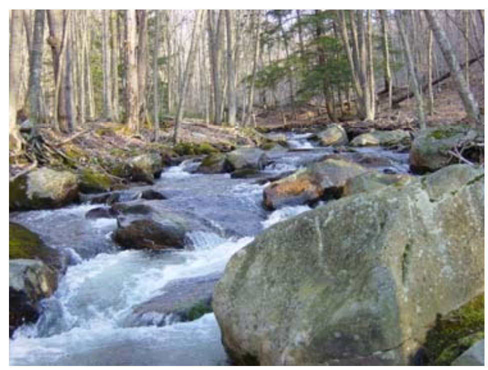
IV. WATER RESOURCES

A. Watershed Drainage and Major Tributaries

Pine Creek is the second largest tributary to the West Branch of the Susquehanna River, encompassing a watershed of 981 square miles. The Pine Creek watershed has 17 major sub-basins that include such tributaries as Ninemile Run, Genesee Forks, Phoenix Run, Elk Run, Long Run, Marsh Creek, Babb Creek, Cedar Run, Slate Run, and Little Pine Creek. Map 7 is a sub-watershed map that shows all 17 sub-basins. A list of the length and drainage area of the sub-basins is found in Table A-1. The total number of stream miles when added up for the Pine Creek watershed is 1,614 miles. The two largest tributaries are Marsh Creek and Babb Creek. Babb Creek travels a length of 21.5 miles and drains an area of 130 square miles. Marsh Creek travels a length of 21.4 miles and drains an area of 81.3 square miles. These two tributaries of Pine Creek account for 21.6% of the total drainage area of the Pine Creek watershed. However, when you consider that the Texas Creek, Black Creek, and Blockhouse Creek watersheds all empty into Little Pine Creek their combined drainage area is 298 square miles and this accounts for 30.4% of the total drainage area of the Pine Creek watershed. Table A-1 and Map 2 provide physiographic information on the tributaries within the Pine Creek watershed with additional information in Table A-7.



The headwaters of Pine Creek originate at an elevation of 2,420 feet in Ulysses Township, Potter County. This area has a unique geographical distinction and can be considered the starting point, (triple point) of three major U.S. watersheds. The north side of this triple point is where the Genesee River originates and flows north eventually emptying into Lake Ontario, the Saint Lawrence River and Atlantic Ocean. The western slope of this triple point forms the Allegheny River, flowing into the Ohio River in Pittsburgh; which flows to the Mississippi and the Gulf of Mexico. Pine Creek, which flows south of the triple point, drains into the West Branch of the Susquehanna at Jersey Shore at an elevation of 520 feet. The West Branch flows into the Susquehanna River at Sunbury and eventually empties into the Chesapeake Bay, the largest estuary in the United States. From Galeton to Ansonia, the creek drops at a rate of 11.3ft/mile. In the Canyon the creek drops approximately 16.8ft/mile; in the steepest part of the canyon from Owassee to Bear Run the creek drops at a rate of 26ft/mile; and from Blackwell to Jersey Shore the creek flattens and drops at approximately 6.9ft/mile.

There are three main USGS gauging stations in the Pine Creek watershed. Their locations and drainage areas are Pine Creek at Cedar Run, 604 sq mi drainage area; Blockhouse Creek near English Center, 37.7 sq mi drainage area; Pine Creek below Little Pine Creek near Waterville, 944 sq mi drainage area. At Cedar Run, from December 2001 to April 2002 average flow was 976 cubic feet per second, while in May through November 2002 average flow was 618.16 cubic feet per second. At Blockhouse Creek, average flow was 62.3 cubic feet per second from December 2001 to April 2002 and 327.24 cubic feet per second from May through November 2002. At Pine Creek below Little Pine Creek, from December 2001 through April 2002 average flow was 1555.8 cubic feet per second, and 1113.10 cubic feet per second from May through November 2002.

The Strahler "stream order system" is a general way of describing the stream make-up of a watershed. In this classification system, two first order streams (also called headwater streams) join to form a larger second order stream; two second order streams join to form a third order, and so on. However, when a smaller stream enters a higher-ordered stream, the order number of the higher-ordered stream does not change (i.e. if a first order stream goes into an already designated second order stream, then the second order stream designation does not change). The largest river in the United States, the Mississippi River, is a 12^{th} order stream at its mouth. Applying this system of classification to streams in the Pine Creek watershed, there are 916.3 miles of first order streams, 337.6 miles of second order streams, 191.3 miles of third order streams, 74.2 miles of fourth order streams, 54 miles of fifth order streams, and 40.9 miles of sixth order streams within the watershed, making a total of 1,614 miles. Thus, 73.1% of the streams in the Pine Creek watershed are the smaller first and second order streams and their protection should be a major concern in order to assure the water quality of the area.

B. Lakes

All lakes within the Pine Creek watershed are manmade and provide flood protection and recreation for residents and tourists. Lakes found in the watershed include: Hamilton Lake, Little Pine Lake, Nessmuk Lake, Kelsey Creek Lake, Galeton Lake (also known as Centertown Lake), and Lyman Run Lake.

Hamilton Lake, on Charleston Creek near Wellsboro, was created in 1968 and has a surface area of 40 acres. It contains 200 million gallons of municipal water for local residents and has been known to have a good largemouth bass population. The lake provides recreation for residents and tourists in the form of parks, boating, fishing, and skating. According to the Pennsylvania Summary of Fishing Regulations and Laws, Hamilton Lake, along with Little Pine Lake in Lycoming County, has been selected for the Trout-Stocked Lake Program. This means that when most trout-stocked waters are closed to fishing, these select lakes are stocked early and open for fishing. Nessmuk Lake, on the Morris Branch of Marsh Creek near Wellsboro, has a 60 acre surface area with a depth of 21 feet. It is important for recreation and flood control. The lake has an 847 million gallon flood storage capacity. Kelsey Creek Lake was completed in 1967 and is located on an abandoned landfill near Wellsboro. It has a six acre surface area with a 15 million gallon flood capacity.

Little Pine Lake was created when a dam was erected on Little Pine Creek in 1949. The lake is located four miles upstream from the mouth of Little Pine Creek and has a 94 acre surface area. It is a flood control reservoir located in the middle of Little Pine State Park near Waterville.

