"SITE EVALUATION"

FOR

COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF ENVIRONMENTAL RESOURCES

MINE AREA RESTORATION DIVISION

PROJECT SL 193-1

KNOX TOWNSHIP

CLARION COUNTY

BY

MINERALS INDUSTRIES DIVISION

GWIN, DOBSON & FOREMAN, INC.

ALTOONA, PENNSYLVANIA

GWIN, DOBSON & FOREMAN, INC.
CONSULTING ENGINEERS
8TH AVENUE & 12TH STREET
P.O. BOX 1589
ALTOONA, PENNSYLVANIA 16603
(814) 943-5214

LEWIS L. GWIN, P.E.
RICHARD T. DOBSON, P.E.
JOHN W. FOREMAN, P.E.

December 12, 1974

Mr. A. E. Friedrich, Chief
Mine Area Restoration
Department of Environmental Resources
P.O. Box 1467
Harrisburg, Pennsylvania 17120

Re: SL 193-1

Dear Mr. Friedrich:

Enclosed please find a corrected draft of the Site Evaluation Study of the above referenced project.

If there is any other information required, please don't hesitate to contact me.

Very truly yours,
GWIN, DOBSON & FOREMAN, INC.
Consulting Engineers

James M. Ward/c.m.
James M. Ward
Project Engineer
Mineral Industries Division

JMW/cm

Enclosure

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.

"SITE EVALUATION"

