III. Problem Identification

Overview

Several types of non-point source (NPS) pollution impair the Anderson Creek watershed. NPS gets its name from the way the pollution is produced and/or how it is transported to waterways. NPS pollution is usually created over a broad area and often pollutes in the same manner, emanating from many individual sources within that area. For example, within the borough of Curwensville are significant areas paved with asphalt or concrete and used as parking areas. As cars and trucks are parked on the paved areas, oil, grease, and other various materials collect on the pavement. When it rains, those materials are washed from all of the paved surfaces and transported to drains that eventually lead to nearby drainage ways and streams. The pollution comes from a broad area and reaches the stream from many sources that collectively can have substantial negative impacts on the stream. NPS pollution can come from many different sources. It is usually classified under one of the following categories: agriculture, silviculture (forestry-related), nutrients, construction and urban runoff, mineral resource extraction, and hydromodification.

Impairment from mining-related resource extraction has been identified as the number one NPS problem in Anderson Creek. The TMDL study and numerous studies before it have identified the problems associated with mining. Although resource extraction has had the largest impact on the watershed, significantly degrading both land and water resources, the other sources of NPS pollution also affect the watershed, but to a much lesser extent. The TMDL study specifically identifies impairments from sediment on the Rock Run/Little Anderson Creek sub-basin and nutrients on the Bilger Run/Kratzer Run sub-basin.

Silviculture

The lumber industry likely began the first major environmental changes in the watershed. Early forestry practices gave little or no consideration to impacts the industry had on ecological systems. Clearcutting removed trees throughout the entire watershed and logs were hauled to nearby streams, where they were eventually floated downstream to area lumber mills. Once trees were removed, many of the steep slopes likely experienced severe soil erosion during periods of heavy rainfall. One can only imagine the devastating effects hundreds or even thousands of logs had on the watershed’s streams as dams were built to impound them and then floated in massive quantities to the mills downstream. On their way downstream, it is very likely the logs impacted the original conditions of the streambed. Such destructive forestry practices have long since vanished and new, more environmentally friendly logging methods have been developed over time.

The lumber industry is very active within the watershed. New methods and machinery have eliminated the need to transport logs in-stream, and logging can be done at a much faster rate. However, with modern forestry methods come new challenges. Logs are now removed using equipment that requires the construction of numerous roads within the areas being logged. Staging areas, which are used to store and load logs onto trucks for transportation to saw mills, are also constructed as part of a logging operation. They require additional clearing and grading. Excessive erosion and sediment can be generated if those roads and staging areas are not properly constructed using “best management practices.” These practices, or BMPs as they are called, were developed to limit erosion and sediment pollution.

Logging operations also often necessitate the crossing of streams. To assure minimal impacts, the construction of stabilized stream crossings is necessary. Proper construction of those crossings is critical in limiting erosion and sediment and protecting in-stream habitats. Logging roads should be constructed in a manner that limits erosion. Techniques that prevent water from flowing long distances down steep slopes, such as following the natural contour of the land and the frequent use of road cross drains, such as water bars, dips, or culverts, can limit erosion problems. Such areas should be drained to undisturbed areas and never directly to a stream. Disturbance within the streamside habitat should be limited or excluded. These methods help prevent silt from reaching the stream and impairing aquatic habitat.

Improperly constructed logging road with poor drainage allows water to collect and sediment to enter the nearby stream.

Agriculture

The original forest clearing, usually done by first “ringing” tree trunks (cutting a ring of bark from the trunk to kill the tree) allowed many areas of the land to be opened up for farming. Early farming was also closely tied to the lumbering industry as farmers turned to lumbering during the times when fieldwork was impractical. Lumbering offered a source of cash income that supplemented the subsistence farming usually practiced at that time. As more trees were cleared and land opened up, the farming industry flourished and the population grew. Farming became a key industry within the watershed.

Unlimited cattle access to streams can cause sedimentation, erosion, and nutrient pollution.

