WATER QUALITY

A . GENERAL

As reported earlier, the Little Schuylkill Basin receives acid mine drainage first at its headwaters from the abandoned Silverbrook

Colliery, and again seven miles downstream at Tamaqua from the coal bearing valley from the east and west, Acid mine drainage sources include gravity discharges from abandoned deep mine workings, seepage from coal refuse piles and pumping at three mine dewatering stations,

The collection of quantitative and qualitative data to evaluate the conditions in a study area were pursued at three levels, sometimes concurrently, One study level included an extensive routine sampling program encompassing the period December 1970 to April 1972, in which samples were collected at monthly intervals at established sampling stations, These included mine discharges of general knowledge, the receiving stream above and below major points of change and the clean tributaries as well, The principal purpose of this study phase was to obtain base quality data, The complete information is tabulated in Appendix A and the location of the stations are indicated on Exhibit 9. Pertinent findings extracted from the data will be discussed in this report section.

Another level of collection effort was a series of detailed studies during the period March through August 1972. At the beginning of that period weirs were installed at the Coaldale No, 7 Mine, Reevesdale No, 1 Drift, Newkirk Drainage Tunnel and Newkirk Mine. Weirs had already been placed at Silverbrook and Reevesdale No. 2 Drift several months earlier. The purpose of this program was to determine the flow and pollution load emanating from all significant surface discharges and to observe the relationship of these outputs with precipitation. Weirs installed at Smith Mine. West Lehigh Shaft and the A and D Mine discharges were subject to vandalism because of their proximity to Tamaqua. Alternatively, these discharges, as well as Zakrewsky's gravity discharge, were measured periodically by employing a bucket and stop watch. The data derived from these studies are tabulated in Appendix B .

The third study level involved local investigations requiring from one to three days and related principally to (1) locating sub-surface acid mine drainage sources and (2) determining the stream impact of certain events, such as conditions with specific mine drainage pumps on or off. In this phase, considerable effort was directed towards investigating refuse banks. Through frequent pH measurements and selective upstream and downstream sampling, coupled with field analyses, quality changes were revealed and the relative importance of refuse areas were determined. On several occasions in the Panther and Wabash Valleys. stream flow rates were measured by the use of a Gurley current meter. This data was applied to material balances to assess pollution contributions.

B. NATURAL STREAM QUALITY

The base flow of the streams in the area outside of the coal basins arise from shale and sandstone formations. These formations contain little soluble minerals and the result is a particularly pure stream water.

Water Quality of Area Streams Free From AMD

	pH	alkalinity	acidity	sulfates	iron
Little Schuylkill River above Silverbrook	5.3	2	4	24	0.1
Lofty Creek	5.6	3	2	22	0.2
Neifert Creek	6.4	0	0	24	0.3
Still Creek	5.9	4	1	--	--
Pine Creek	6.5	7	0	22	0.1
Locust Creek	6.7	8	0	22	0.3

Germane to the basin study is the water's absence of alkalinity, that is, the lack of bicarbonates. This absence manifests itself in that the streams have practically no ability to absorb or buffer the mineral acids discharged by the mines. Relatively small amounts of acid depress pH levels quickly below desirable values.

The assimilative capacity of the area's natural water for mine acid was experimentally determined. Waters from the Still, Pine and Locust Creeks were collected during a period of base runoff and blended proportional to their watershed areas. Mine water was added in controlled amounts to a sample of this mixture and a resultant pH measured. This experiment was repeated employing nine different mine waters and the findings are presented on Exhibits 10 and 11, which follow.

The curves illustrate the inability of the natural waters to receive acid. With initial lag, indicating but little alkalinity, the pH values plunge steeply with increasing acid additions. A pH of 5.5, a minimum standard as judged by the authors, is reached with acid additions of between 5 and 8 mg /1, depending upon its source. A t this amount, the mean flow of 54 CFS passing the USGS Gauge at Tamaqua can accept only 2000 pounds of acid per day without incurring a pH of less than 505. During more severe conditions, for example the 4.8 CFS of the 7-day 10 year low flow, the river can assimilate only 180 pounds of acid per day.

Reference was made above briefly to a pH quality standard of 505. Other desirable water quality characteristics are tabulated below and reference will be made thereto in the section discussing survey findings, that follows:

Desirable Water Quality for Use Indicated

Parameter	Fishing	Drinking and most other uses
pH	5.5 min.	6 to 9
Sulfates	90 max.	250 max .
Iron	1.5 max.	0.35 max.

C. ACID MINE DRAINAGE IN THE LITTLE SCHUYLKILL BASIN

The flow and pollution contributions from the 24 primary sources are compiled on the following page, Table 1. The data represent "average" conditions, conditions which prevail during periods that are neither particularly wet nor dry. The sources are grouped into their respective watersheds.

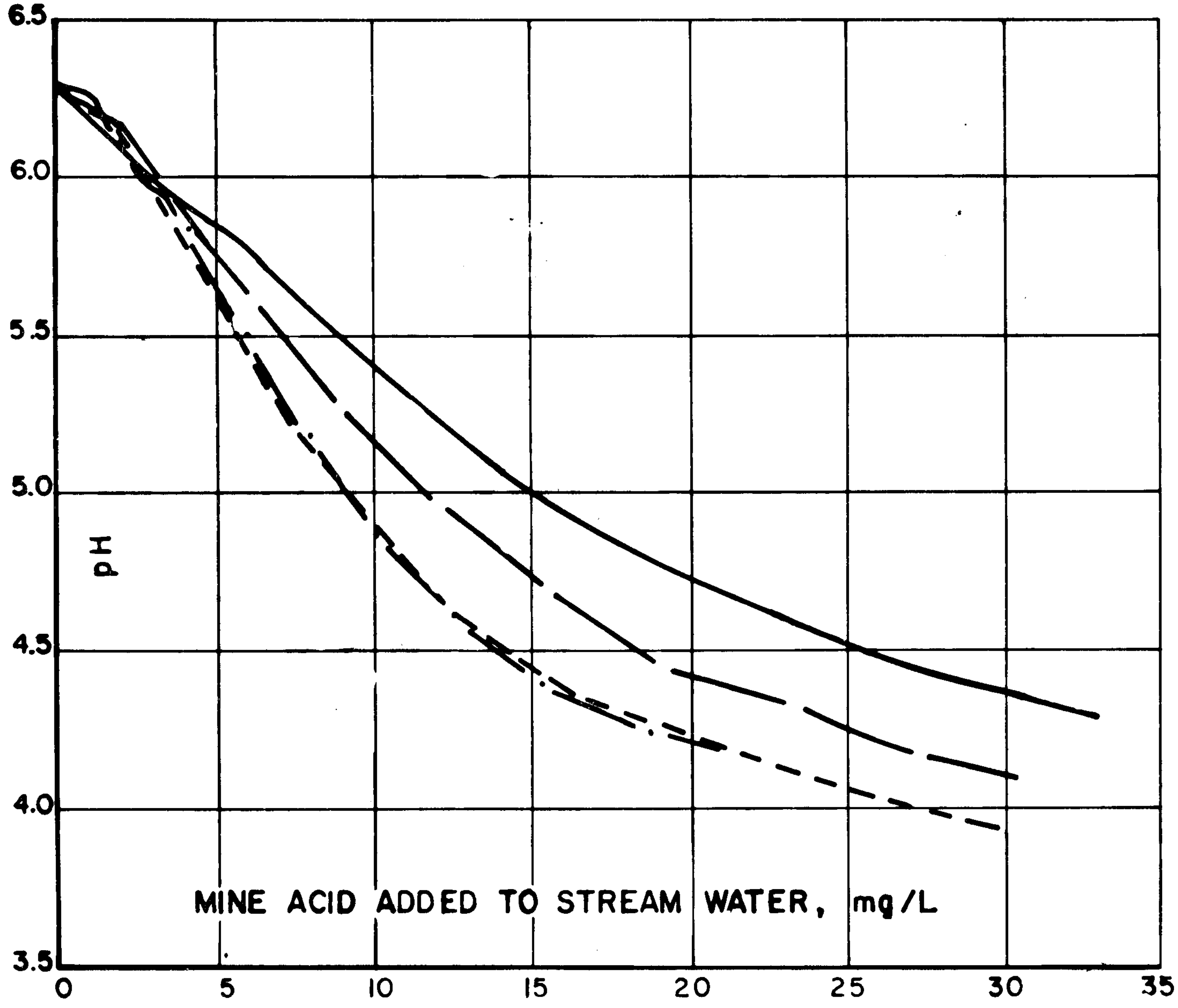
Pump discharges are sub-divided into average, normal and peak rates. Since pumps are either on or off, average pump age is a calculated rate as if the normal daily volume were pumped over 24 hours. Normal rate refers to the operation of the actual system and is the sum

A. W. MARTIN ASSOCIATES, INC. EXHIBIT 10

ASSIMILATIVE CAPACITY OF INDIGENOUS WATER FOR MINE ACID

·LEGEND·

SYMBOL	ACID SOURCE	ACIDITY AS $CaCO_3$, mg/L COLD	 HOT
———	#14 PUMPS	300	306
— —	SILVERBROOK MINE	120	113
- - - -	NEWKIRK MINE	212	232
—·—	WEST LEHIGH	690	695



A. W. MARTIN ASSOCIATES, INC. EXHIBIT 11

ASSIMILATIVE CAPACITY OF INDIGENOUS WATER FOR MINE ACID

·LEGEND·

SYMBOL	ACID SOURCE	ACIDITY AS $CaCO_3$, mg/L	
		COLD	HOT
—··—	E. ELM ST. SEEP	1520	1970
—x—	GREENWOOD SEEP N. BR. (COLD)	230	——
—▲—	GREENWOOD SEEP N. BR (HOT)	——	512

