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# Green Lands

Winter 1998



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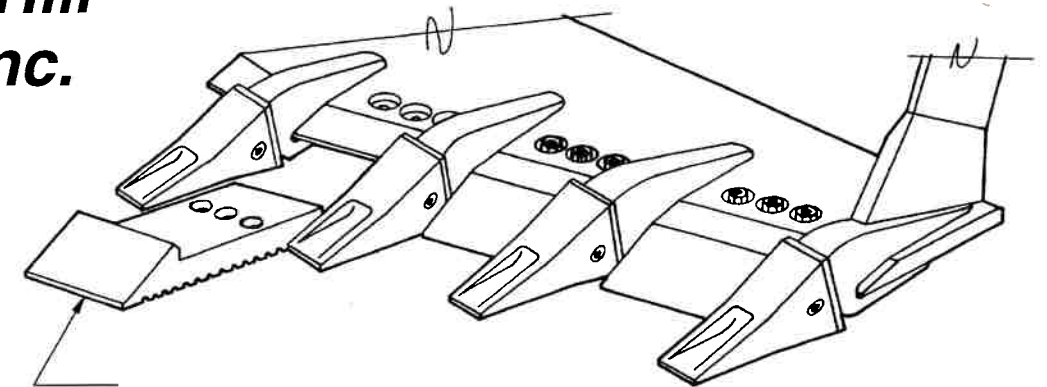
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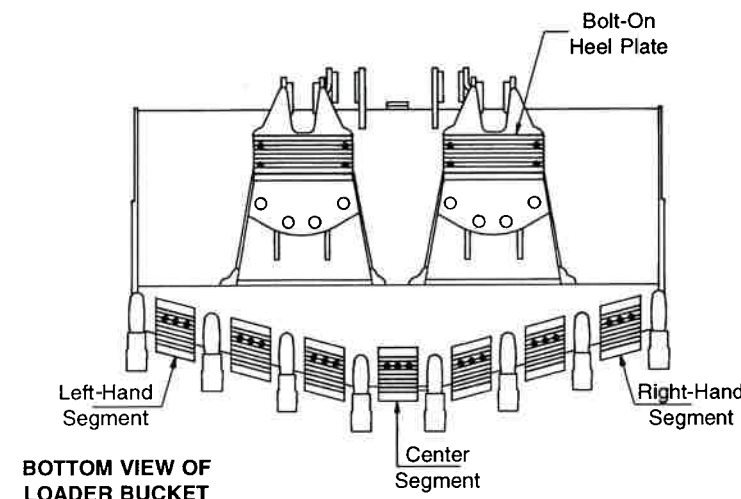
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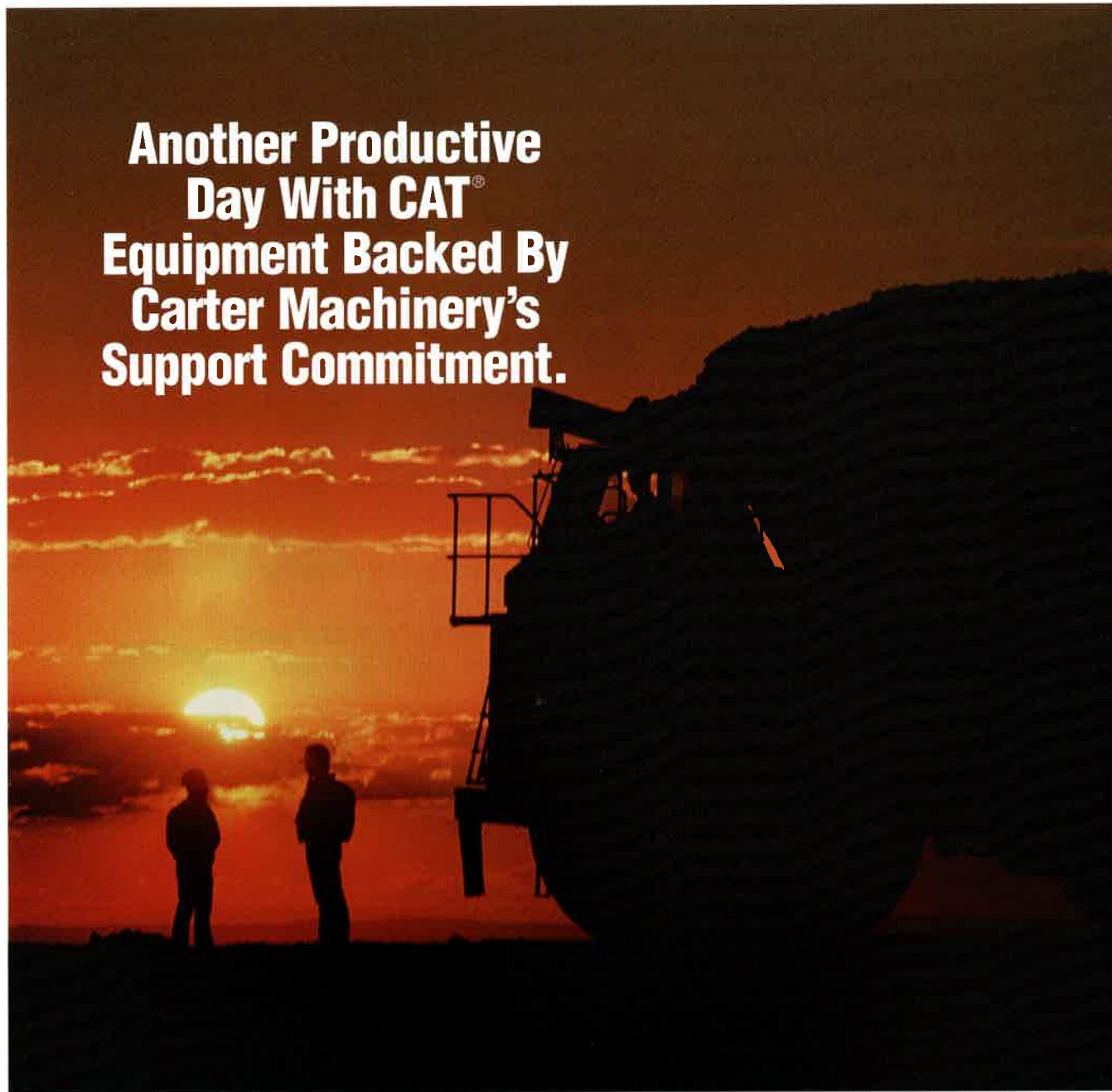
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# Green Lands

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## 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, FAX 346-5310.



## On the Cover

An outstanding scenic view of completed work by Anker Coal Group, Inc. near Osage, West Virginia. Anker won the top reclamation award for 1997 presented at the West Virginia Mining Symposium in January.

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## COAL CALENDAR

### March

**9-13** 23rd International Technical Conference on Coal Utilization & Fuel Systems, Sheraton Sand Key, Clearwater, FL, contact Barbara Sakkestad, (202) 296-1133.

**25-26** EXPO '98, Charleston Civic Center, Charleston, WV, contact West Virginia Equipment Technology Design Exposition, 2114 Kanawha Blvd. East, Charleston, WV 25311, (304) 342-3976, FAX 342-7469.

### April

**3-4** Brownfields Symposium, Lexington, KY, contact Joan Bostrom, University of Kentucky Journal of Natural Resources and Environmental Law, (606) 257-1161.

**7-8** Annual Acid Mine Drainage Task Force Symposium, Ramada Inn, Morgantown, WV, contact Jeff Skousen, West Virginia University, Division of Plant and Soil Science, P.O. Box 6108, Morgantown, WV 26506, (304) 293-6256, FAX 293-2960.

**28-30** Coal Prep '98, Center Heritage Hall, Lexington KY, contact Sam Posa, Intertec Presentations, Inc., 6300 South Syracuse Way #650, Englewood, CO, 80111, (303) 220-0600, FAX 770-0253.

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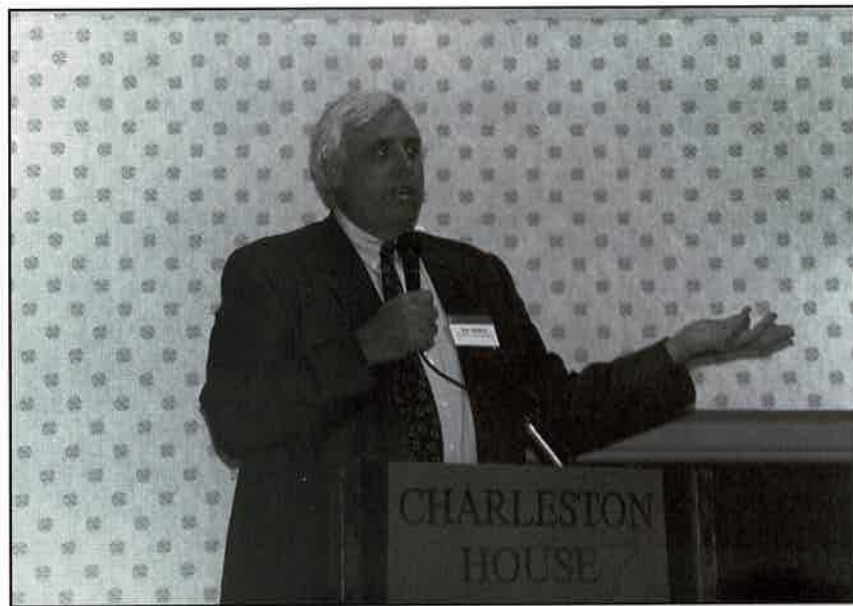
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# West Virginia Mining Symposium Celebrates Silver Anniversary

*Meeting's 25th year deemed huge success*



**West Virginia Mining and Reclamation Association Chairman Jim Justice welcomes everyone to the West Virginia Mining Symposium's 25th annual meeting on January 14-16.**

The silver anniversary of the West Virginia Mining Symposium, held January 14-16 in Charleston, was a huge success and boasted of a record crowd.

