Challenges to Mining Coal in the Midwest

By

Vance Patrick Wirams Manager

Environmental Services Group
AMAX COAL COMPANY
Indianapolis, Indiana

Introduction

As with the rest of the nation's coal industry, coal mining in the Midwest has emerged into the 1980's as a dynamic, sophisticated business. The industry has undergone exponential changes over the past decade in order to keep pace with and survive the on-slaught of environmental, regulatory, and commerce demands. Survival and future success are assured as long as the industry continues to diligently pursue new challenges and seek realistic, cost effective solutions which are proven applicable to achieving the desired goal of mining coal in a profitable and environmental sound manner.

Since enactment of PL95-87 the Surface Mine Control and Reclamation Act of 1977, operational procedures have undergone considerable changes in response to subsequent regulatory performance standards. An analyses (pros and cons) of all the various changes and related impacts go beyond the scope of this endeavor. The primary purpose of this paper however, is to highlight current mining in the Midwest and focus attention on changes and significant challenges facing the coal industry as a result of the new regulatory requirements. These challenges are discussed relative to industry's ability to meet them.

To set the stage for discussing Midwest Coal mining activities and related challenges, preliminary background information on the physical and cultural setting, geologic framework, and coal mining methods and production is provided. As a matter of clarification, the terms, Midwest and Illinois Basin are used interchangeably throughout the text. For purposes of geographic orientation, the Midwest includes the three states of Illinois Indiana, and Kentucky. Portions of each state contain coal reserves of the Illinois Basin formerly called the Eastern Interior Coal Province.

Topography & Land Use

Roughly three-fourths of the land surface of the Illinois Basin is flat-lying. The level land reflects the influence of former glaciation. Practically all coal in Illinois and Indiana is overlain with glacial tills (drift), loess (wind-blown silts) and other glacial related surficial deposits. Topographic relief within the glaciated sections is attributed to glacial features (i.e. terminal and recessional moraines, etc.) and present surface drainage. For the driftless, or unglaciated areas of southern Indiana, Illinois, and all of Western Kentucky, the topography is characterized by rolling hills interrupted by occasional rock outcrops and bluff-lined rivers and streams.

The primary land use in the Midwest is agriculture. For example, in Illinois, cropland and pasture account for 77 percent of the land use designations (Nawrott et al., 1982). The remaining land uses consist of forest, urban, and other lands, including small water areas. Forest and pastureland are the predominant land uses in the shallower soils common to the southern part of the Basin.

Geologic Framework

The coal reserves of Illinois, Indiana and Western Kentucky are associated with the spoon-shaped, geologic structure known as the Illinois Basin. Younger age coals outcrop toward the Basin's center while older coals outcrop along its perimeter. In glaciated areas, the coal outcrops are actually hidden beneath the glacial deposits. Coals in Indiana dip to the southwest while those in western and northern Illinois dip to the southeast. Western Kentucky coals dip to the north toward the center of the Basin.

The coals and associated strata are of Pennsylvanian Age and can be correlated time wise with coals of the Appalachian Coal Region. The coal and associated stratigraphy were deposited in alternating deltaic and shallow marain environments. Major deposition was from the northeast being dominated by many prograding and shifting delta lobes of a former river system (Rice, C. L., et al., 1979). A system similar to our modern day Mississippi River-Gulf of Mexico complex.

In the northern half of the Basin.. it is not uncommon to encounter 40 to 50 feet of glacial till in the highwall. Where pre-glacial valleys have been backfilled with glacial deposits, drift thickness has been observed to exceed 120 feet. Wind-blown silt (loess) deposits provide the final "icing on the cake" atop the drift. The majority of soils developed within the region have developed from the loess. Such soil genesis is the primary reason for the area's high agricultural productivity. The loess derived soils have excellent moisture holding capacities for growing crops like corn and soybeans.