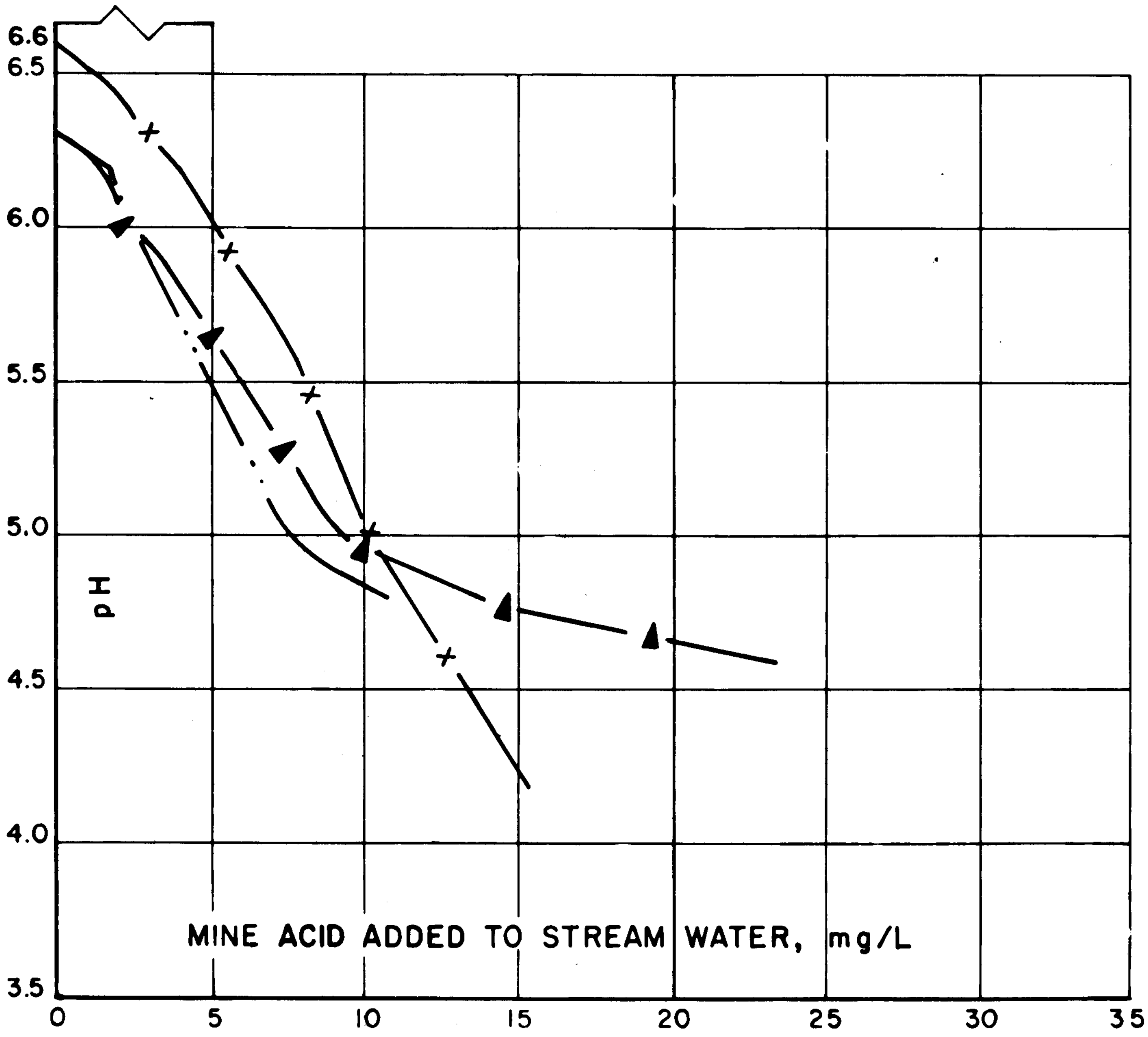


TABLE 1
MINE DRAINAGE POLLUTION IN THE LITTLE SCHUYLKILL RIVER BASIN UNDER AVERAGE WEATHER CONDITIONS

Receiving Stream & AMD Source	Discharge Rate, gpm	Acid		Iron		Sulfate	
		mg/l	lbs./day	mg/l	lbs./day	mg/l	lbs./day
Little Schuylkill River							
Silverbrook Mine	2,000	110	2,640	9	215	260	6,200
West Lehigh Shaft	140	700	1,175	100	170	1,200	2,015
A & D Mine	18	3,300	700	100	18	4,000	720
Zakrewsky Mine: Gravity	90	100	105	1	neg.	180	260
Misc.: Silverbrook Seeps	-	-	500	-	neg.	-	1,200
1st North Seep	-	-	100	-	neg.	-	300
Smith Mine	-	-	50	-	neg.	-	100
E. Elm St. Seep	-	-	660	-	neg.	-	100
Sub-Total			5,930		403		10,895
Zakrewsky Mine: Pump	980	220	-	11	-	235	-
Average Pumpage	250		660		33		705
Normal & Peak Rate	980		2,585		130		2,760
Wabash Creek							
Reevesdale #2 Drift	1,000	75	840	6	72	140	1,680
Newkirk Drainage Tunnel	400	85	410	14	67	190	910
Newkirk Mine	650	260	2,030	17	133	475	3,700
Misc.: Reevesdale #1 Drift	-	-	100	-	neg.	-	350
Reevesdale Seeps	-	-	80	-	neg.	-	150
Newkirk Seeps	-	-	1,400	-	neg.	-	1,400
Sub-Total			4,860		272		8,190
Panther Creek							
Coaldale #7 Mine	130	90	140	5	8	150	235
Greenwood Breaker	3,300	14	555	6	236	160	6,335
Misc.: Manbeck Seeps	-	-	1,500	-	neg.	-	5,500
Coaldale Seeps	-	-	1,500	-	neg.	-	3,900
Greenwood East Seep	-	-	500	-	neg.	-	1,800
Greenwood West Seep	-	-	1,350	-	neg.	-	500
Slum Creek	-	-	80	-	neg.	-	160
Sub-Total #1			5,625		244		18,430
Greenwood #10 Pumps (2)	3,100 & 3,850	0(net)	-	35	-	2,000	-
Average Pumpage	4,660		0		1,960		111,850
Normal & Peak Rate	6,950		0		2,920		166,800
Tamaqua #14 Pumps (2)	7,500 each	250	-	50	-	700	-
Average Pumpage	4,560		13,700		2,735		38,300
Normal Rate	7,500		22,500		4,500		63,000
Peak Rate	15,000		45,000		9,000		126,000
Sub-Total #2-Average			13,700		4,695		150,150
-Normal Rate			22,500		7,420		229,800
-Peak Rate			45,000		11,920		292,800
GRAND TOTAL LOAD WITHOUT PUMPS			16,415		919		37,515
GRAND TOTAL LOAD WITH PUMPS -AVERAGE			30,775		5,647		188,370
(Zakrewsky, #10 & #14) -NORMAL RATE			41,500		8,469		270,075
-PEAK RATE			64,000		12,969		333,075

of the output capacities of the pumps normally operated. Peak rate refers to the maximum capacity of the pumping station with all units operating. In some cases, for example Greenwood #10 Pumps, the normal and peak rate is identical as it is the practice to operate both pumps simultaneously.

Of the pollution load derived from the natural gravity discharges, approximately 36% of the acid is discharged directly to the Little Schuylkill River, with 34% and 30% going into the Panther and Wabash Creeks respectively.

The materials discharged by the pumps, shown as subtotals in the tabulation, add an enormous additional load to the basin. At normal pumping rates, the facilities increase the natural background acid, sulphate and iron levels by 150%, 500% and 725%, respectively. The two sources, Greenwood #10 and Tamaqua #14 pumps have the most significant impact on water quality in the entire Little Schuylkill Basin. Detailed data on the effluent quality from the Greenwood #10 and Tamaqua #14 pumps are included in Appendix B.

The discharges have been rated according to their average impact on the Little Schuylkill River in terms of acid, sulfate and iron on the following tables. The discharges have been divided into magnitude of impact into sources that contribute over 10%, between 1% and 10% and under 1% of the pollutional material.

Of the acid loads, there are two discharges in the First Order category, both from deep mines. Together they contribute 54.23% of the total acid impact on the stream.

The second group, designated Second Order Sources, include fifteen discharges in this category, seven from deep mines, seven from refuse seeps and one breaker discharge. Together they total 43.36% of the acid impact on the Little Schuylkill River.

The third group, designated Third Order Sources, include seven sources, five mine related discharges and two seeps from mine refuse. They total only 2.31% of the total acid impact on the stream.

Greenwood #10 discharge warrants further discussion in that, unlike all other drainage sources in the Basin it exhibits little or no acidity (net value). The pumpage's pH falls in the range of 5.8 and 7.1, averaging 6.3 and, rather than depressing the pH of the receiving stream, it generally tends to improve this factor.

When acidity titrations showed difficulty in reproducibility and also lower values upon sample aging, a side study into this matter was conducted. Pertinent data is given in Appendix B within the Greenwood #10 Mine Pump section. Briefly, the water showed considerable acidity when collected in the field and tested at the discharge pipe, 286 mg/l on July 11th and 267 mg/l on July 19th. Acidity decreased with sample age and the process was accelerated with aeration and boiling of the mine water. The final result of the longer July 19th test was a stable test value of 40 mg/l.

TABLE 2

RELATIVE IMPACT OF EACH ACID LOAD ON THE LITTLE SCHUYLKILL RIVER BASIN

		Average Load Lbs./Day	Basin Impact Lb.-Mi./Day	Portion of Total Impact %
First Order Sources				
Tamaqua #14 Pumps	PC	13,700	291,810	42.90
Silverbrook Mine	LSR	2,640	77,088	11.33
SUB-TOTAL		16,340	368,898	54.23
Second Order Sources				
Newkirk Mine	WC	2,030	43,030	6.32
Coal dale Seep	PC	1,500	32,100	4.72
Manbeck Seeps	PC	1,500	31,950	4.69
Newkirk Seeps	WC	1,400	29,680	4.36
Greenwood West Seep	PC	1,350	28,890	4.23
West Lehigh Shaft	LSR	1,175	24,790	3.64
Reevesdale #2 Drift	WC	840	17,892	2.63
A & D Mine	LSR	700	14,770	2.17
Silverbrook Seeps	LSR	500	14,600	2.14
E. Elm St. Seep	LSR	660	14.190	2.08
Zakrewsky Pump	LSR	660	14,058	2.06
Greenwood Breaker	PC	555	11,880	1.74
Greenwood East Seep	PC	500	10,700	1.57
Newkirk Drainage Tun.	WC	410	8, 690	1.27
SUB-TOTAL		13,690	295,320	43.36
Third Order Sources				
Coaldale #7 Mine	PC	140	3,000	0.44
Zakrewsky Mine (Grav.)	LSR	105	2,270	0.33
Reevesdale #1 Drift	WC	100	2,120	0.31
First North Seep	LSR	100	2,110	0.31
Slum Creek	PC	80	1,710	0.25
Reevesdale Seeps	WC	80	1,690	0.24
Smith Bros. Mine	LSR	50	1,050	0.16
SUB-TOTAL		745	15,850	2.31
GRAND TOTAL		30,775	680,068	99.89

Note: Greenwood #10 Pumps normally show an alkalinity in excess of its acidity, for no net acid contribution; however, a net acidity as high as 40 mg/l has been measured, corresponding to an acid load of 2,240 lbs. / day.

