Green Lands
West Virginia Mining
& Reclamation Association
1624 Kanawha Blvd. East
Charleston, WV 25311

Address Correction Requested

Bulk Rate
U.S. Postage
PAID
Permit No. 1
Ravenswood, WV

BEN B. FAULKNER
RT 1 BOX 673
PRINCETON WV 24740

Green Lands

Spring 1992


A HELPING HAND.
FROM START TO FINISH.
AMERICA'S ENERGY AGENCY
We know the coal business! We have the markets and the expertise to do the job. From start-up to the final reclamation project, we make it our business to know your business, inside and out.
We have specialists who can lend valuable assistance in a variety of areas including the all-important reclamation bonds.
If you are in the coal business and need an agent that can give efficient and professional service to your reclamation bond needs, then you should be doing business with Flat Top Insurance.
Flat Top Insurance
MORGANTOWN, WEST VIRGINIA • 304/598-3660
BLUEFIELD, WEST VIRGINIA • 304/327-3421
CHARLESTON, WEST VIRGINIA • 304/346-0414
PRINCETON, WEST VIRGINIA • 304/425-2176
WEST VIRGINIA • VIRGINIA • TENNESSEE • KENTUCKY

Green Lands

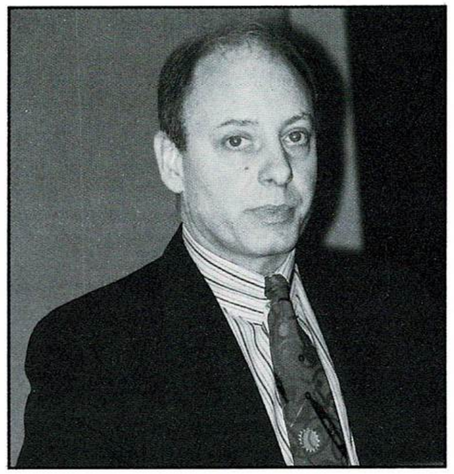
Volume 22 Number 2

Green Lands
is a quarterly publication of the
West Virginia Mining & Reclamation Association,
with offices at 1624 Kanawha Boulevard East
Charleston, West Virginia 25311
(304) 346-5318

Our Cover
Geupel Construction Co. won the 'Callaghan Award' for the outstanding reclamation performance of 1991 with its Logan Airport project. The cover story begins on page 16.

Index to Advertisers

Don Cussins - WVMRA Chairman



John Woodrum - Smith Hennan & Althen

Wayne Lowry - Juliana Mining Co.

Once again, record attendance

19th West Virginia Mining Symposium

The 19th edition of the West Virginia Mining Symposium broke another attendance record this past January, drawing a crowd of more than 700 to the Holiday Inn Charleston House for the "most informative two days in the mining industry."

The symposium got off to an informal start on Wednesday afternoon with a workshop session on ownership and control issues. On Thursday, Chairman Don Cussins officially welcomed a packed house for the morning session, which got off to a rousing start with a presentation by Dr. Stuart McGehee titled, "Why History is Wrong About Coal."

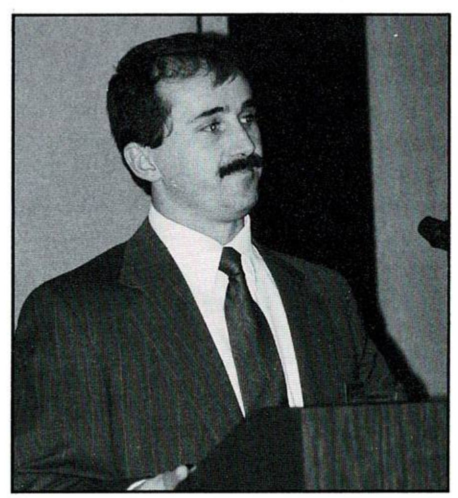
Following reports on fly ash disposal, the NPDES program and Senator Jay Rockefeller's UMWA-BCOA bailout bill, the session ajourned to the Mountaineer Guardian Awards Luncheon (see page 9), where Director Steve Webber of the newly created Office of Coal Miners' Health, Safety & Training distributed safety awards to 37 mining operations, representing more than 300 million tons of fatal free production.

The afternoon session included a panel of experts on equipment innovations for the '90's, followed by a legislative report and the traditional evening reception for state legislators.

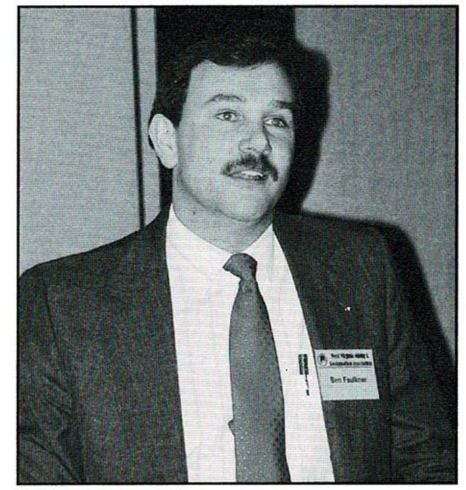
Friday's wrapup session featured acid mine drainage treatment innovations, a presentation from the Wild Turkey Federation, new bonding procedures, a report from OSM on the agency's perspective of West Virginia's revamped regulatory agencies, and New DEP Director Dave Callaghan, with a panel of his key personnel and an open discussion of what to expect from the state in coming months.

The 19th Symposium closed with the annual Reclamation Awards Luncheon (see page 16,) where Callaghan presented awards to 16 companies for their outstanding mining and reclamation accomplishment in 1991.

Ben Elkin - Juliana Mining Co.

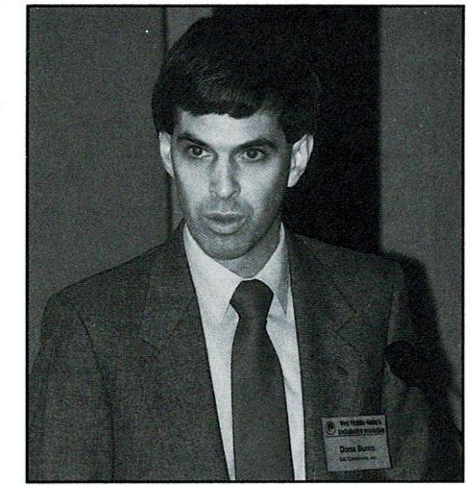


Jeff Hoops - ACR Service Corp.

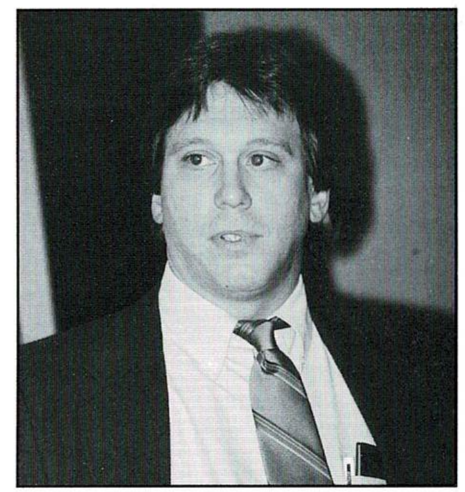


Ben Faulkner - Environmental Consultant

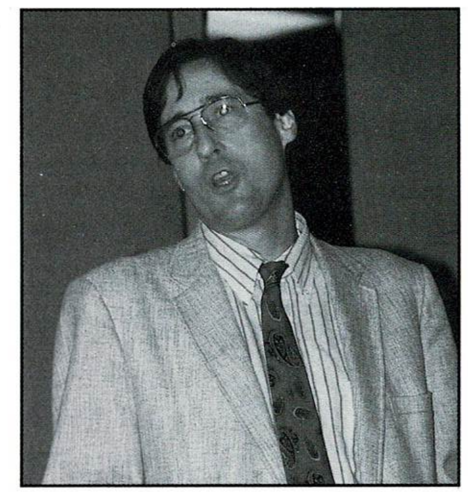
Jeff Skousen - West Virginia University



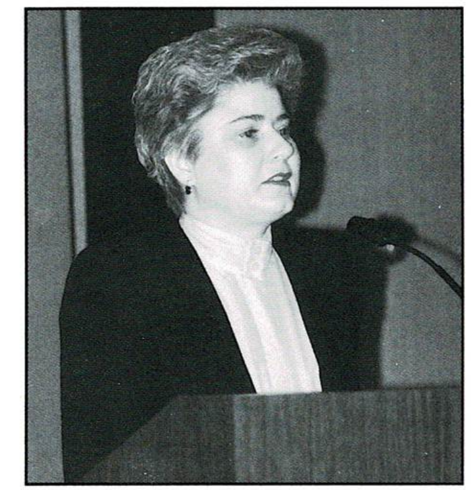
Dana Burns - GAI Consultants



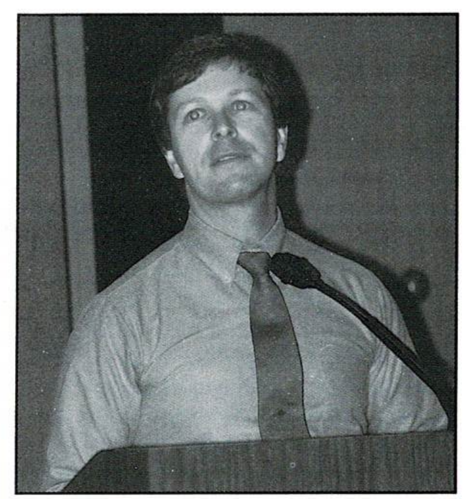
Ken Politan - West Virginia Division of Environment Protection



Stuart McGehee - Eastern Regional Coal Archives, Craft Memorial Library

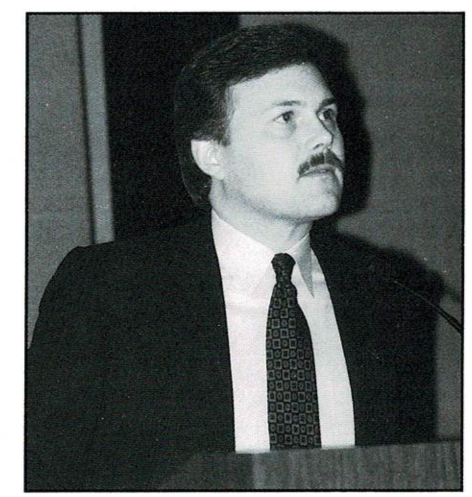


Nina Rose Hatfield - U. S. Interior Department, Office of Surface Mining



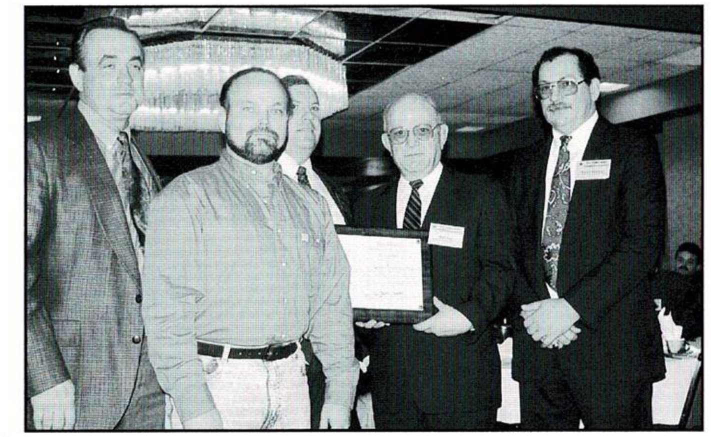
Ken Hodak - Hobet Mining, Inc.

Randy Baker - Driltech, Inc.



John Sido - Komatsu Dresser Co.

