

Figure 1. Generalized boundaries of the Fort Union Formation. The formation continues into Saskatchewan, Canada, but does not show on this map.

# NORTH DAKOTA COAL RESOURCES AND DEVELOPMENT POTENTIAL

In the 24-year period from 1947-1971, gross energy consumption increased from 33.0 quadrillion BTU in 1947 to 69.0 quadrillion BTU in 1971. This represents a 3.1 per cent annual rate of growth of energy demand (3). Assuming an average annual increase of 3.5 per cent, energy use will double by 1985 and almost triple by 2000. The U.S. contains only six per cent of the world's population, yet in 1971 accounted for 33 per cent of total world energy consumption (1).

Norman L. Dalsted and F. Larry Leistritz

The United States is confronted with a serious fuel shortage. The demand for energy is rapidly depleting our deposits of fossil fuels, particularly

oil and natural gas. Some estimates indicate that domestic reserves of oil and natural gas will sustain the U.S. economy for only another 10 to 11 years.

In the near future other sources of energy must be developed in order to ease the "energy

*Dalsted is research associate and Dr. Leistritz is associate professor, Department of Agricultural Economics.*



Figure 2. Immediate energy needs in the U.S. point toward increased development of North Dakota's immense stockpile of lignite coal.

crisis." Nuclear power will no doubt become an important source of energy in years to come. One estimate is that nuclear power will supply 26 per cent of the total energy requirements by the year 2000 (3). Other possibilities for energy development include geothermal, solar and fusion sources, but the prospects do not seem bright for commercial utilization of these sources in the near future. The next 10 to 15 years will be the most crucial period, and the United States will have to depend on its already depleted supply of fossil fuels as well as imports to carry the load until other sources of energy can be developed.

For the time being, energy priorities point toward increased development of the nation's vast coal resources, which total some 1.5 trillion tons and represent three-fourths of national fossil fuel reserves. In 1971, coal provided 18.2 per cent of the United States consumption of energy resources as compared to 77.1 per cent provided by oil and gas. The remaining 4.7 per cent was provided mainly by hydropower (4.1 per cent) and nuclear power (.4 per cent) (3). By 1980, the demand for coal is expected to be 53 per cent greater than it was in 1967, and by 2000 the projected demand will be 78 per cent greater (6). As a result, coal reserves of the Fort Union Formation (Figure 1) are expected to play a major role in supplying energy to meet growing national needs.

The Fort Union reserves account for more than 40 per cent of the total United States coal reserves and up to 90 per cent of the low-sulfur reserves. The Fort Union reserves are ideal for large-scale strip mining, as many of the coal veins are thick (10 to 90 feet) and lie close to the surface (less than 100 feet) (6).

#### NORTH DAKOTA COAL RESOURCES

Much of western North Dakota is underlaid by lignite coal deposits (Figure 3). The lignite area covers more than 28,000 square miles (18 million acres). More than 100 beds over four feet in thickness have been identified. These beds are covered with a clay overburden ranging from 20 to 70 feet in depth in most cases. The 20 beds which are believed to have the greatest develop-

ment potential contain a total of 6.8 billion tons of lignite (Figure 2). Total North Dakota lignite resources are estimated to be 350 billion tons or 22 per cent of United States total (Table 1). Strippable reserves are estimated to total 16.1 billion tons, located in 23 counties (Table 1).

