THE SURFACE CONTROL AND RECLAMATION ACT OF 1977

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Although we did not establish a theme for this forum, asI thought about what I might say it occurred to me that we do indeed have a theme. When I finish my remarks I would hope that you would agree with me.

For those of us who were here in the beginning and for those who weren't at least some review of the history is appropriate to the start of this forum.

The prime farmland provisions were different from mostother requirements of SMCRA, which became effective on August 3, 1977. They created a high level of frustration for everyone with an interest in prime farmland mining and reclamation. The delay was due to problems related to the start up of a new Federal regulatory agency with a complex program that required a substantial amount of training for the technical staff. Otherdifficulties experienced during the start up of SMCRA were:

(1) Most of the existing expertise on mining reclamation regulation was at the state level.
(2) The first OSM inspectors did not reach the field until the summer of 1978.
(3) A major enforcement problem for field staff was that the interim program included performance standards but not permitting standards. This meant that both State and Federal inspectors had to enforce performance standards for prime farmland on permits that did not contain prime farmland restoration plans.
(4) The lack of long-term experience with returning reclaimed mine lands to row crop agriculture.
(5) It would take a long time to familiarize the operators, states, and OSM field staff with the new requirements.
(6) Operators would have to acquire new equipment in order to salvage topsoil, minimize compaction, and conduct the grading necessary to restore cropland. Some operators would be required to obtain specialized equipment to break up compaction following reclamation.
(7) Operators would be required to demonstrate that they had the capability to restore prime farmland to its original capability before they could begin mining.
(8) The lengthy amount of time necessary to develop the implementing regulations for SMCRA. Interpretation of many aspects of SMCRA was very difficult prior to the development of the regulations.
(9) Delays were experienced because of the time it took for states to pass legislation necessary to implement SMCRA. It took from 1977 until 1982 for most states to obtain approved regulatory programs.
(10) The number of legal challenges to SMCRA and its regulations with the resulting regulatory revisions ordered by the courts resulting in confusion over changing requirements.
(11) Although existing operations had the option of "grandfathering" some or all of their prime farmland soils, states needed time to develop standards for the "grandfathered" prime farmland soils. Although the application of the "grandfathering" regulation varied, it did allow the states and the operators some additional time to acquire the necessary equipment and gain experience with prime farmland reclamation. Citizens wanting immediate action on prime farmland restoration, however, were greatly concerned by the delays resulting from the "grandfathering" process.

The Present

The basic requirements of SMCRA are now a part of all state approved programs including:

(1) A soil survey of all prime farmland soils.
(2) A plan for soil reconstruction that separately removes the topsoil and adequate subsoil unless a plan for soil mixing and substitution is approved.
(3) Scientific data supporting the ability ofthe reclamation methods to achieve successful restoration of prime farmland capability.
(4) NRCS consultation concerning the reclamation plan and methods.
(5) The acreage of prime fam7dand soils will not be decreased.

(6) Crop production is to be monitored and measured for a period of three years in order to prove that the soil capability has been fully restored.

What have been the surprises?

(1) The "grandfathering" issue in many states turned out to be much larger than originally visualized. The process has also had a much longer life span than anticipated.

(2) The bond release process has taken much longer than anticipated with some acreage from the initial program and large acreage of "grandfathered" prime farmland soils still under bond. In fact, no one knows yet when many of these acreages will be ultimately released and what normal time for mining through bond release should be expected. We can not provide landowners any certainty as to when they can expect to be able to utilize their land for normal agricultural production.

(3) Many soils experts both from the NRCS and universities have been the greatest advocates of soil mixing and soil substitutes rather than replacement of the original soil horizons. This has resulted in soil mixing and substitution plans being the rule rather than the exception.

(4) The process of developing defensible standards and methods for measuring revegetation success has been much more complex than anticipated. The result has been an increase in the amount of time necessary to achieve bond release.

The Future

Trends that OSM expects to see continue into the future include:

(1) Applications for bond release for large amounts of prime farmland and other reclaimed areas are expected to be received all at once. This is beginning now and is expected to increase in the near future. It will place a heavy burden on state regulatory staffs already operating with continually reduced resources and personnel.

(2) There is increasing pressure being brought by land owners on the NRCS and other state agencies to provide new soil descriptions with associated soils data on productivity and capability for reclaimed soils. This information is necessary for accurate tax assessment and property values.

(3) Operators are desirous of new bond release methods that would shorten the time to prove restoration of the soil capability.

(4) In some states, the continuing trend to high extraction underground mining methods with associated subsidence and impacts to prime farmland and other cropland areas is expected to become increasingly more important.

(5)€ Increasing competition from cheaper coal sources outside the region leave the industry with fewer resources to conduct reclamation and increase the probability of bond forfeiture.

Where is OSM going in the future and what are the implications on prime farmland mining and reclamation?

The first area of change is in the manner in which OSM conducts oversight. In January of 1996, OSM released a new version of its Directive entitled REG-8. This document was the product of a team composed of OSM and state regulatory members and took several years to arrive at the initial version. Based on the first year's experience, adjustments were made, and on September 30,1997, the current version was signed by Director Kathy Karpan whom you will be hearing from today at lunch.

The changes brought about by the new oversight directive are significant in several ways. First it changes the focus of our efforts to the two areas which have the greatest impact on people and resources in and adjacent to mining operations.

The first is in the requirement that during our inspections we document all off-site impacts and that we make an assessment of the degree of impact on people, lands, water, and structures. This represents a change in how we assess the sucess of the state's program, the direction we take in identifying issues, and the resolution of those issues. First we are now starting out with an identified problem an off-site impact. From that we then work backwards to identify the cause. In the past we have been accused of nitpicking and spending time on issues that had no real impact. I firmly believe that this approach will have major benefits for those people and resources that potentially can be impacted by mining. There are those that don't agree with the new approach, and I would be happy to discuss the pros and cons of this approach with you during the breaks (See Overhead No. 1).

The second area where we have our oversight focus has a much stronger relationship to our forum on prime farmland. We are now concentrating our efforts more towards reclamation success and end results. Once again our intent is to address the issues that have the greatest "bang for the buck." Certainly the issues associated with end results and reclamation success meet that criteria. In our oversight directive, we have further refined our definition of reclamation success and end results as to include the following: land form/approximate original contour, land capability, hydrology reclamation, and contemporaneous reclamation. One cannot fault that these four areas define the product of our efforts as miners, regulators, scientists, and landowners, and the intent of SMCRA. Probably there is no area of reclamation where each of these factors is more critical than prime farmland. By definition the slopes of prime farmland are critical before and after mining; capability is the test that it must pass; the hydrology, both surface and subsurface, are basic to successful reclamation of prime farmland; and last, contemporaneous reclamation defines our ability to return the reclaimed land to the landowners without the incumbrance of SMCRA. Each of these have been around since the passage of the Act, but it is this issue of contemporaneous reclamation I want to discuss in more detail, which will lead into the last issue I want to address. First let me say that not everyone agrees on how to measure reclamation success and whether contemporaneous reclamation is really a part of end results. The acreage of prime farmland is at the heart of this issue because of the complexity of the reclamation, the time involved in pre-crop vegetation many believe to be critical to successful reclamation, and the number of years of testing required for prime farmland. The issue that arose in our initial process through which reclamation success was to be measured was that contemporaneous reclamation equated to successful reclamation and that bond release was the measure of our success. Many states made the argument that contemporaneous reclamation was measured by the adherence to time and distance requirements for grading, topsoil replacement, and establishment of vegetation. In recognition of the differences of opinion on this issue, the states and OSM have the option to report both the results of completion of the various time and distance standards and vegetation establishment and the bond release status. As we have seen, the complexities of prime farmland reclamation have had an impact on bond release time frames(See Overheads #2-#5).

This brings me to the last item on the horizon of OSM and SMCRA. The Government Performance and Results Act of 1993. The purposes of the Act in part are stated as:

1) improve the confidence of the American people in the capability of the Federal Government by systematically holding Federal agencies accountable for achieving program results; and
2) initiate program performance reform with a series of pilot projects in setting program goals, measuring program performance against those goals, and reporting publicly on their progress.

The Act also stated in part "No later than Sept. 30, 1997 the head of each Federal agency shall submit to the Director of the Office of management and Budget (OMB) and to Congress a strategic plan for program activities. Such plan shall contain general goals and objectives, including outcomes, for the major functions and operations of the agency."

By now you are asking what does this have to do with prime farmland and our forum. To clarify we need to look at OSM's initial performance goals in just one area. I had mentioned earlier our business line approach to budgeting. We have also adopted the business line approach to our GPRA requirements. The business line which impacts prime farmland is entitled Environmental Protection. The performance goals are listed in Overhead #6.

As you can see OSM will be measured by actions we (all of us in this room) control: the off-site impacts and the number of acres we can successfully move through the reclamation process. Our ability to successfully return prime farmland back to private production is a major component by which the public and Congress will assess our success in many Midwestern coal states. In addition, our budgets both for OSM and for state grants are already tied to our business line. It is only a small step to make the next connection between performance goals and budgets. As we go through this week and hear how we have progressed, let us be mindful that we are in this together and our responsibilities to complete reclamation of the highest producing soils in the world in a timely manner must continue as our highest priority.

In closing I would like you to see a graph (Overhead #7) of where we may be in meeting our goal of successful reclamation based upon permitted acres versus bond release acres. Note that if the same graph was created for prime farmland only, the gap would probably be wider.

During the remainder of the forum, we will have the opportunity to listen to the experts and discuss our success and problems with those most involved with prime farmland restoration. I would encourage you to take advantage of this opportunity to learn and share so that we will all leave with a better understanding of mining and reclamation processes that potentially impact the most productive soils in the world.

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TABLE 4

OFF-SITE IMPACTS

RESOURCES AFFECTED			People			Land			Water			Structures		
DEGREE OF IMPACT			minor	moderate	major	minor	moderate	major	minor	moderate	major	minor	moderate	major
TYPE OF IMPACT AND TOTAL NUMBER OF EACH TYPE	Blasting													
	Land Stability													
	Hydrology													
	Encroachment													
	Other													
	Total													

OFF-SITE IMPACTS ON BOND FORFEITURE SITES

RESOURCES AFFECTED			People			Land			Water			Structures		
DEGREE OF IMPACT			minor	moderate	major	minor	moderate	major	minor	moderate	major	minor	moderate	major
TYPE OF IMPACT AND TOTAL NUMBER OF EACH TYPE	Blasting													
	Land Stability													
	Hydrology													
	Encroachment													
	Other													
	Total													

The objective of this Table is to report all off-site impacts identified in a State regardless of the source of the information. Report the degree of impact under each resource that was affected by each type of impact. Refer to guidelines in Directive REG-8 for determining degree of impact. More than one resource may be affected by each type of impact. Therefore, the total number of impacts will likely be less than the total number of resources affected; i.e. the numbers under the resources columns will not necessarily add horizontally to equal the total number for each type of impact. As provided by the Table, report impacts identified on bond forfeiture sites separately from impacts identified on other sites. If bond forfeitures sites were not evaluated during the period, clearly note the table to indicate that fact. Impacts related to mine subsidence or other areas where impacts are not prohibited are not included in this table. Refer to report narrative for complete explanation and evaluation of the information provided by this table.

the **State** considers to be remined; i.e. areas that were previously mined and not properly reclaimed and will be re-affected by current mining and reclamation.

. NUMBER OF ACRES WHERE BOND WAS FORFEITED DURING THIS EVALUATION YEAR (also report this acreage on Table 7) - Enter the number of acres on which the State forfeited bond during the evaluation year.

Table 6: Optional Data Tables

- If agreed to in the PA, the collection and presentation of additional data for annual State mining and reclamation results is permissible and encouraged in an effort to report the reclamation performance of the State. Listed below are some suggestions, not intended to be all inconclusive, for collection of data. FOs and States will need to develop appropriate tables for the data. If optional tables are not included, Tables 7, 8, and 9 must be renumbered.

Table 6a:

This table or a similar table may be used where a State provides data to OSM on the status of reclamation in a State even though the State has made no final determination concerning site conditions as they relate to meeting all performance standards necessary for bond release. Data reported in this table must not be included in Table 5. Note: Since there has been no final determination on the acceptability of acres reported in this table for bond release purposes, there should be no implication that any of the acreage reported in this table meets any of the phase bond release performance standards.

ANNUAL STATE MINING AND RECLAMATION RESULTS

Reclamation Activity	**Applicable Performance Standard**	**Acreage During This Evaluation Period**
Backfilled/Graded	* Approximate original contour restoration * Drainage reestablishment	
Topsoil Replaced	* Topsoil or approved alternative replacement • Surface Stability	
Revegetation	• Establishment of vegetation	

The following tables or others developed by a FO or the State may be added to document specific aspects of reclamation success that are important to the State. These tables can document various aspects of reclamation in a State where bond release standards have been met and where the State has made no final determination concerning site conditions as they relate to

OVERHEAD

meeting all performance standards necessary for bond release. However, if there has been no final determination on the acceptability of reclamation reported in these tables for bond release purposes, there should be no implication that any of the reported reclamation meets the bond release performance standards.

Table 6b:

LAND USE ACREAGE

Land Use	**Acreage**
Cropland	
Pasture/Hayland	
Grazingland	
Forest	
Residential	
Fish and Wildlife Habitat	
Developed Water Resources	
Public Utilities	
Industrial/Commercial	
Recreation	
Remined	

Table 6c:

AVERAGE PRODUCTIVITY ACHIEVED

Crop	**Yield**	**Percent of Original Yield**
Corn (bu/ac)		
Beans (bu/ac)		
Wheat (bu/ac)		
Hay (bu/ac)		
Other		

Table 6d:

COVER RESTORED•

Cover Type	**Percent Cover or Stems/Acreage**
Forest	
Fish and Wildlife Habitat	
Grazingland	
Residential	
Industrial/Commercial	
Recreation	
Remined	
Other	

Table 6e:

WATER QUALITY

	Average Upstream Data	**Average Downstream Data**
PH		
Fe		
TSS		
Mn		
Set. Solids		

Table 6f:

DISCHARGE POINTS

Percent of Complying Discharge Observations
NPDES Results

PH
Fe
TSS
Mn
Set. Solids

Table 7: State Bond Forfeiture Activity

- Include only those sites for which the indicated action is complete. For example, the "Bonds forfeited" categories do not include sites for which bond forfeiture proceedings

TABLE 5

ANNUAL STATE MINING AND RECLAMATION RESULTS		
Bond release phase	**Applicable performance standard**	**Acreage released during this evaluation period**
Phase I	• Approximate original contour restored • Topsoil or approved alternative replaced	-
Phase II	• Surface stability • Establishment of vegetation	-
Phase III	• Post-mining land use/productivity restored • Successful permanent vegetation • Groundwater recharge, quality and quantity restored • Surface water quality and quantity restored	-
	Bonded Acreage Status [A]	**Acres**
	Total number of bonded acres at end of last review period [B]	-
	Total number of acres bonded during this evaluation year	-
	Number of acres bonded during this evaluation year that are considered remining, if available	-
	Number of acres where bond was forfeited during this evaluation year (also report this acreage on Table 7)	-

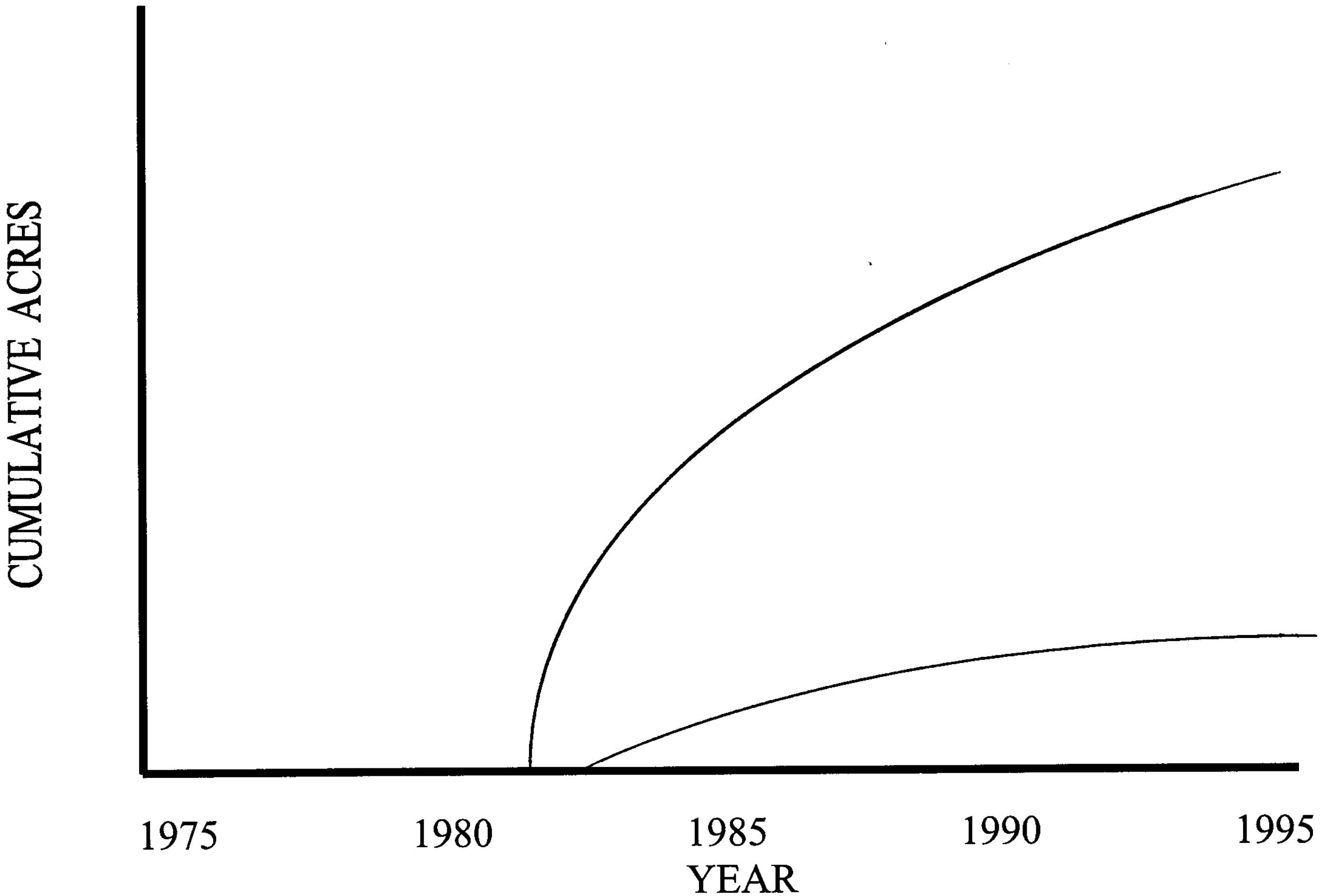
[A] Bonded acreage is considered to approximate and represent the number of acres disturbed by surface coal mining and reclamation operations.

