the northern and northeastern parts of the county, where it is generally thin and in some exposures is of less than minable thickness.

Bed G probably underlies considerable areas in the northern part of the county. At outcrops in T. 140 N., R. 97 W., the lignite is 8.0 to 17.0 feet thick; but it thins to only 3.5 to 4.0 feet to the east in R. 95 W. It may underlie a portion of the southeastern part of the county, where a bed at approximately the same horizon is about 3.0 feet thick.

Bed H crops out in the northeastern part of the county, where the maximum thickness of 7.0 feet is exposed in sec. 11, T. 139 N., R. 92 W. The average thickness in that area is less than 5 feet.

Bed I crops out in the southern part of T. 141 N., R. 93 W., where its thickness ranges from 2.5 to 6 feet. The bed underlies only a small area in Stark County.

Bed J, which probably underlies parts of T. 140 N., R. 94 W., and adjacent townships, has a known maximum thickness of 6 feet, though the average is probably less than 5 feet.

Reserves and production.--The estimated reserves of lignite in Stark County are summarized below; complete figures by townships are given in table 25.

Estimated original reserves of lignite in Stark County
(in millions of short tons)

Thickness of beds (ft.)	Category of reserves			
	Measured	Indicated	Inferred	Total
2½-5	105	1,078	15,407	16,590
5-10	151	836	3,077	4,064
10+	136	1,093	3,815	5,044
Total	392	3,007	22,299	25,698

The estimated reserves of beds D and E are given in tables 22 and 23.

All-time production from Stark County through December 31, 1950 is reported as 3,618,578 tons of lignite, taken from more than 100 mines. The 1941-50 production was 1,041,528 tons; that of 1950, about 100,000 tons. In that year 11 mines were active, as listed below:

Mines operating in Stark County in 1950

Name of mine	Location sec.	T.	R.	Type	Bed
Andy's	34	140N	99W	Strip-	D?
Thomas	28	140N	99W	--do--	D?
Marsh	26	140N	98W	--do--	E
Karsky	27	140N	98W	--do--	E
Kuchenski	11	140N	97W	--do--	E
Elis	3	140N	93W	--do--	F
Polensky	4	139N	99W	--do--	D
Dietz	20	139N	99W	--do--	E
Dakota Briquetting & Tar Products Co.	17	139N	95W	--do--	E or F
Dickinson Coal Mining Co.	7,8	139N	95W	--do--	F
Farm Coal Mine	22	138N	91W	--do--	D

Morton County

Geography and geology.--Morton County lies between Stark County on the west and the Missouri River on the east. The population in 1950 was 19,240, almost equally divided between rural and urban. The principal city is Mandan (1950 pop. 7,268); other important towns are Hebron (pop. 1,414), Glen Ullin

Table 22.--Estimated original reserves of lignite in bed D, Stark County, North Dakota

(in millions of short tons)

Location	Measured reserves			Indicated reserves			Inferred reserves			Total reserves
	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	
T.141N., R.91W.	...	...	...	...	...	...	2.9	7,962	40.41	40.41
T.141N., R.92W.	...	...	...	...	...	...	2.8	7,962	39.01	39.01
T.141N., R.93W.	...	...	...	...	...	...	2.8	7,962	39.01	39.01
T.140N., R.91W.	...	...	...	...	...	...	2.9	23,040	116.93	116.93
T.140N., R.92W.	...	...	...	...	...	...	2.9	23,040	116.93	116.93
T.140N., R.93W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.140N., R.94W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.140N., R.95W.	...	...	...	9.0	824	12.83	5.3	23,420	150.53	163.36
T.140N., R.96W.	7.5	224	2.94	7.3	3,540	41.75	7.3	16,861	143.63	188.62
T.140N., R.97W.	...	...	...	...	...	...	2.9	23,040	116.93	116.93
T.140N., R.98W.	7.5	121	1.59	5.5	2,115	23.24	3.5	17,969	110.06	134.89
T.140N., R.99W.	7.0	32	0.39	5.0	1,559	9.71	3.0	8,435	44.28	54.38
T.139N., R.91W.	...	...	...	...	...	...	2.6	23,040	104.83	104.83
T.139N., R.92W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.139N., R.93W.	...	...	...	2.5	530	2.60	2.8	22,512	110.31	112.91
T.139N., R.94W.	3.0	1,189	6.24	3.0	8,882	46.63	3.0	12,601	66.16	119.03
T.139N., R.95W.	11.0	1,297	24.97	9.3	6,882	128.96	11.3	14,767	160.32	314.25
T.139N., R.96W.	7.5	261	3.69	7.5	5,975	92.63	7.5	16,007	149.47	245.79
T.139N., R.97W.	...	...	...	...	...	...	3.0	21,197	111.28	111.28
T.139N., R.98W.	9.1	460	7.92	7.3	19,843	75.57	3.5	14,595	89.40	172.89
T.139N., R.99W.	7.5	77	1.01	5.4	1,847	14.91	2.9	21,119	107.18	123.10
T.138N., R.91W.	2.8	109	0.53	2.8	1,783	87.36	2.8	20,160	98.78	186.67
T.138N., R.92W.	2.9	300	1.52	2.9	2,096	10.64	2.9	11,476	58.24	70.40
T.138N., R.93W.	...	...	...	...	...	...	2.7	20,077	94.86	94.86
T.138N., R.94W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.138N., R.95W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.138N., R.96W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.138N., R.97W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.138N., R.98W.	...	...	...	...	...	...	2.9	23,040	116.93	116.93
T.138N., R.99W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.137N., R.91W.	...	...	...	...	...	...	2.8	12,345	59.88	59.88
T.137N., R.92W.	...	...	...	2.7	51	0.24	2.7	15,317	72.35	72.59
T.137N., R.93W.	...	...	...	...	...	...	2.7	23,040	108.86	108.86
T.137N., R.94W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.137N., R.95W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.137N., R.96W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.137N., R.97W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.137N., R.98W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.137N., R.99W.	...	...	...	...	...	...	2.8	18,972	93.03	93.03
Total		4,090	50.80		55,700	547.07		752,476	4,003.72	4,601.59

(pop. 1,316), and New Salem (pop. 875). All of these towns are on the main line of the Northern Pacific Railway. A branch of the same system runs north from Mandan, paralleling the Missouri River. (See fig. 18.) The principal industry of the county is farming, but clay products are manufactured at Hebron, and a small amount of lignite mining is carried on in the western part of the county.

The county is in the Missouri Plateau and is a rolling upland deeply dissected by the Missouri and Heart Rivers and Muddy Creek. Altitudes range from about 1,600 feet in the Missouri River valley to 2,200 feet on the upland surface. The edges of the stream valleys contain some badlands, and at many places the valley walls are steep.

The lowest outcropping rock unit, the Hell Creek formation of Upper Cretaceous age, is exposed in the valleys in the southeastern part of the county. Overlying the Hell Creek is the Ludlow member of the Fort Union formation of Paleocene age, which is only 20 feet thick and is composed of fine, cross-bedded sands, clays, and some lignite beds of less than minable thickness (Laird and Mitchell, 1942, p. 17). Above this thin stratum is the Cannonball formation, which over a large part of North Dakota is the marine equivalent of the Ludlow member of the Fort Union. It is about 300 feet thick, consisting of fine-grained buff sandstones and gray shales.

The Tongue River member of the Fort Union, which contains all the known commercial lignite in Morton County, overlies the Cannonball in the northern part of the county. To the south and east much of the unit has been removed by erosion, and although in small outliers as much as 180 feet of the Tongue River is preserved, the southern four townships contain little Tongue River and, correspondingly, little lignite.

Table 23.--Estimated original reserves of lignite in bed E, Stark County, North Dakota

(in millions of short tons)

Location	Measured reserves			Indicated reserves			Inferred reserves			Total reserves
	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	
T.141N., R.91W.	...	...	...	...	...	...	2.6	7,878	35.85	35.85
T.141N., R.92W.	...	...	...	...	...	...	2.8	7,878	38.60	38.60
T.141N., R.93W.	...	...	...	...	...	...	3.3	7,878	45.49	45.49
T.140N., R.91W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.140N., R.92W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.140N., R.93W.	...	...	...	...	...	...	3.5	23,040	141.12	141.12
T.140N., R.94W.	...	...	...	...	...	...	4.0	23,040	161.28	161.28
T.140N., R.95W.	...	...	...	...	...	...	5.6	23,034	171.39	171.39
T.140N., R.96W.	13.0	420	9.56	10.3	3,816	84.36	8.3	16,479	266.87	360.79
T.140N., R.97W.	12.0	1,147	24.09	10.3	15,014	313.78	12.0	7,007	147.15	485.02
T.140N., R.98W.	10.0	903	13.25	10.0	11,396	200.52	10.0	10,887	215.29	429.06
T.140N., R.99W.	...	...	...	8.0	32	0.45	9.5	22,524	340.65	341.10
T.139N., R.91W.	...	...	...	...	...	...	3.0	23,040	120.96	120.96
T.139N., R.92W.	...	...	...	...	...	...	3.6	23,040	145.15	145.15
T.139N., R.93W.	...	...	...	3.7	898	5.82	3.7	22,136	143.33	149.15
T.139N., R.94W.	...	...	...	...	...	...	3.8	23,040	153.22	153.22
T.139N., R.95W.	...	...	...	...	...	...	5.5	23,034	162.50	162.50
T.139N., R.96W.	7.5	197	2.59	9.3	4,516	63.17	7.3	15,625	191.67	257.43
T.139N., R.97W.	9.8	3,211	49.05	9.8	10,855	159.62	8.0	3,465	48.51	257.18
T.139N., R.98W.	7.5	1,185	15.55	7.5	6,529	85.69	7.5	8,727	114.24	215.78
T.139N., R.99W.	7.5	1,077	14.14	7.5	8,816	115.71	7.5	9,956	130.67	260.52
T.138N., R.91W.	...	...	...	...	...	...	3.0	21,518	112.97	112.97
T.138N., R.92W.	...	...	...	...	...	...	3.5	18,284	111.74	111.74
T.138N., R.93W.	3.6	509	3.21	3.6	5,978	37.66	3.6	15,035	94.72	135.59
T.138N., R.94W.	...	...	...	...	...	...	3.8	23,040	153.22	153.22
T.138N., R.95W.	...	...	...	...	...	...	4.3	23,040	173.38	173.38
T.138N., R.96W.	...	...	...	7.0	52	0.39	5.8	23,002	194.26	194.65
T.138N., R.97W.	...	...	...	7.0	45	0.55	5.8	22,989	230.82	230.37
T.138N., R.98W.	...	...	...	...	...	...	5.8	23,251	253.24	253.24
T.138N., R.99W.	...	...	...	...	...	...	5.5	23,034	204.38	204.38
T.137N., R.91W.	...	...	...	...	...	...	3.0	16,664	87.49	87.49
T.137N., R.92W.	...	...	...	...	...	...	3.2	21,333	119.47	119.47
T.137N., R.93W.	...	...	...	...	...	...	3.2	23,040	120.02	120.02
T.137N., R.94W.	...	...	...	...	...	...	3.3	23,040	133.06	133.06
T.137N., R.95W.	...	...	...	...	...	...	3.5	23,040	141.12	141.12
T.137N., R.96W.	...	...	...	...	...	...	3.5	23,040	141.12	141.12
T.137N., R.97W.	...	...	...	...	...	...	4.0	23,040	161.28	161.28
T.137N., R.98W.	...	...	...	...	...	...	4.0	23,040	161.28	161.28
T.137N., R.99W.	...	...	...	...	...	...	3.0	18,913	99.29	99.29
Total		8,649	131.44		67,927	1,067.72		736,091	5,708.96	6,908.12

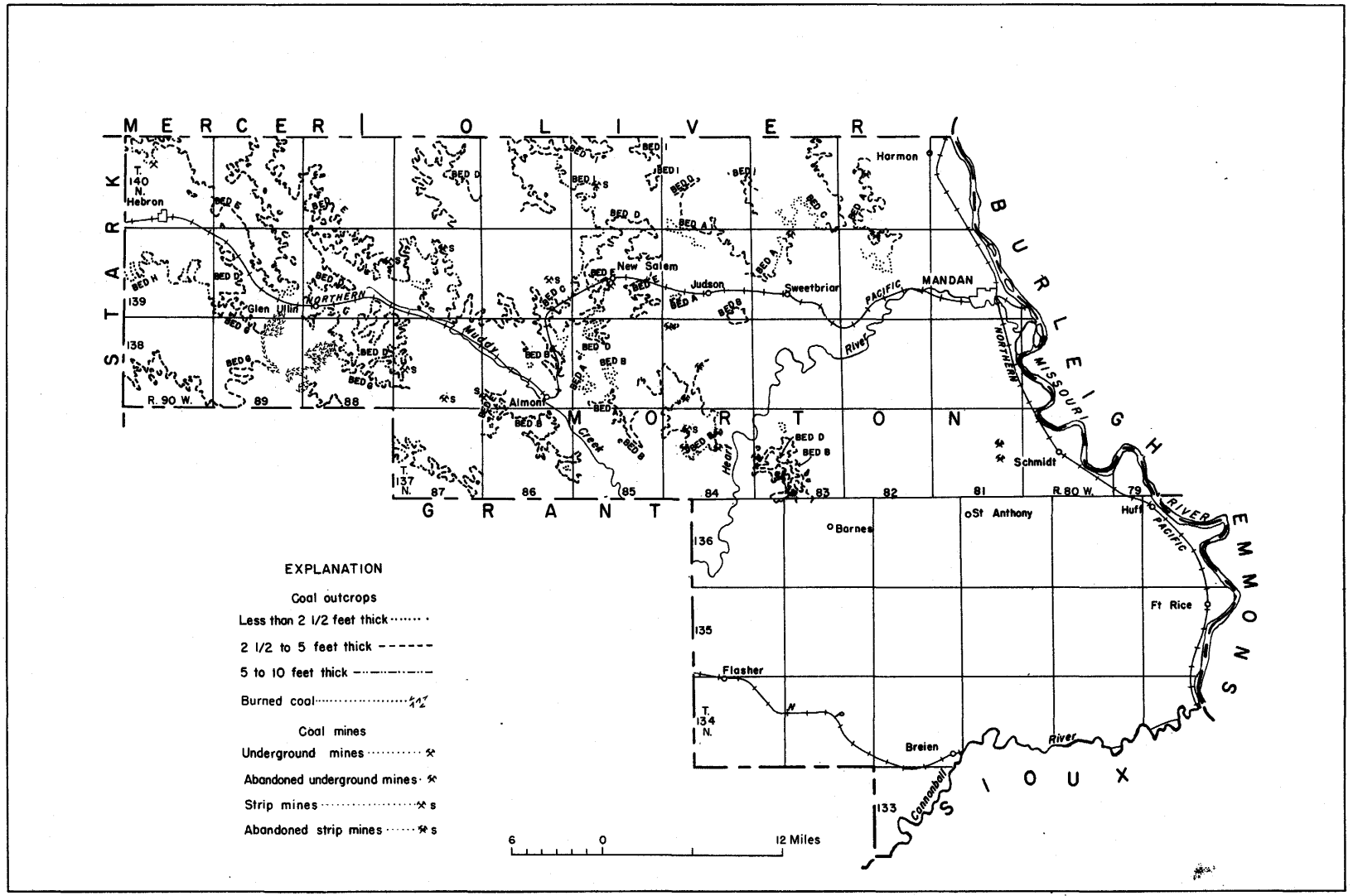


Figure 18.--Lignite outcrops in Morton County, North Dakota.

Lignite beds.--The lignite-bearing part of Morton County was mapped by Hancock (1921) and the Northern Pacific Railway (1923). The outcrops are shown in figure 18. The lowest bed, bed A or the Deep Vein, is about 45 feet above the base of the Tongue River (Hancock, 1921), and crops out at minable thickness in the eastern part of the county in Tps. 139-140 N., Rs. 82-84 W. The bed is 4.2 feet thick in sec. 18, T. 140 N., R. 82 W.; it thickens to the northwest and thins to the southeast to less than minable thickness. At most measured sections it contains several partings. In the southern part of the county bed A is the only lignite in the Tongue River member, but it is less than 2 1/2 feet thick in that area.

Bed B crops out in Tps. 137-139 N., Rs. 83-86 W. The thickest outcrop measurement is 7.8 feet in sec. 14, T. 138 N., R. 86 W.; however, the Deep Mine at New Salem, where the lignite is 14 feet thick, is believed to be in this bed. In the northern part of T. 137 N., R. 84 W., and in secs. 7 and 19, T. 138 N., R. 84 W., where the bed was mined in 1949, the lignite is a little more than 6 feet thick. There is local thinning one or two miles northwest of that area.

Bed C underlies the northern and western parts of the county. The maximum known thickness of the bed is 6.0 feet in sec. 25, T. 138 N., R. 86 W., and the average for the entire outcrop area is about 3 feet.

Bed D crops out over a wide area in the northern part of Morton County. In the northeastern part it probably averages less than 4 feet in thickness; farther west, in the central part of the county, it averages more than 5 feet, the known maximum being 11 feet in sec. 19, T. 137 N., R. 87 W. In sec. 31, T. 138 N., R. 86 W., and sec. 19, T. 138 N., R. 87 W., where the bed was being mined in 1950, it is about 7 feet thick. Generally speaking, bed D is variable in thickness, but of good quality, and contains only a few partings (Hancock, 1921, pl. III). In the New Salem area the bed is about 2,150 feet above sea level.

Bed E crops out along the valleys of Muddy Creek and its tributaries, in the western part of the county, and is relatively thick over large areas. In sec. 13, T. 139 N., R. 85 W., its thickness is 15 feet. It thins rapidly from that locality northeastward, and much more gradually toward the west and southwest. In Tps. 139-140 N., Rs. 88-89 W., measurements of 7 feet are common, and in the southernmost outcrop area, in sec. 31, T. 138 N., R. 86 W., the bed is 9.3 feet thick.

Bed F crops out only in T. 140 N., R. 90 W., where its maximum thickness is 10.0 feet. The bed is probably present also in the divide area north of New Salem.

Bed G crops out in the western part of the county in Tps. 138-139 N., Rs. 87-90 W. In sec. 25, T. 139 N., R. 90 W., the lignite is 11.5 feet thick; from that locality it appears to thin regularly to the west and south. In a small outlier in T. 138 N., R. 88 W., the bed probably averages more than 6 feet thick.

Bed H occurs only in small areas of high land in the northwestern part of the county, though it is relatively widespread in adjacent Mercer, Stark, and Oliver Counties. In sec. 22, T. 139 N., R. 90 W., the bed is 5.6 feet thick.

Bed I is in the divide area north of New Salem in parts of Tps. 139-140 N., Rs. 86-87 W. (N. P. Ry. Co., 1923). In sec. 16, T. 139 N., R. 85 W., the bed is 9 to 15 feet thick. It thins to the north, but probably has an average thickness of 7 feet over most of its outcrop area. Near the border of Oliver County it is only 3 or 4 feet thick. In addition to the area north of New Salem, bed I probably underlies small areas in T. 140 N., R. 88 W., and Tps. 138-139 N., R. 90 W.

Beds J, K, L, M, and O are believed to be present in small areas near the borders of the county, on the basis of data projected from Mercer, Oliver, and Stark Counties.

Reserves and production.--The lignite reserves of Morton County are estimated at 15,251 million tons, as summarized below. The complete estimates by townships are given in table 25.

Estimated original reserves of lignite in Morton County
(in millions of short tons)

Thickness of beds (ft.)	Category of reserves			
	Measured	Indicated	Inferred	Total
2½-5	217	1,435	11,156	12,808
5-10	339	1,302	468	2,109
10+	42	286	6	334
Total	598	3,023	11,630	15,251

All-time production of lignite in Morton County through December 31, 1950, is reported as 1,708,295 tons, of which 335,369 tons was mined in the years 1941-50. The highest annual production was 67,000 tons in 1923; the output in 1950 was 31,637 tons. In that year ten strip mines and two underground mines were in operation. As the cover over the lignite in large parts of the county is thin, it is probable that strip-mining will increase in the future.

Mines operating in Morton County in 1950

Name of mine	Location			Type	Bed
	sec.	T.	R.		
Bethke	8	137N	84W	Strip-	B
Herman Bethke	8	137N	84W	--do--	B
Thor	31	138N	86W	--do--	D
Thiel	34	138N	87W	--do--	D
Genz	19	138N	87W	--do--	D
Deep Mine Coal Co.	21	139N	85W	Shaft--	A
Timpe and Nellis	23	139N	86W	Strip--	C or D
Richter	13	139N	88W	--do--	E
Flemmer	19	140N	85W	--do--	I
Harnisch	8	140N	90W	Slope--	E

Grant County

Geography and geology.--Grant County is in the southeastern part of the lignite-bearing portion of North Dakota, south of Morton County and north of the Cannonball River. The population in 1950 was 7,109 persons, most of whom were engaged in farming. The principal towns are Carson, the county seat; Elgin, Leith, and New Leipzig, none of which have as many as 1,000 inhabitants. Branch lines of the Chicago,

Milwaukee, St. Paul, and Pacific Railroad and the Northern Pacific Railway serve the county. (See fig. 19.)

The county is part of the glaciated portion of the Missouri Plateau and the topography is generally one of low rounded hills, though a few buttes rise above the general level in the western part of the county. The plateau is incised deeply by the Heart and Cannonball Rivers and their tributaries, which have cut broad valleys. Altitudes range from about 1,600 feet in the valley of the Cannonball River to about 2,400 feet in the western part of the county.