Sources drain into:
PC - PANTHER CREEK
WC - WABASH CREEK
LSR - LITTLE SCHUYLKILL RIVER

TABLE 3

RELATIVE IMPACT OF EACH SULFATE LOAD ON THE LITTLE SCHUYLKILL RIVER BASIN

		Average Load Lbs./Day	Basin Impact Lb.-Mi./Day	Portion of Total Impact %
First Order Sources				
Greenwood #10 Pumps	PC	111,850	2,382,405	58.52
Tamaqua #14 Pumps	PC	38,300	815,790	20.04
SUB-TOTAL		150,150	3,198,195	78.56
Second Order Sources				
Silverbrook Mine	LSR	6,200	181,040	4.44
Greenwood Breaker	PC	6,335	134,936	3.31
Manbeck Seeps	PC	5,500	117,150	2.87
Coaldale Seeps	PC	3,900	83,070	2.04
Newkirk Mine	WC	3,700	78,810	1.93
West Lehigh Shaft	LSR	2,015	42,920	1.05
SUB-TOTAL		27,650	637,926	15.64
Third Order Sources				
Greenwood East Seep	PC	1,800	38,340	0.94
Reevesdale #2 Drift	WC	1,680	35,784	0.87
Silverbrook Seeps	LSR	1,200	35,040	0.86
Newkirk Seeps	WC	1,400	29,820	0.73
Newkirk Drainage Tun.	WC	910	19,383	0.47
A & D Mine	LSR	720	15,336	0.37
Zakrewsky Mine Pump	LSR	705	15,017	0.36
Greenwood West Seep	PC	500	10,650	0.26
Reevesdale #1 Drift	WC	350	7,455	0.18
First North Seep	LSR	300	6,390	0.15
Zakrewsky Mine (Grav.)	LSR	260	5,538	0.13
Coaldale #7 Mine	PC	235	5,006	0.12
Slum Creek	PC	160	3,408	0.08
Reevesdale Seeps	WC	150	3,195	0.07
Smith Bros. Mine	LSR	100	2,130	0.05
E. Elm St. Seep	LSR	100	2,130	0.05
SUB-TOTAL		10,570	234,622	5.69
GRAND TOTAL		188,370	4,070,743	99.89

Sources discharge into:
PC - PANTHER CREEK
WC - WABASH CREEK
LSR - LITTLE SCHUYLKILL RIVER

TABLE 4

RELATIVE IMPACT OF EACH IRON LOAD ON THE LITTLE SCHUYLKILL RIVER BASIN

		Average Load Lbs ./Day	Basin Impact Lb. -Mi./Day	Portion of Total Impact %
First Order Sources				
Tamaqua #14 Pumps	PC	2,735	58,256	47.75
Greenwood #10 Pumps	PC	1,960	41,748	34.22
SUB-TOTAL		4,695	100,004	81.97
Second Order Sources				
Silverbrook Mine	LSR	215	6,278	5.14
Greenwood Breaker	PC	236	5,027	4.12
West Lehigh Shaft	LSR	170	3,621	2.96
Newkirk Mine	WC	133	2,833	2.32
Reevesdale #2 Drift	WC	72	1,534	1.25
Newkirk Drainage Tun.	WC	67	1,427	1.16
SUB-TOTAL		893	20,720	16.95
Third Order Sources				
Zakrewsky Mine Pump	LSR	33	703	0.57
A & D Mine	LSR	18	383	0.31
Coaldale #7 Mine	PC	8	170	0.13
SUB-TOTAL		59	1,256	1.01
GRAND TOTAL		5,647	121,980	99.93
Silverbrook Seeps	LSR	Negligible		
First North Seep	"	"		
Smith Bros. Mine	"	"		
E. Elm St. Seep	"	"		
Zakrewsky Mine (Grav.)	"	"		
Reevesdale #1 Drift	WC	Negligible		
Reevesdale Seeps	"	"		
Newkirk Seeps	"	"		
Manbeck Seeps	PC	Negligible		
Coaldale Seeps	"	"		
Greenwood East Seep	"	"		
Greenwood West Seep	"	"		
Slum Creek	"	"		

Sources drain into:

PC - PANTHER CREEK
WC - WABASH CREEK
LSR - LITTLE SCHUYLKILL RIVER

Considering the mine water's pH and behavior characteristics, it is concluded that the water contains a high concentration of carbon dioxide, which can subsequently be airstripped or boiled off. The final titratable acidity is attributed to the hydrolysis and precipitation of the iron by the standard sodium hydroxide employed for the analysis. The mine water contains no free mineral acidity,

D. QUALITY OF STREAMS AFFECTED BY ACID MINE DRAINAGE

The analytical results of three sampling runs under three different flow conditions have been extracted from the data derived from the routine sampling program shown in Appendix A. Exhibits 12, 13, 14 and 15, placed at the end of this report section, show the chemical parameters of pH, acid, sulfate, and iron and typifies conditions of the Little Schuylkill River during high, mean and low flows.

Projected on the curves for reference is the calculated impact of the mine pumps, if they were operating at normal rates at the time of sampling. A discussion of the impact of the mine pumps will be presented in the next report section.

Of the four parameters measured, pH, acidity, sulfate and iron, pH shows the least change with different flow conditions. Because the Silverbrook discharge is at the Little Schuylkill's headwaters, the pH is consistently low from the very beginning of the River. In the downstream direction, the pH gradually improves with the addition of water from unpolluted tributary streams; however, upon reaching the

Tamaqua basin, the stream is again degraded by acid mine drainage.

As the data show. the clean tributary waters are insufficient to dilute and/or neutralize the discharge from the Silverbrook Mine so as to realize an acceptable pH value in the nine mile reach of stream before Tamaqua. Best conditions fall below the confluence with Locust Creek. the largest tributary in the study area and the one most downstream toward Tamaqua. However. pH levels at the point rarely exceed values of 5.5. Of 15 samples collected over 17 months only two showed values greater than 5 .5 and the total averaged 4.9. Thus, at no point on the Little Schuylkill River in the study area is the pH acceptable for normal aquatic life or common water uses.

With respect to acidity, the curves show a greater variation with stream flow than was shown by pH. Immediately upstream of the Silverbrook Mine discharge is a pond west of Highway Route 309. During dry weather this pond has no discharge and the Little Schuylkill River begins with the Silverbrook Mine effluent. During wetter weather the pond receives surface flow from a drainage channel from the north, plus sub-surface acid mine drainage. This pond's effluent comprised the samples collected upstream of the Silverbrook Mine discharge. Sample Station #1, and its chemical quality reflects the relative amounts of surface runoff and sub-surface contamination.

The curves show lower acid concentrations with greater flows reflecting dilution. The steeper downward slope of the curves under conditions of low flows indicate that the relative addition of Silverbrook Mine pollution is proportionally greater than the dilution provided by the clean water from tributaries. It is important to note that even though acidities are sometimes diluted to quite low values, pH levels remain unsatisfactory.

On the subject of sulfates, the Silverbrook Mine is not a large generator of this ion. The sulfate level of the main discharge reaches 200 mg/l as a limit and sometimes falls below 100 mg/l. From a standpoint of sulfates, then, the Little Schuylkill River downstream to Tamaqua shows sulfate concentrations reasonable for most uses and even satisfactory for aquatic needs below the confluence of Neifert Creek, 3- 3/4 miles downstream of Silverbrook.

Below the Tamaqua basin, the river quality again reflects additional mine drainage. Even so, the downstream quality (without the pumps on Panther Creek operating) is still adequate for most uses, but sulfates are excessive to provide good fishing waters.

The curves relative to iron similarly illustrate an improvement in quality downstream from the Silverbrook Mine to Tamaqua; however its level throughout the entire study area nearly always exceeds the 0.35 mg/l limit desirable for drinking and general use. Within one section of the River, between Pine and Panther Creeks) the iron quality is generally suitable for fishing.

Exhibits 16, 17, 18 and 19, Stream Quality at Critical Stations, show a similar situation in a different manner. The value of the water quality parameter is presented for each of the 17 sampling months at 5 critical stations. These stations are: (1) Little Schuylkill River below Silverbrook; (2) Little Schuylkill River below the confluence of Locust Creek, the reach of stream having the highest water quality in the study area; (3) Panther Creek at its mouth; (4) Wabash Creek at its mouth and (5) the Little Schuylkill River below all acid mine drainage discharges.

In the overview, the 17 months of data show no quality trend for any of the 4 parameters measured. Quality generally improves with stream runoff (dilution), except peaks in iron concentrations many times follow higher flows, indicating the resuspension of precipitated iron from the stream bed.

On the subject of pH, the data again show that except for rare cases between the Locust Creek and Tamaqua, pH values are completely unsatisfactory. The River above Tamaqua shows a greater response to stream flow, while pH deviations as a whole are small. Both polluted tributaries exhibit pH values consistently below 5 and, as the itemized data Appendix A will show, the low pH values carryon back through the two streams all the way to their headwaters.

Acid concentrations are the greatest, nearly consistently, from the Wabash Creek. This creek also shows the greatest fluctuation in concentration, due principally to the Reevesdale #2 Drift and Newkirk Mine discharges, which introduce lag time between rainfall and its effect on the discharge rates. During the survey period, the mouth of the Wabash consistently showed acidities greater than 45 mg/l and an average in excess of 100 mg/l.