Bart Lay (l) accepts a plaque designating him as the namesake of the new 'Barton B. Lay, Jr. Milestones of Safety' award. Making the presentation is Director Steve Webber of the Office of Miners' Health, Safety & Training.



Tug Valley Processing won the first 'Milestones of Safety Award. L-r are Ed Jackson, Bill Bowes, and Lonnie Gore, Jr., all of Tug Valley, Bart Lay, and Director Steve Webber.

37 Operations win 'Mountaineer Guardian'

No fewer than 37 West Virginia mining operations picked up Mountaineer Guardian awards at a special luncheon during January's 19th Annual West Virginia Mining Symposium. Together, these operations recorded some 300 million tons of coal without a fatality, nearly two years worth of total West Virginia production.

A new and special part of the program honors former West Virginia Mines Director Bart Lay, Jr. The first annual "Barton B. Lay, Jr. 'Milestones of Safety' Award" recognized Tug Valley Coal Processing Plant for its record of excellence in safety over the last four years.

The Marrowbone Development subsidiary processed 40 million tons of raw coal, working 625,000 manhours through December of 1991 without a lost time accident. According to its certificate, "Tug Valley's safety achievements have set a standard against which future aspirants to the 'Barton B. Lay , Jr. Milestones of Safety Award' will be measured."

According to Association President Ben Greene, the Milestones of Safety program takes the Mountaineer Guardian awards to the next logical level. "It's a natural extension of the Mountaineer Guardian, in that it rewards operations who manage to avoid lost time accidents, as well as fatalities. Nothing could be more fitting that to name this award for Bart Lay, who has overseen the greatest progress in coal mine safety in the history of West Virginia."

Bart Lay held a leadership position in coal mine safety regulation through a variety of state government administrative changes.

Company	Mine
Arch of West Virginia, Inc.	Rufner Surface
Arch of West Virginia, Inc.	Wylo Surface
B A Coal Co.	Nicholas Surface
BethEnergy Mines, Inc.	No.108
Buffalo Coal Co.	Grant, Preston, Tucker
Cannelton Industries, Inc.	Sandlick No. 1
Carter-Roag Coal Co., Inc.	No. 1-A
Consolidation Coal Co.	Osage No. 3
Consolidation Coal Co.	Humphrey No. 7
Consolidation Coal Co.	Loveridge No. 22
Consolidation Coal Co.	Arkwright No. 1
Consolidation Coal Co.	Ireland
Consolidation Coal Co.	Blacksville No. 1
Cub Branch Mining, Inc.	Wayne Surface
Dal-Tex Corp../Sharples Coal Corp.	Bend Branch No. 3
Dal-Tex Corp./Old Hickory Coal Co.	Rockhouse
Eastern Associated Coal Corp./Peabody	Harris No. 1
Elkay Mining Co./Pittston	No. 4-A Mine
Elk Run Coal Co.	Castle
Elk Run Coal Co.	Bishop
Elk Run Coal Co.	Black Knight
Grafton Coal Co.	Brooks Run No. 5
Green Mountain Energy, Inc.	No. 2
Green Mountain Energy, Inc.	No. 1
Maple Meadow Mining Co.	Maple Meadow Mine
Patriot Mining Co., Inc.	Patriot Surface
Peabody/Eastern Associated Coal Corp.	Colony Bay
Rayle Coal Co.	Brooke County Surface
Southern Mingo Coal Co.	No. 1
Stoney Coal Co.	No. 8
Stoney Coal Co.	No. 1
Terry Eagle Coal Co.	Cari Eagle No. 2
Tommy Creek Coal Co.	Tommy Creek No. 1
Tug Valley Processing Co.	Marrowbone Plant
Tygart Coal Co.	Freeport No. 1B
Western Mingo Coal Co.	No. 1
White Flame Energy, Inc.	White Flame No. 1

Jim Compton's 77th birthday saw him surrounded by old friends, family and admirers. Shown left to right are James H. "Buck" Harless, C. E. "Jim" Compton, Lawson Hamilton and Jim's son James Michael.

Grafton Goes Golden

Grafton Coal Co. marked its first half century in style last month, combining its golden anniversary celebration with a birthday observance for its founder.

Some 200 employees, family members, colleagues, friends, and just plain admirers of Jim Compton enjoyed a catered feast at Grafton Coal's new headquarters in Bridgeport.

It was in 1942, at the height of America's frenzied effort to gear up for World War II, that C. E. "Jim" Compton established Grafton Coal Co., naming the fledgling enterprise for his hometown.

In the early days, it appeared that Jim might be more of an inventor than a coal miner. With little formal education, he had a knack for seeing a better way to get things done. His "Compton Auger" first made his name in the mining business and many other innovations followed. He devised a better a way of loading coal, a shortcut to overburden disposal, a more efficient means of reclamation.

What it all amounted to was that Jim Compton got coal out of the ground as well as any other man of his generation. Over the years, Grafton Coal and its sister companies have extracted coal from 19 of the state's 55 counties. Along the way, Jim Compton and his companies have built five churches, a dozen ball fields, and made countless contributions to a wide variety of local community causes.

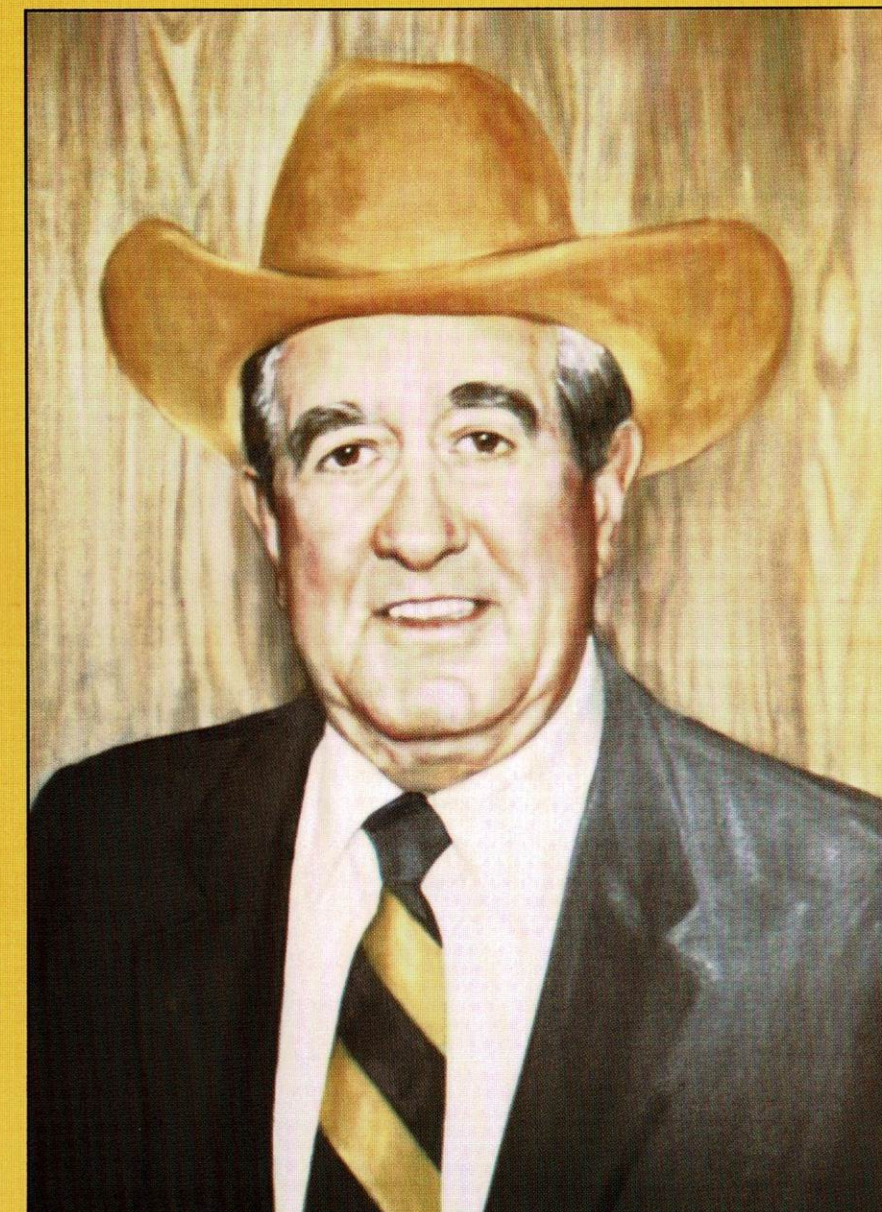
It would be difficult to name the single accomplishment for which Jim Compton is most noted. A man of many interests, his success in the coal business has enabled him to pursue diverse goals in many other fields, nearly always with the same result. Things get done.

But he has never been content with progress, where there were strides yet to be made, and his mind has never rested when there were new fields still to be conquered.

Jim's interest in nutrition led to his establishment of a Chair of Nutrition at West Virginia University, where he is also a major benefactor of the Cancer Research Center, and to the large scale re-introduction of buffalo to West Virginia, which he sees as a nutritional alternative to beef.

His latest venture, and gift to West Virginia, is one of the most amazing of his long career. Where no one else was looking, Jim Compton saw a need for a major aircraft repair center, and saw no reason that it shouldn't be located in Bridgeport, West Virginia. So now we have the West Virginia Air Center, at Benedum Airport, one of only four or five comparable facilities in the nation.

It's no accident that the color of Jim Compton's trademark hat is West Virginia "old gold." On the golden anniversary of his original company, Jim had long since established himself as a truly great West Virginian. And it doesn't get any "golder " than that.



Portrait of a portrait - WVMRA's gift to C. E. "Jim" Compton was a portrait traditionally given only to retiring Board chairmen. Jim's long service to the Association ranks him as one of the organization's pioneers and key figures throughout its history.

This pond at the south end of the project is a popular stopover for turkey and waterfowl.

1991 Reclamation Awards

Geupel Construction takes home the 'Callaghan'

Seventeen West Virginia companies were recognized for excellence in reclamation at the closing luncheon of the 19th Annual West Virginia Mining Symposium.

Sponsored jointly by the Association and the West Virginia Division of Environmental Protection, the Reclamation Awards are presented annually to those companies judged to have done the best work in reclaiming mined land. To be considered for the award, a company must be nominated by its local DEP inspector.

"This is one of our more pleasant duties throughout the course of the year," commented President Ben Greene. "West Virginia companies are in compliance with basic requirements of the law and many do truly outstanding work.

"This program recognizes the best of that group each year, and our members seem to take a great deal of pride in the achievement."

The top award this year went to Geupel Construction Co., Inc., which received the "David C. Callaghan Award" for overall excellence.

The award is named for the former director of the State Department of Natural Resources, who was named last fall to head the newly created DEP

"Geupel Construction is an excellent example of what the Reclamation Awards are all about," said Greene. "For 25 years, the greater Logan County area has been seeking a location for a regional airport. Through this company's cooperation, the coal was removed, the site was regraded and stabilized, a basic runway was located and a new, well engineered access road is in place.

"Geupel went far beyond the call of duty in all phases of this operation. The 'Callaghan Award' is a kind of 'best of show' recognition, and Geupel is most deserving of that honor."

In Logan County, for overall excellence in all phases of mining and reclamation. With diligence, perserverance and technological expertise, the company brought to fruition the completion of a 25 year mining and relamation project which will eventually result in the long sought construction of a regional airport for Logan County. Geupel's spirit of community service and its outstanding record of reclamation accomplishment serve as a shining example of the positive achievements that can result from the planning and implementation of modern mining technology and from the spirit of cooperation that marks West Virginia's coal industry.

DAVID C. CALLAGHAN AWARD
Geupel Construction Company, Inc.

