COAL MINING IN THE COAL-BEARING REGION OF NORTH DAKOTA, 1870-1945

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INTRODUCTION: STATISTICS AND TERMINOLOGY

In addition to the traditional sources of historical enquiry, this study makes extensive use of a computerized database developed by one of the authors to simplify the analysis of mine production statistics and related numerical data. The statistics themselves originate in the published annual and biennial reports of the North Dakota State Engineer and State Mine Inspector for the years 1908 to 1945.[1] Before that period, the state made only sporadic attempts to document its lignite industry; after that period, the industry passes beyond our purview -- fifty years or so being the customary divide for studies in historic preservation.

We did not take our statistical data directly from the original state reports. Instead, after spot checking for accuracy, we relied on a historical compendium of mining statistics prepared by John M. Kjos and Michelle H. Schreiner in 1984 for the Abandoned Mine Lands Division (AML) of the North Dakota Public Service Commission. Provided by AML with a list of over 600 field-verified mine locations, Kjos and Schreiner combed the state reports for matching site-specific production information. They succeeded in compiling production histories of varying completeness for 357 locations operating between 1908 and 1945 in twenty-one counties.[2]

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[1] In 1907, the North Dakota legislature required the licensing of commercial coal mines and the collection of statistical data on the industry. In that same year, the legislature also expanded the duties of the State Engineer to include mine inspection, with a particular emphasis on employee safety. In 1919, these responsibilities were transferred to the newly created position of State Coal Mine Inspector. The state's official mine inspection reports (biennial for 1907-1919; annual for 1920-1945) provide ownership, production, and employment statistics for licensed mines; occasionally, they also contain brief narrative descriptions of the workings. On the enabling legislation, see Colleen A. Oihus, <u>A History of Coal Mining in North Dakota, 1873-1982</u>, Educational Series 15 (Bismarck: North Dakota Geological Survey, 1983), 17-18.

[2] John M. Kjos and Michele H. Schreiner, "Technical Report: AML Cultural Resources Study, Volume 1," prepared by DSKS Research, J.V. for Abandoned Mine Lands Division, North Dakota Public Service Commission, 1984. The mine-specific data is contained in Appendix III of the study. As Kjos and Schreiner point out (p. 8), the field survey of the mine sites was conducted by Technical Planning Information, a Bismarck environmental

In reviewing the Kjos and Schreiner data at the outset of our own study, we were struck by how often mine sites altered or diversified their methods of mining. Not only did individual sites change from underground to stripping operations (and vice versa), but also from one type of underground mining to another: a drift mine succeeding a shaft mine, or a slope mine eventually replacing both.

Although it was not always possible to tell whether the new mining method was an addition to or a replacement of the original mode, the changes themselves seemed to offer valuable insight into the overall technological development of the North Dakota lignite mining industry. We therefore compiled production and employment statistics for each "mode" as well as for the entire location, calling the former a "mine" and the latter a "mine site" (see Appendix B for a profile of the 357 mine sites in the database).

Figure 1 reveals the nature and size of our database sample. Variations in sample size for certain categories reflect variations in original state record keeping for both different periods and different mine sites. The frequency of modal change is indicated by the fact that 357 mine sites yielded 558 mines. It is important to bear in mind that historic mine names rarely acknowledge these modal changes. For example, the Utter Coal Mine (32HT0033) in Hettinger County alternated several times between strip and underground methods during the 1920s and 1930s without any change in name.[3] Usually, a change in name reflected a

consulting firm, in 1981. Brief handwritten survey forms from this study are stored in the AML Office in Bismarck.

[3] The parenthetic notation is a site identification number assigned to North Dakota cultural resources by the Division of Archeology and Historic Preservation of the State Historical Society of North Dakota. It derives from a national method of record keeping known as the Smithsonian Institution Trinomial System Number. There are three main parts: a state indicator (32 for North Dakota); a county indicator (HT for Hettinger County); and an individual site number, usually assigned sequentially in order of entry within each county. For the remainder of

change in ownership rather than technology, although a new owner often did alter previous mining procedures.

As Kjos and Schreiner note in their study, their compendium (and therefore our database) does not include every mine mentioned in state reports. It only tracks those mines that matched 357 locations in the AML list. For all practical purposes, however, these 357 mine sites comprise the sample of field-verified, historically documented mining operations in the state. If one compares the total lignite production of this sample with the total production reported by the state during 1908 to 1945, the sample is short about 6.6 million tons in a total output of 53,585,000 tons -- a difference of 12 percent. In all likelihood, the shortfall is larger, since state bookkeeping almost certainly missed a number of mining operations each year. The discrepancy in production totals, however, may have little bearing on the representativeness of our database sample. Probably most of the excluded mine sites were small producers, like the vast majority of our database. Their inclusion probably would strengthen the trends noted in our study.

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this study, we will omit the state number (32) when referring to specific sites. It should be pointed out that notations for lignite mine sites in North Dakota occasionally contain an "X" immediately after the county abbreviation, such as HTX091. The "X" indicates that the site has been identified as a mine property (usually by the AML), but that it has not been officially inspected and recorded according to the standards of the Division of Archeology and Historic Preservation, which maintains an individual site file for every North Dakota property with a site identification number. For information on site numbering and recordation, see J. Signe Snortland and others, NDCRS Site Form Training Manual (Bismarck: Division of Archeology and Historic Preservation, State Historical Society of North Dakota, 1989).

LIGNITE AND THE GEOGRAPHY OF NORTH DAKOTA

Virtually all coal deposits in North Dakota belong to a variety of the mineral known as lignite, also called "brown coal" and "wood coal" because of its physical appearance. Altogether, there are six major varieties of coal: lignite, sub-bituminous, bituminous, semi-bituminous, semi-anthracite, and anthracite. According to S. M. Darling, a fuel engineer with the United States Bureau of Mines, this classification "rests partly on the percentages of volatile matter, oxygen and moisture contained in the coals . . . , [there being] a progressive loss of these elements in passing from lignite to anthracite." Darling, however, also points out that "chemical criteria alone are not a sufficient basis for such a classification." Distinguishing features are as much economic as physical:

> The dividing line is really determined by physical characteristics that directly affect the market value of the coals. . . . [Lignite] is brown, dull, markedly woody in texture, has no coking quality whatever, [and] carries a greater percentage of moisture. . . . This water is poor stuff to pay freight on or put into a furnace; further, its partial evaporation in warm weather causes rapid disintegration or "slacking," reducing the practical shipping radius [of lignite] during warm weather almost to zero.[4]

The largest deposits of lignite in the United States are found along the Gulf Coast and in the northern Great Plains (see Figure 2). The Gulf Coast deposit extends through parts of Texas, Louisiana, Arkansas, and Mississippi, while the Great Plains deposit includes sections of North Dakota, South Dakota, and Montana. In North Dakota, this deposit covers 28,000

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[4] S. M. Darling, "Sub-Bituminous and Lignite Coals," Railway Review 66 (26 June 1920): 1096. North Dakota lignite customarily contains, by weight, about 36 percent water and 30 percent fixed carbon, with a heating value of 6,000-7,000 BTU per pound. This contrasts with 3.5 percent water, 80 percent fixed carbon, and 13,000-14,000 BTU per pound for eastern Pennsylvania anthracite; see Irvin Lavine, Lignite Occurrence and Properties (Grand Forks: Department of Chemical Engineering, University of North Dakota, 1940), 26.

square miles in "practically all of the western half of the state."[5] In their statistical study of the North Dakota lignite industry, Kjos and Schreiner identified mine sites operating during 1908 to 1945 in the following twenty-one counties: Adams, Billings, Bowman, Burke, Burleigh, Divide, Dunn, Golden Valley, Grant, Hettinger, McKenzie, McLean, Mercer, Morton, Mountrail, Oliver, Renville, Slope, Stark, Ward, and Williams (see Figure 3).

The thickness of North Dakota's lignite seams varies from less than an inch to more than 35 feet. Geologist Irvin Lavine has noted that "where traced for any considerable distance the seam may grow thinner and finally pinch out entirely. Again, a thick bed of lignite may be split up into several by clay seams or clay partings, so that a single bed in one place may be represented a few miles distance by three or more beds." In general, however, North Dakota's lignite seams increase in frequency and thickness with proximity to the state's western border. Of the coal mined before 1945, the five thickest seams were located in Bowman, Golden Valley, Williams, and Divide counties, along the state line with Montana. These seams measured between 25 and 60 feet. In contrast, no seams thicker than 20 feet were mined before 1945 in Ward, Burleigh, and Grant counties.[6]

With its soft, relatively shallow overburden comprised of blue clay, sand, and small rocks, North Dakota lignite generally was accessible by both strip and underground mining techniques. As its name implies, strip mining involves tearing away the overburden to

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[5] Irvin Lavine, "Lignite in the United States," Fuel in Science and Practice 20 (January 1941): 17; W. A. Selvig, "Properties of Lignite in the United States," Fuel 32 (January 1953): 17; Frank A. Wilder, "The Lignite Coals of North Dakota," Economic Geology 1 (July 1906): 674; Walter B. Roe, "Geologic Features of North Dakota Lignite," Economic Geology 45 (August 1950): 434; Kjos and Schreiner, "Technical Report," Appendix III.

[6] Irvin Lavine, "Lignite Fuels of North Dakota," Minnesota Techno-Log, 8 (February 1928): 143; Wilder, 674; Roe, 434.

expose and remove the lignite seam. Historically, miners have employed strip mining when the coal lies close to the surface and the terrain is relatively flat.[7]

Underground mining encompasses three basic methods characterized by the type of entry into the mineral deposit: shaft, slope, and drift. In shaft mining, the miners sink a more-or-less vertical tunnel from the surface to the coal seam. The technique generally is confined to regions where the land is level and the seam is deep beneath the surface. In slope mining, on the other hand, the main tunnel lies at an incline. It is most commonly used when the seam is not quite close enough to the surface for strip mining. Finally, in drift mining, the main tunnel extends horizontally into the side of a hill.[8]

The lignite-bearing region of western North Dakota comprises three main geomorphological zones (see Figure 4). The first, known as the Coteau du Missouri, is located along the east side of the Missouri River and extends from "the northwest corner of the state to about the center in the southern border." Formed by heavy glacial deposits, the region displays "massive hills and ridge. . . hollows and undrained depressions."[9] Its uneven topography is evident in this description of a portion of Ward County:

> In this belt the slope of one hill so blends with that of the others about it that sloughs, pot-holes and lakes are inevitable. As one traverses the area he may pass for miles through a section where all the hills have about the same height, shape and regularity of arrangement, and then comes suddenly upon a broad

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[7] W. B. Pratt, "Lignite Progresses, Future Promising," Mining Congress Journal 26 (September 1940): 30; Gail Greenberg, The Coal Industry: Where To? (Stamford CT: Business Communications Company, Inc., n.d.), 39-40; Kristina Lindbergh and Barry Proverse, Coal: A Contemporary Energy Story (Scribe Publishing Corporation, 1977), 111-116.

[8] Lindbergh and Proverse, 44-45.

[9] J. M. Gillette, Social Economics of North Dakota (Minneapolis: Burgess Publishing, 1942), 13; W. E. Budge, Geology and Natural Resources of North Dakota (Grand Forks: University of North Dakota, Divisions of Mines and Mining Experiments, 1930), 15.

> amphitheater-like depression surrounded by a wall of hills, from which there seems to be no exit to the area beyond. Sloughs 100 feet below the average level are not uncommon, and small ones are so numerous that a dozen may be counted from a single hilltop in some parts of the belt.[10]

The lignite of the Coteau lies beneath a fairly deep glacial drift. As a result, the region contains a higher concentration of underground mines than other sections of the state, where lignite is closer to the surface (see Figure 5).[11]

The second major geomorphological zone in western North Dakota is the Missouri Plateau, in the area south and west of the Missouri River. To a certain extent, "plateau" is a misnomer, for the once-level landscape has been extensively eroded by streams that "branch out in all directions and extend into every part of the region, so that the surface is very largely reduced to slopes leading to some drainage course." The region is also dotted with a number of buttes, some rising 700 feet above the general surface of the land.[12]

In the Missouri Plateau, lignite often appears at the surface. A state geological survey of Morton County, for example, reported that throughout the area coal is concealed "but slightly," especially near the town of Sims, where "exposures of lignite are common in the hills."[13] Generally speaking, the Plateau's overburden is less solid than in the Coteau, which hampered underground mining in the area. As the U. S. Geological Survey noted in 1921:

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[10] Frank A. Wilder, State Geological Survey of North Dakota (Bismarck: North Dakota State Geological Survey, 1902), 89-90.

[11] Wilder, State Geological Survey of North Dakota, 98; E. J. Babcock, Report of the Geological Survey of North Dakota (Grand Forks: North Dakota State Geological Survey, 1901), 63, 70.

[12] Gauger, 17; Gillette, 13.

[13] Wilder, State Geological Survey of North Dakota, 147-149.

> One of the most serious obstacles to underground mining in this field is the character of the overlying shale, which is so weak that it can not be used as a roof. It is therefore necessary in many places to leave a portion of the lignite to form the roof, a necessity which prevents the mining of any but the thicker beds by this method.[14]

Because of the weaker overburden, the Missouri Plateau had more strip mines than underground mines (see Figure 6).

The third geomorphological region is the Badlands, along the Little Missouri River in the extreme western part of the state. Like the Plateau, this area owes its characteristic topography to erosion rather than glacial drift. Its streams have "cut deeply into the soft strata [and] dissected the region into a network of canyons, gorges, ravines, and gullies." The Badlands also display a large number of buttes, including Sentinel Butte in Billings County, which rises 3,300 feet above sea level.[15]

As in the Missouri Plateau, the lignite in the Badlands frequently shows at the surface, particularly along the Little Missouri River and its tributaries in Billings, Golden Valley, and McKenzie counties. In 1904, the state geological survey reported that near Medora, Billings County, "lignite outcrops in even the shallowest of coulees. Ranchmen seldom find it necessary to go far for fuel." In many sections of the Badlands, the exposed lignite has burned in the ground, and its remains, known as "clinker," are visible. In some cases, the heat of the burning lignite has affected the overlying clays, creating a red or pink clinker known as "scoria."[16]

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[14] Eugene T. Hancock, The New Salem Lignite Field, Morton County, North Dakota (Washington D.C.: U. S. Geological Survey, 1921), 24.

[15] A. G. Leonard, State Geological Survey of North Dakota (Bismarck: North Dakota State Geological Survey, 1908), 33-34.

[16] Leonard, 33.

In terms of both total production statistics and number of identified mine sites, lignite mining in North Dakota concentrated in the central and northwestern portions of the state (see Figures 4 and 7). These two regions contained the state's six most productive counties and accounted for roughly 70 percent of its total production to 1945. The central region contained the two counties with the largest production: Mercer (11,366,000 tons) and Burleigh (8,762,000 tons), as well as the sixth largest county: McLean (2,535,000 tons). The northwestern region contained the third, fourth, and fifth most productive counties: Ward (7,638,000 tons), Burke (5,825,000 tons), and Divide (3,432,000 tons). The only other county in North Dakota to produce over 1,000,000 tons by 1945 was Stark (2,425,000 tons) in the southwestern part of the state.[17]

[17] County production totals for 1908 to 1945 are based on the production statistics for the 558 mines in our database. As pointed out earlier in the text, these mines do not include all known lignite producers. The county totals may therefore underrepresent actual production, although the relative ranking of the counties in terms of lignite output is almost certainly the same.

LIGNITE MINING IN NORTH DAKOTA, 1870-1945

Historiographical Remarks

In 1925, the United States Coal Commission published an exhaustive, congressionally mandated, fact-finding study of the American coal industry. Among the numerous exhibits were national production and employment maps for 1920-1921, compiled from state and federal census data. These maps identified all counties annually producing more than 100,000 tons of coal, and all coal districts employing at least 1,000 miners. Of the twenty-four states represented, North Dakota was dead last in both categories, containing only one 100,000-ton county and 1,067 miners statewide. In terms of both employment and production, the state's contribution amounted to a scant two-tenths of one percent of the national total.[18] Although North Dakota almost tripled its coal output during the next twenty-five years, it never was a significant national producer during the pre-1945 period. Its peak annual production in 1943 -- 2.6 million tons -- still represented less than one-half of one percent of total national output.[19] Given these statistics, it is not surprising that national histories of the coal industry overlook North Dakota.[20]

There is nothing wrong, of course, in using a consideration of scale to define an area of study. It is a legitimate, time-honored technique for sharpening historical focus, even

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[18] Report of the United States Coal Commission, Part III (Washington, D.C.: United States Government Printing office, 1925), chart 1, facing 1050; chart 5, facing 1118; 1120.

[19] For yearly production statistics for North Dakota and the nation, 1900 to 1945, see North Dakota Coal Mine Inspection Department, Twenty-Seventh Annual Report (Bismarck, 1945), 7-8; Energy Information Administration, Coal Data: A Reference (Washington, D.C.: United States Government Printing Office, 1987), 37.

[20] There are no references to North Dakota in such standard works as A. T. Shurick, The Coal Industry (Boston: Little, Brown, and Company, 1924); Howard N. Eavenson, The First Century and a Quarter of the American Coal Industry (N.p., 1942); Keith Dix, What's a Coal Miner to Do? (Pittsburgh: University of Pittsburgh Press, 1988).

within a single state. Consider, for example, the relationship between the North Dakota coal industry and the 100,000-ton-per-year criterion that the U. S. Coal Commission customarily used to identify significant coal-producing sites. Before 1945, eight of the nine largest-producing mine sites in North Dakota achieved this level at least once, while the ninth fell short by only a few thousand tons. From a statewide perspective, these nine mines sites are in a class apart. They are the only ones that exceeded one million tons of total output before 1945. Together, they account for a staggering 62 percent of North Dakota's entire coal output for the period 1908 to 1945 (see Figure 8). The smallest of the group surpassed its nearest rival by 25 percent, while the group as a whole out-produced the ten next largest mine sites by tenfold. If North Dakota lignite was a valuable commodity for the state, then these top-producing mine sites would seem to merit special recognition and study.[21]

Outstanding production, however, is only one measure of importance. From both a social and technological standpoint, the commonplace often is more interesting than the extraordinary, since it tends to offer a better picture of actual conditions in an industry. For North Dakota, the 100,000-ton mine site is anomalous in virtually every respect. Representing less than half of the state's coal-producing counties, these large producers account for only two percent of the 558 mines with known locations and documented production histories between 1908 and 1945.

[21] Throughout this narrative, we will attempt to identify the most common historical name associated with a given mine site. Although the historical name refers to a site as though it were a single mining operation, the reader should bear in mind that many sites experienced modal changes, which, in terms of our terminology, means that they comprised more than one "mine" (for further clarification, see pages 1-2 above). In descending order, the nine top-producing mine sites are: Wilton Mine No. 2 (BL0038); Knife River Coal Company Mine (MEX065); Truax-Traer Company Velva Mine (WDX588); Truax-Traer Company Kincaid Mine (BKX779); Zap Colliery Company Mine (MEX455); Baukol-Noonan Mine (DV0011); Stevens Brothers Coal Mine (ML0194); Wilton Mine No. 1 (BL0030); and Lehigh Briquetting Company Mine (SK0069). Only the Stevens Brothers Mine failed to meet the annual 100,000-ton mark.

Far more representative of historic North Dakota coal mining are mine sites with less than 10,000 tons annual production. According to our database sample, this category is responsible for only 16 percent of the state's output between 1908 and 1945, but it embraces 65 percent of all mine sites in our sample. If we shift our attention from mine sites to the individual mines at these locations, we find that the under-10,000-ton category subsumes approximately 85 percent of all underground mines and 90 percent of all strip mines. The under-10,000-ton mine also makes up the majority of mining operations in almost every coal-producing county, as well as the vast majority (at least 78 percent) of all new mine openings in every decade between 1900 and 1945 (see Figure 9). Chronologically, geographically, and numerically, the under-10,000-ton mine site is the paradigm of lignite mining in North Dakota.

The small North Dakota lignite mine presents a difficult historiographical challenge. The typical under-10,000-ton mine remained in service only about six years. Because of its ephemeral nature, modest physical plant, and limited output, the small mine did not attract a lot of attention. Consequently, there are few contemporary documentary sources dealing with its operation.

But a lack of data is not the only problem. From a traditional historical point of view, the small coal mine is, by its very nature, a kind of period piece with limited relevance for the industry as a whole. Traditionally, historians tend to analyze an industry in terms of developmental stages, often invoking organic imagery, such as "birth," "growth," and "maturation," to convey a sense of increasing complexity. In this scheme of things, there is an inherent bias against discussing "early" types of industrial activity after a portion of the industry has accepted a more productive form of technology, even though the older methods may continue for decades.

A case in point is Colleen A. Oihus's otherwise admirable History of Coal Mining in North Dakota, 1873-1982, the only published overview of the state industry. Oihus introduces the small lignite mine as an important adjunct to homesteading in her first chapter, entitled "The Fledgling Industry, 1873-1900." In her second chapter, "The Busy Years, 1900 - 1920," she shifts her attention to the development of commercial, mechanized underground mining, progressing in the next chapter to the advent of large-scale strip mining in the 1920s and 1930s. For the most part, Oihus focusses on a few large mine sites that introduced or perfected various types of technology, and dominated the production statistics of their period. Although Oihus seems to recognize that small-scale lignite mining in North Dakota remained a viable economic activity into the 1940s, the logic of her narrative compels her to treat the small mine site as an irrelevant or atavistic enterprise.[22]

In our own history of the North Dakota lignite industry, we attempt to put both small-scale and large-scale mining into statewide and local perspective. In so doing, we hope to

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[22] Colleen A. Oihus, A History of Coal Mining in North Dakota, 1873-1082 (Bismarck: North Dakota Geological Survey, Educational Series 15, 1983). For a more detailed, but unpublished, history of the industry, see James C. Dahlberg, John M. Kjos, and Michele H. Schreiner, "Lignite Use and Development of the Lignite Industry in North Dakota, Volume 2," prepared by DSKS Research, J.V. for AML Division, North Dakota Public Services Commission, 1984. This study adopts Oihus's framework of periodization but shows more awareness of the continuing importance of "early" technology.

lay the foundation for evaluating the significance of all the state's historic mine sites.

Historical Overview

Native American inhabitants of the North Dakota region seem to have used lignite primarily as a pigment in ceremonial paint and as a grinding tool, although there is some archaeological evidence from as early as the Early Archaic Period (5,500 B.C - 2,800 B.C) that the material at least occasionally served as fuel. According to documentary sources, the area's lignite first attracted the attention of Euro-Americans during the Lewis and Clark expedition's winter encampment at Fort Mandan in 1804-5. The explorers' journals contain references to "coal" and "coal wood," probably mined with axes from exposed veins along the Missouri River.[23]

Use of lignite widened with increased American exploration and settlement of the North Dakota region. By the 1860s, it was known as a fuel to steamboat captains on the Missouri River. In addition, soldiers at Fort Stevenson, located on the Missouri River in present-day McLean County, mined lignite to burn with wood in their stoves.[24] The fort's commander wrote in 1867 that lignite was a godsend in this lightly forested region:

> A mile and a half from camp we have a rich coal mine which is easily accessible. Literally it is only a matter of stooping down to gather it up, the top beds being even with the ground on the slope of the ravine. This coal, which is extracted in hunks with a pick, is of excellent quality and very pure. It burns easily and is all consumed into cinders. It is providentially fortunate

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[23] Dahlberg, Kjos, and Schreiner, 8-12, 14-15.