Sponsored by the West Virginia Mining and Reclamation Association, the air and water quality workshop, experienced its highest attendance ever for the first day of the symposium, with more than 140 people attending.

Permits, TMDL's manganese and by-products of coal combustion were the topics discussed during the workshop.

Speaker of the House, Bob Kiss, captivated the crowd with his legislative preview on the upcoming session.

Later that evening the WVMRA-sponsored legislative reception was the place to be. About 600 members and friends

attended the reception with a good showing of about 75 legislators stopping to discuss issues and interests concerning the coal industry.

The highlight for several companies were the two award luncheons.

On Thursday, the Mountaineer Guardian Awards luncheon had a record attendance with 24 companies receiving awards and it was Arch of West Virginia's Ruffner Mine receiving the Barton B. Lay, Jr. Milestones of Safety Award (story on page 10).


On Friday, 16 companies were recipients during the reclamation awards luncheon with Anker Energy Group, Inc. receiving the prestigious David C. Callaghan Award (more on page 14).

Other presentations included the Wildlife West Virginia Award, West Virginia Wetlands Award and the AML Awards.

The fifth annual Wildlife West Virginia Award, sponsored by the West Virginia Chapter of the National Wild Turkey Federation, was presented to ANR Coal Company, Greenbrier County.

Ducks Unlimited recognized Catenary Coal Company, Kanawha County, with the West Virginia Wetlands Award.

Eastern Arrow, Raleigh County and Green River Company, Barbour County, were commended for their outstanding work in the Abandoned Mine Lands program.

Thanks to the companies having hospitality rooms as well as advertising in the Symposium program, exhibitors, presenters, and to Heenan, Althen & Roles for hosting the breakfast on Thursday. 



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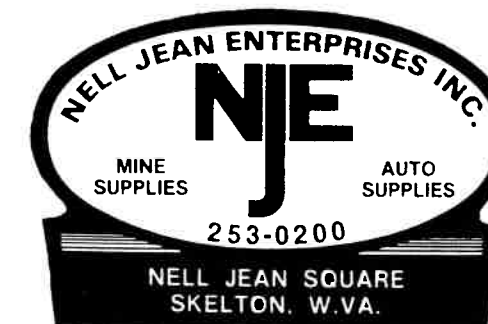
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# Arch of West Virginia's Ruffner Mine Awarded 1997 Barton B. Lay, Jr. Milestones of Safety



Arch of West Virginia's Ruffner Mine received the Barton B. Lay, Jr. Milestones of Safety Award. Pictured are: Steve Caldwell, WVMRA Chairman Jim Justice, MHS&T Inspector James Matthews, MHS&T Director Ron Harris and Cliff Higgerson.

Twenty-four West Virginia coal operations were presented the Mountaineer Guardian Award during the 25th West Virginia Mining Symposium.

The award, established in 1983, is cosponsored by the West Virginia Mining and Reclamation Association and the West Virginia Office of Miners' Health, Safety and Training.

Previously, mining operations won the Mountaineer Guardian by reaching tonnage goals, based on employment levels, without fatality. Ninety-eight operations received the award a year ago. According to WVMRA Vice President Dan Miller, the awards program was revamped this year.

"The safety program established by the State and carried out by the industry has progressed to the point where we felt it was time to significantly raise the standards for this award," said Miller. "There were many deserving operations, as there have been in previous years, but we think we've selected the most outstanding cross section whose safety records have set a standard for the entire industry."

To be considered for this award, companies must be nomi-

nated by its local MHS&T inspector.

In 1997, the West Virginia coal industry experienced a record low six fatalities, eclipsing the old record of nine, set in 1989.

"It is fitting that in this year of unprecedented cooperation between management and labor, the coal industry has achieved the lowest number of fatalities in history," said Ron Harris, West Virginia Office of Miners' Health, Safety & Training Director. "We are now within striking distance of our ultimate goal of zero fatalities."

The Mountaineer Guardian is awarded to companies "in recognition of the significant accomplishments of its employees in the area of mine safety."

This year, the Mountaineer Guardian's top award, the Barton B. Lay, Jr. Milestones of Safety Award, was presented to the Ruffner Mine of Arch of West Virginia, Inc. Named for the former Director of the Department of Mines, this award goes to

the most outstanding safety program for the year.

Since 1985, the Ruffner Mine has produced more than 25 million tons of coal without a fatality. Ruffner, located in Yolin, Logan County, has won the Mountaineer Guardian for eight consecutive years. Ruffner has an extensive safety program, with heavy input from employees. It has instituted safety teams for each shift, which reports and corrects potentially unsafe conditions and investigates not only accidents, but also "near misses," in order to develop and implement new preventive procedures and safeguards.

"For many years, the employees at all levels of the Ruffner operation have exemplified the type of safety program that results in a safe and productive working environment for the mining industry," said Harris. "We are extremely pleased to honor Ruffner and its people with our highest recognition of coal mine safety."

The MHS&T and the WVMRA join in congratulating all Mountaineer Guardian winners, for their successful efforts in providing a safe working environment.



## 1997 Mountaineer Guardian Award Nominees (Winners In Bold)

### Company

Arch of West Virginia  
A.T. V. Voyager Mining Co., Inc.  
**Banner Coal & Land Co.**  
Battle Ridge Companies  
Beckley Stone Co.  
Brock Mining, Inc.  
**Buffalo Coal Co., Inc.**  
**Catenary Coal Co.**  
**Consolidation Coal Co.**  
**Corbin Coal, Inc.**  
Decondor Coal Co., Inc.  
**Eastern Associated Coal Corp.**  
Eastern Associated Coal Corp.  
**Elkay Mining Co.**  
**Evergreen Mining Co.**  
**Fairfax Sand and Crushed Stone**  
Ferrell Excavating Co.  
**Golden Chance Mining, Inc.**  
**Greenbrier Limestone Co.**  
**Independence Coal Co.**  
**J.F. Allen Co.**  
**Keystone Services Industries, Inc.**  
**Kingwood Coal Co.**  
Linn Mining Co.  
Long Branch Energy  
Long Branch Energy  
Peerless Eagle Coal Co.  
**Philippi Development, Inc.**  
Pounding Mill Quarry Corp.  
Princess Beverly Coal Co.  
**Princess Beverly Coal Co.**  
Princess Polly Anna Coal Co., Inc.  
**Quality Energy, Inc.**  
Quality Energy, Inc.  
**Rawl Sales & Processing Co.**  
R.B.S., Inc.  
**Rockspring Development, Inc.**  
Tazz Mining, Inc.  
Terry Eagle Coal Co.  
Twin Star Mining, Inc.  
United Coals, Inc.  
**U.S. Steel Mining Co., LLC**  
U.S. Steel Mining Co., LLC  
Virginia Crews Coal Co., Inc.  
**Williams Mt. Coal Co.**  
**Wind River Resources Corp.**

### Facility

**Ruffner Mine**  
No. 1 Mine  
**No. 13 Mine**  
Skitter Creek No. 1 Mine  
Quarry  
No. 2 Mine  
**Kempton No. 2 Mine**  
**Samples Mine**  
**Robinson Run No. 95 Mine**  
**No. 34 Mine**  
Mine No. 7  
**Harris No. 1 Mine**  
Kopperston Preparation Plant  
**Boardtree Surface Mine**  
**Cowen Mine**  
Quarry  
Quarry No. 1  
**No. 2 Mine**  
**Johnson Quarry**  
**Jacks Branch Buffalo Creek Mine**  
**Limestone Quarry**  
**Keystone Preparation Plant**  
**Albright Tipple**  
Johnstown No. 1 Mine  
Mine Number 16  
Mine Number 18  
Lilly Fork Mine  
**Sentinel Mine**  
Mercer Crushed Stone Quarry  
Kayford Mine  
**Notomine Mine**  
No. 1 Mine  
**No. 1 Mine**  
Superior Mine  
**Sprouse Creek Cleaning Plant**  
Greystone Quarry  
**Camp Creek No. 1 Mine**  
Underground Mine  
Clearfield Preparation Plant  
No. 2 Mine  
Rider No. 1 Mine  
**No. 50 Mine**  
Pinnacle Preparation Plant  
Preparation Plant  
**No. 1 Mine**  
**West Cazy Surface Mine**

