
CHAPTER 3. WATER RESOURCES

A watershed is a basin-like landform defined by highpoints and ridgelines that descend into lower elevations and stream valleys. A watershed carries water "shed" from the land after rain falls and snow melts. Drop by drop, water is channeled into soils, groundwater, creeks, and streams, making its way to larger rivers and eventually the sea. Water is a universal solvent capable of dissolving and transporting many chemicals. What we put on the ground—lawn chemicals, agricultural fertilizers, salt on roads in winter, oils from exhaust on highways—ends up affecting water quality downstream. When we remove vegetation from the watershed, we remove nature's mechanisms for storing and cleaning water. Asphalt surfaces on rooftops, roads, and parking lots keep water from reaching soils. Rain is piped away before soils can retain it, increasing the likelihood of flooding and erosion. Land development and urban retrofitting can be environmentally sensitive if first we understand how natural systems work.

The pollutants that come from runoff contribute to non-point source (NPS) pollution, the leading cause of water quality impairments in Pennsylvania. NPS pollution comes from many diffuse sources and is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into streams, lakes, rivers, wetlands, and underground sources of drinking water.

All the factors that go into making a stream, as well as the diversity of in-stream habitats, are extremely complex and interconnected. Factors affecting a stream's composition include: precipitation (seasonal variations), topography (determines stream gradient), geologic substrate (from which minerals are leached), land uses (determine sediment and contaminant loading of surface runoff and groundwater), soil and bedrock types (determine groundwater availability), sunlight or shade (affect temperature and algae growth), and riparian vegetation (for shade, nutrient source, insect habitat, and more). In addition, streams widen and their volumes increase as tributaries and other streams join them.



Unnamed tributary near Brick Church

Only 30-40 percent of the rain or snow that we see hitting the ground goes directly to streams. Most of it, surprisingly, is taken up and used internally by plants. Some water infiltrates soils and moves below as groundwater, feeding plants and replenishing aquifers. After infiltrating natural systems, water evaporates from streams, rivers, wetlands, and plants. It returns to the atmosphere to fall again as precipitation. This "water cycle" cools the planet, cleans the air, and sustains life as we know it.

Pennsylvania boasts 83,161 miles of streams. The Department of Environmental Protection (DEP) has developed minimum water quality standards (25 Pa. Code § 93 1997) for these streams based on their designated uses. Streams are protected either for their aquatic life, water supply, recreation and fish consumption, special protection (high quality or exceptional value), or navigation uses.

Major Tributaries

Tributaries are streams that flow to larger streams or other bodies of water. Major tributaries to the Lower Crooked Creek watershed include Campbell Run, Elbow Run, Horney Camp Run, Coal Bank Run, Beers Run, Pine Run, Cherry Run, Fagley Run, Sugar Run, Lindsay Run, Craig Run, and Gobbler Run (Table 3-1; Figure 3-1).

Tub Mill Run has no named tributaries. It is designated by 25 Pa. Code § 93 Water Quality Standards as a Warm Water Fishery (WWF). A WWF designation means that the stream is protected for the maintenance and propagation of fish species and additional flora and fauna that are indigenous to a warm water habitat (DEP 2003).

With the exception of Cherry Run, all of the tributaries and the mainstem of Crooked Creek are designated as WWF. The Cherry Run watershed is designated as a Cold Water Fishery (CWF), protected for the maintenance and/or propagation of fish species including the family Salmonidae (Trout and Salmon) and additional plants and animals that are indigenous to a cold water habitat (DEP 2003).

Table 3-1. Named Tributaries to the Lower Crooked Creek Watershed

Tributary	Drainage (square miles)	Stream Miles	PA DEP Water Use*
Campbell Run	6.00	17.77	WWF
Elbow Run	2.04	5.33	WWF
Horney Camp Run	2.59	7.21	WWF
Coal Bank Run	0.46	1.19	WWF
Beers Run	0.79	1.68	WWF
Pine Run	3.84	9.56	WWF
Cherry Run	26.71	70.29	CWF
Fagley Run	3.20	8.16	WWF
Sugar Run	2.69	7.59	WWF
Lindsay Run	2.05	4.87	WWF
Craig Run	2.69	5.18	WWF
Gobbler Run	4.58	11.85	WWF

* 25 Pa. Code § 93 Water Quality Standards
Abbreviations include: WWF - Warm Water Fishery;
CWF - Cold Water Fishery

Wetlands

Wetlands can be defined as marshes, bogs, swamps, wet meadows, or shallow ponds. To be considered a wetland, an area must have supporting hydrology, vegetation, and soils. Frequently occurring in low areas, wetlands are regulated by the Pennsylvania Dam Safety and Encroachments Act – 25 PA Code, Chapter 105 – which reviews all water-related activities to protect and conserve the natural resources of the Commonwealth.



Wetland area in the Lower Crooked Creek watershed

United States Environmental Protection Agency (EPA) and United States Army Corps of Engineers (USACE) use the 1987 Corps of Engineers Wetlands Delineation Manual to define wetlands for the Clean Water Act Section 404 permit program. Section 404 requires a permit from the Corps or authorized State for the discharge of dredged or fill material into the waters of the United States, including wetlands.

The functions of wetlands are very important to water quality and quantity, as well as land conservation. Wetlands help reduce soil runoff and prevent non-point source pollution from surrounding areas. Plants found in wetlands help slow the movement of water, allowing the sediment to drop out.

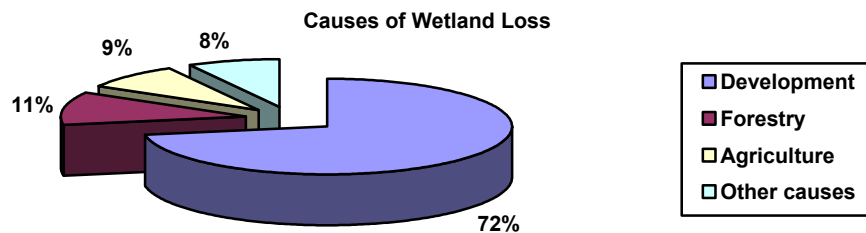
Nutrients, such as nitrogen and phosphorus, which cling to the soil particles, are deposited in the wetland where they are used for food and energy. Chemicals, such as pesticides and herbicides, may be trapped in the wetland and broken down by sunlight and microorganisms. Wetlands also prevent downstream flooding by acting as sponges to absorb heavy rainfall.