Farming remains viable within the Anderson Creek watershed, but many factors have contributed to a decline in full-time farming operations. Economics has long been the determining factor in the viability of family farms. Throughout Pennsylvania and much of the nation, there has been a trend to move away from "family farms" and toward larger-scale operations because of the improved economics. No large-scale, industrial-type farming operations exist within the watershed.

Family farming has generally been a low-profit industry and when faced with the possibility of earning extra income from other resources, many farmers in the Anderson Creek watershed took advantage of the opportunity. Many farmers leased their minerals rights to coal mining companies, which used surface-mining techniques to extract the coal. Such operations gave many farmers much needed income, but eventually many of those farms went out of production. Many of those farms were reclaimed but are comprised mainly of fallow fields. Some have been restored to productive use, while others are left unreclaimed and remain sources of mining-related NPS pollution.

Today, there are a few working farms within the Anderson Creek watershed. Most farms contain areas where the implementation of BMPs could help reduce agricultural NPS pollution sources reaching the stream. Riparian fencing and planting, in-pasture watering systems, barnyard stabilization and runoff control, stabilized stream crossings, alternative watering sources, and various other techniques that minimize soil erosion are just a few of the practices that could be installed to reduce farm impacts to streams.

Construction and Urban Runoff

Construction and urban runoff and hydrologic/habitat modification appear to be having minimal overall impacts in the watershed. Curwensville is the largest urban area within the watershed and is the area mostly associated with these types of pollution sources. As discussed previously, pollution is generated on paved surfaces within the town and is washed into the stream during periods of rain or snow.

Some stream segments of tributaries within Curwensville have been channelized with hard structures (concrete channels) for flood control because homes and businesses within the town have been built within the floodplain. Although the structures control water during periods of high flow, they are detrimental to natural stream conditions and functions. However, it is unlikely the concrete-lined stream segments will be returned to anything resembling natural conditions. Therefore, for this assessment, the areas are just noted as impacted.

Tanners Run, a tributary to Anderson Creek, is enclosed in a concrete channel in Curwensville.

The main stem of Anderson Creek, as it flows through Curwensville, has been previously channelized. It appears that channelization has occurred from approximately one-quarter mile upstream of the confluence with Kratzer Run down to the confluence with the West Branch of the Susquehanna River. The stream channel is very wide and shallow compared with upstream sections. This section does not provide the high-quality stream habitat that exists elsewhere in the watershed.

Anderson Creek braids into two distinct channels just below the State Route 879 Bridge, near the Pike Township Municipal building. The gradient remains steep enough through this segment that no significant sediment bars have appeared within the channel. Curwensville Borough has reported the formation of a large gravel bar below the mouth of the stream in the West Branch of the Susquehanna River. It was reported that during high-flow conditions, the gravel bar is causing water to be diverted towards homes and businesses located along the West Branch of the Susquehanna River. Borough officials planned to apply for a grant through the Growing Greener program in the winter of 2005 to address the problem. It is recommended that natural stream channel design techniques be incorporated into any proposed remediation effort for the gravel bar. A more detailed study of the entire lower main stem of Anderson Creek, from the bridge on Route 879 to the mouth, would likely provide additional opportunities to install natural stream channel design structures that would greatly improve in-stream habitat.

Gravel bar, which has formed in the West Branch of the Susquehanna River at the mouth of Anderson Creek, is causing erosion along the streambank in the background.

Stormwater Runoff

The watershed's steep topography makes flooding steams more destructive. Water velocities can become quite high during periods of very high flow and some areas of the watershed show signs of flood damage. Much of that disturbance is located in areas near roads or places where the stream has been modified. Kratzer Run, in particular, has several areas apparently affected by erosion, and downcutting is actively taking place. The areas are invariably associated with stream modification or stream encroachment, such as at road crossings or near residences.

