ABATEMENT

Three abatement plans are given in this report. The discharges have been grouped together where possible to develop an effective abatement program. Description of the abatement plan for each discharge or group of discharges have been described to give a background of what can be accomplished in the watershed (see following sections). The Abatement Plan I includes all the areas indicated in those descriptions with the data given in Table 9, p. 101, and the locations of these recommended reclamation areas shown in Plates A and B.

The general abatement procedures for Abatement Plan I given in Table 9, include stream modification, backfilling, and diversion ditches which are not associated with any one particular discharge. In these cases stream modification is recommended to control silt and prevent water percolating through the stream bed and entering the mine pool. The areas to be reclaimed are the north portion of R25, R36, and R41 which affects 9 strip pits. A cropfall located at Park Place is recommended to be backfilled. A total of 3800 feet of stream modification is recommended for the North Mahanoy Creek to prevent the stream from picking up acid from pyritic materials as well as silt. West of Mahanoy City along the Mahanoy Creek the channel should be modified for the same reasons. In addition 12,600 feet of stream modification along the Shenandoah Creek would decrease the amount of water entering the underlying mine pools and decrease the silt content of the stream. Along the Mahanoy Creek south of Ashland 3500 feet of stream bed could be modified to decrease silt entering the creek.

MAHANOY CITY GROUP DISCHARGES

The Mahanoy City Group consists of both the headwaters of Mahanoy Creek and the Mahanoy City Bore Hole Discharges. These discharges are the major polluters of Mahanoy Creek from its headwaters, downstream to the town of Gilberton. The headwaters of Mahanoy Creek were originally located along the northern base of Vulcan Hill, but the construction of a fill area for a railroad in the region prevents that area from draining into Mahanoy Creek. The water, which flows only during wet periods, presently collects behind the fill area and infiltrates into the Vulcan-Buck Mountain mine pool. It is recommended that 1000 feet of stream channel be constructed through the fill area (near R45) to drain the water to Mahanoy Creek. This would reduce the flow from the discharges by an estimated .23 MGD.

The backfilling, regrading and seeding of 180 acres of strip mines, along with the construction of 8300 feet of diversion ditch will further reduce the flow from the

discharges by approximately 0.43 MGD. A volume of 1,654,085 cubic yards of fill material is needed to backfill 16 strip pits. The pits are scattered throughout the contributing area, and all are either moderate or small in size. The reclamation areas included are R42, R43, R44, R45, R46, and R47.

The total reduction from the discharge is 0.66 MGD, or a percentage decrease of 8.8. The pollution load will be reduced by 629 lbs/day acidity, 64 lbs/day iron, and 1313 lbs/day of sulfates. The abatement measures should eliminate the flow from the Mahanoy Creek Headwaters Discharge.

GILBERTON SHAFT DISCHARGE

When the Gilberton Shaft Pump House is in operation, the discharge drastically affects the water quality of Mahanoy Creek from Gilberton downstream to its confluence with Shenandoah Creek. By reducing the amount of water entering the mine pools which contribute to the discharge, the levels of the mine pools can be lowered, therefore reducing the amount of time the pump must be in operation.

A total area of 124 acres is recommended to be backfilled, regraded, and seeded. The volume of fill required to backfill the 10 strip pits in the region is 1,456,434 cubic yards. Reclamation areas R32, R34 and the eastern portion of R26 are those effecting this discharge. The eastern portion of R26 has highest priority; here pits along the base of Ashland Mountain, just south of Mahanoy Plane trap surface runoff from the mountain above. A diversion ditch, 6900 feet long, will be constructed above the high wall of this area to deliver the water safely across the reclaimed area to Mahanoy Creek. The backfilling measures will reduce the overall flow of the Gilberton Shaft Discharge by 0.41 MGD, which is a reduction of 7.1 percent. This reduction in flow will result in decreasing by 251 lbs/day net acidity, 270 lbs/day iron, and 3929 lbs/day sulfates, the amount of these constituents which enter Mahanoy Creek.

GIRARDVILLE DISCHARGES

The Girardville Discharges combine to generate 2.96 MGD of acid mine drainage into Mahanoy Creek. To reduce the flow from the discharges approximately 138 acres located at the base of Ashland Mountain south and southeast of Girardville, should be backfilled, regraded, and seeded. The area includes 5 strip pits which will require 1,422,455 cubic yards of fill material. The reclamation areas affecting these discharges are the eastern portion of R23, R24, and the western portion of R26. Diversion ditches totalling 8500 feet will be constructed on the highwalls of all reclamation areas. This measure will allow all of Ashland Mountain to drain unimpeded into Mahanoy Creek. The discharges will be reduced by an estimated 0.35 MGD or 11.8 percent. The amount of pollutants entering Mahanoy Creek can be reduced by approximately 64 lbs/day net acidity, 66 lbs/day iron, and 1303 lbs/day sulfates.

PACKER GROUP DISCHARGES

The major abatement measure for the Packer Discharges is the relocation and diversion of a series of unpolluted streams. The streams, which enter the mine pool system via strip pits, cropfalls and rock fractures, will be safely routed to Mahanoy Creek or one of its tributaries.