The Hell Creek formation of Upper Cretaceous age crops out in the valleys in the eastern part of the county. (See pl. 1.) It is about 350 feet thick and consists of dark shales, yellow sandstones, and a few beds of lignite which are generally less than 2 1/2 feet thick. The Hell Creek is overlain by the Cannonball formation of Paleocene age, which is of marine origin and contains no lignite. Overlying the Cannonball is the Tongue River member of the Fort Union formation, which crops out over most of the western part of the county and is composed of shale, clay, and a number of thick beds of lignite. The highest formation is the White River formation of Oligocene age, which caps the highest buttes in the western part of the county.

Lignite beds.--Of the nine lignite beds in Grant County for which reserves have been estimated, the lowest is in the Hell Creek formation, the others in the Tongue River member of the Fort Union. The unnamed bed in the Hell Creek crops out at minable thickness in parts of secs. 33-35, T. 130 N., R. 88 W., and secs. 2 and 3, T. 129 N., R. 88 W. (See fig. 19.)

The lowest bed in the Tongue River member of the Fort Union, bed A, does not crop out in Grant County but is believed to underlie parts of T. 137 N., Rs. 88-90 W., on the basis of data projected from Morton County, and from mine measurements in the Heart River valley. The next higher bed, bed B, is also assumed to be present under the three northernmost townships of the county, from outcrop data in adjacent counties. The lowest outcropping bed in that area is bed C or the Haynes bed (Lloyd, 1914, p. 268), which is exposed in the western part of the county at thicknesses ranging from 6.0 feet in sec. 8, T. 131 N., R. 90 W., to 3 feet in sec. 36, T. 137 N., R. 89 W. In the central and southwestern parts of the county the bed is thinner; it is only 1.1 to 1.3 feet thick in secs. 11-13, T. 133 N., R. 90 W., but increases in thickness to 2.8 to 3.0 feet to the north.

Bed D is about 50 feet higher in the section than the Haynes bed. Its outcrop area is about the same; its average thickness is 7 feet in T. 137 N., R. 88 W., and thins westward to 4.3 feet in sec. 12, T. 137 N., R. 90 W. In the western part of the county the bed is generally less than 5 feet thick; in the northeastern part of T. 133 N., R. 88 W., however, it is 8.5 feet thick.

Bed F is probably present in a narrow belt north of the Heart River, where its average thickness is 3 feet.

Bed G occurs in the northern parts of T. 137 N., Rs. 88-89 W., at an average thickness of 3.0 feet. The bed occupies several small isolated areas in the upland north of the Heart River.

Bed H crops out in the western part of the county in Tps. 134-136 N., Rs. 89-90 W. Its thickness ranges up to 6.0 feet in sec. 35, T. 135 N., R. 90 W. The bed thins gently toward the north and is only 2.9 feet thick in sec. 1 of the same township. Farther south the average thickness is about 4.5 feet.

Reserves and production.--The lignite reserves of Grant County are estimated at 4,657 million tons, as summarized below. The complete estimates by townships are given in table 25.

Estimated original reserves of lignite in Grant County
(in millions of short tons)

Thickness of beds (ft.)	Category of reserves			
	Measured	Indicated	Inferred	Total
2½-5	94	689	3,055	3,838
5-10	181	457	149	787
10+	21	11	---	32
Total	296	1,157	3,204	4,657

Estimated reserves of the Haynes bed are given in table 24.

All-time production of lignite from Grant County is reported as 659,631 tons, of which 248,638 tons was mined in the years 1941-50. In all, about 66 mines have been reported as operating in the county, of which eight, all but one strip mine, were in operation in 1950. The names and locations of the mines were:

Mines operating in Grant County in 1950

Name of mine	Location			Type	Bed
	sec.	T.	R.		
Davenport-------	34	134N	90W	Strip-	Haynes.
Ketterling------	26	134N	90W	Drift-	Do.
Zeller----------	17	134N	88W	Strip-	Do.
Stelter---------	6	133N	89W	--do--	Do.
Comet-----------	3	133N	88W	--do--	Do.
Lah--------------	1	133N	88W	--do--	Do.
Kolbank---------	7	133N	87W	--do--	Do.
Coffin Butte----	35	132N	90W	--do--	Do.

Sioux County

Two thin beds of lignite are reported (Calvert and others, 1914, fig. 1, pp. 41-42) in T. 129 N., R. 88 W., in Sioux County. Denson (1950, p. 18) reported that only in one tract of about 40 acres in that general vicinity is the lignite thick enough to mine. He also mapped a bed in T. 131 N., Rs. 83-84 W., which was nowhere more than 2 1/2 feet thick. On the basis of data now at hand, the lignite of Sioux County, all of which is in the Hell Creek formation, appears too thin for economical development, and no reserves for the county have been estimated.

Emmons County

Two lignite mines were reported in Emmons County (Wilder and Wood, 1902). They were in

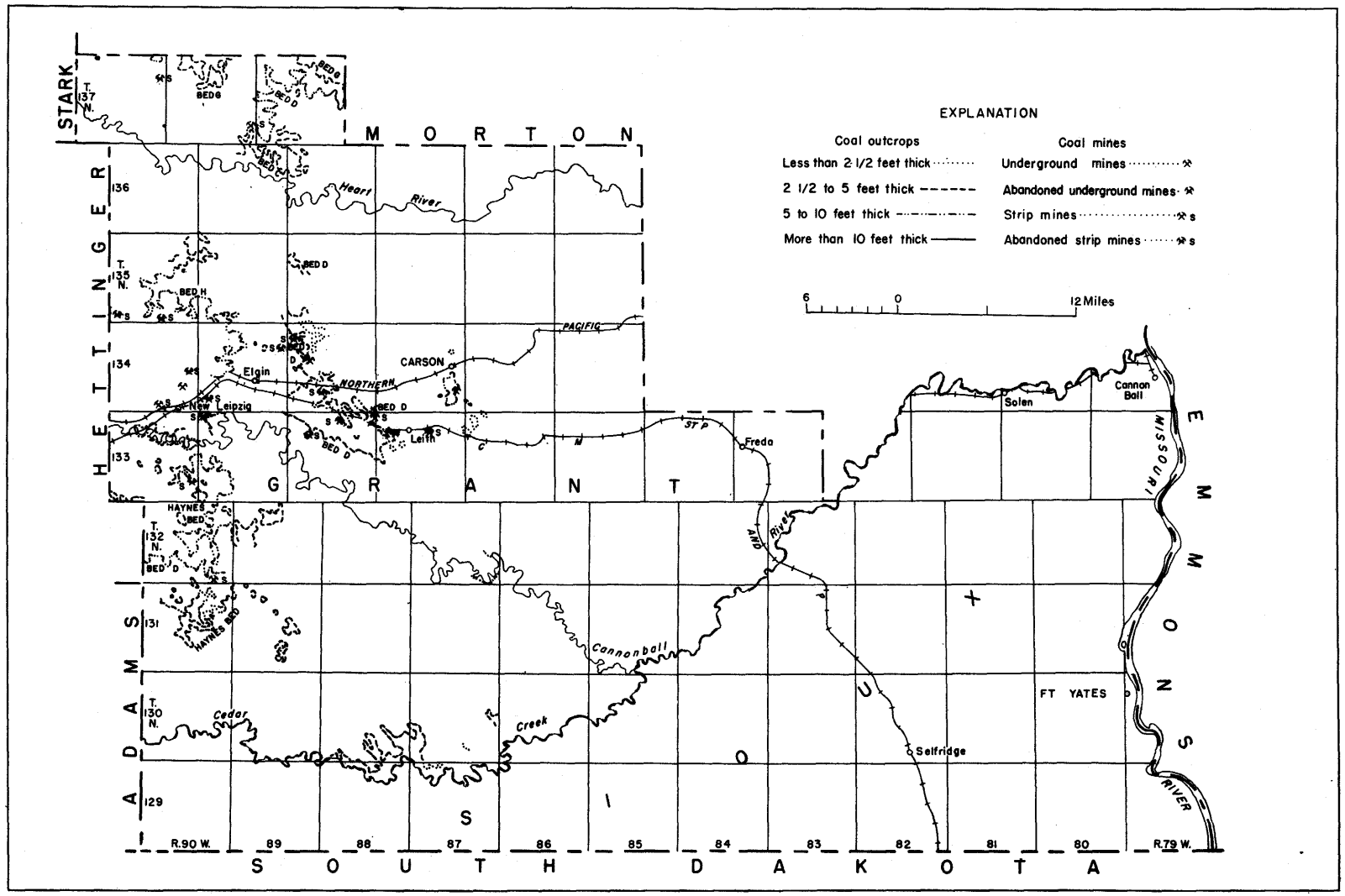


Figure 19.--Lignite outcrops in Grant and Sioux Counties, North Dakota.

Table 24.--Estimated original reserves of lignite in Haynes bed (bed C), Grant County, North Dakota
(in millions of short tons)

Location	Measured reserves			Indicated reserves			Inferred reserves			Total reserves
	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	Average thickness	Acres	Reserves	
T.137N., R.88W.	2.8	65	0.32	2.8	2,597	12.73	2.8	13,669	66.98	80.03
T.137N., R.89W.	2.9	840	4.26	2.9	4,012	20.36	2.9	17,526	88.94	113.56
T.137N., R.90W.	2.7	543	2.57	2.7	4,186	19.78	2.7	14,470	68.37	90.72
T.136N., R.88W.	...	...	...	...	...	...	2.8	1,059	5.19	5.19
T.136N., R.89W.	...	...	...	2.7	1,195	5.78	2.7	10,905	49.82	55.60
T.136N., R.90W.	...	...	...	2.8	788	3.86	2.8	15,833	77.58	81.44
T.135N., R.88W.	2.8	433	2.00	2.8	3,205	15.46	2.7	4,361	20.61	38.07
T.135N., R.89W.	2.7	155	0.73	2.7	3,798	17.95	2.7	18,786	88.76	107.44
T.135N., R.90W.	...	...	...	...	...	...	2.8	23,040	112.90	112.90
T.134N., R.86W.	3.0	65	0.34	...	...	...	...	...	...	0.34
T.134N., R.87W.	3.8	336	2.58	4.5	584	4.60	2.6	1,253	5.70	12.88
T.134N., R.88W.	...	...	...	...	...	...	2.6	17,946	81.66	81.66
T.134N., R.98W.	2.7	7	0.03	2.7	1,811	8.70	2.7	20,924	98.87	107.60
T.134N., R.90W.	...	...	....	2.8	1,021	5.00	2.8	22,022	107.91	112.91
T.133N., R.87W.	...	...	...	...	...	...	2.6	5,820	26.48	26.48
T.133N., R.88W.	...	...	...	...	...	...	2.6	7,539	34.30	34.30
T.133N., R.89W.	3.0	698	3.66	2.8	1,498	6.96	2.6	5,459	24.84	35.46
T.133N., R.90W.	...	...	...	2.7	5,743	27.14	2.7	15,187	71.76	98.90
T.132N., R.89W.	3.5	497	3.05	3.3	2,144	11.36	3.0	2,746	14.42	28.83
T.132N., R.90W.	...	...	...	2.0	2,448	12.85	3.0	19,302	101.34	114.19
T.131N., R.89W.	2.6	304	1.38	2.6	827	3.69	...	...	...	5.07
T.131N., R.90W.	4.8	1,298	9.62	4.8	6,550	45.87	...	...	...	55.49
Total		5,221	30.54		42,437	222.09		237,847	1,146.43	1,399.06

T. 135 N., R. 75 W., where 2 1/2 feet of lignite was recorded, and in R. 78 W., where the bed was 2.0 feet thick. The lignite is in the Hell Creek formation and is not of commercial thickness by present-day standards.

The Turtle Mountains

The Turtle Mountains are in northeastern Bottineau and northwestern Rollette Counties, extending northward into Canada. A three-foot bed north of Dunseith was mined for a short time (Babcock, 1901, p. 71; Wilder and Wood, 1902, p. 162). With the information now available it is not possible to estimate the reserves, if any, in this area.

LIGNITE MINING IN NORTH DAKOTA

Production

The earliest year for which lignite production was reported in North Dakota was 1884, when 35,000 tons was produced. In all probability there had been some operations prior to that date, and it is almost certain that in the early years of settlement in the State, a considerable amount of unreported mining was carried on for domestic uses. The first fairly large-scale operations were opened to supply railroad fuel.

Total all-time production from North Dakota, through 1950, is 70,751,824 short tons. The growth of the industry has been remarkably uniform, no one year being far out of line with the general trend. (See fig. 20.) In terms of annual production, the 500,000-ton figure was passed in 1915; the 1,000,000-ton figure in 1922. Production held its own during the depression years and reached 2,000,000 tons in 1937 and 3,000,000 tons in 1949. (See table 2.) Mining is, however, a relatively minor industry in the State at the present time, the number of miners employed in 1950 being only 475 according to the report of the State Coal Mine Inspector. This figure does not include many farmers who mine lignite for their own use on their own land,

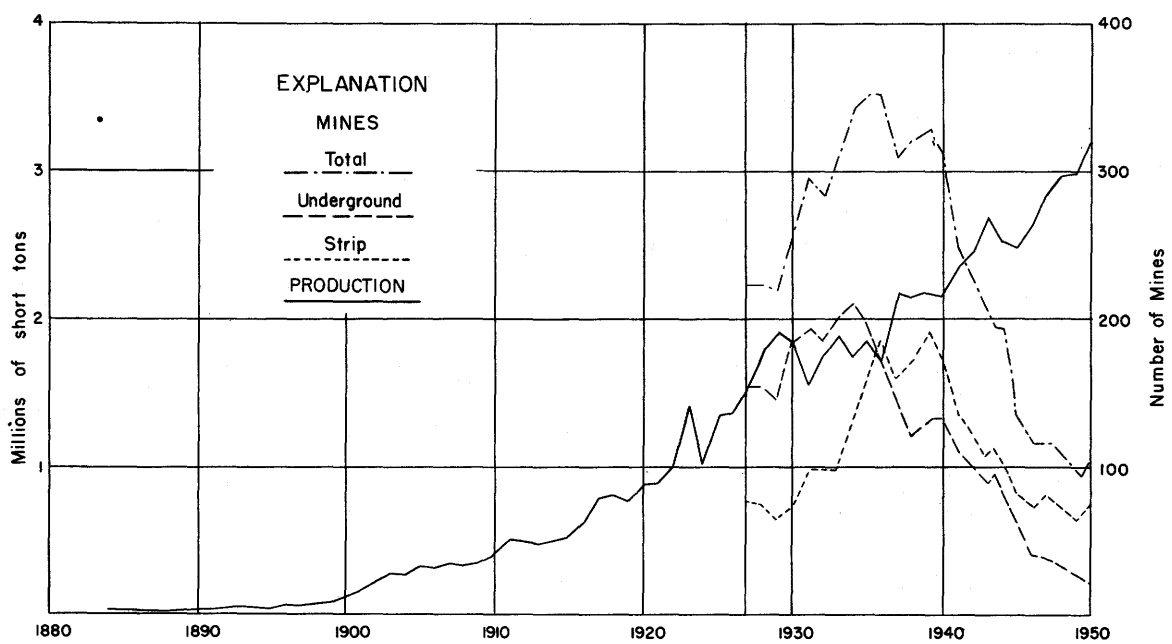


Figure 20.--Chart showing production of lignite in North Dakota, 1884-1950, and number of operating mines, 1927-50.

and the fuel thus recovered is not included in the production totals.

Mining methods

The history of mining in North Dakota is largely one of a shift from underground to surface methods of recovery. No figures on the comparative totals mined by each method prior to 1927 are available, though it is known that most of the coal in the early days was mined underground by drifts and slopes. In 1927, the reports show that 146 underground mines produced 916,690 tons, while 81 strip mines were producing 612,464 tons. It will be noted that strip mining was used on a large scale in North Dakota long before it became common in most other coal-producing states; the strip-mined coal of the State in 1927 was 40 percent of the total production, as compared to 2 percent for the nation as a whole. The percentage of strip-mined lignite has increased since 1927, reaching, in 1950, 86 percent of the total, as compared with 22 percent for the nation.

The reason for the growth of surface mining in North Dakota is not hard to find. Most of the rocks above and under the lignite beds are soft and unconsolidated, so much so that in most underground mines it is necessary to leave two feet or more of lignite in the roof, and in some areas a comparable amount in the floor, to furnish solid bearing surfaces for the timbering. Comparatively large pillars are also necessary, and low recovery of the lignite is unavoidable. By contrast, comparatively thick beds of lignite lie not far below the surface over wide areas, and by utilizing the great capacity of modern earth-moving machinery large tonnages can be strip-mined safely and economically. It is safe to say that in the foreseeable future a very large proportion of the lignite mined in the State will be recovered by surface methods.

Recoverability

Few figures as to the actual recovery of lignite from North Dakota mines are available, though one company operating a strip mine reports that it recovers 1,200 tons per acre-foot, or approximately 70 percent of the lignite originally in the ground. This recovery, low as compared to many stripping operations, is probably due to the necessity of leaving some lignite in the floor of the pit to control mud conditions. As stated in the preceding section, recovery from underground mines in North Dakota is lower than the average for the Nation because of the use of large pillars and the leaving of coal in the floor and roof.

In the absence of definite figures applicable to the State, it is assumed that the average recovery of lignite in North Dakota, including both strip and underground mines, is in line with the estimate of 50 percent mining losses given by Averitt and Berryhill (1950). On that basis, the recoverable lignite reserves as of January 1, 1950, would be 50 percent of the 350,768 million tons of remaining reserves as of that date, or 175,384 million tons.

UTILIZATION OF THE LIGNITE

Most of the lignite mined in North Dakota is used for domestic heating, for industrial uses such as evaporation in the sugar refineries in the State and in adjacent Minnesota, and for steam-raising in thermal power plants. One large producer of lignite ships about 75 percent of its output to industries, and, for the State as a whole, Burr (1951, p. 8) states that 65 percent of the production of the State is used in generating electric power. The fuel is generally used on standard stokers and travelling grates, only a small amount of specialized equipment being used.

Some of the lignite that is to be shipped is dried before shipment, a process which, because of the high moisture content of the fuel, potentially reduces freight charges as much as 40 percent and also minimizes the tendency of the lignite to slack and to ignite spontaneously. Drying methods are of two types: the flash-drying process, in which hot flue gases are passed over the lignite to drive off most of the moisture, and the steam-drying process in which the lignite is subjected to steam under pressure followed by a rapid release of pressure. In the second process the heat adsorbed by the lignite drives off the steam at the reduced pressure; an advantage of the method over the flash-drying process is that larger lumps can be dried. Another method of processing lignite is by carbonization. The lignite is heated in closed retorts and yields water, some gas and light oils, moderate amounts of tar, and char. In the briquetting plant near Dickinson the char is combined with binder and pressed into briquettes. In 1950, production was 35,388 tons of briquettes, which compare favorably in heating value with some of the higher rank coals.

Although not now on a commercial basis, gasification of lignite has been accomplished and has definite economic possibilities. The gas produced is high in hydrogen and hence is suitable for use in hydrogenation of fats and oils and the production of nitrates for explosives or fertilizers. The gas may also be used in the manufacture of synthetic liquid fuels.

In addition to its obvious value as a fuel, the lignite of North Dakota has possibilities as a raw material which can be converted by chemical means to a wide variety of products; in fact Burr (1951) thinks that the greatest future usefulness of the lignite lies in its chemical activity. Leonardite, apparently produced by the natural weathering of lignite, is processed to form wood stains of superior quality and to form a stabilizing agent for mud used in oil and gas well drilling. Gas from the lignite may be used for domestic purposes, and experiments are being made in the reduction of the low-grade iron ores of Minnesota by hydrogen or by the use of lignite char. As research into the chemistry of lignite is still in the early stage of development, it is reasonable to expect that many additional uses will be found in the future.

