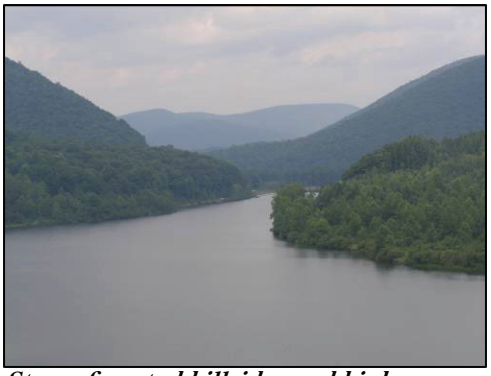
CHAPTER 3. WATER RESOURCES

The Sinnemahoning watershed is blessed with an abundance of high-quality water resources that support fisheries, residents, and businesses. The vast expanse of forested hillsides support the continued preservation of these high-quality streams, but there are several threats that impact some streams within the watershed. Abandoned mine drainage (AMD), erosion and sedimentation, and improperly treated sewage are the main threats to this watershed. In order to maintain high-quality streams and restore degraded areas, local interest and involvement in restoration and conservation efforts will be critical to the continued enjoyment of this beautiful watershed within the Pennsylvania Wilds.



Steep, forested hillsides and high quality water resources characterize the Sinnemahoning Creek watershed

Location

Drainage

The Sinnemahoning Creek watershed is located within the 27,500-square-mile Susquehanna River drainage basin. Sinnemahoning Creek is the largest tributary watershed to the West Branch Susquehanna River, draining 1,034 square miles of land in Cameron, Clearfield, Clinton, Elk, McKean, and Potter counties, Pa. Three major subwatersheds comprise the Sinnemahoning Creek watershed—Bennett Branch, Driftwood Branch, and First Fork. Sinnemahoning Creek is formed at the confluence of Bennett Branch and Driftwood Branch in the borough of Driftwood. The First Fork empties into Sinnemahoning Creek approximately 3.7 miles downstream of Driftwood. Sinnemahoning Creek flows for an additional 11.9 miles, before draining into the West Branch Susquehanna River near the town of Keating, Clinton County, west of Renovo, Pa.

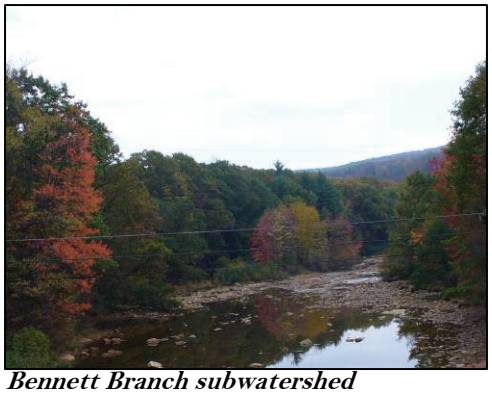
Watershed Address

The U.S. Geological Survey (USGS) has developed a system in order to better catalog and describe the location of surface water resources in the United States. This system divides and subdivides the U.S. into successively smaller units of water drainage, identified with the resulting specific Hydrologic Unit (HU) code. Major watersheds in the U.S. are described as one of 18 Water Resource Regions by the USGS. Each is given a name and two-digit number (Seaber et al., 1987). Pennsylvania is drained by three of these regions—Great Lakes, Ohio, and Mid-Atlantic. The Susquehanna River, including Sinnemahoning Creek, is in Region 02-Mid-Atlantic. The USGS further divides these regions into subregions, accounting units, and cataloging units. The HU for Sinnemahoning Creek watershed is **02050202**, which can be described as follows:

Region 02: Mid-Atlantic
Subregion 0205: Susquehanna
Accounting Unit 020502: West Branch Susquehanna
Cataloging Unit 02050202: Sinnemahoning

The Pennsylvania Department of Environmental Protection (DEP) uses a different cataloging system, which delineates six drainage basins within the state that are further divided into watersheds, each named for their major streams. The Sinnemahoning Creek watershed is located within the Susquehanna/Chesapeake Basin, and subsequently comprises Sub-basin Number 8—the Upper West

Branch Susquehanna sub-basin, and Watershed A—the Sinnemahoning Creek watershed. Therefore, DEP classifies Sinnemahoning Creek as **Watershed 8A**.



Bennett Branch subwatershed

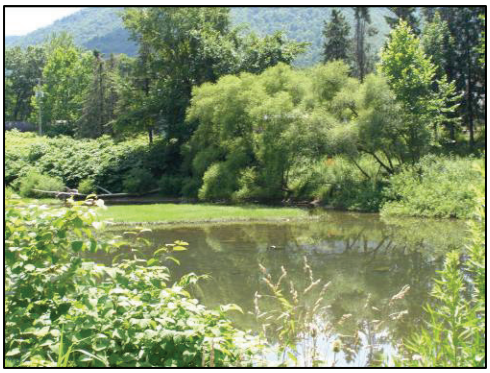
Major Tributaries

Bennett Branch

Bennett Branch of Sinnemahoning Creek originates just across the watershed divide that separates the Susquehanna River drainage basin from the Ohio River drainage basin. This dividing ridge is located east of Sabula, Clearfield County. From this perimeter of the watershed, Bennett Branch flows northeast through the towns of Penfield, Hollywood, Force, Caledonia, Benezette, Grant, Dents Run, and Mix Run before joining the Driftwood Branch in the town of Driftwood to form the Sinnemahoning Creek. Major tributaries to the Bennett Branch include: Byrnes Run, Laurel Run, Medix Run (pronounced mē-diks), Trout Run, Dents Run, Hicks Run, and Mix Run. This subwatershed is heavily impacted by AMD as a result of the resource extraction that occurred throughout the region. Extensive efforts to remediate the effects of that pollution are underway.

Driftwood Branch

The mainstem of Driftwood Branch of the Sinnemahoning Creek begins near the town of Straight Creek, Elk County, and flows southeast through the borough of Emporium and on to the borough of Driftwood. Major tributaries to the Driftwood Branch include: Clear Creek, North Creek, West Creek, Sinnemahoning Portage Creek, Hunts Run, and Sterling Run. The two largest of those tributaries are West Creek and Sinnemahoning Portage Creek. West Creek's headwaters form and flow underground near the outer limits of the city of Saint Marys, south of the Saint Marys Municipal Airport. It flows east to Emporium, where it empties into the Driftwood Branch. Just a short distance downstream, Sinnemahoning Portage Creek enters the Driftwood Branch. Sinnemahoning Portage Creek starts near Route 155 near Keating Summit, Potter County. It flows into McKean County, where several feeder streams empty into it before the village of Gardeau, where the 2006 Norfolk Southern train derailment occurred. Sinnemahoning Portage Creek continues in a southbound direction through Sizerville, ultimately flowing into the Driftwood Branch just outside of Emporium. The mainstem of Driftwood Branch continues flowing southeast to where it is joined by the Bennett Branch to form the Sinnemahoning Creek in Driftwood.



Driftwood Branch of Sinnemahoning Creek

First Fork

The First Fork of Sinnemahoning Creek originates with Prouty Run near Patterson State Park in Potter County. It flows southwest through Prouty Place State Park before Borie Branch converges to form the mainstem of First Fork. First Fork continues in a southwestern direction, picking up waters from Big Moores Run downstream. Freeman Run, a major tributary of First Fork, begins approximately 3.5 miles west of Odin, Potter County. Freeman Run flows south through the borough of Austin, running adjacent to Route 872 from there until it empties

First Fork of Sinnemahoning Creek near Costello

into the First Fork just north of Costello, Potter County. First Fork flows from that point in a more southerly route through Wharton and into Sinnemahoning State Park, where it is impounded by the George B. Stevenson Dam for the primary function of flood control, but also for recreational use of the reservoir. First Fork Sinnemahoning Creek flows adjacent to Route 872 to the mainstem of Sinnemahoning Creek near Jericho, Cameron County.

Sinnemahoning Creek

From the convergence of Bennett Branch and Driftwood Branch in the town of Driftwood, Sinnemahoning Creek flows east to Keating, Clinton County, where it empties into the West Branch Susquehanna River. Along its course, First Fork, Wykoff Run, Upper and Lower Jerry runs, and several other smaller tributaries enter Sinnemahoning Creek.

Table 3-1. Major Tributaries

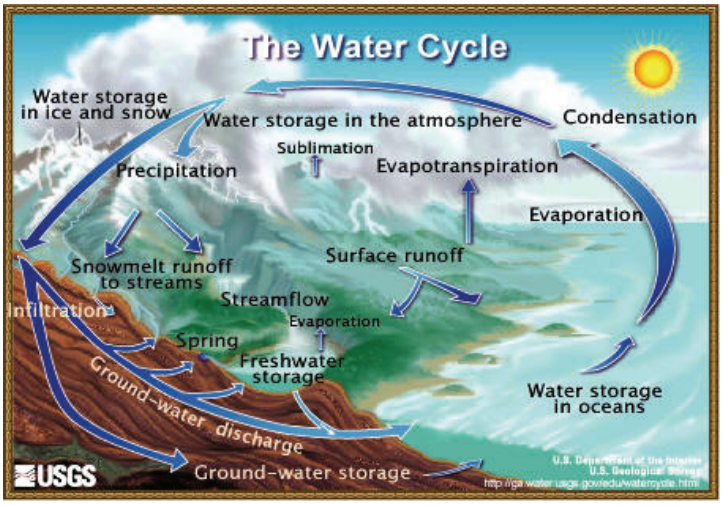
Tributary	% Area	Drainage Area (square miles)
Bennett Branch	***35.42***	***366.26***
Kersey Run	2.87	29.68
Laurel Run	3.65	37.71
Medix Run	2.47	25.49
Trout Run	3.20	33.04
Dents Run	2.42	25.00
Hicks Run	3.31	34.18
Mix Run	3.21	33.24
Driftwood Branch	***30.77***	***318.18***
Clear Creek	1.74	18.04
North Creek	1.83	18.88
West Creek	6.02	62.27
Sinnemahoning Portage Creek	7.08	73.19
Hunts Run	2.97	30.72
Sterling Run	2.38	24.56
Sinnemahoning Creek (mainstem) & First Fork	***33.85***	***350.04***
Freeman Run	3.15	32.56
East Fork	5.30	54.81
Wykoff Run	2.40	24.83

Hydrology

Hydrologic Cycle

The continuous cycle of water on earth, otherwise known as the hydrologic cycle, consists of five basic processes: condensation, precipitation, infiltration, runoff, and evapotranspiration (evaporation plus plant transpiration). Clouds are formed when water vapor condenses to liquid form as air temperature drops. When clouds can no longer hold the moisture within them, precipitation occurs. Precipitation may be contributed to surface water or infiltrate the ground contributing to groundwater. If precipitation occurs faster than the water can infiltrate a particular surface or if the surface is impermeable, the water will run off into streams, lakes, or other surface waters. The water runoff carries contaminants from surfaces, soil, and debris, which may pollute the waterways they drain into. Simultaneously, water may evaporate

(change from liquid to vapor) or be taken up by plants, transpired through the leaves, and evaporated into the atmosphere, where the process of condensation occurs; and the cycle continues.



Watershed Components

Groundwater

Water that seeps into the ground and is stored beneath the land surface in pores and openings of soil and rock is referred to as **groundwater**. Although groundwater is commonly considered a separate entity from surface water found in streams and lakes, the two are constantly interchanging and are actually a single resource. In fact, the majority of freshwater in Pennsylvania is found underground, supplying wells, streams, and reservoirs with water for drinking, industries, and other necessities of life.

