MINE DRAINAGE ABATEMENT PROJECT

TANOMA COMPLEX
(UPPER CROOKED CREEK)
INDIANA COUNTY
PROJECT SL 107-6
A PART OF OPERATION SCARLIFT

COMMONWEALTH OF PENNSYLVANIA
MILTON J. SHAPP, GOVERNOR
DEPARTMENT OF ENVIRONMENTAL RESOURCES
DR. MAURICE K. GODDARD, SECRETARY

PREPARED BY
McDONALD/PHILLIPS ENGINEERS, INC.
PITTSBURGH, PENNSYLVANIA

1972

DEPARTMENT OF ENVIRONMENTAL RESOURCES

REVIEW NOTICE

This report, prepared by outside consultants, has been reviewed by the Department of Environmental Resources and approved for publication. The contents indicate the conditions that are existing as determined by the consultant, and the consultant's recommendations for correction of the problems. The foregoing does not signify that the contents necessarily reflect the policies, views, or approval of the Department.

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May 17, 1973

Dr. Maurice K. Goddard, Secretary
Department of Environmental Resources
Commonwealth of Pennsylvania
Harrisburg, Pennsylvania 17120

Re: Mine Drainage Pollution Abatement Survey
Tanoma Complex
Indiana County, Pennsylvania
Project SL 107-6
Contract No. 70-107

Dear Dr. Goddard:

We hereby submit the following Report on Project SL 107-6. The Report contains results of a one-year stream sampling survey to determine the sources of acid mine drainage in the Upper Crooked Creek Watershed.

The study includes recommendations for abating the discharge of acid mine drainage into Crooked Creek that should restore the stream to its natural state.

We are available at your convenience, for discussion of this Report.

Very truly yours,

James B. McDonald

James B. McDonald, P. E.

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INTRODUCTION

PROBLEM

The Commonwealth of Pennsylvania, Department of Environmental Resources, engaged McDonald/Phillips Engineers, Inc., under Contract No. SL 107-6 on April 15, 1971, to conduct Engineering Serv1ces for the Abatement of Mine Water Discharging from the "Tanoma Borehole". The purpose of this study was to evaluate existing Mine Drainage Pollution and to recommend corrective abatement measures. A one year Stream Sampling Program was established to locate pollution sources and provide samples for laboratory testing.

The original Study included a Design Program to seal existing mine discharges to a high enough pool elevation to divert uncontaminated ground water run-off into Two Lick Creek. A review of the Mine Maps, Field Reconnaissance, the discovery of Borehole MP6 and its pollution significance, resulted in a change in the scope of work under the initial Contract.

This Report contains the results of the investigation together with Conclusions, Recommendations and Cost Estimates to obtain the most promising corrective measures.

DEFINITION OF TERMS

MINE DRAINAGE - Refers to drainage from sources related to coal mining.

POLLUTION - Refers to acid mine discharge resulting from sources created by coal mining.

SYNCLINE - A geological term that describes a fold of stratified rock inclining upward in opposite directions from both sides of its axis.

ANTICLINE - A geological term that describes a fold of stratified rock from the crest of which the strata slope downward in opposite directions.

SLOPE MINING - The entries are cut horizontally with the headings and haulages following downward dip of the coal seam making pumping and pulling mine cars up the main heading necessary.

DRIFT MINING - The entry follows the upward dip of the coal seam allowing the workings to drain by gravity and eliminates the cost for hoisting and pumping equipment.

C.B.C. - The Clearfield Bituminous Coal Company

M.G./L. - Milligrams Per Liter

G.P.D. - Gallons Per Day

P.P.M - Parts Per Million

LIST OF MAPS

TITLE

GENERAL INFORMATION MAP

This is a Reproduction from the U. S. Geological Survey Map, Clymer Quadrangle, Indiana County, Pennsylvania, 7.5 Minute Series with additional information superimposed. The Reproduction is on file at the Office of McDonald/Phillips.

MINE MAPS - LOWER FREEPORT "D" SEAM AND LOWER KITTANNING "B" SEAM

These Maps were reproduced from the C.B.C. original tracings which are on file in their office. The Reproduction has additional information superimposed and is on file at the Office of McDonald/Phillips.

