

Mill Creek Watershed

WESTMORELAND COUNTY PENNSYLVANIA



Conservation Plan

*Prepared By The Forbes Trail Chapter Of Trout Unlimited
Funded By A Grant From The Coldwater Heritage Partnership*

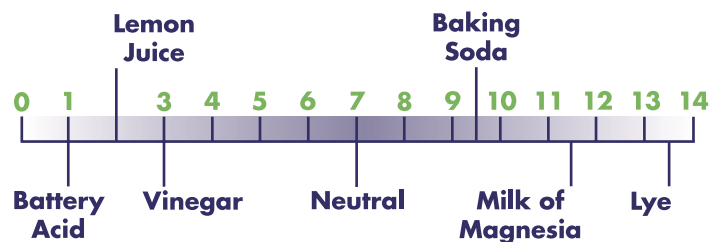


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EXPLAINING pH

pH stands for *potential of hydrogen* and is a measurement used to show the acidity of a solution. The pH scale ranges from 0 to 14 with 7 being neutral. Lower numbers indicate acidity, and higher numbers indicate alkalinity. A pH of 7 is considered ideal for aquatic life. Rain water averages a pH of 5.6, made slightly acidic from the carbon dioxide naturally present in the atmosphere. Rainfall in Pennsylvania, however, averages a 4.1 pH, made more acidic by chemicals put into the atmosphere from the burning of fossil fuels. Although the brook trout is considered to be somewhat acid tolerant, a pH of less than 4.5 is too acidic for most organisms to survive.



ABOUT FTTU

Trout Unlimited is a national organization dedicated to conserving, protecting, and restoring wild trout habitat. The Forbes Trail Chapter was founded in 1969 and was awarded Trout Unlimited's national Golden Trout award in 1977 for the chapter's work on Loyalhanna Creek. The chapter was also the recipient of the Westmoreland County Conservation Club of the Year Award in 2003. FTTU has worked the past several years on habitat improvement and acid mitigation on Linn Run and its tributaries.

In addition to coldwater conservation, FTTU's goal is to be a positive force in the community through our youth club, our partnership with the *Outside In* organization, and through our work to conserve, protect, and restore our regions natural resources.



FTTU volunteers at work on Linn Run

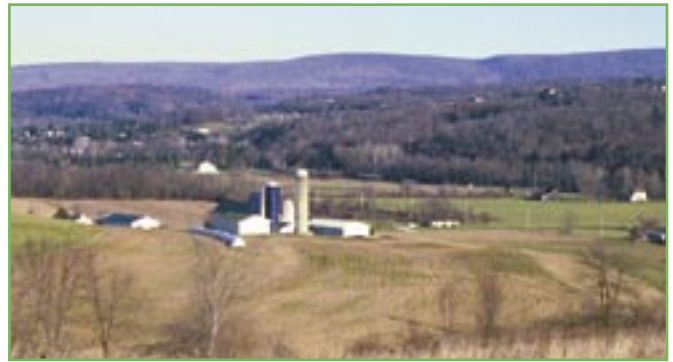
INTRODUCTION

This Mill Creek Watershed Conservation Plan was made possible by a Coldwater Heritage Partnership (CHP) grant that was awarded to Forbes Trail Trout Unlimited (FTTU). By applying for and receiving CHP funding, FTTU enabled itself to take a detailed look at Mill Creek and all of its tributaries. The objective was to create a detailed plan to protect current water quality while working to restore any problem areas we encountered. Through a cooperative effort, members and volunteers were trained in visual stream assessment in the spring of 2004 by Ben Wright of the Western Pennsylvania Conservancy. In the following months, trained volunteers walked the entire watershed, noting impairments in channel condition, riparian zone, canopy, sedimentation, fish cover, macroinvertebrate habitat, and pH of the stream and its tributaries. Information was collected and compiled to help formulate this booklet.

If you live or work within the Mill Creek watershed or visit its valley to fish, hunt, or camp, you are a person who uses and appreciates what it has to offer. The headwaters of Mill Creek are among some of the finest in the state of Pennsylvania. The Middle and South Forks of this watershed are listed as Exceptional Value (EV). The North Fork is listed as a High Quality Cold

Water Fishery (HQCWF). Wildlife is abundant in this area. Deer, black bear, wild turkey and grouse are just a few of the game animals you may encounter.

The entire Mill Creek watershed lies within Westmoreland County. It drains an area of 33.10 square miles. From its pristine beginnings, including all of its tributaries, to where it meets the Loyalhanna Creek, it flows a span of 51.6 miles. During its journey, the stream undergoes many changes, primarily due to its encounter with civilization. Remarkably, the stream remains a viable fishery throughout nearly its entire length. With proper land practices and through education, we hope to encourage responsible stewardship and land protection that will help to improve the Mill Creek watershed's water quality, habitat and aquatic life.