FOR

COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF ENVIRONMENTAL RESOURCES

MINE AREA RESTORATION DIVISION

PROJECT SL 193-1

KNOX TOWNSHIP

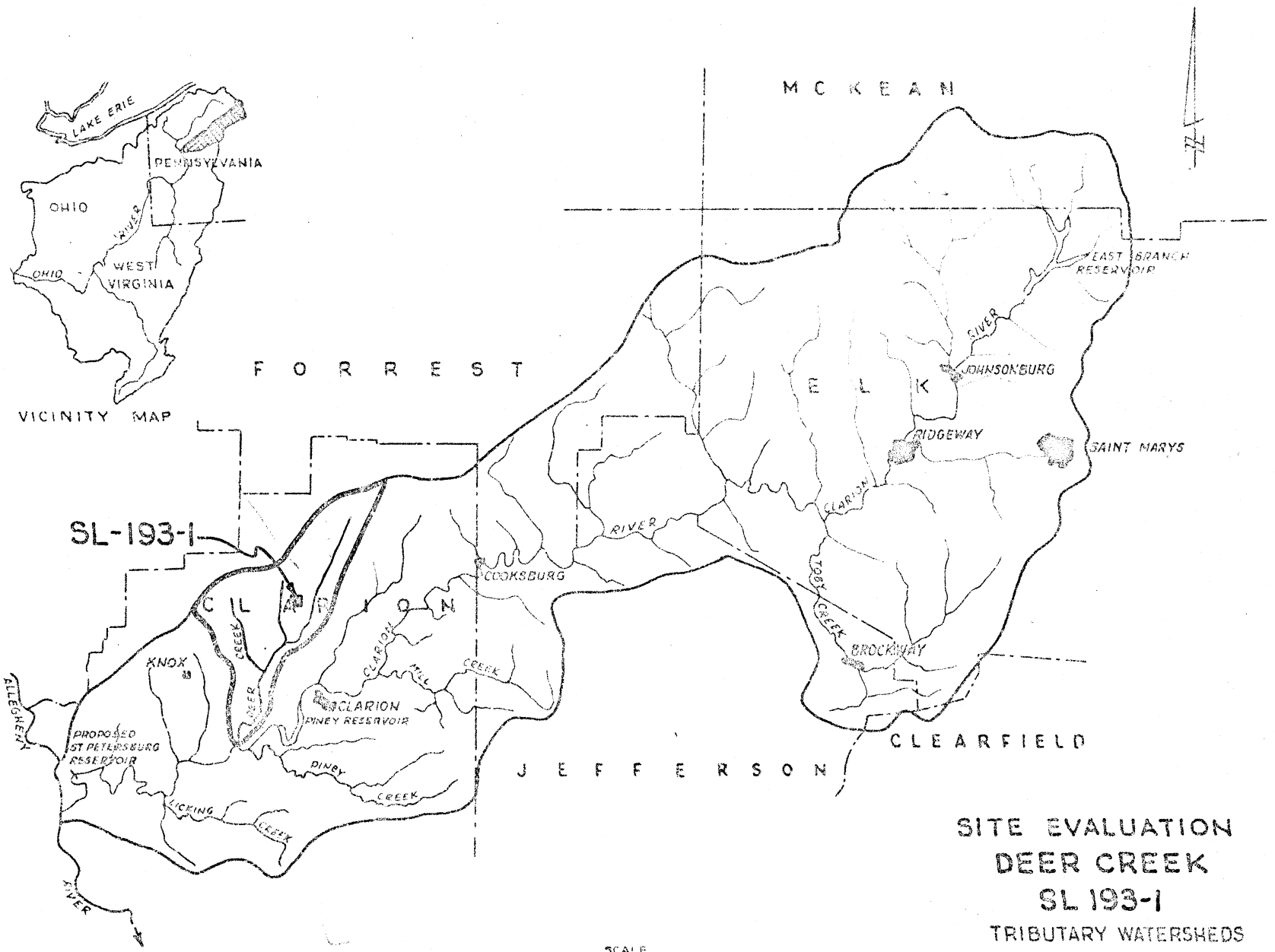
CLARION COUNTY

BY

MINERALS INDUSTRIES DIVISION

GWIN, DOBSON & FOREMAN, INC.

ALTOONA, PENNSYLVANIA



SITE EVALUATION
DEER CREEK
SL 193-1
TRIBUTARY WATERSHEDS
CLARION RIVER BASIN

PROJECT SL-193-1

"SITE EVALUATION"

KNOX TOWNSHIP

CLARION COUNTY

This report covers "site evaluation" on approximately eighty (80) acres of deep and stripped mined land located in Knox Township, Clarion County, Pennsylvania. This "site evaluation" is to determine the extent and nature of work required to substantially abate acid mine drainage into Deer Creek.

Deer Creek Watershed drains sixty-nine (69) square miles, rises in north central Clarion County and flows approximately 18 miles south to the Clarion River. The Watershed, located completely in Clarion County, has a maximum width of eight (8) miles.

This report will be in four (4) parts consisting of the following:

I CONDITIONS

Mining history of the area, Conditions at time of study, etc;

II METHOD OF INVESTIGATION

Flow measurements, Field reconnaissance Sampling program, Exploratory drilling, Strata testing and Collection of data;

III RECOMMENDATIONS AND CONCLUSIONS

Based on investigation and most economical abatement measures;

IV COST ESTIMATES

Construction costs determined from recommended abatement conclusions.

I CONDITIONS

This area has sixteen (16) drift mine openings. The following is a list of these mines, their corresponding numbers, names of owners, dates operated and those affected by stripping. (See project Detail Map).

NUMBER	OWNER AND NAME OF MINE	DATE OPERATED	EFFECTED BY STRIPPING
MOD #11	Barne Fasenmyer	1900	Yes
MOD #12	and Joe Dietz		Yes
MOD #13	Walter Griebel	1939	Yes
MOD #1	Joseph Obenrader (Zietler Mine)	1935 - 1940	Yes
MOD #5	Barney Karley	1915	Yes
MOD #6	Zacherl Coal Co.	1950	Yes
MOD #2	Siegel Mine #1 Surface sealed	Unknown	No
MOD #2A	Siegel Mine #1 Surface sealed	Unknown	No
MOD #3	(Broken air trap seal)	Unknown	No
MOD #3A	Small Country Bank	Unknown	No
MOD #4	Small Country Bank	Unknown	No
MOD #7	Small Country Bank	Unknown	No
MOD #8	Small Country Bank	Unknown	No
MOD #9	Small Country Bank	Unknown	No
MOD #10	Small Country Bank	Unknown	No
MOD #14	Barne Fasenmyer and Joe Dietz	1900	Yes

Of the sixteen (16) adits, seven (7) have been cut into or completely stripped. The largest deep mines were the Siegel #1, Zietler Mine and Fasenmyer Mine. Judging from the gob piles, the majority of the other mines were small country banks.

The table shown on Page 3 lists the name of coal operator, mine drainage permit no., property owner and date of permit.