[B] Bonded acres in this category are those that have not received a Phase III or other final bond release (State maintains jurisdiction).

Potential Strategic Measures and FY 1999 Measures	**1997**	**1998**	**1999**	**Annual Perf Goals**
By 2002, the SMP will minimize the number and severity of off-site impacts while protecting the environment and public from current mining. • In FY 1999, OSM will minimize the number and severity of off-site impacts while protecting the environment and public from current mining. Example: In 1999, the SMP will strive for **50%**? of the sites to be free of off-site impacts.	88%	90%	92%	2.2
By 2002, the SMP will report the number of acres released from Performance Bonding Phases I & II in order to show the progression of permitted acreage being reclaimed. • The SMP will report the number of acres released from Performance Bonding Phases I & II.	60,000 Phase I; 58,000 Phase II			2.3
By 2002, the SMP will maintain the number of reclaimed acres ***(250,000 acres?)*** *which are released from Phase III Performance Bonds, while encouraging more timely Phase III bond release by operators.* • The SMP will maintain the number of reclaimed acres (50,000) which meet the Phase III Performance Bond release criteria, while encouraging more timely Phase III bond release by operators.	82,000	90,000	100,000	2.4

* SMP — Surface Mining Program

ACRES PERMITTED V.S. RELEASED



OVERHEAD #7

ILLINOIS PROGRAM REQUIREMENTS, EXPERIENCE AND RESULTS

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Abstract

The prime farmland and high capability cropland reclamation program in Illinois is presented in terms of historic issues. statistics related to existing liability, current mining acreage, and theoretical impact. Monitoring procedures are discussed concerning the removal,, storage, and replacement of soils during mining and reclamation. The productivity standards of the Agricultural Land Productivity, Formula and regulatory initiatives are also discussed.

Introduction

The last 20 plus years have been very interesting in the area of cropland reclamation. I use the term cropland because not all cropland reclamation in Illinois is prime farmland. Prior to SMCRA, Illinois had its first soil replacement regulations in 1971. It established soil texture, thickness, and coarse fragment limits in the root medium. A major upgrade to this, known as Rule 1 104, was done in 1976 which added a topsoil requirement. This rule included all Class 1, 11, 111, and some of the flatter Class IV soils. This is obviously more broad than the prime farmland definition. These soils are now known as "high capability lands" and include prime farmland that has been exempted by grandfathering or historical use.

SMCRA came with many challenges of which prime farmland was a major issue, particularly in the early days. Illinois has a lot at stake with respect to prime farmland with 21 million of its 35 million acres being prime. Approximately 500,000 acres of prime and another 125, 000 acres of high capability land overlay theoretical surface mineable coal. It is almost impossible to open a surface mine without affecting prime or high capability land. One must keep in mind that this acreage reflects several hundred years of future mining, based on current mining activity. Presently there arc only six active surface mines in the state.

Historical Issues

One of the advantages of being second on today's program is to address some of the issues raised by Sandy in the previous talk. The first issue is grandfathering which was originally very contentious both with OSM and the industry. About 18,000 of the estimated 26,000 acres of eligible prime farmland have been grandfathered to date. Very few acres have been grandfathered in the last few years due to the closure of the larger surface mines. Only one of these operations which existed when SMCRA was passed is still in operation. Due to the fact of the preexistence of Rule 1 104 (High Capability) soil reconstruction standards, all grandfathered prime farmland defaulted to that category, with its 90% productivity, two-year standard. Current permits have approximately 10,000 acres of prime farmland liability. Of this 6,300 acres are proposed to incur overburden removal.

Another historically contentious issue, between OSM, the RA, and a few citizens groups has been the issuance of permits and the approval of subsoil mixing in the highly productive soils of western Illinois. Although one case is still pending on a mine, which has since closed, all other of the decisions of the department that have been contested have been upheld in favor of the department.

A third major issue has been the establishment of productivity standards to measure restoration. The primary portion of the regulations used today were adopted in 1986 after a multiyear rulemaking effort with many parties involved, including citizens groups, the industry, IDOA, USDA Crop Reporting Service, NRCS, University of Illinois, and our agency. I will defer my discussion on this topic to my session later on in the forum.

Field monitoring for compliance with prime reconstruction plans has been relatively easy for most soil parameters. This was primarily due to the fact that we already had inspection and sampling procedures in place when SMCRA was passed for monitoring soil removal and replacement to ensure soil quality and thickness. The most elusive parameter to measure and evaluate has been compaction. Some of you in the audience will remember the original proposals for using bulk density and the discussions on this at the 1979 prime farmland conference in St. Louis. Although no specific numerical standard or procedure has yet to be adopted there are specific tests which can be done to establish that some degree of compaction is present. One or more speakers in tomorrow's sessions will discuss this in detail. It is encouraging to note that many companies have acknowledged that compaction is a reality, at many sites and have now incorporated alleviation (deep tillage) into their reclamation operations prior to initiating productivity testing.

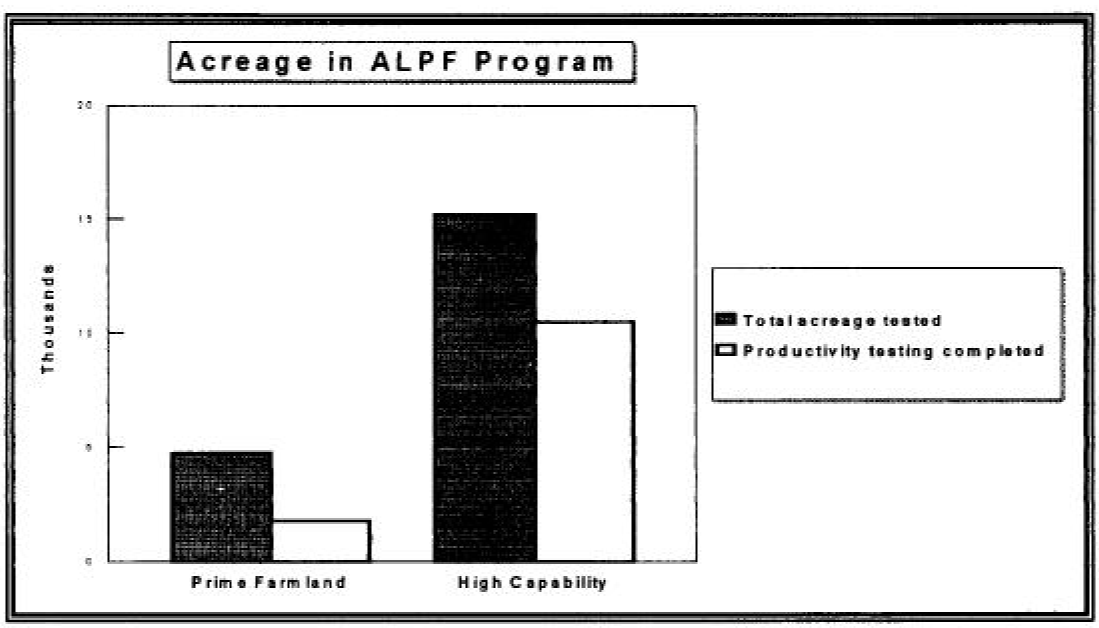
Statistics

The issue of the small numbers of acres of prime farmland final bond release has been raised. The issue of bond release as the measure for prime farmland restoration success, will undoubtedly, be argued from several points of view at this conference. Some will argue the three-year standard is too short, some too long, productivity targets too low and targets too high, and others will argue that until the bond release administrative procedure is completed the results arc not measurable. I plan to discuss our state results on the acreage that has met current productivity standards, regardless if the bond release has been applied for or not.

The Department has recently reviewed productivity testing on approximately 15,200 acres of high capability land and 4,700 acres of prime farmland. Most of these acres have permanent program liability. Testing is done using the Agricultural Land Productivity Formula (ALPF) which uses field sampling of corn, soybeans, wheat, and hay. Corn must be successful at least one year for all prime and high capability cropland. The 1997 crop success results have not been completed, but through the 1996 season, approximately 10,500 acres of high capability land and 1,800 acres of prime farmland have already completed the required two and three year standards. The remainder is still in testing and new fields are added each year (Figure 1). An additional estimate of several thousand acres of interim program high capability lands have also met the productivity requirements; however, the data is not conveniently retrievable for easy analysis.

While issues may be raised at this conference about the adequacy of the current regulations both pro and con', above numbers do make a case that cropland is meeting the established standards. When one also keeps in mind that all of the prime farmland and over 90 plus percent of the high capability acreage affected by surface mining since 1977 has had topsoil and a suitable root medium replaced, a good argument can be made that the combination of SMCRA and the high capability provisions of the Illinois Statute SCMLCRA have offered significant protection to the agricultural base of Illinois.

Figure 1.



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INDIANA'S PROGRAM REQUIREMENTS, EXPERIENCES AND RESULTS

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Abstract

The prime farmland program in Indiana is presented in terms of statistics related to current mining acreage and future impact of these lands. This presentation will discuss how Indiana identifies prime farmland soils through the reconnaissance investigation, the Natural Resources Conservation Service involvement, and exemptions from prime farmland standards. Prime farmland restoration plans will be discussed including the removal, storage, and redistribution of soil materials. Discussion of proof of productivity and revegetation requirements will include success standards, liability period, cropping practices, and crop adjustments for each phase of the bond release process. Actual experiences of the program will be presented. The presentation concludes with a discussion of the Overall Reclamation Success Team (ORST) and potential impacts to the coal mining industry, landowners, and the Division of Reclamation.

Introduction

The coal producing region of Indiana is confined to a seventeen (17) county area located in the southwestern part of the state (Figure 1). The Indiana Coal Field occupies about 7,000 square miles (4,481,029 acres). Around 53.4% of those lands (2,392,078 acres) are classified by the Natural Resources Conservation Service (NRCS) as prime farmland. Since Indiana received primacy on July 29, 1982, 273,271 acres have been permitted for the purpose of coal mining. Underlying this area of Indiana there still remains about 34 billion tons of unmined coal, of which about 18 billion tons is recoverable by current technology. Of the recoverable coal, about 16 billion tons is recoverable by underground mining and 2 billion tons is recoverable by surface mining.

Requirements and Experiences Reconnaissance Investigation

In March 1985, the Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service (SCS), developed a listing of all prime farmland by soil map units in Indiana. These prime farmlands are those lands that the NRCS has determined to have the best combination of physical and chemical characteristics for producing food, feed, and forage. Most of the prime farmland in Indiana has premining slopes of 6% or less. No severely eroded map units are designated as prime farmland in Indiana. Prime farmland soils in Indiana have an estimated corn yield which ranges from 95 to 155 bushels per acre. In December 1986, Indiana became the first major agricultural state and the first midwestern state to have a modern soil survey completed for every county. Therefore, all soil surveys used in coal mine permitting were developed under the standards of the National Cooperative Soil Survey.

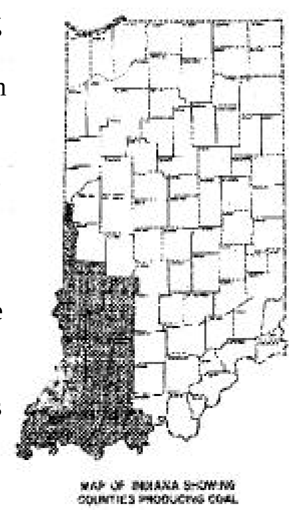


Figure 1

After the NRCS determines that lands within the permit area are designated as prime farmland, the applicant may obtain an exemption from the prime farmland standards in one of two ways under existing law. First, the applicant may request a "negative determination." This requires a demonstration that the land has not been historically used for cropland. The exemption can be obtained if the lands have been used for cropland less than five (5) years out of the ten (10) years prior to acquisition for surface coal mining and reclamation operations. The most common requests for a "negative determination" in Indiana are for forested areas. The current use of the land may clearly indicate that no cultivated crops have been produced during the applicable five in ten year period. The age of the trees within a forested area provides the necessary demonstration. When the current use of the land does not clearly indicate that cultivated crops have not been produced during the applicable five in ten year period, sworn affidavits are required from the landowner and a disinterested third party. Negative determination is also possible under law if the slope of the land is 10% or greater, the surface is very rocky, or the land is flooded during a growing season more than once in two (2) years. However, the NRCS does not consider any soil in Indiana with a premining slope of 10% or greater to be prime farmland so this has not been a factor. The very rocky surface option also has not been used successfully in Indiana.Flooding during the growing season has been used to successfully obtain an exemption on a very limited basis.

The second means of obtaining an exemption from prime farmland reclamation standards is a demonstration that the prime farmland areas are eligible for "grandfathering." The exemption applies to those operations that were operating on August 3, 1977 and have held continuous permits since that date. In Indiana all "grandfathering" demonstrations were completed in 1985. It is estimated that since 1982, a total of 115,380 acres have been grandfathered and permitted by the permanent program, which is 42% of the 273,271 acres permitted throughout the life of the program. Approximately 58,524 of those acres were actual prime farmland soils. At this time, there are approximately 25,000 acres which have been grandfathered, but not yet permitted by a permanent program permit. Grandfathered prime farmland has been reclaimed in a variety of ways throughout the life of the program. Many acres have been converted to wildlife habitat and forest with replacement of 6 to 12 inches of topsoil on unsegregated mine spoil composed of a heterogeneous mixture of rock, shale, and soil rubble. The current requirement for land that was capable of supporting cropland prior to mining is replacement of topsoil and subsoil to a total thickness of 18 inches. However, this requirement is being challenged by two Indiana coal companies who believe the 18-inch standard is overly stringent.

Prime Farmland Restoration Plans

Removal

The operator is required to describe the thickness of the topsoil and subsoil to be removed for each prime farmland soil map unit within the permit. Most of the topsoil in the coal mining region of Indiana will vary from 8 to 15 inches. The subsoil usually varies in thickness from 4 to 10 feet. Most operators use the soil depth information from the published county soil survey. The operator is required to remove and replace a minimum of 48 inches of soil (topsoil and subsoil) for all prime farmland soils (including those soils with a fragipan) within the permit. However, in the early to mid 1980s a few permits allowed removal and replacement to the depth of the fragipan (30 to 36 inches). In 1986, the NRCS determined that in order for fragipans to qualify for exclusion from reconstruction, they must contribute little or nothing to the productive capacity of the soil. This contribution must be less than 0.06 inches per inch of available water capacity to qualify for such exclusion. The fragipansin Indiana contribute more than 0.06 inches of available water per inch and, therefore, are no longer eligible for exclusion from the reconstruction standards.

