MINING AND RECLAMATION OF PRIME FARMLANDS IN WESTERN NORTH DAKOTA[1]

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ABSTRACT. Prime farmland reclamation is required by the 1977 Surface Mining Control and Reclamation Act. The Coteau Properties Company operates a lignite mine in western North Dakota, and is the only mine in the semiarid west to mine and reclaim large acreages of prime farmland. The characteristics of prime farmlands in western North Dakota are not addressed by Federal regulatory requirements, and conflict with State requirements for reclamation of all croplands in North Dakota. This conflict results in unnecessary additional environmental disturbance during mining, and increased reclamation expense to the mine operator. Reclamation operations at the Freedom Mine are described. Recommended changes to prime farmland regulations and interpretations of existing regulations would enhance overall reclamation for all croplands in western North Dakota, both prime and nonprime.

Introduction

The Coteau Properties Company operates the Freedom Mine, a large surface coal mine in western North Dakota. Most land mined and reclaimed has an agricultural land use, and some is classified by the U.S.D.A. Soil Conservation Service as prime farmland. The Freedom Mine is the only surface mine west of the 100th meridian to reclaim significant acreages of prime farmland. This paper discusses mining and reclamation of prime farmlands at the Freedom Mine, and provides recommendations to enhance reclamation by reducing environmental disturbance and costs.

The Soil Conservation Service (SCS) has recognized prime farmland as "land best suited for producing food, feed, forage, fiber, and oilseed crops and also available for these uses although it may be currently used for cropland pastureland, or rangeland" (SCS 1977). The SCS, and other policy-making and regulatory agencies, place a high value on prime farmlands, and recognizes the importance of conserving these valuable agricultural lands for future generations. Describing and mapping prime farmlands helps government agencies establish policies and regulations to stem the loss of the nation's most productive croplands (SCS 1977). Specific criteria are used by the SCS to determine if a soil should be considered prime. (Federal Register 1978)

[1]Paper presented at "Reclamation, A Global Perspective" conference, Calgary, Alberta, August 27 - 31, 1989.

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Proceedings America Society of Mining and Reclamation, 1989 pp 447-458
DOI: 10.21000/JASMR89020447

https://doi.org/10.21000/JASMR89010447

Currently about 65 soils in North Dakota are classified as prime; an additional 100 would qualify as prime if drainage or irrigation practices were applied (Doll 1986). The North Dakota Public Service Commission has additional rules to determine if special prime farmland soil handling and reclamation requirements apply. For example, with regard to surface mining, prime farmland regulations are not applicable to those lands not historically cropped (State of North Dakota 1987).

Site Description

The Freedom Mine is located about 90 miles northwest of Bismarck, North Dakota. Over 11 million tons of lignite coal are mined annually. About half the coal mined is delivered to the adjacent Antelope Valley Station, an 880mw electrical generating station. The remainder is delivered to the Great Plains Coal Gasification Project, also adjacent, where it is converted to synthetic natural gas. Mining began in 1983, following several years of preliminary development.

The mine permit covers approximately 6,000 acres, and active operations occupy about half the permit area. Average annual disturbance is 3-400 acres. Final reclamation of mined lands began in 1986. Over 700 acres have been reclaimed to date. Of the more than 500 acres of cropland reclaimed, some 140 acres have been reclaimed as prime farmland. All cropland, including prime farmland, is seeded with a "pre-crop" hayland mixture of smooth bromegrass, intermediate or pubescent wheatgrass, and alfalfa. Reclaimed croplands and prime farmlands are mixed together in a mosaic throughout the landscape, similar to the premine condition, and are managed identically. Production data are collected separately for prime and nonprime areas, as required by law.

