

SUMMARY OF FINDINGS

COMPARISON OF RIVER STAGES AT RIVER MILE 196± WITH THE FLUCTUATIONS OF THE MINE POOLS, FROM STEVENS & CLEAR SPRING TO LOREE & LANCE INDICATES THAT THE FLUCTUATION OF THE MINE POOLS ARE CLOSELY RELATED TO THE RISE AND FALL IN THE RIVER STAGES (SEE PROFILE AND STAGE-DISCHARGE RELATIONSHIP CURVES).

WHEN THE FLOW IN THE RIVER IS LESS THAN 6,500 CFS, THE LEVELS OF THE LOREE & LANCE MINE POOLS ARE THE LOWEST IN THE NORTHWEST COMPLEX. THIS LEADS TO THE FOLLOWING CONCLUSIONS:

- THE MAIN OUTLET OF THE NORTHWEST MINE POOL COMPLEX IS EXPECTED TO BE IN THE VICINITY OF RICHARD ISLAND (RIVER MILE STATIONS 184 - 185), AS SHOWN ON THE PLAN AND PROFILE.
- THE AMD DISCHARGES FROM THE BUTTONWOOD DRAINAGE TUNNEL CAN ONLY BE ATTRIBUTED TO THE NOTTINGHAM-BUTTONWOOD AND GRAND TUNNEL-AVONDALE MINE POOLS. SINCE THESE POOLS ARE HIGHER THAN THE LANCE & LOREE POOLS, DRAINAGE OF MINE WATER FROM THE REMAINING POOLS IN THE NORTHWEST COMPLEX CANNOT REACH THE BUTTONWOOD TUNNEL BY GRAVITY FLOW.

WHEN THE FLOW OF THE RIVER IS MORE THAN 6,500 CFS (WHICH OCCURS 50% OF THE TIME), THE LANCE AND LOREE MINE POOLS ARE HIGHER THAN THE NOTTINGHAM-BUTTONWOOD POOLS. UNDER THESE CONDITIONS, THE DISCHARGE FROM THE BUTTONWOOD TUNNEL IS MORE THAN 8 MGD. THIS ADDITIONAL DISCHARGE IS ATTRIBUTED TO FLOW FROM THE REMAINING MINE POOLS IN THE NORTHWEST COMPLEX, AS INDICATED BY THE "BUTTONWOOD TUNNEL RATING CURVE". THIS ADDITIONAL DISCHARGE REPRESENTS APPROXIMATELY 70% OF THE ANNUAL FLOW FROM THE BUTTONWOOD TUNNEL.

THE SUSPECTED LOCATION OF THE MAIN OUTLET FOR THE NORTHWEST COMPLEX IS DOWNSTREAM OF THE WILKES-BARRE USGS GAGING STATION. CONSEQUENTLY, RIVER LOSSES INTO THE DEEP MINE POOLS BYPASS THIS STATION AND ARE NOT RECORDED. THIS PHENOMENON WAS OBSERVED TO EXIST SINCE 1970, AS SHOWN IN THE COMPARISON OF FLOW RECORDS OF THE DANVILLE AND WILKES-BARRE GAGING STATIONS.

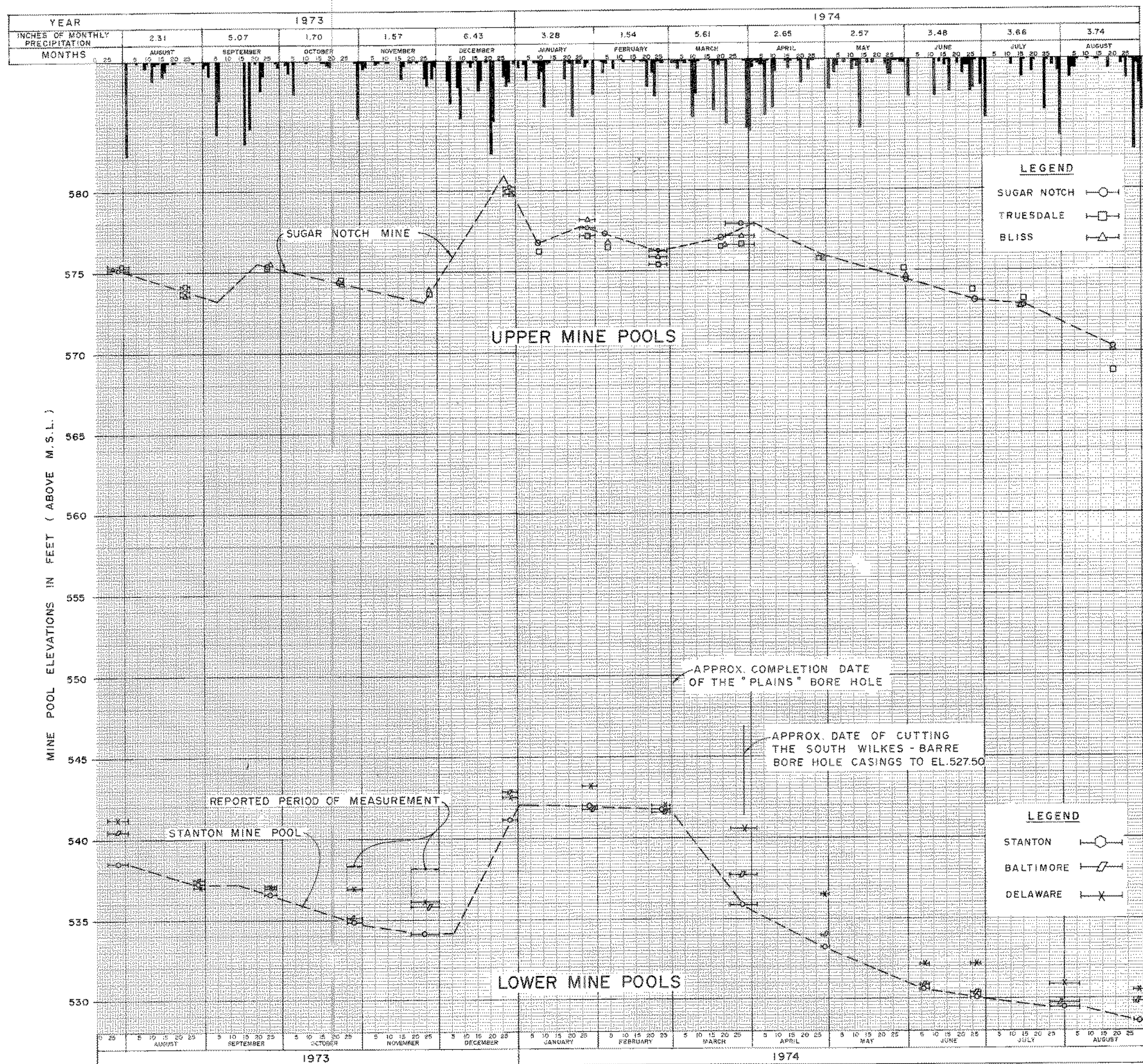
COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES

AMD ABATEMENT STUDY

NANTICOKE, WARRIOR AND SOLOMON CREEKS
PROJECT NO. SL 181-3
HANOVER & WILKES BARRE TWP. LUZERNE CO. PENNA.

**NORTH - WEST MINE POOL COMPLEX
PLAN, PROFILE AND PERTINENT DATA**

DATE DEC. 1974	PREPARED BY GEO - Technical Services CONSULTING ENGINEERS & GEOLOGISTS HARRISBURG, PENNA.	FIGURE No 12
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FLUCTUATION OF MINE POOLS DURING THE STUDY PERIOD

