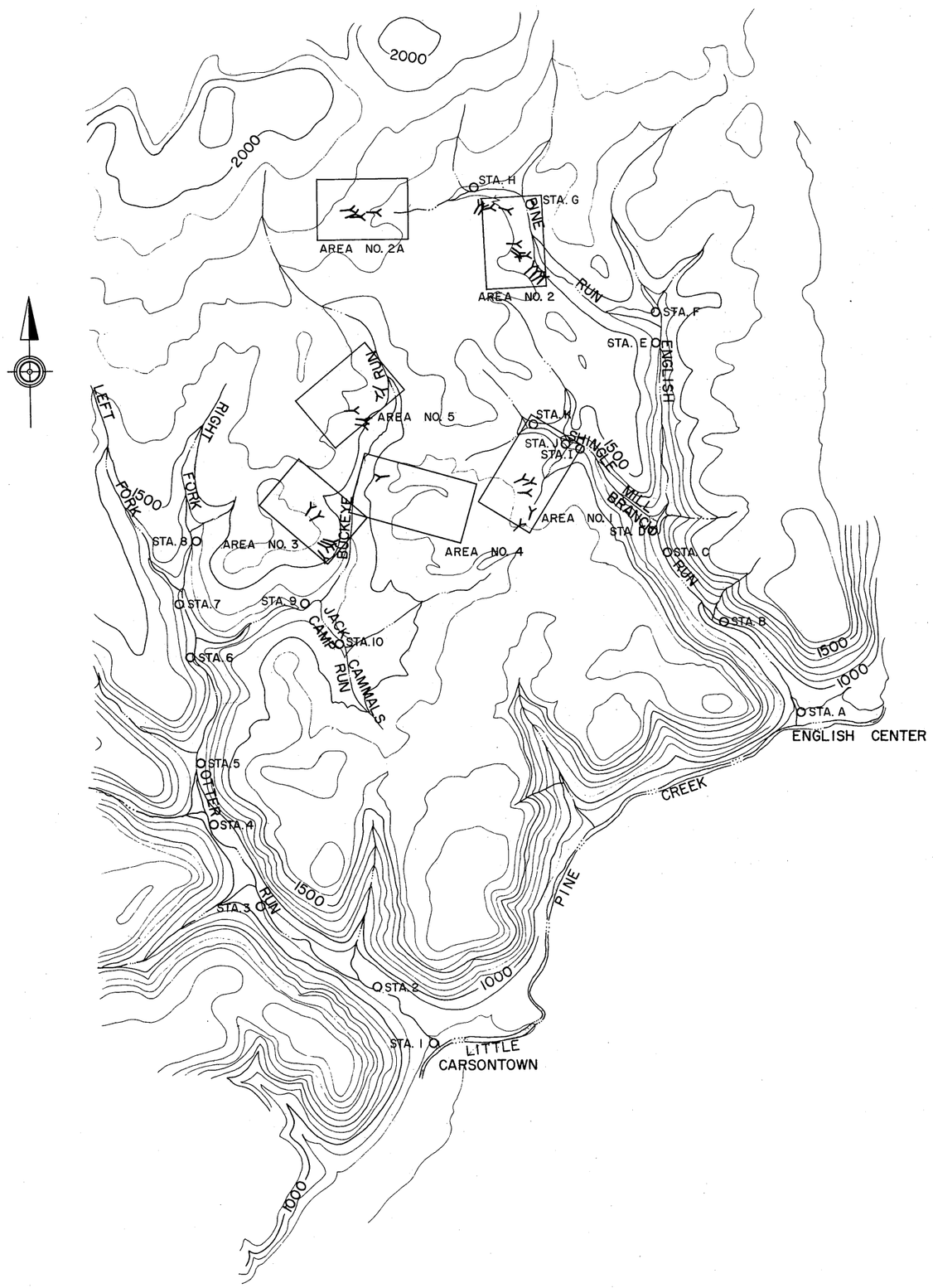
Survey of Stream Quality for Project SL-160