Cropland areas are dominated by soils of glacial origin. Major soils are classified as Argiborolls or Haploborolls (SCS 1978). Zahl, Williams, and Bowbells soils comprise most of the permitted cropland. They are very similar; the primary difference between these soils is the thickness of

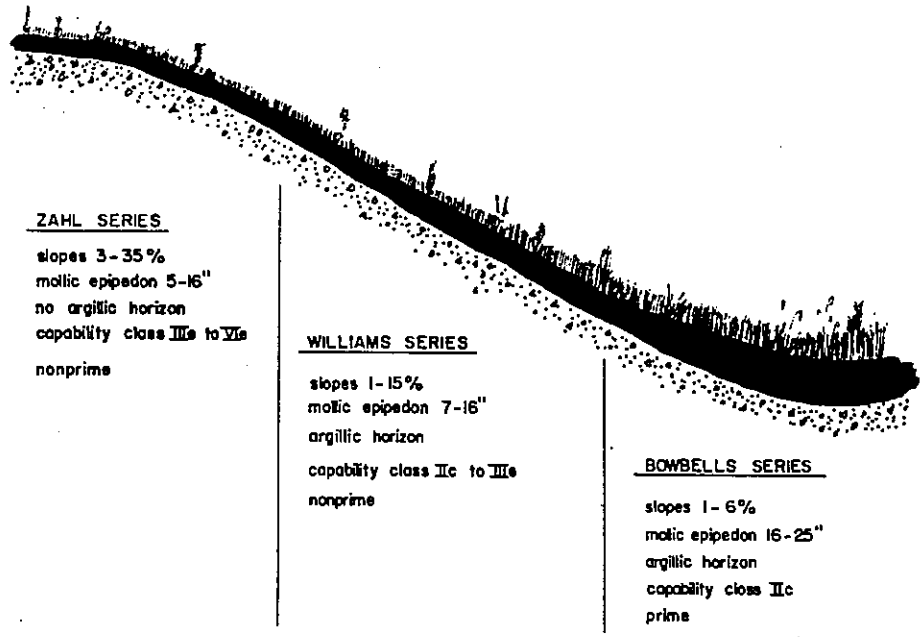


Figure 1. Cross-section comparison of three dominant soils at the Freedom Mine. Parent material for all three soils is calcareous loamy glacial till. Information from SCS 1978.

the mollic epipedon, and lack of an argillic horizon in Zahl soils. These three dominant soils occur adjacent to each other in the landscape, and can most easily be differentiated by their landscape position (Figure 1).

Prime farmlands in western North Dakota are largely the result of favorable landscape position. Several authors have noted enhanced crop production on lower slopes, drainages, valleys, and swales, due to runon water from above (Veneman and Bodine 1982, Land Reclamation Research Center 1988, Richardson and Wollenhaupt 1983, Wollenhaupt and Richardson 1982, Richardson 1983, Schroeder and Doll 1984).

Once stripped by tractor-scrapers, the distinguishing characteristics of soil thickness and landscape position are eliminated. In many parts of the United States there is a significant difference, in physical and chemical characteristics, between adjacent prime and nonprime soils. In western North Dakota, however, prime and nonprime soil materials, once removed from the landscape, are very similar. A review of important characteristics shows little or no difference between prime and nonprime material (Stomberg 1985, SCS 1978, Figure 2). Carter and Doll (1983) compared crop growth on western North Dakota prime and nonprime topsoil, under similar greenhouse conditions, and found no significant differences between them.

Prime Farmland Requirements

Because of the recognized importance of prime farmlands as a source of food and fiber, the Federal government developed special regulations for prime farmland reclamation following surface mining (P.L. 95-87 1977, Federal Register 1983). These rules are more stringent than those for other lands, including nonprime croplands. Highlights of these special rules are:

1) Prime farmlands must be reclaimed to 100% of their premine productivity; all other lands must be reclaimed to 90% of their premine productivity.