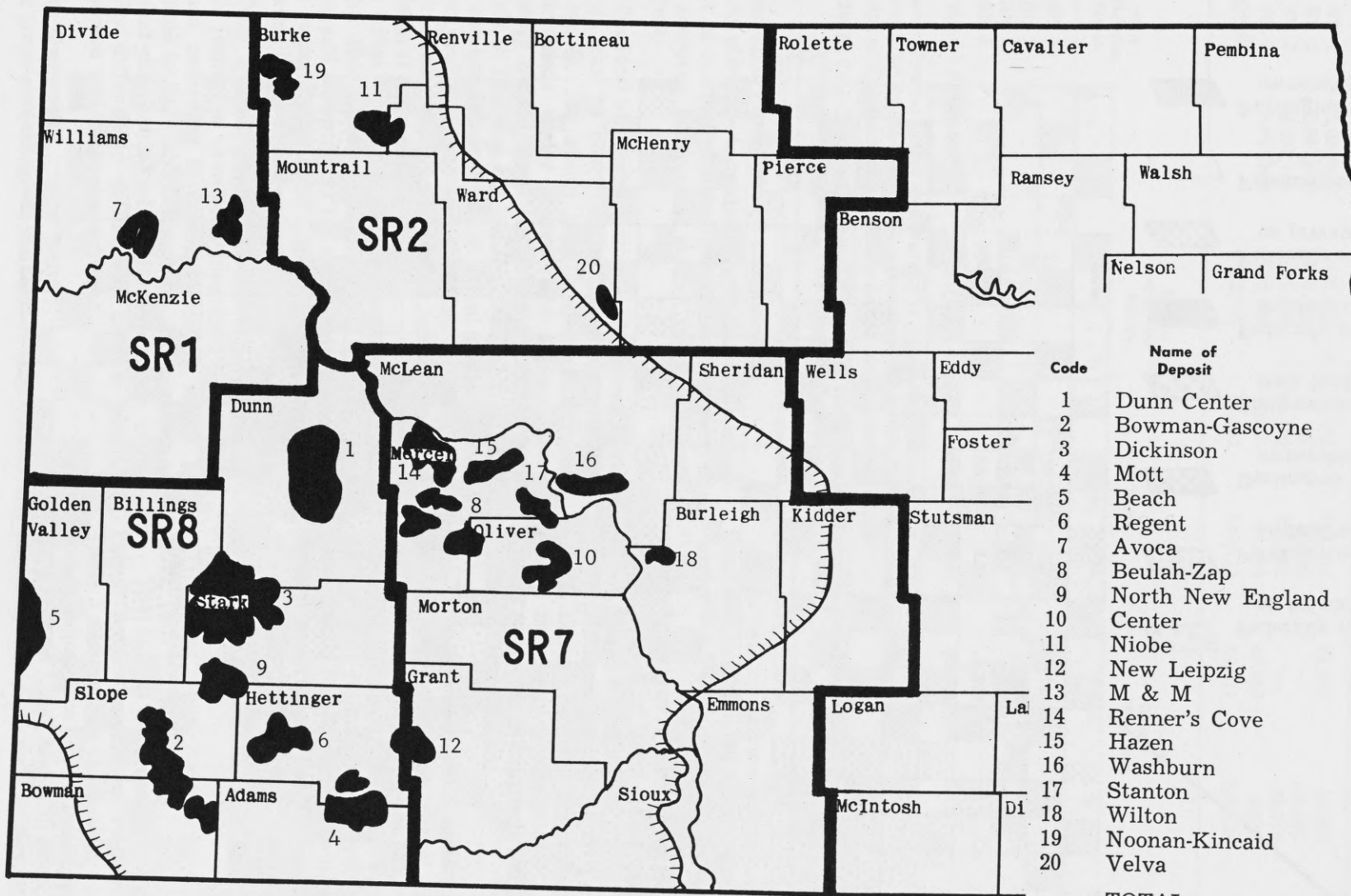
Table 1. Estimated Original Strippable Lignite Reserves and Lignite Resources in North Dakota (Million Tons)

County	Strippable Reserve <sup>1</sup>	Total Resource <sup>2</sup>
Adams	163	1,857
Billings	1,078	17,718
Bowman	785	7,021
Burke	117	6,610
Burleigh	156	1,157
Divide	137	8,264
Dunn	2,000	71,042
Golden Valley	278	8,319
Grant	115	4,658
Hettinger	980	12,653
McHenry	15	118
McKenzie	825	32,183
McLean	1,009	16,478
Mercer	1,986	29,912
Morton	342	15,251
Mountrail	148	15,378
Oliver	629	17,839
Renville	8	783
Sheridan	0	660
Slope	2,326	20,091
Stark	1,275	25,698
Ward	501	10,286
Williams	1,130	26,935
<b>TOTAL</b>	<b>16,130</b>	<b>350,911</b>

<sup>1</sup> Original strippable reserve estimates refer to coal seams 5 feet or thicker and overburden of 100 feet or less. The strippable reserve figures for Dunn and Hettinger counties were supplied by industry.