COAL OPERATOR	MINE DRAINAGE PERMIT NO.	PROPERTY OWNER	DATE OF PERMIT
Zacherl Coal Co.		V. Beichner	1939
Zacherl Coal Co.		J. Obenrader	1944
Zacherl Coal Co.	14326	Zacherl Coal Co.	Nov. 6, 1954
Siegel Coal Co.	Trans 14326	Zacherl Coal Co.	Aug. 2, 1958
Siegel Coal Co.	15465	L. Fasenmyer	Feb. 9, 1956
Siegel Coal Co.	17146	J. Obenrader	July 3, 1957
Siegel Coal Co.	17161	J. Obenrader	July 15, 1957
Siegel Coal Co.	18305	V. Beichner	May 27, 1959

The first strip mining in this area was by Zacherl Coal Co. from 1939 to 1944. In 1954, the Zacherl Coal Co. obtained mine drainage Permit No. 14326. Apparently, little if any coal was stripped by Zacherl Coal Co. under this permit. The mine drainage Permit (#14326) was then transferred to the Siegel Coal Co. who stripped the remaining acreage in the "site evaluation" area. Sketches of the strip mining progression from 1957 to 1960 were compiled from aerial photos and are shown on pages 20 to 25.

All bonds held by the Commonwealth for stripping operations by Zacherl Coal Co. and Seigel Coal Co. have been released.

The Clarion River basin has been partially studied on numerous occasions for the past thirty three (33) years. The U.S. Public Health Service (1943) reported on 1940 acid stream conditions in certain tributaries in the basin. In 1966, the Office of Water Resources Programs of the Environmental Protection Agency (Wheeling Office) utilizing twelve (12) sampling stations along the Clarion River conducted an abatement study. Station 514 (Water Resources Study) was located at the mouth of Deer Creek and showed a flow of 8685 gpm with an acid load of 13,845 lbs/day (see Table 1). During May 1967 to October 1967, a cooperative study by the Environmental Protection Agency and Pennsylvania Department of Environmental Resources was

conducted on the principal mine drainage problem areas in the Clarion River Basin. Samples were taken and analyzed.

Summarizing the Deer Creek Watershed, Clarion County portion of this 1967 study, Station No. 4588 located at the mouth of Deer Creek had a flow of 7,110 gpm and 21,756 ppd acid load (see Table 1.) Fifty-nine (59) acid mine drainage samples, totaling approximately two million gallons per day, were taken from approximately one hundred (100) mining sites and approximately sixteen hundred (1600) acres of strip mine land. Samples collected from thirteen (13) of the fifty nine (59) sources accounted for eighty-one (81) percent of the acid loading. One discharge point (see Table II Mine No. 4253) had an acid load of 1,994 lb/day; the highest single mine drainage pollution source in the Deer Creek Watershed. This source is the main entry of the Fasenmyer Mine. Mine No. 1043 contributed eight hundred and thirty-seven (837) lbs of acid/day. This was the water course of the Fasenmyer mine that was later stripped out by Siegel Coal Co. These discharges will be covered in this "site evaluation" report.

The Mineral Industries Division of Gwin Engineers, Inc. (now Gwin, Dobson & Foreman, Inc.) published a report entitled "Preliminary Report of Mine Drainage Abatement and Land Reclamation," for the Department of the Army, Corps of Engineers, in May 1970. Results from the Deer Creek Watershed, Clarion County portion of this report showed a total acid load of 7,475 lb/day with an estimated flow of 30 cfs (See Table I). Results from this "Site Evaluation Area" showed a total acid loading average of 804 lbs/day (see Table II).

The acid loading from the site evaluation area can be readily seen by comparing the difference in the chemical samples above and below the project (See Table III).