The original Lyman Run Lake, a reservoir in Lyman Run State Park, was built in the early 1950s but was drained in 2003 because of concerns about the dam. Since April 2004 a new dam has been under construction, with a 40 acre reservoir, and is scheduled to be completed by the fall of 2005. The new dam will be 53 feet high and 1000 feet long creating a pool storage capacity of 476 acre/feet.

Centertown Lake at Galeton is a 12 acre stop log construction impoundment. The main purpose of the lake is flood control; it also serves for recreational purposes. But, it is a migration block for trout.

C. Wetlands

Wetlands are defined as transitional areas between terrestrial and aquatic environments where the water table often exists at or near the surface, or where the land is inundated by water. Wetlands perform a variety of environmentally valuable functions. Wetlands function as groundwater discharge/recharge areas as they mitigate the effects of flood and drought by acting as a saturation zone and provide a diverse wildlife and aquatic habitat. Wetlands also play a critical role in sediment/toxicant retention and nutrient removal/transformation.

As described in the Chesapeake Bay Program website (www.chesapeakebay.net), the majority of the wetlands in the Pine Creek watershed are classified as the palustrine type. A palustrine system includes all non-tidal wetlands less than 20 acres wide, and dominated by trees, shrubs, emergents, mosses or lichens. This type of wetland also provides crucial habitat for plants, macroinvertebrates, fish, waterfowl, and several mammal species.

Prominent wetlands in the Pine Creek watershed include areas within Lyman Run State Park, Black Ash Swamp north of Wellsboro, the "Muck" within the Marsh Creek sub-basin, Algerine Bog near Cedar Run and Avis Swamp near Jersey Shore. The Chesapeake Bay website summarizes the number and size of wetlands within five areas along the Pine Creek watershed (Table IV-1). A total of 711 wetlands are less than 3 acres in size and 146 wetlands are greater than 10 acres in size. Black Ash Swamp can be found in Tioga State Forest and makes up a total of 308 acres. Algerine Swamp's 84 acres have been found to contain black spruce, balsam fir, and pitcher plants. However, these wetlands are small in comparison to the "Muck."

Table IV-1: Wetlands Within the Pine Creek Watershed *

Location along Pine Creek	# of Wetlands < 3 acres	# of Wetlands 3-10 acres	# of Wetlands > 10 acres
Galeton area	36	8	2
Marsh Creek area	137	21	3
Babb Creek	223	21	74
Waterville area	145	6	38
Jersey Shore area	170	15	29

* From Chesapeake Bay Website (www.chesapeakebay.net)

The "Muck," along Marsh Creek, contains five types (Forested, Scrub/Brush, Emergent Marsh, Aquatic Bed, and Unconsolidated bottom) of palustrine wetlands as defined by the U.S. Fish and Wildlife Service (Table IV-2). These wetlands cover 91.4% of the 3,000 acre valley floor of Marsh Creek and have been cited as an Important Bird Area by the National Audubon Society with sightings of over 150 bird species. The marshes of the Marsh Creek Valley have historically been considered impediments to progress. In the early 1800s settlers perceived their stagnant waters as a serious health risk and began to modify them. The greatest modification of these wetlands (draining and ditching as well as deforestation) was achieved between the 1890s and 1950s to allow for agricultural production of lettuce and celery. The Marsh Creek Valley is an unusual and important natural area in northcentral Pennsylvania and only a few, if any, pristine acres remain. However, since 1950 most of the drainage ditches have been abandoned and are filling in with silt and organic debris, thus reestablishing marsh characteristics.

Table IV-2: Palustrine Wetlands of the Marsh Creek Valley

Type	Major Vegetation	Acres	% of all Wetlands	Acres Drained	% of Total Drained Wetlands
Forested	Example: Hemlock, red maple	87	9.5	18	2.8
Scrub/brush vegetation	Example: Willows, alders	134	14.4	49	7.7
Emergent Marsh Inundated Muck	Example: Cattails, sedges	650	69.9	557	87.9
Aquatic Bed	Example: Water Lilies	7	00.7	5	0.8
Unconsolidated Bottom	Too deep for vegetation	52	5.5	5	0.8
Total		930	100.0	634	100.0

D. Floodplains and Floodplain Management

Undisturbed floodplains serve a variety of ecological functions including retention and release of surface and groundwater, vegetative stabilization of stream banks, sediment and toxicant filtering from surrounding uplands, production of food sources and cover and protection for wildlife living in the plain.

There has been an accelerating demand for stream-front property within the Pine Creek watershed for businesses, homes and camps. The crowding of the floodplain not only endangers human life, but also affects the water quality, groundwater supplies, stability and natural beauty of stream banks. All of these can have significant impact on the biological health of the stream ecosystems.

Flood management and insurance rates are coordinated through the National Flood Insurance Act of 1968, which created the Federal Insurance Administration and made flood insurance available for the first time. The Flood Disaster Protection Act of 1973 made the purchase of flood insurance mandatory for the protection of property located in Special Flood Hazard Areas. The Federal Emergency Management Agency (FEMA) was given the authority to administer the laws outlined in the Acts. FEMA also conducts routine flood insurance studies throughout the country. The purpose of the studies is to develop risk data that can be used during land use planning and floodplain management. The Department of Environmental Protection also has an established floodplain regulation and management plan outlined in the 25 PA Code Section 106.

Pine Creek's most frequent flooding typically occurs in early spring, after the area has received heavy rainfall on top of deep melting snow. Highest stream flow occurs between March and the beginning of June. Record floods occurred in June 1889, March 1936, May 1946, June 1972, and January 1996. Additional flood information can be found in Table IV-3.