L-R Inspector Harold Ward, Greg Wooten of Dingess Rum Coal Co., Inc., which donated land for the airport project, Fred Miller of Geupel, DEP Director Dave Callaghan, OSM Deputy Director Nina Rose Hatfield, Geupel President Paul Hutchins and Norm Hall, also of Geupel.

Reclamation Award Nominees

Company	Facility	County	Inspector
Anker Energy Corp.	Anker Rail & River Terminal	Monongalia	Michael Carico
Atlas Coal Leasing, Inc.	Surface	McDowell	Larry Cook
B. A. Coal Co., Inc.	Mine No. 2	Nicholas	Bill Little
Battle Ridge Companies	Orgas Surface 1& 2	Boone	
Bentley Coal Co.	Flatbush No. 1 Surface	Randolph	Daniel Lehmann
Berwind Land Co.	Berwind	Fayette	Jim Bennett
Bomac, Ltd.	Kodiak	Nicholas	Russell Keaton
Buffalo Coal Co.	Surface	Grant	Craig See
Buffalo Coal Co.	Coketon No. 1	Tucker	David Idleman
Business Resources, Inc.	Surface	Fayette	John Lambdin
Cannelton Industries, Inc. Panther Energy - contractor	Refuse Disposal	McDowell	Tom Pickett
Coal Valley Mining, Inc.	No. 1 Surface	Raleigh	Grant Connard
Courage Mining Co.	Rough Fork No. 1	Nicholas	Virgil Groves
D & L Coal Co.	Windom Surface	Mineral	David Idleman
Dayton Resources Co. Charcliff Mining - operator	Rock Narrows Surface	McDowell	Arnold Fortner
Dayton Resources Co.	Banacek #2	McDowell	Ronnie Collins
Dayton Resources Co.	Peg	McDowell	Ronnie Collins
Dipple and Dipple Coal Co.	Blaney and Cox	Monongalia	Keith Evans
Eastern Associated Coal Corp.	Keystone #4 Refuse Area	Raleigh	Michael Furey
Eastern Energy Corp.		McDowell	William Thomason
Geupel Construction Co., Inc.	Logan County Airport	Logan	Harold Ward
Grafton Coal Co.	Surface	Webster	Harold Parsons
Greenbrier Coal Co. Kent Coal Co. - contractor	Surface	Greenbrier	Perry Critchley
Green Mountain Energy, Inc.	#2	Wyoming	Larry Cook
Hobet Mining, Inc.	Hobet #7 Surface	Logan	Richard Casserta
Island Creek Mining Co.	Upshur Project	Upshur	Frank Shreve
Level Land Construction Co., Inc.	Church-Hamon	Nicholas	G. Cam Ford
Lightning, Inc.	Town Creek Surface	Fayette	K. William Hauer
Mingo Logan Coal Co. Premuim Energy, Inc. - contractor	Black Bear Preparation Plant	Mingo	Haskel Boytek
Mingo Logan Coal Co. Premuim Energy, Inc. - contractor	Mountaineer	Mingo	Haskel Boytek
New Land Leasing Co., Inc. Tammie Lynn Coal Co. - operator	Surface	Nicholas	Don Gilkeson
Patriot Mining Co.	Chaplin	Monongalia	Keith Evans
Philippi Development, Inc.	Surface	Barbour	Martin Dickinson
Pioneer Fuel Corp.	Pioneer	Wyoming	Keith Porterfield
Raven Hocking Coal Corp.	Surface	Mason	Bill Simmons
Robinson Phillips Coal Co.	Turkey Creek Refuse Area	Wyoming	Jackie Taylor
Second Sterling Corp.	Clark Branch Refuse Disposal	McDowell	Tom Pickett
Stanley Industries, Inc.	Surface	Barbour	Brad Moore
Terry Eagle Coal Co. Ridgetop Mining - contractor	Little Elk Mine No. 1	Nicholas	John Vernon
U. S. Steel Mining Co., Inc.	Seneca	McDowell	Tom Pickett
Westwood Mining Co., Inc.	Cherokee	McDowell	Arnold Fortner

The second annual Wetlands West Virginia Award is presented to Bomac, Ltd. for unselfish dedication and significant contributions to waterfowl conservation.

Wetlands
West Virginia Award
Bomac, Ltd.

L-R Inspector Russ Keaton, Max Bowen, Bob Burnworth of Ducks Unlimited.

In Monongalia County, for outstanding performance in the site modification and expansion of a major rail and river coal loading facility, preparation plant and refuse disposal area. The company's attention to detail and willingness to go beyond requirements of the law have greatly enhanced this sensitive environmental area.

L-R Inspector Mike Carico, Director Callaghan, Howard Adams.

Anker Energy Corporation

In Nicholas County, for the complete restoration of more than 2700 linear feet of 50 foot high wall and the extraordinary success of revegetation efforts which restored the land as a habitat for deer, turkey and other wildlife.

B A Coal Co., Inc.

L-R Tim Adkins, Director Callaghan, Inspector Bill Little.

In Randolph County, for the elimination of three miles of previously existing highwall, the establishment of new and lush vegetation to stabilize the old mine benches and the preservation of several acres of adjacent wetlands for habitat enhancement.

Bentley Coal Co.

L-R DEP Northern Supervisor Rocky Parsons, Director Callaghan, Mike Greenway, Ray Jacobs.

In Fayette County, for the elimination of two miles of pre-existing high wall and old unstable spoil piles, in restoring the previously mined site to its approximate original contour and aiding in the natural reclamation process. A broad based wildlife habitat has been created with a large population of native game present.

Berwind Land Co.

L-R Ron Elliott, Director Callaghan, Inspector Jim Bennett.

In Grant County, for exemplary overall performance in the mining and reclamation process, resulting in a site which blends into the surrounding countryside and enhances post-mining land use of grazing livestock, as well as a feeding ground for deer and other wildlife.

L-R Steve Shaffer, Jerry Duckett, Dennie Dolechek, John Geroski, Director Callaghan, Inpector Craig See, Don Cussins, Melvin Judy.

Buffalo Coal Co.

In Monongalia County, for exceptional results in achieving the designated post-mining land use of hayland and pasture. While the permit was still in Phase I of bond release, hay was harvested in amounts and quality surpassing most local unmined meadowland. The long term use of the land will continue to improve with age.

Dippel & Dippel Coal Co.

L-R Inspector Keith Evans, Director Callaghan.

In Raleigh County, for the outstanding restoration of an old inactive refuse disposal area, through innovative methods of drainage control, meticulous topsoiling and reseeding, with particular attention to preventing future drainage problems.

L-R Inspector Mike Furey, Director Callaghan, Elmer Tilley, Rodney Fernandez.

Eastern Associated Coal Corporation

In Webster County, for outstanding reclamation results in extremely difficult terrain. Through thoughtful planning, careful execution and measures beyond requirements of the law, the company successfully completed reclamation, overcoming both steep slopes and the potential for acid mine drainage.

Grafton Coal Co.

L-R Northern Supervisor Rocky Parsons, Jim Compton, Director Callaghan, George Hefner, Charlie Miller.

In Barbour County, for exemplary engineering and reconstruction of a coal refuse pile, including the addition and redistribution of topsoil, reconstruction of the drainage system using alkaline trench technology and construction of a permanent acid drainage treatment system with several polishing ponds.

L-R Norris Brooks, Inspector Marty Dickinson, Director Callaghan, Frank Krizner, Gary McCauley.

Philippi Development, Inc.

In Mason County, for outstanding contemporaneous reclamation and meticulous attention to reshaping the terrain, which resulted in gently rolling slopes which enhanced the post-mining land use of intensive daily agriculture.

Raven Hocking Coal Corporation

L-R Inspector Bill Simmons, Director Callaghan, Tod Zuspan, Jerry Beane.

In McDowell County, for the containment and elimination of an old burning refuse pile which posed a safety hazard to the community of Keystone, the establishment of an effective drainage system, and the otherwise exemplary transformation of a previously hazardous site into a model of refuse reclamation.

Second Sterling Corporation

L-R Inspector Tom Pickett, Director Callaghan, J. D. Higginbotham.

In Barbour County, for particular attention to timely backfilling and revegetation, and for outstanding success in handling toxic materials, resulting in measurable improvements in postmining vegetative cover and water quality, with intensive agricultural use now a most desired result.

Stanley Industries, Inc.

L-R Northern Supervisor Rocky Parsons, Junior Stanley, Director Callaghan, Wayne Stanley.

In McDowell County, for efforts and results far beyond requirements of the law, in the clean up and transformation of an idled underground mine and preparation plant into a modern and efficient water treatment facility. Working on a site which no longer produces coal, the company went to great lengths to eliminate potential water problems for the community of Maitland and the surrounding area.

L-R Inspector Tom Pickett, Director Callaghan, Larry King.

U. S. Steel Mining, Co., Inc.

In Mason County, for the timely and efficient completion of the Mason County Bond Forfeiture Project, involving the cleanup of an abandoned surface mine and tipple, the elimination of highwalls and the restoration of Tenmile Creek.

AML AWARD-South

Green Mountain Co.

L-R Inspector Tom Morris, Paul Moss, Director Callaghan, Rod Clay, Mike Kelly.

In Randolph County, for the timely and efficient completion of the Beaver Creek Highwalls Project, involving the elimination of old refuse piles, highwalls, underground mine openings and effectively eliminating acid mine drainage from the site.

AML AWARD-North

W. A. Ryder

L-R Chad Ryder, AML Northern Supervisor Dave Brochard, Inspector Harold Ward, L-R Director Callaghan, Thane Ryder.

We go way out to bring you the world's best thinking:

VOLVO BM / MICHIGAN / EUCLID — VME Group

Volvo BM - Wheel Loaders & Articulated Haulers
Michigan - Wheel Loaders, Dozers
Euclid - Rear & Bottom Dump Haulers

HITACHI — Hydraulic Excavators & Front Shovels

Link-Belt® CONSTRUCTION EQUIPMENT — Hydraulic & Lattice Boom Cranes
Hydraulic Excavators

Driltech — Rotary Drills
(West Virginia only)