### Inspector

**James Matthews**  
Ed Miller  
**Ernie Pyles**  
Randall Bailey  
Clark Gillian  
Lewis Vennatter  
**John Lucas**  
**Terry Keen**  
**Albert Lechiara, Jr.**  
**Janice Molineaux**  
Dave Barlow  
**William Bentley**  
Charles Scarbro  
**James Matthews**  
**John Collins**  
**John Larry**  
James Matthews  
**Kenny Frye**  
**Lloyd Collins**  
**Eugene White**  
**John Meadows**  
**Milton Smallwood**  
**Dave Barlow**  
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Danny Davis  
Mike Armentrout  
**Robert True**  
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**William Tucker**  
William Tucker  
Janice Molineaux  
**Robert Cozart**  
**Randall Bailey**



## 1997 Reclamation Award Nominees (Winners In Bold)

COMPANY	COUNTY	INSPECTOR
Anker Coal Group, Inc.	Monongalia/Preston	Rocky Parsons
ANR Coal Co.	Braxton	Joe Altieri
ANR Coal Co.	Greenbrier	Nancy Hieb
Black Oak Mining, Inc.	McDowell	Arnold Fortner
Bluestone Coal Corp.	Wyoming	Jerry Quesenberry
Buckeye Stone Co.	Monongalia	Ron Hooton
<b>Buffalo Coal Co.</b>	<b>Tucker</b>	<b>Craig See</b>
<b>Catenary Coal Co.</b>	<b>Kanawha</b>	<b>Duane Stowers</b>
Coal Valley Mining, Inc.	Raleigh	Manuel Seijo
<b>Dayton Resources Co.</b>	<b>McDowell</b>	<b>Eugene Lacy</b>
Deckers Creek Limestone Co.	Preston	Ron Hooton
<b>Eastern Arrow</b>	<b>Raleigh</b>	<b>Jim Shisler</b>
Eastern Arrow	Wyoming	Allen Vest
Evergreen Mining Co., Inc.	Webster	Keith Evans
Grafton Coal Co.	Grant	D. L. Smith
Grafton Coal Co.	Tucker	D. L. Smith
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<b>Greer Lime Co.</b>	<b>Pendleton</b>	<b>Craig See</b>
<b>HICA Corp.</b>	<b>Clay</b>	<b>Cam Ford</b>
<b>J. F. Allen Co.</b>	<b>Randolph</b>	<b>Gary Meade</b>
Laurita Excavating	Harrison	Jim Baczuk
<b>Marfork Coal Co., Inc.</b>	<b>Raleigh</b>	<b>Jerry Stover</b>
<b>Mingo Logan Coal Co.</b>	<b>Logan/Mingo</b>	<b>Darrell O'Brien</b>
<b>New Land Leasing Co., Inc.</b>	<b>Nicholas</b>	<b>Bill Little</b>
<b>OilTanking Houston, Inc. dba</b>		
<b>Carter-Roag Coal Co., Inc.</b>	<b>Randolph</b>	<b>Gary Meade</b>
Old Ben Coal Co.	Mingo	Darrell O'Brien
Patriot Mining Co., Inc.	Grant	David Idleman
<b>Pen Coal Corporation</b>	<b>Wayne</b>	<b>Scott Eggerud</b>
United Coals, Inc.	Harrison	Glen Cox

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# Anker Coal Group, Inc. Captures 1997 David C. Callaghan Award

It's anchors aweigh for Anker Coal Group, Inc., which captured the 1997 David C. Callaghan award at the 25th West Virginia Mining Symposium in Charleston held on January 14-16.

Anker received the award for its aggressive record of visible success in reactivating and returning abandoned mine areas to the high standards of modern day reclamation, implementation of proven production and innovative technology for coal combustion disposal and pioneering water quality treatment efforts, and for the total commitment to the economic and social well-being of those regions of the state in which it operates.

"The operations of the Anker Coal Group, Inc. across the state continue to be an outstanding representation of the highest standards and long-standing traditions of the West Virginia coal industry," said Ben Greene, president of the West Virginia Mining and Reclamation Association.

One of Anker's most unusual projects is its initiating role in the "River of Promise" shared commitment to restoring the Cheat River watershed.

"When the river was named one of America's most endangered streams by a national environmental group in 1995, Anker offered its expertise and substantial funds to create a problem-solving coalition of private industry, federal and state agencies, the community and environmental activities," Greene said.

Patriot Mining Company, the oldest coal production company under the Anker aegis, continues to build on its excellent record of environmental innovation and community service.



**Anker Coal Group, Inc. received the 1997 Callaghan Award at the 25th West Virginia Mining Symposium. Pictured are: Charles Dunbar, Former DNR and DEP Director David C. Callaghan, Bruce Sparks, DEP Director Jack Caffrey, WVMRA Chairman Jim Justice, Bill Huber, Scott Rotruck, Ron Hamric, and Dick Bolen.**

A recent permit to mine coal on land owned by Christian Help, Inc., adjacent to Patriot's Osage operation, will not only recover the valuable resource, but will help support the nonprofit organization through royalties, and will provide a new championship field for the Morgantown Youth Soccer League when the reclamation is complete.

Patriot's creation of the Albright Ash Reclamation Project demonstrated that combustion by-products from coal-fired power plants could be a marketable resource useful in treating acid mine drainage problems. The project was a massive, historic environmental blight on the banks of the Cheat River in Preston County.

Construction entailed curtailing the leaching of acid water into the Cheat, accomplished through building barriers of calcareous fly ash recycled from power plants.

"The Anker Coal Group companies are great representatives of West Virginia's modern coal industry," Greene said.



For its aggressive record of visible success in reactivating and returning abandoned mine areas to the high standards of modern day reclamation, for its implementation of proven production and innovative technology for coal combustion disposal and pioneering water quality treatment efforts and for the total

commitment to the economic and social well-being of those regions of the state in which it operates.

The operations of the Anker Coal Group, Inc. across the state continue to be an outstanding representation of the highest standards and long-standing traditions of the West Virginia coal industry.



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## Wildlife West Virginia Award ANR Coal Company



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

In 1993, the WVMRA became the first private trade association in the nation to sign a Partnership Agreement with the National Wild Turkey Federation. The stated purpose of the agreement was to provide a framework for cooperative efforts and research activities to enhance wildlife habitat on reclaimed mine lands with a special emphasis on wild turkey habitat.

**Past winners of the "Wildlife West Virginia Award"**

- 1996 Colony Bay Coal Co.
- 1995 Dal-Tex Corp.
- 1994 Buffalo Coal Co.
- 1993 Hobet Mining, Inc.



**Pictured are: (l-r) Turkey Federation Representative Jeff D'Agostino, Kevin Skiles and Inspector Nancy Hieb.**

## 1997 Reclamation Award Winners

## Wetlands West Virginia Award Catenary Coal Company



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



**Pictured are: (l-r) Conrad Larrabee, Eddie Arnold, Ducks Unlimited Representative Rusty Eaton, Bob Bays, Frank Robinette, Inspector Duane Stowers, and Peter Lawson.**

In 1990, WVMRA became the first mining industry organization nationwide to sign a Memorandum of Understanding with Ducks Unlimited, Inc.

The agreement has been a positive influence for both organizations, in that the aims are compatible, as well as beneficial to the status of waterfowl and the overall environment of West Virginia.

**Past winners of the "Wetlands West Virginia Award"**

- 1996 Hobet Mining, Inc.
- 1995 Terry Eagle Coal Co./ Vencill Corp.
- 1994 Arch of West Virginia
- 1993 Kimberly Industries
- 1992 The Lady H Coal Co.
- 1991 Bomac, Ltd.
- 1990 Buffalo Coal Co.



## 1997 Reclamation Award Winners

### Eastern Arrow Abandoned Mine Lands-South Award

In Raleigh County, for the extraordinary attention to detail in the complete reclamation and drainage control of the Alderson Branch refuse area, for many years an impaired visual impact for more than one mile paralleling WV Route 16. Historically a major source of black water in the Guyandotte River Basin, water quality problems have now been completely eliminated.



**Pictured are: (l-r) Inspector Jim Shisler, Mike Wardwell, DEP Director Jack Caffrey, Ann Wardwell, Jay Wardwell, and WVMRA Chairman Jim Justice.**



### Green River Company Abandoned Mine Lands-North Award

In Barbour County, for the elimination of more than 4,000 feet of prominent highwall along Appalachian Corridor H at the Tygart River. This site has now become an aesthetically pleasing natural contour, blending with the scenic surrounding area with improved water quality to Zebs Creek and the Tygart River.



**Pictured are: (l-r) Robert Calvert, Jr., DEP Director Jack Caffrey, Dave Wortring, WVMRA Chairman Jim Justice, and Inspector Dave Smith.**



## 1997 Reclamation Award Winners

### ANR Coal Company



### Buffalo Coal Company



In Tucker County, for meticulous attention to detail in the successful reclamation of a deep mine while simultaneously providing a disposal site for the Division of Environmental Protection, Office of Waste Management, to bury several million tires.



**Pictured are: (l-r) Gary Tinnel, Jim Copley, DEP Director Jack Caffrey, Mark Workman, Dave Martin, WVMRA Jim Justice, and Inspector Joe Altieri.**

In Braxton County, for outstanding engineering and design in an operational underground mine utilizing unique drainage control with an existing inactive site. A well constructed valley fill provides a functional work area with all operations being carried out in a neat, workmanlike manner.