Table 25.--Estimated original lignite reserves in North Dakota, by county and township.
(in millions of short tons)

Township	Measured reserves				Indicated reserves				Inferred reserves				Total in all categories			Township Total
	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	
Adams County																
T.132N., R.97W.	....	....	....	....	....	....	....	....	6.73	....	....	6.73	6.73	....	....	6.73
T.132N., R.98W.	....	....	....	....	....	....	....	....	19.56	49.10	279.24	347.90	19.56	49.10	279.24	347.90
T.131N., R.91W.	2.61	....	....	2.61	8.60	....	....	8.60	7.53	....	....	7.53	18.74	....	....	18.74
T.131N., R.92W.	16.58	....	....	16.58	87.39	....	....	87.39	15.91	....	....	15.91	119.88	....	....	119.88
T.131N., R.93W.	11.18	0.06	....	11.24	43.98	....	....	43.98	59.29	....	....	59.29	114.45	0.06	....	114.51
T.131N., R.94W.	....	....	....	....	0.45	....	....	0.45	....	....	....	....	0.45	....	....	0.45
T.131N., R.95W.	....	....	....	....	....	....	....	....	2.39	....	....	2.39	2.39	....	....	2.39
T.131N., R.96W.	....	....	....	....	....	....	....	....	56.09	....	....	56.09	56.09	....	....	56.09
T.131N., R.97W.	....	....	....	....	....	....	....	....	71.71	116.75	....	188.46	71.71	116.75	....	188.46
T.131N., R.98W.	....	....	....	....	....	7.28	45.30	52.58	0.32	185.90	168.89	355.11	0.32	193.18	214.19	407.69
T.130N., R.92W.	4.14	0.85	....	4.99	11.07	0.79	....	11.86	0.07	....	....	0.07	15.28	1.64	....	16.92
T.130N., R.93W.	0.71	1.82	....	2.53	1.72	0.61	....	2.33	....	....	....	....	2.43	2.43	....	4.86
T.130N., R.94W.	....	4.99	....	4.99	....	6.79	....	6.79	....	....	....	....	....	11.78	....	11.78
T.130N., R.95W.	....	....	....	....	....	....	....	....	17.58	....	....	17.58	17.58	....	....	17.58
T.130N., R.96W.	....	....	....	....	....	....	....	....	152.62	....	....	152.62	152.62	....	....	152.62
T.130N., R.97W.	....	3.03	....	3.03	....	41.39	....	41.39	59.21	98.72	....	157.93	59.21	143.14	....	202.35
T.130N., R.98W.	....	17.81	21.13	38.94	3.30	58.78	32.94	95.02	0.80	2.50	....	3.30	4.10	79.09	54.07	137.26
T.129N., R.94W.	....	....	15.86	15.86	....	....	....	....	....	....	....	....	....	....	15.86	15.86
T.129N., R.95W.	....	....	1.21	1.21	....	....	4.89	4.89	....	....	....	....	....	....	6.10	6.10
T.129N., R.96W.	....	....	....	....	....	....	....	....	5.56	....	....	5.56	5.56	....	....	5.56
T.129N., R.97W.	....	....	....	....	....	....	....	....	1.00	....	....	1.00	1.00	....	....	1.00
T.129N., R.98W.	1.18	....	....	1.18	12.21	....	....	12.21	8.64	....	....	8.64	22.03	....	....	22.03
County total	36.40	28.56	38.20	103.16	168.72	115.64	83.13	367.49	485.01	452.97	448.13	1,386.11	690.13	597.17	569.46	1,856.76
Billings County																
T.144N., R.98W.	....	....	....	....	0.43	....	....	0.43	1,138.60	....	....	1,138.60	1,139.03	....	....	1,139.03
T.144N., R.99W.	....	....	....	....	....	....	....	....	491.81	....	....	491.81	491.81	....	....	491.81
T.144N., R.100W.	....	....	....	....	....	....	....	....	324.40	....	....	324.40	324.40	....	....	324.40
T.144N., R.101W.	....	....	....	....	5.09	1.20	....	6.29	348.54	70.22	....	418.76	353.63	71.42	....	425.05
T.144N., R.102W.	7.15	53.62	....	60.77	73.51	126.60	....	200.11	109.67	43.52	....	153.19	190.33	223.74	....	414.07
T.143N., R.98W.	0.06	4.97	....	5.03	45.87	11.31	....	57.18	1,013.13	....	....	1,013.13	1,059.06	16.28	....	1,075.34
T.143N., R.99W.	....	....	....	....	....	....	....	....	402.30	....	....	402.30	402.30	....	....	402.30
T.143N., R.100W.	....	....	....	....	....	....	....	....	391.01	14.72	....	405.73	391.01	14.72	....	405.73
T.143N., R.101W.	0.39	1.00	....	1.39	19.64	19.73	3.42	42.79	249.59	259.51	....	509.10	269.62	280.24	3.42	553.28
T.143N., R.102W.	17.31	55.55	60.23	133.09	117.30	124.95	46.73	288.98	51.62	23.31	....	74.93	186.23	203.81	106.96	497.00
T.142N., R.98W.	....	....	....	....	4.61	4.65	....	9.26	718.81	0.79	....	719.60	723.42	5.44	....	728.86
T.142N., R.99W.	....	....	....	....	....	....	....	....	442.72	....	....	442.72	442.72	....	....	442.72
T.142N., R.100W.	....	2.16	....	2.16	17.55	22.05	....	39.60	377.06	120.91	....	497.97	394.61	145.12	....	539.73
T.142N., R.101W.	2.58	9.27	....	11.85	27.94	34.78	8.05	70.77	144.97	288.46	8.41	441.84	175.49	332.51	16.46	524.46
T.142N., R.102W.	....	....	13.43	13.43	9.89	34.17	144.37	188.43	215.81	176.64	5.91	398.36	225.70	210.81	163.71	600.22
T.141N., R.98W.	....	13.69	2.14	15.83	....	124.99	54.43	179.42	261.83	6.13	108.07	376.03	261.83	144.81	164.64	571.28
T.141N., R.99W.	1.96	9.60	....	11.56	55.44	57.44	22.47	135.35	328.35	15.23	25.70	369.28	385.75	82.27	48.17	516.19
T.141N., R.100W.	5.62	0.16	2.02	7.80	33.81	8.34	15.46	57.61	247.96	190.70	....	438.66	287.39	199.20	17.48	504.07
T.141N., R.101W.	....	5.68	12.18	17.86	6.69	11.37	20.87	38.93	239.85	283.82	....	523.67	246.54	300.87	33.05	580.46
T.141N., R.102W.	2.24	6.99	....	9.23	1.97	17.94	....	19.91	249.98	302.40	....	552.38	254.19	327.33	....	581.52

Table 25.--Estimated original lignite reserves in North Dakota, by county and township.--Continued.

Township	Measured reserves				Indicated reserves				Inferred reserves				Total in all categories			Township Total
	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	
Billings County — Continued																
T.140N., R.100W.	....	....	....	....	....	....	....	....	249.02	107.23	....	356.25	249.02	107.23	....	356.25
T.140N., R.101W.	....	0.08	....	0.08	34.76	35.93	....	70.69	150.39	239.86	....	390.25	185.15	275.87	....	461.02
T.140N., R.102W.	9.91	14.18	....	24.09	100.57	129.46	13.01	243.04	61.60	80.56	....	142.16	172.08	224.20	13.01	409.29
T.139N., R.100W.	....	....	....	....	2.91	18.15	....	21.06	235.78	0.14	242.82	478.74	238.69	18.29	242.82	499.80
T.139N., R.101W.	0.87	0.14	....	1.01	25.22	4.86	....	30.08	116.98	166.77	240.98	524.73	143.07	171.77	240.98	555.82
T.139N., R.102W.	4.38	10.49	19.11	33.98	60.84	75.97	119.36	256.17	85.82	49.78	52.51	188.11	151.04	136.24	190.98	478.26
T.138N., R.100W.	....	....	....	....	....	....	....	....	218.69	....	427.39	646.08	218.69	....	427.39	646.08
T.138N., R.101W.	0.81	....	....	0.81	29.54	13.82	16.23	59.59	164.94	1.18	434.00	600.12	195.29	15.00	450.23	660.52
T.138N., R.102W.	6.53	55.74	23.04	85.31	34.48	114.47	179.35	328.30	0.60	....	146.24	146.84	41.61	170.21	348.63	560.45
T.137N., R.100W.	....	....	....	....	....	....	7.31	7.31	105.51	....	529.76	635.27	105.51	....	537.07	642.58
T.137N., R.101W.	0.27	....	39.03	39.30	25.74	15.54	277.10	318.38	60.39	....	199.21	259.60	86.40	15.54	515.34	617.28
T.137N., R.102W.	2.55	8.22	42.27	53.04	25.34	58.54	376.24	460.12	....	....	....	....	27.89	66.76	418.51	513.16
County total	62.63	251.54	213.45	527.62	759.14	1,066.26	1,304.40	3,129.80	9,197.73	2,441.88	2,421.00	14,060.61	10,019.50	3,759.68	3,938.85	17,718.03
Bowman County																
T.132N., R. 99W.	....	....	....	....	....	....	....	....	....	22.64	633.67	656.31	....	22.64	633.67	656.31
T.132N., R.100W.	....	....	....	....	2.25	0.07	....	2.32	51.03	84.54	703.19	838.76	53.28	84.61	703.19	841.08
T.132N., R.101W.	8.83	....	22.66	31.49	76.75	5.48	144.20	226.43	177.14	4.82	627.20	809.16	262.72	10.30	794.06	1,067.08
T.132N., R.102W.	....	....	77.40	77.40	18.96	3.63	83.16	105.75	147.98	41.61	....	189.59	166.94	45.24	160.56	372.74
T.132N., R.103W.	....	....	....	....	....	....	....	....	....	177.00	....	177.00	....	177.00	....	177.00
T.132N., R.104W.	....	4.15	8.94	13.09	12.73	67.25	30.68	110.66	....	147.55	20.27	167.82	12.73	218.95	59.89	291.57
T.132N., R.105W.	1.51	8.59	3.14	13.24	10.21	8.01	38.46	56.68	....	....	....	....	11.72	16.60	41.60	69.92
T.131N., R. 99W.	....	....	26.92	26.92	....	....	19.67	19.67	....	....	662.02	662.02	....	....	708.61	708.61
T.131N., R.100W.	....	2.94	17.84	20.78	....	41.21	57.06	98.27	....	36.88	454.92	491.80	....	81.03	529.82	610.85
T.131N., R.101W.	....	....	....	....	13.70	0.44	....	14.14	190.96	63.32	72.63	326.91	204.66	63.76	72.63	341.05
T.131N., R.102W.	....	....	....	....	....	....	8.97	8.97	147.85	94.87	....	242.72	147.85	94.87	8.97	251.69
T.131N., R.103W.	....	....	5.88	5.88	0.73	....	34.44	35.17	....	215.73	....	215.73	0.73	215.73	40.32	256.78
T.131N., R.104W.	12.55	8.18	....	20.73	10.51	87.34	4.54	102.39	....	97.30	....	97.30	23.06	192.82	4.54	220.42
T.131N., R.105W.	....	....	....	....	15.58	1.23	....	16.81	....	....	....	....	15.58	1.23	....	16.81
T.130N., R. 99W.	....	0.13	3.61	3.74	0.27	26.80	1.07	28.14	25.48	64.13	....	89.61	25.75	91.06	4.68	121.49
T.130N., R.100W.	....	....	....	....	....	9.93	....	9.93	81.78	78.36	....	160.14	81.78	88.29	....	170.07
T.130N., R.101W.	3.86	....	....	3.86	6.82	....	....	6.82	127.03	9.39	....	136.42	137.71	9.39	....	147.10
T.130N., R.102W.	5.54	0.37	....	5.91	63.06	56.80	....	119.86	22.89	33.75	....	56.64	91.49	90.92	....	182.41
T.130N., R.103W.	3.35	10.51	....	13.86	24.10	72.34	....	96.44	....	106.71	....	106.71	27.45	189.56	....	217.01
T.130N., R.104W.	2.38	9.15	....	11.53	19.03	44.98	....	64.01	....	1.88	....	1.88	21.41	56.01	....	77.42
T.129N., R. 99W.	....	....	....	....	0.90	....	....	0.90	44.80	....	....	44.80	45.70	....	....	45.70
T.129N., R.100W.	....	6.26	....	6.26	....	40.20	1.34	41.54	31.31	16.44	....	47.75	31.31	62.90	1.34	95.55
T.129N., R.101W.	....	0.06	....	0.06	3.65	2.78	20.71	27.14	4.22	....	....	4.22	7.87	2.84	20.71	31.42
T.129N., R.102W.	6.85	....	....	6.85	22.24	4.03	....	26.27	0.22	....	....	0.22	29.31	4.03	....	33.34
T.129N., R.103W.	2.47	....	....	2.47	9.25	....	....	9.25	3.24	....	....	3.24	14.96	....	....	14.96
T.129N., R.104W.	....	2.60	....	2.60	....	....	....	....	....	....	....	....	....	2.60	....	2.60
County total	47.34	52.94	166.39	266.67	310.74	472.52	444.30	1,227.56	1,055.93	1,296.92	3,173.90	5,526.75	1,414.01	1,822.38	3,784.59	7,020.98
Burke County																
T.164N., R. 88W.	....	....	....	....	....	....	....	....	5.50	....	....	5.50	5.50	....	....	5.50
T.164N., R. 89W.	....	....	....	....	....	....	....	....	27.65	....	....	27.65	27.65	....	....	27.65
T.164N., R. 90W.	....	....	....	....	....	....	....	....	26.73	....	....	26.73	26.73	....	....	26.73
T.164N., R. 91W.	2.88	1.67	....	4.55	7.57	....	....	7.57	15.69	....	....	15.69	26.14	1.67	....	27.81
T.164N., R. 92W.	1.37	1.98	....	3.35	10.26	1.75	....	12.01	17.90	....	....	17.90	29.53	3.73	....	33.26
T.164N., R. 93W.	....	....	....	....	13.63	....	....	13.63	15.16	....	....	15.16	28.79	....	....	28.79
T.164N., R. 94W.	....	....	....	....	5.15	....	....	5.15	34.98	....	....	34.98	40.13	....	....	40.13

T.163N., R. 88W.	....	....	....	....	....	....	....	....	78.77	....	....	78.77	78.77	....	....	78.77
T.163N., R. 89W.	....	....	....	....	....	10.09	6.68	16.77	114.32	14.72	....	129.04	114.32	24.81	6.68	145.81
T.163N., R. 90W.	....	....	11.05	11.05	....	10.90	52.21	63.11	57.28	75.37	29.17	161.82	57.28	86.27	92.43	235.98
T.163N., R. 91W.	0.24	1.67	....	1.91	7.56	7.95	....	15.51	95.12	....	....	95.12	102.92	9.62	....	112.54
T.163N., R. 92W.	1.28	1.67	....	2.95	12.63	2.23	....	14.86	71.88	....	....	71.88	85.79	3.90	....	89.69
T.163N., R. 93W.	2.42	....	....	2.42	21.27	....	....	21.27	69.24	....	....	69.24	92.93	....	....	92.93
T.163N., R. 94W.	....	....	....	....	0.78	....	....	0.78	235.36	....	....	235.36	236.14	....	....	236.14
T.162N., R. 88W.	1.21	....	....	1.21	14.75	....	....	14.75	61.04	....	....	61.04	77.00	....	....	77.00
T.162N., R. 89W.	....	....	....	....	1.78	3.61	5.04	10.43	102.23	20.51	....	122.74	104.01	24.12	5.04	133.17
T.162N., R. 90W.	....	....	....	....	8.29	22.51	16.63	47.43	127.54	0.34	....	127.88	135.83	22.85	16.63	175.31
T.162N., R. 91W.	1.58	2.08	....	3.66	27.22	25.69	....	52.91	94.83	....	....	94.83	123.63	27.77	....	151.40
T.162N., R. 92W.	3.34	9.24	....	12.58	9.62	12.68	....	22.30	111.65	....	....	111.65	124.61	21.92	....	146.53
T.162N., R. 93W.	....	47.35	....	47.35	10.18	62.78	....	72.96	100.74	1.79	....	102.53	110.92	111.92	....	222.84
T.162N., R. 94W.	....	27.68	....	27.68	....	76.07	....	76.07	213.13	68.40	....	281.53	213.13	172.15	....	385.28
T.161N., R. 89W.	....	....	....	....	17.04	....	....	17.04	104.06	....	....	104.06	121.10	....	....	121.10
T.161N., R. 90W.	....	3.65	....	3.65	9.63	27.63	....	37.26	127.97	2.88	....	130.85	137.60	34.16	....	171.76
T.161N., R. 91W.	5.47	11.79	....	17.26	32.68	45.37	....	78.05	193.84	42.26	....	236.10	231.99	99.42	....	331.41
T.161N., R. 92W.	3.78	....	....	3.78	27.92	6.47	....	34.39	218.30	....	....	218.30	250.00	6.47	....	256.47
T.161N., R. 93W.	....	....	....	....	0.11	13.97	....	14.08	237.89	34.07	....	271.96	238.00	48.04	....	286.04
T.161N., R. 94W.	....	....	....	....	....	....	....	....	259.48	15.33	....	274.81	259.48	15.33	....	274.81
T.160N., R. 90W.	....	....	....	....	....	....	....	....	125.91	....	....	125.91	125.91	....	....	125.91
T.160N., R. 91W.	....	....	....	....	....	....	....	....	162.76	....	....	162.76	162.76	....	....	162.76
T.160N., R. 92W.	....	....	....	....	....	....	....	....	255.57	....	....	255.57	255.57	....	....	255.57
T.160N., R. 93W.	....	....	....	....	....	....	....	....	340.61	....	....	340.61	340.61	....	....	340.61
T.160N., R. 94W.	....	....	....	....	....	....	....	....	343.99	....	....	343.99	343.99	....	....	343.99
T.159N., R. 90W.	....	....	....	....	....	....	....	....	249.05	....	....	249.05	249.05	....	....	249.05
T.159N., R. 91W.	....	....	....	....	....	....	....	....	285.33	....	....	285.33	285.33	....	....	285.33
T.159N., R. 92W.	....	....	....	....	....	....	....	....	303.93	....	....	303.93	303.93	....	....	303.93
T.159N., R. 93W.	....	....	....	....	....	....	....	....	314.51	....	....	314.51	314.51	....	....	314.51
T.159N., R. 94W.	....	....	....	....	....	....	....	....	313.61	....	....	313.61	313.61	....	....	313.61
County total	23.57	108.78	11.05	143.40	238.07	329.70	80.56	648.33	5,513.55	275.67	29.17	5,818.39	5,775.19	714.15	120.78	6,610.12

Burleigh County

T.144N., R. 78W.	....	....	....	....	....	....	....	....	0.12	....	....	0.12	0.12	....	....	0.12
T.144N., R. 79W.	....	....	....	....	....	....	....	....	44.23	258.50	....	302.73	44.23	258.50	....	302.73
T.143N., R. 79W.	....	....	....	....	....	....	38.60	38.60	....	289.31	39.24	328.55	....	289.31	77.84	367.15
T.142N., R. 79W.	....	....	27.47	27.47	....	....	33.67	33.67	....	167.13	....	167.13	....	167.13	61.14	228.27
T.142N., R. 80W.	....	2.87	8.73	11.60	....	64.18	3.80	67.98	....	133.37	....	133.37	....	200.42	12.53	212.95
T.142N., R. 81W.	....	2.79	....	2.79	....	25.68	....	25.68	....	17.66	....	17.66	....	46.13	....	46.13
County total	....	5.66	36.20	41.86	....	89.86	76.07	165.93	44.35	865.97	39.24	949.56	44.35	961.49	151.51	1,157.35

Divide County

T.164N., R. 95W.	....	....	....	....	4.23	....	....	4.23	43.26	....	....	43.26	47.49	....	....	47.49
T.164N., R. 96W.	....	....	9.32	9.32	3.32	44.22	32.28	79.82	21.35	4.07	....	25.42	24.67	48.29	41.60	114.56
T.164N., R. 97W.	....	....	....	....	....	0.76	....	0.76	29.32	1.35	....	30.67	29.32	2.11	....	31.43
T.164N., R. 98W.	....	....	....	....	....	....	....	....	7.88	....	....	7.88	7.88	....	....	7.88
T.163N., R. 95W.	1.86	22.34	4.10	28.30	105.81	80.74	46.26	232.81	3.95	....	....	3.95	111.62	103.08	50.36	265.06
T.163N., R. 96W.	2.18	4.59	40.43	47.20	44.74	118.23	221.54	384.51	72.74	33.48	43.89	150.11	119.66	156.30	305.86	581.82
T.163N., R. 97W.	....	....	....	....	0.03	2.21	....	2.24	142.84	16.96	....	159.80	142.87	19.17	....	162.04
T.163N., R. 98W.	....	....	....	....	....	....	....	....	213.32	....	....	213.32	213.32	....	....	213.32
T.163N., R. 99W.	....	....	....	....	....	....	....	....	170.10	....	....	170.10	170.10	....	....	170.10

Table 25.--Estimated original lignite reserves in North Dakota, by county and township.--Continued.