Thunderbird INDUSTRIES — Crushing Plants & Screens

FURUKAWA ROCK DRILLS — Rock Drills

KENT — Hydraulic Hammers

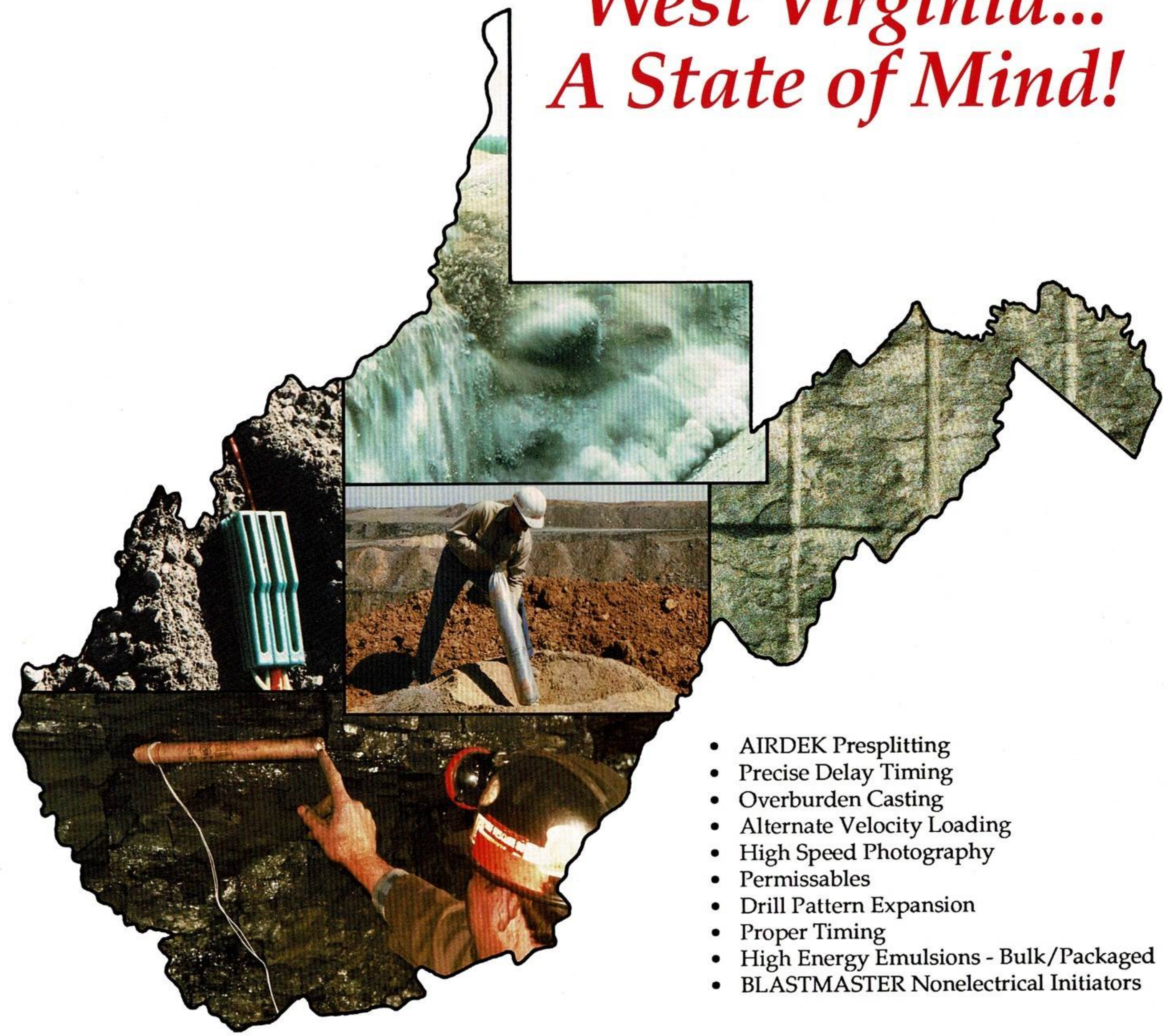
HYSTER — Compaction Equipment

RUDD EQUIPMENT COMPANY

With you from start to finish.

Pittsburgh, PA	Clearfield, PA	Bridgeport, WV	Nitro, WV
(412) 322-1112	(814) 765-8500	(304) 592-1050	(304) 755-7788

West Virginia... A State of Mind!



- AIRDEK Presplitting
- Precise Delay Timing
- Overburden Casting
- Alternate Velocity Loading
- High Speed Photography
- Permissables
- Drill Pattern Expansion
- Proper Timing
- High Energy Emulsions - Bulk/Packaged
- BLASTMASTER Nonelectrical Initiators

West Virginia Explosives... A State-of-the-art Explosives Distributor

Call us for an on-site evaluation of your drilling and blasting program.
Bruce Wood, Vice President • Beckley, West Virginia • (304) 252-8505

West Virginia Explosives Co., Inc.

Atlas Powder Company

A distributor of ICI explosives products

Prevention of Acid Mine Drainage by Alkaline Addition

by Paul F. Ziemkiewicz
The National Mine Land Reclamation Center, West Virginia University
and Jeffrey G. Skousen
Department of Plant and Soil Science, West Virginia University

Abstract

Coal companies mining in acid-producing areas of the eastern United States control acid mine drainage primarily by water treatment. However, they face the prospect of long-term to indefinite water treatment and its attendant liabilities. It is obvious that cost-effective methods which prevent the formation of acid mine drainage would be preferable.

Recent studies with Appalachian coal refuse have indicated that certain types of alkaline amendments have the potential to prevent acid mine drainage from pyritic coal refuse. This paper discusses a research project in which kiln dust, Fluidized Bed Combustion (FBC) ash, and rock phosphate were mixed with various pyritic coal wastes and subjected to intensive oxidation and leaching in the laboratory.

The results indicate that, at least under laboratory conditions, a ratio of neutralization potential to maximum alkaline leachate (NP:MPA) of 0.35 or greater resulted in neutral to alkaline leachate. Trials are now underway to evaluate the performance of these materials under large-scale, controlled field conditions.

Background

Acid Base Accounting (ABA) was developed in the early 1970's by researchers at West Virginia University to identify and classify geologic strata encountered during mining (West Virginia University, 1971). A history of Acid Base Account is provided by Skousen et al. (1990).

Since its development, ABA has been used extensively in the United States and several other countries for premining coal overburden analysis. Its popularity largely stems from its simplicity. However, it has been subject to criticism since it does not account for the different rates of acid and alkali-generating reactions in rock. Modifications to ABA have been recommended (Smith and Brady, 1990; and diPretoro, 1986). Other methods have developed which accelerate or otherwise control the oxidation and leaching process in rock samples. One such procedure, that of Renton et al. (1988), was employed in this study to simulate the rate of weathering of acid-producing rock samples alone and in combination with alkaline amendments. The results are compared with traditional ABA parameters.

Recent Studies

diPretoro and Rauch (1988) found poor correlations (reported R squared = 0.16) between a volume-weighted acid base net neutralization potential (NP) and net drainage alkalinity near 30 mine sites in West Virginia. Erickson and Hedin (1988) showed similar poor correlation between maximum potential acidity (MPA), NP, net NP from ABA and net alkalinity from drainage water. Both papers related that factors other than overburden characteristics were involved in predicting post-mininig water quality.

diPretoro and Rauch (1988) found that sites which had greater than 3% calcium carbonate equivalent (NP) in overburden produced alkaline drainages while at 1% or less acidic drainage resulted. Erickson and Hedin's results indicate that 2% calcium carbonate or less produced acidic drainage while 8% or more produced alkaline drainage. (In this later study there were no sampling points between 2% and 8%).

O'Hagan and Caruccio (1986) found that the addition of calcium carbonate at 5% by weight to a coal refuse containing 1% S produced alkaline drainage. In Minnesota, Lapakko (1988) found that 3% calcium carbonate neutralized an overburden material with 1.17% S.

Hedin and Erickson (1988) compared water quality from rocks weathered in humidity cells to ABA values. Cumulative sulfate from humidity cells was strongly correlated with total sulfur (R squared = 0.69), while cumulative acidity/alkalinity was correlated with net NP (R squared = 0.37). They also showed sulfate from humidity cells was significantly correlated to sulfate from drainage water (R squared = 0.17), but the correlation was not strong enough to predict post-mining drainage quality.

Bradham and Caruccio (1991) conducted several overburden analytical tests on pyritic wastes from Canada. They found water quality resulting from column leachings, ABA projections, and soxhlets correctly predicted eight out of ten sites where drainage was monitored from refuse piles, with weathering cells predicting ten out of ten results.

There have been several modifications in using ABA in predicting drainage quality. The PaDER (Smith and Brady, 1990) developed a spreadsheet which calculates mass-weighted maximum potential acidity (MPA), NP and net NP. The spreadsheet also summarizes the overburden analysis in terms of the ratio of NP/MPA and the percent sandstone. The spreadsheet of ABA data can be compared to significant thresholds or numerical limits for NP and %S and other factors can be changed to estimate the impact of drainage quality. For example Brady and Hornberger (1989) suggested threshold values of NP equal to or greater than 3% and %S less than 0.5 as guidelines for delineating alkaline-producing strata.

In the development of its spreadsheet, PaDER (Cravotta et al. 1990) reviewed the calculation of NP in ABA. In current ABA usage, 3.125 g calcium carbonate equivalent is required to neutralize acidity resulting from oxidation of 1 g S. Cravotta et al. (1990) argue that this ratio should double to 6.25:1. Volume-weighted MPAs are subtracted from NP giving a positive or negative effect or a net NP for the mined area. A negative, or deficient, net NP is interpreted to indicate the amount of calcite that must be added to equalize the deficiency and prevent AMD formation.

Other alkaline materials have higher NP's than calcite. Quicklime, kiln dust and hydrated lime all have higher activities than calcite, though it is not clear that the kinetics of pyrite oxidation favor readily-soluble sources of alkalinity.

Brady et al. (1990) conducted a study of 12 sites where ABA data were available. They computed net NP based on both 3.125% and 6.25% to 1% S. Alkaline addition on the sites was conducted to abate potential AMD problems. When using 6.25%, the sign of the net NP (+ or -) matched the sign of the overall net alkalinity of water at 11 of 12 site.

The results of their study concluded that NP and traditional estimates of MPA (e.g. 3.125% to 1% S) were not equivalent and that NP of overburden must be twice the MPA to produce alkaline mine drainage. They also concluded that mining practices (such as alkaline addition, selective handling, and concurrent reclamation) enhanced the effect of alkaline addition on reducing acidity. Lastly, they concluded additional studies are needed to determine the rates, application and placement of alkaline material during mining.

Brady and Hornberger (1990), after summarizing the work on AMD prediction by ABA made the following conclusions in a recent PaDER Mining and Reclamation Manual. First, NP from ABA shows the strongest relationship with actual post-mining water quality. This relationship is only qualitative (e.g. acid vs. non-acid), and NP must significantly exceed MPA in order to produce alkaline water. If NP and MPA are similar, AMD will most likely result. Sites with less than 0.5% S will not be significant AMD producers, except where little or no NP exists. High sandstone composition in the overburden (greater than 65%) will almost always result in acid drainage.

Factors Which Induce Error in Acid Base Accounting

The foregoing discussion makes it clear that interpretations of ABA are diverse. Given the policy and economic implications of ABA, it is considered useful to better understand the basis for ABA predictions and, where acid problems are identified, to generate cost-effective solutions.

Errors in conventional application of ABA result from variance in total S content (Rymer et al. 1991), and perhaps more significantly, non-homogeneous placement of spoils. For example, Schuek (1990) reported AMD generation from a surface mine site in Pennsylvania resulted largely from buried refuse and pit cleanings within an otherwise neutral to alkaline spoil matrix, as identified by ABA.

Acid neutralization in spoil dumps - a paradigm Obviously, some spoils will be composed entirely of acid forming rocks. Others such as refuse tend to have little NP at all. But in cases where AMD forms despite significant alkalinity in the overburden, it appears to originate from localized sites within the backfill. While finding the path of least resistance to the downstream side of the dump, the acidity contacts only the alkalinity directly in its path. Once this is overcome, AMD flows freely to the nearest stream while the remaining alkalinity in the dump persists as a spectator to the process. This is to be expected since dissolution of calcite is controlled by pH and the partial pressure of carbon dioxide. Where pore water gas is confined and exposed to mineral acidity, the water will remain around 6.2, the buffering point of bicarbonate and carbonic acid. In the absence of mineral acidity, spoil water will reflect bicarbonate saturation - 8.3. In either case, additional calcite will dissolve only upon addition of acidity and outgassing of carbon dioxide. So, unless contacted directly by acidity, most of the spoil calcite will simply remain in solid form. So, the presence of alkalinity in the dump does not ensure that it will be a factor in neutralizing acidity. To be an efficient process, the acid-forming and alkaline rock must by thoroughly mixed.

This largely becomes a materials handling issue. Where there is insufficient alkalinity available, it is necessary to add it to the rock. Otherwise, if one relies on random spoil dumping, the system would need an overwhelming supply of alkaline rock. This probably accounts for the above reported field observations that twice or more NP is required for each unit of MPA.

This paper presents results of accelerated weathering trials on various acid-producing rock units and identifies levels of amendment which appear to neutralize generated acidity. The amendments were kiln dust, rock phosphate and FBC ash. This project was not initially intended to evaluate ABA parameters. It was only during data analysis that relationships with ABA began to appear. They are presented here in the hope that the results can shed some light on the broader issue of ABA interpretation and its application to reclamation policy.