A great diversity of plants and animals live in wetlands. More than 500 threatened and endangered plants live in and depend on wetlands (DEP 2001).

Wetland Loss

Wetland loss, or the loss of wetland area via the conversion of wetlands to non-wetland land use, from human and natural disturbances is a key issue. In the past 200 years, over 56 percent of wetlands in Pennsylvania have been filled or destroyed (Dahl 1990). Specific statistics for historic wetland loss within the Crooked Creek watershed are not available. The National Wetland Loss Index indicates that the Crooked Creek watershed has experienced a moderate level of wetland loss between 1982 and 1992 (EPA 1999).

According to a U.S. Department of Agriculture (USDA), Natural Resources Conservation Service study, the major causes of wetland loss in the northeastern United States, including Pennsylvania, during the 1990s were primarily from development (67.2%), forestry (10.3%), agriculture (8.0%), and other causes (7.5%). Historically, conversion of wetlands to agricultural land uses has been the dominant reason for wetland loss. After 1982, development began contributing most to wetland loss (Ducks Unlimited 2001). The EPA (2002) also lists mining as a major factor in wetland loss, which may contribute in part to the wetland loss within the Lower Crooked Creek watershed.



Within the Lower Crooked Creek and Tub Mill Run watersheds, there are approximately 220-recorded acres of wetlands that play host to a diversity of wildlife and plants, these species are discussed further in the Biological Resources chapter (Figure 2-5).

Floodplains

Floodplains are another feature of a stream providing an array of benefits to watershed systems:

- Gradual retention and release of groundwater, overland flows, and flood flows
- Surface and groundwater filtration
- Sediment deposition
- Production of food sources, cover, and thermal protection for organisms living in riparian or floodplain areas.



Lower Crooked Creek floodplain

Floodplain alterations, such as the removal of vegetation and encroachment by residential and commercial development, interrupt the natural relationship between the stream and its adjacent floodplain. Habitat and food for organisms dwelling within the riparian or floodplain area is also

Table 3-2. Floodplain Ordinances

Municipality	Date
Armstrong County	
Bethel Township	6/3/1988
Burrell Township	11/1/1986
Cowanshannock Township	11/1/1986
Elderton Borough	none
Ford Cliff Borough	none
Kiskiminetas Township	4/5/1988
Kittanning Township	5/1/1986
Manor Township	5/19/1987
Parks Township	4/5/1988
Plumcreek Township	11/1/1986
South Bend Township	6/5/1985
Indiana County	
Armstrong Township	4/16/1990
Young Township	8/1/1986

compromised when encroachment or vegetative removal occurs. Vegetation and floodplain integrity are needed in conjunction with restoration and conservation practices to limit degradation of the water quality and biological resources and protect those living downstream.

The National Flood Insurance Act of 1968 and Flood Disaster Protection Act of 1973 were implemented to handle issues of floodplain alterations and subsequent watershed flooding. The programs were expanded through the National Flood Insurance Reform Act of 1994 and serve as a foundation for the National Floodplain Insurance Program (NFIP), which assists in community floodplain and flood insurance planning through the implementation of local floodplain management ordinances.

In addition, the federal government published a handbook of federal programs offering non-structural flood recovery and floodplain management

alternatives in 1998. In response to severe flooding problems such as loss of life and property, natural resources, and functional floodplains, the Federal government has shifted its focus to improve its floodplain management. This shift in focus entails utilizing non-structural approaches to flooding, as opposed to the traditional structural approaches such as dams, levees, and channels that serve to control flooding. Non-structural approaches tend to modify the susceptibility to flooding. Examples of non-structural approaches include property acquisition, relocation, elevation, and flood-proofing of existing structures, rural land easements and acquisition, and restoration of wetlands. By utilizing the non-structural approach to floodplain management, communities will be made safer and stronger by reducing flood losses, diminishing the mental, physical, and economic toll on towns and farms that have suffered repeated damage, cutting long-term costs, and helping to restore lost or impaired environmental resources. The handbook in its entirety can be found at www.whitehouse.gov/WH/New/html/flood.pdf, and the table cross-referencing the available Federal programs by type of assistance offered and agency can be found in Appendix E.

All of the municipalities within the watershed have floodplain ordinances with the exception of Elderton Borough and Ford Cliff Borough (Table 3-2). Visual assessments of the Lower Crooked Creek watershed indicate that floodplain encroachment has occurred in many areas. This encroachment is primarily the result of temporary and permanent residences along the main stem of Crooked Creek in Manor, Bethel, and Burrell Townships. These homes often sustain flood damages as a result of being located in the floodplain, and being so, are not eligible for flood insurance. As floodplains become more developed, they are less able to function as retention sites, therefore negatively affecting downstream conditions during rain/snowmelt events. Some of the flooding that occurs in the lower 2.5 miles of Crooked Creek is as a result of back-up influence from the Allegheny River during high water.

Lakes and Ponds

Lakes and ponds are valuable ecosystems providing habitats for plant and animal species. Some of these water bodies are used for recreational purposes such as swimming, fishing, and boating while others may be used for flood control and/or drinking water sources.

The Lower Crooked Creek watershed has one large man-made lake, the Crooked Creek Lake. Located seven miles above its confluence with the Allegheny River, the 350-acre Crooked Creek Lake drains 277 square miles. Crooked Creek Lake was authorized by the Flood Control Act of 1936 and has been in full operation since June 1940. The lake is operated by USACE as part of the flood control system for the Allegheny and Upper Ohio Rivers. Crooked Creek Dam is a rolled earth fill dam with an impervious core. The embankment rises 143 feet above the streambed, has a top length of 1,480 feet and a base width of approximately 1,080 feet. The basin is roughly rectangular in shape extending 26 miles in a west-east direction with a varying width of 10-12 miles. The pool elevation at Crooked Creek Lake is generally maintained between elevations 845.0 and 845.5 in order to provide adequate storage during periods of excessive runoff. Heavy rainfall and/or snowmelt will cause rapid and often significant rises in water level.