The Dubois Reservoir provides some flood protection for the main stem of Anderson Creek, though it was not specifically designed for that purpose. The area above the reservoir accounts for only approximately one-third of the entire watershed. Much of the watershed is free flowing and therefore more prone to flooding. In addition, significant areas of forest were removed during surface mining, causing increased stormwater runoff. Implementing BMPs to reduce stormwater runoff from headwater areas may help reduce the possibility of future flooding.

The Grampian/Stronach area is the watershed's second largest urban area, but has seen little recent development pressure. Streams in the area have not been channelized to any major extent, but some has occurred. The Grampian and Stronach areas have experienced little growth over recent years and therefore pollution from construction activities is not a large limiting factor for the stream.

Erosion of streambank due to stream encroachment and poor streamside vegetation

Closely related to stormwater flow is streambank stabilization. When stormwater is released to a stream too quickly, which usually occurs because of an inability of rainwater to soak slowly into the ground, the natural balance of the stream can be quickly upset and its ability to dissipate the energy created within the water during high flows is overwhelmed.

Under normal, unaltered conditions, a stream operates within a state of equilibrium or "balance" that has been created during the formation of the stream over a very long period of time. If this balance is upset by some outside forces, such as the activities of humans that increases runoff, the stream will try to return to its natural state of balance by changing its character. Those changes might include widening of the channel, cutting wider bends, downcutting of the streambed, and so on. These changes often affect the streambanks, causing them to erode at higher rates than normal (it is important to remember that streams do erode their banks naturally, but not excessively). Eroding streambanks cause sediment to be deposited in the stream, which can degrade the habitat for aquatic animals that live in the stream. Eroding banks can eventually encroach on structures located too close to the stream channel and compromise their integrity.

Urban runoff is concentrated in the Curwensville, Grampian, and Stronach areas, but because the areas comprise such a small portion of the watershed, it appears they have little overall impact to the stream compared with other impairments. There is evidence of downcutting and streambank erosion on Kratzer Run and some of its tributaries. Since some of the headwater area has been cleared of trees for agriculture or mining activities, stormwater runoff there is likely to have higher velocities than in forested areas. Also, because many homes have encroached on Kratzer Run in Grampian and Stronach, the erosion problem has been often compounded by the clearing streamside vegetation, which usually serves to stabilize the streambanks.

Dirt and Gravel Roads

In 1997, when the gas tax legislation was amended, Pennsylvania enacted a Dirt and Gravel Roads Program (DGRP). This innovative effort funds environmentally sound maintenance of unpaved roadway sections identified as sources of dust and sediment pollution through Section 9106 of the PA Vehicle Code (PACD website).

The DGRP program is a cooperative effort between local township municipalities and the conservation districts, which assists townships in identifying problem roads and implementing BMPs that reduce or eliminate sediment from road runoff. The Clearfield County Conservation District, in cooperation with Trout Unlimited, has identified several segments of unpaved roads within the assessment area, which are causing sedimentation problems in tributaries of Anderson Creek. The townships have addressed no sites thus far. Information on locations and the status of identified problem sites can be obtained at the Clearfield County Conservation District.

Nutrient Pollution

Nutrient pollution is the presence of unnaturally high concentrations of nutrients, primarily nitrogen and phosphorous, in surface or groundwater. Sources of nutrient pollution include agriculture runoff from fields and pastures, feedlots, and barnyards, discharges from septic tanks and sewage treatment systems, atmospheric deposition from combustion sources, like coal and oil-fired power plants, urban runoff, and runoff from golf courses. Nutrient pollution can cause excessive algal growth, which causes oxygen depletion, and in more extreme cases, may lead to fish kills. The main source of nitrogen pollution is atmospheric deposition, with agriculture being the second-leading source. The chief source of phosphorous pollution comes from agricultural activities, with septic systems contributing the next greatest proportion.

