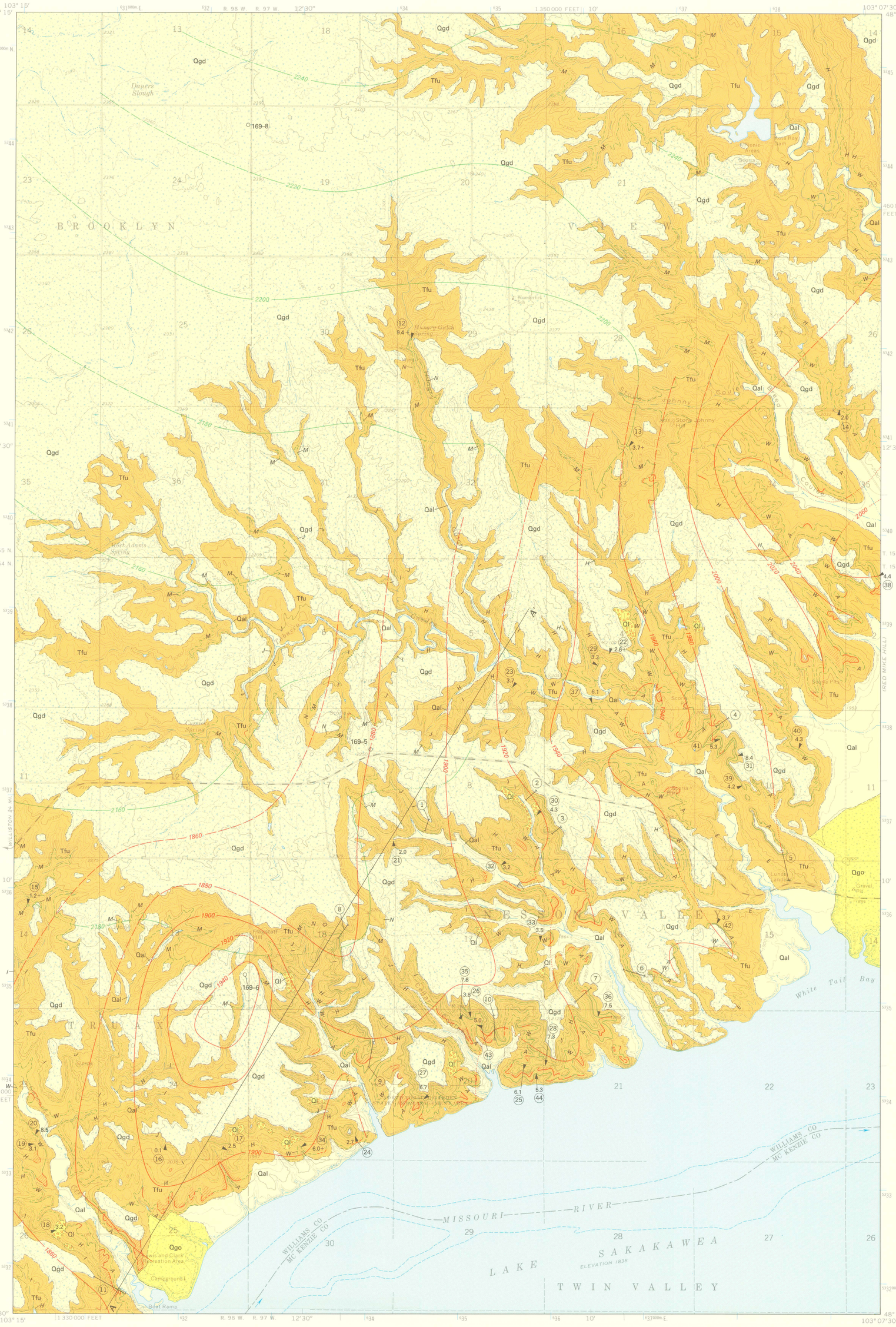

Base from U.S. Geological Survey, 1969
10,000-foot grid based on North Dakota coordinate system, north zone
1000-meter Universal Transverse Mercator grid ticks, zone 13, shown in blue

TRUE NORTH
MAGNETIC NORTH
13°
APPROXIMATE MEAN DECLINATION, 1981

SCALE 1:24 000
1 ½ 0 1 MILE
1 .5 0 1 KILOMETER
CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