Crooked Creek Lake

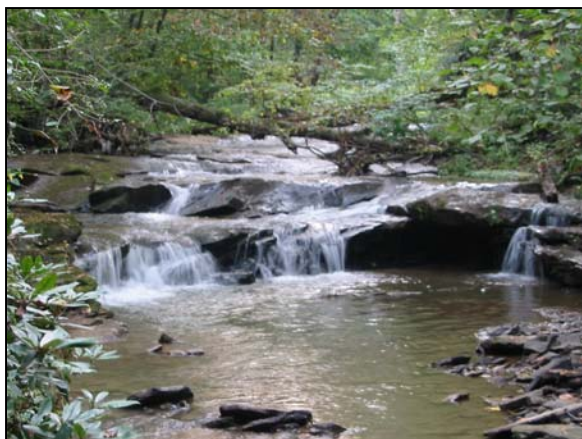
Although the lake's congressionally authorized purposes include flood control and recreation, only flood control has storage allocations. Operations are made to maximize the flood storage capability of the project. Recreation is secondary.

Mostly privately owned and unnamed, 42 ponds throughout the watershed make up about 46 acres (Figure 3-3). Ponds are growing in popularity and are managed for a variety of purposes (fishing, agriculture, dry hydrants, aesthetics, etc.). The majority of these ponds are located on smaller, headwater streams. One issue often overlooked when landowners are considering building and managing ponds is the potential detrimental effect of warming the water and its effect on aquatic life. A study of local ponds and their effects on the receiving streams would be helpful to qualify and quantify any concerns over the detrimental effects.

Another concern to address is the major stresses to lakes and ponds. These stresses include excess nutrients from agricultural and other runoff as well as overgrowth of algae, depleted dissolved oxygen levels due to higher temperatures and decomposition of plant materials, and excess sediment in the lake or pond. All of these stresses can affect the water quality as well as biotic communities within the body of water. Monitoring of lakes and ponds can detect and identify many sources of pollution, allowing an action plan to be developed to address the problem. Water quality standards for lakes and ponds can be found in 25 Pa. Code § 93 Water Quality Standards publication.

Surface Water Quality

According to 25 Pa. Code § 93 Water Quality Standards, water may not contain substances attributable to point or non-point source discharges in concentrations or amounts sufficient to be unfavorable or harmful to the designated water uses or to human, animal, plant or aquatic life. In addition to other substances listed within or addressed by Chapter 93, specific substances to be controlled include, but are not limited to, floating materials, oil, grease, scum and substances which produce color, tastes, odors, turbidity or settle to form deposits (DEP 2003).



Tub Mill Run

Cold and Warm Water Fishery designations are primarily based on temperature and dissolved oxygen levels in the surface waters. To be considered a CWF or WWF, the stream must maintain specific temperatures during specific times of the year and not fluctuate from that temperature more than 2°F over a one-hour period as a result of any effluent entering the stream. A CWF must also maintain a daily average dissolved oxygen (DO) level of 6.0 mg/l, whereas a WWF must maintain a daily average DO level of 5.0 mg/l (DEP 2003).

To effectively regulate and ultimately mitigate the mass load of pollutants entering streams, pollutant sources are classified into two main categories: point and non-point source pollution. Point source discharges are regulated under the National Pollutant Discharge Elimination System (NPDES) permit, established by Section 404 of the Clean Water Act of 1972 (Appendix F). Point source pollutants can be easily traced to their source, such as discharges from industrial or municipal facilities. Non-point source pollutants, sometimes called “runoff pollution”, typically have no readily visible source and often require detailed analysis and research to discern the source. Common sources of non-point pollution are abandoned mines, agriculture, urban runoff, construction activities, malfunctioning on-lot sewage systems, and forestry runoff.

Non-point Source Pollution

Within the Lower Crooked Creek watershed, several sources of non-point pollutants have been identified and/or are believed to exist. These include such things as abandoned mine drainage, erosion and sedimentation, agricultural runoff, raw sewage discharges, excess chemicals applied to lawns for fertilizer and weed control, and stormwater runoff and discharges.

Abandoned Mine Drainage

Abandoned mine drainage (AMD) is a term applied to a polluted groundwater discharge that emanates from former underground or surface mines, for which no legally responsible entity exists. AMD is the number one source of impairment in Pennsylvania streams (DEP 2003b). The water quality of AMD is typically degraded by the increase of dissolved metals and decrease of pH, a measure of hydrogen ions in a solution. The rate of AMD production and the chemical characteristics of the AMD are dependent on factors such as the mine hydrology, the relative abundance of acid-forming and alkaline materials, and the physical characteristics of the spoil (waste/byproducts of mining) within the mine site (Rose and Cravotta 1998).

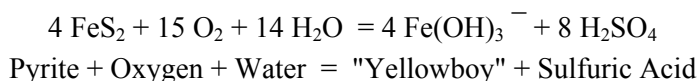
AMD is formed through a complex series of chemical reactions. During the coal mining process, sulfides in the bedrock are exposed to oxygen. When oxygen comes into contact with these often acid-bearing rocks containing pyrite, a series of chemical reactions produce iron hydroxide and sulfuric acid (DEP 1999). Acidic water can appear clean and clear while being severely impaired and toxic to aquatic organisms and plant life.



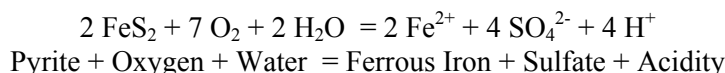
Part of the Myers/Runniger wetland treatment system on the North Branch of Cherry Run

If a mine discharge containing high metals and acidity is exposed to oxygen and/or alkalinity, the dissolved iron hydroxide will settle out of solution leaving a red iron coating, or “yellow boy,” within the stream and on the stream bottom. Two other metals that commonly precipitate in the stream follow the same process. These metals are aluminum, which leaves a grayish-white coating, and manganese, which leaves a black coating on the stream bottom. The following reactions show the process by which AMD and “yellow boy” are formed. Other metals precipitate in a similar fashion.

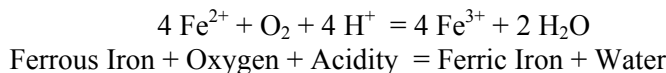
There are four commonly accepted chemical reactions that represent the chemistry of pyrite weathering to form AMD. An overall summary reaction is as follows:



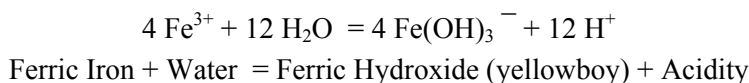
The first reaction in the weathering of pyrite includes the oxidation of pyrite by oxygen. Sulfur is oxidized to sulfate and ferrous iron is released. This reaction generates two moles of acidity for each mole of pyrite oxidized.



