UTILIZATION OF CFB ASH IN RECLAMATION TO PREVENT POST-MINING AMD

Prepared by

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INTRODUCTION

Patriot Mining Company, Inc. has been surface mining coal in Preston County, West Virginia since 1979. Coal seams mined include the Kittannings, Freeports, Mahoning, Bakerstown and Harlem, with the Upper Freeport being the predominate seam mined. In some areas, the Upper Freeport has been successfully mined and reclaimed with no post-mining water problems. Unfortunately, in other areas, even with great care taken to selectively handle acid producing overburden strata, post-mining acid seepages have developed.

Beginning in 199o, the first of two coal supply contracts began which required Patriot to accept the ash generated at the power plant on the back haul. Both of these power plants are new and utilize circulating fluidized bed boilers to produce steam. In addition to coal, limestone is also fed into the boiler in order to control sulfur emissions without the use of a scrubber. Due to inefficiencies in the absorption process, limestone in excess of the theoretical requirement is injected into the boiler, resulting in a highly alkaline ash. Another advantage of CFB boilers is the ability to burn low grade fuels. The second plant which Patriot supplies came on line in 1992 and burns a combination of coal and coal refuse. Thus, an acidic coal waste is excavated and shipped and a highly alkaline ash is returned by back haul.

In preparation for the initial ash shipments to Patriot in 1990, a rail dump was constructed in Albright, West Virginia. Initially, all of the ash unloaded was placed on the Albright mine site. However, the overburden at this site is alkaline and all of the alkalinity being added to the site in the form of the ash was not really serving any useful purpose.

During the time that the ash was being placed at Albright, another interesting property of the material was discovered. The CFB ashes that we were dealing with are pozzalonic. Simply stated, when the material becomes wet, it has a tendency to "set up" like a weak concrete. Unfortunately, this property was discovered when the material was still in the railroad car.

However, aside from unloading the material from railcars, it was felt that this property could have many advantages. Used as a pit lining, the material should also seal the pit floor thus preventing groundwater from coming in contact with potentially acid producing shales immediately below a coal seam. Placed on top of a regraded area, this could reduce infiltration of rainwater into a backfill, thus reducing seepage. Potentially toxic overburden or partings could be encapsulated within this material, greatly reducing the amount of water which would come into contact with it. Another advantage would be the strength of this material in a monofill. Slope stability should never be a problem on a f ill constructed of weak concrete.

OPERATIONAL PROCEDURE

In August of 1990, Patriot began surface mining the Upper Freeport coal at the Birds Creek Mine. The overburden at this site is typical for Upper Freeport in this area of Preston County. It averaged 60 feet in thickness and consisted of a very hard Mahoning Sandstone. The overburden analysis showed, a very low percent sulfur. Unfortunately, the neutralization potentials were relatively low also. The shale parting associated with Upper Freeport and "Big Joel' coals and the pavement below the "Big Joel' coal were acid producing. Based on past experience, we felt that this job had a potential to be acid producing following reclamation due to the low neutralization potential of all of the overburden on the permit area.

It was decided to utilize the ash being shipped to Albright as a reclamation tool at the Birds Creek Surface Mine. Due to permitting time, the first placement of ash did not take place on the site until February, 1991.

During the time period between job start-up and approval to utilize the ash, several pits of coal were mined and reclaimed and the majority of a durable rockfill was constructed. This gave us the opportunity to evaluate areas with and without ash placement on the same mine site.

Following coal removal, pit cleanings and any other potentially acid producing material were hauled out of the pit. Some of this material was hauled to an off-site refuse disposal area and the remainder was selectively buried on the site. The ash was then hauled into the pit and spread in approximately a one foot layer. Sufficient amounts of ash were also placed against the highwall in order to cover the exposed coal seam. The pit was then backfilled and graded to approximate original contour. The backfilled pit was then covered with a six to twelve inch layer of ash which, in turn, was covered with topsoil. All acid producing material buried on the site was placed well above the pit floor and surrounded by ash. No ash was placed on the areas below the coal outcrop where excess spoil was placed. This procedure was followed from February, 1991 until the end of mining in April, 1992. The entire site was reclaimed in the spring of 1992.

