MOSHANNON CREEK

WATERSHED

MOSHANNON CREEK WATERSHED

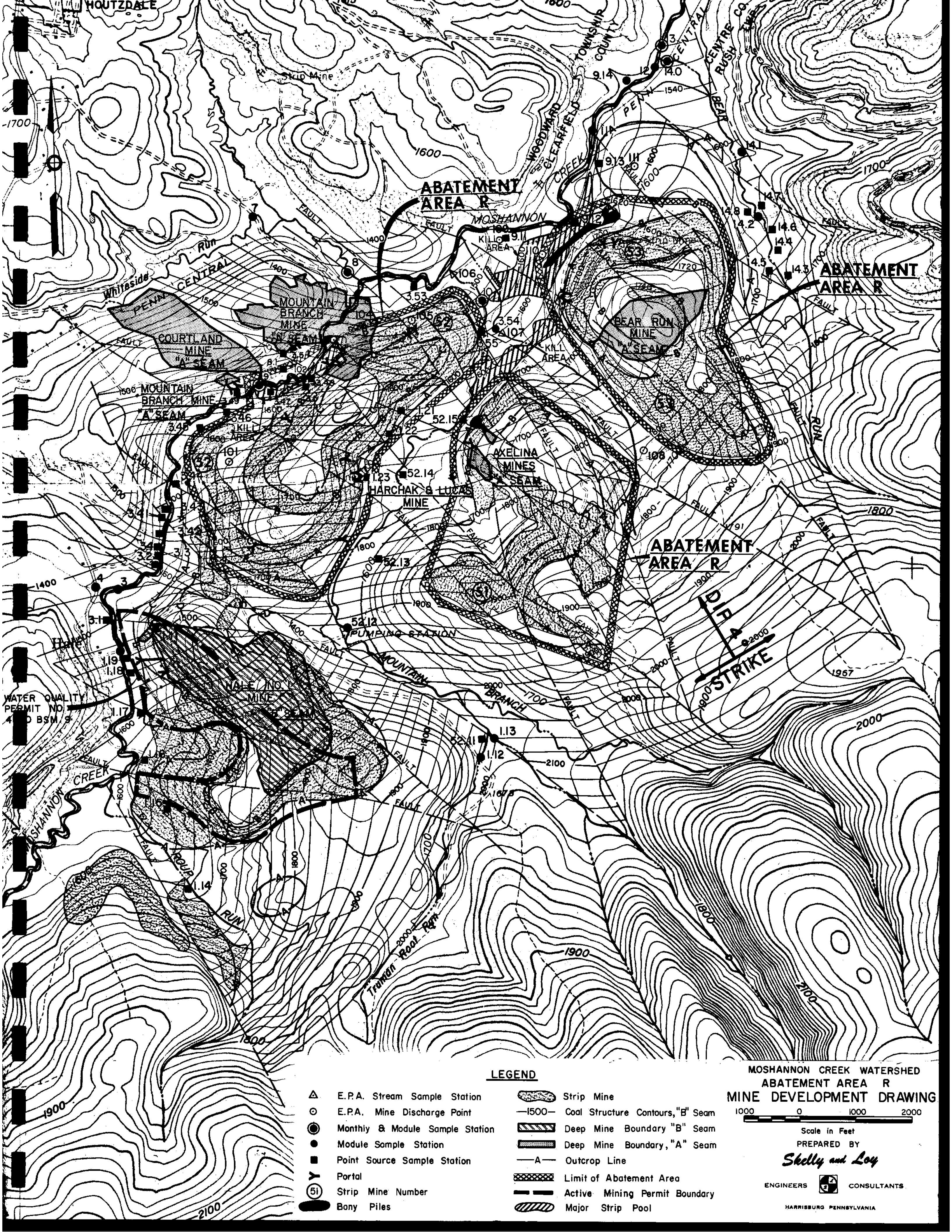
ABATEMENT AREA R
SOUTH OF BEAR RUN

Location

Abatement Area R consists of three strip mines, #'s 51, 52, and 53, situated southeast of Houtzdale in Rush Township, Centre County. The area lies just south of Abatement Area S, which was recommended in Skelly and Loy's first Interim Report. Mine #53 is flanked by Bear Run to the northeast and Mountain Branch to the southwest. Strip mine #52 is flanked by Mountain Branch to the northwest and southwest and strip mine #53 to the northeast. Strip mine #51 is bounded by Mountain, Branch to the northeast and southeast, and Moshannon Creek to the northwest.

Geology

The abatement area is situated on the southeast limb of the Houtzdale Syncline. Allegheny Group units from the Brookville-Clarion to the Middle Kittanning outcrop in the area. These units strike northeast-southwest and dip 40 to the northwest. Overburden associated with the "A" coal consists of a dark, interbedded shale and sandstone, while that associated with the "B" and "C" coals consists of moderately thick, massive sandstone. The area contains numerous northwest trending wrench and splay faults, many showing considerable offset in the coal strata. Faulting is clearly indicated on mine development drawings.


HOUTZDALE
ABATEMENT AREA R
MOSHANNON
COURTLAND MINE "A" SEAM
MOUNTAIN BRANCH MINE "B" SEAM
MOUNTAIN BRANCH MINE "A" SEAM
BEAR RUN MINE "A" SEAM
AXELINA MINES "A" SEAM
HARCHAK & LUCAS MINE
HALE NO. 1 MINE "B" SEAM
PUMPING STATION
MOUNTAIN BRANCH
WATER QUALITY PERMIT NO.
DIP
STRIKE
LEGEND
E.P.A. Stream Sample Station
E.P.A. Mine Discharge Point
Monthly & Module Sample Station
Module Sample Station
Point Source Sample Station
Portal
Strip Mine Number
Bony Piles
Strip Mine
1500 Coal Structure Contours, "B" Seam
Deep Mine Boundary "B" Seam
Deep Mine Boundary, "A" Seam
A Outcrop Line
Limit of Abatement Area
Active Mining Permit Boundary
Major Strip Pool
MOSHANNON CREEK WATERSHED
ABATEMENT AREA R
MINE DEVELOPMENT DRAWING
1000 0 1000 2000
Scale in Feet
PREPARED BY
Skelly and Loy
ENGINEERS CONSULTANTS
HARRISBURG PENNSYLVANIA

Mining History

The entire abatement area has been extensively deep mined on both the "A" and "B" seams. Pulling of coal pillars or stumps in these deep mines preceeded the end of deep mining activities in the early 1950's. No deep mining is known to exist on the "C" seam.

Several of the area's "A" and "B" seam strip mines apparently cut into the extremities of the deep mine workings. All three strip mine areas have had only minimal reclamation work, and are poorly vegetated. The "C" seam portion of strip mine #52 is the only fully regraded section of the abatement area. Several acres of bony refuse that was associated with loading platforms, haulage roads and tipples are also found between the abatement area and Moshannon Creek.

Mine Drainage and Hydrology

Deep and strip mining have extensively altered the natural hydrologic system of the abatement area. The unreclaimed strip mines effectively trap all runoff and rainfall, holding some in surface ponds in the highly acid "A" and "B" seam spoil where pH's drop as low as 1.8. All of the trapped water infiltrates downward through the strip mine spoil. Some of this water enters the underlying deep mine workings and is channeled downdip through the acid producing materials within the workings. This water is discharged from the area through the stripping at the downdip end of the abatement area. The remaining trapped water infiltrates downward only as far as the impermeable "A" seam underclay. The water then seeps downdip through the spoil along the surface of the underclay and into the streams on the downdip side of the abatement area.

Much of the water discharging from the abatement area also passes through or across highly acid bony material before entering the area streams. This bony tends to increase the acidity of the water it contacts. Some of the bony is also eroded and transported by the streams, and is completely converted to acid as the sediments are transported far downstream. Acid formed in this manner can appear many miles downstream from the actual abatement area.

Water Quality

EPA water quality data, obtained during the extremely dry summers of 1966 and 1967, indicated that approximately 9,812 lbs/day acid were emanating from the three strip areas in Abatement Area R.

Skelly and Loy's intensive study program sample data showed that most of Mountain Branch and the headwaters of Bear Run are of good quality, but that both streams are degraded - Bear Run severely and Mountain Branch moderately - in their passage through the area. The adjusted acid load for this abatement area was nearly 21,000 lbs/day at source. It is suspected that, since some of the acid emanating from the area is deep mine related, the standard flow adjustment constants may be too high, and the actual acid load for the area is somewhat lower than that presented. However, even if the adjusted acid load is reduced by one third, the abatement area is still contributing a substantial 14,000 lbs/day acid. Adjusted acid loads associated with strip mines #'s 51, 52, and 53 are 360, 18,000, and 2197 lbs/day respectively. The high value of 18,000 for strip mine #52 may be contributed from some deep mine drainage, however field studies could not verify this. The unadjusted acid loads are 216, 2,748 and 414 lbs/day respectively.

Recommended Abatement

The recommended abatement plan for this area involves a large scale surface restoration program to eliminate the unreclaimed strip mines, bony and kill areas. The purpose of this restoration will be two-fold. It will improve the surface drainage system sufficiently to permit rapid flow of runoff from the area, thus minimizing water contact with acid forming spoil and bony material. The restoration will also minimize infiltration of oxygen into the spoil and underlying deep mine workings, which will also limit the reaction that produces the acid.

Unreclaimed strip cuts should be contour, swale or terrace back-filled as necessary to efficiently remove runoff and rainfall from the area.

Strip mine surfaces should be treated with limestone and fertilizers to provide a satisfactory growth medium, and can then be vegetated with grasses, legumes or trees as dictated by slope stabilities. Diversion ditches should be constructed where deemed necessary, and their discharges flumed across strip mine surfaces to rapidly drain runoff from the strip areas.

Bony material should be buried in the strip cuts in conjunction with backfilling where economical. Other larger bony areas can be regraded and vegetated, after limestone crusher waste and fertilizers are roto-tilled into the top 10 inches of the bony surface.

Kill areas, which are extensive along the streams within the abatement area, will be regraded and revegetated. This will primarily prohibit the widespread erosion that is evident in these areas. In addition, the channels of the abatement area's streams should be reconstructed where necessary to prohibit contact with bony or spoil material.

This surface restoration program should effectively abate roughly 35% of the acid discharging from the abatement area, or 10,000 lbs/day acid. Mine sealing was not recommended due to high hydraulic head conditions created by differences in mine working elevations.

Cost effectiveness for strip mine #51 is high due to low acid loadings attributed to the area. Monitoring of AMD is difficult below the mines where the ground is saturated with drainage and difficult to sample. AMD emanating from the area is probably higher than recorded but correct estimates are difficult to make.

South of Bear Run Mine Drainage Data

SAMPLE			ACID LOAD	
Station #	Description	Strip Mine #	Unadjusted	Adjusted
52.13	deep mine	51	13	13
52.14	deep mine	51	10	10
10.0	Mountain Branch	51,52	386	720
3.45	strip seepage	52	no flow	46ppm
3.47	pond discharge	52	314	2200
3.48	strip discharge	52	570	4000
3.49	pond discharge	52	431	3020
3.5	strip discharge	52	1204	8428
1.21	discharge from	52	no flow	166ppm
1.22	discharge from	52	no flow	120ppm
1.23	deep mine discharge	52	no flow	2130ppm
9.11	strip mine discharge	53	28	168
9.12	deep mine discharge	53	34	34
9.13	strip mine discharge	53	202	1212
14.2	Bear Run	53	120	593
14.5	headwaters Bear Run	53	15	95
14.8	ground water discharge	53	15	95

The above 2 point sources 52.13 and 52.14 do not record all acid entering Mt. Branch from Strip Mine #51. An estimated 80 percent of Mt. Branch's acid load or 576 lb/day should be more accurate.

Estimated Construction Cost

Strip Mine #51

Backfill, regrade, add limestone and fertilizers, revegetate, construct diversion ditches and flumes as necessary.

132 Ac @ $2800/ Ac = $369,600

Strip Mine #52

Fertilize, revegetate, construct diversion ditches as necessary.

34 Ac @ $355/Ac = $12,070

Backfill, regrade, add limestone and fertilizers, revegetate, construct diversion ditches and flumes as necessary.

142 Ac @ $2800/ Ac = $397,600

Strip Mine #53

Backfill, regrade, add limestone and fertilizers, revegetate, construct diversion ditches and flumes as necessary.

153 Ac @ $2800/ Ac = $428,400

Bony Areas

Regrade in place, roto-till limestone and fertilizer as necessary, revegetate.

13.4 Ac @ $2600/Ac = $34,840

Kill Areas

Regrade, fertilize, revegetate as required.

52 Ac @ $500/ Ac = $26,000

Proposed abatement for the bony and kill areas should abate about 2800 lb/day.

Cost effectiveness is difficult to calculate but should be about $28.

Cost Effectiveness

Strip Mine #51

$369,600 per 260 lbs/day acid = $1,420 per lb/day acid abated.

Strip Mine #52

$12,070 per 300 lbs/day acid = $40 per lb/day acid abated.