Method(s) of Mining and Coal Production

Both underground and surface mining methods are used in the Midwest. Shaft and slope mines extract coals to depths of 800 feet in the deeper parts of the Basin. Three methods of surface extraction include area mining (commonly referred to as "strip mining") contour mining and auger mining. By far, the majority of surface operations involve the area mining method. For larger operations, it is not uncommon for life-of-field reserves to exceed 5,000 acres. Contour surface mining is restricted to the more hilly sectors of the Basin, in particular, southern Illinois, Indiana and Western Kentucky.

In terms of total coal production, in 1982, the coal fields of the three (3) states produced over 220 million tons of coal. If one considers the coal production of Western Kentucky to account for 25% of the State's total, then in 1982, coal produced from the Illinois Basin amounted to well over 130 million tons. The majority of coal produced is high volatile, bituminous coal used primarily for stream generation. The following is a breakdown of coal production on an individual state basis.

In Illinois, there are 22 minable coal seams ranging in thickness from 24 inches to 9 feet. By far, the most productive (current and future) coal seams are the Herrin (No. 6) and Springfield (No. 5). Of the remaining 181 billion tons of minable reserves in Illinois, these two seams account for over 70% of the state's reserve. At present, underground mining accounts for 58% of the state's total coal production. Certainly in the future, the per-cent of coal extraction by the underground method will increase over surface production (Ewert, et al.,. 1983).

There are 31 known coals seams in Western Kentucky. Of the 31 seams, less than 20 have been mined to any significant extent. The minable seams range in thickness from 24 inches to 12 feet. The two most prominent coals seams are the Springfield (Western Kentucky No. 9) and the Herrin (Western Kentucky No. 11). Both seams correlate with the Indiana and Illinois Herrin and Springfield coals. Presently over 45% of Western Kentucky coal production is underground. As with Illinois* future coal development will significantly increase underground tonnage as efforts are made to extract the deeper coals. Estimated coal reserves remaining in Western Kentucky are 45 billion tons.

Within Indiana, there are 22 recognized coal seams. Of the 22, four (4) seams account for 90% of the state's production and 85% of its future coal resources. The four (4) seams are: Danville (VII); Herrin (VI), Springfield (V), and Seelyville (III). The seams range in thickness from 18 inches to 9 feet. The Seelyville Coal correlates with the Davis and Dekoven seams of both Kentucky and Illinois. The Danville (VII) correlates with the Illinois Danville (No. 7) and Western Kentucky Baker (No. 13). Contrary to both Illinois and Kentucky, 98% of all coal mined in Indiana is by area surface mining. The shallower reserves in Indiana make surface mining a more attractive economic venture. However, future reserves in the state will require underground development. At presents there exists an estimated 16.5 billion tons of minable coal reserves in the state.

Industry Challenges and Current Status

The laundry list of challenges facing the nation's coal industry is exhaustive. On the one hand, many challenges among coal provinces are quite similar, on the other, each coal region faces its own set of circumstances, concerns, and problems. In the remainder of this papers focus of attention will be drawn to those challenges that specifically relate to mining coal in the Midwest.

Significant challenges to mining coal in the Midwest are: 1) Hierarchy of land use designations; 2) Prime farmland (PFL) and high capability land soil reconstruction; 3) Surface drainage control and restoration; 4) Acid-toxic overburden and coal waste; and 5) Geologic stability controls. Each category mentioned has substantial economic impacts on any given surface mine operation. Failures related to each can lead to undesirable impacts and costly long-term liabilities. In many instances, however, the potential exists for minimal environmental impacts and long-term, cost effective benefits to the mine site and surrounding areas. A brief highlight of each challenge including both a definition and status report follows.

Hierarchy of Land-Use Designations

Throughout the Illinois Basins cropland is generally considered the highest and best use by surface owners and planning and regulatory agencies. A loss of cropland acres as a result of surface mining is frequently inconsistent with land use policies. Current state and federal regulations reinforce such policies by requiring the coal operator to restore land to conditions capable of supporting the premining land uses.