A cropfall located 1.5 miles northwest of Mahanoy City, intercepts Waste House Run and directs the water to the Knickerbocker Mine Pool. The cropfall should he backfilled and a combination flume and channel constructed to deliver the stream 11,300 feet through a large stripped area to Mahanoy Creek. The stream channel is located south of area R35. The Abatement measure will reduce the flow from the Packer Discharges by 2.94 MGD, in addition to diluting the pollution presently in Mahanoy Creek.

Approximately 2000 feet northeast of the Village of Lost Creek the stream of Lost Creek enters a strip pit. Once the water enters the pit, it quickly infiltrates to the Weston Mine Pool. The pit and the surrounding area should be backfilled, regraded and seeded. A newly constructed stream channel roughly 2300 feet long, should direct the water to Shenandoah Creek. Implementing this measure will reduce the flow of the Packer Discharges by 0.43 MGD.

An unnamed tributary entering North Mahanoy Creek 4500 feet north of Mahanoy City, loses a significant portion of its flow by infiltration through the streambed to the Knickerbocker and North Mahanoy Mine Pools. By lining 2400 feet of stream, the flow from the Packer Discharges can be reduced by an estimated 0.16 MGD. The three measures just mentioned will reduce the flow of the discharge by 12 percent.

A project to extinguish a mine fire at the northern edge of Shenandoah is presently being completed by the Department of Environmental Resources. During the length of the project the water from Kehley Run has been allowed to flow into the work area, where it quickly enters the Kehley Run Mine Pool. When work has been completed, measures should be taken to insure that Kehley Run will be safely routed through the project area and into Shenandoah Creek.

Within the area drained by the Packer Discharges are a number of stripped areas that are especially susceptible to large amounts of surface water infiltration. Although not economically and physically feasible to reclaim all these areas, a total of 961 acres are recommended to be backfilled, regraded, and seeded. In the areas to be backfilled are 101 strip pits requiring 8,150,000 cubic yards of fill material. A number of the pits are quite large, needing nearly 1,000,000 cubic yards of fill. Much of the area to be reclaimed is located north of Mahanoy City. Reclamation areas included with this project are R28, R29, R30, R31, R33, R35, R37, R38, R39, R40. Accompanying the backfilling

will be the construction of approximately 9600 feet of diversion ditch, to bring surface runoff safely across regraded areas. These abatement measures will reduce the flow from the Packer Discharges by an additional 1.12 MGD.

In addition to reducing the flow of the Packer No. 5A and 5B Discharges, the abatement measures will also effect four other discharges. The flow from the Lost Creek, Lost Creek Ball Field, Connerton No. 1 and the Connerton No. 2 Discharges will be eliminated or greatly reduced. The total reduction in flow for the Packer Discharges will be 4.65 MGD, a decrease of 16.2 percent. The reduction in pollutants will be 1170 lbs/day iron and 43,872 lbs/day sulfates, with an associated decrease of 4508 lbs/day net alkalinity.

The Packer Discharges which have alkaline characteristics, lend themselves to treatment utilizing aeration and sedimentation. For alkaline discharges this method is both effective and relatively inexpensive. Although the flow of the discharges requires large settling ponds, sufficient area exists in the eastern section of Girardville to construct the ponds. Once the flow has been reduced by previously mentioned abatement techniques, a treatment facility having a 20 MGD capacity will be required.

HAMMOND DISCHARGES

Although the entire region drained by the Hammond Discharges is greatly disrupted, only two areas are critical enough to justify reclamation. Areas R27 and the southern portion of R25 are designated to be backfilled, regraded and seeded. These regions encompass 118 acres and include 10 strip pits requiring 498,838 cubic yards of fill material. The flow reduction will be 0.16 MGD, a decrease of 6.3 percent. The Hammond Discharge (26) should be eliminated. The pollution these discharges contribute to Shenandoah Creek will be reduced by 62 lbs/day iron, 1306 lbs/day sulfates, as well as 95 lbs/day net alkalinity.

An aeration system is recommended for the Hammond Bore Hole Discharge, an alkaline discharge, to eliminate this source of iron to the Shenandoah Creek.

SOUTH PRESTON DISCHARGE

The flow from this discharge can be significantly reduced utilizing backfilling techniques. Areas totalling 100 acres, and containing 13 strip pits requiring 616,278 cubic yards of fill material, are recommended to be backfilled, regraded and seeded. The areas are located along the base of Ashland Mountain, and reclaiming them would allow the entire northern slope of the mountain to drain safely into Mahanoy Creek. The reclamation areas include R21, R22, and the western portion of R23. A diversion ditch along the highwall of area R23, 2200 feet long, should be constructed. An estimated

reduction in flow of 0.28 MGD or 26.9 percent, can be achieved. This would result in a reduction of pollutants entering Mahanoy Creek by 31 lbs/day iron and 501 lbs/day sulfates, as well as reducing the amount of alkalinity by 78 lbs/day.

CENTRALIA TUNNEL DISCHARGE

After careful examination it was determined that the construction of a treatment facility is the only effective and economic means, of significantly reducing the effects of the AMD pollution from the Centralia Tunnel Discharge. Because of the extent and severity of the strippings, it is unrealistic to utilize strip mine reclamation as the major abatement method. The discharge, with its large flow and poor water quality, could not be reduced sufficiently by normal backfilling techniques to have a significant effect on Mahanoy Creek. Another factor considered is that a portion of the area contributing to the discharge lies in the Shamokin Creek Watershed, which is outside the reconnaissance region of this study. The treatment facility will involve the lime neutralization and sedimentation process.