Mill Creek flows through a valley between Chestnut and Laurel Ridges.

GOALS AND OBJECTIVES

On May 3rd, 2004 Forbes Trail Trout Unlimited held its first public meeting, which is a requirement of the CHP grant. At this meeting those in attendance were asked to compile a list of problems that needed to be addressed on Mill Creek. They were also asked to list sections of the stream that are worth protecting.

PROBLEMS TO ADDRESS

- **Timbering practices in the headwaters**
- **Bank erosion**
- **Failing septic systems**
- **Educating landowners on proper stewardship and land practices**
- **Acid mine drainage**

WHAT'S WORTH PROTECTING

- **Stream upgrade for the North Branch (from HQCF to EV)**
- **Confluence with Hanna's Run**
- **Mill Road section through Waterford**
- **McKelvey Road section**
- **The athletic fields section**
- **The entire watershed**

MILL CREEK: ITS ORIGIN

What makes the Mill Creek watershed so unique is that very few streams in western Pennsylvania have such pure beginnings. As mentioned in the introduction, the Pennsylvania Department of Environmental Protection (DEP) designates all three branches that make up the headwaters of Mill Creek as either Exceptional Value (EV) or High Quality (HQ), the highest designations a stream can receive in the state of Pennsylvania. These three tributaries tumble over boulders and rock outcroppings into deep pools as they flow through a mix of state-owned and private lands. These lands consist of hardwood forests that provide shade and help keep these waters cold. The streams harbor populations of reproducing native brook trout, and also supply drinking water for the residents of Ligonier Township. Mill Creek is one of the last remaining high quality recreational resources in the Ligonier Valley. All of those who reside in this watershed are stakeholders in its future, and need to do their share to protect and preserve this wonderful stream.



Mill Creek starts as a small trickle high on Laurel Mountain.



The cold waters of the North Branch in winter.

The Headwaters: North Branch

The North Branch of Mill Creek flows west off Laurel Mountain. Its entire length flows through private property in a wooded ravine of primarily hemlock and other hardwood trees. The Ligonier Township Sportsmen's Club, however, leases some of the stream. It parallels Route 271 south, but cannot be seen from the road. The North Branch is listed as a HQCWF.

During our assessment the North Branch was rated as "Excellent".

Several tributaries enter into the North Branch below the Ligonier Township Sportsmen's access area (the Singer Property). The first tributary, entering from the south, is unnamed. It had noticeable iron deposits in and along the banks, and had a pH reading of 4.3. A short distance downstream, Hess Run enters into the North Branch from the north. This small tributary originates and flows through the only developed area, known as Ligonier East. It then crosses Route 271 and begins its drop into the North Branch hollow. The rest of the stream flows through a series of private lands that are forested and well protected. The North Branch helps form the mainstem of Mill Creek when it meets the Middle and South Branches of Mill Creek at the Robinson Property. The confluence of these branches is known as "Three Forks."



Logging to the stream's edge exposes the water to the heat of the sun, allows siltation and destabilizes the stream banks.

The Headwaters: The Middle Branch

The largest and perhaps the most remote of the three headwater streams, the Middle Branch flows west off Laurel Summit. Its right fork begins its flow out of Sugar Camp Hollow. It then flows to meet the left fork to form the mainstem of the Middle Branch.

The Middle Branch is designated as EV. During the assessment of this tributary, a less than desirable timbering practice was found on the left fork. There is a long stretch of the stream (approximately a quarter mile) where the canopy protecting the left fork was clear-cut on both sides of the stream. The stream was congested with treetops and debris. Little protection was in place to prevent silt from entering the stream from logging roads.

After investigating, it was found the land now belongs to the Pennsylvania Game Commission through a series of land transactions. The timbering rights were preserved throughout these transfers by the landowners, and protecting the stream's canopy and water quality were not addressed. On the positive side, this land has now become State Game Lands and these scars will heal along with the impairments that have occurred. The bad news is that a full mature canopy will not be present for 20 to 30 years. Hopefully, small brush, such as green briars and raspberry, along with fern and moss lining the stream, will help to protect and provide shade and cover to this jewel of a stream. Through this investigation it was found that the timbering industry in our state has little restrictions concerning a stream's riparian zone. Cutting can occur right to a stream's edge. It is the opinion of those doing the assessment, and

FTTU, that some form of stream protection should be in place for the timbering industry, particularly along streams designated as HQ or EV. Without protection, the designation provides little meaning.

The Headwaters: The South Branch

The South Fork of Mill Creek begins its journey in an isolated mountain forest and flows 3.5 miles northwest to its mouth at "Three Forks." Along the way, it flows through a lush forest, is impounded to form the Ligonier Municipal Authority Reservoir, and finally, with its volume swelled by runoff and springs, adds its contribution of clean water to the North Fork and Middle Branch to form the mainstem of Mill Creek.