Township	Measured reserves				Indicated reserves				Inferred reserves				Total in all categories			Township Total
	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	
Divide County -- Continued																
T.163N., R.100W.	....	....	....	....	....	....	....	....	110.40	....	....	110.40	110.40	....	....	110.40
T.163N., R.101W.	....	....	....	....	....	....	....	....	100.80	....	....	100.80	100.80	....	....	100.80
T.163N., R.102W.	....	....	....	....	....	....	....	....	100.80	....	....	100.80	100.80	....	....	100.80
T.163N., R.103W.	....	....	....	....	....	....	....	....	44.98	....	....	44.98	44.98	....	....	44.98
T.162N., R. 95W.	....	28.55	....	28.55	17.45	36.40	....	53.85	342.68	37.60	1.50	381.78	360.13	102.55	1.50	464.18
T.162N., R. 96W.	....	....	....	....	0.98	14.67	....	15.65	268.29	39.93	5.97	314.19	269.27	54.60	5.97	329.84
T.162N., R. 97W.	....	....	....	....	0.96	....	....	0.96	226.55	....	....	226.55	227.51	....	....	227.51
T.162N., R. 98W.	....	7.93	....	7.93	15.54	77.25	....	92.79	222.23	3.17	....	225.40	237.77	88.35	....	326.12
T.162N., R. 99W.	....	....	....	....	....	....	....	....	241.92	....	....	241.92	241.92	....	....	241.92
T.162N., R.100W.	....	....	....	....	....	....	....	....	201.83	....	....	201.83	201.83	....	....	201.83
T.162N., R.101W.	....	....	....	....	0.65	....	....	0.65	122.49	....	....	122.49	123.14	....	....	123.14
T.162N., R.102W.	2.69	....	....	2.69	39.52	....	....	39.52	79.39	....	....	79.39	121.60	....	....	121.60
T.162N., R.103W.	....	....	....	....	....	....	....	....	53.80	....	....	53.80	53.80	....	....	53.80
T.161N., R. 95W.	....	....	....	....	....	....	....	....	338.77	....	....	338.77	338.77	....	....	338.77
T.161N., R. 96W.	....	....	....	....	....	....	....	....	301.02	....	....	301.02	301.02	....	....	301.02
T.161N., R. 97W.	....	....	....	....	....	....	....	....	196.79	....	....	196.79	196.79	....	....	196.79
T.161N., R. 98W.	....	....	....	....	....	....	....	....	221.12	....	....	221.12	221.12	....	....	221.12
T.161N., R. 99W.	....	....	....	....	....	....	....	....	241.92	....	....	241.92	241.92	....	....	241.92
T.161N., R.100W.	....	....	....	....	....	....	....	....	221.76	....	....	221.76	221.76	....	....	221.76
T.161N., R.101W.	4.37	....	....	4.37	29.93	....	....	29.93	129.66	....	....	129.66	163.96	....	....	163.96
T.161N., R.102W.	10.14	....	....	10.14	58.79	....	....	58.79	81.93	....	....	81.93	150.86	....	....	150.86
T.161N., R.103W.	....	....	....	....	....	....	....	....	52.82	....	....	52.82	52.82	....	....	52.82
T.160N., R. 95W.	....	....	....	....	....	....	....	....	338.82	....	....	338.82	338.82	....	....	338.82
T.160N., R. 96W.	....	....	....	....	....	....	....	....	336.70	....	....	336.70	336.70	....	....	336.70
T.160N., R. 97W.	....	....	....	....	....	....	....	....	330.46	....	....	330.46	330.46	....	....	330.46
T.160N., R. 98W.	....	....	....	....	....	....	....	....	256.44	....	....	256.44	256.44	....	....	256.44
T.160N., R. 99W.	....	....	....	....	....	....	....	....	325.44	....	....	325.44	325.44	....	....	325.44
T.160N., R.100W.	....	....	....	....	....	....	....	....	157.98	....	....	157.98	157.98	....	....	157.98
T.160N., R.101W.	....	....	....	....	17.02	....	....	17.02	278.64	....	....	278.64	295.66	....	....	295.66
T.160N., R.102W.	....	....	....	....	24.79	....	....	24.79	165.30	....	....	165.30	190.09	....	....	190.09
T.160N., R.103W.	....	....	....	....	....	....	....	....	102.90	....	....	102.90	102.90	....	....	102.90
County total	21.24	63.41	53.85	138.50	363.76	374.48	300.08	1,038.32	6,899.39	136.56	51.36	7,087.31	7,284.39	574.45	405.29	8,264.13
Dunn County																
T.150N., R. 91W.	1.15	....	....	1.15	....	....	....	....	16.11	....	....	16.11	17.26	....	....	17.26
T.150N., R. 92W.	0.82	....	....	0.82	0.06	....	....	0.06	7.57	....	....	7.57	8.45	....	....	8.45
T.150N., R. 93W.	35.18	3.12	....	38.30	28.12	15.93	....	44.05	76.66	0.90	....	77.56	139.96	19.95	....	159.91
T.149N., R. 91W.	44.19	....	....	44.19	184.86	....	....	184.86	413.76	....	....	413.76	642.81	....	....	642.81
T.149N., R. 92W.	104.32	....	....	104.32	162.99	....	....	162.99	450.32	....	....	450.32	717.63	....	....	717.63
T.149N., R. 93W.	28.45	....	....	28.45	171.59	9.54	....	181.13	702.87	115.85	....	818.72	902.91	125.39	....	1,028.30
T.148N., R. 91W.	13.60	....	....	13.60	38.05	....	....	38.05	209.24	....	....	209.24	260.89	....	....	260.89
T.148N., R. 92W.	40.00	5.74	....	45.74	96.07	1.53	....	97.60	730.49	....	....	730.49	866.56	7.27	....	873.83
T.148N., R. 93W.	48.66	0.86	....	49.52	93.19	....	....	93.19	959.93	....	....	959.93	1,101.78	0.86	....	1,102.64
T.148N., R. 94W.	5.82	0.31	....	6.13	110.34	20.65	....	130.99	1,296.51	28.74	....	1,325.25	1,412.67	49.70	....	1,462.37
T.148N., R. 95W.	6.27	7.58	....	13.85	37.09	27.40	....	64.49	1,064.53	0.29	....	1,064.82	1,107.89	35.27	....	1,143.16
T.148N., R. 96W.	0.22	....	....	0.22	7.10	....	....	7.10	989.47	....	....	989.47	996.79	....	....	996.79
T.148N., R. 97W.	....	....	....	....	....	....	....	....	1,052.30	....	....	1,052.30	1,052.30	....	....	1,052.30

T.147N., R. 91W.	23.51	....	....	23.51	209.69	....	....	209.69	790.30	....	....	790.30	1,023.50	....	....	1,023.50
T.147N., R. 92W.	107.93	5.80	....	113.73	192.76	21.72	....	214.48	494.44	6,40	....	500.84	795.13	33.92	....	829.05
T.147N., R. 93W.	103.06	15.95	....	119.01	268.86	13.18	....	282.04	589.27	11.98	....	601.25	961.19	41.11	....	1,002.30
T.147N., R. 94W.	29.39	23.65	35.81	88.85	92.74	146.48	30.62	269.84	656.65	80.34	....	736.99	778.78	250.47	66.43	1,095.68
T.147N., R. 95W.	2.61	3.93	46.62	53.16	....	58.50	99.77	158.27	1,067.78	150.89	4.66	1,223.33	1,070.39	213.32	151.05	1,434.76
T.147N., R. 96W.	1.78	4.42	....	6.20	22.36	21.20	....	43.56	1,508.54	16.86	....	1,525.40	1,532.68	42.48	....	1,575.16
T.147N., R. 97W.	10.89	47.53	....	58.42	77.26	68.79	....	146.05	1,244.85	....	....	1,244.85	1,333.00	116.32	....	1,449.32
T.146N., R. 91W.	1.96	0.42	....	2.38	37.69	18.40	....	56.09	1,153.48	....	....	1,153.48	1,193.13	18.82	....	1,211.95
T.146N., R. 92W.	54.43	34.88	....	89.31	112.50	135.12	....	247.62	1,017.56	94.40	....	1,111.96	1,184.49	264.40	....	1,448.89
T.146N., R. 93W.	2.08	....	....	2.08	48.48	32.68	....	81.16	1,221.71	241.27	47.40	1,510.38	1,272.27	273.95	47.40	1,593.62
T.146N., R. 94W.	3.09	5.61	1.32	10.02	40.32	73.42	29.30	143.04	1,165.27	86.38	3.25	1,254.90	1,208.68	165.41	33.87	1,407.96
T.146N., R. 95W.	....	....	....	....	....	5.41	....	5.41	1,591.50	173.38	....	1,764.88	1,591.50	178.79	....	1,770.29
T.146N., R. 96W.	....	....	....	....	....	....	....	....	1,745.84	....	....	1,745.84	1,745.84	....	....	1,745.84
T.146N., R. 97W.	0.62	....	....	0.62	14.35	....	....	14.35	1,329.06	....	....	1,329.06	1,344.03	....	....	1,344.03
T.145N., R. 91W.	0.62	1.86	....	2.48	2.89	40.35	0.77	44.01	945.36	81.56	....	1,026.92	948.87	123.77	0.77	1,073.41
T.145N., R. 92W.	....	3.56	....	3.56	10.07	48.99	3.04	62.10	1,002.24	138.47	51.49	1,192.20	1,012.31	191.02	54.53	1,257.86
T.145N., R. 93W.	....	....	33.13	33.13	0.27	....	293.50	293.77	1,044.55	0.80	225.09	1,270.44	1,044.82	0.80	551.72	1,597.34
T.145N., R. 94W.	....	....	1.45	1.45	6.86	....	39.21	46.07	1,122.07	197.88	190.32	1,510.27	1,128.93	197.88	230.98	1,557.79
T.145N., R. 95W.	....	....	....	....	....	....	....	....	1,599.96	92.01	1.43	1,693.40	1,599.96	92.01	1.43	1,693.40
T.145N., R. 96W.	....	....	....	....	....	....	....	....	1,736.71	....	....	1,736.71	1,736.71	....	....	1,736.71
T.145N., R. 97W.	....	....	....	....	....	....	....	....	1,311.26	....	....	1,311.26	1,311.26	....	....	1,311.26
T.144N., R. 91W.	....	7.56	....	7.56	36.17	66.06	....	102.23	954.96	25.55	....	980.51	991.13	99.17	....	1,090.30
T.144N., R. 92W.	1.61	3.64	....	5.25	20.46	49.19	....	69.65	1,081.18	109.09	....	1,190.27	1,103.25	161.92	....	1,265.17
T.144N., R. 93W.	3.10	3.97	....	7.07	39.45	27.26	114.74	181.45	1,135.93	132.94	16.98	1,285.85	1,178.48	164.17	131.72	1,474.37
T.144N., R. 94W.	....	....	....	....	....	....	14.23	14.23	1,261.66	121.48	31.92	1,415.06	1,261.66	121.48	46.15	1,429.29
T.144N., R. 95W.	1.44	....	4.15	5.59	8.45	30.65	48.69	87.79	1,265.70	193.25	28.98	1,487.93	1,275.59	223.90	81.82	1,581.31
T.144N., R. 96W.	0.24	....	....	0.24	34.22	0.15	....	34.37	1,562.16	65.38	....	1,627.54	1,596.62	65.53	....	1,662.15
T.144N., R. 97W.	....	....	....	....	6.57	....	....	6.57	1,380.55	....	....	1,380.55	1,387.12	....	....	1,387.12
T.143N., R. 91W.	....	....	1.71	1.71	6.09	9.07	1.35	16.51	1,075.64	45.15	....	1,120.79	1,081.73	54.22	3.06	1,139.01
T.143N., R. 92W.	....	7.56	1.58	9.14	21.83	82.85	8.49	113.17	1,041.99	61.07	1.75	1,104.81	1,063.82	151.48	11.82	1,227.12
T.143N., R. 93W.	2.12	0.44	4.02	6.58	47.43	79.07	49.22	175.72	997.20	71.45	6.10	1,074.75	1,046.75	150.96	59.34	1,257.05
T.143N., R. 94W.	9.53	....	....	9.53	58.99	0.13	....	59.12	1,113.58	....	....	1,113.58	1,182.10	0.13	....	1,182.23
T.143N., R. 95W.	2.79	....	....	2.79	9.98	....	....	9.98	1,180.88	....	....	1,180.88	1,193.65	....	....	1,193.65
T.143N., R. 96W.	5.10	2.07	6.08	13.25	57.90	19.87	36.69	114.46	1,283.13	28.15	4.25	1,315.53	1,346.13	50.09	47.02	1,443.24
T.143N., R. 97W.	22.42	1.64	4.19	28.25	192.27	20.74	22.18	235.19	1,319.85	37.91	1.29	1,359.05	1,534.54	60.29	27.66	1,622.49
T.142N., R. 91W.	8.43	....	0.59	9.02	31.43	22.58	1.05	55.06	523.43	14.07	....	537.50	563.29	36.65	1.64	601.58
T.142N., R. 92W.	11.83	3.58	5.12	20.53	84.82	17.11	4.30	106.23	618.81	113.84	....	732.65	715.46	134.53	9.42	859.41
T.142N., R. 93W.	4.29	5.96	....	10.25	86.37	54.43	1.24	142.04	721.61	19.79	....	741.40	812.27	80.18	1.24	893.69
T.142N., R. 94W.	7.42	3.96	....	11.38	77.06	13.41	....	90.47	1,063.11	....	....	1,063.11	1,147.59	17.37	....	1,164.96
T.142N., R. 95W.	....	....	....	....	20.59	....	....	20.59	1,416.22	....	....	1,416.22	1,436.81	....	....	1,436.81
T.142N., R. 96W.	3.18	10.93	....	14.11	31.74	17.90	....	49.64	1,245.99	0.65	....	1,246.64	1,280.91	29.48	....	1,310.39
T.142N., R. 97W.	2.92	10.03	....	12.95	53.49	11.97	....	65.46	971.48	....	....	971.48	1,027.89	22.00	....	1,049.89
T.141N., R. 91W.	0.75	4.53	....	5.28	24.93	5.90	....	30.83	382.25	....	....	382.25	407.93	10.43	....	418.36
T.141N., R. 92W.	1.32	0.50	....	1.82	22.11	23.25	....	45.36	680.44	43.91	....	724.35	703.87	67.66	....	771.53
T.141N., R. 93W.	1.54	11.34	....	12.88	36.06	100.31	....	136.37	623.45	43.58	....	667.03	661.05	155.23	....	816.28
T.141N., R. 94W.	3.33	14.85	....	18.18	68.46	29.47	....	97.93	1,083.65	18.18	....	1,101.83	1,155.44	62.50	....	1,217.94
T.141N., R. 95W.	8.26	1.31	....	9.57	92.72	25.43	....	118.15	872.59	167.27	....	1,039.86	973.57	194.01	....	1,167.58
T.141N., R. 96W.	....	....	17.54	17.54	13.94	10.49	62.60	87.03	473.29	402.60	30.45	906.34	487.23	413.09	110.59	1,010.91
T.141N., R. 97W.	....	44.69	31.62	76.31	4.34	97.94	57.97	160.25	361.43	143.97	....	505.40	365.77	286.60	89.59	741.96
County total	772.27	303.78	194.93	1,270.98	3,254.43	1,574.52	918.96	5,747.91	60,000.32	3,377.68	645.36	64,023.36	64,027.02	5,255.98	1,759.25	71,042.25

Golden Valley County

T.144N., R.103W.	5.93	36.05	....	41.98	72.32	103.50	....	175.82	156.85	0.53	....	157.38	235.10	140.08	....	375.18
T.144N., R.104W.	9.98	....	....	9.98	62.81	....	....	62.81	244.99	....	....	244.99	317.78	....	....	317.78
T.144N., R.105W.	8.96	6.74	....	15.70	106.61	1.72	....	108.33	136.92	....	....	136.92	252.49	8.46	....	260.95
T.143N., R.103W.	1.92	25.34	....	27.26	26.11	94.09	....	120.20	287.39	35.93	....	323.32	315.42	155.36	....	470.78
T.143N., R.104W.	27.91	9.89	....	37.80	143.62	55.35	....	198.97	217.08	1.49	....	218.57	388.61	66.73	....	455.34
T.143N., R.105W.	3.39	11.79	....	15.18	65.57	26.88	....	92.45	111.15	....	....	111.15	180.11	38.67	....	218.78
T.142N., R.103W.	....	2.52	0.67	3.19	4.61	3.34	3.91	11.86	373.03	114.58	....	487.61	377.64	120.44	4.58	502.66
T.142N., R.104W.	1.71	3.97	....	5.68	46.72	50.17	....	96.89	425.31	45.20	....	470.51	473.74	99.34	....	573.08
T.142N., R.105W.	3.13	11.84	....	14.97	36.25	32.86	....	69.11	288.93	6.77	....	295.70	328.31	51.47	....	379.78

Table 25.--Estimated original lignite reserves in North Dakota, by county and township.--Continued.

Township	Measured reserves				Indicated reserves				Inferred reserves				Total in all categories			Township Total
	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	
Golden Valley County -- Continued																
T.141N., R.103W.	....	....	....	....	....	....	....	....	301.90	73.58	....	375.48	301.90	73.58	....	375.48
T.141N., R.104W.	....	....	....	....	....	....	....	....	350.64	....	....	350.64	350.64	....	....	350.64
T.141N., R.105W.	....	5.49	....	5.49	1.12	57.35	....	58.47	252.57	2.28	....	254.85	253.69	65.12	....	318.81
T.140N., R.103W.	3.12	2.38	....	5.50	140.77	....	....	140.77	243.65	....	....	243.65	387.54	2.38	....	389.92
T.140N., R.104W.	1.54	7.59	....	9.13	49.82	5.70	....	55.52	286.10	....	....	286.10	337.46	13.29	....	350.75
T.140N., R.105W.	....	....	....	....	....	....	....	....	193.71	....	....	193.71	193.71	....	....	193.71
T.140N., R.106W.	....	....	....	....	....	....	....	....	51.08	....	....	51.08	51.08	....	....	51.08
T.139N., R.103W.	1.10	....	5.87	6.97	38.99	13.87	48.41	101.27	147.10	90.63	8.18	245.81	187.19	104.40	62.46	354.05
T.139N., R.104W.	5.12	0.08	17.41	22.61	30.87	15.36	19.62	65.85	105.82	4.96	....	110.78	141.81	20.40	37.03	199.24
T.139N., R.105W.	0.49	....	2.50	2.99	9.70	....	0.16	9.86	106.32	....	....	106.32	116.51	....	2.66	119.17
T.139N., R.106W.	....	....	....	....	....	....	....	....	54.61	....	....	54.61	54.61	....	....	54.61
T.138N., R.103W.	14.88	3.74	....	18.62	106.77	145.30	....	252.07	1.60	46.32	....	47.92	123.25	195.36	....	318.61
T.138N., R.104W.	4.75	19.01	....	23.76	77.96	51.77	....	129.73	63.65	152.74	....	216.39	146.36	223.52	....	369.88
T.138N., R.105W.	....	....	....	....	72.98	11.42	....	84.40	156.56	45.24	....	201.80	229.54	56.66	....	286.20
T.138N., R.106W.	....	....	....	....	32.79	....	....	32.79	19.31	....	....	19.31	52.10	....	....	52.10
T.137N., R.103W.	22.38	36.86	1.17	60.41	140.00	115.47	3.95	259.42	2.21	....	....	2.21	164.59	152.33	5.12	322.04
T.137N., R.104W.	10.89	22.48	....	33.37	74.35	101.70	....	176.05	48.82	37.45	....	86.27	134.06	161.63	....	295.69
T.137N., R.105W.	....	....	....	....	65.62	36.14	....	101.76	34.66	33.36	....	68.02	100.28	69.50	....	169.78
T.137N., R.106W.	....	....	....	....	25.99	....	....	25.99	16.43	....	....	16.43	42.42	....	....	42.42
T.136N., R.105W.	....	....	....	....	70.49	57.47	0.68	128.64	6.60	....	....	6.60	77.09	57.47	0.68	135.24
T.136N., R.106W.	....	....	....	....	4.33	....	....	4.33	10.82	....	....	10.82	15.15	....	....	15.15
County total	127.20	205.77	27.62	360.59	1,507.17	979.46	76.73	2,563.36	4,695.81	690.96	8.18	5,394.95	6,330.18	1,876.19	112.53	8,318.90
Grant County																
T.137N., R. 88W.	2.93	23.74	13.05	39.72	57.60	77.00	3.12	137.72	259.31	....	....	259.31	319.84	100.74	16.17	436.75
T.137N., R. 89W.	9.52	5.30	....	14.82	49.32	96.72	....	146.04	408.70	133.09	....	541.79	467.54	235.11	....	702.65
T.137N., R. 90W.	4.87	2.28	....	7.15	55.44	3.06	....	58.50	310.48	....	....	310.48	370.79	5.34	....	376.13
T.136N., R. 88W.	1.08	.....	....	1.08	10.85	....	....	10.85	13.10	....	....	13.10	25.03	....	....	25.03
T.136N., R. 89W.	4.89	....	....	4.89	39.46	....	....	39.46	84.52	....	....	84.52	128.87	....	....	128.87
T.136N., R. 90W.	1.90	....	....	1.90	32.95	....	....	32.95	168.44	....	....	168.44	203.29	....	....	203.29
T.135N., R. 88W.	2.00	....	....	2.00	21.63	....	....	21.63	29.54	....	....	29.54	53.17	....	....	53.17
T.135N., R. 89W.	2.91	....	....	2.91	43.56	....	....	43.56	269.15	....	....	269.15	315.62	....	....	315.62
T.135N., R. 90W.	2.14	2.48	....	4.62	15.82	8.70	....	24.52	446.37	....	....	446.37	464.33	11.18	....	475.51
T.134N., R. 86W.	0.34	....	....	0.34	....	....	....	....	....	....	....	....	0.34	....	....	0.34
T.134N., R. 87W.	2.58	....	....	2.58	4.60	0.43	....	5.03	5.70	....	....	5.70	12.88	0.43	....	13.31
T.134N., R. 88W.	12.42	6.45	8.45	27.32	37.08	17.55	7.47	62.10	84.86	....	....	84.86	134.36	24.00	15.92	174.28
T.134N., R. 89W.	2.66	4.60	....	7.26	67.59	23.44	....	91.03	270.12	1.67	....	271.79	340.37	29.71	....	370.08
T.134N., R. 90W.	....	....	....	....	38.76	0.12	....	38.88	379.63	....	....	379.63	418.39	0.12	....	418.51
T.133N., R. 87W.	0.36	64.84	....	65.20	0.46	14.63	....	15.09	26.48	....	....	26.48	27.30	79.47	....	106.77
T.133N., R. 88W.	1.76	28.08	....	29.84	4.91	46.65	....	51.56	38.74	....	....	38.74	45.41	74.73	....	120.14
T.133N., R. 89W.	3.88	7.16	....	11.04	12.47	25.53	....	38.00	25.15	....	....	25.15	41.50	32.69	....	74.19
T.133N., R. 90W.	11.37	12.14	....	23.51	104.34	23.58	....	127.92	117.98	0.22	....	118.20	233.69	35.94	....	269.63
T.132N., R. 89W.	9.10	....	....	9.10	17.37	....	....	17.37	14.42	....	....	14.42	40.89	....	....	40.89
T.132N., R. 90W.	2.40	21.45	....	23.85	20.17	119.96	....	140.13	102.09	14.41	....	116.50	124.66	155.82	....	280.48
T.131N., R. 89W.	1.38	....	....	1.38	3.69	....	....	3.69	....	....	....	....	5.07	....	....	5.07
T.131N., R. 90W.	9.59	1.93	....	11.52	50.04	0.06	....	50.10	....	....	....	....	59.63	1.99	....	61.62