EVALUATION

Eight sample sites were selected to evaluate the post-mining water quality at the Birds Creek Mine. Sites 1 and 2 are located at the toe of the backfill at the end of the job. The job was ended at that point because of abandoned deep mine workings in the vicinity which were of unknown extent. It is,. suspected that these mine workings are contributing to the flow of sites 1 and 2. These seeps make up the f low in sediment ditch No. 1 at the uppermost end. This water quality is typical of Upper Freeport mine drainage with pH ranging between 2.93 and 3.74 and iron between 34 ppm and 416 ppm.

Site 3 is located approximately 800 feet downstream of sites 1 and 2 in sediment ditch No. 1. The ditch continually picks up flow throughout this 800 foot section by way of a series of seeps at the toe of the backfill. All of the mine areas contributing to these seeps were treated with ash. Water quality at site 3 was much improved with pH ranging between 3.96 and 5.63 and iron ranging between I and 15 ppm.

Site 4 is located an additional 300 feet further downstream in sediment channel No. 1 and also picks up additional seepage from ash treated areas of the backfill. At this point, the water showed even more improvement with pH now between 7. 4 7 and 9. 8 3 and iron no higher than 2 ppm.

Sites 6 and 7 are seeps at the base of rockfill No. 1. No ash was placed in the fill nor in the pits immediately above the fill. Site 6 has pH ranging between 2.91 and 3.81 and iron between 16 and 80 ppm. Site 7 has pH ranging between 4.1 and 4.37 and iron less than one.

Site 9 is a seep at the base of a downslope spoil area above sediment ditch No. 6. Although pits above this seep were treated with ash, no treatment was added to any of the fill areas located below the outcrop. It is believed that the poor water quality at this site may be due to the untreated fill area and further investigations are planned into the groundwater quality. Site 9 has a pH range of 3.4 to 3.64 and iron from 27 to 39 ppm.

Another concern, which has been expressed many times, is the potential for heavy metals to leach from ash when it is placed in an acidic environment. Based on metals analyses on seepage coming directly from ash treated areas, this did not occur. Sufficient quantities of ash were placed on the treated areas to keep the discharges alkaline. Concentrations of metals appeared to become lower as the effect of the ash became greater, as can be seen from the analyses on sites 1 through 4. Additional testing will be done over time to see if this trend continues.

CONCLUSIONS

Our initial results indicate that the use of alkaline CFB ash can be effective in the prevention of post-mining AMD in acid producing coal areas. Additional monitoring will tell if this treatment will withstand the test of time. The initial data would also indicate that mobilization of heavy metals from ash is not taking place. Additional groundwater monitoring is proposed in the future to determine the source of acid seepage from areas where spoil was placed below the outcrop. We believe that the groundwater flows are becoming acid when they pass through these fill areas which were never treated with ash. A series of wells between the original outcrop and the toe of the fill could identify the source of acid drainage. This would be useful in the design of future programs.