South Fork's humble beginnings are as a small trickle in a steep hollow on the western slope of Laurel Mountain in State Game Lands #42. This small stream flows over rocks and boulders through a rugged terrain thick with trees, ferns and moss-covered fallen logs. Gathering runoff from the steep hillsides above and additional waters from springs below, South Fork's size gradually increases as it flows through a mature forest of tall hemlocks and broad leaf trees two miles to the border of the State Game Lands. In this section, South Fork averages about six to eight feet in width and its bed is made up of clean cobblestone and gravel with a few large boulders mixed in. There is little siltation, and an informal survey during assessment showed the stream bed to be rich in aquatic insect life. The banks are stable and there is little to no evidence of erosion. Even when observed after an all-day rain, South Fork ran crystal clear, in spite of a dirt and gravel road that runs parallel to the stream in a part of this section.

Although it flows down the side of Laurel Mountain, the gradient of South Fork is not particularly steep. The stream tumbles over boulders and races through fast riffles, but slows in places to form deeper runs and pools important for fish habitat. The character of the stream here is a good mix of oxygen-generating riffles and fish-sheltering pools.

Overall, this section of South Fork could be called a textbook mountain trout stream: clear, cool waters flowing over a clean streambed through a beautiful forest setting. Large trees spreading limbs above shade the stream from the summer sun while their roots below reach out and hold the stream's banks secure, keeping them from washing away with the next storm. The wild brook trout inhabiting South Fork are right at home here with the whitetail deer, mountain laurel, and ruffed grouse that share their mountain habitat. No improvements are needed here, just continued protection of this special place.

Upon leaving State Game Lands #42, South Fork continues a short distance through forest until the tree cover suddenly gives way to a large clearing where the stream has been impounded to form the Ligonier Municipal Authority Reservoir, an important source of clean water for the community. After flowing over the breast of the dam, the waters of South Fork quickly rejoin the forest and it's business as usual for the little mountain stream.

Because South Fork has no tributaries to speak of, its size downstream of the reservoir has grown from the State Game Lands section, largely from water



Wild brook trout are residents of Mill Creek's headwaters.

collected from runoff and springs. The stream here has the same characteristics of the stream above the reservoir: a sequence of riffles and pools, tree cover and solid banks, and a clean streambed. Near the end of this 1.5-mile stretch, South Fork meets up with human habitation for the first time as it flows past a few cottages before meeting the Middle and North Branches.

South Fork, downstream of the State Game Lands, does encounter some problems. The reservoir is a large open area, which slows the stream flow and exposes South Fork's waters to the heat of the sun. Some selective logging was noted in this area and includes some trees cut right on the stream banks. Homemade dams, while providing fish habitat, also collect silt and act as barriers to fish movement.

Numerous pH readings were taken on all sections of South Fork. They all ranged from 7.6 to 8.0, indicating the soil and geology of the area is effective at removing acidity from precipitation collected on the slope of Laurel Mountain. The one exception noted is a small, unnamed tributary that registered a reading of 4.0. With the mouth of this small tributary coming directly into the reservoir, the negative impact on South Fork is minimized.

Although not as pristine as the State Game Lands section, the lower section of South Fork still exhibits many desirable traits and is a viable wild trout stream worthy of protection and care.



South Fork flows into the Ligonier Reservoir.

MILL CREEK MAIN STEM

Mill Road Through Waterford

The mainstem of Mill Creek, commonly known as “Three Forks,” begins on private land above the small village of Waterford. It is here where the North, South and Middle Branches meet. The stream passes under the iron bridge on Mill Road, follows this road, and then cuts away to flow along Trout Avenue to the Route 271 Bridge. This area is primarily residential. A large stone wall built many years ago, and large hemlocks, rhododendron, maples and oaks, create stability and a good canopy to help shade the stream and keep it cool. Our visual assessment showed that the stream has a good pool-to-riffle ratio with a boulder cobble bottom. The Pennsylvania Fish and Boat Commission (PAFBC) begins its stocking program from the Mill Road Bridge downstream. However, native brook trout can still be found through this section of the watershed.

After Mill Creek flows under Route 271, it enters the village of Waterford. It is through this section that Mill Creek experiences its first significant impacts. Improper land use is apparent in the area. Landowners, seemingly concerned about erosion and property protection, have removed viable riparian areas. They have removed much of the stone in the streambed and placed them on its banks. This, in turn, speeds up the stream, causing more bank erosion. Some landowners are practicing proper watershed stewardship by leaving a riparian zone and planting trees and low-growing shrubs. Through education and partnerships with landowners, FTTU hopes to encourage and increase this practice along the impacted sections of the Mill Creek watershed. By creating a better riparian zone and a naturally structured streambed, bank erosion and property loss will be reduced through this corridor; and damage downstream will be diminished.