<sup>2</sup> Total resources refer to coal seams at least 2½ feet thick and overburden of 1,200 feet or less.

SOURCE: Brant, R. A., Lignite Resources of North Dakota. U.S. Geological Survey Circular 22 G, 1953, or Modified Circular 22 G, March, 1974.



Code	Name of Deposit	Strippable Reserves, Million Short Tons
1	Dunn Center	1,500
2	Bowman-Gascoyne	1,372
3	Dickinson	798
4	Mott	500
5	Beach	450
6	Regent	400
7	Avoca	380
8	Beulah-Zap	380
9	North New England	280
10	Center	253
11	Niobe	146
12	New Leipzig	105
13	M & M	100
14	Renner's Cove	78
15	Hazen	71
16	Washburn	30
17	Stanton	21
18	Wilton	15
19	Noonan-Kincaid	15
20	Velva	5
TOTAL		6,794


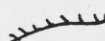
 Major Strippable Deposit  
 Boundary of Commercial Lignite Deposits

Figure 3. Area of commercial lignite deposits and location of major strippable lignite deposits, North Dakota State Planning Regions.



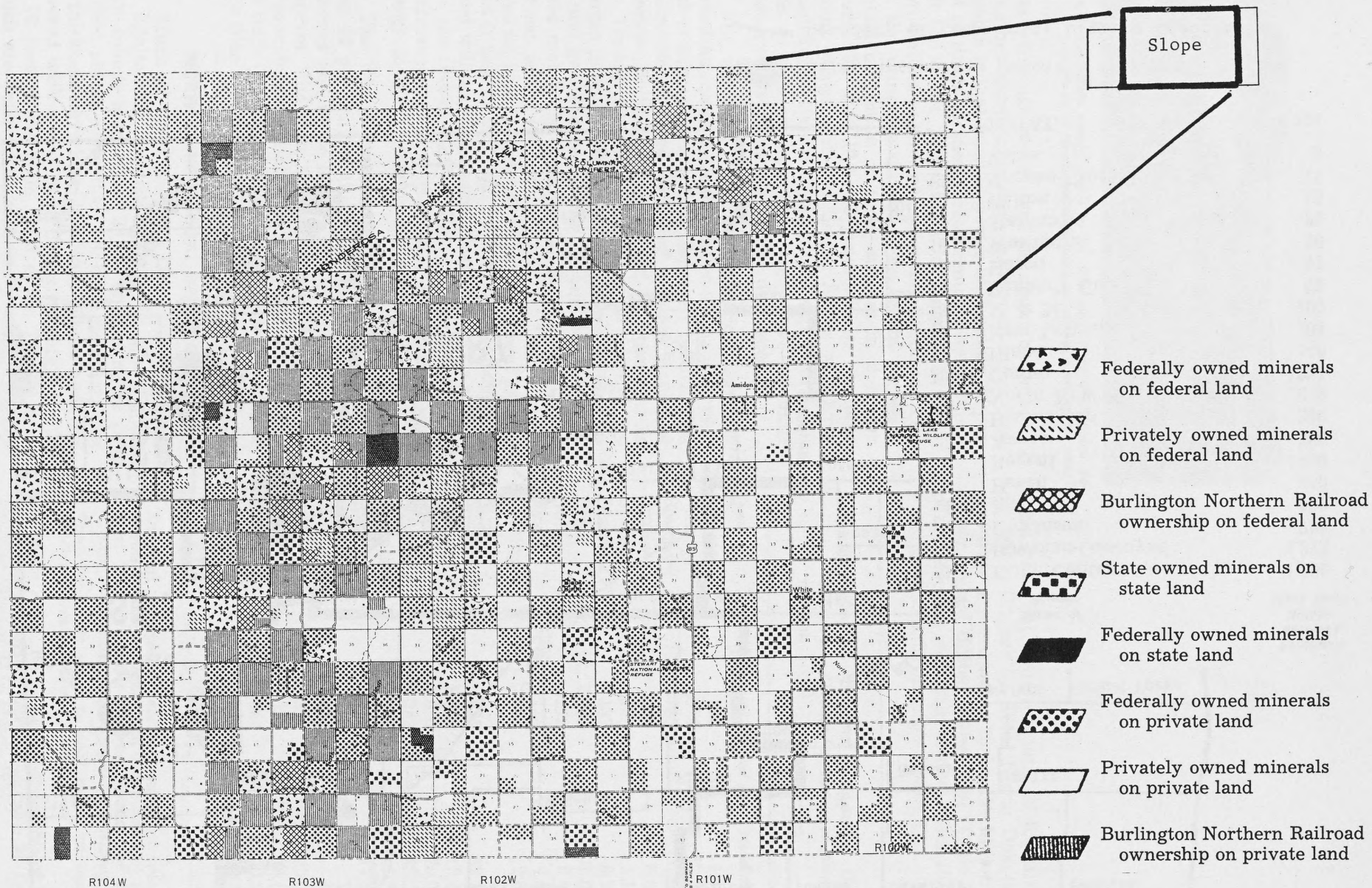


Figure 4. Surface and subsurface ownership patterns in a portion of Slope county, North Dakota.  
 (Source: Richard Ellison, U.S. Forest Service, Dickinson, North Dakota, 1973, unpublished).

**Table 2. Surface Land Ownership Acreage by State Planning Region, by Type of Ownership.**

State Planning Region	Total Land Acreage	BLM & Forest Service <sup>1</sup>	Bureau of Reclamation <sup>2</sup>	Federal Corps of Engineers <sup>3</sup>	NPS	Bureau of SF & W	Federal Sub-Total	
							Total Acres	%
SR 1	4,023,680	507,522	242	114,584	23,701	16,208	662,257	16.5
SR 2	6,851,840	5,802	28	70,190	—	156,680	232,700	3.4
SR 7	9,333,760	12,466	29,410	273,836	—	38,774	354,486	3.8
SR 8	6,447,360	576,600	2,282	64,804	46,010	4,237	693,933	10.8
<b>TOTAL</b>		1,102,390	31,962	523,414	69,711	215,899	1,943,376	7.2

State Planning Region	Bureau of Indian Affairs		State		Private, County & Municipal		
	Acres	%	Acres	%	Acres	%	