NORTH DAKOTA
QUADRANGLE LOCATION

Geology mapped in 1975

CORRELATION OF MAP UNITS

Qal	Holocene	QUATERNARY
Ql		
Qgd, Qgo	Pleistocene	
Tfu	Paleocene	TERTIARY

DESCRIPTION OF MAP UNITS

Qal — ALLUVIUM (HOLOCENE)—Valley fill consisting primarily of reworked local sediments; may include some terraces in glacial outwash

Ql — LANDSLIDE (HOLOCENE)—Small masses of earth and rock moved downslope as a unit

Qgd — GLACIAL DRIFT (PLEISTOCENE)—Unstratified, unsorted glacial sediments which cap upland surfaces and drape gentle slopes. The narrower ridges are capped by pebble and cobble remnants of drift

Qgo — GLACIAL OUTWASH (PLEISTOCENE)—Stratified glacial deposits in stream valleys, generally pebbles and cobbles

Tfu — FORT UNION FORMATION (PALEOCENE)—Interbedded gray to yellowish-brown claystone, siltstone, sandstone, and lignite. The lignite beds mapped: Q, N, Mormon (M), J, I, H, Williston (W), Avoca (A), and E beds. Approximately 500 feet of Fort Union exposed in quadrangle

2.0 A (14) — LIGNITE BED—Long dashed where approximately located, short dashed where inferred. Letter indicates bed mapped: Q, N, Mormon (M), J, I, H, Williston (W), Avoca (A), or E bed. The Mormon, Williston, and Avoca beds are shown by heavier green lines; the other beds by lighter green lines. Thickness measured at arrow. Circled number indicates coal section shown on sheet 2

BAKED AND FUSED ROCK—Created by burning of lignite in place. Pattern indicates inferred extent of burn

BAKED AND FUSED ROCK OF LIMITED LATERAL EXTENT

CONTACT—Long dashed where approximately located, short dashed where inferred

2220 — STRUCTURE CONTOUR—Drawn on top of Mormon bed. Dashed where approximately located, dotted where projected above ground surface. Contour interval 20 feet. Datum is mean sea level

2060 — STRUCTURE CONTOUR—Drawn on top of Avoca bed. Dashed where approximately located, dotted where projected above ground surface. Contour interval 20 feet. Datum is mean sea level

169–8 — U.S. GEOLOGICAL SURVEY—NORTH DAKOTA GEOLOGICAL SURVEY DRILL HOLE—Lithologic log shown on sheet 2

(4) — LINE OF MEASURED SECTION—Circled number indicates measured section shown on sheet 2

ABANDONED DRIFT COAL MINE—Showing reported thickness of lignite, in feet

GEOLOGY

The Cussicks Spring quadrangle lies in southeastern Williams County, N. Dak., on the northern flank of the Williston basin. The geology of the quadrangle was mapped as a part of a U.S. Geological Survey program to evaluate the coal resources of the Northern Great Plains. Bedrock is the Fort Union Formation (Paleocene). Overlying the Fort Union are glacial drift and outwash (Pleistocene) and alluvium (Holocene). Twelve lignite beds are exposed in the quadrangle. From oldest to youngest they are the: E, Avoca, Williston, H, I, J, K, Mormon, N, O, P, and Q beds. Because of their narrow lateral extent and thinness, the K, O, and P beds were not mapped.

Royse (1967, fig. 1) suggested that the area is entirely underlain by the Sentinel Butte Member of the Fort Union Formation. Comparison of exposures in the area with published descriptions of the Sentinel Butte and Tongue River Members of the Fort Union Formation yielded no conclusive identification; consequently, the map shows undifferentiated Fort Union Formation.

The Fort Union consists of interbedded siltstone, sandstone, claystone, and lignite. These are mainly semiconsolidated, with scattered calcareous cement, most commonly in the sandstones, particularly in a zone above the Williston bed. Two prominent concretionary ironstone zones occur in the exposed stratigraphic section, between the Williston and H beds, and between the H and I beds. A few leaf impressions have been found inside the ironstone concretions. Highest in the exposed section is a channel-fill sandstone, found in the northern one-third of the quadrangle. The channel sandstone has large-scale crossbedding and cuts out parts of the N, O, P, and Q lignite beds.