Below Waterford to Route 271 Bridge

As Mill Creek departs Waterford, it passes under the second Route 271 bridge through the lower end of town. It flows behind several residences on Griffith Road. Residences along this section have long backyards, and dwellings are located an acceptable distance from the stream. One noteworthy suggestion for landowners in this area would be to allow the riparian

zones to increase. Because properties are relatively large, sufficient space exists to expand current riparian zones. Once again, through education and partnerships with landowners, FTTU could provide assistance in developing a plan to help inform and encourage landowners to increase the riparian zone in this area. Downstream, on an adjacent section, Mill Creek flows through another small residential area. This area has some outside bank erosion occurring and is lined with thick brush. Though outside bank erosion is normal, landowners in this area have expressed an interest in working with Trout Unlimited to help stabilize the banks and create better fish habitat. FTTU would welcome the possibility of working together with residents in this area to enhance existing habitat, as well as to stabilize current stream bank problems.

From here, we continue downstream where Mill Creek flows through its last acceptable forested area. It is acceptable because, other than in its headwaters, this area is forested and undeveloped. This section of stream flows undisturbed without development or major interference from humans until it meets a large scrap yard near the intersection of Route 271 and Route 711. It then flows under Route 271 for the last time. The portion just described is known as the McKelvey Road section. This road divides the area, and is the only township road that provides access



The North, Middle, and South Branches meet at “Three Forks” to form Mill Creek’s main stem.

for anglers. This area was rated high in the following sections of our visual assessment: good canopy (large trees providing cover and shade), many fine pools (deep areas for fish to find cold water), riffles (moving water to provide oxygen), and pocket water (deep runs with large stones in the stream to provide cover for fish). Development has not yet occurred along this section. Through educating property owners about land conservation options, FTTU seeks to protect and enhance this important section of Mill Creek. This area also has tremendous potential for future habitat enhancement. Log veins and some minor bank stabilization, including deflectors, would help to narrow the stream where needed.

During the assessment, a wide, flat and shallow section was found. Areas such as this one provide little habitat and usually occur when a stream's flow begins to move away from the center of the stream bed. This section would be a good area for deflectors to help narrow the channel and create improved habitat. Deflectors help direct the flow toward the center of the stream. This allows the stream to deepen and narrow itself through time. A narrow, deeper stream helps to keep water colder and provides better habitat for trout and other aquatic species.

FTTU looks forward to conducting outreach in this area, and working with existing and future landowners to promote conservation and habitat enhancement. This section of Mill Creek is one of the more heavily fished sections. It supports a population of wild and stocked trout. Its heavy canopy and deep pools help it to remain cool and provide summer refuge for trout when temperatures on Lower Mill Creek start to warm.



Respect for landowner's property will keep streams open to fishing.



Mill Creek downstream of the McKelvey Bridge.

Intersection of Routes 271 and 711 to the Confluence with Hannas Run

After Mill Creek passes under Route 271, it runs behind the Sheetz convenience store and then turns left to run under Route 711. Here the stream hits large bedrock outcroppings, then flows behind a mobile home court. At this point, it flows almost straight through the small village of Oakgrove. According to our visual assessment, this area has a series of challenges associated with it. First, it is a high traffic area with Sheetz, a scrap yard, a restaurant/bar and a small equipment repair shop all located on two heavily traveled state roads. Local utility companies and PennDOT use the parking lot behind the Sheetz to store heavy equipment. Runoff is the primary pollution concern here due to the large amount of pavement near this section of stream. There is little riparian zone along this section, except for a small portion between an abandoned bridge and the Route 711 Bridge, located behind Sheetz and an old maintenance shed. The challenge will be to create as much of a riparian zone as possible. This would allow runoff from warm pavement in summer months to enter the stream slowly and reduce the thermal impact.

As it flows into Oakgrove, Mill Creek runs between a mix of residences, a bus garage, and the Ligonier Township municipal building. According to our assessment, the riparian zone is in poor condition. Landowners mow near to the bank and there is little canopy. This section of Mill Creek, to the mouth, is primarily a stocked trout fishery; however, during wet, cool summers, it has been known to harbor a holdover trout population. Improvements upstream in canopy cover, extended riparian zones and erosion controls could only help to improve this area and help the fishery.

The most impacted area in this section is the highly eroded bank at the end of Mallard Road. Some large rocks have been placed above this section to protect the road. The erosion, which begins just after this area, would be a high priority for FTTU to repair. This could be accomplished by further extending the stabilization efforts to protect the roadway and by constructing fish habitat devices. Partnering with landowners and other agencies, such as Ligonier Township and the PAFBC, would benefit this area.

Hannas Run enters below the town of Oakgrove. This tributary has a major impact on Mill Creek and will be discussed separately.