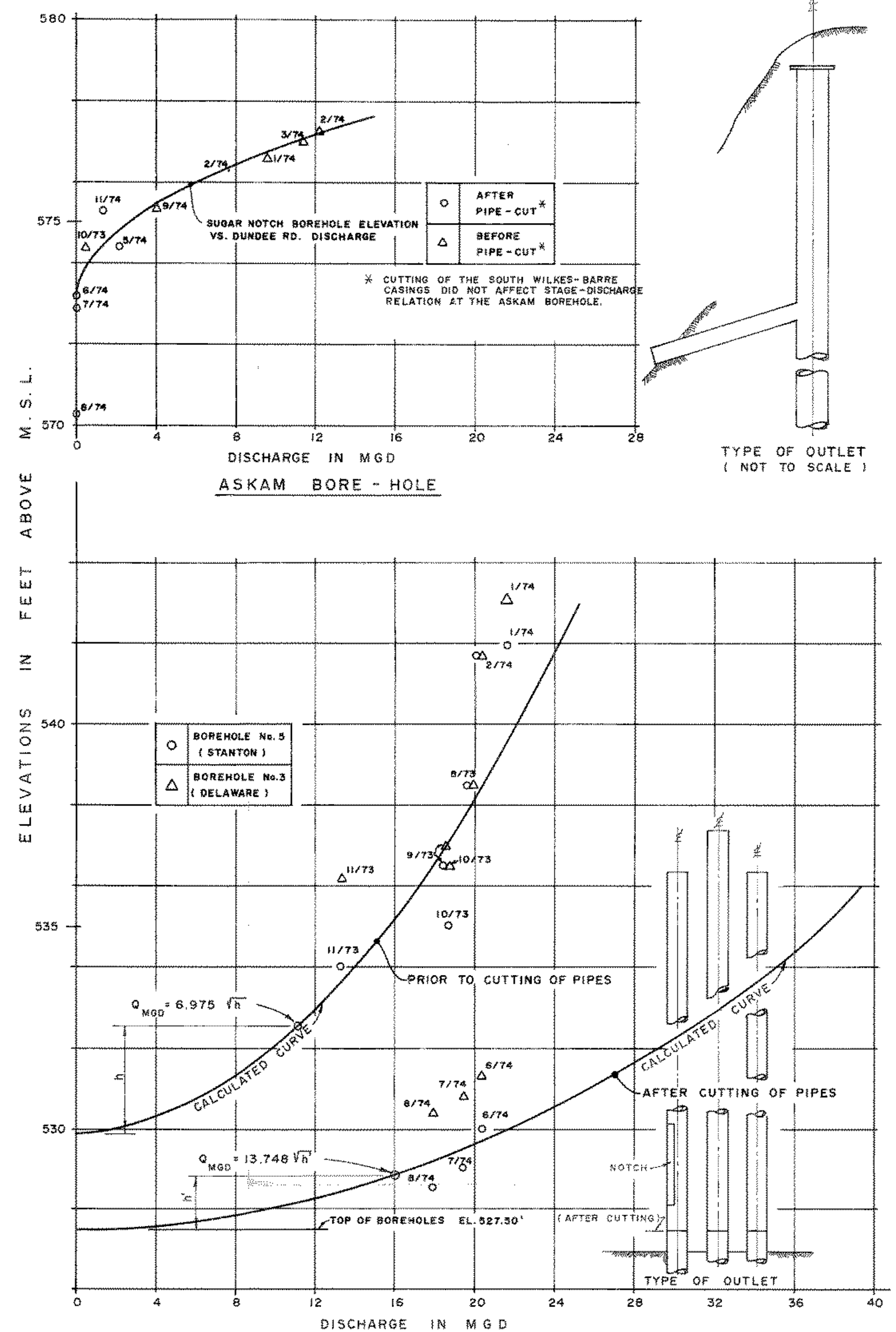
LEGEND
 SUGAR NOTCH ○
 TRUESDALE □
 BLISS △

LEGEND
 STANTON ○
 BALTIMORE □
 DELAWARE ×

COMPUTED RATING CURVES FOR SOUTH WILKES-BARRE BOREHOLES

A. PRIOR TO CUTTING OF PIPES
 DISCHARGE THRU TOP OF CASING AND THRU THE NOTCH AT THE BOTTOM OF ANOTHER CASING. THE FLOW IS GOVERNED BY AN ORIFICE TYPE FORMULA:
 $Q = K 2e \sqrt{h}$ WHERE
 Q = DISCHARGE IN CFS
 K = C x A
 C = COEFFICIENT OF DISCHARGE
 A = TOTAL CROSS-SECTIONAL AREA OF FLOW AT OUTLET
 $e = 32.2 \text{ FEET/SEC}^2$
 h = MINE POOL ELEVATION - ELEV. OF OUTLET
 APPLYING CURVE FITTING METHOD TO RELIABLE DISCHARGE RECORDS:
 $K = 1.345; Q = 1.345 \times \sqrt{2e} \times \sqrt{h}$
 $Q = 6.975 \sqrt{h} \text{ MGD}$

B. AFTER CUTTING OF PIPES
 DISCHARGE FROM THE TOP OF ALL THREE 36" DIA. CASINGS. THE FLOW IS GOVERNED BY THE FOLLOWING EQUATION:
 $Q = CA \times \sqrt{2e} \times \sqrt{h}$ (SEE A ABOVE)
 $A = 3 \times \pi D^2 / 4 = 21.206 \text{ FEET}^2$
 $\sqrt{2e} = 8.025$
 APPLYING CURVE FITTING METHOD TO RELIABLE DISCHARGE RECORDS:
 $C = \frac{Q}{A \sqrt{2e} \sqrt{h}} = 0.125$
 $Q = 0.125 \times 21.206 \times 8.025 \sqrt{h} = 21.1 \sqrt{h} \text{ CFS}$
 $Q = 13.748 \sqrt{h} \text{ MGD}$



RATING CURVES FOR BORE-HOLE DISCHARGES

SUMMARY OF FINDINGS

UPPER MINE POOLS
 WHEN THE WATER LEVEL IN THE SUGAR NOTCH MINE POOL DROPS BELOW ELEVATION 573.2', THERE ARE NO DISCHARGES FROM THE ASKAM BOREHOLE. INDICATING THE EXISTENCE OF OTHER DISCHARGE POINTS BELOW THIS ELEVATION (SEE FLUCTUATION OF UPPER MINE POOLS IN JULY AND AUG., 1974). THESE OTHER DISCHARGE POINTS RECHARGE THE LOWER MINE POOLS. PART OF THE "STREAM RECOVERY" IN THE LOWER PORTION OF NANTICOKE & WARRIOR CREEKS MAY ALSO BE ATTRIBUTED TO THE RECHARGE FROM THESE MINE POOLS.

LOWER MINE POOLS
 THE CUTTING OF THE PIPES TO EL. 527.50' NEARLY DOUBLED THE DISCHARGE CAPACITY OF THESE BOREHOLES UNDER SIMILAR CONDITIONS OF "HEAD DIFFERENTIAL" (h). THEREFORE, FOR THE SAME DISCHARGES THAT PREVAILED PRIOR TO THE CUTTING OF THE PIPES, THE PRESENT MINE POOL LEVELS CAN BE MAINTAINED AT A LEVEL THAT IS 2.5 FEET + 0.507 \sqrt{h} LOWER THAN THE LEVELS OF THE MINE POOLS PRIOR TO THE CUTTING OF THE PIPES.

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SOUTH-EAST MINE POOL COMPLEX
 FLUCTUATIONS OF MINE POOLS & BORE HOLE DISCHARGES

DATE JAN. 1975	PREPARED BY GEO - Technical Services CONSULTING ENGINEERS & GEOLOGISTS HARRISBURG, PENNA.	FIGURE No. 8
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WATER QUALITY RECORDS OF THE SUSQUEHANNA RIVER ON THE INDICATED SAMPLING DATES (AFTER DER)