To increase the value of the region, 386 acres are recommended to be backfilled, regraded and seeded. The area to be reclaimed, R19, contains 10 strip pits requiring 1,650,363 cubic yards of fill material; also accompanying this measure will be the installation of 3300 feet of diversion ditch. The flow from the discharge will be reduced by 0.45 MGD, a drop of 4.6 percent, resulting in the reduction of the amount of pollution entering Mahanoy Creek by 799 lbs/day acidity, 39 lbs/day iron and 2128 lbs/day sulfates.

BAST GROUP DISCHARGES

The major abatement measure for the Bast Discharges is the backfilling, regrading and seeding of 342 acres of strip mines. The areas encompass 20 strip pits which require 4,404,744 cubic yards of fill material, with one pit alone requiring over 1.9 million cubic yards. The reclamation areas effecting these discharges include R14, R16, R17, R18 and R20. Accompanying the backfilling will be the construction of 3600 feet of diversion ditch.

Implementing the abatement measures will reduce the flow of the discharges by 0.53 MGD, a decrease of 15.7 percent. In addition, the North Girardville Discharge may be eliminated. The reduction of pollutants entering Mahanoy Creek will be 11 lbs/day net acidity, 136 lbs/day iron, and 3032 lbs/day sulfates.

ASHLAND DISCHARGES

For these discharges, two strip pits, encompassing a total area of 35 acres, are recommended to be backfilled, regraded and seeded. The pits, which are located in

reclamation areas R15, and the eastern portion of R13, will require 785,145 cubic yards of fill material. The abatement measures will reduce the flow of the discharges by approximately 0.05 MGD, but because of the location of the discharges, only the Ashland No. 3 Discharge is expected to be affected. The Ashland No. 3 Discharge would be reduced by 26.3 percent.

BIG RUN DISCHARGES

To reduce the flow of the Big Run Discharges, areas totalling 350 acres are recommended to be backfilled, regraded, and seeded. Included in the total area are 40 strip pits requiring 2,029,090 cubic yards of fill. Most of the land to be reclaimed lies northwest of Ashland, and includes the following reclamation areas: R9, R10, R11, R12, and the western portion of R13. A diversion ditch 2,700 feet long, should be constructed along the highwall in area R10. These reclamation measures should reduce the flow of the discharges by 0.71 MGD, a decrease of 23.7 percent. The resulting reduction in the mine pool level could greatly reduce the Big Run 2 Discharge (49) which is located near the top of the mine pool and could even eliminate the discharge. The reduction of pollutants entering Mahanoy Creek from these discharges would be 171 lbs/day iron, and 5442 lbs/day sulfates, along with a reduction in alkalinity of 2148 lbs/day.

MOWRY DISCHARGE

A total area of 121 acres is recommended to be backfilled, regraded, and seeded. The region, which includes reclamation areas R7 and R8, contains 23 strip pits requiring 521,620 cubic yards of fill. The reclamation measures will reduce the flow of the discharge by 0.13 MGD. Because of the small flow from the discharge and large area to be backfilled, a large percentage decrease may be achieved, in this case the reduction in flow is 92.8 percent. The resultant pollution reductions would be 54 lbs/day acidity, 6 lbs/day iron and 187 lbs/day sulfates.

DOUTYVILLE TUNNEL DISCHARGES

The large volume and poor quality of water flowing from the Doutyville Drainage Tunnel, seriously affect the lower reaches of Mahanoy Creek. Although the contributing area to the discharge lies entirely outside the Mahanoy Creek Watershed, the discharge is too critical to be ignored. As a result, it is recommended that a treatment facility be constructed to reduce or eliminate the harmful characteristics of the Doutyville Tunnel Discharge. Improved quality of the discharge would be evident in Mahanoy Creek from the plant's outfall downstream to the mouth. The treatment facility should utilize the lime neutralization and sedimentation process.

NORTH FRANKLIN GROUP DISCHARGES

As previously mentioned the large flow from the North Franklin Overflow Discharge, which accounts for nearly all of the AMD pollution entering Zerbe Run, has extremely

poor water quality. In addition to polluting almost the entire length of Zerbe Run, the discharge also seriously affects the water quality of Mahanoy Creek. Backfilling, because of the totally disrupted drainage pattern in most of the stripped regions contributing to the discharge, is of only limited value in reducing the flow of the discharge. Because of these factors, a lime neutralization treatment facility is recommended to be constructed to treat the North Franklin Overflow Discharge. A treatment facility would bring the entire length of Zerbe Run up to acceptable water quality standards.

To reduce the amount of flow that the treatment facility must handle other abatement measures should be considered. A stream which drains the eastern portion of the stripped area, is presently being directed into an abandoned mine opening. Routing the stream past the mine opening and safely into Zerbe Run will reduce the flow of the discharge by 0.81 MGD. The length of stream modification required includes a section west of Trevorton which eliminates a serious silt problem. By reclaiming area R1 located at the western edge of the stripped region and areas R2, R3, R4, R5 and R6 located south and southwest of Trevorton the flow from the discharges can be significantly reduced. These areas encompass 621 acres, and include 65 strip pits that require 10,937,000 cubic yards of fill material. Accompanying the backfilling will be the construction of a diversion ditch 3300 feet long, on the highwall of the eastern portion of reclamation area R4. Backfilling area R1 will reduce the flow of the Sunshine Mine Discharge while the remainder of the reclamation areas will affect the North Franklin Overflow and the South Trevorton Discharges. The reduction in flow will be 0.60 MGD, making a total reduction of 16.8 percent. The South Trevorton Discharge may be eliminated. These measures would reduce the amounts of pollutants entering Mahanoy Creek by 1761 lbs/day acidity, 409 lbs/day iron, and 5978 lbs/day sulfates.