Table IV-3: Flood Damage Centers, State Water Plan: Sub-Basin 9A

Locations	Flood Damages		
	Highest Flood Damages Recorded Prior to 1969		"Agnes" 1972
	Flood Date	Damages* ($1,000)	Damages* ($1,000)
Galeton Boro- Pine Creek	May 1946	1,973	143
Wellsboro Boro-Marsh Creek			912
Morris Township-Wilson Creek & Babb Creek	May 1946	268	
Slate Run- Pine Creek			1,707
Cammal- Pine Creek			255
Jersey Mills- Pine Creek			288
Liberty Boro- Blockhouse Creek			127
English Center- Little Pine Creek			138
Waterville- Pine Creek			1,175
Pine Creek by Jersey Shore- West Branch Susquehanna River	Jan 1959	1,129	

* Damages are times $1000

E. Water Supplies

1. Pubic Water Supplies

There are approximately 50 regulated public water supply systems within the Pine Creek watershed. Of those 50, six are community water supplies (residential communities) and four are non-transient non-community water supplies (routinely serve the same individuals, but not residential communities). The community water supplies are: Wellsboro Municipal Authority, Duncan Township Municipal Authority, Waterville Water Association, Galeton Borough Water Authority, Jersey Shore Area Joint Water Authority, and Country Living Mobile Home Park. The non-transient non-community systems are: Liberty Elementary School, Liberty High School, SMC Powder Metallurgy, and Wellsboro Industrial Park. All of these systems have groundwater sources; however, Galeton Borough Water Authority, Wellsboro Municipal Authority, and Jersey Shore Area Joint Water Authority also have surface water sources within the Pine Creek watershed. These surface water intakes are not necessarily on the main stem of Pine Creek, but in some cases are on one of the tributaries to Pine Creek. Jersey Shore's surface water intake is a backup source and is only used once about every ten years. The remaining approximately 40 regulated public water supplies are transient groundwater systems. These systems do not serve the same individuals on a regular basis and include largely restaurants, campgrounds, and stores not connected to a community water supply.

2. Private Water Supplies

The remainder of the residents and camp owners within the Pine Creek watershed are dependent on private water supplies which may be springs, streams, or wells. However, most of these are probably groundwater wells. These systems are not regulated in any way and there are no records regarding the quality of these supplies.

F. Protected Uses

1. Chapter 93 Classification

The Pennsylvania Department of Environmental Protection (DEP) has established a system classifying each Commonwealth waterway according to its water quality and the quality of its aquatic ecological communities. There are four protected use designations pertaining to aquatic life, described as below. (Refer to Map 8) The classification system and criteria set forth in Chapter 93 of the Pennsylvania Codes are:

CWF	*Cold Water Fishes*—Maintenance or propagation, or both, of fish species including the family Salmonidae and additional flora and fauna which are indigenous to a cold water habitat.
WWF	*Warm Water Fishes*—Maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat.
MF	*Migratory Fishes*—Passage, maintenance and propagation of anadromous and catadromous fishes and other fishes which ascend to flowing waters to complete their life cycle.
TSF	*Trout Stocking*—Maintenance of stocked trout from February 15 to July 31 and maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat.

In addition, waterways or watersheds can be given special protection, either as Exceptional Value (EV) or High-Quality Cold Water Fisheries (HQ-CWF). These designations are based upon the following criteria:

(a) *Qualifying as a High Quality Water*. A surface water that meets one or more of the following conditions is a High Quality Water.

(1) *Chemistry*.

(i) The water has long-term water quality, based on at least 1 year of data which exceeds levels necessary to support the propagation of fish, shellfish, and wildlife and recreation in and on the water by being better than the water quality criteria in § 93.7, Table 3 (relating to specific water quality criteria) or otherwise authorized by § 93.8a(b) (relating to toxic substances), at least 99% of the time for the following parameters:

- Dissolved oxygen
- Aluminum
- Iron
- Dissolved Nickel
- Dissolved Copper

- Dissolved Cadmium
- Temperature
- pH
- Dissolved Arsenic
- Ammonia Nitrogen
- Dissolved Lead
- Dissolved Zinc

(ii) The Department may consider additional chemical and toxicity information, which characterizes or indicates the quality of a water, in making its determination.

(2) *Biology*. One or more of the following shall exist:

(i) *Biological assessment qualifier.*

(A) The surface water supports a high quality aquatic community based upon information gathered using peer-reviewed biological assessment procedures that consider physical habitat, benthic macroinvertebrates or fishes based on *Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish*, Plafkin, et al., (EPA/444/4-89-001), as updated and amended. The surface water is compared to a reference stream or watershed, and an integrated benthic macroinvertebrate score of at least 83% shall be attained by the referenced stream or watershed.

(B) The surface water supports a high quality aquatic community based upon information gathered using other widely accepted and published peer-reviewed biological assessment procedures that the Department may approve to determine the condition of the aquatic community of a surface water.

(C) The Department may consider additional biological information which characterizes or indicates the quality of water in making its determination.

(ii) *Class A wild trout stream qualifier.* The surface water has been designated a Class A wild trout stream by the Fish and Boat Commission following public notice and comment.

(b) *Qualifying as an Exceptional Value Water*. A surface water that meets one or more of the following conditions is an Exceptional Value Water:

(1) The water meets the requirement of subsection (a) and one or more of the following:

- **(i)** The water is located in a National wildlife refuge or a State game propagation and protection area.
- **(ii)** The water is located in a designated State park natural area or State forest natural area, National natural landmark, Federal or State wild river, Federal wilderness area or National recreational area.
- **(iii)** The water is an outstanding National, State, regional or local resource water.
- **(iv)** The water is a surface water of exceptional recreational significance.
- **(v)** The water achieves a score of at least 92% (or its equivalent) using the methods and procedures described in subsection (a) (2) (i) (A) or (B).
- **(vi)** The water is designated as a “wilderness trout stream” by the Fish and Boat Commission following public notice and comment.

(2) The water is a surface water of exceptional ecological significance.

a. Pine Creek Fisheries Designation under Chapter 93

There are a total of 1623.3 miles of stream in the Pine Creek watershed. Of those, 980.1 miles (60.3%) are classified as High-Quality Cold Water Fisheries (HQ-CWF). Another 529.2 miles (32.6%) are designated as Cold Water Fisheries (CWF). There are 56.6 miles (3.5%) designated Exceptional Value. In addition, a 57.9-mile stretch of Pine Creek is designated as a High Quality-Trout Stocked Fishery. These 57.9 miles account for 3.6% of the total stream miles in the Pine Creek watershed. Pine Creek tributaries and their fisheries designations are listed in Table IV-4.