PLAN OF MINE OUTLINE

This Map was prepared by McDonald/Phillips from information supplied by C.B.C. The original drawing is on file at the Office of McDonald/Phillips.

RESIDENTIAL WELL WATER SAMPLE MAP

This Map was prepared by McDonald/Phillips and is on file at their office.

REFERENCES

Soil Survey, Indiana County, Pennsylvania, United States Department Of Agriculture.

Water Measurement Manual, United States Department of the Interior, Bureau of Reclamation, 1967

Stream Map and Watershed Boundaries of Pennsylvania, by the Pennsylvania State University, College of Agriculture

Land Resource Map by the Pennsylvania State University, College of Agriculture

Indiana County Sewer and Water Study, Indiana County Planning and Zoning Commission, 1968

Summary Comprehensive Plan, Indiana County, Indiana County Planning Commission, 1967

Acid Mine Drainage in Appalachia, Appalachian Regional Commission, 1969

Geological Map of Pennsylvania, _Clymer Quadrangle, Pennsylvania, by the United States Geological Survey

ACKNOWLEDGEMENTS

We gratefully acknowledge the assistance given to this Firm during the course of this investigation by the following private companies, public agencies and professional persons:

1. Clearfield Bituminous Coal Corporation
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   Mr. Ralph Roth, Vice President
   Mr. Carl Utberg, Engineer