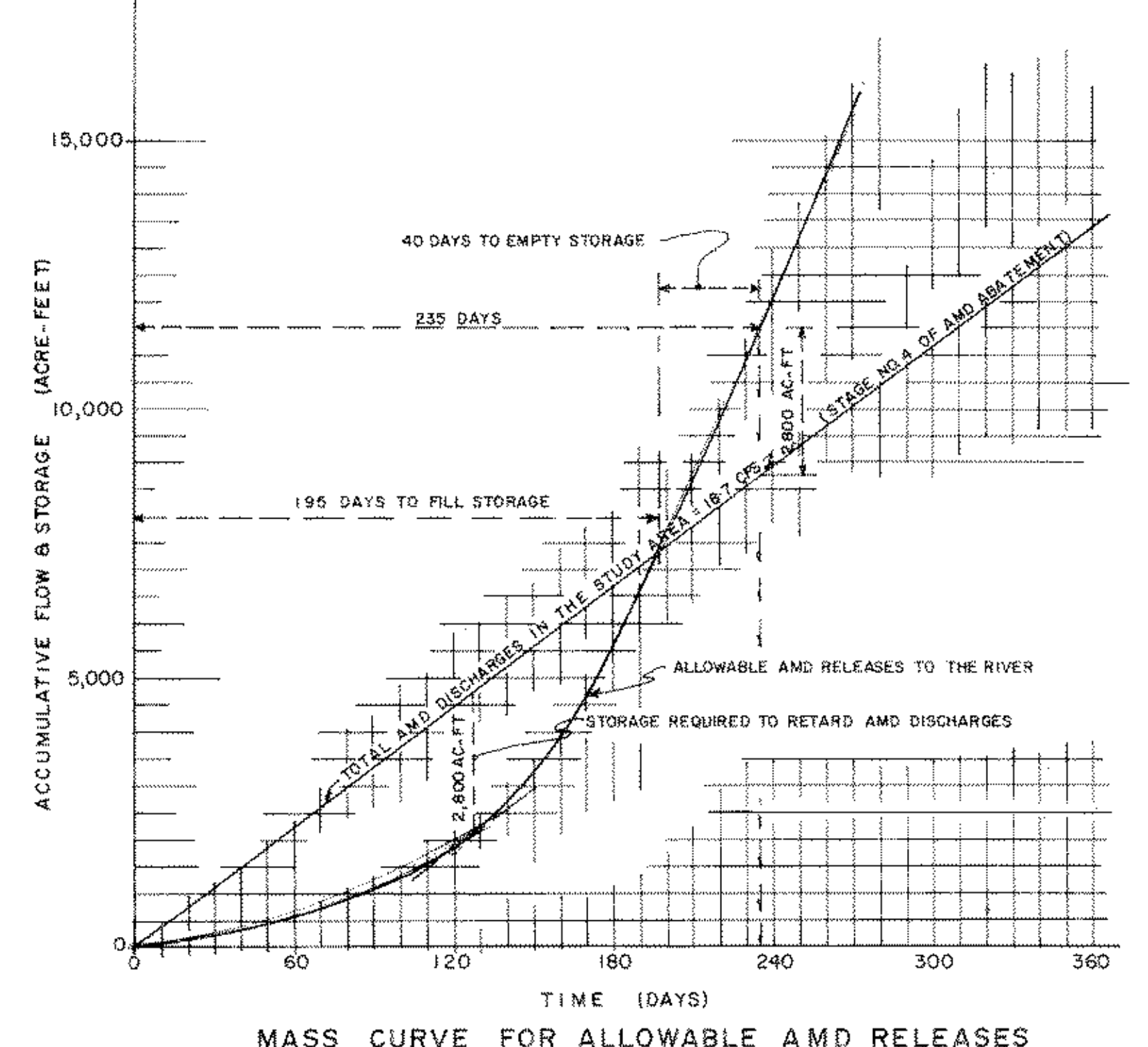
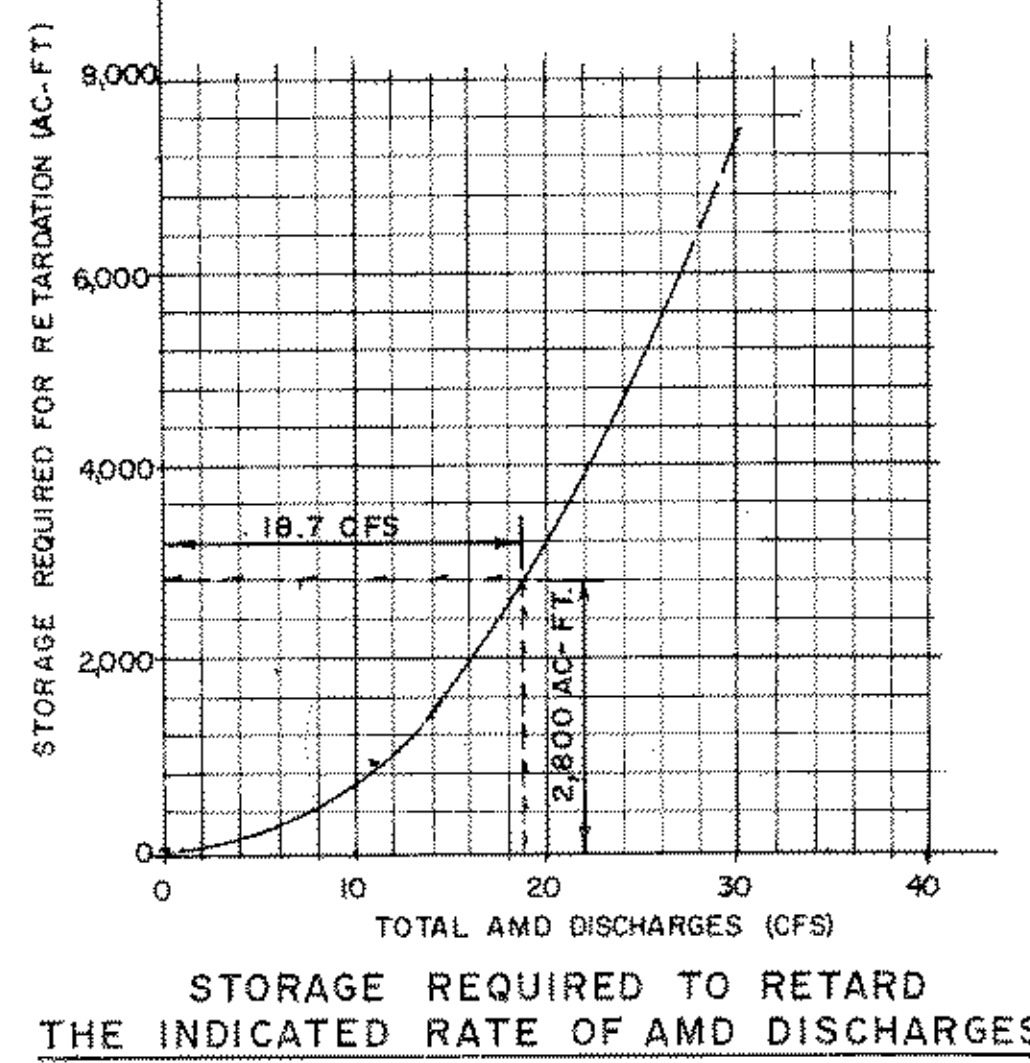
DATE	pH	CONCENTRATION IN ppm			SPL COND	
		TOT. IRON	SO ₄	TOTAL SOLIDS		
7.1	7.4	7.2	31	360	32	120
6.7	6.7	5.0	127	400	74	405
6.8	7.0	4.0	45	200	26	-
6.5	7.1	6.0	26	180	34	130
7.1	6.9	3.8	32	260	40	-
7.0	7.2	2.2	25	160	32	-
7.0	7.1	2.8	65	280	66	360
6.8	6.8	7.7	30	160	46	170
7.2	7.3	2.8	71	200	74	300
6.9	7.0	3.2	79	280	56	400
6.8	7.3	3.9	112	225	56	310
7.6	6.9	4.6	38	-	35	-
-	7.0	5.5	40	220	26	140
-	7.1	1.5	70	-	70	340
-	-	-	-	-	-	-
6.6	6.1	1.5	140	-	66	650
-	6.9	0.9	36	140	36	180
-	7.4	6.4	42	-	80	-
5.9	6.7	4.0	30	-	35	-

DATE	pH	CONCENTRATION IN ppm			SPL COND	
		TOT. IRON	SO ₄	TOTAL SOLIDS		
6.9	7.0	8	31	400	34	140
7.1	6.6	6	112	600	76	320
7.0	7.0	4.0	75	260	30	-
6.7	6.5	5.3	26	420	34	120
7.0	7.0	-	31	500	36	-
6.8	7.1	1.8	23	185	36	-
7.1	7.3	0.8	69	240	66	330
6.8	6.8	8.5	26	200	38	160
7.0	7.0	3.2	71	400	70	290
6.9	7.0	3.2	123	320	58	400
7.0	7.1	2.4	58	230	62	300
6.8	6.6	8.0	125	220	62	390
-	6.8	10.0	43	-	35	-
-	6.8	5.0	32	320	24	140
-	7.1	1.3	70	-	70	340
6.7	7.5	5.9	2200	480	54	485
6.7	5.9	3.0	110	-	66	650
-	6.9	0.8	34	190	40	180
-	7.4	4.5	40	-	85	-
-	6.7	5.3	25	-	40	300

DATE	pH	CONCENTRATION IN ppm			SPL COND	
		TOT. IRON	SO ₄	TOTAL SOLIDS		
6.9	7.0	10	29	520	32	125
6.9	6.9	5	88	640	68	368
6.6	6.8	5.5	45	240	24	-
6.6	6.6	5.3	26	440	30	-
7.0	7.0	4.0	32	360	38	-
6.8	7.1	3.7	32	240	28	-
6.9	7.4	3.5	46	190	68	310
6.8	6.5	3.2	32	80	30	160
6.9	6.9	2.8	68	160	82	280
6.7	7.1	2.0	52	200	56	255
7.0	6.6	9.0	115	160	72	315
7.3	7.6	8.0	34	510	35	-
-	6.8	5.8	28	300	26	120
-	6.9	5.35	90	-	65	385
6.8	6.7	4.1	140	380	74	400
7.0	6.5	4.0	80	-	84	420
-	6.0	4.0	35	160	38	220
-	7.4	7.8	36	-	80	-
6.6	6.8	6.0	30	-	40	-