Hannas Run To the Iron Bridge on Route 711

If one would follow Mill Creek during a high water event or after a summer thunderstorm, they would find that the stream would flow relatively clear through



Mill Creek flows relatively clear during high water just above the Ann Roberts bridge



The lower section of Mill Creek carries a heavy silt load after a rain storm.

Waterford. Below Waterford, it would be off-color due to Macs Run. However, after the confluence with Hannas Run, Mill Creek often has a brown, muddy color. Hannas Run, probably the most impacted tributary, enters Mill Creek below the town of Oakgrove and deposits a large silt load during these conditions.

After the confluence with Hannas Run, Mill Creek flows perpendicular to Route 711 along a Church Camp property. It flows under Route 711 as it hits a large hillside, then turns and flows parallel with this state road until it once again crosses under Route 711 for the final time at the large iron bridge near Peoples Road. Through this section, our assessment found high siltation and algae growth, apparently due to the high nutrient content and silt deposits from Hannas Run caused by agricultural impacts in the Hannas Run watershed. At the confluence of Mill Creek and Hannas Run, the bank erosion is perhaps the most severe of any area in the entire watershed. Lack of a significant riparian zone, and high banks with soft loamy soil allow for high erosion rates during high water events. Landowners in this area have expressed concerns over a high loss of property. FTTU lists this area as its number one priority because of its need for bank stabilization and habitat improvement.



Some careless individuals see streams as just a convenient place to discard trash and unwanted items.

Iron Bridge to Vincent Street Bridge

As Mill Creek flows under the iron bridge on Route 711 its character changes. It no longer has the look of a trout stream. It begins a serpentine route through bottom lands as it continues its journey toward the town of Ligonier. This area is characterized by high banks that have been severely eroded. There are two large horseshoe bends in this section of stream. In the visual assessment it was found that several large trees have fallen into the stream during flood events. One large tree has diverted the flow of the main channel into a secondary channel. The other has created a collection dike for all types of debris such as tires, styrofoam bait containers and other unsightly items. However, both trees have caused the stream to deepen in the areas where they fell, creating fish cover and habitat. Other areas of this section have grass peninsulas and cobble/gravel mounds along and in the middle of the stream. These slumps of land were once areas of bank that have slid into the stream. During high water events, undercutting causes upper portions of the bank that contain vegetation to slide into the stream. These clumps of earth are moved downstream and placed in the stream as the water recedes, creating small islands.

Mill Creek then flows behind the athletic fields. This area is commonly known as “Black Bridge,” named after an old abandoned railroad bridge. This section is a popular area on the opening day of trout season for the local youth. It is also a convenient illegal dumping ground and is often littered with debris from athletic events, which is why FTTU has rated this area poorly. FTTU has also concluded that access would be very difficult in the upper section (above the athletic and practice fields) due to dense areas lining the stream. The area is also characterized by wetlands, which makes it difficult to move equipment into this area for stream improvement work. Although not impossible, it would take a major effort among FTTU, landowners, and the necessary agencies to improve this area. The athletic field area does offer some access, and stream improvement projects could be a possibility with a partnership among FTTU, landowners, and Ligonier Borough officials. Educating organizations that use the facilities and conducting a simple litter pick-up program several times a year, would help improve the aesthetics of the area.



A section of bank is slowly sliding into the stream forming an island. The flow is moving away from the center of the stream.



An island formed by siltation.

Between the athletic fields and Vincent Street, Mill Creek flows behind residential areas in the lower end of Ligonier. It has some deep pools and riffles with rock outcropping creating some habitat. However, this section is primarily wide and shallow with little cover and habitat, with the exception of some undercut banks and root systems. There is also a limited canopy along the stream until it passes under the Vincent Street Bridge.

Vincent Street To Confluence With Loyalhanna Creek

After passing under Vincent Street, Mill Creek flows through a wide shallow stretch. Our assessment found little habitat other than some undercut banks and tree roots. This section is perhaps the last area that has a good canopy. Once the stream flows under the East Main Street Bridge, it has little shade due to Route 30. From the Main Street Bridge to the mouth of Loyalhanna Creek, Mill Creek has been channelized. The stream is wide and shallow and splits into several channels flowing through and around islands. Small cobble and silt make up the bottom of the stream. The lower end of Ligonier experiences flooding during heavy rain events. The flood of January 1996 flooded the entire lower end of town. Residents often experience basement flooding during high water events.

Dredging and channeling has been a past practice in the section between the West Main Street Bridge and the westbound Route 30 Bridge. PennDOT and



Mill Creek's mouth at Loyalhanna Creek in Ligonier.

borough officials have dredged and widened the area in the name of flood control. Due to development of the watershed upstream, Mill Creek is required to transport more water, flowing at a faster rate, than the stream is able to, causing excess flooding and water backups. One should also note that the lower end of Ligonier rests in a floodplain. Dredging has given the stream additional width. This creates more problems for the area, because when a stream is widened it drops its sediment in the middle of the stream instead of along its banks. This allows islands to form, which in turn grow vegetation. These islands have reformed since the dredging. The best plan for this section would be to attempt to narrow this stretch and speed up the flow. This would scrub the bottom of the stream and clean up some of the silt and mud from the streambed during normal flow. FTTU would suggest new alternatives for this area, along with education of elected officials.