TABLE I

MOUTH OF DEER CREEK, CLARION COUNTY

Survey Date & Sample No.	gpm	acid lbs/day
F.W.Q.A. (June,Aug,Sept, 1966) 6 samples No. 514	8,685	13,845
E.P.A. & D.E.R. (June 1967) No. 4588	7,110	21,756
Gwin (May 1970)	13,465	7,475
G.D. & F. (July 1973)	12,823	10,410

TABLE II

SITE EVALUATION AREA

Survey Date & Sample No.		gpm	acid lbs/day
E.P.A. & D.E.R. (June 1967) 4253 & 1043		34	2,831
Gwin (May 1970)		---	2,800
G.D. & F.	(4-3-73)	216	1,172
	(5-7-73)	116	887
	(6-4-73)	227	1,473
	(7-3-73)	110	397
	(8-7-73)	32	269
	(9-5-73)	34	629
TOTAL (FROM THIS REPORT)		735	4,827
AVERAGE		122.5	804.5

TABLE III

	ABOVE					BELOW				
	pH	Acid	Alk.	Fe	Sulf.	pH	Acid	Alk.	Fe	Sulf.
4-3-73	6.2	1	---	0.1	34	3.7	64	---	3.8	190
5-7-73	5.9	2	---	0.8	26	3.7	60	---	4.0	150
6-4-73	6.5	6	---	1.1	19	3.9	60	---	3.4	130
7-3-73	6.3	0	4	1.1	29	3.4	88	---	2.1	240
8-7-73	6.7	0	10	0.2	14	2.9	170	---	6.1	460
9-5-73	6.5	0	8	0.2	26	2.9	210	---	2.4	580

II METHOD OF INVESTIGATION

Fryburg (U.S.G.S. 7½") Quadrangle sheet was enlarged to a scale of one inch equal two hundred feet. This base map was used in field work, weir locations, drill hole locations, geologic mapping and establishing site evaluation boundaries.

Field reconnaissance of the eighty (80) acres that included deep and strip mines plus the surrounding areas was conducted to establish the fifteen (15) acid mine drainage sampling points (See Project Detail Map). The "site evaluation" boundaries were determined and water drainage conditions regarding possible infiltration through strata or previous mining were investigated.

Flow measurements on Little Paint Creek above and below the project were cross-sectioned with a Teledyne Gurley Flow Meter Model 622 and the flow information was computed (pages 26 & 27). The mine drainage discharges fifteen (15) were weired for monthly measurement and sampling programs.

The exploratory drilling program consisted of nine (9) holes. The hole locations were determined by:

Field Geology (attitudes, Strikes & Dips),
Reviewing Federal, State & Local Maps and Reports,
Topographic maps and
Information from Coal companies.

The Consultant performed all administrative functions of the drilling program, including contacting property owners and signing of easements for permissions to drill and test strata. Bid form, special requirements and specifications were prepared. Invitations to Bid and Bid Documents were sent to seven (7) drilling contractors. The drilling, testing and inspection work was under the direct supervision of our engineer.

The total footage drilled was four hundred and forty-three (443) feet. Six (6) inch diameter holes were drilled on September 18, and October 12, 1973, using an air rotary Davey Drill. Nine Holes (9) were drilled to predetermined depths to obtain stratigraphic information (see pages 28 to 44).

The United States Geological Survey, Water Resources Division, on October 3, 1973, ran gamma ray logs on four (4) (DH #3,4,5 & 6) of the nine (9) holes drilled. The gamma ray logs substantiated the descriptive logs compiled during the drilling. The U.S.G.S. Water Resources Division also conducted a pumping test on Hole #4. This test showed that pumping at a rate of 2.1 gpm, suction was broken after thirty and one half (30½) minutes. They continued to pump at 1.38 gpm which appeared to be total capacity (see pages 35 and 36).

Static water levels were measured on January 21, 1974 to try to establish if a water table was present. The elevation to water in each hole was erratic and was determined to be a function of surface runoff. Pressure testing was conducted on February 2, 1974 in Holes #3 and #4 and commenced at the static water head depth. The surrounding strata, below this depth, must have already been saturated because the holes refused water injected under pressure (see pages 32 & 37).

No gas or oil wells were found in the site evaluation area and no information was found that any existed in the area.

Along the southern boundary of the Fasenmyer mine, the water course and numerous rooms were disturbed during stripping operations by the Siegel Coal Co. (Mine Drainage Permit #15465). This information was obtained from Mr. Lawerence Fasenmyer (personal communication, 1974) who worked in the Fasenmyer Mine. Only a few broken sections of clay pipe located below the toe of the spoil are still visible near the site of the old water course. Other sections of pipe, not destroyed during stripping operations were salvaged and sold by the property owner.

