SUMMARY

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The Big Scrubgrass Creek drains an area of 25,610 acres (40.02 sq. mi.) in southwest Venango County and northern Butler County, Pennsylvania. The main stream flows into the Allegheny River just across from the Village of Kennerdell. The watershed has a pleasant rolling topography and, except for abandoned strip mined areas, the scenery is attractive farmland and woodland. The population of the area has experienced a very slight decrease over the past 30 years, and currently is about 1500. Sixty percent of the land in the watershed is forest land with another 20 percent idle and 15 percent being used for agriculture.

Coal deposits underlie approximately 13,200 acres of the watershed, although the thickness of the seams and the quality of the coal have made it generally uneconomical to mine. Some deep mining was done by individuals and families on a small scale up until the middle 1960's. The first strip mining was begun in the 1930's, and since that time approximately 2200 acres have been strip mined, removing approximately 6.8 million tons of coal. The peak mining period was the late 1950's and early 1960's with a slight decrease in annual production since that time.

The earliest water quality records on Big Scrubgrass Creek are from the spring of 1956, and were collected in response to a report of acid mine drainage pollution in the stream. For 30 years prior to this the stream had been stocked

with trout and was considered one of the best trout streams in northwestern Pennsylvania. In the spring of 1960, sampling showed the pH values over the entire length of the main stream to be between 5.1 and 5.2 and the stream was officially declared polluted.

In October, 1970 the present study was initiated to determine the magnitude and seasonal variation of the stream pollution and the exact location of the sources in order to plan a pollution abatement program.

The following table summarizes the findings concerning the magnitude of the acid mine drainage on the major tributaries and subwatersheds of the water.

TABLE 1

Stream	Drainage Area (Sq. Mi.)	Ave. Flow (GPM)	Ave. Acid Load (PPD)	Ave. Alkalinity Load (PPD)
Big Scrubgrass	40.02	32476	2026	5420
Bullion Run	7.33	5241	545	1188
Trout Run	1.36	568	269	-2
Brink Run	1.04	638	1510	0
Gilmore Run	2.96	892	714	0
Upper Main Stream	3.70	2771	1371	39
Southwest Tribs.	2.58	1465	255	151
South Branch	6.29	5100	284	2833
East Tribs.	5.11	4030	320	1731

Four tributary areas, Brink Run, Upper Main Stream, Gilmore Run, and Trout Run, which cover a total of 22.6 percent of the area, contribute 72.6 percent of the total acid discharge. The contributing source areas are primarily strip mines located in the northwest and north central parts of the watershed. Two subwatersheds, South Branch and the combined East Tributaries display predominantly alkaline conditions. The main stream at the confluence with the Allegheny River discharges an average of 3394 pounds per day net alkalinity. However, definite trends

occurred during high and low flows, with high flows having generally lower water quality. During the flood flow caused by Hurricane Agnes on June 23, 1972, the main stream at the mouth had a pH of 5.4 with an estimated discharge of approximately 38,000 pounds per day net acid.

Source abatement of the contributing mine areas has been recommended after careful analysis of the existing conditions and the alternative solution methods. Most of the source areas were found to be strip mines with inadequate regrading and vegetation to control erosion which continually exposes new material for acid formation. Source abatement has the advantage of having a foreseeable end, with side benefits of improved land use possibilities. Treatment of the runoff water should be employed only if needed after carrying out the source abatement plan.

Source abatement plans were developed for 7 subwatersheds of the Big Scrubgrass Creek Watershed. These areas were defined to provide abatement on natural tributary groups which were affected by common source mines. The proposed project areas, anticipated results, and estimated costs of these plans are summarized in Table 2 at the end of this section.

Because of the nature of this watershed and the stream, the successful implementation of the proposed project plans should cause a noticeable improvement in the water quality with the return of excellent trout fishing within a few years. A definite program of followup study to determine the effects of these measures and any needed followup treatment should be initiated following implementation of the plans. This would insure continued success of the abatement program for this

watershed, and would provide valuable data for future abatement projects on other watersheds.

TABLE 2

SUMMARY OF ABATEMENT PLANS AND COSTS

Subwatershed	Total Drainage Area Involved (Sq. Miles)	Total Area Requiring Restoration (Acres)	PPD Estimated Acid Production	PPD Estimated Acid Reduction	Estimated Percent Abatement	Estimated Cost	Cost Per PPD Reduction
Bullion Run	8.27	99.6	725	554	75%	$158,400	$291
Trout Run	2.85	51.3	430	323	75%	$ 38,700	$156
Gilmore Run	5.31	283.1	2430	1823	75%	$286,400	$157
Upper Main Stream	4.78	181.8	1371	864	63%	$224,400	$260
Southwest Tribs.	3.15	41.9	470	316	67%	$ 53,200	$169
South Branch	7.76	26.9	303	64	21% *	$ 97,800	$1529
East Tribs.	7.90	21.9	320	173	54%	$ 32,300	$187
Total Watershed	40.02	706.5	5529	4107	74.3%	$891,200	$217

*Additional abatement is anticipated on this area due to reclamation work associated with re-opening old mines and providing adequate restoration of the mined out areas. Since this reclamation work will be done by the new mining operations, it wasn't counted as a part of the anticipated results for this project.