Freedom Mine Topsoil Samples (Averages)

	n	EC (mmho/cm)	SAR	CCE*	OM (%)	Depth (in.)
Prime	18	0.96	0.82	4.56	2.79	24
Non-Prime	46	0.72	0.37	4.48	3.02	18

* Calcium carbonate equivalent

Range of Topsoil Properties

Soil Type	Depth (in.)	Topsoil Texture (USDA)	Permeability (in./hr.)	Available Water (in./in.)	Salinity (mmho/cm)	pH
Bowbells (prime)	0-11	Loam	0.6-2.0	0.17-0.24	less than 2	6.1-7.3
Williams (non-prime)	0-7	Loam	0.6-2.0	0.17-0.24	less than 2	6.6-7.3
Zahl (non-prime)	0-5	Loam	0.6-2.0	0.17-0.22	less than 2	6.6-7.8

Figure 2. Comparison of prime and non-prime topsoil sampled at the Freedom Mine (Stomberg 1985), and the range of topsoil properties for dominant soils found at the Freedome Mine (SCS 1978).

2) For prime farmlands, both topsoil (A and part of the B horizon) and subsoil (B and C horizons) must be salvaged, and are to be stripped and respread separately; for other lands mined, only topsoil is required to be salvaged.

3) Prime farmland topsoil must be kept separate from nonprime topsoil; topsoil mixing is allowed, however, if nonprime topsoil is proven to have "greater productive capacity" than prime topsoil.

4) Prime farmland subsoil must be kept separate from nonprime subsoil; subsoil mixing is allowed, however, if nonprime subsoil is found to be "equally or more favorable for plant growth".

5) A minimum 48" of suitable plant growth material (topsoil and subsoil) is required to be respread for reclamation of prime farmlands; no specific respread depth is mandated in Federal regulations for reclamation of other lands.

6) Three years of crop production is required to determine successful reclamation of prime farmlands; for other lands, including nonprime croplands, reclamation success is based on two years of crop production.

7) The U.S.D.A. Soil Conservation Service has developed soil handling and soil profile reconstruction specifications for prime farmland only; regulatory agencies use these to evaluate surface mine operators' plans for mining and reclamation of prime farmlands.

North Dakota surface mining regulations, for reclamation of all lands, are much more stringent than those of other states, or even Federal regulations. For all mined lands, including both prime farmland and nonprime cropland, North Dakota's rules require:

1) All lands must be reclaimed to 100% of their premine productivity.

2) Topsoil (A and part of the B horizon) and subsoil (B and C horizons) must be salvaged, and must be stripped and respread separately.

3) All soil must be kept separate by landowner during mining and reclamation, to assure each landowner has his own soil returned to his land.

4) A detailed soil survey, mapped at a scale 1:4,800, is required to identify available soil quantity and quality, and is used to determine how much topsoil and subsoil is available to salvage.

North Dakota's reclamation regulations provide the same amount of protection for all lands that Federal regulations provide for prime farmlands only. In this respect, all land reclamation in North Dakota is performed in a manner consistent with the goals of Federal prime farmland regulations. The current overlap of Federal prime farmland regulations with State regulations causes conflicts, which result in lesser environmental protection and greater cost for cropland reclamation in North Dakota.

Beginning in 1975, up to five feet of topsoil and subsoil was required to be salvaged from all lands to be mined in North Dakota. This requirement addressed underlying clay overburden having high sodium adsorption ratios, detrimental to plant growth. However, much of the overburden in western North Dakota is high quality glacial till; some is equivalent to overlying subsoil, with regard to important physical and chemical characteristics, and is similarly suitable for plant growth. Years of research indicated a five foot soil respread was not always necessary to return 100% postmine productivity (Doll et al 1984, Barth and Martin