The analyzed composite PPM sheet (see page 45) shows all the data collected at each sampling location along with their chemistry for each period. The pounds/day composites (see page 46) are broken down in pounds per day of the analyzed composites. The combined totals are the summation of these elements for each sampling period. We then show the percentage of Weirs #1, 3 and 9 to the combined totals. This evaluation of the collected sampling information shows an

average of seventy-three (73%) percent of the acid loading coming through these three weirs.

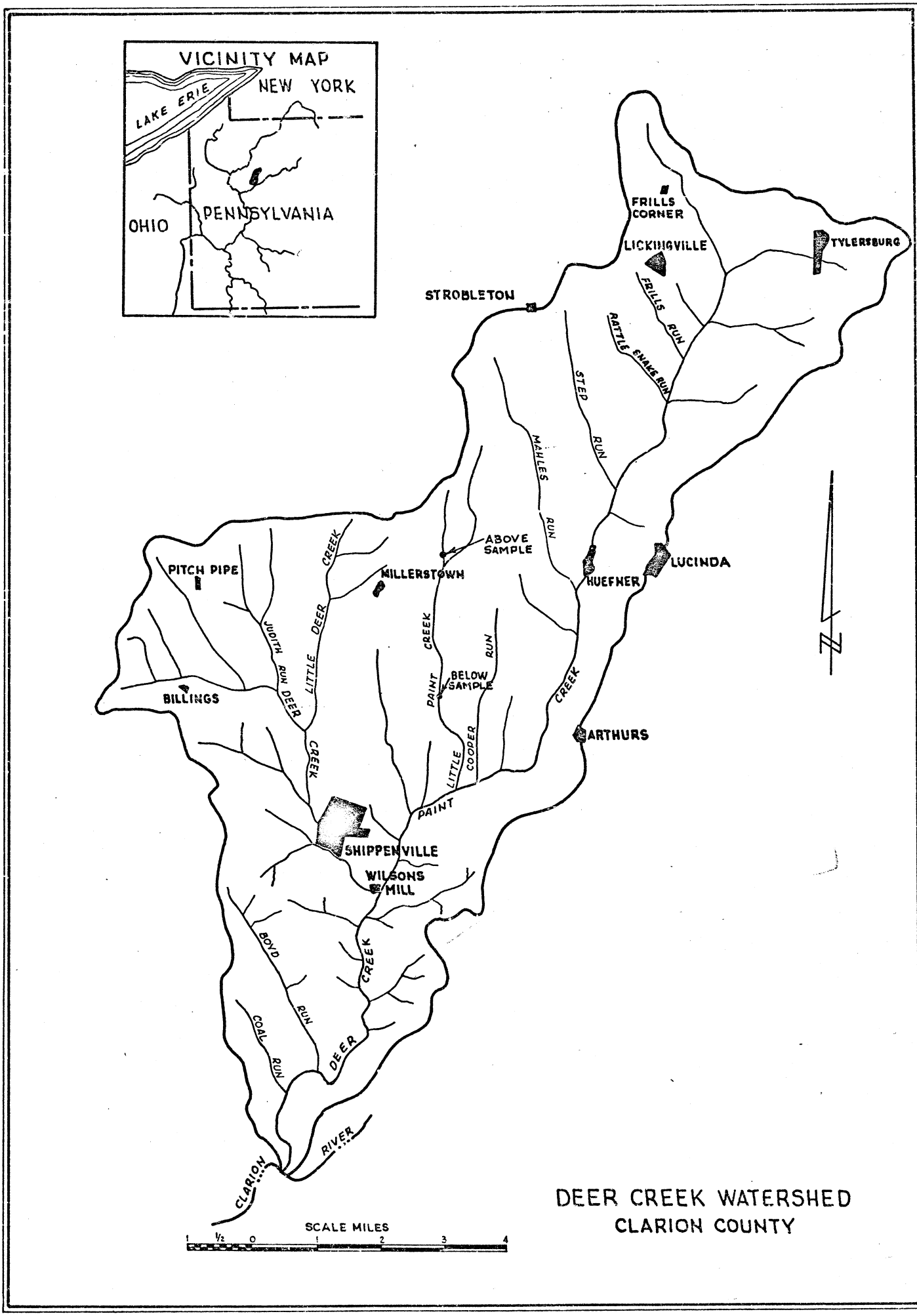
The overall structural geology of the vicinity (see page 10) places this area on the northwest flank of the Millerstown Anticline. The strata to she northwest and south flattens out with no structure evident. The geology of the site appears to have been influenced by the Millerstown Anticline. This is confirmed by our drilling program (see Project Detail Map). Drainage follows the dip of the structure (Millerstown Anticline). Any precipitation falling on the strip area should collect and flow down dip (the path of least resistance).