An examination of existing topographic survey maps, English Center Quadrangle (7 1/2 min. series) and Waterville Quadrangle (15 min. series) and such other records as were available (e.g., Ground Water in North-Central Pennsylvania, Pennsylvania Geologic Survey, Bulletin W6-1939) gave a good preliminary indication of the most desirable locations for stream monitoring or sampling stations. Utilizing these maps and this information, the essential field reconnaissance was performed in order that sampling stations could be accurately located based upon various concomitant factors, such as; accessibility to field personnel, stream mixing following tributary merging with master streams, local flow patterns and channels, etc. The monitoring network finally established for the stream system encountered consisted of some twenty-one (21) permanent sampling points at which the chemical quality of the water was determined and logged at regular intervals. After a period of time, during which a pattern of stream pollution emerged, additional sampling points were located at such diverse spots as: abandoned drift-mine outfalls, strip-mine run-offs, road culverts, and power line drainage ditches. Although field test pH kits were employed periodically for some cursory field examinations, all of the recorded tests of water quality shown in this report (Table No. 1) have been performed by a recognized chemical testing laboratory (Seewald Testing Laboratories and Associates, Williamsport, Pennsylvania.)

Water in the area streams that do not receive acid mine drainage are typical of land with heavy vegetative cover. The water is low in dissolved mineral matter and without the extreme variations of quality found in unprotected basins. The forest growth, in slowing storm run-off and increasing flow during the dry periods, also levels out the discharge of dissolved material.

The sampling stations, listed alphabetically on English Run and numerically on Otter Run, served not only as water sampling points, but also as stream gauging stations since water depth was systematically measured at each station along with the time and water temperature.



O—STREAM SAMPLING STATION

⟩— DRIFT MINE

COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF ENVIRONMENTAL RESOURCES

ENGLISH RUN

MINE DRAINAGE STUDY

MAP NO. 6-STREAM SAMPLING STATIONS

(INDEX TO APPENDIX A)

SCALE	PREPARED BY
1" = 4000'	ENGLISH ENGINEERING CORP.
OCT. 1971	WILLIAMSPORT, PENNSYLVANIA

Table No. 1 - Summary Sheet
Average Water Quality for Period 7-1-70 to 6-30-71

Sampling Station	No. Of Samples	pH Avg.	Acidity Avg.-PPM	Alkalinity Avg. PPM	Iron (Total) Avg.-PPM	Sulphate Avg. -PPM	Flow Avg. - CFS
(Summary of Table 1-A)							
English Run							
A	29	5.80	1.45	1.17	0.356	38.76	23.87CFS
B	29	5.89	0.83	(1.59)	0.309	33.86	
C	29	5.70	1.38	(1.93)	0.274	35.79	
D	30	5.71	0.47	(1.33)	0.327	34.73	
E	30	4.72	3.33	0.40	0.297	30.00	
F	29	5.47	0.97	0.83	0.303	30.34	
G	29	5.11	2.48	0.97	0.202	30.83	
H	29	4.95	1.03	0.83	0.260	28.17	
I	30	4.48	15.60	-	0.318	103.73	
J	29	5.55	1.45	(2.35)	0.238	40.24	
K	27	5.83	1.19	(1.93)	0.463	46.55	
(Summary of Table 1-B)							
Otter Run							
#1	29	5.55	2.89	1.38	0.391	45.72	58.25CFS
2	28	5.46	3.64	1.57	0.296	54.93	
3	28	5.58	1.14	(1.57)	0.401	43.53	
4	28	5.54	2.86	1.29	0.328	51.07	
5	28	5.24	3.86	1.57	0.285	62.43	
6	28	4.80	12.86	1.00	0.452	89.57	
7	28	5.43	2.64	(3.00)	0.318	31.57	
8	28	4.83	3.79	1.07	0.273	53.93	
9	28	4.14	44.14	-	0.971	197.82	
10	26	6.02	0.31	(2.08)	0.437	27.07	
(Summary of Table 1-C)							
Mine Weirs							
TM	12	2.66	1391.67	-	210.42	2804.16	0.133CFS
CM	11	3.07	116.73	-	4.86	304.55	0.187CFS
FM	9	3.76	88.00	-	1.38	399.44	0.196CFS

( ) Equals Generally Alkaline

Tables 1-A, 1-B, and 1-C appear in Appendix A.