Only Kratzer Run and Bilger Run were identified by the TMDL study as having a nutrient problem. The source of the nutrients was indicated to be failing septic systems in the more developed areas as well as agricultural areas. Recently the Grampian and Stronach areas along Kratzer Run were the focus of a sewage treatment system project that addressed a major portion of the nutrient problem on that tributary of Anderson Creek. Failing on-lot sewage systems or non-existent systems that pipe sewage directly to the stream are likely the cause of some localized problems remaining in the watershed.

A more detailed study of the nutrient problems in the watershed should be conducted. One of the difficulties with identifying nutrient problems in the watershed is the AMD problem, which can mask the problem by overwhelming it. Once some of the AMD-impacted stream segments are addressed, it is likely that nutrient problems will become an issue. Identifying those areas prior to AMD cleanup is very difficult and beyond the scope of this study.

Sedimentation/Siltation Pollution

Sedimentation/siltation pollution can come from activities related to all of the NPS categories. It is the number one pollutant by volume in Pennsylvania. In the Anderson Creek TMDL study, sedimentation/siltation problems were identified and calculated within the Little Anderson Creek and Rock Run watersheds. This was primarily due to sparsely vegetated abandoned mine lands and agricultural areas where livestock have access to the stream and no riparian buffers exist. These watersheds were the only basins identified by the TMDL study as impaired. Subsequent visual assessments performed under this study in other sub-basins identified many areas likely causing sedimentation/siltation problems. As mentioned in the TMDL study, sources were often associated with abandoned mine and agricultural areas, but many sites were also associated with a variety of other human activities within or near riparian zones. Of particular note was Kratzer Run, where significant erosion was taking place in several areas.

Acid Deposition

The following information was obtained from the website of Pennsylvania Fish and Boat Commission and is an excellent description of the airborne pollution most affecting Anderson Creek watershed.

Acid Precipitation

Note: This is a text-only file of a Fish and Boat Commission publication that includes graphics and a map. Contact the PFBC if you would like a free copy of the complete publication.

Pennsylvania is blessed with thousands of miles of freshwater streams ranging from high mountain headwater tributaries to the slower-moving lowland varieties. All are affected to some degree by acid deposition. The purpose of this brochure is to acquaint the reader with the causes, effects and the need to reduce its effect on our aquatic environment. "The creek is a symbol of our greatest resource; as the creek flows, so flows mankind."

During the past couple of decades, thousands of scientific reports have documented the serious effects of acid deposition in North America and Europe. The control of the air pollutants that cause acid rain and deposition has become a battle cry for conservation-minded citizens in many industrialized countries. Because Pennsylvania waters receive the highest amount of acid deposition of any state in the nation, the Pennsylvania Fish and Boat Commission is particularly concerned about this problem.

Acid deposition is primarily the result of human-made emissions from burning fossil fuel, automotive exhausts and other industrial processes, which emit sulfur dioxide (SO_2) and nitrogen oxide (NO_x) gases. These pollutants are transported in the atmosphere, chemically transformed, and deposited either as wet deposition (such as rain, sleet or snow) or in the form of sulfuric and nitric acids, or as dry deposition in the form of sulfate and nitrate particles. This deposition has been shown to have adverse effects on streams, lakes, forests, buildings, drinking water and human health.

Pennsylvania receives the most acid deposition of any state in the nation because, in addition to being the third highest producer of the gases that cause acid deposition, we are also located downwind from the highest concentration of air pollution emitters. Monitoring stations located throughout the Commonwealth reveal that the pH of our rainfall averages an incredible 4.0 to 4.1, which is many times more acidic than unpolluted rain.

Different areas of the state may respond differently to acid deposition, depending on the region's natural ability to "buffer" or neutralize the incoming acidity. This ability of a body of water to neutralize acids is called its "acid neutralizing capacity," and depends on the dissolved mineral content in the water, which, in turn, depends on the composition of the soils and bedrock in the watershed. If sandstone or igneous rocks such as granite or basalt primarily underlie the watershed, then the streams and lakes in the region will have low acid-neutralizing capacity. If soils and waters of an area continually receive acid deposition, their neutralizing capacity will decrease. With little or no neutralizing capacity, the water will gradually acidify and fish and other aquatic life forms will be adversely affected.