Operators are allowed to mix non-prime farmland and prime farmland topsoils and subsoils if the parent materials are the same. Any soil that has inferior qualities (i.e., severely eroded) are not allowed to be mixed. In a few instances, a mixing of the A horizon with the BE horizon has been approved. Approval to mix the A/BE has been allowed because this mixing has already occurred due to tillage practices. There are few (if any) plans approved that allow the mixing of the A horizon with deeper soil horizons.

Several operators have received approval to mix the B horizon with the C horizon in recent years. These plans, which allow the mixing of the horizons to a depth of generally 6 to 10 feet, have become more popular as the industry in Indiana has converted from scrapers to truck/shovel operations. The operator is still required to demonstrate that the soil materials that are created by mixing are equal to or more favorable for plant growth than the original B horizon. At a minimum, this demonstration is based upon the analysis of the thickness of the soil horizons, pH, buffer pH, texture, percent rock fragment (>2mm), percent organic matter, phosphorous, and potassium.

Prime farmland soils must be removed from the areas to be disturbed before drilling, blasting, or mining. Several operators have obtained approval to leave the B or C horizons in place in areas that will be affected but not mined (i.e., haulroads, mine management areas). In these areas alltopsoil is removed and the unremoved subsoil is protected by a geotextile fabric or a layer of subsoil from a depth deeper than 48 inches. Where the B or C horizon is not removed, but may have been compacted or otherwise damaged during the mining operation, the operator is required to engage in deep tilling or use other appropriate means to restore premining capabilities.

Storage

Topsoil and subsoil materials are stockpiled (stored) only when it is impractical to replace the material immediately on a regraded area. Stockpiles must be located on stable areas located away from drainageways and depressions, located away from potential contamination sources, and out of the way of pit advancement. Stockpiles must be protected from wind and water erosion through prompt establishment and maintenance of an effective, quick growing non-noxious vegetative cover. Seeding and/or mulching is to be implemented within a time short enough to prevent erosion but in no case longer than 30 days after becoming inactive.

Redistribution

The operator is required to remove and replace a minimum of 48 inches of soil (topsoil and subsoil) for all prime farmland soils (including those soils with a fragipan) within the permit. As discussed in the removal section, in the early to mid 1980s a few permits allowed removal and replacement to the depth of the fragipan (30 to 36 inches).

Relocation of Prime Farmland

Indiana does not allow the aggregate total prime farmland acreage to be less than that which existed prior to mining. Water bodies, if any, to be constructed during mining and reclamation operations must be located within the post-reclamation non-prime farmland portions of the permit area. Operators will often try to aggregate (relocate) the areas of prime farmland to form larger blocks. As with water impoundments, the prime farmland must be relocated to areas of post-reclamation non-prime areas of the permit. Indiana doesnot allow any surface owner to lose prime farmland acreage except for the following example. There have been times when a surface owner wished to have a permanent impoundment and his/her property is all prime farmland. In these cases, the DOR has allowed the affected portion of the prime farmland to be relocated to a neighboring property. The consent of both parties is required prior to the approval of this type of relocation.

Proof of Productivity and Revegetation (Bond Release) Performance Bond and Liability Period

Prior to mining, the operator is required to put up a performance bond for the area within the permit area upon which the operator will conduct mining and reclamation operations. The bond rate will range from a minimum of $3,000 to a maximum of $10,000 per acre and is calculated upon the difficulty of reclamation should the operator fail to fully or properly restore the land and the state must complete reclamation. This bond shall be for the duration of the surface mining and reclamation operation plus a period of liability. The period of liability starts after the last year of augmented seeding, fertilizing, irrigation, or other work, and continues for not less than five (5) years. The DOR may release bond in whole or in part (phases), when the operator demonstrates the reclamation covered by the bond has been accomplished as required and public notice requirements have been met.

Phase I Release (Grading)

An area is eligible for Phase I release, upon completion of the backfilling, regrading, replacement of all soil materials (topsoil and subsoil), and drainage control of a bonded area according to the reclamation plan. The soil is probed by the DOR staff at an average of one (1) hole per three (3) acres to ensure the replacement of proper soil depths. The replaced soil must be seeded and/or protected with mulch. When this stage of reclamation is achieved, 60% of the bond may be released.

Phase II Release (Revegetation)

For an area to be eligible for Phase II release, one (1) proof of productivity is required. The yield must meet or exceed 100% of the success standard. Measurement of soil productivity must be initiated within ten (10) years after completion of the soil replacement. Upon completion of this stage of reclamation, 25% of the bond may be released

Phase III Release (Final)

For Phase III release, two (2) additional proofs of productivity are required. These yields must meet or exceed 100% of the success standard. The release of the remaining 15% of the bond occurs, when an operator has successfully completed all remaining surface mining and reclamation requirements. This portion of the bond must be held for the entire five (5) year period of liability.

Success Standards

Restoration of soil productivity is achieved when the crop yield during the measurement period equals or exceeds 100% of the success standard. The success standard must be met with a 90% statistical confidence level (a one (1) sided test with a 0.10 alpha error). The success standards are 1) an approved reference area, 2) a weighted average of the current (at the time of permit issuance) NRCS predicted yields for the unmined soil map units, or 3) other success standards approved by the director. Only one Indiana company has tried the reference area concept, but has since changed back to the NRCS weighted average of soil map units. A reference area is a land unit maintained under appropriate management for the purpose of measuring ground cover, productivity, and plant species diversity that are produced naturally or by crop production methods. A reference area must be representative of the geology, soil, slope, and vegetation in the permit area. Each reference area is to be located within 20 miles of the area represented.

Soil productivity of the mined and reclaimed prime farmland area must be measured by using one of the following methods: 1) growing crops on all of the area which we call a whole field harvest, or 2) growing crops on a representative area called test plots. The DOR evaluates the soils, topography, age, management, locality, and any other factor that effects production to determine whether a test plot is "representative." Test plots collectively comprise at least 10% of the area under evaluation for bond release. No test plots smaller than one acre in size are allowed.

Random sampling procedures are often used to estimate yields for corn, soybeans, wheat, and hay. For corn, procedures used by the NRCS in Indiana and developed by Purdue University are recognized. We have also used the sampling techniques in Appendix A of 62 Illinois Administrative Code Section 1816 to obtain estimates for these crops.

Acres of Prime Farmland Released for Phase III

Since the end of 1994, DOR has released 1,259.6 acres of prime farmland for Phase III (Final Phase - totally released).

Cropping Practices/ Crops Used

All prime farmland must have a post-mining land use of cropland. One of the three proofs of productivity must be a corn or soybean crop. Other crops may be wheat or hay. The DOR has accepted any crop for which the NRCS can and will provide a target yield. In the past, these crops have included canola, grain sorghum, and corn silage.

Crop Adjustments

Adjustments to predicted target crop yields may be made according to accepted agronomic practices. Adjustments are requested through consultation with the Natural Resources Conservation Service or other sources approved by the director (includes Purdue University) for factors, including disease, weather, tillage management, pests, and seed or plant selection. The DOR has made adjustments for double cropped soybeans, freezing damage to winter wheat, and most recently a soybean disease, charcoal rot. A few operators are currently using Purdue University Cooperative Extension Service bulletin ID-152 which is entitled "Influence of Production Practices on Yield Estimates for Corn, Soybeans and Wheat" for adjusting yields. The DOR has on a limited basis also made adjustments to account for weather variations with the use of the county averages as determined by the Indiana Agricultural Statistics Service.

Results

In 1994, the Overall Reclamation Success Team (ORST) was formed between the Office of Surface Mining (OSM) and the Indiana Division of Reclamation. Three members from each agency met over a two-year time span to devise innovative, on-the-ground techniques to measure program success.

As a result of those meetings, seven projects were defined and studies were conducted for each. Three of those studies, Proof of Productivity, Post Mine Land Use, and Citizen Satisfaction Survey, have a direct relationship to the results of prime farmland reclamation in Indiana and will be further discussed in this presentation.

At this year's annual Division of Reclamation meeting held in mid-February, a group of four landowners considered to be good caretakers of their mined properties provided us a panel assessment of their reclaimed ground several years after mining had taken place. These gentlemen also expressed their opinions of the adequacy of the reclamation laws and their enforcement. Relevant portions of that panel discussion will be discussed at the forum.

Proof of Productivity

The ORST completed a study of the time required for operators to prove productivity on areas of prime farmland and non-prime cropland/pasture land. The study was conducted to determine (1) whether productivity standards are being met overall, (2) how long it is taking to accomplish this in the field. The ORST devised the study using the best available data.

Nearly 70% of the 504 acres of prime farmland included in the study achieved Phase II bond release within four years of initial seeding. An unexpected result of the study showed that only 40% of the 1,086 acres of non-prime cropland and pastureland acres had received a Phase II release and that it took at least seven years for nearly 50% of those released acres to achieve Phase II release.

Figure 2: Years to obtain Phase II release from prime farmland

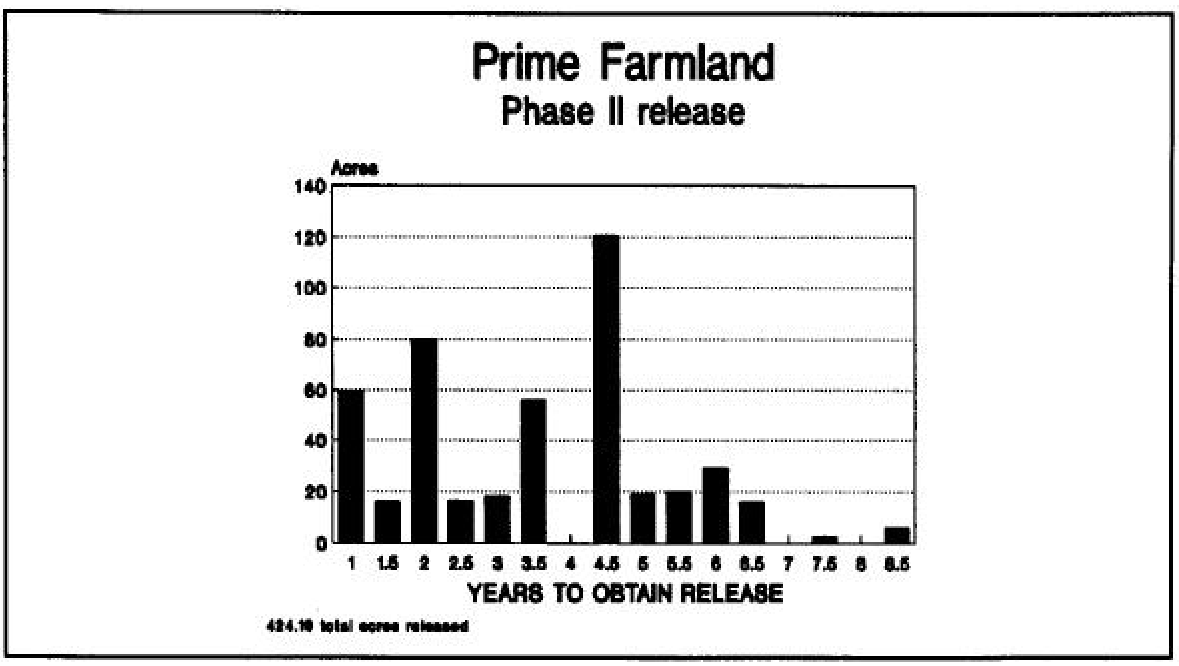


Figure 3: Years to obtain Phase III release for prime farmland

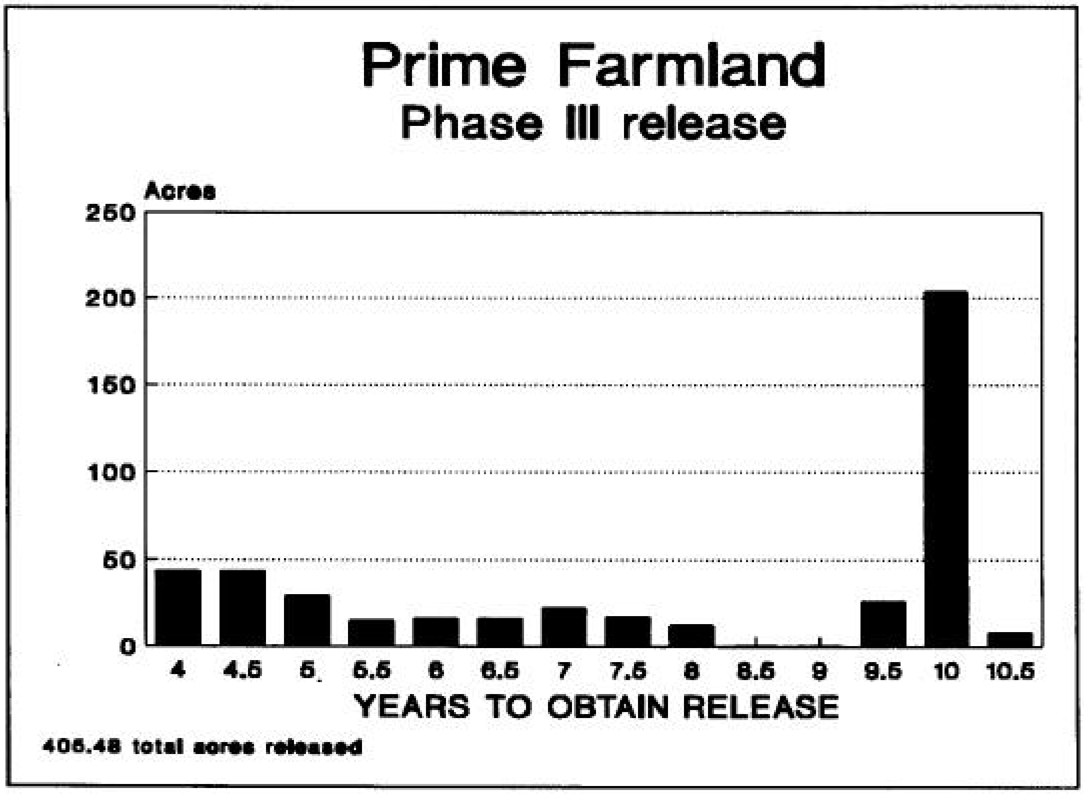
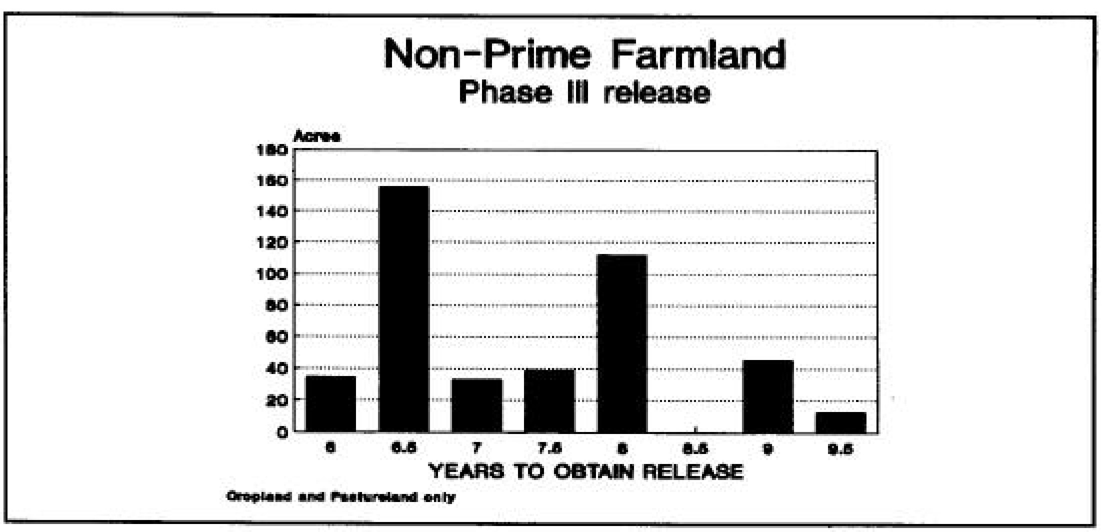


Figure 4. Years to obtain Phase III release for non-prime farmland



Of the 1,086 acres of nonprime cropland/pastureland included in the study, none had achieved a release of Phase III bond prior to six years after initial seeding; five years is the minimum regulatory requirement. This, was unexpected since nearly 100 acres of PFL had already received a Phase III release in the same time frame.

The largest block of NPFL to be Phase III released occurred 6.5 years from initial seeding compared to 10.0 years for PFL.

Post Mining Land Use

The ORST conducted a study of pre- and post- mining land use bond release as an indicator of land capability following the mining and reclamation process. Approved pre- and post-mining land use acreage information was gathered from permit documents. Post-release information was gathered by field visits which examined the actual use of the land on the ground following the completion of the phased bond release process. The most useful data was derived from 15 permit areas where the total affected areas had been 100% released form reclamation bond.

