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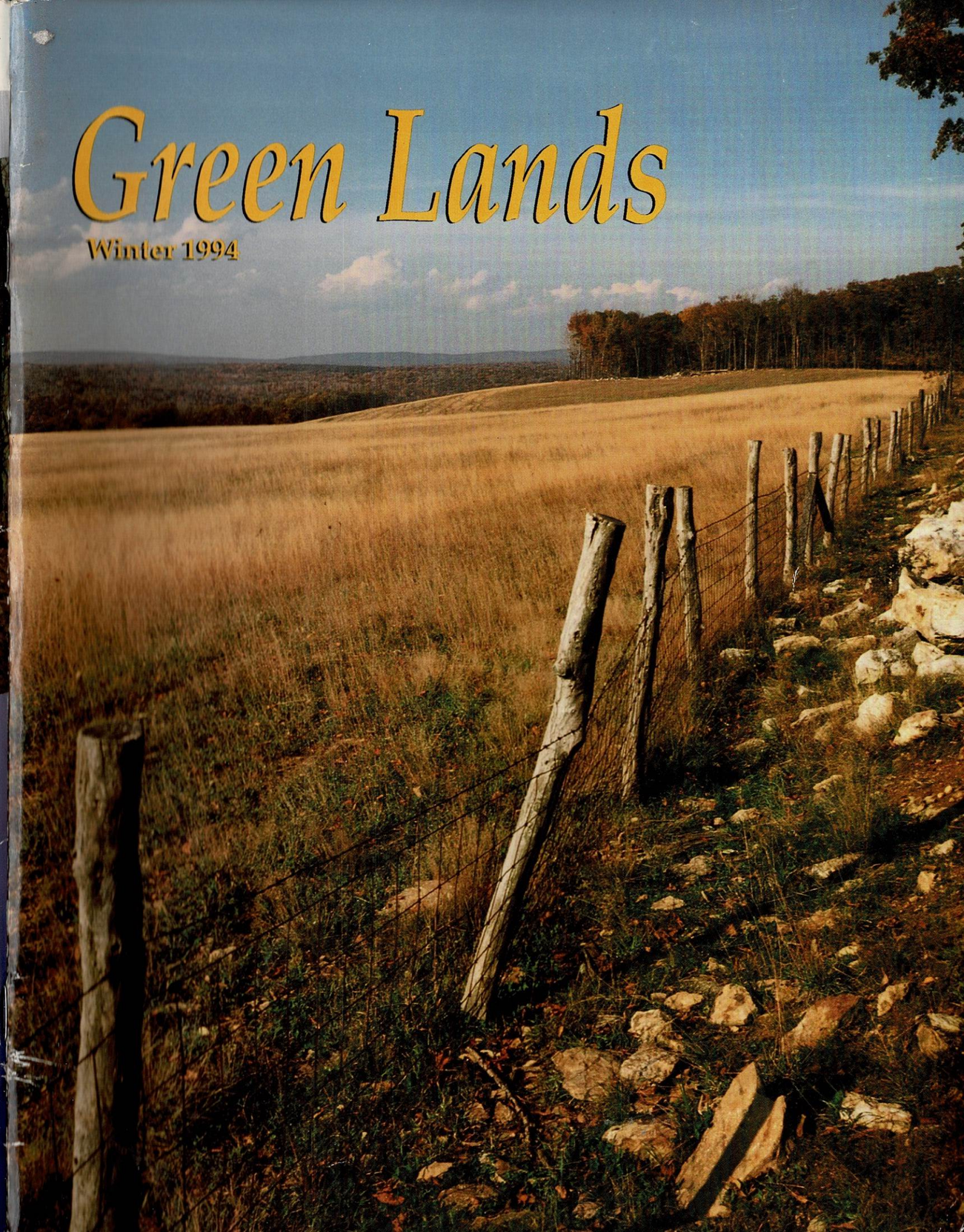
Green Lands

Winter 1994



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Consider the features and benefits that make this hauler stand out:

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Unmatched product support. This rugged Euclid hauler is backed by one of the best mining equipment dealers in the business — Rudd Equipment Company. We support our products like no other.

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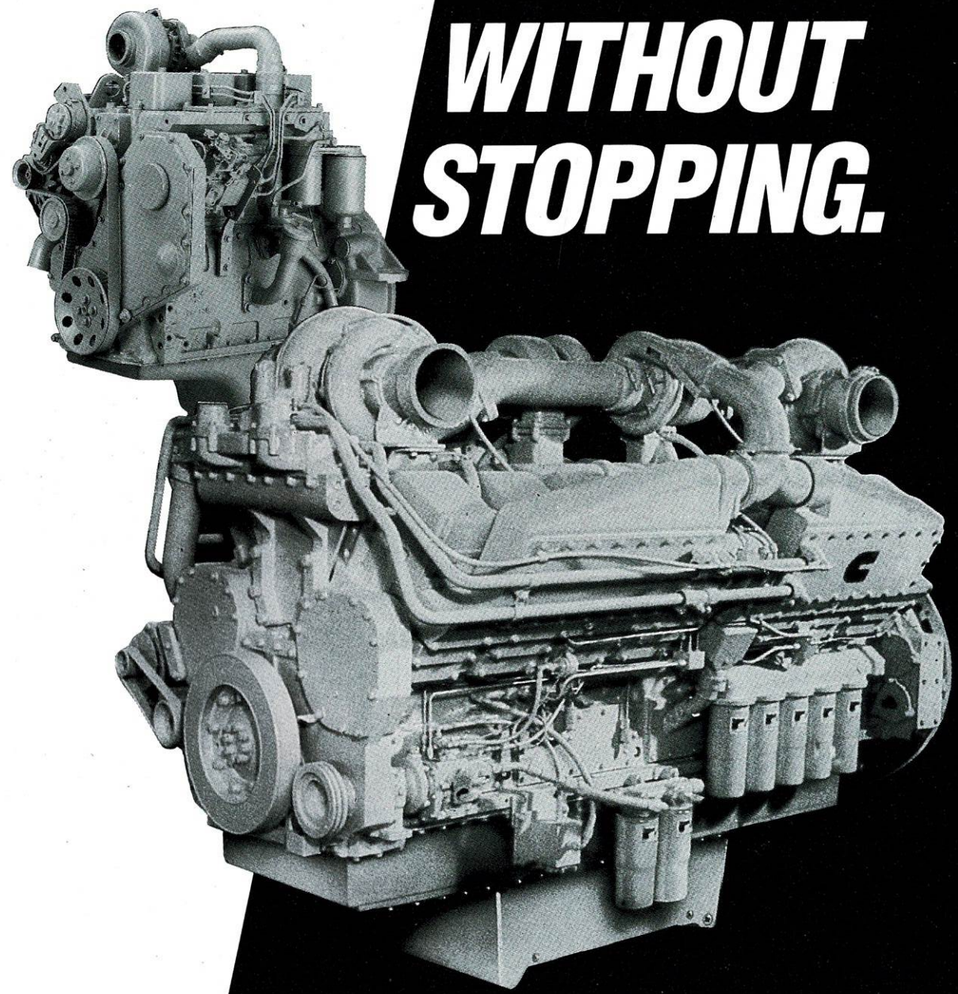

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Green Lands

Volume 24 Number 1

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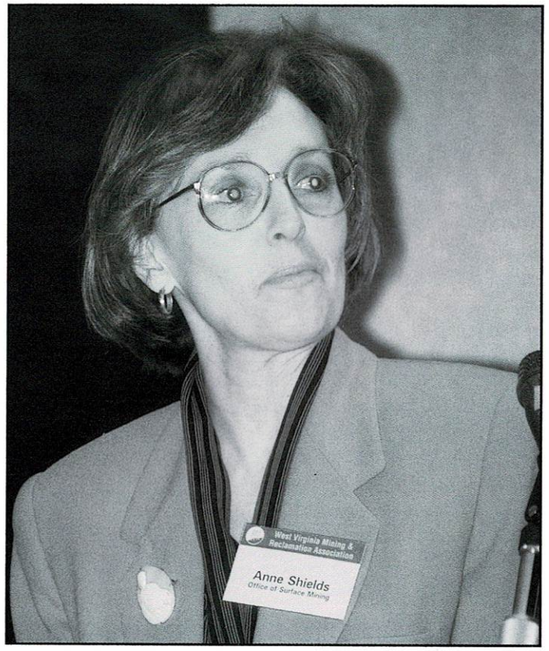
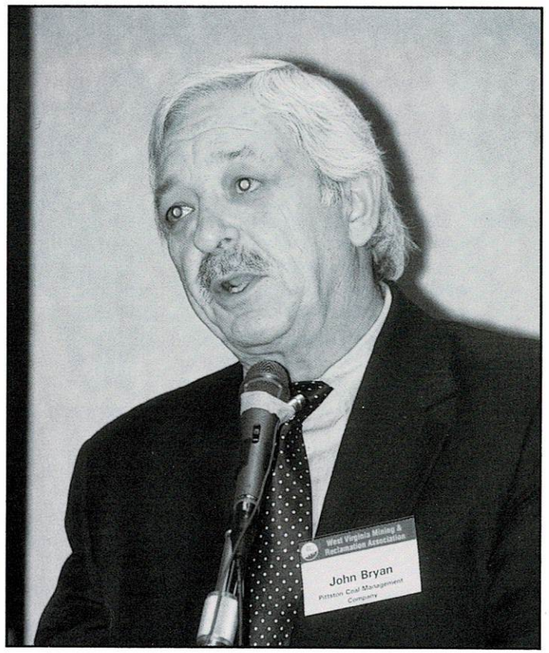
Our Cover
Lawrence and Lemule Myers pose proudly with the rainbow trout caught from a Meadow River Coal Co. sediment pond on Employee Appreciation Day
Our cover story begins on page 6. (photo by Tim Cox)

Index to Advertisers



Acting OSM Director Ann Shields on the new direction of her agency.