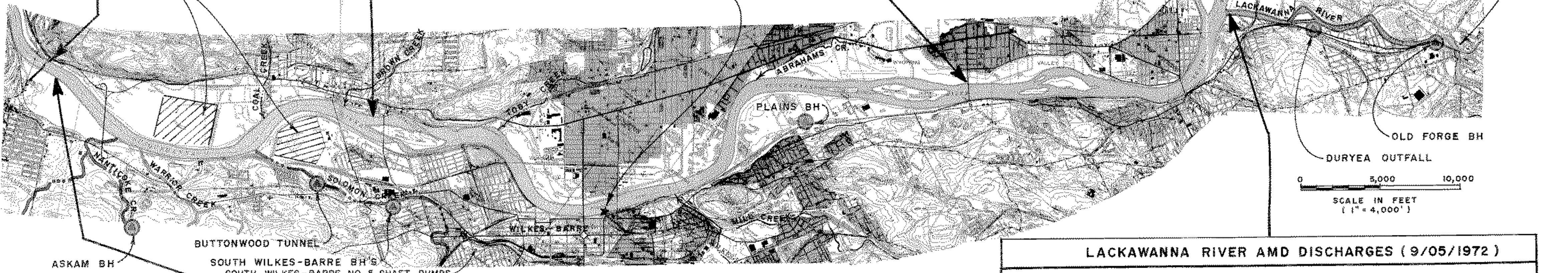
DATE	FLOW IN CFS		FLOW RATIO (2):(1)
	SUSQ. RIVER (1)	LACK. RIVER (2)	
03/25/69	31,000	2,260	7.3
10/15/68	2,100	75	3.6*
04/06/70	66,300	1,840	2.8
03/16/71	75,000	2,870	3.8
11/10/71	42,000	800	1.9
03/30/70	55,000	1,350	2.5
09/30/70	2,910	76	2.6*
02/25/71	41,500	840	2.0
07/14/69	3,000	105	3.5*
08/26/69	2,480	73	2.9*
07/29/70	3,040	82	2.7*
11/23/71	2,830	151	5.3*
12/07/72	62,500	2,530	4.0
03/23/72	76,600	2,260	3.0
02/26/73	6,700	150	2.2
08/24/71	1,510	94	6.2*
09/23/71	2,860	110	3.8*
01/05/72	20,000	597	3.0
11/01/73	8,940	242	2.7
03/01/74	27,300	520	3.0

(1) Susquehanna River at Wilkes-Barre Drainage Area 9,960 sq. mi.
 (2) Lackawanna River at Old Forge Drainage Area 332 sq. mi.
 * Low flow period
 High flow ratio coincides with high iron concentrations



POSSIBLE ALTERNATIVE LOCATIONS FOR IMPOUNDMENTS FOR THE RETARDATION OF AMD DISCHARGES DURING THE LOW FLOW PERIODS IN THE SUSQUEHANNA RIVER.

NOTE: RED INDICATES POLLUTED STREAM
 USGS GAGING STATION DRAINAGE AREA = 9,960 SQ. MILES



ILLUSTRATIVE EXAMPLE FOR THE RETARDATION OF AMD DISCHARGES TO MEET WATER QUALITY STANDARDS
 PROCEDURE FOR THE DETERMINATION OF REQUIRED STORAGE *

TEN YEAR RECURRENCE INTERVAL FOR RIVER NO. OF DISCHARGE IN DAYS	IRON LOAD IN POUNDS PER DAY FOR THE INDICATED CONCENTRATION			EQUIVALENT ALLOWABLE DISCHARGE CFS (5)	ACCUMULATIVE ALLOWABLE DISCHARGE AC-FT (7)=2x(6)x(1)	
	(1)	(2)	(3)			
7	820	1,325	6,625	5,300	4.75	66.50
14	870	1,406	7,030	5,624	5.04	141.12
30	960	1,551	7,755	6,204	5.55	333.00
60	1,100	1,777	8,885	7,108	6.36	763.20
120	1,300	2,101	10,505	8,404	7.52	1,804.80
193	2,890	4,670	23,350	18,680	16.72	6,119.50
270	5,000	8,080	40,400	32,320	28.84	15,627.50
365	7,750	12,522	62,610	50,088	44.85	32,740.50

NOTE:
 Daily discharge of Iron from Wilkes-Barre Boreholes = 8.7CFSx5.39x250ppm = 11,723 #/day
 Daily discharge of Iron from Buttonwood Tunnel = 10.0CFSx5.39x170ppm = 9,163 #/day
 Total daily discharge during low flow period of the River = 20,886 #/day
 Average concentration 18.7CFSx5.39xConcentration = 20,886; Concentration = 207.37 ppm

LOCATION	FLOW CFS	CONCENTRATION (ppm)			AMD LOAD (lbs/day)		
		ACID ALK (-)	SULFATE	TOTAL IRON	ACID ALK (-)	SULFATE	TOTAL IRON
THREE (3) BOREHOLES	30	800	4,000	400	129,263	646,315	64,631
ASKAM BOREHOLE	11	600	2,000	300	35,547	118,421	17,773
BUTTONWOOD TUNNEL	16.6	300	2,200	145	26,822	496,695	22,964
SUSQUEHANNA RIVER							
SUB-TOTAL AMD	57.6				191,632	961,501	95,368
AND LOAD FROM LACKAWANNA					(-503,452)	1,062,429	45,247
TOTAL AMD LOAD					(-311,820)	2,023,930	140,615
RIVER AT USGS GAGE	1,880						
TOBY CREEK	19.4						
SOLOMON CREEK	0.8						
RIVER AT NANTICOKE**	1,900	(-30)**	(198)**	(13.7)**	(-311,820)**	2,023,930	140,615
REPORTED (9/20/72)	2,200	-75	182	5.4			

MAJOR AMD SOURCE	ACID LOAD		SULFATES		IRON	
	LBS/DAY	% OF TOTAL	LBS/DAY	% OF TOTAL	LBS/DAY	% OF TOTAL
LACKAWANNA RIVER	220,744	53.5	761,408	44.2	44,374	31.8
STUDY AREA AND DISCHARGES	191,632	46.5	961,501	55.8	95,368	68.2
TOTAL	412,376	100.0	1,722,909	100.0	139,742	100.0

LOCATION	FLOW (CFS)	CONCENTRATION (ppm)			AMD LOAD (lbs/day)		
		ACID ALK. (-)	SULFATE	TOTAL IRON	ACID ALK. (-)	SULFATE	TOTAL IRON
LACKAWANNA RIVER (USGS GAGE)	(69.0)	20	124	0.32	7,432	46,082	119
AT CONFLUENCE	72.3						
OLD FORGE	130.2	221	820	53	154,977	575,027	37,166
DURYSA	45.7	237	570	28.8	58,335	140,299	7,089
SUB-TOTAL	248.2	(165)*	(570)*	(33.2)*	220,774	761,408	44,374
SUSQUEHANNA RIVER							
ABOVE CONFL.	1,620**	(-83)	34.5	0.10	-724,196	301,021	873
BELOW CONFL.	1,868	(-50)*	(105)*	4.90	-503,452	1,062,429	45,247
(REPORTED BELOW LACK.R. CONFL.)	+	-31†	240†	7.0†			

* COMPUTED
 ** Flow at Wilkes-Barre (1880cfs) = $\left[\frac{248.2}{1880} \right] \left[\frac{9.8}{0.46 \times \text{TobyCr} + 6.1 \times 0.15} \right] \left[\frac{2.1}{2.675 \times \text{SolomonCr}} \right] = 1,619.9$
 † Probably sampled on the East Channel of Susquehanna River near Scovill Island.