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   Mr. Noel N. MOebs

5. Marion Center Mining Company
   Deckers Point, Pennsylvania
   Mr. Clair Kinter

6. U. S. Soil Conservation Service
   Indiana, Pennsylvania

7. Volunteer Cooperative Weather Station
   Indiana, Pennsylvania
   Mr. Harold B. Cunningham

8. Indiana Planning Commission
   Indiana, Pennsylvania

WATERSHED DESCRIPTION

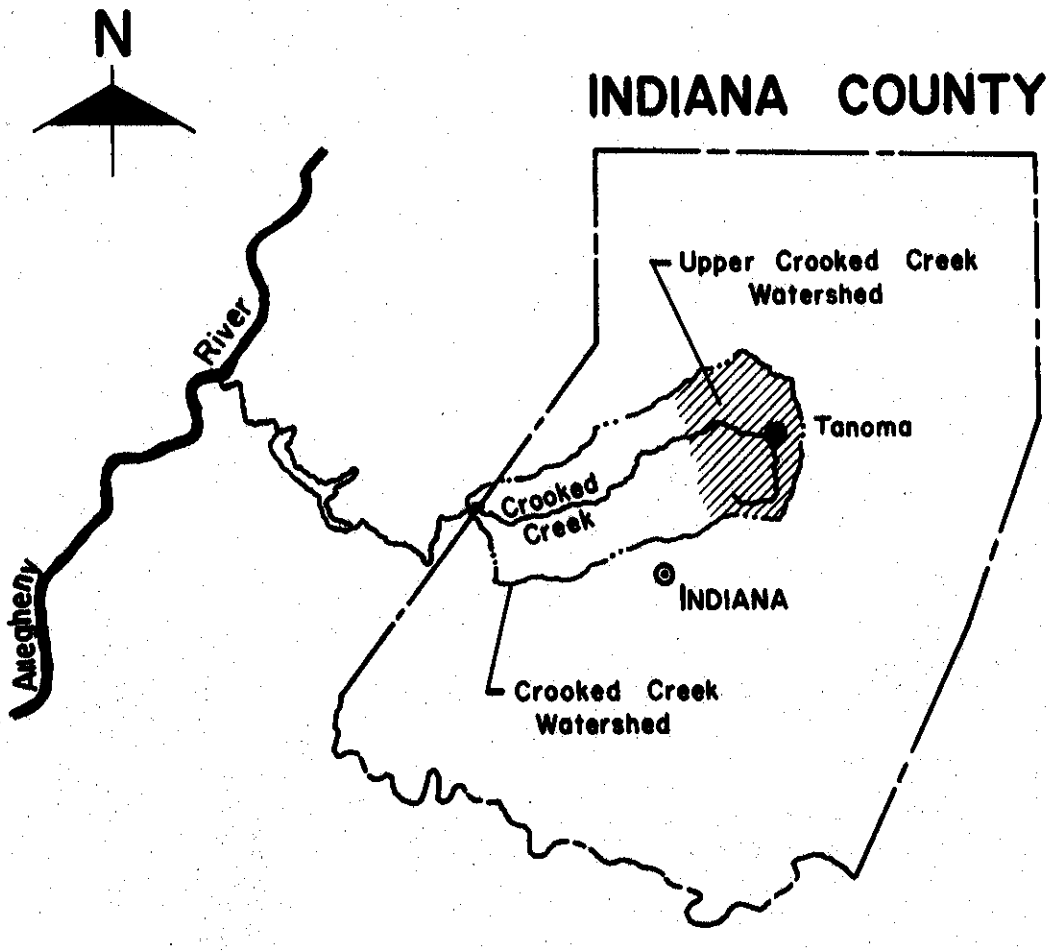
LOCATION AND DESCRIPTION

The Upper Crooked Creek Watershed, located near the headwaters of Crooked Creek; is that portion of the Crooked Creek Watershed affected by the boreholes discharging mine drainage from the Clymer No. 1 and Clymer No. 2 Mines.

The principal town located in the Watershed is the Village of Tanoma, adjacent to Crooked Creek and nine miles northeast of Indiana. The Upper Crooked Creek Watershed covers about 15 square miles and is located in Rayne Township with a small portion extending into Cherryhill Township, Indiana County.

Crooked Creek originates in Rayne Township, Indiana County, and proceeds into adjacent Armstrong County. The Creek is approximately 36 miles in length from its headwaters to the Allegheny River. Rayne Run and Hastie Run are two small unpolluted tributaries that enter directly into Crooked Creek as it flows in a north to northwesterly direction.

The length of Crooked Creek in the study area is approximately seven miles long. The last 4.5 miles are affected by mine drainage pollution which enters the Creek in the vicinity of the Village of Tanoma.



LOCATION MAP

GEOLOGY AND TOPOGRAPHY

Indiana County is located in the center of Pennsylvania's Appalachian Plateau Province. The Appalachian Plateau was formed during the Pennsylvanian Period which began about 300 million years ago. The surface geologic strata of Indiana County was formed during four major periods of geologic time. These periods, listed as they occurred, are: The Devonian Period, the Mississippian Period, the Pennsylvanian Period and the Quaternary Period.

The Pennsylvanian Period of geologic time was characterized by a widespread development of inland swamps having dense vegetational growth. Goal was created by the action of decomposition and compression of the lush vegetation. In Indiana County, the Pennsylvanian Period consists of four major subdivisions, listed in descending order: (1) The Monongahela Series, (2) The Conemaugh Series, (3) The Allegheny Series, and (4) The Pottsville Series.

The Allegheny Series outcrops in almost every Township in Indiana County and generally consists of light to dark shales, shaly to massive sandstone, deep workable coal beds, fire clays and limestones. The Freeport and Kittanning coal seams are of economic importance to the community.

Indiana County's topography is derived from the structure and weathering characteristics of the exposed rock beds. Areas of the County that are underlain by less resistant rock (such as shales and limestones) are easily weathered and eroded and produce rolling valleys with gentle slopes. The more resistant bedrock, (such as crystalline rocks and sandstone) are not as easily eroded and there

fore remain as areas of high elevations and steeper slopes. The County in general, is characterized by many broadtopped, relatively steep sided valleys in which flow meandering streams. The Eastern edge of the County has the highest elevations and each successive westerly ridge lessens until a low point is reached in the South-western section of the County.

CLIMATOLOGY

The climate of Indiana County is characterized by moderate to extreme variations between Summer and Winter temperatures with rather consistent and adequate precipitation.

The Winters are not continuously cold, having an average temperature of about 31 degrees Fahrenheit for the months of December, January and February. The Spring season generally shows greatest variations in temperature and the average temperature of the Spring months of March, April and May is about 49 degrees Fahrenheit. The Summer months are generally mild and pleasant. June, July and August average about 70 degrees Fahrenheit. The Fall season is a gradually changing period and the average temperature of the Fall months of September, October and November is 53 degrees Fahrenheit. Occasional hot and cold spells occur, but they are generally short in duration. The frost free season averages 147 days.