At the mouth of the Panther Creek, acid values were within the relatively narrow range of 20 to 90 mg/l. Although it shows lower concentrations than the Wabash, its substantially higher flow causes the Panther Creek to contribute a greater quantity of pollution.

Assimilation of the Silverbrook effluent is again evident in the River's quality below Locust Creek. However, although acid concentrations are reduced to quite low values, the water's chemical composition is such that low pH prevails.

The curves indicating the quality below Tamaqua show the impact of the acid mine drainage received from the two polluted tributaries. The seemingly out-of-line high chemical values reported in October can only be attributed to the presence of Tamaqua #14 pump age between the time the mouth of the Panther Creek was sampled and the final downstream river sample was collected.

The curves related to sulfates again show the two tributary streams in poor condition. However, in this case, Panther Creek frequently shows considerably higher sulfates than the Wabash. These levels are due to either refuse bank seepage following wet weather or the effects of residuals from the Greenwood #10 pumps.

The River below the confluence with Locust Creek exhibits acceptable sulfate concentrations throughout the entire 17 months. Below Tamaqua, however, sulfates increase to levels beyond that which will support good fishing, but for the most part satisfactory for general water uses.

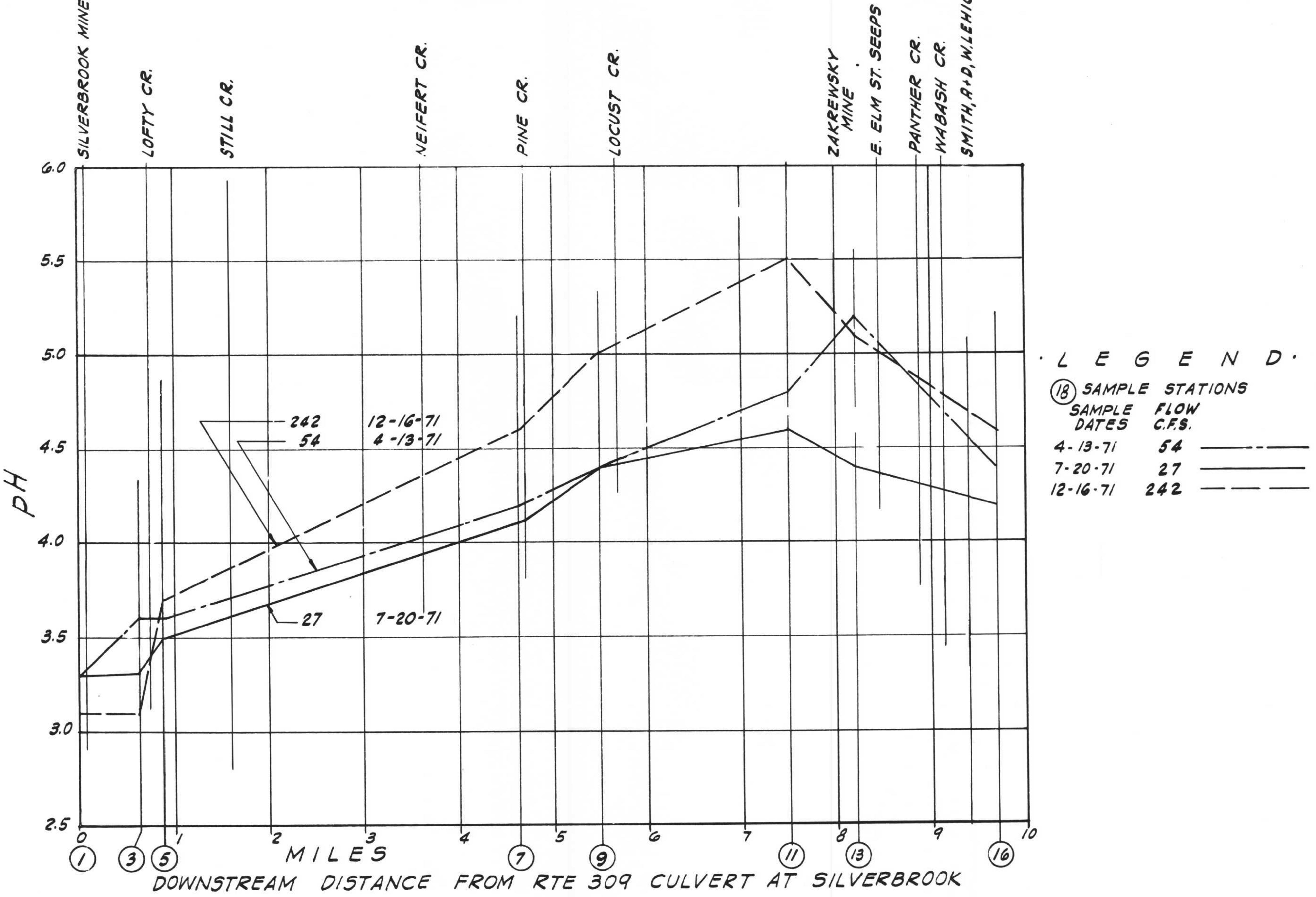
On the matter of iron, the reach of stream just above Tamaqua again shows good quality in this respect. Otherwise, mine drainage renders the river unsuitable for most uses with respect to this quality parameter.

In considering the quality data as a whole, neither sulfate nor iron concentrations are especially high between Silverbrook and Tamaqua and neither are these parameters particularly excessive below Tamaqua when the pumps are not operating. For that matter, neither is the acidity concentration especially high for most of the stream most of the time. However, its depression of the pH makes this factor crucial to the rehabilitation of the Little Schuylkill River. An abatement program which eliminates the production of a reasonable amount of acid mine drainage, for example through surface reclamation and/or mine sealing, will in itself assure adequate iron and sulfate control. The removal of the remainder of the acidity, whether by abatement or treatment, must be extremely thorough, however, as satisfactory pH values are not secured without essentially complete acid elimination.

A.W.MARTIN ASSOCIATES, INC.

EXHIBIT 12

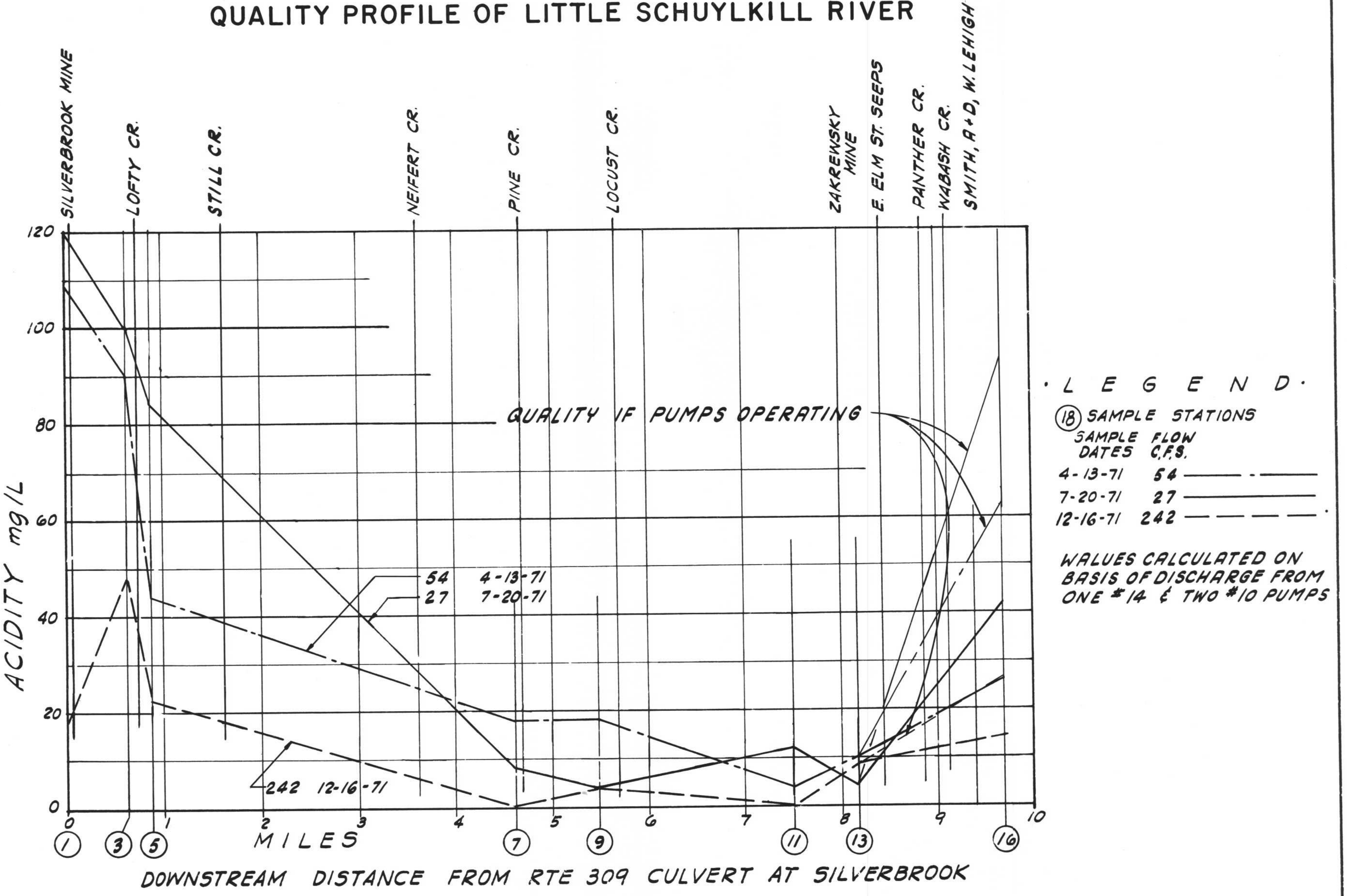
QUALITY PROFILE OF LITTLE SCHUYLKILL RIVER



A.W. MARTIN ASSOCIATES, INC.