Table IV-4: Fisheries Designations of Major Tributaries in the Pine Creek Watershed

Stream	Fisheries Designation
Elk Run	HQ-CWF
Long Run	EV-CWF
Marsh Creek	CWF
Babb Creek	CWF
Wilson Creek	CWF
Stony Fork	CWF
Cedar Run	EV
Slate Run	EV
Blockhouse Creek	CWF

Legend:
(HQ-CWF) High-Quality Cold Water Fisheries
(EV-CWF) Exceptional Value Cold Water Fisheries
(CWF) Cold Water Fisheries
(EV) Exceptional Value

2. Fish Habitat Designation by the PA Fish and Boat Commission

The Pennsylvania Fish and Boat Commission (PFBC), on their website (http://www.fish.state.pa.us), annually shows the designated number of streams in the Pine Creek watershed as Class A Wild Trout water, Natural Trout Reproduction and Wilderness Trout Streams based on the following criteria:

DEFINITION OF CLASS A WATERS:

Streams that support a population of naturally produced trout of sufficient size and abundance to support a long-term and rewarding sport fishery. In the process of designating a Class A water the Fish and Boat Commission also documents Total Alkalinity in mg/l during the time of their fish surveys.

DEFINITION OF NATURAL TROUT REPRODUCTION:

Evidence of native trout reproduction.

DEFINITION OF WILDERNESS TROUT STREAMS:

Wilderness trout stream management is based upon the provision of a wild trout fishing experience in a remote, natural and unspoiled environment where man's disruptive activities are minimized. Established in 1969, this option was designed to protect and promote native (brook trout) fisheries, the ecological requirements necessary for natural reproduction of trout and wilderness aesthetics. The superior quality of these watersheds is considered an important part of the overall angling experience on wilderness trout streams. Therefore, all stream sections included in this program qualify for the Exceptional Value (EV) special protected water use classification, which represents the highest protection status provided by the Department of Environmental Protection (DEP), Chapter 93 referenced above.

a. Pine Creek Fisheries Designation Based on Supporting Trout

In the Pine Creek watershed there are 143.1 miles of stream that have been designated as Class A Wild Trout water. A listing for 2004 Class A Wild Trout can be found in Table A-8. Additionally, due to the overall excellent water quality conditions in the watershed, as well as the limited influences of humans, a number of streams in the watershed support natural reproducing populations of trout, primarily brook trout (Salvelinus fontinalis) and brown trout (Salmo trutta). A listing of natural reproduction for 2004 can be found in Table A-9. There are a total of 76 streams in Potter County, 160 streams in Tioga County, and 125 streams in Lycoming County that contain natural trout reproduction. Therefore, Potter County makes up 21.5% of Pine Creek’s natural trout reproduction, Tioga County makes up 44.3% and Lycoming County makes up 34.6%. The PA Fish and Boat Commission has also set aside sections of streams which fall under the jurisdiction of “Wilderness Trout Streams” protection. A listing of the 2004 Wilderness Trout stream segments designated in the Pine Creek watershed can be found in Table A-10.

G. Water Quality

Several water quality surveys have been conducted in the Pine Creek watershed, all of which indicate that, generally speaking, water quality in the watershed is quite good. Tables A-11a and A-11b show recent water quality data based on water chemistry surveys from the summers of 2003 and 2004, as completed by Clean Water Institute/Lycoming College interns. Table A-11c shows a brief coliform summary from the summer of 2003. Water sampling data from DEP validates Pine Creek’s high quality description. However, some water quality issues continue. These issues can be broken down into two categories, Point Source and Non-Point Source**.** Point Sources occupy a very small area and have a concentrated output, discharging pollution or radiation. Non-Point Sources can be further broken down to Abandoned Mine Drainage (AMD), Acid Precipitation, Nutrients and Sediment, and Storm Water.

1. Point Sources

a. Sewage

As is typical of most free-flowing streams in temperate areas, Pine Creek maintains dissolved oxygen (DO) levels high enough to support all forms of aquatic life. High DO levels also aid in the assimilation of waste products which might enter the stream. These wastes enter the stream primarily through the sewage treatment plants (STPs) at the Boroughs of Galeton and Wellsboro. Before being upgraded to advanced secondary treatment, these two STPs were major sources of ammonia and organic substances that resulted in a high biological oxygen demand (BOD) in Pine Creek. Galeton STP was upgraded to advanced secondary treatment in July of 1986 and Wellsboro in June of 1988.

Under normal circumstances these two discharges are continuously disinfected. However, perhaps the greatest water quality problem associated with these two STPs is the discharge of untreated wastewater directly to the stream in the event of a combined sewage overflow (CSO). CSOs are discharges of untreated wastewater from a combined sewage and storm water system as a result of high precipitation or snow melt. During these periods of increased surface water flows, CSOs result when combined sewage and storm flows exceed the capacity of their respective sewage system or treatment plant. These surplus flows are discharged as raw sewage into adjacent streams before reaching the treatment plant, thus creating environmental and health problems. Both Galeton and Wellsboro do have combined sewage and storm water systems. However, both plants have greatly reduced the occurrence of these discharges over the last several years and both are planning to eliminate them entirely in the future.

Another sewage problem is malfunctioning and/or inappropriately sized private residential septic systems. Between the 1974 and 1996 there were 492 applications approved for on-lot septic systems. Malfunctioning on-lot septic systems are a significant source of the fecal coliform that enters Pine Creek. To limit contamination, tanks should be pumped on a more frequent basis (recommended every two years), and if necessary new or larger on-lot systems with appropriately sized leach fields should be installed.

In spite of these malfunctioning/inappropriately sized on-lot septic systems and occasional CSOs, Pine Creek maintains a relatively high water quality and consistently meets water quality standards. However, increasing development pressure and installation of more on-lot systems, particularly if they malfunction, may result in further degradation to Pine Creek.

b. Toxic Release Inventory (TRI)

Toxic Release Inventory is a reported listing of any toxic chemicals released by facilities or industries. Any chemicals released into the watershed could degrade the fitness of the stream, polluting it and harming the inhabiting wildlife. In the Pine Creek watershed there are six industries that have to report their TRI to the U.S. Environmental Protection Agency (EPA) (www.epa.gov/tri/). These industries are required to report their annual production, disposal, and any emissions to air, soil, and water. This allows the EPA to keep track of anything harmful that these industries are releasing into the environment. The last release year reported on the web is for 2002 and contains information on such contaminants as lead, ammonia, copper, and chromium, etc.