**Pictured are: (l-r) Dennis Dolechek, Don Cussins, DEP Director Jack Caffrey, WVMRA Chairman Jim Justice, John Geroski, Steve Shaffer, Jerry Duckett, Inspector Craig See, and Buz Gosnell.**



## 1997 Reclamation Award Winners

### Catenary Coal Company

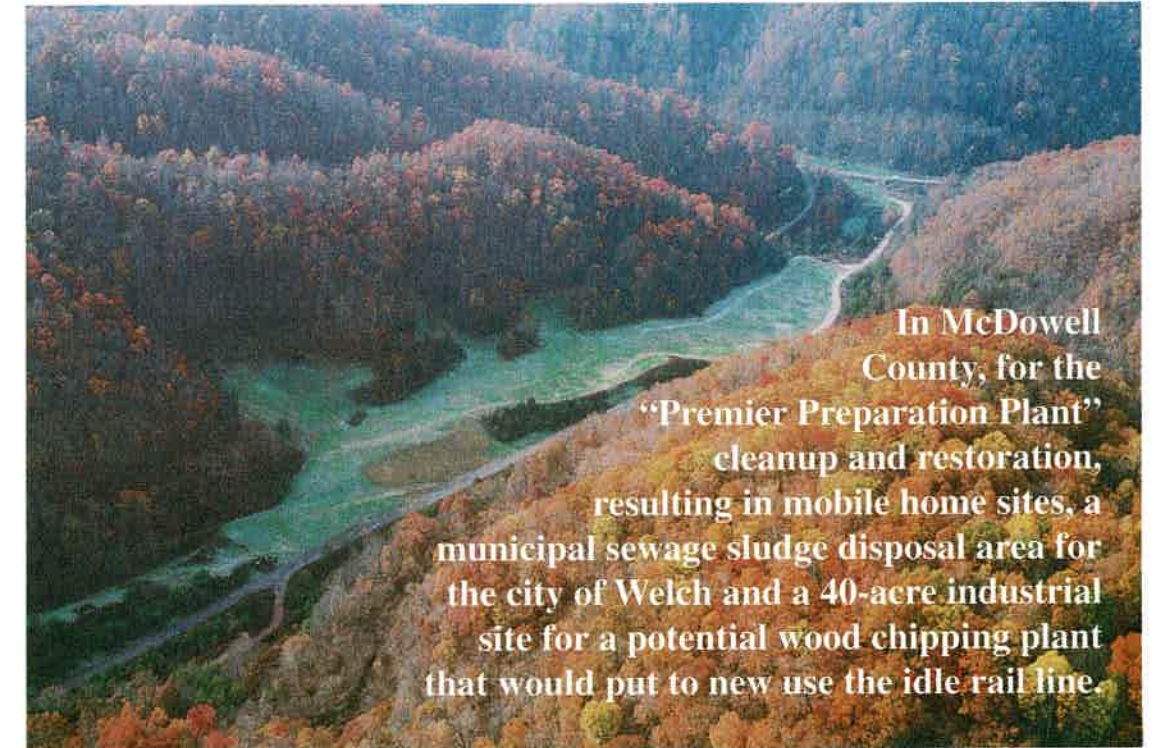


In Kanawha County, for aggressive and exceptional performance in the restoration of the "Campbells Creek Refuse Area." By using alkaline addition, creating more than 12,000 feet of new diversion channel coupled with progressive lift reclamation, previous water quality problems have been completely eliminated.



**Pictured are: (l-r) Peter Lawson, Bobby Phalen, DEP Director Jack Caffrey, WVMRA Chairman Jim Justice, Frank Robinette, Inspector Duane Stowers, and Bob Bays.**

### Dayton Resources Company



In McDowell County, for the "Premier Preparation Plant" cleanup and restoration, resulting in mobile home sites, a municipal sewage sludge disposal area for the city of Welch and a 40-acre industrial site for a potential wood chipping plant that would put to new use the idle rail line.



**Pictured are: (l-r) John Harsanyi, Inspector Eugene Lacy, DEP Director Jack Caffrey, WVMRA Chairman Jim Justice, and Kevin Davis.**



1997 Reclamation Award Winners

Green Valley Coal Company



In Nicholas County, for the remarkable achievement of blending reclaimed land with the natural terrain and surroundings. The completed site is appealing in appearance, with the successful elimination of all erosion and water quality problems.



**Pictured are: (l-r) Inspector Albert Rodebaugh, Frances Meadows, DEP Director Jack Caffrey and WVMRA Chairman Jim Justice.**

Greer Industries



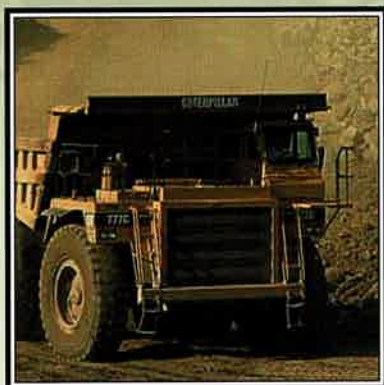
Operating in several locations, utilizing perimeter discharge control, contemporaneous regrading of waste material and seasonal vegetation, the company's quarries have always exceeded all legal reclamation requirements of state law. Producing a wide variety of products utilized by the mining industry for total environmental enhancement, the company is a vital part of the mining and reclamation process.



**Pictured are: (l-r) Dave Consider, Joe Dean, DEP Director Jack Caffrey, WVMRA Chairman Jim Justice, and Inspector Craig See.**



# reclamation

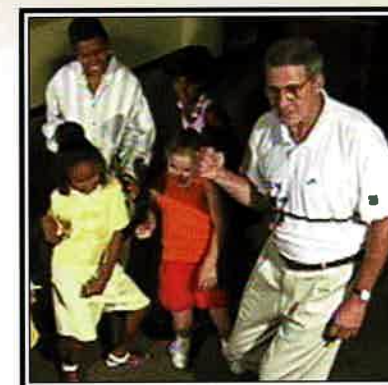
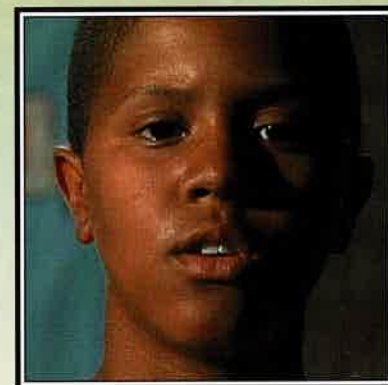
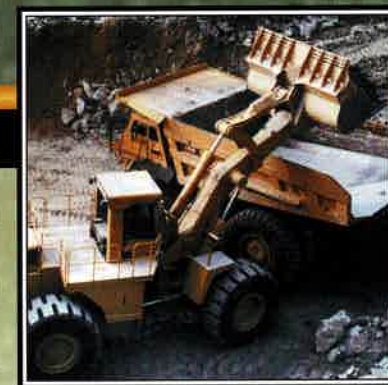


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## 1997 Reclamation Award Winners

### HICA Corporation

In Clay County, for the elimination of more than 3,000 feet of old highwall in a remining and complete backfilling operation. By constructing drainage flumes, properly locating sediment ditches and lining the pit floor with limestone, water quality is enhanced and the area has been returned to woodland post-mining use with the planting of red oak seedlings.



Pictured are: (l-r) Inspector Cam Ford, Frank Rose, DEP Director Jack Caffery, WVMRA Chairman Jim Justice, and Ron Damron.



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**J. F. Allen Company**



In Randolph County, for maintaining a high standard of excellence in material handling, drainage control, slope stability, and progressive revegetation in the operation of a major limestone quarry. For more than 20 years, this operation epitomizes the best in overall reclamation compliance.



**Pictured are: (l-r) Mike Griffith, DEP Director Jack Caffrey, WVMRA Chairman Jim Justice, Inspector Gary Meade, and Steve Sherrard.**

**1997 Reclamation Award Winners**

**Marfork Coal Company**



In Boone County, for the environmental awareness and engineering adaptability in the design, construction and operation of a complex coal preparation plant and refuse disposal areas. This modern facility represents a major new commitment to the proper balance of coal production and environmental protection.



**Pictured are: (l-r) Inspector Jerry Stover, Michael Bays, DEP Director Jack Caffrey, Randy Cunningham, and WVMRA Chairman Jim Justice.**



## 1997 Reclamation Award Winners

### Mingo Logan Coal Company



In Logan County, for extraordinary achievement under adverse conditions in returning a rugged, extremely steep, underground mining site to the original contour. This difficult work has significantly enhanced the economic value of the property while providing future access to mineral reserves.

**Pictured are: (l-r) Inspector Darrell O'Brien, Wayne Hawley, DEP Director Jack Caffrey, Rick Adams, and WVMRA Chairman Jim Justice.**



### New Land Leasing Company, Inc.

In Nicholas County, for the use of haulback methodology and innovative drainage control in returning a steep slope, narrow ridge topography to a highly productive wildlife habitat. Deer, bear, wild turkey and several species of small game currently inhabit this unique area.



**Pictured are: (l-r) Inspector Bill Little (accepting for New Land Leasing Company), DEP Director Jack Caffrey and WVMRA Chairman Jim Justice.**



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LeTourneau loaders offer the most complete range of efficient and productive buckets precisely sized for any material, with solid-state controls providing faster cycle times and greater productivity than any comparably-sized loader.

