THE LIGNITE RESERVES OF NORTH DAKOTA

by

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INTRODUCTION

Lignite deposits underlie approximately 32,000 square miles of western and central North Dakota. Lignite is present in close proximity to the surface throughout much of this area and may extend to depths of 1,800 feet or more.

For most of its history, the North Dakota Geological Survey has been studying and reporting on coal. Roughly half of the very first report of the North Dakota Geological Survey, the First Biennial Report published in 1901, was devoted to the State's abundant lignite resources. The early coal studies had to rely principally on coal outcrops. Later reports typically relied on a mix of outcrop and drill hole data although the latter was generally concentrated in a relatively small area. Beginning in 1975, companies exploring for coal within North Dakota were required to obtain an exploration permit and to provide the ND Geological Survey with copies of all of the drillhole information (primarily geologic and electronic logs). By the early 1980s, the resulting database had grown to approximately 10,000 holes. It was difficult to manage this information in the absence of a computerized database. Beginning in the mid-1990s, the ND Geological Survey obtained a series of grants from the United States Geological Survey through the National Coal Resource Data System (NCRDS). These grants enabled us to hire temporary employees to enter basic data from approximately 20,000 electric logs into a NDGS coal database. This database was then copied into the NCRDS. The coal database was used to generate maps, cross sections, and tables such as those found in this report and in earlier open-file reports that were generated to fulfill the needs of companies exploring for coalbed methane. In 2000, the North Dakota Industrial Commission, working through the Lignite Research Council, established the Vision 21 Program to provide grant money to offset construction costs for a new coal-fired power plant in North Dakota. The Vision 21 Program, along with California's electrical supply problems in 2000/2001, generated interest in North Dakota's coal deposits that we had not seen since the 1970s. In reaction to this renewed interest, I generated a 1:000,000 scale map of the mineable lignite deposits in North Dakota (Figure 1). This report compliments that map by naming the mineable deposits, providing tables on the tonnages present in each of the mineable deposits, and depicting generalized east-west and north-south cross sections through each of the coal-bearing counties.

The quality of the lignite mined in North Dakota is variable, but generally falls within these following ranges: moisture (33.5 - 43.8 %), volatile matter (24.1 - 30.2 %), fixed carbon (25.2 - 32.9 %), ash (4.4 - 8.0 %), sulfur (0.2 - 1.4%), and Btu (5,960 - 7,487 lb) (Murphy, 2003). Coal chemistry is an extremely important component of coal mining. When necessary, companies mine multiple pits simultaneously to enable them to blend the coal to control these various parameters. Unfortunately, very little chemical data is available on North Dakota lignites outside of the current mine areas.

The History of Coal Mining in North Dakota

There is no oral or written history that indicates Native Peoples in the Northern Plains burned lignite. Lewis and Clark did not mention that coal was utilized at the Knife River Indian Villages during their winter stay in 1804 and 1805. There are also no passages in their journals that would indicate the explorers used coal during that long, cold winter at Fort Mandan (Hoganson and Murphy, 2003). They did however, attempt three test burns of coal while in North Dakota. The recorded history of lignite mining in North Dakota dates back to 1873 (Oihus, 1983). The earliest mines were small, seasonal wagon mines, so named because farmers and ranchers would typically bring their own wagons to the mine to be filled with coal. Lignite was generally excavated from the face of an outcrop and deposited directly in the wagons (Figure 2). By the 1890s, large-scale mining, much of it underground, had begun at Sims, Lehigh, Minot, Burlington, Kenmare, Washburn,

Wilton, and Williston. By the early 1900s, Scranton, Haynes, Beulah, Hazen, Velva, Center, New Salem, Hanks, Noonan, Columbus, and Garrison had also become important mining centers. During this period (1880s to 1920s) the number of active coal mines grew to almost 200 and annual coal production steadily increased, but did not exceed one million tons until 1922 (Figure 3). By 1939, 306 mines were operating in North Dakota and over half of these were strip mines. The advent of the steam shovel increased the profitability of surface mines and the last underground mine in North Dakota ceased operation in 1966 (the Black Diamond Mine in Williams County). Large, electric-powered draglines began replacing steam shovels in the mid-1940s. By 1980, the number of mines operating in the state had dropped to a dozen with mining centers at Larson, Velva, Beulah, Washburn, Center, Dickinson, Glenharold, and Gascoyne. By the mid-1990s, mining had ceased at Larson, Velva, Glenharold, Dickinson, and Gascoyne. Currently, six coal mines are operating in North Dakota: four lignite mines (Coteau's mine north of Beulah, Dakota Westmoreland's mine south of Beulah, BNI's mine at Center, and Falkirk's mine south of Underwood) and two leonardite (oxidized lignite) mines (American Colloid's mine at Gascoyne and GeoResource's mine at Williston) (Figure 4). Despite the historically low number of mines now operating in the state, mine production in 2005 was at 30.6 million tons (Figure 3).

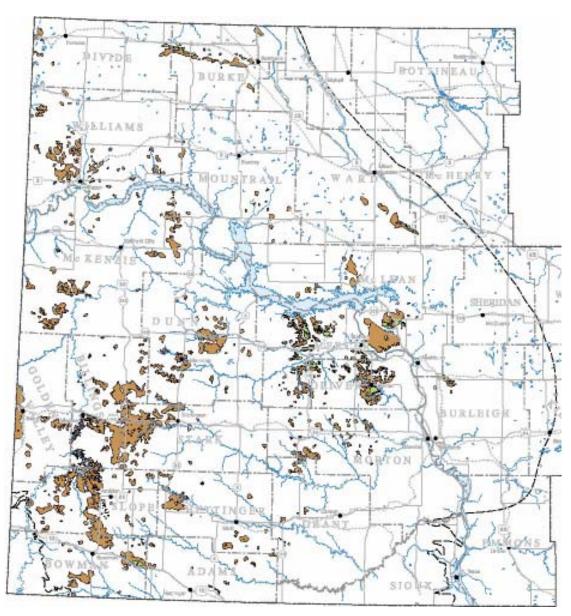


Figure 1. The mineable lignite deposits in North Dakota (Murphy, 2001).



Figure 2. Loading coal into horse-drawn wagons at a wagon mine in western North Dakota. Photo circa 1900.

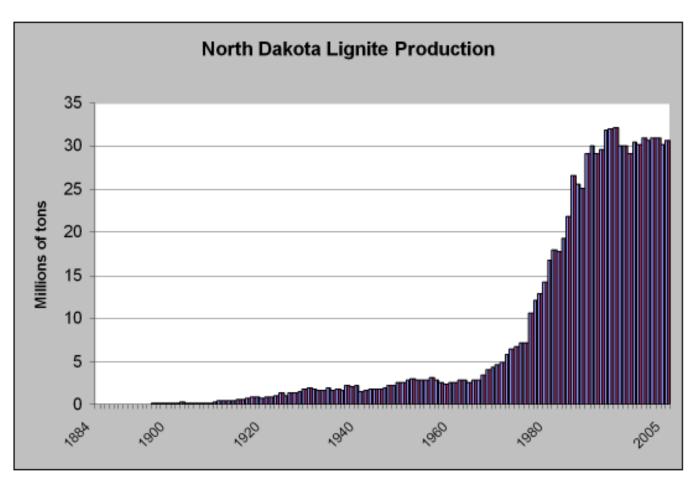


Figure 3. Lignite production in North Dakota from 1884 to 2005.

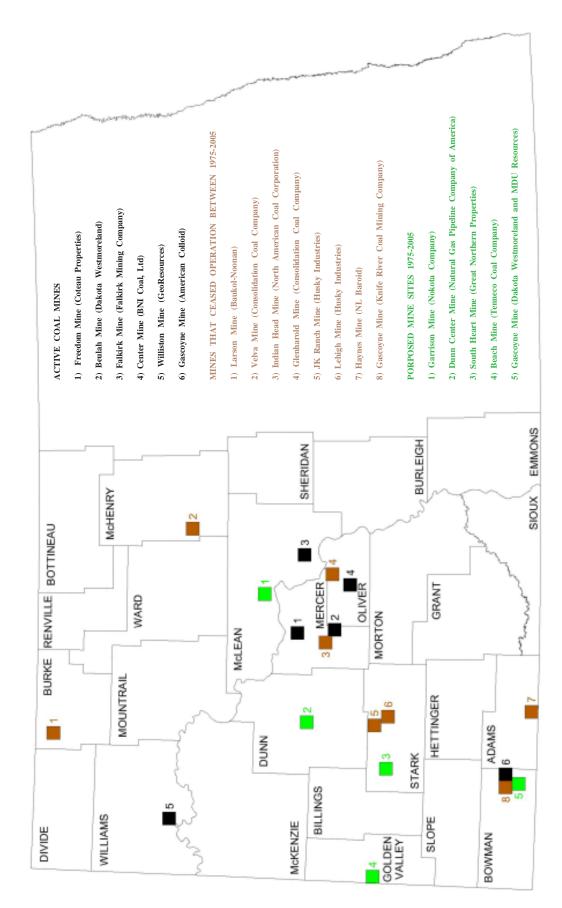


Figure 4. The distribution of proposed coal mines, active coal mines, and mines that have ceased operation in the last 30 years in western and central North Dakota.

While this fell short of 1994's record production of 32.1 million tons, it is nearly equal to all of the state's production during the decade of the 1960s and more than three times that of the average annual production during the 1970s.

Over the years, numerous (perhaps hundreds) of lignite seams have been mined in North Dakota, primarily through small wagon mines (Figure 2). In the last 20 years, only a handful of coal beds have been mined in the state (Figure 5). The Beulah bed is currently mined at two localities in Mercer County (Freedom and Beulah mines) and the Hagel bed is being mined in Oliver (Center Mine) and McLean (Falkirk Mine) counties. An oxidized zone of the Harmon bed is being mined as leonardite in Bowman County. A local bed of oxidized, or weathered, lignite is being mined near Williston (Figure 4).

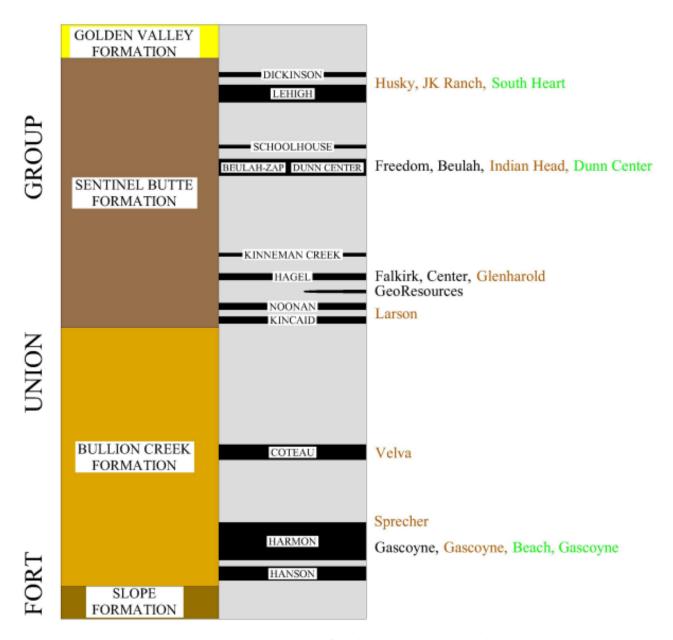


Figure 5. The major coals that have been mined or proposed for mining in North Dakota within the last 30 years (Murphy, 2001). Black text represents active mines, brown text are mines that have closed within the last 30 years, and green text are mines that have been proposed within the last 30 years.

Fort Union Group

For all intensive purposes, the coal-bearing rocks in the North Dakota portion of the Williston Basin fall within the Fort Union Group (Paleocene). A notable exception, is a two-to-three-foot-thick coal in the lower Hell Creek Formation (Upper Cretaceous) which appears to extend over much of central North Dakota and was mined by underground methods in at least one locality in Emmons County (Coal Butte Mine) and by surface methods in Sheridan County (Coal Mine Lake). Thin coals are also present in the upper member of the Golden Valley Formation. While no large-scale mining is known to have occurred in the Golden Valley Formation, coals within this stratigraphic unit may have been mined for local use in Stark, Dunn, and Mercer counties. In addition, there are a few coals that lie deep in the Williston Basin. An oil well core in the Newcastle Formation (Cretaceous) contains a thin coal bed at a depth of 5,240 feet in Slope County.

The Fort Union Group is a clastic wedge (primarily nonmarine) that extends from the Powder River Basin in Wyoming to the Williston Basin in eastern Montana and western North Dakota. In North Dakota, this group consists of, from oldest to youngest, the Ludlow, Cannonball, Slope, Bullion Creek, and Sentinel Butte Formations (Figure 6). The peat, which eventually became coal, was deposited in swamps that were adjacent to large fluvial systems. These rivers flowed primarily from west to east, eventually emptying into the Cannonball Sea. Early in Paleocene time, the Cannonball Sea advanced across western North Dakota, at least as far as the Montana line, before retreating eastward to the Missouri River Valley. As a result, the Cannonball Formation thins from east to west while all other formations within the Fort Union Group thin from west to east.

Based on the variable thicknesses and lateral extent of lignite beds in North Dakota, the size and duration of swamps within which the peat was deposited were extremely variable. In many cases, swamps lasted for relatively short periods of time as indicated by the presence of numerous, thin, discontinuous coals. Peat production was frequently terminated by fluctuating water levels, either the swamps dried up or were drowned by rising water and peat gave way to the deposition of lake sediments. Typically, coals within the Fort Union Group are bounded by claystone indicating lacustrine deposition both preceded and followed peat deposition. Peat production could also he halted by an influx of clastic sediments into the swamp. Rivers occasionally meandered into swamps overwhelming the organic deposits, but outcrops suggest this occurred less frequently. For large swamps, fluctuating water levels and input of clastic sediments would likely be dampened by the size of the system. In contrast, smaller swamps would have been more sensitive to these changes. Some swamp systems were likely in existence for extended periods of geologic time based on coal beds that are both tens of feet thick and extend for hundreds or thousands of square miles.

In 1977, Clayton and others, based largely on observations by Moore (1976), restricted the Ludlow Formation to its lower member, renamed the upper member of the Ludlow Formation the Slope Formation, modified the basal contact of Tongue River Formation, and renamed it the Bullion Creek Formation. The authors felt that the Tongue River name had been overextended, having been applied to nonmarine rocks in two different basins (Williston and Powder River) in a three-state area. During a 1982 fieldtrip from western North Dakota to northern Wyoming, Clarence Carlson became convinced that the Tongue River Formation could be traced laterally from Wyoming to North Dakota. As a result, Carlson (1983) reverted to the original stratigraphic name, but retained the modified basal contact. Although this has created some confusion in the literature, the Bullion Creek and Tongue River Formations essentially encompass the same rocks and can be used interchangeably for large-scale projects.

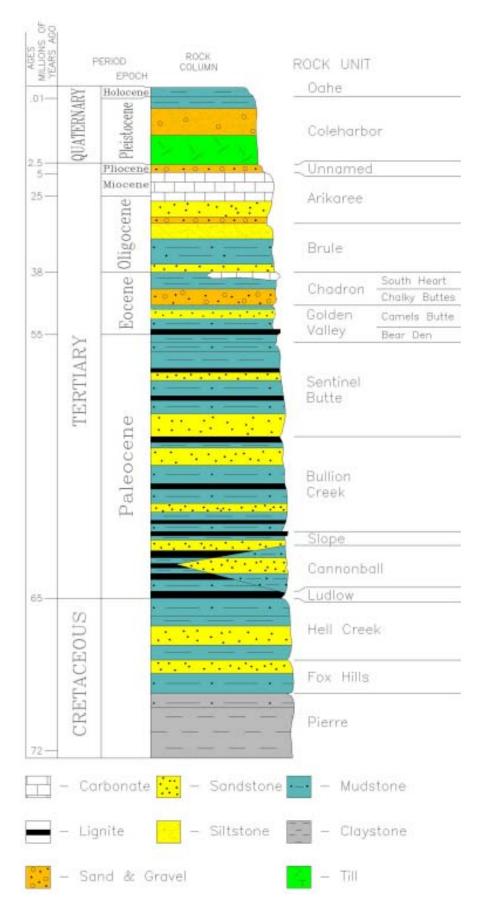


Figure 6. Stratigraphic column of the rocks and sediments present at the surface in western and central North Dakota.

North Dakota Coal Studies

Numerous studies, dating back to the early 1900s, have been conducted on lignite in North Dakota. Most of these studies focused on the thickness and extent of potentially mineable beds in specific areas of the state. The earlier studies depended almost solely on outcrop data supplemented with sparse water well data (Babcock, 1901; Wilder, 1902; Wood, 1904; Leonard, 1906; Smith, 1909; Pishel, 1912; Herald, 1913; Hancock, 1921; Dove and Heaton, 1925; Leonard and others, 1925; Hares, 1928; etc.). Conversely, projects undertaken in the 1970s and early 1980s relied primarily on drill hole data to correlate Fort Union strata (Menge, 1977; Spencer, 1978; Groenewold and others, 1979; Lewis, 1979; Owen, 1979; Banet, 1980; Cook, 1981; Winczewski, 1982; Hinds, 1983; etc.). Arguably, the single best source of drill hole information in North Dakota is the series of U.S. Geological Survey (USGS) open-file reports that were produced in the mid to late 1970s. These reports resulted from a cooperative project between the USGS and the North Dakota Geological Survey (NDGS). Several thousand testholes were drilled under this program in areas that C.G. Carlson (NDGS) or USGS geologists determined would fill gaps within industry data. In general, the lithologic logs from these open-file reports are more detailed and more consistently match the electric logs than those drilled by industry and housed in the files of the North Dakota Geological Survey.

NORTH DAKOTA'S LIGNITE RESERVES

Estimation of Mineable Coal Deposits (Reserves)

Coal beds were correlated across western North Dakota using a dataset of 19,163 electric logs that was created by the North Dakota Geological Survey (Figure 7). Depths to coal and coal thickness were obtained from the dataset and plotted on USGS quadrangle maps (1:24,000 scale). Mineable (surface mineable or strippable) reserves were calculated using economic-based criteria developed by coal companies operating in North Dakota (Table 1). The mineable criteria were applied to the seams to determine the boundaries of the economic deposits. The average coal thickness for the seam or seams under consideration was then estimated for the deposit.

Table 1. Economic Criteria for Recoverable Lignite in North Dakota.

- 1) A minimum cumulative coal thickness of ten feet-typically occurring in one or two beds.
- 2) A minimum individual bed thickness of 2.5 feet.
- 3) A maximum stripping ratio of 10 feet of overburden for every foot of coal.
- 4) A minimum of 20 feet of overburden to minimize the effects of weathering.
- 5) Coal beds were not considered below a depth of 150 feet beneath the surface, in a few rare instances this depth was extended to 170 feet.

The average coal thickness, in feet, for a given area (a reserve deposit or a portion of the deposit) was multiplied by the number of acres within that area to determine the acre-feet of coal (Table 2). An acre-foot of coal was converted to tons by multiplying it by 1,750 tons per acre-foot. Using this method, Murphy (2001) determined there are 25.1 billion tons of lignite reserves (economically recoverable coal) in North Dakota (Figure 1). It would take more than 800 years to exhaust this supply at the present rate of mining (30 million tons per year).

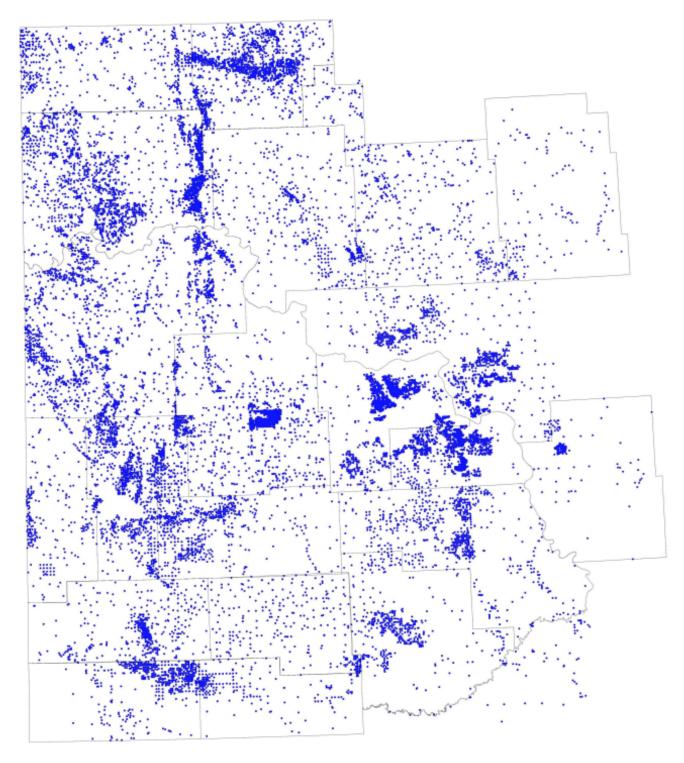


Figure 7. The data points from western and central North Dakota used in this study. The North Dakota Geological Survey entered data from these 19,163 points into the National Coal Resources Database (NCRDS). Several areas of concentrated drilling are evident on the map: 1) the vicinity of the old Noonan, Columbus, and Larson mines in western Burke County, 2) along the Nesson Anticline in eastern Williams and McKenzie counties (gamma logs from oil wells), 3) the site of the Natural Gas Pipeline Company of America's proposed gasification plant in Dunn County, 4) the Freedom Mine in north-central Mercer County (Antelope Valley, a glacial meltwater feature, is clearly visible due to the absence of coal exploration holes), 5) the location of both the Center and old Glenharold Mines in Oliver County, 6) the Falkirk Mine in central McLean County, the old Wilton Mine in northwestern Burleigh County, 7) and uranium exploration in the Chalky Buttes, central Slope County. Map compiled by Jon Haacke, US Geological Survey.

Table 2. Criteria Used to Calculate Lignite Reserves in North Dakota.

- 1) Coal beds were correlated between drill holes.
- 2) The approximate limits of strippable coal deposits were plotted on 1:24,000-scale topographic maps.
- 3) The average coal bed(s) thickness was estimated across the deposit, portions of the deposit, or by township and multiplied by the acreage of the area in question to determine the acre-feet of coal.
- 4) Tonnages were determined by multiplying acre-feet by 1,750 tons per acre-foot.

The limits or boundaries of economic coal deposits were plotted by hand on 1:24,000 scale quadrangle maps by interpolating thicknesses and dips between drill holes and applying that information to a topographic surface. The quadrangle maps went through several xerox reductions before they were spliced together at a scale of 1:125,000. The resulting maps were then published as lignite reserves for each of the coal-bearing counties in North Dakota (Murphy, 2001a – t). Recently, we began digitizing the plotted information from the original quadrangle maps and entering it into a GIS database (Figures 8 and 9). Several of these coal quadrangles (1:24,000 scale) have been published (Murphy, 2005a-i). Eventually, all 600 coal quadrangles will be published for western and central North Dakota. In addition, we have begun replacing the county coal maps with 100K (1:100,000 scale) map sheets plotted on a shaded relief background (Murphy, 2004; Murphy, 2005j-m; Murphy, 2006a-c). Eight 100k map sheets have been completed, the remaining 13 are in progress (Figure 10).

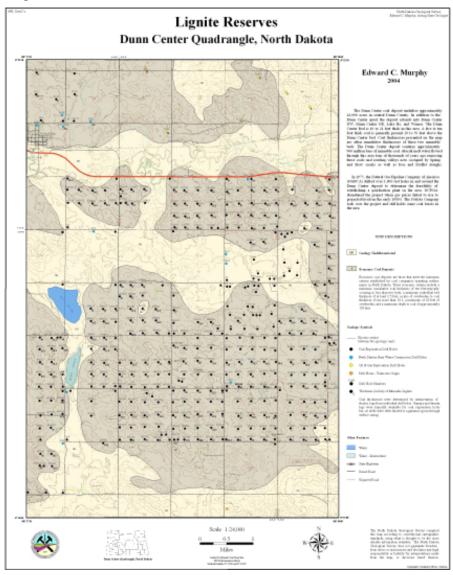


Figure 8. The lignite reserves of the Dunn Center quadrangle, Dunn County, North Dakota. Mineable coal thicknesses are displayed adjacent to drill holes (black dots) that occur within economically mineable coal deposits (brown). The Dunn Center quadrangle is one of 32 maps that make up the Killdeer 100k sheet.

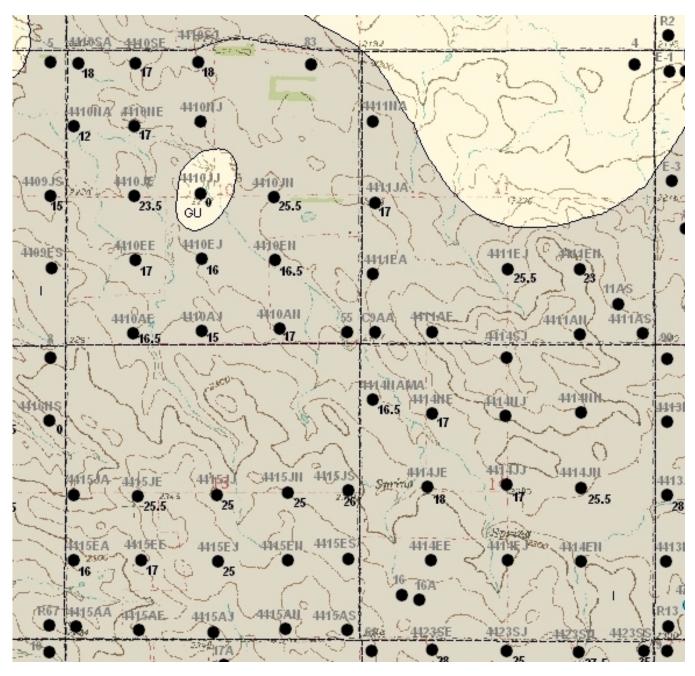


Figure 9. An expanded portion of the Dunn Center quadrangle. Government or industry test hole numbers are displayed in half-tones above the data points. Mineable coal thicknesses are displayed in bold beneath the data points.

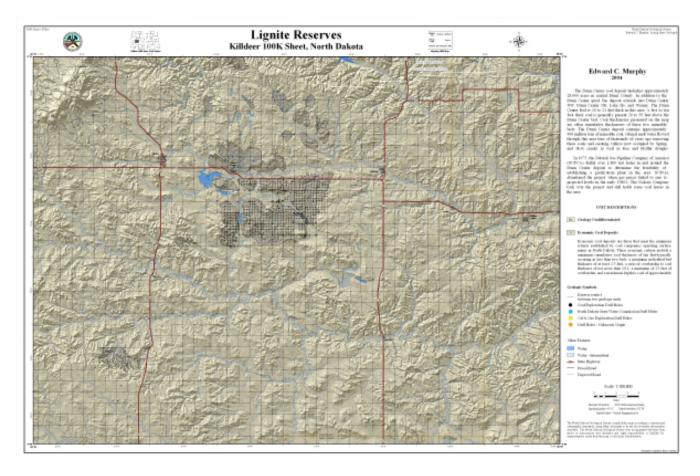


Figure 10. The lignite reserves (mineable coal deposits in gray) of the Killdeer 100k sheet. The Killdeer sheet includes the southern half of Dunn County and the western edge of Mercer County. The Dunn Center Quadrangle (see Figures 8 and 9) is located near the center of the map.

Correlating Electric Logs

Lignite, as with other coals, is most easily identified on gamma and density logs. Lignite has very low counts on the gamma log (unless it is uraniferous) because of its low clay content. Fort Union lignites generally have readings of 5 to 10 gamma counts per second as compared to mudstone which typically have counts around 20. On the density log, lignite typically has about 125 counts per second compared to mudstone which has roughly 50 counts per second. Coal as thin as six inches is easily identifiable on coal exploration expanded-scale gamma or density logs (scale = 5 feet to the inch). However, coals less than two feet thick are virtually impossible to identify on oil well gamma logs where scales are typically 50 feet to the inch. Resistivity logs are of much less utility when it comes to identifying lignites in the Fort Union Group in North Dakota.

Thick Williston Basin lignites, those more than 15 feet thick, are generally correlatable between drill holes spaced three to six miles apart. While thin coals, those less than five feet thick, are often difficult to correlate between holes that are separated by more than one mile. Typically, accurate correlations of thin coals require testholes be spaced no more than 1,500 feet apart. Closely spaced testholes are also beneficial to correlating thick coals because they convey a more gradual change in log signatures that result from parting changes, thinning, thickening, and splitting.

There are few areas outside of existing or recently abandoned coal mines where sufficient subsurface control exists to easily correlate shallow lignites in North Dakota. Generally, coals are best correlated as stratigraphic packages that are bounded by coals. While coal thicknesses may change rapidly over short distances, the thickness of the stratigraphic package remains relatively constant.