T.130N., R. 86W.	0.54	....	....	0.54	....	....	....	....	....	....	....	....	0.54	....	....	0.54
T.130N., R. 87W.	0.90	....	....	0.90	....	....	....	....	....	....	....	....	0.90	....	....	0.90
T.130N., R. 88W.	1.39	....	....	1.39	1.15	....	....	1.15	....	....	....	....	2.54	....	....	2.54
T.129N., R. 88W.	1.24	....	....	1.24	0.18	....	....	0.18	....	....	....	....	1.42	....	....	1.42
County total	94.15	180.45	21.50	296.10	689.44	457.43	10.59	1,157.46	3,054.78	149.39	....	3,204.17	3,838.37	787.27	32.09	4,657.73

Hettinger County

T.136N., R. 91W.	....	....	....	....	....	....	....	....	382.04	....	....	382.04	382.04	....	....	382.04
T.136N., R. 92W.	5.84	....	....	5.84	24.19	....	....	24.19	374.12	....	....	374.12	404.15	....	....	404.15
T.136N., R. 93W.	....	....	....	....	2.76	....	....	2.76	338.69	....	....	338.69	341.45	....	....	341.45
T.136N., R. 94W.	1.83	12.78	....	14.61	20.83	10.35	....	31.18	349.53	....	....	349.53	372.19	23.13	....	395.32
T.136N., R. 95W.	....	2.69	....	2.69	17.84	8.60	....	26.44	381.23	55.78	....	437.01	399.07	67.07	....	466.14
T.136N., R. 96W.	0.61	....	....	0.61	24.19	....	....	24.19	330.03	123.05	2.49	455.57	354.83	123.05	2.49	480.37
T.136N., R. 97W.	....	....	....	....	....	....	....	....	331.30	6.56	406.74	744.60	331.30	6.56	406.74	744.60
T.135N., R. 91W.	....	....	....	....	10.92	....	....	10.92	446.96	....	....	446.96	457.88	....	....	457.88
T.135N., R. 92W.	7.27	....	....	7.27	60.48	....	....	60.48	343.98	....	....	343.98	411.73	....	....	411.73
T.135N., R. 93W.	0.39	....	....	0.39	11.88	....	....	11.88	403.69	....	....	403.69	415.96	....	....	415.96
T.135N., R. 94W.	....	....	....	....	0.46	....	....	0.46	367.46	....	....	367.46	367.92	....	....	367.92
T.135N., R. 95W.	....	2.95	....	2.95	2.60	95.81	1.38	99.79	248.77	137.81	....	386.58	251.37	236.57	1.38	489.32
T.135N., R. 96W.	....	....	20.08	20.08	....	20.02	58.91	78.93	221.76	70.22	37.02	329.00	221.76	90.24	116.01	428.01
T.135N., R. 97W.	....	....	1.38	1.38	....	20.67	20.21	40.88	242.15	91.22	501.70	835.07	242.15	111.89	523.29	877.33
T.134N., R. 91W.	....	4.58	....	4.58	15.69	8.74	....	24.43	332.76	....	....	332.76	348.45	13.32	....	361.77
T.134N., R. 92W.	0.10	....	....	0.10	7.39	....	....	7.39	406.70	....	....	406.70	414.19	....	....	414.19
T.134N., R. 93W.	2.32	....	....	2.32	33.20	....	....	33.20	388.40	....	....	388.40	423.92	....	....	423.92
T.134N., R. 94W.	....	....	....	....	5.82	....	....	5.82	300.69	....	....	300.69	306.51	....	....	306.51
T.134N., R. 95W.	1.38	4.59	....	5.97	27.72	60.38	....	88.10	246.87	13.13	....	260.00	275.97	78.10	....	354.07
T.134N., R. 96W.	....	....	14.70	14.70	....	36.09	131.38	167.47	170.80	83.67	20.62	275.09	170.80	119.76	166.70	457.26
T.134N., R. 97W.	....	....	12.86	12.86	....	53.81	29.86	83.67	56.30	42.99	431.12	530.41	56.30	96.80	473.84	626.94
T.133N., R. 91W.	0.14	....	....	0.14	12.06	....	....	12.06	323.02	....	....	323.02	335.22	....	....	335.22
T.133N., R. 92W.	....	....	....	....	....	....	....	....	363.04	....	....	363.04	363.04	....	....	363.04
T.133N., R. 93W.	1.97	....	....	1.97	20.56	....	....	20.56	404.10	....	....	404.10	426.63	....	....	426.63
T.133N., R. 94W.	3.83	....	....	3.83	31.70	....	....	31.70	272.40	....	....	272.40	307.93	....	....	307.93
T.133N., R. 95W.	....	....	....	....	....	....	....	....	90.75	....	....	90.75	90.75	....	....	90.75
T.133N., R. 96W.	....	....	....	....	....	....	....	....	55.01	....	....	55.01	55.01	....	....	55.01
T.133N., R. 97W.	....	....	....	....	....	....	....	....	13.02	....	317.12	330.14	13.02	....	317.12	330.14
T.132N., R. 91W.	9.13	13.03	....	22.16	39.19	94.42	....	133.61	122.68	73.82	....	196.50	171.00	181.27	....	352.27
T.132N., R. 92W.	0.82	4.15	....	4.97	17.30	52.21	....	69.51	130.89	160.40	....	291.29	149.01	216.76	....	365.77
T.132N., R. 93W.	....	3.19	....	3.19	10.02	47.46	....	57.48	215.09	73.09	....	288.18	225.11	123.74	....	348.85
T.132N., R. 94W.	....	....	....	....	1.11	....	....	1.11	69.15	....	....	69.15	70.26	....	....	70.26
County total	35.63	47.96	49.02	132.61	397.91	508.56	241.74	1,148.21	8,723.38	931.74	1,716.81	11,371.93	9,156.92	1,488.26	2,007.57	12,652.75

McHenry County

T.151N., R. 79W.	7.11	1.10	....	8.21	3.33	....	....	3.33	....	....	....	....	10.44	1.10	....	11.54
T.151N., R. 80W.	0.51	2.81	9.93	13.25	3.35	21.44	4.24	29.03	0.12	63.96	....	64.08	3.98	88.21	14.17	106.36
County total	7.62	3.91	9.93	21.46	6.68	21.44	4.24	32.36	0.12	63.96	....	64.08	14.42	89.31	14.17	117.90

Table 25.--Estimated original lignite reserves in North Dakota, by county and township.--Continued.

Township	Measured reserves				Indicated reserves				Inferred reserves				Total in all categories			Township Total
	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	
McKenzie County																
T.154N., R. 97W.	....	....	....	....	....	2.13	....	2.13	....	4.09	....	4.09	....	6.22	....	6.22
T.153N., R. 94W.	....	....	....	....	....	....	....	....	27.17	....	....	27.17	27.17	....	....	27.17
T.153N., R. 95W.	3.09	8.89	....	11.98	29.97	88.67	....	118.64	159.74	89.63	....	249.37	192.80	187.19	....	379.99
T.153N., R. 96W.	....	23.77	....	23.77	23.37	....	....	23.37	34.48	319.54	....	354.02	57.85	343.31	....	401.16
T.153N., R. 97W.	3.76	14.78	....	18.54	23.74	143.05	....	166.79	....	305.08	....	305.08	27.50	462.91	....	490.41
T.153N., R. 98W.	1.67	13.57	....	15.24	14.64	83.55	....	98.19	3.85	19.74	....	23.59	20.16	116.86	....	137.02
T.153N., R.100W.	....	3.99	....	3.99	....	12.33	....	12.33	....	....	....	....	....	16.32	....	16.32
T.153N., R.101W.	....	....	....	....	....	20.48	....	20.48	5.99	11.41	....	17.40	5.99	31.89	....	37.88
T.152N., R. 93W.	4.10	4.42	....	8.52	31.14	0.75	....	31.89	44.10	....	....	44.10	79.34	5.17	....	84.51
T.152N., R. 94W.	6.15	8.80	....	14.95	113.44	14.81	....	128.25	397.72	....	....	397.72	517.31	23.61	....	540.92
T.152N., R. 95W.	13.49	0.39	....	13.88	40.45	....	....	40.45	736.04	....	....	736.04	789.98	0.39	....	790.37
T.152N., R. 96W.	....	....	....	....	....	....	....	....	789.74	34.09	....	823.83	789.74	34.09	....	823.83
T.152N., R. 97W.	1.38	....	....	1.38	19.13	....	....	19.13	361.24	157.21	....	518.45	381.75	157.21	....	538.96
T.152N., R. 98W.	11.47	36.04	....	47.51	64.83	159.40	....	224.23	162.29	141.01	....	303.30	238.59	336.45	....	575.04
T.152N., R.100W.	3.86	3.34	....	7.20	48.95	63.56	....	112.51	27.25	196.52	....	223.77	80.06	263.42	....	343.48
T.152N., R.101W.	2.00	....	....	2.00	34.62	12.31	....	46.93	155.62	154.77	....	310.39	192.24	167.08	....	359.32
T.152N., R.102W.	....	....	....	....	....	....	....	....	138.28	....	....	138.28	138.28	....	....	138.28
T.152N., R.103W.	....	....	....	....	....	....	....	....	35.14	....	....	35.14	35.14	....	....	35.14
T.152N., R.104W.	....	....	....	....	....	....	....	....	0.33	....	....	0.33	0.33	....	....	0.33
T.151N., R. 93W.	0.25	....	....	0.25	1.01	....	....	1.01	1.04	....	....	1.04	2.30	....	....	2.30
T.151N., R. 94W.	63.40	107.71	....	171.11	130.50	295.04	....	425.54	86.72	196.64	....	283.36	280.62	599.39	....	880.01
T.151N., R. 95W.	6.56	2.08	....	8.64	98.76	32.29	....	131.05	791.63	39.15	....	830.78	896.95	73.52	....	970.47
T.151N., R. 96W.	....	....	....	....	....	....	....	....	898.70	....	....	898.70	898.70	....	....	898.70
T.151N., R. 97W.	....	....	....	....	....	....	....	....	921.26	....	....	921.26	921.26	....	....	921.26
T.151N., R. 98W.	5.48	....	....	5.48	22.83	....	....	22.83	399.47	....	....	399.47	427.78	....	....	427.78
T.151N., R. 99W.	0.92	....	....	0.92	3.01	....	....	3.01	317.77	5.89	....	323.66	321.70	5.89	....	327.59
T.151N., R.100W.	....	....	....	....	8.35	....	....	8.35	306.55	50.87	....	357.42	314.90	50.87	....	365.77
T.151N., R.101W.	....	....	....	....	128.15	....	....	128.15	261.59	1.13	....	262.72	389.74	1.13	....	390.87
T.151N., R.102W.	0.07	....	....	0.07	10.97	....	....	10.97	139.41	....	....	139.41	150.45	....	....	150.45
T.151N., R.103W.	....	....	....	....	7.85	....	....	7.85	103.12	....	....	103.12	110.97	....	....	110.97
T.151N., R.104W.	2.09	....	....	2.09	13.38	....	....	13.38	5.55	....	....	5.55	21.02	....	....	21.02
T.150N., R. 94W.	37.39	171.11	....	208.50	96.47	385.80	....	482.27	197.64	80.22	....	277.86	331.50	637.13	....	968.63
T.150N., R. 95W.	3.50	16.14	....	19.64	41.78	88.10	97.11	226.99	760.54	73.42	....	833.96	805.82	177.66	97.11	1,080.59
T.150N., R. 96W.	....	....	....	....	....	....	....	....	1,113.47	....	....	1,113.47	1,113.47	....	....	1,113.47
T.150N., R. 97W.	....	....	....	....	....	....	....	....	869.23	....	....	869.23	869.23	....	....	869.23
T.150N., R. 98W.	....	....	....	....	....	....	....	....	386.64	....	....	386.64	386.64	....	....	386.64
T.150N., R. 99W.	....	....	....	....	....	....	....	....	117.14	....	....	117.14	117.14	....	....	117.14
T.150N., R.100W.	1.13	....	....	1.13	....	....	....	....	134.55	....	....	134.55	135.68	....	....	135.68
T.150N., R.101W.	2.02	....	....	2.02	21.56	....	....	21.56	124.15	....	....	124.15	147.73	....	....	147.73
T.150N., R.102W.	1.56	....	....	1.56	10.19	....	....	10.19	41.81	....	....	41.81	53.56	....	....	53.56
T.150N., R.103W.	....	....	....	....	....	....	....	....	130.26	....	....	130.26	130.26	....	....	130.26
T.150N., R.104W.	3.41	....	....	3.41	35.95	....	....	35.95	41.49	....	....	41.49	80.85	....	....	80.85
T.149N., R. 94W.	10.90	1.86	....	12.76	90.36	1.26	....	91.62	1,019.20	41.71	....	1,060.91	1,120.46	44.83	....	1,165.29
T.149N., R. 95W.	3.06	....	....	3.06	56.49	0.81	....	57.30	1,086.92	9.98	....	1,096.90	1,146.47	10.79	....	1,157.26
T.149N., R. 96W.	....	....	....	....	....	....	....	....	1,366.56	....	....	1,366.56	1,366.56	....	....	1,366.56
T.149N., R. 97W.	....	....	....	....	....	....	....	....	1,066.67	....	....	1,066.67	1,066.67	....	....	1,066.67
T.149N., R. 98W.	....	....	....	....	....	....	....	....	352.36	....	....	352.36	352.36	....	....	352.36
T.149N., R. 99W.	....	....	....	....	....	....	....	....	65.32	....	....	65.32	65.32	....	....	65.32
T.149N., R.100W.	50.43	....	....	50.43	....	....	....	....	65.98	....	....	65.98	116.41	....	....	116.41
T.149N., R.101W.	3.33	....	....	3.33	13.64	....	....	13.64	205.96	....	....	205.96	222.93	....	....	222.93
T.149N., R.102W.	....	....	....	....	1.17	....	....	1.17	116.74	25.83	....	142.57	117.91	25.83	....	143.74
T.149N., R.103W.	....	....	....	....	....	....	....	....	145.93	12.38	....	158.31	145.93	12.38	....	158.31
T.149N., R.104W.	....	....	....	....	....	....	....	....	145.97	....	....	145.97	145.97	....	....	145.97

T.148N., R. 98W.	....	....	....	....	....	....	....	....	724.65	....	....	724.65	724.65	....	....	724.65
T.148N., R. 99W.	....	....	....	....	....	....	....	....	141.91	....	....	141.91	141.91	....	....	141.91
T.148N., R.100W.	0.06	....	....	0.06	22.47	....	....	22.47	96.26	0,29	....	96.55	118.79	0.29	....	119.08
T.148N., R.101W.	5.67	....	....	5.67	17.80	38.26	....	56.06	171.09	85.99	....	257.08	194.56	124.25	....	318.81
T.148N., R.102W.	2.50	9.69	....	12.19	90.21	51.13	....	141.34	190.39	226.59	....	416.98	283.10	287.41	....	570.51
T.148N., R.103W.	1.52	4.45	....	5.97	38.16	21.60	1.84	61.60	261.81	197.17	2.18	461.16	301.49	223.22	4.02	528.73
T.148N., R.104W.	0.74	3.15	....	3.89	3.61	26.60	....	30.21	126.41	14.17	....	140.58	130.76	43.92	....	174.68
T.148N., R.105W.	....	0.17	....	0.17	1.58	....	....	1.58	9.54	....	....	9.54	11.12	0.17	....	11.29
T.147N., R. 98W.	12.98	47.21	....	60.19	11.87	4.62	....	16.49	684.22	....	....	684.22	709.07	51.83	....	760.90
T.147N., R. 99W.	45.77	2.58	....	48.35	34.01	....	....	34.01	179.45	....	....	179.45	259.23	2.58	....	261.81
T.147N., R.100W.	12.44	8.31	3.66	24.41	67.63	18.45	4.12	90.20	53.81	16.01	....	69.82	133.88	42.77	7.78	184.43
T.147N., R.101W.	3.63	27.05	6.63	37.31	50.19	186.06	56.41	292.66	27.89	41.32	....	69.21	81.71	254.43	63.04	399.18
T.147N., R.102W.	2.66	36.49	2.46	41.61	46.43	129.89	16.87	193.19	108.75	34.91	2.87	146.53	157.84	201.29	22.20	381.33
T.147N., R.103W.	0.36	3.11	7.10	10.57	3.62	7.54	23.06	34.22	120.54	5.90	7.91	134.35	124.52	16.55	38.07	179.14
T.147N., R.104W.	....	0.24	....	0.24	5.23	1.44	....	6.67	88.57	....	....	88.57	93.80	1.68	....	95.48
T.147N., R.105W.	1.31	....	....	1.31	14.75	....	....	14.75	24.54	....	....	24.54	40.60	....	....	40.60
T.146N., R. 98W.	0.17	....	....	0.17	23.09	....	....	23.09	846.92	....	....	846.92	870.18	....	....	870.18
T.146N., R. 99W.	....	....	....	....	4.70	....	....	4.70	353.69	....	....	353.69	358.39	....	....	358.39
T.146N., R.100W.	....	....	....	....	16.98	....	....	16.98	173.75	....	....	173.75	190.73	....	....	190.73
T.146N., R.101W.	10.20	21.03	....	31.23	60.50	37.82	....	98.32	54.89	....	....	54.89	125.59	58.85	....	184.44
T.146N., R.102W.	1.13	4.69	2.56	8.38	0.45	1.13	64.72	66.30	85.43	....	3.38	88.81	87.01	5.82	70.66	163.49
T.146N., R.103W.	0.79	7.31	....	8.10	4.30	28.54	38.51	71.35	150.17	3.45	....	153.62	155.26	39.30	38.51	233.07
T.146N., R.104W.	0.95	2.63	....	3.58	15.12	16.21	....	31.33	145.84	24.94	....	170.78	161.91	43.78	....	205.69
T.146N., R.105W.	....	1.14	....	1.14	3.75	6.97	....	10.72	45.09	....	....	45.09	48.84	8.11	....	56.95
T.145N., R. 98W.	....	....	....	....	....	....	....	....	990.17	....	....	990.17	990.17	....	....	990.17
T.145N., R. 99W.	....	....	....	....	....	....	....	....	368.77	....	....	368.77	368.77	....	....	368.77
T.145N., R.100W.	....	....	....	....	1.33	....	....	1.33	223.64	....	....	223.64	224.97	....	....	224.97
T.145N., R.101W.	3.04	1.95	....	4.99	70.09	....	....	70.09	199.01	1.62	....	200.63	272.14	3.57	....	275.71
T.145N., R.102W.	12.06	34.93	....	46.99	30.71	51.64	6.07	88.42	64.46	7.08	....	71.54	107.23	93.65	6.07	206.95
T.145N., R.103W.	15.32	116.16	....	131.48	122.19	57.11	....	179.30	149.38	16.12	....	165.50	286.89	189.39	....	476.28
T.145N., R.104W.	3.15	11.86	3.15	18.16	79.45	26.65	....	106.10	76.00	19.59	....	95.59	158.60	58.10	3.15	219.85
T.145N., R.105W.	1.35	....	....	1.35	25.31	....	....	25.31	0,15	....	....	0.15	26.81	....	....	26.81
County total	384.27	761.04	25.56	1,170.87	2,102.23	2,116.00	308.71	4,526.94	23,803.51	2,665.46	16.34	26,485.31	26,290.01	5,542.50	350.61	32,183.12

McLean County

T.150N., R. 78W.	1.19	....	....	1.19	6.02	....	....	6.02	7.15	....	....	7.15	14.36	....	....	14.36
T.150N., R. 79W.	10.77	....	....	10.77	40.58	....	....	40.58	79.47	....	....	79.47	130.82	....	....	130.82
T.150N., R. 80W.	....	....	....	....	3.64	....	....	3.64	163.56	23.51	....	187.07	167.20	23.51	....	190.71
T.150N., R. 81W.	....	....	....	....	....	....	....	....	148.44	54.77	....	203.21	148.44	54.77	....	203.21
T.150N., R. 82W.	....	....	....	....	....	1.26	....	1.26	160.08	18.76	....	178.84	160.08	20.02	....	180.10
T.150N., R. 83W.	....	6.67	....	6.67	....	96.76	....	96.76	129.72	197.71	....	327.43	129.72	301.14	....	430.86
T.150N., R. 84W.	....	....	....	....	....	....	....	....	124.99	200.36	124.93	450.28	124.99	200.36	124.93	450.28
T.150N., R. 85W.	....	6.16	....	6.16	....	58.32	84.91	143.23	116.93	59.16	180.47	356.56	116.93	123.64	265.38	505.95
T.150N., R. 86W.	....	....	9.53	9.53	....	....	96.31	96.31	112.90	109.37	176.00	398.27	112.90	109.37	281.84	504.11
T.150N., R. 87W.	....	....	....	....	....	10.13	....	10.13	53.21	276.65	....	329.86	53.21	286.78	....	339.99
T.150N., R. 88W.	....	....	....	....	....	....	....	....	283.00	13.93	....	296.93	283.00	13.93	....	296.93
T.150N., R. 89W.	....	....	....	....	....	....	....	....	145.72	....	....	145.72	145.72	....	....	145.72
T.150N., R. 90W.	2.42	....	....	2.42	21.85	....	....	21.85	76.71	....	....	76.71	100.98	....	....	100.98
T.150N., R. 91W.	5.58	....	....	5.58	0.63	....	....	0.63	....	....	....	....	6.21	....	....	6.21
T.149N., R. 79W.	....	....	....	....	....	....	....	....	112.90	....	....	112.90	112.90	....	....	112.90
T.149N., R. 80W.	....	....	....	....	....	....	....	....	120.96	....	....	120.96	120.96	....	....	120.96
T.149N., R. 81W.	....	....	....	....	....	....	....	....	141.12	....	....	141.12	141.12	....	....	141.12
T.149N., R. 82W.	....	....	....	....	....	....	....	....	167.21	....	....	167.21	167.21	....	....	167.21
T.149N., R. 83W.	....	....	....	....	....	....	....	....	407.57	....	....	407.57	407.57	....	....	407.57
T.149N., R. 84W.	....	....	....	....	4.36	....	....	4.36	135.47	213.36	128.72	477.55	139.83	213.96	128.72	481.91
T.149N., R. 85W.	5.23	....	19.80	25.03	33.46	....	173.54	207.00	103.30	64.48	137.89	305.67	141.99	64.48	331.23	537.70
T.149N., R. 86W.	....	....	....	....	....	....	2.23	2.23	120.96	223.05	104.84	448.85	120.96	223.05	107.07	451.08
T.149N., R. 87W.	....	19.24	....	19.24	....	153.43	....	153.43	120.96	130.38	....	251.34	120.96	303.05	....	424.01
T.149N., R. 88W.	....	....	....	....	....	6.92	....	6.92	253.38	56.96	....	310.34	253.38	63.88	....	317.26
T.149N., R. 89W.	....	....	....	....	....	....	....	....	176.74	....	....	176.74	176.74	....	....	176.74
T.149N., R. 90W.	4.50	2.13	....	6.63	9.64	....	....	9.64	38.60	....	....	38.60	52.74	2.13	....	54.87

Table 25.--Estimated original lignite reserves in North Dakota, by county and township.--Continued.