Groundwater moves with the force of gravity. It may move through the earth until it emerges at the surface as a discharge (springs or seeps) or is stored underground within areas of rock and soil called **aquifers**. Groundwater discharge is a major contributor to surface waters. The average percentage of stream flow from groundwater is 60–70 percent. Therefore, stream flow and surface water availability is heavily dependent on the quantity of groundwater. As a result of this dynamic, the quality of streams and lakes can be directly impacted by the quality of groundwater (Fleeger, 1999).

Sources of contamination that may leach into groundwater include sewage waste, industrial chemicals, agricultural nutrients, metals and acidic compounds from mines and many other sources. These contaminants not only affect groundwater, but also affect surface and potable water supplies. Many public water suppliers and private homeowners rely on wells for drinking water and everyday use, and may be directly impacted by the quality of groundwater.

The yields of wells depend upon the ease of groundwater movement through rock and the level of the **water table**— depth at which the soil is completely saturated. Groundwater is found in two types of openings in rock—primary and secondary. Primary openings are spaces between fine mineral grains. Though the space between unconsolidated grains may be small, cumulatively they are capable of generating large amounts of water. In contrast, secondary openings occur from fractures in rocks. Alluvial deposits generate the most water and were formed from the movement of rivers.

Since groundwater is the single largest source of surface water, the quality of groundwater in an area can generally be determined by sampling streams at base flow, which is the point at which all surface flow comes from groundwater. In streams that are affected by mine drainage, sulfates, iron, and manganese can be found at unnaturally high levels, particularly at base flows. Similar to mine drainage, acid precipitation is able to dissolve the metals found in bedrock, causing those metals to leach into groundwater and streams.

The majority of residents throughout the Sinnemahoning watershed get their water from private wells and springs. The areas that are served with public water obtain their source water from streams and reservoirs. Therefore, these public water sources are affected by groundwater quality and quantity. Water suppliers within the project area may struggle to find clean drinking water free of contamination from

mine drainage and other pollutant sources. Thus, treatment costs increase in order to meet drinking water standards, which translates to higher water costs for municipalities and consumers. Water sources should be tested regularly to ensure drinking water standards are being met.

Surface Water

Surface water refers to water found above the land surface in rivers, streams, lakes, reservoirs, ponds, wetlands, and seeps. Surface water is in constant interaction with groundwater, which is stored below the surface within openings in rock material. Therefore, it is influenced by the quality of the groundwater, as well as inputs from land-use practices associated with farming, forestry, mining, and other activities.

Streams and Rivers

As water drains from ridges, tributaries form and grow in size and volume as the water flows to lower elevations. Larger streams are influenced by the water quality of these tributaries from which they originate, as well as pollution from acid precipitation and human land-use activities.

Not all streams flow year-round. Because surface water flowing in streams is primarily from groundwater, it is important to understand the relative position of the stream bottom with respect to the water table in order to define a perennial, intermittent, or ephemeral stream.

Although not all streams flow year-round, all streams within Pennsylvania are protected under the Pennsylvania Clean Streams Law of 1931, which gave the state of Pennsylvania the power to enact legislation and regulations pertaining to the protection of streams.

According to the Pennsylvania Code (1997), an **intermittent** stream is a "body of water flowing in a channel or bed composed of substrates primarily associated with flowing water, which during periods of the year is below the local water table and obtains its flow from both surface runoff and groundwater discharges." Streams that do not flow year-round are intermittent streams.

An **ephemeral** stream is a "water conveyance which lacks substrates associated with flowing waters and flows only in direct response to precipitation in the immediate watershed or in response to melting snowpack, and which is always above the local water table." For example, a small "stream" that flows down a grassy hill after a heavy rain would be considered ephemeral.

A **perennial** stream is a "body of water flowing in a channel or bed composed primarily of substrates associated with flowing water and is capable, in the absence of pollution or other manmade stream disturbances, of supporting a benthic macroinvertebrate community composed of two or more recognizable taxonomic groups of organisms which are large enough to be seen by the unaided eye and live at least part of their life cycles within or upon available substrates in a body of water or water transport system." Perennial streams flow year-round, because they are always below the water table.

Permissible pollution discharge limits are determined based on the amount a stream can tolerate and still support an aquatic community of species that characterize a perennial stream. In the past, mining operators in Pennsylvania were able to reclassify streams as intermittent or ephemeral, so there was no special protection under state mining regulations. However, DEP has shifted its policy to require detailed biological assessments before approving such changes. Under this new policy, non-permanent intermittent and ephemeral streams receive similar protection as permanent, perennial streams.

Protection of intermittent and ephemeral streams is included for logging and other earth-moving activities, although permitted activities may differ from those involving perennial streams. In cases where there is some question over what protections are in place for an activity, DEP's Northwest (serving Elk

and McKean counties) or Northcentral (serving Cameron, Clearfield, Clinton and Potter counties) Regional Offices should be consulted.

Lakes, Ponds, and Reservoirs

Lakes are inland bodies of water formed through natural or man-made processes. The natural processes by which lakes originated may include geologic events, such as the movement of the earth's plates, which disrupt the flow of a river to form a lake. In the United States, most natural lakes were formed thousands of years ago when the advance of glaciers caused great depressions to form and fill with water. Natural lakes are uncommon in Pennsylvania, and occur only in the northwestern and northeastern parts of the state. Lakes differ from ponds in that they have more visible waves, are deeper, have rooted plants that are only able to grow close to the shore, and have water temperatures that vary with depth. Ponds, natural and man-made, are present throughout the state, though their locations are not well documented.

Reservoirs, or impoundments, are common throughout Pennsylvania. Reservoirs are created when a body of water is detained by a structure, such as a dam. These reservoirs of water behind the dams, sometimes referred to as "lakes," are often utilized for recreational activities, such as fishing, swimming, and boating. They also may provide flood control or water supply for nearby communities. Some industries create reservoirs to contain waste water, which often contains pollutants discharged after use in their operations.

Along with the reservoir of water impounded by a dam, wetlands are often formed on the marginal areas surrounding them. These wetlands provide valuable wildlife and fish habitats. Some trees within those wetlands die when inundated by the saturated soil, but remain standing. These dead, standing trees are referred to as "snags," and they provide valuable habitat for animals that nest in the cavities that can be created in the dead wood.

Wetland in Sinnemahoning watershed

Wetlands

In order for an area to be considered a wetland, it must have three components: anaerobic or hydric soils, wetland vegetation, and indications that it has been covered with water at least part of the year (Mitsch & Gosselink, 2000). Anaerobic or **hydric soils** form under flooded or saturated conditions that last long enough that the upper part of the soil contains no oxygen. An area does not have to be covered with water during the entire year to be considered a wetland. Wetland areas may be permanently flooded by shallow water, permanently saturated by groundwater, or periodically saturated for varying periods of time during the growing season. These characteristics of wetlands are due to the fact that wetlands occur where the water table is at or very near to the surface. Seasonal fluctuations of the water table result in the wetland being wet or dry.

Wetlands retain water, which is slowly released to surface water streams or evaporated. If the water table is lower than the wetland, water may be absorbed into the ground from wetlands. Wetlands reduce the severity of flooding by retaining excess water and slowly discharging it.

Wetlands filter water by a variety of mechanisms. Wetland vegetation slows the velocity of water, allowing more time for suspended sediment to settle out. Pollutants, such as chemicals and metals, which are bound to the sediment particles also settle and separate from the flowing water. Nutrients from fertilizers, manure, and sewage are removed from the water and utilized by the plants growing in the wetland.

Wetland systems often support a variety of living organisms, termed biodiversity. The nutrient rich sediment that collects in a wetland provides abundant nutrients and food resources for plants and wildlife. The emergent vegetation and dead, standing timber provide excellent breeding and nesting habitat for insects and wildlife, especially waterfowl. Many migratory species depend on wetlands for rest and recharge during their long migratory treks.

Vernal pools are one type of wetland, where isolated ponds are created during the spring from rainwater and snow melt that has collected in depressions in the ground. These critical habitats provide breeding grounds for woodland frogs and salamanders. Vernal pools also support a variety of other floodplain, meadow, shrub lands, and woodland species.

Wetland Loss

More than half of all wetland habitats that once occurred in Pennsylvania have been lost. The major causes of wetland loss have been impoundment, drainage for agriculture and development, and conversion to other uses. The reduction of wetlands in any given area can drastically impact health and human safety by leading to increased occurrence and severity of flooding, decreased natural water quality revitalization, and exacerbated drought conditions. Loss of wetland habitat also negatively impacts wildlife.

Stricter environmental regulations today prevent major wetland drainage and impoundment. However, recent federal court decisions have reduced the protections given to smaller, isolated wetlands under the Clean Water Act. Although smaller wetlands still receive some protection under Chapter 105 of the Pennsylvania Code, permits can often be acquired for their alteration or destruction (Pennsylvania Game Commission, 2005b).

In Pennsylvania, the U.S. Army Corps of Engineers permits regulation authority to DEP, where one acre or less of wetlands is impacted. A general permit form must be obtained from your county conservation district or regional DEP office to change, expand or diminish the course, current or cross section of a watercourse, floodway or waterbody, including wetlands. In addition, the local municipality and county must be notified of the applicant's intent to obtain a general permit (DEP, 2006a).

DEP, in conjunction with the National Fish and Wildlife Foundation, has established a fund, called the "Pennsylvania Wetland Replacement Project," to help permit applicants meet the wetland replacement requirements identified in Chapter 105. If, after DEP consultation, wetland replacement onsite is not feasible or deemed unnecessary, the permit applicant may contribute to the fund, based on the size of the disturbance. With the fund, DEP will support restoration projects throughout the state that restore wetlands, riparian corridors, and other aquatic systems (DEP, 2007a).

It is critical to protect and maintain an abundance of wetlands in any watershed for flood protection, water quality improvement, and wildlife habitat. Artificially constructed wetlands do not perform the same as natural wetlands, but in any case, it is important to maintain as much wetland area as possible. Ideally, wetlands that are threatened by development or conversion should be protected with a buffer surrounding them to reduce the secondary impacts.

Wetlands in Sinnemahoning Watershed

Figure 3-6 delineates wetlands found throughout the Sinnemahoning watershed. Wetlands comprise less than one percent of the land area (Table 2-2, Chapter 2).

Wetlands can be constructed to serve a specific purpose related to improving water quality. Wetlands can be constructed to control stormwater runoff in developed areas, remediate polluted mine drainage,

and treat wastewater. Several small, artificial wetlands exist throughout the study area to serve those purposes.

Passive treatment systems to abate the effects of polluted mine drainage often include a system of settling ponds and wetlands to allow metals and pollutants to drop out of the water, incorporating alkaline additions when necessary. These treatment sites and wetlands offer a unique opportunity for a variety of educational workshops to teach the public and students about the effects of pollution, environmental remediation techniques, water quality, and biodiversity.

Floodplains

The area of land adjacent to a river, stream, or lake that absorbs the occasional overflow of water beyond the banks is known as the floodplain. Floodplains and wetlands dually act to absorb flood waters during high-flow and storm events. When houses, buildings, roads, and paved surfaces are constructed in a floodplain or eliminate natural wetlands, the ability of those areas to dissipate flood waters is diminished. In addition, the likelihood of property damage and human health and safety risk increases when development occurs within a floodplain.

The National Flood Insurance Program (NFIP), administered through the Federal Emergency Management Agency (FEMA, 2002), was established in 1968 with the National Flood Insurance Act. Property owners can purchase insurance to protect against flood loss if communities agree to adopt ordinances that reduce flood damage, including limiting building in floodplain areas. Ordinances must meet minimum regulatory standards of NFIP and the PA Floodplain Management Act (PA Act 166). Residents from non-participating communities can still purchase insurance, but at a higher rate (FEMA, 2002).