COAL RESERVES BY COUNTY

The following chapters contain tables of the thickness, number of seams, acre-feet, and tonnages of mineable lignite for every economic coal deposit in western and central North Dakota. Within each table, the deposits are arranged in descending order from the northernmost to the southernmost deposits in the county. Deposits were named for prominent geographical features that occurred within, or adjacent to, the limits of the deposits such as towns, buttes, creeks, rivers, dams, cemeteries, etc. Medium-sized deposits were often informally divided along section lines in the table to enable a more accurate determination of the average coal thickness. The acre-feet of coal was determined for each subdivision of a deposit, but the tonnage was only calculated for the entire deposit. Large deposits were often artificially terminated along township lines to enable a more accurate determination of the average coal thickness.

Two generalized cross sections, one east-west and the other north-south, were constructed for each of the 21 coal-bearing counties in North Dakota. These cross sections demonstrate general relationships between mudstone, lignite, and sandstone in the Fort Union Group. The intent of these sections is to demonstrate the relative abundance of thin, discontinuous coals in the Fort Union Group as compared to relatively rare thick, extensive lignites. Detailed cross sections are available through a variety of North Dakota Geological Survey (e.g. Groenewold et al., 1979; Moran et al., 1978; Murphy, 1998; Murphy and Goven, 1998; Murphy et al., 1999; Murphy et al., 2001) and United States Geological Survey publications (e.g. Lewis, 1977, Lewis, 1979; Cook, 1981; and Hinds, 1983 and 1985).

Measured sections and electric logs through Fort Union strata reveal that 60 to 70% of this rock unit consists of claystone and mudstone. Sandstones constitutes approximately 25 to 30% and lignite 5% of the Fort Union Group. The interbedded nature of these rocks are obvious on the cross sections. It is also readily apparent on these diagrams that thin coals are discontinuous while thick coals are often laterally persistent, sometimes extending throughout a county or through multiple counties. The overall character of Fort Union strata is best seen in the cross sections for Billings, Burke, Golden Valley, McKenzie, Mountrail, Stark, and Williams counties where logs from numerous oil wells have provided deep subsurface control. Unfortunately, prior to 2000, oil companies were not required to run gamma logs through surface casing. Prior to this mandate, many companies quit logging at the base of the surface casing which is routinely set below Fort Union strata.

ADAMS COUNTY

Adams County contains approximately 150 million tons of economically mineable lignite (Figure 11, Table 3). Generalized geologic cross sections through the county demonstrate there is a maximum of 1,000 feet of Fort Union strata in the area (Figures 12 and 13). The Harmon and Hanson beds are the major coals and are present throughout the western and south-central portion of the county (Figures 12 and 13). The Harmon bed was mined by surface and underground methods near Haynes in T.129N., R.94W.

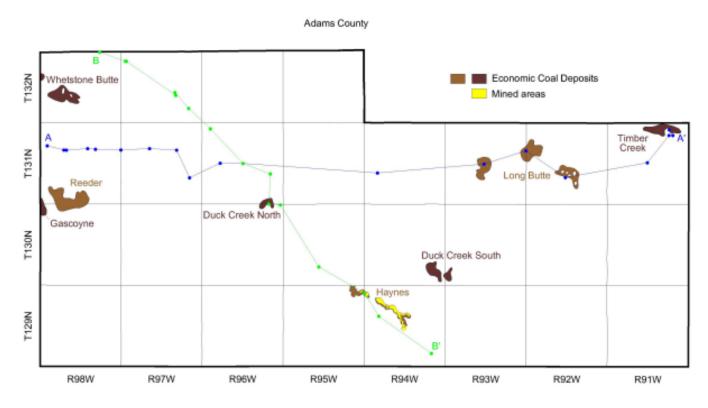


Figure 11. The mineable lignite deposits in Adams County.

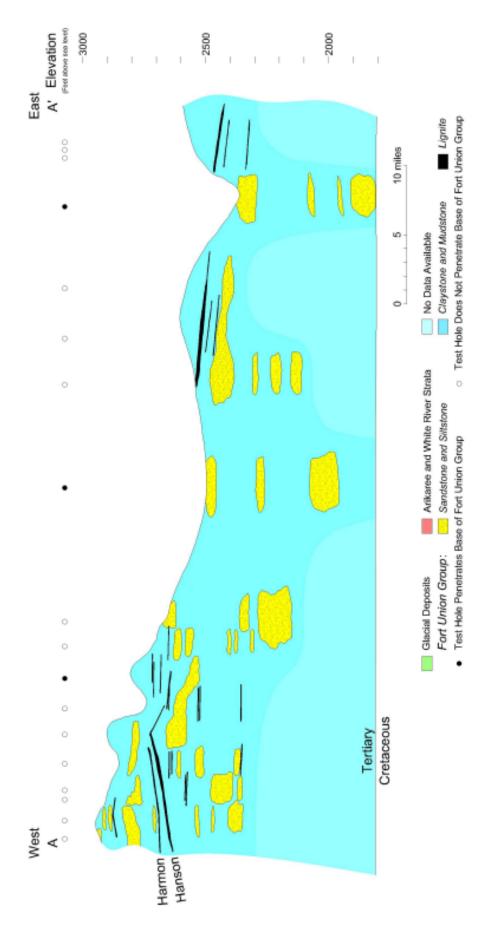


Figure 12. Cross-section A-A' through Adams County. The trace of this cross section is in Figure 11.

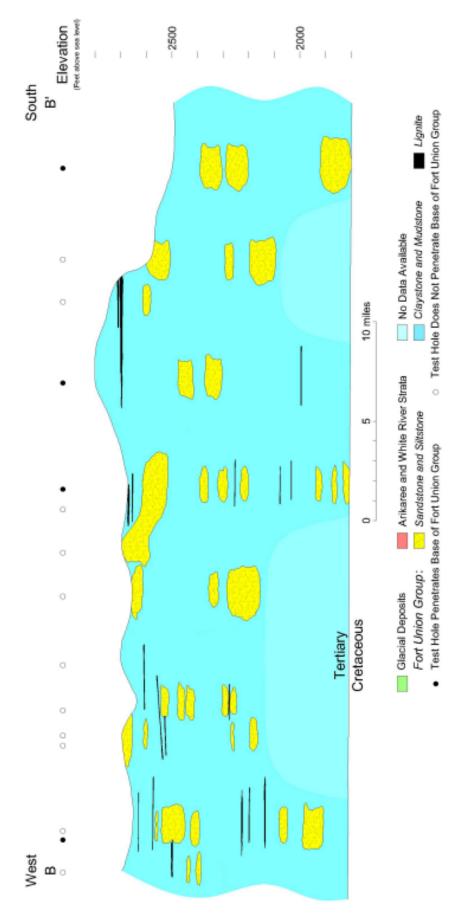


Figure 13 Cross-section B-B'through Adams County. The trace of this cross section is in Figure 11.

Table 3. Mineable Lignite Deposits in Adams County.

		Cumulative coal				
Deposit Name	Legal Description	thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
WHETSTONE BUTTES DEPOSITS	T132N, R98W, sec 18	14	2	100	1,400	
	T132N, R98W, secs 19-21, 28-30	12	2	850	$\frac{10,200}{11,600}$	20,300,000
GASCOYNE DEPOSIT	T130N, R98W, secs 6, 7, 18 T131N, R98W, sec 31	10	l (Harmon)	009	6,000	10,500,000
REEDER DEPOSIT	T131N, R98W, secs 29-34 T130N, R98W, secs 3-5	13	2 (Harmon +1)	1,500	19,500	34,125,000
DUCK CREEK NORTH DEPOSIT	T131N, R96W, secs 35, 36 T130N, R96W, secs 1, 2	Ξ	2	300	3,300	5,775,000
LONG BUTTE DEPOSITS	T131N, R93W, secs 15, 16, 21, 22, 28	10	-	700	7,000	
	T131N, R93W, secs 12, 13 T131N, R92W, secs 7, 8, 17, 18	13	1	800	10,400	
	T131N, R92W, secs 21, 22, 27	14	2	700	<u>9,800</u> 27,200	47,600,000
TIMBER CREEK DEPOSIT	T131N, R91W, secs 1-4	10	1	700	7,000	12,250,000
DUCK CREEK SOUTH DEPOSIT	T130N, R94W, secs 25, 26, 35, 36 T130N, R93W, sec 31	Ξ	1	200	5,500	9,625,000
HA YNES DEPOSIT	T129N, R94W, secs 5-9, 15, 16, 21, 22 T129N, R95W, sec 1	Ξ	1 (Harmon)	200	5,500	9,625,000
TOTAL TONS FOR ADAMS COUNTY	= X.L.				150 MI	149,800,000 150 MILLION TONS

BILLINGS COUNTY

Billings County contains approximately 2.8 billion tons of economically mineable lignite (Figure 14, Table 4). The mineable coal deposits are scattered throughout the county, but the most tonnage comes from the Green River (811 million tons) and Belfield (696 million tons) deposits (Table 4, Figures 15 and 16). There is a maximum of about 1,500 feet of Fort Union strata in this county. There is a propensity of sandstone beneath the Harmon and Hanson coals near the middle of section A-A' (Figure 15). There is fairly good data control in this county due to the number of available gamma logs from oil and gas wells.

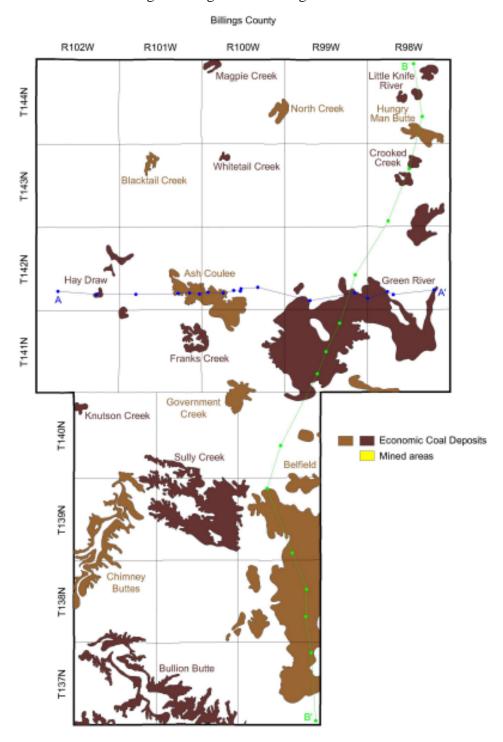


Figure 14. The mineable lignite deposits in Billings County.

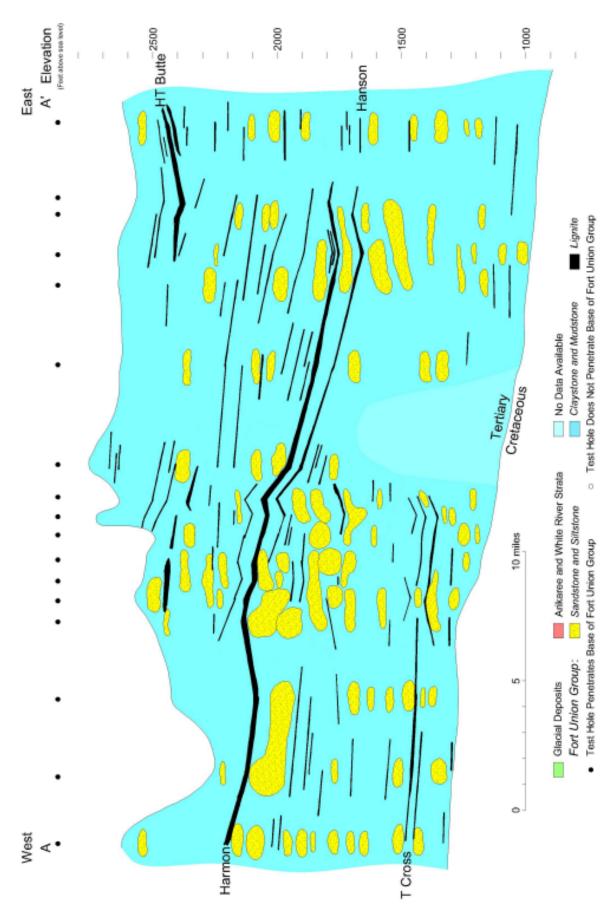


Figure 15. Cross-section A-A' through Billings County. The trace of this cross section is in Figure 14.

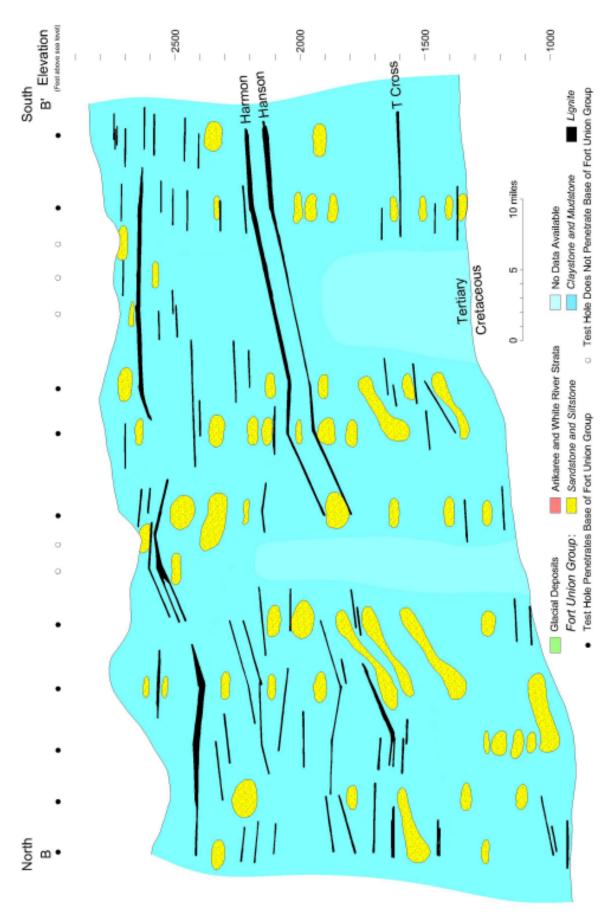


Figure 16. Cross-section B-B' through Billings County. The trace of this cross section is in Figure 14.

Table 4. Mineable Lignite Deposits in Billings County.

	Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
	MAGPIE CREEK DEPOSIT	T144N, R100W, secs 5, 6	10	1	400	4,000	7,000,000
	NORTH CREEK DEPOSIT	T144N, R100W, secs 13, 23-26 T144N, R99W, secs 18, 19	10	1	650	6,500	11,375,000
	LITTLE KNIFE RIVER DEPOSITS	T144N, R98W, secs 1-3, 11	12	1	200	000'9	
		T144N, R98W, sec 16	10	1	240	2,400	
		T144N, R98W, secs 14, 15	17	2	280	$\frac{4.760}{13,160}$	23,030,000
21	HUNGRY MAN BUTTE DEPOSIT	T144N, R98W, secs 26-28, 33-36 T143N, R98W, sec 2	11.5	1 to 2	1,450	16,675	29,181,250
	CROOKED CREEK DEPOSITS	T143N, R98W, secs 3, 10	23	_	350	8,050	
		T143N, R98W, secs 15, 16	13	1	550	7,150	
		T143N, R98W, secs 25-27, 34-36 T142N, R98W, secs 1-3, 10, 11	12.5	-	2,950	<u>36,875</u> 52,075	91,131,250
	WHITETAIL CREEK DEPOSIT	T143N, R100W, secs 5, 8	12.5	7	200	2,500	4,375,000
	BLACKTAIL CREEK DEPOSIT	T143N, R101W, secs 4, 8, 9, 16	11.75	1	400	4,700	8,225,000
	ASH COULEE DEPOSIT	T142N, R100W, secs 29-34 T141N, R100W, secs 3-6, 8, 9 T142N, R101W, secs 22, 23, 25, 26, 35, 36	12.3	1 to 2	4,800	59,040	103,320,000

Table 4. Mineable Lignite Deposits in Billings County (continued).

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
RANKS CREEK DEPOSIT	T141N, R101W, secs 11-14 T141N, R100W, secs 7, 18	15.2	1 to 2	006	13,680	23,940,000
HAY DRAW DEPOSITS	T142N, R102W, secs 12, 13 T142N, R101W, secs 17, 18	24	-	009	14,400	
	T142N, R102W, sec 26	18.5	1 to 2	150	2,775	
	T142N, R101W, sec 31 T141N, R101W, sec 6	17.5	-	180	3,150	
	T142N, R102W, secs 13, 23, 24	18	1	160	$\frac{2.880}{20,430}$	35,725,500
GREEN RIVER DEPOSIT	T141N, R98W, secs 2-11, 14-17, 21, 22 T142N, R98W, secs 19, 29-33	20.7	1 to 2	009,6	198,720	
	T141N, R99W, secs 1-23, 26-34 T141N, R100W, secs 1, 12-14, 23-25 T140N, R100W, secs 1-3	13.8	1 to 2	19,200	<u>264,960</u> 463,680	811,440,000
GOVERNMENT CREEK DEPOSIT	T140N, R101W, secs 1, 12 T140N, R100W, secs 6, 7 T141N, R100W, secs 32-34	12.5	2	1,200	15,000	26,250,000
KNUTSON CREEK DEPOSIT	T140N, R102W, secs 6, 7	14	2	150	2,100	3,675,000
BELFIELD DEPOSITS	T139N, R100W, secs 1-3, 10, 11 T140N, R100W, secs 34-36	13	1 to 2	1,200	15,600	
	T141N, R99W, secs 25, 35, 36 T141N, R98W, secs 31-33	12	1 to 2	800	6,600	
	T140N, R100W, sec 13	15	2	75	1,125	

Table 4. Mineable Lignite Deposits in Billings County (continued).

Deposit Name	C Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
	T140N, R100W, secs 13, 14 T139N, R100W, secs 4, 8-10, 13-18, 21-28, 34-36	11 12.8	2 1 to 2	150 8,500	1,650 108,800	
	T138N, R100W, secs 1-17, 21-28, 34-36	15.4	2	10,880	167,552	
	T137N, R100W, secs 1-3, 10-15, 22-24	16.2	1 to 2	5,760	<u>93,312</u> 397,639	695,868,250
DAVIS CREEK DEPOSIT	T138N, R100W, secs 20, 28-32	12	1	800	9,600	
	T138N, R100W, secs 19, 30 T138N, R101W, sec 25	12	2	400	4,800	
	T138N, R100W, sec 31 T138N, R101W, sec 36	Ξ	2	200	$\frac{2.200}{16,600}$	29,050,000
SULLY CREEK DEPOSIT	T139N, R101W, secs 1-28, 35, 36 T139N, R100W, secs 6, 7, 18, 19, 30, 31	14.8	1 (HT Butte)	12,300	182,040	318,570,000
CHIMNEY BUTTE DEPOSITS	T139N, R102W, secs 1-4, 8-10, 13-18, 20-23, 26-29, 31-34 T138N, R102W, secs 3-8, 17-19	20	1 (Harmon)	7,000	140,000	245,000,000
BULLION BUTTE DEPOSIT	T137N, R102W, secs 2-17, 21, 23-28, 31-34, 36 T137N, R101W, secs 17-22, 26-36 T138N, R102W, secs 32-36	14.75	1 (Harmon)	11,800	174,050	304,587,500

TOTAL TONS FOR BILLINGS COUNTY =

2,771,743,750 2.8 BILLION TONS

BOWMAN COUNTY

Bowman County contains 1.6 billion tons of economically mineable lignite (Figure 17, Table 5). At least 1.2 billion tons, or 80 % of this amount, is attributable to the Harmon bed in the Star and Gascoyne deposits (Table 5, Figures 18 and 19). The Harmon bed was mined at the Gascoyne mine until it closed in 1995. The Harmon bed was also mined in the Bowman (1914-1942) and Halleck (1919-1944) mines both in T132N, R102W. Montana-Dakota Utility and Dakota Westmoreland have been exploring plans to reopen the Gascoyne mine in recent years. Non-coal bearing Cretaceous rocks are exposed at the surface in the western portion of the county (Figure 17). The east flank of the Cedar Creek anticline is readily apparent on both cross sections (Figures 18 and 19).

Bowman County

Rhame Star Medicine Pole Hills T131N Gascoyne North Fork Grand River Lone Tree Creek R107W R104W R102W R101W R100W R99W R106W R105W R103W Economic Coal Deposits Mined areas

Figure 17. The mineable lignite deposits in Bowman County.

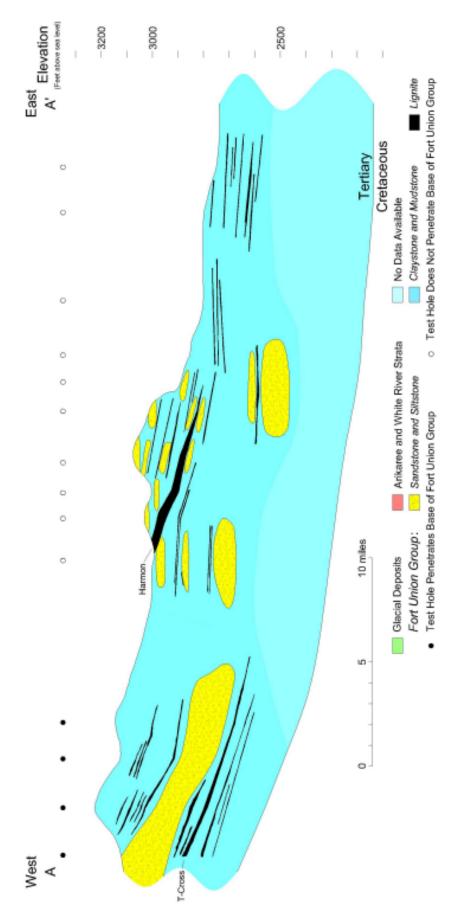


Figure 18. Cross-section A-A' through Bowman County. The trace of this cross section is in Figure 17.

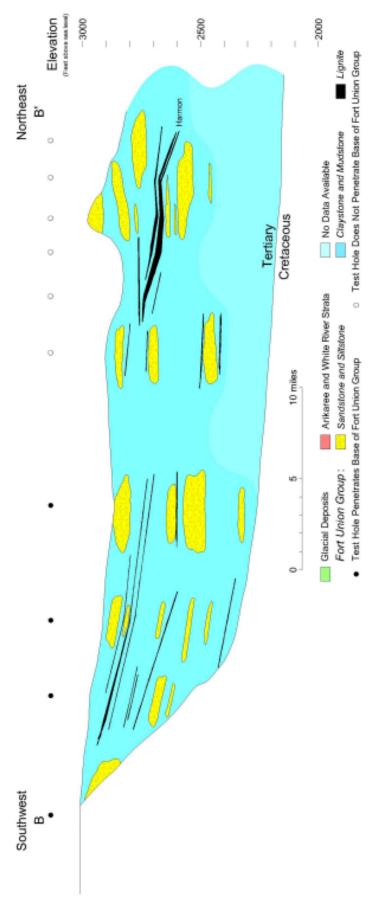


Figure 19. Cross-section B-B' through Bowman County. The trace of this cross section is in Figure 17.

Table 5. Mineable Lignite Deposits in Bowman County.

Deposit Name	(Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
STAR DEPOSIT	T132N, R101W, secs 7-30, 33-35 T132N, R102W, secs 8-16, 22-25	20.5	1 to 2 (Harmon + an upper bed)	16,000	328,000	574,000,000
CEDAR CREEK DEPOSITS	T132N, R99W, secs 10, 11, 14, 15	10	2	250	2,500	
	T132N, R99W, secs 7, 8, 17, 18	12	2	200	<u>2,400</u> 4,900	8,575,000
BUENA VISTA DEPOSITS	T132N, R100W, secs 22, 23	11	2	160	1,760	
	T132N, R99W, sec 30	16	2	180	2,880	
	T132N, R99W, secs 21, 22, 27, 28	11.5	2	160	1,840	
	T132N, R99W, secs 14, 15, 22, 23	12	2	300	3,600	
	T132N, R99W, sec 13	14	2	40	<u>560</u> 10,640	18,620,000
FISCHBEIN DEPOSIT	T131N, R99W, secs 1, 12	17	1	280	4,760	8,330,000
RHAME DEPOSIT	T132N, R104W, secs 25, 26, 35, 36	12	2	300	3,600	6,300,000
MEDICINE POLE HILLS DEPOSIT	T131N, R103W, secs 4, 5, 8, 9	10	2	300	3,000	5,250,000
GRIFFIN DEPOSIT	T132N, R103W, secs 23-26 T132N, R102W, secs 19, 30	20	1	006	18,000	31,500,000
ALKALI CREEK DEPOSIT	T130N, R102W, secs 10, 14-16, 18-23, 26-34					

Table 5. Mineable Lignite Deposits in Bowman County (continued).

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
	T129N, R102W, secs 3-6 T130N, R103W, secs 17, 20-29, 34-36	13	1 to 2	12,160	158,080	276,640,000
GASCOYNE DEPOSIT	T131N, R99W, secs 6, 7, 15-36 T131N, R100W, secs 1-4, 9-16, 22-28, 33-36 T130N, R99W, secs 1-5	19.5	(typically two beds consisting of the Harmon, Harmon splits, Hanson, or an overlying bed)	18, 240	355,680	622,440,000
GRAND RIVER DEPOSIT	T129N, R103W, secs 2-5, 8-11, 14-17 T130N, R103W, secs 33-35	13	2	3,200	41,600	72,800,000
LONE TREE CREEK DEPOSIT	T129N, R103W, secs 26-28, 33-35	11	2	009	6,600	11,550,000
NORTH FORK DEPOSITS	T129N, R100W, secs 16, 20, 21, 28	8 10	2	360	3,600	
	T129N, R100W, secs 25, 36 T129N, R99W, sec 30	12	2	275	3,300 6,900	12,075,000

1,648,080,000 1.6 BILLION TONS

TOTAL TONS FOR BOWMAN COUNTY =

BURKE COUNTY

Burke County contains 527 million tons of economically mineable lignite (Figure 20, Table 6). The largest mineable tonnage is found within the Larson /Columbus deposit (142 million), the Beaver Lake deposits (111 million), and the Woburn deposit (116 million tons). The Noonan and Kincaid beds were mined were mined at the Larson and Columbus mines for many years, the mines ceased operation in the mid 1980s (Figures 21 and 22). There is a maximum of approximately 1,500 feet of Fort Union strata in this county. Glacial deposits are present throughout the surface of the county, thicknesses range from several feet to several hundreds of feet (Figure 22). A thick, extensive sandstone is present in the lower 1/3 of the Fort Union Group in the southern portion of cross section B-B' (Figure 22). This sandstone could be the Cannonball Formation, but it appears to be a little too high stratigraphically.

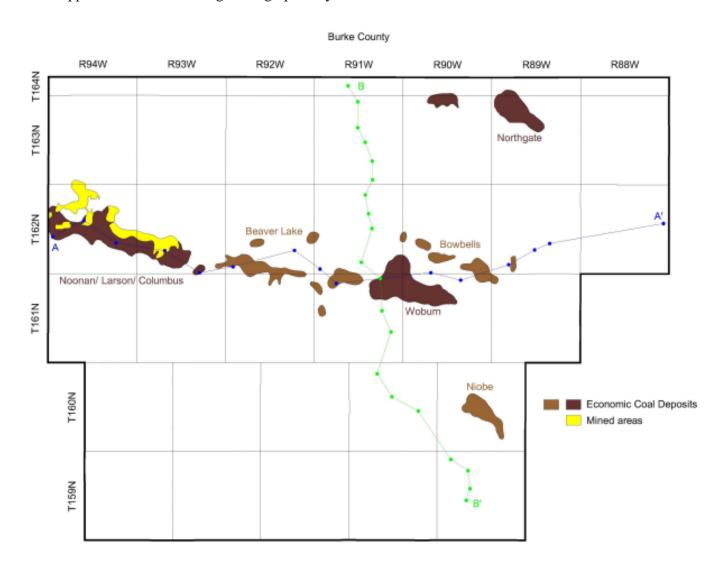


Figure 20. The mineable lignite deposits in Burke County.

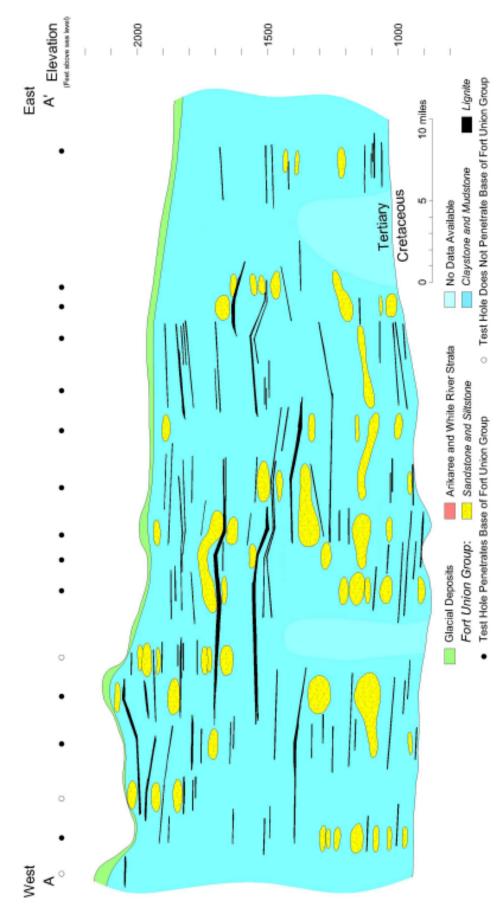


Figure 21. Cross-section A-A' through Burke County. The trace of this cross section is in Figure 20.