Association Chairman John Bryan offers a welcome to the 21st West Virginia Mining Symposium.

OSM Director at 21st Symposium

The 21st West Virginia Mining Symposium, held in Charleston early this year, featured an appearance by Ann Shields, Acting Director of the federal Office of Surface Mining, in addition to the traditional wide array of technical presentations and awards.

Shields was named late last fall to head an OSM "leadership team" pending the appointment of a permanent Director. Shortly thereafter, Robert Uram was nominated to the post. His appointment is pending before the U.S. Senate, where quick approval is expected.

Shields reported that OSM is undergoing a "bottom up review" of its goals, policies and procedures in preparation fo Uram's tenure and that industry should expect "no abrupt shifts of policy" during the upcoming change of leadership.

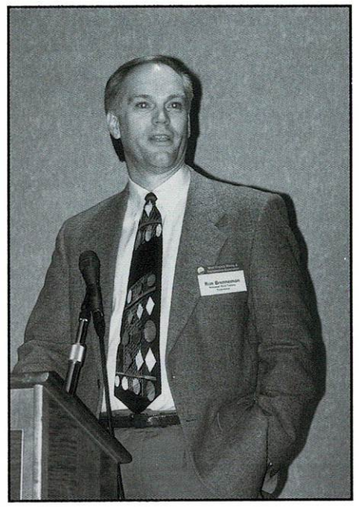
She described the goals of the current OSM administration as a "streamlining" of the agency overall, the "elimination of regulatory overkill," a movement from "contention to consensus" in dealing with various interest groups, and an improved relationship with state regulatory agencies.

She also described the controversial Applicant Violator System as "one of the agency's success stories," citing an improved compliance record by industry and a more even-handed imposition of the federal Surface Mining Control and Reclamation Act.

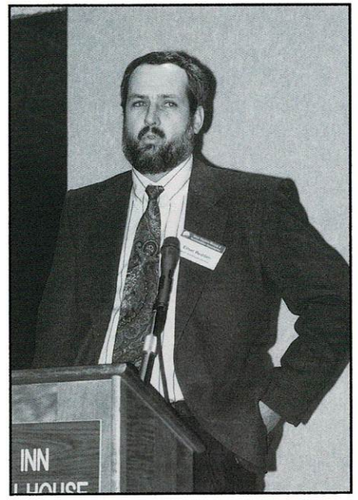
Attendees heard encouraging news from West Virginia Office of Miners' Health, Safety & Training Director Steve Webber, who reported a 50% decline in fatalities from 1991-1993, as well as a 35% drop in lost time accidents over the same period.

Other topics on the agenda included mine planning, fly ash, blasting, bonding, equipment, wildlife, aquaculture, hydrology, a report of the 1994 Regular Session of the West Virginia Legislature and the annual Friday morning session with Director Dave Callaghan and other key personnel from the State Division of Environmental Protection.

The two day session also included the traditional legislative reception.



Ron Brennaman of the National Wild Turkey Federation outlines mine reclamation techniues designed to enhance wildlife habitat.



WVU Extension Agent and Assistant Professor Edsel Redden summarizes the economic opportunities of raising trout in West Virginia's mine water.

Dr. Eli McCoy, newly named Deputy Director of WV-DEP, provides an update on the regulation of stormwater and groundwater.

The Symposium opened with a workshop conducted by (l-r) Steve Mullins, Charlie Sturey, Roger Hall, Louie Halstead, Jim Miller. Dana Burns, Mark Kiser and Tony Grbac.

Director Steve Webber of the West Virginia Office of Miners' Health, Safety & Training reports improved safety statistics for West Virginia miners.

The "Barton B. Lay 'Milestones of Safety' Award" goes to Eastern Associated Coal Co., Federal #2 Mine. West Virginia Office of Miners' Health, Safety & Training Director Steve Webber is flanked by Gary McHenry (l) and Jim Beck of Federal #2.

Record numbers for Mountaineer Guardian

The Mountaineer Guardian Awards luncheon, held halfway through the 21st West Virginia Mining Symposium, honored 92 coal mining operations and three prep plants for mining more than 500 million tons without a fatality. Both totals are a record for the 11 year old program.

Mountaineer Guardian winners are those mining operations which achieve tonnage goals, based on employment levels, without a fatal accident. Steve Webber, director of the West Virginia Office of Miners' Health, Safety & Training, was on hand to make the presentations. The program is sponsored jointly by Webber's agency and WVMRA.

Top honors at this year's luncheon went to Eastern Associated Coal Corp.'s Federal #2 Mine in Monongalia County. This workforce of 450 miners has produced over 40 million tons of coal over the last 13 years without a fatality. The mine was also recognized for its outstanding safety awareness programs, including the use of Safety Improvement Teams.

Federal #2 becomes the third West Virginia operation to receive the prestigious "Barton B. Lay, Jr. Milestones of Safety Award."

Webber and WVMRA Vice President K. O. Damron expanded the program this year to enroll all mining operations.

According to Damron, "This expansion resulted in an additional 47 awards in 1993, primarily for small coal mines. Coupled with the decline in fatalities from 22 in 1991, to 16 in 1992, and 11 in 1993, it is obvious that there is a substantial amount of energy being expended by West Virginia miners and operators towards providing safer workplaces."

Mountaineer Guardian Award Winners

Company	Mine
Ambrec Corp.	Preston Surface
Anchor Mining Co.	Anchor
Appalachian Mining Co.	Alloy
Arch of West Virginia	Ruffner
Arch of West Virginia	Wylo
Baldwin Mining Co.	No. 1
Banner Coal and Land	Winifred No. 8P
Bay Star Coal Co., Inc.	No. 2
Bay Star Coal Co., Inc.	No. 3
Belva Coal Co.	Job No. 1
Birchfield Mining, Inc.	No. 1
Black Bear Mining, Inc.	No. 2
Buffalo Coal Co.	Surface
Cannelton Industries, Inc.	No. 130
Colony Bay Coal Co.	Colony Bay
Consolidation Coal Co.	Amonate No. 31
Consolidation Coal Co.	Arkwright No. 1
Consolidation Coal Co.	Blacksville No. 2
Consolidation Coal Co.	Humphrey No.7
Consolidation Coal Co.	Shoemaker
Cow Creek Coal Co.	No. 4
Cow Creek Coal Co.	No. 6
Cub Branch Mining Co.	Frank Maynard Branch
D. & K. Coal Co.	No. 4-A
Dal-Tex Coal Corp.	Coalburg No. 6
Daniel's Branch Coal Co.	No. 1
Decondor Coal Co., Inc.	No. 7
Doss Fork Coal Co., Inc.	Seminole
Double Camp Energy, Inc.	No. 1
Eagle Carbon Mining Corp.	No. 1
Eastern Associated Coal	Federal No. 2
Eastern Associated Coal	Harris No. 1
Eastern Associated Coal	Kopperston No. 1
Eastern Associated Coal	Lightfoot No.1
Elk Run Coal Co.	Black Castle Surface
Elk Run Coal Co.	Castle
Evergreen Mining Co.	Evergreen
Fairfax Fuel, Inc.	No. 1
Grafton Coal Co.	Brooks Run No. 5
Greasy Creek Coal Co.	No. 2
Heartland Resources, Inc.	Lincoln County Surface
High Power Energy	High Power
Independence Coal Co.	King
Juliana Mining Co., Inc.	Amos Run
Laurel Coal Corp.	Coalburg No. 9
Laurel Creek Co., Inc.	Dingess Surface
Martinka Coal Co.	Tygart River Prep Plant
McElroy Coal Co.	McElroy
Meador Energy, Inc.	No. 1
Meadow River Co.	Meadow River
Mingo Logan Coal Co.	Mountaineer
Murphy's Branch, Inc.	No. 1
Navaro Mining, Inc.	No. 1
Newtown Energy, Inc.	No. 1
Northland Resources Co.	Northland Prep Plant
Old Hickory Coal Co.	Rockhouse Left Fork
Omega Square	No. 1
Patriot Mining Co.	Patriot Prep Plant
Patriot Mining Co.	Patriot Surface
Peabody Coal Co.	Big Mountain No. 16
Peabody Coal Co.	Montcoal No. 7
Philippi Development, Inc.	Sentinel
Pine Creek Mining, Inc.	No. 2-A
Pine Mountain Resources	No. 4 Mine
Premium Energy, Inc.	Mingo Surface
Princess Beverly Coal Co.	Princess Beverly
Quality Energy, Inc.	No. 1
Radec, Inc.	No. 4
Rauer Coal Corp.	No. 108
Rocky Hollow Coal Co.	Rocky Hollow
Select Mining, Inc.	No. 2
Southern Edge, Inc.	No. 1-B
Stanley Industries, Inc.	Barbour & Upshur
Squires Creek Coal Co.	No. 1 S
unrise Mining, Inc.	No. 1
Swamp Fox Development Co.	Coalburg No. 8
Sycamore Fuels, Inc.	No. 1
T.& T. Energy, Inc.	T. & T. Energy No. 1
T.& T. Fuels, Inc.	No. 2
Talon Resources, Inc.	Orion
Toney's Branch Coal Co.	No. 56
Toney's Branch Coal Co.	Shumate Eagle
Trinity Mining, Inc.	No. 1
Twin Branch Coal Co.	No. 20-D B
U.S. Steel Mining Co., Inc.	No. 50
U.S. Steel Mining Co., Inc.	Shawnee
Vandalia Mining Corp.	Monac No. 2
Virginia Crews Coal Co.	No. 14
War Eagle Construction	No. 5
Western Mingo Coal Co.	No. 1
Westmoreland Coal Co.	Hampton No. 41
Wind River Resources Corp.	Cazy Surface
Windsor Coal Co.	Windsor
Wynchester Mining Co.	Black Oak
Wynchester Mining Co.	Campbells Creek No. 2