[24] On the use of lignite by steamboats and military posts, see Dahlberg, Kjos, and Schreiner, 16-22. The army built four forts along the Missouri River in the North Dakota region between 1864 and 1872. All of the posts apparently experimented with lignite as a fuel, but, according to Dahlberg, Kjos, and Schreiner (20), "Fort Stevenson was reportedly the only one . . . that used lignite on a regular basis."

> for us and is used in all our stoves. The fuel is ten times easier to get this way than if we had to send out people to cut green wood or gather deadwood on the sand bars four or five miles from here or on the other side of the river. Economy of time, workmen, and steadier and longer lasting fires. This is what we gain by it.[25]

Like the garrison at Fort Stevenson, early residents of western North Dakota preferred to locate near major rivercourses, where there was some likelihood of finding timber. But for the majority of settlers who later staked their claims on the open plains, there was no native timber for either building or burning. As geographer Alvar W. Carlson has argued, lignite was an essential ingredient for the settlement of this treeless region:

> The availability of lignite as a fuel was probably as important as the availability of prairie sod as a building material in the establishment and sustenance of rural settlements in the region of the Great Plains. . . . Lignite heated the settlers' sod houses and enabled them to cook their food on the semiarid, virtually woodless plains of North Dakota. Without it, settlement certainly would have been more difficult and expensive.[26]

In western North Dakota, the homesteading era lasted from the 1880s to the 1920s. The ranchers and farmers who comprised this wave of settlement frequently mined lignite from their own or a neighbor's property. Mining also was permitted free of charge on the two sections in each township that were set aside as state school lands. The most common mining technique combined simple pick-and-shovel excavation with a liberal use of dynamite. Although it may have been easier to dig coal from a trench, it sometimes was feasible to

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[25] Lucile M. Kane, ed. and trans., Military Life in Dakota: The Journal of Philippe Regis de Trobriand (St. Paul: Alvord Memorial Commission, 1951), 159.

[26] Alvar W. Carlson, "Lignite Coal as an Enabling Factor in the Settlement of Western North Dakota," Great Plains Journal 2 (Spring 1972): 145. Kenneth W. Karsmizki reaches the same conclusions concerning the importance of lignite to homesteaders in his study of the initial settlement of the Havelock area of Hettinger County; see Karsmizki, "Havelock Coal Mining Area Historical Research and Site Inventory," Prepared by Western History Research, 1990, 7, 17, in Division of Archeology and Historic Preservation of the State Historical Society of North Dakota

burrow into a hillside: "A level is run in from the face of some bank . . . and the coal is taken out by the simplest and most economical method."[27] To reach more deeply buried lignite, settlers customarily employed horse-drawn plows, slip scrapers, or fresnoes, which were effective in removing up to 10 feet of overburden. The exposed lignite then was loosened with dynamite or crow bars and loaded into wagons, which were so commonly associated with this type of mining that the mines themselves generally were known as "wagon mines." According to one miner-settler near Mandan, a primitive wagon mine would yield each miner about one-and-one-half tons of lignite for a hard day's work. Since the typical homestead annually consumed about 10 tons of lignite, it was possible for a family to dig a year's supply of fuel in a few days. Mining generally took place in the fall and winter when there were few competing farm chores. The seasonal nature of the activity also was dictated by lignite's high moisture content. Upon prolonged exposure to air, the material dried out and crumbled into "slack," or dust, making it impossible to stockpile lignite for long periods or to ship it over long distances.[28]

No census was ever taken of wagon mines in western North Dakota. Carlson puts the number at 15,000 in 1910, an estimate based on his assumption that half of the region's 30,000 farmers owned a subsistence lignite mine at that time. Since he does not provide

[27] "The Lignite Industry of North Dakota," Scientific American 73 (2 November 1895): 279.

[28] The recollections of the Mandan settler are in Oihus, 8-9. For a good general discussion of homestead mining techniques, see Carlson, 148-149. Carlson, who interviewed several old-time settlers, is the source of the 10-ton-per-year consumption statistic. He also affirms that "the fuel requirement of a family could be satisfied with one or two days of intensive digging." The winter-mining norm was reversed at the U. S. Government Mine (WIX075) in Williams County, which operated from 1907 to 1926 under the supervision of the U. S. Bureau of Reclamation. This mine site provided fuel for electric and steam power pump-irrigation systems at Reclamation's Williston Project and Buford-Trenton Project. It ran during the summer and closed for the winter. See Oihus, 16; C. J. Blanchard, "The Call of the West," National Geographic Magazine 20 (May 1909), 433; MSF, Williams County, 44-47.

supporting documentary or oral-history evidence, it is impossible to evaluate the accuracy of this figure. Although the typical wagon mine may have begun as a subsistence operation, a fair number seem to have developed a commercial character, if only in terms of a local barter economy. As the United States Geological Survey recognized in the 1920s, it was virtually impossible to distinguish in a meaningful way between "wagon" and "commercial" coal mines anywhere in the United States: "All mines that produce 10,000 tons or more a year are classed by the Survey as 'commercial mines,' but the commercial class also includes much smaller mines, some of which have an annual output of 1,000 tons or less but produce year after year and show a fairly continuous existence."[29]

An excellent example of the wagon-mine type is the Abraham Youngquist Mine (MLX019, MLX265) in McLean County. When Scientific American remarked in 1895 that McLean County was notable for "mines worked by settlers to supply neighborhoods with fuel," it may have had this mine site in mind. Opened as a pick-and-shovel homestead operation in 1883, the Youngquist Mine was described in 1911 as "one of the smaller" commercial mines in the county. In that year, it produced a total of 400 tons, enough to satisfy the fuel requirements of about forty rural households. The Youngquist Mine remained in operation until 1941, sometimes yielding as little as 140 tons per year, sometimes as much as 1,200 tons. Since the price of lignite stayed in the $1.50-to-$2.00/per ton price range throughout this period, the mine site never made a great deal of money for

[29] Carlson, 151; F. G. Tryon and Sydney A. Hale, Coal in 1922 (Washington, D.C.: United States Government Printing Office, 1924), 527. As Carlson points out (152-153), Congress prohibited lignite mining on land homesteaded after 1917, reserving coal rights for the federal government. The stipulation apparently was not enforced for subsistence mining.

its owner. Yet its longevity suggests that it was an economically viable venture.[30]

Although subsistence-oriented wagon mines comprised the vast majority of lignite mines in North Dakota during the late nineteenth and early twentieth centuries, purely commercial ventures garnered most of the public attention. From the very beginning, commercial coal mining in North Dakota was associated with railroad development. This connection was common in other Western states as well, for railroads always were interested in developing cheap sources of coal for their locomotives. Despite the fact that North Dakota lignite ultimately proved to be a poor engine fuel, railroads continued to play a vital role in the state's mining industry. They created a large-scale market for lignite by linking fuel demand in the more populated eastern half of the state with fuel supply in the less populated western half.[31]

During the late nineteenth century, lignite mines opened along the main and branch lines of the state's three major carriers: the Northern Pacific Railroad, the Great Northern Railroad, and the Minneapolis, St. Paul and Sault Ste. Marie Railroad (Soo Line). The Northern Pacific was particularly important for the industry because it was the first to open the western part of the state. It also owned a good deal of land in the coal-bearing region. As part of an agreement to construct a line from Lake Superior to the Puget Sound, the company received from the federal government in 1864 more than ten million acres in North

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[30] "The Lignite Industry of North Dakota," Scientific American 73 (November 2, 1895): 279; Fifth Biennial Report of the State Engineer to the Governor of North Dakota for the Years 1911-1912 (Bismarck, 1912), 113; Kjos and Schreiner, Mine Site Forms, McLean County, 6-7, 9-11, in "Technical Report," Appendix III. Hereafter, the Kjos and Schreiner forms will be cited as MSF, county, page(s).

[31] For a discussion of the relationship between coal mining and railroading in general, see Priscilla Long, Where the Sun Never Shines (New York: Paragon House, 1989), 176-191.

Dakota along the proposed rail corridor. Because of its proximity to the rail line, the ceded land in the western part of the state quickly became prime location for commercial lignite mines. With lignite so widespread in the region, the first commercial miners rarely worked seams located away from trackage. The state's coal lands, observed Scientific American in 1895, "are worth no more than other lands unless they are contiguous to a railroad."[32]

As the Northern Pacific laid tracks westward from Bismarck in 1879, commercial mining immediately followed. In late 1879, the company sold a main-line site at the town of Sims in Morton County to Eber H. Bly and Charles W. Thompson, who embarked on the state's first successful commercial lignite venture. This transaction prompted the Northern Pacific management to consider whether future sales of lignite properties were in the company's best interests. For its coal lands in the far western states, the railroad had granted long-term leases to independent miners in exchange for a royalty on all coal mined from the site. In April 1880, the company adopted the same policy for Dakota Territory, stipulating that leases would not cover more than ten years or 640 acres. For the privilege of mining, lessees agreed to produce a minimum amount of coal to be sold only to the Northern Pacific at a "mutually acceptable price." The railroad's managers also decided to keep off the market certain coal lands that they believed might contain higher quality locomotive fuel than ordinary lignite.[33]

In addition to setting these policies, the Northern Pacific formed the Northern Pacific

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[32] "The Lignite Industry of North Dakota," Scientific American, 279; William S. Bryans, "A History of Transcontinental Railroads and Coal Mining on the Northern Great Plains to 1920" (Ph.D. diss., University of Wyoming, 1987), 117-118.

[33] Bryans, 125-126.

Coal Company in February 1882. This firm, which operated as "an adjunct to the railroad," was empowered to "purchase and hold mineral coal lands, to develop and operate coal mines, and to sell and deal in coal in any or all the several states and territories of the United States and elsewhere."[34] It purchased Bly and Thompson's mine in December 1882, renamed it the "Baby Mine," and installed $3,000 of new equipment at the site. The following year, the mine produced 50,000 tons of coal. While some of the lignite was mixed with bituminous coal and burned in Northern Pacific locomotives, most was sold to consumers in Mandan, Bismarck, and Jamestown. After the Northern Pacific expanded its lines into higher grade, bituminous fields in Montana in the mid-1880s, the Baby Mine curtailed its production, closing for good in 1887.[35]

Although the relationship between railroading and commercial mining was intimate, it was not always cordial. Spur lines were a common source of contention. Since railroads profited from freight traffic generated by the coal fields, mine operators argued that the carriers should shoulder the cost of spur-track construction to the workings. The Northern Pacific, however, contended that "the company was not justified in spending the necessary money for a spur to reach [a new mine] simply on the basis of promises." "A spur track to the coal mines," the railroad affirmed, "must be built solely with the idea of the volume of business that we may do from the mine." In questionable situations, the Northern Pacific

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[34] [Illegible signature], Office of Vice President and General Manager, Northern Pacific Railroad Company to Robert Harris, 9 February 1887, in Special Papers #62, Northern Pacific Railway Company Papers, Minnesota Historical Society. Hereafter this collection will be cited as NP.

[35] Bryans, 125-131; Oihus, 4. Between 1882 and 1885, the Northern Pacific Coal Company also operated two other mines in western North Dakota, one near Medora in Billings County and the other near Lignite in Burke County.

expected "the coal people [to] spend the necessary money for the track, we to reimburse them from time to time out of the business done."[36] The Great Northern probably spoke for all the North Dakota carriers when it turned down a spur-track request for a mine near Williston in Williams County in 1914:

> Our experience with trackage to serve lignite mines has been rather a trying one. As you know, we have constructed several spur tracks in the vicinity of Williston to serve lignite mines and all of these propositions have proved to be failures. For instance, I recall the L.R. Gibb mine, Thuet Bros. mine and the Bruegger mine[,] also one or two mines down towards Minot, [every one] of which have proved to be a failure.[37]

Freight rates were an even more volatile subject. Immediately after the division of Dakota Territory into two states in 1889, the new North Dakota legislature accused the railroads of hampering lignite development through excessively high freight rates, a complaint heartily endorsed by mine operators themselves. After investigative hearings seemed to substantiate the charges, the lawmakers imposed a lower rate schedule of their own, only to have their action struck down in federal court. In 1893, 1895, and 1903, renewed legislative attempts at rate control also met with failure. In 1907, the legislature tried still again, and this time, after extensive litigation, the new rate schedule was enforced for a brief period. In 1915, however, the United States Supreme Court nullified the legislature's victory by ruling that the 1907 schedule deprived the railroads of a reasonable

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[36] Howard Elliott to J. M. Hannaford, 22 September 1908, in President's File 910, NP.

[37] [Illegible signature] to J. W. Jackson, 15 April 1914, in File 6766, Great Northern Railway Company Records, Minnesota Historical Society (hereafter cited as GN). In 1920, the railroads' general opposition to paying for spur tracks received legal sanction: "At the conference in Bismarck on June 9th [1920] between representatives of the railway companies and members of the North Dakota Railroad Commission and various shippers, the understanding seemed to be clear that the railroads would not be expected to construct spurs to lignite mines except at the expense of the industry"; E. C. Lindley to R. Budd, 11 June 1920, in File 9448, GN.

profit.[38]

Despite the intense contemporary debate on the subject, the relationship between North Dakota lignite development and freight rates is unclear. According to the available statistics, the state's total commercial lignite tonnage increased in almost every year between 1890 and 1920 (see Figure 10). Between 1910 and 1920, when there is reason to believe that the statistics are fairly accurate, commercial output more than doubled from 416,580 tons to 878,969 tons. Although it is possible that prevailing freight rates retarded the industry's development, they certainly did not set it backwards.

During the late nineteenth and early twentieth centuries, the great preponderance of North Dakota lignite came from underground mines utilizing the room-and-pillar system of extraction, the most common underground mining method in American coal fields. In this method, miners horizontally moved through a coal seam and excavated alternating rectangular areas, leaving wide blocks of coal in place to support the ceiling. The resulting grid of "rooms" and "pillars" gave the method its name (see Figure 11). Since pillars might represent as much as half of the coal in a seam, it was common practice to remove, or "rob," at least part of the pillars while retreating from that section of the mine. Deprived of support, the mine ceiling soon collapsed, frequently causing noticeable subsidence, and sometimes pitting, of the "top-side" surface (see Figures 12 and 13).[39]

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[38] Richard G. Heinert, "The North Dakota Board of Railroad Commissioners, 1889-1916" (Master's Thesis, University of North Dakota, 1974), 35-50, 68-91, 129-131, 165-169; Twenty-First and Twenty-Second Annual Reports of the Board of Railroad Commissioners of North Dakota (N.p., 1912), 65-67; Twenty-Fifth and Twenty-Sixth Annual Report[s] of the North Dakota Board of Railroad Commissioners (Fargo: Walker Bros. and Hardy, 1916), 45-61.

[39] Our discussion of room-and-pillar mining follows Dix, 4-12; Frank H. Kneeland, Getting Out the Coal (New York: McGraw-Hill Book Company, 1926), 55-65. Since pillars often deformed and collapsed over time, surface subsidence also occurred above mines that did not rob the pillars; see C. Richard Dunrud, "Coal Mine Subsidence -

By its very geometry, the room-and-pillar method decentralized the underground work force into small groups laboring in relative isolation from one another. This practice was highly compatible with a labor-intensive, piece-rate industry that generally feared any form of collective activity by its workers. But as coal mining became more mechanized and unionized during the first decades of the twentieth century, mine management in some parts of the country attempted to centralize men and machinery in a more efficient common work space. Instead of individual miners at work in separate rooms, a large team attacked a single coal face in a long narrow chamber. This technique was known as "longwall mining."

Although common in Great Britain, longwall mining never became a significant factor in American coal fields before World War II.[40] In North Dakota, the only longwall operation that has been identified is the Ingison Mine (WX561) in Ward County. Established by J. W. Ingison at an undetermined date, this mine site is known to have operated between 1909 and 1911, producing between 400 and 1,200 tons per year with four to five employees. The State Engineer described the workings as they appeared in 1909:

> . . . A different plan is followed than is usually adopted. The room neck is driven in about a hundred feet and then is widened out to a width of thirty feet, and the work brought back toward the entry. This is in effect a sort of retreating long wall. The wall being thirty feet long, with the roadway in the middle and at right angles to it.[41]

- Western United States," Geological Society of America Reviews in Engineering Geology 4 (1984), 151-194.

[40] M. Albert Evans, "Longwall Mining in the United States," Steal and Coal 187 (9 August 1963): 258-261; Long, 40-41.

[41] Fourth Biennial Report of the State Engineer, 1909-1910 (Bismarck: Tribune, 1910), 97. See also MSF, Ward County, 171-172. In presenting statistical data on "system and method of mining," the state's first two mine inspection reports use the term "top mining" for four mines in Ward County: Diamond Coal Mine (WDX498), Hart Coal Mine, Vadneis Coal Mine (WDX504), and Westergaard Coal Mine. Although the State Engineer does not mention anything unusual about these mine sites in his narrative description of their operation, top mining may refer to a variant of longwall mining more commonly known as "top slicing." See Fourth Biennial Report, 1909-1910, 67-68; Fifth Biennial Report,77; Albert H. Fay, A Glossary of the Mining and Mineral Industry (Washington,

Ultimately, the economic advantage of longwall mining lay in its more efficient concentration of the mining operation.[42] It is doubtful, however, that the technique offered a significant advantage in North Dakota, where the average underground mine employed fewer than ten workers. For all practical purposes, such a small work force already was concentrated by the room-and-pillar method. Longwall mining also had one major economic drawback for North Dakota miners. Because of the greater work area along the coal face, longwall mining required more roof timbering than the room-and-pillar method. In treeless North Dakota, most mine timber was imported from neighboring states, making it "a serious item of expense."[43]

Traditionally, the extraction process involved a technique called "undercutting," whereby the miner cut a horizontal slit at the bottom of an exposed wall of coal with a pick. This task, performed by the miner while laying on his side, was perhaps the most difficult and time-consuming aspect of underground mining. After completing the cut, the miner drilled a hole in the seam with an auger and inserted explosives. He then detonated the charge and shoveled the loosened coal into a mine car for transport to the surface. Since undercutting typically consumed about half of a skilled miner's time, it is not surprising that mine owners eagerly sought a cheaper and faster method of extraction. By the end of the nineteenth century, the favored alternative was "blasting off the solid." In this method, the miner simply drilled and blasted, without any preparatory undercutting.

D.C.: United States Government Printing Office), 693.

[42] John A. Garcia, "Tradition Discarded to Make Possible New Era in Coal-Mine Engineering," Coal Age 31 (27 January 1927): 116-117.

[43] Fourth Biennial Report, 56.

Although blasting off the solid tended to shatter the coal into a lower-grade product, it speeded production and reduced labor costs. The technique was very popular in North Dakota during the early twentieth century. Of the eighty-one underground mines inspected by the State Engineer in 1909-1910, at least 77 percent blasted off the solid.[44]

As elsewhere in the country, the precise layout of North Dakota underground mines varied with the capital expenditures of the mine owner, the involvement of professional engineers, the training of the miners, and the character of the coal seam and overburden. In the early part of the twentieth century, the North Dakota State Engineer reported that rooms ranged in width from 10 to 25 feet and pillars from 8 to 16 feet, with entries "driven as narrow as possible to reduce the timbering expense." Very few mines attempted to retrieve all of the pillar coal; in 1925, the state average for coal-seam extraction was about 60 percent of the whole. Adequate ventilation seems to have been a constant problem, especially since many of the smaller mines had only a single entry into the workings. Pumping, however, was not a major concern, as "there are but few mines which have an excessive amount of mine water to contend with and many of them are entirely dry."[45]

In terms of physical plant, North Dakota underground mine sites varied as greatly as might be expected for a production spectrum ranging from a few hundred tons to over 100,000 tons per year. Generally speaking, larger operations utilized steam-driven,

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[44] For an excellent discussion of blasting off the solid, see Long, 134-135. In 1917-1918, the State Engineer indicated that 89 percent of the state's 149 licensed underground mines blasted off the solid; see Fourth Biennial Report, 1908-1910, 74-77; Eighth Biennial Report, 1917-1918, 92-98.

[45] Fourth Biennial Report 1909-1910, 56-57; Seventh Annual Report of the Coal Mine Inspection Department of the State of North Dakota (Bismarck, 1925), 4; Thirteenth Annual Report of the Coal Mine Inspection Department, State of North Dakota (Bismarck, 1931), 5.

electrical, or gasoline-powered haulage systems, while smaller ones relied on horsepower and manpower. After being delivered to the surface, the coal generally passed through some form of "tipple," an elevated structure that graded and chuted the material into storage bins or transport vehicles, usually wagons or railroad cars. There was wide technological variation even among the state's under-10,000-ton-per-year mine sites. Descriptions from the State Engineer's biennial report for 1917-1918 indicate how difficult it is to posit a "typical" North Dakota lignite operation:

> The coal is hoisted through the shaft by a team and cable where it is dumped from the tipple directly into wagons [Makee Coal Mine (BKX001), Burke County, 891 tons annual production].
>
> The coal bed is seven feet thick and reached by a short slope, through which the coal is hauled by means of a steam hoist. An endless chain is used to which the cars are fastened and hauled to the surface. They are lowered into the mine by means of a cable and drum. The tipple is provided with a chute having two screens, one inch and three-eighths of an inch, over which the coal is passed into wagons [Dougherty Coal Mine (DVX202), Divide County, 11,685 tons annual production].
>
> A horse is used to haul the coal from the mine to the tipple where it is either loaded into wagons or into a 20 ton storage bin [Big Four Coal Mine (WIX174), Williams County, 400 tons annual production].
>
> A tipple is provided with two chutes for loading the coal into wagons and small cars. A three mile narrow gauge track connects the mine with Miller Spur, over which the coal is hauled by a three ton Plymouth gas locomotive. A tipple is also provided at the spur for loading the coal into cars [Black Diamond Coal Mine (WIX088), Williams County, 8,793 tons annual production].[46]

Some North Dakota mine sites dispensed with even the most basic operating equipment. For example, the Sentinel Butte Coal Mine (GVX015), a 1,000-ton-per-year producer in Golden Valley County between 1914 and 1923, got by without a haulage system

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[46] Eighth Biennial Report of the State Engineer, 1917-1918 (Bismarck: Tribune Printing Co., 1918), 135, 138, 169. See also MSF, Burke County, 13-16; Divide County, 31-33; Williams County, 76-78, 113-115.

because customers were expected "to drive into the mine and load at the face."[47] Similarly, the 1,000-ton Paulson Coal Mine (DUX039) in Dunn County made do without a tipple: "the coal is hauled to the surface in sledges with a horse, and shoveled into wagons."[48]

The state's major underground mine sites in the early twentieth century included the the Mouse River Mine near Minot in Ward County, the Smith Dry Coal Company Mine (WDX488) near Kenmare in Ward County, and the Lehigh Mine (SK0068) near Dickinson in Stark County.[49] But none of these compared with the Washburn Lignite Coal Company's Wilton Mine No. 1 (BL0030) in northwestern Burleigh County. As the State Engineer commented in 1910, "The Wilton Coal Mine . . . is the largest and most completely equipped mine operating in the state. . . . The most up-to-date methods of handling coal are used in every respect."[50]

Wilton Mine No. 1 was part of a larger land scheme conceived by William D. Washburn, a wealthy industrialist and former United States Senator from Minnesota. In 1898, Washburn acquired 114,000 acres in Burleigh and McLean counties from the Northern Pacific Railroad. Although he intended to sell land to homesteaders, he was, as historian Francis Wold has noted, "very much aware of the lignite and from the beginning planned its development." Establishing his own railroad to serve the coal field, Washburn in 1899-1900 laid twenty-five miles of track northward from Bismarck to his newly platted town of Wilton.