2. Non-Point Sources

a. Overview of Abandoned Mine Drainage in Watershed

Abandoned mine drainage (AMD), which in most cases results in acid mine drainage, involves a complex set of chemical reactions and begins by exposing sulfide-bearing rock to oxygen during the mining process. Sulfides usually occur as pyritic rock material found in conjunction with bituminous and anthracite coal seams, often as rocks and clays surrounding the seams or within roof shale. When sulfides are exposed to oxygen and water, then sulfate ions, dissolved iron, and acidity are produced. When exposed to stream water with a higher pH, acid/base reactions result, causing the metals to precipitate from solution. The most common precipitates are iron hydroxide, a yellow-orange precipitate, aluminum hydroxide, a white precipitate, and manganese hydroxide, a dark brown/black precipitate.

Low pH water and dissolved metals, particularly aluminum, can be lethal to aquatic organisms. Dissolved aluminum affects the gills of aquatic organisms. The sediments produced by acid mine drainage are also environmentally destructive. Precipitated sediments cover the stream substrate, choking out the smaller organisms which constitute the foundation of the aquatic food chain.

Significant discharges of mine drainage occur at various points within the Pine Creek watershed. Areas include multiple sites along Babb Creek, Lick Creek, Wilson Creek, and Otter Run. Babb Creek has been a major source of concern because of the multiple abandoned mine sites along the creek and its tributaries. Underground mining for bituminous coal began in the headwaters of Babb Creek before the Civil War and continued through World War II. Several coal seams underlie the watershed and at least six abandoned major mine complexes exist within the watershed. Some surface mining was done as well. Antrim Mining had the last active mine of any kind in the watershed. Studies conducted between 1970 and the late 1990s all showed Babb Creek's impaired condition, with slight-moderate impairment at the confluence point with Pine Creek.

Within the Pine Creek watershed, Total Maximum Daily Loads (TMDLs) have been established on Babb Creek and some of its tributaries -- Lick Creek, Wilson Creek, and Stony Fork Creek -- as a result of degradation resulting from AMD. TMDLs for these streams dictate daily allowable loading rates for Iron (Fe), Aluminum (Al), Manganese (Mn), and Acidity in order for the stream to attain its designated use.

The Pine Creek Headwaters Protection Group began monitoring the water at a total of 47 different sites in various parts of the watershed in the summer of 1990. The number of sites monitored on a monthly, quarterly, or yearly basis is now about 25. Water samples are taken to a certified laboratory to verify the findings of streamside testing done by the volunteers. This data provides an excellent baseline that can be used to show any improvements to, or degradation of, the water quality within the Pine Creek watershed.

AMD Remediation and Reclamation Projects in Watershed

AMD remediation and reclamation technology is constantly evolving, but the most recent methods to treat abandoned mine drainage can be lumped into two categories: active or passive treatment. Active treatment is accomplished through a treatment plant similar to treatment plants used to treat sewage, only in this case the water is treated by lime dosing to raise the pH and increase alkalinity, and settling of the metal precipitates. This can be very expensive and requires high maintenance. Passive systems require less maintenance and have become the preferred treatment method where the site-specific water quality allows. Passive treatment systems allow the naturally occurring chemical and biological reactions to take place in a controlled environment and not in the receiving body of water. Some examples of passive treatment systems used in the Babb Creek watershed include: diversion wells, anoxic limestone drains (ALD), and vertical flow wetlands.

Diversion wells are constructed along streams impacted by AMD and contain crushed limestone aggregate. Acidic water from the stream is piped to the well where the hydraulic force of the water causes the limestone to turbulently mix and add alkalinity to the water, which is then piped back to the stream.

ALDs intercept mine flows and prevent contact with oxygen. They also contain a limestone bed that generates alkalinity transforming the acid water into alkaline water. The water can then be transferred to an aerobic wetland to precipitate out metals before being released into the receiving water body.

Vertical flow wetlands are ponds that contain an under-drain system, a layer of crushed limestone, and a layer of compost. Alkalinity is increased through bacterial sulfate reduction and limestone dissolution as the water percolates down through this system. The vertical flow wetland is typically followed by a settling basin and aerobic wetland where metals are oxidized and precipitated.

AMD remediation in the Babb Creek watershed started in 1989, when the Pennsylvania Environmental Defense Foundation filed a complaint accusing Antrim Mining Company of increasing acid mine drainage in Babb Creek by breaking into deep mines underlying its stripping operations. Antrim incurred liability for the long-term treatment of acid mine drainage from the abandoned mine discharges in Duncan Township, Tioga County, after it surface mined much of the remaining coal in the area.

The Babb Creek Reclamation Task Force formed in 1990 to address the acid mine drainage problems in the stream. It grew out of an informal cooperative effort of the Pennsylvania Environmental Defense Foundation, Tioga State Forest officials, Arnot Sportsmens' Club, the Pennsylvania Fish and Boat Commission, and local anglers. The Task Force partnered with DEP, the Department of Conservation and Natural Resources (DCNR), Antrim Mining Co. and others to construct treatment systems to deal with the acid mine drainage in streams in the Pine Creek watershed. These treatment systems have played a major role in raising the pH of the water by neutralizing the acidity and removing the toxic metals entering the creeks. The Babb Creek Reclamation Task Force evolved into the Babb Creek Watershed Association (BCWA), which was officially created in 1998 as a nonprofit corporation whose goal was to restore water quality in Babb Creek.

The Babb Creek Reclamation Task Force and its successor, the Babb Creek Watershed Association, have been the driving force behind the installation of a series of treatment systems in the watershed starting with the construction of their first remediation project -- two limestone diversion wells on Lick Creek in 1990. Lick Creek is the farthest upstream tributary to Babb Creek that has been affected by mining and resultant acid mine drainage. A series of increasingly complex, and often more expensive, treatment systems were installed between 1990 and 2004/05 as described in Table A-12. These projects have been made possible by contributions from multiple funding sources too numerous to mention but including: the Babb Creek Watershed Association, EPA grants, Federal Office of Surface Mining (OSM) funding, DCNR, PA Game Commission, DEP Growing Greener funds, Antrim Mining Company funds, and other private mining company funds or in-kind services.