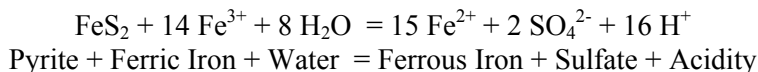
The second reaction involves the conversion of ferrous iron to ferric iron. The conversion of ferrous iron to ferric iron consumes one mole of acidity. Certain bacteria increase the rate of oxidation from ferrous to ferric iron. This reaction rate is pH dependant with the reaction proceeding slowly under acidic conditions (pH 2-3) with no bacteria present and several orders of magnitude faster at pH values near 5. This reaction is referred to as the "rate determining step" in the overall acid-generating sequence.



The third reaction that may occur is the hydrolysis of iron. Hydrolysis is a reaction that splits the water molecule. Three moles of acidity are generated as a byproduct. Many metals are capable of undergoing hydrolysis. The formation of ferric hydroxide precipitate (solid) is pH dependant. Solids form if the pH is above about 3.5 but below pH 3.5 little or no solids will precipitate.



The fourth reaction is the oxidation of additional pyrite by ferric iron. The ferric iron is generated in reaction steps 1 and 2. This is the cyclic and self-propagating part of the overall reaction and takes place very rapidly and continues until either ferric iron or pyrite is depleted. Note that in this reaction iron is the oxidizing agent, not oxygen.



Mine drainage can also be net alkaline, or basic, if limestone-bearing rock layers are present to buffer, or shield, the acidity of the mine drainage. Typically, net alkaline mine drainage is less difficult to treat because acidity problems do not exist; however, removal of heavy metals remains an issue for most mine drainage discharges.

Several mine discharges exist in the Lower Crooked Creek watershed. One of those is located in Plumcreek Township flowing into the North Branch of Cherry Run. In 1992, the Crooked Creek Watershed Association (CrCWA), in partnership with the Armstrong Conservation District (ACD), constructed a passive water treatment system for this discharge. By utilizing a local contractor, CrCWA constructed four small ponds to treat the acidic mine water. As the water travels from chamber to chamber, the iron is settled out. Nature treats the water, improving it prior to flowing into the North Branch of Cherry Run. Although this treatment is not a cure-all for the discharge, it is the best natural way of treating the water at a relatively low cost (CrCWA 2003).

Another mine discharge was located at the Crooked Creek Horse Park. The CrCWA brought in 200 loads of fill and created a two thousand foot diversion in order to control an erosion problem at the site. A pond and wetland system was then constructed to treat the mine drainage. The project was successful at controlling the rate of erosion as well as removing the metals from the mine water (CrCWA 2003).

Other abandoned mine discharges identified in the watershed include one along Porter Road in Burrell Township, one in Girty, one in Mateer, one at a farm about one mile west of Brick Church, two on Fagley Run, and potential AMD impacts on Horney Camp Run. CWM Environmental is currently conducting an assessment on Crooked Creek to locate and identify all AMD impacts. A full report of this assessment is expected in 2005.

Erosion and Sedimentation

Erosion is the mechanical transfer by water and air of soils and rocks that have been weathered into finer particles. Sedimentation refers to the deposit of these particles on the earth's surface. Erosion and sedimentation are natural earth surface processes. These processes can be severely escalated by land use practices that strip land of its vegetation and elevate amounts of sediment that enter stream systems during rainfall. Areas that are sensitive to erosion processes are those with steep slopes and erodible soils. Deposition of eroded sediment occurs in low-lying areas, such as wetlands and floodplains, or in the streams.



Erosion of soils adjacent to Crooked Creek as a result of the lack of vegetation

Streams compensate for increased sediment loads from elevated erosion levels by reconfiguring themselves to carry or deposit the sediment. Stream

reconfiguring results in down cutting, excess sediment deposits choking the stream, vertical deepening of the stream channel, and subsequent horizontal erosion of streambanks. If streams continue on these paths, erosion can eventually slice off the soil supporting roads, homes, and businesses located near tributaries and streams.

In addition to the physical changes that increased supplies of sediment bring to the stream system, sediment can also carry large amounts of nutrients and chemicals, such as nitrogen, phosphorus, pesticides, and herbicides, from runoff that drains from residential lawns, animal feed lots, golf courses, and family farms. Increased sediment delivered to streams can also destroy streambed habitat, and decrease the ability of aquatic organisms to survive.

Sedimentation is the number one cause of impairment in Pennsylvania streams (DEP 2002). Erosion and sedimentation occur as a result of many activities that take place on land, such as dirt and gravel roads, logging, development, agricultural practices, and mining. All of these activities expose unprotected soil to the air and water, making it susceptible to erosion and sedimentation.

ACD addresses erosion and sedimentation in a number of ways. They review E&S (erosion and sedimentation) control plans, perform inspections of disturbance sites, process complaints, and process permit applications pursuant to the NPDES program. The ACD is involved in all instances where soil is being disturbed by development, timber harvesting, or by highway development. The E&S plans that are submitted to the ACD must include measures that will promote the maintenance and protection of existing water quality and its uses (ACD 2003).

The ACD also administers the Dirt and Gravel Road Program for Armstrong County. As of early 2004, the District has spent \$265,960 on 25 projects in 11 municipalities. The District has allocated \$100,124 to solve 13 erosion problems in eight municipalities whose applications were selected for funding in this year's program. In the Lower Crooked Creek watershed, eight sites totaling nearly four miles of dirt and gravel roads have been improved. Additionally, 25.5 miles of dirt and gravel roads have been inventoried but not yet completed (Rupert, personal communication 2003).

The CrCWA has initiated specific projects, such as the Falcon Park/Campbell Run project, in an effort to control erosion and sedimentation within the watershed. In partnership with ACD, Pennsylvania Association of Conservation Districts and a DEP Growing Greener Grant, Campbell Run and Crooked Creek (near Falcon Park) were stabilized along several hundred feet of severely eroded streambank. This project will also make use of native and natural grasses, shrubs, and trees whose entire structure above and below the ground will help to stabilize and hold the soil against future erosion (CrCWA 2003).