COMPUTED LOAD & CONCENTRATION OF AMD PARAMETER IN THE SUSQUEHANNA RIVER ON 9/05/1972

DATE	FLOW IN CFS	LIMITS OF KILL	NO. OF FISH KILLED	SOURCE OF FISH KILL
7/23-24/49	1,290	Ten miles below Pittston	Thousands	Lackawanna River*
8/07/55	732	Pittston to Wyoming Bridge	Not Reported	Lackawanna River*
10/09-10/61	1,570	W. Nanticoke to Sunbury	116-280	#5 Shaft Pumps
8/28-9/01/62	1,200	Berwick to Danville	Not Reported	#3 Shaft Pumps & Lackawanna River
7/28-31/66	1,670	Pittston to Nanticoke	100,000	Lackawanna River

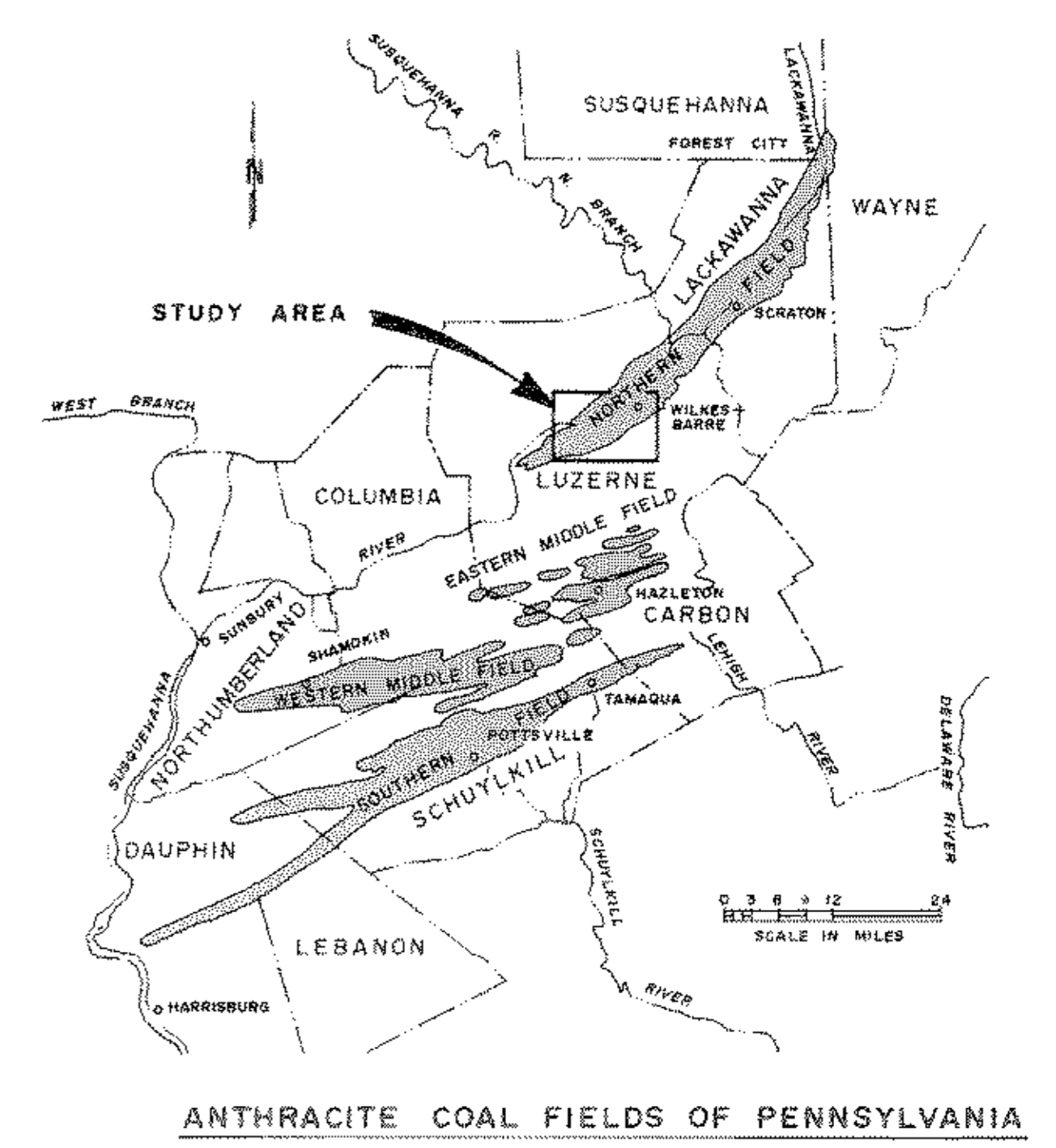
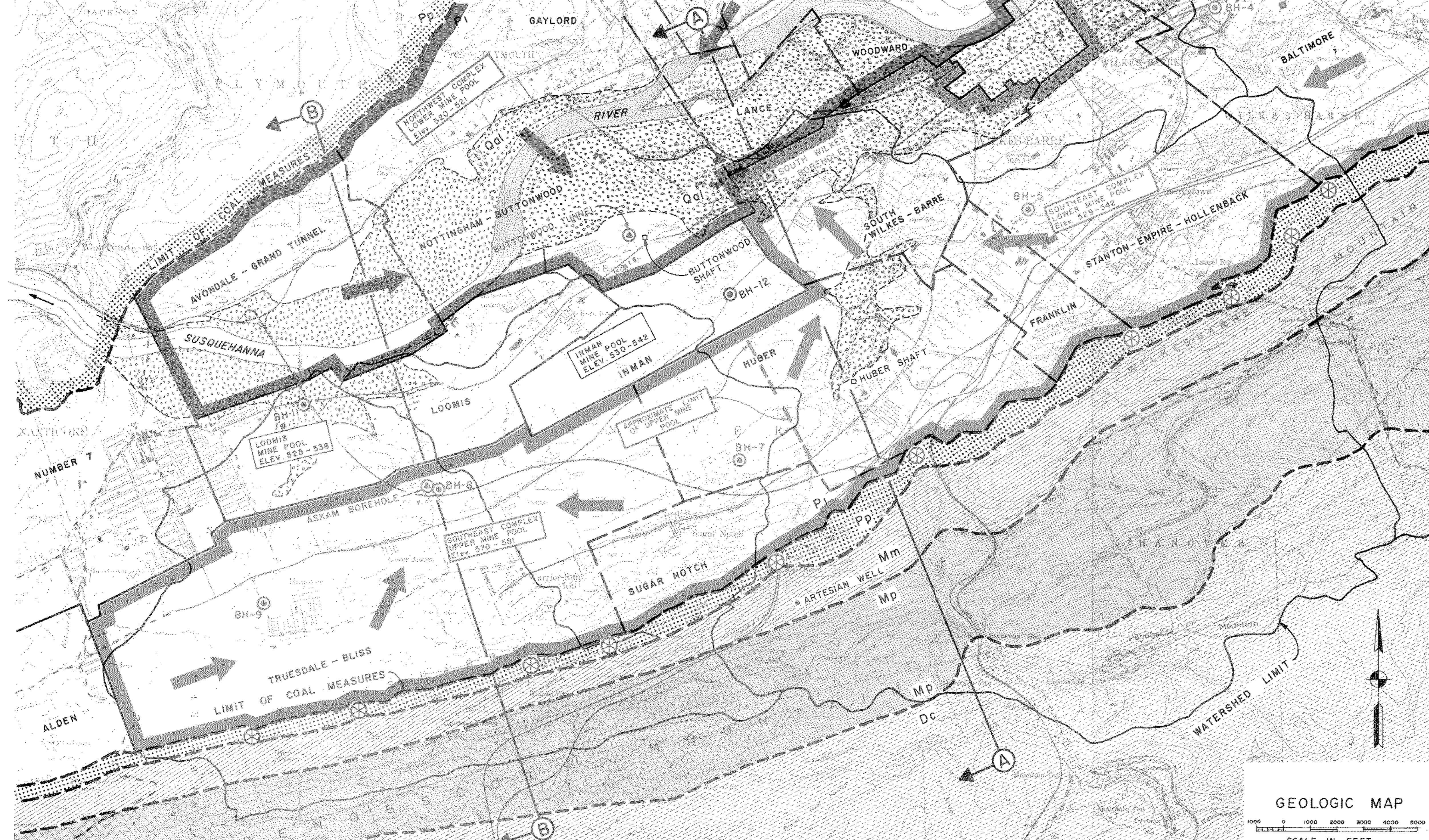
- CONCLUSIONS :
- WITH THE EXCEPTION OF IRON & MANGANESE CONCENTRATIONS, THE SUSQUEHANNA RIVER MEETS ALL OTHER WATER QUALITY STANDARDS. THIS APPLIES TO THE ENTIRE RIVER STRETCH FROM THE LACKAWANNA CONFLUENCE TO THE NANTICOKE BRIDGE.
 - MAXIMUM DEGRADATION IN RIVER QUALITY IS EXPECTED DURING EXTREME LOW FLOW CONDITIONS, OR WHEN THE DISCHARGE RATIO OF THE LACKAWANNA TO THE SUSQUEHANNA IS HIGH.
 - OBSERVED REDUCTION OF IRON CONCENTRATION AND THE HIGH pH VALUES INDICATE THAT PRECIPITATION OF IRON MAY BE TAKING PLACE WITHIN THE SUSQUEHANNA.
 - OF THE TOTAL MAJOR AMD DISCHARGES INTO THE SUSQUEHANNA RIVER ABOVE NANTICOKE ON 9/05/1972, THE LACKAWANNA RIVER CONTRIBUTED 53.5% OF ACID, 44.2% OF SULFATES AND 31.8% OF TOTAL IRON.