Representatvies of **Buffalo Coal Co.** accept the company's unprecedented third "David C. Callaghan Award." From left to right are Association Chairman John Bryan, DEP Director Dave Callaghan, Buffalo officials Don Cussins, Melvin Judy, Jerry Duckett, Steve Shaffer and Inspector Craig See.

Buffalo Coal wins 3rd 'Callaghan Award'

Buffalo Coal Co. has won the "David C. Callaghan Award" as the outstanding mining operation in West Virginia for an unprecedented third time.

Presentation of the Callaghan Award, named for the former director of the State Department of Natural Resources and present director of the State Division of Environmental Protection, is the highlight of the closing luncheon of the annual West Virginia Mining Symposium.

"I can't think of a finer representative for our industry than Buffalo Coal " said WVMRA President Ben Greene. "This is a company which invariably goes the extra mile, not only with outstanding reclamation, but also with regard to community involvement, the use of state of the art technique and technology, tremendous efforts to preserve and expand wildlife habitat, an unfailing willingness to go beyond requirements of the law and a firm commitment to the economic future of West Virginia. Every Buffalo operation has taken its place as a showplace of mining in northern West Virginia.

"This is the third time that (President) Don Cussins and Buffalo Coal have won the 'Callaghan Award.' Only one other company has won it twice. That should stand as a clear indication of Buffalo's stature in the industry."

A total of 19 West Virginia coal companies were recognized at the luncheon for excellence in reclamation.

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 the reclamation of mined land. To be considered for the award, a company must be nominated by its local DEP inspector.

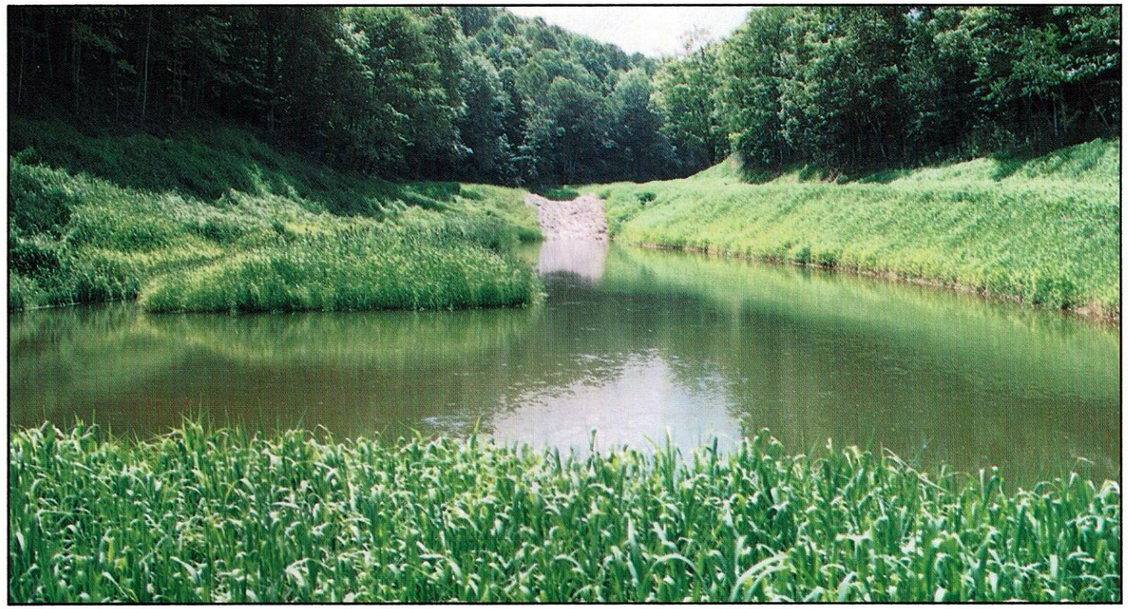
"This premier awards program was the first of its kind in the nation and has been copied in many states as well as on the national level," said Greene. "We had a record number of nominees this year and that reflects well on the state of mining reclamation in West Virginia."

DAVID C. CALLAGHAN AWARD
Buffalo Coal Company

In Grant and Tucker counties, for overall excellence in all phases of design, execution and operation of more than twenty separate mining operations and related facilities, which have become a showcase for a wide variety of touring groups on a state, regional and national basis. The company's long-standing record of exemplary and concurrent reclamation in the face of environmentally sensitive conditions, its ongoing use of state of the art technique and technology, its successful efforts to preserve, improve and expand wildlife habitat, its willingness to go far beyond requirements of the law to the benefit of the community and its citizens, its commitment to the present and future economic well-being of West Virginia, all reflect the highest standards of the modern coal industry.

Congratulations to all Reclamation Award Nominees

COMPANY	COUNTY	INSPECTOR
Ackley Houston Corp.	Fayette	Joe Laughery
Allegheny Mining Corp.	Grant	Craig See
Allied Mining Co.	Preston	Ron Hooton
American Bituminous Power Partners	Marion	Mike Nunan
Appalachian Mining, Inc.	Fayette	K. William Hauer
Arch of West Virginia	Logan	Ron Sheets
Big Bear Mining Co.	Wyoming	John Waggoner
Bluestone Coal Corp.	McDowell	Barry Bowman
Bradford Coal Co.	Kanawha	Phil Mooney
Buffalo Coal Co.	Grant	David Idleman
Buffalo Coal Co.	Grant	Craig See
C & J Coal Co.	Monongalia	Brad Moore
C & W Coal Co.	Upshur	Joe Altieri
C. J. Coal Co.	Upshur	Joe Altieri
Cannelton Industries, Inc.	Kanawha	Mark Foley
Chase Enterprises	McDowell	Allen Vest
Coal Cave, Inc.	McDowell	Earl Holt
Coaltrain Corp.	Taylor	Terry Washburn
Coaltrain Corp.	Preston	Paul Dixon
Coal Valley Mining	Raleigh	Manuel Seijo
Cyprus Kanawha Corp.	Fayette	James Lucas
D & L Coal Co.	Mineral	David Idleman
Donaldson Mine Co.	Kanawha	Pat Lewis
Drummond Co., Inc.	Wyoming	Larry Cook
E. T. & S., Inc.	Mason	Benny Campbell
E & H Mining & Trucking, Inc.	Wyoming	Eugene Lacy
Eastern Energy Corp.	McDowell	William Thomason
Elk Run Coal Co.	Boone	Bill Cook
Evergreen Mining Co.	Webster	Keith Evans
Grafton Coal Co.	Lewis/Braxton/Webster	Frank Shreve
Greenbrier Coal Co.	Greenbrier	Perry Critchley
Greenbrier Coal Co.	Greenbrier	Albert Rodebaugh
Green Mountain Co.	Monongalia	David Pybus
High Power Energy/High Power Mountain Corp.	Nicholas	Bill Little
Hobet Mining, Inc.	Boone	Kevin Quick
Island Creek Coal Co.	Nicholas	Nancy Hieb
Island Creek Coal Co.	Upshur	Martin Dickinson
Kimberly Industries, Inc.	Gilmer	James Bazak
Laurita Energy Corp.	Monongalia	R. K. Henry
Leckie Smokeless Coal Co.	Greenbrier	Robert Norman
Level Land Construction Co.	Nicholas	Nancy Hieb
McCoy Brothers, Inc.	Barbour	Tim Richard
Maple Meadow Mining Co.	Raleigh	Jerry Stover
Marker & Sons	Kanawha	Mike Richardson
Melissa Coals, Inc.	Mercer	Larry Cook
Morgantown Energy Export Co.	Monongalia	M. A. Kromer
National Mines Corp.	Wyoming	Eugene Lacy
PCR Joint Venture	Raleigh	G. A. Morton
Patriot Mining Co.	Monongalia	Steve Ball
Patriot Mining Co., Inc.	Preston	Paul Dixon
Pax Mining Co.	Wyoming	Steve Sizemore
Pioneer Construction Co., Inc.	McDowell	Allen Vest
Pups Creek Coals, Inc.	Raleigh	Jerry Stover
Rawl Sales & Processing Co.	Mingo	Haskel Boytek
Rawl Sales & Processing Co.	Mingo	Timothy Justice
Rawl Sales & Processing Co.	Logan	Timothy Justice/Darrell O'Brien
Southern Minerals, Inc.	McDowell	Tom Pickett
Springdale Mining, Inc.	Fayette	Perry Critchley
T & L Augering	Fayette	Joe Laughery
Terry Eagle Coal Co., ALP	Nicholas	G. Cam Ford
U.S. Steel Mining Co., Inc.	Wyoming	Jerry Quesenberry
V & C, Inc.	McDowell	James Rose/Jackie Taylor
Vaco Enterprises, Inc.	McDowell	Arnold Fortner