Streambank stabilization project at Falcon Park, construction phase, June 2003

Agriculture

Agriculture is one of the leading industries within Pennsylvania, providing pleasing countryside aesthetics and the livelihood of many residents throughout the Commonwealth. However, agriculture is also the number two source of impairment in Pennsylvania streams (DEP 2003b). Most farms within the Lower Crooked Creek watershed can be classified as family farms. Unfortunately, wastes from these farms may degrade surface and groundwater quality. Fertilizers, pesticides, and manure from

concentrated lots, fields, and from cattle access to the stream channel can easily be washed into streams during high rainfalls, increasing nutrient levels and contaminants in the stream. Too many nutrients, such as nitrogen and phosphorus, stimulate the growth of “nuisance vegetation,” such as algal blooms, which subsequently use much of the dissolved oxygen needed to help healthy aquatic plants and animals grow.



Campbell Run – susceptible to agricultural runoff

ACD runs a Nutrient Management Program aimed at using nutrients (mainly nitrogen, phosphorous, and potassium) wisely for optimum economic benefit to the farmer while minimizing impact on the environment. The goal of a nutrient management plan, prepared by a certified plan writer for each individual operation, is to save on fertilizer costs and reduce soil erosion while protecting water quality. The Nutrient Management Act Grant Program provides financial assistance to producers who have approved nutrient management plans to install BMPs that are listed in the plans. There is currently one Nutrient Management Plan completed within the watershed (ACD 2003).

Agriculture is very important to the communities in the Lower Crooked Creek and Tub Mill Run watersheds, and gives the area its rural character. According to a report of interviews conducted in 1993-1994, there were three dairy, three crop, three beef, and one other farm in the watershed (ACD 1994). These farms represent a significant portion of the economy in the area as well. Additional smaller “gentleman” farms can be found throughout the watersheds as well.

The pleasantries of the rural character and economic benefits aside, the Lower Crooked Creek and Tub Mill Run watersheds are plagued with deficient agricultural practices. Although some of the farms employ conservation practices such as contour farming, strip cropping, terraces, diversions, waterways, animal waste storage, pasture management, and grass strips, most lack the needed level of implementation to make the practices most effective. Implementation of best management practices results in increased farm production and a decreased amount of sediment and nutrients being washed into the streams. The Assessment of Non-point Source Pollution for the Crooked Creek and Cowanshannock Creek watersheds yielded 10 high priority sub-watersheds for remediation. Among those high priority selections was Crooked Creek (Armstrong Co.) Rt. 359 to county line, Campbell Run, Lower Crooked Creek to mouth, and Cherry Run. The Armstrong Conservation District recommends a cost-share program be instituted to develop and implement complete nutrient/conservation plans for each of the high priority farms (ACD 1994).

There are currently several programs to assist farmers implementing these best management practices, many times at little or no cost to the farmer (Appendix L). One such program is Environmental Quality Incentives Program (EQIP), administered by NRCS. NRCS in Pennsylvania identified the following natural resource concerns:

- Erosion and sedimentation
- Nutrient management
- Water pollution from livestock farming
- Wildlife habitat degradation
- Odor problems from animal waste

Appendix G contains a more comprehensive list and description of agricultural best management practices, as well as a summary guide. Contact your local county conservation district for more information about best management practices and programs.

Sewage

Residential sewage and wastewater are treated and disposed of by various methods, ranging from large municipally-owned sewage treatment plants to community or individual onlot disposal systems, also called septic systems. Malfunctioning sewage disposal systems, regardless of type, pose a serious threat to public health and the environment. They can pollute public and private drinking water sources, often by discharging directly to ground and surface waters. Raw sewage can expose humans and animals to various bacteria, viruses and parasites. Repairs to sewage systems however, can often lead to financial hardships for affected municipalities or homeowners. A much more affordable system for clusters of homeowners that are located too far away from public sewage is the community sewage system. Community sewage systems are those disposal systems serving multiple structures, residential or commercial. Many areas in the watershed could benefit from installation of community systems, but few, if any, currently exist (Bohonak, personal communication 2003).



There are many old 'camps' along Crooked Creek with inadequate septic systems

In response to malfunctioning sewage systems in the Commonwealth, the Pennsylvania Sewage Facilities Act, Act 537, was enacted in 1966 to correct existing sewage disposal problems and prevent future problems. The Act requires proper planning for onlot disposal systems, uniform standards for design, and permitting of single and community onlot disposal systems. Most residential systems in the Commonwealth, however, were built before the Act and are in need of repair. On-lot systems that are not properly functioning channel nitrogen-laden water back into the groundwater, possibly contaminating drinking water supplies (Lauch 1996).

Major Provisions of Act 537 (DEP 2003c):

- All municipalities must develop and implement an official sewage plan that addresses their present and future sewage disposal needs. These plans are modified as new land development projects are proposed or whenever a municipality's sewage disposal system needs upgraded. DEP reviews and approves the official plans and any subsequent revisions.
- Local agencies are required to employ both primary and alternate Sewage Enforcement Officers (SEO). After successfully completing training and being certified by a state board, a SEO works for the local agency and is responsible for implementing the daily operation of that agency's permitting program. SEOs are not DEP employees.
- Local agencies, through their SEO, approve or deny permits for construction of onlot sewage disposal systems prior to system installation.
- DEP provides grants and reimbursements (funded by annual legislative appropriations) to municipalities and local agencies for costs associated with the Act 537 planning and permitting programs.
- An Environmental Quality Board (EQB) must adopt regulations establishing standards for sewage disposal facilities. These regulations apply throughout the Commonwealth.

- A Sewage Advisory Committee (SAC) reviews existing and proposed rules, regulations, standards and procedures and then advises the Secretary of DEP. This advisory committee is comprised of members representing many sectors of the regulated community.

Municipalities are required to develop and implement comprehensive official sewage plans that address existing sewage disposal needs or problems; account for future land development; and provide for future sewage disposal needs of the entire municipality.

Official plans contain comprehensive information such as:

- Population figures and projections
- Drinking water supplies
- Waterways, soil types and geologic features
- Sanitary survey results
- Location, type and operational status of existing sewage facilities
- Local zoning and land use designations
- Estimates of the future sewage disposal needs
- Identification of potential problem solving alternatives
- Cost estimates necessary to carry out those alternatives
- The selection of appropriate problem solving alternatives.