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EFFECT OF AMD DISCHARGES ON THE QUALITY OF THE SUSQUEHANNA RIVER

DATE: DEC. 1974
 PREPARED BY: GEO - Technical Services CONSULTING ENGINEERS & GEOLOGISTS HARRISBURG, PENNA.
 FIGURE No. 7

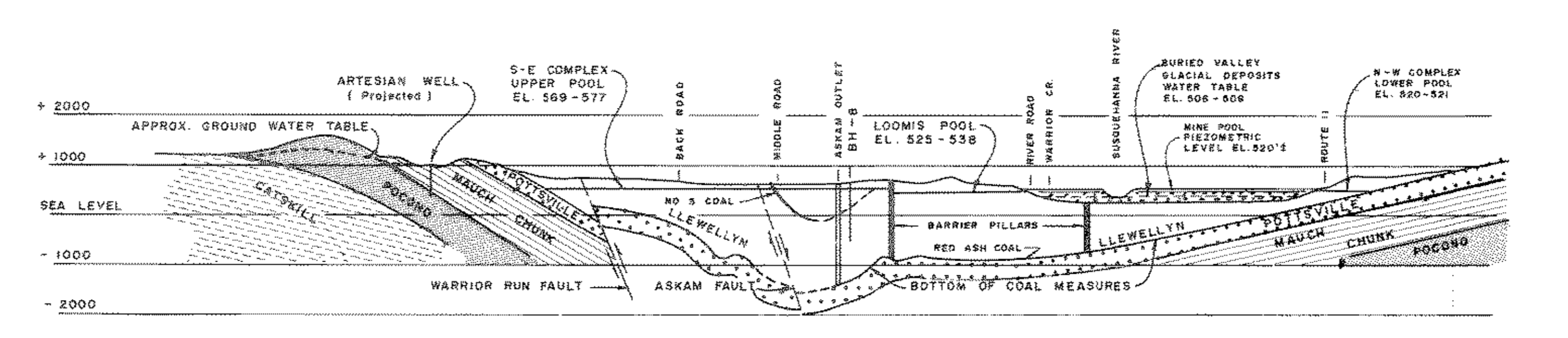
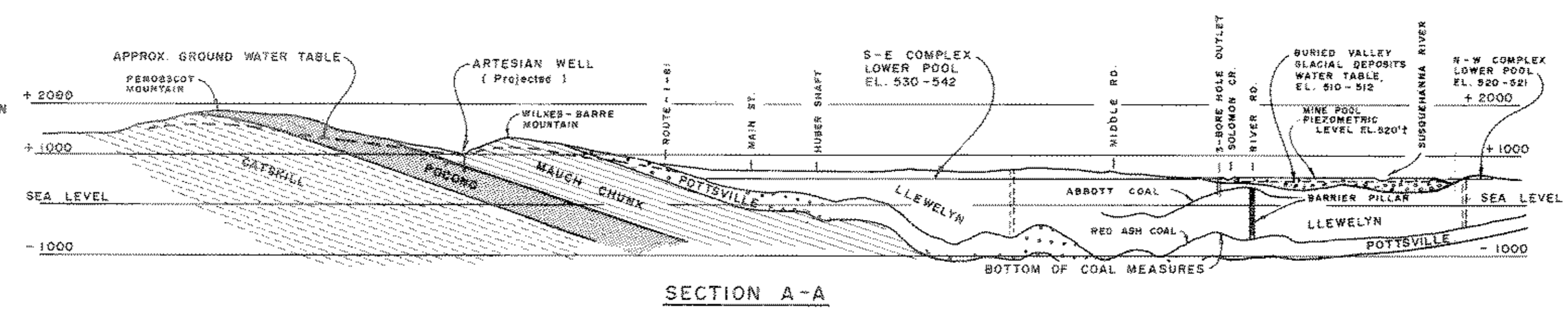
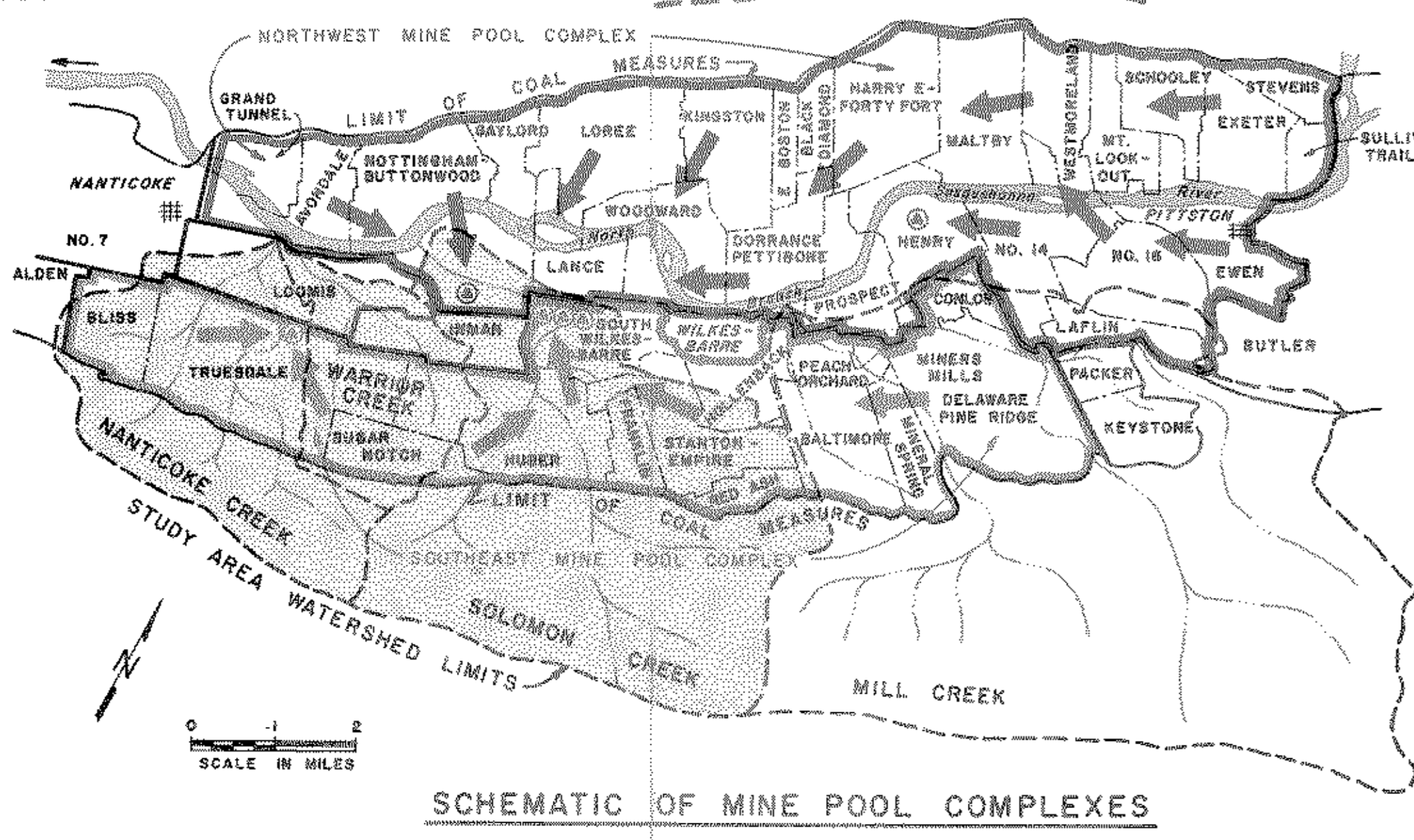


GENERALIZED STRATIGRAPHIC COLUMN

AGE	FORMATION	SYMBOL	DESCRIPTION
QUATERNARY HOLOCENE PLEISTOCENE	SEDIMENTS ALLUVIAL DEPOSITS GLACIAL DEPOSITS	Qal	RECENT RIVER SEDIMENTS UNDERLAIN BY GLACIAL LAKE SEDIMENTS TO 300' DEEP. BEDS OF CLAY, SILT, FINE TO COARSE SAND AND GRAVEL.
PENNSYLVANIAN	LLEWELLYN (2,300')	Pi	LIGHT TO MEDIUM GRAY SANDSTONE AND CONGLOMERATE WITH SHALE, CLAYSTONE AND AT LEAST 26 BEDS OF ANTHRACITE COAL (1" TO 2" THICK) 10' RED ASH - BOTTOM OF COAL MEASURES
	POTTSVILLE (300')	Pp	LIGHT GRAY TO WHITE MEDIUM TO COARSE GRAIN SANDSTONE AND CONGLOMERATE.
MISSISSIPPIAN	MAUCH CHUNK (1000')	Mm	RED SHALE INTERBEDDED WITH SOME GREEN, GRAY AND BROWN SHALE, SILTSTONE AND SANDSTONE.
	POCONO (600')	Mp	GRAY, MASSIVE SANDSTONE AND CONGLOMERATE WITH SOME SHALE AND SILTSTONE.
DEVONIAN	CATSKILL (2000')	Dc	RED, GRAY AND GREEN SHALE, SILTSTONE AND FINE TO MEDIUM SANDSTONE.