No distinction was made for the cropland land use of the actual number of acres classified as prime farmland vs. number of acres of non-prime farmland; four our study it was considered to be just cropland. Of the 3,391 acres of premining cropland land use, 3,005 were still being managed as cropland, post-bond release (87%). Of the 3,005 acres, 2,636 acres were in a row crop rotation of either corn, wheat, or beans; the remaining 369 acres were being managed as hayland. This shows a substantial continuing use of cropland and that the restored capability of reclaimed land has been sustained.

Citizen Satisfaction

The ORST was charged with designing and implementing methods to measure the overall success of the implementation of the Indiana Regulatory program. One method used by the team was a survey of 265 individuals who owned property that had been mined and reclaimed. The purpose of the survey was to gain, in general terms, a feel for the level of citizen satisfaction with completed mining and reclamation. The questions contained in the survey were not intended to gather technical or specific environmental information.

For the questionnaires sent out, the team received completed responses from 59 individuals. While the responses showed a general level of satisfaction with the completed mining and reclamation activities, several general comments were received which indicate that additional actions may be merited. For areas specific to this prime farmland presentation, six respondents indicated that they could not achieve pre-mining production on the reclaimed sites. Landowner estimates were generally in the range of 75% - 90% of pre-mining productivity. Two additional respondents indicated that the post mining land was fragile and that it was difficult to make a profit from it.

References

Doster, D.H., S.D. Parsons, D.R. Griffith, G.C. Steinhardt, D.B. Mengel, R.L., Nielsen and E.P. Ellsworth. 1992. Influence of Production Practices on Yield Estimates for Corn, Soybeans and Wheat. Bulletin ID-152. Purdue University Extension Service. West LaFayette, IN 47907.

Indiana Administrative Code, Title 310Department of Natural Resources, Article 12 Coal Mining and Reclamation Operations.

Indiana Coal Facts. 1995-96 Indiana Coal Council, Inc. Indianapolis, In 46204.

Illinois Department of Mines and Minerals. 1986. 62 Illinois Administrative Code 1816.116 Appendix A.

Code of Federal Regulations. 1997. Title 30 Office of Surface Mining Reclamation and Enforcement, Department of Interior.

Indiana's Citizen Guide for Coal Mining Soil Resources. 1998. Indiana Department of Natural Resources, Division of Reclamation.

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SURFACE MINING AND RESTORATION OF PRIME FARMLAND SOILS IN KENTUCKY'S COAL INDUSTRY

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Abstract

The Kentucky presentation takes the permittee from initiation of the permitting process through final bond release. Permit reclamation plans, determination of pre-mining and post-mining land uses, and exemptions are discussed. Information will be presented on methods utilized during the mining process for the removal, storage, and replacement of soil horizons. The final segment exhibits program requirements for meeting crop production goals and achieving final bond release.

The "Federal Surface Mining Control and Reclamation Act of 1977" (Public Law 95-87), " 1992 Kentucky Surface Mining Law" (KRS 350), and 405 KAR Chapter 7 through 24 regulate the surface mining and restoration of prime farmland soils in Kentucky. Surface mining of prime farmland sods in Kentucky's coal industry are divided into three processes. These processes are permitting, mining and reconstruction, and demonstration of productivity restoration.

Permitting

A valid permit must be obtained prior to surface coal mining in Kentucky as per 405KAR7:040(l). The permit applicant must, per 405KAR8:030(21), investigate to determine if lands within the permit area may be prime farmland. Prime farmland soils are defined as lands designated by the Secretary of Agriculture in 7 CFR 657 (also see 405KAR8:030(21)) and have been historically used as cropland. "Historically used for cropland" is defined by 405KAR7.001(64) as land used for cropland for any five (5) years or more of the last ten (10) years preceding an application for or acquisition of lands for the purpose of surface coal mining. Generally, soils are not considered prime farmland if (1) they have not historically been cropped; (2) the slope is 10% or greater; (3) they exhibit a very rocky surface; (4) they are subject to frequent flooding; or (5) they have not been designated by U.S. Soil Conservation Service (SCS) as prime farmland. Additional lands exempted are lands encompassed by coal mining permits issued prior to August 3, 1977, or areas that are part of a single continuous coal mining operation begun on permits issued prior to August 3, 1977.

The permit applicant is required to conduct an investigation to determine if prime farmland regulations apply. When an applicant's investigation concludes prime farmland soils are not present or exempt, the permit application must include a detailed request for negative determination. The Kentucky Natural Resources and Environmental Protection Cabinet (NREPC) shall approve or deny the negative determination based upon information provided by the applicant as well as any other pertinent information available. Other pertinent information may include cropping histories and records available from the Agriculture Stabilization and Conservation Service.

If the investigation indicates prime farmland is present, a plan in accordance with 405KAR8:050 Section 3 and 405KAR20:040 must be included in the application. The plan must include a soil survey of the permit area by the SCS or to the standards of the National Cooperative Soil Survey (NCSC). The Survey shall provide a soils map, soil mapping unit descriptions, and soil profile descriptions with horizon depths, textures, pH values, and bulk densities. The plan shall also include details for the removal, storage, and replacement of soil horizons. "Soil Conservation Service, Kentucky Standard and Specifications for Land Restoration, Currently Mined Prime Farmland" establishes the guidelines for the removal, storage, and replacement of prime farmland soils. Adequate soil material must be removed to reconstruct 48 inches of soil. A lesser soil depth may be approved if the lesser depth is equal to the natural soil depth. A greater depth may be required if necessary to restore original soil productivity. Substitute soil materials or a combination of soil materials, B horizon, and/or C horizon may be utilized if proven to meet requirements. The proof must include an analysis by a qualified soil scientist of the physical and chemical parameters of the original soils, substitutes, and/or mixtures. The topsoil, B, and/or C horizons are to be removed separately. Regardless of the material approved, it is imperative to devise a plan for the implementation of all actions feasible during soil removal to minimize negative impacts during the reconstruction and proof of production phases.

Maps and plans designating the final grade and post-mining location of restored soil units are to be included. This plan must contain a demonstration of soil productivity restoration to equivalent or higher levels than non-mined prime farmland of the same type with equal levels of management. Revegetation plans, crop production plans, and yield measurement methodologies must be provided to demonstrate restoration of productivity.

Mining and Reconstruction

Upon issuance of the permit, the removal, storage, and replacement of soils may begin. During the times when prime farmland soils are being disturbed or restored, NREPC personnel will conduct at least weekly inspections. The plan's soil surveys will be used to locate and identify the soils to be removed prior to any drilling, blasting, or mining, and to flag the boundaries for easy field identification, Actual field conditions of topography, drainage patterns, flooding, soil descriptions, soil profile horizon thickness, and soil depth should be checked against permit plans. More detailed observations of soil color, texture, bulk densities, and fragment size may prove necessary. If discrepancies are found between permit plans and actual field conditions, further documentation by a professional sod scientist or soil classifier to meet standards of the NCSS and a permit revision may be necessary prior to disturbance. Consider soil moisture conditions and fluctuations to plan removal during dry conditions to avoid compaction. Physical soil loss will occur during removal, storage, and replacement; therefore, plan to remove sufficient quantities to replace horizons as per permit plans. Use equipment to allow for effective segregation of soil layers and minimize compaction. Back-dump trucks, low ground pressure dozers, and front-end loaders are currently the preferred equipment used. Taking up and replacing soil with a minimum number of lifts and traffic passes minimizes material handling and compaction.

If the natural topsoil (A or E horizon) is less than six (6) inches thick, remove and segregate the top six inches as topsoil. Separately remove the B and/or C horizon material or approved substitute material to a depth adequate for soil replacement.

If not replaced immediately, stockpile the soils removed in separate designated areas appropriately marked by horizon type. Locate the stockpile m areas of adequate drainage that are not subject to flooding or slippage and are protected from contamination, Remove all woody vegetation and other material that may interfere with placement or removal. Construct the pile to avoid ponding, erosion, or contamination from other sources. ff stockpiles are in place for more than thirty (30) days, erosion control measures are to be implemented to meet all requirements of 405KAR16:050.

The segregated B and/or C horizons and the topsoil are to be separately replaced upon removal or restored from stockpiles as the situation warrants. The replaced soils are to be restored to a uniform depth, typically to a total depth of 48 inches including a minimum of six (6) inches of topsoil. The reconstruction shall occur when moisture conditions minimize compaction. The equipment and methodology used in reconstruction shall avoid excessive compaction and preserve porosity. The reconstructed soil shall be replaced on the original land in the location specified in the permit plan. The final grade of the area will provide uniform slopes and adequate surface drainage. The average slope shall be within the slope range of the original soils mapping unit and not exceed 6%.

Appropriate erosion control measures shall be implemented immediately upon soil replacement. Mulching, or other soil stabilizing practices, shall be used until the first period for favorable planting conditions. Then the area will be seeded and planted with species approved in the permit to provide a stableground cover of 90% until crop rotations are begun.

Productivity Demonstration

Crops must be grown on the replaced soils and the yields measured to prove soil productivity has been restored as per specificationsin "Kentucky Prime Farmland Revegetation and Crop Production Restoration After Mining" incorporated by reference in 405KAR20:040(6). Production studies may begin anytime after replacement; however, the studies must begin within ten years. Target yields must be met for a minimum of three crop years. The crops grown must be selected from those most commonly grown in the surrounding area. Generally in Kentucky this means corn, soybeans, wheat, or grass-legume hay, The row crop requiring the greatest rooting depth shall be chosen as one of the reference crops; therefore, in Kentucky, corn shall be chosen as one of the reference crops. Corn may be grown for all three of the measurement years or grown in rotation with other approved crops. The same levels of management must be applied to the test crops as those on non-mined prime farmland. Fertilization, planting, tillage, and weed control records shall be kept on file by the pemiittee and made available to NREPC upon request.

Target yields are contained in "Estimated Crop Yields on Prime Farmland Soils in Western Kentucky Coalfields", SCS, 1980, and in "Estimated Crop Yields on Prime Farmland Soils in Eastern Kentucky Coalfields", SCS, 1985. Yields may be adjusted down by a maximum of 15% with the approval of SCS for damage by disease, pests, or weather. Where authorization has been granted for the mixing of two or more soil mapping units, a weighted average based upon acreage of the different soil mapping units prior to mining shall be calculated to determine the target yields.

Yield measurement techniques are taken from: (1) Technical Reclamation Memorandum # 19 "Field Sampling Techniques for Determining Ground Cover, Productivity, and Stocking Success of Reclaimed Surface Mined Lands." Kentucky DSMRE, 1991; (2) cropping the entire restored prime farmland area; or (3) any other sampling and techniques for productivity determinations approved m advance by NREPC in consultation with SCS as per 405KAR16:200(9). All crop yields shall be corrected to the standard moisture content for that crop. The standards are 15.5% for corn, 12.5% for wheat, and 15% for hay. All moisture levels are to be calculated on wet weight basis.

Notification of intention to measure productivity shall be provided to the NREPC regional office as per 405KAR 16:200(9). The notification shall be in writing at least thirty (30) days prior to and again by phone within two (2) days prior to the measurement dates. The NREPC may take measurement or other appropriate actions to verify measurements made by the permittee.

Conclusion

Thousands of acres of prime farmland soils have been successfully surface named and restored to production in Kentucky's coal fields. Prime farmland permits are eligible for Phase I release when the soil horizons have been physically restored and erosion control procedures have been implemented. A Phase 11 release is obtainable when target yields have been met for three (3) years. The fmal or Phase III bond release requirements have been met when the total five (5) year liability has expired. Careful planning during the permitting process, attention to detail in the mining and restoration process, and valid demonstration of productivity restoration have made successful restoration and bond release possible.

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NORTH DAKOTA PRIME FARMLAND RECLAMATION PROGRAM

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Abstract

North Dakota adopted prime farmland regulations with the passage of SMCRA in 1977. Many of the permitted areas are grand-fathered or exempt from the prime farmland standards. The mine operator must submit an operations and reclamation plan for the prime farmland areas that are subject to the prime farmland regulations. Full restoration of production must be achieved before final bond release can be granted.

Setting and Conditions

Currently, there are four surface mines operating in North Dakota. These mines are located in central and western North Dakota and produce approximately 30 million tons of lignite per year. The soils from this area developed from glacial till and soft sedimentary bedrock. The pre-mining land use of the area consists primarily of cropland and native grassland. Small grains, primarily spring wheat, are the dominant crops grown in the area. Average annual precipation in this area is approximately 16 inches per year.

In central and western North Dakota, approximately 13 soils have been identified as prime farmland soils by the Natural Resource Conservation Service (NRCS). These prime soils occur in small areas on foot slopes, swales, or mild depressions. They are usually 5 to 30 acres in extent. Generally, the prime farmland soils receive run-on water from higher surrounding upland areas that generally do not meet prime farmland criteria.

In many cases, the soils of the adjacent prime and nonprime areas are morphologically similar, oftentimes only differing by thickness of the A and B horizons, presence of argillic horizons, depth to carbonates, etc. The prime soils generally have thicker, darker topsoil layer, higher organic matter content, and thicker solum (A and B horizons) than the adjacent nonprime soils.

The prime soils generally have a higher productive capacity than the adjacent nonprime soils. Numerous studies (Richardson and Wollenhaupt 1983, Schroeder andDoll 1984, and Wollenhaupt and Richardson 1983) have shown that the higher productivity of the prime soils is related to the more favorable moisture regime as a result of the additional soil water contributed by the run-on water from the adjacent upland areas. The authors did not feel that the higher productivity of the prime soils was the result of any inherent soil properties.

Omodt et.al. (I 975) reported that the following soil properties are of special importance to reclamation of mined land in North Dakota: organic matter, soluble salts, exchangeable sodium free lime, soil texture, bulk density, soil structure, soil depth, and pH. It should be noted that bulk density and soil structure of pre-mining soils are drastically altered by the mining and reclamation activities. The remaining pre-mine soil properties tend to be little altered by mining and reclamation activities.

Prime Farmland Determination

Mining companies are required to identify prime farmland areas as part of the peanut application. This determination is based on the NRCS county soil surveys that have been completed for each county in the state. The NRCS has identified which map units in each county are considered prime farmland. The NRCS county soil surveys are prepared at a scale of 1:20,000 and the minimum size delineation is approximately five acres.

The mining company also has a detailed soil survey prepared for each permit area. A professional soil classifier prepares this detailed soil survey, and it is generally more detailed than the NRCS Soil Suney. The mining permit survey is prepared at a scale of 1:4,800, and the minimum size delineation is approximately two acres. This detailed soil survey is used to determine the soil salvage depths, the adequacy of the soil resources for reclamation, and development of the reclamation success standards.

When the NRCS soil survey map (from which the prime farmland determination is made) is enlarged to the same scale and overlaid on the detailed permit soil survey map, the locations of prime farmland as mapped by, the NRCS may not correspond with the detailed soil survey map. Stomberg (1985) found that within the areas mapped as prime farmland by the NRCS, about 35% of the acreage was actually comprised of nonprime soils-. for any particular landowner, nonprime soils comprised from 22 to 91% of mapped prime soils. The prime farmland section of Permit NAFK-9503 for the Falkirk Mine indicates nonprime components (based on the detailed soil survey) comprise from 7 to 93% of the prime farmland delineations within this permit area. Oftentimes, the discrepancies may be minor such as similar, nonprime soils being included in the prime delineation; however, significantly contrasting soils may be within the prime delineation. If significant differences exist between the two surveys, the NRCS and the professional soil classifier who prepared the permit soil survey may be requested to field review the questionable areas and, if necessary, make the appropriate adjustments.

Several exemptions to the prime farmland success standards exist. Lands that the permittee had the legal right to mine before August 3, 1977 and are part of a continuous mining plan that was under permit before August 3, 1977 are exempt from the prime farmland standards. This is commonly referred to as the "grandfather clause." Areas that are not "historically used as cropland" are not subject to the prime farmland standards. These include native grassland areas, tame pastureland, trees, and native and industrial areas.

Of the 55,425 acres currently under permit at the four active mines, approximately 28,760 (52%) acres are subject to the prime farmland handling requirements. The remaining acreage is exempt based on the "grandfather clause." There are approximately 4,285 acres of prime farmland within the 28,760 acres that are subject to the prime farmland standards.

Prime Farmland Operations and Reclamation Plans

Since 1975, North Dakota has required segregation of topsoil and subsoil from <u>all</u> mined lands. Topsoil normally consists of the A horizon and the upper part of the B horizon, typically the dark colored organic-rich, noncalcareous, non-sodic. and non-saline upper horizons of the soil profile. Subsoil typically consists of the calcareous, non-sodic and non-saline material to a depth of 5 feet. The stark color change between topsoil and subsoil makes it a fairly simple task for trained equipment operators to successfully segregate topsoil and subsoil materials.