This data, in conjunction with the meteorological information being gathered simultaneously, permitted a complete analysis of the ground water system to be made either discretely or continuously. The additional water sampling locations throughout the watersheds were given descriptive titles, such as: Carson Mine Outfall, Fisher Mine Weir, Jack Cammals' Weir, etc., so they were readily identifiable and not confused with existing stream sampling stations.

The discussion of the water quality within the project's boundaries has been divided into two parts, those areas effecting English Run and its watershed in one part, and those effecting the Otter Run stream system and watershed in the other part.

English Run Watershed

From July 1, 1970, through June 30, 1971, 306 water samples were collected at the various collection points (lettered "A" through "K") located on English Run and its tributaries. Of the eleven sampling stations throughout this monitoring system, six ("A" through "F") were located on the master stream, English Run, while five additional stations were placed on its main tributaries, three (I, J, and K) on Shingle Mill Branch and two (G and H) on Pine Run. The average pH value of all the samples (306) collected from this system during the year is a moderately acid 5.371. Although the significance of this sample mean pH value is questionable, a weighted average, based upon volume of stream flow would undoubtedly raise this average value into the pH range of 5.5-6.0, or that of freshly fallen rain. Verifying this, the mean pH value at the initial station (A) turned out to be 5.80 based upon 29 samples during the 52 week sampling period. The common pH range is 4.8 to 6.6 at this point, which is located near the mouth of English Run. Data at this location represents information on the effect this volume of water will have upon Little Pine Creek, the stream into which it subsequently empties.

FREQUENCY DISTRIBUTION OF ENGLISH RUN pH VALUES

A = Sampling Station A
B = Sampling Station B
C = Sampling Station C
D = Sampling Station D
E = Sampling Station E
F = Sampling Station F
G = Sampling Station G
H = Sampling Station H
I = Sampling Station I
J = Sampling Station J
K = Sampling Station K