The acid-neutralizing capacity of a waterway is measured by a test called alkalinity, which can be expressed as milligrams per liter (mg/l), or parts per million (ppm) of calcium carbonate. According to international standards, streams and lakes are considered vulnerable to acid deposition if base flow alkalinity values are 10 mg/l or less. These waters are especially susceptible to effects of the continued influx of atmospheric acids. Using this criterion, about one-third of the 4,800+ miles of stocked trout streams in Pennsylvania are considered vulnerable. These streams are indicated on the accompanying map and county lists. In addition to the stocked trout streams on the map, there are even more miles of unstocked waters throughout the Commonwealth that are vulnerable to acid deposition. Some of these vulnerable waters in Pennsylvania are lakes, but most are high-quality small, mountain streams that support naturally reproducing trout populations.

What is the effect of acidification on vulnerable streams and lakes? As a waterway becomes acidified, algae and rooted aquatic plants die off, reducing the available food supply for aquatic insects and fish. Healthy aquatic insect communities are replaced by acid-tolerant individuals, which are not as desirable or abundant a food supply for higher organisms such as certain species of fish. More tolerant fish species may begin to replace the original populations, or the fish may disappear entirely from a waterway.

Fish populations can also be directly affected in several ways. Acidity can stress a fish's basic body function, because it upsets the fish's ability to regulate its blood chemistry. Toxic metals, such as aluminum, can be leached from the soils and delivered to the lakes and streams by acidic rainfall. For example, small amounts of dissolved aluminum can cause mortality in fish by damaging their gills and decreasing sodium in their bloodstream. Finally, fish eggs and fry are very susceptible to high acidity and toxic metals. Partial or entire year classes can perish, leaving older, more resistant individuals to maintain a remnant population.

Over the years, the Fish and Boat Commission has been forced to change many of its stocking patterns on streams receiving increased acidity from acid deposition. In the beginning stages of acidification, it might be possible to change a stocking pattern simply by using a different species of fish. For example, one pattern change may be to change from the stocking of acid-sensitive rainbow trout to the more acid-tolerant brook trout. Another strategy is to change stocking schedules, so that the sensitive fish are not stocked preseason, when the heavy spring rains and winter snowmelt increase the acid and aluminum content of the streams.

Finally, the Fish and Boat Commission may be forced to discontinue stocking altogether when even the brook trout cannot live in the acid runoff. A review of the stocking records in Pennsylvania indicates that since the late 1950s, more than 90 streams have been subject to trout stocking management changes as a result of increasing acidity. Since 1969, the Fish and Boat Commission has had to remove 18 waterways from the trout-stocking list, because of degraded water quality caused by increasing acidity and toxic aluminum.

Currently Fish and Boat Commission managers test water samples from known vulnerable streams every year during March and April. To make future management decisions, fisheries management personnel have also conducted studies on the chemical characteristics and survivability of trout stocked in sensitive water.

Numerous government and university studies have also been conducted in Pennsylvania. Studies conducted by the U.S. Environmental

Protection Agency indicate that the Pocono lakes region is the second most negatively affected lakes region in the country. A Lehigh University study determined that out of 160 lakes in the Pocono region for which there were data, 70 percent were sensitive to acid deposition and 8 percent were already acidified. Scientists from the Pennsylvania State University and from California University of Pennsylvania conducted many watershed studies on the Laurel Hill Ridge, which contains the majority of the natural trout streams in southwestern Pennsylvania. One of their studies revealed that 10 of the 61 watershed samples were fishless and concluded "26 percent of the headwater streams on the Laurel Hill are severely impacted by acidification episodes." The National Academy of Science has stated that protection or recovery would occur on 80 percent of the nation's affected waters if sulfate deposition were reduced to 17 kg/ha/year (15 pounds/acre/year). In Pennsylvania, sulfate deposition ranges from 25 to 45 kg/ha/year (23 to 41 pounds/acre/year), so a reduction of approximately 50 percent would be required.