The Summer months are the months of greatest precipitation in the County with a monthly average of about 4.32 inches. The rains are generally of the thunderstorm type of quick duration and moderate to high intensity of rainfall. Spring rains are usually moderate in density and frequent in occurrence; the three Spring months averaging about 3.9 inches per month. The three Fall months average 3.01 inches per month. Winter precipitation is in the form of snow and the average is 11.03 inches per month, which is equal to about 1.10 inches of rainfall.

Average annual snowfall is 50 inches per year, the maximum snowfall occurring in January. Generally the snow remains on the ground for long periods of time before melting away. For this reason, frequent flooding occurs in March when the snow and ground start to thaw. See Appendix III for graphic presentation of Monthly Precipitation and Average Monthly Precipitation.

POPULATION AND WATER RESOURCES

The village of Tanoma consists of about a dozen families, the remainder of the study area being predominantly woodland and small farms and sparsely populated. The Indiana County Planning Commission has projected a 26% increase of population growth over a twenty-year period between 1960 and 1980, for the Central portion of the County.

There is no supply of water by a public or private system operating in the area. The principal sources of water supply are wells and springs, with a greater demand on the springs due to the poor quality of water received from the wells. Indiana County contains a moderate supply of ground water. In areas where the ground water is abundant, the water tends to be high in iron content. The sandstone of the various geological formations are the best water bearing materials. None of the members, however, have definite water bearing properties due to structural variation. Any series may change from sandstone to shale within a short distance. It is not uncommon to find two wells drilled a short distance apart in the same member producing entirely different yields. Coal beds commonly are water bearing but iron content problems exist, especially if the coal has been worked in the surrounding area. Some wells penetrating coal beds yield water not excessively high in iron. This may be due to the fact that coal beds that have not been opened to the air have not been affected by oxidation

MINING HISTORY

The major mineral resource of Indiana County, is Bituminous Coal. Since 1948 approximately 93,500,000 tons have been mined. During the past several years, less than five million tons have been mined annually and over the last 15 years, an average of five to eight million tons have been mined. The maximum amount of coal mined was 10,800,000 tons in 1944. Indiana County has an extensive reserve of coal.

Countless small country bank mines were operated for local consumption during the early 1900's, but none are presently operating. The Clearfield Bituminous Coal Corporation operated several slope mines in the Watershed, Clymer No.1 and No.2 at Sample Run, Clymer No. 3 at Weimer and the Barr Slope Mine at Barr Slope near Dixonville. The main haulage and entries of these slope-type mines are located in the adjacent Two Lick Creek Watershed with the greater portion of the mined-out area underlying the Crooked Creek Watershed. The acid mine drainage emanating from the mines and draining into Crooked Creek is the primary concern of this project. Drift Mining and Slope Mining were the methods employed in conjunction with Room and Pillar extraction of the coal.

Presently, only one active deep mine exists. The mine is operated by the Mears Coal Company and is located about one mile east of Kintersburg just off L.R. 32063. The name of this mine is Kerry No. 1, Water Permit No. 368M028 and the operation extracts coal from the Lower Freeport "D" Seam not reached by the Clymer No. 1 Mine.

The coal is shipped by truck to Dixonville where it is processed for delivery. The only active strip mine in the area is south of the Intersection of Crooked Creek and U. S. Route 286. Operated by the Head Coal Company under Strip Permit 124-5-6, License No. 124-70 and Water Permit No. 3970BSM6.

WATEHSHED STUDY

GENERAL DISCUSSION

Interviews with public agencies and private coal companies were conducted. Contact was established with the Clearfield Bituminous Coal Corporation and prints were reproduced from all available maps pertaining to the Project. Residents, retired and active miners were interviewed to obtain information about the mined areas.

Through Field Reconnaissance, all the known active and inactive boreholes, portals, fan shafts and manways were located and flagged. See Appendix I for detailed l1st of outlets including elevation and size. Sampling stations and weirs were established to evaluate the various sources of pollution. Residential water well samples were collected and a sampling program of the streams and drainage outlets was initiated and was carried out for a period of one year on a monthly basis. The samples were analyzed to determine pH, acidity, alkalinity, iron, ferrous and sulfate content of the water. On May 8, 1972, well samples were collected for Coliform Analysis; the results are included in Appendix II.

Maps included in this Report are as follows: General Information Map, Mine Map ("D" Seam), Mine Map ("B" Seam), Residential Well Water Sample Map and Plan of Mine Outline. A detailed explanation and discussion of these maps can be found in Appendix I of this Report.