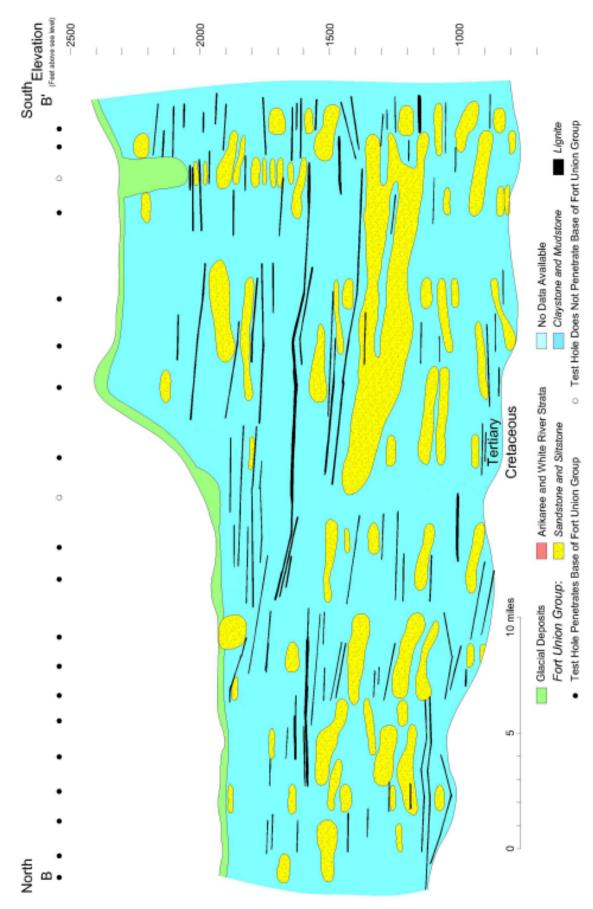


Figure 22. Cross-section B-B' through Burke County. The trace of this cross section is in Figure 20.

Table 6. Mineable Lignite Deposits in Burke County.

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
NORTHGATE DEPOSIT	T163N, R89W, secs 4-10, 15, 16 T164N, R89W, secs 31, 32	13	1 to 2	3,520	45,760	80,080,000
WEST NORTHGATE DEPOSIT	T164N, R90W, secs 33, 34 T163N, R90W, secs 2-4	14.5	2	640	9,280	16,240,000
BOWBELLSDEPOSITS	T162N, R90W, sec 19 T162N, R91W, sec 24	Ξ	2	100	1,100	
	T162N, R90W, secs 19, 20, 29, 30	14	2	300	4,200	
	T162N, R90W, secs 27-29, 32-34	13	2	450	5,850	
	T162N, R90W, secs 35, 36 T161N, R90W, sec 1 T161N, R89W, sec 6	Ξ	2	1,150	12,650	
	T162N, R89W, secs 29, 32	10	2	250	$\frac{2.750}{26,550}$	46,462,500
WOBURN DEPOSIT	T161N, R90W, secs 4-10, 16 T161N, R91W, secs 1-3, 10-12 T162N, R91W, secs 25, 35, 36 T162N, R90W, secs 30, 31	11.5	2	5,760	66,240	115,920,000
BEAVER LAKE DEPOSITS	T162N, R92W, secs 20, 21, 28, 29	11	2	300	3,300	
	T162N, R92W, sec 24 T162N, R91W, sec 19	16.5	2	300	4,950	
	T162N, R92W, secs 29-36 T161N, R92W, secs 1-5 T162N, R93W, sec 36	12	2	2,560	30,720	
	T161N, R91W, secs 3-5 T162N, R91W, secs 32, 33	11.5	2	1200	13,800	

Table 6. Mineable Lignite Deposits in Burke County (continued).

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
	T161N, R91W, secs 6, 7 T161N, R92W, sec 1	Ξ	2	300	3,300	
	T161N, R91W, sec 18	14	-	200	<u>2.800</u> 58,960	103,180,000
LARSON/COLUMBUS DEPOSIT	T162N, R94W, secs 7, 9-11, 13-26 T162N, R93W, secs 19-21, 27-34	10.4	7	7,680	79,788	
	T162N, R93W, secs 34, 35	10	1	160	$\frac{1.600}{81,388}$	142,429,000
NIOBE DEPOSIT	T160N, R90W, secs 15-17, 21-23, 26, 35	11	2	1,600	17,600	30,800,000
TOTAL TONS FOR BURKE COUNTY =	TY =				535 M	535,111,500 535 MILLION TONS

TOTAL TONS FOR BURKE COUNTY =

BURLEIGH COUNTY

Burleigh County contains approximately 31 million tons of economically mineable lignite (Figures 23-25, Table7). The Wilton Deposit is the only economic deposit in the county. Wilton was an important early mining center and both abandoned underground and surface mines are present in the area. Mining ceased at the Wilton Mine in 1946 although mining continued in this area until 1968. Glacial deposits are present throughout the county, but are generally only a few tens of feet thick. Fort Union strata is only 600 to 700 feet thick in Burleigh County and noncoal-bearing Cretaceous rocks are present at the surface in the southern part of the county (Figure 25).

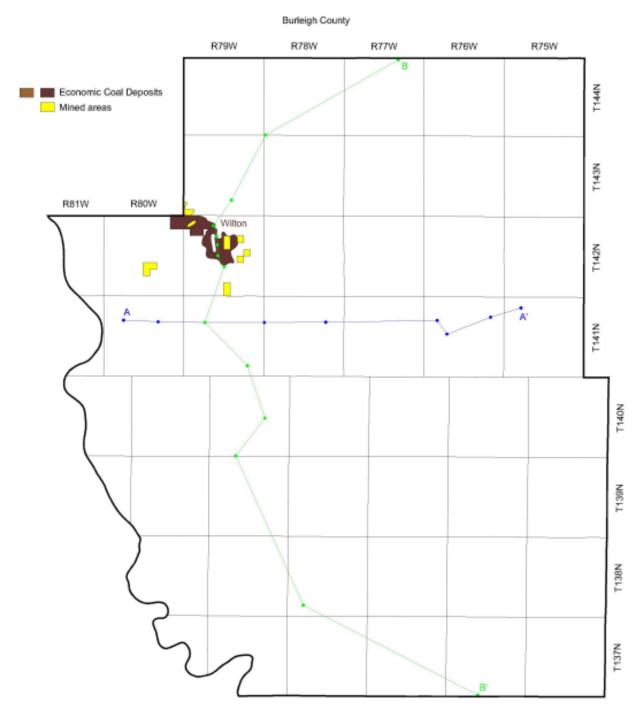


Figure 23. The mineable lignite deposits in Burleigh County.

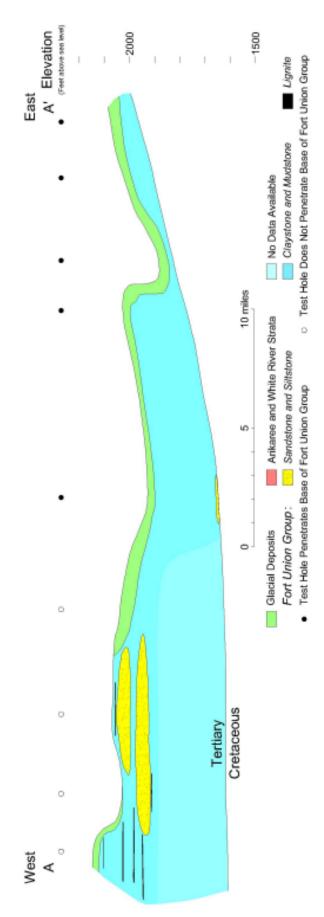


Figure 24. Cross-section A-A' through Burleigh County. The trace of this cross section is in Figure 23.

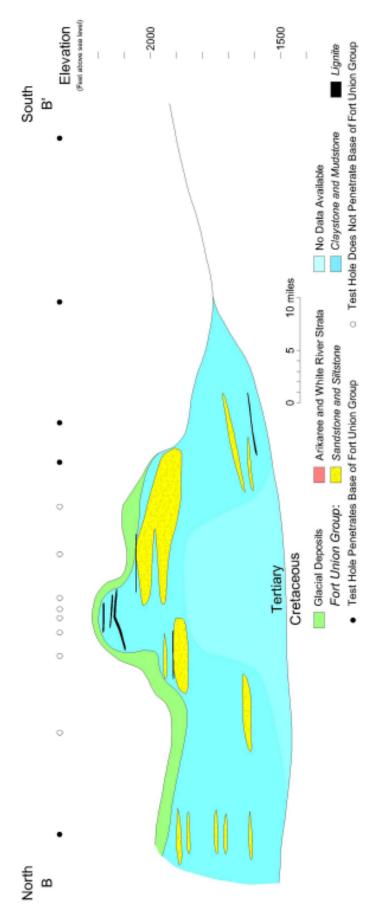


Figure 25. Cross-section B-B' through Burleigh County. The trace of this cross section is in Figure 23.

Table 7. Mineable Lignite Deposits in Burleigh County.

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
WILTON DEPOSIT	T142N, R79W, secs 4, 8-10,15-17	11	1 to 2	1,600	17,600	30,800,000
TOTAL TONS FOR BURLEIGH COUNTY	H COUNTY =				31 M	31 MILLION TONS

DIVIDE COUNTY

Divide County contains approximately 318 million tons of mineable lignite (Figure 26, Table 8). Several economic deposits occur along the western edge of the county as well as the Noonan/Larson deposit along the eastern edge. The Alkabo bed, previously unreported in the literature, is up to 25 feet thick and accounts for most of the economic coal in the western part of the county (Figures 27 and 28). The thickness and depth of this bed make it an excellent candidate for coalbed methane exploration. The Noonan bed is approximately ten feet thick and was mined by both underground and surface methods in the Noonan area from the early 1900s until 1962. Glacial cover ranges in thickness from zero along a few drainages north of ND Highway 5 to several hundred feet in buried channels (Figure 27).

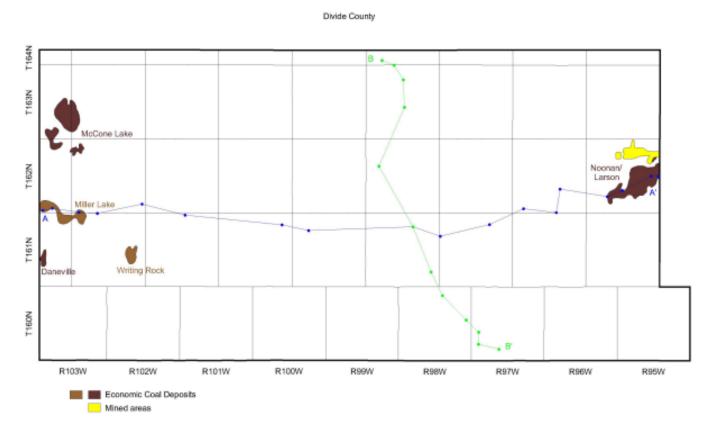


Figure 26. The mineable lignite deposits in Divide County.

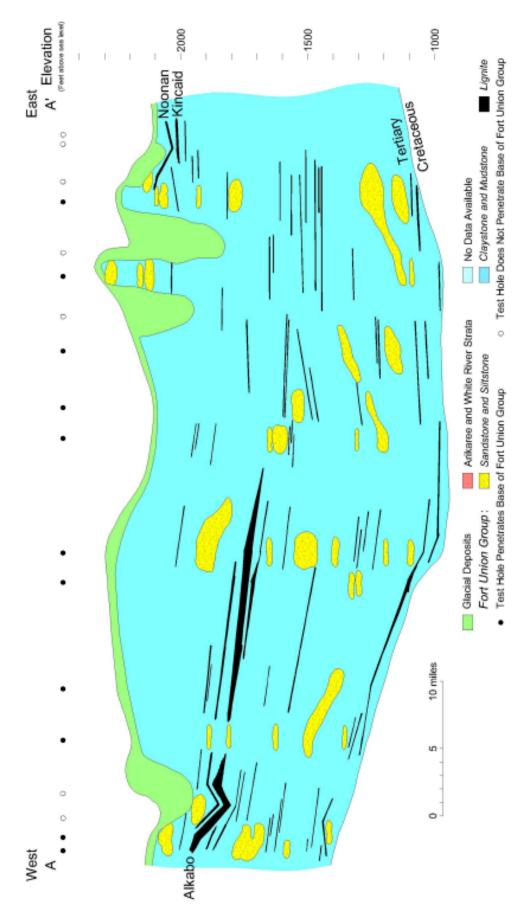


Figure 27. Cross-section A-A' through Divide County. The trace of this cross section is in Figure 26.

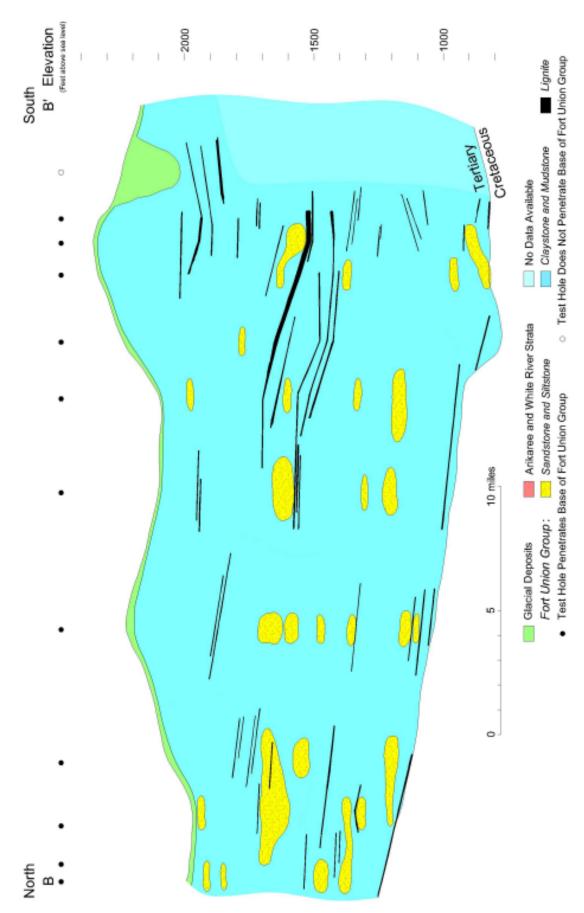


Figure 28. Cross-section B-B' through Divide County. The trace of this cross section is in Figure 26.

Table 8. Mineable Lignite Deposits in Divide County.

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
McCONE LAKE DEPOSITS	T163N, R103W, secs 13, 23, 24, 25, 36 T163N, R102W, secs 19, 30, 31	24.5	(Alkabo and an overlying coal)	1,920	47,040	
	T163N, R103W, secs 34, 35 T162N, R103W, secs 1, 2	24	1 (Alkabo)	800	19,200	
	T162N, R92W, secs 6, 7	21	1 (Alkabo)	250	$\frac{5,250}{71,490}$	125,107,500
MILLER LAKE DEPOSIT	T162N, R103W, secs 34, 35 T161N, R103W, sec 1 T162N, R102W, sec 6	25.4	1 (Alkabo)	1,400	35,560	62,230,000
DANEVILLE DEPOSIT	T161N, R103W, secs 22, 27	20	1 (Alkabo)	275	5,500	9,625,000
WRITING ROCK DEPOSIT	T161N, R102W, secs 13, 14, 22-27	34	Alkabo and an overlying bed	1,580	53,720	94,010,000
NOONAN/LARSON DEPOSIT	T162N, R95W, secs 12-15, 21-29, 32	17	2 (Noonan + Kincaid)	3,520	59,840	104,720,000
TOTAL TONS IN DIVIDE COUNTY =	II				396 M	395,692,500 396 MILLION TONS

DUNN COUNTY

Dunn County contains approximately 1.7 billion tons of mineable lignite (Figure 29, Table 9). Economic coal deposits occur throughout the southern and central portion of the county. More than half of this mineable tonnage (891 million tons) comes from the Dunn Center coal. The Dunn Center bed reaches a maximum thickness of 22 feet in this area (Figures 30 and 31). The Gas Pipeline Company of America planned to establish a coal gasification plant in this area in the mid to late 1970s, but abandoned the project. More than 100 million tons of mineable coal are present in the Fayette, Crooked Creek, Lighting Creek, and JK Ranch deposits (Figure 29, Table 9). A number of wagon mines have operated in Dunn County, but no large-scale mines have ever operated in the county. The JK Ranch deposit is an extension of a deposit in Stark County where the Lehigh bed was mined by Royal Oak Industries. The Harmon bed is one of the more laterally persistent coals in the county (Figures 30 and 31). The general lack of subsurface control in Dunn County as compared to Billings County is evident when comparing figures 15 and 30.

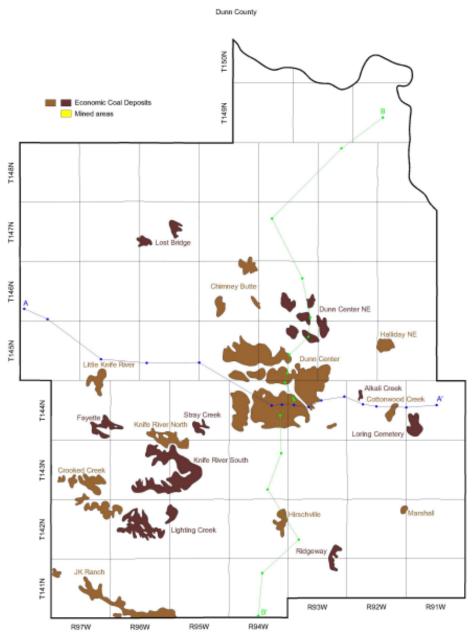


Figure 29. The mineable lignite deposits in Dunn County.

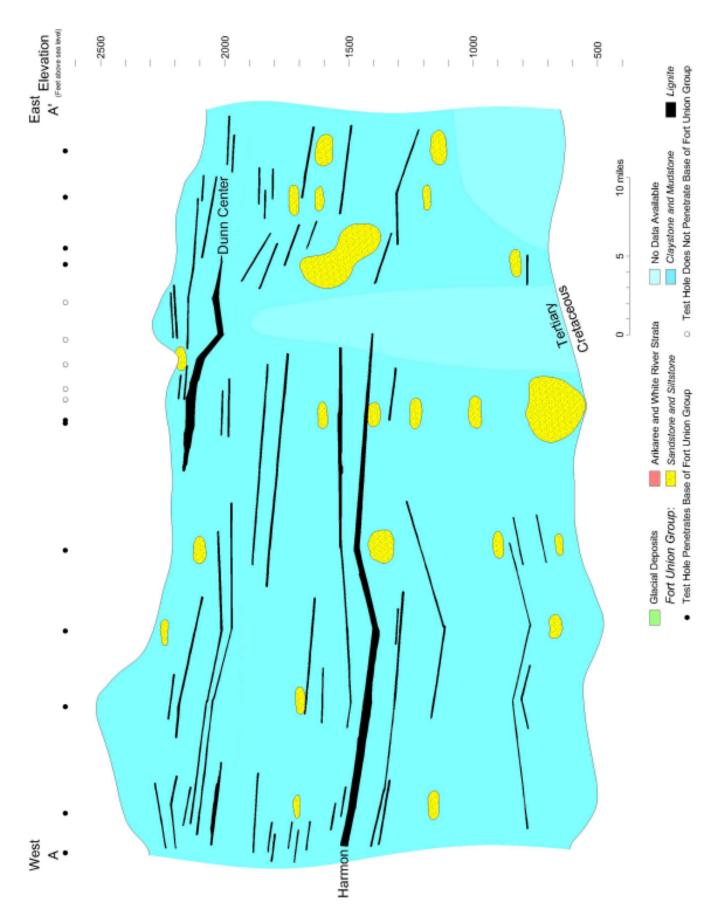


Figure 30. Cross-section A-A' through Dunn County. The trace of this cross section is in Figure 29.

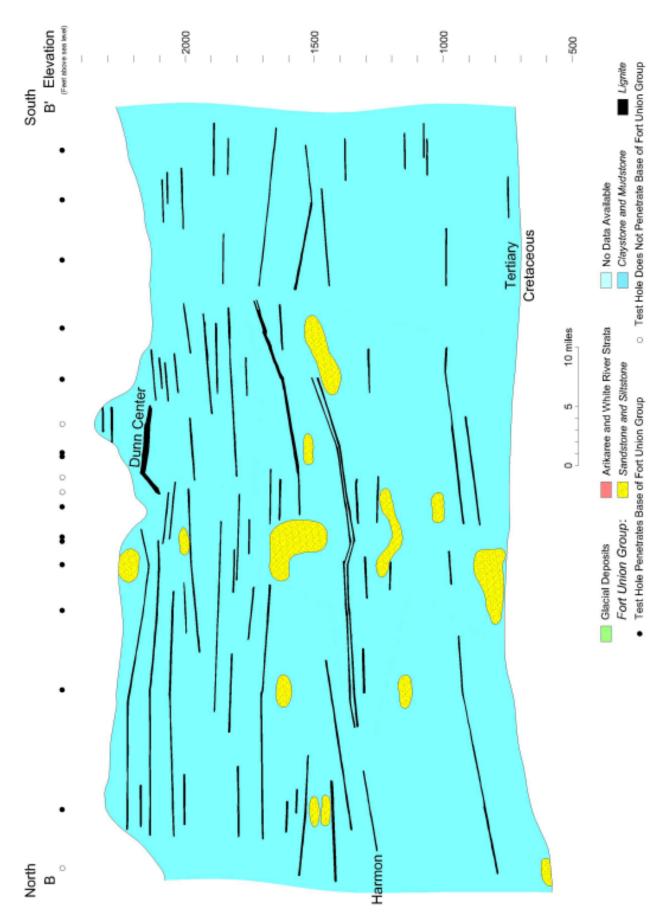


Figure 31. Cross-section B-B' through Dunn County. The trace of this cross section is in Figure 29.

Table 9. Mineable Lignite Deposits in Dunn County.

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
LOST BRIDGE DEPOSITS	T147N, R95W, secs 10, 14-16, 22	10	1	009	6,000	
	T147N, R95W, secs 19, 29, 30 T147N, R96W, secs 24, 25	12	2	300	3,600 9,600	16,800,000
CHIMNEY BUTTE DEPOSIT	T146N, R94W, secs 1, 2, 11, 12 T147N, R94W, secs 35, 36	12	1	006	10,800	
	T146N, R94W, secs 24, 25 T146N, R93W, sec 30	12	2	150	1,800	
	T146N, R94W, secs 20, 21, 28, 29, 32, 33	15	2	800	$\frac{12,000}{24,600}$	43,050,000
DUNN CENTER NE DEPOSITS	T146N, R93W, secs 21, 22, 27, 28	111	2	006	006'6	
	T146N, R93W, secs 23-25	20	1	450	000'6	
	T146N, R93W, secs 34-36 T145N, R93W secs 1, 2	14	61	700	008'6	
	T145N, R93W, secs 3, 4, 9, 10	12	2	300	3,600	
	T145N, R92W, secs 5-7 T146N, R92W, sec 31	10	2 (1 to N 2 to S)	800	8,000	
	T145N, R93W, secs 2, 11-13	10	1	700	$\frac{7,000}{47,300}$	82,775,000
HALLIDAY NE	T145N, R91W, secs 7, 8, 17-19 T145N, R92W, sec 13	12	2	940	11,280	19,740,000
LITTLE KNIFE RIVER DEPOSIT	T145N, R97W, secs 31-33 T144N, R97W, secs 1-3	11	7	1100	12,100	21,175,000

Table 9. Mineable Lignite Deposits in Dunn County (continued).

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
FAYETTE DEPOSIT	T144N, R97W, secs 24-27, 34-36 T144N, R96W, secs 29-31	37	2	1,600	59,200	103,600,000
KNIFE RIVER NORTH DEPOSIT	T144N, R96W, secs 26, 34-36 T144N, R95W, secs 31 T143N, R96W, secs 1, 2 T143N, R95W, secs 4-6	15	2	2,370	35,550	62,212,500
STRAY CREEK DEPOSIT	T144N, R95W, secs 26-28, 33-34	15	2	800	12,000	21,000,000
ALKALI CREEK DEPOSIT	T144N, R92W, sec 8	10	2	150	1,500	2,625,000
COTTONWOOD CREEK DEPOSIT	T144N, R92W, secs 13-14, 22,	14	2	850	11,900	20,825,000
LORING CEMETERY DEPOSIT	23, 26 T144N, R91W, secs 19, 20, 29-32	16	2	1,600	25,600	44,800,000
DUNN CENTER DEPOSIT	T145N, R94W, secs 11, 13-16, 21-24, 25-28 T145N, R93W, secs 16-22, 27-30	15	2 (primarily Dunn Center occasionally with another bed)	6,400	000'96	
	T145N, R94W, secs 34, 35	20	2 (Dunn Center + 1)	006	18,000	
	T145N, R94W, sec 36 T145N, R93W, sec 31	18.5	1 (Dunn Center)	1000	18,500	
	T145N, R93W, secs 29, 31, 32 T144N, R93W, sec 2	22.7	2 (Dunn Center + 1)	006	20,430	
	T145N, R93W, secs 28, 33 T144N, R93W, sec 1	19.8	1 (Dunn Center)	006	17,832	

Table 9. Mineable Lignite Deposits in Dunn County (continued).

Deposit Name

Cegal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
T145N, R93W, secs 27, 34 T144N, R93W, sec 6	13.9	1 (Dunn Center)	006	12,510	
T145N, R93W, secs 26, 35 T144N, R93W, sec 5	15.2	1 (Dunn Center)	1,480	22,517	
T145N, R93W, secs 25, 36 T144N, R93W, sec 4	13.6	1 (Dunn Center)	1,480	20,165	
T145N, R92W, secs 29-32 T144N, R93W, sec 3	14	1 (Dunn Center)	1,480	20,720	
T144N, R93W, secs 7-10	24.3	2 (Dunn Center + 1)	1,300	31,590	
T144N, R93W, secs 15, 16, 17 (n part)	25	2 (Dunn Center + 1)	426	10,650	
T144N, R94W, secs 3, 4, 9, 10	17.6	1 (Dunn Center)	950	16,720	
T144N, R94W, secs 11, 12	22.6	2 (Dunn Center + 1)	006	20,340	
T144N, R93W, secs 7	23.1	2 (Dunn Center + 1)	320	7,392	
T144N, R94W, secs 15, 16	18.8	2 (Dunn Center + 1)	1000	18,800	
T144N, R94W, secs 13, 14	25.9	2 (Dunn Center + 1)	1280	33,152	
T144N, R93W, secs 17, 18	24.4	2 (Dunn Center + 1)	1040	25,376	
T144N, R94W, secs 21, 22	19.4	2 (Dunn Center + 1)	1,120	21,728	
T144N, R94W, secs 23, 24	23.6	2 (Dunn Center + 1)	1,280	30,208	
T144N, R94W, secs 25-28	13	2 (Dunn Center or two other beds)	1,280	16,640	
T144N, R93W, secs 19 -21, 28, 29	25.9	2 (Dunn Center + 1)	1,200	31,100	
T144N, R93W, secs 29, 30	10	2 (Dunn Center or two other beds)	$\frac{320}{27,856}$	$\frac{3,200}{513,570}$	898,747,500

Table 9. Mineable Lignite Deposits in Dunn County (continued).

Deposit Name	Ca Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
KNIFE RIVER SOUTH DEPOSIT	T143N, R96W, secs 1-3, 10-14, 22, 23, 25-28, 33-36 T143N, R95W, secs 6-8, 15-22, 28-32	17	2	8,000	136,000	238,000
CROOKED CREEK DEPOSITS	T143N, R97W, secs 19, 20, 29, 30	10	2	160	1,600	
	T143N, R97W, secs 20, 21, 28, 29	14	2	280	3,920	
	T143N, R97W, secs 21-28, 35	14	1	1,800	25,200	
	T143N, R97W, secs 33, 34 T142N, R97W, secs 3, 4	12.5	7	380	4,750	
	T142N, R97W, secs 1-3, 10-12	15	2	1,350	20,250	
	T142N, R96W, secs 5-8	15	2	009	<u>9,000</u> 64,720	113,260,000
LIGHTING CREEK DEPOSITS	T142N, R96W, secs 4, 8-10, 13-24	15	1 to 2	3,500	52,500	
	T142N, R95W, secs 6, 7 T142N, R96W, secs 1, 12, 13	12.5	2	700	$\frac{8.750}{61,250}$	107,187,500
HIRSCHVILLEDEPOSIT	T142N, R94W, secs 11-14	16.5	1 to 2	1,000	16,500	28,875,000
MARSHALL DEPOSIT	T142N, R92W, secs 1, 12 T142N, R91W, secs 6, 7	10	1	160	1,600	2,800,000
JK RANCH DEPOSITS	T141N, R97W, sec 7	25	2	300	7,500	

Table 9. Mineable Lignite Deposits in Dunn County (continued).