MINE SEALS

The use of mine seals as an abatement technique was evaluated for the following mine discharges: Sunshine (65), Doutyville Tunnel (56), Helfenstein Tunnel (54), Mowry (53), Big Run No. 2 (49), Bast (38), Centralia Tunnel (36), North Preston (34), South Preston (32), North Girardville (31), Lost Creek (21), and Headwaters Mahanoy Creek (1). Due to a hydraulic head of between 316-420 feet mine seals were not feasible for the Doutyville, Helfenstein, and Centralia Tunnels. A mine seal for Big Run No. 2 Discharge was not considered feasible due to the interconnection of this discharge with Big Run No. 1 (48) Discharge. Any attempt to seal the slope at discharge 49 would result in the mine water discharging at sample Site 48. The danger of mine seal failure to surrounding communities and the existence of several seepage discharges in the surrounding areas have indicated that mine seals for the Bast, North Preston, South Preston, North Girardville, and Lost Creek discharges are not feasible. Seepage areas at the Bast Discharge occur not only at points along the hillside but also at several locations in the adjacent roadways. In addition, several mine openings (mine slopes and air vents) exist near the Lost Creek and South Preston discharges which could easily become new discharge points as a result of a mine seal being constructed. Several mine slopes at

elevations with 20-30 feet above the current discharge point for the Headwaters Mahanoy Creek Discharge (1) indicate that the construction of a mine seal for discharge 1 will result in new discharge locations and therefore will not abate mine drainage.

The placement of double bulkhead mine seals with associated grout curtains will be able to successfully abate mine drainage of two mine discharges in the watershed. A mine seal for the Mowry Discharge (53), while eliminating the discharge in the Mahanoy Creek, may eventually reach a mine pool level which will result in an additional discharge in the Shamokin Watershed located to the north of the Mahanoy Creek Watershed. The Sunshine Discharge (65) mine seal will flood mine workings which are isolated from the mine workings of several active mines in the region. The Sunshine Mine probably will contain sufficient volume to handle the flooding of the mines. The estimated hydraulic head will be 90-100 feet. However, there may be the possibility of a discharge eventually appearing at a mine opening located 150-175 feet above the current discharge. More detailed studies should be undertaken before the decision to install these mine seals is made.

ABATEMENT PLAN BREAKDOWNS

Abatement Plan I shown in Tables 9 and 10 at an expenditure of over 31,000,000 dollars only results in a reduction of the flow of mine drainage by 13 percent. The reduction of pollutants entering Mahanoy Creek will be approximately 4026 lbs/day acid, 2425 lbs/day iron and 69,037 lbs/day sulfates, along with a reduction of 8185 lbs/day alkalinity. However, the reduction of flow, and therefore of the pollutants could be higher due to the longterm effect of gradually lowering the mine pool levels. Effects of the elimination of water introduced by Waste House Run and other streams into the mines (see preceding section) may be larger due to concentrated flows created by heavy rainfalls. The heavy rainfall results in a much greater amount of surface runoff entering the streams which eventually enters the mine openings. Thus a larger than expected percentage of the average rainfall in the watershed is introduced during a short period of time. A one inch rainfall concentrated over one hour contributes more water to the stream than a one inch rainfall concentrated over a 24 hour period. This may result in some discharges being reduced to a greater degree than the reclamation procedures indicate. Examples of these discharges include the South Preston, Big Run No. 1 and 2, and the Packer Discharge Group. These comments are also applicable to the other Abatement Plans.

Since a large percentage of the total pollution load is represented by only a few discharges, Abatement Plan II considers only five of the largest discharges which are equivalent to approximately 72 percent of the mine drainage flow (see Table 11, p. 111). After surface reclamation procedures have been completed an aeration system for the Packer Discharges and a treatment system for the North Franklin Overflow should be installed. The treatment system for the North Franklin Overflow will clean up an entire subwatershed. The aeration system will eliminate a major iron source to the Mahanoy

Creek. This abatement plan only reduces the total mine drainage flow by 45.2 percent at a cost of 21,352,696 dollars. The plan will reduce the pollution load of the watershed by 12,443 lbs/day acid, 9836 lbs/day iron, and 299,735 lbs/day sulfate.

As a result of the investigations of this report as well as previous experience in this field, abatement plans based entirely on preventive measures for this watershed are not cost effective and are impractical. The net reduction in flow of the discharges is so small that the condition of the watershed with respect to coal mine drainage would not appreciably change, although the physical features of the area would be vastly improved.