Also included in Appendix I, is an explanation of all the known boreholes, manways, air shafts and other openings into the abandoned mines. For this Report, thesl8 openings are referred to as "Drainage Outlets" on the maps.

DESCRIPTION OF MINE COMPLEX

A description of the Mine Complex specifically involves four separate mining operations conducted by the Clearfield Bituminous Coal Company with two of the mines extensively interconnected.
The purpose of this section is to analyze each of the individual mines and the significant effects they have to the Upper Crooked Creek Watershed.

Barr Slope Mine: Opened just after the turn of the Century, this mine extracted coal from the Lower Freeport "D" Seam until 1962.
Its two slope-type entries are located in the Two Lick Creek Watershed adjacent to the Town of Barr Slope. The total area mined was nearly 1500 acres at an average thickness of 36 inches. The only flowing discharge, B6, is a twelve-inch diameter pipe driven horizontally through a caved opening located at a low point in the abandoned workings. B6 was flowing continuously during this study and in April of 1972, reached a high discharge of 450,000 gallons a day. The average discharge was 300,000 gallons per day for the one year Sampling Program. Other openings and boreholes in the Barr Mine were located, but none had a discharge that was measurable and are not a significant pollution factor.

Clymer No.1 and Clymer No.3: Clymer No.1 opened in the Teens and Clymer No.3 in the 30's. The two mines operated in the "D" Seam and are extensively interconnected and as such, were considered as one mine for study purposes. The mines closed in 1952 and 1956 respectively. Both mines have two slope-type entries located in the Two Lick Creek Watershed, the Clymer No.1 Mine at Sample Run and Clymer No. 3 at the Town of Weimer. The mines cover over 3,000 total

acres at an average thickness of 42 inches. Due to the down dip characteristics of the coal seam and the location of the drainage outlets, the mine is roughly half full of impounded water, or about 2 billion gallons. The most prominent drainage outlet is the Tanoma Borehole, C7, a twelve-inch diameter pipe adjacent to Crooked Creek near the Village of Tanoma. C7 was flowing continuously during the entire period of this study and reached a high of 3.5 million gallons of mine water discharge a day. C7 usually exceeded the permissible limits of iron content and normally carried free acid in its discharge during the study period. Other drainage outlets that discharge during the Fall and Winter months are MP1, c6 and B3. MP1 consists of two 27 inch diameter pipes and c6 is a 10 inch diameter borehole, both outlets discharge directly into Crooked Creek and are located in the vicinity of the Tanoma Borehole. The only other borehole that exists, is B3, an 8 inch diameter pipe driven vertically into a heading that connects the Barr Slope Mine and the Clymer No.1 Mine. B3 is located in the Village of Tanoma and discharges directly into Hastie Run. Numerous boreholes, manways and openings into these two Clymer Mines have been located and staked, but none had "measurable" discharges during the study period.

Clymer No.2: This mine operated in the 30's and closed in 1962. Three slope-type openings provided entries into this mine which extracted coal from' the Lower Kittanning "B" Seam. The entries are located near Sample Run in the! Two Lick Creek Watershed and are driven west under the Crooked Creek Watershed, as is the case with

the three other C.B.C. Mines mentioned above. Both the "B" and "D" Seams follow a dip of about 2%, and are separated by approximately 150 feet. At this time, about 60% of the "B" Seam mine void is filled with mine water and only two known boreholes exist. CL1 is a 12 inch diameter pipe completely filled with debris, driven vertically near the Sample Run Tipple. The tipple and CL1 are both located outside of the mined area of the Clymer No.1 Mine, therefore the borehole does not pass through the "D" Seam before entering the Clymer No.2 "B" Seam. Borehole CL1 was used to pump "B" Seam water into Two Lick Creek via Sample Run. As the headings were driven deeper, it became necessary to install an additional borehole. The second of the “B” Seam boreholes, MP6, is a 10 inch diameter pipe driven from the surface through the "D" Seam down to the "B" Seam, a total length of 353 feet. The pipe was then cut into, at the "D" Seam and "B" Seam water was pumped up the borehole and discharged into the abandoned Clymer No.1 Mine. In addition to the 10 inch diameter borehole, a 4 inch diameter power borehole was driven from the surface through a block of coal in the "D" Seam and then down to the Clymer No.2 Mine; presently the pipe is clogged with wires and debris. During installation both the 10 inch and the 4 inch pipes were grouted in place their entire length. North of the Clymer No.2 Mine is another “B" Seam mine that was operated by the Imperial Keystone Coal Company. Between the two mines, there exists a 100 foot barrier. There are no known boreholes similar to MP6 interconnecting the Imperial Keystone Mine and the "D" Seam above.