Township	Measured reserves				Indicated reserves				Inferred reserves				Total in all categories			
	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Township Total
							McLean County -- Continued									
T.148N., R. 79W.	....	....	....	....	....	....	....	....	132.20	....	....	132.20	132.20	....	....	132.20
T.148N., R. 80W.	....	....	....	....	....	....	....	....	206.55	....	....	206.55	206.55	....	....	206.55
T.148N., R. 81W.	....	....	....	....	....	....	....	....	185.33	....	....	185.33	185.33	....	....	185.33
T.148N., R. 82W.	....	....	....	....	....	....	....	....	138.01	....	....	138.01	138.01	....	....	138.01
T.148N., R. 83W.	12.27	13.45	....	25.72	50.26	2.05	....	52.31	55.81	1.75	....	57.56	118.34	17.25	....	135.59
T.148N., R. 84W.	18.91	29.41	....	48.32	16.95	5.45	....	22.40	78.54	....	....	78.54	114.40	34.86	....	149.26
T.148N., R. 85W.	24.32	18.31	....	42.63	73.57	5.80	....	79.37	20.53	64.79	....	85.32	118.42	88.90	....	207.32
T.148N., R. 86W.	29.69	3.87	....	33.56	49.78	0.83	....	50.61	37.63	94.06	....	131.69	117.10	98.76	....	215.86
T.148N., R. 87W.	23.51	1.09	....	24.60	107.73	....	....	107.73	47.93	70.02	....	117.95	179.17	71.11	....	250.28
T.148N., R. 88W.	....	....	....	....	30.83	....	....	30.83	246.93	14.92	....	261.85	277.76	14.92	....	292.68
T.148N., R. 89W.	2.24	16.89	....	19.13	40.15	26.33	....	66.48	197.32	....	....	197.32	239.71	43.22	....	282.93
T.148N., R. 90W.	1.09	....	....	1.09	8.66	....	....	8.66	32.99	....	....	32.99	42.74	....	....	42.74
T.148N., R. 91W.	0.94	....	....	0.94	....	....	....	....	....	....	....	....	0.94	....	....	0.94
T.147N., R. 79W.	....	....	....	....	....	....	....	....	142.52	....	....	142.52	142.52	....	....	142.52
T.147N., R. 80W.	....	....	....	....	....	....	....	....	210.16	....	....	210.16	210.16	....	....	210.16
T.147N., R. 81W.	....	....	....	....	0.82	....	....	0.82	253.19	....	....	253.19	254.01	....	....	254.01
T.147N., R. 82W.	....	....	....	....	2.36	....	....	2.36	302.74	....	....	302.74	305.10	....	....	305.10
T.147N., R. 83W.	19.30	5.18	....	24.48	53.71	6.90	....	60.61	233.00	7.53	....	240.53	306.01	19.61	....	325.62
T.147N., R. 84W.	11.49	20.80	....	32.29	39.25	25.17	....	64.42	36.38	4.98	....	41.36	87.12	50.95	....	138.07
T.147N., R. 85W.	2.83	....	....	2.83	....	....	....	....	....	....	....	....	2.83	....	....	2.83
T.147N., R. 86W.	17.66	11.18	....	28.84	38.28	56.40	....	94.68	....	....	....	....	55.94	67.58	....	123.52
T.147N., R. 87W.	20.32	3.57	....	23.89	58.31	28.88	....	87.19	9.66	....	....	9.66	88.29	32.45	....	120.74
T.147N., R. 88W.	15.60	2.56	....	18.16	43.74	5.06	....	48.80	76.67	....	....	76.67	136.01	7.62	....	143.63
T.147N., R. 89W.	7.22	19.90	....	27.12	26.39	4.98	....	31.37	7.55	....	....	7.55	41.16	24.88	....	66.04
T.147N., R. 90W.	0.54	....	....	0.54	....	....	....	....	....	....	....	....	0.54	....	....	0.54
T.146N., R. 79W.	....	....	....	....	....	....	....	....	140.14	1.52	....	141.66	140.14	1.52	....	141.66
T.146N., R. 80W.	....	....	....	....	....	26.77	....	26.77	83.14	113.89	....	197.03	83.14	140.66	....	223.80
T.146N., R. 81W.	0.97	13.91	....	14.88	23.58	72.54	....	96.12	108.72	35.19	....	143.91	133.27	121.64	....	254.91
T.146N., R. 82W.	3.98	3.71	....	7.69	50.40	37.23	....	87.63	263.10	14.33	....	277.43	317.48	55.27	....	372.75
T.146N., R. 83W.	....	....	....	....	0.90	....	....	0.90	308.42	102.42	....	410.84	309.32	102.42	....	411.74
T.146N., R. 84W.	5.15	11.29	....	16.44	126.30	47.38	....	173.68	21.07	120.42	....	141.49	152.52	179.09	....	331.61
T.145N., R. 78W.	....	....	....	....	....	....	....	....	86.30	93.82	....	180.12	86.30	93.82	....	180.12
T.145N., R. 79W.	....	....	....	....	....	....	....	....	....	96.60	....	96.60	....	96.60	....	96.60
T.145N., R. 80W.	....	2.85	....	2.85	....	44.19	....	44.19	36.45	357.96	....	394.41	36.45	405.00	....	441.45
T.145N., R. 81W.	....	2.45	....	2.45	7.33	59.43	....	66.76	125.91	244.76	....	370.67	133.24	306.64	....	439.88
T.145N., R. 82W.	4.21	10.73	....	14.94	45.80	108.59	....	154.39	220.02	121.12	....	341.14	270.03	240.44	....	510.47
T.145N., R. 83W.	0.12	8.02	....	8.14	19.98	67.59	....	87.57	244.52	118.99	....	363.51	264.62	194.60	....	459.22
T.145N., R. 84W.	3.33	5.61	....	8.94	12.56	31.50	....	44.06	5.45	48.47	....	53.92	21.34	85.58	....	106.92
T.144N., R. 80W.	....	....	....	....	....	....	....	....	....	465.47	....	465.47	....	465.47	....	465.47
T.144N., R. 81W.	....	3.50	....	3.50	....	23.58	....	23.58	....	115.38	....	115.38	....	142.46	....	142.46
T.144N., R. 82W.	3.87	20.34	....	24.21	20.51	26.24	....	46.75	4.79	51.97	....	56.76	29.17	98.55	....	127.72
T.144N., R. 83W.	2.88	19.28	....	22.16	10.40	35.25	....	45.65	89.52	....	....	89.52	102.80	54.53	....	157.33
T.144N., R. 84W.	....	8.68	....	8.68	....	31.21	....	31.21	37.16	2.81	....	39.97	37.16	42.70	....	79.86
T.143N., R. 80W.	....	6.07	2.42	8.49	....	48.29	22.22	70.51	....	368.31	0.64	368.95	....	422.67	25.28	447.95
T.143N., R. 91W.	....	9.02	....	9.02	....	52.02	....	52.02	....	59.42	....	59.42	....	120.46	....	120.46
County total	262.13	305.87	31.75	599.75	1,078.73	1,206.48	379.21	2,664.42	7,927.40	4,433.35	853.49	13,214.24	9,268.26	5,945.70	1,264.45	16,478.41
							Mercer County									
T.147N., R. 84W.	....	3.90	....	3.90	2.49	61.58	....	64.07	2.39	15.29	....	17.68	4.88	80.77	....	85.65
T.147N., R. 85W.	26.89	3.76	....	30.65	25.23	42.57	1.04	68.84	24.06	17.03	185.41	226.50	76.18	63.36	186.45	325.99
T.147N., R. 86W.	4.14	26.48	....	30.62	0.87	13.77	....	14.64	4.23	....	140.30	144.53	9.24	40.25	140.30	189.79
T.147N., R. 87W.	....	10.65	....	10.65	....	6.48	....	6.48	....	....	74.51	74.51	....	17.13	74.51	91.64
T.147N., R. 88W.	0.04	3.11	....	3.15	0.58	....	....	0.58	2.76	12.38	50.54	65.58	3.38	15.49	50.54	69.41
T.147N., R. 89W.	5.27	30.77	....	36.04	48.90	46.61	....	95.51	44.54	155.84	....	200.38	98.71	233.22	....	331.93
T.147N., R. 90W.	16.61	....	....	16.61	97.25	4.00	....	101.25	411.92	48.21	....	460.13	525.78	52.21	....	577.99

T.146N., R. 84W.	3.28	2.07	....	5.35	2.35	4.34	....	6.69	....	....	....	....	5.63	6.41	....	12.04
T.146N., R. 85W.	10.48	10.15	....	20.63	68.84	192.60	....	261.44	100.31	434.75	232.60	767.66	179.63	637.50	232.60	1,049.73
T.146N., R. 86W.	....	5.46	5.05	10.51	67.40	54.78	....	122.18	393.80	184.24	524.16	1,102.20	461.20	244.48	529.21	1,234.89
T.146N., R. 87W.	2.28	25.01	12.67	39.96	10.74	92.87	341.22	452.83	193.32	243.92	457.57	894.81	214.34	361.80	811.46	1,387.60
T.146N., R. 88W.	7.74	16.28	33.58	57.60	54.60	35.14	137.81	227.55	259.29	114.50	485.19	858.98	321.63	165.92	656.58	1,144.13
T.146N., R. 89W.	4.82	7.72	....	12.54	43.37	86.45	....	129.82	559.73	382.55	....	942.28	607.92	476.72	....	1,084.64
T.146N., R. 90W.	....	....	....	....	7.17	....	....	7.17	1,090.55	63.68	....	1,154.23	1,097.72	63.68	....	1,161.40
T.145N., R. 84W.	0.32	0.55	....	0.87	32.01	2.94	....	34.95	3.62	5.98	....	9.60	35.95	9.47	....	45.42
T.145N., R. 85W.	16.34	8.84	....	25.18	88.22	104.09	....	192.31	68.84	243.01	9.45	321.30	173.40	355.94	9.45	538.79
T.145N., R. 86W.	6.24	13.25	3.56	23.05	65.43	141.26	41.19	247.88	149.93	435.77	326.60	912.30	221.60	590.28	371.35	1,183.23
T.145N., R. 87W.	....	....	111.72	111.72	....	....	269.62	269.62	257.47	256.82	503.46	1,017.75	257.47	256.82	884.80	1,399.09
T.145N., R. 88W.	....	5.32	23.27	28.59	....	71.06	142.12	213.18	376.09	362.85	356.29	1,095.23	376.09	439.23	521.68	1,337.00
T.145N., R. 89W.	....	1.71	....	1.71	8.43	54.42	....	62.85	758.12	486.06	....	1,244.18	766.55	542.19	....	1,308.74
T.145N., R. 90W.	4.48	2.98	....	7.46	21.10	26.96	....	48.06	860.71	99.26	....	959.97	886.29	129.20	....	1,015.49
T.144N., R. 84W.	....	3.53	3.31	6.84	0.60	17.10	20.14	37.84	139.20	....	....	139.20	139.80	20.63	23.45	183.88
T.144N., R. 85W.	....	10.36	14.65	25.01	1.51	134.59	36.63	172.73	269.89	99.80	....	369.69	271.40	244.75	51.28	567.43
T.144N., R. 86W.	0.51	25.22	....	25.73	0.68	126.16	....	126.84	67.61	258.11	....	325.72	68.80	409.49	....	478.29
T.144N., R. 87W.	....	24.95	53.01	77.96	4.56	112.43	10.71	127.70	100.46	364.20	....	464.66	105.02	501.58	63.72	670.32
T.144N., R. 88W.	3.48	4.06	292.83	300.37	25.70	48.24	31.48	105.42	176.75	534.07	....	710.82	205.93	586.37	324.31	1,116.61
T.144N., R. 89W.	1.16	44.36	7.95	53.47	45.96	60.56	7.07	113.59	349.18	321.89	....	671.07	396.30	426.81	15.02	838.13
T.144N., R. 90W.	....	38.81	1.17	39.98	5.72	228.55	2.44	236.71	611.65	81.35	....	693.00	617.37	348.71	3.61	969.69
T.143N., R. 88W.	8.93	1.72	51.55	62.20	62.77	16.43	243.18	322.38	362.43	296.96	101.98	761.37	434.13	315.11	396.71	1,145.95
T.143N., R. 89W.	3.42	35.34	0.92	39.68	32.49	45.64	72.65	150.78	612.82	1.60	....	614.42	648.73	82.58	73.57	804.88
T.143N., R. 90W.	19.15	0.25	4.80	24.20	130.90	30.62	15.92	177.44	792.01	31.03	....	823.04	942.06	61.90	20.72	1,024.68
T.142N., R. 88W.	14.20	3.87	19.25	37.32	124.68	10.66	130.74	266.08	760.33	64.90	228.19	1,053.42	899.21	79.43	378.18	1,356.82
T.142N., R. 89W.	11.96	18.65	....	30.51	160.11	85.84	90.94	336.89	712.48	11.33	71.18	794.99	884.45	115.82	162.12	1,162.39
T.142N., R. 90W.	34.17	....	....	34.17	102.80	....	....	102.80	624.52	....	....	624.52	761.49	....	....	761.49
T.141N., R. 88W.	10.79	30.38	10.32	51.49	134.10	67.60	26.99	228.69	1,117.80	55.80	....	1,173.60	1,262.69	153.78	37.31	1,453.78
T.141N., R. 89W.	16.05	6.43	....	22.48	174.14	29.83	....	203.97	711.02	0.09	....	711.11	901.21	36.35	....	937.56
T.141N., R. 90W.	15.36	....	....	15.36	81.61	....	....	81.61	768.77	....	....	768.77	865.74	....	....	865.74
County total	248.01	425.94	649.61	1,323.56	1,741.31	2,056.17	1,621.89	5,419.37	13,738.60	5,683.27	3,747.43	23,169.30	15,727.92	8,165.38	6,018.93	29,912.23

Morton County

T.140N., R. 82W.	2.84	....	....	2.84	26.61	....	....	26.61	35.74	....	....	35.74	65.19	....	....	65.19
T.140N., R. 83W.	4.85	....	....	4.85	73.33	....	....	73.33	299.93	....	....	299.93	378.11	....	....	378.11
T.140N., R. 84W.	15.70	....	....	15.70	119.48	14.11	....	133.59	439.09	14.71	....	453.80	574.27	28.82	....	603.09
T.140N., R. 85W.	1.73	1.94	....	3.67	28.68	5.40	....	34.08	741.69	122.23	....	863.92	772.10	129.57	....	901.67
T.140N., R. 86W.	10.08	0.66	....	10.74	88.06	1.25	....	89.31	888.67	78.89	....	967.56	986.81	80.80	....	1,067.61
T.140N., R. 87W.	8.48	0.39	....	8.87	70.22	3.21	10.59	84.02	470.40	3.88	....	474.28	549.10	7.48	10.59	567.17
T.140N., R. 88W.	8.02	23.13	....	31.15	58.30	64.89	....	123.19	845.65	....	....	845.65	911.97	88.02	....	999.99
T.140N., R. 89W.	14.08	11.87	....	25.95	77.61	9.05	....	86.66	496.65	....	....	496.65	588.34	20.92	....	609.26
T.140N., R. 90W.	12.19	13.71	....	25.90	11.42	49.75	....	61.17	524.14	....	....	524.14	547.75	63.46	....	611.21
T.139N., R. 82W.	....	....	....	....	....	....	....	....	5.42	....	....	5.42	5.42	....	....	5.42
T.139N., R. 83W.	5.41	....	....	5.41	28.48	....	....	28.48	36.75	....	....	36.75	70.64	....	....	70.64
T.139N., R. 84W.	2.35	2.08	....	4.43	40.32	1.68	....	42.00	41.66	....	....	41.66	84.33	3.76	....	88.09
T.139N., R. 85W.	16.42	11.34	32.86	60.62	105.34	155.39	244.05	504.78	549.74	109.16	5.54	664.44	671.50	275.89	282.45	1,229.84
T.139N., R. 86W.	3.66	93.97	....	97.63	21.47	194.97	....	216.44	487.27	....	....	487.27	512.40	288.94	....	801.34
T.139N., R. 87W.	1.02	36.74	....	37.76	6.11	69.79	....	75.90	359.81	....	....	359.81	366.94	106.53	....	473.47
T.139N., R. 88W.	13.45	20.27	....	33.72	32.55	55.52	....	88.07	326.12	0.32	....	326.44	372.12	76.11	....	448.23
T.139N., R. 89W.	7.23	14.50	0.39	22.12	60.17	18.21	....	78.38	486.63	....	....	486.63	554.03	32.71	0.39	587.13
T.139N., R. 90W.	1.14	15.15	5.39	21.68	101.63	43.28	25.20	170.11	677.77	....	....	677.77	780.54	58.43	30.59	869.56
T.138N., R. 84W.	8.79	2.41	....	11.20	49.38	8.97	....	58.35	58.77	....	....	58.77	116.94	11.38	....	128.32
T.138N., R. 85W.	42.88	1.59	....	44.47	113.14	20.99	....	134.13	160.48	5.39	....	165.87	316.50	27.97	....	344.47
T.138N., R. 86W.	10.12	18.96	....	29.08	22.30	57.73	....	80.03	173.64	57.33	....	230.97	206.06	134.02	....	340.08
T.138N., R. 87W.	....	20.33	....	20.33	8.35	97.95	....	106.30	519.20	14.74	....	533.94	527.55	133.02	....	660.57
T.138N., R. 88W.	....	28.09	....	28.09	43.02	306.92	....	349.94	477.33	....	....	477.33	520.35	335.01	....	855.36
T.138N., R. 89W.	....	0.37	....	0.37	32.14	21.04	....	53.18	750.86	....	....	750.86	783.00	21.41	....	804.41
T.138N., R. 90W.	7.28	1.93	....	9.21	84.45	13.26	....	97.71	723.89	....	....	723.89	815.62	15.19	....	830.81

Table 25.--Estimated original lignite reserves in North Dakota, by county and township.--Continued.