Table 3-2. Municipal Floodplain Ordinances

Municipality	Floodplain Ordinance
Cameron County	**Yes**
Driftwood Borough	N/A
Emporium Borough	Yes
Gibson Township	N/A
Grove Township	Yes
Lumber Township	Yes
Portage Township	N/A
Shippen Township	No
Clearfield County	**No**
Goshen Township	Yes
Huston Township	No
Lawrence Township	Yes
Clinton County	
East Keating Township	No
West Keating Township	No
McKean County	**Yes**
Norwich Township	Yes
Elk County	**No**
Benezette Township	Yes
Fox Township	No
Jay Township	Yes
Jones Township	Yes
Saint Marys, City of	Yes
Potter County	**No**
Austin Borough	Yes
Eulalia Township	No
Homer Township	N/A
Keating Township	No
Portage Township	No
Summit Township	N/A
Sylvania Township	N/A
West Branch Township	Yes
Wharton Township	N/A

In communities that adopt such ordinances, building in Special Flood Hazard Areas (SFHA) may occur only if the owner agrees to purchase flood insurance. SFHAs are areas within the 100-year flood zone, which means that there is a one percent chance of a flood reaching this zone each year. Special subsidies are available for existing structures built before the adoption of ordinances. Future structures

built in 100-year floodplains must meet certain requirements. During declared national disasters, FEMA may also make grants and loans available to those not participating in the program (FEMA, 2002). Many communities in Pennsylvania have adopted a riparian buffer approach to floodplain management. These "total prohibition" ordinances encourage the reduction of construction and development in the floodplain.

Vegetated riparian buffer zones are critical for protecting water quality

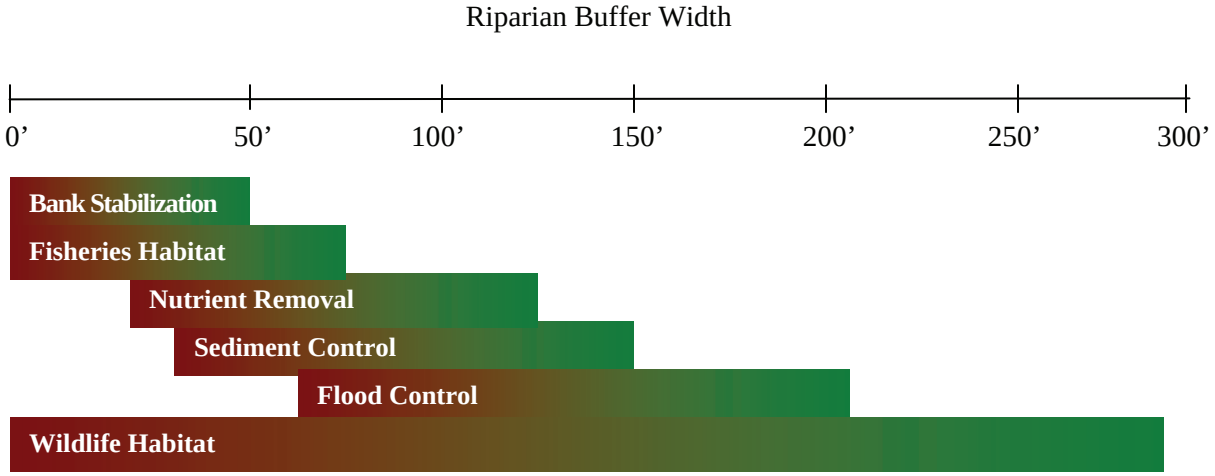
Due to the topography of the region—steep hillsides and narrow valleys—development and occupation is limited to valley areas, which affects floodplains. Floodplains can be considered "sensitive" areas because they are both inappropriate for building purposes and important for protection of streams and wildlife.

Currently, slightly more than half—56 percent—of the watershed's municipalities have floodplain ordinances in effect. Special attention to these flooding and floodplain development issues should be addressed when development projects are considered.

Riparian Areas

Riparian zones along a stream filter pollutants and sediment from runoff and provide a buffer between the land and water. A healthy riparian zone contains a variety of grasses, wildflowers, shrubs, and trees that reduce flooding and erosion by retaining water, slowing its velocity, and stabilizing soil. This also promotes groundwater retention. Riparian zones provide habitat for wildlife, regulate water temperature through shading, enhance recreational activities, and create in-stream fish habitat. Studies have shown that the wider and more substantial the riparian zone, the better it performs these functions (Klapproth & Johnson, 2000). Some streams that flow through agricultural properties or developed areas may not have adequate riparian zones to filter runoff. A lack of riparian zone vegetation may cause severe bank erosion and allow the spread of invasive plants, which thrive in disturbed areas, like the bare soil of an eroded streambank. Figure 3-9 shows recommended riparian zone widths for bank support, fisheries habitat, nutrient and pollution removal, sediment control, flood control, and wildlife habitat.

Figure 3-9 Recommended Riparian Buffer Widths



Retaining existing buffers is a cost-effective method to protect waterways from sedimentation, streambank erosion, and flooding. A number of tools and programs are available in Pennsylvania for landowners and communities to protect and enhance these important riparian zones and other important green areas, such as:

- Pennsylvania Stream ReLeaf Plan (DEP, 1997) and forest buffer tool kit (Alliance for the Chesapeake Bay [ACB] & DEP, 1998)
- Stream corridor restoration: principles, processes, and practices (Federal Interagency Stream Restoration Working Group, 1998)
- Chesapeake Bay riparian handbook: A guide for establishing and maintaining riparian forest buffers (Palone & Todd, 1997)
- Riparian forest buffers: function and design for protection and enhancement of water resources (Welsch)
- Pennsylvania's Conservation Reserve Enhancement Program (U.S. Department of Agriculture Farm Service Agency)

Floodplain and Riparian Area Protection

In addition to the programs previously mentioned, there are several avenues a community may pursue to protect, restore, and conserve riparian corridors and natural areas. These methods are discussed below. A municipality or conservation organization may pursue **land acquisition**, which is the purchase or donation of land, to protect or restore a high quality riparian zone or land located in the floodplain. The Pennsylvania Department of Conservation and Natural Resources (DCNR) offers funds for land acquisition to protect and restore natural areas. Land acquired with these funds must remain open to the public. Another financing option for the purchase of riparian land is to subdivide the area and sell the less-sensitive sections to offset the costs.

Another way to protect riparian land and natural areas is by establishing a **conservation easement**—a voluntary land preservation agreement between the landowner and a land trust or local government that permanently restricts the type of land use allowed on that property. The landowner maintains ownership of the land, but gives up some of the development rights. The conservation easement compensates the landowner for the economic loss resulting from these restrictions, such as limited timber harvesting or grazing. The landowner may receive a tax credit for the reduced value of the property. Within Pennsylvania, municipalities may hold conservation easements and use various taxing schemes to raise money for the acquisition of open space and agricultural land. The Recreation Use of Land and Water Act and the Rails to Trails Act limit landowner liability for property owners with easements or adjoining trails (ACB, 2004) that are open to the public for recreation.

Municipalities have several options in regards to **land-use planning**. County Comprehensive Plans are documents that address the timing and character of development. Although non-regulatory, the Municipalities Planning Code states that zoning ordinances must be consistent with comprehensive plans, which should contain planning for natural and historic preservation (Pennsylvania Municipalities Planning Code). An official municipality map designates existing and proposed open space reservations. If a municipality wishes to set aside a landowner's property for open space purposes, then the municipality has a legal obligation to buy the land within 12 months of the landowner's decision to develop it.

Municipalities may adopt **ordinances** to restrict activities within a certain distance of a stream, based on stream size, slope of the land, wetlands, etc. This may include limiting the building of structures in areas prone to flooding, restricting streamside vegetation removal, and regulating the amount of earth disturbance in riparian zones. Typically, restrictions increase in zones that are the closest to the stream.

Structures present before an ordinance is enacted are often exempt from these restrictions. Several examples of municipalities in Pennsylvania that have riparian ordinances include Salford and Horsham townships, Montgomery County; Kennett Township, Chester County; Warwick Township, Lancaster County; and Radnor Township, Delaware County (ACB, 2004).

Transferable development rights are used to compensate property owners in areas where development is restricted, by allowing them to sell development rights to increase development densities in other areas.

Density bonuses allow developers to increase development density in exchange for conserving natural areas or contributing to an open space fund.

A riparian stream buffer helps reduce stormwater runoff. Developers can receive **stormwater credits**, which result in construction of less costly stormwater management facilities, in exchange for maintaining or restoring riparian buffers (ACB, 2004).

Stormwater

Excess water from storm events and spring snow melt is commonly referred to as **stormwater**. Stormwater has traditionally been managed by creating ditches, drains, and pipes to funnel the water to the nearest stream or, in some cases, water treatment facility. While moving water away from homes and streets is important, we must also address the pollutants carried with the runoff and the potential for flooding due to the quick input of a large volume of water into the stream.

Stormwater picks up and carries debris, chemicals, and other pollutants to streams and reservoirs. Garbage, tree limbs, other types of debris can clog drains or even streams, causing isolated floods, not to mention the visual degradation of natural areas. Sediment can degrade aquatic habitat and interfere with the reproduction of fish, mussels, and other aquatic life. Excess nutrients from agricultural runoff increase the growth of algae. As the algae dies and decomposes, it removes vital oxygen from the water. Bacteria and other pathogens carried to streams and reservoirs by stormwater may cause health hazards to humans who use those water sources for recreation or drinking water. Harmful chemicals from industrial and household wastes and pesticides that wash into water supplies are toxic to wildlife and humans. Even when stormwater is diverted to a waste treatment facility, some pollutants are missed, and the increased volume of water results in increased treatment costs for the public. Often times, the amount of water reaching the facility is so great that the system overflows and untreated water and raw sewage are discharged directly into streams.

Impervious surfaces, such as roads, buildings, parking lots, and compacted soil, prevent or hinder stormwater's ability to soak into the ground, exacerbating its impacts. In municipalities with combined stormwater and sewage systems, this results in the aforementioned overflows. Significant stream impacts have been shown to occur when only 10 percent of the surface area is impervious (Booth, Montgomery, & Bethel, 1996). Impervious surfaces and stormwater runoff increase the volume and velocity of surface water flowing in a stream, which diminishes groundwater replenishment and increases the rate of erosion. These changes result in flooding, loss and degradation of habitat, erosion, sedimentation, and physical changes in the stream. Small floods may increase by up to 10 times with increases in imperviousness from urbanization (Hollis, 1975).

Municipalities are encouraged to minimize impervious surfaces and manage stormwater by using tools and techniques, such as performance zoning, residential design, and open space subdivision. In cooperation with businesses and homeowners, municipalities should encourage the use of porous pavement, rain barrels, rain gardens and vegetated swales, and vegetative buffers (especially in riparian

areas). Reducing impervious surface not only has environmental benefits, but reduces social, economic, and development costs as well.

Everyone can minimize the negative impacts associated with polluted stormwater runoff by doing their part at home. Use only the minimum effective amount of lawn fertilizers, pesticides and other household chemicals. Better yet, compost and use your own natural fertilizer on gardens and flower beds. Dispose of hazardous waste properly or through a local recycling program. Test septic systems regularly to ensure proper functioning and quick response to leaks. Clean your vehicles at a car wash where the water is treated and recycled and check for leaking fluids. Pick up and flush pet waste. Create rain gardens using native plants to control runoff from your home. Collect rainwater from the roof of your house in a rain barrel, and use this chlorine-free water to water plants, wash pets, and clean your house and outdoor furniture.