Many of the small communities along the main stem of the Lower Crooked Creek contain a substantial number of temporary residences (camps/summer homes). Many of these houses were built before Act 537 Sewage Facilities Program was enacted in 1966, and therefore have inadequate sewage systems.

Table 3-3. Municipal Sewage Plans (DEP 2003c)

Municipality	Plan Approval Date	Status
Armstrong County		
Bethel Township	6/1/1980	Plan older than 20 years
Burrell Township	6/1/1980	Plan older than 20 years
Cowanshannock Township	6/1/1980	Plan older than 20 years
Elderton Borough	6/1/1980	Plan older than 20 years
Ford Cliff Borough	6/1/1980	Plan older than 20 years
Kiskiminetas Township	6/1/1980	Plan older than 20 years
Kittanning Township	6/1/1980	Plan older than 20 years
Manor Township	6/1/1980	Plan older than 20 years
Parks Township	8/9/2001	Plan less than 5 years old
Plumcreek Township	6/1/1980	Plan older than 20 years
South Bend Township	6/1/1980	Plan older than 20 years
Indiana County		
Armstrong Township	10/7/1995	Plan between 5 and 10 years old
Young Township	10/7/1995	Plan between 5 and 10 years old

The Sewage Enforcement Agency of Armstrong County was formed in 1977 through an association of townships. The agency is guided by a nine-member board and employs a secretary and director/manager. The proper procedure for installing an onlot septic system is to first apply for a permit through the Agency, make an appointment to meet with the Sewage Enforcement Officer, call PA One-Call to be sure you will not be working over buried utility lines, and arrange for the officer to perform the testing once you've secured a backhoe to dig the percolation hole. A soil profile is documented initially, and then the percolation test is performed. Once the percolation test is complete and if it passes the test, a design for the proper system should be submitted to the Agency for approval. The ACD offers to design standard sandmound sewage systems for residences for a fee of \$50. Installation of the system could then occur. The Sewage Enforcement Officer would return for a final inspection once the system is installed. Questions pertaining to sewage permits are directed to the Agency at (724) 548-7743 (Beale, personal communication 2003).

In addition to the permit process, the Sewage Enforcement Agency also handles complaints related to malfunctioning systems and permits for malfunctioning systems in Armstrong County. If a complaint is received, an investigation is required to be performed by the Sewage Enforcement Officer. The result of the investigation could lead to no action at all, legal action to resolve the issues, or an agreement to resolve the issue between the parties without legal action (Beale 2003). It is recommended that septic tanks be pumped every two to five years, and utilization of multiple tanks is encouraged.

Common Sewage Systems

- Standard in-ground (less than 15% of sewage systems in Armstrong County)
 - Trench
 - Seepage bed
- Elevated Sand Mound (mostly permitted in Armstrong County due to soil profiles)
- Subsurface Sand Filters
- Dry Irrigation

Stormwater

Management of stormwater involves planning for surface runoff into streams and river systems during rain and/or snowmelt events. As development increases within a watershed, the amount of impervious surfaces, such as asphalt driveways or roofs of buildings, increases. This increase results in greater amounts of surface runoff during rainfall and snowmelt periods, and a need for stormwater management.



Streambank stabilization project on Tub Mill Run required as a result of excessive stormwater runoff

Historically, local governments have been authorized, via the Pennsylvania Municipalities Planning Code, Act 247 as amended, to develop comprehensive plans for development, zoning, and subdivision and land development ordinances. The comprehensive plans may include provisions for stormwater management, but the municipalities or counties are not obliged to adopt them.

In 1978, the Pennsylvania legislature enacted the Stormwater Management Act 167. Act 167 affords local government planning, implementation, and enforcement of stormwater ordinances. DEP provides grant money to counties for the development of stormwater management plans on a watershed basis.

Individuals and property owners affected by runoff due to development need to know who is responsible for management of stormwater runoff in their particular situation. The following guide can assist in making that determination (DEP 2001b):

Municipalities: Historically, municipalities have been responsible for enacting ordinances to regulate stormwater as they review subdivision and land development plans.

Developers: Developers are required to follow local drainage regulations. In watersheds having a completed Act 167 plan, developers, by following local ordinances, would be following the standards and criteria of the approved watershed plan.

Department of Environmental Protection: DEP is responsible for management of the stormwater planning program but has no regulatory authority for individual activities. Sections 10 and 12 of the Act provide DEP with authority to compel county planning and municipal implementation in studied watersheds. DEP also provides technical guidance and training to counties, municipalities and individuals.

County Conservation Districts: The Districts investigate runoff complaints resulting from earthmoving activities. Stormwater may be controlled during construction activities through temporary erosion and sedimentation control devices such as sedimentation basins. Upon stabilization of work sites, temporary erosion and sedimentation structures are often converted to permanent stormwater facilities under the jurisdiction of municipalities.

As of October 2003, no DEP approved Stormwater Management Plan exists for the Lower Crooked Creek watershed. Each county is required to develop a stormwater management plan for each watershed within its boundaries. The state will reimburse the county for 75 percent of the costs associated with the planning, leaving the county to contribute 25 percent. The counties should prioritize their watersheds according to greatest need for management; for example, the most populated watershed or the watershed experiencing the most growth (Manahan 2003).

Studies

Water quality data was collected during an aquatic biology study in the Crooked Creek watershed from 1983-1986 by Clarion University of Pennsylvania. The objectives of the study were to monitor, evaluate, and determine the effects of acid mine drainage on the water quality in the study area using the aquatic life as the principal indicator. The study concluded that the Lower Crooked Creek improved in water quality from upstream to downstream and that toward the upper reaches of the study area, water quality was impacted from mining activities as well as sedimentation from surface mining, agriculture, and development (CU 1986).

Another study is currently underway in the Crooked Creek Watershed. CrCWA received a Growing Greener Grant to assess the watershed for non-point source pollution and develop a remediation plan. CWM Environmental, an environmental consulting firm, is conducting the study, which is to be completed in 2005. As of December 2003, over half of the sub-watersheds in the Lower Crooked Creek watershed had been assessed by CWM Environmental. Several AMD



Confluence of Cherry Run and Crooked Creek

discharge sites were identified, including two small flow discharges within the Fagley Run sub-watershed. Additionally, roughly 50 AMD seeps were identified within the sub-watershed of an unnamed tributary of Crooked Creek. A water sample of Horney Camp Run also indicated the likelihood of abandoned mine drainage impacts.