WETLANDS WEST VIRGINIA AWARD
Kimberly Industries, Inc.

Kimberly Industries receives the third annual "Wetlands West Virginia Award" from Ducks Unlimited. l-r Inspector James Bazak, DU Howard Blyle of DU, George Freshour of Kimberly.

Presented by Ducks Unlimited for outstanding accomplishment in the creation and preservation of wetlands wildlife habitat.

WILDLIFE WEST VIRGINIA AWARD
Hobet Mining, Inc.

National and state officials of the National Wild Turkey Federation present **Hobet Mining Co**. with the first "Wildlife West Virginia Award." l-r Dr. John Starcher, Larry Emerson of Hobet, Mickey Hurst, Dennis Campbell, John Lowe of Hobet, Inspector Kevin Quick, Jim Ratcliff and Bob Fala, both of Hobet.

Presented by the West Virginia Chapter of the National Wild Turkey Federation for outstanding accomplishment in the establishment and enhancement of overall wildlife habitat, with special emphasis on wild turkeys.

Allegheny Mining Corporation

In Grant County, for the complete and successful conversion of more than 160 acres of timberland to a more productive hay and pasture use. Unique to the operation is the development of steep slope areas for wildlife habitat, which is now home to a wide variety of upland game species.

Allegheny Mining Corp. - John Kortas, Chairman Bryan, Director Callaghan, Lawrence Streets.

Appalachian Mining, Inc.

Appalachian Mining, Inc. - Chairman Bryan, Inspector William Hauer, Director Callaghan, G. O. Young, Roy Hamilton.

In Fayette County, for the successful use of maximum extraction technology in remining more than 7,400 feet of old highwall in extremely steep sloped terrain. The operation included complete highwall elimination and stabilized all unconsolidated material through the construction of a modified 12 lift rock buttressed valley fill.

Arch of West Virginia, Inc.

In Logan County, for outstanding reclamation on the Abe Burgess Refuse Area, using innovative direct seeding techniques. Originally established in the early 1950's, the site was used by several companies before regrading and revegetation were initiated in 1991. The company's direct seeding has been highly successful with an impressive reclamation result.

Arch of West Virginia, Inc. - Chairman Bryan, Inspector Ron Sheets, Dave DePasquale, Director Callaghan, Linda Torre, Fred Barata.

Big Bear Mining Company

Big Bear Mining Co. - Chairman Bryan, Inspector John Waggoner, Director Callaghan, Lloyd Adams.

In Wyoming County, for aggressive pursuit of a major mining complex cleanup, including more than 950 feet of new stream channel, an automated acid mine drainage treatment system and major upgrading of the local road system. Design and supervision for the overall work was carried out with wildlife and aquatic enhancement as a top priority.

C & W Coal Company

In Upshur County, for exemplary attention to detail and finesse in the planning and construction of drainage control structures and haulroads, with careful attention to the protection of local residents. All drainage channels have been rip-rapped with durable rock and an extremely lush growth of grasses and legumes covers all disturbed areas.

C & W Coal Co. - Chairman Bryan, Director Callaghan, Gerald Ramsburg.

Cannelton Industries, Inc.

Cannelton Industries, Inc. - Chairman Bryan, Kevin Whipkey, Director Callaghan, Inspector Mark Foley, Joe Overbay.

In Kanawha County, for the successful installation of a new underground operation with particular attention to detail in the development of a valley fill to provide a working area, the utilization of a modern conveyor system for accelerated coal transportation and stabilization of the total disturbed area with extensive herbaceous cover.

"Are you sure this used to be a coal mine, Grandpa?"

This reclamation site at White Flame Energy in Mingo County exemplifies the reasons why Walker Machinery and Caterpillar strongly believe in keeping our environment green. Not only has this site been preserved for future generations, but it was mined successfully and uniquely recognized for its reclamation and safety record.

In the spring of '93 the folks at White Flame Energy, Inc. received a prestigious reclamation award from the West Virginia Mining and Reclamation Association. The Association said that this mine has shown "extraordinary efforts and results in drainage construction, valley and durable rock fill construction and has gone beyond the call of duty in revegetation plans to maximize the post-mining land use of forest land in accordance with the wishes of the landowner."

At the same time, the Association gave White Flame Energy, Inc. a Mountaineer Guardian Award. These certificates are awarded to coal mines which achieved designated tonnage goals, based on employment, without a fatal accident.

This demonstrates the ability to compete in a tough coal market without compromising safety or the environment... meaning jobs for West Virginians while keeping our state green.

As a West Virginia company, Walker is proud to have provided the Caterpillar equipment used to mine and reclaim this land. We recognize that there is a delicate balance between mining West Virginia coal and preserving the land for future generations. Our goal is for West Virginia's grandchildren to say, "Are you sure this used to be a coal mine, Grandpa?"

Walker CAT

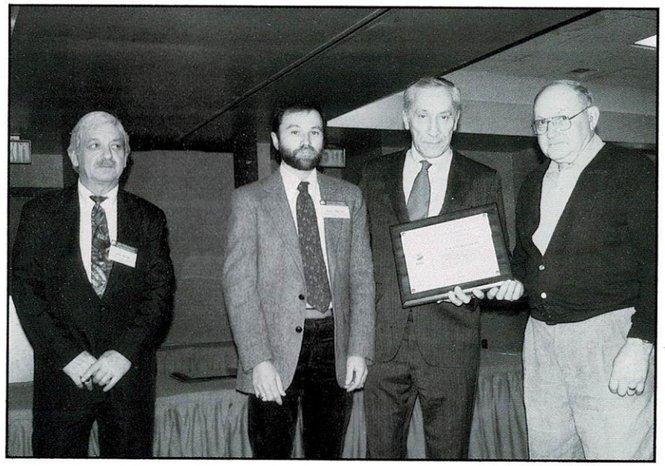
304/949-6400

Coaltrain Corporation

In Taylor County, for the complete elimination of more than 7,000 feet of abandoned highwall, the toxic remnants of an old underground mine and the major conversion of a wasteland to a highly productive hayland and pasture use. All farm access roads and two very beneficial farm ponds were upgraded to the benefit of the landowner.

Coaltrain Corp. - Chairman Bryan, Inspector Terry Washburn, Director Callaghan, Glen Larew.

D & L Coal Company



D & L Coal Co. - Chairman Bryan, Inspector David Idleman, Director Callaghan, Lawrence Streets.

In Mineral County, for the removal of an abandoned tipple, junked cars and many years accumulation of local trash during the successful mining of a contiguous, previously mined underground site. A major barrier of undesirable trees, brush and rough terrain was carefully transformed to provide the Nethkin Hill Cemetery with much needed expansion area.

Elk Run Coal Company, Inc.

In Boone County, utilizing ridgetop removal with four valley fills, this 239 acre site was completed in less than two years with excellent workmanship in all phases of mining and reclamation. Concurrent revegetation complemented ongoing mining with a uniform herbaceous cover which has greatly expanded the resident wildlife

Elk Run Coal Co., Inc. - Inspector Bill Cook, Chairman Bryan, Billy Legg, Gary Underwood, Director Callaghan, Doug Wilcox.

McCoy Brothers, Inc.

McCoy Brothers, Inc. - Chairman Bryan, Inspector Tim Richard, Director Callaghan, Jerry Kittle, Terry Upton.