Backfilling on the stripped area was fairly good. The main problems are the old deep mine workings and one strip area that cut into the water course of the Fasenmyer Mine.

PROJECT DETAIL MAP

This map shows general topographic features, surface contours, coal outcrops, drill hole locations, deep mine openings, strip mine limits, weir locations and general mining data. A geologic structure contour map (superimposed on the Project Detail Map) was drawn from previously published information and updated from drilling data. The drill logs are made a part of this report and show dates drilled, surface elevations, elevations and depths of formations or voids encountered, and ground water or mine water elevations (pages 28-44). The pressure testing data of the columnar sections that were tested are also included (see pages 32 and 37). Weir locations were determined from field reconnaissance. This sampling and measuring program which included fifteen (15) weir locations was conducted over a six (6) month period. Water samples and field data were collected on a monthly basis. The samples were sent to Gwin, Dobson & Foreman, Inc. Laboratory in Altoona for analysis.

The samples were analyzed for pH, acidity, alkalinity, iron (total) and sulphates (page 45). The measured flows and chemical parts were converted to


VICINITY MAP
LAKE ERIE
NEW YORK
PENNSYLVANIA
OHIO
FRILLS CORNER
LICKINGVILLE
TYLERSBURG
STROBLETON
FRILLS RUN
RATTLE SNAKE RUN
STEP RUN
MAHLES RUN
ABOVE SAMPLE
HUEFNER
LUCINDA
PITCH PIPE
MILLERSTOWN
DEER CREEK
JUDITH RUN
LITTLE DEER CREEK
PAINT CREEK
BELOW SAMPLE
RUN
BILLINGS
ARTHURS
COOPER
LITTLE PAINT CREEK
SHIPPENVILLE
WILSONS MILL
BOYD RUN
COAL RUN
DEER CREEK
CLARION RIVER
SCALE MILES
1 ½ 0 1 2 3 4
DEER CREEK WATERSHED
CLARION COUNTY

pounds/day for each mine discharge station (page 46). We have included the individual analysis, composites of analyses and composites of pounds/day for each sample period. Drill hole locations, one (1) through nine (9), are shown on the Project Detail Map.

The meterological information as to daily rainfall was obtained from Pennsylvania Electric Company, Piney Dam Gauging Station (see page 47). Piney Dam is located on the Clarion River approximately 7 miles south of the study area.

III RECOMMENDATIONS AND CONCLUSIONS

Sketches drawn from aerial photos, made available by General Engineering Company, show the strip mining progression during the years noted (pages 21 through 25). Mine drainage permits are also shown on these sketches (see page 26). A completed sketch (with the dates completed) for the one hundred and fifteen (115) acres is shown on page . All bonds have been released.

The overall backfilling is good and no additional work of this type is recommended. However, stripping operations by the Siegel Coal Co. did cut into the water course (M.O.D.-14) of the Fasenmyer Mine (see Project Detail Map). We are recommending a clay blanket in this area. The monitoring point (Weir #1) for this area recorded approximately thirty five (35%) percent of the total acid load over the six (6) month survey.

We are recommending seven (7) hydraulic seals for the following adits M.O.D.: 11, 12, 4, 3, 3A, 2 and 2A (see Project Detail Map). Deep mine openings M.O.D. 11 and M.O.D. 12 are the main portals of the Fasenmyer Mine.

Flow measurements and water samples were taken at the following locations: Above and below the "Site Evaluation Area", at the mouth of Little Paint Creek (DF-6) and at three (3) different locations on Deer Creek (including the mouth). The average pounds per day of acid originating at the "Site Evaluation Area" were

compared with the pounds per day averages of acid at the various sampling points on Little Paint Creek and Deer Creek (See Composite Sheet on page 13).