ACKNOWLEDGEMENTS

The composition of a report such as this depends upon a number of individuals, local organizations and government agencies. We wish, at this time, to express our gratitude for the assistance received and single out their contributions.

A concentrated cooperative effort in many phases of the project was received from the United States Soil Conservation Service; to itemize would be superfluous. However, we wish to recognize those who were directly responsible for the contributions. Karl Hellrick, Venango County District Conservationist, who initiated the project and the formation of the Watershed Association and his successor, Lyle G. Cathcart, whose willingness to discuss various problems at any time and his many hours of consultations provided insight to our recommendations and analysis; Samuel E. Young, S.C.S., Project Engineer, who, prior to his transfer to the Bloomsburg, Pennsylvania Office, provided immeasurable assistance as coordinator between our firm and the S.C.S., supplying us with pertinent information, publications and advice; William Bowers, Hydrologist and Project Engineer, whose continued cooperation after Mr. Young's departure is deeply appreciated; and Clarence Wilson, Resource Conservation and Development Coordinator, who provided information concerning the availability of financial and technical assistance for reclamation from the United States Department of Agriculture, Resource Conservation and Development. For their continued cooperation, concerned interest, and field investigations, our appreciation is thoroughly expressed.

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Respectfully,

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DEFINITION OF TERMS

Accelerated Erosion – Erosion that occurs at a rate exceeding the natural erosion rate, primarily as a result of man's activities.

Acid Soil – A soil with a preponderance of hydrogen ions in proportion to hydroxyl ions. Specifically, soil with a pH value less than 7.0. For most practical purposes, a soil with a pH value less than 6.6.

AMD – Abbreviation for Acid Mine Drainage – Surface or ground water flowing through or from mines and mine sites, characterized by concentrations of acidity, iron, manganese, aluminim, sulfates, and sediment.

Amortization – To repay a debt in a sequence of equal payments. Part of each payment is used to pay the interest due at the time it is made, and the balance is applied to the reduction of the principal.

Anticline – A fold in rocks in which the strata dip outward from a central axis. A structural upfold or arch.

Bony – The refuse from coal mining which generally contains some carbon but is of such low quality as to be waste. Also called gob.

Canopy – The cover of leaves and branches formed by the tops or crowns of plants.

Cover, vegetative – Any vegetation producing a protective mat on or just above the soil surface.

Cropland – Land used primarily for the production of adapted crops for harvest, alone or in association with sod crops.

CFS – Abbreviation for cubic feet per second. The rate of fluid flow at which one (1) cubic foot of fluid passes a measuring point in one (1) second.

Debris dam – A barrier built across a stream channel to retain rock, sand, gravel, silt, or other material.

Discharge – Rate of flow; a volume of fluid passing a point per unit of time, commonly expressed as cubic feet per second, million gallons per day, or gallons per minute.

Diversion – Channel constructed across the slope for the purpose of intercepting surface runoff. An individually designed side-hill sod waterway to carry the design flow from the contributing drainage area at a velocity which will not cause erosion. Sometimes called a diversion terrace.

Drainage Area – Watershed. The area which contributes runoff water to a particular point.

Drop structure – A structure for dropping water to a lower level and dissipating its surplus energy without causing erosion of the slope or the area at the base.

Environment – The sum total of all external conditions that may act upon an organism or community to influence its development or existence.

Erosion – The wearing away of the land surface by running water, wind, ice, or other geological agents, including such processes as gravitational creep. See also natural erosion, accelerated erosion, gully erosion.

Erratics (Geology) – Transported rock fragments different from the bedrock on which they lie.

Fertility, Soil – The quality of a soil that enables it to provide neutrients in adequate amounts and in proper balance for the growth of specified plants when other growth factors, such as light, moisture, temperature, and the physical condition of the soil, are favorable.

Fertilizer analysis – The percentage composition, expressed in terms of nitrogen, phosphoric acid, and potash. For example, a fertilizer with a 6-12-6 analysis contains six (6) percent nitrogen (N), 12 percent available phosphoric acid (P_2O_5), and six (6) percent water-soluble postash (K_2O).

Forest Litter – The accumulation of decaying leaves and branches on the ground under trees.

Frequency – The average number of occurrences in a given period of time, particularly peak runoff flow rates. Generally expressed as the average number of years between such events. For example a 10-year frequency storm would be expected to occur on the average once every ten (10) years.