In Barbour County, for the elimination of several thousand feet of existing highwall during the remining and reclamation of a 30 acre site and for the successful restoration of the area through the careful blending of the site with adjacent acreage resulting in a productive and visually pleasing pastureland.

Patriot Mining Company, Inc.

In Monongalia County, for exemplary performance in transforming a 40 acre site of forestland and pasture to a highly productive pasture and meadowland. An excellent cover of grasses and legumes has been established and a large, well maintained sediment control structure has enhanced the postmining land use for the landowner.

Patriot Mining Co., Inc. - Chairman Bryan, Roy Eddy, Brownie Stuart, Dottie Brand, Inspector Steve Ball, Director Callaghan, Dick Bolen, Ron Hambric.

V & C, Inc..

V & C, Inc. - Chairman Bryan, Inspector James Rose, Director Callaghan, Carmen Di Angelo.

In McDowell County, for the successful reprocessing of an abandoned refuse site, for the complete reclamation of a partially burned area and for the total restoration of an extremely steep 50 acre eyesore to a stable and visually pleasing, well vegetated area, all of which was accomplished with no funding from the Abandoned Mine Land program.

Rawl Sales & Processing Company
Contractor: E & D Construction Company

In Logan County, for outstanding community involvement in the establishment of a modern underground mining complex, including the paving of the entire mine area, for the construction of a new bridge to highway specifications and for the land acquisition and subsequent construction of a fully equipped playground and walking track for the benefit of the residents of Sarah Ann.

Rawl Sales & Processing Co. - Chairman Bryan, Inspector Timothy Justice, Johnny Jones, Director Callaghan, Charles Snavely, Gary Hatfield.

Terry Eagle Coal Company, ALP
Contractor: Vencill Corporation

Terry Eagle Coal Co., ALP / Vencill Corp. - Chairman Bryan, Delmer Vencill, Inspector Cam Ford, Director Callaghan, Ernest Vencill, Monte Heib.

In Clay County, for upgrading and stabilizing 5.5 miles of local service roads to facilitate haulage from a contour haulback operation. The use of sediment cells and drainage control impoundments, together with concurrent reclamation, provided excellent sediment control for Buffalo Creek. A four acre reserve was established to protect the second largest yellow poplar tree in West Virginia.

AML Award - North
Green Mountain Company

In Monongalia County, for the timely and economical completion of an Abandoned Mine Lands contract for the "Camp Run Highwall Project," in which the company removed a threatening outslope adjacent to a local residence, eliminated an inactive underground mine, recontoured all existing highwalls, and stabilized the entire area with a sophisticated underdrainage system.

Green Mountain Co. - Chairman Bryan, Dave Bowman, Director Callaghan, Inspector David Pybus.

AML Award - South
Pioneer Construction Company, Inc.

Pioneer Construction Co., Inc. - Chairman Bryan, Inspector Allen Vest, Ann Wardwell, Director Callaghan, Jay Wardwell.

In McDowell County, for the effective completion of an Abandoned Mine Lands contract for the "Jed Haveco Dump Project," during which the company eliminated an unconsolidated burning refuse pile and removed an unstable impoundment. This project involved almost one million yards of material handling and more than a half mile of velocity controlled stream channel construction.

Floc Generation
by Chemical Neutralization of Acid Mine Drainage

H. Brown, J. Skousen, and J. Renton
West Virginia University

Introduction

Acid mine drainage (AMD) is a low pH, sulfate-rich solution with high acidity and iron concentrations. It results from the oxidation of metal disulfide minerals upon exposure to air and water. Coal and metal mining operations throughout the world are plagued by the generation of AMD and its potential to pollute water resources. Laws and regulations require that water contaminated by AMD must be treated to remove metals and neutralize acidity before discharging into ground or surface waters.

Chemical treatment of AMD is primarily designed to neutralize acidity, raise pH, and to precipitate metals dissolved in the water. Four chemicals (calcium hydroxide, sodium hydroxide, sodium carbonate, and ammonia) are predominately used to treat AMD, and costs of treating various amounts of AMD with these chemicals have been outlined (Skousen et al. 1990).

After chemical treatment, the treated water flows into sedimentation ponds so metals in the water can precipitate. Residence time of the water, which is dictated by pond size and depth, is important for adequate metal precipitation. Hilton (1993) found pond size to be too small on most AMD treatment sites to result in complete treatment of the water and precipitation of dissolved metals, and encouraged adequate sizing for AMD treatment. Sometimes when pond size is inadequate, special chemicals such as coagulants, flocculants, or oxidants are needed to improve the removal of metals in AMD (Skousen et al. 1993).

Dissolved metal ions are precipitated from AMD as a loose, open-structured mass of tiny grains called "floc". The amount of metal floc generated by AMD neutralization depends on the quality and quantity of water being treated. Large quantities of highly acidic AMD are treated with chemicals in West Virginia and other Appalachian states thereby creating vast amounts of AMD floc.

In order to maintain adequate water-holding volumes, floc must be periodically removed from AMD treatment ponds to provide sufficient residence time for metal precipitation. Costs of removing floc from AMD ponds and hauling the floc to disposal sites are estimated to be almost equal to the costs of chemically treating the water. Locations commonly used for disposal of AMD pond floc include abandoned deep mines, pits on surface mines, and refuse piles. Because of the large amount of pond floc being generated, concern for adequate disposal of this material is growing. In addition, little is known about the stability of these flocs once they are removed from AMD ponds.

Table 1. General characteristics of sites used in this study.

Site	Treatment Chemical	AMD Composition	Coal Bed	Mining Type
1	Calcium Hydroxide	Hi Fe, Lo Mn	Pittsburgh	Underground
2	Ammonium Hydroxide	Hi Fe, Lo Mn	Upper Freeport	Underground
3	Sodium Carbonate	Lo Fe, Hi Mn	Pittsburgh	Surface
4	Sodium Hydroxide	Mod Fe, Hi Mn	Waynesburg	Surface

Previous Work

Ackman (1982) investigated the chemical and physical characteristics of AMD floc and concluded that each floc varied depending on the nature of the AMD, the neutralization chemical, and the mechanical mixing or aeration device used with the chemical. According to him, the most important floc physical property is its settleability, which includes both the settling rate and final floc volume.

Ackman found that calcium hydroxide and sodium carbonate produced a granular, dense floc versus a more gelatinous, loose floc generated by sodium hydroxide or ammonia (ammonium hydroxide). The chemical compositions of flocs were generally composed of hydrated ferrous or ferric oxides, gypsum, hydrated aluminum oxide, calcium carbonate and bicarbonate, with trace amounts of silica, phosphate, manganese, copper, and zinc.

Payette et al. (1991), using scanning electron microscope analyses, found that AMD neutralized by calcium hydroxide resulted in the formation of crystalline gypsum as well as various amorphic metal hydroxides. Amorphic materials are those that have little or no structure and order, and have a tendency to dissolve more quickly than crystalline materials under the same conditions. Rocks and minerals, on the other hand, show strong order, structure, and crystallinity. Amorphic materials may also become ordered or crystalline with time. Payette et al. showed that AMD floc was mostly amorphous at 1 hour after formation, while crystals developed in the floc 24 hours after formation.

The purpose of this study was to determine the effects of four different neutralization chemicals on floc generation from four AMD sources. We also assessed the efficiency of floc production with the chemicals at various pH levels. In subsequent papers, chemical compositions of these flocs and the effect of ageing will be evaluated.

Experimental Procedures

Four AMD treatment sites were selected, each having unique concentrations of dissolved constituents (Table 1). Different neutralization chemicals for AMD treatment were used at each of the sites. (In an upcoming Green Lands article, experimental flocs generated in the laboratory will be compared to field flocs collected from AMD ponds at each site).

Untreated AMD from each site was characterized by standard methods in the National Research Center for Coal and Energy Laboratory at West Virginia University. The water was analyzed for pH, specific conductance, acidity, total iron, ferrous iron, manganese, aluminum, calcium, nickel, zinc and sulfate. Acidity and pH measurements were performed upon reaching the laboratory. The samples were then further acidified to prevent precipitation of metals until their analysis by atomic absorption spectrophotometry.

Experimental flocs were generated by treating each AMD with each of the four chemical reagents in the laboratory. Twelve samples of each AMD were treated with each neutralization chemical to 6 different final solution pH's (4.5, 5.5, 6.5, 7.5, 8.5 and 9.5). Six of the samples were allowed to react for 2 days while the other six were allowed to react for 2 weeks.

Table 2. Laboratory analyses of untreated AMD from four different sites in West Virginia. Ionic concentrations are given in mg/L, while acidity is given in mg/L $CaCO_3$ equivalent and conductance (cond) in micromhos/cm.