Of the 12 lignite beds exposed in the quadrangle, 9 are at least 2.0 ft thick and 8 are at least 5.0 ft thick. The three most important economically are the Avoca, Williston, and Mormon beds. All three are traceable for several miles east and west of the quadrangle (Spencer, 1978). The total estimated coal resources for the mapped area, calculated according to Bulletin 1450–B (U.S. Bureau of Mines and U.S. Geological Survey, 1976), are 1.1x10⁸ tons (tables 1 and 2). Analyses of samples from the Williston and Avoca beds in the region (Great Northern Railway, 1955, 1966) average heating values of 6,200 Btu/lb and 6,760 Btu/lb (as-received), respectively. The heating value of a sample from the Mormon bed at drill hole 169–5 (sec. 7, T. 154 N., R. 97 W.) is 5,850 Btu/lb (as-received) (J. R. Hatch, written commun., 1977).

The glacial drift is of Wisconsin age. As a mapped unit, it consists of fill, lag gravel concentrations, and reworked till along stream terraces. The broad drift area in the northwestern part of the quadrangle is at least 35 ft thick (drill hole 169–8, sec. 24, T. 155 N., R. 98 W.). Elsewhere, the till is thinner and tends to drape over the ridged areas in the quadrangle. Erosional lag gravels occur on the tops of knobs and the narrower ridges. Coarse, stratified outwash gravels are mapped at the mouths of Tobacco Garden and Gamache Creeks.

Although the center of the regional Williston basin is south of the quadrangle, the local structure is dominated by the Nesson anticline, 8 miles to the east. Structural dips of 0.2° to 0.5° W. prevail through the mapped area.

During the 1930's and 1940's, one- and two-man mines were opened to work the lignite beds in the area. The majority of the mining was by tunneling. Economics and safety regulations shut down the last operating mine in 1967. No total production figures are available; however, the tonnage was only sufficient for local home and ranch use.

The Nesson anticline was originally developed for oil and gas production in the early 1950's and has undergone renewed development since 1970. The Cussicks Spring area appears to be off the producing trend, however, and has not been subjected to exploratory drilling. Outwash gravels and baked and fused rock from the burning of lignite beds have been mined at many locations for use as road metal.

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Freers, T. F., 1970, Geology and ground water resources, Williams County, North Dakota—Pt. 1, Geology: North Dakota Geological Survey Bulletin 48, pt. 1, 55 p.

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Royse, C. F., Jr., 1967, The Tongue River-Sentinel Butte contact in western North Dakota: North Dakota Geological Survey Report of Investigation 45, 53 p.

Spencer, J. M., 1978, Lignite geology of southeastern Williams County, North Dakota: U.S. Geological Survey Open-File Report 78–168, 12 p.

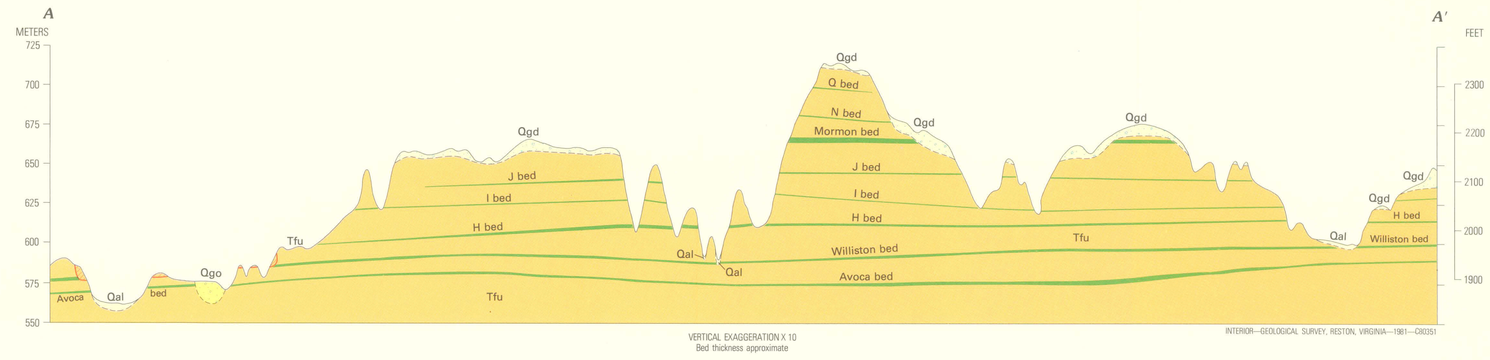
U.S. Bureau of Mines and U.S. Geological Survey, 1976, Coal resource classification system of the U.S. Bureau of Mines and U.S. Geological Survey: U.S. Geological Survey Bulletin 1450–B, 7 p.