WATER QUALITY CRITERIA

Certain parameters may affect a given water use at one concentration and affect another water use at a different concentration. Parameter values for domestic and the three fish classes can be observed from the following table:

Class / Parameter	Domestic	Cold Water Sport Fish	Warm Water Sport Fish	Coarse Fish	Wildlife
Temp. ^{o}F	-	70	85	87	87
PH	6.5	6.0	6.0	6.0	6.0
Acidity MG/L	20	50	50	50	50
Alkalinity MG/L	-	180	180	180	180
Iron MG/L	0.3	0.2	0.2	0.2	0.3
Sulfate MG/L	250	30	30	30	-

The above Table was obtained from the Carson Engineer's Preliminary Report for Project SL-159, Cowanshannock Creek.

Crooked Creek flow is utilized to create a large impoundment of water by means of a dam at Crooked Creek State Park near Idaho, Pennsylvania, in adjacent Armstrong County. Swimming and other water sports are carried on quite extensively on the man-made lake formed by the dam. Besides recreation, industry also relies on the use of

Crooked Creek. Sixteen miles downstream of the study area, the Shelocta Power Plant uses Crooked Creek water in its cooling towers. The Phillips Gas Company generates excessive heat in gas lines at their Kintersburg Pumping Station; the effect of the Creek passing over these gas lines dissipates the unwanted heat.

CHEMICAL ANALYSIS

The parameters used in this study and the method of analysis, are described as follows:

1. pH

Method - Glass electrode pH meter
Reference - American Public Health Association and others, Standard Methods for the Examination of Water and Waste Water ("Standard Methods"), Twelfth Edition, 1965, p. 225.

2.a. Hot Acidity

Method - Phenolphthalein Acidity (at boiling temperature)
Reference – “Standard Methods”, Thirteenth Edition, 1971, p. 374.
Note - The samples collected from 11/3/71 to 2/17/72 and on 10/26/72 were analyzed by the Hot Acidity Method. The absence of results for this period can be attributed to the method the sample was tested.

2.b. Cold Acidity

Method - Phenolphthalein Acidity (at room temperature)
Reference - "Standard Methods", Thirteenth Edition, 1971, p. 51.
Note - The samples collected from 3/17/72 to 9/25/72 were analyzed by the Cold Acidity Method.

3. Net Alkalinity

Method - Potentiometric titration to pH 4.5
Reference - "Standard Methods", Twelfth Edition, 1965, p. 369.

4. Iron (total)

Method - Phenanthroline Method
Reference - "Standard Methods", Twelfth Edition, 1965, p. 156.

5. Sulfate

Method - Turbidmetric method. The photometer used is a Coleman Junior.
Reference – “Standard Methods", Twelfth Edition, 1965, p. 291.

6. Ferrous Iron

Method - Same as 4 except deletion of 1 ml of solium sulfite solution.
Reference - "Standard Methods", Twelfth Edition, 1965, p.482.

WELL SAMPLE REPORT

Water Well samples were collected from the low lying areas where the ground cover is shallow. Well depths were recorded when known, some residents refused to have a sample taken and a few could not be contacted. Most wells are drilled to a depth that nearly penetrates the abandoned Clymer No. I "D" Seam and. several are cased and driven below the voided coal vein. No known wells in the study area are drilled to a depth where they approach the Clymer No.2 "B" Seam. Due to the relationship of the wells and the mined-out coal seam, most families along Crooked Creek and in the Village of Tanoma rely on springs for their supply of water. Several springs produce sufficient water; free of the sulfur odor and iron precipitate found in the well water. Laboratory analysis of the well samples is included in Appendix II of this Report along with the results of Coliform Analysis collected on May 8, 1972, and other pertinent information.