One of the biggest steps forward in the reclamation of Babb Creek was the construction of an acid mine drainage treatment plan at the Antrim mine discharge to Wilson Creek in 1991. This was accomplished as part of a settlement agreement between DEP and Antrim Mining. This plant treats nearly 50 percent of the acid load flowing down Wilson Creek into Babb Creek and had almost an immediate effect on Pine Creek.

Success on Babb Creek results in removal of a section of Pine Creek from Impaired Streams List

In February 2000, DEP removed a 5.2 mile section of Pine Creek in Tioga County from its list of impaired streams because the water quality had improved. DEP's 1998 stream survey data showed a significant increase in aquatic life and a decrease in metals like aluminum, iron, and manganese, all of which can be toxic to fish. This success story demonstrates that projects similar to Babb Creek restoration should be encouraged for continued improvement of the water quality of the watershed.

An updated study done by DEP in February 2002 on the Babb Creek watershed showed net alkalinity and pH both markedly increased following the installation of systems to that point. According to the study, these treatment projects resulted in noticeable improvement in habitat quality and the biological community. The study in 2002 surveyed Pine Creek from Blackwell to Cedar Run, and also areas at the mouth of Babb Creek. The results show that the biological conditions on all of the Pine Creek sites were unimpaired, and the Creek also met all water quality standards. Babb Creek received a moderately impaired score on the biological test, and although sulfate and manganese levels were slightly elevated, they did not exceed the state standards.

The water monitoring results of the Pine Creek Headwaters Protection Group also shows improvement to the waters of Babb Creek. The pH has increased to more acceptable levels, but, more importantly, the alkalinity has increased from the zero level to some values in the hundreds of parts per million. This additional alkalinity allows the stream to counteract any naturally occurring acid, such as from acid rain.

b. Acid Precipitation

Acid Precipitation is defined as any precipitation (wet or dry) that has a pH of less than or equal to 5.6. Wet and dry depositions are two types of precipitation. Wet deposition includes rain, snow, and any other form of wet precipitation. Dry deposition includes particles in the air which after collection are wet down to determine their composition.

Studies have shown that Pennsylvania receives the most acid rain of any state in the nation and the average pH over the last 10 years is between 4.0 and 4.3. Acid rain is caused by sulfur dioxide and nitrogen oxides, which mainly come from coal burning power plants and mobile sources. Acid deposition is the result of human made emissions from burning fossil fuels, automotive exhaust, and other industrial processes which emit sulfur dioxide and nitrogen oxide gases. These chemicals in the atmosphere are deposited as either wet acid in sleet, rain or snow (wet deposition), or as dry sulfate and nitrate particles (dry deposition). The buffering ability of the creek to neutralize the acidity of the deposition depends on the dissolved mineral content in the water, and the composition of the soils and bedrock. If soils and waters of Pine Creek continue to receive acid deposition, their neutralizing capacity will decrease and may be completely used up. With no neutralizing capacity, the water will gradually acidify and fish and other aquatic forms will be adversely affected.

An acid precipitation gauging station exists at Little Pine in the Pine Creek watershed at 41º 22’ 48” latitude and 77 º 22’ 28” longitude. The station is maintained by DCNR and The Pennsylvania State University. Historical and weekly data was recorded as far back as 1982. Each week, the station at Little Pine measures and records deposition and concentration levels of calcium, magnesium, potassium, sodium, nitrate, ammonium, chloride, sulfate, and hydrogen. Annual concentrations of each pollutant were recorded from 1982 to 2003. Potassium concentrations experienced a significant increase over approximately 20 years. Ammonium, calcium, magnesium, sodium, and chloride concentrations were fairly constant, while sulfate and nitrate concentrations decreased over the last 20 years. In the early 1980s hydrogen ion levels, also known as pH, were around 4.0, however, 4.3 is the average level that has been currently measured. Annual wet depositions of each pollutant were also recorded by DEP from 1982 to 2003. Hydrogen ion, sulfate, and nitrate depositions decreased over the last 20 years, while magnesium experienced only a slight decrease. Potassium and sodium increased over the last 20 years, while chloride increased, but then started to decrease over the last 10 years. Calcium and ammonium deposition has remained fairly constant each year since 1982 (refer to http://www.dep.state.pa.us/dep/deputate/airwaste/aq/acidrain/sites/littlepine.htm for more information).

c. Agricultural Impacts

Current agricultural practices create frequent disturbances to waterways. First, during high rainfall, snowmelt, or flood events, the fertilizers, manure, pesticides, and silt from agricultural lands can be transported via overland flow into streams within the watershed. This can create heavy siltation, nutrient accumulation, and suspended solids washing into stream systems, disrupting both the chemical and biotic health of the watershed. Additionally, increasing the abundance and size of silt entering into the stream channel will result in alterations to the stream’s structure and flow characteristics.

Nutrients from agricultural runoff can also leach into soils and contaminate groundwater supplies. The material leached into groundwater can affect drinking water supplies and can eventually feed into stream channels.

Finally, unrestricted access of livestock into streams also creates numerous problems. Along with increasing peril to the livestock, i.e. creating an increased capacity for bone fractures, and herd contamination, livestock can accelerate stream bank erosion, sedimentation, and surface water nutrient enrichment through excrement entering the streams.

Agricultural land cover along Pine Creek was evaluated at five locations, by the Chesapeake Bay Foundation, breaking the watershed up into sections. The combined square miles at the five locations were 71.

Along Wilson Creek, the land use is predominantly agriculture. The ecological impacts of agriculture witnessed on Wilson Creek include suspended sediment releases, loss of habitat, reduced dissolved oxygen, and high water temperature due to the loss of riparian habitat.

Best management practices are practical means of reducing the amount of pollution generated by non-point sources to a level compatible with water quality goals. Stream bank fencing is an example of a best management practice. It deters cows from entering the stream and has the potential to decrease pollution in the stream by 565 million fecal coliform bacteria per cow per day (Dawes, 1996). Fencing also allows a vegetative buffer to develop in the riparian area, which reduces erosion and nutrient deposition caused by livestock, and results in a lower creek temperature. Primary pollution in the Chesapeake Bay is caused by nutrient runoff from agricultural lands. Nutrients cause excessive algae growth which limits oxygen to aquatic life in the bay. The DEP helps with stream bank fencing by offering 100% cost-share to install stream bank fencing and stabilized stream crossings.