Township	Measured reserves				Indicated reserves				Inferred reserves				Total in all categories			
	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Township Total
Morton County -- Continued																
T.137N., R. 83W.	9.44	....	....	9.44	20.15	....	....	20.15	0.05	....	....	0.05	29.64	....	....	29.64
T.137N., R. 84W.	4.51	....	....	4.51	31.24	....	....	31.24	....	....	....	....	35.75	....	....	35.75
T.137N., R. 85W.	1.64	....	....	1.64	6.63	....	....	6.63	....	....	....	....	8.27	....	....	8.27
T.137N., R. 86W.	0.48	4.50	....	4.98	34.85	2.08	....	36.93	116.28	61.70	....	177.98	151.61	68.28	....	219.89
T.137N., R. 87W.	2.90	14.71	3.18	20.79	39.98	86.31	6.37	132.66	460.41	....	....	460.41	503.29	101.02	9.55	613.86
T.136N., R. 83W.	....	....	....	....	....	....	....	....	1.97	....	....	1.97	1.97	....	....	1.97
T.136N., R. 84W.	0.35	....	....	0.35	....	....	....	....	....	....	....	....	0.35	....	....	0.35
County total	217.04	338.64	41.82	597.50	1,435.41	1,301.75	286.21	3,023.37	11,156.01	468.35	5.54	11,629.90	12,808.46	2,108.74	333.57	15,250.77
Mountrail County																
T.158N., R. 88W.	....	....	....	....	....	....	....	....	288.65	....	....	288.65	288.65	....	....	288.65
T.158N., R. 89W.	....	....	....	....	....	....	....	....	269.43	....	....	269.43	269.43	....	....	269.43
T.158N., R. 90W.	....	....	....	....	....	....	....	....	338.69	....	....	338.69	338.69	....	....	338.69
T.158N., R. 91W.	....	....	....	....	....	....	....	....	338.69	....	....	338.69	338.69	....	....	338.69
T.158N., R. 92W.	....	....	....	....	....	....	....	....	338.69	....	....	338.69	338.69	....	....	338.69
T.158N., R. 93W.	....	....	....	....	....	....	....	....	338.69	....	....	338.69	338.69	....	....	338.69
T.158N., R. 94W.	....	....	....	....	....	....	....	....	353.50	....	....	353.50	353.50	....	....	353.50
T.157N., R. 88W.	....	....	....	....	....	....	....	....	367.99	....	....	367.99	367.99	....	....	367.99
T.157N., R. 89W.	....	....	....	....	....	....	....	....	395.82	....	....	395.82	395.82	....	....	395.82
T.157N., R. 90W.	....	....	....	....	....	....	....	....	358.85	....	....	358.85	358.85	....	....	358.85
T.157N., R. 91W.	....	....	....	....	....	....	....	....	353.92	....	....	353.92	353.92	....	....	353.92
T.157N., R. 92W.	....	....	....	....	....	....	....	....	337.57	....	....	337.57	337.57	....	....	337.57
T.157N., R. 93W.	....	....	....	....	....	....	....	....	310.17	....	....	310.17	310.17	....	....	310.17
T.157N., R. 94W.	....	....	....	....	....	....	....	....	291.87	....	....	291.87	291.87	....	....	291.87
T.156N., R. 88W.	....	....	....	....	....	....	....	....	318.41	....	....	318.41	318.41	....	....	318.41
T.156N., R. 89W.	....	....	....	....	....	....	....	....	366.91	....	....	366.91	366.91	....	....	366.91
T.156N., R. 90W.	....	....	....	....	....	....	....	....	352.29	....	....	352.29	352.29	....	....	352.29
T.156N., R. 91W.	....	....	....	....	....	4.33	....	4.33	289.29	4.16	....	293.45	289.29	8.49	....	297.78
T.156N., R. 92W.	....	....	....	....	....	5.58	....	5.58	296.90	3.66	....	300.56	296.90	9.24	....	306.14
T.156N., R. 93W.	....	....	....	....	....	....	....	....	302.40	....	....	302.40	302.40	....	....	302.40
T.156N., R. 94W.	....	....	....	....	....	....	....	....	262.08	....	....	262.08	262.08	....	....	262.08
T.155N., R. 88W.	....	....	....	....	....	....	....	....	338.69	....	....	338.69	338.69	....	....	338.69
T.155N., R. 89W.	....	....	....	....	....	....	....	....	365.16	....	....	365.16	365.16	....	....	365.16
T.155N., R. 90W.	....	....	....	....	....	....	....	....	369.38	....	....	369.38	369.38	....	....	369.38
T.155N., R. 91W.	....	....	3.29	3.29	....	33.96	14.65	48.61	268.99	10.41	....	279.40	268.99	44.37	17.94	331.30
T.155N., R. 92W.	....	....	5.18	5.18	....	34.20	17.56	51.76	267.20	9.07	....	276.27	267.20	43.27	22.74	333.21
T.155N., R. 93W.	....	....	....	....	....	....	....	....	302.40	....	....	302.40	302.40	....	....	302.40
T.155N., R. 94W.	....	....	....	....	....	....	....	....	302.40	....	....	302.40	302.40	....	....	302.40
T.154N., R. 88W.	....	....	....	....	....	....	....	....	319.55	....	....	319.55	319.55	....	....	319.55
T.154N., R. 89W.	....	....	....	....	....	....	....	....	263.35	....	....	263.35	263.35	....	....	263.35
T.154N., R. 90W.	....	....	....	....	....	....	....	....	302.40	....	....	302.40	302.40	....	....	302.40
T.154N., R. 91W.	....	....	....	....	....	....	....	....	310.46	....	....	310.46	310.46	....	....	310.46
T.154N., R. 92W.	....	5.59	....	5.59	20.87	55.77	....	76.64	246.91	....	....	246.91	267.78	61.36	....	329.14
T.154N., R. 93W.	....	3.23	....	3.23	13.87	7.08	....	20.95	286.83	....	....	286.83	300.70	10.31	....	311.01
T.154N., R. 94W.	9.63	2.26	....	11.89	83.92	5.68	....	89.60	159.81	....	....	159.81	253.36	7.94	....	261.30

T.153N., R. 88W.	....	....	....	....	....	....	....	....	241.59	....	....	241.59	241.59	....	....	241.59
T.153N., R. 89W.	....	....	....	....	0.61	1.33	....	1.94	294.54	9.73	....	304.27	295.15	11.06	....	306.21
T.153N., R. 90W.	....	....	....	....	....	23.13	17.28	40.41	219.25	101.54	....	320.79	219.25	124.67	17.28	361.20
T.153N., R. 91W.	....	....	....	....	....	0.35	....	0.35	293.57	32.77	....	326.34	293.57	33.12	....	326.69
T.153N., R. 92W.	....	....	....	....	....	13.98	20.10	34.08	242.99	110.28	....	353.27	242.99	124.26	20.10	387.35
T.153N., R. 93W.	....	5.28	....	5.28	9.75	6.07	....	15.82	164.95	5.78	....	170.73	174.70	17.13	....	191.83
T.153N., R. 94W.	....	2.27	....	2.27	4.35	4.88	....	9.23	1.13	....	....	1.13	5.48	7.15	....	12.63
T.152N., R. 88W.	....	....	....	....	....	....	....	....	224.28	....	....	224.28	224.28	....	....	224.28
T.152N., R. 89W.	3.59	....	....	3.59	18.59	....	....	18.59	153.02	....	....	153.02	175.20	....	....	175.20
T.152N., R. 90W.	3.59	6.26	8.03	17.88	10.92	42.50	40.19	93.61	121.16	5.89	....	127.05	135.67	54.65	48.22	238.54
T.152N., R. 91W.	7.62	4.91	47.57	60.10	8.25	29.47	97.81	135.53	142.14	9.38	....	151.52	158.01	43.76	145.38	347.15
T.152N., R. 92W.	16.88	8.79	10.31	35.98	....	51.82	13.13	64.95	14.12	7.05	....	21.17	31.00	67.66	23.44	122.10
T.152N., R. 93W.	7.91	0.66	0.53	9.10	13.54	1.42	12.85	27.81	35.96	0.92	....	36.88	57.41	3.00	13.38	73.79
T.151N., R. 88W.	....	....	....	....	....	....	....	....	227.48	....	....	227.48	227.48	....	....	227.48
T.151N., R. 89W.	....	....	....	....	....	....	....	....	98.17	....	....	98.17	98.17	....	....	98.17
T.151N., R. 90W.	3.62	....	....	3.62	20.54	....	....	20.54	90.01	....	....	90.01	114.17	....	....	114.17
T.151N., R. 91W.	8.98	....	....	8.98	8.25	....	....	8.25	33.87	....	....	33.87	51.10	....	....	51.10
T.151N., R. 92W.	6.53	....	....	6.53	27.20	....	....	27.20	121.07	....	....	121.07	154.80	....	....	154.80
T.151N., R. 93W.	3.98	28.72	4.61	37.31	30.95	46.50	....	77.45	111.55	....	....	111.55	146.48	75.22	4.61	226.31
T.150N., R. 92W.	34.84	....	....	34.84	50.62	....	....	50.62	1.87	....	....	1.87	87.33	....	....	87.33
T.150N., R. 93W.	40.95	....	....	40.95	33.80	....	....	33.80	6.82	....	....	6.82	81.57	....	....	81.57
County total	148.12	67.97	79.52	295.61	356.03	368.05	233.57	957.65	13,813.88	310.64	....	14,124.52	14,318.03	746.66	313.09	15,377.78

Oliver County

T.144N., R. 81W.	....	....	....	....	....	....	....	....	0.06	....	....	0.06	0.06	....	....	0.06
T.144N., R. 82W.	....	....	....	....	1.83	....	....	1.83	36.10	23.90	0.25	60.25	37.93	23.90	0.25	62.08
T.144N., R. 83W.	....	....	....	....	5.22	....	....	5.22	16.10	....	4.39	20.49	21.32	....	4.39	25.71
T.143N., R. 81W.	....	....	....	....	2.28	....	....	2.28	8.44	....	....	8.44	10.72	....	....	10.72
T.143N., R. 82W.	0.09	5.79	....	5.88	29.63	6.10	49.07	84.80	222.89	122.63	121.62	467.14	252.61	134.52	170.69	557.82
T.143N., R. 83W.	2.75	6.44	19.57	28.76	34.99	60.83	139.25	235.07	222.00	94.72	110.50	427.22	259.74	161.99	269.32	691.05
T.143N., R. 84W.	10.29	36.04	....	46.33	73.81	149.73	....	223.54	501.53	18.24	....	519.77	585.63	204.01	....	789.64
T.143N., R. 85W.	4.41	6.26	....	10.67	26.93	52.49	....	79.42	1,101.46	115.53	....	1,216.99	1,132.80	174.28	....	1,307.08
T.143N., R. 86W.	14.04	17.62	....	31.66	108.54	105.95	....	214.49	470.21	456.75	....	926.96	592.79	580.32	....	1,173.11
T.143N., R. 87W.	13.78	6.91	....	20.69	81.43	140.96	11.97	234.36	241.35	361.20	30.35	632.90	336.56	509.07	42.32	887.95
T.142N., R. 81W.	1.70	0.82	....	2.52	13.56	12.66	....	26.22	35.75	....	....	35.75	51.01	13.48	....	64.49
T.142N., R. 82W.	2.03	6.33	....	8.36	48.01	63.16	....	111.17	356.59	230.88	....	587.47	406.63	300.37	....	707.00
T.142N., R. 83W.	7.35	14.87	6.41	28.63	63.06	55.66	55.09	173.81	456.51	253.90	54.98	765.39	526.92	324.43	116.48	967.83
T.142N., R. 84W.	2.07	24.81	....	26.88	15.37	265.31	15.14	295.82	566.76	148.55	19.50	734.81	584.20	438.67	34.64	1,057.51
T.142N., R. 85W.	7.79	7.22	2.43	17.44	93.38	62.58	27.80	183.76	1,132.96	119.58	29.86	1,282.40	1,234.13	189.38	60.09	1,483.60
T.142N., R. 86W.	21.73	10.45	....	32.18	213.21	26.37	....	239.58	774.73	52.30	....	827.03	1,009.67	89.12	....	1,098.79
T.142N., R. 87W.	22.72	....	....	22.72	206.42	....	....	206.42	972.30	41.74	....	1,014.04	1,201.44	41.74	....	1,243.18
T.141N., R. 81W.	....	....	....	....	....	....	....	....	199.73	....	....	199.73	199.73	....	....	199.73
T.141N., R. 82W.	....	....	....	....	0.28	....	....	0.28	223.96	14.24	....	238.20	224.24	14.24	....	238.48
T.141N., R. 83W.	9.62	2.99	....	12.61	40.97	27.98	....	68.95	401.56	....	....	401.56	452.15	30.97	....	483.12
T.141N., R. 84W.	3.08	21.81	9.52	34.41	45.60	76.95	18.92	141.47	652.43	....	....	652.43	701.11	98.76	28.44	828.31
T.141N., R. 85W.	3.70	....	7.26	10.96	42.14	34.98	57.79	134.91	997.20	65.98	79.20	1,142.38	1,043.04	100.96	144.25	1,288.25
T.141N., R. 86W.	5.85	30.54	7.02	43.41	92.54	101.30	32.29	226.13	1,013.33	1.21	....	1,014.54	1,111.72	133.05	39.51	1,284.08
T.141N., R. 87W.	6.09	7.35	....	13.44	108.23	14.15	....	122.38	1,253.39	....	....	1,253.39	1,367.71	21.50	....	1,389.21
County total	139.09	206.25	52.21	397.55	1,347.43	1,257.16	407.32	3,011.91	11,857.34	2,121.35	450.65	14,429.34	13,343.86	3,584.76	910.18	17,838.80

Renville County

T.162N., R. 86W.	....	....	....	....	....	....	....	....	8.60	....	....	8.60	8.60	....	....	8.60
T.162N., R. 87W.	....	....	....	....	....	....	....	....	46.92	....	....	46.92	46.92	....	....	46.92
T.161N., R. 86W.	....	....	9.46	9.46	23.06	1.44	....	24.50	64.09	....	....	64.09	87.15	1.44	9.46	98.05
T.161N., R. 87W.	0.25	5.29	....	5.54	22.48	5.43	....	27.91	82.82	....	....	82.82	105.55	10.72	....	116.27
T.160N., R. 85W.	....	....	....	....	....	....	....	....	2.25	....	....	2.25	2.25	....	....	2.25
T.160N., R. 86W.	....	....	9.11	9.11	19.42	28.14	....	47.56	72.75	....	....	72.75	92.17	28.14	9.11	129.42

Table 25.--Estimated original lignite reserves in North Dakota, by county and township.--Continued.

Township	Measured reserves				Indicated reserves				Inferred reserves				Total in all categories			Township Total
	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	
Renville County -- Continued																
T.159N., R. 85W.	....	....	....	....	....	....	....	....	49.79	....	....	49.79	49.79	....	....	49.79
T.159N., R. 86W.	....	....	....	....	....	....	....	....	100.80	....	....	100.80	100.80	....	....	100.80
T.158N., R. 84W.	....	....	....	....	....	....	....	....	9.11	....	....	9.11	9.11	....	....	9.11
T.158N., R. 85W.	2.88	....	....	2.88	45.05	....	....	45.05	65.95	....	....	65.95	113.88	....	....	113.88
T.158N., R. 86W.	0.63	....	....	0.63	7.03	....	....	7.03	100.03	....	....	100.03	107.69	....	....	107.69
County total	3.76	5.29	18.57	27.62	117.04	35.01	....	152.05	603.11	....	....	603.11	723.91	40.30	18.57	782.78
Sheridan County																
T.148N., R. 77W.	....	....	....	....	....	....	....	....	1.89	....	....	1.89	1.89	....	....	1.89
T.148N., R. 78W.	....	....	....	....	....	....	....	....	49.06	....	....	49.06	49.06	....	....	49.06
T.147N., R. 77W.	....	....	....	....	....	....	....	....	104.23	....	....	104.23	104.23	....	....	104.23
T.147N., R. 78W.	....	....	....	....	....	....	....	....	141.12	....	....	141.12	141.12	....	....	141.12
T.146N., R. 77W.	....	....	....	....	....	....	....	....	88.24	....	....	88.24	88.24	....	....	88.24
T.146N., R. 78W.	....	....	....	....	....	....	....	....	141.12	....	....	141.12	141.12	....	....	141.12
T.145N., R. 77W.	....	....	....	....	....	....	....	....	13.42	....	....	13.42	13.42	....	....	13.42
T.145N., R. 78W.	....	....	....	....	....	....	....	....	120.98	....	....	120.98	120.98	....	....	120.98
County total	....	....	....	....	....	....	....	....	660.06	....	....	660.06	660.06	....	....	660.06
Slope County																
T.136N., R. 98W.	....	....	....	....	....	....	....	....	168.22	....	508.58	676.80	168.22	....	508.58	676.80
T.136N., R. 99W.	....	....	....	....	....	....	....	....	7.56	....	586.82	594.38	7.56	....	586.82	594.38
T.136N., R.100W.	....	....	....	....	....	....	....	....	38.95	....	643.77	682.72	38.95	....	643.77	682.72
T.136N., R.101W.	....	....	51.76	51.76	31.76	1.98	276.76	310.50	100.74	....	375.92	476.66	132.50	1.98	704.44	838.92
T.136N., R.102W.	4.15	8.60	139.56	152.31	97.96	86.17	143.57	327.70	....	....	....	....	102.11	94.77	283.13	480.01
T.136N., R.103W.	7.49	16.52	16.03	40.04	62.78	168.53	124.55	355.86	....	28.46	....	28.46	70.27	213.51	140.58	424.36
T.136N., R.104W.	2.68	23.57	21.13	47.38	49.28	297.11	23.89	370.28	2.51	....	....	2.51	54.47	320.68	45.02	420.17
T.135N., R. 98W.	....	....	....	....	....	....	....	....	168.12	....	640.37	808.49	168.12	....	640.37	808.49
T.135N., R. 99W.	....	....	....	....	....	....	....	....	3.98	....	800.03	804.01	3.98	....	800.03	804.01
T.135N., R.100W.	....	....	....	....	....	....	....	....	110.50	....	934.11	1,044.61	110.50	....	934.11	1,044.61
T.135N., R.101W.	....	....	32.11	32.11	34.50	1.31	350.72	386.53	130.25	....	671.14	801.39	164.75	1.31	1,053.97	1,220.03
T.135N., R.102W.	8.32	....	14.41	22.73	59.24	129.54	268.97	457.75	43.31	....	....	43.31	110.87	129.54	283.38	523.79
T.135N., R.103W.	3.81	....	47.55	51.36	37.60	232.15	136.89	406.64	55.02	84.46	....	139.48	96.43	316.61	184.44	597.48
T.135N., R.104W.	9.38	43.32	2.84	55.54	97.11	189.80	30.04	316.95	44.41	1.99	....	46.40	150.90	235.11	32.88	418.89
T.135N., R.105W.	....	....	....	....	201.79	116.50	29.36	347.65	....	....	....	....	201.79	116.50	29.36	347.65
T.135N., R.106W.	2.98	12.59	....	15.57	52.95	33.05	....	86.00	0.68	....	....	0.68	56.61	45.64	....	102.25
T.134N., R. 98W.	....	....	....	....	....	....	....	....	....	....	558.44	558.44	....	....	558.44	558.44
T.134N., R. 99W.	....	....	....	....	....	....	....	....	6.38	....	701.57	707.95	6.38	....	701.57	707.95
T.134N., R.100W.	....	....	....	....	....	....	....	....	123.40	....	836.41	959.81	123.40	....	836.41	959.81
T.134N., R.101W.	....	....	....	....	2.94	1.63	289.86	294.43	244.96	....	733.73	978.69	247.90	1.63	1,023.59	1,273.12
T.134N., R.102W.	9.20	4.19	17.40	30.79	69.71	88.14	216.73	374.58	133.38	....	....	133.38	212.29	92.33	234.13	538.75
T.134N., R.103W.	....	....	13.18	13.18	17.27	178.44	70.80	266.51	179.78	109.56	....	289.34	197.05	288.00	83.98	569.03
T.134N., R.104W.	6.08	11.90	....	17.98	104.93	97.58	9.17	211.68	115.70	75.46	....	191.16	226.71	184.94	9.17	420.82
T.134N., R.105W.	16.59	45.15	5.87	67.61	136.96	30.66	20.77	188.39	0.18	....	....	0.18	153.73	75.81	26.64	256.18

T.133N., R. 98W.	....	....	....	....	....	....	....	....	....	....	573.19	573.19	....	....	573.19	573.19
T.133N., R. 99W.	....	....	....	....	....	....	....	....	....	....	750.49	750.49	....	....	750.49	750.49
T.133N., R.100W.	....	....	....	....	....	....	....	....	109.34	....	921.62	1,030.96	109.34	....	921.62	1,030.96
T.133N., R.101W.	....	....	12.10	12.10	28.71	11.70	396.14	436.55	270.05	0.13	640.47	910.65	298.76	11.83	1,048.71	1,359.30
T.133N., R.102W.	....	....	....	....	29.19	84.64	20.21	134.04	150.60	34.62	....	185.22	179.79	119.26	20.21	319.26
T.133N., R.103W.	....	....	....	....	11.37	4.79	....	16.16	17.31	256.69	....	274.00	28.68	261.48	....	290.16
T.133N., R.104W.	....	1.92	22.14	24.06	38.80	66.26	192.02	297.08	3.27	125.59	25.70	154.56	42.07	193.77	239.86	475.70
T.133N., R.105W.	1.87	1.92	....	3.79	11.77	7.32	....	19.09	....	....	....	....	13.64	9.24	....	22.88
County total	72.55	169.68	396.08	638.31	1,176.62	1,827.30	2,600.45	5,604.37	2,228.60	716.96	10,902.36	13,847.92	3,477.77	2,713.94	13,898.89	20,090.60