Materials and Methods

Nine cores were drilled on a prospective mining site in West Virginia and samples of these cores were subject to hot oxidation (105 degrees C) and leaching in soxhlet apparatus after the methods of Renton et al. (1988). The stratigraphic sequence was of the Allegheny Formation, specifically from the base of Lower Freeport seam to the base of the Lower Clarion seam. Lithic units which generated acidity were identified. All of the simulated refuse materials (via float-sink tests) were acid generators as were several of the spoil units.

Following identification of the acid-producing rock types, a complete core was obtained which encompassed the full mining sequence. The purpose of the study was to:

1) establish the acid-producing potential of the various lithic units;
2) evaluate the relative ameliorative effectiveness of 2wt% and 4wt% of rock phosphate, kiln dust, and FBC ash on selected samples from the core;
3) evaluate the relative effectiveness of two application schedules (2wt% and 4wt%) for each treatment material.

Sampling - Twenty-seven samples were selected from the core for analysis. The samples included both overburden and the rocks immediately associated with the coals. Initial screening indicated that most of the overburden samples had no sulfur and were strongly to mildly alkaline. Those which contained measurable sulfur were processed for further evaluation.

Sample Preparation - Each sample was crushed to a top size of 1/4" and the -200 mesh fraction was removed by dry sieving to fulfill the procedural requirements of the acid evaluation procedure. Each sample was thoroughly blended and statistically sampled using a Jones Splitter to provide 100 gram samples for the acid evaluation procedure and for total sulfur analysis. The sample removed for sulfur analysis was ground to -200 mesh in a Spex Shatterbox. All samples were sealed in plastic until analyzed.

Acid Evaluation - The acid producing potential of the untreated and treated samples was determined by the procedure reported by Renton et al. (1988). One hundred gram portions of each sample were weighed into 123 mm cellulose Soxhlet extractor thimbles. The untreated samples, samples amended with FBC ash, lime kiln dust (from APG Lime), and rock phosphate (Texasgulf code 31) were weighed into 500ml beakers. Distilled, deionized water was added to make a slurry and each sample was thoroughly mixed. The treated samples were then transferred quantitatively into 123 mm cellulose thimbles. All samples were prepared and run in triplicate.

Chemical Analysis - Sulfur analyses were performed using a LECO IR432 Automatic sulfur analyzer. Each determination was an average of three analyses. Each leachate from the soxhlet procedure was clarified by using a 0.45 micron filter and analyzed for:

1) pH; 2) Specific Conductivity 3) sulfate ion concentration 4) acidity to pH 8.3 5) alkalinity to pH 4.5.

Results and Discussion

Six rock units were identified as the chief acid producers and were selected for further testing. The rock units were identified as Upper or Middle Kittanning (UK, MK) Upper and Lower Clarion (UC, LC) refuse or spoil. Sulfur contents in the samples ranged from 0.22 to 2.27%. Samples of each rock unit were treated with amendment and, with an unamended control sample, were subjected to the 10-week hot oxidation and soxhlet leaching process of Renton et al. (1988).

Table 1 summarized the analyses of leachates and ABA from each of the six rock units. NP and MPA are the sum of values measured in the raw rock samples and the amounts added via the amendments. All ABA units are in percent by weight (tons/1000 tons multiplied by 0.1). The data showed a wide range of sulfur contents, resulting acidities, and required amendments. Clear patterns were evident, however. While each amendment controlled AMD, kiln dust did so more consistently and at a lower application rate than either FBC ash or phosphate. This was expected in the case of FBC ash since it only contains about 20% CaO on an otherwise inert alumino-silicate coal ash matrix. Phosphate was inefficient, generally requiring twice as much as kiln dust for control.

The measured NP expressed in percent calcium carbonate equivalent for each of the amendments were, kiln dust = 99, FBC ash = 26 and phosphate = 14.

Pyrite oxidation did not appear to be strongly affected by any of the treatments. Cumulative sulfate data suggest that oxidation was similar to slightly lower in the kiln dust samples relative to the control while sulfate was similar to slightly higher on the phosphate samples. FBC ash,

Table 1. Soxhlet leachate data for six rock types treated 2-4% of with rock phosphate (P), kiln dust (KD) and FBC (FB) ash. The data represent final pH, alkalinity, acidity and sulphates after five oxidation cycles or cumulative levels after the same period.

Rock ID	Rock Unit	Rock Type	%S	Amend.	Rate (%)	End pH	CUMULATIVE ALK. @4.5 (ppm)	CUMULATIVE ACID @8.3 (ppm)	SO4 (ppm)	NP (%)	MPA (%)	Ratio NP/MPA	Net (%)
8077	UK/MKI	Spoil	1.35	C	0	2.1	20	179	1648	0.01	4.22	0.00	-4.22
				P2	2	2.3	1054	669	1690	0.29	4.22	0.07	-3.94
				P4	4	2.4	398	69	1517	0.57	4.22	0.14	-3.66
				KD2	2	7.8	217	165	1173	1.89	4.22	0.45	-2.34
				KD4	4	8.2	717	25	1342	3.77	4.22	0.89	-0.46
				FB2	2	3.3	195	15	2035	0.53	4.22	0.13	-3.70
				FB4	4	6.8	1533	25	2074	1.05	4.22	0.25	-3.18
8078	UK	Ref.	0.49	C	0	5.2	1565	46	602	0.00	1.53	0.00	-1.53
				P2	2	6.9	1373	7	1171	0.28	1.53	0.18	-1.25
				P4	4	9.5	628	0	1162	0.56	1.53	0.37	-0.97
				KD2	2	9.0	518	1	534	1.88	1.53	1.23	0.35
				KD4	4	8.9	1812	0	519	3.76	1.53	2.46	2.23
				FB2	2	6.0	1107	0	1165	0.52	1.53	0.34	-1.01
				FB4	4	8.7	1275	6	1984	1.04	1.53	0.68	-0.49
8078	UK	Spoil	1.87	C	0	2.3	13	214	1732	0.00	5.84	0.00	-5.84
				P2	2	2.3	317	341	1607	0.28	5.84	0.05	-5.56
				P4	4	4.3	282	57	1522	0.56	5.84	0.10	-5.28/
				KD2	2	6.8	1160	8	1168	1.88	5.84	0.32	-3.96
				KD4	4	7.9	213	28	1449	3.76	5.84	0.64	-2.08
				FB2	2	2.4	179	79	1209	0.52	5.84	0.09	-5.32
				FB4	4	2.7	1415	117	2311	1.04	5.84	0.18	-4.80
8078	UK	Ref.	0.22	C	0	3.2	764	113	340	0.01	0.69	0.01	-0.69
				P2	2	7.5	4485	19	697	0.29	0.69	0.42	-0.41
				P4	4	8.5	544	0	559	0.57	0.69	0.83	-0.13
				KD2	2	9.0	535	0	261	1.89	0.69	2.75	1.19
				KD4	4	9.0	1381	1	281	3.77	0.69	5.48	3.07
				FB2	2	6.7	1006	4	592	0.53	0.69	0.77	-0.17
				FB4	4	8.5	1368	3	1622	1.05	0.69	1.53	0.35
8078	UK	Ref.	2.27	C	0	2.0	0	628	1386	0.00	7.09	0.00	-7.09
				P2	1.6	2.2	247	348	1385	0.22	7.09	0.03	-6.87
				P4	3.2	3.0	292	37	1415	0.45	7.09	0.06	-6.65
				KD2	1.6	3.3	199	824	965	1.50	7.09	0.21	-5.59
				KD4	3.2	8.6	1338	0	953	3.01	7.09	0.42	-4.09
				FB2	1.6	1.9	366	415	1362	0.42	7.09	0.06	-6.68
				FB4	3.2	2.7	1066	25	1994	0.83	7.09	0.12	-6.26
8078	UK	Ref.	0.97	C	0	2.3	0	272	1818	0.00	3.03	0.00	-3.03
				P2	2	2.9	438	119	1348	0.28	3.03	0.09	-2.75
				P4	4	8.6	510	3	1711	0.56	3.03	0.18	-2.47
				KD2	2	8.6	1014	3	687	1.88	3.03	0.62	-1.15
				KD4	4	8.5	2142	1	762	3.76	3.03	1.24	0.73
				FB2	2	2.9	1239	35	2202	0.52	3.03	0.17	-2.51
				FB4	4	8.2	241	2	2673	1.04	3.03	0.34	-1.99