The Pennsylvania Fish and Boat Commission has actively sought legislation to control acid deposition since 1978. Our 1986 "Policy on Acid Precipitation" urged the federal and state governments to reduce SO_2 and NO_x emissions by 50 percent. After 13 years of study, deliberation and hearings, Congress approved the Clean Air Act Amendments of 1990. Many provisions including acid deposition were new to the Clean Air Act. One of the goals of the acid deposition provision is to reduce annual SO_2 emissions by 10 million tons/year from the 1980 emission levels and cap the annual utility SO_2 emission rate at approximately 8.9 million tons by the year 2010. Another important goal of the provision is to reduce annual NO_x levels by two million tons from the 1980 levels, but unfortunately no caps were put in place. The Congressional findings and passage of the Clean Air Act Amendments were historic in a sense that the long debate about the cause and effect of acid rain was ended.

The Pennsylvania Fish and Boat Commission was pleased that Congress finally passed the necessary legislation that will hopefully end the acid rain crisis. Scientists are optimistic that the 1990 Amendments will benefit Pennsylvania's affected waterways. A National Acid Precipitation Assessment Program (NAPAP) report speculates that because the major emission sources are located along the Ohio River Valley, Pennsylvania should experience a reduction of SO_2 emissions by greater than 50 percent and a SO_2 deposition rate of less than 17 kg/ha/year. Although NAPAP will continue to monitor deposition rates and test water quality, we will not know the final results of the Clean Air Act Amendments until the year 2010.

The passage of the 1990 Amendments is a credit to all the concerned anglers, citizens and scientists who took the time to voice their opinions for cleaner air. However, our work is not done. Attempts will continuously be made to weaken the current legislation. We all must remind our Congressional leaders that acid deposition is still a major concern and that complete enforcement of the 1990 regulations is a must. We can also do our part to limit air pollution by conserving energy, promoting mass transit and supporting strict automobile emission inspections. Future generations of Pennsylvanians are counting on us to protect, conserve and enhance the water resources of our state.

Acid Activity

Many people not familiar with chemistry have a hard time understanding the pH scale. The scale represents the potential hydrogen ion activity of a water environment and therefore its relative corroding action. Although the scale contains 15 numbers (0 to 14), the acid activity at a pH of 7 and above is not very significant. Numbers below a pH of 7 represent increased acid activity and potential harm to the environment. Most organisms live in environments where the pH ranges between 6 and 9. At pH levels below 4.5, the acid activity is too toxic for most organisms to survive.

A pH number is a negative logarithm, so the number is a decimal part of a whole number. A change from one whole pH number to another represents a tenfold increase or decrease in the acid potential of a water environment. The chart above shows several ways to present the concept of acid potential (pH) and some pH levels for common liquids in our environment. [Note: Chart is omitted in this “text only” version.]

Although all Pennsylvania waters receive acid deposition, the locations of the most vulnerable streams are directly related to the geology and physical features of the state. By comparing the larger map above with the smaller one to the right, it becomes apparent that most of our vulnerable streams are located in the sandstone mountainous regions of Pennsylvania. [Note: Maps are omitted in this “text only” version.]

As mentioned above, acid precipitation affects all of Pennsylvania. The assessment area is particularly vulnerable to the effects of acid precipitation because of its geologic makeup, which provides very little, if any, neutralizing ability against acid deposition. During field reconnaissance, very few stream segments had pH values of 7 or above. Surface or deep mining affects much of the watershed. Some stream segments clearly suffered from depressed pH and elevated aluminum levels due to acid precipitation, because there was either very limited or no mining done near the area of the reconnaissance. The previous study performed on the area of the watershed draining to the Dubois Reservoir indicated the same.