The most practical and cost effective of the various abatement plans considered is shown in Table 12, p. 112. Abatement Plan III is a combination of preventive measures supplemented by treatment methods. Approximately 70 percent (58.62 MGD) of the total mine drainage flow is reduced at a cost of 6,419,567 dollars which is considerably less than the first two plans. It is felt by the engineer that reclamation of stripped areas is not cost effective for the Packer Discharge Group and has not been considered in this plan. Thus the capital costs for the Packer Discharge Group only includes the construction of 16,000 feet of flumes and stream channels at a cost of 288,000 dollars, along with the construction of a 20 MGD aeration treatment system. The construction of flumes and channels will reduce the flows of the Lost Creek, Lost Creek Ball Field and Connerton Nos. 1 and 2 Discharges by approximately 1.2 MGD, in addition to affecting the Packer No. 5A and 5B Discharges. The Centralia and Doutyville Tunnels and North Franklin Overflow discharges have been included due to their high concentrations of acid. These discharges have a major impact on the stream water quality of the watershed. Of particular importance is the North Franklin Overflow which is the only appreciable discharge entering Zerbe Run. The discharge affecting over 4.75 miles of stream not only deteriorates an entire subwatershed, but causes a significant zonation in the Mahanoy Creek after Zerbe Run enters the creek.

The annual costs of the treatment systems after amortization are given in the following:

SYSTEM	PROJECT COST	ANNUAL COST*	OPERATING COST
North Franklin Overflow (10MGD)	$157,600	$16,657	$35,800
Centralia Tunnel (10MGD)	157,600	16,657	45,800
Doutyville Tunnel (10MGD)	162,600	17,185	39,300
Hammond (3MGD)	53,500	5,654	6,000
Packer No. 5 (20MGD)	260,000	27,482	35,000

* Annual cost calculated on basis of 8.5 percent interest rate and 20 year repayment period. Operating cost includes cost of lime.

TABLE 9

ABATEMENT PLAN I

DISCHARGE GROUP	FILL REQ'D (YD^3)	COST ($0.75/$YD^3$)	STREAM MODIFICATION (FEET)	COST* ($18/LF)	AREA SEEDED (ACRES)	COST ($700/AC)	AREA PLANTED (ACRES)	COST ($90/AC)	DIVERSION DITCH (FEET)	COST ($3.25/LF)	TOTAL COST
Mahanoy City Headwater Mahanoy Creek Mahanoy City Bore Holes	1,654,085	1,240,564	1,000	18,000	180	126,000	48	4,320	8,300	26,975	1,415,859
Gilberton Shaft Discharge	1,456,434	1,092,326	2,200	39,600	124	86,800	56	5,040	6,900	22,425	1,236,191
Girardville No's 1, 2, 3, and 4	1,422,455	1,066,841	0	0	138	96,600	61	5,490	8,500	27,625	1,196,556
Packer Discharges Packer No. 5A, 5B Lost Creek Ball Field Lost Creek Connerton No's 1 and 2	8,769,298	6,576,974	33,100	595,800	961	672,700	500	45,000	9,600	31,200	7,921,674
Hammond Hammond Bore Hole Hammond Discharge	498,838	374,129	0	0	118	82,600	118	10,620	0	0	467,349
South Preston Discharge	616,278	462,209	0	0	100	70,000	30	2,700	2,200	7,150	542,059
Centralia Tunnel	1,650,363	1,237,772	0	0	386	270,200	335	30,150	3,300	10,725	1,548,847
Bast Bast Discharge, North Girardville, North Preston	4,406,744	3,305,058	0	0	342	239,400	150	13,500	3,600	11,700	3,569,658
Ashland No's 1, 2, and 3	785,145	588,859	6,200	111,600	35	24,500	20	1,800	0	0	726,759
Big Run No's 1 and 2 Discharge	2,029,090	1,521,818	0	0	350	245,000	200	18,000	2,700	8,775	1,793,593
Mowry Discharge	521,620	391,215	0	0	121	84,700	41	3,690	0	0	479,605
North Franklin North Franklin Overflow South Trevorton Sunshine Mine	10,937,000	8,202,750	6,600	118,800	621	434,700	395	35,550	3,300	10,725	8,802,525
General	1,521,068	1,140,801	19,900	358,200	114	79,800	59	5,310	9,600	31,200	1,615,311
TOTALS	36,268,418	27,201,316	69,000	1,242,000	3,590	2,513,000	2,013	181,170	58,000	188,500	31,325,986

* Varies greatly with type and size of stream modification, $18/LF is an average value.