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[47] Seventh Biennial Report of the State Engineer, 1914-1915 (Fargo: Walker Bros and Hardy, 1916), 135; MSF, Golden Valley, 4-5.

[48] Eighth Biennial Report, 141.

[49] Oihus, 3-8; MSF, Stark County, 34-36. The locations of the Smith-Kenmare and Mouse River mine sites have not been identified.

[50] Fourth Biennial Report of the State Engineer, 87.

In late summer of 1900, he began excavation of the 50-foot vertical shaft of Wilton Mine No. 1. Before the end of the year, the mine was producing 50 tons of lignite per day, most of it shipped via railroad to consumers in Bismarck and Fargo.[51]

Wilton Mine No. 1 did not introduce mechanized underground mining to North Dakota. That honor apparently belonged to the Lehigh Mine (SK0068), which in 1896 installed the state's first undercutting machine, a device that transformed the industry's most laborious, highly skilled task into a high-speed, common-labor activity.[52] Wilton Mine No. 1, however, did implement mechanized mining on a scale that was unique in the state. By 1910, the mine's electric generating plant provided power for virtually all of the undercutting, drilling, hauling, pumping, lighting, and ventilating in the underground workings. At that time, no other mine site came close to Wilton's work force of 250 or its annual production of 140,000 tons.[53]

In 1915, the Washburn Lignite Coal Company abandoned its Wilton Mine No. 1, which had been depleted by sixteen years of intensive mining, and moved to a site about two miles to the east. The new mine, known as Wilton Mine No. 2 (BL0038), quickly became the industry leader, surpassing the 300-employee mark and the quarter-million-ton annual-

[51] Francis Wold, "The Washburn Lignite Company: A History of Mining at Wilton, North Dakota," North Dakota History 43 (Fall 1976): 4-7.

[52] Dahlberg, Kjos, and Schreiner, 58. First developed in England in the 1850s, the undercutting machine made its appearance in the United States in the 1870s. It penetrated the coal face with either cutting blades, a puncher, or a loop of chain. The Lehigh Mine employed an electric-powered chain cutter manufactured by the Ohio-based Jeffrey Corporation, one of the leading producers of mining equipment during the late nineteenth and early twentieth centuries. The chain cutter was preferred by most mine operators because of its superior speed. See Dix, 28-32, 50-51.

[53] Fourth Biennial Report, 87; MSF, Burleigh County, 21-23. When the Wilton Mine No. 1 opened in 1900, mining machines were responsible for producing about 25 percent of American bituminous coal; by 1910, their share had increased to about 40 percent; see Tryon and Hale, 524; Coal Data: A Reference, 36.

production level before the end of the decade. In 1920, its annual production equalled about one-third of the state's yearly commercial output. The mine supplied fuel for nearly every state-owned building in North Dakota, as well as many privately-owned mills and power houses.[54]

Although some Washburn Company employees had previously worked as miners in the United States or Europe, a large number were area homesteaders who were new to the underground trade. For the most part, they saw mining as a cash-paying winter job rather than a future vocation.[55] The Washburn Company itself, however, was interested in eliminating the seasonal nature of the industry, which lowered return on capital investment by idling plant facilities for several months a year. In Europe the lignite industry had enhanced its profitability by developing a lignite brickette, which burned hotter and could be stored longer than the uncompacted material. In 1903, the Washburn Company considered purchasing a bricketting plant from Germany, but discovered that the European process was not completely suitable for North Dakota lignite.[56]

To help the state's lignite industry develop a brickette, the North Dakota legislature in 1908 appropriated $30,000 for the creation of a lignite experiment station at Hebron, under the supervision of Earle Jay Babcock, head of mining engineering at the University of North Dakota. Within a few years, Babcock had both a small mine and a model bricketting plant

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[54] North Dakota State Engineer, Seventh Biennial Report, 1915-1916 (Fargo: Walker Brothers & Hardy State Printers, 1916), 131-132; E. G. Wanner, "North Dakota's Largest Single Industrial Concern," North Dakota Good Roads Magazine 2 (15 April 1922): 12-14; Wold, 12-13; MSF, Burleigh County, 1-4.

[55] Wold, 8.

[56] Elwyn Waller and H. Stanley Renaud, "Lignite Briquets," Engineering and Mining Journal 82 (October 6, 1906): 637-640; "The Briquette Works," Minneapolis Journal, 10 March 1903; Letter to J. W. Jackson, 15 April 1914, in File 6766, GN.

in operation. In 1914, Babcock's work received its first large-scale commercial application in the new Minot factory of the Northern Briquetting Company. Supplied with lignite by the company's own Davis Mine located a few miles northeast in Burlington, the briquetting plant by 1916 was "turning out from 50 to 70 tons of good briquettes per day of ten hours."[57]

In 1917, another briquetting plant opened at the Johnson Fuel Company Mine (BOX023) in Scranton in Bowman County, but both it and the Northern Briquetting Company factory shut down in the 1920s. In the long run, neither operation was able to maintain reliable quality at a competitive price.[58] A third attempt at large-scale commercial briquetting occurred at the Lehigh Mine (SK0069) on the Northern Pacific Railroad near Dickinson in Stark County. Constructed in 1929, this plant exemplified a recently developed German method of briquetting known as the Lurgi Process. During its first years, the Lehigh plant struggled with mechanical difficulties and poor sales. The Northern Pacific Railroad believed that "the principal obstacle" was "the very limited market for the product within hauling range of the plant and the difficulty in disposing of by-products at a profit . . . . [Lignite briquettes] have a considerable transportation handicap to overcome in meeting . . . competition of the raw fuel . . . ." By the late 1930s, however, the Lehigh plant was processing about 80,000 tons of lignite per year, and it generally managed to

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[57] Oihus, 23-25; William O. Beck, "Earle Jay Babcock and North Dakota Lignite," North Dakota History 43 (Fall 1976): 4-20; Sixth Biennial Report, 1913-1914, 141; "Briquetted Lignite Coal," Power 43 (21 March 1916): 419-420.

[58] Eighth Biennial Report, 1917-1918, 134; MSF, Bowman County, 9-11; Dahlberg, Kjos, and Schreiner, 138-139. Inspired by Babcock's work, a group of investors in 1909 organized the Minneapolis-based National Briquetting Company to manufacture lignite-briquetting machines. Although the company purchased and operated for several years the Reeder Coal Mine (ADX048) in Adams County and the Smith Dry Coal Mine (WDX488) in Ward County, it apparently did not establish a commercial briquetting plant at either mine site; see "New Industry Begins," Minneapolis Journal, 9 June 1909; Sixth Biennial Report, 1913-1914, 145; Eighth Biennial Report, 1917-1918, 132-133, 166-167; MSF, Adams County, 25-27; MSF, Ward County, 132-135, 166-167.

sustain that level until closing in the 1960s.[59]

Since briquetting theoretically made it possible to ship lignite in a usable form to manufacturing and population centers outside of North Dakota, it initially seemed to represent the lignite industry's most promising avenue of development. But mine owners and operators also explored the alternative of bringing manufacturing directly to the mine site, thereby eliminating the lignite-shipping problem altogether. In certain cases, brick making seemed to be an especially suitable venture, since some mines were able to supply both clay as a raw material and lignite as a fuel. In Ward County alone, at least five mine sites were reported to be planning, building, or operating brick works before 1920. The state's most successful example was probably the Hebron Brick Company Mine (MOX139) in Morton County, which produced about 250,000 tons of lignite for its brick works between 1909 to 1939.[60]

The industry that became most closely associated with lignite mining was electric power. During the early twentieth century, several mines subsidized their own industrial generating plants by selling surplus power to neighboring communities.[61] By the 1920s,

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[59] MSF, Stark County, 41-45. "Vast Lignite Resources of Northwest to be Unlocked by N.D. Lehigh Plant," Commercial West (4 August 1925): 111-112; Newell G. Alford and Edward Prostel, "Briquettes from Carbonized Lignite," Mining Congress Journal 17 (April 1931): 194-197, 216; R. Dawson Hall, "North Dakota Plant Carbonizes Lignite at Mine Mouth," Coal Age 45 (August 1940): 47-48; H. E. Stevens to Chas. A. Pfeiffenberger, 16 July 1931, in President's File 910, NP.

[60] The Ward County mines included the Davis Mine of briquetting fame and the Kenmare Brick and Coal Mine (WDX514); see Dahlberg, Kjos, and Schreiner, 99; MSF, Ward County, 146-148. Wilton Mine No. 1 (BL0030) in Burleigh County also made bricks for a short period; see Wold, 9. On the Hebron mine site, see Coal Mine Inspection Department, State of North Dakota Eighth Annual Report, 1926 (N.p., 1926), 38-39; MSF, Morton County, 135-138.

[61] These included Wilton Mines No. 1 (BL0030) and No. 2 (BL0038) in Burleigh County; the Truax Mine (DVX196) in Divide County; the Aaby Light and Power Company Mine (HTX127) in Hettinger County; the Bitumina Mine (MLX012) and Garrison Coal Mine (MLX297) in McLean County; the New Salem Mine in Morton County; and the U. S. Government Mine in Williams County (WIX088). See Dahlberg, Kjos, and Schreiner, 98;

however, these quasi-commercial, mine-mouth plants had either been absorbed into or replaced by a regional transmission grid controlled by a public utilities company. Power was no longer a by-product of mining; it was an important end-product in its own right. In 1923, for example, the United Public Utilities Company took control of the Knife River Company Coal Mine (MEX065) in Beulah, Mercer County and improved the mine site with a commercial power plant. A few years later, the mine site passed to the North Dakota Power and Light Company, which counted on the Knife River mining operation to fuel its regional grid. As a company spokesman for the mining-power combine explained in 1932: "In addition to supplying electric service for 35 towns in southwestern North Dakota, [our company] furnishes steamheat in the cities of Mandan, Bismarck, and Dickinson. The electric generating stations, quite naturally, are large consumers of our coal."[62]

The association between lignite and electricity was even more forcefully demonstrated in 1928, when the Otter Tail Power Company purchased the state's most productive coal site

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Wold, 6; Wanner, "North Dakota's Largest Single Industrial Concern," 13; MSF, Divide County, 22-24; MSF, Hettinger County, 85-86; MSF, McLean County, 5a-5c, 87-89; MSF, Williams County, 76-78.

[62] M. C. Blackstun to Charles Donnelly, 9 June 1932, in President's File 1132-4, NP. See also Beulah, North Dakota, Golden Anniversary, 1914-1964 (Beulah: Jubilee Book Committee, 1964), 19, 24, 102; MSF, Mercer County, 34-39. The Beulah mining venture was originally organized as the Beulah Coal Mining Company in 1917; it was reorganized as the Knife River Coal Mining Company in 1922. From the beginning, the guiding spirit was Madison M. Mounts, who served as Knife River's superintendent until after World War II. The Knife River operation was able to meet the fuel demands of the North Dakota utility network by virtue of extensive mechanization. By the mid-1920s, several North Dakota mines employed mechanical drills and undercutters, but Knife River was the state's only underground operation that installed mechanical loaders at the coal face, replacing labor-intensive hand-shoveling into cars. This commitment to state-of-the-art technology was truly significant, for at that time, there were only about fifty underground mines in the entire country that extensively used mechanical loading at the coal face. Knife River also seems to have been unusual for the state in that it removed all roof and pillar coal. In 1926, Knife River for the first time surpassed Wilton Mine No. 2 in annual output, and it remained the state's leading underground producer until it was converted to strip mining in the early 1950s. See Coal Mine Inspection Department, Eighth Annual Report, 1926, 43-44; M. M. Mounts, "Underground Mechanization at Knife River," Mechanization 2 (March 1938), 14-17; L. E. Young, "Mechanization of Coal Mines," Mining and Metallurgy, 9 (August 1928), 355-356.

up to that time, the Wilton Mine No. 2 (BL0038), in order ensure an adequate fuel supply for its new 3,000-kw generating plant in nearby Washburn. The largest lignite-burning facility yet built in North Dakota, the Washburn Plant was a major link in a transmission system stretching over 200 miles eastward to Otter Tail's original base in western Minnesota.[63] According to statistics compiled by the Federal Power Commission, 20 to 25 percent of North Dakota's annual, commercial output of lignite was dedicated to electric power generation by 1941.[64]

In the same way that the adoption of mine-mouth industry maximized mine-site utilization, so, too, did the construction of a company town permit more efficient exploitation of labor. Since coal mines frequently started up in isolated uninhabited regions, a successful operation required some form of settlement to accommodate a resident work force. In addition to answering this purely logistical concern, the company town gave mine owners additional profits from house rents and store sales. The towns also gave management a powerful tool for policing its work force, since removal from the company payroll meant not only the loss of a job, but also a home. Few disputed the U.S. Department of Labor's conclusion in 1917: "A housed labor supply is a controlled labor supply."[65]

As Frederick Lynne Ryan noted in the 1930s, "coal mining communities have similar

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[63] Ralph S. Johnson, The Power People: The Story of Otter Tail Power Company (N.p., n.d.), 21-22; MSF, Burleigh County, 1-4. In 1930, Otter Tail Power leased the Wilton Mine No. 2 to the Truax-Traer Coal Company.

[64] C. E. Needham, ed., Minerals Yearbook, 1942 (Washington, D.C.: United States Government Printing Office, 1943), 904.

[65] Leifur Magnusson, "Employers' Housing in the United States," Monthly Labor Review, No. 5 (Washington, D.C.: United States Government Printing Office, 1917), 879, as quoted in Margaret M. Mulrooney, A Legacy of Coal: The Coal Company Towns of Southwestern Pennsylvania (Washington, D.C.: Historic American Buildings Survey/Historic American Engineering Record, National Park Service, U. S. Department of the Interior, 1989), 9.

social, political, and economic patterns in all coal-producing regions of the United States. Their prototype is the Pennsylvania coal town."[66] Recently, architectural historian Margaret M. Mulrooney has attempted to define the salient physical characteristics of the Pennsylvania coal town, which came into existence in the mid-nineteenth century. As outlined below, her findings emphasize the degree of company control over the communities and the rudimentary quality of their architecture:

1. The town was entirely financed, built, and maintained by one mining company.

2. The town was laid out in a grid or linear pattern within a 15-minute walk of the mine entrance.

3. Since mines often had a short lifespan, the town was considered a temporary settlement and houses were constructed as economically as possible.

4. The most common dwelling type was a standard-plan detached or semi-detached house, usually arranged in anonymous rows.

5. Architecture reflected the social stratification of the work place: dwellings for mine management were more elaborate than those for miners.

6. The company store occupied the most prominent location in the town, with other important public buildings nearby.[67]

The Pennsylvania coal-town model seems to have relevance only for the largest mining operations in North Dakota. Of the nine mine sites that exceeded the 100-employee level before 1945, seven played host to company coal towns.[68] These are also the only

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[66] Frederick Lynne Ryan, The Rehabilitation of Oklahoma Coal Mining Communities (Norman: University of Oklahoma Press, 1935), 34-37.

[67] Mulrooney, 12-19.

[68] The two excluded mine sites are in Mercer County: the Knife River Mining Company Coal Mine (MEX065) near Beulah and the Dakota Colliery Company Mine (MEX0137) near Zap. Both mine sites were within walking distance of their neighboring town, which apparently had sufficient housing to accommodate the mines' workers.

towns of this type that have been identified for the pre-1945 period. The earliest was Chapin, erected by the Washburn Lignite Coal Company at its Wilton Mine No. 1 (BL0030) in 1900. It eventually included a schoolhouse, company store, company offices, seventy-five-bed boarding house, mine manager's residence, and about thirty miner's houses. Within a few years, Chapin apparently had covered its allotted area, for in 1907 the Washburn Company built another settlement, named Langhorn, to the south of the mine site. When the company abandoned Wilton Mine No. 1 in 1915, it moved the buildings from Chapin and Langhorn to its new Wilton Mine No. 2 to form the nucleus of a third company town known as Macomber. During the 1920s, other company coal towns were founded by the Zap Colliery Mine Company (MEX455) near Zap in Mercer County, the Steven Brothers Coal Company (ML0194) near Garrison in McLean County, and the Truax-Traer Coal Company near Velva (WDX588) in Ward County and near Kincaid (BKX779) in Burke County.[69]

Since the vast majority of North Dakota mine sites employed fewer than ten workers during any given year, it is not surprising that company towns were relatively rare in the

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[69] Wold, 5-10; Kathe L. Lemmerman, Columbus/Noonan Study: The Impact of Coal Development and Decline on Two North Dakota Communities (Denver: Northern Great Plains Resource Corporation, 1974), 42; A.H. Truax, "Modern Strip Mining in North Dakota," Mining Congress Journal 15 (September 1929): 704; "Main Street and Miner's Homes," Minot Daily News, 20 October 1927; Dahlberg, Kjos, and Schreiner, 133, 147-149, 183. Apparently, none of these company towns remain. When their associated mines closed, the town buildings were sold and removed from the locations. Contemporary observers commonly referred to certain North Dakota communities as "coal mining towns," such as Haynes and Reeder in Adams County, Scranton and Bowman in Bowman County, Columbus and Larson in Burke County, Underwood and Wilton in Burleigh County, Noonan and Crosby in Divide County, Coalbank and Havelock in Hettinger County, Beulah and Zap in Mercer County, Zenith and Lehigh in Stark County, and Burlington and Kenmare in Ward County. All of these towns were in the coal fields, and all benefitted economically from the local mining industry; some even were platted by mining interests. But none of these appears to have been managed as a private housing preserve by a mining company. See Oihus, 15, 96-97; Dahlberg, Kjos, and Schreiner, 89-92.

state's lignite industry.[70] Most mining operations were able to quarter their employees in a bunkhouse or a few cabins. At many small mines, labor relations probably were as informal as the living arrangements. Consider, for example, the 1,000-ton-per-year Teuber Mine (ME142) in Mercer County, which operated with a handful of workers from 1927 to 1942. As one former employee recalled, terms like "management" and "labor" were highly relative:

> In those days, you know, we just went in there and worked, and there were only one or two men. One guy was the boss and the other was the helper. If the main boss wasn't there, the other guy was the boss. If one guy decided he had to go to town to celebrate for a few days, the other guy would take over.[71]

Although labor-management conflicts were noted at North Dakota's mines as early as 1907, the influence of organized labor was not pronounced until the formation of the state's first chapter of the United Mine Workers of American (UMWA) at Wilton Mine No. 2 in 1917. Founded in 1890, UMWA represented mine workers in every coal-producing region of the United States by this time. As a result of unionization, pay for miners and maintenance workers at the Wilton mine almost immediately doubled.[72] The union's power became apparent throughout North Dakota during the national coal strike of 1919. Two years earlier, the country's lignite and bituminous miners had agreed to freeze their wages

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[70] The statistic is based on our study sample of 357 mine sites operating between 1908 and 1945. Only 12 percent of the sample employed more than twenty workers in a single year; only 6 percent surpassed the fifty-employee mark.

[71] Interview with George Moorman, 12 November 1983, in North Dakota Cultural Resources Survey Form for 32ME142, 1983, in North Dakota State Historical Society.

[72] Greenberg, 61-62; Wold, 9, 13-14; "1,500 Lignite Miners Would Go Out November 1 Under Original Order of United Mine Workers," Bismarck Tribune, 28 October 1919, p. 1. Coal Age reported two small strikes in 1917, but did not indicate their location or cause. It only noted that they were "of short duration" and "had no appreciable effect on production." See J. W. Bliss, "Activities in Different Coal Producing States in 1917," Coal Age 13 (19 January 1918): 96.

for the duration of World War I, or until 31 March 1920. But as the war drew to a close, demand for coal diminished, causing a marked reduction in the average miner's work week and income. In response, UMWA called upon the nation's mine operators to approve a 60-percent pay increase, a six-hour day, a five-day week, and an end to the double-shift system. The owners refused, contending that such measures would raise wages 153 percent, cut production in half, and double prices for consumers. They also noted that the war was not officially over and therefore the miners were still bound by the 1917 agreement. UMWA called a strike for 1 November 1919.[73]

Although union miners and mine operators in North Dakota had a separate contract from the rest of the nation, the local UMWA leadership announced that its membership would strike in solidarity.[74] North Dakotans were well aware that this action portended disaster. In 1919, UMWA represented about 1,500 workers in the state's lignite industry. As one labor official noted, "Every mine of any consequence but one in North Dakota is organized. The Mine Workers in this state control about seventy percent of the total production." Winter was coming, and North Dakota needed lignite to heat its homes. To ward off the strike, North Dakota Governor Lynn J. Frazier met with UMWA District President Henry Drennan, who agreed to keep the mines open in exchange for a 60-per cent

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[73] Oihus, 20-21; see also "The Criminal Coal Strike," Railway Review 65 (8 November 1919): 693-694.

[74] Our discussion of the 1919 strike follows Nancy Hesseltine Balazadeh, "The Process of Power and the Relative Autonomy of the State: Nonpartisan League in North Dakota, 1915-1922," (Ph.D. diss., Southern Illinois University, 1988), 197-279. See also "1,500 Lignite Miners Would Go Out on November 1 Under Original Order of United Mine Workers," 1; "Miners Quit as Winter Tightens Grip in State," Bismarck Tribune, 8 November 1919, pp. 1,3; "Washburn Lignite Co. Gives Up Property Under Protest; Claims Frazier's Actions to be Unlawful," Bismarck Tribune, 13 November 1919, pp. 1, 4; "Frazier Today in Possession of State Mines," Bismarck Tribune, 15 November 1919, pp. 1, 4; "Martial Law's Reign in State Virtually Ends," Bismarck Tribune, 23 December 1919, p. 1.

pay raise, which would be donated to striking miners in Montana. The Governor also promised that no lignite would be shipped out of North Dakota, where it might be used to break the strike in other districts. North Dakota operators, however, refused to accept the agreement, causing the union to walk out on 7 November 1919. Five days later, Governor Frazier declared martial law and reopened the mines under state supervision. The strike ended in December, when the state's miners accepted a 14-percent pay increase, anticipating by a few weeks a similar settlement on the national level.[75]

Labor strife returned to North Dakota in 1922. In the spring of that year, UMWA called a national walkout that matched the 1919 strike in intensity and far exceeded it in duration. Despite its disruption of local production, the 1922 strike stimulated the state's lignite industry. In the North Dakota coal fields, the labor disturbance lasted on the average about two months, but nationally it went on for more than twice that long.[76] Before the post-war labor disputes, North Dakota had relied on out-of-state fuel -- primarily Eastern bituminous and anthracite -- for slightly more than half of the annual coal tonnage it consumed. In 1922, however, the prolonged strike so effectively shut off the Eastern supply that many consumers switched to lignite, and a goodly number did not go back. Reflecting the impact of the 1922 strike, the state's annual commercial production of lignite increased by 60 percent from 1921 to 1923. By 1929, annual production was up more than 100 percent from the 1921 level (see Figure 10). At the same, the state's reliance on out-of-state

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[75] The state's miners had achieved other gains earlier in the year, when the state legislature passed the North Dakota State Coal Mining Act, establishing the eight-hour work day and prohibiting the employment of those under sixteen years of age; see Oihus, 17-18.