The actual handling of prime and nonprime soils is similar with the exception that the prime farmland soils are removed, stockpiled and respread separately from nonprime soils. A total of 48 inches of topsoil and subsoil (if available) must be removed and respread from the prime farmland areas. Mine operators prefer to directly respread soils when possible, but when suitable respread areas are not available, the soil materials must be stockpiled.

Reclaimed prime farmland areas must have topography similar to the pre-mine prime farmland areas, i.e., concave or swale positions with gentle slopes (O-6%slopes) to ensure run-on water. Schroeder (199I) found that lower slope positions (foot slope and toe slope positions) had a positive effect on available soil water at planting and wheat yields. Post-mining topography including prime farmland areas must be approved by the Commission prior to soil respread. Soil is respread to a total depth of 48 inches on prime farmland areas. Typical cropland (prime and nonprime) reclamation consists of planting a pre-crop mixture of grasses and legumes following soil respread. The purpose of the pre-crop mixture is to stabilize the soil following reclamation and promote soil structure development. After several years the pre-crop mixture is plowed down and cropping with small grains begins. Recently, the mining companies have gone directly into small grain production following soil respread rather than planting the reclaimed areas to a pre-crop mixture of grasses and legumes.

The North Dakota prime farmland rules are similar to the Federal law and rules with one exception. North Dakota allows for the mixing of prime topsoiland subsoil with nonprime topsoil and subsoil, respectively, provided that the resulting mix is of equal or better quality, The permittee must demonstrate that the resulting mixture is of equal or better quality. If this demonstration can not be made, the prime and nonprime materials must be handled separately.

Mixing of prime and nonprime subsoil has been routinely allowed in those instances where the resulting mixture is of equal or better quality. The permittee must make a comparison in the permit application demonstrating that the resulting mixture will be of equal or better quality, i.e., that the prime and nonprime subsoil materials are of similar quality. In certain instances when the adjacent nonprime subsoil is of marginal quality, segregation of the prime subsoil is required.

Historically, prime topsoil has been segregated from nonprime topsoil. Halvorson and Nathan (1993, 1995) and Halvorson (1996) indicated that certain prime and nonprime soils could be mixed without affecting crop yields or reclamation success. This research found that landscape position was the most important factor in determining reclamation success of reclaimed prime farmland.

A comparison of the soil properties of a typical prime and nonprime soil is provided on tables I and 2. Table I compares the soil series criteria, characteristics, and interpretations of the most common prime and nonprime soils in the coal mining region. Soil laboratory data for typical prime and nonprime soils is compared on Table 2. A weighted average is provided for the topsoil and subsoil materials of the prime and nonprime soils. You will note that prime and nonprime soils are similar in chemical and physical characteristics.

Recently, The Falkirk Mining Company submitted a proposal to mix prime and nonprime topsoil materials. Table 3 compares the soil laboratory data of the most common prime and nonprime soils occurring within this permit area. These three soils make up approximately 80% of the entire permit area. This proposal is currently under review; however, the Commission feels this proposal has merit for the following reasons:

* The dominant prime and nonprime soils are very similar in chemical and physical characteristics.
* A significant amount of mixing of prime and nonprime topsoil is already taking place as discussed above.
* The required productivity standard for the reclaimed prime areas is generally not significantly higher than the nonprime areas, usually less than a bushel per acre for spring wheat.
* The topsoil respread thickness for prime and nonprime respread areas is not significantly different. Usually the prime topsoil thickness is only slightly thicker (oftentimes less than a 2-inch difference) than the adjacent nonprime areas.

Even though segregation of the prime and nonprime topsoil is currently being practiced, a significant amount of mixing of prime and nonprime topsoil is talking place due to the amount of nonprime "inclusions" within the prime areas. These nonprime inclusions result in a lower productivity standard for the prime areas and thinner topsoil respread thickness. It should be noted that the permittee will still be required to meet the required standard for the prime areas for three years prior to bond release.

The types and amount of nonprime topsoil that can be mixed must be restricted to similar prime and nonprime soils. In this instance, we do not feel that the benefits gained by segregating prime and nonprime topsoil are worth the additional cost. We feel the slightly elevated organic matter levels of the pre-mine prime farmland soils justify the segregation of the prime and nonprime topsoil materials especially when one considers that mixing of prime and nonprime topsoil is taking place with the current practice of segregating prime and nonprime topsoil.

Respread depths of nonprime areas are typically determined by the graded spoil quality. Total soil respread depths range from 2 to 4 feet depending on graded spoil quality. If the graded spoil is non-sodic (SAR<12) and medium textured (loam) or finer, then the total soil respread depth would be 24 inches, If the graded spoil is moderately sodic (SAR = 12-20) or coarse textured (sandy loam or coarser), then the total soil respread depth would be 36 inches. If the graded spoil is highly sodic (SAR >20), then the total soil respread depth would be 48 inches. As mentioned above, prime farmland areas are respread to a total depth of 48 inches regardless of the graded spoil quality. The Falkirk Mining Company has also submitted a proposal to utilize the graded spoil as part of the subsoil respread requirement provided that the graded spoil quality is of equal or better quality than the prime subsoil. Additional sampling of the graded spoil will be required. This proposal is currently under consideration by the Commission.

Determining Reclamation Success

North Dakota has a 10-year responsibility period, i.e., the reclaimed area must remain under bond a minimum of 10 years from the last augmented seeding. Productivity (crop yield) is the only vegetation parameter that must be assessed for final bond release. Reclamation success is achieved when the annual average crop production from the area is equal to or greater than that of the approved reference area or standard with 90% statistical confidence for a minimum of three years for prime farmland areas and two years for the nonprime areas,

For assessment of revegetation success on surface mined land reclaimed to prime farmland, the permittee may use either a reference area standard or a technical standard based on NRCS data. Each of these standards provides a procedure for climatic correction of yields. If a tract is owned by more than one landowner, production on each landowner's property must be assessed separately. A separate yield must be obtained and a separate standard developed for each landowner's property. A separate standard must be derived for prime farmland tracts. Spring wheat must be used to determine reclamation success for at least two of the three years that productivity measurements are taken. Barley and oats may be used for the remaining year.

The cropland reference area standard combines a reference area with SCS productivity indices for soil mapping units. This method is well suited to reclaimed prime farmland tracts and reclaimed nonprime cropland tracts that subtend only a few soil map units. A cropland reference area is established for soil mapping units that were predominant in the reclaimed tract prior to mining. The reference area must include one or two reference soils which singly or together occupy more than 50% of the reclaimed tract. The reference area must be topographically similar to the reclaimed tract and must be established in the vicinity of the mine area.

The yield from each soil map unit in the reference area must be separately harvested or sampled. The crop yield of one of the reference soils must be used along with the NRCS soil productivity indices to calculate the expected yields for the other premining mapping units not represented in the reference area. The current year's actual yield from the reclaimed tract is then compared to the derived standard. The yield standard must be derivedfor each year that the reclaimed tract is evaluated for bond release. Appropriate statistical tests must be applied as necessary to determine if the yields are significantly different.

Under the technical standard based on the NRCS productivity indices method, productivity index values for all premining soil map units which existed in the reclaimed cropland tract are obtained. Index values are converted to yields using the assigned county yield for the Productivity Index of 100%. A yield value is determined for each soil mapping m the tract and multiplied by the acreage each mapping unit occupied m the tract. These weighted yields are summed and divided by the total acreage of the tract to obtain a weighted average yield per acre. This value is the unadjusted yield standard for the reclaimed cropland tract. NRCS yield ratings for productivity indices are based on long-term average data and do not account for annual climatic variations. Therefore, the unadjusted yield standard must be adjusted using the four approved methods.

To date, no final bond release applications have been received for prime farmland.

Summary

Significant portions of permitted areas in North Dakota are exempt or grand-fathered from the prime farmland standards. Prime farmland soils in the coal mining region of North Dakota are morphologically similar to many adjacent nonprime soils. By regulation, prime soils are to be salvaged, stockpiled, and respread separately from nonprime soils. However, regulations allow for themixing of prime and nonprime topsoil and subsoil, respectively, provided that the resulting mixture is of equal or better quality. In North Dakota mixing of prime and nonprime subsoil has been routinely approved provided that the resulting mixture is of equal or better quality. Recent research has indicated that certain prime and nonprime topsoil can be mixed without affecting reclamation success. Successful reclamation consists of restoring 100% of the premine productive capacity for a minimum of three years.

References

Friedlander, J.D., 1989, "Mining and Reclamationof Prime Farmlands in Western North Dakota," Reclamation, A Global Perspective, American Society for Surface Mining and Reclamation, pp. 447457.

Halvorson, G.A, 1996, "Comparative Evaluation of Productivity of Prime and Nonprime Land," North Dakota State University, Land Reclamation Research Center, Mandan, ND.

Halvorson, G.A., and Nathan, M.V., 1995, "Reclamation of Prime and Nonprime Soils,” Mineland Reclamation Review, March 29, 1995, North Dakota State University, Land Reclamation Research Center, Mandan, ND.

Halvorson, GA, and Nathan, M.V., 1993, 'Research on the Reclamation of Prime Farmland in North Dakota,' North Dakota State University, Land Reclamation Research Center, Mandan. ND.

North Dakota Public Service Commission, 1997, "Rules Governing Surface Mining and Reclamation Operations, June 1, 1997," Bismarck, ND.

North Dakota Public Service Commission, 1995. "Standards for Evaluation of Revegetation Success and Recommended Procedures for Pre- and Postmining Assessments, Revised May 1995,"Bismarck, ND.

Omodt, H.W., Schorer, F.W., and Patterson, D.D., 1975, "The Properties of Important Agricultural Soils as Criteria for Mined Land Reclamation,” Bulletin 492., North Dakota State University, Fargo, ND.

Richardson, J.L., and Wollenhaupt, N.C., 1983, "Natural Soil and Landscape Development,"Can Mined Land Be Made Better Than Before Mining? Conference Proceedings, November 7, 1982, Stronghold Press, pp. 9596.

Schroeder, S.A., 1991, "Topographic Position Effects on Soil Water and Wheat Yields on Reclaimed Minelands.," North Dakota Farm Research, Vol. 48, No. 5, pp. 3-5.

Schroeder, S.A., and Doll, E.C., 1984, Productivity of Prime, Nonprime, and Reclaimed Soils in Western North Dakota, " North Dakota Farm Research, Vol. 4 1, No. 5, pp. 3-6., 31.

Soil Conservation Service, 1984, "North Dakota Important Farmlands," Bismarck ND.

Stomberg, A, 1985, "Prime Soils Handling in North Dakota,"Proceedings of the 1985 Annual Meeting of American Institute of Mining Engineers, Albuquerque, NM, pp. 1-3.

The Falkirk Mining Company, 1995, "Surface Coal Mining Permit No. NAFK-9503," The Falkirk Mining Commpany, Underwood, ND.

Wollenhaupt, N.C. and Richardson, J.L., 1982, "The Role of Topography in Revegetation of Disturbed Lands," Symposium on Surface Coal Mining and Reclamation in the Northern Great Plains Proceedings, March 8-9, 1982, pp. C.2. I-C.2. I 1.

Table 1. Comparison of Williams, Bowbells, and Falkirk Soils (based on soil series criteria, characteristics, interpretations, etc.)

Soil Property	Williams Soil (nonprime)	Bowbells Soil (prime)	Falkirk Soil (prime)
Classification	Fine loamy, mixed Typic Argiborolls	Fine-loamy, mixed Pachic Argiborolls	Fine-loamy, mixed Pachic Haploborolls
Drainage Class *[1]	Well	Well and moderately well	Well
Permeability *[1]	Moderately slow or slow	Moderate to slow	Moderate and moderately slow
Parent material *[1]	Calcareous glacial till	Glacial till and alluvium from glacial till	Glacio-fluvial sediments underlain by glacial till
Thickness of A horizon *[1]	5-15"	5-15"	5-15"
A horizon texture *1	L, CL, SL, FSL, SiL	L, SiL, CL	L, SiL
Thickness of mollic epipedon *[1]	< 16"	> 16"	16 – 30"
Thickness of non-calcareous B horizon *[1]	5-20"	6-24"	5-22"
B horizon texture *[1]	CL, L (24-35% clay)	CL, L	L (18-27% clay & >15% fine & coarser sand)
Bulk density (g/cm^3)*[1]	1.2-1.6 (0-24") 1.3-1.6 (24-60")	1.1-1.4 (0-6") 1.2 – 1.5 (6-23") 60")	1.1 - 1.4 (0-28") 1.3 - 1.7 (28-60")
Available Water Capacity (in/in) *[1]	0.17-0.24 (0-6") 0.16-0.2 (6-24") 0.15-0.18 (24-60")	0.17-0.24 (0-6") 0.16 - 0.22 (6-23") 0.14 –0.18 (23-60")	0.2 - 0.22 (0-7") 0.17 – 0.19 (7-28") 0.13 – 0.17 (28-34") 0.14 – 0.16 (34-60")
K factor *[1]	.28	.28	.28
T factor *[1]	4	5	5
Wind Erodibilty Group *[1]	6	6	6
Organic Matter (%) *[1]	2-7% (0-6")	2-6% (0-6")	2-6% (0-7")
Productivity Index	85 (0-3% slopes) 80 (3-6% slopes) 60 (6-9% slopes)	100 (0-3% slopes) 90 (3-6% slopes)	95 (0-3% slopes) 85 (3-6% slopes) 75 (3-6% slopes)

*[1] Source – The official series description and Form 5 for Williams, Bowbells, and Falkirk soils.

Table 2. Comparison of Williams & Bowbells Topsoil & Subsoil Properties Based on NRCS Lab Data

	Williams soil (nonprime)		Bowbells soil (prime)	
Soil Property	Topsoil	Subsoil	Topsoil	Subsoil
n (# of pedons)	4	4	3	3
Average Topsoil Thickness	10.2	40	22.3"	37.7
Electrical Conductivity (mmhos/cm)*1	0.57	0.71	0.71	0.43
Sodium Adsorption Ratio *1	0.12	1.9	Not available	1.33
Calcium Carbonate Equivalent *1	< 0.1	14.1	Not available	7.6
Organic Matter % *1	3.38%	0.5%	2.8%	0.96%
% Sand *1	27%	23.1	26.6%	29.3%
% Clay *1	28.4	29.2	29.3%	31.5%

*1 Weighted average

Table 3. Comparison of Williams, Bowbells, and Falkirk Topsoil Properties Based on Soil Lab Data Submitted with Permit NAFK-9503

Soil Property	Williams soil (nonprime)	Bowbells soil (prime)	Falkirk soil (prime) *2
N (# of pedons)	20	3	26
Average Topsoil Thickness	12.2"	17.1"	19.5
Electrical Conductivity (mmhos/cm) *1	0.33	0.46	0.41
Sodium Adsorption Ratio *1	0.41	0.35	0.39
Calcium Carbonate Equivalent *1	1.66	1.67	1.57
pH *1	6.7	7.1	
Organic Matter % *1	2.77%	3.06%	3.13%
% Sand *1	31.5	28.5%	51.6%
% Clay *1	25.3%	23.8%	15.8%

*1 Weighted average

[1]Dean Moos, Environmental Scientist, North Dakota Public Service Commission, Reclamation Division; B.S. Soil Science, North Dakota State University; Registered Professional Soil Classifier; 10 years with the Reclamation Division.

KANSAS PRIME FARMLAND PROGRAM REQUIREMENTS MEASUREMENT METHODS AND RESULTS

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Abstract

Prime farmland restoration accounts for more than 40 percent of the current surface coal mining reclamation activities in Kansas. Since 1991, Kansas has had formal revegetation guidelines in place to guide the coal mining industry through acceptable revegetation sampling methods for final bond release of this critical land use. This paper presents an overview of the Kansas program including permitting issues, reclamation plan requirements,. revegetation standards, and sampling methods involved. Program achievements, along with a discussion of problems and anticipated future modifications, complete this brief overview of the bond release program for Kansas prime farmland.

Introduction

The Kansas Department of Health and Environment, Surface Mining Section (SMS), is charged with the responsibility of administering all Title 5 Coal Mining and Title 4 Abandoned Mine Land Reclamation and Emergency Program activities in Kansas, a minimum program state. Fifteen people manage all three programs out of the Frontenac, Kansas office.

Coal mining in Kansas has been regulated since May 3, 1969. The Kansas Law, as it was known, required the surface mine operators to strike the tops of the spoil ridges so the area could be traversed by farm equipment and to then seed the area twice. Soils were not salvaged and minimum emphasis was placed on hydrology or revegetation success. With the passage of SMCRA, Kansas fell under the auspices of the interim law until primacy was achieved on January 26, 1981.

Kansas has a continental climate with warm to hot summers, generally mild winters, light to moderate winds, and low annual snowfall. The average annual precipitation is 40 inches for the coal bearing regions. The precipitation distribution, three-quarters being received from April through October, coincides with favorable crop and grass growth periods.