To respond to increased stormwater runoff, Pennsylvania created the Stormwater Management Act in 1978, which requires each county to develop stormwater management plans for each of its watersheds. Municipalities are required to adopt and implement ordinances consistent with these plans to regulate development. DEP provides funding options for stormwater management plans and model stormwater ordinances on its website, http://www.dep.state.pa.us (Keyword: Stormwater). Cameron County does not yet have a stormwater management plan. Clinton County has developed watershed-specific management plans for other watersheds in the county, but has not yet developed a county-wide stormwater management plan that includes Sinnemahoning Creek. Clearfield, Elk, McKean, and Potter counties have completed Phase I by developing county-wide stormwater management plans and are working with municipalities to develop and adopt stormwater management ordinances as part of Phase II implementation of the plans (DEP, 2009).

Dams

Dams were often installed along streams and rivers to harness the natural power of water for operating mills of varying sorts— saw, grist, and paper mills. Dams have also been established for navigation purposes and transportation of goods. The natural power of stream currents is still utilized for some industries today, and it can be harnessed for hydroelectric power generation.

The ruins of the Austin Dam remain as a symbol of the tragic flood of 1911

Often times, dams no longer serve a purpose, and are abandoned. If not maintained, they may fall into a state of disrepair and pose a safety risk. Dam failures may cause flooding, resulting in injury or death to humans, property damage, and interruption of transportation and emergency services. Dams obstruct migration paths of fish, and may inhibit the movement and dispersal of other aquatic life. Abandoned dams also hinder recreational paddlers' ease of transportation down a stream.

It must be determined, based on maintenance costs, safety, and potential uses of the dam, whether or not to remove one. If a community decides to leave a dam in place, a portage trail may be constructed around the dam for paddlers. If it is determined that a dam should be removed, a plan must be developed for the removal process and restoration of the stream and its habitat afterwards.

There are a few organizations responsible for the oversight of dam maintenance, regulation, and removal in Pennsylvania, including the U.S. Army Corps of Engineers, DEP, Pennsylvania Fish and Boat Commission (PFBC), and American Rivers. Necessary permits must be obtained prior to removing a dam, and assistance is available to support the planning and restoration process. A useful resource for

additional information about the benefits of dam removal, volunteer monitoring, and references for assistance is the *Citizen's Guide to Dam Removal and Restoration*, which can be obtained from the Pennsylvania Organization for Watershed and Rivers (POWR) at www.pawatersheds.org.

The George B. Stevenson Dam at Sinnemahoning State Park created a man-made lake by damming First Fork Sinnemahoning Creek in 1955 for flood control in the West Branch Susquehanna River Basin. The George B. Stevenson Reservoir is 142 acres in size and offers fishing, boating, and wildlife viewing opportunities for the public. Some concerns have been raised by the public about the extreme water-level fluctuations at this dam and how it affects the ecology of the stream, public safety, and local establishments that depend on recreation-based business from tourists and visitors to the reservoir.

The Austin Dam was built in 1909 to create reservoir from the flowing waters of Freeman Run to support a paper mill. That structure failed in September of 1911, flooding the downstream community of Austin, and killing nearly 80 people. More information on this disaster can be found in the Cultural Resources chapter.

There are several more small dams, some privately owned, throughout the watershed that are not well-documented. These small reservoirs serve or had served the purpose of supplying water for communities or mills. Many of these small dams and reservoirs no longer exist, and some of those that remain have been abandoned.

Water Quality

Water Quality Designations

Existing and Designated Uses

The Clean Water Act is enforced through the assignment of existing and designated water uses. **Existing uses** are uses that a waterbody has had since November 1975. **Designated uses** are those that are currently recognized, regardless of whether they have been attained since 1975 (Elder et al., 1999). Examples of uses include aquatic life, shellfish harvesting, and agriculture. Polluted discharges are not permitted if they violate this existing use. If a point source will violate a current or designated use, a public hearing must be held to inform the public before the permit is issued.

Water Classifications

A watershed designated as **High Quality (HQ)** or **Exceptional Value (EV)** is considered to satisfy all designated uses. Within Pennsylvania, a stream designated as HQ or EV meets a number of criteria, including specific water quality and biological standards. As with other designated uses, any proposed discharge that will degrade a HQ stream below these criteria can only occur if a special exception is granted and the public is informed. Typically, no special exceptions are granted for EV streams.

DEP Exceptional Value Qualifications

- Located in a national wildlife refuge or a state game propagation and protection area
- Located in a designated state park or state forest natural area, national natural landmark, federal or state wild river, federal wilderness area, or national recreational area
- The water is an outstanding national, state, regional, or local resource
- Has exceptional recreational significance
- Achieves a score of at least 92% using approved biological assessment methods
- Designated as a "wilderness trout stream"
- Surface water has exceptional ecological significance.

DEP High Quality Water Qualifications

- Long-term water quality criteria better than PA Code Chapter 93.7 at least 99 percent of the time
- Chemical and toxicity characterizing good water quality
- Surface water quality supports high quality macroinvertebrate community
- EPA *Protocols for Use in Streams and Rivers* score of at least 83 percent compared to high quality reference stream
- Surface water has been designated a Class A Wild Trout Stream

The classifications of **Warm Water Fishery (WWF)** and **Cold Water Fishery (CWF)** describe the aquatic life that a waterbody is able to support. Warm-water streams support plants and animals that can survive in warmer temperatures, while cold-water streams support species that thrive at lower temperatures. In Pennsylvania, a WWF has a maximum healthy water temperature of 87° Fahrenheit versus 66° Fahrenheit for a CWF (PA Code, 1997).

Typically, streams are warmer because less vegetation is present in the riparian area to cast shade over the stream. Impoundments may slow water flow, raising the temperature of the pooling water to be somewhat higher than water in faster flowing segments. Warm water streams often are found in areas that have been more intensively developed or used for agricultural activities, while CWFs can be found in forested areas. In Pennsylvania, many CWFs that would otherwise be pristine are impaired by AMD. Often, streams have temperature characteristics that are intermediate, between a CWF and WWF, and contain species characteristic of both types. Though there is no official classification, many people refer to these streams as "coolwater" streams.

A **Trout Stocked Fishery (TSF)** possesses water quality that is not high enough to support naturally reproducing trout, but is able to support trout stocked by the Pennsylvania Fish and Boat Commission (PFBC).

Nearly three quarters—74.4 percent—of the streams within the Sinnemahoning watershed are designated HQ or EV, affording them more stringent protection from deliberate pollution and degradation. For the most part, the watershed is healthy and many of the streams are attaining their designated uses. A complete listing of all stream designations can be found in Appendix G (PA Code, 1997).

North Creek, one of the many high-quality coldwater fisheries found within the Sinnemahoning Creek watershed

Most of the stream segments within the Bennett Branch subwatershed are designated CWF, with many HQ-CWF segments and three EV segments—Byrnes Run, West Branch Hicks Run, and the headwaters of Mix Run. The mainstem of Bennett Branch is a WWF from Mill Run to its confluence with the Driftwood Branch. Many of these quality streams have been degraded by high levels of metals and low pH resulting from pollution from abandoned mines.

Over 88 percent of the stream segments within the Driftwood Branch subwatershed are designated as HQ-CWF or EV streams. Six EV stream segments are found within this subwatershed, including the headwaters of Elk Fork to Nichols Run, Cooks Run, Tannery Hollow Run, the headwaters of Clear Creek to Mud Run, the headwaters of Sinnemahoning Portage Creek to Cowley Run, and Cowley Run. The train derailment that resulted in thousands of gallons of sodium hydroxide being spilled into Sinnemahoning Portage Creek, severely devastated the stream's exceptional water quality. The mainstem of Driftwood Branch from Elk Fork to its confluence with Bennett Branch is a TSF.

First Fork is a major tributary to the mainstem of Sinnemahoning Creek. Looking at this tributary as a subwatershed, a vast majority—92.54 percent—of its stream segments are designated HQ-CWF. Five EV streams are present within the drainage area; they include East Fork Sinnemahoning Creek, Stony Lick Run, Birch Run, Bailey Run, and Lushbaugh Run. The mainstem of First Fork from the Stevenson Dam at Sinnemahoning State Park to its mouth is designated as HQ-TSF. Other than those segments, no CWF, WWF, or TSF streams were designated.

The entire Sinnemahoning Creek mainstem is designated as a WWF. While there are no EV tributaries flowing directly to it, all unnamed tributaries, as well as Grove Run, Wykoff Run, Upper Jerry Run, and Lower Jerry Run are designated HQ-CWF streams.

Water Quality Monitoring

The monitoring of surface waters should be regular, systematic, and ongoing. Watershed groups, conservation organizations, and conservation districts throughout the region should work together to monitor water quality in all tributaries of the Sinnemahoning Creek watershed. Water quality monitoring achieves the documentation of baseline stream health data to monitor conservation, preservation, and restoration efforts. Typically, tests are conducted for pH, conductivity, dissolved oxygen, alkalinity, sulfates, nitrates, temperature, flow volume, and macroinvertebrates. Macroinvertebrate sampling, along with aquatic salamander surveys, can be used to analyze water quality based on the presence and abundance of certain pollution-intolerant animals, also known as bio-indicators.

Water quality monitoring of groundwater should also be conducted, since a majority of surface water is derived from groundwater discharge. Detection of pollution in the groundwater before it is discharged to surface water sources would enable proactive treatment exploration. This may aid in the identification of pollution sources through early detection, and allow for prioritized treatment and remediation strategies to be implemented.

Pollution Sources

Point Source Pollution

Point source pollution refers to discharges, or pollution inputs, that enter a stream or lake directly via a pipe, culvert, container, or other means. One way the Clean Water Act is enforced is through the National Pollutant Discharge Elimination System (NPDES), whereby DEP issues permits for point source discharges (DEP[7]). In Pennsylvania, the DEP and local conservation districts are responsible for issuing point source permits to industrial operations, municipal wastewater treatment plants, concentrated animal feeding operations, and households. In addition, any disturbance of land from one to five acres requires an NPDES permit, even if it is a non-point source. The exceptions are for tilling, agricultural practices that are not part of a concentrated animal feeding operation (CAFO), and most logging disturbances that are less than 25 acres. However, many of these activities still require a soil and erosion control permit (DEP[7]).

Dents Run is severely impacted by abandoned mine drainage, which is prevalent throughout the Bennett Branch subwatershed

Non-point Source Pollution

Non-point source pollution is pollution that enters a waterbody through an undefined source, usually in the form of polluted groundwater discharge or runoff from places, such as agricultural fields, logging operations, residential lawns, and streets. Non-point source pollution comprises the majority of pollution, mainly because they cannot be as easily regulated. Usually, AMD is considered non-point source pollution because it is created in large, poorly-defined areas that often discharge into a stream in a diffuse manner. Efforts to reduce non-point source pollution are often conducted on a state or local level through programs to implement best management practices (BMPs) offered by conservation districts and other agencies and organizations.

Major Sources of Impairment

While the majority of the streams in the Sinnemahoning Creek watershed are pristine and high-quality waterways, pollution and impacts are present, yet isolated. Abandoned mine drainage impacts are particularly present in the Bennett Branch subwatershed and in a few isolated streams elsewhere in the watershed. Since a majority of the watershed in forested and many dirt and gravel roads exist, erosion and sedimentation impacts are present throughout the project area. An isolated train derailment caused severe pollution impacts in the Sinnemahoning Portage Creek, which flows into the Driftwood Branch, causing fish kills and severe degradation to those fisheries. The vast expanse of protected and public lands bodes well for the continued conservation of this important tributary to the West Branch Susquehanna River.