[76] David J. McDonald and Edward A. Lynch, Coal and Unionism: A History of the American Coal Miners' Unions (N.p.: Lyndald Books, 1939), 156-158; Tryon and Hale, 517-519, Plate V.

coal plummeted. In 1929, only 28 percent of the coal consumed in North Dakota originated in other states -- about a 50-percent drop since the beginning of the decade.[77] In assessing the effect of the 1922 strike, North Dakota mine operator A. H. Truax remarked in 1929:

> North Dakota retailers suddenly accepted lignite as their own . . . . Not all of the territory won during the strike was retained. Governing freight rates set up a line beyond which this low heat fuel may not be economically shipped. However, almost overnight the field of lignite consumption was more than doubled . . . . Since the time of the strike, the industry moved steadily forward.[78]

According to Truax, the North Dakota lignite industry was able to meet the increased demand of the 1920s because of the emergence of large-scale, power-shovel strip mining. Invented in 1839, the steam shovel made its American coal-mining debut in the bituminous fields near Pittsburgh, Kansas, in 1877; soon afterward, it found favor among anthracite owners in Pennsylvania.[79] Capable of rotating its dipper through only a small arc, the nineteenth-century power shovel had limited range and maneuverability; it was most suitable

[77] According to federal statistics, North Dakota in 1918 consumed 1,509,407 tons of coal, "of which 45.8 percent was lignite, 43.4 percent originating at the lake docks [ie., Eastern coal shipped through the Great Lakes] and the remainder having origin in Illinois, Montana, Wyoming, and Canada." The federal authorities calculated the state's lignite consumption as 85 percent of total commercial production; the remaining 15 percent represented the annual lignite tonnage shipped out of the state. In 1925, North Dakota state authorities acknowledged that there were no reliable coal consumption statistics since 1918, but they estimated that "today probably more than 50 percent of the fuel used in the State is lignite." They accepted the earlier federal statistic for in-state lignite use: "Conservative estimates show that fully 85 percent of all lignite produced in North Dakota is consumed within the state." See Board of Railroad Commissioners, Case No. 1944, 2-3 November 1925, 264-265, in State Archives, State Historical Society of North Dakota. In the late 1920s, the North Dakota Public Service Commission began compiling annual statistics on total tons of anthracite and bituminous coal carried into the state as a terminal load. These figures show that imported coal tonnage declined from 639,627 in 1929, to 368,477 in 1935, to 271,689 in 1939. Over this same period, the state's reliance on out-of-state coal, on a tonnage basis, dropped from 28 percent of total consumption in 1929, to 19 percent in 1935, to 13 percent in 1939 (these percentages also reflect a 15-percent correction for lignite "exports"). See North Dakota Public Service Commission, Annual Reports of Railroads, 1929-1939 in State Archives.

[78] Truax, 674-675.

[79] On the early use of power shovels in coal mining, see the following articles in Coal Age: E. C. Drum, "Economy of Mining Coal by Stripping," 12 (22 December 1917), 1055-1056; Grant Holmes, "Early Coal Stripping Full of Heartbreak," 25 (29 May, 15 June 1924), 797-800, 835; "Stripping," 41 (October 1936): 412-413.

for coal fields with less than 15 feet of overburden. In such areas, mine operators often found it more economical to use simple plow-and-scraper excavation, which, except for its larger commercial scale, was essentially the same technique employed in homestead strip mining:

> The usual method of exposing the coal was in long pits; first an oblong section along one edge of the field was plowed up, and then the scrapers took off the loose dirt. The piece was plowed again. Thus by alternate plowing and scraping, the bed was finally reached; the overburden being piled in a long mound overlooking the pit. Teams and wagons hauled out the coal during the winter, and the next summer a new block parallel to that just taken out, was stripped, the waste being dumped into the abandoned cut.[80]

Large-scale mechanized strip mining did not attract the serious attention of American coal-field operators until after 1911, when both the Marion Steam Shovel Company of Marion, Ohio, and the Bucyrus Steam Shovel Company of South Milwaukee, Wisconsin, put on the market a heavy-duty, fully-revolving power shovel capable of removing up to 50 feet of overburden. Like their nineteenth-century predecessors, these first units were mounted on railroad tracks, but equipment manufacturers soon offered increased mobility in the form of "walking" models, based on caterpillar-tread combat vehicles developed during World War I. Strip miners finally had a durable and maneuverable excavating machine that seemed to offer a competitive edge over room-and-pillar underground mining. In 1917, an advocate for strip mining listed the technique's new-found advantages: "All coal deposits recovered . . . no underground ventilation or drainage system . . . no accidents from falling roof . . . no mules

[80] Holmes, 797.

. . . no artificial lighting system unless the pit works at night . . . no miners . . . ."[81]

Although the North Dakota State Engineer reported the occasional use of steam shovels in stripping operations between 1910 and 1919, mechanized strip mining did not come into its own until the next decade.[82] The 1920s saw the opening of five large-scale stripping operations, whose combined output by the end of World War II represented about 30 percent of all commercial lignite mined in North Dakota between 1908 and 1945.[83]

The acknowledged leaders in North Dakota strip mining were the brothers A. H. and E. M. Truax. The pair had been involved with lignite mining since at least 1902, when they opened an underground mine site (DV196) in Divide County. In 1918, they shut down their Truax Coal Mine and relocated to Burke County. During the national coal strike of 1922, the Truax brothers correctly saw that "the demand [for lignite] was coming and it was time to expand to meet the expected business." They immediately invested in the state's first large stripping shovel, a 175-B Bucyrus model capable of moving three-and-one-half cubic feet of fill with each cut. Since UMWA had not organized the North Dakota strip mines, the

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[81] E. C. Drum, 1056. On the development of the early twentieth-century stripper, see Harold Barger and Sam H. Schurr, The Mining Industries, 1899-1939 (New York: National Bureau of Economic Research, Inc., 1944), 138-140; John Timmons, "A New Method of Mining Coal," Scientific American Supplement 81 (1 January 1916), 12; "A Half Century in Stripping and the Next Ten Years," Coal Age 66 (October 1961), 180-182; R. H. Sherwood, "The Development of Strip Mining," Mining Congress Journal 31 (November 1945): 31-34; Holmes, 835-839.

[82] The strip mine sites, with recorded dates of power-shovel mechanization, are as follows: Anderson Mine, 1910, Burke County; Sunlight Coal Mine, 1917, Burke County; Leff Mine (ADX049), 1918, Adams County; Johnson Fuel Company Coal Mine (BOX023), 1918, Bowman County; Crockett and Company Coal Mine (BK0927), 1919, Burke County. See Oihus, 110-113.

[83] These mine sites, with dates of opening, are Truax Coal Company Mine (BK927), 1922, Burke County; Steven Brothers Coal Mine (ML0194), 1922, McLean County; Zap Colliery Mine Company (MEX455), 1922, Mercer County; Truax-Traer Coal Company Kincaid Mine (BK779), 1927, Burke County; Truax-Traer Coal Company Velva Mine (WDX588), 1927, Ward County. See the following MSF: Burke County, 6d-6f, 6g-6j; McLean County, 90-92; Mercer County, 48-53; Stark County, 41-45; Ward County, 1-4.

Truax Company lost no time in getting the new machine into production at their mine site near Kincaid (BKX927).[84]

From the beginning, the Truax operation relied on "area stripping," a technique that was to dominate American strip mining until well after World War II. Briefly, area stripping involved the sequential digging of parallel or concentric trenches by a large power shovel to expose the lignite, which was then removed by smaller shovels and loaded onto cars for processing at the tipple outside the pit. As the large shovel dug its way forward, it side-casted the overburden into the lignite-depleted trench of the previous cut, creating distinctive ridges of cone-shaped spoil piles. The dimensions of the cut and waste banks usually reflected the capacities of the individual stripping machine. A typical stripper, for example, was able to "excavate only to half its normal working radius; if it undertakes more, there is excessive loss of stacking space in the wider valleys between the waste-cone ridges." By the 1930s, the average large shovel was capable of stacking overburden to a height of 50 feet, but 40 feet was more often the rule, since the additional reach created "strains making for high maintenance charges that do not justify constant working at these heights."[85]

Shortly after opening, the Truax stripping operation was documented in some detail by the national engineering press:

> The heavy artillery of the mine consists of a 175-B Bucyrus revolving shovel which carries a 3-1/2-cubic-yard dipper and a 75-foot-boom. This machine is used to strip the overburden from the lignite deposit . . . . The 175-B is followed by a 35-B Bucyrus revolving shovel on caterpillars with a 1-1/2-yard dipper, a 30-foot boom and a 19-foot handle, which digs the coal which the 175-B has uncovered. The big shovel

[84] Truax, 674.

[85] A. T. Shurick and F. E. Toenniges, "Coal-Mine Stripping Practice with Giant Power Shovels," Engineers News-Record 108 (5 May 1932): 647.

casts the overburden into the pit from which the smaller shovel has taken the coal on the previous cut. The 175-B as a rule works one 12-hour shift . . . . The 35-B shovel operates a 10-hour shift and handles an average of 1200 tons in this period when operating steadily.

The lignite is loaded into three-ton, home-built side-dump cars. The company has 40 of these cares, which as a rule are made up into four 8-car trains . . . handled by three 14-ton locomotives . . . . The haul to the tipple varies between 800 feet and 3/4 of a mile. At the tipple the lignite is dumped into a shaking screen which extracts the lump [coal], this passes off the screen into an Ottumwa box car loader. The screenings are re-screened from 1/4 inch to 1 inch. This is elevated 30 feet, where it is put through a roller screen, the dust being carried to the waste bank by a conveyor, and the nut [coal] through spouts to box cars below. Two men on the tipple can handle 1200 tons in ten hours.[86]

In December 1926, the Truax brothers joined forces with Chicago businessman Glen W. Traer, who owned bituminous mines in Illinois and Iowa. Incorporating in Delaware as the Truax-Traer Coal Company, the venture in 1927 opened a new strip mine (WDX588) near Velva in Ward County, and expanded the Truax's previous operation in Burke County by acquiring a nearby strip mine known as the Whittier-Crockett Coal Company Mine (BKX926). The enlarged mine site operated as the Truax-Traer Coal Company Kincaid Mine (BK779). In 1930, Truax-Traer continued its expansion by leasing the former Wilton Mine No. 2 from the Otter Tail Power Company and converting it into a strip mine. During the 1930s, the three Truax-Traer mine sites contributed about one-third of the state's total commercial lignite tonnage for the decade.[87]

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[86] "Mining Lignite in North Dakota," Excavating Engineer 17 (March 1923): 83-86.

[87] Oihus, 45-47; Johnson, The Power People, 22; Moody's Manual of Investments, American and Foreign Industrial Securities (New York: Moody's Investors Service, 1935), 1551-1552; MSF, Burke County, 6a-6c, 6d-6f, 6g-6j; MSF, Burleigh County, 1-4; MSF, Ward County, 1-4. In 1930, Truax-Traer Coal Company reorganized its North Dakota mining properties as Truax-Traer Lignite Coal Company. For an oral-history description of the Kincaid operation by a former employee, see Larry Sprunk, "Howard E. and Francis Winzenburg," North Dakota History 44 (Fall 1977): 11-15. On the Velva mine, see "Mammoth Electrical Shovel Strips Earth Exposing Coal Veins," Minot Daily News, 20 October 1927, p. 13; R. Dawson Hall, "Strip Shovels Invade Dakota Lignite Field," Coal Age 34 (February 1929): 99-101; "The Velva Mine," Mining Congress Journal 31 (October 1945): 30-34.

Statistics are not readily available to compute the profitability or efficiency of strip mining versus underground mining in North Dakota. There is no question, however, that after 1920 strip mining increasingly claimed a greater percentage of the state's commercial lignite output, far outpacing the national average. From a mere 13 percent of total annual production in 1921, North Dakota strip mining steeply accelerated its output, claiming 48 percent in 1930 and reaching 87 percent in 1950. During this same period, strip mining steadily expanded its role in national bituminous as well, but its share of total output was still only 24 percent nation-wide in 1950 (see Figure 14).

Although underground mining lost ground to strip mining in terms of total North Dakota lignite production, underground workings did not relinquish their numerical superiority. In the 1940s, as well as in preceding decades, underground mining claimed the majority of all new mine starts in North Dakota (see Figure 15). As pointed out earlier (see Figure 9), the vast majority of new mines during 1908-1945 were in the under-10,000-ton-per year production category, and here, too, underground mines retained their numerical edge in every decade (see Figure 16). The technology of these small workings is largely unrecorded, but oral-history evidence indicates that some at least were virtually indistinguishable from early twentieth-century underground operations. For example, at the Standard Coal Mine (WI062) in Williams County, which averaged about 2,500 tons per year during the 1940s, "hand-operated drills were used for placing the black powder into the coal seam . . . . After the coal was loosened by blasting, it was hand-loaded into small coal cars and transported out of the mine . . . by a mule along narrow-gauge steel track."[88]

[88] Interview with Elmer Tofte, 6 October 1982, in North Dakota Cultural Resources Survey Form for 32WI62.

Conditions at the Teuber Mine (ME142), a 1,500-ton producer in Mercer County in 1944, were equally labor-intensive:

> The coal cars, which ran on narrow-gauge steel tracks, were loaded and pushed by hand to the shaft, where a steam-powered cable hoist raised them to the level of the tipple. With the exception of the steam-powered hoist, all work in the Teuber Mine was done by hand. [As a former employee recalled,] "There was all that hand work at the Teuber Mine. There wasn't a machine of any kind . . . . We didn't have electricity. We did everything by carbide lights and hand tools."[89]

In 1943, the federal Bureau of the Census published a housing survey for 1940 that sheds considerable light on the importance of lignite to North Dakota. During the census year, the state contained approximately 150,000 occupied dwelling units with heating equipment. Eighty-five percent of these units reported heating with coal.[90] Since North Dakota lignite accounted for about 80 percent of all coal tonnage consumed in the state during the five-year period preceding the census, it seems clear that lignite furnished much of the state's heating fuel.[91] For a more precise estimate of lignite's contribution, it is possible to compare, on a BTU basis, the state's consumption of various heating fuels for the period 1935 to 1939. As Figure 17 reveals, lignite during this period supplied about 64 percent of the total BTU value, far surpassing any other fuel.[92]

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[89] Interview with George Moorman, 12 November 1983, in North Dakota Cultural Resources Survey Form for 32ME142.

[90] U. S. Bureau of the Census, Housing, Volume II. Sixteenth Census of the United States: 1940 (Washington, D.C.: United States Government Printing Office, 1943), 524.

[91] See footnote 77.

[92] The table in Figure 17 is based on state and federal statistics for 1935, 1937, and 1939 for the following: North Dakota's annual lignite production; annual importation of anthracite and bituminous coal; and annual sales of fuel oil and natural gas. See Report of Coal Mine Inspection Department, State of North Dakota, Thirtieth Annual Report, 1948, 9; North Dakota Public Service Commission, Annual Reports of Railroads, 1935, 1937, 1939; H. D. Keiser, ed., Minerals Yearbook, 1940 (Washington, D.C.: United States Government Printing Office, 1941), 1005, 1053. Based on assumptions explained in footnote 77, annual North Dakota consumption of lignite was

Lignite's importance as a heating fuel probably was greatest in the western counties where it was mined. Although there are no statistics on the comparative consumption of various fuels within individual counties, state records do offer a clue to local lignite use. In the early 1920s, state authorities began categorizing lignite mine-site production as to whether the material was sold locally or shipped out of the region. If lignite were the dominant fuel in the mining region, we might expect state statistics for "local trade" in the different counties to vary according to their population. For example, if, all other things being equal, County A had twice the population of County B, its lignite consumption should be roughly twice as much, and therefore its production for local sale should be twice as much. To test this hypothesis, we computed an average population statistic, based on federal census data for 1920, 1930, and 1940, for each of the state's twenty-one counties involved in commercial lignite production. We then analyzed our database of 357 mine sites to compute the total local production of each county during the approximate period 1920 to 1945. Finally, we compared the population-production relationships for all the counties. Figure 18 shows the results. If there were a perfect positive correlation between the two sets of statistics, all of the circles (each representing a county) would be located on the diagonal line, and the coefficient of correlation for the entire exercise would be equal to 1.00. Although only four circles fall directly on the line, the majority are quite close, yielding an

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calculated at 85 percent of the state's total annual production. The comparative heating values of the various fuels were based on the following: lignite, 6,500 BTU per pound; anthracite, 13,600 BTU per pound; bituminous, 13,100 BTU per pound; fuel oil, 6,000,000 BTU per barrel; natural gas, 1,075 BTU per cubic foot; see Minerals Yearbook, 1940, 777; Lavine, Lignite Occurrence and Properties, 26.

overall coefficient of correlation of 0.80.[93]

The evidence in Figure 18 suggests that the state's production statistics for local lignite trade are useful indicators of local lignite consumption. This relationship underscores the historical importance of small commercial mine sites in western North Dakota. Although large commercial mine sites produced the great bulk of North Dakota lignite, they shipped almost all of it out of the western half of the state. Consider, for example, the state's nine top-producing mine sites before 1945 (see Figure 8). As noted earlier, these mines sites were responsible for 62 percent of the state's total commercial lignite tonnage between 1908 and 1945. But they sold only 5 percent of this amount to the local market, and these sales represented only 5 percent of the state's total recorded local-trade production before 1945.

In contrast, the state's small wagon mines were strongly oriented to local consumers. According to our database sample, the typical under-10,000-ton-per-year mine locally marketed at least 40 percent of its output. Although the production of an individual wagon mine was minuscule from a statewide perspective, these small operators as a group dominated the lignite market in the western half of the state. Large producers simply could not compete with their lower overhead and profit margins. The Knife River Coal Mining Company, the state's largest underground mining outfit, summed up the situation in 1932:

[93] In 1928, the State Mine Inspector noted that "lignite is now used almost exclusively for domestic heating and for large power and steam plants"; Tenth Annual Report, 1928, 11. Lignite production for mine-mouth generating plants apparently was not included under "local production" if it was shipped to the plant by rail; at least, this seems to be the case for the Wilton Mine No. 2, which railroaded large amounts of lignite to the nearby Washburn Power Plant during the 1930s, but annually reported only a few thousand tons of local production; see MSF, Burleigh County, 1-4. If mining for industrial use were included under local production, it might explain why some counties represented in Figure 18 appear to have disproportionately high production statistics in relation to their populations. As a general rule, the data on which the graph is based under-reports lignite production for local domestic heating. As pointed out earlier in the text, our database does not include all known commercial mine sites. Nor did the state's reporting of local production include the numerous subsistence mines that were not licensed for commercial operation.

> The territory west of the Missouri River is practically all underlaid with lignite deposits. The towns in this territory are supplied with lignite in practically every instance by operators doing business on a small scale and trucking the fuel into the communities. We have not attempted to market our coal, or compete with the small operators west of Mandan.[94]

North Dakota's commercial wagon mines survived only as long as the local market valued lignite as a heating fuel. After World War II, North Dakotans increasingly turned to cleaner-burning fuel oil and natural gas. Although 55 percent of the state's households still relied on coal for heat in 1950, the number sharply declined to 23 percent in 1960. During this same period, the number of operating lignite mines decreased from 102 to 47. After 1960, the story of North Dakota lignite mining is largely told by the electric power industry, which would come to consume over 90 percent of the state's annual lignite output, supplied by a dozen or so mammoth stripping operations in the vicinity of mega-kilowat generating plants.[95] As for the wagon mines of an earlier era, what historian Alvar W. Carlson wrote in 1972 remains true today:

> Some of the abandoned strip mines or open pit diggings of the early settlers are still visible on the rural landscape. Many mines have grown over with vegetation making it difficult to causally determine whether the depressions along rivers or in fields are man-made. Those along rivers look like natural washouts while those in fields resemble prairie gullies. The cave-ins of the commercial underground mines are more easily detectable . . . . The sod houses are gone, but the lignite digings remain as permanet scars upon the rural landscape. They are reminders of the importance of lignite in enabling this region of the Great Plains to be settled with less hardship.[96]

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[94] M. C. Blackstun to Charles Donnelly, 9 June 1932, in President's File 1132-4, NP.

[95] Dahlberg, Kjos, and Schreiner, 170-179.

[96] Carlson, 152.

PROPERTY TYPES[97]

This discussion of property types is based primarily on the documentary sources cited in the preceding historical narrative.[98] In addition, it draws on a collection of several hundred unpublished mine maps, dating from about 1920 to 1970, in the State Historical Society of North Dakota. These maps apparently were submitted to state authorities by mine operators as part of the licensing procedure for commercial lignite mines. Although the maps focus on underground workings and stripping pits, many identify surface features, such as roads, trackage, buildings, and machinery.[99] Along with published reports of state mine

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[97] This section assumes familiarity with National Park Service guidelines for evaluating the eligibility of cultural resources for listing in the National Register of Historic Places; see National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation (U. S. Department of the Interior, National Park Service, Interagency Resources Division, n.d.); National Register Bulletin 16A: How to Complete the National Register Registration Form (U. S. Department of the Interior, National Park Service, Interagency Resources Division, 1991); National Register Bulletin 16B: How to Complete the National Register Multiple Property Documentation Form (U. S. Department of the Interior, National Park Service, Interagency Resources Division, 1991).

[98] We also greatly benefitted from the work of previous historians who have attempted to formulate guidelines for the National Register evaluation of mining resources elsewhere in the nation. Before beginning our own research on North Dakota coal mining, we discussed the project with the National Register staff of the National Park Service, as well as with the cultural resource management staffs of the State Historic Preservation Offices in the twenty-three other states that were listed as having significant coal production by the U. S. Coal Commission in the early 1920s. As a result of these queries, we obtained the following useful studies: Michael E. Workman, "Historical Context for the [West Virginia] Coal Heritage Survey," Draft prepared for the West Virginia Division of Culture and History, 19 June 1991; James B. Jones, Jr., "The Development of Coal Mining on Tennessee's Cumberland Plateau, 1880-1930," Prepared for the Comprehensive Cultural Resource Management Section, Tennessee Historical Commission, 30 October 1987; Steven Mehls, "Coal Mining, 1870-1930," Colorado Mountains Historic Context (Denver: Office of Archaeology and Historic Preservation, Colorado Historical Society, 1984), 45-51; Oklahoma Historic Preservation Survey, Department of History, Oklahoma State University, "Historic Context and Predictive Model Document: Architectural/Historic Intensive Level Survey of Coal Mining Related Resources of Pittsburgh County [Oklahoma]," Prepared for the State Historic Preservation Office, Oklahoma Historical Society, 30 June 1990; "South Dakota Mining Resources Historic Context," (N.p., n.d.); Bruce J. Noble, Jr., "Evaluating Historic Mining Resources," CRM Bulletin 12 (2 November 1989): 1-4; Bruce J. Nobel, Jr. and Bob Spude, "National Register Bulletin 42: Evaluating and Nominating Historic Mining Sites," An unpublished draft prepared for the U. S. Department of the Interior, National Park Service, Interagency Resources Division, September 1991.

[99] Workman's Compensation Bureau, Series 505 Coal Mine Maps, in State Archives and Historical Research Library, State Historical Society of North Dakota. The maps are filed by counties, but not all lignite-producing counties are represented.

inspectors, this cartographic collection is the best source of information concerning historic property types at North Dakota lignite mines.