Mill Creek beautifies and enhances the region through which it flows. It provides recreation for people and habitat for wildlife.

ek Watershed



TRIBUTARIES

Macks Run



The Macks Run riparian zone is a mix of woodlots and fields

Macks Run flows south into the mainstem of Mill Creek in Waterford. It originates just across the Fairfield and Ligonier Township border, east of Route 711. It can be accessed via Hanna Walt Way and Harvey Road. It is classified as a cold water fishery, but does not receive annual trout stockings. It flows through private property along its entire length. In its upper stretch along Harvey Road, it flows through farmland and is impaired by agricultural runoff with little streamside cover. After passing through this area, Macks Run snakes its way through bottomland comprised of heavy cover. Crab apple, small trees, shrubs and multiflora rose make this area difficult to access. The stream in this section is well protected. It then flows into a small wooded area with a larger canopy. During the visual assessment, this section of stream was rated the highest. This area has good fish and macroinvertebrate habitat, deep pools, riffles and shade. Protecting this section of stream will play a key role in improving the quality of Mack's Run.

Macks Run then enters a large open area that was cleared for a home site. There is a steep gravel driveway and a footbridge with a picnic area across the stream. The entire riparian zone was cleared away and the lot is mowed and trimmed to the stream's edge.

After passing this area, Macks Run flows through an area of mixed woods and homes until it empties into Mill Creek. Though many landowners have left a

riparian zone sufficient enough to protect the stream bank, on several properties the riparian zone has been eliminated. Lawns are mowed to the edge. Landowner education would be a top priority along the lower section of the stream. Macks Run has tremendous potential. It would be an excellent tributary for spawning brown trout during fall migration. Fish would find protection from predators under the thick cover that grows along the stream's edge. Other than periodic agricultural runoff, the stream appears to have good water quality and a decent minnow and macroinvertebrate population. With proper land practices, the silt load that empties into Mill Creek could be reduced.

Hannas Run and its Tributaries

The 4,560 acre sub-watershed of Hannas Run is located in the northwest corner of Ligonier Township, north of Route 30, east of Route 259 and west of Route 711. The headwaters of the western branching section of the watershed begin very close to Route 259, whereas the main branch of the watershed starts within yards of Route 711 north of Ligonier. Hannas Run flows southward and meets Mill Creek, a large tributary to the Loyalhanna, just outside of Ligonier Borough behind the Ligonier Camp and Conference Center located on Route 711 North.

A majority of the watershed flows through a rural area comprised of residential dwellings and active and non-active farm properties. The only exception to this is the small coal patch town of Wilpen, which sits about three quarters of the way through the watershed. Most of its residents live either right beside the mainstem of Hannas Run or beside one of its tributaries. As with most coal patch towns, Wilpen was created when the coal mines opened.

The Hannas Run watershed is historically notable because of its coal mining history. In its prime, the Wilpen area boasted approximately 4 operating deep mines. In the 1930s the majority of the water that flowed from Hannas Run was laden with iron and acidity due to poor environmental regulations and an exploitation of the area's resources. During the Roosevelt administration, Works Progress Administration (WPA) mine seals were installed in an attempt to alleviate the detrimental impact created by discharges from operating deep mines. They were effective, but could not compensate for the large overall impact that coal

mining caused. The quality of the water found in the area today has dramatically improved from the early 1900s. More stringent environmental regulations combined with re-mining and other technological advances have made a tremendous difference in the water quality found in the Hannas Run Watershed. Based on their appearance, it would be difficult to imagine that most of the headwater streams found in this watershed originate from deep mined areas. These areas, now stripped of their coal, have begun to restore themselves to a viable fishery. Today, Hannas Run Watershed is designated as a Cold Water Fishery under Pennsylvania's Code, Chapter 93 designations.

At its uppermost area, the stream is very small. It begins by flowing through active and inactive agricultural operations. In this area small brush and other woody shrubs tend to be prevalent along the riparian area. As Hannas Run makes its way downstream somewhat paralleling Wilpen Road, it remains narrow and rather shallow. There are few natural riparian areas, but instead old fields come right to the bank. In this area, one landowner appears to have created a drainage trench from his field to the stream. This has created quite a build-up of silt and mud that can be seen from Wilpen Road.