For surface minable coal reserves underlying relatively flat to gently rolling land* such requirements spell significant financial impacts. The problem becomes further complicated if the soils involved are prime farmland. For such conditions, locations of post-mining box-cut spoil and final impoundments become crucial elements to the mine plan. A very important economical factor to be considered in such a situation is the potential inability to replace all the post-mine cropland acreage, thus requiring expensive box-cut pre-benching and final pit backfilling.

In order to adequately plan surface mine operations to minimize the cost impacts of the land use requirements, detailed evaluations of long range (life-of-mine) plans and exhaustive mine plan analyses are essential. By defining conditions well in advance, through mine scenario analyses, the most cost effective and environmentally acceptable mine plans can be generated.

Prime Farmland and High Capability Land Reconstruction

Planning prime farmland and high capability land reclamation is a formidable challenge since it involves moving entire farm fields without reducing crop productivity. America has never before been faced with the problem of moving 40 acre corn fields and achieving field restoration of crop productivity within a reasonable time frame. There exist three (3) concerns involved with restoring crop productivity. The primary concern is that of compaction of the replaced soil materials (Ralston, 1982). Second, is minimizing differential settling and third is the identification of methodology for a fair means of comparing pre and post-mining yields. To summarize the overall challenge, we are involved with a very complicated, emerging science and technology of which the primary objective is to develop methods capable of alleviating the adverse effects of soil reconstruction.

Since early 1976, considerable strides have been made toward achieving soil reconstruction goals. University of Illinois research in cooperation with the industry has identified the key limiting factors to restoring crop yield. Efforts are now underway to minimize or eliminate the limiting factors. Alternatives to mining procedures and reclamation equipment are being evaluated. Belt systems, and end dump trucks in conjunction with major stripping equipment have been effective in reducing compaction. AMAX's approach to deep tillage amelioration of replaced soils coupled with grass-legume vegetation show real promise toward restoring crop productivity following mining. Land leveling coupled with good water management practices reduce the time necessary in meeting reclamation goals. The combination of good surface drainage and good internal soil drainage will provide an excellent root zone for crops.

Surface Drainage Control and Restoration

Diversion of surface drainage away from an active pit of any area surface mine has been and will continue to be standard operating procedures. For Midwest mining however, with implementation of federal and subsequent state permanent programs, surface drainage both pre and post-mining has blossomed into a major challenge. The problem is further complicated with the stream buffer zone requirements. Practically every stream, (all but the smallest streams, i.e. ephemeral streams of 1-3 square miles watershed), regardless of watershed size or flow regime requires special handling and restoration treatment following mining. Of major challenge to the industry is the reconstruction aspects of permanent diversion and stream relocations.. in particular, those which are relocated behind the active operation through reclaimed mine land (Thompson, 1983). For such features concern for long-term stability,, wildlife and aquatic restoration, and overall hydrologic balance arise. Although methodologies in stream design and habitat restoration have been around for sometime, their application and implementation are rather new to the industry. Therefore, time and experience will combine to enable the industry to meet restoration goals.

In response to this particular challenge, the direction has been clear that detailed planning on a life-of-mine scale is crucial to survival of surface mining in the Midwest. Much time and energy have been devoted to planning all surface drainage well in advance of mining. Coupled with the planning aspect, in-depth stream analyses of pre and post-mine conditions are underway to better equip AMAX Coal in meeting goals of aquatic and wildlife habitat restoration. The construction of meanders and riffles, installation of habitat improvement structures (i.e. wing deflectors, boulders, log structures, etc.) and incised pools, and the establishment of riparian vegetation show real promise in meeting the challenge. The data generated from the aquatic stream surveys support such conclusions.