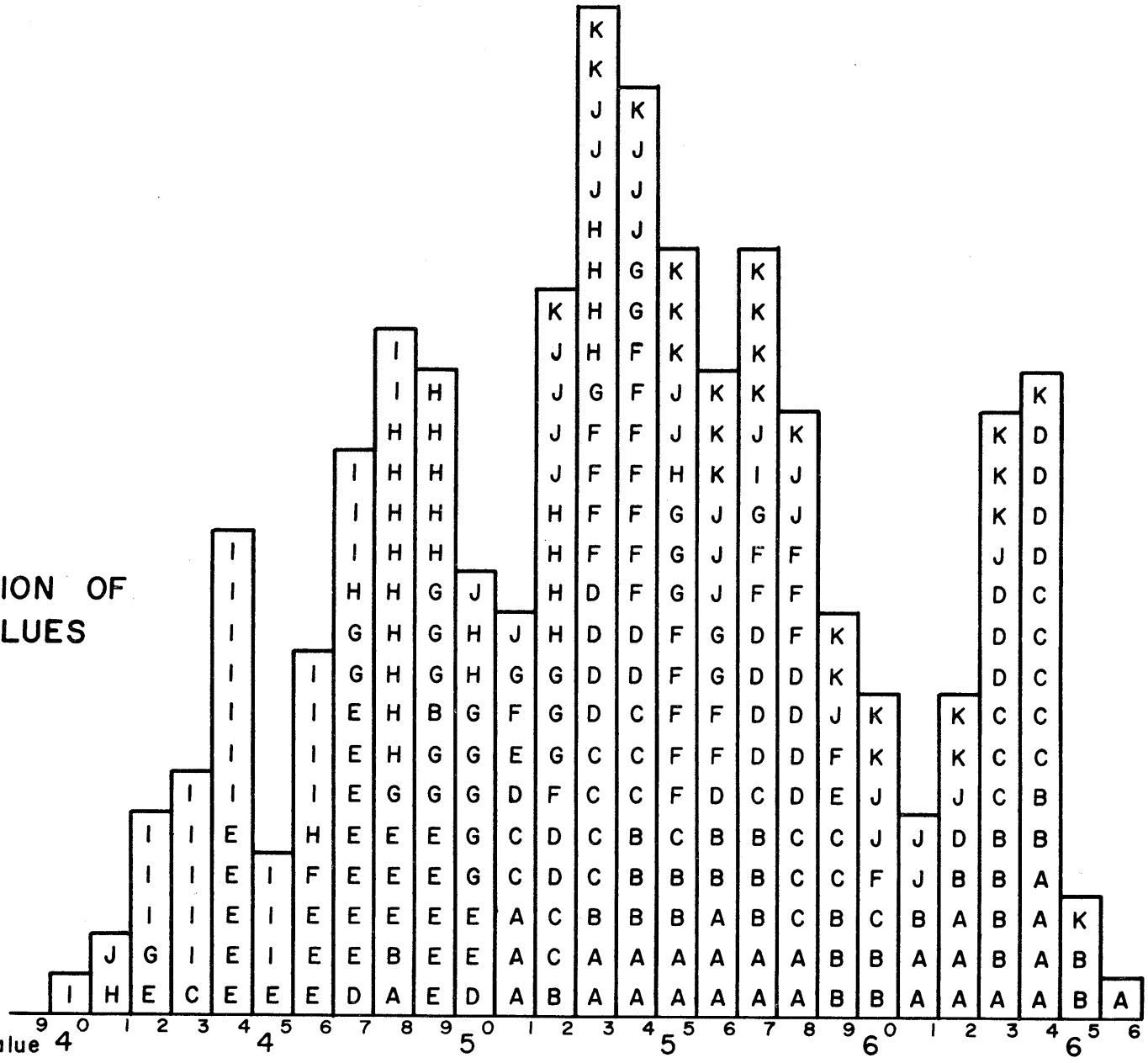


FIGURE NO. 4

Area No. 1 The statistical information for the first feeder stream entering the Shingle Mill Branch of English Run is interesting because it represents a typical "hot stream" in the local sense of acid mine drainage (AMD) and too because it is the only stream draining to the north within the project's entire stream network. This small unnamed tributary drains the northwest section of Warrant 1631, which is the location of five abandoned drift mines (circa 1931-5) that are active suppliers of AMD (Acid Mine Drainage) to the Shingle Mill Branch of English Run. These abandoned mines are shown on Page 67, Area No. 1. Thirty samples were drawn from this stream at sampling station "I" during the study period of July 1, 1970, to June 30, 1971. The initial samples were taken at weekly intervals and at approximately the same time of day. After statistical control seemed established (nine weekly samples with an average pH of 4.567), the sampling interval was lengthened to two-weeks and held constant for the remainder of the sampling period. The resultant thirty samples had a common pH range of 4.0 to 5.7 and a simple mean value of 4.48. The central item (median) was also 4.48 and the most frequently occurring pH value (mode) was 4.40, showing an extremely normal distribution of frequency with nearly perfect symmetry (i.e., no skewness apparent). This latter was verified by a modal deviation calculation, indicating a value of 1.018 or a deviation of the mean from the mode of less than 2 percent (1.8% actual). The significance of these figures is that for this particular group of shallow cover mines the effect of AMD upon the stream receiving it is practically a constant, irrespective of the flow and the corresponding poundage of acid entering the stream. Even though pH does not represent the titratable acidity in AMD, due to the buffering action of the principal acid forming constituents in mine drainage, it is a fair criterion in many mild cases of AMD (16 PPM - average acidity for this stream) and serves as a handy evaluation tool. Since strip mining is now (at time of report) in progress on the eastern edge of warrant 1632, adjacent to the drift mines under discussion in this area (Area No. 1), periodic future sampling at sampling station "I" should reveal interesting information concerning the effects of such mining on the delicate balance that exists in the ground water table under such a combination of past and present conditions.

The sulfate concentration at sampling station "I" averaged 103 ppm over the one-year sampling period and ranged from a high of 330 ppm (October 8, 1970-stream temperature 55˚) to a low of 24 ppm (March 20, 1971-stream temperature 36°). Due to the drainage of oxidized sulfuritic minerals in the form of sulfates and sulfuric acid from the coal seams and spoil banks of the area, the aforementioned sulfate concentration causes a lowering of the pH and consequent dissolving and retention in solution of iron and other metals by the acid water. The iron concentration reached a high of 3 ppm in late July (July 31, 1970), but for the most part remained a very low 0.1 ppm during the entire study period.