As Hannas Run continues to flow towards Wilpen, some tributaries begin to influence the stream. Additional flow allows some downcutting and the stream begins to develop some riffles, pools and runs. Much of the riparian area here consists of wetland or fields left to grow naturally. The banks themselves are brush covered, and the stream bed is mostly gravel with quite a lot of silt. From Hamill School Road to Ramsey Road Hannas Run travels through wetlands or uncultivated fields that appear to be cut yearly. Here too, much of the bank is lined with thick brush and thorny trees.

Middle Section of Hannas Run

Past Ramsey Road and continuing toward Wilpen, Hannas Run gets slightly wider and begins to offer more in the way of in-stream fish cover and macroinvertebrate cover. Here, the riparian zone varies from thick brush to an occasional few trees offering more of a canopy cover. The stream-bed is primarily gravel with silt filling in between the rocks. Deep pools become more prevalent, and sediment seems to be beginning to fill them. As in other sections of



Hanna's Run

Hannas Run, aquatic life was visible, although it was difficult to find a great deal of habitat there to support it.

As Hannas Run nears Robb Road it begins to infringe on private properties, some of which have back lawns coming almost to the bank.

After the Robb Road Bridge, Hannas Run flows through the town of Wilpen. Through Wilpen, the stream has been channelized and riprap lines the bank. Most homes are either right on the bank or mow to the bank for accessibility. Sewage is a major concern through this area. Soil types are not conducive for supporting septic systems, and often gray water and other impacts were noted as a result. Ligonier Township is presently in the planning stages to put sewage in place; however, because of the distance from town, it seems unlikely that Wilpen will be part of this plan. The pH readings on Hannas Run in this area tend to range from 7.8 to 8.0. Riparian vegetation is lacking in this section; where it is present, it consists of small shrubs and trees that have been planted for the aesthetic purposes of the property owners. Hannas Run flows through Wilpen and is immediately joined by a large tributary that seems to follow Marietta Road. This tributary adds significant flow to the watershed and again, changes in the stream's structure and processes can be seen.

Lower Section and Mouth of Hannas Run

Downstream from Wilpen Road Bridge, a pH reading of 8.4 was obtained. This high pH could be a result of the culmination of agricultural and sewage impacts to the stream to this point.

Before its confluence with Mill Creek, Hannas Run flows through Ligonier Camp and Conference Center property. Additional flow from numerous tributaries has increased the amount of water in Hannas Run; therefore, the stream has widened considerably and has some deeper pools along with many shallow areas. The area is comprised of a good canopy cover, in-stream fish cover, and a natural riparian zone with fairly large trees. Unfortunately, impacts upstream have resulted in poor bank stability, wide channel condition, excessive algae growth, and large amounts of silt and mud. This area and the mouth of Hannas Run were rated very poorly because of these impacts.

To further illustrate the impact of sediment on the stream, one small tributary contained so much mud and silt, it was difficult for volunteers to pick up their feet once they sunk into the tributary. During our initial survey of the area, we felt that this section offered the most significant protection in the form of riparian vegetation, canopy cover and habitat; however, we were disappointed to see that the effects of land use upstream had negatively impacted this section. One last challenge plagues Hannas Run near its confluence with Mill Creek. It seems that the mouth of Hannas Run is quite constricted by the remnants of an old railroad bridge. This bridge seems to constrict flow and increase velocity, a possible cause of erosion and sediment problems that are occurring downstream from this point on Mill Creek.

Upper Section Tributaries of Hanna's Run

The uppermost tributary of Hannas run begins its journey by flowing through an active livestock operation. It is approximately one foot wide and shallow. This tributary was inaccessible because of animals and fencing, but we were able to get a pH reading of 7.9 before it crossed Wilpen Road. It was difficult to trace the course of tributaries in this area. Most of them are narrow and shallow, flowing through a decent riparian zone with good canopy cover. There seems to be multiple wetlands in the area that may provide a natural buffer for the watershed itself.

Middle Section Tributaries of Hanna's Run

The unnamed tributaries that join Hannas Run coming from the Ramsey Road area are for the most part inaccessible. These tributaries are about 1 to 2 feet wide and appear to flow through brush, wetlands or unmowed fields. There are residences, but most seem to be well away from the tributaries. At a few places, nearest Ramsey Road, we could access the tributaries and obtained normal pH readings. Farther downstream, a tributary that follows Hotel Road enters the stream. This tributary is more sizeable and measures 2 to 3 feet with a primarily tree or brush lined-path. There are many residences located near this tributary, so we did not feel we could access it without going through private yards.

The next tributary downstream enters Hannas Run just below Marietta Road. This tributary has many branches and seems to carry a significant amount of water. For the most part, the upper tributaries are lined with a thick, dense wetland area. Most of these tributaries are narrow and shallow, with many being inaccessible because of private property or because they travel through areas of thick vegetation. About 8 lots are for sale along this section, and the area is being marketed as Wineland Estates. As it moves towards its confluence with Hannas Run, the riparian zone and canopy cover on this tributary does improve. When this tributary meets Hannas Run, both are about the same width of 5 to 6 feet.