$397,600 per 5,880 lbs/day acid = $67 per lb/day acid abated.

Strip Mine #53

$428,400 per 770 lbs/day acid = $556 per lb/day acid abated.

Overall Cost Effectiveness

$1,270,000 per 10,000 lbs/day acid = $127 per lb/day acid abated

MOSHANNON CREEK WATERSHED

ABATEMENT AREA S
HILL SOUTH OF OSCEOLA MILLS
(INCLUDED IN INTERIM REPORT II)

Location

Abatement Area S, submitted as Quick Start No.1 in Skelly and Loy's first Interim Report, is a large hill in the south-western portion of the Moshannon Creek Watershed. The hill is situated immediately south of Osceola Mills between Bear Run and Trout Run on the east side of Moshannon Creek. It lies entirely within Rush Township, Centre County, Pennsylvania. Mine drainage from the hill discharges into the following streams:

1) Trout Run and its minor tributaries on the east and southeast side of the hill.

2) Moshannon Creek, from the north and west sides.

3) Bear Run on the southwest side.

The total surface area of the hill is 4,154 acres, or 6.5 square miles.

Geology

The abatement area is located on the southeastern limb of the Houtzdale Syncline, two and one half miles from the synclinal axis. All of the Allegheny Group coals and a small layer of the Pottsville Group outcrop on the hill. Capping the higher portions of the hill is a very small portion of the Conemaugh Group above the Upper Freeport coal. A group of minor wrench faults trending northwest-southeast pass through the hill. The Geology of this area has recently been developed and mapped by Mr. Gary Glass while he was with The Pennsylvania Geological Survey. His work, which has not been published as yet, was made available by the Survey. The average strike of the strata is northeast-southwest and the dip averages 2 to 3 to the northwest.

Mining

There has been extensive mining in the area from the latter part of the 19th century to present. Deep mining accounted for most of the coal extracted prior to 1940, after which strip mining predominated. All the coals of the Allegheny Group have been strip and deep mined on the hill. The Lower Kittanning ("B") coal is the most extensively mined coal on the hill. The entire seam has been deep mined, and most of the outcrop has been stripped. These deep mines are interconnected throughout the hill.

The Brookville-Clarion ("A") coal has been extensively mined by both strip and deep mines, but some coal still remains.

All of the seams above the Lower Kittanning (“B") coal have been mined to various degrees by both strip and deep mining. Most of the Lower Freeport ("D") Coal has been removed by many small old deep mines, for which mine maps are not available, and outcrop strip mines.

All available mine maps have been obtained and were plotted on the Mine Development Drawing for this area.

The most important mines from an acid mine drainage abatement standpoint are on the “A" and "B" coals. These produce most of the acid in the area. Most of the discharges are from "A" and "B" deep mines which drain much of the infiltrating water in this hill.

There are several large active mine permits which cover nearly all portions of the abatement area, particularly on the Upper Allegheny Group coal seams. It is felt, however, that coordination of work between the strip operators and the Department of Environmental Resources, will reveal strippings in the lower coals of the hill which can be reclaimed with no conflict to the mining industry.

Mine Drainage and Hydrology

Most of the mine drainage is emanating from large extensively mined "A" and "B" seams which underlie a major portion of the hill. These "A" and "B" seam mines are typically heavy acid producers and are responsible for most of the acid production within this entire region.

The "B" seam mines are continuous throughout the hill and serve as an underdrain for most of the ground water. These mines collect and channel most of the water percolating downward and infiltrating the hill. Although most of this water follows a downdip course to the outcrop where many discharges occur, some water exits on the updip side as noted at Penn #5 and Weston Mine. The "A" seam mines in the southwestern portion of the hill act in the same manner as that described for the overlying "B" seam mines.

The deep and strip mining has completely altered the previous natural hydrologic system. The natural disposition of rainfall on the hill originally controlled by natural topographic and geologic structure is almost non-existent. Nearly all of the water emanating from the hill has been intercepted by deep mine complexes.

Precipitation is the only source of water to the hill. Most of the precipitation is intercepted by mine workings and enters the ground water system. An area of 1,457 acres, or 35% of the surface area of the hill, has been strip mined. Most of the rain that falls on the strip mines is trapped and enters the ground water system.

In most cases rain water never reaches a surface flow channel. Some of the rain that falls on non-stripped areas and does not immediately infiltrate, flows overland until it is intercepted by contour stripping, at which time it enters the ground water system.

The large "A" and "B" seam deep mines have altered the natural ground water flow patterns and the groundwater table. Roof collapse in these abandoned mines opens the vertical joint partings above, providing vertical drainways for any ground water over the mines. Most of the precipitation that falls on the hill eventually enters the "A" and "B" seam mines, becomes acid, and is then discharged to the surface.

Elevations of Moshannon Creek and the "A" seam indicate that all "A" seam mines are flooded Just southwest of Osceola Mills. The southern limit or extent of flooding is a line along strike intersecting sample station #15.4. Mine pooling in "B" seam mines is only local in nature where rolls and depressions in the "B" seam trap mine drainage. The Peerless #4 deep mine is flooded, as well as the north end of Dushan #1 . "A" seam mines flooded are: the Cripple Creek slope (northeast end) and an unknown mine below the Weston #1 mine. The Peerless #6 "D" seam mine is not flooded due to extensive stripping and drift entry development along the down dip side.

WATER QUALITY

General Interpretation

Stream quality data was obtained from four different source measurements, all of which established this abatement area as a major source of pollution within the Moshannon Creek Watershed. The data revealed low pH's and high acid loads for nearly all water within the area. The acid loadings were, where sufficient data was available, divided into individual loadings for the three streams bounding the area--Bear Run, Trout Run and Moshannon Creek,

The oldest data was obtained from a stream quality and' mine drainage survey of the Moshannon Creek Watershed made by the EPA between June, 1966 and August, 1967. At that time, the area was contributing 2,400 lbs/day acid to Bear Run, which is 55% of the total acid load of 4,400 lbs/day measured at the mouth of Bear Run. The area contributed an acid load of 26,700 lbs/day directly into Moshannon Creek where the Creek is adjacent. This area was also the source of 4,000 lbs/day of acid in Trout Run, which was 64% of Trout Run's total acid load of 6,300 lbs/day. A total of these loadings for the bounding streams yields an acid load from this area of 33,000 lbs/day to Moshannon Creek. This amounts to 24% of the 136,200 lbs/day acid load at the mouth of Moshannon Creek, based on the EPA data.

The remaining three data source measurements were comprised of stream sampling runs made by Skelly and Loy during widely varied flow conditions between June, 1972, and August, 1972. The study methods (a modular system) used were designed to give the best possible results, for a large number of samples over a wide area, in a relatively short study time period. Weirs and surveyed stream cross-sections were not used. Average widths, depths and velocities of the streams sampled were measured each time as accurately as possible. Field pH's were taken, and water samples were collected and later chemically analyzed. From this data stream channel cross-section areas, flows in cfs, and stream loadings were computed. The computed stream flows were not seasonally adjusted.

The first sample run was of a modular nature, designed to point to areas within the entire watershed that would require further study. Therefore, the first run results for any particular location, such as the Quick Start area, are fairly general. These samples were taken in late June, 1972, just after the flood waters caused by tropical storm Agnes had subsided. As a result, the streams' depths and flows were still extremely high. Many streams and tributaries that were normally dry at this time of year still had considerable flow, and some tributaries that had never before existed were produced as a result of the extreme rainfall and buildup of water head within deep mines. Sampling data obtained during these water conditions was actually helpful, since it was a good indication of the relative effects of high water flow on the area's streams, and flushed (thereby locating) the sluggers.

Since the first sample run was modular, there were insufficient sampling stations to enable a calculation of the individual loadings for Bear Run and Trout Run. Therefore, the increase in the acid load of Moshannon Creek, from a point just upstream to a point Just downstream from this area, was calculated and then adjusted. The adjustment was made to account for Beaver Run and Big Run, which also enter Moshannon Creek within that stretch, but do not drain the Quick Start area. During these extreme high flow conditions, the Quick Start area contributed 234,000 lbs/day of acid to Moshannon Creek. The sample nearest to the mouth of Moshannon Creek on this run indicated the total acid load at this time to be 1,164,000 lbs/day. Thus, even in these unusual conditions, the Quick Start area was contributing 20% of the total acid load of Moshannon Creek.

The second modular water sampling run was an expanded version of the first, covering selected portions of the entire watershed. The purpose was to further narrow the search for the major mine drainage pollution source areas. This sampling was executed in early July. The extremely high waters produced by tropical storm Agnes had receded by this time, but streams were still higher than normal for mid-summer, with many tributaries still flowing that are normally dry during the summer months. The sample data from this run revealed that this area was contributing 500 lbs/day acid to Bear Run, 8,800 lbs/day acid to Trout Run, and 24,800 lbs/day acid directly to Moshannon Creek where it is adjacent to the area. This yields a total acid load from the Quick Start area of 34,100 lbs/day acid.

Part of the third sample run was aimed specifically at this Quick Start area, thus it more accurately reflects the effects of this area on Moshannon Creek. Detailed field explorations were then conducted that included walking the three stream stretches bounding the area, and sampling <u>every</u> pollution source originating within that area. This was accomplished under fairly normal summer water conditions, and some of the smaller streams had dried up since the second run. However, the effects of tropical storm Agnes were still noticable: Several pollution sources, some of them major, that did not exist when the EPA survey was made, were found. Data obtained in this sample run indicated that the Quick Start area was contributing 1,400 lbs/day acid to Bear Run, 13,700 lbs/day acid to Trout Run, and 33,200 lbs/day acid directly to Moshannon Creek; or a total of 48,300 lbs/day acid to Moshannon Creek. Using a standard total acid load value for the mouth of Moshannon Creek (130,000 lbs/day), this figure represents 37% of all remaining acid (unneutralized).

It is concluded that under normal conditions, the pollution sources on this hill produce one fourth of the total acid load reaching the mouth of Moshannon Creek.

The 40 sample stations, listed below and shown on the Abatement Area S mine development drawing, monitored AMD point sources and tributaries conveying acid. Descriptions are presented along with average unadjusted and yearly average adjusted acid loadings.

		ACID LOAD	
Station #	Description	Unadjusted	Adjusted
14.10	deep, strip,& refuse pile	2778	2778
14.20	strip mine discharge	121	594
14.30	strip mine discharge	116	362
14.50	Bear Run Headwaters	15	94
14.60	swamp disch. to Bear Run	24	24
14.70	strip mine discharge	86	108
14.90	strip mine discharge	46	292
14.92	strip mine discharge	121	626
15.10	deep mine discharge	13,890	13,890
15.20	strip mine discharge	505	2347
15.30	strip mine discharge	25	45
15.40	pond discharge	291	1842
15.50	strip mine discharge	837	1481
15.60	kill area discharge	2120	2120
20.11	trib to Mosh. Creek	19	19
20.21	trib to Mosh. Creek	27	27
20.31	trib to Mosh. Creek	5	5
20.41	trib to Mosh. Creek	243	243
21.3	bony discharge to Trout Run	47	47
21.4	seepage to Trout Run	0	0
21.5	seepage to Trout Run	158	1112
21.6	seepage to Trout Run	28	196
21.72	air shaft discharge	222	222
21.8	swamp discharge to Trout Run	5	35
21.9	trib to Trout Run	9	63
23.4	trib to Trout Run	2006	3885
24.2	seepage to Trout Run	8	34
24.41	strip mine discharge	372	1626
24.52	trib to Trout Run	4134	29,184
24.53	seepage to Trout Run	10	71
24.54	air shaft discharge	1915	1915

Station #	Description	ACID LOAD Unadjusted	ACID LOAD Adjusted
24.7	trib to Trout Run	917	6477
24.8	trib to Trout Run	96	674
24.9	trib to Trout Run	5	36
24.91	trib to Trout Run	155	1000
25.2	seepage to Trout Run	0	0
25.3	trib to Trout Run	7	45
25.4	seepage to Trout Run	1	6
25.5	seepage to Trout Run	22	143
25.6	spring disch. to Trout Run	11	21
	TOTAL	31,397	73,689

POLLUTION SOURCE DESCRIPTIONS AND RECOMMENDED ABATEMENT MEASURES

The AMD abatement plan recommended for this Quick Start area should achieve approximately 50-60% abatement of the total acid load. There are three major contributors of AMD in this area which will require abatement measures:

1. Deep mines.
2. Strip mines.
3. Extensive bony piles associated with old deep mine workings.

Deep and Strip Mines

Fortunately, a very large number of deep mine maps were obtained for this area, which helped to define the problems at an early stage. It became apparent very early in the study that sealing the deep mines from which most of the pollution finally emerges would not work. The extensive areas and the steep dip of the interconnected deep mines on both the "A" and "B" seams, which underlie a large portion of the hill, offer a number of reasons why deep mine sealing would be an impractical solution to the problem. Differences in elevations on the "B" seam alone could produce as much as 400 feet of head on the mine seals.