TABLE 1.—*Lignite resources, by township, of the Cussicks Spring quadrangle, North Dakota*
[Resources reported in millions of short tons. Meas, measured; Ind, indicated; Inf, inferred; - - -, no resources in category]

Lignite bed	Economic (Reserve Base) ≥60 in. at ≤120 ft overburden				Subeconomic 30-60 in. at ≤120 ft overburden				Subeconomic ≥30 in. >120 ft overburden				Hypothetical	Grand total
	Meas	Ind	Inf	Total	Meas	Ind	Inf	Total	Meas	Ind	Inf	Total		
T. 154 N., R. 97 W.														
Q	- - -	- - -	- - -	- - -	0.3	1.4	- - -	1.7	- - -	- - -	- - -	- - -	- - -	1.7
N	0.5	2.3	- - -	2.8	- - -	- - -	- - -	- - -	0.1	0.5	- - -	0.6	- - -	3.4
Mormon	3.2	8.4	1.9	13.5	- - -	- - -	- - -	- - -	.5	3.1	0.2	3.8	- - -	17.3
J	.2	1.6	.1	1.9	1.2	5.9	1.4	8.5	.4	2.7	.7	3.8	- - -	14.2
I	.2	.4	- - -	.6	1.5	6.3	2.6	10.4	1.2	3.5	1.1	5.8	- - -	16.8
H	2.7	7.0	4.2	13.9	2.3	7.4	1.6	11.3	2.3	11.9	2.4	16.6	- - -	41.8
Williston	3.4	10.0	4.8	18.2	2.3	5.9	.1	8.3	3.0	20.6	10.7	34.3	- - -	60.8
Avoca	3.3	14.8	11.9	30.0	2.5	5.2	.7	8.4	3.7	29.7	14.1	47.5	- - -	85.9
E	- - -	- - -	- - -	- - -	.2	2.7	6.5	9.4	- - -	.5	5.3	5.8	- - -	15.2
Total	13.5	44.5	22.9	80.9	10.3	34.8	12.9	58.0	11.2	72.5	34.5	118.2	- - -	257.1
T. 154 N., R. 98 W.														
Q	- - -	- - -	- - -	- - -	- - -	0.2	- - -	0.2	- - -	- - -	- - -	- - -	- - -	0.2
N	- - -	0.2	- - -	0.2	- - -	- - -	- - -	- - -	- - -	0.2	- - -	0.2	- - -	.4
Mormon	1.0	4.9	15.2	21.1	- - -	- - -	- - -	- - -	0.2	2.5	10.3	13.0	- - -	34.1
J	.4	- - -	- - -	.4	0.1	- - -	- - -	.1	.3	- - -	- - -	.3	- - -	.8
I	.7	.6	- - -	1.3	.1	.9	1.9	2.9	- - -	.1	3.3	3.4	- - -	7.6
H	- - -	.5	2.9	3.4	.5	2.5	1.2	4.2	.9	5.7	33.2	39.8	- - -	47.4
Williston	.8	6.1	3.5	10.4	- - -	- - -	- - -	- - -	.7	8.8	39.7	49.2	- - -	59.6
Avoca	- - -	- - -	1.2	1.2	.8	1.5	2.4	4.7	.2	6.2	47.5	53.9	- - -	59.8
E	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Total	2.9	12.3	22.8	38.0	1.5	5.1	5.5	12.1	2.3	23.5	134.0	159.8	- - -	209.9
T. 155 N., R. 97 W.														
Q	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
N	- - -	- - -	- - -	- - -	0.1	1.1	- - -	1.2	0.1	1.1	- - -	1.2	- - -	2.4
Mormon	4.9	16.7	35.7	57.3	- - -	- - -	- - -	- - -	1.9	25.5	30.2	57.6	- - -	114.9
J	- - -	- - -	- - -	- - -	- - -	- - -	1.3	1.3	- - -	- - -	- - -	- - -	- - -	1.3
I	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	.3	2.4	- - -	2.7	- - -	2.7
H	- - -	- - -	10.4	10.4	- - -	.3	8.1	8.4	.8	6.7	55.2	62.7	9.4	90.9
Williston	- - -	- - -	13.0	13.0	- - -	.1	.3	.4	- - -	- - -	5.7	5.7	58.3	77.4
Avoca	- - -	- - -	5.7	5.7	.4	4.0	8.2	12.6	- - -	- - -	72.1	72.1	29.2	119.6
E	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Total	4.9	16.7	64.8	86.4	.5	5.5	17.9	23.9	3.1	35.7	163.2	202.0	96.9	409.2
T. 155 N., R. 98 W.														
Q	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
N	- - -	- - -	- - -	- - -	0.3	2.2	- - -	2.5	- - -	0.1	- - -	0.1	- - -	2.6
Mormon	- - -	- - -	8.5	8.5	- - -	- - -	- - -	- - -	1.0	1.8	35.1	37.9	- - -	46.4
J	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
I	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	.3	2.9	- - -	3.2	- - -	3.2
H	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	.9	7.1	45.6	53.6	- - -	53.6
Williston	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	16.8	16.8	33.6	50.4
Avoca	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	21.9	21.9	41.6	63.5
E	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Total	- - -	- - -	8.5	8.5	.3	2.2	- - -	2.5	2.2	11.9	119.4	133.5	75.2	219.7