		Cumulative coal				
Deposit Name	Legal Description	thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
	T141N, R97W, secs 13-15, 21-26 T141N, R96W, secs 29-33	20	2	2,880	$\frac{57,600}{65,100}$	113,925,000
RIDGEWAY DEPOSIT	T142N, R93W, secs 25, 26, 35, 36 T141N, R93W, secs 2, 11, 12	11	2	006	6,900	17,325,000
TOTAL TONS IN DUNN COUNTY =	- X				1.7 I	1,720,960,500 1.7 BILLION TONS

GOLDEN VALLEY COUNTY

Golden Valley County contains approximately 1.4 billion tons of mineable lignite (Figure 32, Table 10). Most of this, almost 900 million tons is contained in the Beach deposit (historically referred to as the Beach/Wibaux deposit because it extends into eastern Montana near the town of Wibaux). Tenneco purchased coal leases in the Beach area in the 1970s with the intent of establishing a coal gasification plant in the area. The project was abandoned in the 1980s due to concerns over availability of water and the failure of natural gas prices to reach levels that had been projected earlier. The Harmon bed, the primary coal in the Beach deposit, is more than 30 feet thick in and around the town of Beach (Figure 33). The underlying Hanson bed is more than 15 feet thick in the central part of the county. The HT Butte bed obtains a thickness of 25 feet near Flat Top Butte (Figure 33). The Flat Top Butte deposit contains approximately 400,000 million tons of mineable coal, but would likely never be mined due to its close proximity to the South Unit of the Theodore Roosevelt National Park (approximately 8 miles to the northeast). The T Cross, and a few associated coals underlying it, can be traced over much of the central portion of the county. The Harmon, Hanson, and T Cross are likely coalbed methane targets in the area (Murphy et. al., 2000). Strata dips steeply to the north in the southern portion of the county due to the influence of the eastern flank of the Cedar Creek anticline (Figure 34).

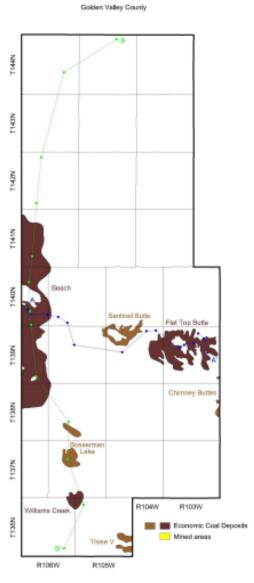


Figure 32. The mineable lignite deposits in Golden Valley County.

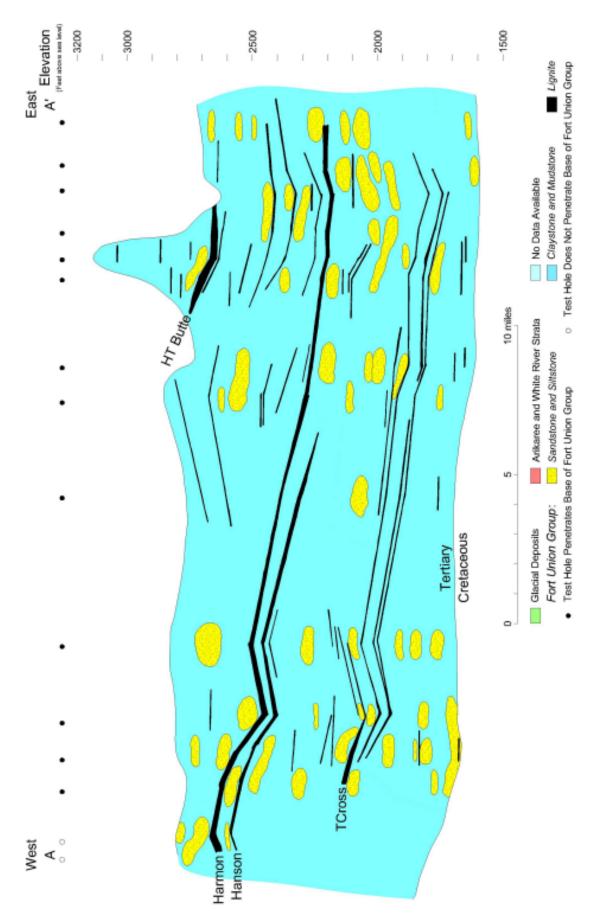


Figure 33. Cross-section A-A' through Golden Valley County. The trace of this cross section is in Figure 32.

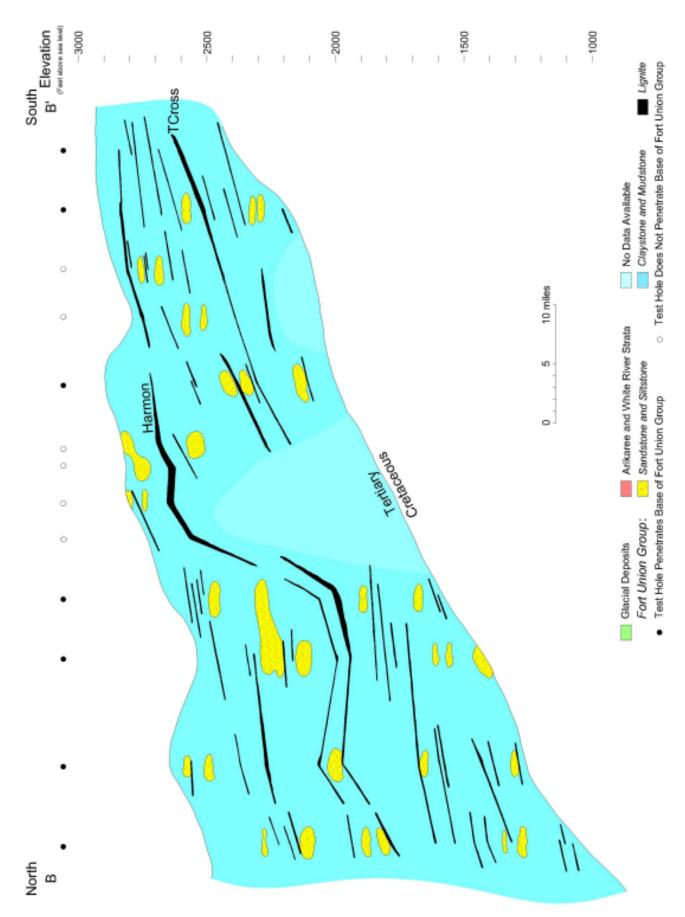


Figure 34. Cross-section B-B' through Golden Valley County. The trace of this cross section is in Figure 32.

Table 10. Mineable Lignite Deposits in Golden Valley County.

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
BEACH DEPOSIT	T141N, R105W, secs 6-9, 16-21, 28-34	19.5	2 (Harmon alone in 90% of area)	6,465	126,068	
	T140N, R106W, secs 1-3, 10-15, 22-27, 34-36 T140N, R105W, secs 19, 30, 31	28	2 (Harmon alone in 95% of area)	7,240	202,720	
	T139N, R106W, secs 1-3, 10-15, 22-24, N/2 25-27	20.5	1 (Harmon)	6,059	124,210	
	T139N, R106W, secs S½ 25-27, 34-36 T138N, R106W, secs 1-3, 10-15 T139N, R105W, sec 31 T138N, R105W, secs 6, 7	r-36 13	2 (Harmon + 1)	4,320	<u>56.160</u> 509,158	891,026,500
SENTINEL BUTTE DEPOSIT	T139N, R104W, secs 3-9 T139N, R105W, sec1 T140N, R104W, 31-34	20	1 (HT Butte)	2,240	44,800	78,400,000
FLAT TOP BUTTE DEPOSIT	T139N, R103W, secs 3-24, 26, 28, 29 T139N, R104W, secs 1, 11-14, 23, 24	25	1 (HT Butte)	8,960	224,000	392,000,000
BOSSERMAN LAKE DEPOSITS	T138N, R105W, secs 28, 29, 33, 34	4 10	-	500	5,000	
	T137N, R105W, secs 4, 5, 8-10, 15-17	11	2	1,200	$\frac{13,200}{18,200}$	31,850,00
WILLIAMS CREEK DEPOSIT	T136N, R105W, sec 6 T137N, R105W, secs 33, 34 T136N, R106W, sec 1	10	2	950	9,500	16,625,000

Table 10. Mineable Lignite Deposits in Golden Valley County (continued).

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
THREE V DEPOSIT	T136N, R105W, secs 23-26, 35, 36	10	1	1000	10,000	17,500,000
TOTAL TONS FOR GOLDEN VALLEY COUNTY =	ALLEY COUNTY =				1.4 B	1,433,001,500 4 BILLION TONS

GRANT COUNTY

Grant County contains approximately 173 million tons of mineable lignite in about a half dozen deposits that occur in the west-central and northwestern portions of the county (Figure 35, Table 11). None of these deposits contains more than 70 million tons of coal and none of the mineable coals were more than 10 feet thick (Figures 36 and 37). Well control is generally poor throughout the county except for the areas around New Leipzig and Elgin. Deep subsurface control, ie., wells that penetrate the Fort Union Group, is limited throughout the county (Figures 36 and 37). Coal-bearing rocks of the Fort Union Group are absent along the southeastern edge of the county (Figure 36). Coal was mined from the Haynes bed in the Davenport Mine near New Leipzig from 1925 until 1970 (Groenewold et al., 1983).

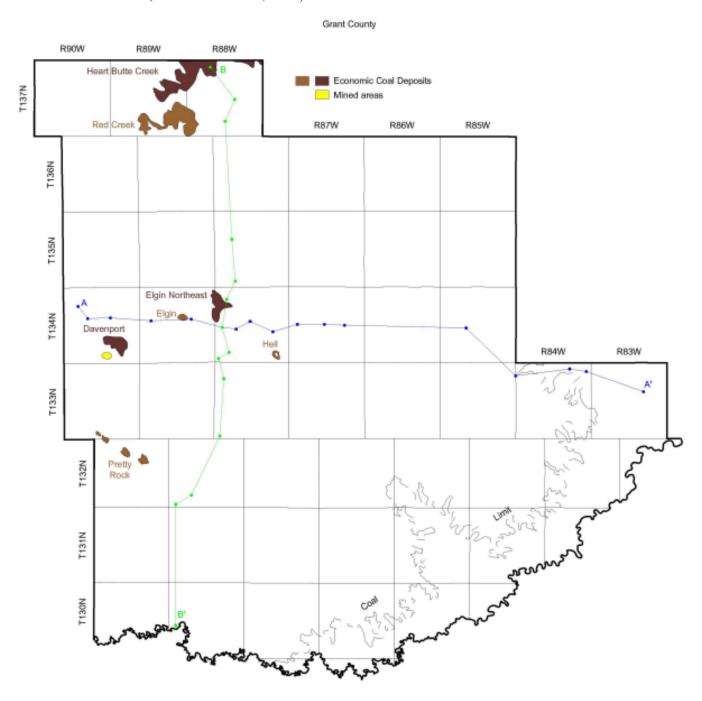


Figure 35. The mineable lignite deposits in Grant County.

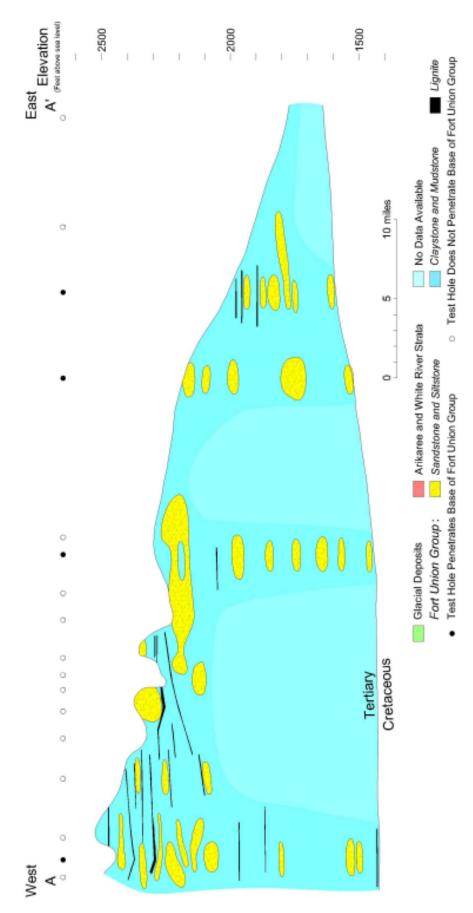


Figure 36. Cross-section A-A' through Grant County. The trace of this cross section is in Figure 35.

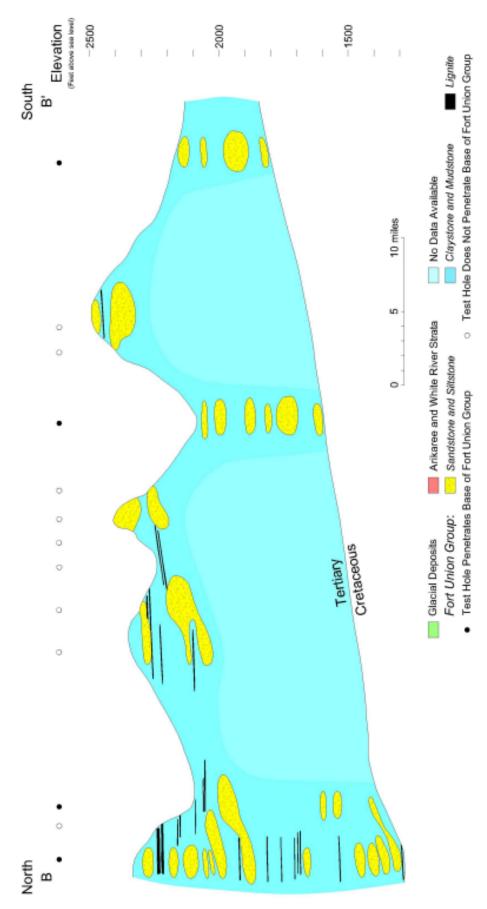


Figure 37. Cross-section B-B' through Grant County. The trace of this cross section is in Figure 35.

Table 11. Mineable Lignite Deposits in Grant County.

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
HEART BUTTE CREEK DEPOSITS	T137N, R88W, secs 1-9, 18 T137N, R89W, secs 1, 10-15, 22, 23	10	-	3,800	38,000	66,500,000
RED CREEK DEPOSIT	T137N, R88W, secs 19, 30, 31 T137N, R89W, secs 23-28, 33-36	11	2	3,200	35,200	61,600,000
DAVENPORT DEPOSIT	T134N, R90W, secs 22, 23, 26, 27, 35	10	1	096	009'6	16,800,000
ELGIN DEPOSIT	T134N, R89W, sec 15	10	1	120	1,200	2,100,000
ELGIN NORTHEAST DEPOSIT	T134N, R88W, secs 6-8, 18 T134N, R89W, secs 1, 12, 13	10	64	800	8,000	14,000,000
HEIL DEPOSIT	T134N, R88W, secs 35, 36180	11	2	80	880	1,540,000
PRETTY ROCK DEPOSITS	T132N, R90W, secs 10, 11, 14, 15	10	1	150	1,500	
	T132N, R90W, sec 9	14	2	200	2,800	
	T132N, R90W, secs 5, 6 T133N, R90W, secs 33, 34	Ξ	2	150	1,650 5,950	10,412,500
TOTAL TONS FOR GRANT COUNTY =	FY =				173 MII	172,952,500 173 MILLION TONS

HETTINGER COUNTY

There are approximately 730 million tons of economically mineable lignite in Hettinger County (Figure 38, Table 12). Two deposits, Coal Bank Creek and Mehrer Creek, contain more than 100 million tons of mineable coal. Four of the major coals in southwestern North Dakota, HT Butte, Harmon, Hanson, and T Cross appear to be present in this county (Figures 39 and 40). The Fort Union Group is 800 to 1,200 feet thick in this county. Deep subsurface control through the basal four hundred feet or so of the Fort Union is lacking throughout the county. Several small, abandoned coal mines are present in the central portion of the county.

Hettinger County

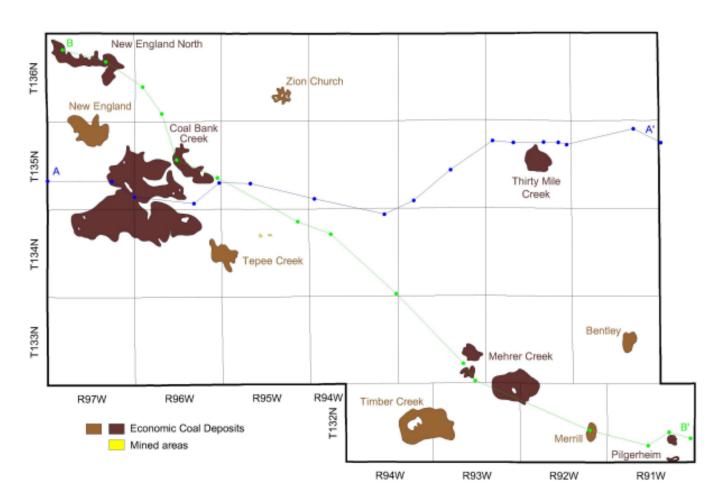


Figure 38. The mineable lignite deposits in Hettinger County.

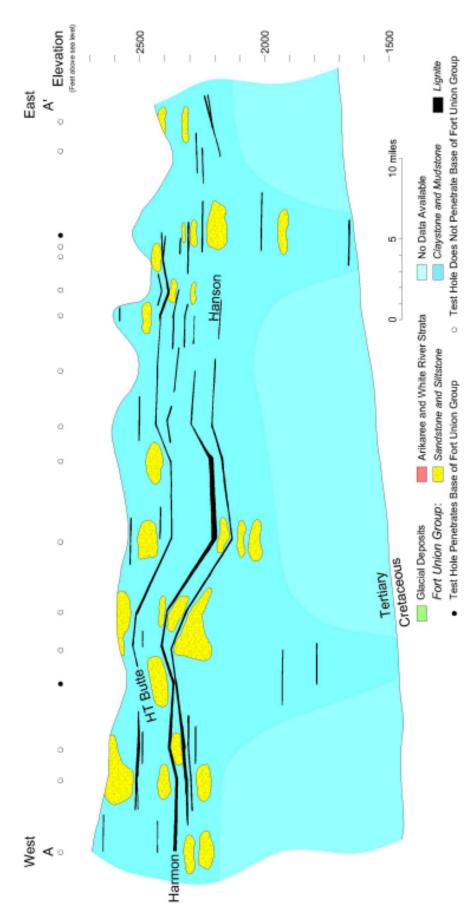


Figure 39. Cross-section A-A' through Hettinger County. The trace of this cross section is in Figure 38.

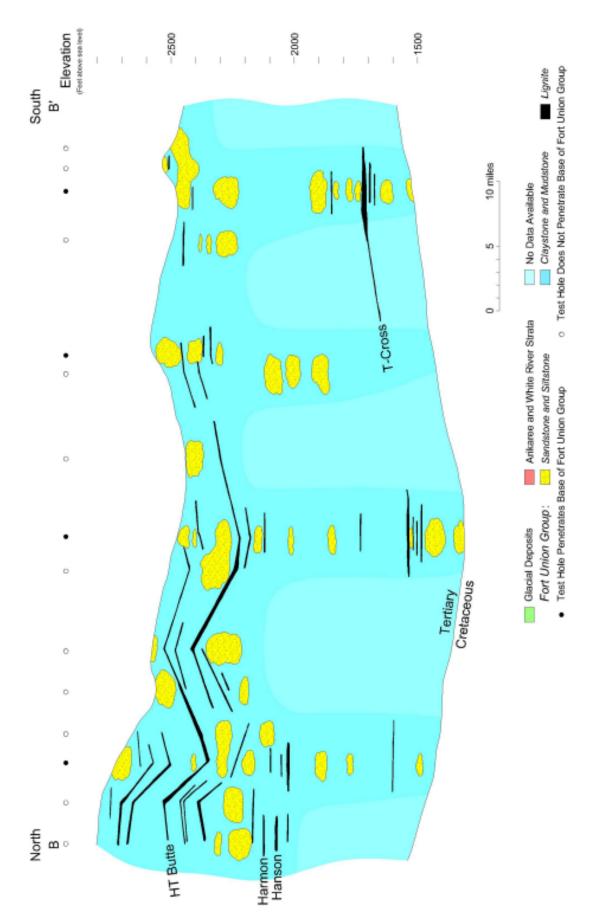


Figure 40. Cross-section B-B' through Hettinger County. The trace of this cross section is in Figure 38.

Table 12. Mineable Lignite Deposits in Hettinger County.

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
NEW ENGLAND NORTH DEPOSIT	T136N, R97W, secs 5-11, 13-17, 22, 23	13	7	2,560	33,280	58,240,000
NEW ENGLAND DEPOSIT	T135N, R97W, secs 2-5, 9, 10 T136N, R97W, secs 32-34	13	2	1,800	23,400	40,950,000
COAL BANK CREEK DEPOSITS	T135N, R96W, secs 9, 10, 15-34 T135N, R97W, secs 12, 13, 14, 23-26, 34-36 T134N, R97W, secs 1-12 T134N, R96W, secs 2-11, 16-18	10.5	1 to 2	19,520	204,960	358,680,000
TEPEE CREEK DEPOSIT	T134N, R95W, secs 18-19, 20, 30 T134N, R96W, secs 13, 24	10.5	7	1,300	13,650	23,887,500
ZION CHURCH DEPOSIT	T136N, R95W, secs 22, 23, 26, 27	12	2	450	5,400	9,450,000
THIRTY MILE CREEK DEPOSIT	T135N, R92W, secs 10, 14, 16, 22, 23	Π	-	1200	13,200	23,100,000
MEHRER CREEK DEPOSITS	T133N, R93W, secs N½ 23-26	Π	1	640	7,040	
	T133N, R93W, secs S½ 25, 26, 35, 36	36 14	2	320	4,480	
	T133N, R92W, secs 31-34 T132N, R92W, secs 5-8 T132N, R93W, secs 1, 2, 11, 12	18	7	3,000	$\frac{54,000}{65,520}$	114,660,000
BENTLEY DEPOSIT	T133N, R91W, secs 14, 15, 22, 23	11	2	550	6,050	10,587,500
TIMBER CREEK DEPOSIT	T132N, R94W, secs 13-15, 22-27 T132N, R93W, secs; 18-20, 29, 30	16	7	3000	48,000	84,000,000

Table 12. Mineable Lignite Deposits in Hettinger County (continued).

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
MERRILL DEPOSIT	T132N, R92W, secs 23-26	6	1	130	1,170	2,047,500
PILGERHEIM DEPOSIT	T132N, R91W, sec 26	10	2	160	1,600	
	T132N, R91W, sec 35	14	2	09	$\frac{840}{2,440}$	4,270,000
TOTAL TONS FOR HETTINGER COUNTY =	OUNTY =				730 MI	729,872,500 730 MILLION TONS

McHENRY COUNTY

Only about 5 million tons of mineable lignite is present in McHenry County (Figures 41-43, Table 13). The Fort Union Group is absent from the eastern and northern portions of the county. The Coteau bed is approximately 12 feet thick within the Bonnes Coulee deposit. The Velva mine extended into this area from Ward County. The mine was in existence from 1927 until the mid-1980s. It was first operated by Truax-Traer and later by the Consolidation Coal Corporation (Groenewold et al., 1983).

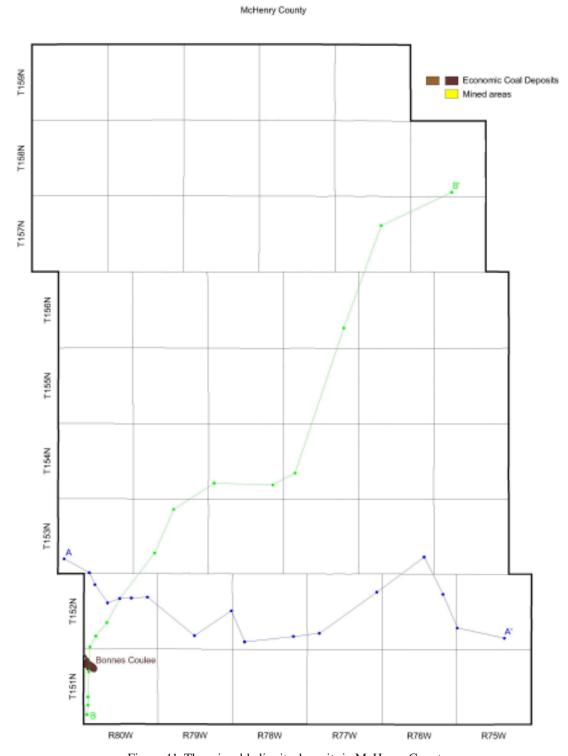


Figure 41. The mineable lignite deposits in McHenry County.

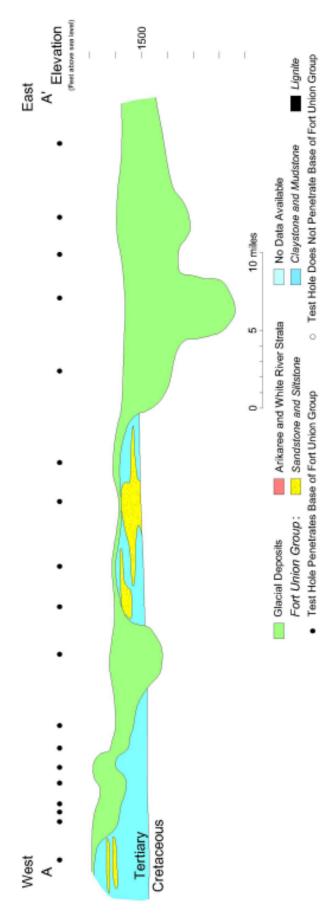


Figure 42. Cross-section A-A' through McHenry County. The trace of this cross section is in Figure 41.

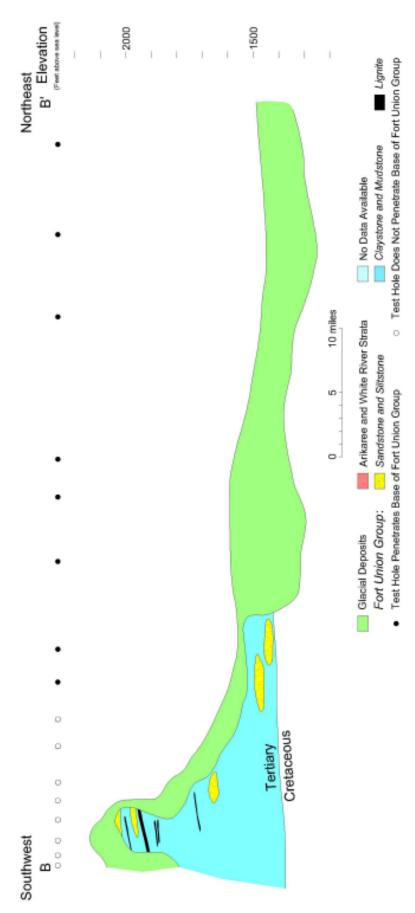


Figure 43. Cross-section B-B' through McHenry County. The trace of this cross section is in Figure 41.

Table 13. Mineable Lignite Deposits in McHenry County.

		Cullulative coal				
Deposit Name	Legal Description	thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
BONNES COULEE DEPOSIT	T151N, R80W, secs 6-8	12	1 (Coteau)	250	3,000	5,250,000
TOTAL TONS FOR MCHENRY COLLARY	= ALMIOD					SAMILLION

McKENZIE COUNTY

McKenzie County contains approximately 1.8 billion tons of mineable lignite (Figure 44, Table 14). Six deposits (Keene, Blue Buttes, Bowline Creek, Poker Jim Creek, and Prairie Dog Creek) contain more than 100 million tons of mineable lignite. Most of the economic deposits in this county consist of two coal beds with combined thicknesses that range from 10 to 20 feet. The axis of the north-trending Nesson anticline is readily apparent on figure 44 as reflected in the Tertiary/Cretaceous contact. Strata within the Bullion Creek and Sentinel Butte Formations can be seen dipping away from the axis of this anticline in this area. In general, McKenzie County has excellent deep, subsurface control due to the large number of oil wells that have been drilled in the area (Figures 45 and 46).

The Harmon bed reaches a maximum thickness of 53 feet in central McKenzie County, the thickest coal in North Dakota (Murphy and Goven, 1998). The Harmon bed is 400 to 800 feet beneath the surface in this area, too deep for surface mining, but a candidate for coalbed methane (Figures 45 and 46). The underlying Hanson bed is thin and discontinuous in this county. McKenzie County likely contains many old wagon mines that were active in the early 1900s. However, no large scale surface or underground mining has taken place in this county.

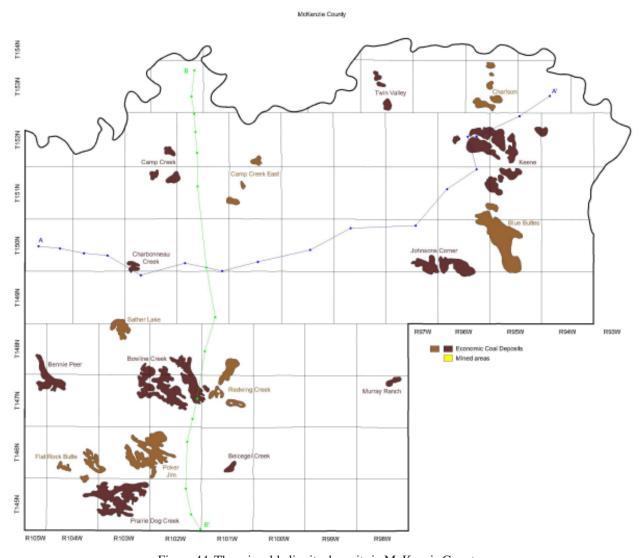


Figure 44. The mineable lignite deposits in McKenzie County.