Figure 1. 8077 UK/MK Spoil S=1.35%

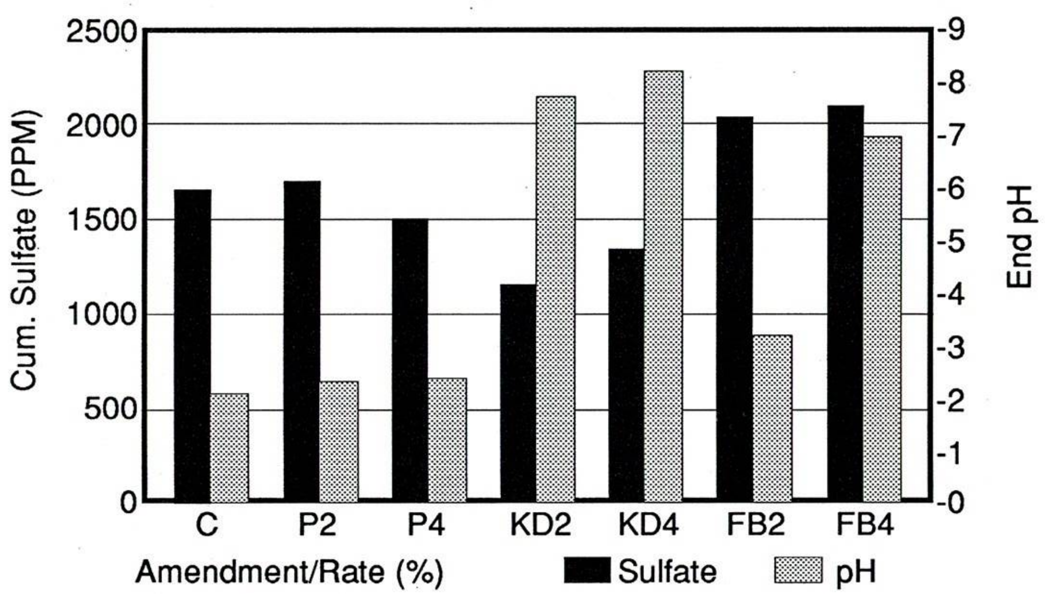


Figure 2. 8078 UK Refuse S=0.49%

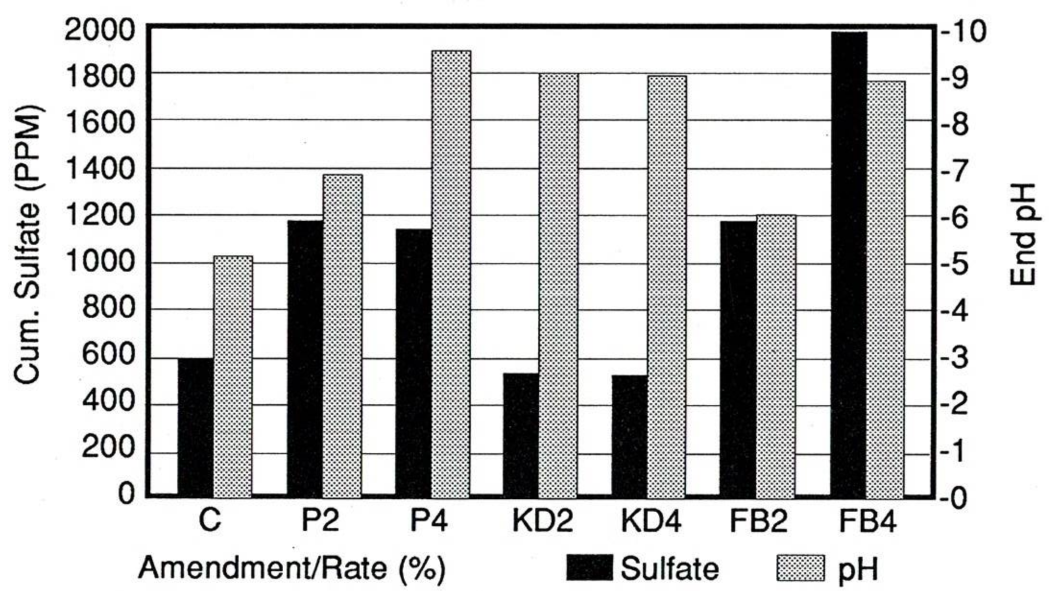
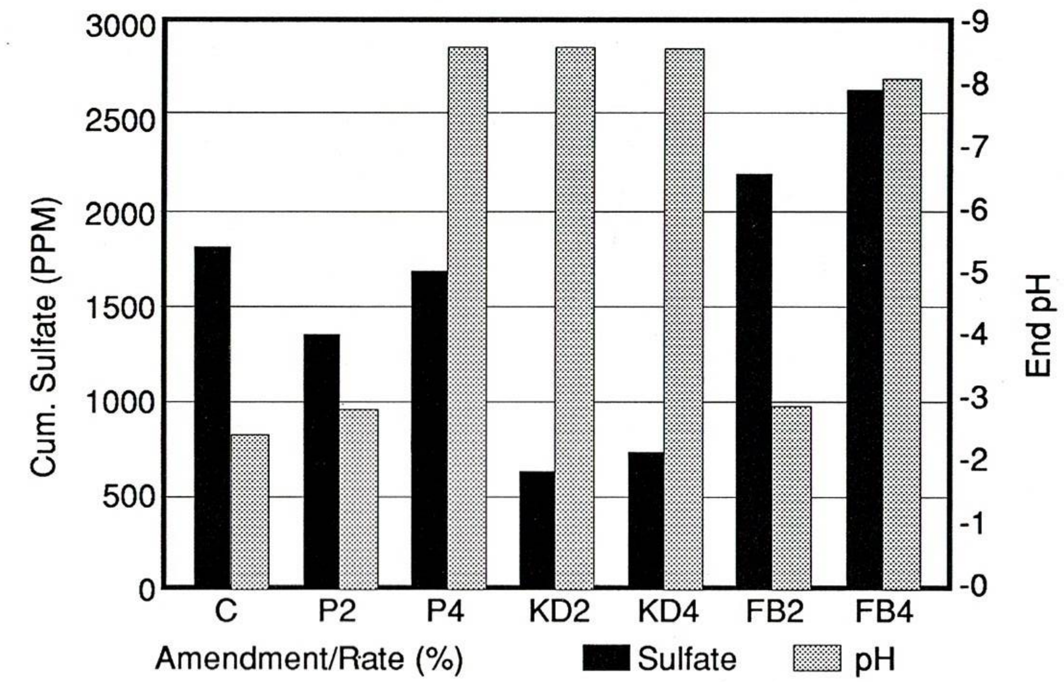


Figure 3. 8096 LC Refuse S=0.96%



however, probably due to its inherent gypsum content (calcium sulfate), consistently produced more sulfate than the control pH levels forsamples. Figures 1, 2 & 3 indicate cumulative sulfate and final pH levels for three rock units. Thus, it appears that while pyrite oxidation proceeds unhindered, its products are precipitated in situ as either hydroxides in the case of kiln dust and FBC ash or as a combination of iron phosphates and hydroxides in the case of phosphate addition.

Supporting the latter contention is the NP/MPA ratio at which AMD is controlled in the laboratory tests. For kiln dust and FBC ash, the ratio was 0.35 or greater. Phosphate was lower in two cases, generating neutral drainage (e.g. greater than pH 6.0) with ratios of 0.18 (samples 8078 and 8096). The NP of the rock phosphate used in this study was only 0.14% suggesting that at least some of its effect on acidity reduction may stem from precipitation of iron phosphate. Except for these two phosphate treatments, every sample which had an NP/MPA ratio of 0.35 or greater generated neutral drainage.

Figure 4 draws a weakly correlated linear regression line through control, FBC ash and kiln dust observations for net alkalinity and NP/MPA ratio. Among other things, the data points suggest that the function is probably not linear. Nonetheless, while an R squared of 0.14 is nothing to get excited about, the prediction line crosses the zero net alkalinity line intriguingly just below an NP/MPA ratio of 1. This compares with a prediction model presented by diPretoro (1986) taken from seeps within two kilometers of uncontrolled field sites of various ages. That prediction line crossed zero net alkalinity at an NP/MPA ratio of about 3.2 though diPretoro indicated that neutral drainage would probably result at a ratio of 2.4 or above (Figure 5).

The data, excluding the phosphate data, were used to develop a simple curvilinear regression model to predict pH on the basis of NP and MPA. A model with an R squared of 0.73 was produced (Figure 6). Other parameters such as NP/MPA ratio were evaluated, but none with an R squared above 0.5 was found. The field data reported in diPretoro (1986) were subjected to the same analysis and produced a model of similar form with an R squared of 0.4 (Figure 7).

Why the divergence between laboratory and field requirements? Intimate mixing of the materials is undoubtedly one of the reasons. Also, the reactivity of alkaline amendments in the laboratory study were greater than that of calcite. Kiln dust has about 20% CaO with the remainder unreacted calcite. FBC ash has about 20% CaO with no calcite. Both of these amendments would provide higher

Figure 4. Net Alk. vs. Ratio $R2 = 0.14$

^Net alk = -53.5 + (61.1 Ratio)

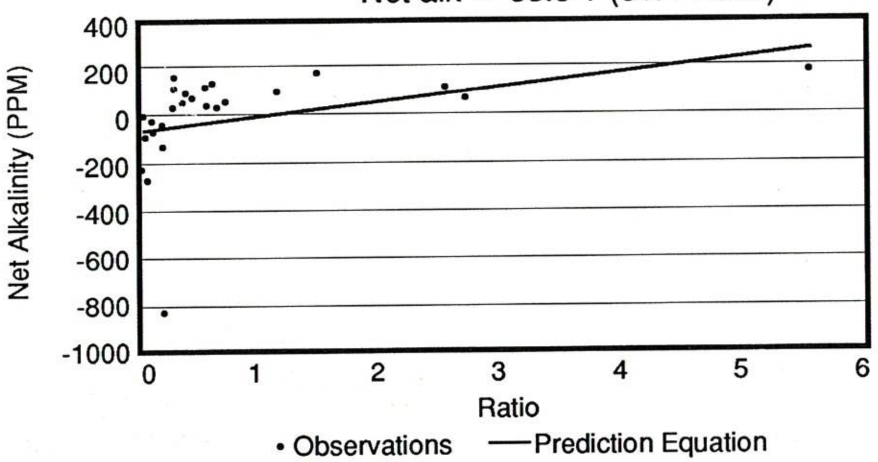
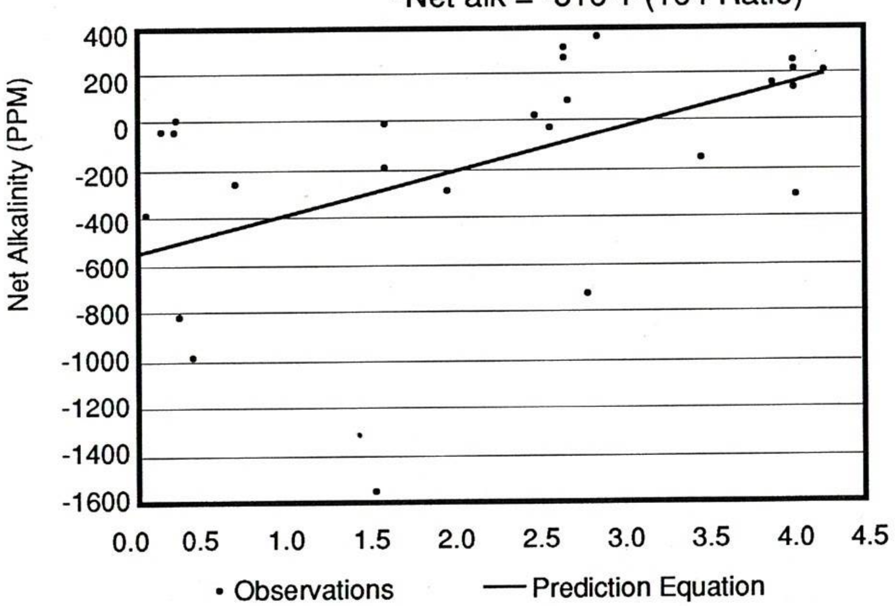


Figure 5. Net Alk. vs. Ratio $R2 = 0.30$*

^Net alk = -516 + (164 Ratio)



* Data from diPretoro, 1986

levels of readily soluble alkalinity than would be encountered within naturally occurring spoils.

Why did neutral drainage occur at NP/MPA ratios below 1? The obvious response is that within the 10 week term of the laboratory trials, the pyrite was not completely oxidized. This may be true and only rigorous comparison to field trials with identical rock types can resolve this question. Another explanation is that up to one half of the total sulfur in coal-related rocks can be in the organic form, particularly in the more carboniferous units. This sulfur will only oxidize very slowly and would not contribute significantly to acidity.

In a similar experiment, a West Virginia refuse was subjected to the same hot oxidation/leaching procedure and amended with 0.22% CaO, 0.4 and 0.8% kiln dust. The results were compared to the company's operation in which 2% kiln dust is added to its refuse. Table 2 indicates observed pH and predicted pH (^pH) based on a prediction model developed in this study. The results indicated that, while the model predicted a pH of 4.6 under controlled conditions, 4.0 was observed. While after amendment with 2% kiln dust, a pH of 7.42 was predicted and 7.2 to 7.6 was observed. These results were from a three year old refuse dump, completed in 1991.

It is too early to suggest the NP/MPA ratio which will prevent AMD under operational conditions. However, a good deal of excellent research, much of it cited in this paper, has brought us to a point where we may begin to narrow the range of uncertainty. It seems that between amended systems and randomly spoiled rock, an NP/MPA ratio ranging from 0.35 or greater gives a span where AMD can be prevented.