EXHIBIT 13

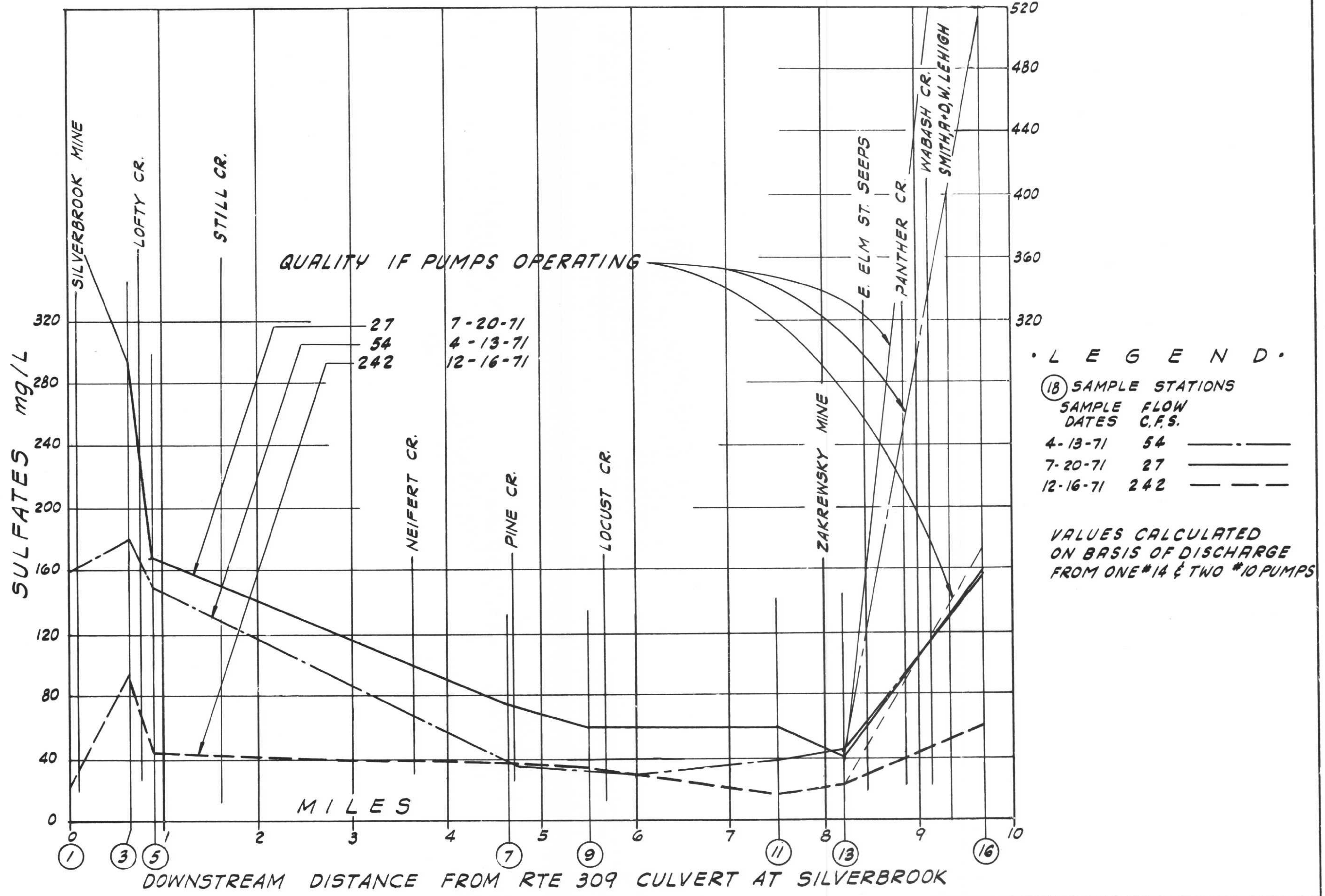
QUALITY PROFILE OF LITTLE SCHUYLKILL RIVER



A.W. MARTIN ASSOCIATES, INC.

EXHIBIT 14

QUALITY PROFILE OF LITTLE SCHUYLKILL RIVER

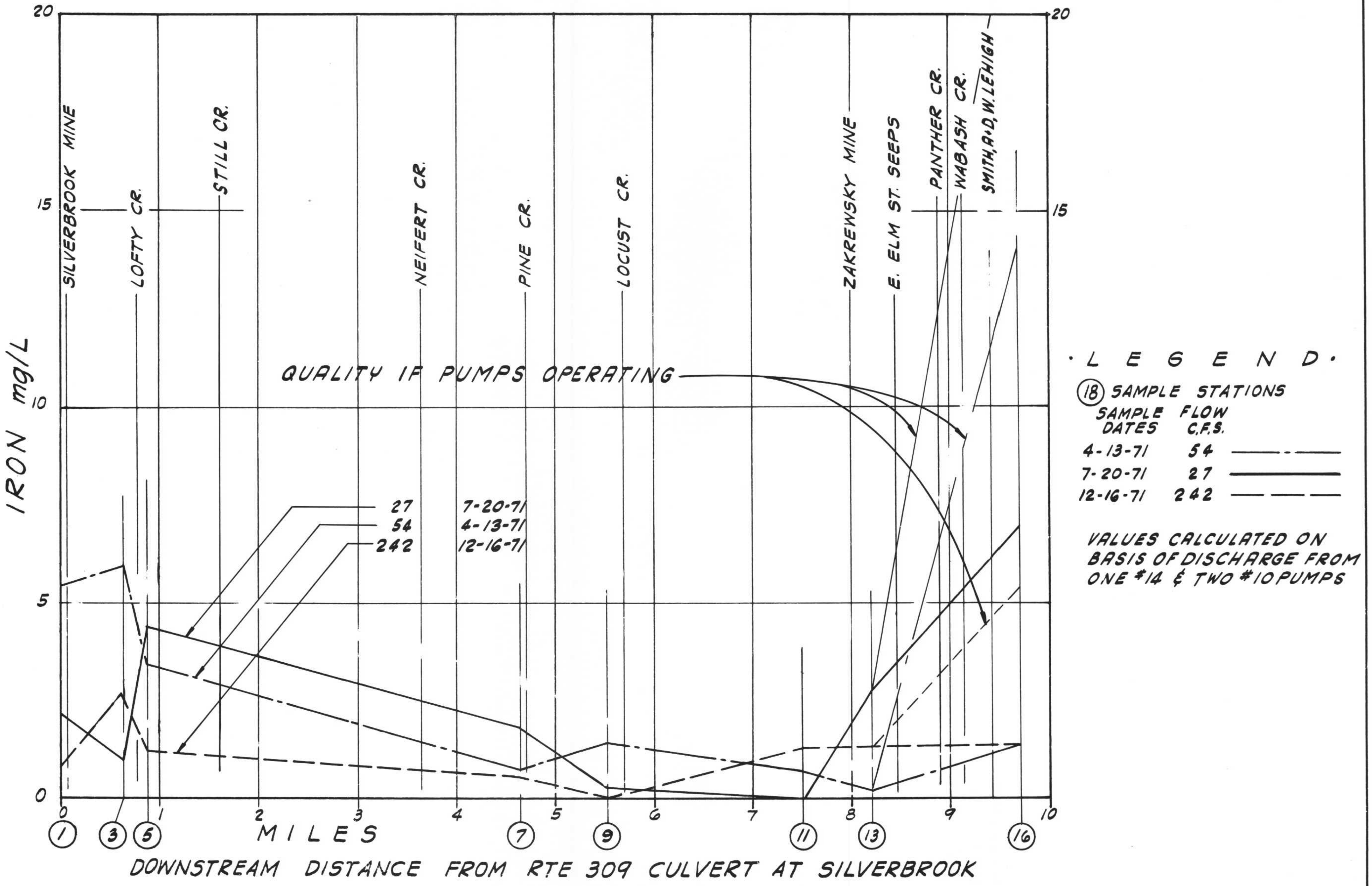


VALUES CALCULATED ON BASIS OF DISCHARGE FROM ONE #14 & TWO #10 PUMPS

A. W. MARTIN ASSOCIATES, INC.

EXHIBIT 15

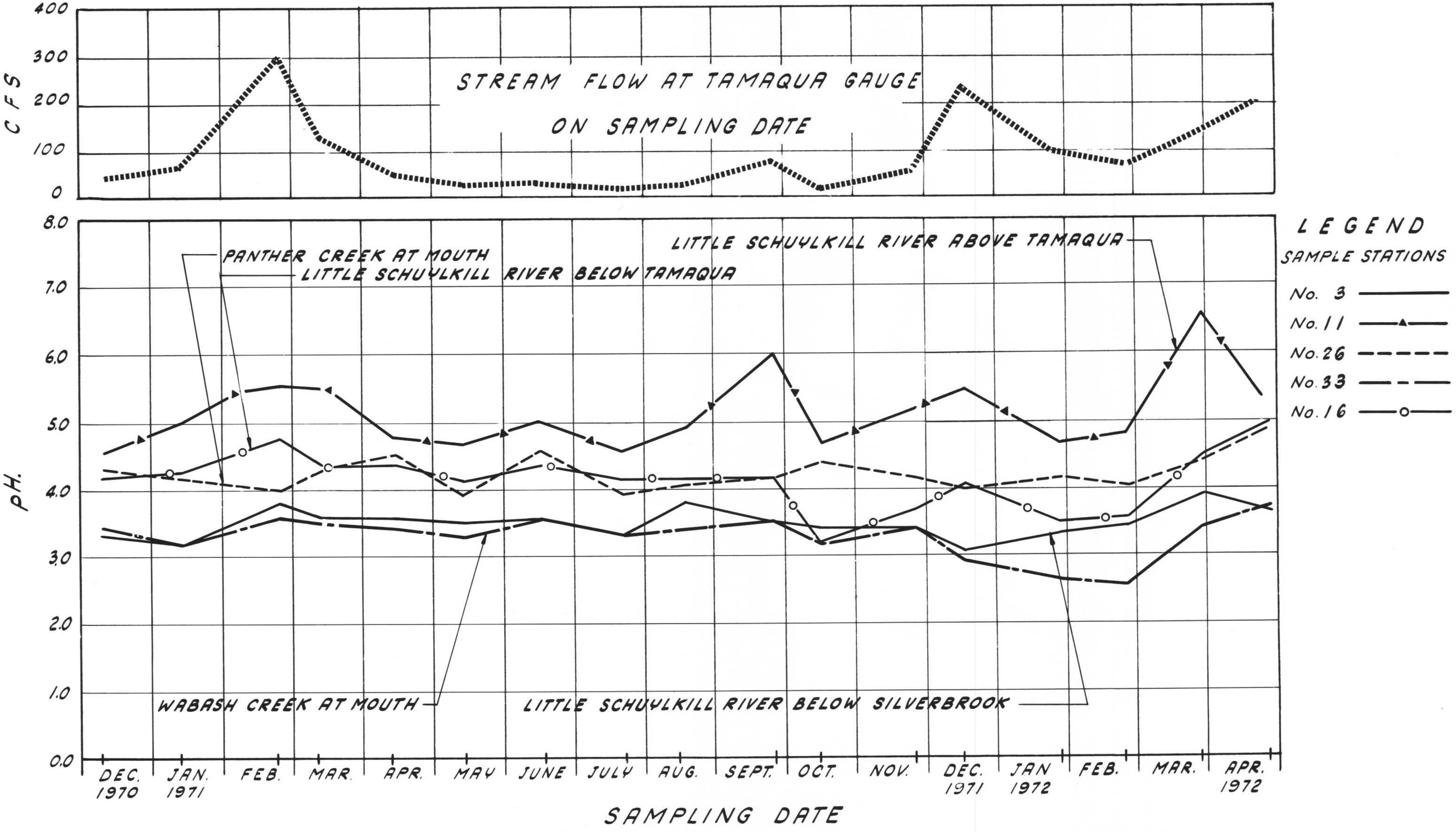
QUALITY PROFILE OF LITTLE SCHUYLKILL RIVER



A.W. MARTIN ASSOCIATES, INC.