Parameter	Site 1	Site 2	Site 3	Site 4
pH	3.6	3.0	3.6	4.3
Cond	2880	4720	949	2380
Acid	1263	3152	516	1212
Fe_T	341	1129	7	160
Fe^{+2}	4	870	1	151
Mn	4	7	20	42
Al	80	118	41	38
Ca	353	329	78	270
Ni	1	4	1	2
Zn	1	15	1	2
SO_4	2850	4300	640	2097

Results and Discussion

The untreated AMD from the four sites showed wide variation in elemental compositions (Table 2). Acidity ranged from 516 mg/L on site 3 to 3152 mg/L on site 2. Total iron varied between 7 mg/L on site 3 to 1129 mg/L on site 2. Manganese and aluminum were also variable. The iron to manganese ratios of these four sites were 85, 161, 0.3, and 3.8, respectively.

The oxidation status of the water can be evaluated by noting the ferrous iron composition of the water and comparing it to total iron. The percentage of ferrous iron to total iron was 1, 77, 14, and 94%, respectively on these sites. Sites 2 and 4 were therefore presumed to have low oxygen concentrations.

The treatment pH and the composition of the chemical reagent significantly affected metal removal and floc generation from these four untreated waters. Figure 1 summarizes the amount of floc produced per liter (quart) of treated AMD for each site. Raising the pH to six different final solution pH's with each chemical allowed a comparison of the amount of floc produced at these pH levels.

As expected, the amount of floc generated from each AMD generally increased with increasing treatment pH. However, the responses were not always predictable. The amount of floc produced on site 3 was particularly difficult to explain.

Chemical Effects on Floc Generation

Sodium hydroxide (first column of each pH in Figure 1) produced a linear response between floc production and pH on sites 1, 3, and 4, while it did not produce much more floc on site 2 at pH 7.5 or greater. Most of the acidity on site 2 was related to aluminum and iron concentrations, especially ferrous iron. These two ions precipitate at about pH 5.5 and 8.5, respectively. Some of the ferrous iron was probably oxidized to ferric iron which precipitates at much lower pH's (3.5 and above). Therefore, adding more sodium hydroxide to attain a pH of greater than 7.5 did not appear to greatly increase the amount of floc on site 2.

Ammonium hydroxide (second column) showed a linear response between floc generation and pH on sites 1 and 4. On site 2, floc production was low at pH 4.5 to 6.5, and, while floc production increased at higher pH, the quantity of floc stayed about the same between pH 7.5 to 9.5. On site 3, floc production at pH 5.5 to 8.5 was similar, while it was low at pH 4.5 and much higher at pH 9.5.

Calcium hydroxide treatment presented some problems in the laboratory. Because of its limited solubility, a greater amount of water was needed to dissolve the same strength of chemical in the treatment solution. As a result, a dilution effect was introduced when using this chemical. There also are a few points of missing data; namely, on site 1 at pH 8.5, and on site 4 at pH 6.5. Sites 1 and 4 showed a general linear response, site 2 leveled off at pH 7.5 and greater, and no trend was apparent on site 3. On site 3, calcium hydroxide produced the most floc at pH 6.5.

Sodium carbonate produced the most floc at pH 9.5 on sites 1, 2, and 4, and generally produced a logarithmic response as pH increased. The reason for high amounts of floc at this pH was due to the formation of calcite ($CaCO_3$), as indicated by X-ray diffraction analysis of the flocs (compositions of flocs will be developed in a later paper). Site 3, however, showed similar amounts of floc at pH 4.5 to 7.5, while pH 8.5 and 9.5 were similar in floc production with both being much higher than at lower pH's.

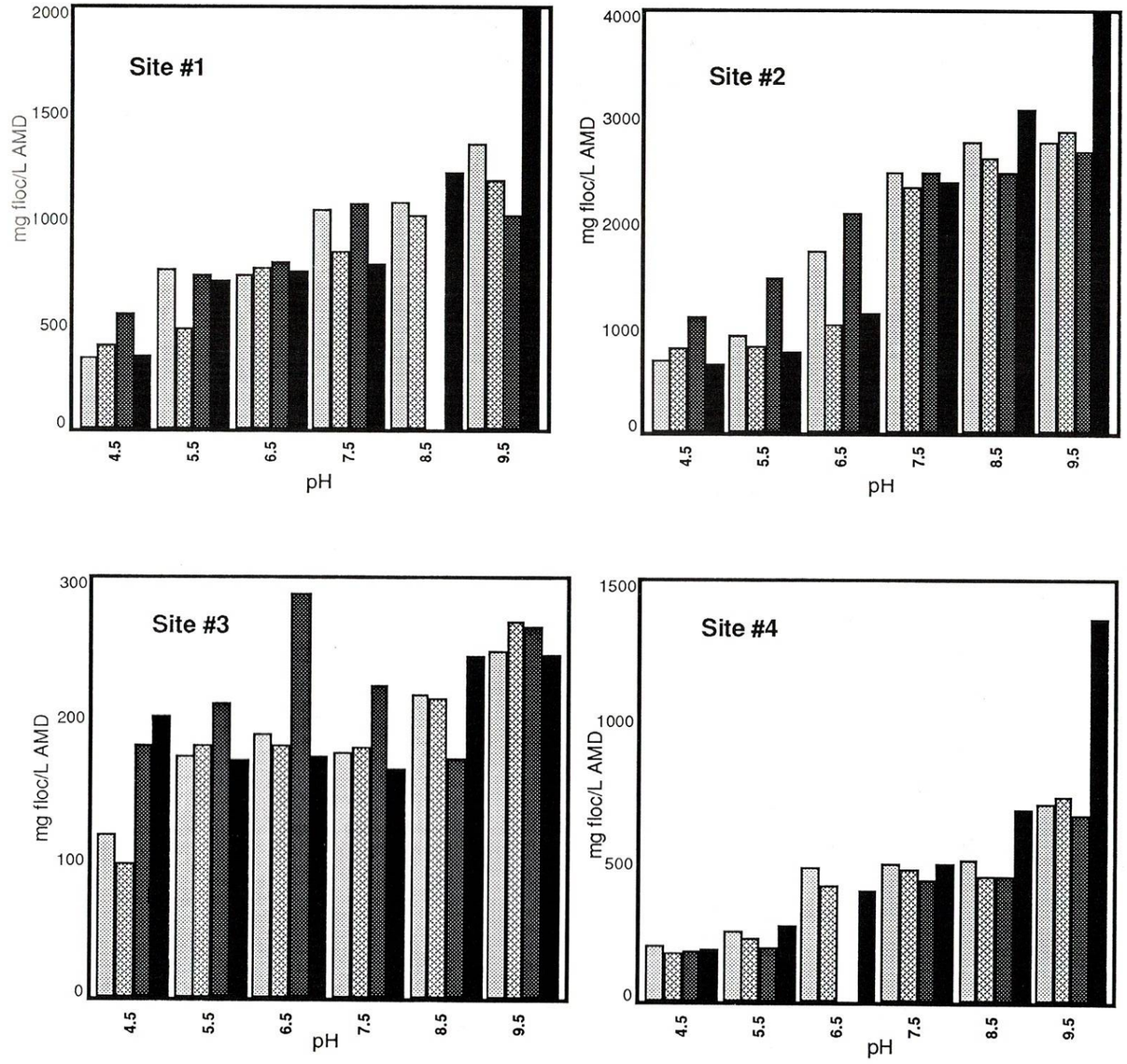


Figure 1 Amount of floc produced by treating four AMD sources (Sites 1 to 4) with sodium hydroxide (NaOH), ammonium hydroxide (NH_4OH), calcium hydroxide ($Ca(OH)_2$), and sodium carbonate (Na_2CO_3) to various final solution pH (4.5 to 9.5). Note differences in scale on vertical axis.