This is actually a remarkable level of consensus and one where properly controlled field studies will be of great benefit. Of particular interest is the

Figure 6. pH vs. NP and MPA $R2 = 0.73$

^pH = 5.88 + (1.49 NP) - (0.58 MPA)

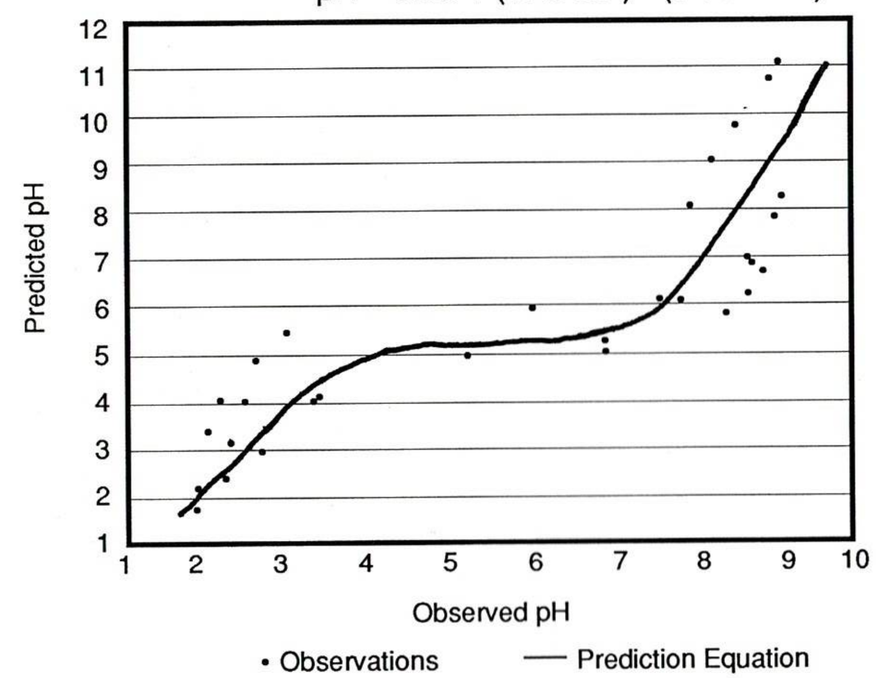
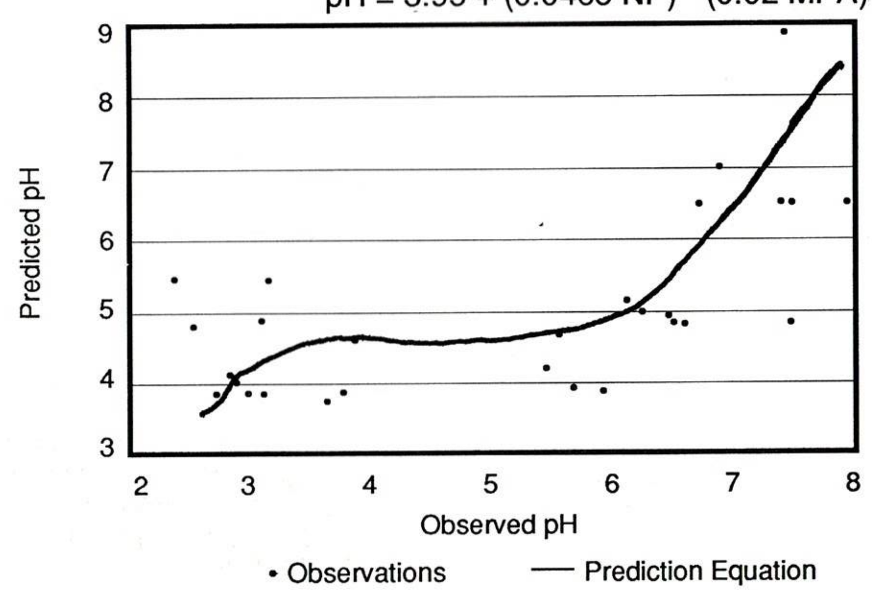


Figure 7. pH vs. NP and MPA $R2 = 0.40$*

^pH = 3.95 + (0.0465 NP) - (0.02 MPA)



* Data from diPretoro, 1986

prospect of identifying rocks units with acid potential and treating them in a predictable manner with alkaline amendments. The National Mine Land Reclamation Center at West Virginia University will continue to explore this technique and generate the required information for both regulatory agencies and the industry.

Conclusions

FBC Ash - At an application rate of 2%, FBC ash was only able to stop acid production in the mild acid-producing rocks. At 4%, it stopped acid generation in all but the two strongest acid producers: Middle Kittanning spoil and Upper Clarion refuse.

Kiln Dust - Kiln dust performed better than the FBC ash. The 2% % application of kiln dust prevented AMD production in all rock units except the Upper Clarion refuse. At a rate of 4%, kiln dust prevented AMD production in all of the rock samples.

Phosphate - Like FBC ash, phosphate was able to control AMD in mild acid-producing rock units at two percent application rates, but required four percent to achieve significant reductions with the strong acid-producing rocks.

Kiln dust outperformed CFBC ash and phosphate. It is relatively inexpensive and has the added advantage (with FBC ash) of improving stability for mobile equipment operating on refuse dumps. Particularly those with high moisture content filter cake, the free CaO stabilizes the moisture in the fines fraction to the extent that heavy trucks can move freely over the freshly dumped surface (Rich and Hutchison, 1990).

Rock phosphate originating in North Carolina would cost about $80/ton while the cost of the waste product FBC ash would largely reflect haulage costs. Unfortunately, while production is likely to increase rapidly over the next decade, relatively little FBC ash is presently generated.

Table 2. Application of the following pH prediction model to a field site treated with kiln dust and to other laboratory studies.

^pH = 5.88 + (1.49 NP) - (0.58 MPA) R squared = 0.73

TRT	Rate	%S	NP	MPA	Ratio	OBSpH	^pH
Field Results							
Control	0.0	0.71	0.01	2.22	0.00	4.0	4.80
Kiln Dust	2.0	0.71	1.89	2.22	0.85	7.4	7.42
Other Lab Trials							
Kiln Dust	0.8	0.71	0.76	2.22	0.34	7.3	5.73
Kiln Dust	0.4	0.71	0.38	2.22	0.17	6.8	5.17
CaO	0.22	0.71	0.32	2.22	0.15	6.2	5.08

This results in potential supply problems leaving kiln dust, applied at rates of 2 to 4%, the most attractive of the three amendments included in this study. At these levels, it is expected to control formation of AMD on any of the rocks found on this site.

Fortunately, there is a precedent for this treatment. Rich and Hutchison (1990) indicated that on an operationally-scaled application of 2% kiln dust, AMD was controlled at a mine near Drennen, WV. This project is now three years old and the treated sites are producing compliance water.

Literature Cited

Bradham, W.S., and F.T. Caruccio. 1991. A Comparative Study of Tailings Analysis Using Acid-Base Accounting, Cells, Columns and Soxhlets. pp. 157-174. In: Proceedings of the Second International Conference on the Abatement of Acidic Drainage. Montreal, Canada.

Brady, K., and R.J. Hornberger. 1989. Mine Drainage Prediction and Overburden Analysis in Pennsylvania. In: Proceedings of the 1989 West Virginia Surface Mine Drainage Task Force Symposium. West Virginia Mining & Reclamation Association, Charleston, WV.

Brady, K., and R.J. Hornberger. 1990. A Manual for Premining Prediction of Coal Mine Drainage Quality. Pennsylvania Department of Environmental Resources, Harrisburg, PA.

Brady, K., M.W. Smith, R.L. Beam and C.A. Cravotta. 1990. Effectiveness of the Use of Alkaline Materials at Surface Coal Mines in Preventing or Abating Acid Mine Drainage: Part 2. Mine Site Case Studies. pp. 227-241. In: Proceedings of the 1990 Mining and Reclamation Conference, West Virginia University, Morgantown, WV.

Cravotta, C.A., K. Brady, M.W. Smith, and R.L. Beam. 1990. Effectiveness of the Addition of Alkaline Materials at Surface Coal Mines In Preventing or Abating Acid Mine Drainage: Part 1. Geochemical Considerations. pp. 221-225. In: Proceedings of the 1990 Mining and Reclamation Conference, West Virginia University, Morgantown, WV.

diPretoro, R.S. 1986. Premining Prediction of Acid Drainage Potential from Surface Coal Mines in Northern West Virginia. M.S. Thesis, Geology Department, West Virginia University. 217 pp.

diPretoro, R.S. and H.W. Rauch. 1988. Use of Acid-Base Accounts in Premining Prediction of Acid Drainage Potential: A New Approach from Northern West Virginia. pp 2-10. In: Mine Drainage and Surface Mine Reclamation. USDI Bureau of Mines Information Circular 9183.

Erickson, P.M. and R. S. Hedin. 1988. Evaluation of Overburden Analytical Methods as Means to Predict Post-Mining Coal Mine Drainage Quality. pp. 11-19. In: Mine Drainage and Surface Mine Reclamation. USDI Bureau of Mines Information Circular 9183.

Hedin, R.S. and P.M. Erickson. 1988. Relationships Between the Initial Geochemistry and Leachate Chemistry of Weathering Overburden Samples. pp 21-28. In: Mine Drainage and Surface Mine Reclamation. USDI Bureau of Mines Information Circular 9183.

Lapakko, K. 1988. Prediction of Acid Mine Drainage from Duluth Complex Mining Wastes in Northeastern Minnesota. pp. 180-190. In: Mine Drainage and Surface Mine Reclamation. USDI Bureau of Mines Information Circular 9183.

O'Hagan, M. and F.T. Caruccio. 1986. The Effect of Admixed Limestone on Rates of Pyrite Oxidation in Low, Medium and High Sulfur Rocks. In: 1986 National Symposium on Mining, Hydrology, Sedimentology and Reclamation. University of Kentucky, Lexington, KY.

Renton, J.J., T. E. Rymer and A.H. Stiller. 1988. A Laboratory Procedure to Evaluate the Acid Producing Potential of Coal Associated Rocks. Mining Science and Technology, 7 (1988) pp. 227-235.

Rich, D. H. and K. R. Hutchison. 1990. Neutralization and Stabilization of Combined Refuse Using Lime Kiln Dust at High Power Mountain. In: Proceedings of the 1990 Mining and Reclamation Conference, West Virginia University, Morgantown, WV.

Rymer, T.E. J.J. Renton and P.F. Ziemkiewicz. 1991. Isolation of Critical Predictive Acid-Producing Parameters from Variable Field Data Using Advanced Computer Technology. In: Proceedings of the Second International Conference on the Abatement of Acidic Drainage, Montreal, Canada.

Shueck, J. 1990. Using a Magnetometer for Investigating Underground Coal Mine Fires, Burning Coal Refuse Banks and for Locating AMD Source Areas in Surface Mines. In: Proceedings of the 1990 Mining and Reclamation Conference, West Virginia University, Morgantown, WV.

Skousen, J., R. M. Smith and J. Sencindiver. 1990. The Development of the Acid-Base Account. *Green Lands* 20:1, pp 32-37.

Smith, M.W. and K. Brady. 1990. Evaluation of Acid Base Accounting Data Using Computer Spreadsheets. pp. 213-219. In: Proceedings of the 1990 Mining and Reclamation Conference, West Virginia University, Morgantown, WV.

West Virginia University. 1971. Mine Spoil Potentials for Water Quality and Controlled Erosion. 14010 EJE 12/71. Contract with West Virginia University by the U.S. Environmental Protection Agency, Washington, D.C.

Coal Calendar

April

2-3 **"Mine Safety and Health,"** Washington, D.C., contact Sharon Daniels, Eastern Mineral Law Foundation, WVU Law Center, P.O. Box 6130, Morgantown, 26506, (304) 293-2470.

8-9 **West Virginia Surface Mine Drainage Task Force Symposium,** Ramada Inn, Morgantown, contact Patty Bruce, West Virginia Mining & Reclamation Association, 1624 Kanawha Blvd. E., Charleston 25311, (304) 346-5318, FAX 346-5310.

23-25 **Annual Meeting, National Independent Coal Operators Association,** Holiday Inn North, Lexington, KY, contact NICOA, 1514 Front St., P. O. Box 354, Richlands, VA 24641, (703) 963-9011.

29-30 **West Virginia Mining & Reclamation Association,** Congressional Visit and Spring Board of Directors' Meeting, Loew's L'Enfant Plaza Hotel, Washington, D. C., contact Patty Bruce, WVMRA, 1624 Kanawha Blvd. E., Charleston 25311, (304) 346-5318, FAX 346-5310.

May

3-7 **Coal Prep '92 and American Mining Congress Coal Convention,** Convention Center, Cincinnati, OH, contact Maclean Hunter Presentations, Inc., 12371 E. Cornell Ave., Aurora, CO 80014, (303) 696-6100, FAX 751-1880, or American Mining Congress, 1920 N St. NW, Suite 300, Washington D. C. 20036, (202) 861-2800.