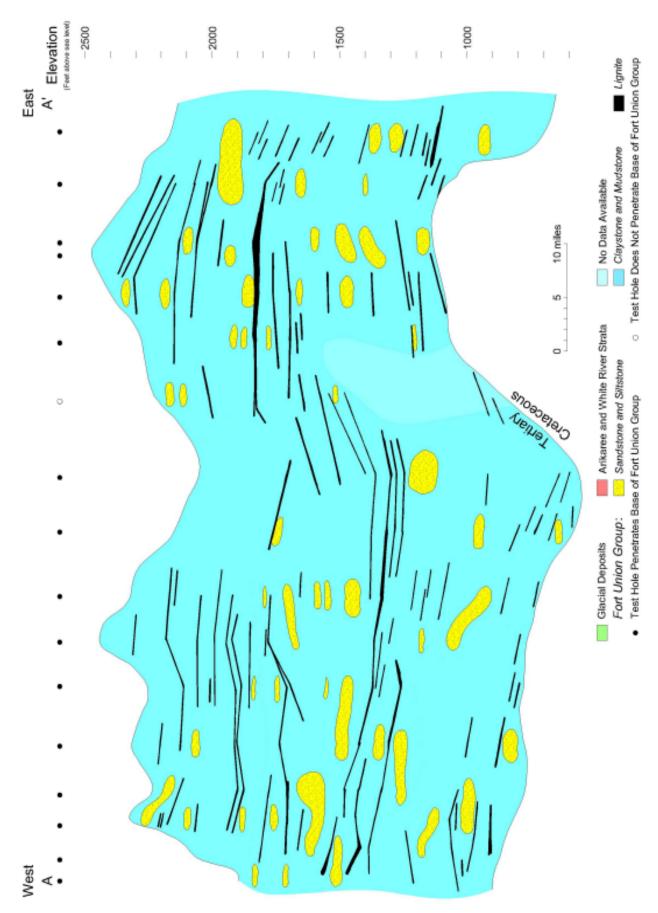


Figure 45. Cross-section A-A' through McKenzie County. The trace of this cross section is in Figure 44.

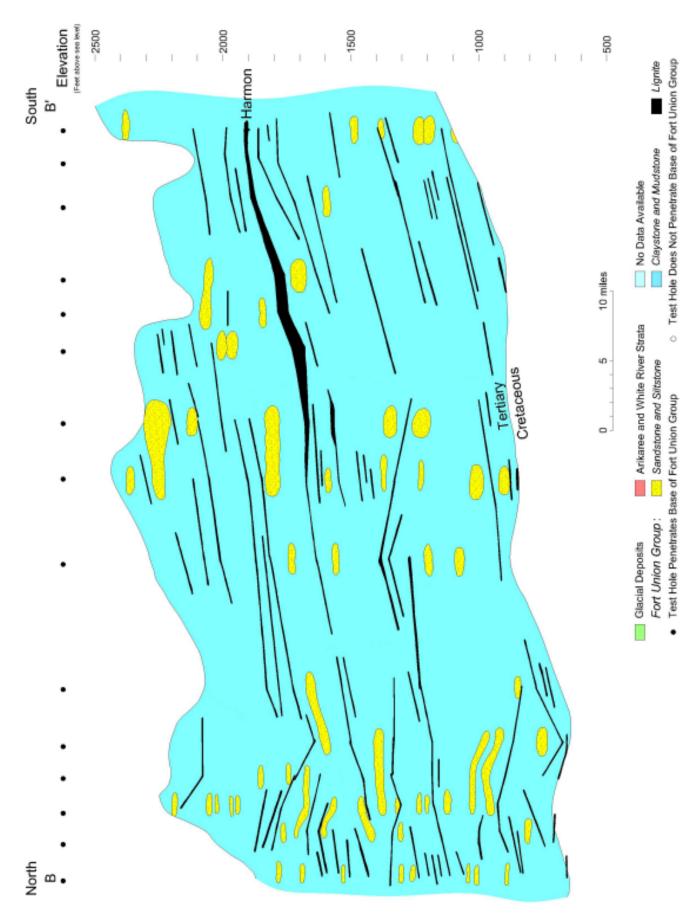


Figure 46. Cross-section B-B' through McKenzie County. The trace of this cross section is in Figure 44

Table 14. Mineable Lignite Deposits in McKenzie County.

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
TWIN VALLEY DEPOSITS	T153N, R97W, secs 4, 5, 8, 9	12	2	300	3,600	
	T153N, R97W, secs 15, 16	12	2	125	1,500	
	T153N, R97W, secs 27, 28, 33, 34	18	7	700	12,600 17,700	30,975,000
CHARLSON DEPOSITS	T153N, R95W, secs 3, 4	10	1	300	3,000	
	T153N, R95W, sec 10	13	2	75	975	
	T153N, R95W, secs 15, 16, 21, 22	11	2	400	4,400	
	T153N, R95W, secs 22, 23, 26, 27	13	2	700	9,100	
	T153N, R95W, secs 27-29, 32-34	17.5	2	1200	$\frac{21,000}{38,475}$	67,331,250
KEENE DEPOSITS	T152N, R95W, secs 12, 13 T152N, R94W, secs 7, 18	16	7	700	11,200	
	T152N, R95W, secs 7, 8, 17-20, 29 152N, R96W, 10-15	16	7	3,330	53,300	
	T152N, R95W, secs 16, 21, 22, 27-29, 33	13	2	1,600	20,800	
	T152N, R95W, secs 19, 29-32 T152N, R96W, secs 13-15, 22-27	15	7	3,000	45,000	
	T152N, R96W, secs 16, 17, 20, 21	19.5	2	250	4,875	
	T151N, R95W, secs 3-5, 8-10	10.5	2	1,475	15,488	
	T151N, R95W, sec 8	12.75	1	250	3,188	
	T151N, R95W, secs 7, 17-20 T151N, R96W, secs 12, 13	15	2	1,600	$\frac{24,000}{177,851}$	311,239,250

Table 14. Mineable Lignite Deposits in McKenzie County (continued).

Deposit Name	(Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
BLUE BUTTES DEPOSITS	T150N, R95W, secs 4-10, 15-21, 27-29, 32-34 T151N, R95W, secs 30, 31 T151N, R96W, secs 25, 35, 36 T150N, R96W, secs 1, 2, 12	13.3	24	6,880	131,404	229,957,000
JOHNSONS CORNER DEPOSITS	T150N, R96W, secs 27-35 T149N, R96W, secs; 2-4, 6	15.5	1	3,200	49,600	
	T150N, R97W, secs 25-27, 34-36 T149N, R97W, secs 1, 2	12	-	1,800	<u>21,600</u> 71,200	124,600,000
CAMP CREEK DEPOSITS	T152N, R102W, secs 23-26	10	2	009	6,000	
	T151N, R102W, secs 1, 11, 12 T151N, R101W, secs; 6, 7	15	7	840	12,600	
	T151N, R102W, secs 3, 4, 9, 10	10	2	200	$\frac{5,000}{23,600}$	41,300,000
CAMP CREEK EAST DEPOSITS	T152N, R100W, secs 27, 33, 34	17	2	700	11,900	
	T151N, R100W, secs 8, 17	12	2	160	1,920	
	T151N, R100W, secs 19, 20, 29, 30 T151N, R101W, secs 24, 25	14	2	009	$\frac{8.400}{22,220}$	38,885,000
CHARBONNEAU CREEK	T150N, R102W, secs 29-32 T149N, R102W, sec 6	13	1	700	9,100	15,925,000
SATHER LAKE DEPOSIT	T148N, R103W, secs 3-5, 9, 10 T149N, R103W, secs 35, 36	10	1	1,800	18,000	31,500,000
MURRAY RANCH DEPOSIT	T147N, R98W, secs 1-3, 10, 11	20	-	009	12,000	21,000,000

Table 14. Mineable Lignite Deposits in McKenzie County (continued).

Deposit Name	Cu Legal Description t	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
BOWLINE CREEK DEPOSIT	T147N, R102W, secs 1-18, 21-24 T147N, R101W, sec 7 T148N, R102W, secs 26-28, 31-35 T148N, R103W, secs 25, 36 T147N, R103W, secs 1, 2, 11-14	15.4	1 to 2	006,6	152,460	266,805,000
RED WING CREEK DEPOSITS	T148N, R101W, secs 26-28, 33, 34 T147N, R101W, secs 3, 4	21	2	1,760	36,960	
	T147N, R101W, secs 8, 9, 16-18	10	1	009	90009	
	T147N, R101W, secs 14, 15, 22, 23	11	1	350	$\frac{3.850}{46,810}$	81,917,500
BENNIE PEER CREEK DEPOSIT	T147N, R104W, secs 4-9 T148N, R105W, secs 23-25, 36 T147N, R105W, secs 1, 2, 11, 12	11.75	_	3000	35,250	61,687,500
FLAT ROCK BUTTE DEPOSIT	T146N, R104W, secs 28, 29, 33	15	2	009	000,6	
	T146N, R104W, secs 13, 14, 23-26, 36 T146N, R103W, secs 30, 31	15.5	-	1,600	24,800	
	T146N, R104W, secs 35 T145N, R104W, sec 2	19	2	300	$\frac{5.700}{39,500}$	69,125,000
POKER JIM CREEK DEPOSIT	T146N, R103W, secs 10-14, 15, 22-27					
	T146N, R102W, secs 5-8, 17-21,	13.8	1 to 2	7,600	104,880	183,540,000
BEICEGEL CREEK DEPOSIT	T146N, R101W, secs 27, 28	11	1	380	4,180	7,315,000
PRAIRIE DOG CREEK DEPOSIT	T145N, R103W, secs 1-12, 13-22, 27-30			ļ		
	T145N, R104W, secs 1, 11-14	14.5	1 to 2	7,000	101,500	177,625,000
TOTAL TONS FOR MCKENZIE COUNTY =	JUNTY =				1.8 BI	1,760,727,500 1.8 BILLION TONS

McLEAN COUNTY

McLean County contains approximately 1.5 billion tons of economically mineable lignite (Figures 47-49, Table 15). As noted on Table 15, we initially determined the county contained about 580 million tons of mineable lignite based upon non-confidential information in our files. Dennis James, Falkirk Mining Company, provided us with the outline of the economic coal and reserve estimates for the Underwood area (Underwood and Falkirk deposits). We did not revise the numbers for the Underwood deposit or show the data for the Falkirk deposit in order to protect the confidentiality of this information.

In addition to the Underwood and Falkirk deposits, the Garrison deposit contains more than 100 million tons of mineable lignite (277 million tons). This deposit contains a maximum of 12 feet of mineable coal, often as not in two beds (Figure 49). This site has been of some interest to companies due to its close proximity to Lake Sakakawea, a source of cooling water for a power plant (Morin, 1979). Deep well control is absent throughout much of McLean County (Figures 48 and 49).

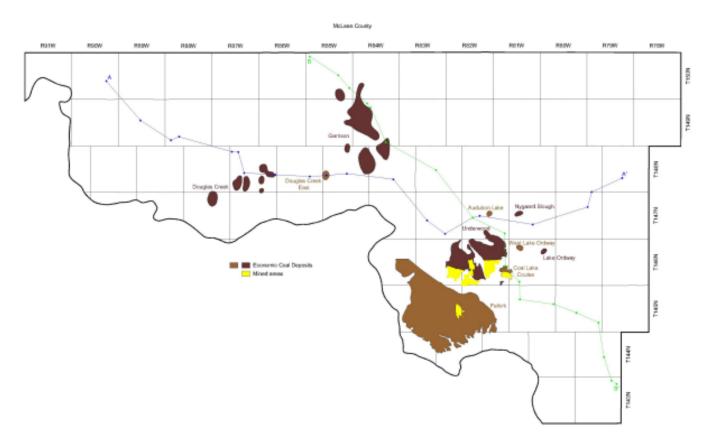


Figure 47. The mineable lignite deposits in McLean County.

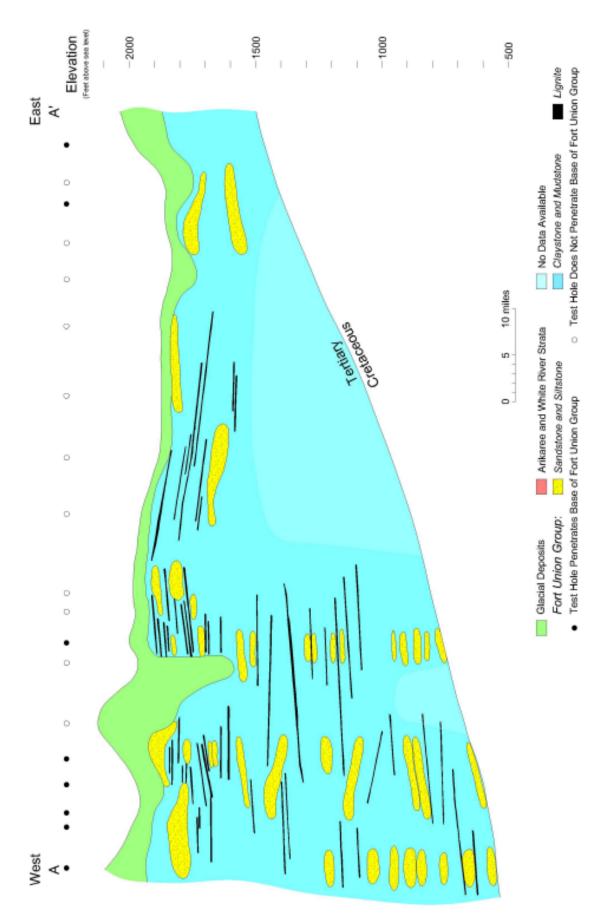


Figure 48. Cross-section A-A' through McLean County. The trace of this cross section is in Figure 47.

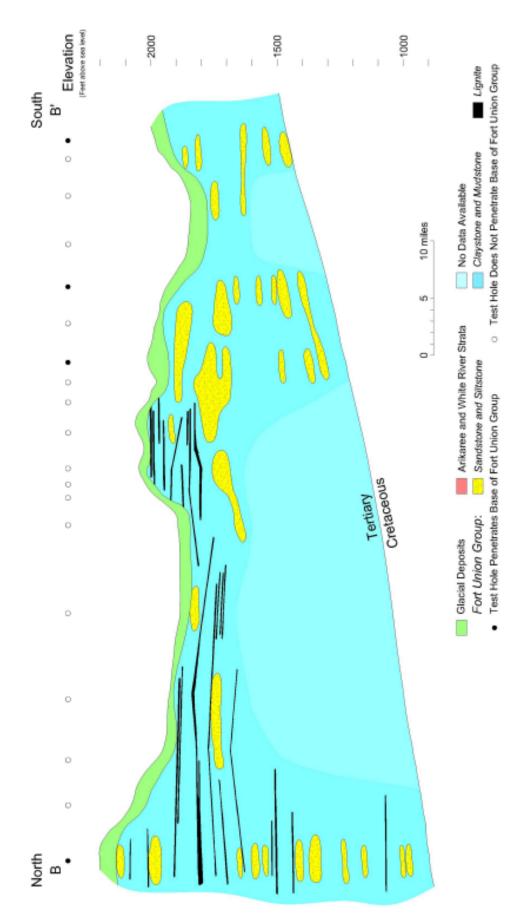


Figure 49. Cross-section B-B' through McLean County. The trace of this cross section is in Figure 47.

Table 15. Mineable Lignite Deposits in McLean County.

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
GARRISON DEPOSITS	T150N, R85W, secs 26, 27, 34, 35	12	2	009	7,200	
	T150N, R84W, secs 19, 20, 29-32	6	1	800	7,200	
	T149N, R85W, secs 1, 11-14, 24	10	1	1,580	15,800	
	T149N, R85W, secs 35, 36 T148N, R85W, sec 4	10	2	300	3,000	
	T149N, R84W, secs 4-9, 16-21, 28-30	12	2	6,400	76,800	
	T149N, R84W, secs 33-35 T148N, R84W, secs 4-6, 8, 9	11	2	1,580	17,380	
	T148N, R85W, secs 1, 2, 11-14, 23, 24	12	П	2,560	$\frac{30,720}{158,100}$	276,675,000
DOUGLAS CREEK EAST DEPOSIT	T148N, R85W, secs 19, 30 T148N, R86W, secs 24, 25	10	7	200	2,000	8,750,000
DOUGLAS CREEK DEPOSITS	T148N, R87W, secs 14, 15, 22-24	11	2	940	10,340	
	T148N, R87W, secs 22, 27	111	2	200	2,200	
	T148N, R87W, secs 20, 29, 32	111	2	700	7,700	
	T148N, R87W, secs 19, 30, 31 T148N, R88W, sec 25, 36	11	2	008	8,800	
	T148N, R87W, sec 34	9.5	2	200	1,900	
	T147N, R88W, secs 3, 4, 9, 10 T148N, R88W, secs 33, 34	6	1	700	$\frac{6.300}{27.740}$	000 001 33
COAL LAKE COULEE DEPOSIT	T146N, R82W, secs 14, 15, 22-27 T146N, R81W, secs 29-32	11.3	2 (Hagel+1)	4,160	47,008	82,264,000

Table 15. Mineable Lignite Deposits in McLean County (continued).

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
UNDERWOOD DEPOSITS	T146N, R82W, secs 28, 29, 32-34 T145N, R82W, secs 3-5	11.3	I (Hagel)	1,792	20,250	
	T146N, R82W, secs 30, 31 T146N, R83W, secs 25, 36	12.1	2 (Hagel + Travis Creek)	009	$\frac{7.260}{27,510}$	48,142,500
NYGAARD SLOUGH DEPOSIT	T147N, R81W, secs 16, 17, 20, 21	11	2	400	4,000	7,000,000
AUDUBON LAKE DEPOSIT	T147N, R82W, secs 14, 15, 22, 23	11.5	2	250	2,875	5,031,250
LAKE ORDWAY DEPOSIT	T146N, R81W, secs 11-14	12	2	300	3,600	6,300,000
WEST LAKE ORDWAY DEPOSIT	T146N, R82W, secs 8, 9	11	2	275	3,025	5,293,750
WEST UNDERWOOD DEPOSITS	T146N, R83W, sec 13, 14, 23, 24	14	2	250	3,500	
	T146N, R83W, secs 23, 26, 27	11.5	2	200	$\frac{2,300}{5,800}$	10,150,000
RIVERDALE SOUTH DEPOSITS	T146N, R83W, secs 19, 20 T146N, R83W, sec 32	Ξ	-	150	1,650	
	T145N, R83W, sec 5	10	1	100	1,000	
	T146N, R84W, secs 35, 36 T145N, R84W, secs 1, 2	10.5	1	008	$\frac{8,400}{11,050}$	19,337,500
BLACK DIAMOND MINE DEPOSIT	T144N, R83W, sec 1 T144N, R82W, sec 6	11	1	150	1,650	2,887,500

Table 15. Mineable Lignite Deposits in McLean County (continued).

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
FORT CLARK DEPOSITS	T144N, R83W, secs 10-12	10	2	200	5,000	
	T144N, R83W, secs 3, 4, 9, 10	14	7	300	4,200	
	T145N, R83W, sec 33 T144N, R83W, sec 6	Ξ	2	200	$\frac{5,500}{14,700}$	25,725,000
WELLER SLOUGH	T145N, R84W, secs 14, 15, 22, 23	10	2	150	1,500	
SOUTH DEPOSITS	T145N, R84W, secs 13, 24 T145N, R83W, secs 18, 19	10.5	2	550	5,775	
	T145N, R83W, sec 20	12	2	160	$\frac{1,920}{9,195}$	16,091,250
TOTAL TONS FOR MCLEAN COUNTY = TOTAL REVISED ESTIMATE =	UNTY =				1.5 B	*578,817,750 1.5 BILLION TONS

* The reserve estimates do not match the map limits of the economically mineable coal because the Falkirk Mining Company provided the Geological Survey with a map and reserve estimates additional information raises the county-wide strippable deposits to 1.5 billion tons, but we did not revise the site specific estimates in order to protect the confidential status of this information. As revised, the Falkirk deposit includes the following deposits listed on the table: Riverdale South, Black Diamond Mine, Fort Clark, and Weller Slough South. of the Underwood area. The proprietary data indicates there is significantly more strippable coal reserves in the Underwood area then our public (non-confidential) records indicate. This

MERCER COUNTY

Mercer County contains approximately 1.3 billion tons of economically mineable lignite (Figure 50, Table 16). Several deposits exceed 100 million tons of mineable coal (Beulah Trench West, 311 million; Beulah Trench East, 176 million; Renner Trench East, 138 million; and Coyote Creek, 195 million). The Beulah or Beulah-Zap bed is the major coal in this area (Figures 51 and 52). The Coteau Properties Company mines the Beulah-Zap bed at the Freedom Mine. The Freedom Mine encompasses portions of the Beulah Trench East, Beulah Trench West, Renner Trench East, and Truax North deposits. The Beulah bed is also being mined within the Brush Creek North and South deposits by Dakota Westmoreland at the Beulah Mine (Figure 50). The Beulah-Zap has an average thickness of 18 feet in the Beulah Trench East and West deposits and is the thickest coal in the county (Figures 51 and 52). It accounts for more than half of the mineable coal in the county. Groenewold and others (1979), conducted a detailed study of the Knife River Basin which includes Mercer County (Table 16).

Table 16. The Major Coals in Central Mercer County in descending order (after Groenewold, 1979).

SENTINEL BUTTE FORMATION

Harnisch

Twin Buttes

Schoolhouse

Beulah-Zap

Spaer

Jim Creek

Antelope Creek

Kinneman Creek

Hagel

BULLION CREEK FORMATION

Tavis Creek Coal Lake Coulee Weller Slough

Beulah became an important mining center in the early 1900s, first by underground methods and later by surface methods. A number of large mines have operated in this county; including the Indian Head mine that operated from 1922 to the mid-1980s (Figure 50). Currently, two-thirds of North Dakota's coal production is coming from this county. The Freedom mine, which supplies coal to both the Antelope Valley powerplant and Basin Electric's gasification plant, mines approximately 16 million tons of coal per year, slightly more than half of North Dakota's annual production. Approximately three million tons is mined annually at the Beulah Mine.

Mercer County T147N В Tschae Kofske Beaver Creek Beulah Trench East T146N Renner Trench East Truax North Beaver Cree South Coal Creek North Beulah Trench West T145N Knife River Northwest Zap Antelope Creek Glenharold Golden Valley T144N Beulah Trench South Indian Head Kinneman Creek R87W R86W R85W R84W T143N Economic Coal Deposits Brush Creek North Mined areas Coyote Creek North Creek South Brush Creek SE T142N Coyote Creek T141N Coyote Creek South Elm Creek South R90W R89W R88W

Figure 50. The mineable lignite deposits in Mercer County.

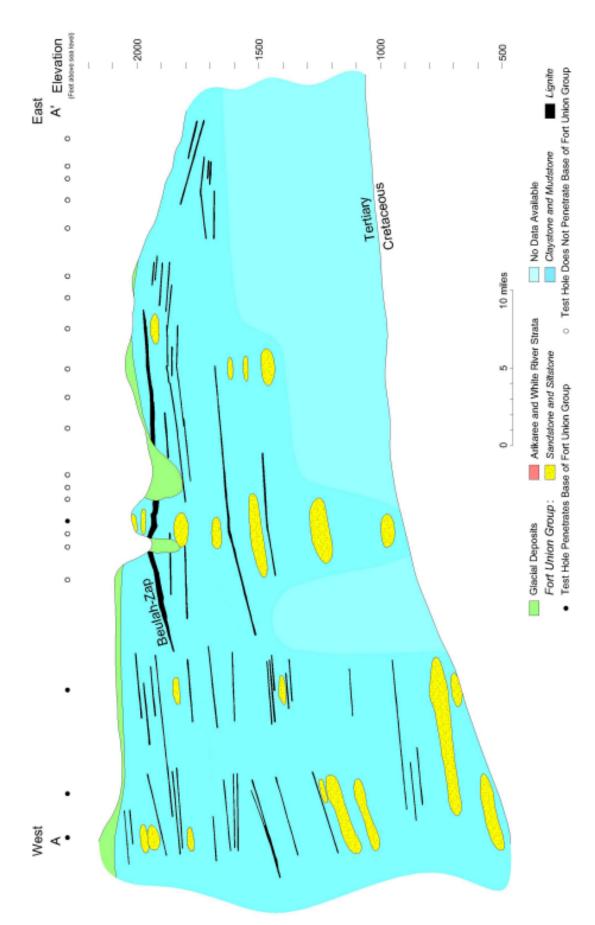


Figure 51. Cross-section A-A' through Mercer County. The trace of this cross section is in Figure 50.

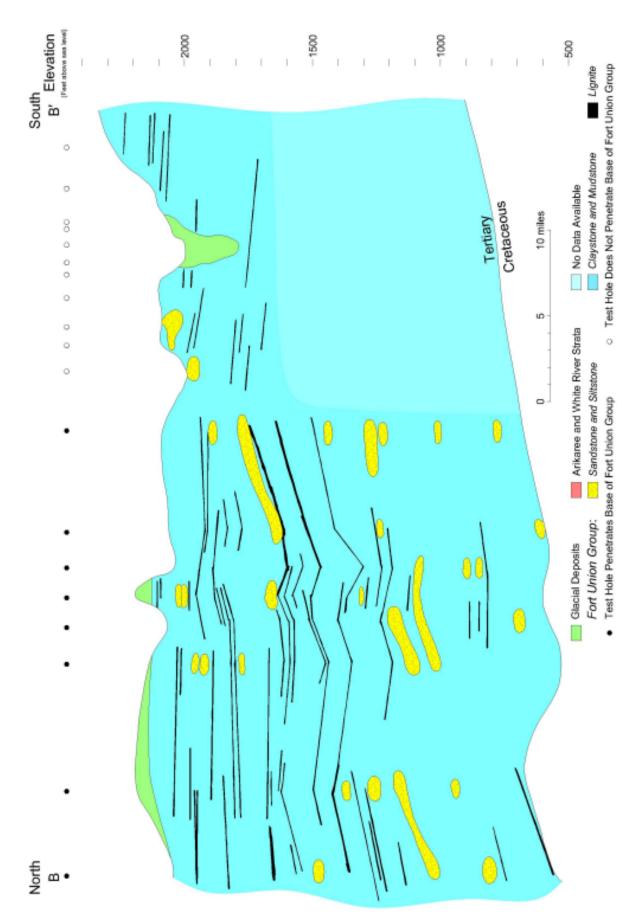


Figure 52. Cross-section B-B' through Mercer County. The trace of this cross section is in Figure 50.

Table 17. Mineable Lignite Deposits in Mercer County.

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
BEAVER CREEK DEPOSIT	T146N, R89W, secs 10-15, 23, 24 T146N, R88W, secs 18, 19	13	2	1,140	14,820	
	T146N, R88W, sec 17	17	-	25	$\frac{425}{15,245}$	26,678,750
BEAVER CREEK SOUTH DEPOSITS	T146N, R88W, secs 30, 31 T146N, R89W, secs 25, 26	18	-	160	2,880	
	T145N, R88W, sec 6 T146N, R88W, sec 31 T146N, R89W, sec 36 T145N, R89W, sec 1	16.5	-	450	$\frac{7.425}{10,305}$	18,033,750
BEULAH TRENCH WEST	T146N, R88W, secs 20, 21, 28-33 T145N, R88W, secs 3-5, 9-11, 13-16, 21-23, 25-28, 33-36 T145N, R87W, secs 30-32 T144N, R88W, secs 2-8 T144N, R89W, secs 1, 2, 11, 12	5,	1 (Beulah-Zap)	9,920	177,568	310,744,000
NORTHWEST ZAP DEPOSIT	T145N, R88W, secs 31, 32 T144N, R89W, secs 2, 3	19	61	300	5,700	
	T144N, R89W, secs 4-6 T145N, R89W, secs 34-36	10.5	7	600	$\frac{6.300}{21,000,000}$	
BEULAH TRENCH EAST	T146N, R88W, secs 8-10, 14-16, 21-27, 34-36 T146N, R87W, secs 19, 30, 31 T145N, R87W, secs 17, 20, 21, 28-30	80 18.3	1 to 2 (Beulah-Zap +)	5,500	100,650	176,137,500
ANTELOPE CREEK DEPOSITS	T145N, R87W, secs 21, 22	14.5	1 to 2	290	4,205	
	T145N, R87W, secs 27, 28	19.5	1	80	1,560	

Table 17. Mineable Lignite Deposits in Mercer County (continued).