BIRDS CREEK WATER QUALITY
pH

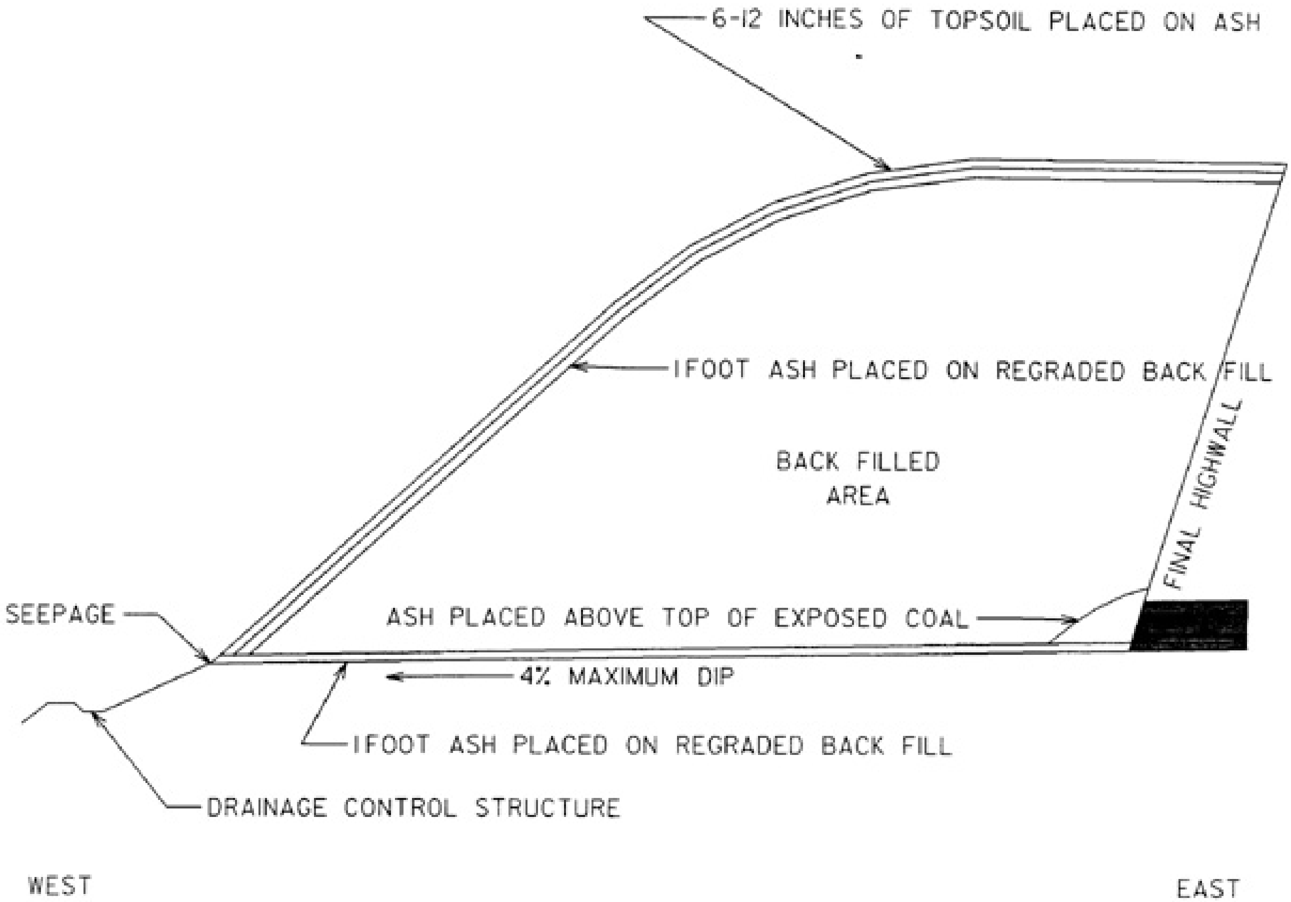
Date	Site 1	Site 2	Site 3	Site 4	Site 6	Site 7	Site 9
09/16	3.32	3.67	5.63	9.72	3.2	4.2	3.64
09/18	3.2	3.74	5.54	9.83	3.02	4.13	3.5
09/22	3.01	3.1	4.22	9.03	2.91	4.12	3.44
09/24	3.2	3.02	4.04	9.22	2.97	4.14	3.5
09/28	2.93		4.65	7.76	2.91	4.1	3.4
10/01			3.96	7.47	2.95	4.12	3.46
10/05					3.24	4.22	
10/28				7.55	3.81	4.37	

BIRDS CREEK WATER QUALITY
Acidity (total)

Date	Site 1	Site 2	Site 3	Site 4	Site 6	Site 7	Site 9
09/16	1190	420	62	14	1390	470	98
09/18	1282	394	70	20	1440	482	108
09/22	1410	394	80	0	1292	438	1030
09/24	1366	342	72	0	1271	431	1100
09/28	1266		58	0	1254	418	1070
10/01			102	0	740	636	1108
10/05					1004	384	
10/28				0	420	296	