Pennsylvania Impaired Waters List

The Department of Environmental Protection (DEP) has developed a program to assess the quality of waters in Pennsylvania and identify streams and other water bodies that do not meet water quality standards. The goal is to protect those uses the water can support, such as aquatic life, recreation, and potability (drinking water). There are numerical and/or narrative water quality criteria that express the in-stream levels of substances that must be achieved to support the uses. Periodic reports are required under section 305(b) of the federal Clean Water Act.

Section 303(d) of the federal Clean Water Act requires Pennsylvania to identify all impaired waters within the Commonwealth where technology-based treatment requirements for point and non-point sources of pollution are not stringent enough to attain and/or maintain applicable water quality standards. The 303(d) list includes those water quality limited segments that require the development of total maximum daily loads (TMDLs) to assure future compliance with water quality standards.

A TMDL is a document that identifies allowable pollutant loads from point and non-point sources to a specific waterbody. A TMDL also includes a margin of safety to ensure protection of the water. Water quality limited segments are defined as waterbodies that do not meet water quality standards even after the application of technology-based treatment requirements to point and non-point sources of pollution. Water quality standards consist of three components including: water uses to be protected, water quality criteria necessary to protect those uses, and an anti-degradation statement designed to protect existing water quality and uses.

DEP must develop a Total Maximum Daily Load (TMDL) for each waterbody on the 303(d) list. A TMDL is designed to reduce pollutant loads to impaired waters and enable these waters to meet water quality standards. Pennsylvania has committed to developing TMDLs for all impaired waterbodies and will use both traditional and new approaches to correct water quality problems.

Waterbody assessment and data evaluation is a continuous process. The 2002 303(d) list was developed using information from stream and lake surveys and other sources, including DEP's Statewide Surface Water Assessment Program (formerly known as 'Unassessed Waters'), the Water Quality Assessment Process, the Non-point Source Program, and existing and data submitted by external groups and agencies.

Table 3-4. Impaired Streams on the 303(d) List

Stream Name	Length of Stream Segment	Source of Impairment	Cause of Impairment	Priority	Year Listed
Craig Run	1.2 miles	Abandoned Mine Drainage	Other Inorganics	Medium	1996
Crooked Creek	0.9 miles	Agriculture	Organic Enrichment, Low Dissolved Oxygen, Nutrients	Medium	1998
		Abandoned Mine Drainage	Metals, Suspended Solids	Medium	1996
	14.4 miles	Abandoned Mine Drainage	Metals, pH	Medium	1996

Within the Lower Crooked Creek and Tub Mill Run watersheds, the streams listed on the 303(d) list include Craig Run as well as Crooked Creek. Table 3-4 shows the lengths of the stream segments impaired as well as the sources and causes of impairment. Much in line with the rest of the Commonwealth, abandoned mine drainage and agriculture are the top two sources of impairment to Crooked Creek (DEP 2003). DEP plans to complete TMDLs on these stream segments in 2007-2009.

Monitoring

Monitoring is the observation or measurement of selected watershed features in order to assess watershed ecosystem health, assess the ability of the watershed ecosystem to support human uses, detect early warning of changes, provide insight into the causes of problems, and determine achievement of management goals. Monitoring is an essential tool that helps people understand what is going on in their particular watershed. It builds public awareness and support for watershed programs and activities. It helps identify and understand the causes of problems, determine whether implemented solutions are making a difference, and determine whether changes in land and water uses are affecting the health of the ecosystem.

Watershed monitoring is generally grouped into three categories: physical, chemical, and biological. Physical monitoring studies characteristics such as temperature, clarity, turbidity, solids, flow (the amount of water flowing past a given point), channel structure, riparian areas, and stream bottom habitat. Chemical monitoring involves testing for chemical elements and compounds dissolved or suspended in the water column. Biological monitoring includes living things in their various habitats, including the water column, the stream channel, and the riparian areas.

One USGS monitoring station exists in the Lower Crooked Creek watershed at Idaho, PA. This station is located 1.5 miles downstream from Plum Creek and 2.4 miles west of Shelocta. The flows measured at this point covers a drainage area of 191 square miles. The flow is regulated to some extent by Keystone Lake, located seven miles upstream. Operations at the steam-electric Keystone Generation Station 0.4 miles upstream can affect flow readings.



Stream habitat improvement project on Cherry Run

There are currently no other monitoring programs in place in the watershed. It is recommended that CrCWA implement a monitoring program to assess current conditions on completed projects as well as future projects.

Drinking Water

Pennsylvania's Source Water Assessment and Protection Program (SWAP), required under the 1996 Safe Drinking Water Act reauthorization, assesses the drinking water sources serving public water systems for their susceptibility to pollution. SWAP reports have been completed for all 14,000 public water systems throughout the Commonwealth. Requirements of the program are to delineate the boundaries of the areas providing source waters for all public water systems and to identify the origins of regulated and certain unregulated contaminants in the delineated area to determine the susceptibility of

public water systems to such contaminants. The most important objective for conducting source water assessments is to support the development of local, voluntary Source Water Protection Programs (DEP 2001c).

As a follow-up to the SWAP report, source water protection grants will be available from DEP for municipalities and water suppliers to develop local source water protection programs. DEP will also provide technical assistance and loans to communities to assist them in developing protection plans. Other organizations available for assistance include the League of Women Voters through the Water Resource Education Network and the Pennsylvania Rural Water Association. The source water protection plan will address emergency response plans, land use planning, municipal decisions, and public health and safety.

Nearly half of Pennsylvania's residents rely on ground water as a source of drinking water. As a public water supply, groundwater is less expensive to use than surface water due to land acquisition costs and various treatment requirements for surface water supplies. However, if ground water contamination occurs, it is very costly to employ remedial activities and to provide the necessary treatment to comply with drinking water standards. Also, once ground water is polluted, it remains contaminated for a long



Crooked Creek at Falcon Park

period of time (LWV 2003). For this reason, Section 1428 of the federal Safe Drinking Water Act (SDWA) requires the Commonwealth to submit plans to EPA that describe how they will protect ground water sources used by public water systems from contamination. The Wellhead Protection Program (WHPP) is a proactive effort designed to apply proper management techniques and various preventive measures to protect ground water supplies thereby ensuring public health and preventing the need for expensive treatment of wells to comply with drinking water standards. The underlying principle of the program is that it is much less expensive to protect ground water than it is to try to restore it once it becomes contaminated.