No one has yet conducted a systematic survey of lignite-associated properties in North Dakota for purposes of National Register evaluation. In 1981, however, the AML conducted a field investigation of over six hundred mine locations in twenty-one counties to assess environmental hazard. When the AML survey work is combined with other survey data gathered by the SHPO since the late 1970s, the total number of inspected mine locations is about 650. Of this group, only about 4 percent were reported to contain standing structures of any description. Since this data indicates a very high attrition rate for historic mine features, surviving property types should be treated with generosity in the National Register evaluation of their physical integrity.[100]

Based on research findings to date, it seems reasonable to evaluate the North Dakota

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[100] Handwritten survey forms for the AML study are in the AML Office, State Capitol, Bismarck. Since 1976 about fifty AML sites have also been surveyed by archaeologists or historians involved in cultural resources studies sponsored or mandated by the North Dakota State Historic Preservation Office (SHPO). For the most part, the two sets of survey data agree in their general descriptions of surviving buildings and structures. Analysis of the AML and SHPO data reveals that the most commonly reported surface works were: tipple (8), house (4), shack (4), power shovel (3), powder magazine (2), and scale house (2). It is probable that several of these structures have been removed as part of federally-funded mine-reclamation activities, which were generally the reason for SHPO's involvement in the survey work. Consequently, the attrition rate for surface works may be even higher than the 4-percent survival rate mentioned in the text.

National Park Service historians Bruce J. Noble, Jr. and Bob Spude have noted that historic mine structures are rare throughout the nation. They attribute this scarcity to the "transient nature" of most mining operations, which encouraged the construction of inexpensive, temporary facilities that quickly succumbed to the elements and vandalism. Noble and Spude also point out that a single mine site often experienced changes in technology, which, especially in recent decades, tended to alter or obliterate the physical remains of previous activity; see Noble and Spude, "National Register Bulletin 42: Evaluating and Nominating Historic Mining Sites," 2. Production histories for the 357 mine sites in our database support these claims about the general mutability of mining operations. Before 1945, the state's lignite mine sites remained in production, on the average, for only about twelve years, with one-third lasting less than six years. In addition, at least one-quarter of the mine sites altered their basic mode of operation, switching from one type of underground entry to another (e.g., from drift to shaft) or from underground mining to strip mining, or vice versa. But perhaps most important of all, almost 80 percent of the mine sites terminated production before 1945. At the very least, this means that most of the state's historic lignite-related resources have been in an abandoned state for nearly half a century. These statistics would seem to predict a high attrition rate for mine-site construction and equipment.

lignite industry before 1945 in terms of two main property types: Mine Workings, and Surface Works and Related Construction. All lignite-producing sites contained mine workings, but not all contained surface works. Usually, however, both property types co-existed at a mining location.

Mine Workings

Description of Mine Workings

Mine workings were the heart of the state's lignite industry: it was here that the production process started. In the workings, miners extracted the lignite from the earth and prepared it for delivery to the surface, usually by shoveling it into track-mounted mine cars. The mine cars were delivered to the surface in a variety of ways, including engine-driven cable systems, self-propelled locomotives, animal haulage, and hand-pushing of carts by the miners themselves. There were two principal varieties of workings: underground and strip. A single mining operation might contain both varieties, either simultaneously or sequentially.

Underground Workings

Underground workings are categorized by the nature of their entry into the earth. There are three main types: drift, shaft, and slope. In a drift mine, the entry penetrates the coal seam by burrowing horizontally into a hillside, cliff, or outcropping. In a shaft mine, the entry tunnel descends vertically into the earth to reach the coal. Finally, in a slope mine, as the name implies, the angle of entry is somewhere between the vertical and horizontal.

Although shaft mines became rare in North Dakota after 1940, all three types of entry played an important historic role in the development of the state's lignite industry (see Figure 15). In absolute numbers, however, slope mines seem to have been the most common; they account for about half of the 357 underground mines in our database. Drift mines are next numerous with about 40 percent of the database total, while shaft mines account for the remaining 10 percent. Underground workings often contained different types of entries, as well as different numbers of each type. North Dakota's underground lignite workings generally employed some variant of the "room-and-pillar" system of mining, the most common method throughout the American coal fields. In this method, miners horizontally moved through a coal seam and excavated alternating rectangular areas, leaving wide blocks of coal in place to support the ceiling. The resulting grid of "rooms" and "pillars" gave the method its name (see Figure 11). Typically, North Dakota miners extracted the coal by "blasting off the solid," without preparatory undercutting. They then shoveled the loosened coal into track-mounted cars for transport to the surface. Since pillars might represent as much as half of the coal in a seam, it was common practice to remove, or "rob," at least part of the pillars while retreating from that section of the mine. Deprived of support, the mine ceiling soon collapsed, frequently causing noticeable subsidence, and sometimes pitting, of the "top-side" surface (see Figures 12 and 13).

Strip Workings

A strip workings is a surface excavation from which overburden and lignite have been extracted. While the lignite is removed from the site, the overburden almost always remains in some form of "spoil pile." According to our database sample, strip mines represented about one-quarter of the state's mines during the period 1908 to 1945. Before the power-shovel era, stripping operations depended on plows, scrapers, picks, and shovels, assisted by a liberal use of dynamite. Pits tended to be rectangular and shallow, with overburden excavation rarely exceeding 15 feet in depth. Spoil piles tended to be low, mounded, and scattered. When North Dakota mine operators took up the power shovel after World War I, they generally adopted a mining system known as "area stripping." Briefly, area stripping involved the sequential digging of parallel or concentric trenches by a large power shovel or drag line to expose the lignite, which was then removed by smaller shovels and loaded onto tram cars or conveyors for processing at the tipple outside the pit. As the large shovel dug its way forward, it deposited overburden from the present cut into the lignite-depleted trench of the previous cut. Since the overburden took up more volume as a spoil pile than it did in the earth, it formed an extended row of gently-peaked dunes, higher in elevation than the original surface. The resulting landscape with its parallel rows of spoil piles resembled the ridges of a giant washboard. Although strip mines accounted for all of the state's largest new producers after 1920, they did not numerically surpass underground workings until after 1945.

Significance of Mine Workings

Period of Significance: 1870-1945

Criterion A

From the appearance of the first farmer wagon mines in the 1870s to the emergence of the large mine-mouth, power-plant operations of the 1930s and 1940s, lignite has been historically important in North Dakota as a fuel. The relationship between North Dakota and its lignite industry was especially close because the great preponderance of the commercial tonnage produced was consumed within state borders. During the late nineteenth and early twentieth centuries, settlers in the treeless regions of western North Dakota depended on lignite mining for both fuel and cash-paying winter employment. Although lignite initially faced competition from Eastern coal in the eastern half of North Dakota, it eventually became the dominant fuel in that region as well. In addition to serving as a domestic heating fuel, lignite also was an important industrial energy source, especially for brick making and electric power generation.

By the mid-1920s, the North Dakota lignite industry supplied more than half of the state's coal, the most important energy source at that time. By the mid-1930s, despite the state's increasing use of fuel oil and natural gas, lignite clearly outranked all other heating fuels, accounting for about 65 percent of the state's total BTU consumption in that category (see Figure 17). To keep pace with the state's demand for lignite, the mining industry doubled its output between 1910 and 1920, doubled it again between 1920 and 1930, and continued to expanded production, although at a more gradual rate, into the 1940s (see Figure 10). After 1950, North Dakotans increasingly turned to other cleaner-burning heating fuels, causing a rapid decline in the number of operating lignite mine sites. By the 1980s, the electric power industry was the only major market, and its demands were met by a dozen large stripping operations.

In terms of statewide significance, it is possible to identify nine mine workings that made an outstanding contribution to North Dakota's fuel supply (see Figure 8). In descending order of total production, these are Wilton Mine No. 2 (BL0038), Knife River Coal Company Mine (MEX065), Truax-Traer Company Velva Mine (WDX588), Truax-Traer Company Kincaid Mine (BKX779), Zap Colliery Company Mine (MEX455), Baukol-Noonan Mine (DV0011), Stevens Brothers Coal Mine (ML0194), Wilton Mine No. 1 (BL0030), and Lehigh Briquetting Company Mine (SK0069). These were the only mine sites in the state that exceeded the one-million-ton mark in total production before 1945; the smallest contributed at least two percent of the state's total commercial lignite output between 1908 and 1945. Together, the nine mine sites accounted for 62 percent. These mammoth producers so clearly dominated statewide production that the collective output of the next ten largest mines barely equalled one-tenth their total.

Mine workings of statewide significance also include properties that contributed to the lignite industry's development by promoting the production or use of the material, such as the state-operated mine experiment station established at Hebron in 1908, and the pilot briquetting plant built by the

Northern Briquetting Company in 1914 for the Davis Mine near Minot.

Mine workings of regional significance include properties that contributed to the successful operation of regionally important industrial or agricultural enterprises. These enterprises were usually mine-mouth operations, such as the Otter Tail Power Company's Washburn Power Plant, which was built for the Wilton Mine No. 2 (BL0038) about 1930; the Hebron Brick Company's brick works, which operated from about 1909 to 1939; the briquetting plant established at the Lehigh Mine (SK0069) near Dickinson in 1929; and the electric-generating plant at the U.S. Bureau of Reclamation Mine (WIX075) near Williston, which powered the pump-irrigation systems of Reclamation's Williston Project and Buford-Trenton Project.[101]

Mine workings of local significance include properties that made an outstanding contribution to the local fuel supply. Such contributions can be evaluated for each county by comparing the annual "local trade" statistics published by the State Mine Inspector for the various mine sites in each county. As explained in the historical narrative section of this study, a county's local trade statistics were indicative of its actual lignite consumption. It therefore seems reasonable to assume that mine workings with the highest cumulative, local-production statistics contributed the most to that county's fuel supply. Another measure of local significance is longevity of operation, especially if it is combined with above-average production for the local market.

Mine workings also have local significance if it can be demonstrated that they helped establish a community as a population or trade center; helped sustain a community, by means of fuel or wages, through a period of major hardship; played an important local role as employer or social center; or otherwise effected a major social or economic change in a community, possibly as a result of a mine disaster or labor dispute.

Criterion B

Significance under this criterion derives from a mine working's association with an individual who achieved local, regional, or statewide prominence by virtue of his/her role in the lignite industry. To properly apply Criterion B, it

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[101] A mine-mouth plant was not necessarily located directly at a mine site, The Washburn Power Plant, for example, was considered "essentially a mine-mouth plant" even though it was twenty miles away from its associated mine site; see Johnson, 22. The terms applies to an industrial plant that had priority rights to the output of a specific mine, which was generally owned by the same interests. The associated mine was often known as a "captive mine." For economic reasons, the two operations were always located within a relatively short shipping distance of each other.

is necessary to establish three points: (1) the property directly contributed to, or appropriately reflected, the individual's historical significance; (2) the property illustrates the individual's significance more fully than other properties known to be similarly associated; (3) the individual was indeed historically significant. Individuals who achieved noteworthy prominence in the North Dakota lignite industry include: William D. Washburn, for founding Wilton Mines No. 1 and No. 2 (BL0030, BL0038); A. H. and E. M. Truax, for establishing large-scale strip mining in North Dakota; and Madison M. Mounts, for developing and managing the Knife River Coal Company Mine (MEX065), which contained the state's largest and most mechanized underground workings.

Criterion C

Mine workings are significant under this criterion by virtue of notable design or engineering. To identify such qualities, it is necessary to evaluate a property's technology in terms of the lignite industry's innovations and normal operating procedures. In North Dakota, the room-and-pillar method dominated underground mining throughout the late nineteenth and early twentieth centuries. Although some of the state's largest underground mines adopted mechanical undercutting by 1900, blasting off the solid remained the most popular method for decades. As was true nationally, underground mechanical loading was rare before 1930. In strip mining, horse-drawn plows and scrapers were the rule in North Dakota before World War I, and total excavation rarely exceeded 15 feet in depth. After the national coal strike of 1922, power shovels became common in the state's stripping pits, and surface excavations deepened to more than 50 feet. Although professional mining engineers probably were involved in laying out some of the state's mine workings, their identity is unknown.

Registration Requirements for Mine Workings[102]

Criterion A

A mine workings in North Dakota may be eligible for the National Register if it fulfilled any of the following conditions:

1. Was an integral part of one of the following nine mine sites that

[102] It is possible that a lignite mine's workings may not meet any of the Registration Requirements listed in the text, yet still be eligible for the National Register. A possible example is a small, farmstead, mine workings that only supplied lignite to the immediate farm family. Although this workings would lack distinction in terms of the present historical context on lignite mining in North Dakota, it might be significant under another historical context dealing with North Dakota agricultural settlement.

individually achieved one million tons in total production and collectively were responsible for producing 62 percent of the state's total commercial lignite tonnage between 1908 and 1945: Wilton Mine No. 2 (BL0038), Knife River Coal Company Mine (MEX065), Truax-Traer Company Velva Mine (WDX588), Truax-Traer Company Kincaid Mine (BKX779), Zap Colliery Company Mine (MEX455), Baukol-Noonan Mine (DV0011), Stevens Brothers Coal Mine (ML0194), Wilton Mine No. 1 (BL0030), and Lehigh Briquetting Company Mine (SK0069).

2. Contributed to the lignite industry's statewide development by involvement in a state-operated mine experiment station or a pilot mine-mouth industrial plant that established the feasibility of using lignite in an industrial or commercial process.

3. Contributed to the successful operation of a regionally important industrial or agricultural enterprise, such as brick making, electric power generation, briquetting, or pump-irrigation.

4. Was an integral part of a mining operation that contributed significantly to its county's fuel supply, as measured by either its cumulative production for local consumption (listed in State Mine Inspector's reports as "Local Trade"), or by a combination of its total local production and longevity of operation. A table in Appendix A of this report analyzes the 357 mine sites in our database to establish statistical significance criteria, on a county-by-county basis, for both "Tons Sold Locally" and "Mine Site Lifespan."[103] On the basis of the table's statistics in Appendix A, a mine site is eligible for the National Register, if it:

    a. Surpassed the "Significance Level" for "Tons Sold Locally" listed for its county (the table in Appendix A includes all mine sites in the database that fulfilled this criteria); or

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[103] The "significance level" is computed as the first standard deviation above the mean (fsd) for that particular mine-site trait in the county, as represented in our database of 357 mine sites operating between 1908 and 1945. The fsd is a common statistical gauge for measuring high performance for a trait when it is normally distributed within population. In such a population, approximately 16 percent of the members fall above the fsd. For the purposes of this study, we assumed that the mine sites in our database were normally distributed in each county for total local production and lifespan. Our county-fsd screenings selected 18 percent of the total database population as significant for total local production, and 14 percent as significant for longevity -- which is pretty much what one would expect if these traits were normally distributed for the database sample as a whole.

b. Surpassed the "Significance Level" for "Mine Site Lifespan" listed for its county and surpassed its "County Average" for "Tons Sold Locally" (the table in Appendix A includes all mine sites in the database that fulfilled this criteria).

5. Was an integral part of a mining operation that helped establish a community as a population or trade center; helped sustain a community, by means of fuel or wages, through a period of major hardship; played an important local role as employer or social center; or otherwise effected a major social or economic change in a community, possibly as a result of a mine disaster or labor dispute.

Criterion B

A mine workings in North Dakota may be eligible for the National Register if it was associated with an individual who achieved local, regional, or statewide prominence by virtue of his/her role in the lignite industry. Examples of such noteworthy individuals are William D. Washburn, for founding Wilton Mines No. 1 and No. 2 (BL0030, BL0038); A. H. and E. M. Truax, for establishing large-scale strip mining in North Dakota; and Madison M. Mounts, for developing and managing the Knife River Coal Company Mine (MEX065), which contained the state's largest and most mechanized underground workings.

Criterion C

A mine workings in North Dakota may be eligible for the National Register if it fulfilled any of the following conditions:

1. Systematically employed an underground mining technique other than the room-and-pillar method.

2. Systematically employed an underground extraction technique other than blasting off the solid.

3. Employed underground mechanical loading before 1930.

4. Excavated more than 10 feet of overburden in a stripping operation before 1910.

5. Employed power shovels for stripping before 1923.

6. Employed a mining or engineering technique which was innovative for its period, or which solved exceptionally demanding technical problems.

7. Embodied the work of a master mining engineer or miner.

Integrity Requirements

Criteria A, B, and C

Loss of integrity occurs:[104]

1. For an underground workings, if it is no longer possible to identify any of the entries.

2. For a strip workings, if it is no longer possible to distinguish the spoil piles from naturally occurring features, or from other artificial earth work.

3. For all workings, if it is no longer possible to distinguish the effects of mining activity that occurred during the Period of significance 1870 to 1945) from the effects of mining activity that occurred after the Period of Significance.

Surface Works and Related Construction

Description of Surface Works and Related Construction

Surface works depended upon mine workings for their existence. Their purpose was to process and ship recently mined lignite. Usually, they also contained facilities to support the mining process and its personnel. In North Dakota, surface works appear to have varied widely. There was no uniform plan for either underground or strip mining operations. Surface works could comprise several dozen facilities, or a single structure. A surface power plant could be as sophisticated as a brick boilerhouse with steam turbines and an electrical generating plant, or as simple as a stationary tractor engine. Consequently, surface works should be defined in

[104] In the past, some investigators have maintained that loss of integrity occurs if underground workings experienced major cave-ins and surface subsidence, or if a strip workings was completely infilled with spoil piles. These events, however, were the natural result of the historic mining process and customarily occurred during the Period of Significance. They therefore are not necessarily damaging to integrity. It also should be pointed out that the integrity criteria listed above do not exhaust the possibilities of adverse impacts that might deprive a property of eligibility. They are meant only to indicate a minimum level of structural sufficiency that a property must retain to convey a sense of its original setting, design, materials, and workmanship.

functional rather than structural terms. The following list includes the major surface features that have been documented for the North Dakota lignite industry:

Primary Production Facilities

Hoist: mechanical device for lowering and/or raising men and materials into and out of the mine.

Headframe: structural support for hoist.

Tipple: structure that received lignite directly from the mine workings, unloaded it from cart or conveyor, and transferred it, usually by chute or conveyor, to bins for storage or to vehicles for shipment. In many operations, the tipple contained sorting devices (screens, bars, grids, etc.) to grade the lignite by size. Tipples frequently were combined with hoists and power plants.

Mine car trackage: facilitated movement of mine cars into and out of the mine workings.

Power plant: supplied power for operation of hoist, tipple, and, depending upon capacity and technology, mining equipment.

Pump house/pump/windmill: removed water from mine workings.

Fan house: helped maintain circulation of fresh air in underground workings.

Wash house: permitted miners to change into work clothes before a shift, store their "civilian" clothes during the shift, and clean up after a shift. The wash house often adjoined steam power plants to ensure an ample supply of hot water.

Scale house: contained or adjoined a device for weighing car/wagon-loads of lignite. Scales often were incorporated into the tipple complex in order to keep track of daily production. In small operations, a single scale might be located near the mining property's perimeter to weigh arriving and departing wagons, trucks, or sleighs.

Railroad spur trackage: facilitated shipment of lignite from mine. Not all shipping mines had spur trackage. Some mines wagon-hauled their output several miles to loading and shipping points on a rail line.

Haulage road: facilitated shipment of lignite by trucks, sleighs, and wagons.

Power shovel/drag line: stripped and stacked overburden, extracted lignite from the resulting excavation, and loaded it into mine cars. The mine's largest shovels generally handled the overburden, while smaller equipment worked the lignite.

Production Support Facilities

Office, maintenance and repair shops, storage and supply sheds, garage, barn, stables.

Personnel-Support Facilities

Bunkhouse, bathhouse, boarding house, mess hall, dwelling house, barn, garage: primarily responsible for feeding employees and for sheltering employees and their possessions.

Related Construction

This category includes mine-mouth industrial plants that utilized lignite.[105] It also includes construction that was functionally associated with, or symbolic of, a given mining operation or the lignite industry in general, but not necessarily located at a specific mine site. For example: administrative, shipping, and storage facilities (office, tipple, warehouse, etc.) located at a railroad siding or nearby town; company-town facilities (i.e., properties owned-and-operated by a mining company for the sole, and, often, compulsory use of its employees); commercial, educational, or scientific facilities primarily devoted to promoting the production or use of lignite (such as a state-run mine experiment station); associative properties (e.g., "off-mine" properties that strongly reflected the production or use of lignite in a given area, such as the residences of prominent mine-owners, mine-operators, or miners).

There is little published information on the layout of surface works at North Dakota mining operations. Since the vast majority of the state's lignite mine sites were associated with underground workings producing less than 10,000 tons per year, it seemed especially useful to compile data for this category. To this end, the cartographic holdings of the North Dakota State Historical Society were searched for maps of underground mining operations that produced less than 10,000 tons in the year they were mapped. Sixty-five maps were located, covering the period 1918 to 1940. Figure 19 lists the surface works mentioned on more than one map, and summarizes in percentage form the frequency of their occurrence for the underground

[105] See footnote 102.

group as a whole.[106] It also presents data on general mine layout by noting the average distance of the various surface facilities from the tipple. When interpreted in terms of the maps themselves, this "table of distances," suggests that surface works were laid out by function in the following series of either linear or concentric zones: primary production facilities (tipple, hoist, power plant, wash house, scale house); production support facilities (office, shops, supply sheds, garage); personnel-support facilities (bunkhouse, commissary, dwelling house, barn/stable); perimeter facilities (outer scale house, powder magazine). Although the data does not indicate the actual location of any facility, it helps establish approximate spatial relationships.

Significance of Surface Works

Period of Significance: 1870-1945

Criterion A

At North Dakota lignite mines, surface works were basically support facilities for underground workings. Consequently, they derive their significance under Criterion A by association with underground workings that are significant under Criterion A. In other words, if the associated underground workings are significant under Criterion A, then the surface works may be significant as well. Conversely, if the associated underground workings are not significant under Criterion A, then the surface works are not significant under Criterion A A (although they might be significant under Criterion C and should be evaluated accordingly).

The exception to this rule pertains to the category of surface works described as "Related Construction." This category contains facilities that were historically important for the state's lignite industry in their own right, such as mine-mouth industrial plants. In the form of brick works, mine-mouth plants were operating in North Dakota at least as early as the 1890s. The state's lignite mining interests were constantly seeking new mine-mouth industries to expand their market. With the research assistance of a state-run mine

[106] Privies and toilets were not included in the tabulation, although they were occasionally noted on the maps. The maintenance and repair category includes blacksmith shops, the most frequently mentioned facility of this type. The accuracy of the maps is unknown. But considering the much higher occurrence rates for tipples, power plants, and houses than for shops, fan houses, and supply sheds, it seems likely that the map makers were more scrupulous in recording major buildings than minor ones. Taken as a whole, however, the list in Figure 19 appears to be a useful index to the nature of surface works at a small North Dakota underground lignite mining operation. When the list is compared with available maps of larger underground operations and strip operations, it satisfactorily accounts for all property types, with two exceptions: power shovels (for strip locations), and roundhouses or locomotive sheds (for both strip and underground operations with annual production exceeding 25,000 tons). The larger underground operations also seem to have had a higher incidence of the various surface works, while strip operations generally had a lower incidence.

experiment station at Hebron, these efforts led to establishment of briquetting plants after World War I. The most successful mine-mouth application, however, was lignite-fired, electric-power generation, which assumed large-scale proportions in the 1920s, when Otter Tail Power Company purchased Wilton Mine No. 2 (Bl0038) and constructed the nearby Washburn Power Plant. By 1941, approximately 20 percent of the state's commercial lignite output was consumed by the electric power industry.