Acid-Toxic Overburden and Coal Waste

By far, the greatest contributors of acid mine drainage (AMD) in the Illinois Basin are the numerous pre-law (PL95-87) abandoned gob piles, slurry ponds, and unreclaimed spoils and not active operations (underground and surface). For example, in Indiana alone, there currently exist over 600 abandoned coal processing waste (slurry and gob) sites and 10,000 acres of spoils which have contributed to the development of over 425 miles of acid streams and 900 acres of acid lakes (Snellenberger.. communications; 1984). Similar situations exist in both Illinois and Kentucky. Hopefully within the next 5 to 10 years, Abandoned Mine Land (AML) Programs in the respective states will drastically reduce the environmental impacts of AMD. Although concerns remain for current mining activities due to the ever present potentials for creating undesired acid problems, new laws and regulations and corresponding improved mining and reclamation techniques have minimized and will continue to prevent the creation of unmanageable AMD problems.

As expected, when dealing with disposal of coal processing waste, especially coarse refuse (gob), the potential always exists for developing undesired AMD problems. This is particularly true for waste handling associated with underground mining. Above surface drainage disposal and limitations of adequate cover material to bury coarse refuse increase AMD potentials for underground operations. The comprehensive regulatory requirements addressing performance standards involved with handling and disposal of coal processing waste reflect overall concerns for such materials.

As for active pits and associated reclaimed lands related to surface mining activities, concerns for AMD exist due to the presence of acid-bearing overburden/interburden and overall hydrologic balance obligations. However, because of current mining and reclamation practices, types of materials involved, and burial depths below normal surface drainage and groundwater levels, AMD does not pose a serious threat to the environment. This does not mean that existing surface mines are exempt from encountering situations involving AMD. To the contrary, prolonged exposure of acid material in the pit and associated spoils can lead to temporary AMD problems. However* such problems are manageable and can be treated prior to discharged off the mine permit boundary.

The major challenge or problem associated with acid-toxic overburden in the Midwest is related more to revegetation concerns rather than water. In particular real concerns arise over appropriate cover and treatment techniques for acid "hot spots" in the graded spoil prior to root media and/or topsoil replacement. Because of the emphasis on agriculture, replaced soil materials must be capable of sustaining its intended land use. Acid materials left in the rooting zone of reclaimed lands pose a threat to meeting productivity goals following mining.

In response to challenges associated with acid-toxic overburden and coal processing wastes several things are underway in the Midwest. From the standpoint of coal waste handling, efforts are being made to bury gob below projected post-mining water table levels either in the active pit or depression areas (i.e. abandoned inclines, pits, etc.) in the spoil. At a minimums all such coarse refuse is buried and covered with four (4) feet of suitable materials.

Regarding slurry or fine coal refuses exciting and promising approaches are being pursued in the area of slurry pond reclamation. Attempts are being made at developing "wetland habitats" out of former slurry impoundment areas as well as demonstrating select fractions of slurry to be suitable substitutes for soil replacement. Studies are underway to evaluate existing slurry circuits systems to assess their total acid generation potentials and impacts on the surrounding areas. Many slurry systems are alkaline in nature and can be converted to "wetlands" as well as other land uses following final use. Such an approach is cost effective and has long term benefits from an environmental standpoint. Thus, a potential liability can be converted into a viable resource.

Regarding handling potentially acid-overburden encountered in a surface operation, efforts are being made to selectively remove and deeply bury identified strata where feasible with the major stripping equipment. For areas blessed with an abundance of calcium carbonate-rich glacial tills and/or alkaline shale materials, co-mingling efforts during stripping are more than adequate to minimize and/or prevent development of acid conditions. For operations involving double seam mining, co-mingling capabilities are limited thus leaving an operator to pursue various cover and/or treatment options of the graded spoil.

For acid waters encountered in the pit during mining, standard AMD treatment techniques and/or combinations are applied. Treatment methods Include, anhydrous ammonia, sodium hydroxide, soda ash, and finely crushed limestone and lime slurries. Use of SLS detergent sprays to Impede acid production during consequent pit exposures offer the Midwest an opportunity to mitigate acid problems during mining.