TABLE 10

ABATEMENT PLAN I

DISCHARGES	FLOW (MGD)	POLLUTION LOAD (POUNDS/DAY)				REDUCTION IN POLLUTION LOAD					TOTAL COST, $	COST UNIT REDUCED				
						FLOW (MGD)	POUNDS/DAY					FLOW $/1000 GAL	ACID $/LB	ALK $/LB	IRON $/LB	SULFATE $/LB
		ACID	ALK	IRON	SULFATES		ACID	ALK	IRON	SULFATES						
Mahanoy City Group	7.55	7,193	–	727	15,021	0.66	629	–	64	1,313	1,415,859	2,145	2,250	–	22,122	1,078
Gilberton Shaft Discharges	5.76	7,643	4,109	3,793	55,185	0.41	544	293	270	3,929	1,246,191	3,039	2,291	4,253	4,616	317
Girardville Discharges	2.96	581	37	561	11,026	0.35	69	4	66	1,303	1,196,556	3,419	17,341	229,139	18,130	918
Packer Discharge Group	28.8	35	27,929	7,239	271,486	4.65	6	5,411	1,170	43,845	7,921,674	1,704	1,302,279	1,464	6,771	181
Hammond Discharges	2.54	35	1,542	981	20,729	0.16	2	97	62	1,306	467,349	2,920	233,675	4,818	7,538	358
South Preston Discharges	1.04	–	291	114	1,864	0.28	–	78	31	501	542,059	1,936	–	6,949	17,486	1,082
Centralia Tunnel Discharges	9.83	17,453	–	858	46,453	0.45	799	–	39	2,128	1,548,847	3,412	1,938	–	39,714	728
Bast Group	3.38	1,033	965	868	19,339	0.53	162	151[1]	136	3,032	3,569,658	6,735	22,034	23,640	26,247	1,177
Ashland Discharges	0.42	56	367	51	1,453	0.05[1]	–	3[1]	1[1]	73[1]	726,759	14,535	–	242,253	726,759	9,956
Big Run Discharges	3.00	–	9,063	722	22,961	0.71	–	2,148	171	5,442	1,793,593	2,526	–	835	10,488	330
Mowry Discharge	0.14	58	–	6	202	0.13	54	–	6	187	479,605	3,689	8,882	–	79,934	2,565
North Franklin Group	8.38	10,465	–	2,430	35,521	1.41	1,761	–	409	5,978	8,802,525	6,243	4,999	–	21,522	1,472
General											1,615,311					
TOTAL	73.8	44,552	44,303	18,350	501,240	9.79	4,026	8,185	2,425	69,037	31,325,986	3,200	7,781	3,827	12,918	454

1 Abatement measures will affect only the Ashland No. 3 Discharge.

TABLE 11

ABATEMENT PLAN II

DISCHARGES	REDUCTION IN POLLUTION LOAD (POUNDS/DAY)				COST $	COST UNIT REDUCED			
	ACID	ALK	IRON	SULFATES		ACID $/LB	ALK $/LB	IRON $/LB	SULFATE $/LB
Mahanoy City Group Reclamation	629	–	64	1,313	1,415,859	2,250	–	22,122	1,078
Gilberton Shaft Discharge Reclamation	544	293	270	3,929	1,246,191	2,291	4,253	4,616	317
Packer Discharge Group Reclamation Aeration System	6	25,517	7,033	256,844	7,921,674 260,000	1,363,612	320	1,163	32
Centralia Tunnel Discharge	799	–	39	2,128	1,548,847	1,938	–	39,714	728
North Franklin Group Reclamation Treatment System	10,465	–	2,430	35,521	8,802,525 157,600	856	–	3,687	252
TOTAL	12,443	25,810	9,836	299,735	21,352,696	1,716	827	2,170	71

TABLE 12

ABATEMENT PLAN III

DISCHARGES	REDUCTION IN POLLUTION LOAD (POUNDS/DAY)				COST $	COST/UNIT REDUCED			
	ACID	ALK	IRON	SULFATES		ACID $/LB	ALK $/LB	IRON $/LB	SULFATES $/LB
Mahanoy City Group Reclamation	629	–	64	1,313	1,415,859	2,250	–	22,122	1,078
Girardville Discharges Reclamation	69	4	66	1,303	1,196,556	17,341	229,139	18,130	918
Packer Discharge Group Reclamation Aeration System	5	25,300	7,010	256,000	288,000 260,000	109,600	22	78	2
Hammond Discharges Aeration System	35	1,542	981	20,729	53,500	1,529	35	55	3
South Preston Reclamation	–	78	31	501	542,059	–	6,949	17,486	1,082
Centralia Tunnel Discharge Treatment System	17,453	–	858	46,453	157,600	9	–	184	3
Big Run Discharges Reclamation	–	2,148	171	5,442	1,793,593	–	835	10,488	330

TABLE 12 (Continued)

DISCHARGES	REDUCTION IN POLLUTION LOAD (POUNDS/DAY)				COST $	COST/UNIT REDUCED			
	ACID	ALK	IRON	SULFATES		ACID $/LB	ALK $/LB	IRON $/LB	SULFATES $/LB
Mowry Discharge Mine Seal	58	–	6	202	18,500	319	–	3,083	92
Doutyville Tunnel Treatment System	11,337	–	1,627	53,947	162,600	14	–	100	3
North Franklin Group Treatment System Mine Seal	10,465	–	2,430	35,521	157,600 15,500	17	–	71	5
General Steam Modification					358,200				
TOTAL	40,051	29,072	13,244	421,411	6,419,567	160	220	484	15

As in the first abatement plan, general stream modification is included in Abatement Plan III. The same descriptions given in Abatement Plan I for this procedure are applicable in the third plan.

Aeration is recommended for the Hammond Bore Hole which contains very high amounts of iron. It is included in this plan as a result of the high concentration of iron which pollutes the Shenandoah Creek. The aeration system for the Packer Discharges will eliminate a major source of iron to Mahanoy Creek. These discharges are also the major influence on iron content in the creek from Girardville to the mouth of Mahanoy Creek.

The abatement of approximately 70 percent of the total mine drainage flow does not take into account certain discharges which could be eliminated or greatly reduced as pointed out in the preceding sections on abatement of the groups of discharges. The total reduction of pollutants is 40.051 lbs/day acid, 13,244 lbs/day iron, 421,411 lbs/day sulfates along with a reduction of alkalinity of 29,072 lbs/day. Therefore, the Abatement Plan III is the more realistic and cost effective of the several plans considered.