EXHIBIT 16

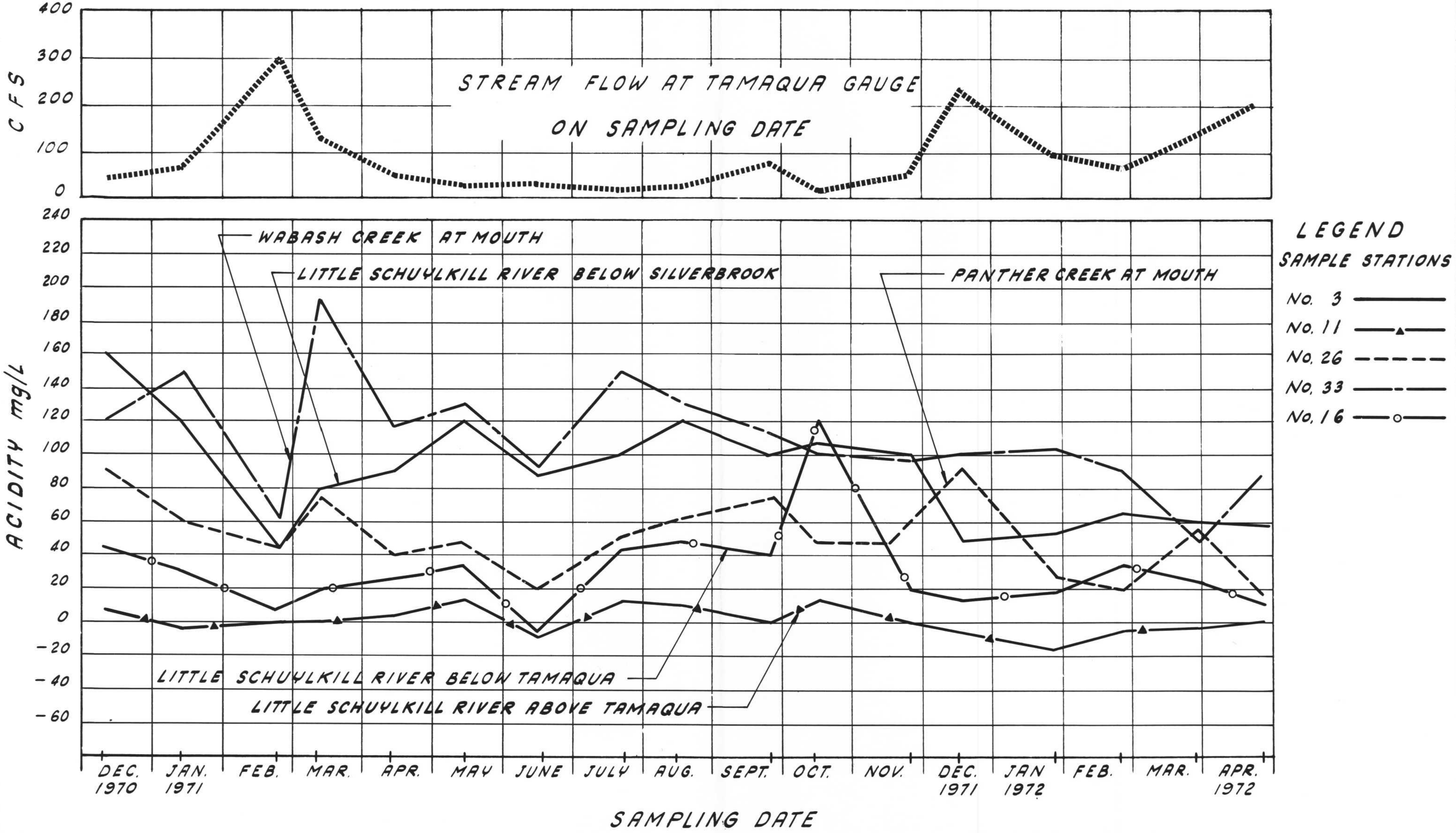
STREAM QUALITY AT CRITICAL STATIONS



A.W. MARTIN ASSOCIATES, INC.

EXHIBIT 17

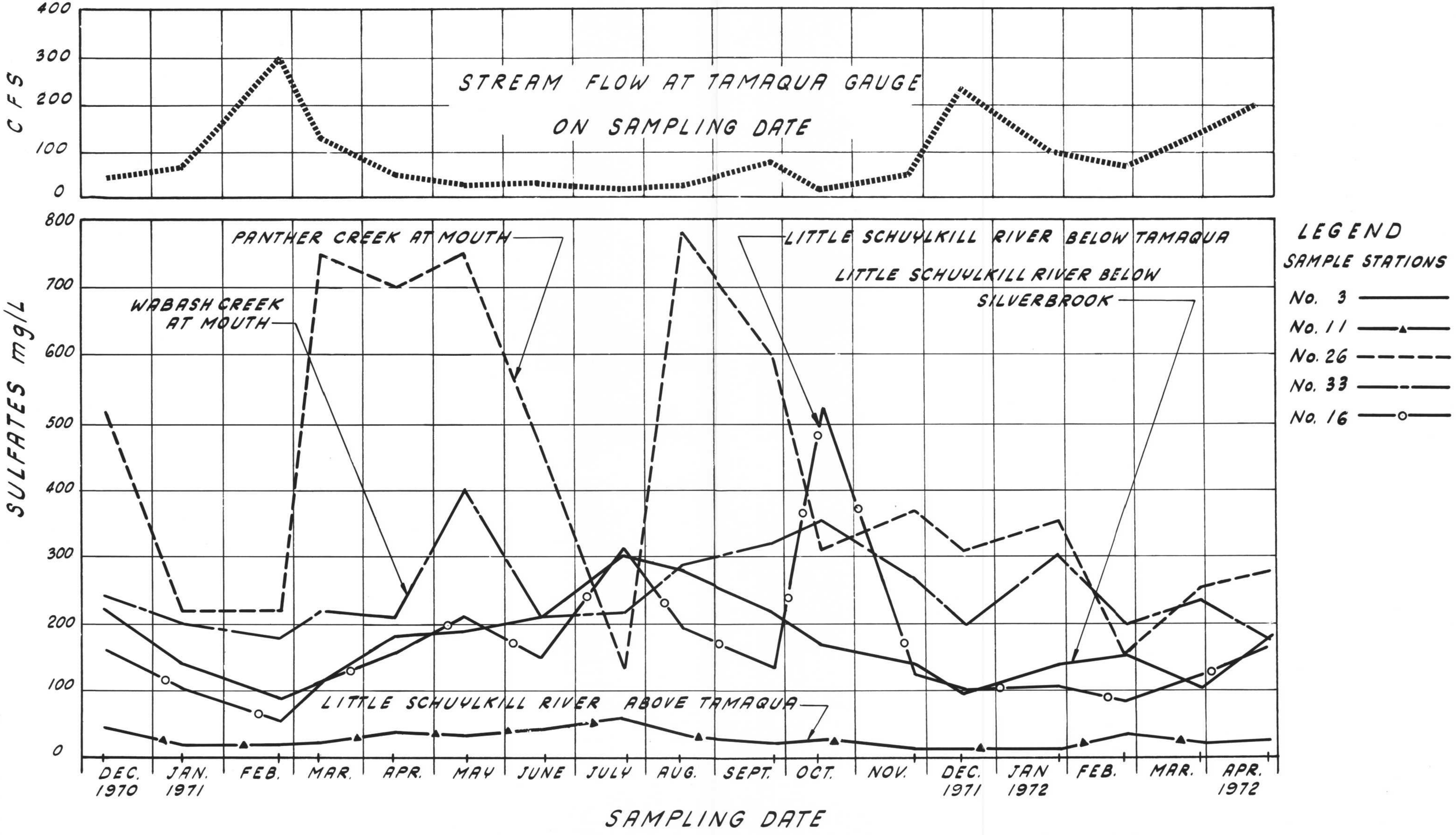
STREAM QUALITY AT CRITICAL STATIONS



A.W. MARTIN ASSOCIATES, INC.