Geologic Stability Controls

The last challenge to be addressed relates to stability concerns in mining and reclamation. The three basic categories of concerns are: slope; 2) foundation; and 3) erosion. Although the categories are not unique to the coal mining industry, in general, the geologic/hydrologic properties and subsequent behavioral and control characteristics of Midwest overburden conditions make for unique mine planning and operational considerations. In many instances, the success of an operation in the Midwest is dependent on how well the coal operator understands and works the geologic stability controls during mining.

The majority of surface mining in the Midwest encounters an abundance of unconsolidated overburden materials. The unconsolidated section of the overburden varies considerably from site to site. In certain areas, the section may consist almost entirely of well indurated., high strength glacial tills posing minimal concerns for stability to mining. Other areas, however, may have similar tills interstratified with saturated sand and gravel lenses which can generate unstable "back sapping" conditions in a given highwall situation or side-slopes of a permanent stream relocation. Still further, the entire unconsolidated section of the overburden may consist of very low strengths lacustrine (lake) and/or fluvial (river) deposits which can play havoc to overburden handling and coal recovery. When dealing with stripping equipment that weighs over 15.6 million lbs., foundation stability factors are a prime concern to the overall safe and efficient use of the equipment. The stacking and subsequent slope stability characteristics of the unconsolidated materials have far-reaching impacts on both immediate and long-term success of mining in the Midwest. Major costs involved with safety considerations and spoil rehandle can drastically narrow margins of profit. Regulatory reclamation obligations requiring safe and stable lands and permanent structures (i.e. final impoundments, stream relocations.. end and box-cut outslopes, roads, etc.) can pose a real challenge to an operator when overburden conditions encountered involve thick sequences of low strengths unconsolidated materials.

Although most of the unconsolidated section compliments cropland restoration, some of the materials used, in particular loess and lacustrine deposits, are some of the most erosive materials in Therefore, such materials present special problems relative to foundation stability as well as overall erosion stability of reclaimed land. From the standpoint of erosion stability, exposed unconsolidated materials warrant immediate protection involving both quick revegetation and surface water control following reclamation.

To meet the challenges posed by stability factors in Midwest mining, considerable pre-planning exercises are essential. First and foremost, pre-mine overburden characterization must include evaluation (in-depth) of both the unconsolidated and bedrock sections of prospective highwalls. Soil and geotechnical characterization is just as important as a geochemical emphasis. Once characterization is complete, mine plan analyses involving stripping equipment selection, stripping/spoiling procedures, and blasting schemes can be evaluated in light of the geologic restraints and desired reclamation objectives.

From the standpoint of erosion control, rainulator and rainfall simulation studies have documented the erosion characteristics of replaced soils (Mitchell, et al., 1983). Basic conclusions reinforce the need for quick revegetation establishment as the primary goal toward minimizing impacts of erosion in the Midwest. Further, the studies emphasize the importance of interrupting slope lengths and allowing for controlled surface drainage off reclaimed lands. As a response to the study findings, industry Is implementing various erosion control techniques including terrace and downdrain structures. Further, considerable attention is being given to mulching practices to influence speedy revegetation establishment and control erosion during the interim.

Conclusion

From challenges addressed here, one can see that attempts have been made to identify key concerns or factors which currently impact or have the potential for making significant impacts on the desired goal of mining coal in a safe, profitable, and environmentally sound manner. Improved mining technology has evolved over the last decade in direct response to changes in environmental and regulatory emphases. Progress is being made toward finding realistic, workable solutions to current challenges. Because coal mining is a dynamic process with variables changing on a day to days site-to-site basis, however, the industry should never relax its vigilance for projecting, tracking, and ultimately minimizing or preventing potential problem areas. Industry's goal should be to eliminate any problem that detours mining activities from their common goal. Through in-depth pre-planning analyses and continuation of research efforts and studies* the industry should continue to develop the needed technology to meet tomorrow's new challenges and gather tomorrow's rewards.

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