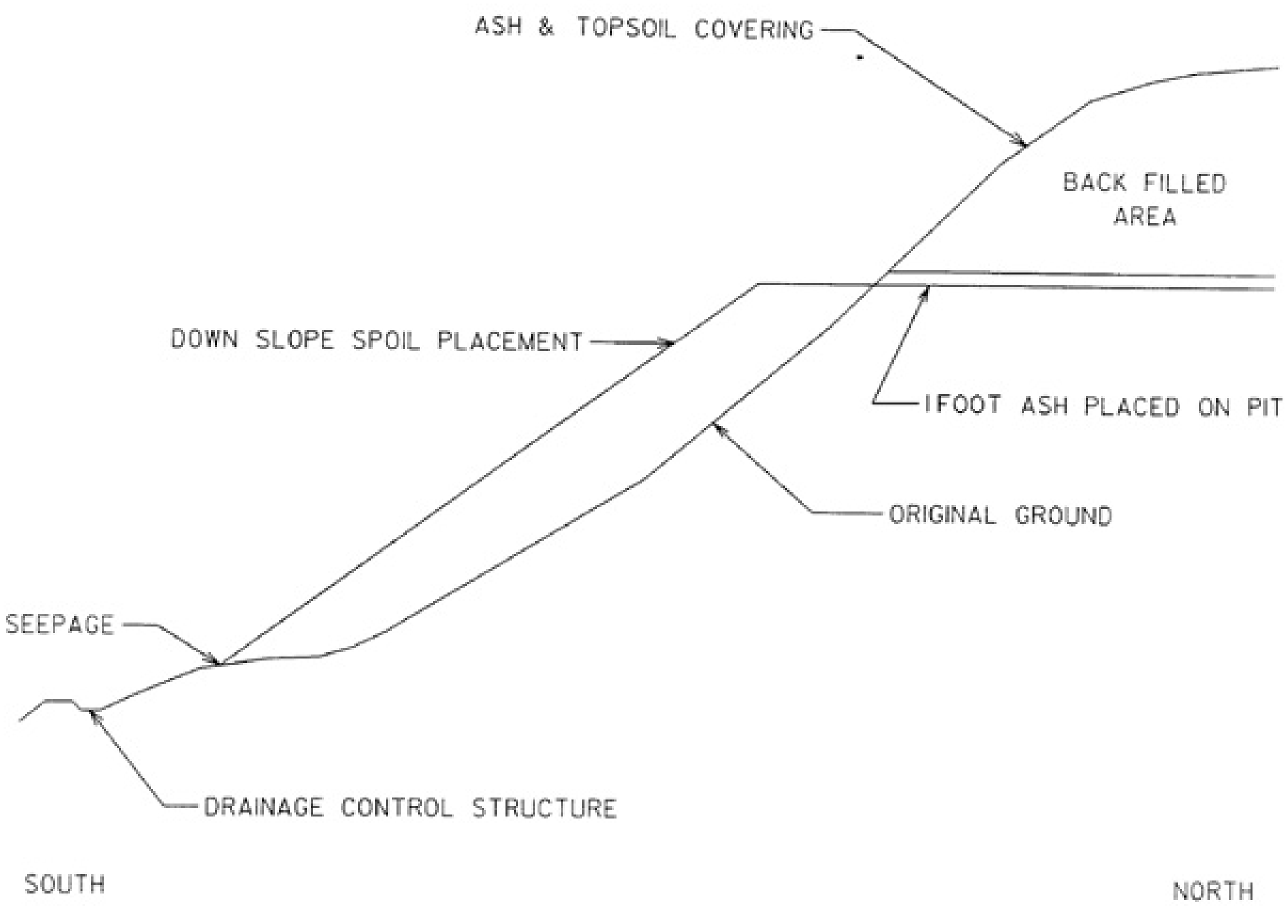
BIRDS CREEK WATER QUALITY
Iron ppm

Date	Site 1	Site 2	Site 3	Site 4	Site 6	Site 7	Site 9
09/16	347.4	97	7	2	72	0	31
09/18	335	100	7	2	76	0	30
09/22	319	64	8	0	80	0	27
09/24	416	34	1	0	69	0	39
09/28	50		4	0	73	0	32
10/01			15	0	61	0	26
10/05					21	0	
10/28				0	16	0	



TYPICAL CROSS SECTION A
BIRDSCREEK SURFACE MINE
POST MINING WATER STUDY

NOT TO SCALE



TYPICAL CROSS SECTION B
BIRDSCREEK SURFACE MINE
POST MINING WATER STUDY

NOT TO SCALE

Sturm Environmental Services

JOHN W. STURM, PRESIDENT

DATA FOR EPA FORM 2-C

COMPANY: PATRIOT MINING COMPANY

SAMPLE ID: S-1022-88 BCWS #2

DATE SAMPLED: 11/19/92
DATE RECEIVED: 11/20/92
SAMPLED BY: Troy Tichenell

FORM 2-C, PART A	CONCENTRATION	UNITS
a) BOD		ppm
b) COD		ppm
c) TOC		ppm
d) TSS	21	ppm
e) NH_4 as N		ppm
f) Flow	2	gpm
g)h) Temp		°C
i) pH	3.4	