Stark County

T.141N., R. 91W.	....	....	....	....	....	....	....	....	214.56	....	....	214.56	214.56	....	....	214.56
T.141N., R. 92W.	....	....	....	....	4.34	....	....	4.34	260.69	....	....	260.69	265.03	....	....	265.03
T.141N., R. 93W.	1.87	4.42	....	6.29	18.18	2.75	....	20.93	289.67	....	....	289.67	309.72	7.17	....	316.89
T.140N., R. 91W.	....	....	....	....	3.41	....	....	3.41	653.27	....	....	653.27	656.68	....	....	656.68
T.140N., R. 92W.	3.91	....	....	3.91	19.55	....	....	19.55	712.16	....	....	712.16	735.62	....	....	735.62
T.140N., R. 93W.	1.51	3.05	....	4.56	49.84	3.69	....	53.53	814.12	....	....	814.12	865.47	6.74	....	872.21
T.140N., R. 94W.	1.26	4.51	....	5.77	38.68	6.88	....	45.56	915.04	....	....	915.04	954.98	11.39	....	966.37
T.140N., R. 95W.	9.78	....	....	9.78	121.42	5.79	7.04	134.25	473.11	59.62	2.39	535.12	604.31	65.41	9.43	679.15
T.140N., R. 96W.	3.60	3.07	16.08	22.75	49.47	39.45	189.36	278.28	330.25	540.34	540.45	1,411.04	383.32	582.86	745.89	1,712.07
T.140N., R. 97W.	....	10.96	44.19	55.15	9.90	60.02	444.96	514.88	229.95	277.82	301.87	809.64	239.85	348.80	791.02	1,379.67
T.140N., R. 98W.	....	13.10	1.74	14.84	3.95	96.88	122.93	223.76	349.51	216.36	188.62	754.49	353.46	326.34	313.29	993.09
T.140N., R. 99W.	....	0.39	....	0.39	7.05	3.11	....	10.16	331.56	247.83	92.82	672.21	338.61	251.33	92.82	682.76
T.139N., R. 91W.	4.96	12.97	....	17.93	61.03	51.91	....	112.94	698.27	....	....	698.27	764.26	64.88	....	829.14
T.139N., R. 92W.	1.26	12.72	....	13.98	57.40	24.23	....	81.63	861.43	....	....	861.43	920.09	36.95	....	957.04
T.139N., R. 93W.	0.62	0.07	....	0.69	53.75	2.63	....	56.38	753.30	....	....	753.30	807.67	2.70	....	810.37
T.139N., R. 94W.	8.50	....	....	8.50	85.97	....	....	85.97	496.47	....	....	496.47	590.94	....	....	590.94
T.139N., R. 95W.	21.67	....	24.97	46.64	79.15	7.55	121.41	208.11	288.38	119.29	4.18	411.85	389.20	126.84	150.56	666.60
T.139N., R. 96W.	1.26	6.28	7.95	15.49	9.89	91.34	161.82	263.05	197.26	273.87	213.53	684.66	208.41	371.49	383.30	963.20
T.139N., R. 97W.	1.78	35.59	13.46	50.83	....	134.48	30.69	165.17	117.13	298.87	131.71	547.71	118.91	468.94	175.86	763.71
T.139N., R. 98W.	....	17.56	5.91	23.47	4.70	142.05	14.51	161.26	183.75	259.16	16.10	459.01	188.45	418.77	36.52	643.74
T.139N., R. 99W.	....	15.15	....	15.15	6.16	124.46	....	130.62	288.62	130.67	141.04	560.33	294.78	270.28	141.04	706.10
T.138N., R. 91W.	17.51	4.63	22.14	44.28	160.66	29.54	....	190.20	569.01	....	....	569.01	747.18	34.17	22.14	803.49
T.138N., R. 92W.	5.61	....	....	5.61	42.42	....	....	42.42	443.10	....	....	443.10	491.13	....	....	491.13
T.138N., R. 93W.	12.23	6.47	....	18.70	91.91	8.69	....	100.60	318.65	....	....	318.65	422.79	15.16	....	437.95
T.138N., R. 94W.	....	....	....	....	1.54	....	....	1.54	371.64	....	....	371.64	373.18	....	....	373.18
T.138N., R. 95W.	....	....	....	....	....	....	....	....	306.71	....	....	306.71	306.71	....	....	306.71
T.138N., R. 96W.	....	....	....	....	....	0.39	....	0.39	312.36	56.56	....	368.92	312.36	56.95	....	369.31
T.138N., R. 97W.	....	....	....	....	....	0.55	....	0.55	227.01	286.03	81.68	594.72	227.01	286.58	81.68	595.27
T.138N., R. 98W.	....	....	....	....	....	....	....	....	347.81	209.86	373.10	930.77	347.81	209.86	373.10	930.77
T.138N., R. 99W.	....	....	....	....	....	....	....	....	398.06	100.66	413.16	911.88	398.06	100.66	413.16	911.88
T.137N., R. 91W.	....	....	....	....	3.74	....	....	3.74	294.72	....	....	294.72	298.46	....	....	298.46
T.137N., R. 92W.	....	....	....	....	49.37	....	....	49.37	303.94	....	....	303.94	353.31	....	....	353.31
T.137N., R. 93W.	7.37	....	....	7.37	44.83	....	....	44.83	347.37	....	....	347.37	399.57	....	....	399.57
T.137N., R. 94W.	....	....	....	....	....	....	....	....	341.08	....	....	341.08	341.08	....	....	341.08
T.137N., R. 95W.	....	....	....	....	....	....	....	....	254.02	....	....	254.02	254.02	....	....	254.02
T.137N., R. 96W.	....	....	....	....	....	....	....	....	254.02	....	19.19	273.21	254.02	....	19.19	273.21
T.137N., R. 97W.	....	....	....	....	....	....	....	....	274.18	....	360.16	634.34	274.18	....	360.16	634.34
T.137N., R. 98W.	....	....	....	....	....	....	....	....	307.77	....	452.75	760.52	307.77	....	452.75	760.52
T.137N., R. 99W.	....	....	....	....	....	....	....	....	276.54	....	482.02	758.56	276.54	....	482.02	758.56
County total	104.70	150.94	136.44	392.08	1,078.31	836.39	1,092.72	3,007.42	15,406.49	3,076.94	3,814.77	22,298.20	16,589.50	4,064.27	5,043.93	25,697.70

Ward County

T.161N., R. 88W.	7.55	1.37	....	8.92	49.22	0.80	....	50.02	50.59	....	....	50.59	107.36	2.17	....	109.53
T.160N.																
T.160N., R. 87W.	0.41	....	....	0.41	23.23	1.76	....	24.99	92.87	....	....	92.87	116.51	1.76	....	118.27
T.160N., R. 88W.	23.14	....	....	23.14	100.08	....	....	100.08	2.75	....	....	2.75	125.97	....	....	125.97
T.160N., R. 89W.	1.58	0.94	....	2.52	36.10	....	....	36.10	96.54	....	....	96.54	134.22	0.94	....	135.16
T.159N., R. 87W.	....	....	....	....	2.13	....	....	2.13	109.50	....	....	109.50	111.63	....	....	111.63
T.159N., R. 88W.	1.93	7.92	....	9.85	37.71	1.43	....	39.14	82.47	....	....	82.47	122.11	9.35	....	131.46
T.159N., R. 89W.	....	....	....	....	4.42	....	....	4.42	187.12	....	....	187.12	191.54	....	....	191.54

Table 25.--Estimated original lignite reserves in North Dakota, by county and township.--Continued.

Township	Measured reserves				Indicated reserves				Inferred reserves				Total in all categories			Township Total
	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	Total	In beds 2 1/2 to 5 feet thick	In beds 5 to 10 feet thick	In beds more than 10 feet thick	
Ward County -- Continued																
T.158N., R. 87W.	4.37	....	....	4.37	38.26	....	....	38.26	202.34	....	....	202.34	244.97	....	....	244.97
T.157N., R. 84W.	0.13	0.33	....	0.46	20.76	....	....	20.76	15.51	....	....	15.51	36.40	0.33	....	36.73
T.157N., R. 85W.	8.20	0.26	....	8.46	44.96	5.98	....	50.94	30.46	....	....	30.46	83.62	6.24	....	89.86
T.157N., R. 86W.	1.87	....	....	1.87	20.67	....	....	20.67	76.75	....	....	76.75	99.29	....	....	99.29
T.157N., R. 87W.	....	....	....	....	....	....	....	....	275.80	....	....	275.80	275.80	....	....	275.80
T.156N., R. 83W.	....	....	....	....	6.52	2.91	....	9.43	....	....	....	....	6.52	2.91	....	9.43
T.156N., R. 84W.	5.54	3.02	....	8.56	4.54	32.14	....	36.68	....	12.30	....	12.30	10.08	47.46	....	57.54
T.156N., R. 85W.	....	2.29	....	2.29	8.69	72.43	....	81.12	39.26	55.83	....	95.09	47.95	130.55	....	178.50
T.156N., R. 86W.	....	....	....	....	....	....	....	....	125.83	....	....	125.83	125.83	....	....	125.83
T.156N., R. 87W.	....	....	....	....	....	....	....	....	207.62	....	....	207.62	207.62	....	....	207.62
T.155N., R. 83W.	10.13	....	....	10.13	32.56	....	....	32.56	....	....	....	....	42.69	....	....	42.69
T.155N., R. 84W.	11.69	1.64	....	13.33	53.80	1.27	....	55.07	42.91	....	....	42.91	108.40	2.91	....	111.31
T.155N., R. 85W.	....	....	....	....	9.14	....	....	9.14	150.21	....	....	150.21	159.35	....	....	159.35
T.155N., R. 86W.	....	....	....	....	....	....	....	....	154.36	....	....	154.36	154.36	....	....	154.36
T.155N., R. 87W.	....	....	....	....	....	....	....	....	232.11	....	....	232.11	232.11	....	....	232.11
T.154N., R. 83W.	....	....	....	....	....	....	....	....	29.43	....	....	29.43	29.43	....	....	29.43
T.154N., R. 84W.	....	....	....	....	....	....	....	....	169.52	....	....	169.52	169.52	....	....	169.52
T.154N., R. 85W.	....	....	5.73	5.73	13.12	19.60	7.22	39.94	226.66	0.25	....	226.91	239.78	19.85	12.95	272.58
T.154N., R. 86W.	....	....	....	....	....	....	....	....	249.98	....	....	249.98	249.98	....	....	249.98
T.154N., R. 87W.	....	....	....	....	....	....	....	....	262.84	....	....	262.84	262.84	....	....	262.84
T.153N., R. 82W.	....	12.17	....	12.17	6.71	11.39	....	18.10	36.36	....	....	36.36	43.07	23.56	....	66.63
T.153N., R. 83W.	....	....	....	....	....	....	....	....	226.48	....	....	226.48	226.48	....	....	226.48
T.153N., R. 84W.	....	....	....	....	....	....	....	....	262.08	....	....	262.08	262.08	....	....	262.08
T.153N., R. 85W.	....	....	4.37	4.37	9.20	29.82	6.41	45.43	179.55	139.78	....	319.33	188.75	169.60	10.78	369.13
T.153N., R. 86W.	....	....	....	....	....	....	....	....	138.66	221.03	....	359.69	138.66	221.03	....	359.69
T.153N., R. 87W.	....	....	....	....	....	....	....	....	248.49	50.60	....	299.09	248.49	50.60	....	299.09
T.152N., R. 81W.	....	....	98.53	98.53	....	....	63.92	63.92	....	....	....	....	....	....	162.45	162.45
T.152N., R. 82W.	....	3.83	9.55	13.38	....	26.20	131.26	157.46	30.78	71.61	55.15	157.54	30.78	101.64	195.96	328.38
T.152N., R. 83W.	....	....	....	....	0.32	2.61	....	2.93	301.85	33.54	....	335.39	302.17	36.15	....	338.32
T.152N., R. 84W.	....	....	....	....	....	....	....	....	238.41	7.50	....	245.91	238.41	7.50	....	245.91
T.152N., R. 85W.	....	....	....	....	....	....	....	....	212.16	102.07	....	314.23	212.16	102.07	....	314.23
T.152N., R. 86W.	....	....	....	....	....	15.25	....	15.25	108.86	291.84	....	400.70	108.86	307.09	....	415.95
T.152N., R. 87W.	....	....	....	....	....	....	....	....	121.08	207.89	....	328.97	121.08	207.89	....	328.97
T.151N., R. 81W.	....	....	11.05	11.05	....	2.72	74.00	76.72	....	167.90	135.52	303.42	....	170.62	220.57	391.19
T.151N., R. 82W.	....	....	....	....	....	....	....	....	114.34	160.74	65.21	340.29	114.34	160.74	65.21	340.29
T.151N., R. 83W.	....	3.66	4.37	8.03	16.36	72.24	....	88.60	174.04	144.73	....	318.77	190.40	220.63	4.37	415.40
T.151N., R. 84W.	....	....	....	....	....	....	....	....	161.34	173.47	....	334.81	161.34	173.47	....	334.81
T.151N., R. 85W.	....	....	....	....	....	28.12	....	28.12	157.32	143.12	....	300.44	157.32	171.24	....	328.56
T.151N., R. 86W.	....	....	11.95	11.95	....	54.69	58.12	112.81	112.90	148.81	112.08	373.79	112.90	203.50	182.15	498.55
T.151N., R. 87W.	....	....	....	....	....	....	....	....	153.79	172.85	....	326.64	153.79	172.85	....	326.64
County total	76.54	37.43	145.55	259.52	538.50	381.36	340.93	1,260.79	6,091.92	2,305.86	367.96	8,765.74	6,706.96	2,724.65	854.44	10,286.05

T.159N., R. 95W.	....	....	....	....	....	....	....	....	393.09	....	....	393.09	393.09	....	....	393.09
T.159N., R. 96W.	....	....	....	....	....	....	....	....	436.84	....	....	436.84	436.84	....	....	436.84
T.159N., R. 97W.	....	....	....	....	....	....	....	....	382.00	....	....	382.00	382.00	....	....	382.00
T.159N., R. 98W.	....	....	....	....	....	....	....	....	286.22	....	....	286.22	286.22	....	....	286.22
T.159N., R. 99W.	....	....	....	....	....	....	....	....	328.05	....	....	328.05	328.05	....	....	328.05
T.159N., R.100W.	....	....	....	....	19.07	....	....	19.07	188.66	....	....	188.66	207.73	....	....	207.73
T.159N., R.101W.	5.89	56.01	....	61.90	57.76	63.11	....	120.87	196.95	....	....	196.95	260.60	119.12	....	379.72
T.159N., R.102W.	....	31.07	2.92	33.99	12.23	101.19	....	113.42	82.06	67.55	....	149.61	94.29	199.91	2.92	297.02
T.159N., R.103W.	....	....	....	....	....	....	....	....	5.19	....	....	5.19	5.19	....	....	5.19
T.158N., R. 95W.	....	....	....	....	....	....	....	....	485.97	....	....	485.97	485.97	....	....	485.97
T.158N., R. 96W.	....	....	....	....	....	....	....	....	534.24	....	....	534.24	534.24	....	....	534.24
T.158N., R. 97W.	....	....	....	....	....	....	....	....	495.89	9.19	....	505.08	495.89	9.19	....	505.08
T.158N., R. 98W.	....	....	....	....	....	....	....	....	317.42	97.61	....	415.03	317.42	97.61	....	415.03
T.158N., R. 99W.	....	....	....	....	....	....	....	....	249.36	118.30	....	367.66	249.36	118.30	....	367.66
T.158N., R.100W.	....	....	....	....	5.80	....	....	5.80	407.88	24.96	....	432.84	413.68	24.96	....	438.64
T.158N., R.101W.	....	....	....	....	26.21	2.49	....	28.70	395.46	....	....	395.46	421.67	2.49	....	424.16
T.158N., R.102W.	....	....	....	....	1.95	1.06	....	3.01	351.67	1.15	....	352.82	353.62	2.21	....	355.83
T.158N., R.103W.	....	....	....	....	....	....	....	....	118.01	....	....	118.01	118.01	....	....	118.01
T.157N., R. 95W.	....	....	....	....	....	....	....	....	393.00	....	....	393.00	393.00	....	....	393.00
T.157N., R. 96W.	....	....	....	....	....	....	....	....	483.84	....	....	483.84	483.84	....	....	483.84
T.157N., R. 97W.	....	....	....	....	....	....	....	....	444.96	209.43	....	654.39	444.96	209.43	....	654.39
T.157N., R. 98W.	....	....	....	....	....	....	....	....	412.41	302.40	....	714.81	412.41	302.40	....	714.81
T.157N., R. 99W.	0.20	1.50	....	1.70	10.35	....	....	10.35	256.37	302.40	....	558.77	266.92	303.90	....	570.82
T.157N., R.100W.	1.88	7.01	....	8.89	15.51	35.00	....	50.51	222.26	119.96	....	342.22	239.65	161.97	....	401.62
T.157N., R.101W.	0.35	0.71	....	1.06	23.54	19.11	....	42.65	428.51	18.01	....	446.52	452.50	37.83	....	490.33
T.157N., R.102W.	....	....	....	....	....	....	....	....	388.67	....	....	388.67	388.67	....	....	388.67
T.157N., R.103W.	....	....	....	....	....	....	....	....	183.28	....	....	183.28	183.28	....	....	183.28
T.156N., R. 95W.	....	....	....	....	....	....	....	....	373.75	....	....	373.75	373.75	....	....	373.75
T.156N., R. 96W.	....	....	....	....	....	....	....	....	508.40	....	....	508.40	508.40	....	....	508.40
T.156N., R. 97W.	3.16	....	....	3.16	42.80	....	....	42.80	459.80	186.03	....	645.83	505.76	186.03	....	691.79
T.156N., R. 98W.	....	....	....	....	6.14	....	....	6.14	389.77	531.37	23.10	944.24	395.91	531.37	23.10	950.38
T.156N., R. 99W.	....	....	....	....	....	....	....	....	371.03	505.95	111.13	988.11	371.03	505.95	111.13	988.11
T.156N., R.100W.	0.13	9.05	....	9.18	47.79	24.03	....	71.82	177.87	273.50	....	451.37	225.79	306.58	....	532.37
T.156N., R.101W.	2.89	20.10	....	22.99	6.46	121.20	....	127.66	163.84	60.84	....	224.68	173.19	202.14	....	375.33
T.156N., R.102W.	....	4.80	....	4.80	5.72	2.67	....	8.39	366.30	35.87	....	402.17	372.02	43.34	....	415.36
T.156N., R.103W.	....	....	....	....	....	....	....	....	386.44	....	....	386.44	386.44	....	....	386.44
T.156N., R.104W.	....	....	....	....	....	....	....	....	95.34	....	....	95.34	95.34	....	....	95.34
T.155N., R. 95W.	....	....	....	....	12.80	....	....	12.80	249.35	....	....	249.35	262.15	....	....	262.15
T.155N., R. 96W.	3.29	1.17	9.63	14.09	53.05	35.33	8.93	97.31	265.25	....	....	265.25	321.59	36.50	18.56	376.65
T.155N., R. 97W.	0.86	....	....	0.86	80.68	....	....	80.68	495.22	126.48	....	621.70	576.76	126.48	....	703.24
T.155N., R. 98W.	....	....	....	....	19.07	228.13	12.57	259.77	361.18	203.45	278.19	842.82	380.25	431.58	290.76	1,102.59
T.155N., R. 99W.	2.54	8.81	35.13	46.48	58.39	98.74	292.20	449.33	245.04	175.89	635.94	1,056.87	305.97	283.44	963.27	1,552.68
T.155N., R.100W.	0.61	12.11	....	12.72	38.05	74.92	1.35	114.32	131.60	351.75	....	483.35	170.26	438.78	1.35	610.39
T.155N., R.101W.	4.62	12.67	....	17.29	42.35	133.65	....	176.00	100.33	45.38	....	145.71	147.30	191.70	....	339.00
T.155N., R.102W.	1.69	....	11.55	13.24	1.99	6.58	....	8.57	308.71	85.16	....	393.87	312.39	91.74	11.55	415.68
T.155N., R.103W.	0.91	....	....	0.91	21.83	....	....	21.83	373.86	....	....	373.86	396.60	....	....	396.60
T.155N., R.104W.	9.32	2.94	....	12.26	16.75	3.52	....	20.27	71.67	....	....	71.67	97.74	6.46	....	104.20
T.154N., R. 95W.	1.91	....	....	1.91	28.78	....	....	28.78	47.30	18.57	....	65.87	77.99	18.57	....	96.56
T.154N., R. 96W.	....	....	....	....	0.55	....	....	0.55	3.52	....	....	3.52	4.07	....	....	4.07
T.154N., R. 97W.	16.15	....	....	16.15	60.76	....	....	60.76	164.00	0.20	....	164.20	240.91	0.20	....	241.11
T.154N., R. 98W.	6.31	....	....	6.31	78.30	....	0.25	78.55	528.46	83.54	4.85	616.85	613.07	83.54	5.10	701.71
T.154N., R. 99W.	2.92	6.10	....	9.02	85.29	32.69	80.63	198.61	336.44	339.88	319.21	995.53	424.65	378.67	399.84	1,203.16
T.154N., R.100W.	72.14	34.72	4.64	111.50	140.78	127.94	190.49	459.21	72.36	55.52	85.86	213.74	285.28	218.18	280.99	784.45
T.154N., R.101W.	3.47	12.35	....	15.82	28.94	53.20	....	82.14	22.00	6.87	....	28.87	54.41	72.42	....	126.83
T.154N., R.102W.	15.34	0.05	....	15.39	102.20	28.37	....	130.57	222.14	43.90	....	266.04	339.68	72.32	....	412.00
T.154N., R.103W.	2.63	....	....	2.63	52.02	....	....	52.02	319.09	....	....	319.09	373.74	....	....	373.74
T.154N., R.104W.	5.52	1.18	....	6.70	29.40	3.31	....	32.71	18.84	....	....	18.84	53.76	4.49	....	58.25
T.153N., R. 98W.	....	....	....	....	....	....	....	....	176.79	....	....	176.79	176.79	....	....	176.79
T.153N., R. 99W.	....	....	....	....	2.56	....	....	2.56	370.33	59.80	....	430.13	372.89	59.80	....	432.69
T.153N., R.100W.	16.85	9.98	....	26.83	58.17	39.00	....	97.17	72.28	10.91	....	83.19	147.30	59.89	....	207.19
T.153N., R.102W.	12.66	9.58	....	22.24	28.38	16.40	....	44.78	7.21	....	....	7.21	48.25	25.98	....	74.23
T.153N., R.103W.	12.57	....	....	12.57	63.36	....	....	63.36	95.26	....	....	95.26	171.19	....	....	171.19
T.153N., R.104W.	3.49	....	....	3.49	41.53	....	....	41.53	3.94	....	....	3.94	48.96	....	....	48.96
County total	210.30	241.91	63.87	516.08	1,427.31	1,251.64	586.42	3,265.37	17,223.07	4,471.82	1,458.28	23,153.17	18,860.68	5,965.37	2,108.57	26,934.62

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