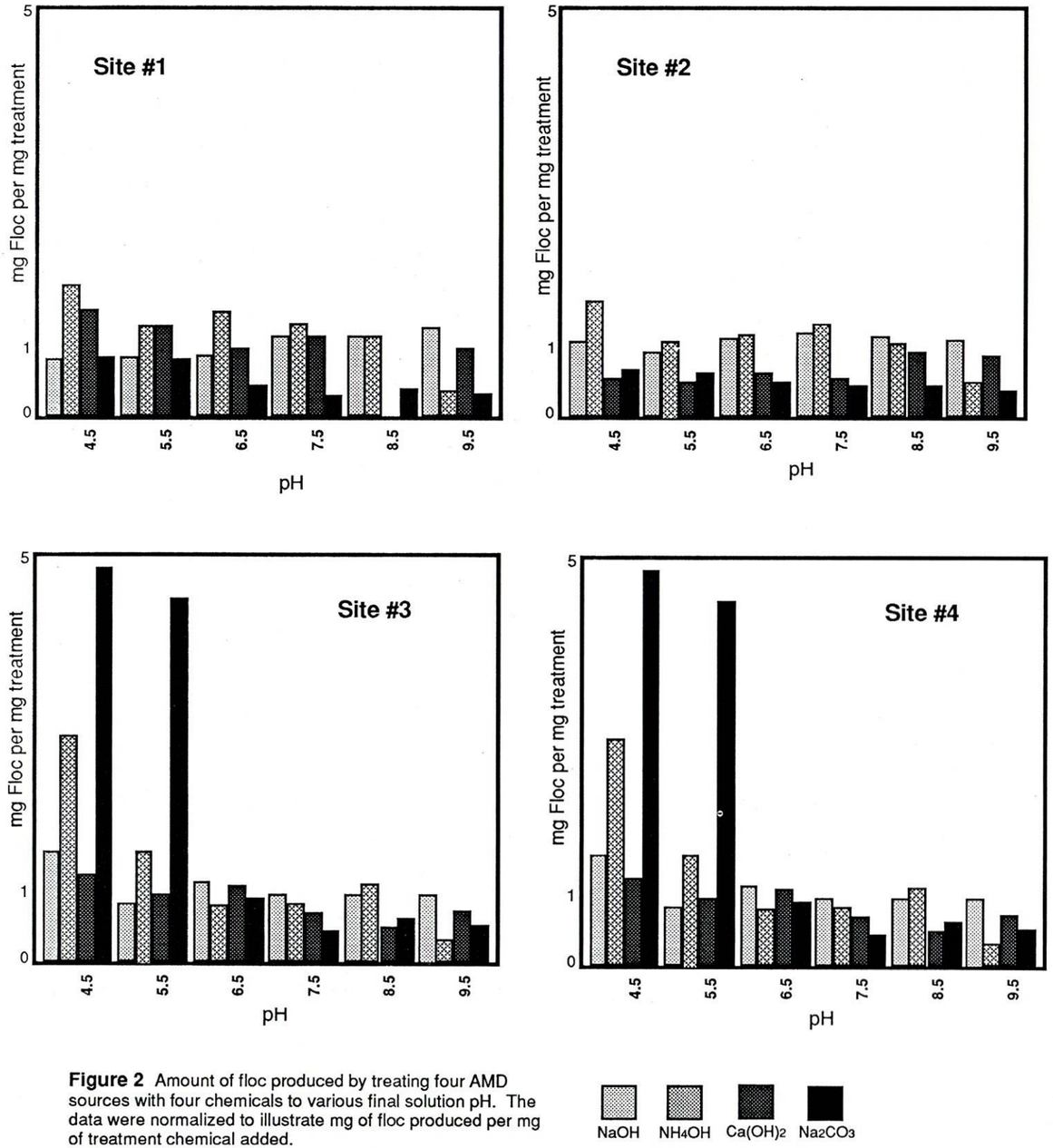


Figure 2 Amount of floc produced by treating four AMD sources with four chemicals to various final solution pH. The data were normalized to illustrate mg of floc produced per mg of treatment chemical added.

Chemical Efficiency

Since each chemical was added to the AMD in different concentrations and since the floc amounts were different for each site, the data were normalized. The data were evaluated by graphing the mg of floc produced per mg of treatment chemical added across all pH ranges (Figure 2). The more floc produced per unit of treatment means more efficient treatment by a chemical. The efficiency of each chemical for removing metals from these four AMDs was clearly different and indicated that each AMD responds differently to chemical treatment.

Site 1 - Ammonium hydroxide and calcium hydroxide produced more floc per unit of treatment at pH 4.5 to 7.5 than sodium carbonate. Sodium hydroxide remained about the same in floc production with increasing pH, while the other chemicals decreased with increasing pH. In fact at pH 9.5, sodium hydroxide produced more floc per mg of treatment than any other chemical.

Site 2 - Ammonium and sodium hydroxides were similar in their levels of floc production at intermediate pH, while sodium and calcium hydroxide produced more at pH 9.5. One reason that sodium hydroxide became more effective than ammonium hydroxide at pH 9.5 was because ammonium hydroxide solutions become buffered at about pH 9.2, thereby making it less efficient at pH values of 9.5 or above.

Site 3 - This site behaved very differently than the other sites in floc production. Sodium carbonate at pH 4.5 and 5.5 showed very large amounts of floc produced per unit of treatment. Ammonium hydroxide also showed high floc production at low pH. This is difficult to explain since this site has such low iron concentrations and this element is the primary element that precipitates at this low pH. (The composition of this floc will be discussed in our next paper). Ammonium hydroxide and sodium carbonate showed a decline in mg of floc produced per unit of treatment as pH increased, while sodium and calcium hydroxide remained about the same.

The strange responses to sodium carbonate and ammonium hydroxide at pH 4.5 and 5.5 could be due to the formation of aluminum carbonates. However, no such compounds were identified by X-ray diffraction analysis and, if formed, must have been amorphic.

Site 4 - Ammonium hydroxide produced more floc per mg of treatment from pH 4.5 to 7.5 than any other chemical, while sodium hydroxide showed a gradual decline until pH 9.5. Again, all chemicals showed a general decline in floc produced with higher pH.

Quantities of Chemical Needed for Neutralization

Figure 3 shows the amount of chemical needed to bring a liter (about a quart) of AMD to a desired pH. This information is of practical importance because it relates to the actual cost of treating AMD on any of these sites. Given the fact that iron and manganese are removed at pH 9.5, the amount of chemical needed to raise the pH to 9.5 gives a good estimate of the chemical usage necessary. Costs for purchasing and delivering the reagent to the site then become important.

In general, sodium hydroxide was the chemical used in the lowest amount on all sites at pH 9.5. It showed a slightly increasing linear response with a leveling off above pH 7.5 on sites 1, 2, and 4. On site 3, about the same amount of sodium hydroxide raised the pH of the AMD to 5.5 or 9.5. Even though the quantity of chemical needed to raise pH to 9.5 was lowest with sodium hydroxide, the cost of 20 or 50% sodium hydroxide often makes it one of the most expensive chemical neutralization reagents.

A gradually increasing linear response was also shown with ammonium hydroxide until a pH of 9.5 on all sites. In fact, less ammonium hydroxide was needed to raise the pH to 4.5 through 8.5 than any other chemical on sites 1, 2, and 4. To attain a pH of 9.5, a much greater amount of ammonium hydroxide was required because ammonium hydroxide tends to buffer the water at about pH 9.2.

Calcium hydroxide also showed a gradual increasing response with pH on sites 1, 3, and 4, with a leveling off at higher pH, similar to sodium hydroxide. Site 2 showed a linear response from pH 4.5 to 7.5, then much lower treatment amounts needed for pH 8.5 and 9.5. The lower amount of chemical needed to bring the pH up to 8.5 and 9.5 was due to the dilution effect discussed earlier.

Much more sodium carbonate was needed to bring the pH to 7.5 or higher than any other chemical on all sites (except for ammonium hydroxide at pH 9.5 on site 3). This is also largely due to a buffering of water treated with sodium carbonate at around pH 8.3 due to calcite formation.

Summary

In nearly every case for sites 1, 2, and 4, the amount of floc produced by addition of neutralizing reagents increased with increasing treatment pH.

On site 3 (low iron and high manganese), the amount of floc produced was about the same between pH 5.5 and 8.5. At pH 9.5 on site 3, the amount of floc generated was about the same with all four chemicals. The data illustrate the uniqueness of each site's AMD and its distinct reaction to different chemicals.