Extensive stripping on the downdip side of the "B" seam has produced, in addition to the previous deep mine entryways, countless weak spots where seepage occurs, and created new openings into old deep mine workings. The Mine Development Drawing shows, graphically, the relationship between the deep mines and the strip mined areas. It becomes obvious when studying the map that sealing the deep mines is not practical. The effects on deep mines by the stripping, in conjunction with the considerable head that would be produced by sealing, indicated a need for an alternative solution to be developed that would prevent the formation and eventual discharge of acid from the deep mines in the area. All abatement measures described herein are of a non-accumulative cost, preventative nature, as opposed to continual treatment.

As a result of inadequate previous restoration of the region when stripped, normal surface runoff is practically nonexistent. Consequently, most of the precipitation falling on the hill becomes acid, and does not runoff, dilute, or improve the water quality. The two major sources of acid production in the hill, deep and strip mines, intercept most of the water and channel it through acid producing areas. A solution to the problem which would improve water quality of the deep mine discharges seems appropriate and most feasible.

The solution therefore proposed for these two associated types of pollution sources is a general restoration of the stripped land surface as follows:

Backfilling and regrading of the strip mined lands (1,457 acres). This grading will be accomplished to achieve three major results:

1) increase runoff from the strip mines.

2) surface restoration to the extent necessary to establish a good vegetation cover.

3) provide drainage diversion ditches and reconstruct surface channel areas to pass surface flow across strip mines, thereby preventing water entry to the deep mines.

Various types of backfilling will be used as appropriate. (contour, terrace, swale). The backfilling will be designed to:

1) decrease permeability of the mine surface.

2) effect quick runoff from the mine.

Surface restoration will be suited to the requirements of the particular mine. Limestone surface treatment is recommended for most of the "A" and "B" seam strip mines because of the high acidities associated with these seams. None of the overlying seams, with the exception of portions of the "C" seam, will require the limestone surface treatment. The surface of all regraded strips will be treated to obtain proper pH, fertilized and seeded with grasses except where erosion may be a problem then trees will be planted. A good vegetative cover will also reduce the amount of water entering the deep mines. The vegetative cover will consume a lot of water, and will in time build up a soil profile which will consume water by retaining it near the surface. From the surface it will be lost to the atmosphere by evaporation.

All highwalls should have drainage diversion ditches. These ditches will be collected and flumed across the mines directly to the receiving tributaries.

A secondary abatement technique is being investigated at the present time, but which will not be recommended until its feasibility has been established. This technique uses drill holes through the hill to drain overlying aquifers, thereby preventing the water from entering lower lying deep mines. The use of this technique will not alter the recommendations in this report, but wilt serve as a measure to further reduce pollution if proven feasible.

The strip mined areas have been divided into construction projects and a recommended priority list established. The next section of this report describes the nature of the bony pile pollution sources and the recommended abatement method for each. The attached Mine Development Drawing shows the recommended projects by priorities, and defines the mined areas by coal seam mined. It will be necessary to secure 1" = 100'

5' contour interval, aerial photogrammetrics for each of the construction project areas to be designed.

Specific grading plans for each construction project can then be developed on the photogrammetric mapping.

Bony Piles

Bony piles of varying sizes are found in association with some larger deep mine entryways. These piles definitely contribute to the acid pollution of the streams surrounding the Quick Start area. It is extremely difficult to measure acid loading coming from these piles, due to the seasonal and rainfall - dependent nature of their acid production, and due to the limited time span of the study. These piles become an important pollution factor during wet weather, but may contribute little acid during dry periods. To compute an accurate seasonal average in pounds per day for a bony pile of this nature would require precise daily measurements for an entire year.

Instead, a "bony pile constant" was developed from the equation, shown below, in which the only variable is the average yearly rainfall for the area in question - 44 in/yr. in this case.

43,560 ft^2/acre **X** 44 in./yr. **X** ft./12 in **X** yr./365 days **X** day/24 hrs. **X** hr./60 min. **X** min./60 sec. = 0.00506 cfs/Acre

Thus, the "bony pile constant" for the Quick Start area is 0.00506 cfs/Acre. With this constant, a bony pile loading value can be computed for each of the piles in question using the following equation:

Bony Pile Constant (0.00506) X Area of Pile (Acres) X Acidity (ppm) X

5.39 = Average Acid Load (lbs/day)

If the acidity (ppm) is not available for the bony pile in question, the surface pH of the bony pile can be used. A determination of the acidity is then obtained by averaging the acid values of all other available water quality data for that same pH, regardless of where those other samples were taken.

It is important to point out that the bony pile loadings derived by this method actually only evaluate the rainfall that directly strikes and then passes through the pile. In addition, other sources of water entering the pile must be considered. Bony piles are commonly located at the base of a hill, since the deep mines generally were developed from a hillside outcrop. As a result of their location, bony piles may frequently be affected by the surface drainage of the entire hillside. This will produce acid which is not accounted for in the "bony pile equations" mentioned above. The surface runoff passing through the pile may also wash bony fines into the streams. These fines are then carried by the stream, and all of their acid producing minerals will be leached out. This will produce more acid downstream from the bony pile itself. These factors are extremely difficult to measure and are not included in the calculations The bony pile loadings presented here are <u>minimal</u> values for the bony piles in question.

Project Priority Area No.10

First Bony Pile

This bony pile is the largest of the two shown in project priority area no. 10, and is the most extensive one in the Quick Start area. This represents the remains of a large Du Shan Coal Company Mine. This pile covers 2.9 acres, has a surface pH of 3.0, and a total volume of 74,000 cubic yards. Using the bony pile loading equations it contributes 31 lbs/day acid to Trout Run.

Most of the pile is located on the flood plain of Trout Run, and the stream has eroded into the pile along its banks. The resultant eroded bony fines then produced more acid, as described previously. The location of the pile and its volume are such that regrading the pile in its present location would be impossible. Instead, two existing strip cuts just uphill from the pile were chosen as bony disposal sites. The first of these pits, the narrow one nearest the bony pile as shown on the map, was chosen as the primary disposal site, and can hold two thirds of the bony pile volume. The second disposal pit, located just above the first pit, can easily hold the remaining bony.

The bottom of each disposal pit will be covered initially with 3 feet of coarse material. This will enable any water that does pass through the bony to drain through this coarse material and out of the pit. Thus, water entering the pit can only become acid by downward percolation, and not by lateral transport when exiting the bony or by being trapped and held in the bony-filled pit. Each pit will then be filled and compacted with bony to within 3 feet of grade. A layer of impermeable clay will be placed over the bony to minimize the amount of water entering the bony. The clay will be covered with topsoil and seeded. In addition, surface water diversion ditches will be positioned to prevent runoff from entering the bony or the pit. Thus, when the work on the pits is completed, the only water that will contact the pit area, or the bony within, will be a small amount of precipitation that does not runoff or is not lost through evaporation-transpiration at the surface of the pit.

Project Priority Area No.10

Second Bony Pile

The small bony pile located near the Weston Mine, and shown in priority area no. 10 will be moved to the same bony disposal pits mentioned for the large bony pile. This second pile covers 0.17 acres, has a volume of 1,900 cubic yards, and produces a computed average of

2 lbs/day acid. The bony is located at the base of a hill, where the effects of surface runoff will greatly increase this average daily acid load. Since both bony pi les will be placed in the same disposal pits, the actual method of disposal Will be the same as that discussed for the large bony pile.

<u>Project Priority Area No.8</u>

<u>First Bony Pile (large)</u>

The largest of the two bony piles in this priority area shown on the drawing covers the bony piles and tipple area at the main heading of the abandoned Penn Five "B" seam mines. The bony here covers 8.8 acres, has a surface pH of 2.7, and based on the bony pile loading equation, . produces 95 lbs/day acid. The abatement plan recommended here requires removal of all of the abandoned mining equipment and buildings, and re-grading of the entire area. This will enhance surface drainage from the bony itself and prevent surface drainage from surrounding areas from entering the bony. The entire regraded surface will then be covered with crushed limestone, which will be roto-tilled into the bony to a depth of ten inches. The limestone mixed with the bony will provide a satisfactory growing medium and negate the need for topsoil on the area. The area will then be planted.

Project Priority Area No.8

Second Bony Pile (small)

The small bony pile in Area 8 on the drawing, which is only a few hundred yards from the Penn Five area, covers 0.11 acres, has a surface pH of 3.0, produces a computed 1 .2 lbs/day acid, and has a volume of 1,150 cubic yards. This material will simply be moved to the Penn Five site and be graded in with the Penn Five bony as discussed above.

Project Priority Area No.9

Northern Bony Pile

The bony pile shown on the north part of Area No.9 on the drawing is found in association with a Penn #4 deep mine opening. This 2,000 cubic yard pile covers 0.20 acres and is presently burning in some sections. Therefore, along with its ability to produce acid, there is also air pollution. There is also a very distinct possibility of this pile producing a forest fire. An extensive fire could drastically reduce the amount of water being transpired by existing and future vegetation, thereby increasing acid production. The acid contribution computed is 2.8 lbs/day. The cost of abatement at $0.80 per cubic yard would amount to $600 per pound of acid abated. The abatement procedure would include spreading and quenching the burning portion, with subsequent removal to the area of deposition indicated just north of the pile. If needed, a second bony disposal pit is located just northeast of the pile, as shown on the drawing. The abatement procedure mentioned for the large bony pile in Area 10 will be used for placing the material in the disposal area.

Project Priority Area No.9

Southeastern Bony Pile

This bony pile is located on the side of a hill in the southeast section of Area 9, The top of the hill is stripped. Here again, surface drainage plays an important role, and the acid loading value computed is only a minimum. This pile covers 0.07 acres, has a volume of 650 cubic yards, and contributes a computed average of .8 lbs/day acid. Abatement here would consist of removal of the pile to one of the disposal pits mentioned in the abatement procedure for the northern bony pile.

Project Priority Area No.9

Southwestern Bony Pile

This bony pile as shown on the drawing is on the southwest side of Area No.9 at the two openings of an "A" seam portion of the mining complex. The tipple and other structures on the pile have burned down and there is evidence that the bony was and still may be burning. A considerable amount of water is draining from each of the mine headings across the bony pile. This pile covers 0.33 acres, has a volume of 11,700 cubic yards, a surface pH of 2.6, and produces a computed 5.8 lbs/day acid. This bony would be quenched if necessary and removed to the disposal pits mentioned in reference to the northern bony pile in Area 9.

Property Ownership

As indicated in the original proposal, a most important aspect of this work is to provide information related to property ownership.

The attached Mine Development Drawing shows property lines and the names of the property owners within each boundary. This information has been obtained from the latest tax maps and computer print-out parcel list, and is shown for those areas where reclamation work is recommended.

As soon as design work begins, enlarged drawings indicating the property owners' names, addresses and affected areas will be submitted to the Department. This will permit the Department to begin securing the necessary releases, so that the releases will be at hand when the construction projects are ready for bidding.

RECOMMENDED PRIORITIES
ABATEMENT AREA S

Setting Priorities and Method of Computing Loading

The entire 6.5 square miles of the Quick Start area is one interconnected hydro-geologic system. The total acid load from this area has been measured and defined. However, the total acid load from each of the project areas is not directly measurable, because the interconnection between areas occurs in the ground water system. The acid loads for each project area have therefore been computed by proportioning the total acid load with respect to the percentage of total Quick Start surface drainage area that lies within the particular project area. This method of indirect add loading computation is based on three assumptions:

1) rainfall is distributed evenly throughout the hill.

2) the percent of rainfall that enters the ground water system is the same for all areas.

3) that all water, regardless of priority area of origination, discharges from the Quick Start area with the same amount of acidity (ppm).

Considerations for determining priorities were:

1) the length of the flow path through the deep mines to the point of discharge.

2) characteristic acidity of the seams mined.

3) cost per pound per day of acid abated.

4) engineering judgment related to project viability.

The Quick Start area has been divided into 10 separate project areas and ranked according to priority. All of the strip mining has been divided into 7 areas which comprise project priority classes 1 through 7. The seven bony piles have been placed into three projects which comprise project priorities 8 through 10.

The ten projects within the Quick Start area are numbered on the Mine Development Drawing in order of decreasing priority.

Project Priority #1

This area is comprised of very old (before 1944) unregraded strip mines on the "A" seam and some newer stripping on the "A" seam. These mines trap all of the rainfall within the area and channel it to the "A" seam deep mine. A portion of this water exits locally as a mine discharge on the downdip outcrop, but some of the water passes out of the area through the interconnected deep mines on the "A" seam.

This area was placed at the top of the priority list because of the highly acidic nature of the "A" seam in the area, the long flow path through very acidic material that the water must travel to its discharge point, and because the topography of the spoil piles is such that <u>all</u> of the rainfall in the area is trapped and forced into the deep mines.

Area of stripping = 148 acres.

Drainage area = 197 acres.

Proportion of total acid load = 3,840 lbs/day.

Anticipated abatement = 1,920 lbs/day.

Estimated abatement cost = $3,500/acre.