		Cumulative coal				
Deposit Name	Legal Description	thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
	T145N, R87W, secs 33, 34	16	1 to 2	160	2,560	
	T145N, R87W, secs 26, 27	10	1 to 2	40	400	
	T145N, R87W, secs 25-27, 34-36	10.8	1 to 2	550	$\frac{5,940}{14,665}$	25,663,750
RENNER TRENCH EAST DEPOSIT	T146N, R87W, secs 15, 16, 20-22, 25-28, 33-36 T145N, R87W, secs 1-3, 10-15 T145N, R86W, secs 6, 7	15.5	1 to 2	5,100	79,050	138,337,500
TRUAX NORTH DEPOSIT	T146N, R86W, secs 27, 34 T146N, R86W, secs 32-34	11.5	1	160	1,840	
	T145N, R86W, secs 3-5 T146N, R86W, secs 32	11.5	_	008	9,200	
	T145N, R86W, secs 4, 5, 7-9, 18, 20	12	-	750	<u>9,000</u> 20,040	35,070,000
COAL CREEK NORTH DEPOSITS	T145N, R86W, secs 2, 3 T146N, R86W, sec 35	11.4	2	640	7,296	
	T146N, R86W, secs 25, 36	10.5	2	80	840	
	T146N, R86W, sec 26	10.5	2	09	630	
	T145N, R86W, secs 11, 14	Ξ	2	350	3.85 <u>0</u> 12,616	22,078,000
TSCHAEKOFSKE CEMETERY DEPOSIT	T146N, R85W, secs 7-9, 16-18	13.3	2	089	9,044	15,827,000

Table 17. Mineable Lignite Deposits in Mercer County (continued).

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
BEULAH TRENCH SOUTH DEPOSIT	T144N, R88W, secs 9-11, 14-17, 21, 22	15.7	2	1,200	18,840	32,970,000
KNIFE RIVER DEPOSITS	T145N, R85W, secs 24, 25	25	2	300	7,500	
	T145N, R84W, secs 20, 21	10	2	160	1,600 9,100	15,925,000
GLENHAROLD DEPOSITS	T144N, R85W, sec 6	12	2	50	009	
	T144N, R85W, secs 15, 21, 22	14	2	140	1,960	
	T144N, R85W, sec 24	12	2	250	3,000	
	T144N, R84W, secs 29-33 T144N, R85W, secs 25, 36	12	7	009	$\frac{7.200}{12,760}$	22,330,000
KINNEMAN CREEK DEPOSITS	T144N, R85W, secs 33-35	12.5	2	800	10,000	
	T144N, R85W, secs 30-32	14	2	089	<u>9,520</u> 19,520	34,160,000
INDIAN HEAD DEPOSIT	T144N, R89W, secs 24-26, 34-36 T143N, R89W, secs 1-3	=	2	099	7,260	12,705,000
GOLDEN VALLEY DEPOSIT	T144N, R90W, secs 16, 17	11	2	140	1,540	2,695,000
BRUSH CREEK NORTH DEPOSIT	T143N, R88W, secs 13, 24	16.2	2	580	962'6	16,443,000
BRUSH CREEK SOUTH DEPOSIT	T143N, R88W, secs 15-22, 26-33 T142N, R88W, secs 5-8	12.3	1 to 2	4,160	51,680	90,440,000

Table 17. Mineable Lignite Deposits in Mercer County (continued).

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
COYOTE CREEK NORTH DEPOSIT	T143N, R89W, secs 23-26 T143N, R88W, secs 19, 30	10	-	059	6,500	
	T143N, R89W, secs 25, 36	12	1	180	2,160	
	T143N, R89W, secs 26, 35	12	-	120	$\frac{1.440}{10,100}$	17,675,000
MUD CREEK DEPOSIT	T142N, R89W, secs 4, 5, 8, 9	12.5	2	200	6,250	10,937,500
COYOTE CREEK DEPOSIT	T142N, R88W, secs 15-17, 20-28, 30-36 T141N, R88W, secs 1-6 T141N, R89W, sec 1 T142N, R89W, sec 36	13.4	2	8,300	111,220	194,635,000
COYOTE CREEK SOUTH DEPOSIT	T141N, R88W, secs 7, 8, 17, 18	17	2	450	7,650	13,387,500
ELM CREEK DEPOSITS	T141N, R89W, secs 2, 3, 10, 11	13	2	640	8,320	
	T141N, R89W, sec 24 T141N, R88W, secs 19, 30	12.5	2	06	1,125	
	T142N, R89W, secs 31, 32	10	1	50	500	
	T142N, R89W, secs 28, 29, 32, 33	10	2	30	300	
	T142N, R89W, sec 33	10	2	40	400	
	T142N, R90W, sec 24	10	7	80	800	
	T142N, R89W, secs 17, 20	11	2	09	<u>660</u> 2,660	4,655,000

Table 17. Mineable Lignite Deposits in Mercer County (continued).

		Cumulauvecoal				
Deposit Name	Legal Description	thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
BRUSH CREEK SOUTHEAST DEPOSIT	T142N, R88W, secs 1, 12	11.5	7	250	2,875	5,031,250
ELM CREEK SOUTH DEPOSIT	T141N, R89W, secs 35, 36	12.5	1 to 2	180	2,250	3,937,500
TOTAL TONS FOR MERCER COUNTY =	UNTY =				1.3 B	1,267,497,000 1.3 BILLION TONS

MORTON COUNTY

Morton County contains approximately 590 million tons of economically mineable lignite (Figure 53, Table 18). Coal-bearing rocks of the Fort Union Group are absent along the southeastern edge of the county (Figures 54 and 55). As mapped, the Heart Butte Creek North deposit was the only one that exceeded 100 million tons in the county (210 million). The Sweet Briar deposit was close at 90 million tons. The northwestward dip of strata towards the center of the Williston Basin near Watford City is very pronounced in both cross sections (Figures 54 and 55).

Several small surface and underground coal mines have operated in Morton County. The first coal mine in North Dakota began operation at Sims in the 1870s. Early mining was primarily by underground methods, other underground mines operated near New Salem. According to the North Dakota Public Service Commission, there are 71 listings for abandoned mine sites in this county.

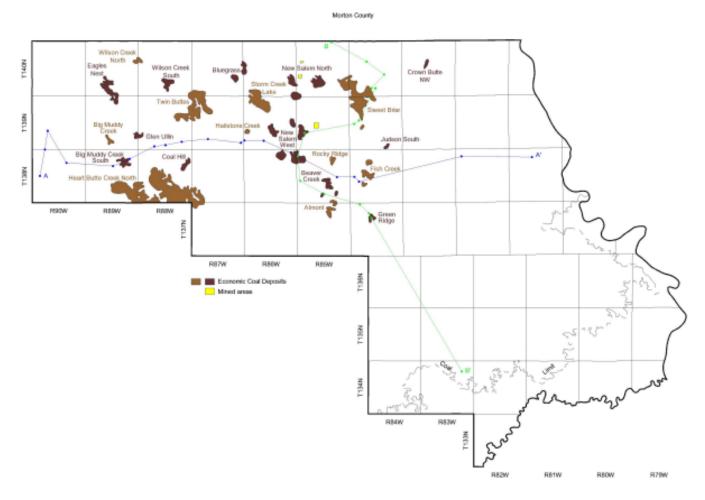


Figure 53. The mineable lignite deposits in Morton County.

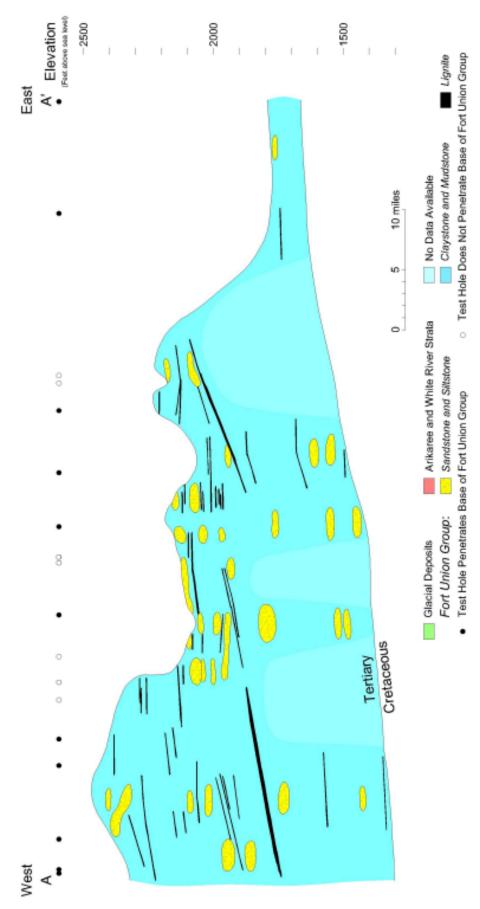


Figure 54. Cross-section A-A' through Morton County. The trace of this cross section is in Figure 53.

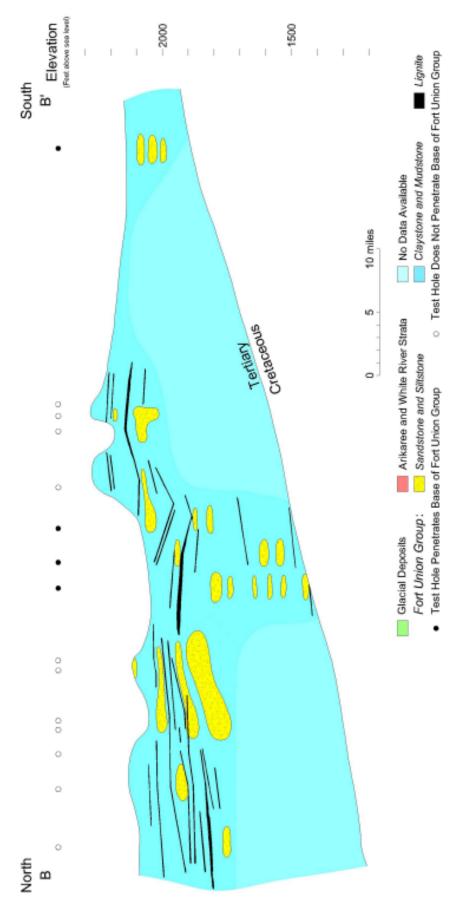


Figure 55. Cross-section B-B' through Morton County. The trace of this cross section is in Figure 53.

Table 18. Mineable Lignite Deposits in Morton County.

Deposit Name	C Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
TWIN BUTTES DEPOSIT	T139N, R87W, secs 5-9, 17, 18 T140N, R87W, secs 31, 32 T140N, R88W, secs 36 T139N, R88W, secs 1, 12-14	10.5	2	3,200	33,600	58,800,000
WILSON CREEK NORTH DEPOSIT	T140N, R88W, secs 7, 18 T140N, R89W, secs 12, 13	10	2	160	1,600	2,800,000
WILSON CREEK SOUTH DEPOSIT	T140N, R88W, secs 27, 28, 33, 34	10	2	480	4,800	8,400,000
EAGLES NEST DEPOSIT	T140N, R89W, secs 21, 27-29, 33, 34 T139N, R89W, secs 3, 4	13	7	1,100	14,300	25,025,000
BIG MUDDY CREEK DEPOSIT	T139N, R89W, secs 28, 33, 34	12	2	250	3,000	5,250,000
BIG MUDDY CREEK SOUTH DEPOSIT	T138N, R89W, secs 10-12	10	1	009	000'9	10,500,000
GLEN ULLIN DEPOSIT	T139N, R89W, sec 25 T139N, R88W, sec 30	10	2	200	2,000	3,500,000
HEART BUTTE CREEK DEPOSITS (NORTH)	T138N, R88W, secs 15-17, 19-22, 25-36 T138N, R89W, secs 22-28, 35, 36 T138N, R87W, secs 30-32 T137N, R87W, secs 5, 6	12	7	006,6	118,000	207,900,000
COAL HILL DEPOSIT	T138N, R88W, secs 1, 12-14	12	2	250	3,000	5,250,000
BLUEGRASS DEPOSITS	T140N, R87W, secs 13, 23-26 T140N, R86W, secs 18, 19	12	2	008	009,6	16,800,000

Table 18. Mineable Lignite Deposits in Morton County (continued).

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
STORM CREEK LAKE DEPOSIT	T140N, R86W, secs 31-33 T139N, R86W, secs 4-6, 8-10	11.25	2	1,800	20,250	35,437,500
NEW SALEM NORTH DEPOSIT	T140N, R85W, secs 21, 27-29	14	2	700	6,800	
	T140N, R86W, secs 23-25	10	2	009	6,000	
	T140N, R86W, sec 36 T140N, R85W, sec 31 T139N, R85W, sec 6 T139N, R86W, sec 1	16	2	300	4.800 20,600	36,050,000
HAILSTONE CREEK DEPOSIT	T139N, R86W, secs 19, 30	18	2	100	1,800	3,150,000
NEW SALEM WEST DEPOSITS	T139N, R86W, secs 21, 22, 27	12	1	300	3,600	
	T139N, R86W, secs 13, 24 T139N, R85W, secs 19, 20, 29, 30	13	2	800	10,400	
	T138N, R86W, secs 2, 3	10	1	200	5,000	
	T138N, R85W, secs 6, 7 T138N, R86W, secs 1, 12	13	2	700	$\frac{9.100}{28,100}$	49,175,000
SWEET BRIAR DEPOSIT	T140N, R84W, secs 19, 28, 30-33 T140N, R85W, secs 24-26, 36 T139N, R84W, secs 4-9, 17, 20 T139N, R85W, sec 1	11.5	1 to 2	4,480	51,520	90,160,000
JUDSON SOUTH DEPOSIT	T139N, R84W, secs 34, 35	12	2	130	1,560	2,730,000

Table 18. Mineable Lignite Deposits in Morton County (continued).

		Cumulative coal				
Deposit Name	Legal Description	thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
CROWN BUTTE NW DEPOSIT	T140N, R83W, secs 9, 16	10	2	06	006	1,575,000
ROCKY RIDGE DEPOSIT	T138N, R85W, secs 2, 3, 10, 11	10.5	2	06	945	1,653,750
BEAVER CREEK DEPOSITS	T138N, R85W, secs 21, 22, 26, 27	10.5	1 to 2	360	3,780	
	T138N, R85W, secs 28, 33	12	2	40	480	
	T138N, R85W, secs 26, 35	10	1	09	<u>600</u> 4,860	8,505,000
ALMONT DEPOSIT	T137N, R85W, secs 2, 3, 10 T138N, R85W, secs 34, 35	11	7	480	5,280	9,240,000
FISH CREEK DEPOSITS	T138N, R84W, secs 8, 9	12	2	06	1,080	
	T138N, R84W, secs 16, 17, 20, 21	10	2	340	3,400	
	T138N, R84W, secs 20, 21	Ξ	2	80	$\frac{880}{5,360}$	9,380,000
GREEN RIDGE DEPOSIT	T137N, R84W, secs 9, 16	10.75	7	160	1,720	3,010,000
TOTAL TONS FOR MORTON COUNTY =	UNTY =				S90 M	594,291,250 590 MILLION TONS

MOUNTRAIL COUNTY

Mountrail County contains approximately 220 million tons of mineable lignite (Figure 56, Table 19). The Shell Creek deposits contain 64 million tons, more coal than any other deposit in the county. Adequate subsurface control (one well every three miles) across six townships enables the stratigraphic relationships between sandstone, mudstone, and lignite in the Fort Union Group to be displayed across portions of the cross sections in this county (Figures 57 and 58). The eastern flank of the Nesson Anticline is reflected in the Tertiary/ Cretaceous contact in western Mountrail County (Figure 57).

Large-scale coal mining has never taken place in Mountrail County. However, a number of small, abandoned coal mines are scattered across the area, especially in the north-central portion of the county.

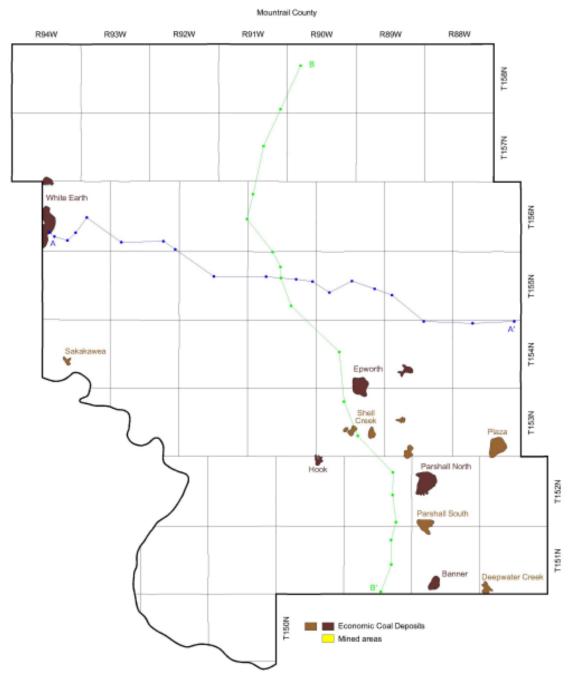


Figure 56. The mineable lignite deposits in Mountrail County.

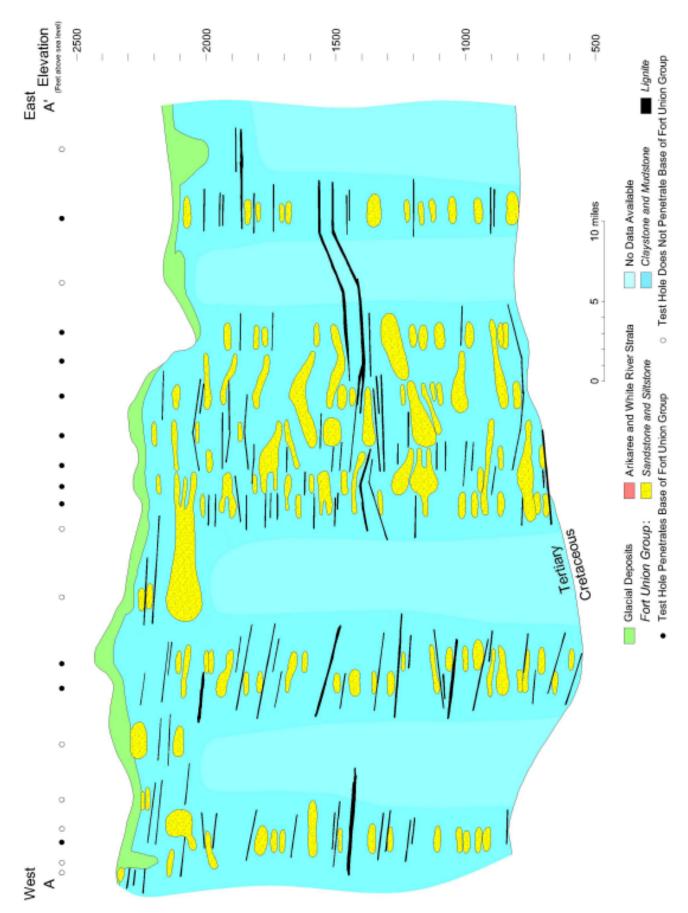


Figure 57. Cross-section A-A' through Mountrail County. The trace of this cross section is in Figure 56.

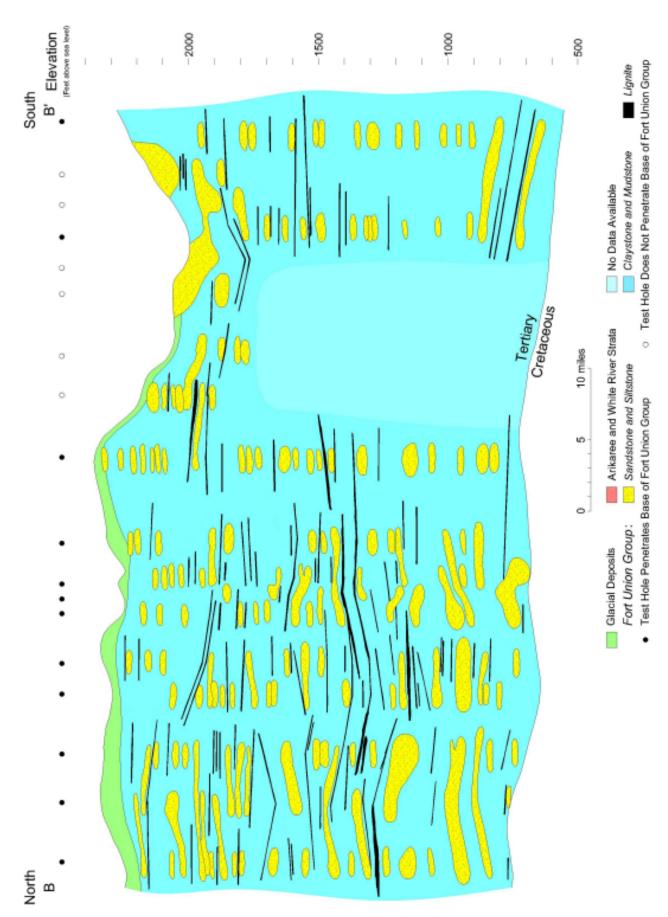


Figure 58. Cross-section B-B' through Mountrail County. The trace of this cross section is in Figure 56.

Table 19. Mineable Lignite Deposits in Mountrail County.

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
WHITE EARTH DEPOSIT	T156N, R94W, secs 18-20, 30, 31	12	2	1,440	17,280	
	T156N, R94W, sec 6 T157N, R94W, secs 33, 34	10.5	7	180	<u>1.890</u> 19,170	33,547,500
SAKAKAWEA DEPOSIT	T154N, R94W, secs 20, 21	12	2	140	1,680	2,940,000
EPWORTH DEPOSIT	T154N, R89W, secs 20, 28, 29	10	2	250	2,500	
	T154N, R90W, secs 34, 35 T153N, R90W, secs 2, 3	41	-	006	<u>12.600</u> 15,100	26,425,000
SHELL CREEK DEPOSITS	T153N, R89W, secs 17, 18	10	2	120	1,120	
	T153N, R89W, secs 32, 33 T152N, R90W, sec 1	10.5	2	300	31,500	
	T153N, R90W, sec 21	11	1 to 2	40	440	
	T153N, R90W, secs 21, 22, 27, 28	12.5	2	150	1,875	
	T153N, R90W, secs 23-26	10	1	170	$\frac{1.700}{36,635}$	64,111,250
HOOK DEPOSIT	T152N, R91W, secs 2, 3 T153N, R90W, sec 31 T153N, R91W, sec 36	10	0	140	1,400	2,450,000
PLAZA DEPOSIT	T153N, R88W, secs 26, 27, 34, 35 T152N, R88W, secs 5, 6	12		086	11,760	20,580,000
PARSHALL NORTH DEPOSIT	T152N, R89W, secs 7-9, 16-20	11	2	1,700	18,700	32,725,000

Table 19. Mineable Lignite Deposits in Mountrail County (continued).

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
PARSHALL SOUTH DEPOSIT	T152N, R89W, secs 31, 32 T151N, R89W, secs 5, 6	13	2	700	9,100	15,925,000
DEEPWATER CREEK DEPOSITS	T151N, R88W, secs 30-32	10	2	250	2,500	4,375,000
BANNER DEPOSIT	T151N, R89W, secs 28, 29, 32, 33	18	2	480	8,640	15,120,000
TOTAL TONS FOR MOUNTRAIL COUNTY =	COUNTY =				M 000	218,198,750

OLIVER COUNTY

There are approximately 1.1 billion tons of mineable coal in Oliver County (Figure 59, Table 20). Several deposits contain more than 100 million tons of coal; Center (300 million), Square Butte Creek (247 million), Center Northeast (141 million), and Fort Clark (109 million). The Kinneman Creek and Hagel (A and B) coal beds extend throughout much of the central portion of the county (Figures 60 and 61). Fort Union strata is 700 to 1,200 feet thick in this county. Unfortunately, there is little to no subsurface control beyond a depth of about 400 feet in this area. A detailed study of western Oliver County, involving numerous cross sections through the upper and middle portions of the Fort Union, was undertaken by Groenewold and others (1979).

The Center Mine, operated by BNI Coal, Ltd., was established in 1970. In this mine, the Kinneman Creek (5 feet thick) and Hagel (10 feet thick) beds are the target beds and annual production is approximately 4.5 million tons.

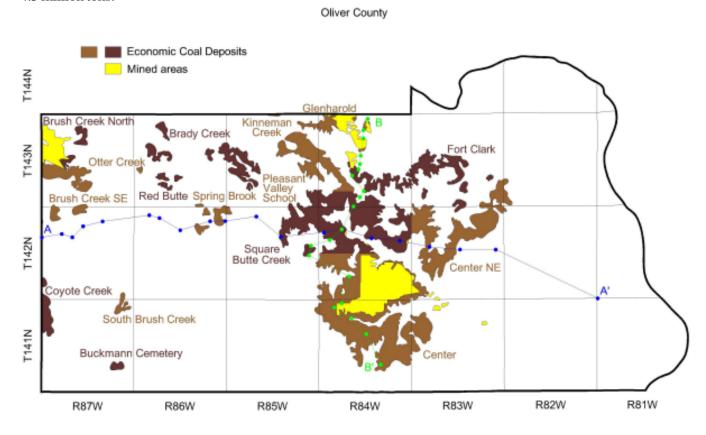


Figure 59. The mineable lignite deposits in Oliver County.

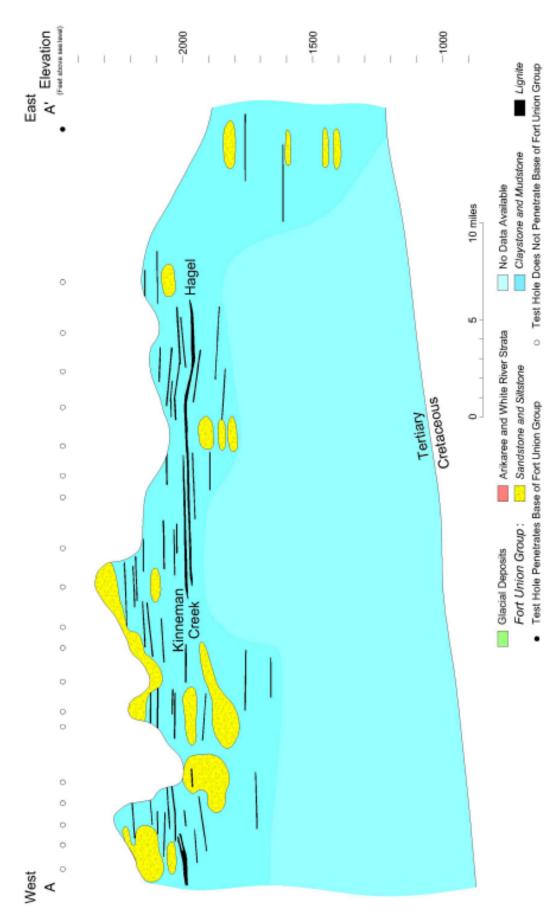


Figure 60. Cross-section A-A' through Oliver County. The trace of this cross section is in Figure 59.

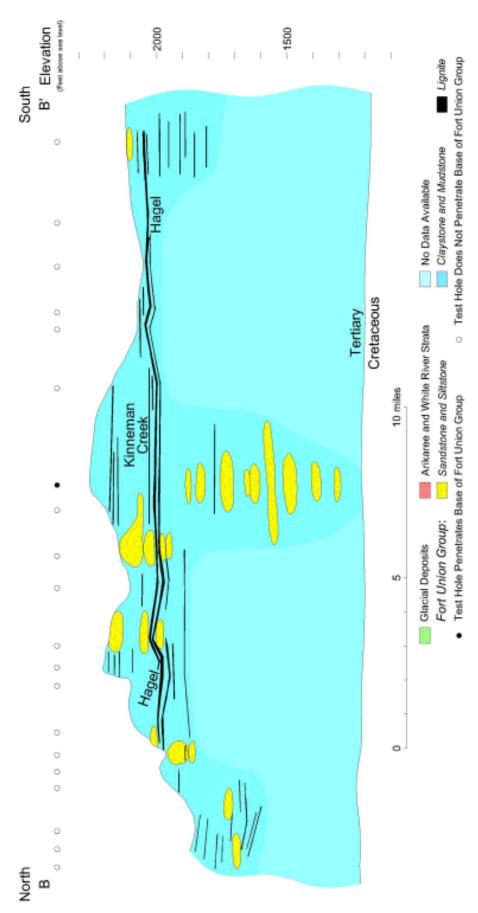


Figure 61. Cross-section B-B' through Oliver County. The trace of this cross section is in Figure 59.

Table 20. Mineable Lignite Deposits in Oliver County.