Located in the western region of the Interior Coal Province, Kansas coal resources have been mined for over a century by both surface and underground methods. The actively mined coal is classified as highly volatile A bituminous with 2 to 5% sulfur. The coal seams average I to 3 feet thick and are located generally in the eastern third of the state. The active coal fields are isolated in five southeast Kansas counties.

On a national scale, Kansas is estimated to have about 0.2% of the United States coal reserves. In financial terms, agriculture plays a much more important role in the economy of Kansas than does coal mining. Since program primacy, only thirty-one coal mining permits have been issued in Kansas. However, of these permits, nineteen contained prime farmland resources. Within the current permit sites, excluding tipples and haulroads, fully 45% of the permitted acreage is prime farmland cropland.

Permitting

Permitting requirements for Kansas prime farmland cropland parallel the Federal Regulations at 30 CFR 785.17. At this time, Kansas has not adopted any more stringent regulations. Permitting focuses on the existing soils volume, cropping history, proposed replacement depths, and productivity standards. Because the Kansas program has adopted the Federal regulations, permits are broken into appropriate sections utilizing the federal numbering system.

The primary task in permitting is to identify, and inventory prime farmland soils with a history, of cropping. The process begins by utilizing the county Soil Survey to map the soils on site. The applicant conducts a field reconnaissance to inventory the depth and distribution of the soils and ascertain current cropping status. The depth is measured by probing on 200 foot centers reported on an individual map in the permit and discussed in the applicable permit sections, specifically Soils (779.2 1) and Reclamation Plan (780.18). This information. correlated to a soils mass balance, is used to determine the reclamation soil and subsoil replacement depth. Kansas prime soils arc probably considered thin by comparison to other mid-western coal region states. Many prime soils are documented at less than 12 inches thick in the premine condition. Replacement depths are stated as a range,. with the overall minimum requirements being 6 inches topsoil and a total 48 inches horizon replacement for topsoil and subsoil combined.

The field review conducted by the applicant often identifies areas where minor modifications in soil boundaries need to be made. All changes to pre-mine soil boundaries must be reviewed and verified in writing by the responsible Natural Resource Conservation Service (NRCS) personnel. An administrative record of the process is included in the permit. Often the pre-mine soil boundaries include areas of previously mined land that must be more clearly and precisely identified in order to obtain an accurate accounting of the soil resources on site.

Aerial photography is used to gain insight into cropping history, along with personal interviews and signed affidavits bv landowners. The results arc presented in the permit under Prime Farmland (785.17). The staff of the SMS works with the NRCS to maintain a valid listing of those soils that are currently classified as prime. This, combined with a knowledge of the history of the area, provides the SMS with the appropriate requirements for the area. Historically, several of the large coal companies qualified for exemption from prime farmland standards through the grandfathering process.

Occasional allowances are made on a case-by-case basis for inclusion of some non-prime soil areas. These are typically where the soil was classified as non-prime due to its slope or position. Inclusions are allowed only in conjunction with NRCS approval and only on a small scale where the area of inclusion is typically less than one acre in size. The soils are reviewed to ascertain that they are of the same parent material as the prime soil. The overall standard for revegetation for the site is not lowered due to this inclusion.

During permitting, the productivity standards for bond release are addressed and incorporated into thepermit. The operator has the option of setting a productivity standard based on the soil types for the area using NRCS soil productivity database standards or by selecting a reference area to use for comparison. The reference area method is seldom used and is discouraged due to the difficulty in selecting and managing the reference area site.

When the productivity standard is developed based on soil types, it is based on the acreage of the prime farmland soil mapping units being cropped premine. The acreages are used as weighting factors to develop the overall productivity standards for bond release. The premine acreage of each soil unit is verified to the nearest 1/10th acre. Accuracy is important as the productivity standard can vary substantially within different prime soil series.

Reclamation Plan

While several sections of each permit discuss prime farmland cropland reconstruction, the Reclamation Plan (780.18) outlines the minimum and average depth of soil replacement, as well as the methods to be used for handling prime farmland soils. During the active stages of mining, this information provides the basis for compliance determination during inspections.

Acceptable soil handling is outlined in NRCS Technical Guide *Kansas Standard and Specifications for Land Reconstruction, Currently Mined Land-544.* This document, first developed for use in Kansas in the mid 1980s', applies to the identification, removal, storage, replacement, and reconstruction of soils subject to coal mining.

As with any large construction job, the better the site conditions are studied and the more known about the site, the better the end result. Because mining deals with unknowns, the typical permit will have variations. There will be areas that are not mined due to poor coal quality, or the coal may dip and thus be uneconomical to recover. In almost every permit in Kansas, a final cut impoundment is part of the approved reclamation plan because landowners recognize the value of a large water body. Due to any of the variations that can occur, special attention must be taken to have a tight control on acres so there, will be no net loss of prime farmland. Accurate land use mapping is important and all acres must be accounted for to the nearest 1/10th acre.

The reclamation plan also includes the list of equipment to be used. From this the SMS determines if the soils can be suitably handled to insure adequate replacement with minimum compaction or destruction of the soil resources. There must be some demonstration that the operator has the technical expertise and sufficient experienced field personnel to handle prime farmland soils.

Revegetation Standards

While the productivity standard for revegetation success is set in the permit prior to the initiation of mining. the use of this standard does not apply until mining is complete. According to 30 CFR 816.116(a)(1),"*Standards for success and statistically valid sampling techniques for measuring success shall be selected by the regulatory authority and included in an approved regulatory program.*" Kansas developed extensive guidelines to meet this requirement.

The process of developing the Kansas revegetation guidelines involved numerous hours by the SMS Soil Scientist in research, expert consultation, and consultation with the regulated industry. In 1991, the guidelines under the title *Revegetation Standards for Success and Statistically Valid Sampling Techniques for Measuring Revegetation Success*, became part of the approved program. It is important to note that the revegetation guidelines as written represent a "cookbook" approach that deals with revegetation requirements for bond release of all land uses. The document provides a clear step-by-step approach to the process that can be used by anyone.

The prime farmland cropland standards for revegetation success are based on the row crop productivity standards from the USDA-NRCS Technical Guide Notice KS-145 for each county by soil mapping unit. At the time of the development of the guidelines, this was the best available information for setting productivity standards for reclaimed prime farmland. There remains an allowance for adjustment to crop yields based on 30 CFR 823.15(b)(8).

The most common crops grown in the mined area of Kansas are soybeans, grain sorghum (milo), and wheat. During the initial research for the approved revegetation guidelines, it was determined that the most common row crop requiring the greatest rooting depth could not be practically determined on a statewide basis. Also, the subsurface clays can prohibit the penetration of roots and thus affect the productive capabilities of the soils. Overall it was determined that the most common row crops, with the greatest rooting depths regardless of soil physical barriers are soybeans and grain sorghum.

In Kansas,, the row crops of soybeans or milo must be used to achieve final bond release on prime farmland cropland. Row crops must be grown one out of the three required crop years. This required year of row crops must meet the calculated success standard to obtain a Phase 11 release. Two additional successful growing season data sets must be obtained for the Phase III release. The crops of wheat, milo, or soybeans may be used for the additional two years or forage can be used. The Kansas program allows a Phase 11 bond release to occur with only one year of row crop data.

Sampling Methods

The Revegetation Standards for Success and Statistically Valid Sampling Techniques for Measuring Revegetation Success document outlines approved sampling methods in a step-by step manner. The operator maintains the flexibility to choose between productivity standards based on a reference area or a productivity standard based on the technical standard for the soil types involved. The operator also determines whether the area will be put into a forage crop with row crop test plots or if the entire field will be put into row crop production.

Test plots have always been considered advantageous for soil conservation purposes. In many instances, once a forage crop is established on a mined area, it may be kept in grasses for years to come and actually put into a pasture type land use following bond release. More recently however, operators, either based on landowner request or in an attempt to offset costs, are returning entire areas to row crop production. In either case, the reclaimed soils production capability must still be proven based on crops prior to release. All methods require random samples to be taken from the cropped area. Presently, there is no approved method for whole field harvest sampling. Either representative samples are collected from a field that is being cropped in its entirety or representative samples are taken from test plots that represent the reclaimed area. When test plots are used the forage production and cover in the area around the test plot must also be sampled and meet prime farmland forage productivity requirements for the same sampling year.

According to the *Revegetation Standards for Success and Statistically Valid Sampling Techniques for Measuring Revegetation Success,* test plots are to be selected based on the replaced soil depth and the slope as the primary determinants, with a secondary grouping of bulk density. topsoil texture, and color. Test plots must be a minimum of two acres in size and in totality must be large enough to represent 5% of the representative area in size. For a 120 acre field, three two-acre test plots or one six-acre test plot could be used. The maximum representative area is 200 acres. For sampling data to be acceptable, each individual test plot in the representative field area must meet the production success standard for that season. Failure of any test plot to meet the success standard invalidates the data on the other test plots in that sample area.

Whether a row crop area is in test plots or is a field from which representative random samples are being taken, a minimumof 15 samples is required. Samples are checked on both a wet and a dry basis for statistical sample adequacy. Up to 30 samples can be collected from an area if needed to meet sample adequacy. If greater than 30 samples are required, then sampling has to be abandoned due to variability,

As required by regulation, the goal of reclamation is to meet or exceed the premine production capability of the area. The production databases used present yields in bushels per acre for wheat, milo, and soybeans, as well as forage production in animal unit month, or AUMs. Actual sampling can be tedious and labor intensive. The basic steps are summarized below:

For milo, the average row width is determined by measuring across five rows and dividing by four to calculate the average row width for the particular planter that was used. The grain heads in a ten feet section of a randomly located point are clipped about ½ inch below the grain and weighed to the nearest five grams. This wet weight is used to check sample adequacy for field purposes. The grain heads are stored in an individual container, then dried, thrasher and checked for moisture content. For milo, the moisture is adjusted to 13%, and the production is calculated on a 56 lb/bushel basis.

For wheat, the process is the same, except that a five foot section from each of five adjacent rows isclipped, and the production is calculated based on a 60 lb/bushel basis. Soybeans require the same five row/five foot section scenario, and the pods from the plants in the sample are to be removed. However, practicality dictates that removal of the entire plant is much easier for field adequacy determination.

In all sampling scenarios, the permittee is to mark the starting location of the random grid and the individual sampling spots. Since the Kansas program is small, the opportunity for the SMS to accompany operators or consultants while sampling or to review the area shortly thereafter is good. In order to minimize problems with verification of sample results, Kansas has adopted additional regulations that require all productivity and ground cover data to be submitted within 30 days of sampling. Raw field data is accepted for this requirement recognizing that drying and thrashing times can vary.

Prime farmland areas in forage require the same 15 minimum samples. The basal vegetation in a given sample circle, .96 ft^2 minimum to 2.4 ft^2 maximum,, is clipped between 1½ to 3 inches from the surface. All unacceptable species, as defined by the land use, and litter are removed and the sample weighed to the nearest five grams. Sample adequacy is calculated in the field based on the wet forage weight. Final sample adequacy is based on dry weights. Sample adequacy greater than 30 disqualifies the sampling. Once dry, the samples are reweighed and corrected to 12% moisture. Should an operator utilize a row crop test plot for productivity, then they must also assess the productivity and ground cover of the remaining prime farmland forage areas outside the row crop test plots according to the forage sampling techniques.

Forage sampling is based on the recognized Harvest Technique. All forage areas are stratified according to factors that would account for production variability. Most often field area locations have been defined previously. and the stratification factors used are vegetation types and planting dates. Sampling must be conducted during approved time frames, which involves sampling during periods of optimum performance. As with any land use in Kansas. a bond release can be denied based on active site erosion.

The standards for forage crops on prime farmland cropland have been set using the USDA-NRCS crop -yield database from the published county soil surveys and from technical guides of the NRCS. Both cool season and warm season grasses are addressed. When composition of a field is a combination, then the standard is based on a combination of the grasses. The production standards are derived from the AUM value from the databases. These are converted to a lbs/acre of dry forage per growing season by a factor of 900 pounds of dry forage per AUM. As with row groups, the soil productivity is given a weighted value based on the percentage of the permit it occupies.

Because eastern Kansas soils have high production capabilities under a high level of management, the technical success standard for ground cover was set by the SMS at 100%. A lower value can be approved based on premine sampling and demonstration by the operator why the site can not achieve the 100% standard. This justification must include site specific physical or chemical characteristics that can not be modified under a high level of management.

Ground cover sampling is limited to the time period of April 1 to November 1. The forage sampled must be representative of the species that comprised the seeding mix with allowances for up to 10% of other acceptable plant species as defined by the land use and up to 5% fitter to count as ground cover. Diversity is based on initial seed mixes.

Program Achievements: Phase III Bond Release Results

Since Kansas achieved primacy in 1981, there have been a total of 19 permits issued that contained prime farmland cropland disturbances. These permits represent over 11,000 acres containing about 41.500 acres of prime farmland cropland. Of this, about 2,200 acres of prime farmland on ten permits have achieved final bond release. The remaining 2,300 acres are contained on the two active coal mine permits presently operating in Kansas and on seven other special case permit sites. The special case permits have, in most instances, met liability time frames, but have not achieved final bond release due to bankruptcies of the three companies involved.

The majority of the successfully restored prime farmland cropland areas have had productivity demonstrated through forage sampling and row crop test plots. Recent permits are tending to return entire fields to row crop production with random sampling of the fields. Prior to the approval of the revegetation guidelines, wheat was accepted for both phase II and III bond release.

In Kansas, when a mining company declares bankruptcy and the reclamation responsibility shifts to the surety company, the surety is required to meet the terms and conditions of the regulations including the revegetation requirements and sampling methods as outlined in the *Revegetation Standards for Success and Statistically Valid Sampling Techniques for Measuring Revegetation Success.* Bond forfeiture areas are reclaimed using available funds according to the regulations and the approved reclamation plan; however, productivity sampling is not being conducted at this point in time.

Problems and Future Modifications for the Revegetation Guidelines

Several aspects of the Kansas revegetation guideline document met with resistance from the regulated industry. The nature of the concerns depended somewhat on the size of the company involved. The initial concern was that the flexibility to use the document as a guideline, and not as a regulation, was not clearly defined. In actuality, should an operator wish to sample using a method not included in the document, a program amendment must be processed to include the proposed methodology.

Numerous technical aspects of the document have also been challenged. The bulk density measurement for test plot location has met with resistance due to the increased cost and time involved. Industry representatives felt the results were so broad based that they did not have substantial meaning.

The requirement for all tests plots in a sample field to meet the productivity standards and sample adequacy during a given sampling has been challenged, as well as the requirement for a minimum number of 15 samples for any size field. The test plots, being located to represent the fields variety, will yield at different rates. Thus the request has been made to allow for the production of the test plots to be averaged. The minimum sample size of 15 was selected to protect against the loss of an entire year's worth of sampling due to variations between wet field adequacy weights and dry weights. However, the industry indicates that they should have the option to sample at a lowerlimit, such as 10 samples, as long as sample adequacy is achieved.

Stratification, while designed to define minimum sampling areas, came under appeal as the scale of reclamation for some companies was considerably larger than others. The current forage sampling requirements place limitations on the field size that-do not allow for reduced sampling on large contiguous tracts.

Other considerations needing attention are diversity and the AUM conversion factor. Diversity, according to regulation, requires that a diverse cover that is permanent and effective be established. The current Kansas diversity measurement requires percentage composition studies based on initial seed mixes. However, prime fanrdand does not need to meet this requirement when areas are cropped or where a forage monoculture for hay production is being established. The 900 lbs. conversion factor for the AUM value is, according to industry, artificially high and not based on valid technical and scientific data. The SMS is researching various sources, both county and state, to use the most suitable conversion factor for prime farmland soils in the coal mining region.

Since the initial introduction of a guideline for determining revegetation success, several extensive modifications to the approved document have been attempted. but none successfully completed. While some minor issues have been addressed through the program amendment process, the major issues dealing with prime farmland cropland are still being worked on. Future modifications may include allowances for different sampling methodology, especially a whole field harvest. Due to the perceived problems with test plots, there is a possibility they will be eliminated entirely; if not, a provision may be made to allow averaging of test plots within some minimum standard requirements. Kansas maN, also add an allowance to use corn to prove productivity, but not make it the required crop for Phase III.

Conclusion

Since primacy, the state of Kansas has released over 2,200 acres of prime farmland cropland. Approximately 1,950 acres of this has been maintained in forage production. The tendency on currently mined lands is to return the area to row crop production and prove productivity while enjoying the economic benefits of a crop. As of January, 1998, there was only one company actively mining in Kansas on two individual permit areas. Three coal company bankruptcies have resulted in the remaining permitted sites being reclaimed either by sureties or through a bond forfeiture proceeding.