Total estimated abatement cost = $518,000.

Cost effectiveness = $270 per lb/day acid <u>abated</u>

<u>Project Priority #2</u>

The area has extensive strip mining on the "A", "B", "C", and "C' " seams. Most of the rain that falls in the area eventually collects in the lower lying deep mine on the "B" seam. This water will have picked up some acidity by passing through the strip mines. It will pick up much more acidity as it flows through the "B" seam mines to its discharge point at the outcrop on the western side of the hill.

Area of stripping = 203 acres.

Drainage area = 275 acres.

Proportion of total acid load = 5,760 lbs/day.

Anticipated abatement = 2,880 lbs/day.

Estimated abatement cost = $3,100 per acre.

Total estimated abatement cost = $629,000.

Cost effectiveness = $219 per lb/day acid abated.

Project Priority #3

The description and abatement for this area is the same as for project priority area #2. This was ranked lower than project #2 because the water has a shorter flow path through the acidic deep mine to its discharge point. The water will have less residence time in the deep mine and will pick up less acid.

Area of stripping = 224 acres.

Drainage area = 372 acres.

Proportion of acid load = 7,680 lbs/day.

Anticipated abatement = 3,840 lbs/day.

Estimated abatement cost = $3,300/acre.

Total estimated abatement cost = $739,000.

Cost effectiveness = $193 per lb/day acid abated.

Project Priority #4

This area is similar to project priority area #1 except that there has been mining on seams higher than the “A". There is a portion of a large "B" seam that was contour strip mined, and two knobs of "C" coal were removed. A major portion of the strip mining is on the highly acidic "A" and "B" seams. There is a major discharge from the Penn # 11 and #12 mine on the "A" seam.

Area of stripping = 150 acres.

Drainage area = 213 acres.

Proportion of total acid load = 4,320 lbs/day.

Anticipated abatement = 2,160 lbs/day.

Estimated abatement cost = $3,500/acre.

Total estimated abatement cost = $525,000.

Cost effectiveness = $243 per lb/day acid abated.

<u>Project Priority #5</u>

This area has extensive strip mining on the "A", "B", "C" and "C' " seams. It is similar hydrogeologically to the other strip mine areas except that the water flow paths through the "B" deep mine are shorter. The northern three fifths of this area is covered by an active mine permit but there is no active mining in this area at the present time. The recommended abatement will not affect active mining because the strip mine grading is only recommended for old non-regraded mines.

Area of stripping = 281 acres.

Drainage area = 428 acres.

Proportion of total acid load = 9,120 lbs/day.

Anticipated abatement = 4,560 lbs/day.

Estimated abatement cost = $3,200/acre.

Total estimated abatement cost = $899,000.

Cost effectiveness = $197 per lb/day acid abated.

Project Priority #6

The hydrology, geology and abatement for this area is the same as for area #5 except that the flow path is again shorter through the "B" seam deep mines. The active mine permit covers all of priority area #6. The miner is presently operating on an 82 acre strip mine in the southern portion of the area.

Area of stripping = 260 acres.

Drainage area = 565 acres.

Proportion of total acid load = 12,000 lbs/day.

Anticipated abatement = 6,000 lbs/day.

Estimated abatement cost = $3,300/acre.

Total estimated abatement cost = $858,000.

Cost effectiveness = $143 per lb/day acid abated.

Project Priority #7

All of the strip mines in this area are on the "D" and "E" seams. The Freeport seams occur only on the top of the hill. These strips are not acid producers but they act as catchment areas for rainfall. The rainfall that is collected in these mines percolates downward until it reaches the "B" seam deep mines where it becomes acid and then becomes part of the big "B" seam discharges. The abatement proposed will prevent water from entering the deep mine by increasing runoff and by establishing a good vegetative cover. The abatement cost per acre for this area is lower than for the other areas because of the flatter topographic gradient.

Area of stripping = 191 acres.

Drainage area = 254 acres.

Proportion of total acid load = 5,280 lbs/day.

Anticipated abatement = 2,640 lbs/day.

Estimated abatement cost = $2,800/acre.

Total estimated abatement cost = $535,000.

Cost effectiveness = $203 per lb/day acid abated.

Project Priority #8 (Two Bony Piles)

The description and abatement for this work is included in the abatement section of this report.

Large Bony Pile: Penn #5, Area = 8.8 acres, pH = 2.7, Acidity = 388 ppm or 93 lbs/day.

This bony pile will be graded in place. Estimated Abatement Cost = $30,800.

Small Bony Pile: pH = 3.0, Area = 0.11 acres, 1.2 lbs/day acid. Volume = 1,151 cu. yd. Estimated Cost = 1,151 cu. yds. @ $0.80/cu. yd. = $900.

Estimated total cost for project #8 = $31,700.

Project Priority #9 (Three Bony Piles)

The description and abatement for these bony piles is included in the abatement section of this report.

Northern Bony Pile - Burning: Area = 0.20 acres, 2.8 lbs/day acid. Volume = 2,074 cu. yd. Estimated Cost = 2,074 cu. yd. @ $0.80/ cu. yd. = $1,700 or $607 per lb/day acid abated.

Southeastern Bony Pile - Across the valley from the burning pile: Area = 0.07 acres, .8 lbs/day acid. Volume = 650 cu. yd. Estimated Cost = 650 cu. yd. @ $0.80/cu. yd. = $520 or $650 per lb/day acid abated.

Southwestern Bony Pile - "A" drifts (possibly burning): Area = 0.33 acres, 6 lbs/day acid. Volume = 11 ,678 cu. yd. Estimated Cost: 11,678 cu. yd. @ $0. 80/cu. yd. = $9,300 or $1550 per lb/day acid abated.

Estimated Total Cost for Project #9 = $11,500. Total Acid Load = 9.5 lbs/day. This cost is $1210 per lb/day acid abated.

Project Priority #10 (Two Bony Piles)

The description and abatement for this area is included in the abatement section of this report.

Large Bony Pile (Du Shan): Area = 2.9 acres, pH = 3.0, Acidity = 388 ppm, 31 lbs/day acid. Volume of Pile = 74,074 cu. yd. Estimated Cost = 74,074 cu. yd. @ $0.60/ cu. yd. = $44,400.

Small Bony Pile - bony pile near Weston Mine will go in same pit as Du Shan: Area = 0.17 acres, 1.8 lbs/day acid. Volume = 1,925 cu. yd. Estimated Cost = 1,925 cu. yd. @ $0.60/cu. yd. = $1,200.

Total Estimated Cost for Project #10 = $45,600.

ABATEMENT AREA S
SUMMARY OF ESTIMATED PROJECT CONSTRUCTION COSTS

Project Priority Number	Acid Load (lbs/day)	Total Estimated Construction Cost	Type of Mining
1	3,840	$518,000	Strip Mine
2	5,760	$629,000	Strip Mine
3	7,680	$739,000	Strip Mine
4	4,320	$525,000	Strip Mine
5	9, 1 20	$899,000	Strip Mine
6	12,000	$858,000	Strip Mine
7	5,280	$535,000	Strip Mine
8	94	$ 31,700	Bony Pile
9	9.5	$ 11,500	Bony Pile
10	33	$ 45,600	Bony Pile

Total Projects 1 - 7	Acid Load = 48,000 lbs/day	Cost = $4,703,000
Total Projects 8 - 10	Acid Load = 136 lbs/day	Cost = $ 89,000

TOTAL COST OF ALL TEN PROJECTS
PRIORITIES 1 THRU 10

Total Cost	=	$4,792,000
Total Acid Abated	=	24,000 lbs/day.
Cost Effectiveness	=	$200 per lb/day acid abated.

MOSHANNON CREEK WATERSHED

ABATEMENT AREAS T and T-1
MOSHANNON CREEK ACTIVE MINING AREAS

Location

Abatement Areas T & T-1 consist of over 14,300 acres of land in the central portion of the Moshannon Creek Watershed. The western portion of this area lies between Beaver, Little Beaver, and Coal Runs west of Moshannon Creek in Decatur Township, Clearfield County. The eastern, and much larger, section of the abatement area lies east of the creek in Rush Township, Centre County between Trout Run in the south and Cold Stream and Black Bear Run in the east. These two portions of the abatement area, while somewhat isolated from one another geographically, are presented as a single area because they present identical abatement problems.

Geology

Both portions of the abatement area lie structurally within the Houtzdale Syncline, where all of the Allegheny Group rocks from the Clarion to the Upper Freeport units are present. The western section of the area lies on the northwest flank of the syncline, and the strata dip to the southeast toward Moshannon Creek and the synclinal axis, which lies approximately beneath the creek. The larger area in the east lies on the southeastern flank of the syncline, and strata here generally dip to the northwest toward the creek. The northwest - trending wrench and splay faults associated with the synclinal folding are numerous throughout the abatement area, and produce an extremely complex pattern of fault blocks, particularly west of Moshannon Creek.

Mining

Since the abatement area occupies a large central portion of the Houtzdale Syncline, mining activity within the area has been extremely heavy. Both sections of the area have been extensively undermined on all seams that could be profitably mined. The names of these deep mines are too numerous to mention or attempt to verbally locate here, but all available mine mapping information for Abatement Area T and T-1 is shown on the accompanying Mine Development Drawings.

Active mining is still of major importance within this abatement area, and constitutes the bulk of the problem encountered in recommending abatement here. Only two active deep mines remain in the area - the extensive Rushton Mine between Osceola Mills and Philipsburg in the Brookville-Clarion coal and Associated Drilling's "C" seam deep mine overlying Rushton (Abatement Area T). All of the Allegheny Group coals in the area have been stripped, are presently being stripped, or are a part of some strip miner's future mining plans. Strip mining began in this region many years ago with the removal of outcrops adjacent to deep mine drifts and workings and has continued throughout the abatement area. Only in recent years, when reclamation of strip mined lands has been required by law, has any work been done to reclaim strips. The majority of the strip mines within the abatement area are unreclaimed, partially reclaimed or very poorly reclaimed. These unreclaimed strip mines frequently stripped open the downdip sides of deep mines, allowing them to drain.

The problems encountered in recommending abatement for this area involve the present and future stripping operations rather than the older mines that are actually causing the pollution. At present, roughly 50% of the abatement area, including most of the unreclaimed strip mines, is covered by active mining permits. The strip operators tend to acquire water quality permits covering very large areas, but then only strip or restrip relatively small, more profitable portions of those areas, which they subsequently reclaim as required by law. Thus, although many of the major acid producing portions of the abatement area are under active permit, only relatively small areas of older stripping are actually being restripped and subsequently reclaimed. Reclamation work within this active area will probably be accomplished on remaining unreclaimed strip mines after mining is completed.

Mine Drainage and Hydrology

The natural hydrologic system of the entire abatement area has been extensively altered by the strip and deep mining. The stripping within the 14,315 Ac of land within both sections of the abatement area interrupts rainfall and surface runoff. The water seeps through the strip mine spoil material, which is highly acid in the case of the "A" and "B" seams or infiltrates downward into deep mine workings which underlie a large portion of the area. The water passes downward from the higher seam workings to the Lower "A" or "B" seam workings through roof collapse and fracture zones. These lower workings on either of the acid coal seams, the "A" and the "B", underlie nearly all of the abatement area. The water entering the deep mine workings is channeled downdip through the acid producing coal, bony and overburden materials. The acid water in many cases discharges from existing drift openings on the downdip sides of mines, since many of the old mines were originally driven updip to facilitate natural drainage. Many of the downdip coal crops adjacent to the old deep mine workings have been stripped out, permitting water to easily exit the deep mine workings and either pond in or flow through the strips and into the streams. There are also areas where water seeps directly through thin outcrop barriers above impermeable underclays to form large surface seepage and tree kill areas.

Surface water contact with acid spoil material is also an important source of acid, even in areas underlain by deep mine workings. This water commonly migrates laterally downdip along an impermeable underclay. The water is rendered acid in this process and emerges on the downdip side of the stripping as an acid seepage from the spoil material.

Water Quality

Water quality data for Abatement Area T and T -1 was obtained by EPA and by Skelly and Loy. Both sources of data include sampling of acid mine drainage discharge points as well as main streams. Where possible, only the main stream data has been utilized in an attempt to simplify the massive amounts of data obtained.

EPA sampling in this area occurred in the mid-1960's during an extended drought. As a result, stream flows and corresponding acid loads were well below normal. EPA data revealed that 25,284 lbs/day acid was discharging from the abatement area. This acid load represented slightly over 60% of the entire acid load observed at Moshannon Creek's mouth as measured by the EPA.

Skelly and Loy's sampling in this area was much more intensive than the EPA's. All tributaries within the abatement area, as well as all acid mine drainage discharge points, were sampled during the study program. The stream sample data was adjusted to represent yearly flow averages, and thus present a more accurate picture of the actual importance of the abatement area as an acid source. Point source acid loadings which did not show up in the tributary sample data, such as discharges directly to Moshannon Creek, were also used to compute the acid load. This point source data was not seasonally adjusted, as it was felt that much of this flow was of deep mine origin and therefore would not reflect flow variations of local surface streams.