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
BRUSH CREEK NORTH DEPOSITS	T143N, R87W, secs 4, 9	10.5	2		300	3,150
	T143N, R87W, secs 16, 17, 19-22, 27-30	16.9	2 (Beulah + Zap)	1,850	$\frac{31,265}{34,415}$	60,226,250
BRUSH CREEK SOUTHEAST DEPOSITS	T142N, R87W, secs 4, 7 T143N, R87W, secs 31, 33, 34	15	2	009	000,6	15,750,000
OTTER CREEK DEPOSIT	T143N, R86W, sec 19	10	2	100	1,000	1,750,000
COYOTE CREEK DEPOSIT	T141N, R87W, secs 6, 7, 18 T142N, R87W, secs 30, 31	14.5	2	1,100	15,950	27,912,500
SOUTH BRUSH CREEK DEPOSIT	T141N, R87W, secs 1, 2 T142N, R87W, sec 36	11	2	250	2,750	4,812,500
BUCHMANN CEMETERY DEPOSIT T141N, R87W, secs 25, 26	T141N, R87W, secs 25, 26	10	2	160	1,600	2,800,000
BRADY CREEK DEPOSITS	T143N, R86W, secs 4, 5, 8, 9	11	2	200	2,200	
	T143N, R86W, secs 7, 8, 16-18, 20, 21	10.5	2	200	5,250	
	T143N, R85W, secs 17-21, 28-30 T143N, R86W, secs 12-14	11.9	2	1,800	$\frac{21,420}{28,870}$	50,522,500
RED BUTTE DEPOSITS	T143N, R86W, secs 20-22, 27-29	11	2	350	3,850	6,737,500
SPRING BROOK CEMETERY DEPOSITS	T142N, R86W, secs 1, 2, 11 T143N, R86W, sec 35 T142N, R85W, sec 6	10.5	2	750	7,875	13,781,250

Table 20. Mineable Lignite Deposits in Oliver County (continued).

Deposit Name	C ₁ Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
KINNEMAN CREEK DEPOSITS	T143N, R84W, secs 5, 6 T143N, R85W, secs 1, 2	14.5	2	750	10,875	19,031,250
GLENHAROLD DEPOSITS	T143N, R84W, secs 3, 4, 9, 10, 15, 16, 20, 21	10	1 to 2	50	500	875,000
FORT CLARK DEPOSITS	T143N, R83W, secs 15-22, 24-31 33, 34 T142N, R83W, secs 3, 4 T143N, R84W, secs 20-28, 34, 35	12.5	1 to 2	5,000	62,500	109,375,000
CENTER NE DEPOSITS	T142N, R83W, secs 1-12, 14-21, 28-30 T143N, R82W, secs 30, 31 T142N, R82W, sec 6	13.4	2	6,000	80,400	140,700,000
PLEASANT VALLEY SCHOOL DEPOSIT	T143N, R85W, secs 10-15, 23-25 T143N, R84W, secs 18-20, 28-30	12.4	2	3,000	37,200	65,100,000
SQUARE BUTTE CREEK DEPOSITS	T142N, R84W, secs 1-18 T143N, R85W, secs 25, 36 T142N, R85W, secs 1-3, 10-13, 15 T143N, R84W, secs 31-35	14.1	2	10,000	141,000	246,750,000
CENTER DEPOSIT	T142N, R84W, secs 19-25, 27-36 T142N, R83W, secs 30-32 T141N, R84W, secs 1-17, 21-28 T141N, R83W, secs 6-8, 17-19 T142N, R85W, secs 24, 36 T141N, R85W, sec 1	13.1	2	13,100	171,610	300,317,500
TOTAL TONS FOR OLIVER COUNTY =	[Y =				1.1 BII	1,066,441,250 1.1 BILLION TONS

SLOPE COUNTY

Slope County contains four billion tons of mineable lignite, more coal reserves than any other North Dakota county (Figure 62, Table 21). Within this county, there are eight deposits that contain more than 100 million tons of mineable lignite: Mud Creek (123 million), Bacon Creek (192 million), Boyce Creek (328 million), Spring Creek (965 million), Spring Creek East (479 million), Black Butte North (914 million), and Black Butte South (711 million). The Bacon Creek deposit consists primarily of the T Cross coal. Stratigraphically, the T Cross is the oldest mineable coal in North Dakota. According to C.J. Hares (1928), it was mined in at least six small mines in the area (T.133N.,R.104W). The T Cross bed is one of only two coals in North Dakota, the other is the Harmon bed, that are more than 30 feet thick (Figures 63 and 64).

The Harmon bed is 36 feet thick in outcrop along Sand Creek in central Slope County, the thickest surface exposure of coal in North Dakota. Three billion tons, or 75 percent of Slope County's coal reserves, are attributable to the Harmon bed (Table 21). Spring Creek, Spring Creek East, Black Butte North, and Black Butte South are subdivisions of one continuous deposit of the Harmon coal in central Slope County. This deposit was subdivided, as were others, to enable more accurate estimations of the reserves.

The Harmon, Hanson, and T Cross coals can be traced in the subsurface throughout much of Slope County (Figures 63 and 64). The HT Butte coal outcrops at the base of Black Butte. Black Butte was formerly known as HT Butte, which is how this coal derived its name. The HT Butte is absent in the west half of the county due to erosion and was difficult to trace in the subsurface in the eastern half of the county. A persistent coal was identified as the HT Butte in figure 63 because it is at the correct stratigraphic position. Strata in western Slope County is dipping steeply off the east limb of the Cedar Creek anticline (Figure 63). As a result, the Harmon and Hanson beds decrease in elevation about 700 feet over a distance of about 30 miles from west to east across western Slope County. A northeast-trending synclinal feature may be present in the Chalky Buttes where White River strata is preserved 100 feet below adjacent Fort Union strata. There are hundreds of shallow uranium holes in this area, but they are generally less than 200 feet deep.

There are several small abandoned coal mines (wagon mines) spread across Slope County. However, coal has never been mined on a large-scale in this county.

Slope County

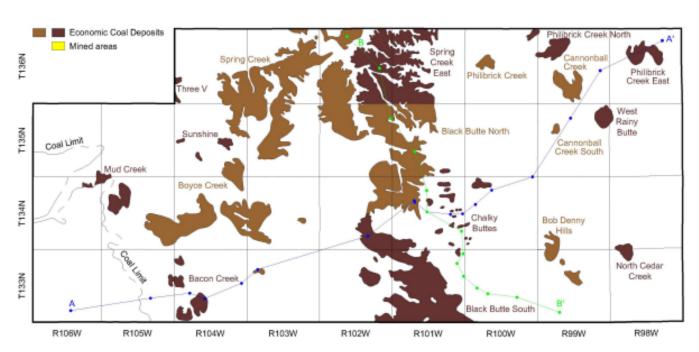


Figure 62. The mineable lignite deposits in Slope County.

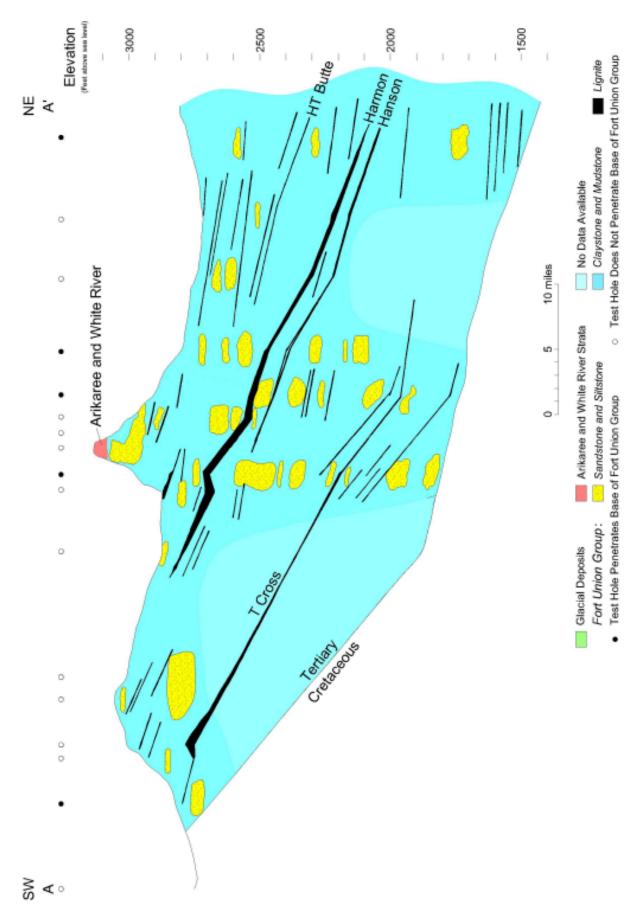


Figure 63. Cross-section A-A' through Slope County. The trace of this cross section is in Figure 62.

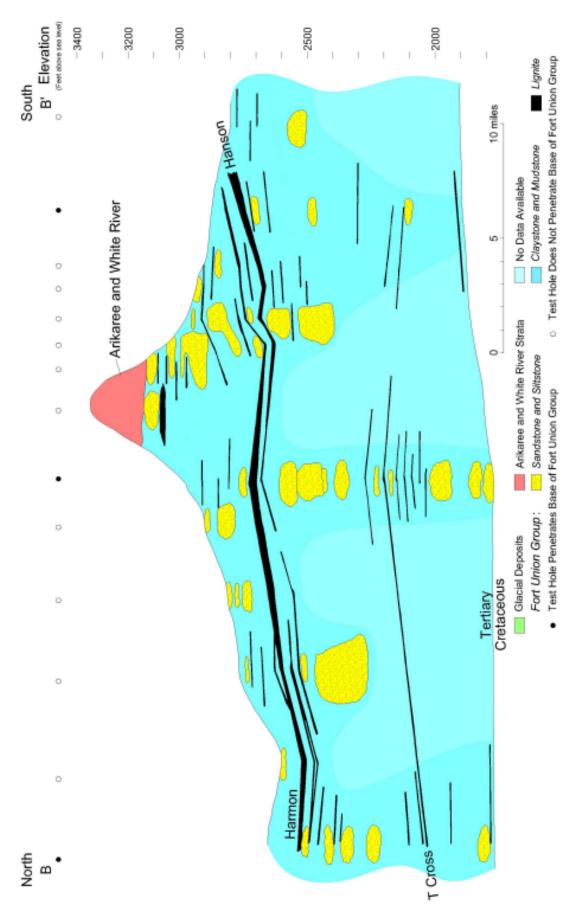


Figure 64. Cross-section B-B' through Slope County. The trace of this cross section is in Figure 62.

Table 21. Mineable Lignite Deposits in Slope County.

Deposit Name	C _u Legal Description t	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
MUD CREEK DEPOSITS	T134N, R106W, secs 1, 2 T135N, R106W, sec 36 T135N, R105W, sec 31 T134N, R105W, secs 4-9, 16-18, 20	20	l (Harmon)	3,500	70,000	122,500,000
BACON CREEK DEPOSITS	T133N, R104W, secs 6, 7	10	2	280	2,800	
	T133N, R104W, secs 18, 19 T133N, R105W, sec 13	12	2	550	6,600	
	T133N, R104W, secs 29-32	13.5	2	009	81,000	
	T133N, R104W, secs 20, 21, 28, 29, 32, 33	24	-	800	$\frac{19,200}{109,600}$	191,800,000
BOYCE CREEK DEPOSITS	T134N, R104W, secs 8, 9, 15-17, 19-22, 28-31 T134N, R105W, secs 22-27, 35, 36	16	1 to 2	5,760	92,160	
	T134N, R104W, secs 12-15, 22-25 T134N, R103W, secs 17-20, 23, 29-32	14	2	4,800	67,200	
	T133N, R103W, secs 7, 8	10	1	100	1,000	
	T135N, R104W, secs 25, 26, 35, 36 T134N, R104W, secs 1, 2, 12	15	2	1,800	$\frac{27,000}{187,360}$	327,880,000
SUNSHINE DEPOSITS	T135N, R104W, sec 18	14.5	1	09	870	
	T135N, R104W, secs 28, 29	10	2	09	009	
	T135N, R104W, secs 14, 15, 22, 23	12	2	275	$\frac{3,300}{4,770}$	8,347,500
THREE V DEPOSIT	T136N, R104W, secs 19, 30, 31	10	2	220	2,200	3,850,000

Table 21. Mineable Lignite Deposits in Slope County (continued).

Deposit Name	C Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
SPRING CREEK DEPOSIT	T136N, R103W, secs 1-3, 9-17, 19-24, 26-34 T136N, R102W, secs 3-8, 19 T136N, R104W, secs 22-26, 34-36 T135N, R103W, secs 3-10, 13-17, 19-22, 27-29 T135N, R104W, secs 1, 2, 11-14	4, 81	1 (Harmon)	19,800	356,400	623,700,000
	T136N, R102W, secs 17-21, 28-33 T135N, R102W, secs 4-9, 15-17, 20-22	23	1 (Harmon)	6,560	219,880	384,790,000
SPRING CREEK EAST DEPOSIT	T136N, R102W, secs 1, 2, 9-16, 22-27, 34-36 T136N, R101W, secs 3-10, 16-22, 27-34	19	l (Harmon)	14,400	273,600	478,800,000
BLACK BUTTE NORTH DEPOSIT	T135N, R102W, secs 1-3, 11-14, 24, 25, 35, 36 T135N, R101W, secs 3-10, 15-21, 28-34 T134N, R102W, secs 1, 2, 11-15 T134N, R101W, secs 4-9, 16-18, 21	30.8	1 (Harmon)	16,960	522,368	914,144,000
BLACK BUTTE SOUTH DEPOSIT	T134N, R102W, secs 22, 23, 25-27, 34-36 T134N, R101W, secs 31, 32 T133N, R102W, secs 1, 2, 10-15, 24, 25, 35, 36 T133N, R101W, secs 4-10, 14-36	26	I (Harmon)	15,360	399,360	
	T133N, R100W, secs 31, 32	24	1 (Harmon)	300	$\frac{7.200}{406,560}$	711,480,000
CHALKY BUTTES DEPOSITS	T134N, R101W, secs 2, 3, 9-16, 23-27, 35, 36 T135N, R101W, sec 35 T134N, R100W, secs 4-6, 19, 30, 31 T135N, R101W, sec 35	7,	1 to 2	1,800	19,800	34,650,000

Table 21. Mineable Lignite Deposits in Slope County (continued).

Deposit Name	C. Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
PHILBRICK CREEK DEPOSIT	T136N, R100W, secs 16-18, 20, 21	12	2	350	4,200	7,350,000
PHILBRICK CREEK NORTH DEPOSITS	T136N, R99W, secs 4-6, 7-9, 17, 18 T136N, R100W, sec 1	14	2	1,600	22,400	39,200,000
PHILIBRICK CREEK EAST DEPOSIT T136N, R98W, secs 4,	T136N, R98W, secs 4, 8-11, 14-17	11	6	1,900	20,900	36,575,000
CANNONBALL CREEK DEPOSIT	T136N, R99W, secs 20-22, 27-29, 33, 34	13	2	2,100	27,300	47,775,000
CANNONBALL CREEK SOUTH DEPOSIT	T135N, R99W, secs 8, 17	11	2	160	1,760	3,080,000
WEST RAINY BUTTE DEPOSIT	T135N, R99W, secs 1, 2, 11, 12 T135N, R98W, secs 6, 7	15	-	1,200	18,000	31,500,000
BOB DENNY HILLS DEPOSIT	T134N, R99W, secs 29-32 T133N, R99W, secs 4-6, 9, 10, 15, 16	16.5	2	1,800	29,700	51,975,000
NORTH CEDAR CREEK DEPOSIT	T133N, R98W, secs 5, 6 T134N, R98W, secs 31, 32	11	2	700	7,700	13,475,000
TOTAL TONS FOR SLOPE COUNTY =	<i>Y</i> =				41	4,032,871,500 4 BILLION TONS

STARK COUNTY

Stark County contains approximately 3.1 billion tons of mineable lignite (Figure 65, Table 22). Two-thirds of this reserve is held in the Belfield deposit (2.3 billion tons) where mineable coal thickness average 16.3 feet (often in two beds). The Lehigh and the overlying Dickinson bed are the primary mineable coals in the county (Figures 66 and 67). The Lehigh bed has a maximum thickness of 25 feet north of Dickinson and is approximately 15 feet thick south of Belfield. The Dickinson bed is situated 30 to 50 feet above the Lehigh bed and is approximately 5 feet thick (Murphy et al., 2000). Two other deposits in this county exceed 100 million tons of lignite reserves: West Dickinson (159 million) and JK Ranch (353 million). Duck Creek is close to this amount at 92 million tons. The Lehigh bed accounts for 80 to 90% of the lignite reserves in Stark County.

The Harmon and Hanson coal beds can be traced through the western portion of the county at depths of 700 to 800 feet (Figure 66). These coals may extend beyond this area. However, it is difficult to correlate beds across the northeast-trending Little Badlands syncline in areas without adequate subsurface control (Biek and Murphy, 1997). The Little Badlands structure is prominently displayed by the Lehigh bed on the east-west cross section through this county (Figure 66). This structure is less evident in the underlying Harmon and Hanson beds in that same figure. Figure 66 is one of the few county cross sections that contains sufficient well control to give an accurate depiction of Fort Union strata.

Lehigh, just east of Dickinson, was an important mining center in the 1900s (Biek and Murphy, 1997). More than a dozen mines, primarily underground, operated in this area from the late 1890s until 1988 when the Husky Briquetting Company closed the last mine. Husky operated a short-term venture, the JK Ranch Mine, five miles north of Dickinson from 1988 to 1990. The mining in this area removed either the Lehigh and/or Dickinson beds. Great Northern Properties is currently studying the feasibility of establishing a coal mine and electric generating station along the east edge of the Belfield Deposit, southwest of the town of South Heart.

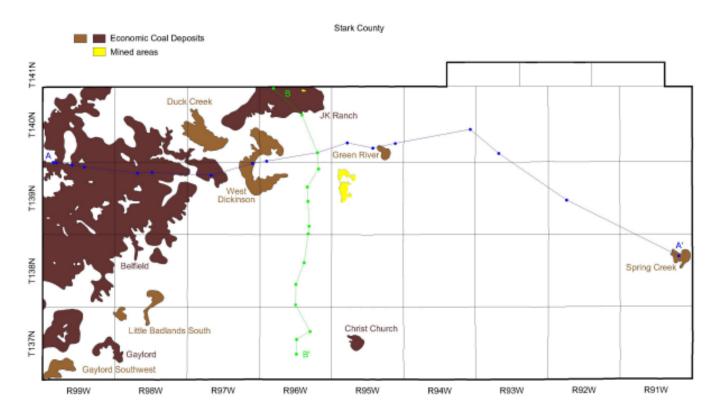


Figure 65. The mineable lignite deposits in Stark County.

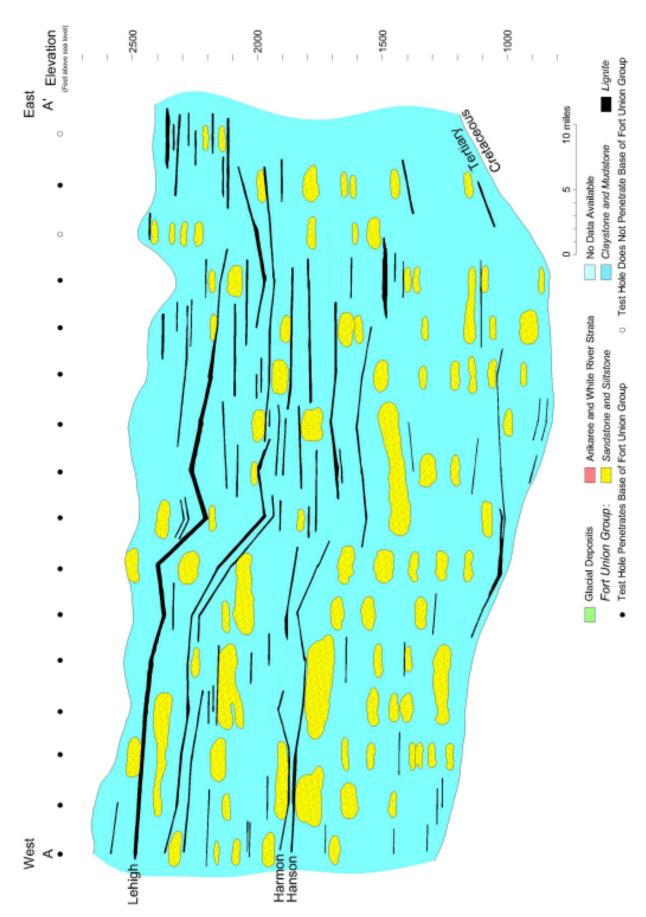


Figure 66. Cross-section A-A' through Stark County. The trace of this cross section is in Figure 65.

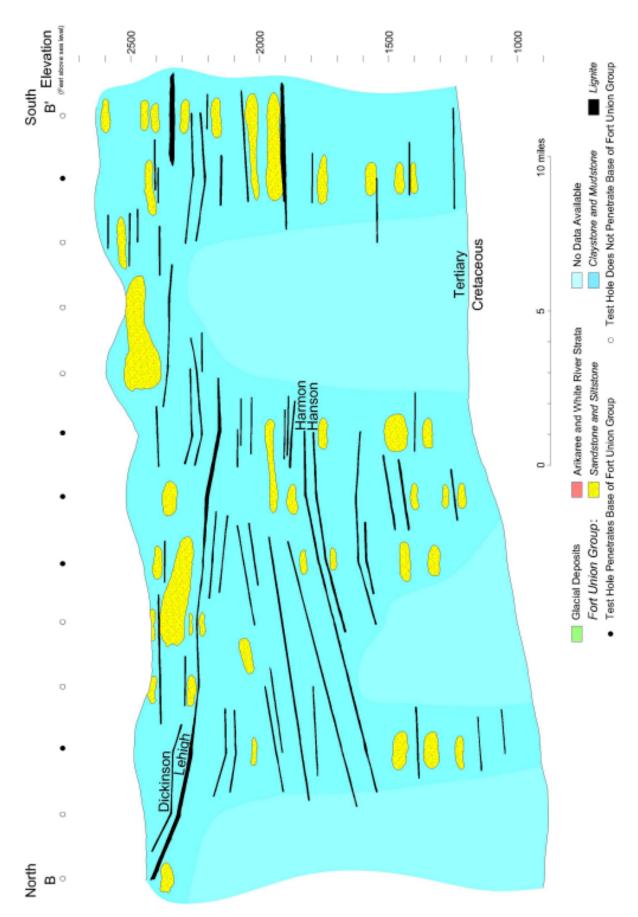


Figure 67. Cross-section B-B' through Stark County. The trace of this cross section is in Figure 65.

Table 22. Mineable Lignite Deposits in Stark County.

;		Cumulative coal	,		,	E
Deposit Name	Legal Description tl	thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
SPRING CREEK DEPOSIT	T138N, R91W, secs 11-14	20	2	700	14,000	24,500,000
GREEN RIVER DEPOSIT	T140N, R95W, secs 26, 27, 35	17	2	009	10,200	17,850,000
CHRIST CHURCH DEPOSIT	T137N, R95W, secs 16, 17, 20, 21	13	2	400	5,200	9,100,000
WEST DICKINSON DEPOSIT	T140N, R96W, secs 19, 29-32 T140N, R97W, secs 24, 25, 35, 36 T139N, R97W, secs 1, 2, 11-13 T139N, R96W, secs 7-9, 18	17.8	1 to 2	5,100	90,780	158,865,000
JK RANCH DEPOSIT	T140N, R96W, secs 1-12, 16-18 T140N, R97W, secs 1, 10-15, 22, 23	22.7	2 (JK Ranch (Lehigh) + sometimes an overlying bed)	7,700	174,790	305,882,500
DUCK CREEK DEPOSIT	T140N, R97W, secs 7, 17-21, 27-30, 32					
	T140N, R98W, secs 13, 24	16.4	2 (Lehigh + an overlying bed)	3,200	52,480	91,840,000
BELFIELD DEPOSIT	T140N, R99W, secs 1-11, 14-23, 25-36	15.8	1 to 2	12,160	192,128	
	T140N, R98W, secs 16-18, 20-23, 26-36 T140N, R97W, secs 31-33	13.3	2	6,080	80,800	
	T139N, R99W, secs 1-36	19.4	2	19,200	372,480	
	T139N, R98W, secs 1-35	17.6	1 to 2	17,600	309,760	
	T139N, R97W, secs 3-10, 18 T138N, R99W, secs 1-26, 28-31, 35	17 16.2	1 to 2 1 to 2	1,900 14,400	32,300 233,280	

Table 22. Mineable Lignite Deposits in Stark County (continued).

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
	T138N, R98W, secs 1-10, 14, 15	14.3	1 to 2	3,200	45,760	
	T137N, R99W, secs 3-10, 15-21	16	7	4,500	$\frac{72,000}{1,338,508}$	2,342,389,000
LITTLE BADLANDS SOUTH	T138N, R98W, secs 27, 28, 33, 34 T137N, R98W, secs 4, 9	17	2	006	15,300	
	T137N, R98W secs 6, 7 T137N, R99W sec 1 T138N, R98W sec 31	Ξ	2	450	$\frac{4.950}{20,250}$	35,437,500
GAYLORD DEPOSIT	T137N, R99W, secs 13, 23-25 T137N, R98W, secs 19, 30	17.5	2	096	16,800	29,400,000
GAYLORD SOUTHWEST DEPOSIT	T137N, R99W, secs 28-33	13	1 to 2	1,600	20,800	36,400,000
TOTAL TONS FOR STARK COUNTY =	TY =				1.8	3,051,664,000 3.1 BILLION TONS

WARD COUNTY

Ward County contains approximately 420 tons of mineable lignite in three deposits located in the southeastern portion of the county (Figure 68 and Table 23). The Bonnes Coulee deposit, at 272 million tons, is the only one that exceeds 100 million tons. The Coteau bed accounts for most of the lignite reserves in the county. The Coteau bed extends over an area of at least 162 square miles in southeastern Ward and southwestern McHenry counties (Figures 69 and 70). This bed is, on average, 10 to 12 feet thick and has a maximum thickness of 22 feet (Murphy, 1998).

The Coteau bed outcrops along numerous coulees and ravines that lead into the Souris River Valley. A number of small underground and wagon mines operated within these ravines in the past. The Coteau bed was the target of these mines including the Velva mine, the only large-scale surface mine to have operated in this county. This mine, in existence from 1927 until the mid-1980s, was first operated by Truax-Traer and later by the Consolidation Coal Company (Groenewold et al., 1983). Approximately 18 underground coal mines operated along the Des Lacs Valley, near Kenmare, in the early 1900s.

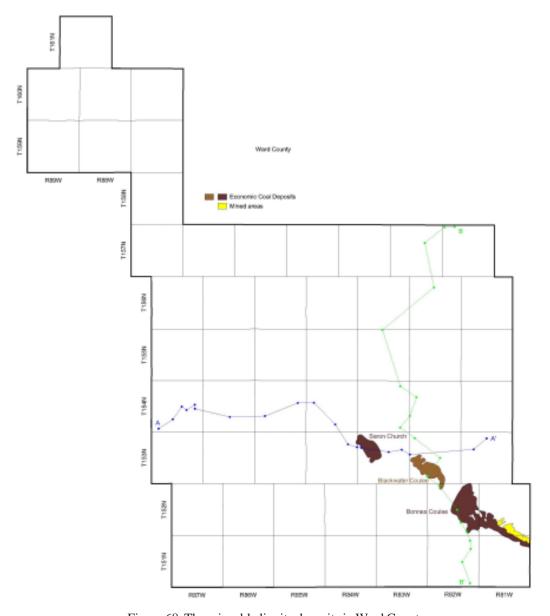


Figure 68. The mineable lignite deposits in Ward County.

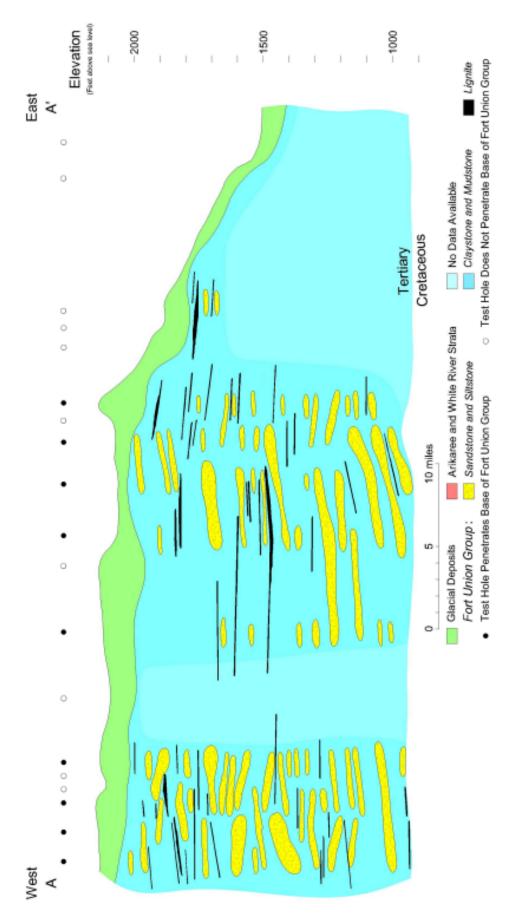


Figure 69. Cross-section A-A' through Ward County. The trace of this cross section is in Figure 68.