- LEGEND**
- DIRECTION OF MINE POOL FLOW AND DISCHARGE POINT
 - BOREHOLE LOCATION TO MEASURE MINE POOL LEVEL
 - BARRIER PILLARS BETWEEN MINE PROPERTIES (DASHED WHERE BREACHED BY MINING OPERATIONS)
 - POTENTIAL LOCATION FOR GROUNDWATER INTERCEPTION

- NOTES**
1. BASE TOPOGRAPHIC MAP FROM USGS 7.5 QUADRANGLES (WILKES - BARRE WEST & WILKES - BARRE EAST.
 2. BASE GEOLOGIC DATA OBTAINED FROM REPORTS AND MAPS PUBLISHED BY THE PENNA. GEOLOGIC SURVEY.
 3. BASE DATA RELATED TO DEEP COAL MINING OPERATIONS AND BARRIER PILLARS FROM REPORTS PUBLISHED BY THE US BUREAU OF MINES AND THE US GEOLOGIC SURVEY.
 4. PERTINENT DATA RELATED TO MINE POOL MOVEMENTS OBTAINED FROM FIELD MEASUREMENTS DURING THE STUDY, SUPPLEMENTED BY PA DER RECORDS OF FLUCTUATIONS OF MINERWATER POOLS FROM SEPT 1973 THRU NOV 1974.

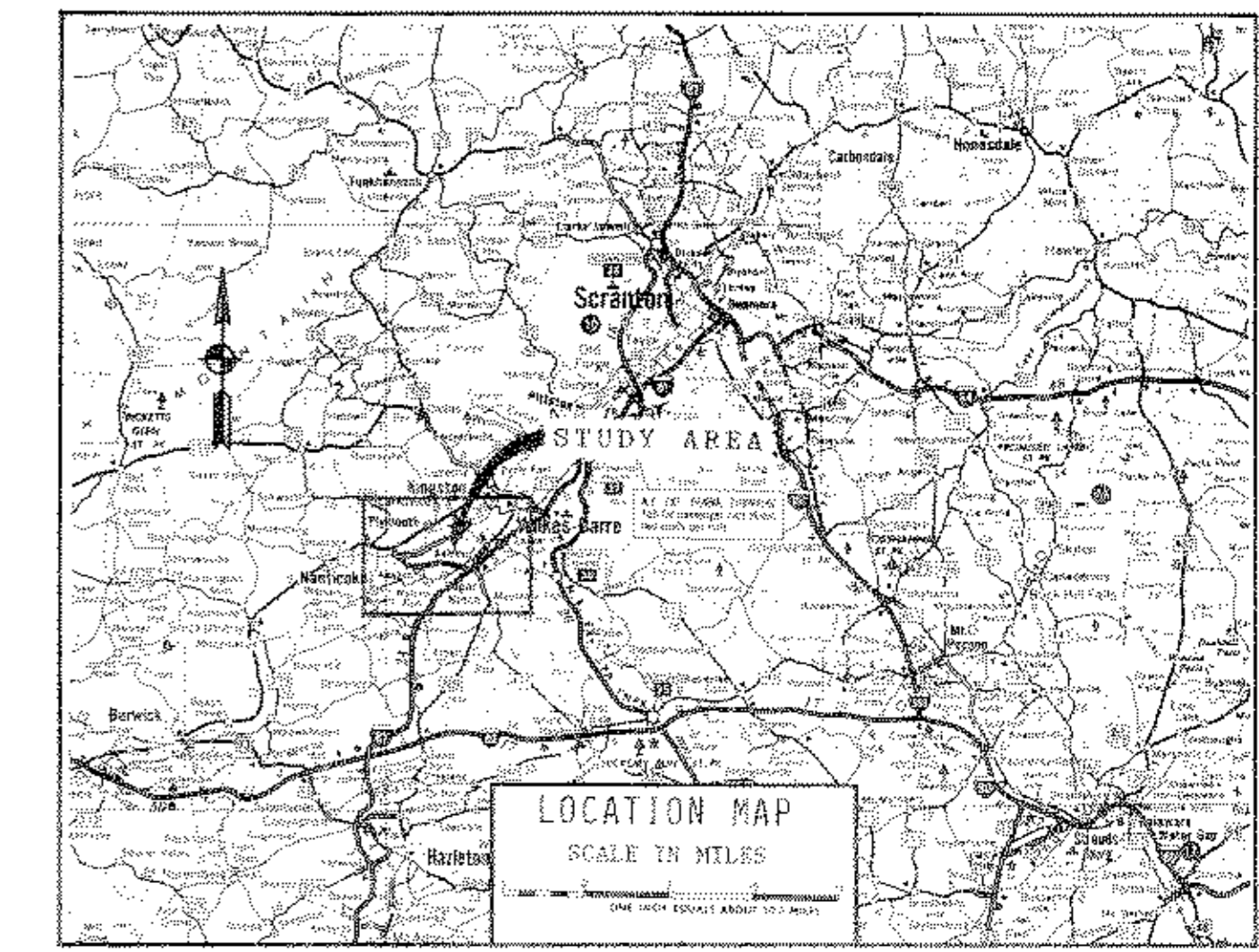
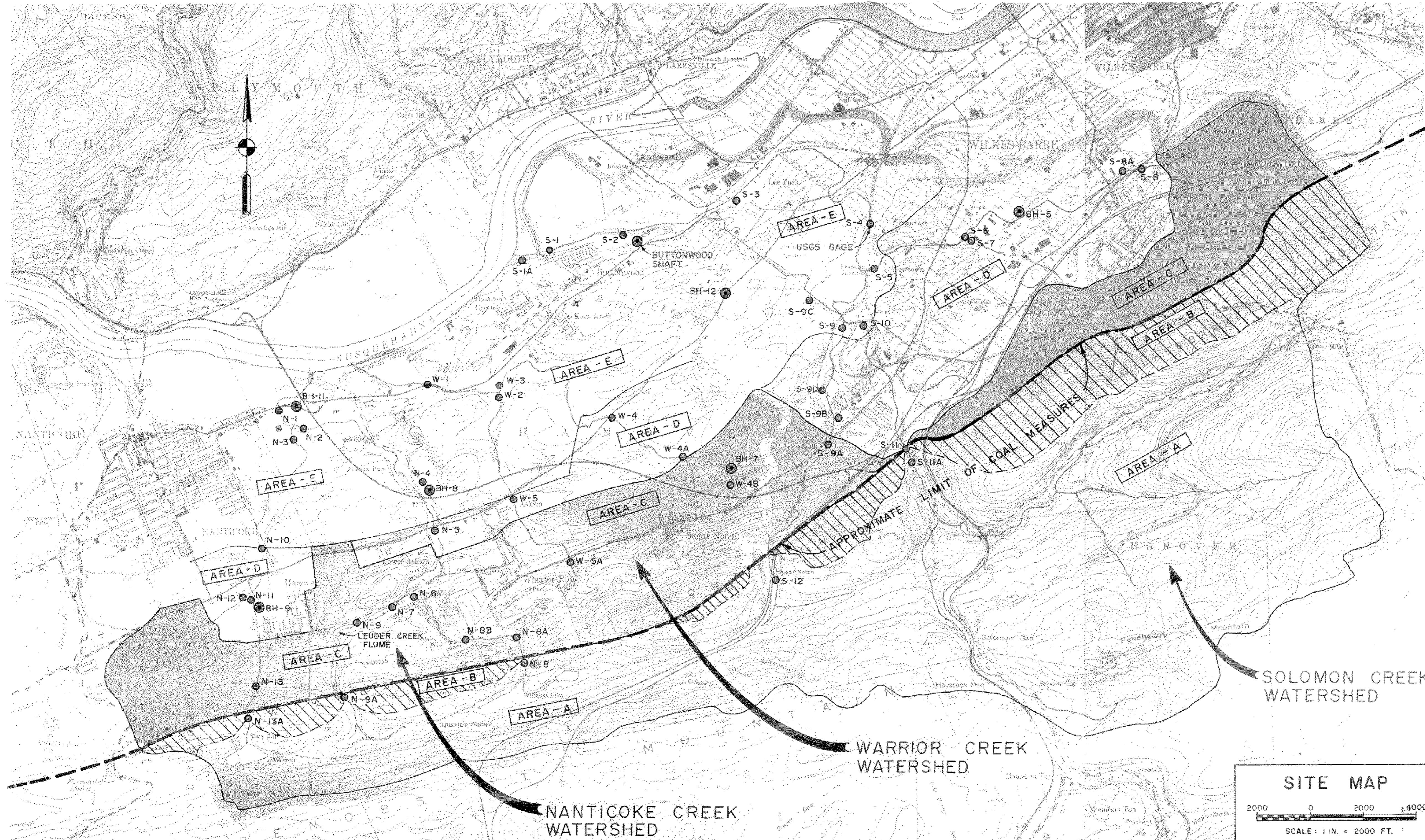