Abandoned Mine Drainage

Abandoned mine drainage (AMD) is a significant cause of impairment throughout the Bennett Branch sub-watershed. It also is a concern in Sterling Run and West Creek, as are minimal AMD impacts affecting Parker Run and Canoe Run. AMD is formed when the fractured bedrock of abandoned mines allows rain, groundwater, and oxygen to come into contact with coal seam. Chemical reactions result in water contaminated with dissolved metals, including iron, manganese, and aluminum. Acid mine drainage is formed when sulfur-oxidizing bacteria in rock converts inorganic sulfur to sulfate and sulfuric acid in water. If there are insufficient neutralizing compounds, the water will become acidic. The polluted water discharges into streams and groundwater through mine openings, springs, and seeps. When the water is exposed to oxygen in the air, the metals will precipitate, or drop out of the solution as solids, creating even more acid and coating stream bottoms with silt-like metals. High levels of iron and aluminum can poison fish and threaten drinking water supplies (Fripp, Ziemkiewicz, & Charkavorki, 2000). Metal siltation and altered pH also affect the survivability of aquatic macroinvertebrates, which form the base of the food chain and the basis of a healthy, functioning stream ecosystem.

Underground mining refers to practices that extract coal by tunneling into the earth. Surface mining involves extracting deposits of mineral resources close to the surface. A common surface mining method is strip mining, which removes the layers of rock directly over the coal seam.

Remediation refers to treatment methods used to minimize or remove pollution from a contaminated area. The goals of AMD remediation are to reduce metals and water acidity or to raise water pH to acceptable levels. AMD treatment falls into two broad categories—active and passive. Active treatment involves the physical addition of a neutralizing agent, such as chemicals and lime, to the source of the AMD or directly into the stream. Passive treatment includes a variety of techniques to raise the pH and reduce metal loading using a constructed treatment system or containment project, such as a wetland or limestone drain. While initial costs for passive treatment can be higher, passive treatment generally requires less maintenance than active treatment systems (Turner et al.).

The type of treatment system used is highly dependent on the type and concentration of metals present in the AMD and site conditions. Chemical treatment is typically implemented through passive and active methods, such as the addition of lime or the use of limestone-lined ponds. If it is necessary to reduce metal concentrations and raise pH, then a variety of passive treatments may be used, including an anaerobic wetland, aerobic wetland, or combination of systems (Pennsylvania State University).

Previously mined areas can also be dangerous, with unstable portals and roofs associated with underground mines and dangerous high walls and spoil banks associated with surface mines. In some cases, reclamation techniques, such as removal of refuse and/or re-grading and re-vegetating, can be used to make a site safer and reduce discharges.

Some funding for mine reclamation is available through the Office of Surface Mining and other state and federal programs. See the Land Resources chapter for information about the impacts of mining on the

landscape and for funding opportunities. Underground and surface mining continue to be utilized. As more profitable coal seams are mined in Pennsylvania, the reclaiming of old areas and targeting of once unprofitable coal seams may become more cost effective.

Table 3-3. Public Sewage Facilities

Municipality	Public Sewage	Facility	Capacity
Cameron County			
Driftwood Borough	No		
Emporium Borough	Yes	Mid-Cameron Authority	1 million gallons per day
Gibson Township	No		
Grove Township	No		
Lumber Township	No		
Portage Township	N/A		
Shippen Township	Yes	Mid-Cameron Authority	1 million gallons per day
Clearfield County			
Goshen Township	No		
Huston Township	Yes	Huston Township Sewer Authority	N/A
Lawrence Township	Yes	Clearfield Municipal Authority	N/A
Clinton County			
East Keating Township	No		
West Keating Township	No		
McKean County			
Norwich Township	No		
Elk County			
Benezette Township	No		
Fox Township	Yes	Fox Township Sewer Authority	N/A
Jay Township	Yes	Jay Township Authority	N/A
Jones Township	Yes	Johnsonburg Municipal Authority	N/A
Saint Marys, City of	Yes	Saint Marys Sewage Authority	N/A
Potter County			
Austin Borough	Yes	Austin Borough Sewer	N/A
Eulalia Township	No		
Homer Township	No		
Keating Township	No		
Portage Township	No		
Summit Township	N/A		
Sylvania Township	No		
West Branch Township	No		
Wharton Township	N/A		

Sewage Waste

Contamination from both public sewage treatment systems and private on-lot septic systems is a potential source of water pollution throughout the watershed. Public sewage services are concentrated in boroughs and more populated townships. All public systems must have a DEP point discharge permit to discharge treated wastewater, which may contain small amounts of nutrients and bacteria. Public and private systems have the potential to impact stream health and public water supplies, particularly if they are malfunctioning. This could cause drinking water contamination and increase drinking water treatment costs.

Rural, on-lot septic systems typically contribute a greater amount of sewage waste to streams when they are not maintained properly. Conventional systems consist of a large tank designed to hold about two days worth of wastewater and allow solids to settle out, as well as a drain field that distributes the wastewater so it can slowly absorb into the soil. Septic systems remove much of the bacteria, but are not very effective at removing nitrogen. They often fail when the drain field becomes clogged or saturated, and may cause raw sewage to contaminate streams and groundwater. These systems should be pumped out every few years to prevent buildup and clogs (BF Environmental Consultants, 2004).

More advanced on-lot systems are designed to remove nitrogen by moving effluent through a series of chambers containing different kinds of microbes. These systems have pumps, moving parts, and other components that need to be inspected every few years. These more advanced systems can remove twice the amount of nitrogen as conventional systems, but are more expensive and can have higher environmental impacts if not pumped out (BF Environmental Consultants, 2004).

Due to the remoteness of the watershed, there are few isolated population centers that offer public sewage systems for residents and businesses. Only nine of the 27 municipalities reported having public sewage services within the project area (Table 3-3). Of those, five were in the process of upgrading or foresaw the need to upgrade within sewage facilities within the next ten years. Of all the municipalities, including those that do not offer public sewage, nine municipalities were anticipating upgrades or considering the establishment of public sewage facilities.

Pharmaceuticals

For years, the public was instructed to flush unwanted or unused medicines down the toilet. Many sewage treatment facilities are not designed to remove specific pharmaceuticals from wastewater. In light of recent research, this practice is now being discouraged due to the potential pollution impacts to aquatic ecosystems and drinking water supplies. Hormones, antibiotics, and over 100 different pharmaceuticals have been found in waterways around the world (Hemminger, 2005).

Hormones, vitamins, and other chemicals within those medicines may affect water quality, the reproduction and development of aquatic organisms, as well as human health. Fish caught within the Allegheny River near Pittsburgh, Pa. exhibited sexual mutations, such as feminized males, which may be caused by prolonged exposure or accumulated levels of estrogen hormones in the water.

Due to the rising concern of chemical and hormone pollution from pharmaceuticals, many conservation districts and watershed groups have begun organizing unwanted household medicine collections to prevent the potential contamination of waterways. One major challenge to organizing such and event is that pharmacists and police officers must be present at the collection to monitor controlled substances.

More information about pharmaceutical pollution may be obtained by contacting your local Penn State Cooperative Extension or county conservation district.

Nitrates

Nitrates are commonly used in fertilizers and in industrial applications, but are also found in rodenticides (pesticide used to kill rodents) and food preservatives (EPA, 2007b). Nitrates also are a component of animal (including human) waste. Nitrates are easily soluble, and do not attach to soils, so it easily migrates to contaminate groundwater. Nitrates do not evaporate, and remain in water until ingested by plants or other organisms.

Nitrates have been found to contaminate unprotected wells (U.S. Agency for Toxic Substances and Diseases Registry, 2001). Nitrates can pollute streams by direct discharge of industrial effluent, runoff from agricultural lands, and faulty septic and municipal sewage systems. High levels of nitrates in water can result in eutrophication and algae blooms, which disrupt oxygen levels when the material decays, causing the death of aquatic life (EPA, 2006b). Nitrate pollution can also prove to be a risk to human health.

Infants, pregnant women, and nursing mothers are particularly at risk of adverse health effects in association with high levels of nitrates in drinking water. Methemoglobinemia, also known as "blue baby syndrome," is a syndrome that occurs in infants, due to the unique way the body metabolizes nitrate at that age. Infants metabolize nitrate into nitrite, which robs blood cells of oxygen, thus creating a blue coloration in body tissues. The most serious consequences of this condition are coma and death (Knobeloch et al., 2000). Nitrates also have been linked to certain types of cancer in young children and adults, as well.

Sodium Hydroxide

On June 30, 2006, a Norfolk Southern freight train traveling through the watershed derailed in McKean County near the town of Gardeau and spilled approximately 42,000 gallons of caustic sodium hydroxide into Sinnemahoning Portage Creek. The spill traveled over 30 miles, flowing down Sinnemahoning Portage Creek to Driftwood Branch and on down the Sinnemahoning Creek mainstem toward the West Branch Susquehanna River. The subsequent poisoning resulted in the death of thousands of aquatic animals. Shortly after the accident, in July, PFBC officials conducted a thorough assessment of the fish, amphibians, and other aquatic life of Sinnemahoning Portage Creek, Driftwood Branch, and Sinnemahoning Creek to gather data on the far-reaching impacts of the spill (Hartle, 2006).

Fish kill resulting from the sodium hydroxide spill as a result of the Norfolk Southern train derailment along Sinnemahoning Portage Creek in 2006 Photo credit: Jim Zoscho, Jr.

Sinnemahoning Portage Creek is designated as an EV stream from its headwaters to Cowley Run. The train accident occurred within this stretch, severely degrading a great portion of these exceptional value waters and devastating the aquatic life that depended upon it. The sodium hydroxide that was spilled into the creek is known to cause caustic chemical burns. It was estimated that up to 98 percent of the aquatic macroinvertebrates in the stream were lost as a result of the poisoning, and all fish within an 11 mile stretch immediately downstream of the spill site were killed. Not only did the chemical spill kill fish and other aquatic organisms for miles downstream; but due to the potential health risk posed to humans, a warning against recreation within those waters was issued to the public (Hartle, 2006).

Fishermen would notice the impact as well. Prior to the train derailment, Sinnemahoning Portage Creek was managed as a Class A Wild Trout stream from the headwaters downstream to Cowley Run. Naturally reproducing wild brook and brown trout were found throughout this section. Wild trout also

inhabited Sinnemahoning Portage Creek from Cowley Run to the mouth, and this section was also supplemented with stocked trout. Due to the severity of the fish kill, it was estimated that these wild trout populations could take up to six years to recover (Hartle, 2006).

In 2007, Norfolk Southern agreed to a damage settlement with the Commonwealth of Pennsylvania for $7.35 million, which was distributed evenly to DEP and PFBC to support conservation initiatives in the Sinnemahoning watershed, as well as throughout the counties in the region. The funds will be used for restoration of Sinnemahoning Portage Creek, as well as to increase and enhance fishing and boating opportunities throughout Cameron, Elk, McKean, and Potter counties (PFBC, 2007b). More information about the availability of these funds for projects can be obtained by contacting your local conservation district.

Acid precipitation

The term pH is used to quantify whether a solution is an acid or a base. Acidity is the concentration of hydrogen (H+) ions in solution, while basicity is the concentration of hydroxide (OH-) ions. A solution with an equal number of hydroxide and hydrogen ions is considered neutral. The lower the pH, the more acidic the solution, while a higher pH solution is more basic.

Rainwater is naturally slightly acidic—generally having a pH around 5.6—from the atmospheric reaction of carbon dioxide and oxygen to form carbonic acid. However, acidity from non-natural sources has caused rainwater in some areas to have a pH of 4.9 or lower. Acidity in precipitation (rain, snow, fog, dew, etc.) that results from the reaction of air pollutants with water is called **acid precipitation**. These pollutants mainly include sulfur and nitrogen oxides, which turn into sulfuric and nitric acids. The sources of this pollution include emissions from vehicles, industries, and power generating plants. The effects of acid precipitation are usually felt many miles away from the source. Most pollutants in the project area come from emissions from more populated areas in the east and Midwest and from coal-burning power plants to the west.