An all gravity collection system for mine discharges 15, 16, 25, 28, 29, 31, 32, 34, 36, 38, 40, 41, and 42 was considered as an option to Abatement Plan III. This collection system would combine acid and alkaline discharges to form a net alkaline discharge which would require aeration and sedimentation to remove iron and sulfate. The treatment plant would be located in the area northwest of Gordon, PA, on the west side of the Mahanoy Creek. The system would replace the treatment systems of Centralia Tunnel, Hammond Bore Hole, and Packer No. 5 Discharges. The initial project cost of the collection system, however, is much greater. The collection system installation will cost $2,440,000 with the associated treatment system costing $1,139,000 for a total initial cost of $3,579,000. The yearly operating cost will be close to $60,000. The disadvantages of the system include: the problem of overflows at the pollution source and leaks and breaks in the pipe; the breakdown of the system would have a major affect on the quality of the Mahanoy Creek while breakdowns in any one of the three individual systems would have a much less impact; sludge disposal at the treatment site is a serious problem; and cost. Although the collection system will eliminate more discharges than the individual systems, the disadvantages of the system indicate that individual treatment systems should be the abatement approach.

In addition to the three abatement plans presented an abatement technique connecting the Girard Mine Pool to the Packer No. 5 Mine Pool and the connection of the Vulcan-Buck Mountain Mine Pool to the Primrose Mine Pool will eliminate several discharges. Connecting the Girard Mine Pool to the Packer No. 5 Mine Pool will involve angle drilling (35°-45°) of 2 bore holes approximately 800 feet to lower the Girard Mine Pool level. Lowering the mine pool level will eliminate discharges 10, 11, 12, and 13. The cost of

the project is estimated to be $65,000. Using the same method and drilling for 500 feet will lower the Vulcan-Buck Mountain Mine Pool. This will eliminate the Mahanoy City Bore Hole and Headwaters Mahanoy Creek Discharges. The mine water will enter the Primrose Mine Pool and eventually flow into the Packer No. 5 Discharges. The cost of this project is estimated to be $45,000. Changes in layers of the mine pools as well as a more detailed study to determine other effects should be conducted before beginning both of these drilling projects. The drilling projects can be accomplished in conjunction with any of the three abatement plans.

The total initial project costs and annual costs of the three abatement plans have been compared in Table 13. The total annual cost data indicate that Abatement Plan III is the most cost effective plan. The operating costs of the treatment systems can be justified not only by lower annual costs but by the elimination of a large proportion of the total pollution load which will result in the Mahanoy Creek meeting the water quality limits set by the State of Pennsylvania.

TABLE 13

ANNUAL ABATEMENT COSTS

	TOTAL INITIAL PROJECT COST	ANNUAL COST FOR SURFACE RECLAMATION[1]	ANNUAL COST OF TREATMENT SYSTEMS[2]	ANNUAL OPERATING COST	TOTAL ANNUAL COST
ABATEMENT PLAN I	31,325,986	2,708,445	0	0	2,708,445
ABATEMENT PLAN II	21,352,696	1,810,048	44,139	70,800	1,924,987
ABATEMENT PLAN iII	6,419,567	486,620	83,635	161,900	732,155

1 Based on 8.5 percent interest rate and 50 year repayment period.

2 Based on 8.5 percent interest rate and 20 year repayment period.

The hydrological, mine pool, and reclamation investigations of this report suggest that disturbed aquifers are an important source of water in the mine pools. Surface reclamation (a preventive measure which reduces the flow of the mine discharges) alone

may therefore be inadequate in the reduction of water entering the mine pools. If aquifers, for example, are contributing large amounts of water into the mine pools surface reclamation, while reducing a mine discharge will never eliminate enough water in the mine pool to eliminate the various mine discharges. This is due in part to water entering the aquifer in areas outside the watershed.

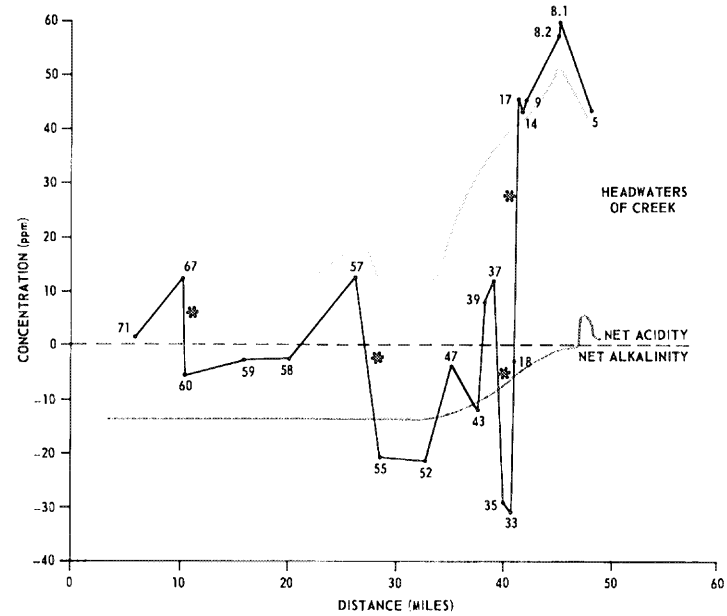
Water quality in the watershed will be significantly improved after implementation of the abatement plan. The treatment of the Doutyville Tunnel Discharge (Site 56) is anticipated to result in a net alkalinity in the Mahanoy Creek as well as lower the total iron content of the stream (see Figure 19). Treatment of the Centralia Tunnel Discharge (Site 36), also a major contributor of acid to the stream, should result in a net alkalinity of the Mahanoy Creek. The North Franklin Overflow treatment system is anticipated to clean 4.75 miles of Zerbe Run and hence an entire subwatershed as well as eliminate the discharge's influence on the water quality of the creek.