Marsh Creek is the second tributary that deals with agricultural runoff and multiple impairments. In the Marsh Creek watershed agricultural runoff downstream has been reduced since the installation of three dams located on each of the three major tributaries above Wellsboro.

d. Storm Water Management

Storm water management involves controlling water runoff from various sources, typically through the use of detention/retention and infiltration facilities. Another best management practice is to reduce the amount of impervious surfaces, which are any buildings, pavement, or any other structure that replaces vegetation and effectively prevents infiltration. Impervious surfaces can do two major things: increase the volume of storm water runoff and increase the energy of the storm water runoff. By impeding infiltration, impervious surfaces can also reduce groundwater levels and base flow to a stream during low flow periods. A stormwater management plan was adopted by Lycoming County, and Tioga County is currently in the process of creating a storm water management plan.

e. Long Term Stream Dynamics

Residents, anglers, conservationists, and other users of Pine Creek are concerned about changes they have noticed in the form and function of Pine Creek and its tributaries over the years. Observers note that the stream seems to be filling in with silt in many areas, including backwater channels that used to be accessible via canoe but no longer are. Others state that Pine Creek seems to turn muddy much more quickly in response to a rainfall event than it did in the past and that eroding stream banks are much more obvious throughout the watershed.

These changes are not uncommon in Pennsylvania streams and are usually the result of many cumulative impacts. Specifically, higher volumes of storm water runoff from increased impervious surfaces in the form of buildings, roads, etc. can overwhelm the stream channel and cause erosion during storm events. Soil and gravel eroded from upstream creek banks are deposited downstream, filling in parts of the channel. Development within the floodplain constricts flow during storm events, which can also lead to increased water velocities in the channel and stream bank erosion. Woody vegetation with deep root systems such as trees and shrubs along the stream banks helps to resist erosion. However, this riparian vegetation is often removed in favor of lawns or agricultural fields. Grasses and crops do not have as much root depth and therefore do not provide as much bank protection as woody vegetation. Wetlands that naturally act as sumps to absorb storm water are filled in as development pressure increases, causing more storm water to run off the land instead of infiltrate.

All of these factors and probably a few others cumulatively cause the form of a stream to change over time. Some areas may show increased erosion of stream banks while other areas show heavy deposition in the form of silt and gravel bars. History has shown that simply trying to address these problems with a band-aid approach at the site by installing rip-rap or dredging a gravel bar does not solve the problem for the long term and, in some cases, may actually make it worse. In order to fully understand the problem and restore the long-term dynamics of Pine Creek, a comprehensive watershed effort is needed to identify and address the specific factors, such as those mentioned above, affecting stream stability within the Pine Creek watershed. Some of these efforts have already been initiated on a sub-watershed basis.

f. Other Tributary Studies in the Pine Creek Watershed

Sub-watershed Projects – Tioga County

Impaired Tributaries: Wilson, Stony Fork, Charleston and Marsh Creeks

The impaired tributaries of Pine Creek have been studied, monitored, and had restoration work designed and completed with varying degrees of success. The restoration of a large section of Babb Creek, from acid mine drainage, is perhaps the best example of a community working together for a long period of time to restore an impaired tributary. While the Babb Creek story is an interesting one that can be found in other sections of this plan, the remaining tributaries to Pine Creek are only now coming under some type of assessment and planning for restoration. The three organizations that are active in these watersheds are: Pine Creek Headwaters Protection Group, Babb Creek Watershed Association, and the Charleston Creek Watershed Association with the assistance of the Tioga County Conservation District. A review of the projects underway or just completed is included here to document their efforts and to address their concerns, issues, and needs.

Wilson Creek

Wilson Creek is the last link in the Babb Creek Watershed Association (BWCA) acid mine drainage restoration project. With the anticipated completion of the Rattler Mine treatment systems the BWCA contracted with the Tioga County Conservation District

(TCCD) and Grand Canyon Ecological Services to assess the watershed for other sources of impairments. This study was completed in May of 2003 and included recommendations for improving conditions in the watershed. Portions of Wilson Creek are on the Clean Water Act Section 303(d) list of impaired waters in the watershed.

The BWCA again approached the Conservation District to partner on some of these recommendations; specifically, working with the farmers and residents in the watershed to improve water quality and fish habitat. Several meetings with farmers and a public meeting to explore the potential for restoration work where held. As a result of these meetings a proposal to develop a watershed management plan and several demonstration projects were planned and funding is currently being sought.

Charleston Creek

Charleston Creek is one of three headwater streams that join in the Borough of Wellsboro to form Marsh Creek, a major tributary to Pine Creek. This stream is on the Clean Water Act Section 303(d) list of impaired waters in the watershed. This section of the Act requires states to list impaired waters that do not support uses even after appropriate and required water pollution control technologies have been applied. It is a significant percentage of the drinking water supply for the Borough of Wellsboro. Drinking water is supplied to the Borough of Wellsboro through a combination of sources. There is a well field in Brownlee, three surface water intakes along Charleston Creek and its tributaries and an intake in Hamilton Lake.

Because of the presence of surface water in the supply, slow sand filtration is used to remove Giardia cysts and other harmful organisms. The presence of high levels of suspended solids severely impacts filter efficiency and increases maintenance. In addition, sediments deposited in Hamilton Lake reduce storage volume and impact water quality.

Based on this knowledge the borough received a Growing Greener grant to assess the watershed in 2001. The results of that assessment included recommendations, one of which was to support the startup of a watershed association. This was done and there is now a startup grant for the Charleston Creek Watershed Association. The CCWA is meeting on a regular basis, has elected officers, and has approved by-laws. They are moving forward with planning several stream projects including assessment of the tributaries and stream channel stability work, which includes Adopt-A-Stream projects. Stability in the watershed will benefit not only the watershed residents and customers of the borough water system, but also recreational users of Lake Hamilton, residents of the Marsh Creek/Pine Creek watershed, and ultimately the Chesapeake Bay

Stony Fork and Marsh Creek

In 2004, the Pine Creek Headwaters Protection Group (PCHPG) began a study of the impaired waters (nutrient and sediment loading) of Stony Fork and Marsh Creek. The PCHPG has a long history of water monitoring in the headwaters of Pine Creek. This is the first time, however, that they have undertaken the assessment of impaired streams at this level of detail. The current study design includes high school seniors working on their senior project. The students are assisting the group in sediment and nutrient loading and routine water quality analysis of eight impaired tributaries. The project has the potential to expand with the addition of land use analysis, macroinvertebrate surveys and erosion assessment.