SR 1	89,180	2.2	130,615	3.2	3,141,628	78.1	
SR 2	21,666	.3	107,750	1.6	6,489,724	94.7	
SR 7	412,526	4.4	248,103	2.7	8,318,645	89.1	
SR 8	200,103	3.7	180,681	3.3	5,372,643	80.2	
<b>TOTAL</b>	25,656,640	723,475	2.7	667,149	2.5	23,322,640	87.5

<sup>1</sup> Forest Service Lands and Bureau of Land Management are Combined.

<sup>2</sup> Bureau of Reclamation and Agriculture Research Service Lands are Combined.

<sup>3</sup> Corps of Engineers and Military Lands are Combined (BIA).

**SOURCE:** Otis Copeland, **Surface Resources Work Group, Northern Great Plains Resource Program, 1974**, Unpublished data.

### Ownership of North Dakota's Coal Resources

As plans are formulated for extensive development of North Dakota's lignite, the ownership of the resource becomes a matter of considerable interest.

The land ownership patterns of western North Dakota can be described as incredibly complex (Figure 4). The area's land is divided between public lands under federal and state control, privately owned lands controlled by either individuals or business entities (e.g., railroad, oil, and coal companies), and Indian tribal lands. Coordination problems also exist because different regulations may apply to adjoining lands owned by the federal government, the state, private parties, or in tribal ownership and also because it is possible for the surface rights, mineral (sub-surface) rights, and water rights for a particular tract each to be owned by different parties and regulated by different levels of government.

Only a small portion of the total estimated lignite resources have been identified or defined, at least according to that information which is available to the public. Therefore, the concentration and distribution of lignite ownership is especially difficult to define, and only a general perspective will be presented here.