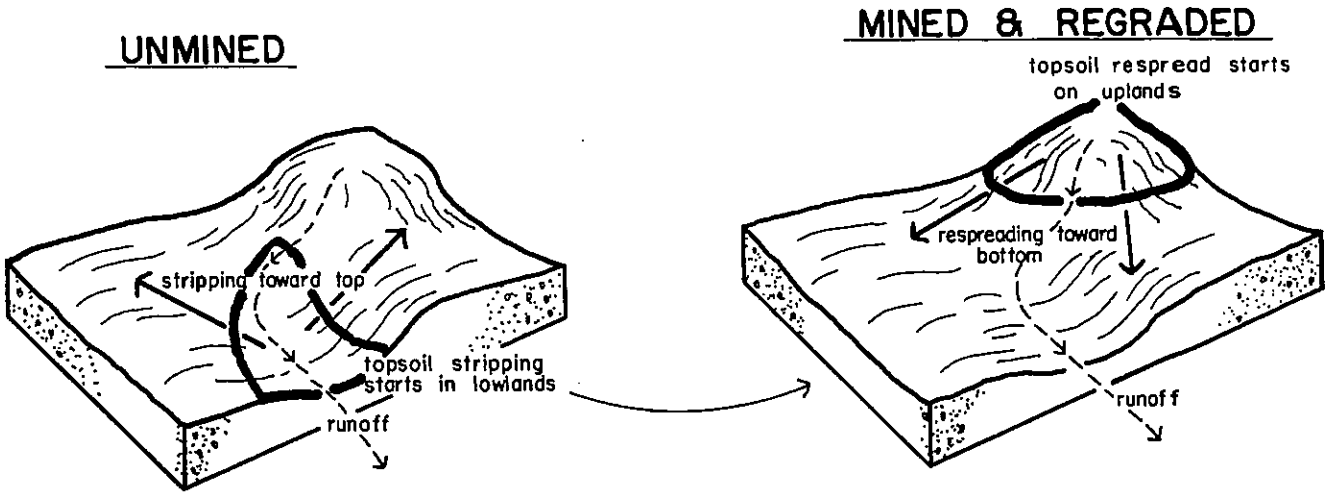
1982, Power et al 1976, 1978, 1979, 1981, Bauer et al 1976). In 1986 the North Dakota Public Service Commission approved new regulations allowing a lesser total respread thickness, based on regraded spoil quality. They found that as little as 24 inches of total suitable plant growth material (topsoil plus subsoil) may be sufficient to achieve 100% equivalent production over high quality spoils. These regulations are not applicable to prime farmlands. Despite research proving such respread depths are not necessary, a minimum 48 inches of soil is required to be respread for prime farmland reclamation. This requirement increases environmental disturbance, by requiring larger soil stockpile areas and water management facilities. In addition, it adds unnecessary earthwork costs.

Current North Dakota regulations require segregation of topsoil and subsoil for all lands mined. Topsoil is considered to be a combination of the A horizon and the dark-colored portion of the underlying B horizon. Topsoil at the Freedom Mine averages about 14 inches thick; in cropland and prime farmland it generally ranges from 10 to 20 inches. In heavily cropped areas, where conservation practices were not previously employed and erosion has taken its toll, topsoil has been found to range from less than six inches on hilltops to over six feet in drainages.