Criterion B

At North Dakota lignite mines, surface works were basically support facilities for underground workings. Consequently, they derive their significance under Criterion B by association with underground workings that are significant under Criterion B. In other words, if the associated underground workings are significant under Criterion B, then the surface works may be significant as well. Conversely, if the associated underground workings are not significant under Criterion B, then the surface works are not significant under Criterion A (although they might be significant under Criterion C and should be evaluated accordingly).

The exception to this rule pertains to the category of surface works described as "Related Construction." This category includes the off-mine residences of prominent mine owners, mine operators, or miners. These residences may directly reflect the significance of individuals who achieved prominence in the lignite industry. To properly apply Criterion B in terms of a residence, it is necessary to establish three points: (1) the property appropriately reflects the owner's or occupant's historical significance; (2) the property illustrates the individual's significance more fully than other properties known to be similarly associated; (3) the individual was indeed historically significant. Individuals who achieved noteworthy prominence in the North Dakota lignite industry include: William D. Washburn, for founding Wilton Mines No. 1 and No. 2 (BL0030, BL0038); A. H. and E. M. Truax, for establishing large-scale strip mining in North Dakota; and Madison M. Mounts, for developing and managing the Knife River Coal Company Mine (MEX065), which contained the state's largest and most mechanized underground workings.

Criterion C

Surface works are significant under this criterion by virtue of notable design, architecture, or engineering. As is true for the nation's historic mining properties in general, the available evidence for North Dakota lignite mining indicates that almost no historic surface works of any description remain. The few surface works that have survived must be considered "notable" examples under Criterion C because they are the only examples left to document this historically significant industry.

Registration Requirements for Surface Works

Criterion A

Surface works in North Dakota may be eligible for the National Register if they if they fulfill any of the following conditions:

1. Were functionally associated with an underground workings that is eligible for the National Register under Criterion A.

2. Comprised a state-operated mine experiment station or pilot mine-mouth industrial plant that established the feasibility of using lignite in an industrial or commercial process.

3. Comprised a mine-mouth industrial plant that contributed to a regionally important manufacturing or agricultural enterprise, such as electric-power generation, briquetting, or pump-irrigation.

Criterion B

Surface works in North Dakota may be eligible for the National Register if they fulfill any of the following conditions:

1. Were functionally associated with an underground workings that is eligible for the National Register under Criterion B.

2. Were "off-mine" residences of prominent mine owners, mine operators, or miners and appropriately reflect their owners' historical significance in the state's lignite industry.

Criterion C

All surviving surface works in North Dakota are eligible for the National Register if they meet the integrity criteria listed below.

Integrity Requirements

Criteria A, B, and C

Loss of integrity occurs:[107]

1. If it is not possible to give a reasonably accurate description of the feature's historic function based on its surviving physical fabric.

2. If the historic fabric of a feature has been irretrievably replaced by activities that occurred after the Period of Significance.

Criterion C Only

Since the significance of surface works under Criterion C is based on their typological characteristics rather than associational qualities, the relocation of surface works from their historic site does not necessarily entail loss of integrity.

[107] It should be pointed out that the integrity criteria listed above do not exhaust the possibilities of adverse impacts that might deprive a property of eligibility. They are meant only to indicate a minimum level of structural sufficiency that a property must retain to convey a sense of its original setting, design, materials, and workmanship.

HISTORIC-ARCHEOLOGICAL PROPERTIES

The evaluation of historic-archeological mining properties draws heavily on the concepts of "visibility" and "focus," first formulated by American anthropologist James Deetz.[108] Briefly, visibility refers to the amount of physical remains at a site, while focus indicates the degree to which they can be interpreted. Under normal circumstances, the simplest way to increase a site's visibility is to conduct a thorough field survey of the location. At abandoned mine sites, however, underground survey generally is ruled out as too hazardous, and even above-ground reconnaissance may be restricted by unstable surface or pit conditions. Archeological investigators should therefore consider the use of appropriate remote-sensing techniques, which range in technological sophistication from the analysis of aerial photography to the deployment of ground-penetrating radar.

Investigators often find that it is more practical to attempt to increase a mine site's focus than its visibility. To a certain extent, the degree of focus reflects the level of the investigator's own knowledge, which often can be improved through documentary research and the interviewing of local-history informants. There is a point, however, at which no amount of focus can compensate for poor visibility. The site simply no longer contains (or indicates that it contains) sufficient historic fabric to yield significant information in the prevailing framework of scholarly inquiry. In such cases, it does not have integrity as an historic-archeological site.

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[108] See John J. Knoerl, "National Register Bulletin 36: Historic Archeological Properties," An unpublished draft prepared for the U. S. Department of the Interior, National Park Service, Interagency Resources Division, 1988, 100-102; Noble and Spude, "National Register Bulletin 42: Evaluating and Nominating Historic Mining Sites," 18-19.

Description of Historical-Archeological Lignite Mining Properties

Historic-archeological lignite properties consist of features, and their associated material scatter, that no longer retain integrity under the two property types previously discussed, mine workings and surface works.

Significance of Historical-Archeological Lignite Mining Properties

Period of Significance: 1870-1945

Criterion A

Historic-archeological lignite properties derive significance for the same associational reasons as the two previously discussed property types, mine workings and surface works. If a feature would have been significant as a property type under Criterion A, but was disqualified for lack of integrity, then it may be significant as a historic-archeological property under Criterion A.

Criterion B

Historic-archeological lignite properties derive significance for the same associational reasons as the two previously discussed property types, mine workings and surface works. If a feature would have been significant as a property type under Criterion B, but was disqualified for lack of integrity, then it may be significant as a historic-archeological property under Criterion B.

Criterion C

Under Criterion C, significance derives more from typological than associational factors. For this reason, it is doubtful that any historic-archeological properties will be significant under Criterion C. Integrity Requirements under Criterion C for the two previously discussed property types allow great latitude for loss of historic design, materials, and workmanship. The requirement stipulates: "Loss of integrity occurs if it is not possible to give a reasonably accurate description of the feature's historic function based on its surviving physical fabric." If a lignite-related feature fails this integrity test as a property type, it probably does not have sufficient historic fabric to be of typological significance as an historic-archeological site.

Criterion D

Compared to the other three significance criteria, Criterion D has the lowest integrity requirements for visibility (i.e., the surviving physical characteristics of historic design, materials, and workmanship). Properties eligible under the other criteria must demonstrate significance through their surviving physical features. Under Criterion D, however, a property is eligible for its potential to reveal significant information within the current context of scholarly inquiry.

Since so little research has been done on the North Dakota lignite industry, it is understandable if archeological investigation begins by addressing very basic questions about mine-site layout, mining technology, and work force composition. Archeological research on these topics will be especially valuable if conducted at mining locations of known historical significance. Such sites generally are associated with historical production and employment data that can guide the archeological investigation and assist in the interpretation of its findings. In addition, archeological findings will have immediate value, for they will increase the interpretive potential of historically significant properties.

Research Questions

1. Historical geographer Richard V. Francaviglia has written, "ethnic diversity appears to be common to all of America's mining areas."[109] Apart from historian Frances Wold's observation that the Washburn Lignite Coal Company hired immigrant workers, the role of ethnicity in North Dakota lignite mining has not been examined. Do artifactual remains (personal effects, food packaging, vernacular construction techniques, etc.) indicate ethnic diversity at lignite mining operations? Do site-distribution patterns of ethnic-related artifacts indicate ethnic-based differences in mine-site housing or employment? Do ethnic-related artifacts indicate that a mine site differed in ethnic composition from its surrounding area? Are there seriation patterns in ethnic-related artifacts that indicate a change in work force composition over time?

2. According to historian Priscila Long, "women's work in the coal communities supported the miners' work underground."[110] Do gender-related artifactual remains at North Dakota lignite mining locations support gender distinctions in employment or in other mine-site activities? Are there seriation patterns in gender-related artifacts that indicate a change in work-force composition over time?

3. Figure 19 of this study analyzes the spatial relationships among surface works at 65 small North Dakota underground mining operations during

[109] Richard V. Francavilglia, Hard Places: Reading the Landscape of America's Historic Mining Districts (Iowa City: University of Iowa Press, 1991), 107. For supporting documentation for a number of American coal fields, see Long, 125-132.

[110] Long, 42.

the period 1918 to 1940. The data suggests that surface works were laid out by function in the following series of either linear or concentric zones: primary production facilities (tipple, hoist, power plant, wash house, scale house); production support facilities (office, shops, supply sheds, garage); personnel-support facilities (bunkhouse, commissary, dwelling house, barn/stable); perimeter facilities (outer scale house, powder magazine). Do the spatial relationships among surviving archeological features at either underground or stripping operations support the data in Figure 19? Do the spatial relationships indicate another type of functional organization of the site? Was there change in the organization of the site over time?

4. North Dakota underground mining depended on the room-and-pillar method. According to the State Engineer's biennial report for 1909-1910, rooms typically ranged in width from 10 to 25 feet and pillars from 8 to 16 feet. In 1925, the State Engineer reported that the state's mining industry extracted about 60 percent of the coal seam, which means that very few mining operations attempted to pull all of the pillar coal. Do surviving room-and-pillar dimensions support these statistics? Do there appear to have been changes in method and layout over time?

   During the period 1910 to 1920, the State Engineer compiled statistics showing that the vast majority of underground mining operations blasted off the solid, without preparatory undercutting. Are there surviving channel cuts at the base of coal faces which indicate that undercutting occurred? Are there artifactual remains that indicate the type of undercutting equipment? Were there changes in extraction technique over time? Although the State Engineer does not specifically address the issue of underground loading of coal, national statistics for the bituminous coal industry indicate that less than 10 percent of total production was mechanically loaded underground before 1930 (and only 31 percent by 1939).[111] Do artifactual remains reveal the nature of underground loading? Do they reveal the nature of motive power for mining operations? Were there changes in loading techniques or motive power over time?

   In addressing the nature of underground mining at a location, investigators should explore the applicability of remote sensing techniques, especially the analysis of surface subsidence patterns revealed in aerial photographs (see Figures 12 and 13). As geologists C. Richard Dunrud and Frank W. Osterwald have noted, "spectacular

[111] Barger and Schurr, 174.

surface subsidence features occur above abandoned coal mines in western North Dakota, particularly in the Beulah area . . . . The geometry of the room-and-pillar mine is vividly portrayed by subsidence pits and troughs."[112]

5. Before 1910, horse-drawn plow-and-scraper operations were the rule in North Dakota strip mining operations. According to historian James Dahlberg, excavations rarely exceeded 15 feet in depth, which also appears to have been the limit for early bituminous stripping elsewhere in the nation.[113] Do existing soil profiles at known, historic plow-and-scrapper mining locations support this data? Do artifactual remains indicate the nature of the excavation tools, or changes in excavation method over time? After World War I, North Dakota stripping operations began to use power shovels, which were capable of excavating 30 to 50 feet of overburden. By the 1930s, power shovels in use nationally were customarily excavating overburden to 50 feet and stacking spoil piles to 40 feet.[114] Do the nature of existing spoil piles and excavations support this data? Are there variations in excavation and spoil-pile dimensions at a site that can be correlated with changes in mining technology?

Registration Requirements for Historic-Archeological Lignite Mining Properties

Criterion A

A historic-archeological lignite property may be eligible for the National Register under Criterion A if, except for a lack of integrity, it would have been eligible as a property type under Criterion A.

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[112] C. Richard Dunrud and Frank W. Osterwald, Effects of Coal Mine Subsidence in the Sheridan Wyoming Area (Washington, D.C.: United States Government Printing Office, 1980), 20. In North Dakota, the underground-mine landscape is sometimes characterized by a checkerboard pattern of pits and depressions known in the technical literature as "subsidence." When the extraction of lignite creates unstable subterranean passageways and chambers, as it does in the room-and-pillar method, the overburden eventually slumps into the voids, recreating the underground pattern in surface pits, troughs, fissures, and depressions. These depressions can equal in depth the thickness of the lignite mined. Since subsidence is influenced by a variety of geological factors, it does not always occur at the same rate, even at the same site. Although some depressions appear soon after the robbing of pillars, others may take years or decades to form. See Dunrud, "Coal Mine Subsidence -- Western United States," Geological Society of America Reviews in Engineering Geology, 157, 170.

[113] Dahlberg, Kjos and Schreiner, 38; Holmes, 797.

[114] "A Half Century in Stripping," 180-181; Shurick and Toenniges, 654-647.

Criterion B

A historic-archeological lignite property may be eligible for the National Register under Criterion B, if except for a lack of integrity it would have been eligible as a property type under Criterion B.

Criterion D

A historic-archeological lignite property may be eligible for the National Register under Criterion D, if:

1. Except for a lack of integrity it would have been eligible as a property type under Criteria A, B, or C.

AND

2. It has the demonstrated potential to furnish information concerning any of the Research Questions discussed above.

Integrity Requirements

Criteria A and B

Loss of integrity occurs under any of the following conditions:[115]

1. A feature's historic function cannot be identified from its surviving physical fabric and siting.

2. A feature's surviving physical fabric is largely the result of activities that occurred after the Period of Significance.

Criterion D

Loss of integrity occurs if field survey and available remote sensing techniques fail to reveal physical evidence of historic mining activities or to document a property's ability to yield useful information pertinent to any of the Research Questions discussed above.

[115] It should be pointed out that the integrity criteria listed above do not exhaust the possibilities of adverse impacts that might deprive a property of eligibility. They are meant only to indicate a minimum level of structural sufficiency that a property must retain to convey a sense of its original setting, design, materials, and workmanship.

DATA GAPS

Project Methodology

In June 1981, we prepared a "Research Plan" for the present study which outlined a basic methodology involving bibliographic research, documentary research, database compilation, formulation of research hypotheses, limited field testing of hypotheses, and report preparation (see Appendix C). For the most part, the study unfolded according to plan. The only major methodological revision concerned field work. After concluding most of our documentary research, we had planned to inspect a limited number of lignite mining locations in order to test preliminary hypotheses about lignite-related property types. However, unseasonably early snow cover in the fall of 1991 made field work impractical at this stage in the project. Instead of delaying report preparation, we completed a draft discussion of property types, with the understanding that its conclusions were subject to revision in the light of subsequent field findings.[116] In April 1992, we spent five days informally surveying about fifteen lignite mining locations in Billing, Burleigh, Grant, Hettinger, McKenzie, Mercer, Mountrail, Ward and Williams counties. This trip was of great value in clarifying our thinking about both mine workings and surface works.

[116] "As explained in our original proposal, the purpose of field inspection is to test various research hypotheses derived from documentary data. In developing property types on documentary evidence alone, it is quite possible to formulate logical, internally consistent categories, which, unfortunately, have little to do with 'as-built' conditions. The field inspection phase of the project was intended to guard against this mishap. Since it's impossible to predict how soon the snow will disappear, I suggest that we simply begin writing the context and leave field verification until next spring . . . . Although the delay in field work may require greater revision of the context next year, it will allow us to go into the field with a much better idea of what to look for"; Jeffrey A. Hess to Barbara Honeyman Pierce, Grants and Contracts Officer, State Historical Society of North Dakota, 8 November 1991.

Sources of Information

As we pointed out earlier (see "Historiographical Remarks," pp. 10-12), national histories of the American coal industry do not discuss North Dakota lignite mining. There are two works, however, that attempt an historical overview from an in-state perspective. The first is Colleen A. Oihus's published master's thesis, <u>A History of Coal Mining in North Dakota, 1873-1982</u> (North Dakota Geological Survey, 1983). The second, an unpublished study entitled "Lignite Use and Development of the Lignite Industry in North Dakota," was prepared for the North Dakota Public Service Commission (AML Division) in 1984 by James C. Dahlberg, John M. Kjos, and Michele H. Schreiner. In addition, there are a few studies of narrower focus that merit attention. Alvar W. Carlson has contributed a brief but important assessment of lignite's importance for North Dakota homesteading in <u>Great Plains Journal</u> 2 (Spring 1972), and Francis Wold has chronicled the fortunes of the Washburn Lignite Coal Company in <u>North Dakota History</u> 43 (Fall 1976). Nancy Hesseltine Balazadeh's doctoral dissertation on the Nonpartisan League in North Dakota (Southern Illinois University at Carbondale, 1988) contains valuable information on the coal strikes of 1919 and 1922, while Richard G. Heinert's master's thesis on the North Dakota Board of Railroad Commissioners (University of North Dakota, 1974) gives a useful discussion of the political controversy surrounding lignite freight rates during the late nineteenth and early twentieth centuries.

As might be expected, the national engineering press focussed its attention on the state's largest lignite operations -- the Truax-Traer strip mines and the Knife River Coal Mine Company's well-mechanized underground mine at Beulah. For information on the state's smaller mines, it is necessary to consult the biennial reports of the State Engineer (1907-1919) and annual reports of the State Mine Inspector (1920-1945); these documents are by far the most important single resource for studying the state's lignite mining industry. Valuable information on individual sites also is provided by a collection of unpublished mine maps filed by county in the research library of the State Historical Society of North Dakota (Workman's Compensation Bureau, Series 505 Coal Mine Maps). Dating from about 1920 to 1970, these maps apparently were submitted to state authorities by mine operators as part of the licensing procedure for commercial lignite mines. Although the maps focus on underground workings and stripping pits, many identify surface features. Unfortunately, only a small percentage of the state's licensed mines are represented. Information on individual mines also can be found in local newspapers, published local histories, and the site files of the Division of Archeology and Historic Preservation of the State Historical Society of North Dakota.

In terms of manuscript collections, the most valuable proved to be the Great Northern Railway Company Records and the Northern Pacific Railway Company Records, both in the Minnesota Historical Society in St. Paul. These holdings provided us with extremely useful information concerning spur-track construction, the development of briquetting, and the operation of specific mine sites. Other researchers (eg., Dahlberg, et. al., and Karsmizki) have made profitable use of oral histories relating to lignite mining compiled by the WPA and preserved in the agency's "Historical Data Projects Records" in the State Historical Society of North Dakota. Time constraints prohibited our use of this material.

Research Recommendations

Industry Demographics

There is no quantitative data about the age, gender, and ethnic backgrounds of North Dakota mine workers, managers, and owners. Research on these topics should be conducted in federal census records.

Company Towns and Townsites

Research to date has identified seven North Dakota mine settlements that fit the Pennsylvania model of a coal company town (see page 35). All seven towns were associated with mine sites that employed over 100 people during at least one year before 1945. Approximately, twenty other mine sites in our database achieved a peak annual employment of at least fifty people (see Appendix B). These mine sites should be targeted for research regarding company town operations. It also might be rewarding to research the developmental patterns of several communities that bordered on lignite mines, such as Haynes and Reeder in Adams County, Scranton and Bowman in Bowman County, Columbus and Larson in Burke County, Wilton in Burleigh County, Noonan and Crosby in Divide County, Coalbank and Havelock in Hettinger County, Underwood in McLean County, Beulah and Zap in Mercer County, Zenith and Lehigh in Stark County, and Burlington and Kenmare in Ward County. Interviews with local residents, combined with research in county deed records, may reveal that mining companies, or land-company affiliates, owned and operated some of these communities, or at least a significant portion of them, for the "benefit" of their employees.

Labor Unions

Although the United Mine Workers of America (UMWA) played a significant role in the North Dakota lignite industry during the decade after the First World War, we know very little about the union's rise and fall in North Dakota, the extent of its organization, and its relationship to other labor and political groups in the state. An effort should be made to locate and research relevant local and national UMWA records.

Corporate Consolidation

Coal mining historian Keith Dix has noted that the American coal industry experienced considerable corporate consolidation during the mid-1920s.[117] The rise to prominence of the Truax-Traer Company in North Dakota seems to have been part

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[117] Dix, What's a Coal Miner to Do?, 173.

of this movement. Future research should examine the degree of corporate consolidation of the state's lignite industry and its impact on technology, production, labor relations, and pricing.

Mine-Mouth Industrial Plants

Research should be conducted in local histories, city directories, and industrial census data to identify mine-mouth plants and other manufacturing industrial establishments that used lignite as a fuel or raw material.

Strip Mining Technology

During the period 1910 to 1920, the State Engineer frequently included narrative descriptions of mine sites in his official reports. After 1926, however, state reports on the industry discontinue this practice, restricting their purview to statistical information. Consequently, we know more about the lignite industry's technology before 1926 than afterwards. This is particularly true for the state's stripping operations, which experienced tremendous growth during the 1930s and 1940s. Research needs to be done on all aspects of strip mining technology after 1925, especially regarding the use of small power shovels and drag lines, which apparently were popular in the Midwest bituminous fields during the 1930s.[118]

Coal Lands Reclamation

In 1945, a spokesman for the American bituminous stripping industry observed that "much thought has been given and experimental work done . . . throughout the middle west in an effort to find the best way to put the turned over strip land back into profitable agricultural use."[119] Research should focus on North Dakota's involvement in early reclamation programs and its impact on historic mining techniques and landscapes.

Oral History Research

A concerted effort should be made to identify and interview people who have been associated with the state's lignite industry. All of the research topics listed above are appropriate areas for oral-history work. Informants can be located by contacting local historical societies and by placing notices in local newspapers.

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[118] "A Half Century in Stripping," 182; "Stripping," 417.

[119] R. H. Sherwood, "The Development of Strip Mining, Mining Congress Journal 31 (November 1945): 31.

PRESERVATION STRATEGIES AND GOALS

We hope that this study marks the beginning of a systematic effort to document, evaluate, and preserve North Dakota's historic lignite-related properties. We recommend that future work along these lines should proceed as follows:

1. Survey of Lignite-Related Properties

   This study's historical overview and registration criteria permit the identification of over 100 potentially significant lignite mining sites; most are listed in Appendix A. A formal field survey of these sites should be conducted to assess their integrity and to compile additional historical information, as needed, to determine their eligibility for listing in the National Register of Historic Places.

2. Development of Remote Sensing Techniques

   A study of remote sensing techniques should be undertaken to evaluate their usefulness in evaluating North Dakota historic-archeological lignite properties, particularly under Criterion D. This study should have a field-survey component, preferably focussing on sites identified for the general field survey discussed in the recommendation immediately above.

3. Nominate Eligible Lignite-Related Properties to the National Register

   This is a logical, and important, next step. National Register designation automatically grants the protection of Section 106/4(f) review to these properties. Designation also creates public recognition of the role that historic mining properties have played in North Dakota's development.

4. Formulate a Preservation Management Plan

   The preservation of historic mining properties is in its infancy throughout the nation. Since North Dakota is one of the few states to have prepared a full contextual study of its historic mining resources, it is in a position to take a leading role in the formulation of preservation policy. State authorities should explore the use of federal reclamation funds for preservation purposes; an important precedent is the use of federal highway monies for the preservation of historic transportation properties. In consultation with the National Park Service, a study should be undertaken of the preservation of historic mining properties elsewhere in the nation to evaluate which procedures may be most suitable for North Dakota. Ideally, participants in this study should include representatives of the state's lignite industry and local historical groups from the mining region.