Perhaps the area of greatest concern in an Abatement Program, is the adverse effect that may occur to the residential water well supply. Due to the nature of the abandoned coal seams in the Tanoma Complex and the method we recommend to eliminate pollution, this problem is not involved. A more detailed explanation concerning this relationship will be discussed later in the Report.

CONCLUSIONS

The original concept of this project was to seal the Tanoma Borehole and other existing drainage outlets and divert uncontaminated ground water to Two Lick Creek. To accomplish this, a hydraulic head of 150 feet would have to be developed, this would then allow uncontaminated mine water to discharge at Sample Run into Two Lick Creek from a much higher elevation. A study of the Mine Maps indicate an area from Route 286 running parallel to L.R. 32063 and Crooked Creek where the overburden is 50 feet or less. The Maps also indicate several places where subsidence had occurred; additionally, a large sinkhole was recently filled by the Department of Environmental Resources in this area. This field of shallow cover and subsidence would not be able to withstand the hydraulic head developed in sealing the discharging boreholes in the vicinity of Tanoma. It was soon apparent that any abatement measure could not inundate the abandoned "D" Seam workings due to the shallow ground cover.

Through discussion with residents and miners familiar with the abandoned workings, we were informed of Borehole MP6. Also, during the interviews, the miners always mentioned the difference in the quality of water found in the two seams. A search of the Clymer No. 2 "B" Seam Maps revealed Borehole MP6, the vertical connection between the "B" and "D" coal seams. A head sufficient enough had developed in the Clymer No.2 Mine to naturally discharge "B" Seam water upward into the "D" Seam at MP6. Water samples were secured and their analyses revealed a severely acid mine water, very high

in iron and sulfates. This acid mine water is partially neutralized by the impounded "D" Seam mine water before being discharged at the Tanoma Borehole and the other active outlets. The effect of this neutralization is difficult to analyze, since the quantity of mine water discharged at MP6, the exact flow pattern in the "D" Seam and the length of time involved before it is discharged into Crooked Creek cannot be accurately determined. Improved water quality can be observed at B3, especially in total iron and sulfate content, in comparison to the discharges at C7 which are closer to the source of pollution, MP6. B6, the Barr Slope drainage outlet lies beyond the range of pollution from MP6 and its discharge meets the requirements established by the Department of Environmental Resources. The acceptable limits are as follows: Ph 6.0 - 9.0, no free acidity and less than 7 PPM of Iron.

In Appendix I, the plan of the Mine Outline Map has been color-coded to reflect the quality of stream flow within the study area. Crooked Creek and the other streams which are not affected by the borehole discharges are mildly alkaline with a low content of iron, sulfate and carry no free acid. Inspection of the Sampling Station Data Sheets indicates that the discharges from C6, C7 and MPl are nearly always of an acid nature. C7, which flows continually, always carries free acid in its discharge and all three boreholes exceed the permissable limit for iron content. For several miles downstream of the boreholes, the creek bed has been discolored from the oxidation of the iron and the results of the Sampling Station

Data Sheets indicates a slightly acid condition several times during the study period.

RECOMMENDATIONS

Drainage from the Barr Slope Mine is within acceptable limits and requires no abatement measures. The high iron content of the discharge at the Tanoma Borehole and the other boreholes from the Clymer No.1 Mine, originates in the "B" Seam. This severely acid mine water is transported vertically from the "B" Seam to the "D" Seam by Borehole MP6. The most effective method of eliminating the pollution from the Tanoma Complex, would be at its source by sealing MP6. A permanent type seal should be installed at the 10 inch diameter borehole.

The 4 inch diameter power borehole adjacent to MP6 was grouted in place for it's entire length. This hole is presently clogged with wires and debris. It should be bored and cleaned to use as an observation hole for watching the level of impounded water in the Clymer No.2 Mine.