The water quality of Mahanoy Creek resulting from implementation of each of the three abatement plans is given in Figure 19, p. 117. The effects of Abatement Plan I will be minimal with water quality not significantly different than present conditions. Abatement Plan II will reduce the iron (primarily through abatement of the Packer Discharges), however, iron values for the Mahanoy Creek will still be higher than the water quality limits. In addition, abatement of the Packer Discharges will eliminate a major source of alkalinity which at present neutralizes the acid in the creek originating upstream of the discharges. If Abatement Plan II is implemented acid contents will actually increase downstream of the Packer Discharges. Sulfate content should be close to the sulfate water quality limits if Plan II is selected.

The recommended plan, Abatement Plan III, will result in the water quality of Mahanoy Creek meeting the water quality limits of pH, acid, iron, and sulfate. The immediate vicinity of Gilberton shaft is the only section of the stream which will not meet the water quality criteria. The creek immediately downstream from the discharge will be slightly acid and probably contain close to 7 ppm iron. Due to dilution effects of the clean stream, however, the impact of the discharge should be minimal.

The Shenandoah Creek is anticipated to have a much lower iron content as a result of treatment of the Hammond Bore Hole Discharge. Stream modification to eliminate contact with pyritic materials and especially to eliminate discharges from an active colliery would significantly reduce the abrupt increase in total iron and acidity between sample Sites 18 and 20 resulting in a substantial increase in water quality of the entire creek.

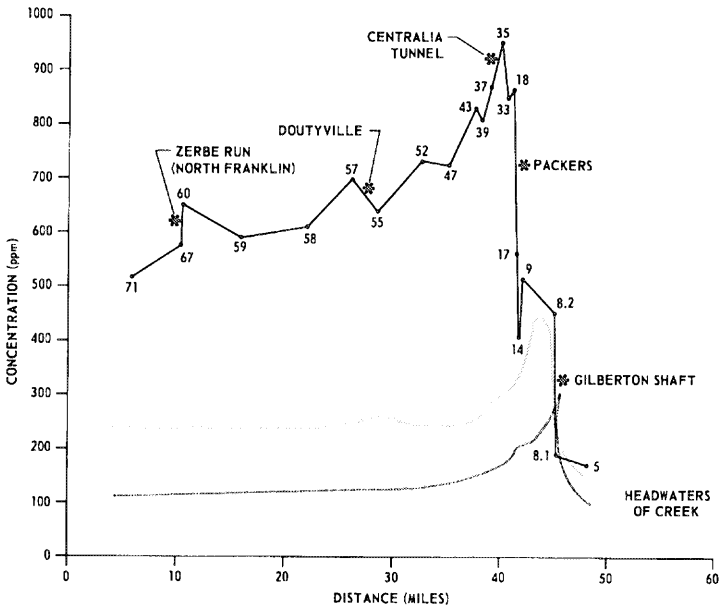
The other tributaries are also anticipated to improve in quality. Silt content should be greatly reduced in the North Mahanoy Creek. Removing pyritic materials also will reduce acid in this stream. The flow of Big Mine Run which is primarily a result of mine discharges should be reduced resulting in less pollution reaching Mahanoy Creek.



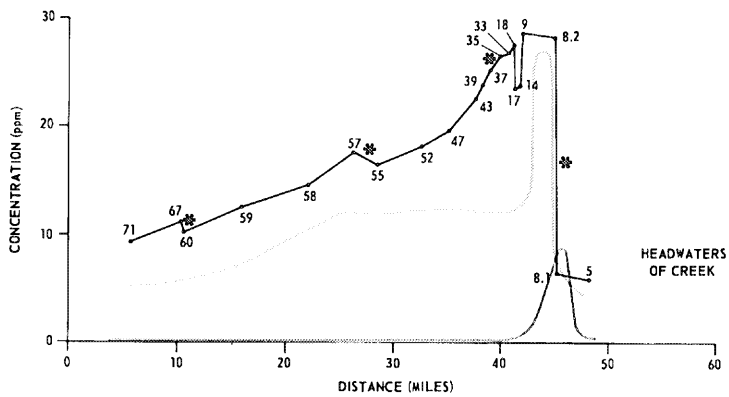
LEGEND

- ✱ DISCHARGE SITE
- 37 DISCHARGE SAMPLING POINT
- ABATEMENT PLAN III
- ABATEMENT PLAN II
- ABATEMENT PLAN I
- EXISTING CONDITIONS

GRAPH A.
EFFECTS OF THE ABATEMENT PLANS ON WATER QUALITY OF MAHANOY CREEK IN TERMS OF ACIDITY



GRAPH B.
EFFECTS OF THE ABATEMENT PLANS ON WATER QUALITY OF MAHANOY CREEK IN TERMS OF SULFATE (SO_4^{2-})



GRAPH C.
EFFECTS OF THE ABATEMENT PLANS ON WATER QUALITY OF MAHANOY CREEK IN TERMS OF TOTAL IRON

Figure 19. Effects of the implementation of the three abatement plans on water quality in the Mahanoy Creek