Area No. 2 Pine Run, the major tributary to English Run, is historically unique for it was on this stream that pollution first became evident within the watershed. The gradual deterioration of this stream's ability to support fish life and subsequent removal of the stream from the Fish Commission's list of approved Brook Trout Stocking Streams in 1958 brought the problem into sharp focus. A local sportsmen's organization investigated the stream pollution and located the origin of what appeared to be the major source of the stream pollutant. This source, a drift mine located adjacent to the stream, delivered a continous flow of AMD to Pine Run with little or no natural interruptions. A liming device (Shirley Machine Co.) and impounding basins were constructed to treat this mine outfall and are currently maintained by the local consolidated sportsmen under DER contract SL-125.

During the field survey of this area, eleven additional drifts, in various states of activity, were located and accurately positioned on a field map - Pages 68 and 69, titled areas No. 2 & No. 2-A. Sampling stations E, G, and H, placed on Pine Run and English Run revealed an interesting picture of pollution for this once viable stream. In addition to the regular sampling performed at the sampling stations, periodic sampling was conducted at various mine outfalls and impoundments throughout the area. The total effect of the acid mine drainage on Pine Run can be detected in part from the average pH value of 4.72 determined for the complete sampling period from first weekly and then bi-weekly samples at station "E".

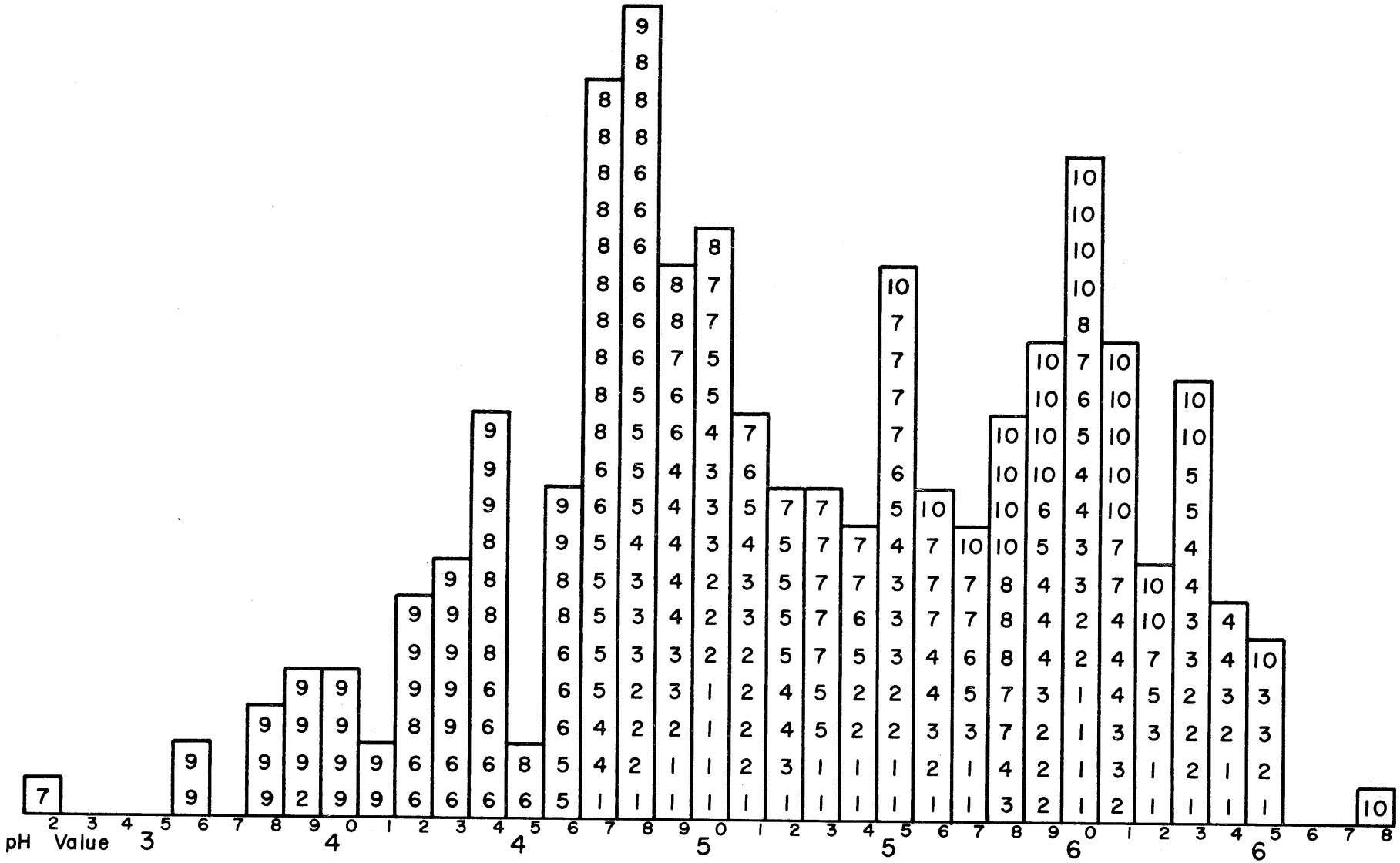
Spot samples taken in September, 1966, just prior to the installation of the Shirley Limer on the Carson Mine outfall, indicates that the lower section of Pine Run (near station "E") had 53 ppm acid, 50 ppm-sulfate, and an associated pH of 3.6. In September, 1967, one year after the installation of the aforementioned limer, spot checks at the same location on Pine Run showed a significant improvement in water quality to 7 ppm-acid, 28 ppm-sulfate, and a pH value of 6.1. During September, 1970, two samples were taken at station "E" as part of the stream sampling program, and neither of these indicated any titratable acidity or basicity; however, their average pH was 4.85, somewhat below that found three years earlier, indicating an increase in the activity of acids in the water. One possible explanation of the condition of Pine Run in September of 1970 might be the presence of large amounts of organic polluting materials in the stream, caused by freshly constructed beaver dams, that consume oxygen, create carbon dioxide and depress the pH values.