Superior safety features include an acoustically advanced operator's cabin design with non-obstructive integral ROPs and sloped rear cowling for unequalled visibility. The primary regenerative dynamic-retarding brake system brings the loader to a complete stop, with secondary air-operated disc brakes mounted on each motor.

And when it comes to state-of-the-art technology, LeTourneau continues to lead the pack. The generators, traction motors and solid-state electronic controls are the most advanced in the industry, with interchangeable modular components for easy service and maintenance access.

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High Lift .....	48,000 lbs. (21,773 kgs.)	60,000 lbs. (27,216 kgs.)	78,000 lbs. (35,381 kgs.)
SAE-Rated Bucket Capacity			
Standard .....	17 yd <sup>3</sup> (13.00 m <sup>3</sup> )	22 yd <sup>3</sup> (16.82 m <sup>3</sup> )	28 yd <sup>3</sup> (21.4 m <sup>3</sup> )
High Lift .....	16 yd <sup>3</sup> (12.00 m <sup>3</sup> )	20 yd <sup>3</sup> (15.29 m <sup>3</sup> )	26 yd <sup>3</sup> (19.9 m <sup>3</sup> )
Dump Heights			
Standard .....	18'-5" (5.61 m)	18'-10" (5.74 m)	21'-6" (6.55 m)
High Lift .....	19'-10" (6.04 m)	20'-0" (6.10 m)	23'-6" (7.16 m)



## **Oiltanking Houston, Inc. dba Carter-Roag Coal Company, Inc.**

In Randolph County, for utilizing an exceptional drainage control plan, practicing contemporaneous revegetation and returning to the natural contour an area of old spoil and marred landscape. The refuse disposal site is now an eye-pleasing natural hilltop with all of the drainage meeting effluent limits in this environmentally sensitive area.



**Pictured are: (l-r) Inspector Gary Meade, DEP Director Jack Caffrey, Gary Begley, and WVMRA Chairman Jim Justice.**

## **1997 Reclamation Award Winners**

### **Pen Coal Corporation**

In Wayne County, for attention to detail in the segregation and encapsulation of potentially toxic overburden and coal refuse waste. By following an intense drilling, testing and materials handling plan, water quality problems have been eliminated with more than two million cubic yards of material being handled in a successful restoration and reclamation effort.



**Picture are: (l-r) Darrel Johnson, Inspector Scott Eggerud, DEP Director Jack Caffrey, Randy Maggard, Raymond Maynard, Robert Marsh, WVMRA Chairman Jim Justice, Monte Hieb, and Steve Capelli.**





## Winter Meeting Productive For Association

### New Board Members Selected

By narrowly escaping the heavy West Virginia snow, an enthusiastic crowd enjoyed the Association's winter meeting in late January at El Conquistador Resort Hotel in Fajardo, Puerto Rico.

Highlights of the technical sessions included I.N. "Ike" Smith, vice chairman, United National Bank who talked about financing coal industry ventures and Forrest Roles, partner of Heenan, Althen and Roles, who spoke about the new contract between the United Mine Workers and Bituminous Coal Operators Association.

During the WVMRA Board of Directors meeting, three new members were elected to the board. They were: Ronald E. Gallimore, Pocahontas Land Corporation, Bluefield, replacing Bob Raines; Markus J. Ladd, AMVEST Minerals Corporation, Charlottesville, VA; and Randy L. McMillion, Pittston Coal Management Company, Charleston, replacing John Bryan.

### WVMRA Has 10 New Members

New WVMRA members were approved during the board meeting in Puerto Rico on January 30th. New members in the general category are: Spruce Fork Coal Company, Buckhannon, Jeff Kelley - representative and Vindex Energy Corporation, Mt. Storm, Mark Lantz - representative.

The new associate members are: Artistic Promotions LLC, Charleston, Shannon Westerman - representative; D&G Distributors, Inc., Whitesville, Gary Cooper - representative; Environmental Regulatory Service Group (ERSG), Charleston, Fred Boggs - representative; and Pace Carbon Fuels, LLC, Fairfax, VA, Jim Treptow - representative. Robert Raines, Princeton was the new individual member.

Members approved earlier this year were: Black Diamond Trucking Company, Big Stone Gap, VA, Arnold Riggs - representative and Svedala Reedrill Corporation, Hodgenville, KY, Walt Pfaff - representative. George A. Hall, Charleston joined as an individual member.

### A Special Thanks To Some Generous Members

During the golfing outing, at the semi-annual meeting, amazingly, all teams tied for first place.

Nonetheless, all participants received an El Conquistador Resort golf shirt, made possible through the kind generosity of the following companies: Steve Walker, Cecil I. Walker Machinery; John Smith, Rudd Equipment; Tab Hudson, Nelson Brothers; Dave Hibbs, Cummins Cumberland; Chris Supcoe, Crown Hill Equipment; and Norm Duncan, GH Hensley.

## DATES TO REMEMBER

- Annual meeting at the Greenbrier, August 6-9, 1998.
- Fall Board meeting, Lakeview Resort and County Club, Morgantown, November 20-21, 1998.
- The Board voted to return to El Conquistador Resort for next year's winter meeting, January 26-31, 1999.
- Start planning for the winter meeting in 2000 when the membership will be meeting at the Westin Maui, Feb. 1-9.

### WVMRA Organizational Changes

Two organizational changes have occurred at the West Virginia Mining and Reclamation Association that were effective January 1, 1998.

Dan Miller, publications editor, was promoted to Vice President. Dan has 21 years of service with the WVMRA.

Jim LeFev, who is new to the WVMRA, filled Dan's position.

Previously, Jim was communications manager for the West Virginia Forestry Association and more recently, he was communications manager for a Georgia-Pacific paper mill near Lynchburg, VA. He has a bachelor's degree from WVU and a master's from Marshall University.

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# Mountain State Coal Classic Becoming More Exciting Every Year

More than 14,000 fans attended and \$17,000 in scholarships were presented during the nationally recognized Mountain State Coal Classic held January 18-24, 1998 in Beckley.

At the tournament's banquet opener, more than 2,000 guests and fans heard Jerry West, former Mountaineer great and pro basketball hall of famer, give an inspirational speech. The most impressive thing about West that afternoon was, however, that he made sure that anyone who wanted his autograph, which appeared to be most of the crowd, got one.

Truly, an admirable mentor to any young athlete or sports fan.

During the tournament, one player and one cheerleader of every high school, as well as one college cheerleader participating, were awarded a \$500 scholarship totaling \$17,000.

Scholarships have been a tradition at the Mountain State Coal Classic since its inception in Charleston nine years ago.

One highlight of the Classic was when Woodrow Wilson High School defeated nationally ranked Mt. Zion Christian Academy before a sold out crowd.

WWHS won 81-72 in double overtime, ending what may be called the best Coal Classic ever.

"And next year promises to be even better," said Jim Justice tournament chairman.

## Coal Classic's Scholarship Winners

HIGH SCHOOL	PLAYER	CHEERLEADER
(Boys)		
Baileysville	Ricky Miller	Erin Stone
Liberty	Jeff Canterbury	Kim Farely
Gilmer County	Chad Drennen	Misty Tomblin
James Monroe	Tim Bradley	Carla Bostic
Tucker County	Chad Kisamore	Devon Snyder
Poca	Tim Lyle	Miranda Milhorn
Oceana	Brandon Laxton	Lindsay Brooks
Richwood	Patrick Nichols	Mary Bess
Woodrow Wilson	Jamel Bradley	Kiki Dodson
Socastee	Derrick Hilton	Shannon Pyles
Parkersburg	Matt Murphy	Amanda Samples
Mt. Zion	(\$1,000 given to the school's scholarship fund)	
(Girls)		
George Washington	Lindsey Copeland	April Callaway
Mercer Christian Academy	Elizabeth Lewis	Pennie Miller
		Nora Burge
Parkersburg	Caroline Fleek	Mindy Valentine
Woodrow Wilson	Meredith Sutphin	Amy Cogar
COLLEGE		
College of W.Va.		Amy Price

## TOURNAMENT WINNERS

High School	
AAA	Woodrow Wilson
AA	Tucker County
A	Gilmer County
Girls	George Washington
Jr. High (Boys)	Beckley/Stratton
(Girls)	Beckley/Stratton
College	College of WV

## MAKING THE GRADE

Bill Raney, president of the West Virginia Coal Association and co-sponsor of the Coal Classic, presents a \$500 scholarship to Jamel Bradley of Woodrow Wilson High School.

These scholarships, totaling \$17,000, were awarded to one player and one cheerleader as well as one college cheerleader during the tournament.

Scholarships have been a part of the Mountain State Classic since the tournament's inception nine years ago in Charleston.



## Jim Justice Receives Award For His Services to Education

For the last four years, West Virginia Mining and Reclamation Association Chairman Jim Justice, Terry Miller and many other people working behind the scenes, have organized and run one of the best basketball tournaments in the country and it is getting more exciting every year.

During this year's Mountain State Coal Classic in Beckley, Justice was presented a plaque as a token of appreciation, for his dedication and support of Raleigh County schools.

Knowing that education is the foundation of any community, Justice is involved with many community activities that support Raleigh and the state's education systems which includes heading the Mountain State Coal Classic.