This data obtained by Skelly and Loy showed Abatement Area T and T-1 to be discharging over 98,000 lbs/day acid at source to Moshannon Creek. The 32 sample stations used to obtain these results are listed below: (the stream stations are underlined)

9.16	22.1	28.14	49.24
9.17	33.31	28.17	<u>51</u>.
9.18	22.4	28.18	<u>52</u>.
9.21	22.5	<u>47.17</u>	<u>56</u>.
9.22	24.52	49.12	56.17
<u>17.8</u>	24.53	49.19	56.18
<u>18.8</u>	<u>27</u>.	49.21	56.19
<u>21.1</u>	28.13	49.23	<u>57</u>.

This acid load represents roughly two-thirds of the 130,000 lbs/day acid load at the mouth of Moshannon Creek. It is evident that, even if the presented acid load is excessively high, this area is a major acid mine drainage source to Moshannon Creek and the West Branch of the Susquehanna River. Sample stations 46.51, 46.52, 46.53, 45.11, and 22.5 monitored AMD discharging from ineffective air seals.

Recommended Abatement

It has now been shown that both sections of the abatement area are major sources of acid and that the acid originates in the old strip and deep mines. The most effective means of eliminating at least a portion of this acid load involves the surface restoration of much of the unreclaimed stripping within the area. Such restoration, if accomplished, would decrease infiltration of runoff into deep mines beneath the strips and significantly lower the abatement area's acid load.

Present active mining and active permit conditions within the abatement area are too complex and comprehensive to allow any worthwhile abatement recommendations to be made. However, there are several worthwhile steps that can be taken to facilitate implementation of the surface restoration. The first step taken should be to work out the complete permit structure of both sections of the abatement area to determine where abatement work can be done. Some specific abatement recommendations can then be made based on this newly acquired information.

The second step that can be taken is highly recommended not just for this abatement area, but for all portions of the study area and the entire state in which old, unreclaimed strip mines and active strip mines coexist. In such portions of the Clearfield and Moshannon Creek Watersheds, of which the abatement area is a prime example, there are numerous old strip cuts still containing good mineable coal that could be restripped, but only at marginal profits. This is true because of the added costs of restripping existing highwalls further into the hillsides and the additional expense involved in later reclaiming both the new stripping and the older strip cut, as required by law. Strip mine operators frequently shy away from such operations because of the financial difficulties they present.

This situation could be remedied if the State were to establish a bounty of $100 to $200/Ac, for example, to be paid to strip operators who restrip unreclaimed land. This relatively small bounty would be sufficient to offset part of the additional costs incurred by the strip operator when he has to reclaim both old and new portions of the strip mine area, and would raise many operations from the marginal to the profitable level. If, by the introduction of such a bounty or incentive, a reasonable profit could be made by restripping unreclaimed lands, many miners would restrip and reclaim these old mines, alleviating a portion of the State's reclamation burden in the process. Such a program effectively instituted in Abatement Area T and T -1 could, in combination with normal Department of Environmental Resources abatement programs, eliminate one-third of the acid discharging from this area. Abatement of this much acid would have significant effects on both Moshannon Creek and the West Branch of the Susquehanna River below the creek.

MOSHANNON CREEK WATERSHED

ABATEMENT AREA U
COAL RUN HEADWATERS

Location

This abatement area consists of a large, strip mined hill that affects the west branch of Coal Run's headwaters. The 120 acre area consisting of strip mines #54 and #55 lies just west of Coal Run one-half mile northwest of Ashland in Decatur Township, Clearfield County, Pennsylvania.

Geology

The area is situated structurally on the southeast flank of the Laurel Hill Anticline. The Lower, Middle and Upper Kittanning coals of the Allegheny Group outcrop within the area, which is straddled by two major northwest-southeast tranding faults. The strata here strike northwest-southeast, dipping steeply from 3° to 8° to the northeast from a local structural high in the southwest corner of the area.

Mining

The area's Lower Kittanning and Middle Kittanning coals were deep mined many years ago, as evidenced by several bony areas and abandoned tipple sites. Trojan No.1 and several other mines for which no mapping could be found worked the "B" seam in the abatement area, and a small, unnamed "C" seam mine may have extended into the area. Following this, the "B" coal in areas adjacent to and within deep mine workings was stripped and left totally unreclaimed. Still later, the "B" and "C" and "C' " coals within the southern half of the area were stripped. Spoil piles on strip mine #54 were rounded inward toward the highwalls and partially revegetated.

Mine Drainage and Hydrology

The natural hydrologic system of the area has been altered by extensive deep and strip mining. Runoff and direct rainfall on the strippings and the hilltop above are trapped in the unrestored strip cuts. The water must then either seep through the strip mine spoil to exit the area or infiltrate into the deep mines. No ponds or seepages directly from the spoil material were observed in the area, thus most of the trapped water must be infiltrating downward to the underlying deep mines. The deep mines serve as an underdrain and channel all infiltrating water down dip through the workings. Water entering the "C" seam workings rapidly passes downward into the "B" seam workings through fractures and collapsed portions of the mine. The water moves downdip through the "B" seam deep mine and discharges all along the base of the hill, generally below the stripping, in the form of relatively small deep mine discharges and seeps directly from the ground and possibly from the deep mine workings through the "B" coal itself to the outcrop.

Water Quality

EPA water quality data for this area obtained during 1966 showed three acid mine drainage pollution sources discharging 883 lbs/day to Coal Run.

Skelly and Loy's intensive sampling of Coal Run revealed an adjusted 1, 130 lbs/day acid emanating from the following point source samples: 19.13, 19.14, 19.15, 19.16, 19.17, 19.18, 19.19, 19.21, 19.22, 19.23, 19.3. The area accounts for nearly all of the acid and from one-third to one-half of the total flow of Coal Run above station 19.

Recommended Abatement

The primary goal of the abatement plan here is to minimize the amount of runoff and rainfall that enters the strip mines and infiltrates downward to the underlying acid-producing deep mine workings. This can be accomplished by complete surface restoration of the strip mines within the area. This will require contour, swale or terrace backfilling, addition of limestone and fertilizers, if necessary, and revegetation with appropriate grasses, legumes or trees. In addition, the several small bony piles that exist within the area should be buried in nearby strip cuts to minimize their contact with water.

Implementation of these abatement recommendations should result in the abatement of 60% of the total acid load of the area, or 680 lbs/day acid.

Coal Run Mine Drainage Data

SAMPLE			ACID LOAD	
Station #	Description	Strip Mine #	Unadjusted	Adjusted
19.13	strip seepage from	55	101	not required
19.14	strip seepage from	55	228	not required
19.3	strip seepage from	55	151	not required
19.16	strip seepage from	54	407	not required
19.17	strip seepage from	54	131	not required
19.18	strip seepage from	54	9	not required
19.19	strip seepage from	54	50	not required
19.21	strip seepage from	54	11	not required
19.22	strip seepage from	54	21	not required
19.23	strip seepage from	54	20	not required

Estimated Construction Cost

Strip Mine #54

Backfill, regrade, add limestone and fertilizers, revegetate, construct diversion ditches and flumes in unreclaimed stripping.

32 Ac @ $2,600/ Ac = $83,200

Backfill, regrade, fertilize, revegetate in partially reclaimed stripping.

62 Ac @ $2,200/Ac = $136,400

Strip Mine #55

Backfill, regrade, add limestone and fertilizers, revegetate, construct diversion ditches and flumes as required.

9 Ac @ $2,600/Ac = $23,400

Total Estimated Cost, Abatement Area U = $243,000

Cost Effectiveness

Strip Mine #54

$83,200 per 128 lbs/day = $650 per lb/day acid abated

$136,400 per 261 lbs/day = $522 per lb/day acid abated

Strip Mine #55

$23,400 per 288 lbs/day = $81 per lb/day acid abated.

Overall Cost Effectiveness

$243,000 per 680 lbs/day acid = $357 per lb/day acid abated

MOSHANNON CREEK WATERSHED

ABATEMENT AREA V
BIG RUN

Location

Abatement Area V consists of a total of 364 acres of unreclaimed stripping in strip mines #56 through #64. The area lies in the northern half of the Big Run Watershed and just southeast of a tributary to Little Laurel Run. Big Run is a major acid source to Moshannon Creek discharging just west of Osceola Mills in Decatur Township, Clearfield County.

Geology

The abatement area is structurally situated just northwest of the axis of the Houtzdale Syncline. Allegheny Group rocks from the Brookville-Clarion to the Lower Freeport outcrop within the area. The area lies within the highly disturbed trough of the syncline and contains numerous northwest trending wrench and associated splay faults. The strike of the strata generally varies from north-south to northeast-southwest, and dips range from 1° to 3° to the east and southeast. One small fault block at the extreme northern end of the area dips shallowly to the southwest.

Mining

The abatement area has been extensively deep and strip mined. The "B" coal within much of the area was worked out many years ago by the Martin Mine, Olympia Mine, Rocky Ledge Mine, Burtner and Jackson Mine and the Bucket Line Mine. The mine mapping information obtained indicated that of these deep mines, the Bucket Line Mine was driven down-dip, the Burtner and Jackson Mine was driven parallel to strike, and the remaining mines were all driven updip to facilitate drainage. Most of these mines closed down many years ago, and several have since been stripped out. There is also evidence in the vicinity of strip mine #56 of an "A" seam deep mine, but no other information or mapping could be obtained.

The abatement area has been extensively stripped on the Lower Kittanning seam, with some additional stripping on the Middle and Upper Kittanning coals. Reclamation work in these strip areas has been minimal, and the majority of the abatement area's strip cuts are unvegetated.

The only evidence of active mining within the abatement area is a newly completed strip area occupying the eastern 2/3 of strip mine #61.

Mine Drainage and Hydrology

Strip and deep mining activities have severely disrupted the natural hydrologic system in the northern half of the Big Run Watershed. The 364 acres of poorly reclaimed strip mines intercept surface drainage and direct it through the acid "B" seam spoil material or into the deep mine workings, where they still exist. The water is channeled downdip through the deep mines, which serve as an underdrain for much of this portion of the watershed, and discharges at the lowest opening within each mine. Deep mine discharges of varying size and quality were observed from the Martin Mine and the “A" seam mine beneath it east of strip mine #56 and from the Rocky Ledge Mine, the Burtner and Jackson Mine, the Bucket Line Mine, and an unnamed mine near strip mine #63 that was discharging into the headwaters of a tributary to Little Laurel Run.

Strip mine #56 contains several large strip cuts, with no visible surface outlets, and spoil piles are scattered throughout the area. There is no surface flow from this strip mine, and the only large pond is at the extreme southeast end of the area. This suggests that intercepted run off must rapidly infiltrate into the spoil and deep mine workings. The pond is fed by several small flows with pH's around 2.5 that seep from the vicinity of a stripped out deep mine drift and flow across a bony area. The pond has no visible outlet but its level remains relatively constant, suggesting that water must be entering the underlying “A" seam workings. Two discharges from this "A" seam mine, the major acid sources in this area, emerge just southeast of the strip and adjacent to Big Run.

The Bucket Line Mine is assumed to be almost entirely flooded due to the updip location of its drifts. The discharge here appears to be an overflow of the mine pool. Adjacent to the drift is an open strip cut with a large pond, which is probably also related to the mine pool level of the Bucket Line Mine. The combined flow from the pond and the deep mine drift passes through a large bony area between the mine drift and Big Run. This contact with the acid bony material tends to further decrease the quality of the acid discharge.

The stripping activity in the vicinity of the branching of Big Run's headwaters has eliminated most evidence of deep mining here, but the deep mine workings are still an important acid source. Strip mine #60 cut through Big Run's eastern branch, and this, combined with seepage from the Burtner and Jackson Mine, renders that branch of Big Run acid. The Rocky Ledge Mine discharges acid into Big Run's western branch. In addition, all acid surface discharges from strip mines #58, 59, 60, 63 and 64 also degrade Big Run.

Strip mines #61 and 62 apparently contribute to the several small discharges from the abatement area that enter the Little Laurel Run Watershed. Both strips contain ponds, and strip mine #62 has several small, acid surface discharges into this tributary to Little Laurel Run. A "B" seam drift just west of strip mine #63 also has an acid discharge to that tributary. These discharges contribute an acid load sufficient to moderately degrade the tributary.

Water Quality

Water quality data for the Big Run area was obtained by both the EPA and Skelly and Loy. EPA sampling in 1966 attributed 741 lbs/day acid to strip mine #57 and 1380 lbs/day acid to the vicinity of strip mines #58, 59 and 60.

Skelly and Loy's intensive sampling program data, adjusted to represent yearly average flows, revealed the following for Abatement Area V:

Strip mine #56 - 2642 lbs/ day acid from stations 51 .04 and 51.05.

Strip mine #57 - 864 lbs/ day acid from stations 20.2, 20.4 and 51.01.

Strip mines #58, 59, 60, 63 and 64 - 2426 lbs/day acid from stations 20.1 and 53.01 .