TABLE 2.—*Summary of lignite resources of the Cussicks Spring quadrangle, North Dakota*
[Resources reported in millions of short tons. Meas, measured; Ind, indicated; Inf, inferred; - - -, no resources in category]

Lignite bed	Economic (Reserve Base) >60 in. at ≤120 ft overburden				Subeconomic 30-60 in. at ≤120 ft overburden				Subeconomic ≥30 in. at >120 ft overburden				Hypothetical	Grand total
	Meas	Ind	Inf	Total	Meas	Ind	Inf	Total	Meas	Ind	Inf	Total		
Q	- - -	- - -	- - -	- - -	0.3	1.6	- - -	1.9	- - -	- - -	- - -	- - -	- - -	1.9
N	0.5	2.5	- - -	3.0	.4	3.3	- - -	3.7	0.2	1.9	- - -	2.1	- - -	8.8
Mormon	9.1	30.0	61.3	100.4	- - -	- - -	- - -	- - -	3.6	32.9	75.8	112.3	- - -	212.7
J	.6	1.6	.1	2.3	1.3	5.9	2.7	9.9	.7	2.7	.7	4.1	- - -	16.3
I	.9	1.0	- - -	1.9	1.6	7.2	4.5	13.3	1.8	8.9	4.4	15.1	- - -	30.3
H	2.7	7.5	17.5	27.7	2.8	10.2	10.9	23.9	4.9	31.4	136.4	172.7	9.4	233.7
Williston	4.2	16.1	21.3	41.6	2.3	6.0	.4	8.7	3.7	29.4	72.9	106.0	91.9	248.2
Avoca	3.3	14.8	18.8	36.9	3.7	10.7	11.3	25.7	3.9	35.9	155.6	195.4	70.8	328.8
E	- - -	- - -	- - -	- - -	.2	2.7	6.5	9.4	- - -	.5	5.3	5.8	- - -	15.2
Total	21.3	73.5	119.0	213.8	12.6	47.6	36.3	96.5	18.8	143.6	451.1	613.5	172.1	1,095.9



VERTICAL EXAGGERATION X 10
Bed thickness approximate

INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1981—C80351

GEOLOGIC MAP AND LIGNITE RESOURCES OF THE CUSSICKS SPRING QUADRANGLE, WILLIAMS COUNTY, NORTH DAKOTA

By
John M. Spencer
1981

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