The best way to document the pH of rain is to collect rainwater with rain gauges. Rain that is not affected by pollutants will naturally be acidic, with a pH between 5.0 and 6.0; however, a pH below 5.0 may indicate acid precipitation.

The 1990 Clean Water Act amendments include the most significant legislation to lessen emissions contributing to acid precipitation. The amendments promote the use of market-based approaches to reduce emissions, including pollution trading; innovative technologies to reduce sulfur and other emissions; and promoting the use of low-sulfur coal. Through the use of stricter standards for the emission of sulfur and the use of innovative sulfur scrubbers, sulfur emissions are now 20 percent lower than when the legislation was enacted. Unfortunately, affordable technologies have not been developed to remove the nitrogen component (Driscoll et. al., 2001).

The low pH of acid precipitation can adversely affect water quality. In addition, toxic metals in soils may leach into streams and groundwater. Aluminum pollution is amplified in waterways receiving acid precipitation. Both aluminum and acidity disrupt the water-salt balance in fish, causing red blood cells to rupture. Acid precipitation can also leach important nutrients from soils and decrease forest growth. Fortunately, ecosystems can recover from acid precipitation impacts. Research shows that macroinvertebrate life in a stream re-establishes itself within three years of decreased acidity, whereas fish populations may take up to 10 years (Driscoll et. al., 2001).

The acid precipitation issue is particularly difficult because there is little that can be done locally to solve the problem. The addition of alkalinity-producing chemicals to streams is a temporary solution for aquatic systems. Individuals can make changes to reduce their personal contribution to emissions through

activities, such as driving fuel-efficient cars and using less energy. Additionally, legislators should be encouraged to support regulations that would further reduce pollution from smokestacks and cars.

Proper management of the numerous dirt and gravel roads that are found throughout the region is important to control erosion and sedimentation

Erosion and Sedimentation

Soil **erosion** is movement of soil by wind or water. A lack of vegetation, poor land management practices, stream channelization, and stormwater runoff greatly increase the rate of erosion. **Sedimentation** is the process by which eroded soil from streambanks, dirt roads, and land settle on a stream bottom.

Erosion and sedimentation are concerns throughout the watershed, particularly in areas with dirt and gravel roads, which are prevalent in many rural areas of the region. Many new dirt and gravel roads are constructed for resource extraction activities, including oil and gas well drilling, timber harvest, and surface mining. Erosion and sedimentation rates may also increase as the result of poor land management practices associated with development, agriculture, and forestry. However, there are regulations in place to control erosion and sedimentation associated with land management practices.

In Pennsylvania, any disturbance over 5,000 square feet must have an Erosion and Sediment Control Plan on site. Earth disturbance permits must be obtained for activities disturbing over 25 acres, including timbering and development. Most agricultural operations do not require earth disturbance permits, but must have a conservation plan to take part in incentive programs. Both earth disturbance permits and conservation plans require provisions for sediment control. A separate permit is required for stormwater management. Local county conservation districts assist in the development of erosion and sediment control and conservation plans (PA Code, 1997c). They also assist with paperwork for earth disturbance permits. However, all permits in High Quality and Exceptional Value watersheds must be approved by DEP.

Sediment control best management practices protect the quality of land and water by preventing erosion and sediment pollution. There are various erosion and sediment prevention and control techniques that are designed specifically for the type of development activity, including agriculture, forestry, and general development practices.

Best Management Practices

Agricultural Practices

Agricultural pollution is the second-leading cause of water quality degradation in Pennsylvania, after AMD. Pasture and hay fields comprise a majority of the agricultural land use within the project area (Table 2-2, Chapter 2). Polluted runoff increases with improper management of nutrients, such as manure and fertilizers, as well as inadequate stormwater runoff controls on crop and pasture fields, barnyards, and storage facilities. Agricultural best management practices (BMPs) focus on nutrient reduction, proper storage of manure, and runoff control techniques.

To reduce the potential for nutrient pollution in streams, farmers may develop a nutrient management plan, and then can participate in cost-incentive programs, such as Environmental Quality Incentives Program (EQUIP) and Conservation Reserve Enhancement Program (CREP) (see Chapter 2 for more information on these programs). Cost-incentive programs provide reimbursement for 75 percent or more of incurred costs to implement BMP strategies.

To reduce erosion and sedimentation in runoff, recent efforts have focused on promoting no-till or reduced-till practices, which greatly reduce erosion and fuel costs associated with plowing. The local USDA Natural Resources Conservation Service (NRCS) service centers located in DuBois, Coudersport, and Mill Hall can be contacted for more information (Appendix P). Many of the following examples of agricultural BMPs were recommended by the EPA to protect water quality.

Conservation tillage involves leaving crop residue—plant materials from past harvests—on the soil surface versus tilling and mixing the materials into the churned soil. This practice reduces runoff and soil erosion, conserves soil moisture, helps keep nutrients and pesticides on the field, and improves soil, water, and air quality (EPA, 2008).

Nutrient management planning involves accounting for all nutrient inputs on fields to plan and manage nutrient needs and where the nutrients are applied in order to prevent excessive nutrient buildup in soils and to lessen the potential for nutrients leaching into groundwater or polluting streams via runoff (EPA, 2008).

Integrated pest management employs pest control techniques that utilize minimal amounts of chemical pesticide and maximize mechanical and biological control methods to control insects, weeds, disease, and other pests to protect soil, water, and air quality (EPA, 2008).

Conservation buffers vary from grassed waterway filter strips to vegetated riparian buffers, all of which capture potential pollutants from runoff before it enters the stream (EPA, 2008).

Contour farming involves planting that follows the slope of the land, creating ridges that slow the run of water and allow increased infiltration and groundwater recharge.

Silt fences provide a temporary barrier to retain sediment by slowing water flow and promoting sediment deposition on the uphill side of the fence.

Strip cropping is the partitioning a field into alternate bands of different crops, such as row crops, hay, and small grains; when combined with contour farming methods, it allows increased infiltration and filtering of sediment from runoff.

Filter strips are areas of grass planted next to crops to filter sediment, organic matter, nutrients, and chemicals carried in runoff.

Grazing management may involve rotating livestock through different pastures/paddocks to minimize soil compaction, over-grazing, and soil erosion; providing alternate watering sources to deter livestock from seeking water in vulnerable areas of a pasture or directly from a stream running through the pasture to reduce nutrient polluted runoff and erosion and sedimentation; utilizing appropriate vegetation mixes to stabilize soil; and managing stocking rates and timing/season of grazing practices (Toor, Sims, & Maguire).

Animal feeding operations (AFOs) management minimize waste discharges through runoff controls, by using sufficient waste storage and utilization methods, as well as nutrient management planning (EPA, 2008).

Forestry Practices

The amount of water running off a forest during a storm event depends, in large part, on the forest age and proportion affected by timber harvesting. Following a timber cut, there is an increase in the

amount of water running off a forest patch, because fewer trees exist to take-up the water or to intercept rainfall to slow its velocity and reduce soil compaction. Runoff carries sediment and nutrients to the stream.

High-grade cuts (which remove the best-quality trees and leave little for regeneration) and other forestry practices that leave few standing trees can increase the amount of runoff to streams. The filtering function of forests can be maintained through a number of sustainable forestry practices, such as dispersing harvesting operations so that only a small percentage of any watershed is affected at any one place and time, utilizing forestry methods that leave an appropriate amount of trees to prevent erosion, leaving a wide enough streamside forest buffer to filter sediment from surface runoff, utilizing thinning practices to maximize filtering capacity and forest health, and implementing additional sediment and erosion control BMPs (Klapproth & Johnson, 2000). These are discussed further in the Land Resources chapter.

Pre-harvest planning is a crucial element in forestry to protect water resources from polluted runoff, erosion, and sedimentation. Pre-harvest planning considers the lay of the land, important natural resources, and potential environmental impacts that may result from the logging activity. The plan should include information on how the operation will proceed in regards to site preparation, road and landing placement, and post-harvest erosion control and site management procedures.

Streamside forested riparian buffer zones should be protected and maintained during the operation to reduce streambank erosion and filter sediment and other pollutants from runoff. An intact forested buffer will also provide shade to help regulate water temperature of the stream, which is especially important for coldwater streams.

Forested wetland buffer zones are important also, not only to protect the vital wetlands, but to provide habitat for displaced wildlife, filter runoff, and recharge groundwater.

Logging roads and landings should be located away from steep slopes and be designed to minimize runoff, drain properly, and provide stabilized stream crossings.

Silt fencing, erosion control mats, and vegetated strips are additional measures that can be employed along roads, around landing areas, and between the operation and any water resources on the site to further control and prevent sediment and polluted runoff from reaching streams.

Sustainable harvest practices, such as those mentioned in Chapter 2, should take precedence over more detrimental and all inclusive harvest methods, such as clear-cutting and high-grading.

Integrated pest management techniques that employ the least chemically-intensive approach to controlling pests will reduce the potential for those chemicals and pollutants to be carried off the land by runoff.

Post-harvest site management is planning for erosion control measures to be employed after the harvest. These may include replanting or reseeding the area, installing erosion control devices, and follow-up tree pruning and site management.

Development Practices

Land ordinances can be tailored to protect water resources. One of the biggest development impacts on water resources is developing in floodplain areas. Even small-scale development along a floodplain can reduce its effectiveness at dissipating floodwaters. Removing riparian vegetation can also increase the

streambank erosion, causing stream widening and a buildup of sediment on the stream bottom. Effective land ordinances restrict building in these and other sensitive areas, or allow building if certain requirements are met (Klapproth & Johnson, 2000).

Stormwater runoff is another issue that should be adequately addressed in ordinances. During storm events, large amounts of water run off paved surfaces and other impervious areas, rapidly increasing the amount of pollution and water entering streams. Some of these issues can be avoided by preventing

Table 3-4. Development and Stormwater Best Management Practices

Construction BMPs

Land grading to reduce slope steepness and control runoff
Preserving natural vegetation reduces establishment time and control runoff
Stabilizing entrances keeps dirt from construction vehicles on site
Riprap slows runoff velocity and stabilizes ditches
Check dams slow the velocity of runoff in channels like speed bumps to control erosion
Filter berms are temporary ridges of materials used to slow or divert runoff
Grass-lined channels slow runoff, reducing erosion and allowing water to absorb into the ground
Mulching is the placement of materials, such as hay, seed, or wood chips, on exposed soil to temporarily control erosion
Seeding, often combined with mulching, will establish vegetation on disturbed soils to control erosion
Sodding is the placement of established vegetation mats on soil that will root and bind to the soil
Geotextiles are porous fabrics that can be used for a variety of purposes
Gradient terraces are level terraces on a hillside that slow water flow to control erosion
Dikes may be constructed along the perimeter of a site to confine sediment to that area
Brush barriers utilize debris, such as stems, rocks, and brush, to create a perimeter or barrier
Silt fences are fabric barriers that trap sediment
Sediment basins and rock dams capture runoff and allow sediment to settle out

General Construction BMPs

Dust control is utilized to control wind erosion of soil particles
Temporary slope drains funnel runoff through a conduit rather than allowing it to flow over soil
Temporary steam crossing are stabilized crossing to minimize traffic impacts to streams
Vegetated buffers filter pollutants and sediment from runoff from construction sites

Post-Construction BMPs

Dry detention ponds hold small amounts of runoff from isolated storm events causing them to be dry for extended periods; they allow sediments to settle and water absorption into the ground
Wet ponds retain water for longer periods of time and serve the same purpose as dry ponds
Infiltration basin is a small impoundment used to allow water to soak into the ground
Porous pavement is created by mixing material with larger particles to create pores to allow water penetration through the pavement
Alternative pavers are semi-permeable pavement blocks, used in conjunction with porous material in between each paver block, allows increase water infiltration
Bioretention areas are vegetated areas that increase stormwater retention and filtration; examples include vegetated medians, islands, and parking lot perimeters and rain gardens
Swales are vegetated channels to manage stormwater
On-lot treatment of runoff typically refers to stormwater management practices applied at residential homes and lots; there a variety of mechanisms to achieve runoff interception and treatment, including green (vegetated) roofs, rain gardens, vegetated swales, and rain barrels to collect runoff

certain types of building in sensitive areas and encouraging building options that allow rainwater to percolate into soils.