Strip mines #61 and 62 - 148 lbs/day acid at station 38.02.

This sample data accounts for an adjusted 6080 lbs/day acid load from the area, nearly all of which enters Big Run.

Recommended Abatement

The abatement plan for the Big Run area involves the complete surface restoration of strip mines #56 through 64. This will prevent interception of rainfall and runoff by the strip mines, limiting contact with the acid "B" seam spoil material and minimizing water infiltration into and passage through the deep workings. Such an abatement plan can eliminate 50% of the acid emanating from this area, or 3000 lbs/day.

To achieve these abatement goals, strip mine ponds should be drained and highwalls should be contour, swale or terrace backfilled and regraded as necessary to obtain the fastest possible runoff from the area. Regraded spoil surfaces should be treated with limestone and fertilizers as required to obtain a satisfactory growth medium. Grasses, legumes or trees should then be planted as dictated by slope stabilities.

All bony material within the area should be buried in a strip cut prior to backfilling where convenient, or regraded in place, in which case limestone would be roto-tilled into the top 10" of the bony surface and grasses, legumes or trees would be planted.

Diversion ditches should be constructed where necessary and flumed across strip mine surfaces. This will aid in rapidly removing runoff from the abatement area. Stream channels should also be reconstructed where they pass through strip mine areas, to prevent acid formation by contact with the strip mine spoil. Deep mine sealing was considered but not recommended due to faulting and lack of deep mine mapping. Hydraulic head conditions could also be prohibitive.

These abatement recommendations should be effective in improving the quality of water emanating from the area. The priority recommended for work within the abatement area is as follows: strip mines #56, 57, 58, 59, 60, 63, 64, 61, and 62. Strip mines #56 and 57 should be completed first, since they include the largest amount of acid abated and the best cost effectiveness. Strip mines #58, 59, 60, 63 and 64 should be completed next because of their location and effects on Big Run's headwaters. Strip mines #61 and 62 with the highest cost effectiveness within the abatement area, are of lowest priority within the area because of their relatively small acid load and poor cost effectiveness. No great water quality improvements will be achieved for Big Run, however, such abatement contributes to water quality improvements in the main stream and the West Branch.

Big Run Mine Drainage Data

SAM P L E			ACID LOAD	
Station #	Description	Strip Mine #	Unadjusted	Adjusted
51.05	air hole discharge	56	91	91
51.04	mine discharge	56	586	586
20.2	tribute to Big Run	57	200	272
20.4	tribute to B 19 Run	57	70	85
51.01	deep & strip discharge	57	83	323
53.01	deep & strip discharge	58	101	394
38.02	Little Laurel (headw.)	61,62	208	148
20.1	Big Run	59,60 ,63,64	1783	2032

Estimated Construction Cost

Strip Mine #56

Drain pond, backfill and regrade as required, add limestone and fertilizers, revegetate, construct diversion ditches and flumes where necessary in unreclaimed strip area.

41 Ac @ $3000/Ac = $123,000

Regrade bony, roto-till limestone, fertilize, revegetate.

7.5 Ac @ $2600/Ac = $19,500

Fertilize and revegetate reclaimed stripping as required.

11 Ac @ $355/Ac = $3,905

Strip Mine #57 (active permit area)

Drain ponds, backfill and regrade as necessary to improve runoff, add limestone and fertilizers, revegetate, construct diversion ditches as required in unreclaimed stripping.

52 Ac @ $2800/Ac = $145,600

Regrade bony, roto-till limestone, fertilize and revegetate.

1.8 Ac @ $2600/Ac = $4,680

Strip Mine #58

Backfill and regrade to maximize runoff, add limestone and fertilizers as required, revegetate, construct diversion ditches and flumes as necessary in unreclaimed stripping.

51 Ac @ $2800/Ac = $142,800

Strip Mine #59

Drain pond, backfill and regrade to obtain rapid runoff, add limestone and fertilizers as required, revegetate.

10.5 Ac @ $2500/Ac = $26,250

Strip Mine #60

Backfill and regrade to maximize runoff, add limestone and fertilizers as required, revegetate, construct diversion ditches and flumes where necessary in unreclaimed stripping.

139 Ac @ $3000/ Ac = $417,000

Strip Mine #61

Drain pond, backfill and regrade, fertilize and revegetate.

7 Ac @ $2400/Ac = $16,800

Strip Mine #62

Drain ponds, backfill and regrade to maximize runoff, add limestone and fertilizers, revegetate, construct diversion ditches and flumes where necessary.

27 Ac @ $2600/ Ac = $70,200

Strip Mine #63

Backfill, regrade, add limestone and fertilizers, revegetate, construct diversion ditches and flumes where necessary.

5.6 Ac @ $2600/Ac = $14,560

Strip Mine #64

Backfill and regrade as required, add limestone and fertilizers, revegetate, construct diversion ditches and flumes where necessary.

20 Ac @ $3000/Ac = $60,000

<u>Total Estimated Cost, Abatement Area V</u> = $1,044,295
Call: $1,045,000

<u>Cost Effectiveness</u>

Strip Mine #56

$146,405 per 340 lbs/day = $430 per lb/day acid <u>abated</u>

Strip Mine #57

$150,280 per 340 lbs/day = $442 per lb/day acid <u>abated'</u>

Strip Mines #58, 59, 60, 63, 64

$660,610 per 1213 lbs/day = $545 per lb/day acid <u>abated</u>

Strip Mines #61 and 62

$87,000 per 74 lbs/day = $1176 per lb/day acid <u>abated</u>

<u>Overall Cost Effectiveness</u>

$1,045,000 per 1967 lbs/day acid = $530 per lb/day acid <u>abated</u>

MOSHANNON CREEK WATERSHED

ABATEMENT AREA W
LITTLE LAUREL AND ALBERT RUNS

Location

Abatement Area W consists of 606 Ac of stripping, in strip mines #65 through 70, in various states of reclamation, and a large bony area. The stripping lies just west of U. S. Route 322, flanking the lower reaches of Little Laurel Run and the entire length of Albert Run. The small 10 Ac bony area lies east of Route 322, just northwest of Philipsburg and adjacent to the mouth of Laurel Run.

Geology

The abatement area is structurally situated on the northwest flank of the Houtzdale Syncline. Allegheny Group rocks from the Brookville-Clarion to the Upper Freeport outcrop within the area. Strata generally strike northeast-southwest and dip to the southeast at about 2° Numerous northwest trending wrench and splay faults pass through the abatement area.

Mining

All seams within the abatement area have been extensively deep and strip mined. The deep mines in the vicinity are generally quite old, having closed down many years ago. Strip mining has been carried out for many years in this area, as indicated by the varying amounts and sizes of vegetative cover in these previously stripped areas.

Strip mine #69 is underlain by the old workings of the "A" seam Meadowbrook Mine and probably by some small "B" seam workings. The strip itself is fairly recent and has been well regraded, but is poorly vegetated. Strip mine #68,just across the road, is the site of the Meadow-brook Mine's acid discharge and is only partially reclaimed.

Strip mine #70 cut into the workings of an unnamed "A" seam deep mine. The spoil associated with this small cut consists of dark shale and acid forming bony material.

Strip mine #67 overlies the workings of the "A" seam Riekert No.3 Mine and several other unnamed deep mines in the "A" coal and possibly its underclay. This strip mine is well regraded, but supports a poor vegetative cover.

Strip mine #66 is the largest mine within the abatement area, occupying 296 acres south of Little Laurel Run. The area probably contains numerous deep mines of varying sizes on all of the Allegheny Group coal seams, but no mine mapping information could be located. The stripping that overlies and cuts into the deep mines is of all ages and shows all degrees of reclamation. Much of the older, higher seam stripping is unreclaimed but very heavily vegetated. Other portions of these mines are unvegetated and contain ponds of varying sizes. The most recent stripping activity here has been on the Brookville-Clarion coal, and reclamation on that seam ranges from complete regrading to simple rounding off of spoil piles. Most of the lower seam stripping is poorly vegetated. The size of the bony area adjacent to strip mine #65 suggests that a fairly large deep mining operation existed there at one time, but no mine mapping could be located. The bony material is acid in nature, and the large pond adjacent to the bony is highly acid. The strip itself is a very small unreclaimed "D" seam cut.

Mine Drainage and Hydrology

Strip and deep mining within the abatement area have greatly altered the natural hydrologic system. The unreclaimed strip mines in the area, #65, 66, 68 and 70 trap rainfall and runoff. The trapped water either seeps through the acid spoil material to exit the area or infiltrates downward through the strip cut floor and into the deep mine workings.

Even where strip mines have been regraded, the unvegetated spoil surfaces are sufficiently permeable to allow all rainfall and runoff to infiltrate downward to the deep mine workings. All water in the workings is rendered acid in its passage downdip to the mine discharge points. These deep mine related acid discharges severely degrade Little Laurel Run, Albert Run, and Laurel Run itself near its mouth.

Several of the discharges pass through or near areas of acid bony material, which further degrades water quality. This is particularly important in the large bony area near strip mine #65, where a small highly acid mine discharge has formed a large pond in and adjacent to the bony material, and at station 38.01 in strip mine #66, where a small discharge flows directly across a bony area prior to entering Little Laurel Run.

Water Quality

Water quality data for Abatement Area W was obtained from both EPA and Skelly and Loy's sampling programs. EPA data showed the following acid loads:

1) Strip mine #65 - 348 lbs/day acid
2) Strip mine #66 - 1085 lbs/ day acid
3) Strip mine #67 - 453 lbs/day acid
4) Strip mines #69 and 70 - 97 lbs/day acid

Thus EPA data showed the abatement area to be the source of 1983 lbs/day acid.

Skelly and Loy's water quality data was obtained during the intensive sampling program, and flows were adjusted to represent an average yearly flow. This data revealed the following acid loads for the abatement area:

1) Strip mine #65 and vicinity is the source of 1360 lbs/day acid from sample station 36.04. Note: 36.04 is not included in computer printouts because its analysis values were too large to fit the computer format. Those values were - pH = 2.1 , acidity = 12,600 ppm, alkalinity = 0, Total Fe = 6,300 ppm Sulfate = 11,800 ppm, Ferrous Fe = 730 ppm, and flow = .02 cfs.

2) Strip mine #66 is the source of 816 lbs/day acid.

3) Strip mine #67 is the source of 2887 lbs/day from sample stations 38.06, 38.07 and 38.08.

4) Strip mines #68, 69 and 70 are the source of 384 lbs/day acid to Albert Run from sample stations 38.04 and 38.05.

Skelly and Loy's intensive sampling therefore attributed 5447 lbs/day acid to Abatement Area W.

Station #	Description	Strip Mine #	ACID LOAD Unadjusted	Adjusted
36.04	deep mine, bony	65	1360	1360
38.01	deep mine, bony	66	816	816
38.06	deep mine, strip	67	448	448
38.07	strip mine	67	380	269
38.08	deep mine, strip	67	2059	2059
38.04	deep mine, strip	68, 69, 70	384	384

Recommended Abatement

The recommended abatement for this area involves the complete surface restoration of all stripping to the point where runoff flows out of each strip area as rapidly as possible with only minimal infiltration or contact with acid producing spoil or bony material. An ponds should be drained, and strip mines #65, 66, 68 and 70 should be contour, swale or terrace backfilled as necessary to provide efficient drainage. Older, vegetated portions of the stripping should be disturbed as little as possible. All regraded strip mine surfaces within the abatement area, including #'s 67 and 69 should be treated with limestone and fertilizers to prepare the surface to support plant growth. Grasses, legumes and trees should be planted as dictated by slope stabilities. Diversion ditches should be constructed where necessary to keep water out of the strip mines. The ditch discharges should be flumed across any lower lying strip mines.

The small burning bony pile near strip mine #70 should be quenched and buried in one of the nearby strip cuts prior to backfilling. The large bony area near strip mine #65 can be graded in place. Limestone should be roto-tilled into the top 10" of bony and the necessary fertilizers should be added prior to revegetation of this bony.

These abatement recommendations should achieve the following goals:

Strip mine #65 - abate 60% of the acid discharge, or 816 lbs/day.

Strip mine #66 - abate 40% of the acid discharge, or 326 lbs/day.

Strip mine #67, 68, 69, 70 - abate 60% of the acid discharge or 1963 lbs/day.

The recommended priority for the abatement work is as follows: strip mines #68, 69, 70, 67, 65, 66. This order of priorities will abate acid progressively downstream in this module. Strip mine #66, the largest, most expensive, and least cost effective portion of the project is last on the priority listing. All others portions of the recommended abatement work can effectively abate acid and improve the quality of Little Laurel and Albert Runs at moderate cost effectiveness. Deep mine sealing was not recommended for abatement area W. The Soldiers Home mine located just east of the abatement area may be sealable, however, more information would be required to determine mine sealing feasibility. Available mine mapping indicates that the southern edge of the mine was affected by stripping, and hydraulic head at this point could reach 40 feet. Drift entries to the west of the Soldiers Home mine may have been used to develop a mine interconnected with the Soldiers Home mine. If the unknown mine is interconnected hydraulic head would be increased. On e remaining mine sealing possibility, for the Rickert & Company No.3 mine is also questionable due to lack of complete deep mine mapping.