31-2 **Coal Heritage Celebration,** Bramwell, contact the Preservation Alliance of West Virginia, 612 Main St., Sutton 26601, (304) 765-5716.

June

16-18 **Longwall U.S.A. Exhibition and Conference,** David L. Lawrence Convention Center, Pittsburgh, PA, contact Maclean Hunter Presentations, Inc., 12371 E. Cornell Ave., Aurora, CO 80014, (303) 696-6100, FAX 751-1880, or American Mining Congress, 1920 N St. NW, Suite 300, Washington D. C. 20036, (202) 861-2800.

18-21 **National Coal Association 75th Anniversary Meeting,** The Broadmoor, Colorado Springs, CO, contact NCA, 1130 17th St. NW, Washington, D. C. 20036, (202) 463-2625.

July

10-12 **Annual Meeting, Contractors Association of West Virginia,** The Greenbrier, White Sulphur Springs, contact CAWV, 2114 Kanawha Blvd. E, Charleston 25311, (304) 342-1166.

August

6-9 **Annual Meeting, West Virginia Mining & Reclamation Association,** The Greenbrier, White Sulphur Springs, contact Patty Bruce, WVMRA, 1624 Kanawha Blvd. E., Charleston 25311, (304) 346-5318, FAX 346-5310.

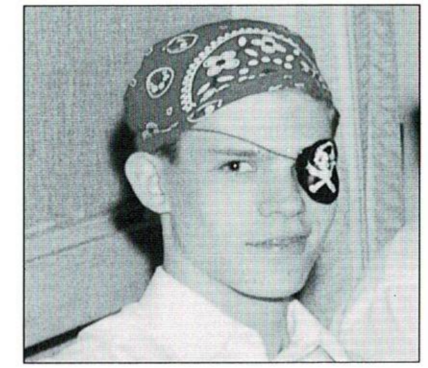
18-20 **Pikeville Area Coal Expo '92,** Pikeville College Gym, Pikeville, KY, contact Jenny Powell, Pike County Chamber of Commerce, 225 College St., Suite 2, Pikeville, KY 41501, (606) 432-5504.

September

16-17 **Richlands Coal Show,** National Guard Armory, Richlands, VA, contact Barbara Altizer, 1901 Front St., Mullins Professional Bldg., Richlands, VA 24641, (703) 962-2366.

Association Notebook

When pirates invaded the Association's winter gathering on Grand Cayman Island, there was little to do but cvheck out their attire. The most authentic were John Lee (left) of **Willis Branch Coal Co.,** who won the individual award, and Bill & Ida Trimble (below) of **Trimble Engineers & Constructors, Inc.,** judged the best dressed couple.



Carl Ostring of Askersund, Sweden, a Rotary International exchange student at Morgantown High School, joined in the Pirate spirit. Carl is a guest of Dick Bolen and family of **Patriot Mining Co., Inc.**

IMPRESSIVE TRACK RECORD

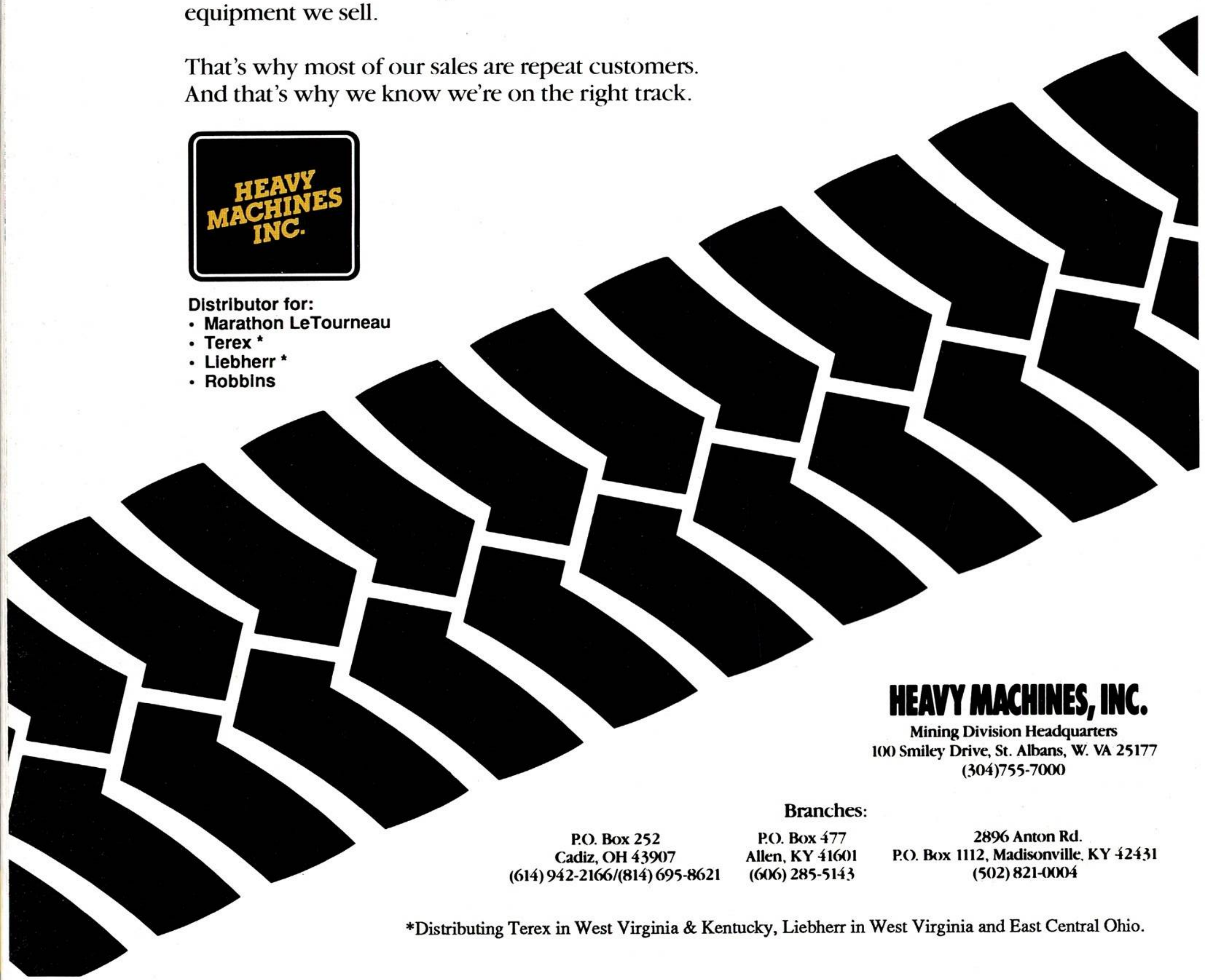
We're with you for the long haul.

Heavy Machines, Inc. builds relationships that last. Based on a firm commitment to your cost efficiency and success. With installation assistance, aggressive sales policies, creative financing efforts and comprehensive service support that give added value to the mining and construction equipment we sell.

That's why most of our sales are repeat customers. And that's why we know we're on the right track.

HEAVY MACHINES INC.

Distributor for:
- Marathon LeTourneau
- Terex *
- Liebherr *
- Robbins

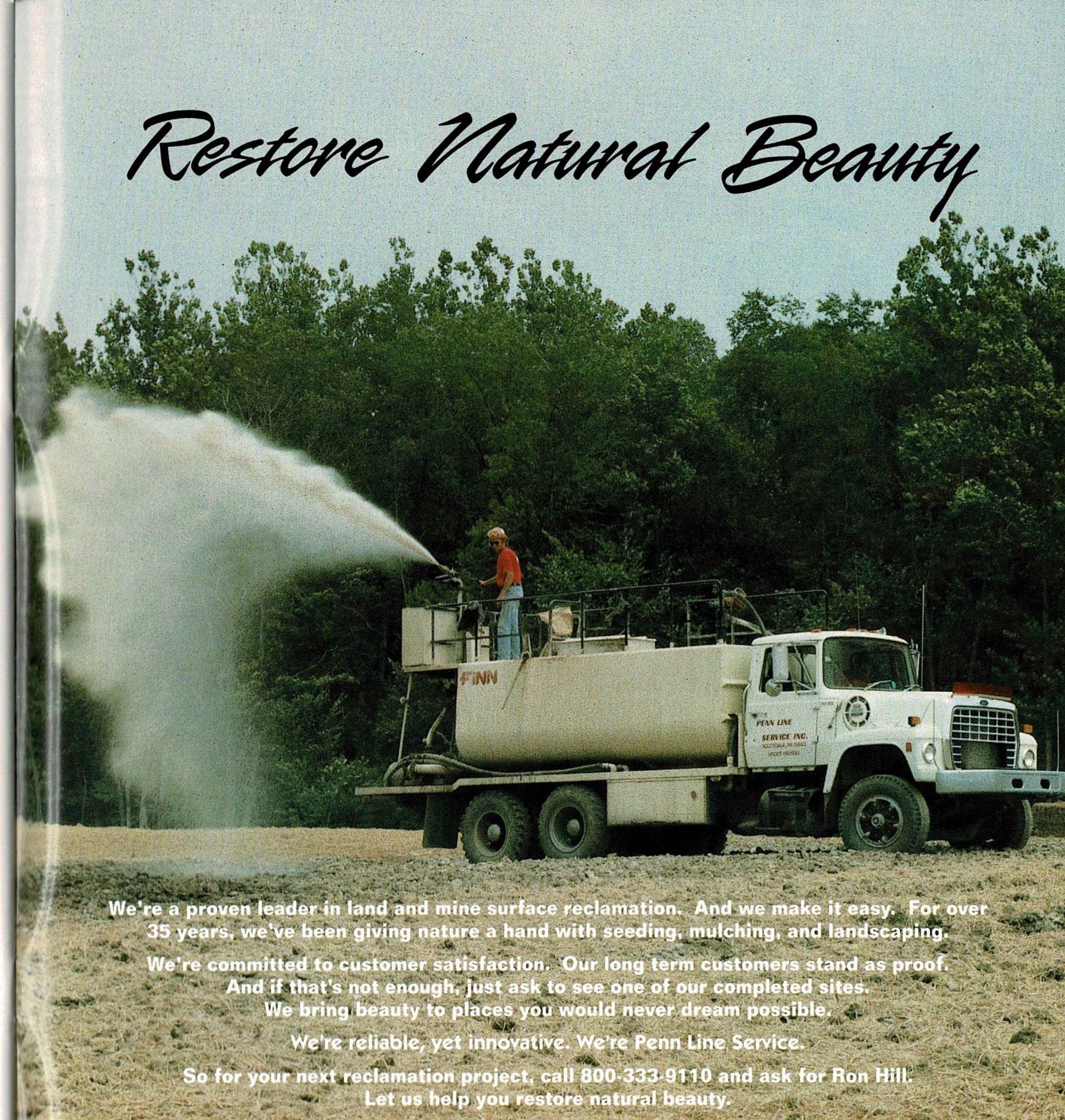


HEAVY MACHINES, INC.
Mining Division Headquarters
100 Smiley Drive, St. Albans, W. VA 25177
(304)755-7000

Branches:

P.O. Box 252	P.O. Box 477	2896 Anton Rd.
Cadiz, OH 43907	Allen, KY 41601	P.O. Box 1112, Madisonville, KY 42431
(614) 942-2166/(814) 695-8621	(606) 285-5143	(502) 821-0004

*Distributing Terex in West Virginia & Kentucky, Liebherr in West Virginia and East Central Ohio.



PENN LINE SERVICE INC.

Diverse Dimensions in Specialty Contracting

Scottdale, PA 15683 • 412/887-9110