### Surface Ownership

A large percentage of the surface land owner-

ship is held by private individuals. Another major surface land holder is the federal government under the following managing agencies:

1. U.S. Forest Service (National Grasslands)
2. Bureau of Land Management
3. Corps of Engineers
4. National Park Service
5. Bureau of Sport Fisheries and Wildlife
6. Bureau of Reclamation
7. Agriculture Research Service
8. Military Lands

Table 2 contains the surface land ownership acreages by the various federal, state, private and Indian landowners for the four western State Planning Regions (SR 1, 2, 7 and 8). Private, county and municipal ownership together comprise almost 88 per cent of the total land base. The federal government has 7.2 per cent, tribal ownership comprises 2.7 per cent, and the state of North Dakota has control of 2.5 per cent of the total land base.

### Subsurface Ownership

The federal government is a major holder of subsurface ownership in western North Dakota. Table 3 summarizes the federal, state, private and Indian subsurface land ownership for state planning regions 1, 2, 7 and 8. In SR 1, federal subsurface ownership exceeds 48 per cent (1.94 million

**Table 3. Subsurface Land Ownership Acreages by State Planning Region, by Type of Ownership. (SR 1, 2, 7 and 8)**

State Planning Region	Total Land Acreage (acres)	BLM & Forest Service <sup>1</sup> (acres)	Bureau of Reclamation <sup>2</sup> (acres)	Federal Corps of Engineers <sup>3</sup> (acres)	NPS (acres)	Bureau of SF & W (acres)	Federal SubTotal Acres	%
SR 1	4,023,680	1,918,417	291	—	23,701	1,911	1,944,320	48.3
SR 2	6,851,840	487,324	6	4,757	—	132,096	624,183	9.1
SR 7	9,333,760	558,752	16,006	12,141	—	24,153	611,052	6.5
SR 8	6,447,360	2,177,536	43	1,190	45,930	2,431	2,227,130	34.5
<b>TOTAL</b>		<b>5,142,029</b>	<b>16,346</b>	<b>18,088</b>	<b>69,631</b>	<b>160,591</b>	<b>5,406,685</b>	<b>20.2</b>

State Planning Region	Bureau of Indian Affairs		State		Burlington Northern Railroad		Other Private, County & Municipal		
	Acres	%	Acres	%	Acres	%	Acres	%	
SR 1	103,440	2.6	130,615	3.2	126,959	3.2	1,718,348	42.7	
SR 2	107,475	1.6	107,748	1.6	—	—	6,012,434	87.7	
SR 7	549,675	5.9	248,103	2.7	472,200	5.1	7,452,730	79.8	
SR 8	255,200	4.0	180,681	2.8	539,845	8.4	3,244,504	50.3	
<b>TOTAL</b>	<b>26,656,640</b>	<b>1,015,790</b>	<b>3.8</b>	<b>667,147</b>	<b>2.5</b>	<b>1,139,004</b>	<b>4.3</b>	<b>18,427,016</b>	<b>69.2</b>

<sup>1</sup> Forest Service Lands and Bureau of Land Management are combined.

<sup>2</sup> Bureau of Reclamation and Agriculture Research Service Lands are Combined.