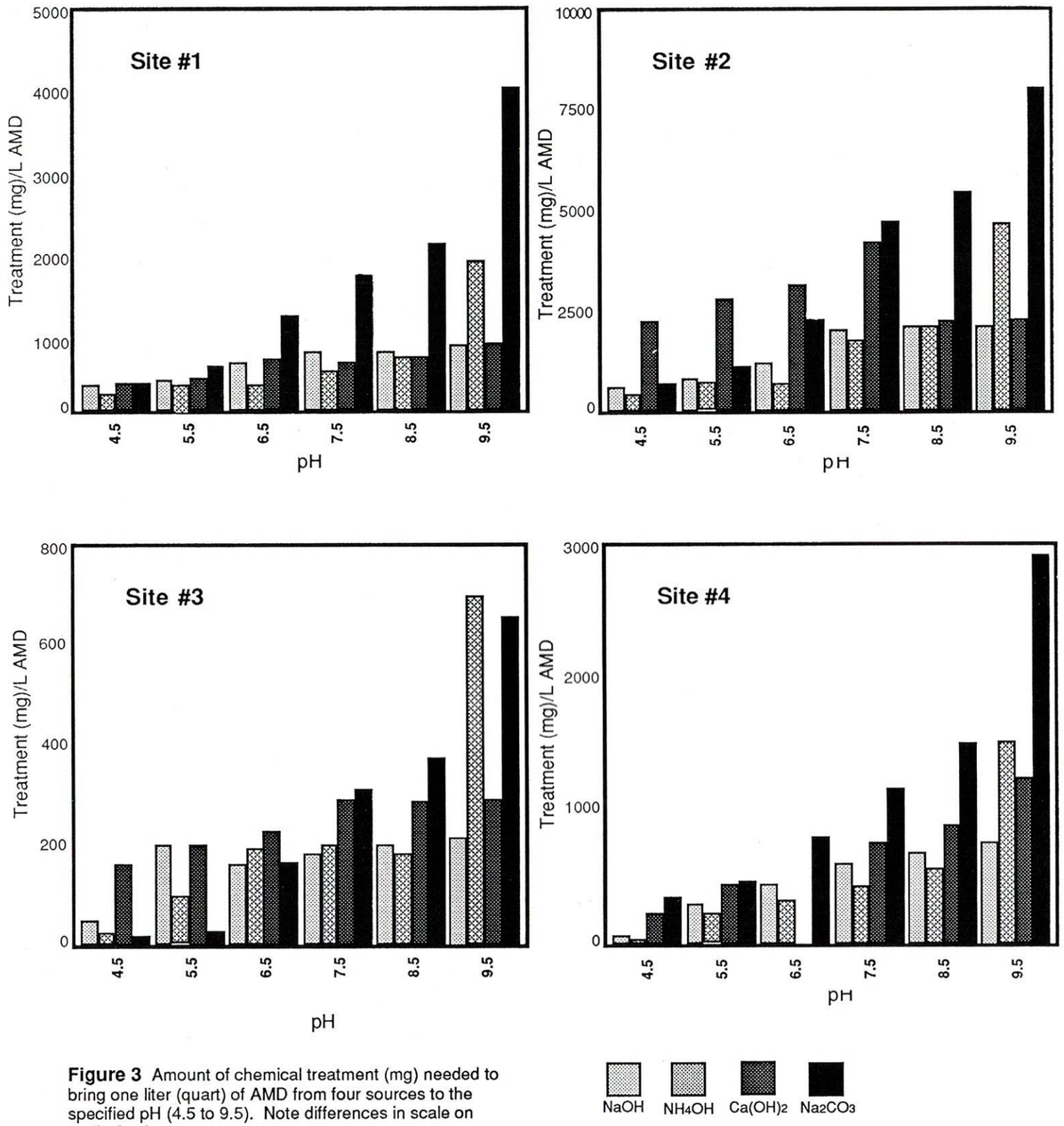


Figure 3 Amount of chemical treatment (mg) needed to bring one liter (quart) of AMD from four sources to the specified pH (4.5 to 9.5). Note differences in scale on vertical axis.

Efficiency (described as the mg of floc produced per mg of treatment chemical) remained about the same for calcium and sodium hydroxide, and sodium carbonate on sites 1, 2 and 4. A declining trend of chemical added to floc produced was found for ammonium hydroxide with increasing final solution pH on sites 3 and 4.

The amount of chemical needed to bring a liter (quart) of AMD to a specified pH showed sodium and calcium hydroxide to be linear (slightly increasing linearly with increasing pH). Ammonium hydroxide was linear between pH 4.5 to 8.5, then showed much higher amounts needed to attain a final solution pH of 9.5. Sodium carbonate was generally required in much greater amounts to raise pH to 7.5 or greater than any of the other chemicals.

Conclusions

The study confirms the fact that each AMD is unique and the chemical treatment of any particular AMD source is site specific. While a few trends were evident across chemicals and among different AMD sources, floc production and the quanitity of chemical needed for treatment varied. Therefore, before installing a chemical treatment system for AMD treatment, we recommend that each AMD source be tested with various chemicals by titration tests to evaluate the most effective chemical to cause precipitation of the metals. The costs of each AMD treatment system based on neutralization (in terms of the reagent cost and capital investment and maintenance of the dispensing system) and floc volumes and disposal can be evaluated. Subsequent papers in **Green Lands** will evaluate the floc volumes at various flow rates with these AMD's (estimates, pond size and cleanout frequencies), floc composition from each of these AMD sources with each chemical, and assess the effects of "ageing" on floc stability.

Acknowledgements

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Literature Cited

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Hilton, T. 1993. Technical information for fighting acid mine drainage. In: *Proceedings, 14th West Virginia Surface Mine Drainage Task Force Symposium.* Morgantown, WV.

Payette, C., W. Lam, C. Angle, and R. Mikula. 1991. Evaluation of improved lime neutralization processes. In: *Proceedings of the Second International Conference on the Abatement of Acidic Drainage.* Montreal, CAN.

Skousen, J., K. Politan, T. Hilton, and A. Meek. 1990. Acid mine drainage treatment systems: chemicals and costs. *Green Lands* 20(4):31-38.

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Association Notebook

Chairman John and Mary Bryan, Jim and Marie Green, Chris and Fred Shewey.

Bill Anderson, Pearl Ward (Tracy's sister), Tracy and Betty Hylton, Paul Ena Anderson.

California Dreamin'

Even after the massive California earthquake, a hardy band of WVMRA members made their way west to the sunny California desert and a few days respite from West Virginia's wicked winter.

The folks pictured on these pages are shown enjoying the hospitality of the beautiful Marriott Desert Springs and the cool (but not cold) California evenings.

Arlou and Ed Surgeon

Tom and Deloris Dotson, Jeanne and Lawson Hamilton.

Seventeen new members

Seven companies were approved for WVMRA membership during the fall Board of Directors' meeting, including the following:

General Division - **Philippi Development, Inc.**, Philippi, Norris Brooks - representative; **Pritchard Mining Co., Inc.**, Charleston, Andrew Jordon - representative;

Associate Division - **D. R. Allen & Associates, P. C.,** Abingdon, VA, David Allen - representative; **Cascades Coal Sales, Inc.**, Charleston, Robert Goldsmith - representative; **River Trading Co**., Marmet, R. Alan Johnston - representative; **Fielding Hydroseeding Inc**., Wharncliffe, Edward Brown - representative; **Standard Laboratories, Inc**. South Charleston, Troy Stallard - representative.

Ten more companies, all in the Associate Division, were approved for membership at the Semi-Annual Meeting, including the following:

Aquafix Systems, Kingwood, Michael Jenkins - representative; **Bio Gro Systems, Inc.**, Lockbourne, OH, Gregory V. Cybulski - representative; **Clonch Coal Sales, Inc**., Chesapeake, Richard W. Clonch - representative; **Dryden Oil Co., Inc**., Zelienople, PA, Jeff Conte - representative; **El Dorado Chemical Co**., St. Louis, MO, Roger Lawrence - representative; **Industrial Plating & Machine, Inc**., Princeton, George H. Nuce - representative; **See Engineers & Associates, Inc.**, Mill Creek, Thomas W. Redman - representative; **U.S. Generating Co**., Bethesda, MD, Andy Yanik - representative; **Vandalia Mining Corp.**, Hurricane, Francis A. Amendola - representative; **West Virginia Association of Land Surveyors, Inc.**, Gassaway, Marshall Robinson - representative.

Coal Calendar

March

2 **National Coal Association - Energy and Environment Conference**, Texas A&M University, College Station, TX, contact NCA, 1130 17th St. NW, Washington, DC 20036, (202) 463-2640, FAX 857-0135.

7-8 **Evaluating, Buying & Selling Coal Properties**, Vista Hotel, Pittsburgh, PA, Contact Pasha Publications, Inc., 1616 N. Fort Myer Dr., Suite 1000, Arlington, VA 22209, 1-800-424-2908, (703) 528-1244 (in VA), FAX 528-1253.

7-11 **Short Course: Environmentally Important Elements In Coal**, UK, Lexington , KY, contact Geaunita H. Caylor, OISTL, 643 Maxwelton court, Lexington, KY 40506, (606) 257-2820.

April

13-15 **15th Annual Eastern Mineral Law Institute**, Marriott Griffin Gate Resort, Lexington, KY, contact EMLF, WVU Law Center, P.O. Box 6130, Morgantown, WV 26506, (304) 293-2470.

16 **Virginia Mining Association - Annual Meeting**, Holiday Inn, Norton, VA, contact VMA, 18 Seventh St., Park Ave. Center, Suite 203, Norton, VA 24273, (703) 679-0456, FAX 679-0457.

23-25 **Coal Conference '94**, Palmer House Hotel, Chicago, IL, Contact Portia Graham, American Mining Congress, 1920 N. St. NW, Suite 300, Washington, D.C. 20036, (202) 861-2850.

25-29 **International Land Reclamation and Mine Drainage Conference/Third International Conference on Abatement of Acidic Drainage,** contact Debbie Lowanse, American Society for Surface Mining & Reclamation, P.O. Box 18070, Pittsburgh, PA 15236, (412) 892-6708, FAX 892-4067.

June

16-19 **NCA 77th Anniversary Convention,** The Broadmoor, Colorado Springs, CO, contact NCA, 1130 17th St. NW, Washington, DC 20036, (202) 463-2640, FAX 857-0135.

16-19 **West Virginia Coal Association, Annual Membership Meeting,** Glade Springs Resort, Glade Springs, WV, contact WVCA, 1301 Laidley Tower, Charleston, WV 25301, (304) 342-4153.

August

16-19 **West Virginia Mining & Reclamation Association Annual Meeting,** The Greenbrier, White Sulphur Springs, WV, contact Patty Bruce, WVMRA, 1624 Kanawha Boulevard East, Charleston, WV 25311, (304) 346-5318, FAX 346-5310.