Station "H", located well upstream from the mine outfall upon which the lime neutralization plant was placed by the local sportmen's group, showed some interesting sampling results. The average pH value for this station during the sampling year was 4.94, indicating that the obvious mine drainage being treated by the lime feeder was by no means the only source of AMD on Pine Run. The group of mines shown on Page 69, titled Area No. 2-A, drain directly into the headwaters of Pine Run and are apparently adding their share to the contamination of this stream. The five drift mines in this area (No. 2-A) are situated close to a former state road and are part of an abandoned mining operation known as the English Center Coal Company. Located at relatively high elevations near the Pine Run headwaters, these mines are especially undesirable because they effect the entire length of the stream with their continuing acid drainage.

Otter Run Watershed

The sampling network for water quality on Otter Run and its tributaries consisted of ten numbered stations on the streams and several miscellaneous sampling points strategically located at known sources of pollution. These latter having been discovered through the combined efforts of the various state agencies involved in the protection of the State's Forests and Streams. In all, 304 samples of water were collected throughout the watershed during the year, July 1, 1970, to June 30, 1971. These samples were analyzed for hydrogen-ion concentration (pH), titratable acidity, ferrous and total iron concentration, sulfate content, and periodically for all elements present. Since the amount of sulfate present is known to be chemically equivalent to the sum of the metallic elements, the total amount of metals, if not the kinds, was available from each sample.

During the period of sampling the waters of Otter Run, a white deposit was observed coating the rocks of the stream and creating a band of material in the stream center. This white band, apparently building up and growing wider with the passage of time, had been noted several years earlier by local residents and was one of the initial warning signs that something was changing within the stream's ecology. Scrapings from the rocks of Otter Run, near its confluence with Little Pine Creek, were removed and analyzed. These dry sediment scrapings proved to be mostly hydrous aluminum silicates (clay) with very small amounts of iron, magnesium, and manganese present. Although precious little clay is to be found in the area, there is a thin band of underclay (Mercer Fireclay) found beneath the "B" or Blossburg Coal. Since this coal has been removed locally by surface mining, there may have been periods of time that this easily transportable clay has been exposed to areal surface water run-off and attendant erosional and siltation processes. A singularly large cloudburst in the area on May 20, 1969, with the liklihood of occurrence of once every five years, is known to have placed in suspension in the waters of the entire Pine Creek watershed the staggering sum