AMD

The most prevalent pollution problem within the Anderson Creek watershed stems from past mineral resource extraction activities. There are a number of significant coal and clay layers, or "seams," located throughout the watershed. The combination of valuable coal and clay resources being located within a large portion of the watershed led to a substantial amount of both underground and surface mining. Past unregulated and under-regulated mining of those resources led to significant pollution problems for many areas within the Anderson Creek watershed. Problems affecting land and water are associated with both surface and underground mining.

Abandoned mine drainage, or AMD, is a term given to water that has been polluted due to mining activities. A mineral called pyrite, which is often contained within coal and shale layers usually associated with coal, produces sulfuric acid through a series of complex chemical reactions when it is exposed to oxygen and water. Under normal or undisturbed conditions, little or no chemical reactions occur. After mining, whether underground or on the surface, oxygen and water comes in contact with pyrite and begins the chemical reaction. Depending on the chemical makeup of the rock layers, highly acidic water can be produced. This acidic water often leaches toxic metals from the rock layers it contacts. The metals often discolor the water or the streambed as they are deposited in the stream channel. Metal precipitation in AMD is highly dependent on pH. At very low pH, AMD-polluted water can look clear and unpolluted because the metals are completely dissolved in the water. As a general rule, as pH rises and acidity decreases the metals will begin to precipitate. At pH 4.5, aluminum will usually begin to precipitate

Iron from AMD pollution sources deposited on the streambed of Little Anderson Creek.

from AMD and will impart a white cast to the water or the rocks that it contacts. Approaching pH 6, iron begins to precipitate and will color the water or stain the streambed orange. This orange color is usually associated with AMD-impaired streams.

In the Anderson Creek watershed, extensive coal and clay mining have occurred. The highest area of concentration of mining occurs in the Little Anderson Creek and Rock Run sub-basins of Anderson Creek, which are identified in the Scarlift and TMDL reports as heavily polluted by metals and acid. AMD also pollutes numerous other stream segments within the watershed. Kratzer Run and all of its major tributaries, which include Bilger Run, Fenton Run, and Hughey Run, are also impacted to varying degrees.

In some instances, because the clay seams that were mined were relatively thick and often close to the surface, significant areas of subsidence have occurred. The subsidence not only creates surface depressions that create flow paths of surface water into the mine voids, it also increases the opportunity for oxygen to enter the mine, which accelerates the chemical reactions that produce AMD. Furthermore, a coal seam often lies above the clay. When subsidence occurs, the coal and surrounding materials, which contain the pyrite that produces AMD, collapses into the clay mine, increases acid production, and helps leach the aluminum from the clay. Eventually, the toxic AMD discharges from the mine and enters surface water streams where it has a devastating effect on all aquatic life.

Many areas throughout the watershed have been remined since the completion of the Scarlift reports and the development of the BAMR Problem Area maps. Remining is the process by which areas that have been previously mined, and often left unreclaimed, are mined once again. Using modern equipment and methods it is often possible to extract additional coal, and in the case of the Anderson Creek watershed, sometimes clay, that has economic value. In the process of remining, the land is reclaimed to a condition much improved over what was there prior to remining. The approval of modern-day mining permits relies heavily on evaluating the soils and rock that lie above the coal to contain a net positive balance of alkalinity over acidity. Often, when conditions are such that the balance is net acidic, additional alkaline material is incorporated into the remining and reclamation process to gain the net alkaline balance. These techniques have thus far been very successful in the reclamation and restoration of many areas previously degraded by mining within the Anderson Creek watershed. However, there are areas within the watershed where site conditions are such that remining is impractical because of the extremely acidic rock layers. Remining continues within the watershed. If improved conditions hold over time, it can be expected that additional improvements in water quality will be realized through additional remining in the future.