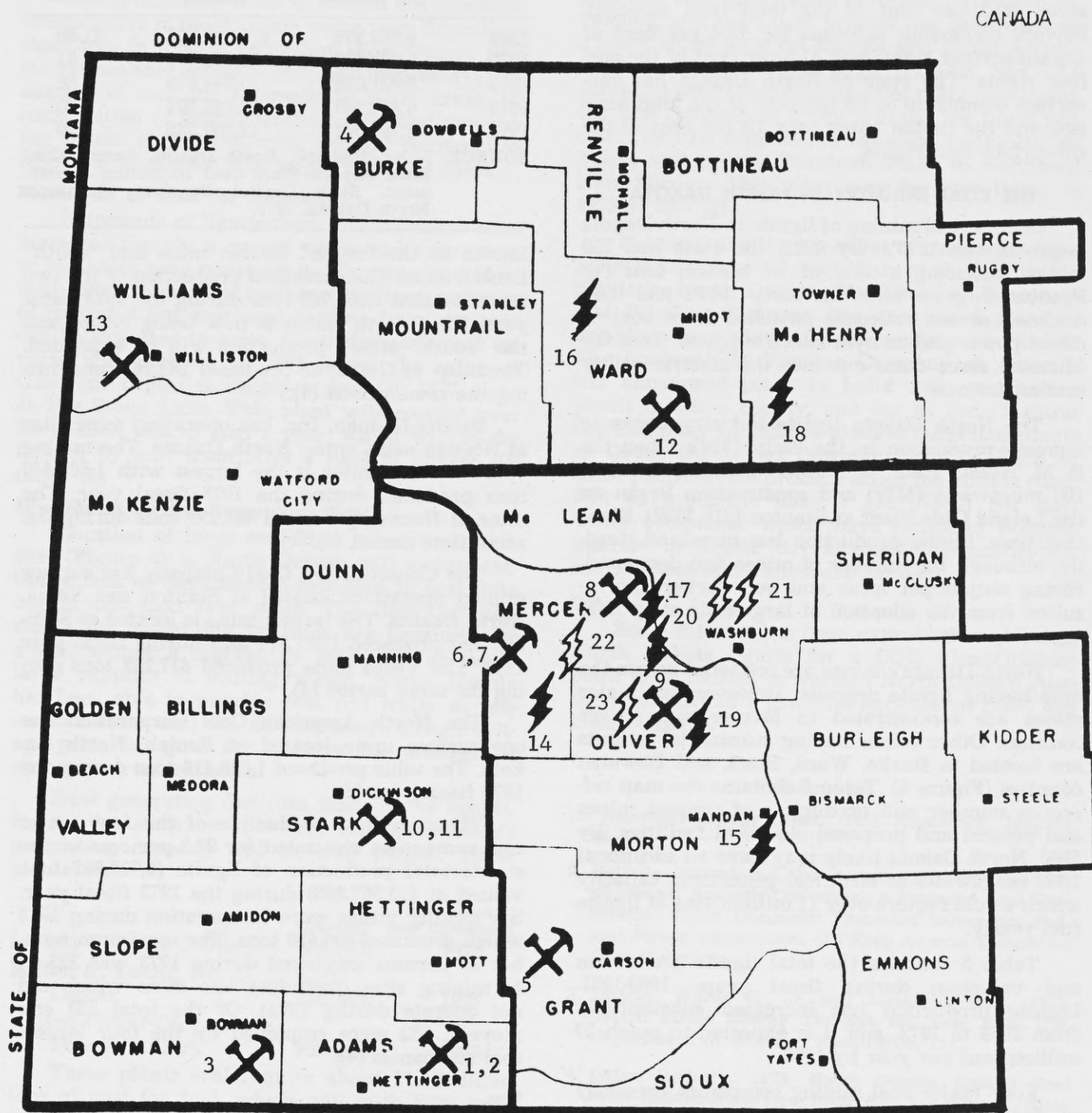
<sup>3</sup> Corps of Engineers and Military Lands are Combined (BIA).

**SOURCE:** Otis Copeland, Surface Resources Work Group, Northern Great Plains Resources Program, 1974. Unpublished data. Burlington-Northern Railroad, 1974. Unpublished data.

**Table 4. Map Reference Numbers and Production of Present and Proposed Coal Mines and Electrical Power Generating Facilities.**

Map Ref. Number	County	Target Year	Operation or Plant	Production (tons) or Capacity (megawatts) <sup>1</sup>
1	Adams	present	mine	2,332
2	Adams	present	mine	10,142
3	Bowman	present	mine	182,161
4	Burke	present	mine	482,299
5	Grant	present	mine	5,000
6	Mercer	present	mine	1,327,314
7	Mercer	present	mine	1,585,769
8	Mercer	present	mine	1,049,416
9	Oliver	present	mine	1,563,446
10	Stark	present	mine	2,709
11	Stark	present	mine	160,657
12	Ward	present	mine	417,732
13	Williams	present	mine	9,630
14	Mercer	present	steam-electric	13.5
15	Morton	present	steam-electric	100.0
16	Ward	present	steam-electric	10.0
17	Mercer	present	steam-electric	215.7
18	McHenry	present	steam-electric	34.5
19	Oliver	present	steam-electric	234.6
20	Mercer	present	steam-electric	172.0
21	McLean	1978-79	steam-electric	900
22	Mercer	1975	steam-electric	438.0
23	Oliver	1977	steam-electric	435.0

<sup>1</sup> In the case of a mine, production is in the 1973 fiscal year production tons. In the case of a steam-electric plant capacity is in megawatts (nameplate capacity). Only electrical generation plants utilizing lignite are considered.