Estimated Construction Cost

Strip mine #65

Backfill, regrade, fertilize and revegetate unreclaimed strip cut, construct diversion ditch.

2.5 Ac @ $2400/Ac = $6,000

Drain pond, regrade bony, roto-till limestone, fertilize, revegetate, construct diversion ditch.

10 Ac @ $2600/Ac = $26,000

Strip mine #66

Drain ponds, minimally backfill and regrade to achieve maximum surface drainage, add limestone and fertilizers as required, revegetate, construct diversion ditches and flumes where necessary.

394 Ac @ $2700/Ac = $791, 100

Regrade, roto-till limestone crusher waste, fertilize, and revegetate bony material.

3 Ac @ $2600/ Ac = $7,800

Drain, regrade, fertilize and revegetate large pond, kill area at deep mine discharge site.

3 Ac @ $1800/Ac = $5,400

Strip mine #67

Add limestone and fertilizers and revegetate regraded strip surface.

120 Ac @ $355/Ac = $42,600

Strip mine #68

Backfill, regrade, add limestone and fertilizers revegetate unreclaimed portion of strip.

7 Ac @ $2600/Ac = $18,200

Strip mine #69

Add limestone and fertilizers and revegetate regraded strip surface.

120 Ac @ $355/ Ac = $42,600

Backfill, regrade, add limestone and fertilizers, revegetate unreclaimed portion of strip.

7 Ac @ $2600/ Ac = $18,200

Strip mine #70

Quench small burning bony pile and bury in strip cut.

Cover carbonaceous shale and bony in strip cut, backfill, regrade, add limestone and fertilizers as necessary, revegetate and construct diversion ditch.

5 Ac @ $2600/Ac = $13,000

<u>Total Estimated Cost, Abatement Area W= </u>$1,003,630

Call: $1,004,000

Cost Effectiveness

Strip mine #65

$32,000 per 816 lbs/day acid = $39 per lb/day acid abated.

Strip mine #66

$804,300 per 326 lbs/day acid = $2467 per lb/day acid abated.

Strip mine #67, 68, 69, 70

$167,070 per 1963 lbs/day acid = $85 per lb/day acid abated.

Overall Cost Effectiveness

$1,004,000 per 3105 lbs/day acid = $323 per lb/day acid abated.

MOSHANNON CREEK WATERSHED

ABATEMENT AREA X
HAWK, SULPHUR AND GRASSFLAT RUN BONY AREAS

Location

Abatement Area X consists of several large bony areas and a few relatively small associated strip mines in the northwest quarter of the Moshannon Creek Watershed. These bony areas are located along Hawk, Sulphur and Grassflat Runs and are related to the large "B" seam deep mining complex, the eastern edge of which underlies the three areas. Area #71 consists of the 15 Ac Hawk Run bony areas and a 7 Ac strip cut located just upstream from the Hawk Run Acid Mine Drainage Treatment Plant. The Sulphur Run area, #72, consists of 41 Ac of bony and a 51 Ac strip cut just northwest of Winburne. The Grassflat Run bony area #73 lies just south of Grassflat and occupies 17 Ac.

Geology

All three portions of the area are associated with the massive Lower_ Kittanning coal deep mining complex that extends west to the Alder Run watershed, south to Emeigh Run and east to Moshannon Creek. The "B" coal is far below the surface in portions of the abatement area, but crops in the valleys of Sulphur and Grassflat Runs on the downdip eastern end of that complex. The higher non-acid Allegheny Group coals also outcrop throughout the abatement area. Strata dip eastward toward Moshannon Creek. No information on local faulting was obtained.

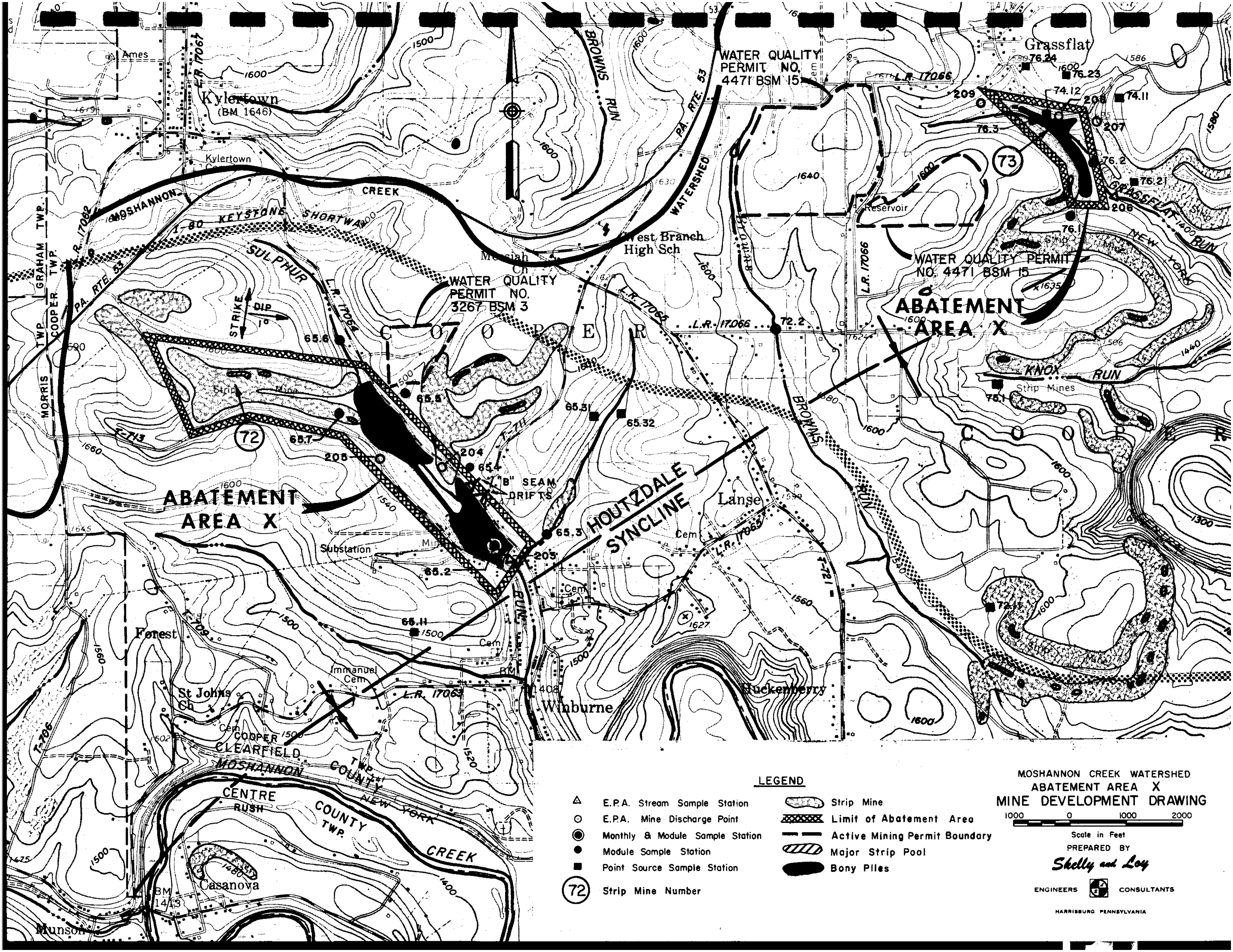
Mining

The deep mining history of the abatement area has been quite complex, and is irrelevant in the case of these bony areas. It is sufficient to point out that all three "B" seam bony areas are quite large, reflecting but not solely representing the extensive deep mine workings.

The small strip mines associated with the bony areas are old, unreclaimed, unvegetated, and have cut through the tributaries to Hawk and Sulphur Run. As the accompanying mapping indicates, stripping has been extensive around all three portions of the abatement area, but particularly in the vicinity of the northern two bony areas. Here the "B” seam outcrop adjacent to the deep mine workings and the underlying "A" coal have been stripped. These strips are generally unreclaimed, and the deep mine workings are discharging into and through the strips at many locations.

Mine Drainage and Hydrology

The largest acid sources in the vicinity of the abatement area are the deep mine discharges from the extensive "B" seam workings. These discharges are not directly related to the abatement area, however. The strip mines in the area cut through local watersheds permitting


MOSHANNON CREEK WATERSHED
ABATEMENT AREA X
MINE DEVELOPMENT DRAWING
1000 0 1000 2000
Scale in Feet
PREPARED BY
Shelly and Loy
ENGINEERS CONSULTANTS
HARRISBURG PENNSYLVANIA
LEGEND
E.P.A. Stream Sample Station
E.P.A. Mine Discharge Point
Monthly & Module Sample Station
Module Sample Station
Point Source Sample Station
72 Strip Mine Number
Strip Mine
Limit of Abatement Area
Active Mining Permit Boundary
Major Strip Pool
Bony Piles
ABATEMENT AREA X
WATER QUALITY PERMIT NO. 4471 BSM 15
WATER QUALITY PERMIT NO. 3267 BSM 3
HOUTZDALE SYNCLINE
STRIKE
DIP 1°
"B" SEAM DRIFTS
MOSHANNON CREEK
I-80 KEYSTONE SHORTWAY
SULPHUR RUN
BROWNS RUN
KNOX RUN
GRASSFLAT RUN
Kylertown
(BM 1646)
Grassflat
Ames
West Branch High Sch
Messiah Ch
Lanse
Winburne
Forest
St Johns Ch
Immanuel Cem
Huckenberry
Casanova
Munson
Reservoir
Substation
COOPER
CLEARFIELD COUNTY
CENTRE COUNTY
RUSH TWP.
COOPER TWP.
GRAHAM TWP.
MORRIS TWP.
PA. RTE. 53
L.R. 17066
L.R. 17063
L.R. 17064
L.R. 17067
72
73
65.6
65.5
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65.3
65.2
65.11
65.31
65.32
72.2
72.11
75.1
76.1
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76.21
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surface drainage to enter the underlying workings where it would normally be channeled out of the area in the surface drainage network. This infiltration through the stripped out stream channels probably contributes only slightly to the acid loads observed at the deep mine discharges.

The discharges flow through the bony areas in all three portions of the area. Most of the acid actually emanating from the three bony areas probably appears as wet weather slugs. The bony areas are all located on or near the valley floor of the adjacent tributary because the old mine drifts entered the hillsides midway up the valley. Bony was simply brought out of the mine and dumped downslope, toward the tributary. In such a position, the bony piles intercept all surface drainage from the hillsides above them. The water percolates downhill through the bony and becomes acid as it reacts with the pyrite in the bony and the oxygen within the pile's airspaces.

The locations of the three streams adjacent to or actually flowing over the bony material results in erosion of the bony fines. The fines are transported downstream and in the process react completely to form add. This acid is not evident at the bony source because it gradually appears farther downstream.

<u>Water Quality</u>

The following point source sample stations were major contributors of acid to streams in abatement area X. Sample stations 65.3 and 65.11 were each sampled one time and found discharging 88,000 and 28,000 lbs/day acid (unadjusted) to tributaries of Sulphur Run respectively. The large discharge at sample station S5.3 is a deep mine blow-out in the stream bed. This discharge was always found contributing large quantities of AMD. In the Grassflat Run Watershed, sample stations 74.11 and 76.21 contribute 1,100 and 810 lbs/day acid (unadjusted) to the main stream respectively. In the Hawk Run Watershed two major sources of AMD were found. Sample stations 9.15 and a discharge at the Hawk Run treatment plant, located 1,000 feet to the northwest, contribute an average of 2,200 and 17,000 lbs/day acid to the main stream respectively. A portion of the larger discharge is currently being treated by the States ion-exchange pilot plant. No data that would actually reflect the quality of the water emanating from the bony areas was obtained. Sulphur and Grassflat Runs are grossly polluted by deep mine discharges at the bony sites, and any acid contributed by the bony would not show up as further degradation of the water.

Utilizing the bony pile constant determined for Abatement Area S, 0.00506 cfs/acre, representative acid concentrations for each bony area and the acres of bony material, the following calculation was performed for each area. Bony pile constant (0.00506) x acres of bony x acidity (ppm) x 5.39 = average acid load (lbs/day). The values for acidity for area #71, 72 and 73 were selected from discharges sampled at stations 53.2, 65.2 and 76.21 respectively. The average annual acid loads calculated in pounds per day for areas #71, 72 and 73 are 266, 962 and 468 respectively.

Thus, the three bony or strip mine areas, #71, 72, and 73 are contributing a combined adjusted total of 1700 lbs/day acid.