FREQUENCY DISTRIBUTION OF OTTER RUN pH VALUES

1 = No. 1 Sampling Station
2 = No. 2 Sampling Station
3 = No. 3 Sampling Station
4 = No. 4 Sampling Station
5 = No. 5 Sampling Station
6 = No. 6 Sampling Station
7 = No. 7 Sampling Station
8 = No. 8 Sampling Station
9 = No. 9 Sampling Station
10 = No. 10 Sampling Station

FIGURE NO. 5

of 52,100 tons of soil for that particular day. Even though the Otter Run watershed represents a small fraction of the overall Pine Creek watershed, it is not difficult to imagine what that same cloudburst must have done to the loamy soils, strip-mine spoil banks, and exposed clay (if any) of the area. Thus this apparent stream degradation would appear to be nothing more than a simple case of aggradation by soil sediments, perhaps speeded up by the cutting of two power line rights-of-way across the watershed, one before 1964 and one since that date.

During the project sampling period, July 1, 1970, through June 30, 1971, 279 water samples were collected directly from the streams of the Otter Run watershed at sampling stations one to ten. The first seven stations (1 through 7) were located on the master stream, Otter Run, with three additional stations (8, 9, and 10) on tributaries draining from areas of past or present mining activity. The average pH for all the samples collected at these ten stations was 5.333, indicating moderate acidity almost identical to that found on English Run, where the composite mean pH was 5.371. As previously noted (English Run watershed), a weighted average of the pH values, based upon individual stream contribution to total water volume, would be more realistic. Station number one, located as it is at the mouth of Otter Run, does, however give an accumulative picture of the stream condition. At this point, the average pH for the sampling year (1970-71) is 5.55, somewhat more acidic than English Run which had an annual average pH of 5.80 at its initial sampling station. The range of pH values at this initial station (No. 1) on Otter Run is 4.7 to 6.5, both extreme values occurring in the fourth quarter of 1970, the minimum (acid) during high flow and the maximum (base) during low flow. Thus it seems that the lower portion of Otter Run has at least one of the characteristics of a pure stream, that is, its alkalinity is greater during low flow and therefore has a greater neutralizing power per unit of volume in this state.

Buckeye Run, a major tributary to Otter Run, drains the central region of the Little Pine Creek Coal Basin and is bounded on both sides by abandoned drift mines as well as active

or recently completed surface mines. Due to this proximity to extensive coal lands and the numerous workings in those lands, Buckeye Run is the scene of the most significant acid mine drainage in the entire area studied under Project SL-160. The water test stations were set up in this region in an effort to best evaluate all sources of known or suspected pollution. Station number nine located immediately below the confluence of Jack Cammal's Camp Run and Buckeye Run was expected to receive most of the AMD and it did. In addition, station ten was positioned on Jack Cammal's Camp Run to the right hand side (southeast) of station nine, in order to intercept any drainage coming from strip-mined areas located east of Buckeye Run. Surprisingly this sampling station indicated little if any contamination from AMD. Station eight, placed on the Right Fork of Otter Run, was located on the left hand side (northwest) of station nine to serve a function similar to that of station ten, i.e., intercept any drainage coming from those stripped areas west of Buckeye Run. This sampling station showed mild pollution from recently covered areas of surface mining. Periodic water samples were also collected throughout this same area at the various weir points, located at the mouth of the Thomas Mine, a ditch draining the Fisher Surface Mine, and on the upper section of Jack Cammal's Camp Run.