On Little Paint Creek, between the Above and Below Sampling Stations, forty and three tenths (40.3%) percent of the total acid load was contributed by water originating in the "Site Evaluation Area" and thirty-four and seven tenths (34.7%) percent between the Below Sampling Station and the mouth of Little Paint Creek (DF-6). Compared with water sampled at three (3) different locations on Deer Creek; seven and seven tenths (7.7%) percent of the acid load at DF-4, five and five tenths (5.5%) percent at DF-3, and five and two tenths (5.2%) percent at the mouth of Deer Creek (DF-1) was contributed by water originating at the "Site Evaluation Area". The monitoring points (Weir #7 and #9) recorded approximately twenty-eight (28%) percent of the acid loading during the six month survey.

Precipitation has a direct relationship to the quantity of acid mine drainage. The graph (see page 48) shows the precipitation on a weekly time basis and the total measured flow through the weirs. The geologic structure and the topography give the apparent direction to the ground water. The mined-out regions (strip and deep) act as accumulation areas and are sometimes the paths of least resistance for the outflows of the acid mine drainage.

We recommend the following construction (based on this investigation) as the most economical abatement measures. This construction will be in one (1) phase:

Construction

(A) Hydraulic Sealing of Mine Openings M.O.D. #2, 2A, 3, 3A, 4, 11, 12

(B) Clay Blanket in the spoil area for Mine Opening M.O.D. #14

The hydraulic seal (see page 19) is a double bulkhead type with concrete center plug and a fifty (50) foot grout curtain on each side of the seal. The concrete plug will be core drilled, pressure tested and grouted. Observation holes will be used to monitor the perched water table.

POUNDS PER DAY OF ACID COMPOSITE FOR
SITE EVALUATION AREA AND SAMPLING STATIONS
ON LITTLE PAINT CREEK AND DEER CREEK

SAMPLING STATION	DISTANCE FROM MOUTH OF DEER CREEK	POUNDS PER DAY 4-3-73	5-7-73	6-4-73	7-3-73	8-7-73	9-5-73	AVG. PPD
Above Site Evaluation Area	13.8 miles	37.0	5.7					21.35
Site Evaluation Area		1,171.7	886.8	1,472.7	397.1	269.28	628.57	804.36
Below Site Evaluation Area	11.3 miles	2,301.7	1,728	25	10	9	13	HIGH 2,014.85
DF-6 Mouth of Little Paint Creek	8.7 miles	1,160	810	5,805	1,485			2,315
DF-4 on Deer Creek	8.5 miles	6,646	14,072	22,586	6,744	2,174		10,444.4
DF-3 on Deer Creek	7.6 miles	7,025	7,470	24,482	22,162	11,232		14,474.2
DF-1 Mouth of Deer Creek	0 miles	10,156	9,750	26,487	239,164*	10,048	20,142	15,316.6

*Omitted

Three other alternatives are given for abating the remaining acid mine drainage areas. A typical cross-section of Alternatives A (Slurry Trench), B (Clay Blanket) and C (Grout Line) is shown on page 17. Cost estimates are described on pages 14, 15 & 16. All three alternates involves the mine drainage discharge from the disturbed portions of the Fasenmyer Mine. A hydrostatic head of approximately twenty-five (25) feet is needed to cover the coal still present in the mine. The Clay Blanket will act as an underground coffer dam. The perched conditions produced by the Clay Blanket and seals will inundate the coal measure.

By installing seven (7) hydraulic seals and following one (1) of the three (3) construction alternatives, we estimate that this work will abate approximately seventy-five (75%) percent of the pollution originating in the "Site Evaluation Area".