5. Further Research

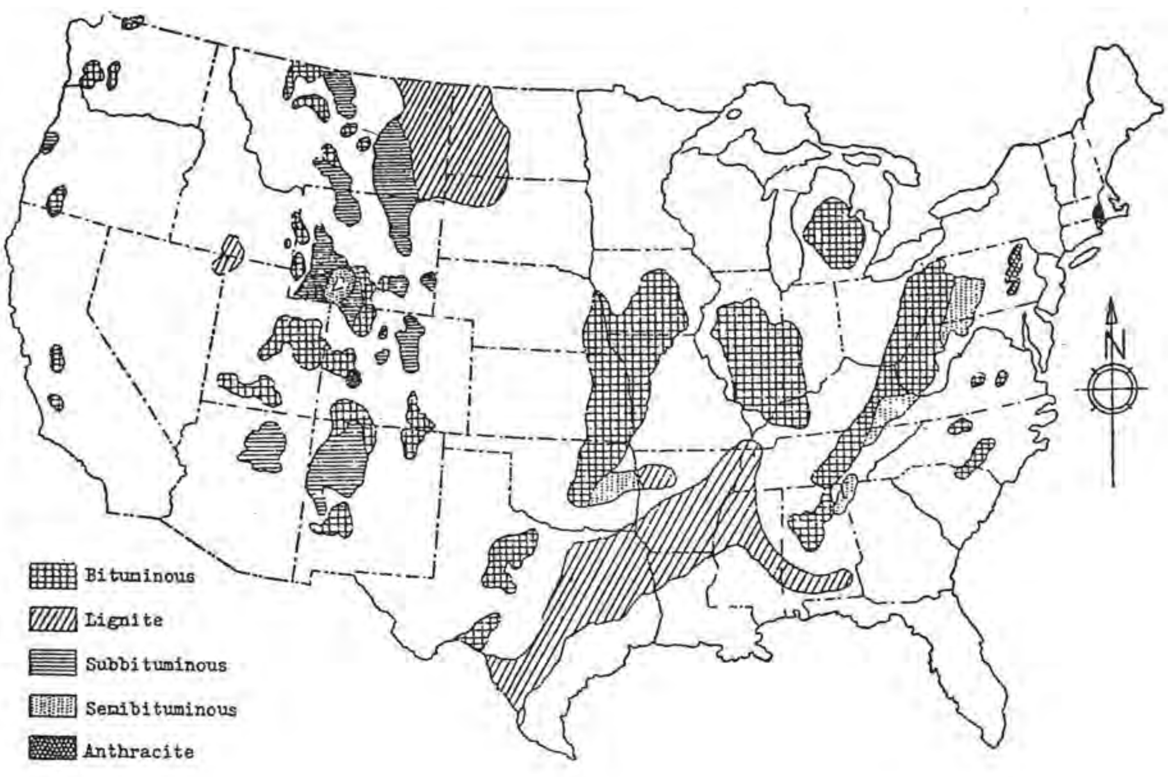
Research should be conducted on the topics listed in the "Data Gaps" section of this report, with the highest priority assigned to the study of property-type related issues (company towns, mine-mouth plants, strip mining). Since lignite mining was a wide-spread "grass-roots" activity in western North Dakota, it lends itself to study by area residents who often are in a privileged position to gather oral-history data. An attempt should be made to encourage the participation of local historical societies, high schools, and colleges.

ILLUSTRATIONS

Figure 1: Nature of Database Sample

Contents of Sample	Size of Sample	
Total mine sites	357	
Total mines	558	
Period covered	1908-1945	
Mines:		
Beginning year of production	558	
Ending year of production	558	
Production in peak year	448	thousands of tons
Total production sold locally	558	thousands of tons
Total production shipped	558	thousands of tons
Total production	558	thousands of tons
Employees in peak employment year	454	

Figure 2: Map of Coal Areas in the United States



Source: Irvine Lavine, "Lignite in the United States," Fuel in Science and Practice 20 (January 1941), 15.

Figure 3: Map of the Lignite-Bearing Region of North Dakota

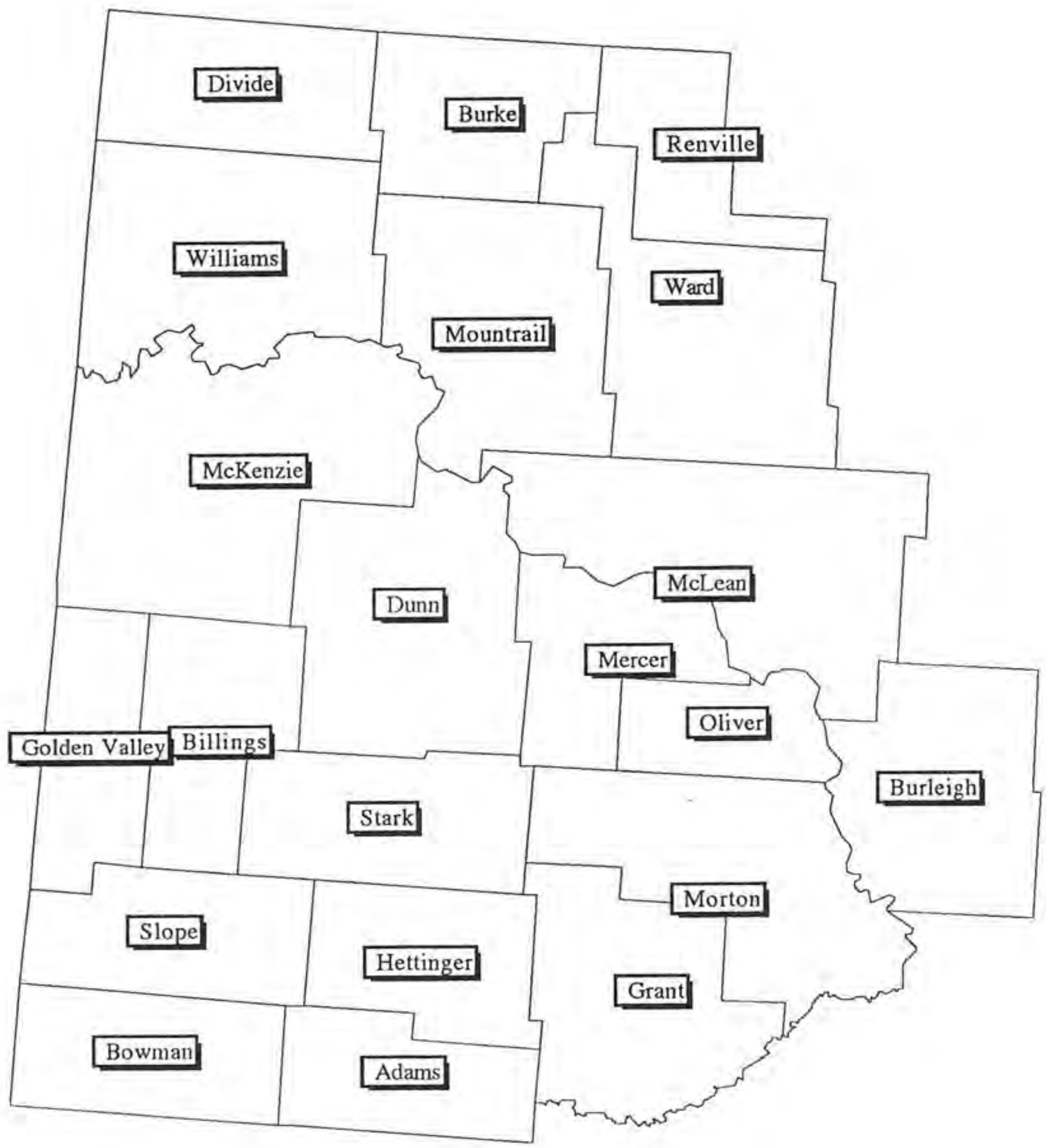
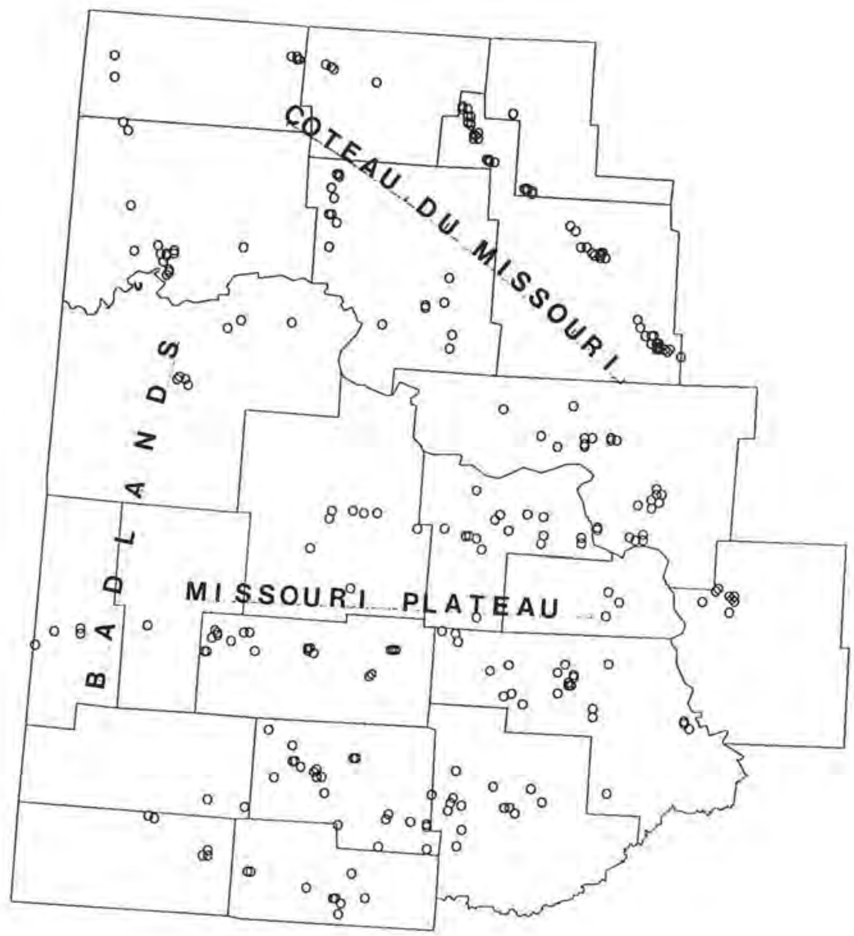
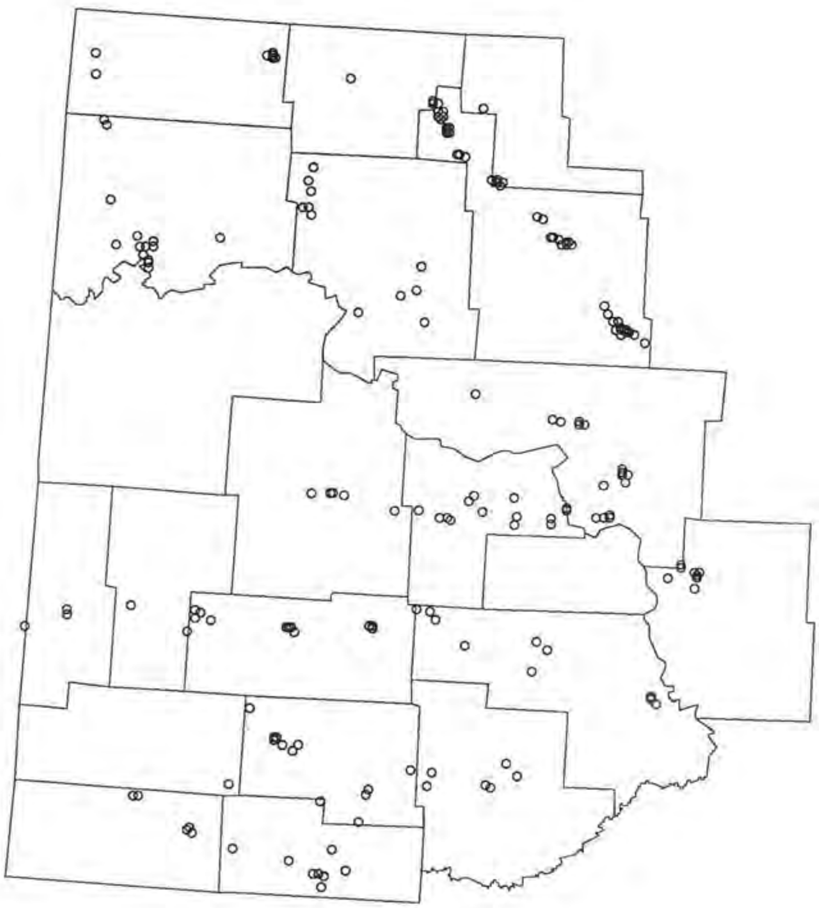


Figure 4: Map of North Dakota Lignite Mine Sites, 1908-1945



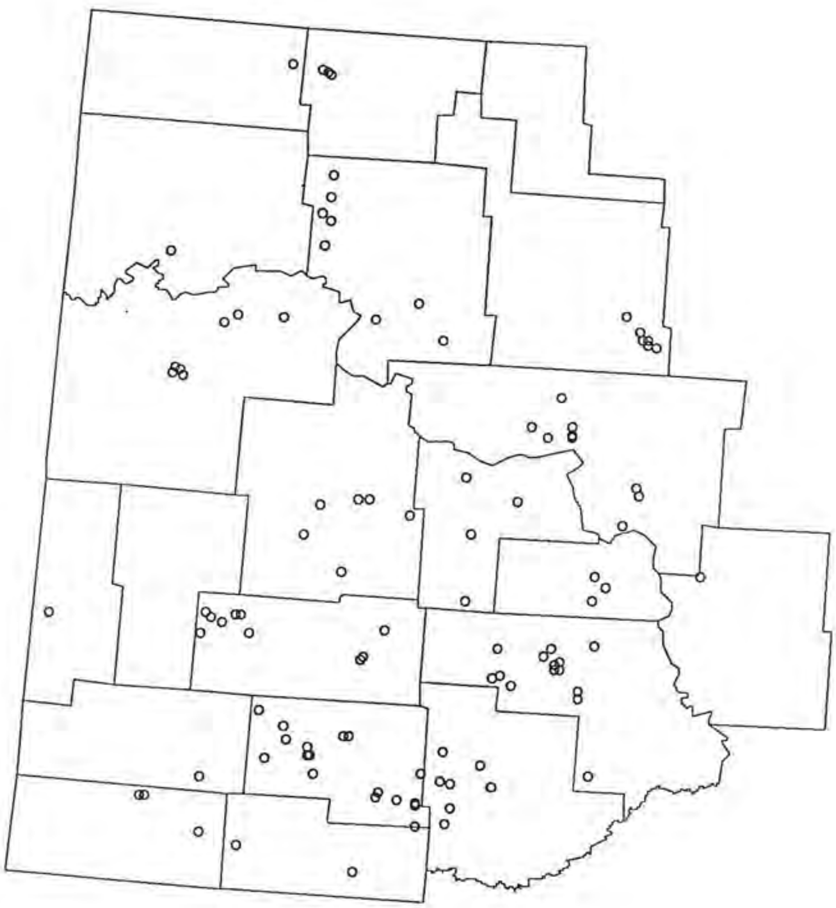
Source: Database sample of 357 mine sites. Deficiencies in data have caused underrepresentation of sites in Williams County.

Figure 5: Map of North Dakota Underground Mine Sites, 1908-1945



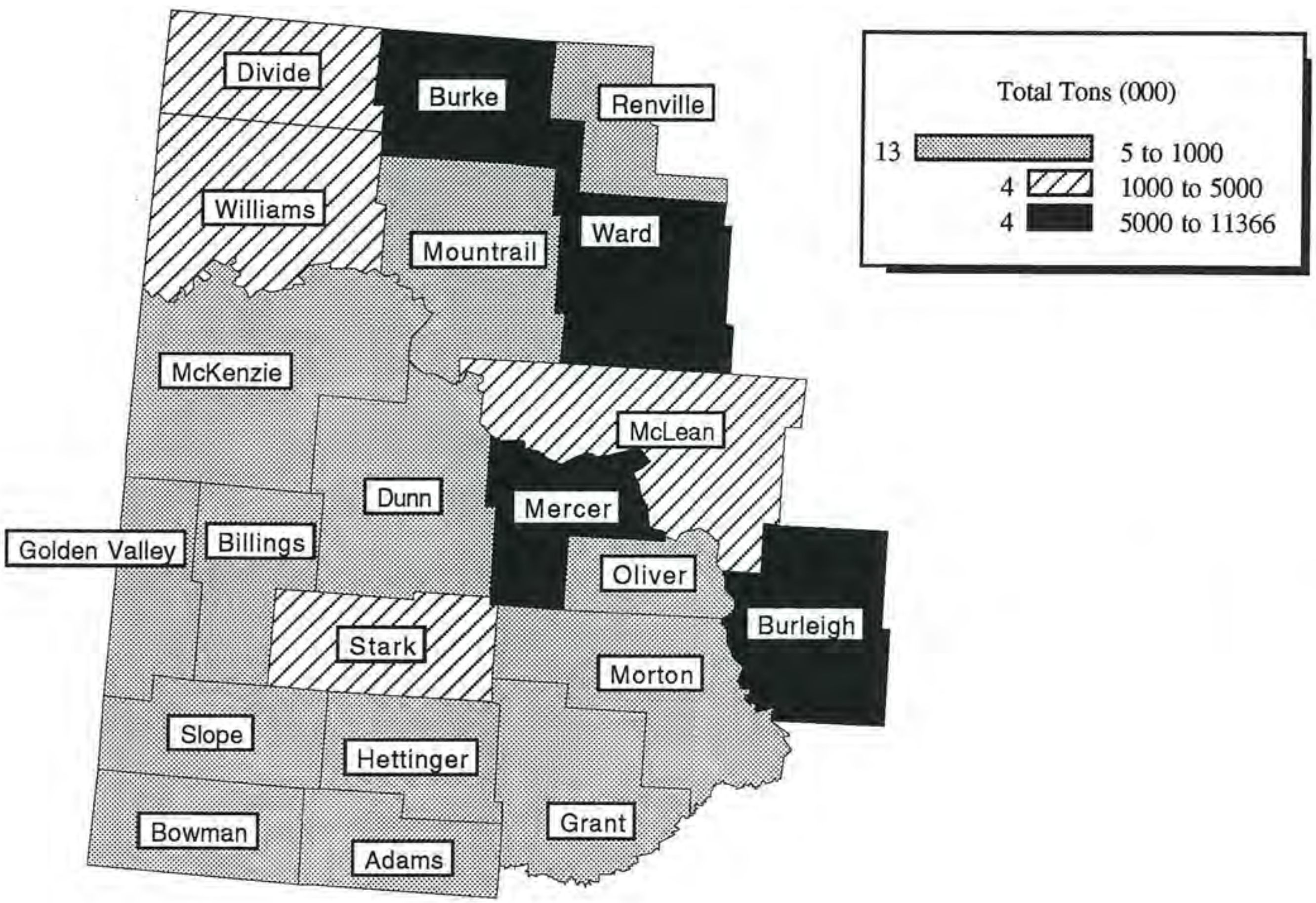
Source: Database sample of 357 mine sites. Deficiencies in data have caused underrepresentation of sites in Williams County.

Figure 6: Map of North Dakota Strip Mine Sites, 1908-1945



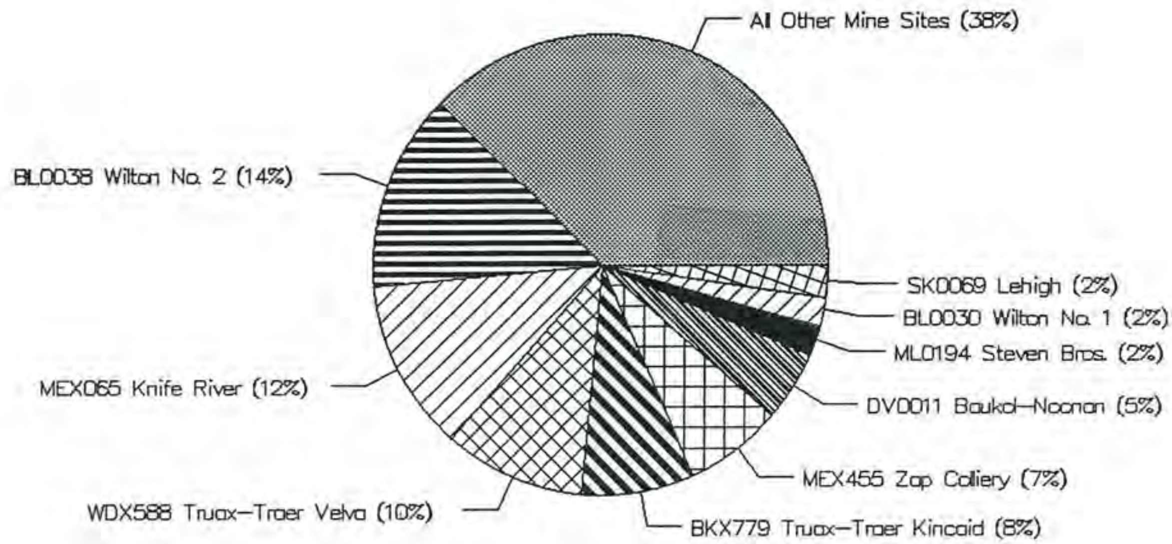
Source: Database sample of 357 mine sites. Deficiencies in data have caused underrepresentation of sites in Williams County.

Figure 7: Map Showing North Dakota Lignite Production by County, 1908-1945



Source: Database sample of 558 mines.

Figure 8: Production Comparison of Largest North Dakota Mine Sites, 1908-1945



Top 9 mine sites accounted for 62 percent of total North Dakota production.
Total North Dakota production: 53,585,000 tons.