This year the tournament provided \$17,000 in scholarships,



most of which was presented to West Virginia High School students.

Presenting the plaque of appreciation is Paul Vennari, a member of the Raleigh County Board of Education.

## 10 Reasons Why You Should Have Attended The 1998 Mountain State Coal Classic

10. Live entertainment is always better.
9. One-of-a-kind T-shirts.
8. It's sponsored by the WVMRA and WV Coal Association.
7. Games from elementary to college are exciting to watch.
6. To be a part of the 14,000 plus fans that supported the tournament, players and cheerleaders.
5. Woodrow Wilson upset nationally ranked Mt. Zion in double overtime.
4. Jim Justice, Terry Miller and everyone else working behind the scenes did a great job with the Classic.
3. Jerry West who is still, truly, one of the most humble and down to earth "sports stars" anyone will ever meet.
2. It supports state schools at all levels.
1. \$17,000 in scholarship money.



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## Taking Time To Remember An Esteemed Colleague And Friend



During the West Virginia Mining Symposium in January, WVMRA Chairman Jim Justice presented a plaque to Bruce Sparks and Dick Bolen of Anker Energy Group, Inc. in memory of the company's founder and chairman John Faltis and his wife Kathy.

On the 24th day of October, 1997, at a regular Board of Directors' meeting of the West Virginia Mining and Reclamation Association, held in Morgantown, West Virginia, a unanimous resolution was adopted expressing the profound sorrow of not only of the Board, but as well that of the entire membership, at the tragic and untimely demise of John J. Faltis, an esteemed member and former Chairman, and of his wife, Kathleen (Kathy) Ann Faltis.

John's dedication to and concern for the success of the coal industry was well-known throughout the state and nation, as was the support of Kathy in his endeavors.

Their passing leaves a void most difficult to fill, but to their families and to all the employees of the Anker Energy Group, we are confident that the ability and desire to proceed and succeed will continue in the same spirit.

It is the Board's wish to convey its condolences to the family, as well as to all the employees of the Anker Energy Group, and to express its desire to be of whatever aid it can render at this time of great sorrow.

Respectfully, this 24th day of October, 1997.

James C. Justice  
Chairman of the Board



# The Use of Steel Slag in Acid Mine Drainage Treatment and Control

by Paul Ziemkiewicz, National Mine Land Reclamation Center  
and Jeff Skousen, West Virginia University

## Introduction

Slag is defined as the solid material resulting from the interaction of flux and impurities in the smelting and refining of metals. The solid product generally forms a silicate glass-like material, which is primarily nonmetallic. In the power industry, boiler slag is the residue from coal burning which sticks to the walls and pipes of the boiler. This slag is removed from the boiler and pipes through routine maintenance and is a valuable product in the construction industry (sometimes called "black beauty"). Boiler slag should not be confused with bottom ash or fly ash, which are by-products of coal burning, and both are continuously generated and removed during coal combustion. In the base metal industry, slags result from the smelting of various ores of copper, zinc, lead, etc. These metal ore slags can have high concentrations of heavy metals imbedded in the glassy matrix or residing on the solid's surface.

In making steel, iron ore or scrap metal are melted in combination with limestone, dolomite or lime. Pure iron is soft, bends easily under loads and has only limited uses. Adding small amounts of carbon, nickel, manganese and other elements converts the iron into various alloys of steel. There are hundreds of grades of steel, ranging from basic carbon steel to high grade stainless steel, with each having unique properties. In this paper, only the slags from the steel making process are discussed.

Steel making begins by reducing metal oxides (removing oxygen) in the melt to pure iron metal, while scavenging ions such as aluminum, silicon and phosphorus. The latter three elements cause problems in steel making because they cause the

steel to become weak, brittle or otherwise difficult to roll into sheets in a predictable way. These elements make it nearly impossible to make anything useful out of iron. Even though iron is much more readily available as a resource, these element impurities caused enough problems with making tools from iron that man began making tools from copper (Bronze Age) after stone tools became obsolete (Stone Age).

Fortunately, our ancestors discovered that iron's imperfections could be controlled by adding limestone or dolomite. These calcium compounds complex with aluminum, silicon and phosphorus to form slag. Slag floats to the top of the melt, is poured off and placed in piles for disposal. Slag starts its life at about 2,700 degrees F and cools almost immediately. The slag cools so quickly, in fact, that very few crystals form. Rather, the slag solidifies as an amorphous, glass-like solid ranging from fine sand particles to large blocks, both of which can be extremely hard.

Enormous slag dumps or piles can be found anywhere where steel was made over the past 150 years. Many of these slag piles (containing both nonmetallic slag and wasted steel products) are being processed for use as aggregate in road construction, rail ballast and structural fill.

Processing involves crushing and grading the slag. Much of the metallic fraction (the discarded steel products in the pile) is removed with large magnets and sold as steel scrap. All of the resulting nonmetallic grades have applications in construction. The finest fraction (-1/8 in.) is the one of particular interest for acid mine drainage (AMD) treatment.

This product is referred to as slag fines. Some slag fines are further refined using the patented Recmix process. This process involves further grinding and a

hydraulic separation process. The fine grinding and flotation further remove metals, which are imbedded in the glassy matrix.

Previous work at the National Mine Land Reclamation Center has centered on other low cost alkalinity sources like kiln dust and fluidized bed combustion (FBC) ash. Both are effective for AMD control and both are heavily utilized by the industry.

In an effort to provide the coal industry with the broadest choice of alkaline materials, we are constantly looking for other low-cost alkaline products which may be available in large supply and located within short haul distances to our mining districts. We have worked with slag fines produced by International Mill Service, Inc. (IMS) and Recmix, a product of Recmix of PA, Inc., and have found both to show positive results for AMD control. The products are very different and have different applications.

## Properties of Steel Slag

Steel slags are calcium aluminosilicate oxides. Since they form at the melting point of iron (>2,700 degrees F), most compounds with lower boiling points have been driven off. These compounds contain

elements like sulfur, selenium, carbon, cadmium, lead, copper, and mercury. Most of the residuals are encased within a glassy matrix. Fortunately, the matrix is soluble and releases calcium and manganese oxides, which can drive the pH of the dissolving fluid to 10 or 11. Since slag is a coarse glass, it will maintain high permeability (~ 4.5 x 10<sup>-2</sup> cm/sec) regardless of how much water has passed through it. The permeability of this material can be reduced if it is compacted or ground up into smaller particles. Recmix, on the other hand is a much finer material and barely lets any water pass through (permeability is ~ 1.0 x 10<sup>-6</sup> cm/sec). Unlike lime, steel slags do not absorb CO<sub>2</sub> from the air and convert back to relatively insoluble limestone according to the reaction:



This is an extremely important property, since it means slag can be left outside, exposed to the atmosphere for years, and still achieve high levels of alkalinity upon dissolution.

The neutralization potential (NP) of steel slags range from 45 to 78% (Table 1). Most of the residuals

**Table 1.**  
**Neutralization potential of various steel slags.**

Steel Slag Type	Neutralization Potential	
	%	Tons/1000 tons
C fines, Mingo Jct., OH	78	780
C fines, Weirton, WV	77	770
Slag fines, Weirton, WV	76	760
Fallen slag: Cartech, Reading, PA	71	710
Fallen slag: Lukens, Coatesville, PA	70	700
Recmix, Washington, PA	69	690
Slag fines - 1/8 in., Mingo Jct., OH	66	660
EAF: Waylite, Johnstown, PA	59	590
Slag fines - 1/8 in., Hecate, Ashland, KY	59	590
Slag fines - 1/8 in., USX, Fairfield, AL	53	530



are in the form of aluminosilicates and iron oxides. Table 2 summarizes the chemical compositions of Recmix and a slag from IMS in Mingo Junction, Ohio.

Slag Leaching and Analysis

Column leaching studies were performed with various thicknesses of -1/8 inch IMS slag from Mingo Junction. Two-inch diameter columns were filled with slag to thicknesses ranging from 4 to 24 inches. Four

times each day, 0.5 L of deionized water was poured through these columns for five days (giving 20 leachings per week). Leachings were not performed on weekends. This leaching procedure occurred over a period of three months. After pouring the water into the columns, leachate was collected and a water sample was taken from the collected leachate.

Leachate samples were analyzed for pH, electrical conductivity, alkalinity concentration, and

metals. Alkalinities are given as mg/L CaCO3 equivalent.

Water pH of leachate was 11.7 and alkalinity averaged 1,450 mg/L (Table 3).

Figure 1 summarizes the alkalinity concentration of the leachate samples over time. The results can be related to the leaching procedure (constant leaching for 5 days, followed by a 2 day wait).

Highest levels of alkalinity were found on the Monday leachate samples (the peaks on the graphs) because the slag had time to dissolve and accumulate alkaline products during the weekend when leaching was suspended. The 12-inch-thick layer of slag produced initial alkalinities of 2,000 mg/L, and these alkalinity concentrations gradually declined as more water was flushed through the system.

At the lowest points (toward the end of the week

Table 2. Total elemental compositions of Recmix and Mingo Junction slag fines.