The Kansas Surface Mining Section worked diligently to provide Kansas coal mine operators with a methodology that would allow for timely release of performance bonds from all permit areas. The revegetation guideline document provides a step-by-step procedure that, when followed will be acceptable for use in bond release. Both coal and prime farmland are valuable resources. While coal exists in very, limited quantities in Kansas, with proper planning and management, prime farmland soils can be an unlimited resource for generations to come.

References

Continental Coal, Inc.. 1997. Surface Coal Mining and Reclamation Permit LN-SM- 1201. Continental Coal, Inc., Leawood, Kansas.

Kansas Department of Health and Environment, Division of Environment, Surface Mining Section, 1991. Guidance Document-Revegetation, Revegetation Standards for Success and Statistically Valid Sampling Techniques for Measuring Revegetation Success. KDHE, Pittsburg, Kansas.

Kansas Department of Health and Environment, Division of Environment, Surface Mining Section, 1997-1998. Records and files. KDHE, Frontenac, Kansas.

The Clemens Coal Company, 1993. Surface Coal Mining and Reclamation Permit CR-SM-306. The Clemens Coal Company, Pittsburg, Kansas.

USDI-OSM, 1997. Annual Evaluation Summary Report for the Regulatory Program Administered by the State of Kansas, Office of Surface Mining, Alton, Illinois.

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PRIME FARMLAND VARIABILITY IN MEETING POST-MINING YIELD TARGETS

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Abstract

The data collected by the Department of Agriculture (DOA) and Department of Natural Resources (DNR) in Illinois on mining operations, soil replacement practices, and crop yields on post-mined soils is a rich source of information for assessing the reclamation of mined soils. The data set includes over 700 fields; however, the most complete data is for 448 fields in the Illinois Permanent Program. The yield testing data for fields in the Permanent Program span the years 1985 to 1996 (latest available data). Although the fields in the data set fall into three categories, this report focuses on fields designated as prime farmland (PF), which must pass the highest and most difficult-to-reach target yields. The working hypotheses were that variation in the success of restoring crop yields on mined farmland depends on the methods of sub-soil and top-soil replacement, soil compaction, the depth of deep tillage, crop growing conditions, the presence of problem sub-soils, the number of attempts per field to pass the yield tests, and whether the field is located in northern Illinois (young soil) or southern Illinois (old soil). At least for the data collected for fields in the Permanent Program, the reclamation of prime farmland apparently does not depend significantly on the index of growing conditions, the index of problem sub-soils, or the age of the soil (location of the field). However, the reclamation of prime farmland does depend statistically significantly on soil compaction (and, thus, on the soil replacement equipment), the depth of deep tillage, and the effort per field to pass the yield tests.

Introduction: Citizen Concerns

As consumers and producers, we benefit from cheap electricity-55% of our electricity comes from coal fired generation (Darmstader, 1997). As citizens, we benefit from a safe, healthy, and aesthetically pleasing environment. The environmental safeguards and benefits, of course, increase the cost of mining and burning coal and, thereby, the cost of coal generated electricity. The members of the Citizens' Organizing Project (COP), Knox County, Illinois and many other citizens from distant communities are genuinely concerned about how our society measures and balances such benefits and costs.

Thus, not completely impaired by romantic delusions, we raise specific, practical questions. They include: Are some property owners near the mines not receiving timely and adequate compensation for blasting damage? Are the regulations for post-mining water tables and surface water drainage enforced fully? Have post-mined fields that have passed the target yields really been restored to pre-mining productivity (as required by federal and Illinois law), or are the target yields too low? If the post-mined fields pass target yields that are too low, the fields will not be as productive as undisturbed fields, and the property tax base will not be restored to the pre-mining level. Even if target yields are unbiased, is passing three yield tests in a ten year liability period enough? Should the standard require five passes or six or some higher number? What constitutes a successful program of reclaiming and restoring prime farmland? Should mining firms with limited success in restoring fields to pre-mining yields be permitted to mine new areas? Are the standards for issuing mining permits too lenient? After satisfying the target yields, why do some mining firms wait so long to apply for bond release?

Data to Assess the Satisfaction of Yield Targets by Post-Mined Prime Farmland

My empirical results can help to answer some-but not all-of the questions raised. Satisfactory answers to some citizen concerns may require something beyond mine site inspection reports and peer-reviewed, scientifically controlled studies concluding that physical and chemical soil characteristics may be restored sufficiently that post-

[1]The author gratefully acknowledges the following individuals and institutions: Mr. Dean Spindler, Illinois DNR, for sending the DNR data. Dr. John Lohse. DOA, for providing yield data by field and year. Ms. Anna Sophia Johnson for suggesting that OSM invite me to make this report. And Mr. Emmons, OSM, and others for accepting her suggestion.

mined fields may satisfy the targeted crop yields, e.g., that post-mining deep tillage reduces soil compaction. Many of the public concerns require a broader assessment of the observed results of the farmland reclamation program in place in Illinois.

This report, focusing on prime farmland (PF) reclamation in Illinois, illustrates an approach to assessment that interested academics, citizens, mine operators, and regulators may wish to apply to assessing reclamation success of fields in the post-mining farmland reclamation program in Illinois (maybe to programs in other states, too). This approach to assessment is observational rather than experimental with several treatments and a control group. This method looks at the observed results of the farmland reclamation program in Illinois for many fields over many years and across numerous mine operators. It is data intensive. Fortunately, the Illinois Department of Natural Resources (DNR) and the Illinois Department of Agriculture (DOA) in the course of performing regulatory duties have collected most of the data needed to conduct such a study, and both departments supplied data. The data set consists of data on over 700 fields in the post-mining crop yield reclamation program in Illinois. Illinois started its Permanent Program of farmland reclamation in 1983, so the most complete data is for the 448 fields in the Permanent Program. For most fields the data include entries for the acreage, the year of final grading, the year of deep tillage, the years when yield testing occurred, the crop grown and tested the target yield and the average yield for each season the field was tested for crop productivity. Fields are not tested each growing season and are usually tested only enough seasons to reach the required number of passes in the approved crops (Appendix 1 summarizes the standards). The yield testing data aggregated over all the fields ever in the Permanent Program span the years 1985 to 1996 (latest available data).

I have chosen two measures of reclamation success: (1) the number of growing seasons before a PF field passes the requisite yield tests and (2) whether the field has passed the requisite yield tests by a PF field. The first, the number of growing seasons, measures the growing seasons elapsed from the year after final grading of the field to the year that the field satisfies the requisite crop yield targets or to the year 1996 if the field has not passed the requisite yield tests.

I approached the data set with several hypotheses in mind. Briefly, my hypotheses were that variation in both success measures depends on variation in and among the following factors: the compaction of the post-mined soils which, in turn, depends on the methods of sub-soil and top-soil replacement, the depth of deep tillage (if the field was deep tilled), the crop tested (beans, corn, hay, and wheat), growing conditions the year of yield testing, and whether the field is located in northern Illinois (young soil) or southern Illinois (old soil). I have not yet investigated whether fields tested for corn yield, for example, pass less frequently than fields yield-tested for more shallow rooted crops. The data do indicate that mining and reclamation practices account for more than 75% of the variation in reclamation success. The practical choices include the equipment for replacing the sub- and top-soils, the depth of deep tillage, and the number of seasons the mine operator grew a crop and tested it.

Natural History and Age of Soil

The surface geology and soil age of Illinois soils is the result of several episodes of glaciation during the Ice Age (Pleistocene). After the last glaciation, the Wisconsinan, winds deposited silt (loess), sometimes on territory beyond the reach of the glaciers. Loess, rich in calcium and possessing a high capacity to absorb water, is naturally fertile. Contemporary soils that developed from loess are extraordinarily productive and account for much of the farmland designated as prime farmland (PF) by NRCS. One effect of the Wisconsinan glaciation is that older, less fertile soils were replaced by soils that are younger (about 11,000 years old) and more fertile. Since the Wisconsinan glaciation did not reach as far south as the previous glaciation, the soils in southern Illinois are generally older (over 100,000 years old) and less fertile, (For this report I count Brown, Coles, Edgar, Fulton, Knox, Macoupin, McDonough, Peoria, and Schuyler as northern Illinois counties, and Gallatin, Jackson, Perry, Randolph, St. Clair, White, and Williamson as southern Illinois counties.[2]) Mine operators have worked Pennsylvanian-age coal deposits in both northern and southern Illinois. This natural history and the locations of mines raise the related questions: Is there a North-South difference in reclamation success of post-mined soils? Is reclamation success for prime farmland lower or higher than for the less fertile soils?

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[2] This geographical division of counties was suggested by Dr. John Lohse, DOA in a FAX dated Feb. 6, 1998.

Table 1 shows the North-South distribution of fields in the Illinois Permanent Program by productive capability. The classifications for capability or yield test liability for post-mining crop productivity are as follows: low capability (LC), high capability (HC), and prime farmland (PF). The first row of data in each cell gives the percentage of fields that have passed the requisite target yields for the required number of growing seasons and crops. The second row shows the average number of growing seasons for fields that have and have not passed the requisite yield tests. The third row counts the number of fields in each cell of the cross tabulation.

Table 1: Farmland Reclamation (% Passing and Seasons Elapsed)
Northern and Southern Illinois Fields by Yield Test Liability

	Yield Test Liability				
	LC	HC	PF	Total	
North	87.5	49.1	56.2	56.1	<-% Passing
	5.1	5.8	5.3	5.5	<-Avg. Seasons
	24	110	80	214	<-Count
South	20.0	45.3	16.3	37.6	
	6.7	6.0	6.7	6.2	
	15	170	49	234	
Total	61.5	46.8	41.1	46.4	
	5.7	5.9	5.8	5.9	
	39	280	129	448	

The following example illustrates how to count the seasons elapsed while a field is in the testing program. Suppose a mine operator contoured and graded Field 1 in 1988. then the field would have been eligible for crop testing in the 1989 growing season, If Field 1 passed the final required yield test in 1994, then it ‘required’ six seasons to pass the requisite tests and the reported average would reflect six seasons. Continuing the example, suppose that an otherwise similar field, Field 2, had not passed the requisite yield tests by 1996 (last year of data), then that field would have been in the Permanent Program without passing for a total of eight seasons, which the reported average would reflect.

```
  Final                                   Field 1 Passes
  Grading                                 3rd Yield Test
    ↓                                         ↓
1988   1989  1990                        1994        1996            Year
  |-----|-----|-----|-----|-----|-----|-----|-----|-----|--→        Time Line
  0     1     2     3     4     5     6     7     8     9           Season
        ↑                                         ↑
     First Season                            Last Available
     Fields 1 & 2 are Eligible               Data
     for Yield Testing
```

Table 1 supports the notion that there is a North-South difference. In northern Illinois 56% of the fields had passed the requisite yield tests by 1996, better than the 37.6% pass rate for southern fields. Further, 56% of prime farmland fields in northern Illinois have passed, while only 16% in southern Illinois have passed. While these results are interesting in themselves, they also require some additional investigation and explanation. For example, do the differences in the percentages depend upon the method of soil replacement, soil compaction, deep tillage, and so forth? Do the data, adjusted and controlled for these additional factors, reveal which mining and reclamation practices speed (or retard) reclamation? After adjusting for these factors, is there a North-South difference? These are among the interesting investigations to which this report turns.

Post-Mining Soil Compaction

Soil compaction in part depends upon the weight of the equipment used to replace and grade freshly replaced soil. In the process of re-depositing soil, for example, scrapers with their weight carried by tires inevitably compact much of the freshly deposited soil as the tires pass over it. Bulldozers, riding on tracks, spread their weight over a greater surface area and generally compact the soil less in the process of distributing and grading the redeposited soil. Table 2 indicates the method or equipment used to replace soil and the degree of compaction associated with the combinations of equipment used in Illinois.

Table 2: Soil Replacement Equipment and Soil Compaction

Soil Replacement Equipment			
Sub-soil	**Top-soil**	**Combination (Sub-/Top-Soil)**	**Soil Compaction**
AP Belt (Belt)	**ABC** Mix	Belt/ABC	Low
AP Belt (Belt)	Scraper (Scr)	Belt/Scr	High
Bucket Wheel Excavator (BW)	BW & Bulldozer (BWDzr)	BW/BWDzr	Low
Bucket Wheel Excavator (BW)	Scraper (Scr)	BW/Scr	Medium
Dragline (DrgL)	Scraper (Scr)	DrgL/Scr	High
Shovel (Shv)	Scraper (Scr)	Shv/Scr	High
Shovel (Shv)	Truck (Trk)	Shv/Trk	Low
Truck (Trk)	Scraper (Scr)	Trk/Scr	Medium-High
Truck (Trk)	Truck (Trk)	Trk/Trk	Medium

The highly compacted soils slow the percolation of water through the soil and impede root growth. Consequently, one expects that the percentage of fields passing the yield tests to be lower on fields with highly compacted soils and that highly compacted fields spend more growing seasons in the yield testing program. The evidence is mixed. Table 3 (previous page) shows in each cell the percentage of passing fields, the growing seasons elapsed in the yield testing program, and the number of prime farmland fields.

A comparison across soil compaction categories shows that prime farmland fields have passed the requisite yield tests less frequently than the non-prime fields (41.4% to 47.4% in the bottom rows labeled "Total"). Also, according to the middle (PF) column of Table 3 and confirming one hypothesis, only 15.8% of the high-compaction prime farmland fields passed target yields the required three years in 10 with at least one passing corn crop. The comparable pass rate for low-compaction PF fields is 84%. The difference in pass rates between the medium-compaction and medium-high-compaction cells in the PF column, while not as dramatic, fits the expected pattern.

Deep Tillage

Deep tillage is used to reduce soil compaction following soil replacement by heavy equipment. While mine operators have deep tilled about 42% of all fields in the data set, they have deep tilled only about 30% of the fields in the Permanent Program. According to Table 4, among the fields in the Permanent Program, operators have deep tilled a smaller percentage of prime farmland (PF) fields (27%) than high capability (HC) fields (35%). Mine operators with fields in the Permanent Program have not deep tilled low- and medium-high compaction fields, and they have not deep tilled low capability (LC) fields, regardless of the degree of compaction. It seems reasonable that mine operators rarely deep till low-compaction fields. Table 4 does, however, contain a surprise. A single mine operator accounts for most of the fields in the medium-high compaction group. This operator deep tilled only a handful of high capability (HC) fields and no prime farmland (PF) fields after using a truck to replace the sub-soil and a scraper to replace the topsoil. Since scrapers usually compact the soil to a high degree, what is surprising is that this operator has a high percentage of fields passing the requisite yield tests. (This surprise raises questions for further research: Is the data set lacking important information about this mine operator and the fields it mined? Is the medium-high compaction category flawed?)

Table 3 : Prime Farmland Reclamation (% Passing and Seasons Elapsed)
by Soil Compaction and Yield Test Liability

Compaction		not PF	PF	Total	
Low	66.7	84.8	80.0	<-% Passing
	5.6	5.3	5.4	<-Avg. Seasons
	12	33	45	<-Count
Med	44.4	50.0	44.8	
	6.7	9.5	6.9	
	27	2	29	
Med-High	61.6	41.7	55.0	
	4.1	5.3	4.5	
	73	36	109	
High	41.1	15.8	35.3	
	6.4	6.3	6.4	
	192	57	249	
Total	47.4	41.4	45.6	
	5.8	5.8	5.8	
	304	128	432	

As Table 5 shows, among the low-compaction fields that were not deep tilled one operator has passed 29 PF fields out of 34 (85%) and another has passed 15 never deep-tilled, medium-high compaction PF fields out of 36 (41.7%). One clear lesson is that high pass rates have been achieved on PF soils after the use of low-compaction soil replacement methods. As a result the pass rate is 42% for PF fields that were never deep tilled. By comparison, the pass rate for PF fields that were deep tilled was only 24%. The last result may be due to high soil compaction. Among the high-compaction PF fields, as expected, only those that were deep tilled passed (23%) the requisite yield tests, High-compaction fields account for 76 PF fields, slightly more than half of all PF fields. Of those 76 high-compaction PF fields, only 13% have passed.

Citizens in Knox County, Illinois have expressed a special interest in the restoration of crop yields on mined Ipava, Sable, and Tama soils, which are prime farmland soils. Investigating that specific issue is important and feasible; I may have the time to address it this summer. However, I can now report on restoration of yields in counties where mining has frequently disturbed Ipava, Sable, and Tama soils. These counties include Fulton, Knox, Peoria, and Schuyler. all north of the Illinois River. Table 6 (next page) indicates that four mine operators have mined 85 PF fields located in those counties. Of the high-compaction PF fields, two out of 15 (13%) had passed by 1996. Mine operator 11 used high-compaction soil replacement equipment and deep tilling, and had not passed a single PF field by 1996. On the other hand, operator 8 used low-compaction soil replacement equipment, never deep tilled, and has passed 85% of its PF fields. These observations raise an important policy question. Since the data can reveal the practices and mine operators that have passed a high percentage of PF fields and the practices and operators associated with failure to restore yields, should such results be used to deny new surface mining permits to operators with poor track records?