The elimination and draining of wetlands for development can exacerbate flooding occurrences and severity, reduce a watershed's filtering capacity, and lead to increased sedimentation in streams. Stream channelization, another root cause of increased erosion, sedimentation, and flooding, is sometimes utilized during construction practices.

The main objectives of construction BMPs or stormwater BMPs are to control runoff to reduce flooding, minimize erosion, and provide filters to remove pollutants and sediments from runoff. Numerous construction and stormwater BMPs can be employed at large and small developments, residential settings, road construction, and many other types of development sites to achieve water resource protection. Table 3-4 is a partial list of the practices that can be employed on site to control better control and manage stormwater and runoff. More detailed descriptions and additional BMP examples can be found at the Stormwater Authority website at: http://www.stormwaterauthority.org/bmp/bmp_presentation.aspx.

Road Maintenance

Municipal and state road maintenance can impact waterways by contributing chemical pollutants, as well as sediments and minerals to area waterways. Residual materials left from the use of salt and cinder to improve safety during winter conditions may be pushed into storm drains or directly dumped into streams and wetlands during winter maintenance activity. This practice may have a direct, negative impact on fisheries and water quality. In addition, excess salt, cinder, and other related debris may be removed from roadways, including bridges that span the waterways, by washing the materials into stormwater drains and over the sides of bridges. Municipalities and Pennsylvania Department of Transportation (PennDOT) road maintenance crews should be encouraged to utilize dry sweeping methods of debris removal to avoid contaminating waterways.

Dirt and gravel roads are prevalent throughout the Sinnemahoning watershed. Runoff from these roads often causes erosion and sediment pollution in local waterways. The Penn State University's Thomas D. Larson Pennsylvania Transportation Institute houses the Center for Dirt and Gravel Road Studies and the Dirt and Gravel Road Maintenance Program, which is administered at the local level by county conservation districts. The Center's purpose is to provide education, training, and technical assistance to municipalities and other road maintenance professionals to improve roads that in disrepair, especially those contributing to sedimentation of streams. Funding for **Environmentally Sensitive Maintenance (ESM)** practices comes from the PA State Conservation Commission and PA Bureau of Forestry to improve rural, dirt and gravel roads. ESM practices are essentially the same as BMPs.

These ESM practices result in decreased runoff, erosion, and sedimentation, as well as decreased long-term maintenance costs (Center for Dirt and Gravel Road Studies). In addition to the following examples of ESM practices for dirt and gravel road repair, numerous other surface drains and maintenance techniques are described on the Center's website at: http://www.dirtandgravelroads.org/.

Pipes or culverts convey water under a road to maintain the natural flow pattern of a stream, while reducing runoff and stabilizing the roadway; they can also be used to move ditch flow away from the road to reduce erosion.

"Through-the-bank" pipes serve the same purpose of directing flow, but in this case runoff is piped from the road through an adjacent bank to a vegetated release area.

Headwalls and endwalls are stabilized walls to funnel water into a pipe or to control outflow. These walls reduce erosion surrounding the pipe and prevent water from redirecting around the pipe.

Sub-surface drainage techniques are used to add support to the roadway and allow water to drain through more easily, as well as allow the water to be slowly released, rather than being concentrated in a ditch.

Ditch flow redirection funnels water to a vegetated buffer area, rather than releasing it directly to a stream, to allow groundwater recharge and to let sediment and pollution to be filtered out.

High-water bypass is a subsurface drainage area on a low, flat section of the road where high flows may pass over the surface of the road to reduce damages overall.

Driving Surface Aggregate (DSA) is a road surfacing material composed of varying sized particles that lock tightly together, yet provide water infiltration, dust reduction, and decreased erosion. In addition to the environmental benefits provided by DSA, it requires less maintenance than a tradition dirt and gravel road, and it retains its structural integrity longer.

Bank benches, much like terraced hillsides, are vegetated steps in an embankment that slow runoff.

The Dirt and Gravel Road Program funding is administered at the local level by county conservation districts. Of the six counties of the Sinnemahoning watershed, Potter County received the most funding for dirt and gravel roads improvement of the 2009–2010 county allocations. In fact, Potter County received the sixth largest allocation throughout the state, with $132, 361 (Center for Dirt and Gravel Road Studies). See Table 3-5 for more information on the amount of each county's allocation.

Table 3-5. Sinnemahoning Dirt and Gravel Road County Allocations 2009–2010

County	2009–2010 Allocation	Percentage of Overall Funding	Rank Among All Counties
Potter	$132,361	3.75%	6th
Clearfield	$66,577	1.89%	17th
Cameron	$33,094	0.94%	32nd
Elk	$24,025	0.68%	43rd
Clinton	$22,747	0.64%	45th
McKean	$21,129	0.60%	47th

Impaired Waterbodies

In order to satisfy the requirements of the Clean Water Act, states must report to EPA every two years on the status of its waterways and provide a list of waterways not meeting water quality standards. Water quality standards are a combination of the designated use for a particular waterbody and the water quality criteria to protect that use. Typically, states report on the status of all assessed waterbodies, and this list is referred to as the Integrated Waterbody List (Pennsylvania). Streams are assigned to one of five categories based on their status on this list and states are required to develop a Total Maximum Daily Load (TMDL) for streams in Category 5. These streams include those that are not meeting their designated uses, excluding those where point source pollution controls may alleviate the problem.

Total Maximum Daily Load

All waterways are classified with a designated use; those that do not attain this use are considered to be impaired and must have a TMDL study conducted. The study is performed to determine the maximum amount of pollution that a waterbody can handle, while meeting certain safe water quality standards. The

subsequent report on the study identifies objectives and methods to restore and maintain good water quality. The targeted pollutant reduction is the difference between the maximum pollution a waterway can tolerate and its existing amount of pollution.

Over 118 miles of waterways within the project area have been identified on the 2008 Pennsylvania Impaired Waterbody List. A complete listing of these 52 is available in Appendix H. To date, five TMDL studies have been completed for West Creek, Dents Run, Spring Run, Trout Run, and Bennett Branch.

Bennett Branch Sinnemahoning Creek Watershed TMDL (DEP, 2008a) addresses metals and pH impairments resulting from drainage of abandoned mines in three segments of the watershed. While there are no active mining operations in the study area, the TMDL report does account for the potential inclusion of a future active mining operation in addition to the present wastewater treatment facility of Jay Township. Historic mining operations and coal refuse have led to the metals and pH impairments of the watershed. Efforts are underway to correct these impairments through the installment of a major active treatment facility in Hollywood.

Dents Run Watershed TMDL (DEP, 2005a) addresses impairments to 22 stream segments caused by high levels of metals and decreased pH resulting from AMD. Abandoned mine land reclamation and passive AMD treatment systems have been utilized to correct these impairments. These efforts are ongoing and anticipated to continue through the cooperation of state agencies and the Bennett Branch Watershed Association.

Spring Run Watershed TMDL (DEP, 2007b) addresses AMD impairments resulting in high levels of metals and low pH affecting Spring Run, Stony Brook, and several unnamed tributaries. At the time of the study, there was one active mining operation in the area, but the majority of the impacts were due to discharge from abandoned mines.

UNT 24679 to Trout Run TMDL (DEP, 2004) addresses high metals and low pH resulting from AMD impairments to this watershed. Several projects to passively treat AMD, reclaim abandoned mine lands and refuse piles, and to seal mine openings have been completed throughout the area.

West Creek Watershed TMDL (DEP, 2007c) addresses impairments caused by high levels of metals and low pH from AMD from past mining operations, spoil piles, and a railbed composed of mine spoil materials.

Water Quality Trading

Water quality trading is applied when facilities with higher pollution control costs, called “buyers” purchase the right to pollute from “sellers”, or other companies that have reduced their pollution output below their required limits. This enables polluters to reduce pollution at a lower cost than making reductions at their facilities. For instance, it may be cheaper for a polluter that discharges nitrates to buy credits from a polluter that can reduce its nitrate discharges more easily. Or, it may be cheaper for a polluter to pay for the installation of BMPs on a farm than to develop technologies to reduce pollution from nitrates. If the same pollution reduction goal can be achieved through trading, then it is a benefit to both the company and the farmer.

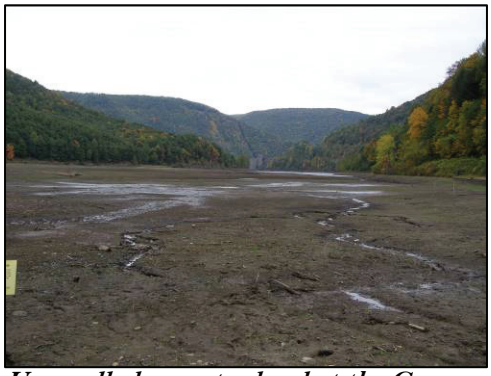
Generally, certain criteria must be met for a water quality trading program to work. There must be a “driver” or reason why pollution reductions are being sought. This is usually a TMDL, which requires point-source polluters to reduce their level of pollution by a certain amount in order to meet water quality standards. Water quality trading is most effective if there are different costs to control pollution within a watershed, making it more economically profitable to trade. Also, the levels of pollution must be such

that not all sources must reduce their inputs. This provides a reason to bargain. Finally, watershed stakeholders and state regulatory agencies must be willing to try an innovative approach and engage in trading design and implementation. Water quality trading should be conducted within a legal, regulatory framework, such as the NPDES Program, which requires point-source polluters to obtain permits to discharge pollution in waterways of the U.S.

If nonpoint source pollution is present, a company could potentially pay for the implementation of BMPs in exchange for polluting over its target limit. All water trading activities must comply with the requirements of the Clean Water Act, as well as state and local requirements, including public notification of transfers of trading credits. One potential problem with water quality trading is localized impacts. For example, all of the credits purchased may discharge into the same small stream. Because of these possible complications, it is important that the trading program be designed so that localized impacts do not occur. For instance, the amount of credits that can be purchased by certain polluters can be set by the regulatory agency. Water quality trading is usually most successful in developed areas, and it is unclear whether such mechanisms would be effective in the project area.

Water Quantity

Groundwater recharge plays a major role in the availability of water for human consumptive uses. Groundwater recharge is the amount of water that has permeated the ground during periods of precipitation and replenished groundwater supplies. During periods of drought, more water is being withdrawn and used than can be recharged into the ground. Some areas in Pennsylvania and across the U.S. withdraw more water than can be recharged on a regular basis. In these areas, water quantity, in addition to water quality, becomes an extremely important issue.



Unusually low water level at the George B. Stevenson Dam reservoir at Sinnemahoning State Park in the fall of 2008

Water is withdrawn from both surface and groundwater sources. Many public water suppliers utilize groundwater or surface water from local waterways, and treat it to ensure that it meets safety standards for drinking water. In many rural and suburban areas, public water systems are not available, and residents depend upon private wells and springs.

Due to the rural location of the project area, the majority of residents rely on private wells and springs for their water needs. Public water suppliers are available in some of the more populated areas of the watershed, such as Emporium and Saint Marys.

When groundwater is utilized, a well is drilled into the **aquifer**—an underground area containing groundwater. There are two kinds of aquifers—confined and unconfined. In a **confined aquifer**, groundwater is under pressure because there is a layer of impermeable or nearly impermeable rock above it to confine the groundwater. When a well is drilled into a confined aquifer, pressure forces the water up the borehole. These are commonly referred to as artesian wells, and some receive so much pressure that they flow without being pumped. **Unconfined aquifers** do not have a layer of low permeability rock above them to restrict flow and create pressure. Wells established in unconfined aquifers must be pumped (Fleeger, 1999).