Figure 9A: North Dakota Mine Starts, by Mine Size, by Decade, 1908-1945

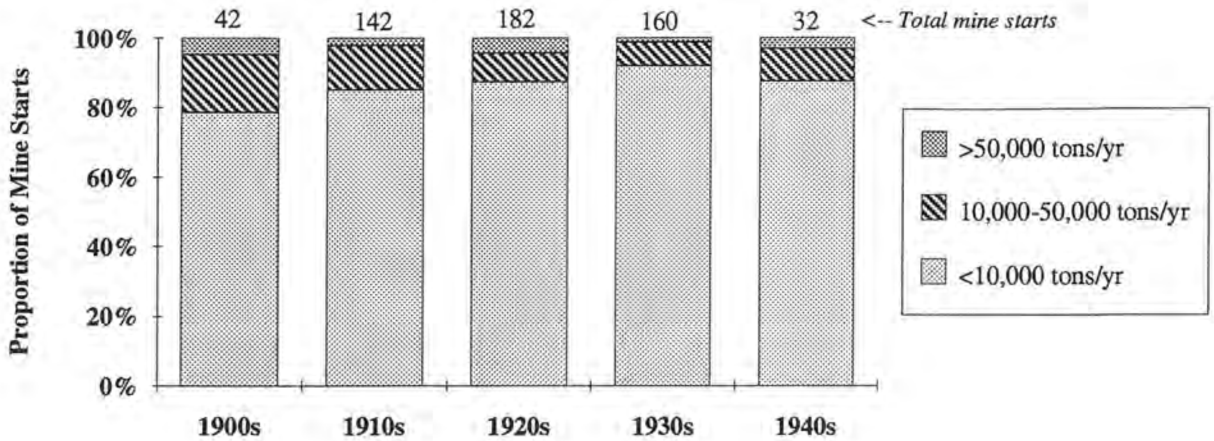
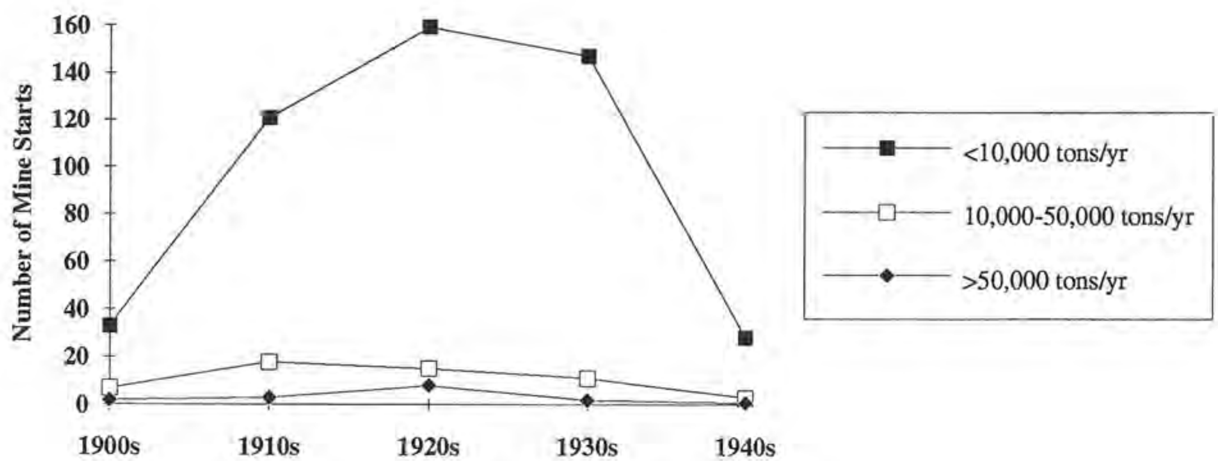


Figure 9B: North Dakota Mine Starts, by Mine Size, by Decade, 1908-1945



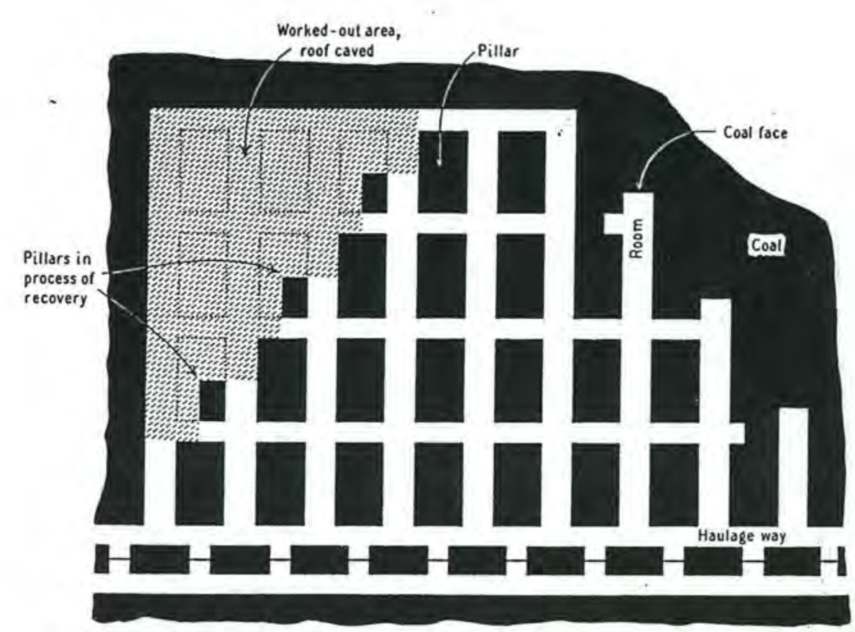
Source: Database sample of 558 mines.

Figure 10: Commercial Lignite Production in North Dakota, 1884-1945

Year	Shipped	Produced	Year	Shipped	Produced
1884	.....	35,000	1915	.....	528,078
1885	.....	25,000	1916	.....	634,912
1886	.....	25,955	1917	.....	790,548
1887	.....	21,470	1918	.....	813,000
1888	.....	34,000	1919	.....	783,694
1889	.....	28,907	1920	.....	878,969
1890	.....	30,000	1921	.....	895,715
1891	.....	30,000	1922	.....	1,057,823
1892	.....	40,725	1923	1,187,170	1,435,605
1893	.....	49,630	1924	826,237	1,029,449
1894	.....	42,015	1925	1,036,242	1,357,408
1895	.....	38,997	1926	1,048,457	1,385,362
1896	.....	78,050	1927	1,181,569	1,529,154
1897	.....	77,246	1928	1,437,068	1,783,624
1898	.....	83,895	1929	1,497,029	1,902,593
1899	.....	98,809	1930	1,390,378	1,849,144
1900	.....	129,883	1931	1,155,804	1,552,242
1901	.....	166,601	1932	1,298,871	1,743,053
1902	.....	226,511	1933	1,474,924	1,872,381
1903	.....	278,645	1934	1,369,610	1,746,226
1904	.....	271,928	1935	1,356,196	1,828,214
1905	.....	317,542	1936	1,254,756	1,704,983
1906	.....	305,689	1937	1,551,767	2,184,928
1907	.....	347,760	1938	1,450,318	2,142,061
1908	.....	320,742	1939	1,545,140	2,176,841
1909	.....	372,570	1940	1,511,023	2,165,181
1910	.....	416,580	1941	1,628,035	2,347,258
1911	.....	502,628	1942	1,707,847	2,474,006
1912	.....	499,480	1943	2,019,024	2,694,600
1913	.....	495,320	1944	1,910,819	2,515,823
1914	.....	506,685	1945	1,898,484	2,485,469

Source: Coal Mine Inspection Department, State of North Dakota, Thirtieth Annual Report, 1948 (Bismarck: Tribune, 1948), 8-9.

Figure 11: Diagrammatic Plan of Room-and-Pillar Mining

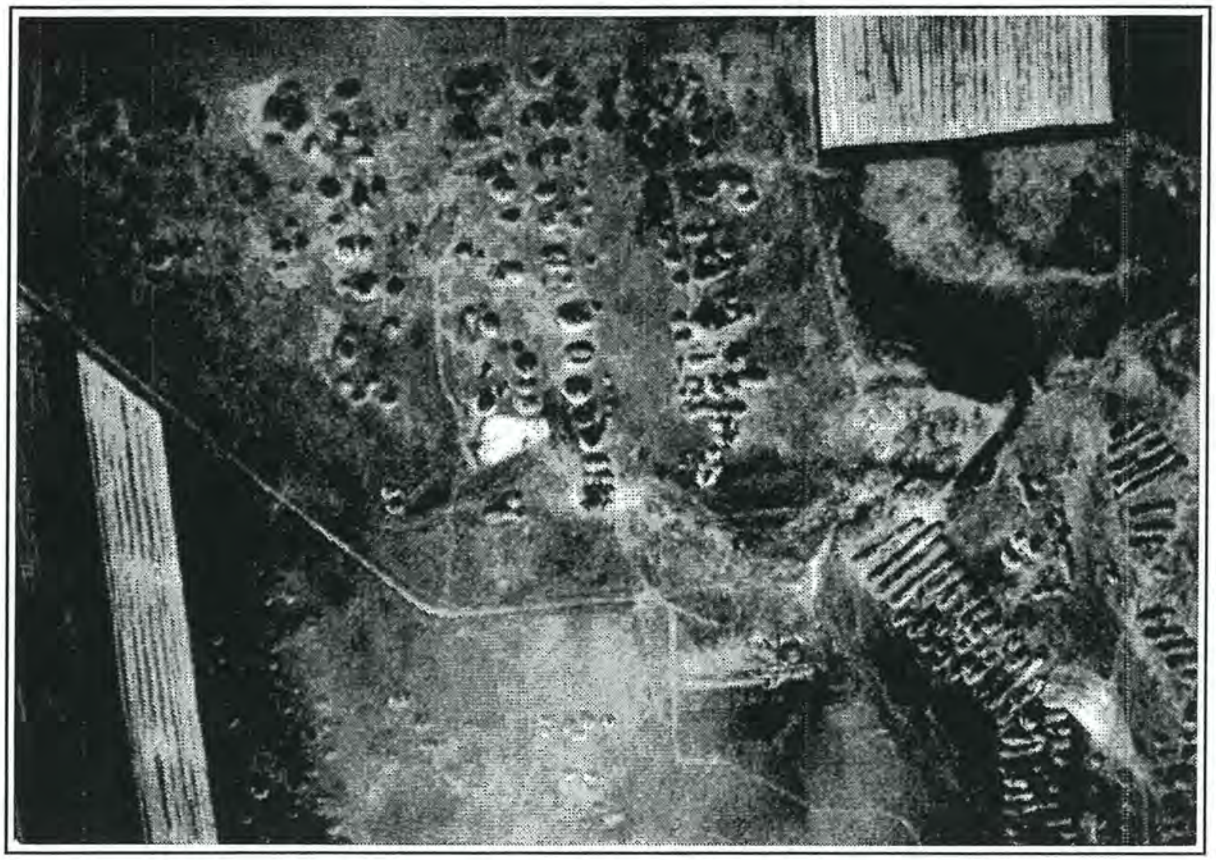


Source: Harold Barger and Sam H. Schurr, The Mining Industries, 1899-1939 (New York: National Bureau of Economic Research, Inc., 1944), 172.

Figure 12: Surface Subsidence at Knife River Coal Company Mine (MEX065), Beulah, North Dakota, 1992

Source: Jeffrey A. Hess, Hess, Roise and Company

Figure 13: Aerial View of Surface Subsidence at Knife River Coal Company Mine (MEX065), Beulah, North Dakota, c. 1985



Source: Beulah City Engineer's Office

Figure 14: Bituminous and Lignite Strip Mine Production, North Dakota and Nation, 1921-1950
Percentage of Total Output

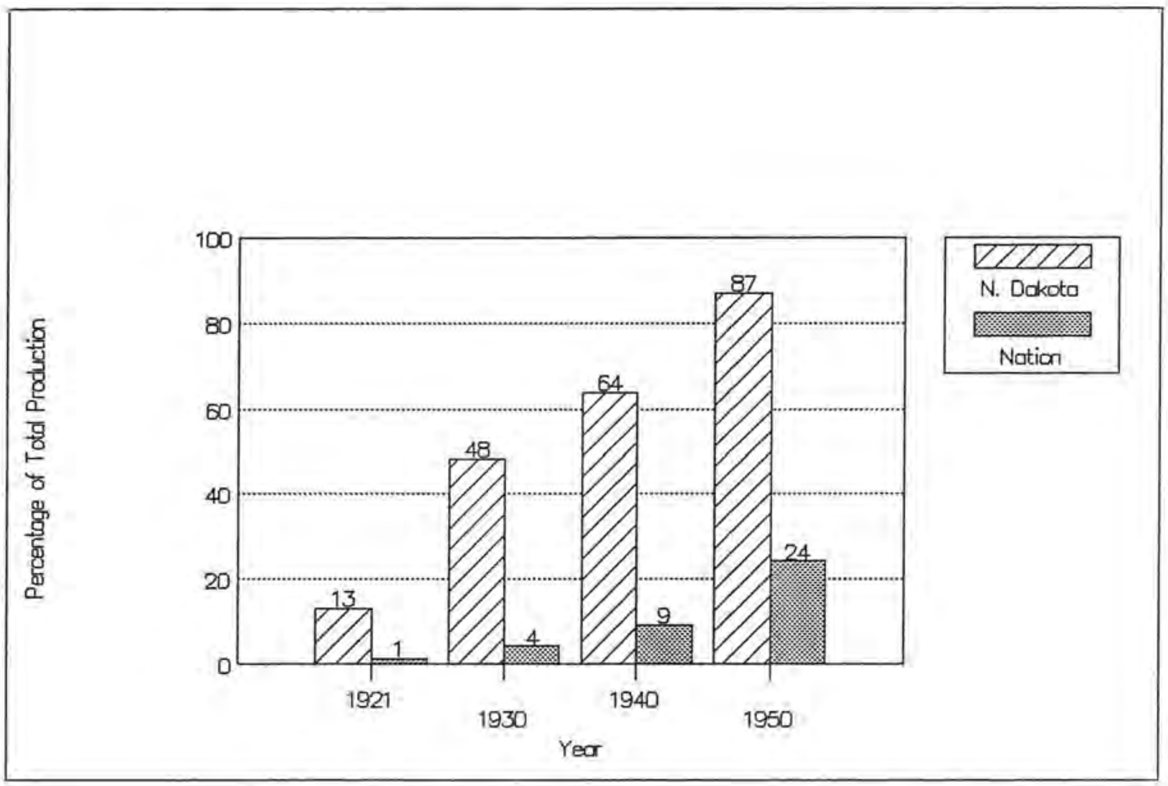
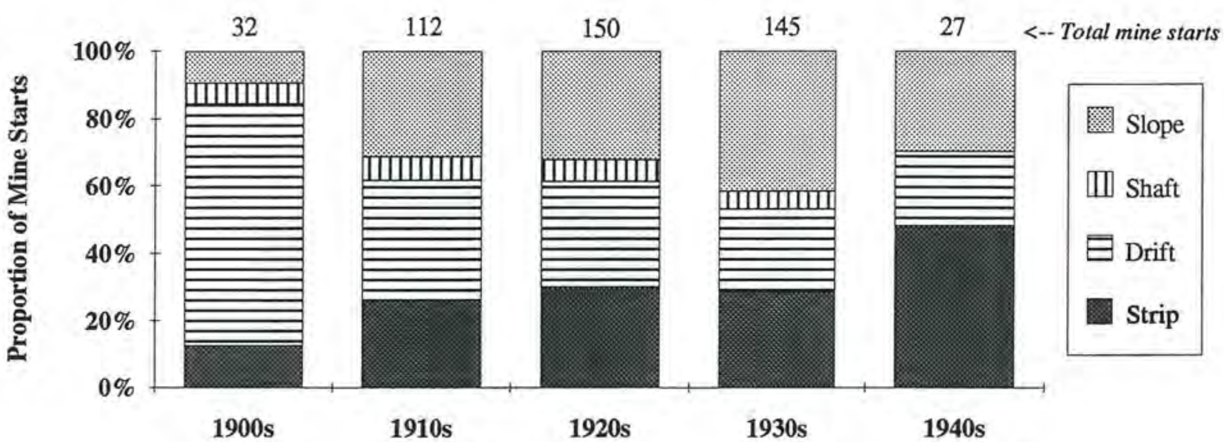
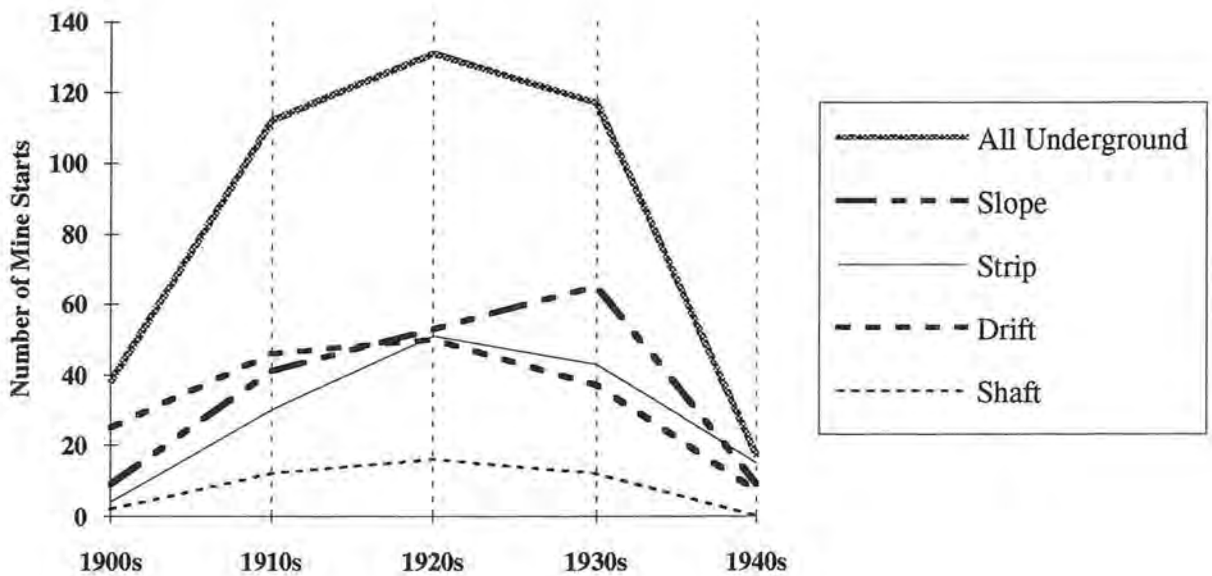


Figure 15: North Dakota Lignite Mine Starts, by Type, by Decade, 1908-1945



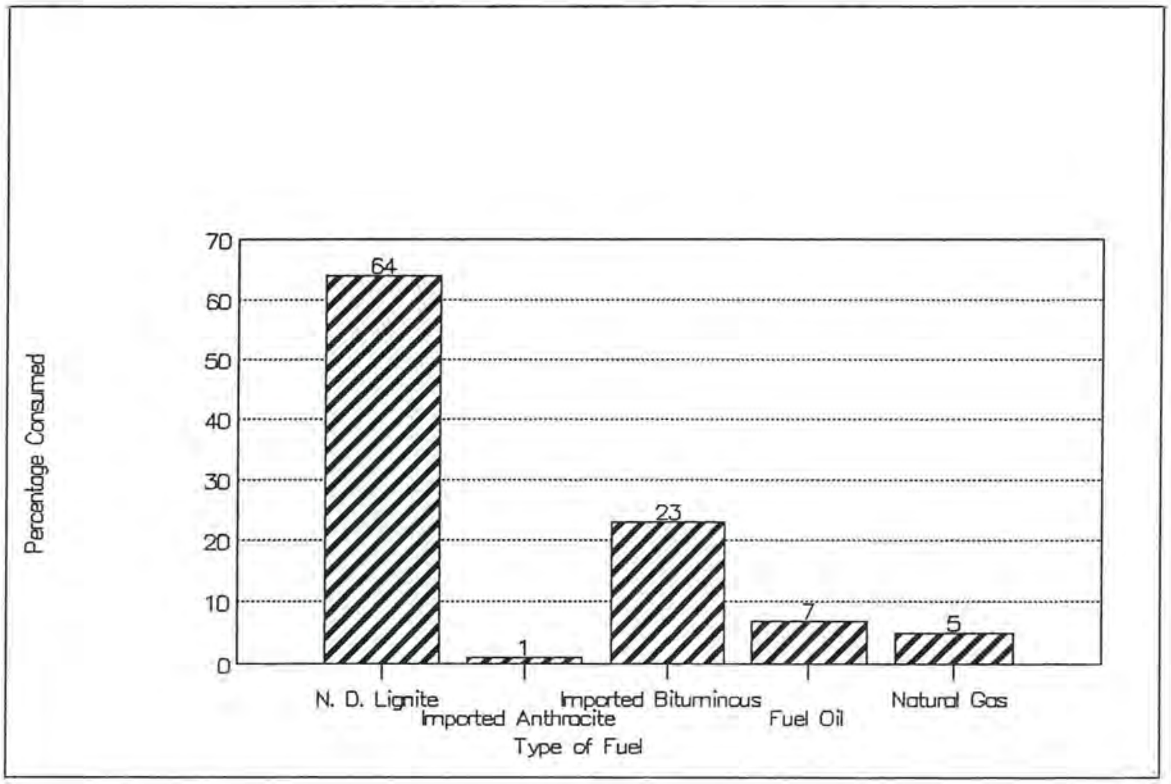
Source: Database sample of 558 mines.

Figure 16: North Dakota Mine Starts, by Mine Type, by Decade, for Mines Producing Under 10,000 Tons per Year, 1908-1945



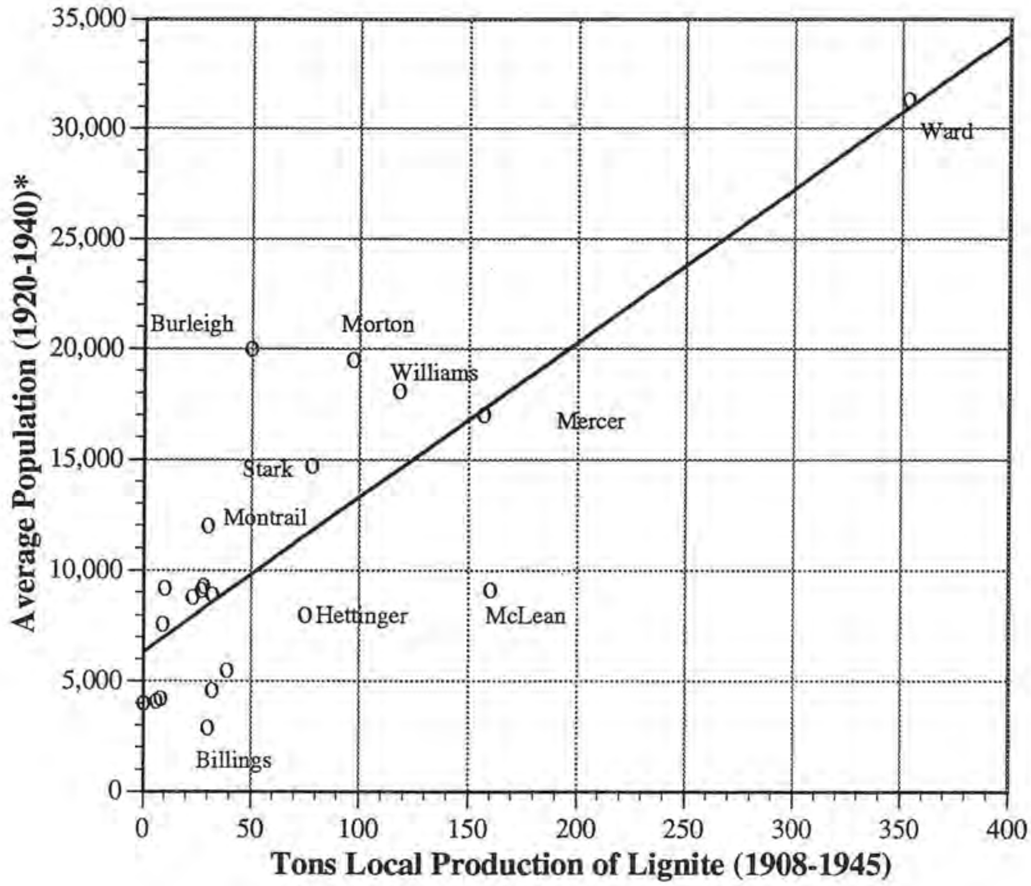
Source: Database sample of 558 mines.

Figure 17: North Dakota Heating Fuel Consumption by Btu, by Percent, 1935-1939



Source: See Footnote 93 in text.

Figure 18: Mine Production Sold Locally and Average County Population, c. 1920-1940



Coefficient of correlation = .80

Source: Database sample of 558 mine sites; U. S. Census of Population, 1920, 1930, 1940.

Figure 19: Analysis of Surface Works at Small North Dakota Underground Mines, 1918-1940

Property Type	Frequency (percent)	Average Distance to Tipple (feet)	Cases Adjoining Tipple
Tipple/hoist	91	0	--
Wash house	11	42	0
Power plant	37	42	12
Scale/scale house	40	68	6
Garage	8	98	0
Storage/supply	6	100	0
Shops	15	109	1
Plant Office	21	138	3
Bunkhouse	35	178	0
Commissary*	12	260	0
Dwelling house	40	296	1
Barn/Stable	28	288	0
Perimter scale	12	319	0
Powder magazine	12	321	0
Pump/windmill	22	--	0
Fan house	8	--	0

*Includes boarding house, mess hall, cook house

Source: Sixty-five maps prepared by mine owners (1918-1940); State Historical Society of North Dakota.