Recommended Abatement

The abatement plan here calls for complete surface restoration of all three bony areas. The excessive amounts of bony present make the cost for burying the material in a strip cut prohibitive. Instead, the bony can be regraded in place. Limestone crusher waste should be rototilled into the top 10" of the regraded bony surface and fertilizers should be added as necessary to sustain a vegetative cover. Grasses, trees or legumes should then be planted on the bony surface as dictated by slope stability. Diversion ditches should be constructed, where deemed necessary, upslope from the bony areas. New stream channels should also be constructed where Hawk, Grassflat and Sulphur Runs pass through or near the three bony areas. These steps will all be helpful in limiting the bony contact with surface water and atmospheric oxygen.

In addition to the bony area abatement work, the two small strip cuts should also be backfilled, regraded, fertilized and revegetated. New stream channels will also have to be constructed through or around these strip areas to alleviate the present condition in which the streams flow through the strips and at least partially infiltrate into underlying deep mine workings.

Effective implementation of these abatement recommendations should abate roughly 80% of Abatement Area X's total acid load, or 1360 lbs/day.

Estimated Construction Cost

Areas #71, 72 and 73

Remove abandoned surface structure, regrade bony, roto-till limestone into top 10" bony, fertilize, revegetate, construct diversion ditches and stream channels as required.

74 Ac @ $3000/ Ac $222,000

Backfill and regrade, fertilize as necessary, revegetate, construct diversion ditches and stream channel as required.

59 Ac @ $2600/ Ac = $153,400

Total Estimated Cost, Abatement Area X = $375,400
Call: $375,000

Cost Effectiveness

$375,000 per 1360 lbs/day acid = $276 per lb/day acid abated

MOSHANNON CREEK WATERSHED

ABATEMENT AREA Y
BLACK MOSHANNON AREA

Location

Abatement Area Y consists of 702 acres of poorly reclaimed strip mines that are large acid sources to Black Moshannon and Moshannon Creeks. The four large strip mines associated with the area lie within Burnside and Snowshoe Townships in Centre County, Strip mine #74 occupies 245 acres just south of Gorton. Strip mine #75 consists of 540 acres, of which 194 acres are recommended for reclamation, from Gorton north toward Black Moshannon Creek. Strip mine #76 occupies 139 acres between the town of Moshannon and Black Moshannon Creek. The recommended 35 acre portion of strip mine #77 lies north of the town of Moshannon.

Geology

The abatement area is structurally situated on the southeast limb of the Houtzdale Syncline very close to the synclinal axis. Relief in this northern portion of the Moshannon Creek Watershed is extreme, and rapid downcutting by the major streams has exposed rocks of the Pocono Formation, the Mauch Chunk Formation, the Pottsville Group and the Allegheny Group. The Brookville-Clarion, Lower and Middle Kittanning coals of the Allegheny Group outcrop fairly high on the hills within this area.

No formalized geologic work has been done in the area and only minimal geologic information was obtained. Strikes appeared to vary within the abatement area, from northeast-southwest in strip mines #74 and #75 to northwest - southeast in strip mines #76 and #77. Shallow to fairly steep dips were noted throughout the area, to the northwest in strip mines #74 and #75 and to the southwest in strip mines #76 and #77. No information pertaining to faulting in the abatement area was obtained.

Mining

The only evidence of any large scale deep mining operations within the abatement area was found in the hill underlying strip mine #74. This area south of Gorton was extensively undermined on the "B" seam prior to 1940 by the Tunnel or Pioneer No.3 Mine and on the "A" seam or its underclay at a much earlier date. The size of the bony area and the remains of the tipple at the main drifts indicates that the "B" seam operation was large, and a very poorly reproduced mine map indicated that the entire hill had been undermined. No information or mapping could be obtained for the lower seam workings. The entire" B" coal outcrop adjacent to these deep mine workings was later strip mined, and remains unreclaimed.

The only evidence of deep mining in the vicinity of strip mine #75 was a small bony pile along the "A" outcrop at the extreme northern end of the area. Area residents and local mining engineers knew of no deep mining within the area. The Brookville-Clarion, Lower and Middle Kittanning coals were all stripped within the area. Apparently the "C" and much of the "B" coal was stripped first, as no reclamation work of any kind was done on these areas. Somewhat later the "A" coal was stripped from the northern and western sides of the area and more "B" coal was stripped from the eastern side. Spoil piles here were rounded inward toward the high walls and an attempt was made to revegetate the spoil, but overall reclamation was very poor. A 246 Ac portion of this strip mine is presently within a water quality permit. No active mining permits have yet been issued in the area, however.

No direct evidence or information concerning any deep mining beneath strip mine #76 could be found. The entire strip mine is very recent, fairly well regraded, and partially planted with pine seedlings. Many of the pines did not survive, however, and where they did, the trees are extremely small and totally ineffective in abating acid production and limiting erosion of the spoil. The mining permit covering this area has not been officially completed yet, due to water quality problems. The mining operation itself has been completed.

Strip mine #77 also appears to be unaffected by deep mining. The "A" and "B" coals here have been contour stripped with only limited reclamation. Vegetative cover is generally sparse and relatively ineffective in utilizing water. Here again, an extremely large "A" coal mining permit covers most of the strip mine, with only the southeastern 24 Ac outside of the permit area.

Mine Drainage and Hydrology

The natural hydrologic systems in the vicinity of each of the four strip mines were altered extensively by the mining activities. The entire 1073 acres of strip mines trap all rainfall striking them and all runoff entering them. This water seeps laterally through the strip mine spoil or infiltrates downward to deep mine workings where they exist. In all four areas, this water is rendered acid during its passage through and contact with the acid producing spoil material and deep mine workings.

The water entering strip mine #74 infiltrates downward into the extensive" B" seam deep mine workings and is channeled downdip through the workings to the northern side of the hill. A portion of this acid water is discharged at the northwest end of the hill, where it flows through a large bony and spoil area prior to entering the local tributary to Moshannon Creek. The remaining water in the "B" seam workings apparently infiltrates downward into the deep mine workings in the Brookville-Clarion coal or clay on the northern end of the hill. The discharge from these lower workings is the largest acid source in the vicinity of this strip mine. Strip mining intercepted some of deep mine workings but avoided some of the drift entries along the southwestern part of the Tunnel Mine.

The acid production problem in strip mines #75 and #77 is less complicated. Here the sole source of acid in each case is runoff and rainfall contact with strip mine spoil. These strip mines are unreclaimed and easily trap water, which must then pass through the spoil material to exit the area.

In strip mine #76, which is fully regraded, the problem is still one of spoil entrapment of runoff and rainfall. The blocky sandstone spoil surface is so coarse that all water infiltrates downward through the spoil and discharges at a common point, sample station 90.2. The large flow and the high acidity of the discharge here is indicative of the recent disruption of the spoil by regrading to expose fresh, unweathered, acid-producing material to the rainfall and infiltrating water. The rapid permeability of this spoil could also give this strip mine a higher than normal potential for "slugging" during high rainfall periods.

Water Quality

Water quality data for these four strip mines was obtained by Skelly and Loy during the intensive sampling program in this area. All measured flows were adjusted to represent a yearly average, and the values obtained for the individual strip mines are shown below:

1) Strip mine #74 discharges 2284 lbs/day acid from sample stations 82.11,82.12,82.34,82.35,82.36 and 82.37.

2) Strip mine #75 discharges 2237 lbs/day acid from sample stations 82.2, 82.32, 82.33, 84.01, 84.02, 84.03, 84.05, 84.06 and 89.24.

3) Strip mine #76 discharges 3820 lbs/day acid from a single discharge at station 90.2.

4) Strip mine #77 discharges 3546 lbs/day acid at stations 90. 14 and 90. 15 .

It is evident from this water quality data and from the mine Development Drawing for Abatement Area Y that the two largest acid producing strip mines, #75 and #76, both discharge into Black Moshannon Creek, which is reputedly an excellent trout stream. In fact, strip mines #76 and 77 are the only major sources of acid mine drainage to Black Moshannon Creek. Strip mines #74 and #75 discharge the bulk of their acid loads into small tributaries to Moshannon Creek.

		Strip	ACID LOAD.	
Station #	Description	Mine #	Unadjusted	Adjusted
82.11	strip seepage	74	72	454
82.12	strip seepage	74	93	585
82.35	strip seepage	74	252	70
82.36	bony refuse seepage	74	316	88
82.34	strip seepage	74	315	87
82.37	deep, refuse	74	3580	1000
82.2	strip seepage	75	634	1820
82.32	strip seepage	75	296	82
82.33	strip seepage	75	4	1
84.01	strip seepage	75	172	48
84.02	strip seepage	75	214	60
84.03	strip seepage	75	274	76
84.04	strip seepage	75	295	82
84.05	strip seepage	75	244	68
89.13	strip seepage	76	105 ppm	no flow
89.14	strip seepage	76	8 ppm	no flow
90.2	strip seepage	76	5300	3817
90.13	strip seepage	76	143	382
90.14	strip, deep	77	665	2762
90.15	strip seepage	77	162	500
90.12	strip seepage	77	67	284

Recommended Abatement

The abatement plan for all four strip mines in this area involves complete surface restoration of all strip mined areas that lie outside of the active mining permits. The exception here is strip mine #76, in which mining is completed although the permit is still active. Here, complete restoration of the entire strip mine is recommended. Contour swale or terrace backfilling should be used as appropriate to maximize runoff from the strip mine surfaces. Limestone and fertilizers should be added to the acid spoil as necessary; and grasses, legumes or trees should be planted as dictated by slope stabilities. Diversion ditches can be constructed where required and their discharges flumed across strip mine surfaces.

Bony material should be regraded in place. Limestone crusher waste should then be roto-tilled into the top 10" of the regraded bony surfaces. Fertilizers should be added to the bony prior to revegetation with grasses, legumes and trees.

These steps should achieve the following percentages of abatement in the four strip mines:

Strip mine #74 - 50% or 1100 lbs/day
Strip mine #75 - 25% or 600 lbs/day
Strip mine #76 - 80% or 3100 lbs/day
Strip mine #77 - 10% or 350 lbs/day

This accounts for a total of 5100 lbs/day acid abated.

It is important to point out here that the estimated acid loads abated refers only to portions of the strip in which work is recommended. If this work is properly coordinated with the reclamation plans of the operators holding the active permits in strip mines #75 and #77, the final acid load abated for this area can be much higher.

The recommended priority for abatement work within this area is as follows: strip mines #76, #77, #74, #75. Strip mines #76 and #77 directly affect Black Moshannon Creek, rendering it acid. The recommended abatement work in these two strip mines can eliminate or minimize acid discharges to the creek, returning its lower reaches to their natural quality. Strip mines #74 and #75 affect only the minor tributaries adjacent to them and the grossly polluted Moshannon Creek itself. The recommended abatement in these two mines is not as critical as that in strip mines #76 and #77, since immediate benefits will not accrue. Reclamation of strip mine #76 would greatly improve 4 miles of main stream and reclamation of strip mine #77 would improve 2 miles of tributary and 0.75 miles of main stream.

<u>Estimated Construction Cost</u>

Strip mine #74

Regrade, add limestone, revegetate 16 acres bony material.

16 Ac @ $800/Ac = $12,800

Regrade, revegetate, construct diversion ditches and flumes.

245 Ac @ $2,600/ Ac = $637,000

Total Estimated Cost = $649,800

Strip mine #75

Regrade, add limestone and fertilizers, revegetate, construct diversion ditches and flumes.

294 Ac @ $2,600/Ac = $764,400

Strip mine #76

Prepare planting surface, limestone and fertilizers, and revegetate regraded strip mine surface.

139 Ac @ $1,000/Ac = $139,000

Strip mine #77

Backfill, regrade, add limestone and fertilizers as required, revegetate, construct diversion ditches and flumes as necessary.

35 Ac @ $2,600/Ac = $62,400

Total Estimated Cost, Abatement Area Y = $1,615,600
Call: $1,620,000

Cost Effectiveness

Strip mine #74

$649,800 per 1100 lbs/day acid = $591 per lb/day acid abated

Strip mine #75

$764,400 per 600 lbs/day acid = $1,274 per lb/day acid abated

Strip mine #76

$139,000 per 3100 lbs/day acid = $45 per lb/day acid abated

Strip mine #77

$62,400 per 350 lbs/ day acid = $178 per lb/ day acid abated

<u>Overall Cost Effectiveness for Abatement Area Y</u>

$1,620,000 per 5150 lbs/day acid = $318 per lb/day acid <u>abated</u>

MOSHANNON CREEK WATERSHED

ABATEMENT AREA COST SUMMARY

Abatement Area	At Source Acid Load (lbs/day)	Estimated Construction Cost
R	20,557	$ 1,270,000
S	48,300	4,792,000
T*	98,000	Unknown
U	1,131	243,000
V	4,117	1,045,000
W	5,446	1,004,000
X	654	375,000
Y	10,325	1,620,000
TOTAL	188,530	$10,349,000
		Call: $10,400,000

Total Acid to be Abated (for recommended projects) = 50% of 90,530 lbs/day or 45,265 lbs/day

Total Project Cost = $10,400,000

Total Cost Effectiveness = $229 per lb/day acid abated.

*Abatement area not recommended for abatement