STATE OF



Surface Mining Operations (Dark figures are present facilities)

Steam-electric Plants (Dark figures are present facilities)

The site locations within the county boundaries are not necessarily the exact location.

Figure 5. Location of present coal mines and present and proposed electrical power generation facilities.

acres), and in SR 8 it is almost 35 per cent (2.23 million acres). Of the total land acreage of 26.7 million acres in SR 1, 2, 7 and 8, the federal government has subsurface ownership of 5.4 million acres (20.2 per cent of the total land acreage). Private ownership accounts for 73.4 per cent of the subsurface rights and 87.5 per cent of the surface rights. The state of North Dakota has subsurface ownership of 2.5 per cent of the land acreage, and the Indian tribes own 3.8 per cent of the subsurface land rights.

### THE COAL INDUSTRY IN NORTH DAKOTA

Commercial mining of lignite in North Dakota began in the 1870's. By 1923, the state had 259 mines producing a total of 1.4 million tons (4). Production grew until the early 1950's and then declined as the railroads switched from coal to diesel power and as hydroelectric power from the Missouri river dams cut into the electric utility market for coal.

The North Dakota lignite industry began to increase production in the early 1960's when the R. M. Heskett Plant at Mandan was expanded to 100 megawatts (MW) and construction began on the Leland Olds Plant at Stanton (216 MW). Since that time, lignite production has increased steadily, although the number of mines had decreased. Rising output per mine and per worker has resulted from the adoption of large-scale strip mining equipment.

North Dakota's mines are scattered across the area having lignite deposits. However, the major mines are concentrated in Mercer and Oliver counties. Other mines having substantial outputs are located in Burke, Ward, Stark and Bowman counties (Figure 5). Table 4 contains the map reference number and production of present mines and present and proposed electrical facilities. By 1980, North Dakota likely may have an additional 1,773 megawatts of electrical generating capacity which would require over 11 million tons of lignite fuel yearly.

Table 5 contains the total lignite production and valuation during fiscal years, 1969-1973. Lignite production has increased substantially from 1969 to 1973, and it is expected to reach 20 million tons per year by 1980.

Four major coal mining companies presently produce 97 per cent of North Dakota's total lignite output. They are the Knife River Coal Mining Company, Baukol-Noonan, Inc., Consolidation Coal Company and the North American Coal Corporation.

The Knife River Coal Mining Company has surface mining operations at Beulah and Gascoyne, North Dakota, and Savage, Montana. The largest mines are located at Beulah and are

**Table 5. Total Lignite Production and Valuation, North Dakota, Fiscal Years 1969-1973.**

	Tons Produced	Valuation	Average Value Per Ton
1969	4,590,276	\$ 8,245,222	\$1.80
1970	5,001,828	9,053,676	1.81
1971	5,821,076	10,844,675	1.86
1972	6,343,769	12,045,301	1.90
1973	6,798,607	13,567,386	2.00

**SOURCE:** Iszler, Rudolph, *North Dakota Annual Coal Mine Report*, State Coal Inspection Department, State Capitol Building, Bismarck, North Dakota, 1973.

known as the "north" Beulah mine and "south" Beulah mine. The combined production of the two mines totaled 1,585,769 tons during the 1973 fiscal year. The "north" mine is now being closed and the "south" mine's production will be expanded. The mine at Gascoyne produced 182,161 tons during the same period (4).

Baukol-Noonan, Inc. has operating mine sites at Noonan and Center, North Dakota. The mining operation at Center is the largest with 1,563,446 tons produced during the 1973 fiscal year. The mine at Noonan produced 482,299 tons during the same time period (4).

The Consolidation Coal Company has surface mining operations located at Stanton and Velva, North Dakota. The largest mine is located at Stanton and produced 1,327,314 tons during fiscal year 1973. The Velva mine produced 417,732 tons during the same period (4).