Area No. 3 This area (see Page 70) covers a portion of coal lands west of Buckeye Run that has been both deep mined (through 1964) and surface mined (through 1966). Area No. 3, also is the location of an effort by the Commonwealth to uncover abandoned shallow underground workings and create a workable mine seal by backfilling with local clays and covering with overburden. This particular project (Thomas Mine) was completed in mid-May, 1971, and up until the time of this report appears to have been successful. The general area where underground workings were exposed and the coal pillars removed by stripping prior to sealing and covering is shown on Page 71, Area No. 3 - Mine Seal. The drainage from this site was considered especially dangerous and worthy of special consideration because the old workings and associated openings (drifts) were so situated as to form a natural course for waters draining across and through large contiguous areas

of strip-mine spoil. The Department of Environmental Resources had a portable limer (Shirley Machine Co.) on loan to a local strip-mine operator in order to combat this source of pollution before resorting to sealing.

Samples taken at station nine on Buckeye Run, a short distance below the recently sealed Thomas Mine, have already begun to reflect an improvement in stream quality since the aforementioned mine was sealed on May 15, 1971. Although the sampling for Project SL-160 was terminated about July 1, 1971, several promising signs of improving water quality were noted in this short period of time. For example, average pH increased to 4.52 from 4.06 and the yearly high reading of 4.8 was recorded on June 18, 1971. Of course the possibility of seasonal stream improvement exists in this situation, but the reduction of average acid in ppm, from 50 before sealing, to 8 after sealing, seems to reflect some external influence such as sealing of the mine or increased treatment of the AMD. The averages for the various water quality parameters for the testing period (1970-71) at station nine are as follows: acid - 44 ppm, sulfate - 198 ppm, iron - 1.0 ppm, and pH equal to 4.14. These averages are composites that include samples before and after sealing of the Thomas Mine and would be of even poorer quality if the post-sealing samples were not included.

The volume and quality of water draining from the Thomas Mine may be noted in Table 1. Although this mine outfall was impounded before entering Buckeye Run, the neutralizing treatment with the portable liming equipment was sporadic and under very loose control.

Area No. 4 This particular portion of the overall Project Area (see Page 72) lies east of Buckeye Run and contains an abandoned drift mine and large stretches of strip mine spoil. In addition, active surface mining is in evidence along the boundary between state warrants 1631 and 1632. Mineral rights to warrant 1632 have been reserved by the present strip-mine operator through 1984, and represents one of the few remaining areas within State Game Lands No. 75 so designated. The drainage from the drift mine, located close to

Buckeye Run, is treated by a small fixed neutralization plant manufactured by the Shirley Machine Company. At one time, this drift was sealed with an earthen plug but the head created within the confined area soon blew the seal and since that time the mine discharge has been neutralized and impounded before passing into Buckeye Run.

The surface run-off from previous strip-mining (the near surface E-coal has been removed) is generally diverted to pass through the aforementioned neutralizing station located at the mine drift; however, certain portions of this surface run-off are not diverted and drain unabated into Buckeye Run. This particular flow has been monitored for quantity (weir) and quality during much of the project duration. Since the first of the year, 1971, the pH of this water never exceeded 4.0 with acid concentrations up to 200 ppm and associated sulfate readings ranging from 190 to 560 ppm. Flows as high as 165 ppm (0.365 cfs) have been recorded at this location (Fisher Strip-Mine Weir) indicating the rather substantial contribution this drainage makes to the pollution of Buckeye Run and subsequently to Otter Run.

The current strip-mining operations in this area (permit No. 4770 BSM10) will remove the three remaining seams of coal found in the lands adjacent to the boundaries of the former deep-mine. If it seems advisable, a plan for removing all coals within the limits of the old deep-mine as well might be integrated into the overall surface mining plan. (See Map No. 9, Page 61)

Area No. 5 The several drift mines in this area (see Page 73) are the oldest to be found in the Little Pine Coal Basin and for this reason alone are of particular interest. One of the mines was opened in 1870 by John English somewhat to the north of the present sealed Thomas Mine. The drainage from this mine and its companion drifts is to the southeast into Buckeye Run but sampling of the stream above and below these openings indicates little if any contamination or pollution contributable to this particular mine drainage. Since all but one of these openings exist at virtually the same elevation above sea level it is

possible that they have been successfully sealed off naturally by virtue of being below the area ground water table. Large swampy regions in this particular area, offer some surface evidence to substantiate the aforementioned theory. Then too, the mining community that once existed at this location may have exercised strict control over the mine waters in order to assure the domestic water supply and in so doing developed a pattern that continues to this day in some unknown fashion.