EXHIBIT 18

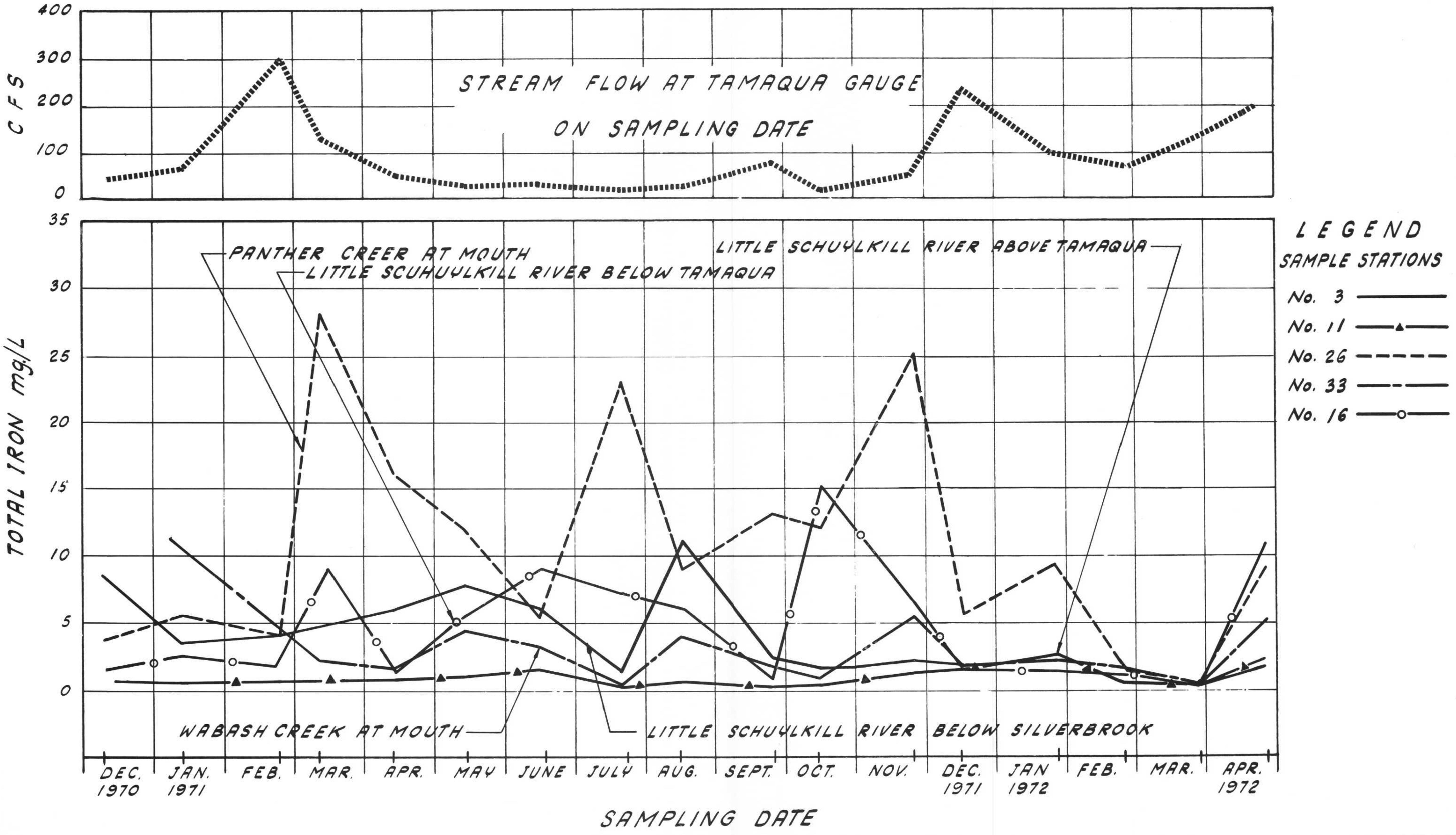
STREAM QUALITY AT CRITICAL STATIONS



A.W. MARTIN ASSOCIATES, INC.

EXHIBIT 19

STREAM QUALITY AT CRITICAL STATIONS



E. IMPACT OF MINE PUMPAGE ON STREAM QUALITY

The chemical quality of the Little Schuylkill River and its tributaries compiled in Appendix A and visually presented by Exhibits 12 thru 19 were secured from the routine sampling program, during which time neither the Greenwood #10 nor the Tamaqua #14 Pumps were operated. It is apparent from the pH values, then, that the acid contributed by the natural sources is sufficient of itself to degrade the Panther and Wabash Creeks from their headwaters to their mouths and the entire Little Schuylkill River from its beginning to beyond the limit of the study area, below Tamaqua .

With the Greenwood #10 and Tamaqua #14 Pumps being the greatest sources of mine water pollution, the scope of the study was expanded on a limited basis to the measurement of the downstream impact on the River by the Pumps.

The securing of this information was a complex task, principally because of the difficulty of securing equilibrium conditions in the reach of the stream under investigation. Complications in the matter are: 1) The pumps operate intermittently on an as-required basis, rather than any established schedule and 2) in order to secure favorable power rates, the pumps operate mainly on off-peak hours. Under normal conditions, both Greenwood #10 Pumps operate most nights and the weekends, while the Tamaqua #14 Pumps alternate operation mainly on weekends and only occasionally a weeknight.

During the Summer of 1972, however, when the Pumps were subject to study, one #10 Pump was down for maintenance, so that the second pump operated nearly 100% of the time. Still a further complication (3) was that #10's discharge was diverted to a process water holding pond, that supplies a fine coal recovery plant, on no set schedule, but roughly during much of the day shift. Then (4), six miles below Tamaqua is a desilting basin operated by the Pennsylvania Department of Forests and Waters and its mass offers attenuation of the composition of the influent and introduces a considerable lag in the downstream effect. Still another problem (5) was precipitation and, because of the unstable conditions surface runoff introduces, sampling runs were called off when rain occurred.

The difficulties notwithstanding, several downstream sampling runs were successfully completed and clearly show the downstream impact of the pumps. The results of river quality surveys conducted during June, July, August and September, under various conditions of stream flow and pump operations, are compiled on the following pages Table 5 through 8.

The data disclosed that the lower reach of the Little Schuylkill River is adversely affected by acid mine drainage to its very mouth. pH conditions were unacceptable throughout the entire period, even under good stream flow and minimal mine pumpage, as on June 8, 1972.

TABLE 5

STREAM QUALITY AT TAMAQUA AND BELOW DURING VARIOUS CONDITIONS OF PUMPING

	6/8/72		6/15/72		6/26/72	
Pumping Conditions	1-#10		1-#10 & 1-#14		1-#10 &1- #14	
Flow at Tamaqua Gage, CFS	107		65		1270	
	pH	Acidity	pH	Acidity	pH	Acidity
Little Schuylkill above Tamaqua	5.0	5	4.5	7	4.7	9
Panther at Mouth	4.4	36	3.4	104	4.1	149
Wabash at Mouth	3.2	86	3.5	84	3.5	111
Little Schuylkill below Tamaqua	4.0	23	3.7	45	4.1	26
Little Schuylkill at South Tamaqua	4.2	21	3.9	43	4.5	21
Little Schuylkill at New Ringgold	4.3	18	4.0	28	-	-
Little Schuylkill at Port Clinton	4.5	13	4.1	24	-	-
Main Stem at Auburn	-	-	6.4	10	-	-
Main Stem at Hamburg	-	-	6.3	5	-	-

TABLE 6

STREAM QUALITY AT TAMAQUA AND BELOW DURING VARIOUS CONDITIONS OF PUMPING

	7/15/72			7/18/72			7/28/72
Pumping Conditions	1-#10 & 1-#14			1-#10			1-#10 & 1-#14
Flow at Tamaqua Gage, CFS	47			39			23
	pH	Acidity	Sulfate	pH	Acidity	Sulfate	Acidity (1)
Little Schuylkill above Tamaqua	5.0	21	42	4.8	17	38	11
Panther at Mouth	4.5	190	720	4.6	66	960	166
Wabash at Mouth	4.0	126	226	3.9	104	205	107
Little Schuylkill Below Tamaqua	4.4	80	315	4.5	43	226	87
Little Schuylkill at South Tamaqua	-	-	-	4.5	44	280	75
Little Schuylkill at New Ringgold	4.8	40	250	-	-		53
Little Schuylkill at Port Clinton (2)	5.0	20	187	-	-		36
Main Stem at Auburn (2)	6.1	15 (Alk.5)	255	-	-		13 (Alk. 25)
Main Stem at Hamburg (2)	5.7	9 (Alk.3)	235	-	-		11 (Alk. 15)

(1) pH meter out of order.

(2) Values do not show effect of acid expected; #14 pump had been running 27 hours before sampling, but it is believed time lag delayed impact,

TABLE 7

STREAM QUALITY AT TAMAQUA AND BELOW DURING PUMPING AT LOW FLOW CONDITIONS (1)

Pumping Conditions: 1-#10 all the time, 1-#14 from 4: 00 P.M. 8/18 to 7: 00 A.M. 8/21

	8/19/72		8/21/72	
Flow at Tamaqua Gage, CFS (Prov.)	5.5		2.8	
Flow at Berne Gage, CFS (Prov.)	396		378	
	pH	Acidity	pH	Acidity
Little Schuylkill above Tamaqua	3.9	23	-	-
Panther at Mouth	3.1	165	-	-
Wabash at Mouth	3.5	98	-	-
Little Schuylkill below Tamaqua	3.2	110	-	-
Little Schuylkill at South Tamaqua	3.2	96	-	-
Little Schuylkill at New Ringgold	3.7	46	-	-
Little Schuylkill at Port Clinton	3.9	32	3.8	51
Main Stem at Auburn	-	-	6.4	10 (Alk. 27)
Main Stem at Hamburg	-	-	5.3	16 (Alk. 11)

(l) Low flows only present in Little Schuylkill Basin:

Magnitude of Low Flows, CFS

Recurrence Interval	at Tamaqua	at Berne
7 Day - 2 Year	10	120
7 Day - 10 Year	4.8	100

TABLE 8

STREAM QUALITY AT TAMAQUA AND BELOW DURING PUMPING AT LOW FLOW CONDITIONS

9/10/72 - 9/12/72

Pumping Conditions: 2-#10 all the time, 1-#14 from 2: 00 P.M. 9/8 until 6: 00 A.M. 9/11/72