Impairment of Water Quality and Aquatic Life

NPS pollution has its most profound impact on the plant and animal life that live in the streams. AMD and acid deposition are the main pollution sources affecting life in the streams of the Anderson Creek watershed, often causing them to be virtually devoid of fish and other aquatic life. The primary pollutants from AMD are metals, most often iron, aluminum, manganese, and acidity. Pennsylvania established in-stream water quality standards for iron and manganese, which are published in the Pennsylvania Code, Chapter 93 Water Quality Standards. The standards set the limits as follows: Iron – 30 day average 1.5 mg/L as total recoverable, Manganese – Maximum 1.0 mg/L as total recoverable, and pH - 6.0 – 9.0 inclusive. Water quality standards for aluminum are identified in the Pennsylvania Code, Chapter 16 as 750 ug/L (0.75 mg/L) in Appendix A, Table 1, Water Quality Criteria for Toxic Substances. In-stream water quality below the standards can be considered as impaired.

A search of available information on existing best management practices implemented within the watershed to address identified NPS pollution turned up very little specific information. Several remining operations that have reclaimed abandoned surface mines have apparently improved water quality in some stream segments, however those improvements are based on empirical information. Any future remining and reclamation of abandoned mine sites or implementation of BMP’s within the watershed, particularly those which will successfully address AMD sources, should be coupled with instream chemical and biological monitoring to quantify improvements on affected stream segments.

1979, the Pennsylvania Fish and Boat Commission (PFBC) performed a stream survey on Anderson Creek. The study divided Anderson Creek into five sections. Two sections were located in the headwaters above the Dubois Reservoir, two sections between the reservoir and Little Anderson Creek, and the final section covering from the confluence of Little Anderson Creek to the mouth of the stream in Curwensville. The study found conditions much the same as they were during this study. The upper sections to Little Anderson Creek were impaired by acid deposition but contained life, although in depressed numbers. From Little Anderson Creek to the mouth, the stream was severely degraded. PFBC found one pumpkinseed sunfish at the confluence with Kratzer Run, likely where some alkalinity entered the stream. Otherwise, very little aquatic life was noted. The recommendation from the study suggested that a trout-stocked fishery be maintained in section three, from the Dubois Reservoir to one kilometer downstream of the Route 322 Bridge. Section four below that to the confluence with Little Anderson Creek was considered too inaccessible to be stocked. Those recommendations were still in effect at the time of this study.

In July 1999, Headwaters Charitable Trust, in cooperation with the PFBC, Canaan Valley Institute, and DEP performed a biological survey of Anderson Creek and several of its major tributaries. Four stations were sampled along Anderson Creek from below the Dubois Reservoir to the mouth of the stream. Only the first station recorded fish species (seven species), indicating good water quality, though no trout were captured. The remaining three downstream sites recorded no fish, indicating the degraded nature of the stream due to AMD. Three stations were located along Little Anderson Creek, from its headwaters above SR 219 to the mouth of the stream. Only the uppermost station produced fish (three species), indicating moderate stream quality. The remaining two stations showed a complete absence of fish due to AMD. Five additional tributaries of

Anderson Creek were sampled—Panther Run, Bear Run, Kratzer Run, Fenton Run, and Bilger Run. Panther Run, Bear Run, and Fenton Run all contained naturally reproducing brook trout. Bear Run scored the highest for habitat of all streams and contained the most trout, with Panther Run and Fenton Run successively fewer. Kratzer Run also contained trout, but they were identified as hatchery trout, very likely those stocked by ACWA during the limestone sand-dosing project. Bilger Run contained no fish as a result of its AMD impacts. Macroinvertebrates were also sampled during the assessment, but no data on the results was available.

DEP's Unassessed Stream Program, which is required to assess all of the waters of Pennsylvania, recently performed a biological assessment of the Anderson Creek watershed. The findings of this assessment generally confirmed the findings of the PFBC study and this assessment. The stream segments on Anderson Creek above the confluence with Little Anderson Creek were considered relatively unimpaired, though populations were noted as depressed because of acid deposition. Much of the remainder of the watershed was impaired biologically, due to AMD, with some of those segments also containing impaired habitat, mostly due to precipitate from AMD or sediment from surface mining.