Element	Recmix (mg/kg)	Mingo Jct. Slag Fines (mg/kg)
Al	21,625	29,200
As	6	<3
Ba	130	34
Be	<3	<3
Cd	5	67
C	N/A	4,300
Ca	297,320	501,000
Cr	1,988	1,227
Cu	30	75
Fe	8,327	284,000
Pb	14	84
Mg	57,162	98,000
Mn	9,252	70,000
Hg	0.05	<1
Mo	87	36
Ni	157	12
P	74	8,260
K	325	<100
Sb	N/A	<3
Se	5	<3
Si	142,196	85,000
Ag	5	<3
Na	299	N/A
S	1,805	1,492
Ti	3,285	6,000
T	N/A	<3
Zn	61	80

N/A = Not available

Table 3. Metal concentrations of leachate after Mingo Junction steel slag was leached with deionized water compared to USEPA TCLP and drinking water standards.

Mingo Junction Slag - 1/8 in.		TCLP		EPA Drinking Water	
		Limit	Pass	Limit	Pass
pH	11.7				
Cond.	4780 uS/m				
alkalinity	1450 mg/L				
As	<0.05 mg/L	5 mg/L	yes	50 ug/L	yes
Se	0.05 mg/L	1 mg/L	yes	50 ug/L	yes
Ba	0.02 mg/L	100 mg/L	yes	2000 ug/L	yes
Cd	<0.001 mg/L	1 mg/L	yes	5 ug/L	yes
Cr	0.03 mg/L	5 mg/L	yes	100 ug/L	yes
Cu	0.058 mg/L				
Pb	0.1 mg/L	5 mg/L	yes	15 ug/L	yes
Ni	0.041 mg/L	70 mg/L	yes	10 ug/L	no
Zn	<0.002 mg/L	1 mg/L	yes	6 ug/L	yes
V	<0.05 mg/L				
Tl	<0.05 mg/L	7 mg/L	yes	2 ug/L	?
Be	0.0013 mg/L	0.007 mg/L	yes	4 ug/L	yes
Ti	<0.05 mg/L				
Sb	0.08 mg/L				
Mo	0.008 mg/L				
Ag	<0.005 mg/L	5 mg/L	yes		
Hg	<0.0003 mg/L	0.2 mg/L	yes		
SO4	1.6 mg/L			2 ug/L	yes



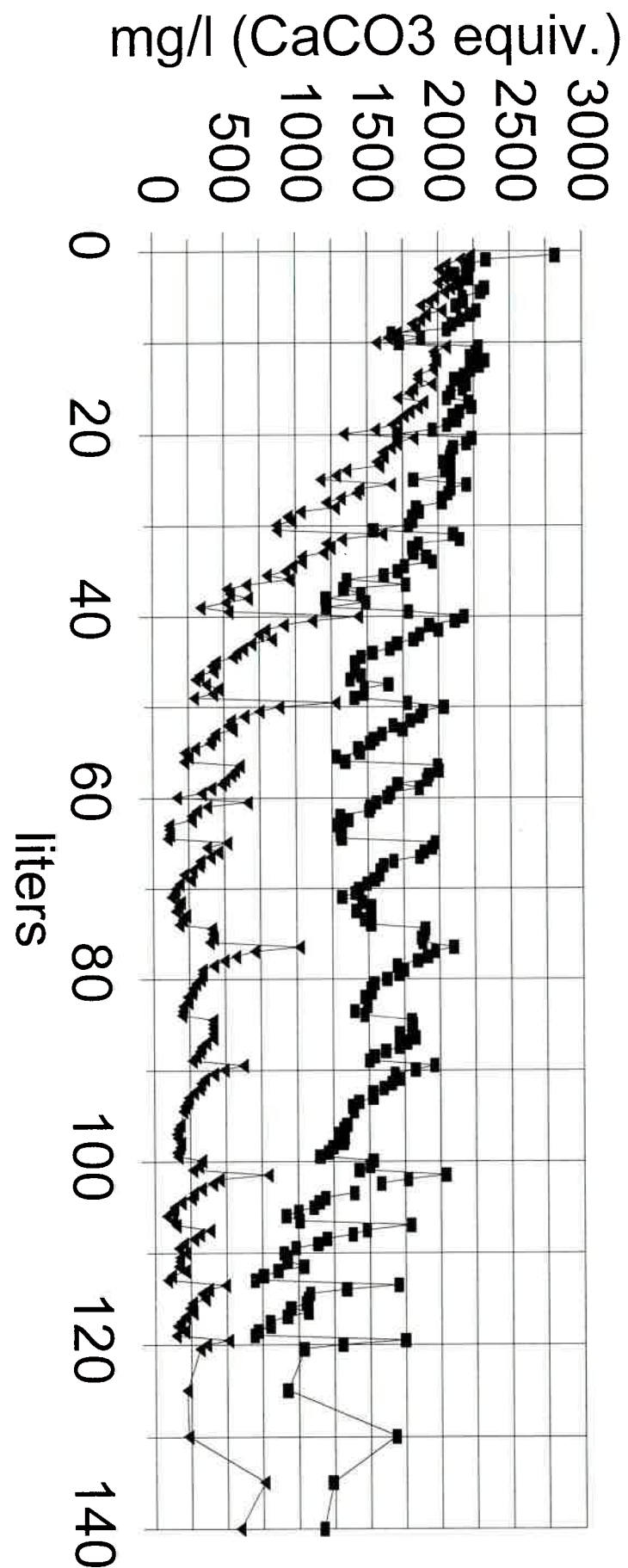


Figure 1 Alkalinity Generation  
Mingo Junction Slag (<1/8")

after constant leaching), alkalinities of about 100 mg/L were found. The 24-inch-thick layer of slag produced similarly high initial alkalinity concentrations and the decline in alkalinity over time was much slower. Even after 100 L of water had flowed through the 24-inch-thick slag column, the alkalinity was still in the 1,750 mg/L range. Alkalinity in the leachate declined over time due to the dissolution of the finer slag particles, leaving only larger particles in the column for reaction.

Larger particles provide less surface area, which in turn give less reaction time and alkalinity production. As mentioned, concentrations of about 100 mg/L were reached, which showed no tendency to decrease further.

In comparison, crushed limestone leached in a similar way yielded alkalinities near 5 mg/L. In order to reach its maximum alkalinity of 80 mg/L (under open conditions), water had to be in contact with the limestone for about 12 hours.

In general, steel slag yielded more alkalinity than equal weights of limestone (from 500 to 2,000 mg/L compared to 60 to 80 mg/L). Hydrated lime or quicklime will yield similar alkalinities as steel slag for a short period, but these lime products expand when wet, seal off allowing little permeability, and gradually turn into limestone. In order to be effective in a leaching application, lime products need periodic agitation.

Measurements on the time it took for the water to flow through the columns gave permeability values of  $4.5 \times 10^{-2}$  cm/sec. These permeability values were maintained throughout the leachings, and they are similar to the permeability values of large sand-sized particles and fine gravel. Alkalinity concentrations stayed near 2,000 mg/L for extended periods depending on the thickness of the slag layer.

#### Heavy Metals in Steel Slag

Since most steel slags contain heavy metals, extensive leaching tests were performed with slags.

It is important to remember that all steel slags are not the same; they vary in composition, quality, and fineness. Nonetheless, similar steel-making processes (like basic steel vs. specialty or stainless steels) should produce slags that are comparable.

In general, basic steel slags like Mingo Junction have lower concentrations of metals than specialty steel slags that often add other metals for specific purposes. Recmix has even lower concentrations of metal than basic steel slags.

Deionized water was passed through a 2-inch diameter by 24-inch long column of Mingo Junction steel slag fines. The leachate metal concentrations were compared to metal standards for the U.S. Environmental Protection Agency's Toxicity Characteristic Leaching Procedure (TCLP) and to EPA's drinking water standards. The results indicate that the slag did not release any element in quantities higher than TCLP limits (Table 3).

As for drinking water standards, other than high pH and alkalinity, only Ni was above the EPA drinking water standard. The Ni concentration in leachate was 41 ug/L versus the drinking water standard of 10 ug/L (Table 3).

The same slag was subjected to a TCLP test, which included extracting metals from the slag with a weak acetic acid leaching solution while being shaken for 18 hours (standard EPA procedures).

All of the metals listed under leachate parameters in TCLP were below the maximum allowable limits (Table 4), and most of the metals were below detection using an analytical instrument commonly used for measuring metals in solution (ICP-AES).

Given the amount of alkalinity in steel slag, few metals were expected to be mobilized unless the leaching medium became extremely acid or continued leaching eventually exhausted the alkalinity in the slag material. To check the release of metals in an acid situation, an acid-producing coal refuse was amended with 2% and 4% slag for neutralization



**Table 4.**  
Metal concentrations in leachates following TCLP testing on Mingo Junction slag fines.

Element	Concentration (mg/kg)	Detection limit (mg/kg)	Maximum allowable (mg/kg)
As	BDL	<0.005	5.0
Ba	BDL	<0.005	100.0
Be	BDL	<0.005	NL
Cd	BDL	<0.005	1.0
Cr total	0.047	<0.010	5.0
Cu	0.017	<0.005	NL
Pb	0.006	<0.005	5.0
Hg	BDL	<0.001	0.2
Ni	BDL	<0.005	NL
Sb	BDL	<0.005	NL
Se	BDL	<0.005	1.0
Ag	BDL	<0.005	5.0
Tl	BDL	<0.005	NL
V	BDL	<0.005	NL
Zn	0.012	<0.002	NL

BDL = Below Detection Limit NL = Not Listed in TCLP (40 CFR 261 7/1/91)

(these rates represent only one quarter to one half the amount of neutralizing material needed to neutralize the acid that is produced from the refuse).