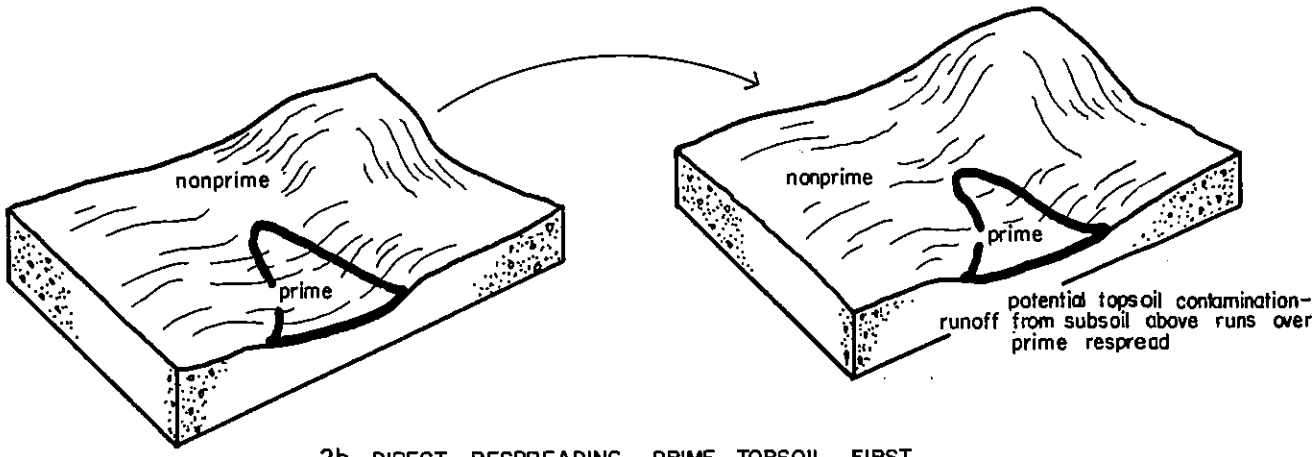
Subsoil is considered to be the underlying, lighter colored, B and C horizons, to a depth of five feet. In most croplands mined, subsoil has elevated levels of calcium carbonate, visible to heavy equipment operators in the field as white streaks of "lime". The stark color change between topsoil and subsoil makes it a fairly simple task for trained operators to successfully segregate these materials with tractor-scrapers.

Current rules allow the mixing of prime and nonprime subsoil, because of their similarity. Prime and nonprime topsoil, however, must be segregated from each other, based on the inherent assumption there are significant differences between prime and nonprime topsoil. As previously described, however, there is no significant difference between adjacent prime and nonprime topsoils in western North Dakota. Segregation of prime and nonprime topsoil results in increased environmental disturbance and costs. Where separate landowners are involved, or where no regraded areas are available yet for direct prime farmland respread, larger soil stockpile areas and water management facilities are required. Because there is no discrete break between prime and nonprime topsoils in the field, increased surveying and staking is required.

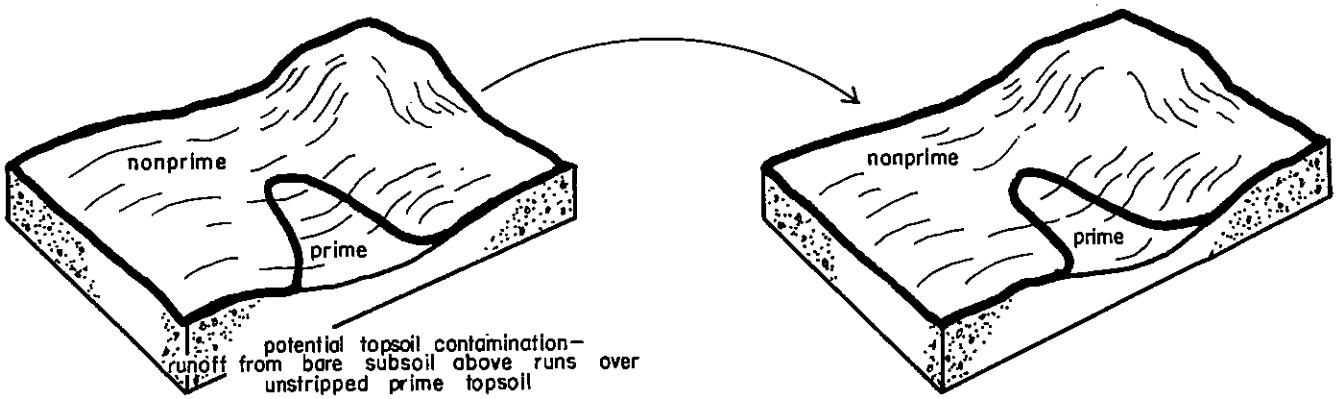
Potential for environmental degradation is increased significantly by prime/nonprime topsoil segregation. Normally, to affect proper water management, drainages are stripped of soil first. This reduces the possibility of runoff water draining off stripped, exposed subsoil areas from running over unstripped topsoil, lower in the landscape, resulting in contamination (Figure 3a). Reclaimed drainages are respread with topsoil last for the same reason (i.e., to avoid the possibility of runoff water from respread subsoil contaminating respread topsoil below). Prime topsoil is stripped from low drainages or swales, and must be replaced in a similar landscape position on reclaimed land. As prime and nonprime topsoil must be handled separately, operations are faced with two environmentally unsuitable alternatives: strip and respread prime farmland topsoil first, resulting in potential prime farmland topsoil contamination in the respread area (Figure 3b), or strip and respread upland, nonprime topsoil first, resulting in potential prime topsoil contamination in the area being stripped (Figure 3c).