FORM 2-C, PART B	CONCENTRATION	UNITS
CHLORIDE	45.4	ppm
SULFATE	1420	ppm
TOTAL ALUMINUM	27.3	ppm
TOTAL IRON	110.	ppm
TOTAL MANGANESE	14.1	ppm

FORM 2-C, PART C	CONCENTRATION	UNITS
1M. Antimony	<.005	ppm
2M. Arsenic	<.001	ppm
3M. Beryllium	.065	ppm
4M. Cadmium	.027	ppm
5M. Chromium	<.05	ppm
6M. Copper	.04	ppm
7M. Lead	.022	ppm
8M. Mercury	.0010	ppm
9M. Nickel	.74	ppm
10M. Selenium	<.002	ppm
11M. Silver	<.01	ppm
12M. Thallium	<.001	ppm
13M. Zinc	2.69	ppm
14M. Cyanide		ppm
15M. Phenols		ppm

APPROVED: [signature]

REX B. TENNANT, II - CHEMIST/LAB MANAGER

Sturm Environmental Services

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DATA FOR EPA FORM 2-C

COMPANY: PATRIOT MINING COMPANY

SAMPLE ID: S-1022-88 BCWS #3

DATE SAMPLED: 11/19/92
DATE RECEIVED: 11/20/92
SAMPLED BY: Troy Tichenell

FORM 2-C, PART A	CONCENTRATION	UNITS
a) BOD		ppm
b) COD		ppm
c) TOC		ppm
d) TSS	19	ppm
e) NH_4 as N		ppm
f) Flow	4	gpm
g)h) Temp		°C
i) pH	3.1	

FORM 2-C, PART B	CONCENTRATION	UNITS
CHLORIDE	124	ppm
SULFATE	1420	ppm
TOTAL ALUMINUM	14.4	ppm
TOTAL IRON	59.7	ppm
TOTAL MANGANESE	7.04	ppm

FORM 2-C, PART C	CONCENTRATION	UNITS
1M. Antimony	<.005	ppm
2M. Arsenic	<.001	ppm
3M. Beryllium	.026	ppm
4M. Cadmium	.015	ppm
5M. Chromium	<.05	ppm
6M. Copper	.04	ppm
7M. Lead	.006	ppm
8M. Mercury	<.0005	ppm
9M. Nickel	.42	ppm
10M. Selenium	<.002	ppm
11M. Silver	<.01	ppm
12M. Thallium	<.001	ppm
13M. Zinc	1.08	ppm
14M. Cyanide		ppm
15M. Phenols		ppm

APPROVED:

REX B. TENNANT, II – CHEMIST/LAB MANAGER

Sturm Environmental Services

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DATA FOR EPA FORM 2-C

COMPANY: PATRIOT MINING COMPANY

SAMPLE ID: S-1022-88 BCWS #4

DATE SAMPLED: 11/19/92
DATE RECEIVED: 11/20/92
SAMPLED BY: Troy Tichenell

FORM 2-C, PART A	CONCENTRATION	UNITS
a) BOD		ppm
b) COD		ppm
c) TOC		ppm
d) TSS	27	ppm
e) NH_4 as N		ppm
f) Flow		gpd
g)h) Temp		^oC
i) pH	4.7	

FORM 2-C, PART B	CONCENTRATION	UNITS
CHLORIDE	106	ppm
SULFATE	1060	ppm
TOTAL ALUMINUM	.16	ppm
TOTAL IRON	8.97	ppm
TOTAL MANGANESE	5.59	ppm

FORM 2-C, PART C	CONCENTRATION	UNITS
1M. Antimony	<.005	ppm
2M. Arsenic	<.001	ppm
3M. Beryllium	<.005	ppm
4M. Cadmium	<.005	ppm
5M. Chromium	<.05	ppm
6M. Copper	<.02	ppm
7M. Lead	.004	ppm
8M. Mercury	<.0005	ppm
9M. Nickel	.11	ppm
10M. Selenium	<.002	ppm
11M. Silver	<.01	ppm
12M. Thallium	<.001	ppm
13M. Zinc	.241	ppm
14M. Cyanide		ppm
15M. Phenols		ppm

APPROVED:

REX B. TENNANT, II - CHEMIST/LAB MANAGER

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CORE DESCRIPTION

Patriot Mining Company, Inc.
Hole BCR-11
12/7/87

Sample Number	Depth (feet)	Strata
1	10.0-16.0	Sandstone, medium to coarse grained, light brown, micaceous.
2	16.0-22.0	Sandstone, medium to coarse grained, light brown, micaceous.
3	22.0-28.0	Sandstone, medium to coarse grained, light brown, micaceous.
4	28.0-34.0	Sandstone, medium to coarse grained, light brown, micaceous.
5	34.0-40.0	Sandstone, medium to coarse grained, light brown, micaceous.
6	40.0-46.0	Sandstone, medium to coarse grained, light brown, micaceous.
7	46.0-52.0	Sandstone, medium to coarse grained, light brown, micaceous.
8	52.0-56.0	Sandstone, medium to coarse grained, light brown, micaceous.
9	56.0-58.0	Sandstone, medium grained, light gray, silty streaks, micaceous.
10	58.0-62.6	Coal, Upper Freeport.
11	62.6-64.3	Shale, dark gray, carbonaceous.
12	64.3-65.4	Coal, Big Joe.
13	65.4-65.7	Shale, medium gray.
14	65.7-67.9	Shale, silty, medium gray, slickensides.
15	67.9-70.6	Siltstone (1.4'), sandy, light to medium gray; sandstone (1.3'), fine grained, light gray, micaceous.
16	70.6-71.8	Shale, silty, light gray.

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Sturm Environmental Services

Company: Patriot Mining Company, Inc.
Site: Hole BRC-11
Date: 12/7/87

ACID-BASE ACCOUNT

Sample Number	Depth (Feet)	Strata Thick. (Feet)	Rock Type	Fiz	Color	% S	Max. From % S	N.P. $CaCO_3$ Equiv.	Max. Needed (pH-7)	Excess $CaCO_3$	Paste pH
							Calcium Carbonate Equivalent Tons/1000 Tons of Material				
1	10.0-16.0	6.0	SS	0	10yr 8/2	,007	.22	2.11		1.89	5.4
2	16.0-22.0	6.0	SS	0	10yr 8/2	.002	.06	3.20		3.14	5.7
3	22.0-28.0	6.0	SS	0	10yr 8/2	.001	.03	1.31		1.28	5.8
4	28.0-34.0	6.0	SS	0	10yr 8/2	.001	.03	4.18		4.15	5.7
5	34.0-40.0	6.0	SS	0	2.5y 8/2	.003	.09	2.52		2.43	6.0
6	40.0-46.0	6.0	SS	0	10yr 8/3	.001	.03	2.04		2.01	6.2
7	46.0-52.0	6.0	SS	0	10yr 8/3	.001	.03	1.54		1.51	6.1
8	52.0-56.0	4.0	SS	0	10yr 8/2	.001	.03	1.09		1.06	6.0
9	56.0-58.0	2.0	SS	0	2.5y 7/2	.438*	13.69	.90	12.79		5.2
10	58.0-62.6	4.6	Coal	0	10yr 2/1	1.14*	35.62	.13	35.49		5.1
11	62.6-64.3	1.7	SH	0	5y 4/1	.264	8.25	3.38	4.87		6.0
12	64.3-65.4	1.1	Coal	0	10yr 2/1	3.02*	94.38	.35	94.03		6.1
13	65.4-65.7	.3	SH	0	75.yr8/0	.485*	15.16	1.71	13.45		4.9
14	65.7-67.9	2.2	SH	0	7.5yr8/0	.136	4.25	7.36		3.11	5.8
15	67.9-70.6	2.7	SlS-SS	0	7.5yr8/0	.073	2.28	12.99		10.71	6.7
16	70.6-71.8	1.2	SH	0	2.5y 8/0	.070	2.19	10.83		8.64	6.8

*Pyritic sulfur

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SULFUR FORMS

Patriot Mining Company, Inc.
Hole BCR-11
12/7/87

Sample Number	Total Sulfur (%)	Pyritic Sulfur (%)	Sulfate Sulfur (%)	Organic Sulfur (%)
9	.489	.438	.025	.026
10	2.02	1.14	.180	.705
12	4.06	3.02	.150	.891
13	.660	.485	.142	.033

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