9/10/72

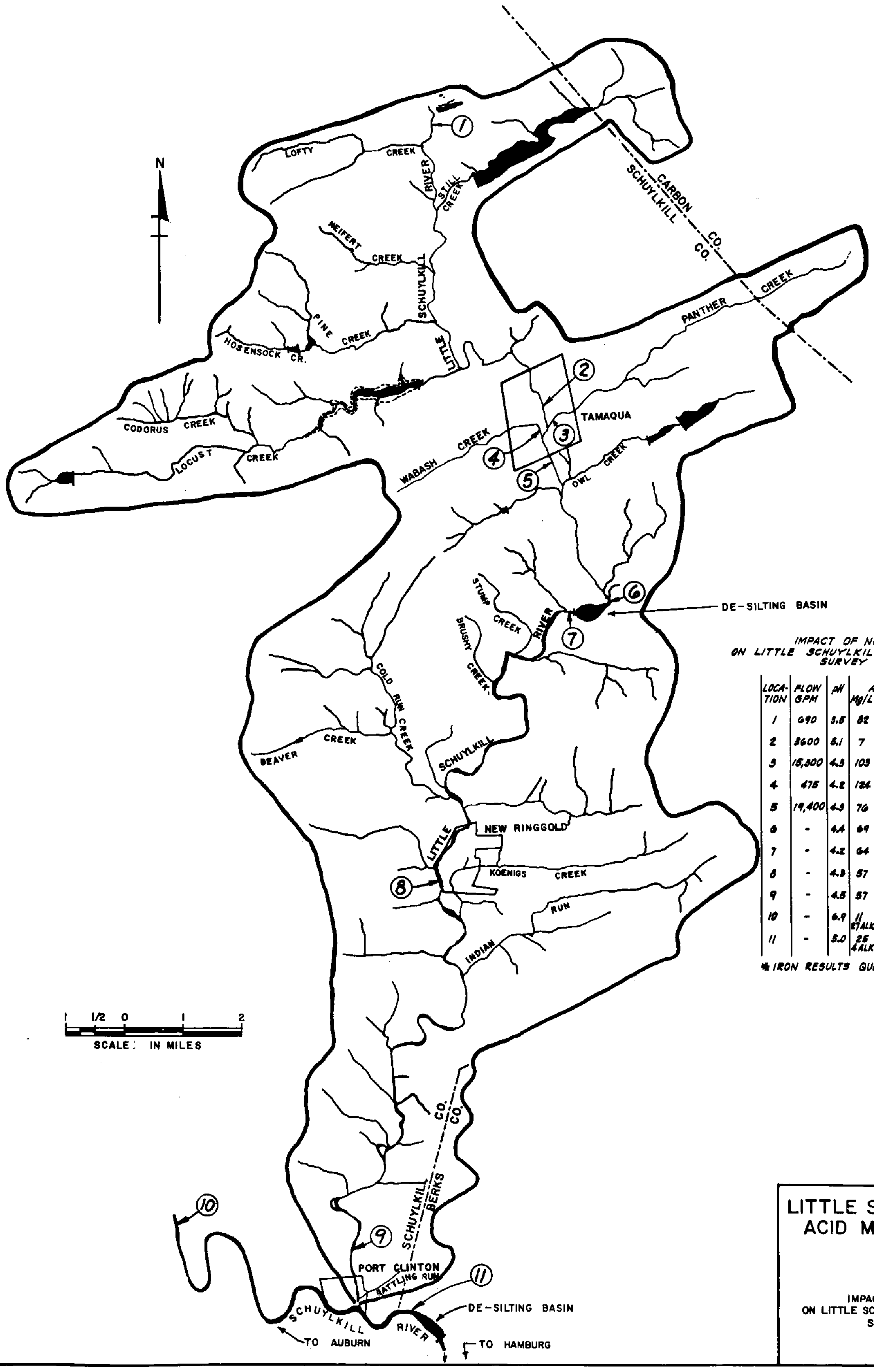
Estimated Flows: Little Schuylkill at Tamaqua, CFS (est.) - 8
Main Stem at Berne, CFS (est.) - 350

	pH	Acidity (Alkalinity)	Total Iron		Sulfate
			Acid Fixed	Not Fixed	
Little Schuylkill above Tamaqua	5.1	10 (3)	7.66	0.21	84
Panther at Mouth	4.3	103	48.0	30.8	1230
Wabash at Mouth	4.2	123	18.0	8.0	280
Little Schuylkill below Tamaqua	4.3	76	22.6	23.3	850
Little Schuykill at South Tamaqua	4.4	69	23.8	13.5	860
Little Schuylkill at New Ringgold	4.3	57	1.82	0.27	400
Little Schuylkill at Port Clinton	4.4	44	0.47	0.24	330
Main Stem at Auburn	6.7	12 (22)	0.63	0.47	310
Main Stem at Hamburg (above desilting basin)	5.4	16 (5)	0.90	0.30	295

9/12/72

Estimated Flows: Little Schuylkill at Tamaqua, CFS (est.) - 8
Main Stem at Berne. CFS (est.) - 350

Little Schuylkill at New Ringgold	4.6	25 (1)	2.36	1.06	350
Little Schuylkill at Port Clinton	4.5	57	2.76	0.32	420
Main Stem at Auburn	6.9	11 (27)	1.56	0.50	390
Main Stem above Hamburg (above desilting basin)	5.0	25 (4)	3.52	0.24	450



IMPACT OF NORMAL PUMP OPERATION
ON LITTLE SCHUYLKILL RIVER AT LOW FLOW CONDITIONS
SURVEY SEPT. 10 TO 12, 1972

LOCATION	FLOW GPM	pH	ACID		SULFATE		IRON	
			Mg/L	LBS/DAY	Mg/L	LBS/DAY	Mg/L	LBS/DAY
1	690	3.5	82	675	320	2650	9.0	75
2	3600	6.1	7	300	84	3600	7.6*	330*
3	15,300	4.3	103	19,000	1230	226,000	48	8800
4	475	4.2	124	710	280	1600	18	100
5	19,400	4.3	76	18,000	860	200,000	23	5260
6	-	4.4	69	-	860	-	29	-
7	-	4.2	64	-	680	-	9	-
8	-	4.3	57	-	400	-	1.8	-
9	-	4.5	57	-	420	-	2.8	-
10	-	6.9	11 27 ALK.	-	390	-	1.6	-
11	-	5.0	25 4 ALK.	-	450	-	3.5	-

* IRON RESULTS QUESTIONABLE

LITTLE SCHUYLKILL RIVER BASIN
ACID MINE DRAINAGE STUDY

A. W. MARTIN ASSOCIATES, INC.
Consulting Engineers
KING OF PRUSSIA, PA. - PHILADELPHIA, PA.

IMPACT OF NORMAL PUMP OPERATION
ON LITTLE SCHUYLKILL RIVER AT LOW FLOW CONDITIONS
SURVEY SEPT. 10 TO 12, 1972

EXHIBIT 20

June 15 data showed a doubling in the acidities over June 8, the result of a combination of lower flow and the addition of one Tamaqua #14 Pump to the already operating Greenwood #10 Pump. Negligible effect on the main stem of the Schuylkill River is indicated.

The information collected June 26th was four days after the tropical storm Agnes and, in spite of the enormous amount of dilution from surface runoff, acidities are still significant and pH values are unacceptably low,

The July 15 and July 18 sampling runs were a two-part collection series to specifically reveal conditions at mean stream flow with and without the operation of one Tamaqua #14 Pump (together with the one #10 Pump). A comparison of the data shows that without the #14 Pump, downstream acidities are halved; however, pH values as usual are but little reduced.

Sulfate levels downstream on both days are somewhat higher than the upper desirable limit. It is noteworthy, too, that the Main stem is similarly excessive in sulfates.

The pH on the Main Stem at Hamburg showed a slightly adverse effect, which was not so apparent in June with higher stream flows.

The survey of July 15 was an extensive and comprehensive pollution study. Samples for quality analysis were collected upstream and downstream of all significant acid mine drainage discharges. In addition to the Tamaqua gage, stream flow measurements were made at several locations on the Wabash and Panther Creeks. The result of this program is presented on Exhibit 30,

The data of July 28th show conditions at still lower flows, with predictable results.

In August and September extremely low flow conditions were experienced. The sampling runs in these two months were split with the lower river reach being sampled two days later to compensate for chemical attenuation and the time delay caused by the desilting basin at South Tamaqua.

August's data, because of the extremely low stream flow, showed the highest downstream acid concentrations in the entire study, The data also revealed a very significant impact on the Main Stem, with its pH being depressed from the value of 6.4 to 5.3. This impact of the Little Schuylkill was exhibited even though the flow in the Main Stem was still substantial, at 378 CFS.

Also, an important factor is that upstream of the sampling point from Hamburg is a desilting basin on the Main Stem, Its pool extends to within 0.7 mile of the confluence of the Little Schuylkill River. Inasmuch as both this basin and that on the Little Schuylkill are reservoirs for substantial amounts of water and if the Tamaqua #14 Pumps were operated for an extended period of time under low stream flow conditions, a local intense storm above either desilting basin would displace low pH water as a slug that may possibly have repercussions far downstream.

The survey in September was, in a way, unique in that it was the first occasion all summer that pumping was conducted by the Greenwood Stripping Corporation under its "normal" operating scheme. The second #10 Pump having been repaired, both #10' s and one #14 operated during this sampling run. In addition to compiling these data in Table 8, the information was transposed to a basin map to aide in orientation, Exhibit 20, which follows Table 8.

Again low flow conditions prevailed (8 CFS), and again the mine water depressed pH values to low levels, including the pH of the Main Stem.

With respect to iron, in this particular sampling run duplicate samples were collected for analysis. To one bottle 5 milliliters of reagent grade nitric acid were added to stablilize the iron in solution. The results of the tests show almost consistently low values for the "not fixed" sample, to the extent of approximately 50% of the iron present. It appears that an accurate iron analyses requires sample acidification.

Regarding the numerical data, the results show quite high iron concentrations through South Tamaqua. Further downstream, looking at the September 12 data, iron levels are considerably lower indicating precipitation and settling in the stream, but concentrations are still excessive for aquatic and most other uses.

The Little Schuylkill River is similarly degraded for essentially all uses by the sulfate ion, which in this run included the enormous output of both Greenwood #10 Pumps.

In summary, the acid discharged by the gravity sources is sufficient to produce an acid stream, but unlikely to damage the Main Stem. The impact of the Pumps is to further degrade the Little Schuylkill River and under conditions of lower flows to produce intolerable iron and sulfate concentrations. Furthermore, under low flow conditions the acid load from one #14 Pump is sufficient to depress the Main Stem's pH to an unacceptable value.