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GEOLOGIC MAP & SECTIONS
SHOWING MINE POOLS
AND BARRIER PILLARS

DATE DEC. 1974	PREPARED BY GEO - Technical Services CONSULTING ENGINEERS & GEOLOGISTS HARRISBURG, PENNA.	FIGURE No. 2
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MONITORING STATION DRAINAGE AREAS

SOLOMON CREEK		NANTICOKE CREEK		WARRIOR CREEK	
STATION	DR. AREA	STATION	DR. AREA	STATION	DR. AREA
MOUTH	18.4	MOUTH	7.57	MOUTH	4.51
S-10	mine outfall	N-1	7.47	W-1	4.32
S-1	18.2	N-2	4.25	W-2	1.51
S-2	mine outfall	N-3	3.14	W-3	2.69
S-3	mine outfall	N-4	mine outfall	W-4	1.63
S-4	15.7	N-5	3.50	W-4A	1.00
S-5	4.43	N-6	2.94	W-4B	silt pond overflow
S-6	4.00	N-7	1.01	W-5	1.00
S-7	1.53	N-8	1.30	W-5A	0.25
S-8	1.45	N-8A	1.34		
S-8A	0.20	N-9	0.89		
S-9	2.33	N-9A	0.61		
S-9A	1.74	N-10	2.47		
S-9B	silt sump overflow	N-11	1.11		
S-9C	pond seepage	N-12	0.86		
S-10	8.33	N-13	0.40		
S-11	6.90	N-13A	0.30		
S-11A	6.81				
S-12	1.05				

LEGEND

- S-2 WATERSHED MONITORING STATION
- BH-5 MINE POOL MONITORING STATION
- WATERSHED LIMIT

NOTES

- BASE MAP IS REPRODUCTION OF U.S.G.S. 7 1/2 MIN. QUADRANGLE (WILKES-BARRE EAST, WILKES-BARRE WEST AND NANTICOKE)
- FLOW AND WATER QUALITY RECORDS FOR THE INDICATED MONITORING STATIONS ARE PRESENTED IN APPENDIX A.

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES

A M D ABATEMENT STUDY
NANTICOKE, WARRIOR AND SOLOMON CREEKS
PROJECT NO. SL 181-3
HANOVER & WILKES BARRE TWP. LUZERNE CO. PENNA.

**LOCATION MAP, SITE MAP AND
PERTINENT WATERSHED DATA**

DATE JAN. 1975	PREPARED BY GEO - Technical Services CONSULTING ENGINEERS & GEOLOGISTS HARRISBURG, PENNA.	FIGURE No 1
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CHARACTERISTICS OF WATERSHED SUB-AREAS

UNMINED AREAS: BOTH AREAS A & B ARE OUTSIDE THE COAL MEASURES. THESE AREAS ARE CHARACTERIZED BY RELATIVELY STEEP SLOPES AND TREE COVER. SURFACE RUNOFF CONTRIBUTION IS HIGH AND ESSENTIALLY CLEAN.

AREA A SURFACE RUNOFF FLOWS INTO EXISTING STREAMS UPSTREAM OF THE COAL MEASURES. SOME OF THIS WATER IS INTERCEPTED AND LOST IN AREAS C & D.

AREA B SURFACE RUNOFF FLOWS DIRECTLY INTO AND IS COMPLETELY INTERCEPTED BY STRIP MINE PITS AND SUBSIDENCE DEPRESSIONS IN AREA C.

MINED AREAS: AREAS C, D & E ARE WITHIN THE COAL MEASURES AND CONTAIN SOME URBANIZED AREAS. IN AREAS C & D, THE GROUNDWATER TABLE (MINE POOL) IS BELOW STREAMBED LEVELS RESULTING IN LOSSES FROM RUNOFF AND STREAM FLOW INTO THE DEEP MINES. IN AREA E, THE GROUNDWATER TABLE (MINE POOL) IS AT OR NEAR STREAMBED LEVELS. STREAM RECHARGE OCCURS AND THERE IS NO LOSS OF STREAM FLOW TO THE DEEP MINES.

AREA C THIS AREA CONTAINS ISOLATED SUBURBAN AREAS AND IS EXTENSIVELY STRIP MINED AND DEEP MINED. MOST OF THE PRECIPITATION AND RUNOFF IN THIS AREA IS INTERCEPTED BY STRIP PITS AND SUBSIDENCE DEPRESSIONS AND INFILTRATES INTO THE DEEP MINES. RUNOFF CONTRIBUTION TO STREAM FLOW IS NEGLIGIBLE IN AREA C.

AREA D THIS AREA IS URBAN AND SUBURBAN WITH EXTENSIVE DEEP MINING AND LIMITED STRIP MINING OPERATIONS. PRECIPITATION AND RUNOFF IN THIS AREA IS INTERCEPTED IN LIMITED AREAS BY MINING OPERATIONS WHERE SOME WATER LOSSES TO THE DEEP MINES OCCUR. RUNOFF CONTRIBUTION TO STREAM FLOW IS LIMITED.

AREA E THIS AREA IS URBAN AND SUBURBAN WITH EXTENSIVE DEEP MINING AND ISOLATED STRIP MINING OPERATIONS. SOME PRECIPITATION AND RUNOFF IS INTERCEPTED AND LOST IN ISOLATED STRIP MINES AND MINE WASTE DUMPS. THERE ARE NO STREAMBED LOSSES TO THE DEEP MINES IN AREA E. IN THIS AREA, THE STREAMS ARE RECHARGED BY GROUNDWATER AND MINE POOL SEEPAGE. THE MAJOR OUTFALLS ARE ALSO LOCATED IN AREA E.

DISTRIBUTION OF ANNUAL SURFACE WATER LOSSES
(TOTAL LOSSES 4,369 MG)

LOCATION	WATERSHED					
	SOLOMON CREEK		WARRIOR CREEK		NANTICOKE CREEK	
	AREA	ANNUAL LOSS	AREA	ANNUAL LOSS	AREA	ANNUAL LOSS
	(SQ. MI.)	(INCHES) (MG)	(SQ. MI.)	(INCHES) (MG)	(SQ. MI.)	(INCHES) (MG)
AREA A	7.87	2.75 513	0	0 0	2.25	14.90 582
AREA B	1.88	20.40 667	0.17	20.40 60	0.44	20.40 156
AREA C	1.83	20.40 649	1.78	20.40 631	2.45	20.40 869
AREA D	3.06	2.76 147	0.82	2.76 39	0.55	2.76 26
AREA E	3.72	0 0	1.90	0 0	1.88	0 0
TOTALS	18.36	1976	4.57	780*	7.57	1633
		6.19		9.82		12.41

THE ACTUAL LOSSES IN INCHES OVER AREAS A,B,C&D ARE SHOWN BELOW

LOSS IN AREAS A,B,C&D	14.64	7.77	1976	2.77	16.20	780*	5.69	16.51	1633
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* Including 50 MG annual losses of raw sewage from the Boro of Sugar Notch.