Table 4: Percentage of Fields Deep Tilled by Soil Compaction and Yield Test Liability

Compaction1	Liability LC	HC	PF	Total	
Low		0	0	0	<-% Deep Tilled
	0	12	33	45	<-Count
Med	.	40.74	50	41.38	
	0	27	2	29	
Med-High	0	0	0	0	
	18	55	36	109	
High	0	47.67	59.65	46.59	
	20	172	57	249	
Total	0	34.96	27.34	29.63	
	38	266	128	432	

Table 5 :Percentage of Passing Prime Farmland Fields by Soil Compaction and Deep Tillage

Compaction	No Till	Deep Till	Total	
Low	85.3		85.3	<-% Passing
	5.4		5.4	<-Avg. Seasons
	0.0		0.0	<-Median Till Depth[1]
	34		34	<-Count
Med	0.0	50.0	33.3	
	11.0	7.5	8.7	
	0.0	30.0	30.0	
	1	2	3	
Med-High	41.7		41.7	
	5.3		5.3	
	0.0		0.0	
	36		36	
High	0.0	23.3	13.2	
	6.8	6.5	6.6	
	0.0	48.0	30.0	
	33	43	76	
Total	42.3	24.4	36.9	
	5.8	6.6	6.0	
	0.0	48.0	0.0	
	104	45	149	

Table 6: Percentage of Passing Prime Farmland Fields in Fulton, Knox, McDonough, Peoria, and Schuyler Counties, Illinois by Firm and Soil Compaction

Firm ID	Compaction Low	Med-High	High	Total	
3	.	.	66.67	66.67	<-% Passing
	0	0	3	3	<-Count
5	.	41.67	.	41.67	
	0	36	0	36	
8	85.29		.	85.29	
	34	0	0	34	
11	.	.	0	0	
	0	0	12	12	
Total	85.29	41.67	13.33	54.12	
	34	36	15	85	

Variation in the Speed and Success of Mined PF Soils Satisfying Target Yields

The evidence presented in the cross tabulations indicate that soil compaction and deep tillage have an impact on yield restoration. Such cross tabulations are fine for showing that two variables may affect a third, but when three or more independent variables affect a dependent variable other methods may be less cumbersome and more powerful (if not as easy to digest). Therefore, I turn to multivariate analysis and the results from two multivariate regressions and two multivariate logits.

I used regression analysis to estimate how the first dependent variable, seasons elapsed until the field passes the yield tests or until 1996 (whichever came sooner), responds to several independent variables. Among them are variation in (1) soil compaction, (2) location (North-South), (3) deep tillage, (4) number of attempts to pass the field (which may measure in part the effort to pass the field), and (5) year or season the 10 year testing window opened for a field. The complete list of independent variables appears in Appendix 2 in column 1. The observations on each field were weighted for the acres actually cropped in that field; therefore, the regression results must be interpreted as seasons elapsed for an acre of prime farmland. Columns 2 and 3 contain the regression coefficients (t statistics in parentheses) and summary statistics, A blank cell indicates that the variable in that row was omitted from the regression analysis reported in that column.

In general a regression equation, with estimated coefficients A, B_1, B_2, B_3, etc., is useful for estimating or predicting the dependent variable (Y) given selected values for the independent variables (the Xs). An example of a regression equation in symbolic form follows:

$$est.Y = A + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + \ldots\ldots + B_mX_m$$

Each regression slope coefficient (each B) is the estimated magnitude and direction of response of the dependent variable to variations in the associated independent variable. Using the symbolic regression equation above, for example, the second slope coefficient B_2 reveals the expected magnitude and direction of change in the estimated dependent variable Y from a one unit change in the second independent variable X_2. Designating the symbol A to mean change, $B_2 = \Delta Y/\Delta X_2$.

As indicated by the F statistics and the R^2s near .79, the regressions reported in Appendix 2 in columns 2 and 3 fit the data for the 132 prime farmland fields about equally well. The error terms turned out roughly normal, and the coefficients have reasonable signs. For those interested in statistical significance, the coefficient t statistics appear enclosed in parentheses below the coefficients in columns 2 and 3. Using the estimated coefficients from column 3, I constructed the following regression equation:

Est.Seasons = 4.15 - .74*LowCompaction + .67*Med.Compaction
+ l.O8*HighCompaction - .59*North - .026*Depth + .37*Attempts
+ 1.O9*DuetoDeepTill - .516*NewWindow

The intercept coefficient suggests that the average acre of prime farmland would spend about four years in the testing program were it not for the effects of soil compaction and the other variables. The results for the policy relevant variables are highlighted next.

Low Compaction: Other things the same, an acre oflightly compacted prime soil has spent about nine months (3/4 year) less in the testing program than more compacted acres. This result does not necessarily mean that low-compaction acres passed nine months earlier than more compacted acres. The results in Table 3 are consistent with the results of the regression analysis.

High Compaction: Other things the same, an acre of highly compacted prime soil has spent about one year longer in the testing program.

Northern Illinois Location: Table 1 implies that an average northern Illinois PF field has spent 5.3 seasons in the testing program and that its southern analogue has spent 6.7 seasons, a difference of 17 months. This result is driven in part by the success achieved by operator 8 on low-compaction soils. The regression analysis, adjusting for the effects of compaction, depth of tillage, and other independent variables, implies that an acre of prime farmland spends about seven months less than its southern analogue in the testing program (one tail P value = 0.07).

Depth of Deep Tillage: This coefficient may seem small (-.026). but it has important policy implications. The coefficient indicates that PF acres deep tilled to a depth of 48 inches (a DM1 for example) have spent about l-1/3 fewer seasons in the testing program (-0.02655*48 = -1.27 years off the years spent in the testing program). The other regression reported in column 2 indicates that deep tillage in general reduces the seasons elapsed by about 1.3 years. Since the DNR does not allow yield testing the season following deep tillage, deep tillage adds one full season to the dependent variable. So the net gain from deep tillage for an average acre of prime farmland works out to about l/3 year or about four months.

Attempts: This variable (I hoped) would measure operator effort to pass a field. It is highly positively correlated with the dependent variable, which rises by one each season a field is in the Permanent Program whether or not it is tested. A better measure of effort is needed. I have experimented with an 'effort' variable constructed by dividing Attempts by the number of Seasons a field has been in the Permanent Program. Although not reported here, the estimated coefficient for the constructed variable is negative as expected.

Seasons Elapsed Due to Deep Tillage For a deep tilled field this variable accounts for and controls for the seasons after final grading spent marking time in the testing program. The time line illustrates the final grading, deep tillage, and yield testing story for one hypothetical field. In the illustration, the field spends five growing seasons in the Permanent Program without passing all the yield tests and is deep tilled at the end of the fifth season; so the seasons elapsed before deep tillage is equal to live. The deep tillage triggers the start of a new 10 year testing window, and the DNR does not allow testing the first season after deep tillage (season 6). Suppose the hypothetical field passes the three required yield tests during seasons 7 through 10. Deep tillage at the end of season 5 actually means that six of the 10 seasons this field needed to pass were just marking time and pushing upward the dependent variable, The estimated coefficient for this variable, therefore, should equal or be very close to one, which at 1.09 it is.

```
Final     1st 10 Year           Deep       New 10 Year
Grading   Win&w  Opens          Tillage    Win&w  Opens
   ↓        ↓                     ↓           ↓
   |-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--→ Time Line
   0     1     2     3     4     5     6     7     8     9    10    Season
         ↑                             ↑     ↑                ↑
      First Season                    No   Field again       Field Passes
      Field is Eligible          Testing   Eligible for      3rd Yield Test
      for Yield Testing                    Yield Testing
```

New Window: This variable is the year the DNR opened the first 10 year testing window or opened a new window if a field had been deep tilled. Prime farmland must pass three yield tests in a 10 year window. The closer in time this opening was to 1996, the fewer the seasons available for a field to pass the three required yield tests. The further back in time the 10 year testing window opened for a field, the greater the number of opportunities that field had to pass three yield tests. The negative estimated coefficient seems reasonable.

I used logit analysis to estimate the Pass/Fail response of PF fields to variation in (1) soil compaction, (2) the location (North-South), (3) deep tillage, (4) the number of attempts to pass the field (which may measure in part the effort to pass the field), and (5) the year or season the 10 year testing window opened for a field. The observations on each field were weighted for the acres actually cropped in that field; so the logit results must be interpreted in terms of the probability of an acre passing the yield tests. Columns 5 and 6 in Appendix 2 contain the logit coefficients (t statistics in parentheses) and summary statistics.

In general a logit equation, with estimated coefficients A, B_1, B_2, B_3, etc., is useful for estimating the probability of an event, such as passing the three yield tests in a 10 year window, given selected values for the independent variables (the Xs). An example of a logit equation in symbolic form is:

estimated probability of passing all tests = $P = 1/(1 + e^{-Z}) = 1/(1 + \exp(-Z))$, $e \cong 2.7183$ and

estimated logit $Z = A + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + .. + B_mX_m$

Each logit coefficient (each B) is the estimated magnitude and direction of response of the logit variable Z to variations in the associated independent variable. Using the symbolic logit equation above, for example, the third coefficient B_3 reveals the expected magnitude and direction of change in the estimated Z from a one unit change in the third independent variable X_3. That is, $B_3 = \Delta Z/\Delta X_3$. However, the estimated probabilities (P) are non-linearly related to the coefficients (Bs) and the independent variables (Xs).

As indicated by the high χ^2 statistics and the low rates of false negatives and false positives, the logit analyses reported in Appendix 2 in columns 5 and 6 fit the data for the 132 prime farmland fields quite well. The coefficient t statistics appear enclosed in parentheses below the coefficients in columns 5 and 6. Using the estimated coefficients from column 6, I constructed the logit Z equation below and the equation for predicting changes in the probability of an acre passing:

est.logit Z = -2.54 + 1.27*LowCompaction - 2.93*Med.Compaction - 5.7*HighCompaction

- 1.87*North + .13*Depth + 5,4*Effort - .63*NewWindow

$AP = (P - P^2)*B*\Delta X = (p - P^2)*\Delta Z$, where P is the average pass rate for PF acres = .3623

The logit and regression results are generally consistent in the sense that the variables associated with reductions in the number of seasons taken by an acre to pass the yield tests are also associated with higher probabilities of passing the yield tests. Before concluding I highlight the logit results for several policy relevant variables.

Low Compaction: Other things equal, <u>low soil compaction raises the probability that an otherwise typical acre of prime farmland passes the yield tests from .3623 to .6557.</u> $AP = (.3623 - .3623^2)*1.27*(1) \cong .29$.

Northern Illinois Location: Table 1 reports that the percentage of northern Illinois PF fields having passed the yield tests is 56%, much higher than the 16% pass rate for southern PF fields. This implies that northern fields have a higher probability of passing. On the other hand the logit analysis, adjusting for the effects of the other independent variables, implies that a northern PF acre has a lower probability of passing the tests. AP $= (.3623 - .3623^2)*(-1.87)*(1) \cong -.432$. The one tail P value is 0.11. This result reflects the impact of the other independent variables as well as the poor showing by firm 11 (Table 6).

Depth of Deep Tillage: The estimated coefficient is statistically significant and implies that increasing the depth one inch increases the probability of passing by 0.03 $= (.3623 - .3623^2)*(-.131)*(1)$.

Conclusions

I have reported on an observational study of what actually happened or, at least, of what was recorded by DNR and DOA. The reported results summarize years of experience for PF fields in the Illinois Permanent Program. When I started, I expected to find that very few PF fields had passed the yield tests. I found, instead, that about 41% of the PF fields had passed the three yield tests in the 10 year liability period. The 41% is still disappointingly low, but the pass rate is higher than I expected. My results, based on observational data, confirm what other studies using experimental data have shown. The policy relevant results include: Low compaction methods of soil replacement and grading reduce the seasons elapsed by a PF acre in the testing program by about nine months and increase the probability of passing the tests by .29. High compaction methods add at least one season elapsed in the testing program. Deep tillage increases the probability of PF fields passing the yield tests and shortens the time to passage by about one year. Such results give state and federal regulators, concerned citizens, and mine operators an opportunity to assess this important regulatory program in ways not possible without comprehensive data. All parties may check the results of this observational study against what they expected based on their experience and the results reported from, for example, controlled experiments done at agricultural research stations, Is the response of PF fields to compaction more or less than expected? Is the response to deep tillage more or less than expected? Which mine operators are least successful at passing fields? Why? Which are the most successful? Why? Do the results suggest modifications to mine and regulatory practices?

Because I have not explored the entire data set (in particular the average yields per acre for each field) and because parts of the data set are incomplete, I urge that the results reported here be treated as preliminary. Much remains to be done and can be done. I intend to ask the DNR and DOA for more information in order to complete the data set before I re-edit it for accuracy. After completing the work started in this report, I intend to investigate how pass rates varied by crop, compaction, and deep tillage as well as how yields varied with location, compaction, deep tillage, and so on. When I'm done, I hope that the results of these future investigations, like the results reported here, will provide useful information to mine operators and regulators-information that helps them to make better decisions in pursuing the goal of restoring mined farmland to pre-mining crop productivity.

Appendix 1

Required Number of Passes in 10 Seasons and by Crop

		Number of Required Seasons Passing Target Yields by Crop			
Capability/Liability of Soil in Mining Permit	Total Required Passes in 10 Seasons	**Corn**	**Beans**	**Wheat**	**Hay**
Prime Farmland PF	3	1 or more	at most 1	at most 1	at most 1
High Capability HC	2	1 or more	no limit	at most 1	at most 1
Low Capability LC	2	no limit	no limit	no limit	1 or more

Deep Tillers and Till Depths

Deep Tiller	Till Depth Range
DM1	48"
DM2	48" +
DM3	30"
DMI-TIGER2	18"
HDT	30" to 36"
MURAY	24" to 30"
RKP	24" to 30"
RM1	36"
STING	48"
TALON	30"
TLG12	30" to 36"

Appendix 2

Regression and Logit Results					
(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	**Regression Coefficients**		**Dependent Variable**	**Logit Coefficients**	
Seasons elapsed to Pass or to 1996			Indicator variable for Pass		
(1)	(2)	(3)	(4)	(5)	(6)
Independent Variables			**Independent Variables**		
intercept (t statistic)	3.5683 (11.100)	4.1483 (7.996)	same as in column 1	-2.871627 (-1.515)	-2.54056 (-1.452)
indicator variable for low compaction	-.73823 (-2.772)	-.73993 (-2.798)		1.203873 (1.563)	1.271279 (1.775)
indicator variable for medium compaction	1.7241 (3.200)	.672479 (0.939)		-5.622442 (-2.872)	-2.93286 (-1.335)
indicator variable for high compaction	1.66451 (5.862)	1.07737 (2.268)		-7.445314 (-2.872)	-5.705677 (-2.537)
indicator variable for northern Illinois field		-.58708 (-1.459)		-3.303361 (-1.815)	-1.875454 (-1.242)
indicator variable for deep tillage	-1.29222 (-2.725)				
depth of deep tillage in inches		-.02655 (-2.281)		.0940637 (2.032)	.1315627 (3.302)
attempts by operator to pass field	.37125 (4.552)	.37337 (4.595)			
attempts to pass divided by seasons elapsed				7.694291 (3.465)	5.396401 (3.024)
years elapsed due to deep tillage	1.09202 (8.534)	1.099067 (8.583)		1.073245 (2.554)	
season 10 year window starts	-.51627 (-9.835)	-.516093 (-9.992)		-.7731305 (-4.092)	-.6282835 (-3.987)
Summary Regression Statistics			**Summary Logit Statistics**		
(1)	(2)	(3)	(4)	(5)	(6)
number of observations	132	132		132	133
degrees of freedom	124	123			
F statistic	71.11	63.35	χ^2	95	88.04
P value for F statistic	0.0000	0.0000	P value of χ^2	0.0000	0.0000
R^2	.8006	.8047			
Adjusted R^2	.7893	.7920	Pseudo R^2	.5351	.4919
RMSE	1.0854	1.0785	specificity = 100 - %false neg.	83.65%	85.15%
			sensitivity = 100 - %false pos.	80.29%	81.4%

Bibliography

Darmstader, Joel, "Productivity Change in U.S. Coal Mining," Discussion Paper 97-40, Resources for the Future, Washington, DC.

Fehrenbacher, et. al., "Soil Productivity in Illinois," College of Agriculture, University of Illinois at Champaign-Urbana, 1978.

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