Final Cut – The last trench cut in a strip mined area to uncover the coal seam.

Gob – The waste material from a deep mining operation sometimes also called bony.

GPM – Abbreviation for gallons per minute. The rate of fluid flow at which (1) gallon of fluid passes a measuring point in one (1) minute.

Ground Moraine – The material deposited form a glacier on the ground surface over which the glacier has moved.

Gully – A channel cut by concentrated runoff but through which water commonly flows only during and immediately after heavy rains or during the melting of snow.

Gully Erosion – The erosion process whereby water accumulates in narrow channels and, over short periods, removes the soil from this narrow area to considerable depths, ranging from one (1) to as much as 100 feet.

Highwall – The nearly vertical undisturbed side of a cut made during strip mining.

Horizon (Soil) – A layer of soil or soil material approximately parallel to the land surface and differing from adjacent layers in physical, chemical and biological properties.

Hydraulic radius – The cross-sectional area of a stream divided by its wetted perimeter. The "R" in Manning's Formula.

Liming – The application of lime to land, primarily to reduce soil acidity and to maintain a high degree of availability of the nutrient elements required by plants.

Manning's Formula – A formula used to predict the velocity of water flow in an open channel or pipeline.

$$V = \frac{1.486}{n} R^{2/3} S^{1/2}$$

where V is the mean velocity of flow in feet per second, R is the hydraulic radius, S is the channel slope in feet per foot, and n is the roughness coefficient.

MSL – Mean sea level. The base level from which land elevations are usually measured.

Mulch – A natural or articifical layer of plant residue or other materials, such as sand or paper, on the soil surface.

Natural Erosion – Erosion which occurs by natural agents such as water, wind or ice under natural environmental conditions of climate, vegetation, etc., undisturbed by man.

Neutral Soil – A soil which is neither acid nor alkaline in reaction. For most practical purposes, soil with a pH ranging from 6.6 through 7.3.

Overburden – The soil and rock which lie over a coal seam and which must be removed during strip mining.

Outcrop – The exposed edge of a geologic bed or strata, particularly a mineral deposit, along the ground surface.

Outlet Channel – A waterway constructed or altered primarily to carry water from man-made structures, such as terraces, tile lines, and diversions.

Oxidation – Combination with oxygen; addition of oxygen or removal or hydrogen or removal of electrons.

Permeability – The capacity of a soil to transmit water, generally measured as the number of cubic inches of water passing through a square inch of soil area per hour which reduces to units of inches per hour.

pH – A measure of the relative acidity or alkalinity of a substance. Specifically, the negative logarithm of the hydrogen ion activity. For example, a pH of 7 indicates a hydrogen ion activity of 10^{-7} moles/liter. A pH less than 7 is acidic and a pH greater than 7 is alkaline.

PPD – Pounds per day. The measure of the rate of movement of a particular pollutant from a source area.

PPM – Parts per million. The measure of the concentration of a particular pollutant in water in weight units per million weight units of water.

Riparian Land – Land situated along the bank of a stream or other body of water.

Runoff – That portion of the precipitation on a drainage area that is discharged from the area in stream channels. Includes both direct surface runoff and base flow that enter the channel as seepage from ground water.

Seepage – Water escaping through or emerging from the ground over an extensive line or surface area.

Slope Length – The length measured perpendicular to the contours of a field from the ridge line to the bottom or to a collecting channel such as a diversion.

Sod Cover – Vegetative cover on a soil created by the presence of grasses or legumes.

Spoil – The deposited overburden material that has been removed during strip mining.

Spillway – An open or closed channel, or both, used to convey excess water from a reservoir.

Subswatershed – The drainage area above and contributing runoff water to a point which is itself upstream from the mouth of the main watershed being considered.

Syncline – A fold in rocks in which the strata dip inward from both sides toward the axis, forming a trough.

Synclinorium – A broad regional fold in rocks in which the strata dip inward from both sides toward the axis and on which are superimposed minor folds.

Terrace – An embankment or combination of embankment and channel constructed across a slope to control erosion by diverting or storing surface runoff instead of permitting in to flow un-interrupted down the slope.

Watershed – All land contributing runoff water to the flow at a particular point, usually in a defined stream channel.

Watershed Divide – The line along the ridges separating two (2) watersheds.

Waterway – A natural water course or constructed channel for the flow of water. A sod waterway is a channel with sod growing in it designed to carry the water flow while preventing erosion of the channel bottom.

Wetted Perimeter – Length of the wetted contact between a liquid and its containing conduit, measured along a plane at right angles to the direction of flow.

Wildlife land – Land managed or used primarily for wildlife habitat.

Woodland – Any land used primarily for growing trees and shrubs.