Otter Run

Otter Run in Lycoming County is a tributary to Little Pine Creek and receives discharge from abandoned coal mines. The mine drainage flows directly from Buckeye Run, which is a tributary of Otter Run. Mine water is now treated for iron and acidity. Future hope is to treat the manganese and help rid the stream of this coal mine discharge. (Zimmerman, 2000).

While these projects are relevant to the scope of the Rivers Conservation Plan, the detail of study and analysis that is occurring in each of them would not be possible under this plan. We mention them here as points of reference and in the way of support for future funding assistance and opportunities.

g. Summary of Current Water Quality

Pine Creek is a stream of very high quality. This is supported by data found in a survey completed by the Susquehanna River Basin Commission (SRBC) in 2003. SRBC has worked up a general water quality summary of the Pine Creek watershed, which can be found in their West Branch Susquehanna Subbasin Survey (LeFevre 2003). The survey was conducted from July to November 2002, and includes comparisons of data collected from the current survey to data collected from a previous survey in 1994. Four sampling sites along Pine Creek were used to determine water quality. The locations of the sites are as follows: near Jersey Shore upstream from Tiadaghton Drive bridge (Clinton/Lycoming County line), near Waterville upstream of Little Pine Creek at the Route 44 bridge (Lycoming County), in Blackwell at the Route 414 bridge (Tioga County), and in Ansonia upstream of Marsh Creek and the Colton Road bridge (Tioga County). All of the sampling sites which were on the main stem of Pine Creek were rated as “higher” water quality. The sampling site upstream from Marsh Creek, and the section of the stream in the headwaters that encompasses this site, was designated as Exceptional Value.

The SRBC also sampled several tributaries in the Pine Creek watershed. West Branch Pine Creek was non-impaired and rated as “higher” quality. Marsh Creek was rated “middle” quality and was found to be slightly impaired. The slight impairment of this low gradient stream was due to exceeding levels of nitrogen, nitrate, phosphate, and orthophosphate. Two sampling sites on Little Pine Creek were rated “higher” quality and were non-impaired or very slightly impaired. The survey proposes that the slight impairment at the mouth of Little Pine Creek may have been due to abandoned mine drainage on a tributary, Otter Run. Wilson Creek was rated “lower” quality due to exceeding limits of various metals, high hardness, and high total suspended solids. Wilson Creek was impacted by abandoned mine drainage, which contributed to the low quality. A site on Babb Creek, which was located below where Wilson Creek empties into Babb Creek, was slightly impaired and found to have low alkalinity. Impairment in Wilson Creek from abandoned mine drainage may have impacted the water quality in Babb Creek, contributing to its slight impairment.

Water quality assessment for Wilson Creek was completed in 2003 by Grand Canyon Ecological Services. Wilson Creek is a tributary to Babb Creek and is impacted by agriculture. Six water chemistry sites were established along the creek from north to south. Results of water chemistry show the headwater first and second order tributaries are each impacted, to some degree, by pollution from runoff and sources that cannot be directly identified.

The loss of riparian habitat (vegetation and tree cover) along the banks of the creek results in a loss of shade, which in turn causes excess sun exposure, increasing water temperature during the warm months. As water temperature increases, less oxygen is dissolved and retained in the water, which in turn affects the survival of the aquatic life in the creek. The impact from loss of riparian habitat can be seen in the water temperature data collected from Pine Creek. From February to August 2003, the water temperature at the second station (where the first major tributary enters the creek) increased from 3ºC to 25ºC. The temperature then decreased back to 3ºC by November 2003. Phosphate levels ranged from 0.00mg/l to 0.30mg/l among all of the six sites. The second site recorded the highest phosphate level (0.30mg/l) in August 2003.

Three macroinvertebrate and fish sampling sites were selected along the creek. Two of the sites were at major tributaries and the third was in the midsection of the main stem of Wilson Creek. The data collected showed which sites were in good condition and which may have been affected by pollution or other contaminants. The condition of each section was decided based on the number and types of macroinvertebrates found at each location. Macroinvertebrate data results showed the two sites at the tributaries to be impaired, while the third on the main stem was in good condition.

Water quality assessment for Charleston Creek was completed from the summer of 2001 to summer of 2002 by William S. Brey in accordance with groups including the Pine Creek Headwaters Protection Group and the Borough of Wellsboro. Data was collected and analyzed monthly at six sampling points. Overall water quality was determined to be good and was evaluated based on nine parameters: temperature, pH, alkalinity, turbidity, nitrates, phosphates, conductivity, total dissolved solids, and suspended solids. The following data was collected at each site in July 2001 and June 2002. Temperature at the six sites in July 2001 ranged from 22ºC to 29ºC, while in June 2002 the range was from 15ºC to 17ºC. The pH ranged from 7.3 to 9.2 in 2001, and in 2002 the range was from 7.46 to 7.99. Nitrates for the six sites in 2001 was 0.00mg/l to 0.24mg/l and in 2002 0.00mg/l to 0.31mg/l. Phosphate ranged from 0.02mg/l to 0.15mg/l in 2001 and 0.08mg/l to 0.12mg/l in 2002. Total suspended solids ranged from 0.00mg/l to 10.0mg/l in August 2001 to 4.0mg/l to 12.0mg/l in 2002.

In the summer of 2003 and 2004, water chemistry data was collected and compiled for sampling sites along Pine Creek. Clean Water Institute/Lycoming College Intern Amy Curry collected samples in 2003 from 22 sites along the Creek. In 2004, Clean Water Institute/Lycoming College Interns Kristen Colgan and Kristina Kleintop collected samples from 18 sites within the watershed. Water chemistry data from 2003 can be found in Table A-11a, and 2004 data can be found in Table A-11b. In the summer of 2003, Amy Curry also completed a preliminary survey for coliform bacteria at six sites in the Pine Creek watershed. This data, found in Table A-11c, suggests that a more comprehensive survey be done, especially during peak tourist seasons.

In conclusion, except where abandoned mine drainage impacts the Creek, overall water quality is good in the Pine Creek watershed.