3a. NORMAL OPERATIONS- TOPSOIL FROM LOW AREAS STRIPPED FIRST AND RESPREAD DIRECTLY ON RECLAIMED UPSLOPE POSITIONS, ELIMINATING POTENTIAL TOPSOIL CONTAMINATION BY RUNOFF FROM BARE SUBSOIL ABOVE.



3b. DIRECT RESPREADING PRIME TOPSOIL FIRST



3c. DIRECT RESPREADING NONPRIME TOPSOIL FIRST

FIGURE 3

Mixing prime and nonprime topsoil would eliminate the potential for environmental damage. In addition, it would reduce unnecessary additional stockpiles and related water management facilities. Staking and survey time would also be reduced. Because prime farmland soils are created largely as a result of erosion from above in the unmined landscape, such mixing during respread would more closely reflect premine conditions before intensive cropping accelerated soil losses. Richardson (1983) and the Land Reclamation Research Center (1988) recommended mixing prime and nonprime topsoils to enhance reclamation.

Because of conflicting regulations requiring the use of two different soil surveys, field identification of prime soils is often difficult, and sometimes totally inaccurate. The SCS Mercer County Soil Survey (SCS 1978) is used to determine the locations of prime farmland for separate handling during mining. This is required by both the North Dakota Public Service Commission and the Soil Conservation Service. The county soil survey is conducted at a scale of 1:20,000, and mapping for this survey is not performed at the detail required for soil survey maps for mining permits and operations (1:4,800). Consequently, enlarging the county soil survey, and overlaying it on the detailed soil survey map, reveals several discrepancies. For this reason, locations of prime farmlands mapped by the SCS may not correspond to those indicated on the detailed soil survey. As a result, mapped prime farmlands are often staked on hillsides, steep slopes adjacent to drainages, and on ridges having shallow soils. Stomberg (1985) found within the area mapped as prime farmland by the SCS, about 35% of the acreage was actually comprised of nonprime soils, and that for any particular landowner, nonprime soils may comprise from 22 to 91% of mapped prime farmlands. Using county soil surveys results in many prime soils being identified and handled as nonprime. When drainages are stripped as nonprime soil, and hilltops are stripped as prime soil, considerable confusion results in field operations.

Operations on Prime Farmlands

Actual handling of prime and nonprime soils is identical, except that prime topsoil is segregated from nonprime, as previously described. Special stakes are used to delineate stripping limits for prime farmland topsoil. During regrading operations, prime farmland landscapes are constructed. These regraded areas have plane to concave slopes less than six percent. This is not a regulatory requirement, but a permit condition, developed after examination of the nature of premining prime farmland landscapes. During soil stripping operations, if areas are available to respread stripped prime topsoil, it will be directly respread. If no areas are available, it will be stockpiled until a later date. If a favorable reclaimed prime farmland landscape is available, but no prime farmland is being stripped at the time, prime topsoil must be taken from a stockpile. Acreages of prime respread and stripping areas are rarely exactly the same, requiring stockpiling prime topsoil or opening up a stockpile to get more material. This results in construction of new stockpiles, or disturbance of otherwise existing stable stockpiles. Timing of regrading and stripping operations therefore becomes critical to reduce unnecessary disturbance, and more efficiently reclaim prime farmlands with prime topsoil.