IV COST ESTIMATES

The approximate quantities of work required for an average hydraulic seal

DRILLING			
Front Bulkhead six (6) holes at 50'		300'	
Center Plug two (2) holes at 50'		100'	
Rear Bulkhead six (6) holes at 50'		300'	
Grout holes ten (10) holes on 10' center 50'		500'	
Exploration holes three (3) holes at 50'		150'	
		1,350'	
1,350' Cost $3.00/Lin. Ft.			$ 4,050.00
Core Drilling - Center Plug 60' at $8.00/Lin Ft.			480.00
Observation Holes - 300 Ft. at $3.00/Ft.			900.00
Casing 250 Ft. at $8.00/Ft.			2,000.00
		DRILLING	$ 7,430.00
COURSE AGGREGATE			
Front Bulkhead	35 tons		
Rear Bulkhead	35 tons		
	70 tons at $20.00/ton		$ 1,400.00
		COURSE AGGREGATE	$ 1,400.00
CONCRETE			
30 cu.yds at $40.00 cu.yd.			$ 1,200.00
		CONCRETE	$ 1,200.00

CEMENT FOR GROUTING
Length x width x depth = volume
(20% by volume needed)
37.6 tons at $149/ton $ 5,600.00
CEMENT FOR GROUTING $ 5,600.00

FLY ASH FOR GROUTING
Length x width x depth = volume
(20% by volume needed)
90 tons at $30/ton $2,700.00
FLY ASH FOR GROUTING $ 2,700.00

AVERAGE COST OF ONE (1) SEAL TOTAL $ 18,330.00

AVERAGE COST OF SEVEN (7) SEALS TOTAL $ 128,310.00

ALTERNATIVES FOR M.O.D.-14

A. Slurry Trench

(1,000' long x 25' deep x 2' wide)

Work consists of approximately 25,000 square feet of 2' - 0" thick slurry trench which will be backfilled with a specified impervious mixture.

Require tons of Bentonite: (2500 cu. yds.)
(2,500 cu. yds.) (50 lbs/cu. yd.) = 125,000 lbs.
125,000 lbs. = 62.5 tons

COSTS
$44.20 per ton (F.O.B.)
20.80 per ton (Transportation)
$65.00 per ton of Bentonite
62.5 tons x $65.00 per ton $4,062.50
COSTS $4,062.50

EXCAVATION, TRANSPORTATION AND COMPACTION
25,000 square feet x $3.25/sq. feet $ 81,250.00
EXCAVATION, TRANSPORTATION AND COMPACTION $ 81,250.00

SOIL TREATMENT AND PLANTING
2 Ac. @ $600.00 $1,200.00
SOIL TREATMENT AND PLANTING $1,200.00

TOTAL $ 86,512.00

B. Clay Blanket
(1000' long x 100' wide x 40' deep)

CLAY EXCAVATION & TRANSPORTATION & COMPACTION
10,000 cu. yds. x $3.00 = $30.00 $ 30,000.00
CLAY EXCAVATION & TRANSPORTATION & COMPACTION $ 30,000.00

B. Clay Blanket (Cont'd)

EXCAVATION, TRANSPORTATION AND COMPACTION		
70,000 cu. yds. x $2.00 = $140,000		$ 140,000.00
EXCAVATION, TRANSPORTATION AND COMPACTION		$ 140,000.00
SOIL TREATMENT & PLANTING		
2.3 Ac @ $600.00/Ac.		$1,380.00
SOIL TREATMENT & PLANTING		$1,380.00
TOTAL		$ 171,380.00

C. Grout Line
(1,100' in length)

DRILLING		
130 holes @ 70' hole = 7,700'		
9100' @ $3.00/ft. = $27,300.00		$ 27,300.00
Length x width x depth = volume		
(20% by volume needed)	DRILLING	$ 27,300.00
FLY ASH		
1237.5 tons @ $30.00/ton		$ 37,125.00
Length x width x depth = volume		
(20% by volume needed)	FLY ASH	$ 37,125.00
CEMENT		
11,000 cu. ft. @ $7.00		$ 77,000.00
Length x width x depth = volume		
(20% by volume needed)	CEMENT	$ 77,000.00
STONE		
100 tons @ $20.00/ton		$ 2,000.00
	STONE	$ 2,000.00
GROUT CONNECTION		
160 connections @ $12.00		$ 1,920.00
	GROUT CONNECTION	$ 1,920.00
ADDITIVES		
150 gal. @ $10.00/gallon		$ 1,500.00
	ADDITIVES	$ 1,500.00
SAND		
50 tons @ $50.00/ton		$ 2,500.00
	SAND	$ 2,500.00
SOIL TREATMENT & PLANTING		
1 Ac. @ $600.00		$ 600.00
		$600.00
TOTAL		$ 149,945.00