The North American Coal Corporation has one surface mine located at Beulah, North Dakota. The mine produced 1,049,416 tons during the 1973 fiscal year (4).

The combined production of the four major coal companies accounted for 97.2 per cent of the state's total production of lignite (6,798,602 tons valued at \$13,567,386) during the 1973 fiscal year. Six smaller mines were in operation during 1973 which produced 190,470 tons. The maximum number of persons employed during 1973 was 323 at 14 mining sites (including one mine which did not operate during 1973). Of the total 323 employees, 302 were employed by the four largest coal companies (4).

### Use

The predominant use of North Dakota's lignite production is for electric power generation. In 1971, 84 per cent of the state's coal production was used by electric utilities in North Dakota, South Dakota and Minnesota. In 1971, 61 per cent of the electric power generated in North Dakota came from coal-fired plants. In 1971, 62 per cent of North Dakota's coal output was used within the state and 38 per cent was exported. Most ship-



ments out of the state went to Minnesota and to South Dakota (7).

### Future Development Potentials

Coal production in North Dakota has increased dramatically in recent years rising from 2.5 million short tons in 1960 to 6.8 million short tons in 1973 (4). Future coal development may involve: (1) production of coal for shipment to other areas, (2) construction of more coal-fired electrical generating plants within the area, and (3) construction of plants to convert coal to gas or liquid fuels.

### Production of Coal for Shipment

Shipments of lignite from North Dakota have increased sharply in recent years, and even greater increases have occurred in Wyoming and Montana. Unit trains allow movement of large volumes of coal at a low cost, and exports from the area can be expected to grow. North Dakota's coal exports will increase in 1975 when the mine at Gascoyne begins to supply a new 440 MW plant at Big Stone Lake. This plant will require over 2.5 million tons of coal a year, which will be delivered by unit train after a haul of almost 400 miles (5).

### Mine-Mouth Electric Generating Plants

Location of large coal-fired generating facilities (Figure 4) in North Dakota will almost certainly lead to considerable increases in coal mining in the next few years. The basic requirements for generating facilities are proximity to a fuel source, a market, or both, and access to large supplies of cooling water. North Dakota has been able to provide coal and water at reasonable costs, and the development of high voltage grids has gone far to solve the problem of economical transmission.

New generating facilities likely to be operating in the state by 1980 will triple the state's generating capacity and its coal output. These plants are:

	Capacity	Anticipated Date Operational
Leland Olds No. 2, Stanton	438 MW	1975
Milton R. Young, No. 2, Center	435 MW	1977
United Power-Cooperative Power, Falkirk	900 MW	1979

These plants will require about 11.3 million tons of coal for fuel, which will push 1980 total coal production past the 20 million ton level.

A number of electric power generating companies are planning for additional generating facilities in western North Dakota. For example, Montana-Dakota Utilities is planning an additional major facility for the Beulah area, and the Minnkota Power Cooperative has announced plans for a series of installations in the Cannonball valley.

### Coal Gasification

Coal can be converted to various gaseous forms as a substitute for natural gas. About 65 different coal gasification processes have been developed, and the Lurgi process has been used on a commercial scale (in Europe and South Africa). While other processes (e.g., HYGAS and CO<sub>2</sub> acceptor) are being tested in pilot plant operations, the first commercial plants will use the Lurgi process. The first commercial size plant in the United States will be the Burnham Plant in northwest New Mexico. This plant may be operational in 1976 or 1977 (2).

In recent months a number of companies have announced plans to establish coal gasification plants in North Dakota. The Michigan-Wisconsin Gas Pipeline Company has announced plans to establish four plants in the vicinity of Beulah. The Natural Gas Pipeline Company of America has announced plans to build four gasification plants in Dunn county, and the El Paso Natural Gas Company announced plans to build four plants in Dunn, Stark and Bowman counties. Each of these plants would produce about 250 million cubic feet of substitute natural gas (SNG) per day. Other companies which have indicated possible interest in lignite development for gasification are Tenneco and Panhandle Eastern.

### Other

Some interest has been expressed in utilizing North Dakota lignite for a COG (Coal-Oil-Gas) plant to be located in western North Dakota. Also the possibility of a uranium enrichment plant has been reported.

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