Pennsylvania State Water Plan

In 2008, an updated draft of the Pennsylvania State Water Plan was unveiled, providing a vision to sustain water supply with goals and recommendations. The plan includes an inventory of water

availability, an assessment of current and future water use demands and trends, and an assessment of resource management alternatives and proposed methods of implementation. It also provides an analysis of problems and needs associated with specific water resource uses, such as navigation, stormwater management, and flood control (DEP, 2008d).

In the updated Pennsylvania State Water Plan, information is broken down into six watershed regions—Ohio River, Great Lakes, Potomac River, Delaware River, upper/middle Susquehanna River, and lower Susquehanna River. The Sinnemahoning Creek project area is located within the upper/middle Susquehanna region.

Water Use

In 2000, it was estimated that Pennsylvania withdrew 9,950 million gallons of water per day. Of the water withdrawn, 93 percent came from surface waters. Table 3-6 shows water withdrawal trends in Pennsylvania from 1990 to 2000 (Hutson, et al., 2004).

Table 3-6. Water Use

	Groundwater			Surface			Total		
Year	Fresh	Saline	Total	Fresh	Saline	Total	Fresh	Saline	Total
1990	1,020	0	1,020	8,810	0	8,810	9,830	0	9,830
1995	860	0	860	8,820	0	8,820	9,680	0	9,680
2000	666	0	666	9,290	0	9,290	9,950	0	9,950

All values are in millions of gallons per day

(***Sources*: *Solley, Pierce, & Perlman, 1993 & 1998; Hutson, et al., 2004***)

It was estimated that the largest water withdrawals in the U.S. in 2000 were used for thermoelectric power—48 percent—and irrigation—34 percent. Public water supply utilized 11 percent, while the remaining seven percent was utilized for industrial, mining, livestock, and aquaculture purposes (Huston, et al., 2004).

Within the entire Susquehanna River Basin, approximately 500 million gallons of water per day (Mgal/day) are withdrawn for consumptive uses. Of that, approximately 200 Mgal/day are utilized for public water supply, 130 Mgal/day for thermoelectric generating plants, 120 Mgal/day for agriculture, and 30 Mgal/day for industries. Hospitals, prisons, institutions, and golf courses account for approximately 60 Mgal/day of consumptive water uses (DEP, 2008d).

The majority of the water withdrawn from the upper/middle Susquehanna region of Pennsylvania was utilized for thermoelectric, public water supply, and industry uses, respectively. It was estimated that 71 percent of water was used for utilities and thermoelectric plants, while 19 percent was utilized by public water suppliers, and six percent was used for industry. The remaining four percent was comprised of mining, commercial, and agricultural uses (DEP, 2008d).

Thermoelectric generating power plants and public water suppliers are mandated to register water withdrawls through DEP. In addition, any industry that withdraws more than 10,000 gallons per day must also register. No additional industries have met that requirement within the upper West Branch Susquehanna River, which includes the headwaters of the West Branch Susquehanna River to the point where Sinnemahoning Creek drains into it; and 97 percent of the registered water withdrawn from this region is used for thermoelectric plants and three percent is used by public water suppliers (DEP, 2008d).

Water withdraw associated with gas well drilling is another major concern throughout the region. Depending on the type of natural gas exploration, different amounts of water are required to fracture the bedrock surrounding the formation to release the gas. Marcellus shale gas formations require millions of gallons for well fracking water, which results in waste brine water that contains salt and other pollutants. Often, this water must be disposed of with a water treatment facility offsite, thereby removing it from the watershed. With limited regulatory and monitoring resources, there may be violations that include illegal disposal of untreated water into local waterways, illegal water withdraws, and increased pressure on small water treatment facilities.

Flooding and Drought

In addition to water withdraw, flooding and drought are major concerns related to water quantity. In fact, the Susquehanna River is one of the nation's most flood-prone regions. In response to flooding throughout the region, the Susquehanna River Basin Commission (SRBC) and other state and federal agencies developed a network of dams and reservoirs to control flooding, as well as a the Susquehanna Flood Forecast and Warning System to warn communities of flooding potential due to weather conditions. The George B. Stevenson Dam at Sinnemahoning State Park is one of the flood control structures in the Susquehanna River basin network. Its primary function is to offer flood protection, but secondarily it offers recreational resources to the region.

Concerns have been raised by local residents and business owners regarding the management of water levels in the reservoir behind the dam. Several community members feel that the dam should be controlled by a trained professional dam tender to better maintain consistent water levels in the reservoir for the benefit and safety of the public. In the summer of 2008, water levels at the reservoir dropped so severely that much of the lake bottom was exposed. While state agency personnel investigated the cause of the severe drawdown, they also took advantage of the opportunity to install fish habitat structures in the reservoir area. Current drought information can be obtained from the DEP Bureau of Watershed Management website: http://www.depweb.state.pa.us/watershedmgmt.

Watershed Protection Laws

Clean Water Act

The 1977 amendments to the federal Water Pollution Control Act became known as the Clean Water Act (CWA). This act establishes the basic structure for regulating discharges of pollution into waterbodies of the United States. The CWA gives the United States Environmental Protection Agency (EPA) the authority to regulate pollution discharges and set water quality standards. It also makes it unlawful for any person to discharge pollution from a "point source" into navigable waters without a permit. The CWA funds construction of sewage treatment plants and recognizes the need for planning to address "non-point source" pollution problems, as well (Elder, et al., 1999).

NPDES Permits

One of the ways that the CWA is executed is through the NPDES, whereby DEP issues permits for point source discharges. DEP and local conservation districts are responsible for issuing point source permits to industrial operations, municipal wastewater treatment plants, concentrated animal feeding operations, and households. A list of current permits can be found in Appendix F.

In Pennsylvania, an earth disturbance activity from one to five acres requires an NPDES permit if a point source exists at the site. Any disturbance over five acres requires a permit regardless of whether or not there is a direct point source to a waterway. Farmers do not need to obtain an NPDES permit unless the farm meets the criteria to be considered a concentrated animal feeding operation (CAFO). However, they must complete a conservation plan. Timber operations fewer than 25 acres are also exempt from

NPDES permits, but must complete Erosion and Sediment Control Plans. Active NPDES permits may be found at the EPA Envirofacts website (http://www.epa.gov/enviro/index.html).

Nutrient Management Program

The Pennsylvania State Conservation Commission, formed through the Pennsylvania Nutrient and Odor Management Act (NOMA), administers the Pennsylvania Nutrient Management Program (PNMP). The program is controlled by the commission and county conservation districts with approved delegated authority. Concentrated Animal Operations are required to participate in the program, as well as any operation that wishes to gain liability protection under the act, or has received financial assistance through NOMA for BMP installation. In addition, any agricultural operation in violation of the Pennsylvania Clean Streams Law may be required to submit a nutrient management plan that meets NOMA requirements (PNMP).

Farmers participating in NOMA must develop and implement approved nutrient management plans. Nutrient management planning is a series of BMPs designed to reduce nutrient pollution by balancing nutrient inputs with nutrient requirements. Plans must be developed by a certified Pennsylvania Department of Agriculture (PDA) Nutrient Management Specialist. The intent of NOMA is to address water quality issues from such activities as animal number and density, nutrient losses from manure storage and handling areas, nutrient runoff from animal concentrated areas, and manure fertilization. Questions about the program should be directed to the appropriate county conservation district. Financial and technical assistance is available (PNMP).

Pennsylvania Sewage Facilities Act

Sewage is a major cause of pollution in western Pennsylvania streams. Sewage pollution can come from municipal and non-municipal sewage treatment plants, as well as from private septic systems. This pollution can occur from plants that have inadequate capacity due to population growth or poor design and private systems that are not properly built or maintained. In some cases, both sewage waste and stormwater enter a municipal system through the same infrastructure, and the plant is not capable of handling all of this waste at once. The overflow waste deposited directly into the stream is called a combined sewage overflow (CSO) event.

The main type of pollution entering streams from sewage treatment plants and septic systems is inorganic and organic nutrients, sediment, and bacteria. Nutrients can lead to excessive plant growth, which depletes the oxygen levels of streams. Sediment is responsible for clogging the gills of aquatic organisms and affecting in-stream hydrology and habitat. Bacteria can be harmful, and sometimes fatal, to both stream life and humans.

Stream impacts caused by AMD can sometimes mask the effects of other pollutants, such as septic systems and agricultural runoff. In fact, these other pollutants can add pH and alkalinity to a stream, canceling some of the harmful effects of acidic mine drainage. Many streams in the watershed have a HQ or EV designation, which put limitations on the types of pollutants that may be permitted to enter a stream. Sewage pollution can have a significant negative impact on stream ecosystems and can affect the use of the stream for recreation and water supply. Six sewage treatment plants have permits to discharge treated wastewater to local streams. Depending on the age, condition, infrastructure, capacity of the system, and treatment methods used, the amount of waste matter entering streams from each of these plants may vary greatly.

Sewage treatment systems can affect groundwater storage quantity depending on the source of the water supply used for sewage disposal. If water entering a sewage treatment plant was obtained from sources of public water derived from wells, and thus groundwater, the water budget for that source will decrease, because the treated water is typically discharged to a surface body of water. Conversely, private

on-lot septic systems return treated water to the groundwater storage area, and therefore don't disrupt the natural hydrologic budget.

The Pennsylvania Sewage Facilities Act (Act 537) was enacted in 1966 to repair existing sewage disposal problems and to inhibit future problems. Defective sewage disposal systems can create a grave hazard to public health and the environment. They pose a risk of pollution to public and private drinking water sources, as they frequently can be directly discharged into the groundwater, and can expose various bacteria, viruses and parasites to humans and animals. The contaminated groundwater also pollutes surface water supplies as it discharges into those streams and reservoirs.

The major provisions of Act 537 are (DEP[1]):

1. All municipalities must develop and implement an official sewage plan that addresses their present and future sewage disposal needs.

2. Local agencies are required to employ both primary and alternate Sewage Enforcement Officers (SEO), who are responsible for implementing the daily operation of that agency's onlot disposal systems (OLDS) permitting program.

3. Local agencies, through their SEO, approve or deny permits for construction of onlot sewage disposal systems prior to installation.

4. DEP provides grants and reimbursements to municipalities and local agencies for costs associated with the Act 537 planning and permitting programs.

5. An Environmental Quality Board (EQB) must adopt regulations establishing standards for sewage disposal facilities.

6. A Sewage Advisory Committee (SAC) reviews existing and proposed rules, regulations, standards, and procedures, and then advises the Secretary of the DEP.

Abandoned Mine Drainage Legislation

The Federal Surface Mining Control and Reclamation Act (SMCRA) of 1977 established mandatory uniform standards for coal mining activities on state and federal lands, including environmental performance protection standards to reduce adverse effects of fish, wildlife, and other environmental values. An important component of this legislation is that mining companies are required to conduct remediation efforts for environmental degradation caused after the Act's passage (mine discharges, coal refuse, etc.) It gives companies an incentive to reduce environmental impacts in order to avoid the high costs of remediation. The Act also created the Abandoned Mine Reclamation (AMR) fund to help pay for the clean up of mine lands abandoned before 1977, which are not covered by the new standards and regulations (Environmental Literacy Council, 2002).

This Act, along with the Clean Water Act, has important implications for mining activities throughout Pennsylvania. Future mining activities in the Sinnemahoning watershed must comply with SMCRA, as well as the anti-degradation component of the Clean Water Act (Environmental Literacy Council, 2002).