Required respread depth for prime farmlands must be 48 inches, as previously described. Because prime and nonprime topsoils are segregated from each other throughout the entire mining and reclamation process, separate topsoil respread depths must be calculated. Currently, prime topsoil is respread 16 inches thick, and nonprime topsoil is respread 13 inches

thick. There is some question regarding the wisdom of respreading deeper topsoil in the lowest part of the reclaimed landscape, and shallower depths on hills and slopes above (Richardson 1983). Natural erosional processes will eventually result in deeper topsoil in lower, reclaimed prime farmland areas. By respreading soils evenly, or even respreading a thicker amount on slopes and hilltops, overall reclamation would be enhanced. This is further reason to mix prime and nonprime topsoil.

Regulations require the same acreage of prime farmland be reclaimed as existed prior to mining. The acreage of regraded prime farmland landscapes far exceeds the acreage required for reclaimed prime farmland (Figure 4). If prime farmland is primarily a function of landscape position, rather than soil quality, the potential exists for a larger amount of reclaimed land to be classified as prime farmland several years from now. Schafer (1984) found an increase in agricultural land capability at several reclaimed sites in the Northern Great Plains, with improvement in many areas a result of constructing more favorable landscapes.

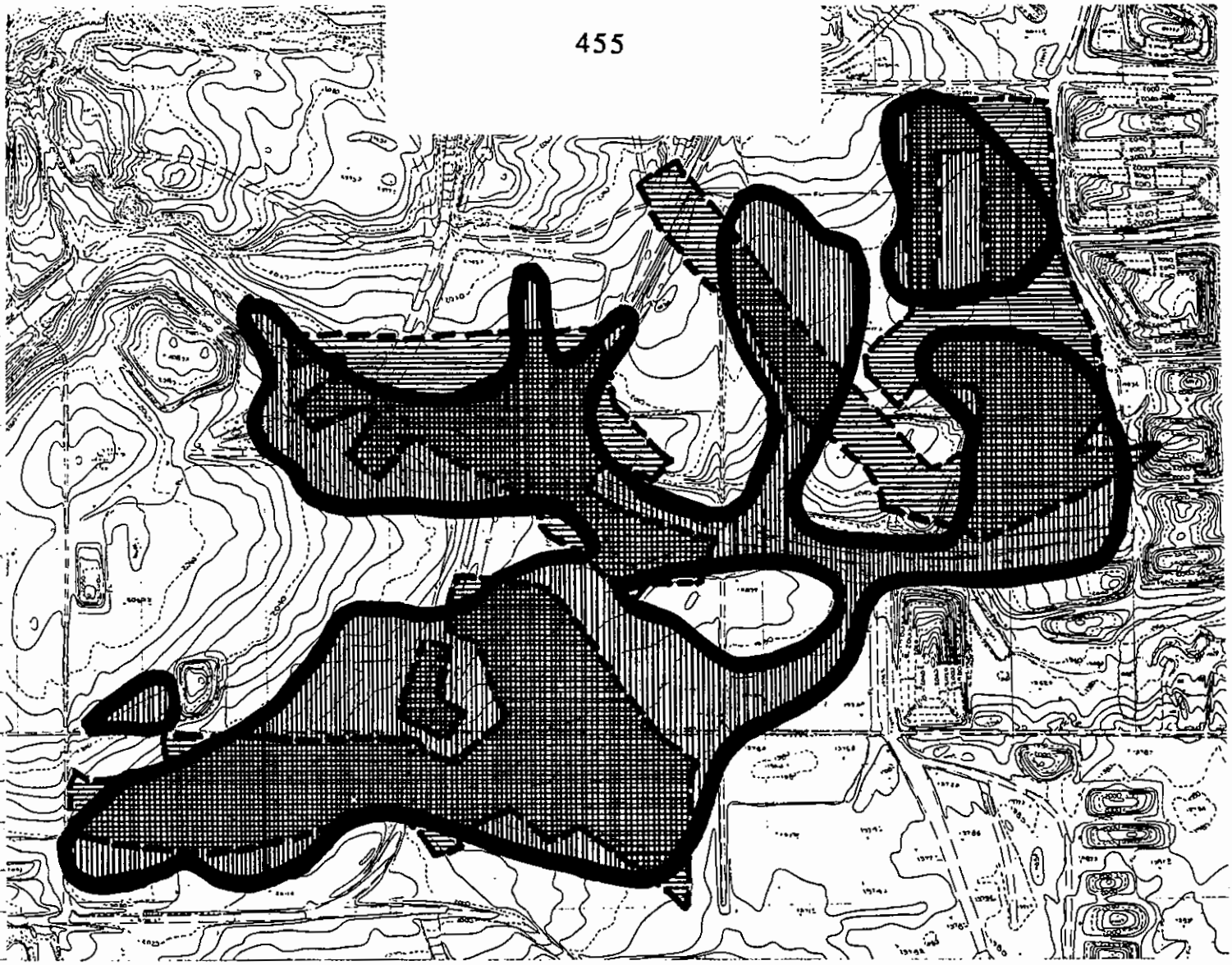
All reclaimed prime farmlands are mapped. Vegetative production was measured during 1988. This was an exceptionally dry year, with precipitation less than half of normal. Nonetheless, few differences were found between reclaimed prime and nonprime farmland, with regard to hay production. Productivity monitoring will continue for the next several years. To determine successful reclamation in North Dakota, prime farmlands are evaluated for three years, and nonprime lands for two.