The body of water impounded in the abandoned "B" Seam has created an underground reservoir in the mine void. This reservoir is supplied by percolating ground water through fissures, underground springs, seepage channels and fractures. Eliminating the outlet of this reservoir by sealing MP6 will end the cycle which transports severely acid mine water to Crooked Creek and cause further inundation of the Clymer No.2 Mine and the "B" Seam. The seal will increase the volume of water in the reservoir. Initially, the volume of water in the void is expected to increase rapidly until the distribution of pressure throughout the reservoir reaches equilibrium. As the point of equilibrium is approached, the cycle that

transported the ground water to the "B" Seam will be eliminated and the percolation of water through the seepage channels and fractures will cease. The strata between the two zones will become saturated, similar to the effect of a rising water table. By increasing the volume of water of the reservoir cavity, a reduction in the amount of oxygen available for adverse reactions will occur. Also, as the water table rises in the strata between the “B" and "D" Seams, it will be released into the void created by the abandoned "D" Seam and not transmitted into the area above the Clymer No.1 Mine and the residential wells. No significant decrease in the quantity of the discharge at C7 is expected, but the quality of the water should improve to meet the requirements of the Department of Environmental Resources.

The decision to seal Borehole MP6 was based on several important facts. First, the pollution is attacked at its source. Secondly, to seal the "D" Seam outlets, shallow and weak overburden would have been encountered creating unpredictable problems due to the additional hydraulic head developed in the "D" Seam. Finally, and most important, there are no known residential water wells driven to a depth that would approach the "B" Seam. Since residences located above the "B" Seam have about 300 feet of cover, the inundation will not reach a level that would have a detrimental effect on the wells. A few wells are cased and driven below the "D" Seam but they are beyond the mining limits of the Clymer No.2 Mine and the seal at MP6 will not force the impounded "B" Seam water into this area.

By sealing MP6, the impounded water in the "D" Seam will continue to flow from the Tanoma Borehole. The cycle that transports ground water to the "D" Seam will not be interrupted by the seal and the water table in the strata above the Clymer No.1 Mine will not be affected. Therefore, it seems apparent that the recommendations stated should not have harmful effects on the water wells in the area.

Fluctuation of the mine water level in the "D" Seam was recorded at MPl (two 27 inch diameter pipes). See Sketch in Appendix I which indicates the level of impounded water in the Clymer No.1 Mine when the borehole was not discharging.

COST ANALYSIS

Mine acid drainage from the Tanoma Complex can be eliminated by:

1. Placement of a packer shoe in Borehole MP6 between the "B" and "D" Seams.

2. Bore and clean existing 4 inch diameter power borehole for use as a sight tube.

Total cost is estimated to be $6,500. This estimated figure includes all the necessary cost to eliminate acid mine drainage on this Project. See Sketch in Appendix IV.

PROPOSED PROJECT AREAS

Throughout the course of this study, constant observation of the Project Area revealed no other sources of pollution relating to present or abandoned mining operations. The measures taken within the scope of this Project should effectively restore Crooked Creek to its natural environment in the Upper Crooked Creek Watershed. Therefore, no additional project areas are recommended for the Watershed.

QUICK START PROJECTS

QUICK START PROJECT MP6

Sealing Borehole MP6 will eliminate the acid discharges from the Clymer No.1 Mine in the vicinity of Tanoma. Abatement of the severely acid discharge can be achieved without affecting residential water wells in the Project Area.

Additionally, post-construction monitoring will be provided to determine the effectiveness of the seal at MP6 on a monthly basis for a period of one year. The monitoring program will consist of the following:

1) Monitoring and recording "B" Seam inundation at the observation hole installed at MP6.

2) Measure flow and sample for water quality analysis at the boreholes utilized during the study.

3) Sample for water quality at five residential water wells.

4) Prepare a brief report at the conclusion of the one year period that will describe the effectiveness of the sealing and water quality changes noted during post-construction monitoring.

Two areas of subsidence have occurred within the Barr Slope Mine Complex. Neither of the two is of a sufficient size to justify a Quick Start Program, but both present a hazard to residents, hunters and wildlife. The first is located adjacent to L.R. 32071 across from the intersection of Township Road T674. It covers an area of approximately 20 feet by 50 feet and is above a heading connecting the Barr Mine to the Clymer No.1 Mine, the overburden measures just 24 feet. Subsidence occurred here several years ago and the hole was filled with scrap and debris and then covered with coal waste material. The area should be filled and planted with crown vetch or similar vegetation. The second area of concern, is

a sink hole about 25 yards from B1 and B2. It measures 10 feet by 12 feet and is about 8 feet deep. It has been filled with logs, but still presents a hazard in the Summer months when the foliage is dense. This hole should also be filled in and seeded.