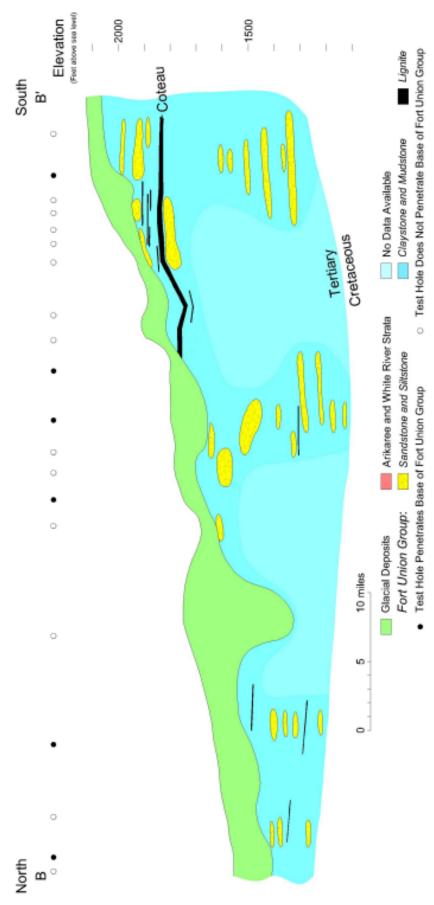


Figure 70. Cross-section B-B' through Ward County. The trace of this cross section is in Figure 68.

Table 23. Mineable Lignite Deposits in Ward County.

		Cumulative coal	coal			
Deposit Name	Legal Description	thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
SARON CHURCH DEPOSIT	T153N, R83W, secs 5-9, 16-18, 20, 21	14		2,560	35,840	62,720,000
BLACKWATER COULEE DEPOSIT	T153N, R82W, secs 17-22, 27-30, 32-35 T152N, R82W, sec 5	14.5	2	3,200	46,400	81,200,000
BONNES COULEE DEPOSIT	T152N, R82W, secs 1-3, 10-16, 21-27, 35, 36 T152N, R81W, secs 19, 20, 28-34 T151N, R81W, secs 1-3, 11, 12	16.8	2 (Coteau + 1)	9,280	155,904	272,832,000

TOTAL TONS FOR WARD COUNTY =

416,752,000 420 MILLION TONS

WILLIAMS COUNTY

Williams County contains approximately 1.6 billion tons of economically mineable lignite in 15 deposits that occur throughout all but the northeastern portion of the county (Figures 71-73, Table 24). About half of these deposits contain more than 100 million tons; Willow Creek (167 million), Blacktail Lake (102 million), Camp Creek (269 million), Cow Creek (110 million), Sand Creek (402 million), Stony Creek (199 million) and Beaver Creek (149 million).

A fourteen-foot thick lignite is present along the northern edge of the cross section in figure 73. This is the exception however, as most coals in Williams County are less than 10 feet thick. Figures 72 and 73 demonstrate the limited lateral extent of thin coals in Williams County. There is good well control in the central portion of the county where deep wells (generally oil and gas gamma logs) are spaced only a few miles apart (Figure 73). The west flank of the Nesson anticline is evident along the eastern edge of cross section A-A' (Figure 72).

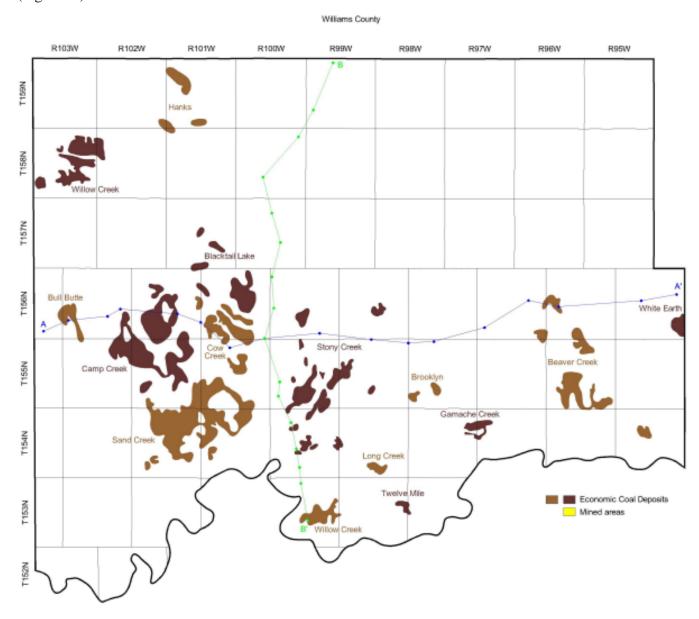


Figure 71. The mineable lignite deposits in Williams County.

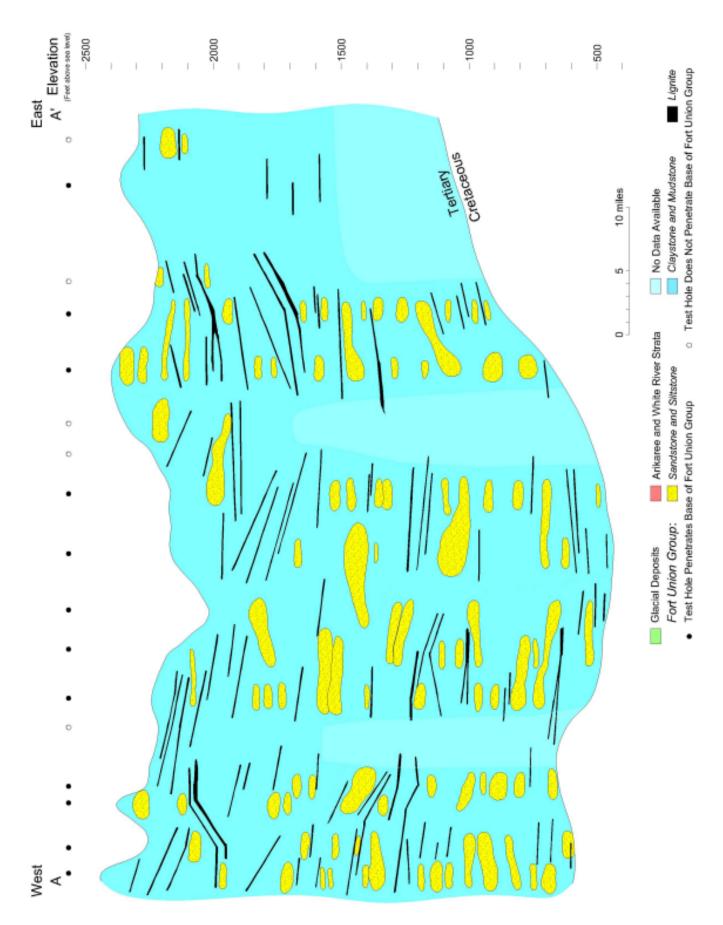


Figure 72. Cross-section A-A' through Williams County. The trace of this cross section is in Figure 71.

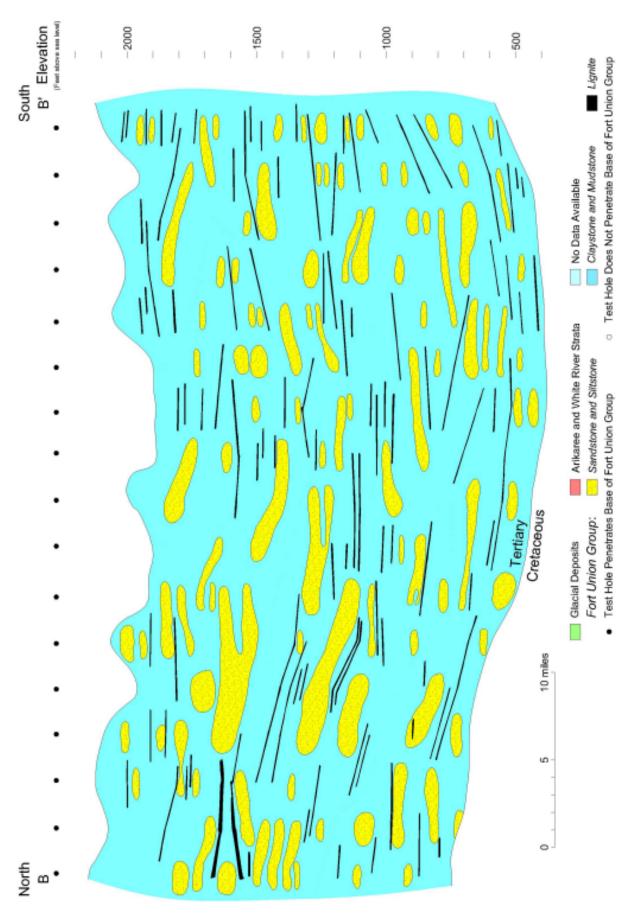


Figure 73. Cross-section B-B' through Williams County. The trace of this cross section is in Figure 71.

Table 24. Mineable Lignite Deposits in Williams County.

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
WILLOW CREEK DEPOSIT	T158N, R103W, secs 1, 2, 9-16 T158N, R102W, secs 6, 7, 18	15	2	2,880	43,200	
	T158N, R103W, secs 13-16, 21-28	16	2	2,773	44,368	
	T158N, R103W, secs 29-32	16	7	480	$\frac{7.680}{95,248}$	166,684,000
HANKS DEPOSIT	T159N, R101W, secs 7-10, 17, 18 T159N, R102W, secs 11, 12	Ξ	2	400	4,400	
	T159N, R101W, secs 33, 34 T158N, R101W, secs 3, 4	12	2	009	$\frac{7.200}{11,600}$	20,300,000
BLACKTAIL LAKE DEPOSITS	T157N, R101W, secs 15, 16, 21, 22	18	33	250	4,500	
	T157N, R101W, secs 22, 23, 25-27	13	2	009	7,800	
	T157N, R101W, secs 33, 34	11	2	400	4,400	
	T156N, R101W, sec 6 T156N, R102W, sec 1, 12 T156N, R101W, secs 7, 18	11	1 to 2	480	5,280	
	T156N, R101W, secs 2, 3, 4, 9-11, 14-16, 22, 23	12	7	3,040	<u>36,480</u> 58,460	102,305,000
BULL BUTTE DEPOSIT	T156N, R103W, secs 19, 20, 29, 30, 32 T156N, R104W, secs 24, 25 T155N, R103W, sec 5	.32	2	1,900	19,000	33,250,000
CAMP CREEK DEPOSITS	T156N, R102W, secs 8, 9, 16, 17	10	2	009	000'9	
	T156N, R102W, secs 15, 16, 20-22, 27-30, 32-34 T155N, R102W, secs 4, 5	Ξ	2	5,120	56,320	

Table 24. Mineable Lignite Deposits in Williams County (continued).

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
	T155N, R102W, secs 1-3, 5-12, 14-18, 21-23, 27 T155N, R103W, secs 1, 2, 11-13 T156N, R103W, secs 24, 25, 36 T156N, R102W, sec 35	12	2	7,360	88,320	
	T155N, R102W, secs 20, 29, 30	10	7	300	$\frac{3,000}{153,640}$	268,870,000
COW CREEK DEPOSIT	T156N, R102W, secs13, 24	12	3	300	3,600	
	T156N, R101W, secs 20, 21, 26-28	11	2	840	9,240	
	T156N, R101W, secs 20, 27-29, 33-35 T155N, R101W, secs 2, 3	-35	61	2,080	22,880	
	T156N, R101W, secs 29-33 T155N, R101W, secs 4-6	10	2 to 3	1,600	16,000	
	T155N, R101W, secs 9-11, 15, 16, 22	22 10	7	1,100	11,000 62,720	109,760,000
SAND CREEK DEPOSIT	T154N R102W, secs 1-5, 8-16, 21-23, 24-27 T155N R102W, secs 24, 25, 32, 35, 36 T155N R101W, secs 19, 20, 27-31, 34, 35	23, 36				
	24, 35 T154N R101W, secs 2-22, 16-19, 20, 30	14	2	16,000	224,000	
	T154N, R101W, secs 19, 20, 30	10	1	300	3,000	
	T154N, R102W, secs 28, 29, 32	10	2	280	$\frac{2.800}{229,800}$	402,150,000
STONY CREEK DEPOSITS	T156N, R99W, secs 21-23, 27	13	2	009	7,800	
	T156N, R100W, secs 21, 22, 27, 28	12	1 to 2	800	6,600	

Table 24. Mineable Lignite Deposits in Williams County (continued).

Deposit Name	Legal Description	Cumulative coal thickness (ft)	No. of beds	Acres	Acre-Feet	Tonnage
	T155N, R100W, sec 28	10	1 to 2	200	2,000	
	T155N, R99W, sec 7, 17, 18-20 T155N, R100W, sec 13, 24, 25	12	71	1,600	19,200	
	T155N, R100W, secs 3, 4	12	2	200	2,400	
	T155N, R100W, secs 10, 15	14	2	160	2,240	
	T155N, R100W, secs 14, 23	12	2	160	1,920	
	T155N, R100W, secs 20, 21	12	1	100	1,200	
	T155N, R100W, secs 14, 15, 22, 23, 26-28, 32-34 T154N, R100W, sec 5	3,	1 to 2	1,920	26,880	
	T155N, R100W, secs 26, 34, 35 T154N, R100W, secs 2, 3	10	-	096	009'6	
	T155N, R100W, secs 35, 36 T154N, R100W, secs 1, 2	17	2	750	12,750	
	T154N, R100W, secs 8, 9	11	2	280	3,080	
	T154N, R100W, secs 13, 24 T154N, R99W, secs 18, 19	10	2	400	4,000	
	T154N, R100W, secs 15, 16, 21-23	3 14	7	800	<u>11,200</u> 113,870	199,272,500
LONG CREEK DEPOSIT	T154N, R99W, secs 26-28, 33-35	10	6	700	7,000	12,250,000
WILLOW CREEK DEPOSIT	T153N, R100W, secs 12-15, 22-27	. 10	1 to 2	2,080	20,080	36,400,000
TWELVE MILE DEPOSIT	T153N, R99W, secs 13, 24 T153N, R98W, secs 18, 19	Ξ	6	480	5,280	9,240,000

Table 24. Mineable Lignite Deposits in Williams County (continued).

Denocit Name	C Legal Description	Cumulative coal	No of bods	Acres	A cro. Root	Tonnage
Deposit ivanie	Legal Lescription		IVO. OI DCUS	ACICS	ACI C-1: CC1	LUIIIIABC
BROOKLYN DEPOSITS	T155N, R98W, secs 21, 28	10	2	400	4,000	
	T155N, R98W, secs 29-32	10	2	300	<u>3,000</u> 7,000	12,250,000
GAMACHE CREEK DEPOSIT	T154N, R98W, secs 12, 13 T154N, R97W, secs 7, 8, 18	10	-	1,600	16,000	2,800,000
BEAVER CREEK DEPOSIT	T156N, R96W, secs 17-20 T156N, R97W, secs 13, 24	Ξ	2	800	8,800	
	T156N, R96W, sec 31 T156N, R97W, sec 36 T155N, R96W, sec 6 T155N, R97W, sec 1	16	1 to 2	580	9,280	
	T155N, R96W, secs 2-4, 9-11 T156N, R96W, secs 33, 34	10	2	1,080	10,800	
	T155N, R96W, secs 17, 19-21, 25-29, 32-36	15	2	3,520	52,800	
	T155N, R96W, secs 9, 10, 15, 16	Ξ	2	320	$\frac{3.520}{85,200,000}$	149,100,000
WHITE EARTH DEPOSIT	T156N, R95W, secs 24-26, 35, 36	13	2	1,300	16,900	29,575,000
TOTAL TONS FOR WILLIAMS COUNTY =	OUNTY =				1.61	1,554,206,500 1.6 BILLION TONS

NORTH DAKOTA LIGNITE RESERVES

Murphy (2001), using the same methodologies as this report, determined that North Dakota contains 25.1 billion tons of strippable lignite reserves (Table 25). At the present rate of mining, it would take 835 years to exhaust North Dakota's supply of economically recoverable lignite. Slope county contains over 4 billion tons of mineable coal, the most of any county in North Dakota (Figure 74). Slope County, along with three other North Dakota counties (Stark, Billings, and McKenzie), account for approximately half of the mineable lignite in North Dakota (Figure 74). Interestingly, large-scale coal mining has only taken place in one of these counties, Stark County. The three counties that are commonly referred to as "the heart of coal country" (McLean, Mercer, and Oliver) rank 8th, 10th, and 11th, respectfully, in tons of mineable lignite. This relationship emphasizes the importance of proximity of mineable deposits and mine-mouth power plants to reliable water sources (for cooling) and infrastructure (transmission lines, highways, railroads, etc.).

Table 25. North Dakota Lignite Reserves by County

County	Lignite Reserves (tons)	ReserveRanking
Adams	149,800,000	19
Billings	2,771,743,750	3
Bowman	1,648,080,000	6
Burke	535,111,500	14
Burleigh	30,800,000	20
Divide	395,692,500	16
Dunn	1,720,960,500	5
Golden Valley	1,433,001,500	9
Grant	172,952,500	18
Hettinger	729,872,500	12
McHenry	5,250,000	21
McKenzie	1,760,727,500	4
McLean	1,500,000,000	8
Mercer	1,267,497,000	10
Morton	594,291,250	13
Mountrail	218,198,750	17
Oliver	1,066,441,250	11
Slope	4,032,871,500	1
Stark	3,051,664,000	2
Ward	416,752,000	15
Williams	1,554,206,500	7
TOTAL	25,055,914,500	

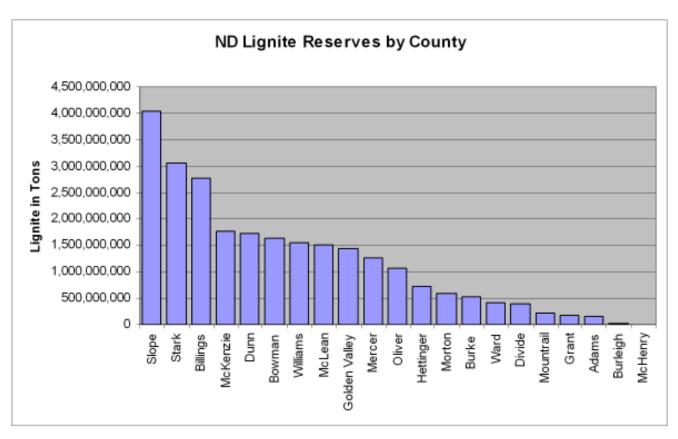


Figure 74. North Dakota's lignite reserves by county. Eleven counties contain more than one billion tons of mineable lignite.

THICK COALS IN NORTH DAKOTA

The Fort Union Group contains thousands of individual coal beds, as demonstrated by the cross sections in the previous county chapters. As previously noted, thick seams can be traced for hundreds or thousands of square miles, sometimes through multiple counties in western North Dakota. Conversely, thin seams of coal split, thin, and disappear within a township or do not extend beyond a few sections.

There are only two coals in western North Dakota that are known to be more than 30 feet thick, the T Cross and the Harmon (Murphy and Goven, 1998a; Murphy et. al., 1999). The T Cross is more than 30 feet thick within one or two sections in southwestern Slope County (T.133N., R104W). The Harmon bed is more than 30 feet thick in four localities; north of Bowman in Bowman County, southwest of Amidon in Slope County (Figure 75), near Beach in Golden Valley County, and over portions of six townships in south-central McKenzie County (Murphy and Goven, 1998c). The Harmon bed underlies parts of at least nine counties in southwestern North Dakota; Bowman, Adams, Hettinger, Slope, Golden Valley, Billings, Stark, McKenzie, and Dunn (Murphy et al., 2002). The Harmon bed obtains a maximum thickness of 53 feet and is more than 50 feet thick in four localities in T147N, R101-102W (Murphy and Goven 1998a).

The T Cross is more than 20 feet thick over an area of approximately 10,000 acres in portions of three counties, Bowman, Slope, and Golden Valley. The Harmon bed is more than 20 feet thick in an area of approximately 414,700 acres in eight counties, Bowman, Slope, Hettinger, Billings, Golden Valley, Dunn, McKenzie, and Williams (Figure 76). There are six additional coals that are more than 20 feet thick and extend for a combined area of 59,000 acres; the HT Butte bed in eastern Golden Valley and western Billings counties, the Lehigh bed near Dickinson in Stark County, the Dunn Center bed in central Dunn County, the Beulah-Zap



Figure 75. The Harmon bed is visible in the cut bank of Sand Creek in Slope County. The photograph was taken near the old Russell Ranch in Slope County, site of the thickest exposure of coal (the Harmon bed at 36 feet) in North Dakota.

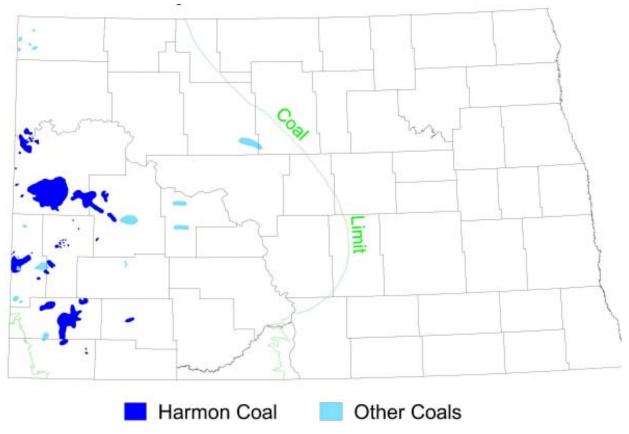


Figure 76. Distribution of thick coals (coals more than 20 feet thick) in western North Dakota.

bed in northern Mercer County, the Alkabo bed in western Divide County, and the Coteau bed in southeastern Ward and southwestern McHenry counties (Murphy and Goven, 1998b). There are approximately 20.7 billion tons of coal within beds that are more than 20 feet thick (Figure 76).

Forty-two cross sections were created for this report (Figure 77). When possible, these sections were oriented north-south, east-west and aligned with sections in adjacent counties to provide seamless or near seamless control. However, the traces of the sections were ultimately determined by the available subsurface control. The general demeanor and scope of the cross sections somewhat limits their usefulness. To cover this area in stratigraphic detail would have required several hundred cross sections, each extending from two to four feet in length. Even with these limitations, the general character of the Fort Union Group and the relationships between various seams of coal are evident on these sections. For example, as first noted by Groenewold and others (1979), the Beulah-Zap and Dunn Center coals may be equivalent. Both coals are about 20 feet thick (Dunn Center ranges from 18 to 26 feet and the Beulah Zap from 16 to 23 feet) and occur at the same approximate stratigraphic horizon (Figure 78). The Beulah-Zap bed thins and splits in western Mercer County and the Dunn Center thins and splits in eastern Dunn County. It is difficult, if not impossible, to correlate the coals across those areas with the existing drillhole control. The Beulah-Zap and Dunn Center beds may or may not be physically connected. What we do know is that conditions were favorable during that interval of geologic time for thick deposits of peat to accumulate in a large swamp or a series of swamps in this area.

These sections also accurately depict the known structural features in western North Dakota. The dip of strata towards the center of the Williston Basin, near the town of Watford City, is evident in nearly every cross section. Structural features, such as anticlines and synclines, are also readily apparent. No doubt some of these sections cross faults, but there is insufficient data control to identify them and they would generally not be identifiable on sections of this scale.

Of necessity, I named all of the mineable lignite deposits. As noted previously in this report, deposits were named for prominent geographic features in the area such as buttes, creeks, and cemeteries. In the 1970s, there were about a dozen companies actively exploring for coal (North American Coal Company, Consolidation Coal Company, W.H. Hunt, Lone Star Producing, Baukol Noonan, Sunoco Energy Development Company, Gulf Minerals, Nokota, etc). The exploration department of these companies often named deposits using the same general criteria that I did. As a result, three companies may have known one deposit by three different names. Rather than attempting to determine which name or names took precedence amongst the companies, I named the deposits myself. In a number of cases, the names will likely mirror those chosen by at least one company in the past because there are often a limited number of prominent geographic features in a given area. As of 1982, there were 100 named coal beds in North Dakota (Lerud, 1982). I purposely avoided naming coal beds because there is insufficient drillhole control in many areas to determine with any certainty the exact relationship between beds. I also did not see the usefulness of naming hundreds or thousands of thin beds of coal that will likely never be utilized for anything. I did propose the name Alkabo for a thick lignite in western Divide County that I view as a prime candidate for coalbed methane exploration (Figure 79).

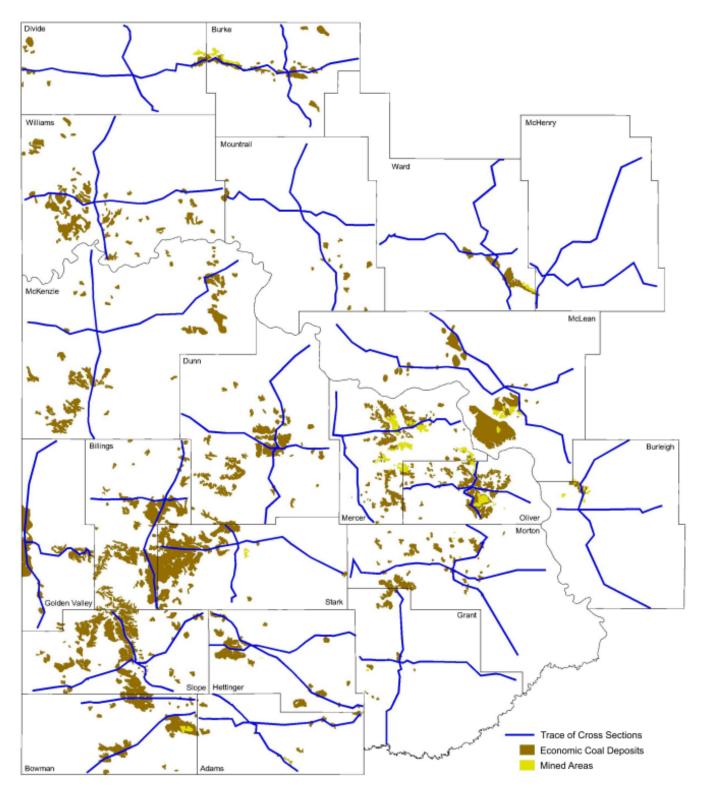


Figure 77. The cross sections and coal deposits presented in this report.

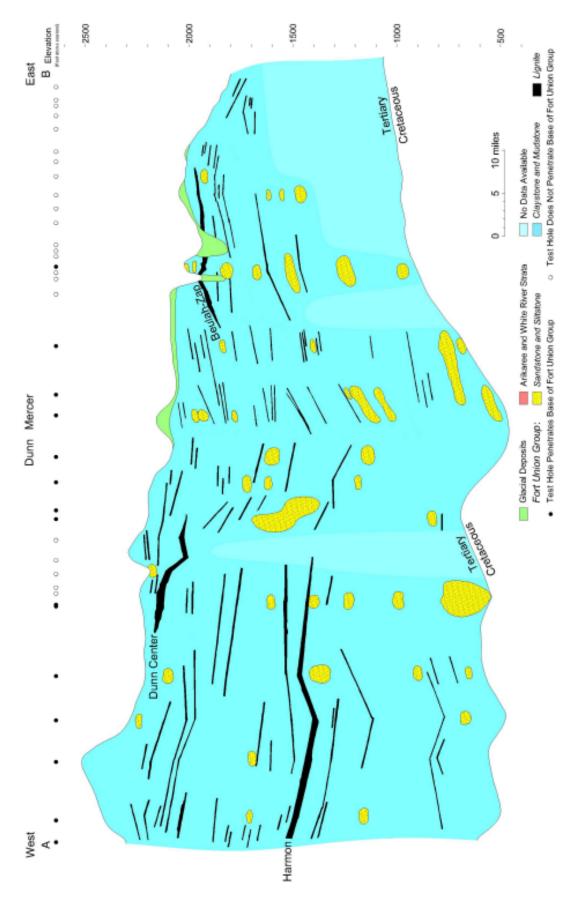


Figure 78. Stratigraphic cross-section across Dunn and Mercer counties. The Dunn Center and Beulah-Zap beds are at the same approximate stratigraphic horizon. Modified from figures 30 and 51.

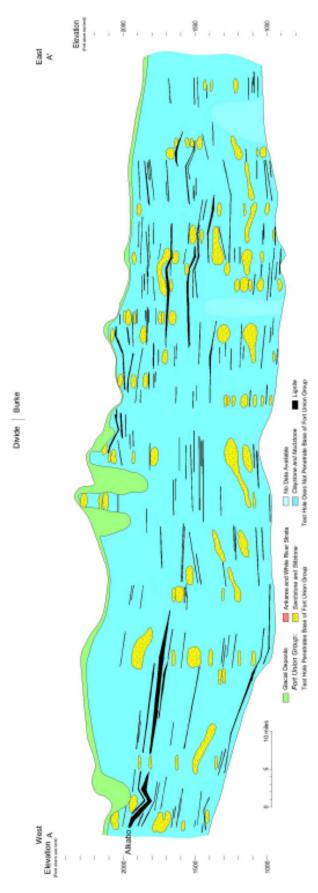


Figure 79. Cross section from western Divide County to eastern Burke County. At a maximum thickness of 29 feet, the Alkabo coal dominates over all other coals in this section. Modified from figures 21 and 27.

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