Conclusions and Recommendations

In summary, prime farmland reclamation requirements are counterproductive, when applied to conditions in North Dakota. These include determination of prime farmlands based on county soil surveys, separate handling of prime and nonprime soils, separate respread depths for prime and nonprime topsoils, and a minimum 48" total soil respread depth. These requirements increase environmental disturbance and the potential for soil contamination. Costs are increased with no enhanced reclamation benefit. An opportunity to reduce erosion losses, by respreading soils evenly over the reclaimed landscape, is lost when prime topsoil must be respread more deeply in low reclaimed areas.

Two recommendations are provided to enhance reclamation, reduce environmental disturbance, and lower costs: (1) allow mixing of prime and nonprime topsoil; this will result in a more even respread over all reclaimed lands, and reduce stockpiling needs, and (2) allow the use of spoil quality to determine respread depths for prime farmlands, as it is currently being used for all other reclaimed lands to be returned to 100% productivity in North Dakota.

Current prime farmland regulations do not address site specific requirements of surface coal mining and reclamation in North Dakota. North Dakota surface mining regulations are adequate to protect all lands mined, including prime farmlands. Overlap and conflicts between Federal and State rules result in reduced environmental protection and increased costs. Proposed changes would enhance environmental protection and reclamation potential, and decrease costs.



0 500 1000 2000 feet

PRE-MINING PRIME FARMLAND

ACTUAL RECLAIMED PRIME FARMLAND, OR REGRADED AREAS WITH LANDSCAPES SUITABLE FOR PRIME FARMLAND RECLAMATION

CRITERIA FOR PRIME FARMLAND LANDSCAPES

- Slopes plane to concave
- Slopes less than 6%

Figure 4. Pre-mining prime farmland acreage vs. reclaimed prime farmlands and potential post-mining prime farmland landscapes on areas mined and regraded at the Freedom Mine.

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