The responsibilities for wellhead protection are shared among many stakeholders including public water suppliers, local governments, the Commonwealth, facility operators, landowners, local agencies, and the public. The WHPP emphasizes technical, financial and educational assistance to facilitate the development of voluntary local programs. Although the WHPP is voluntary for existing wellhead areas, it is mandatory for any new wells or expansion of existing wells.

Very few Lower Crooked Creek watershed residents are served by public water supplies. The boroughs of Ford Cliff and Elderton have public water supplies, with those services reaching very minimally beyond the boroughs. Manor Township and parts of Plumcreek and Kittanning Townships also have public water. This leaves most of the watershed residents relying on well or spring water as their drinking source. Homeowners should be aware of proper protection measure to take to help assure healthy drinking water. Periodic laboratory testing is also recommended to be sure the water quality meets all state and local requirements for safe drinking. To learn more about protecting your private drinking water source, visit <http://pa.lwv.org/wren/pubs/primer.html> to view the Groundwater Primer for Pennsylvanians.

Water Resources

Water Resources Plan

On November 27, 2002, the Pennsylvania Senate passed the Water Resources Planning Act, ending a more than 20-year effort to adopt water resources legislation in Pennsylvania. This legislation will answer such basic questions as how much water we have, how much water we use, and how much water we need.

Major components of the legislation are:

- Requirement to update the State Water Plan within 5 years
- Requirement to register and report certain water withdrawals
 - Users of 10,000 gallons per day or more will register and periodically report their water use, with no fees.
 - The Act expressly prohibits any requirement of metering of homeowner wells.
- Identification of Critical Water Planning Areas
 - Areas where the demand for water exceeds, or is projected to exceed, available supplies.
 - “Water budgets” will be established for the areas.
 - Planning areas will be identified on a regional basis.
- Creation of Critical Area Resource Plans
 - The plans will include a water availability evaluation, assess water quality and water quantity issues, and will identify existing and potential adverse impacts on water resource uses.
- Establishment of a Voluntary Water Conservation Program
 - Establishes a formal program to promote voluntary water conservation practices.
 - Creates a Water Resources Technical Assistance Center to promote the use and development of water conservation and water use efficiency education, and technical assistance programs.

More information on the Water Resources Plan is presented in Appendix H.

Water Quality Trading

Water quality trading is a new approach by the EPA to improve and preserve water quality. Water quality trading allows one discharger to meet their regulatory standards by using clearly defined units of trade created by another discharger who has exceeded their obligations in the same watershed. Pollutant specific credits are examples of tradable units for water quality trading (EPA 2003). Currently, the trading program is mainly geared to nutrient trading. For more information on water quality trading, see Appendix I.



Overlook of Crooked Creek watershed

Management Recommendations

Agriculture

- Encourage farmers to take advantage of current cost share programs to implement best management practices.
- Encourage farmers to develop nutrient management plans.

Abandoned Mine Drainage (AMD)

- Continue to address AMD issues using the best available technology.
- Encourage AMD abatement in the Upper Crooked Creek watershed in order to improve water quality in the Lower Crooked Creek watershed.

Dry Hydrants

- Identify additional funding to install more dry hydrants throughout the watershed.
- Develop a maintenance program for dry hydrants.

Erosion/Sedimentation

- Encourage municipalities to take advantage of the Dirt and Gravel Road Program to reduce erosion and sedimentation.
- Identify additional funding to control runoff from roads.
- Reduce erosion and sedimentation by incorporating best management practices in all earth-moving activities.

Floodplain

- Conduct a detailed flood prone area assessment of Lower Crooked Creek and Tub Mill Run watersheds.
- Develop an education program addressing flood issues and floodplain protection.
- Establish and maintain riparian areas in floodplains.
- Encourage non-structural approaches to floodplain management.
- Enforce floodplain zoning ordinances.

Monitoring

- Analyze water samples for bacteria to identify problem areas.
- Develop a watershed monitoring program for completed project areas as well as areas of concern and reference reaches.
- Involve schools and community groups in water quality monitoring programs.

Sewage and Septic

- Reduce the amount of sewage entering the streams.
- Educate homeowners about alternative sewage treatment systems, and maintenance and repair of existing on-lot sewage systems.
- Encourage DEP to approve more alternative sewage treatment systems for rural areas.
- Encourage homeowners to properly test, maintain, and upgrade their septic systems periodically.
- Encourage municipalities to enforce sanitation laws.
- Encourage municipalities to maintain sewage infrastructure.
- Perform a watershed-wide assessment of on-lot and municipal sewage systems to determine the amount and location of raw sewage entering the waterways.

Sewage and Septic (continued)

- Work with the local SEOs, the sewage associations, DEP, and municipalities to strengthen the implementation of Act 537 Sewage Planning.

Stormwater

- Develop Act 167 Stormwater Management Plans for Crooked Creek and Tub Mill Run watersheds.

Stream Restoration

- Identify additional funding for stream restoration projects.
- Work with local governments and build collaborative partnerships to develop tax incentives for developing greenways and preserving riparian corridors.
- Develop partnerships with local groups and individuals to Implement streambank restoration projects.
- Repair degraded streambanks using natural stabilization techniques.

Water Conservation

- Establish guidelines that require all new construction to install low flow/water conservation devices.

Water Quality

- Implement the remediation plan developed for the Crooked Creek watershed.
- Complete the Crooked Creek Watershed Assessment to identify non-point sources of pollution.
- Inventory Crooked Creek Lake to identify and locate native and invasive species.
- Develop source water protection plans throughout the watersheds.
- Develop total maximum daily loads for impaired streams.
- Perform an assessment of lakes and ponds throughout the watershed.
- Protect Cherry Run for its designation as a cold water fishery.
- Work with USACE to discharge floodwaters more gradually during and following significant precipitation events in order to protect aquatic life and stream habitats.

Water Quality Trading

- Explore and develop institutional framework for water quality trading.

Wetlands

- Inventory and monitor wetland plants and animals.
- Protect wetland habitats for their many uses and benefits.