The two slags used in this study, J&L and CarTech, were from specialty steel mills. As expected, most of the columns leached acidic water. Nonetheless, the leachate concentrations were, in nearly every case, less than that from the untreated refuse (Table 5). Nickel and manganese, two important elements, both increased in leachates from refuse treated with slag compared to leachate from untreated refuse.

#### Field Applications Using Steel Slags

#### Leach Beds

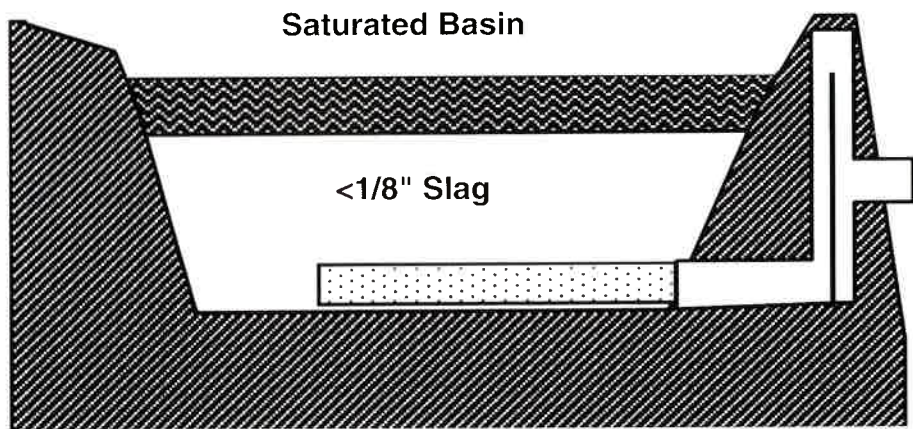
The alkaline load achievable from a leach bed

of steel slag is determined by the amount of fresh water available to drive the leaching process. It is important to note that slag fines in leach beds will plug up if exposed to AMD or sediment. Metals will precipitate within the slag material and cause it to stop transmitting water. Leach beds containing slag fines should be used only in conjunction with fresh (metal free) water. Slag beds can be constructed to catch runoff without a sediment load or to use direct rainfall. The effluent from the leach beds can be allowed to infiltrate directly into a spoil or refuse pile to achieve in-situ AMD treatment, or the effluent can be combined with an AMD source to treat downstream of the spoil. Either application has potential for very low maintenance AMD treatment in either active mining or AML programs. Figure 2 shows how a leach bed

**Table 5.**  
Leachate quality resulting from the addition of 2% and 4% slag from two sources (J&L and CarTech). The results are from the fifth leach cycle in an accelerated leaching procedure.

Analyte	Units	Control No Slag	Refuse + 2% J&L Slag	Refuse + 4% J&L Slag	Refuse + 2% CarTech Slag	Refuse + 4% CarTech Slag
pH		2.6	4.0	5.3	3.5	7.3
acidity	(mg/L)	1155	157	24	139	9
alkalinity	(mg/L)	0	0	7	0	25
SO4	(mg/L)	2080	1551	1424	1650	1413
As	(mg/L)	34	18	31	32	40
Se	(mg/L)	1	5	15	3	30
Ba	(mg/L)	639	21	31	773	28
Ag	(mg/L)	2	11	3	2	2
Cr	(mg/L)	41	5	5	36	3
Ni	(mg/L)	507	1000	283	713	57
Cd	(mg/L)	23	38	6	18	3
Pb	(mg/L)	25	9	13	3	20
Mn	(mg/L)	8	36	22	17	3
Fe	(mg/L)	207	162		216	0
Al	(mg/L)	10	1		6	1

**Figure 2 Leach Bed**





<b>Table 6.</b> <b>Expected performance from leach beds constructed with limestone versus steel slag.</b> <b>Two types of leach beds are presented: those with a steady flow of fresh water (alkaline leach bed) and those driven by precipitation only (dry leach bed).</b>							
ALKALINE LEACH BED							
	FLOW gpm	SIDE LENGTH ft.	DEPTH ft.	MATERIAL REQUIRED tons	FINAL ALK mg/ L	LIFE years	ALKALINE LOAD lbs/day
LIMESTONE							
OPEN	100	135	4	6,160	79	200+	95
CLOSED	100	120	4	4,900	196	100+	235
STEEL SLAG							
OPEN	100	118	4	3,009	1,500	5	1,800
DRY LEACH BED							
	AREA acres	DEPTH ft.	FLOW gpm	MATERIAL REQUIRED tons	COST	FINAL ALK mg/L	ALKALINE LOAD lbs/day
LIMESTONE	5	1	9.13	16,000	\$240,000	2	2.2
STEEL SLAG	5	1	9.13	11,760	\$176,400	800	87.6

might be designed.

Table 6 indicates expected performance and volume requirements in both limestone and steel slag leach beds for a specific flow of water. The alkaline leach bed (with a steady flow of fresh water) can provide up to 1,800 lbs per day of alkalinity compared to 95 lbs per day with open limestone leach beds (open limestone) and 235 lbs per day with an anoxic limestone leach bed (closed limestone).

#### Direct Water Treatment

Water treatment using slag was also tested. This involved placing slag directly in a stream of AMD

as a replacement for quicklime in an Aquafix doser. A site at Lenox, WV was selected, and the AMD to be treated had high manganese (56 mg/L) and moderate iron (10 mg/L) concentrations. This approach had mixed results.

Slag fines were too coarse to dissolve quickly and very high application rates were needed for adequate treatment to achieve effluent limits.

On the other hand, Recmix, due to its smaller particle size, worked well as a treatment chemical. It removed manganese at a pH of 8.7 at about twice the application rate of CaO. Iron was also removed.

Table 7 shows the performance of Recmix

compared to CaO in the Lenox water treatment trial.

In addition to monitoring for Fe, Mn and Al in the water, we analyzed for TCLP metals in the initial AMD and also in the water 300 feet downstream of the Aquafix machine applying Recmix.

The results indicate that all of the TCLP metals dropped after treatment with Recmix. The only surprising result was the tendency for Al to remain around 7 mg/L in the treated water. At a pH of 8.7, Al is not expected to be dissolved in the water.

The water sample was taken at the inlet to the settling pond and we expect that the Al would precipitate given time. This is something that we will continue to monitor.



Picture 1. Alkaline leach bed with a visible layer of steel slag on the bottom.

#### Field Considerations

Until more is understood about the leachability of various slags in acid environments, we do not recommend that steel slags be placed in areas that may become acid.

If slag is to be used as an alkaline amendment, we recommend that enough slag is added so that the spoil or refuse cannot turn acid. Both Recmix and slag fines have been used successfully as alkaline amendments to spoils.

We recommend that slags be considered as surface amendments to soils, as amendments to slightly acidic spoil and refuse (where the slag will overwhelm the small potential for acid production), and as an



Picture 2. Dry leach bed that receives water only from rainfall. The trench is filled with steel slag.



alkaline material in freshwater leaching beds.

Acid mine drainage treatment with Recmix appears promising as long as treatment is maintained. Given the solubility of slag's alkalinity, this might be a promising application.

Slags generally do not feed well through an Aquafix unless dried to <3% moisture. For proper dosage, a lime hopper with a shaker is required for adequate flow of the slag.

Another promising alternative is to directly apply slag into AMD in a ditch upstream of a settling pond, much like limestone sand applications.

**Cost**

In most locations in the Appalachian coalfields, slag can be obtained very inexpensively. Transportation is the major cost component.

**Conclusion**

Steel slag appears to have a number of applications for AMD control and treatment. In addition to the uses identified so far, future work will evaluate its use as a capping material and as an alkaline amendment.

Several field studies were initiated in the summer of 1997 and their progress will be reported in future issues of Greenlands.

**Table 7. Water quality of untreated AMD at Lenox, WV and the quality after treatment with CaO and Recmix. Both chemical and slag were applied by an Aquafix machine. Treated water was sampled at 30 and 300 feet from where the Aquafix machine was located.**

	Calcium Oxide Treatment			Recmix Treatment	
	Upstream Aquafix Lenox B	30' Downstream CaO Aquafix Lenox 2	300' Downstream CaO Aquafix Pond Inlet	30' Downstream Recmix Aquafix Lenox 2	300' Downstream Recmix Aquafix Pond Inlet
pH	4.3	4.9	4.7	8.1	8.7
alk	0	2	1	25	555
acd	270	141	171	61	0
Al	31	8	19	6	7
Fe	10	5	6	0	0
Mn	56	55	50	21	0
Cond.	2190	2120	2120	2180	2150
Sb	.6				.4
As	.7				.5
Ba	BDL				BDL
Be	BDL				BDL
Cd	.1				BDL
Cr	.1				BDL
Pb	.4				.3
Ni	1.2				BDL
Se	.8				.6
Ag	BDL				BDL
Tl	1.3				.9
Hg	BDL				BDL

BDL = Below Detection Limit

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