Lower Section Tributaries of Hanna's Run

All of the lower tributaries join Hannas Run on Ligonier Camp and Conference Center property. The tributaries are narrow, shallow streams that go through mixed areas of overgrown field with very few sections having adequate canopy cover. Closer to the mouth of Hannas Run, a small tributary parallels the steep hillside. The bed of this tributary is almost entirely mud and silt. This mud and silt deposit then continues into Hannas Run at the point where the two meet. No pH readings out of the ordinary were obtained in these lower tributaries.

One last item to note is that plans are in the very early stages to develop a trail from Ligonier to the abandoned coke ovens near Wilpen. The trail will follow the old railroad line. In some places this trail will probably influence the riparian area of Mill Creek and Hannas Run. FTTU should remain involved with the trail planning to ensure that impacts associated with it are minimal.

LIMITING FACTOR TABLES

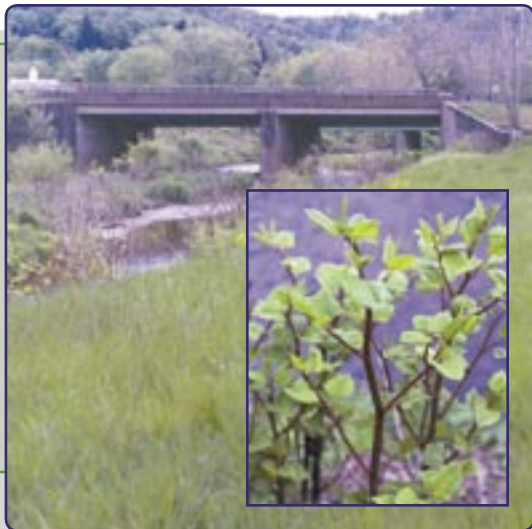
A listing of problem areas in the watershed and possible solutions

LIMITING FACTOR: RIPARIAN VEGETATION DEGRADATION				
<i>Stream Segment Name</i>	<i>Description of Impact</i>	<i>Remediation Strategy</i>	<i>Possible Funding Sources</i>	<i>Priority Rating</i>
Confluence of Hannas Run and Mill Creek	Stream flows through residential area where landowners and flooding have removed riparian vegetation from stream banks. Only one side of the stream is impacted.	<ul style="list-style-type: none"> Stabilize bank and install instream structures to divert flow from bank. Riparian planting Educate public and landowners on best practices for creating and maintaining healthy streams 	<ul style="list-style-type: none"> DEP EPA LWV WREN PaF&BC USDA WPWP 	High
Along Mill Road, 75 yards upstream from Pole Bridge	Gigantic hemlock tree is severely undercut and at risk for fall into home which could further impair stream bank.	<ul style="list-style-type: none"> Stabilize undercut bank and root system Remove tree leaving root system Construct high water device to allow stream to drop sediment where needed 	<ul style="list-style-type: none"> DEP PaF&BC USDA WPWP 	Medium
Hannas Run above Wilpen	Stream flows through area where riparian zone is comprised primarily of shrub and scrub, i.e., multiflora rose and greenbriar.	<ul style="list-style-type: none"> Riparian planting Educate public and landowners on best practices for creating and maintaining healthy streams 	<ul style="list-style-type: none"> CVI DEP EPA LWV WREN PACD USDA 	High
Headwaters of Hannas Run	Active and inactive farming operations surround the stream. Riparian zone has been removed by landowners and cattle.	<ul style="list-style-type: none"> Install Agricultural Best Management Practices on active farms Riparian planting and restoration 	<ul style="list-style-type: none"> CUP DEP Pa Act 6 Program USDA WPWP 	Medium

Key To Possible Funding Sources

- CUP - California University of Pennsylvania
- CVI - Canaan Valley Institute
- DCNR - Department of Conservation and Natural Resources
- DEP - Department of Environmental Protection Growing Greener Program
- LWV WREN- League of Women Voters Water Resources Education Network
- EPA - Environmental Protection Agency
- NFWF - National Fish and Wildlife Foundation
- PACD - Pennsylvania Association of Conservation Districts
- PaF&BC - Pennsylvania Fish and Boat Commission Adopt a Stream Program
- TU - Trout Unlimited
- USDA - United States Department of Agriculture Various programs including CREP, CCRP, WHIP and others.
- WPWP - Western Pennsylvania Watershed Program

Listed funding sources are not meant to be comprehensive and all efforts should be made to explore other public and private sources.



Areas where riparian vegetation has been removed are susceptible to erosion, allow invasive species such as Japanese Knotweed to move in and expose the stream to the warming effects of direct sunlight.

LIMITING FACTOR: RIPARIAN VEGETATION DEGRADATION CONTINUED

<i>Stream Segment Name</i>	<i>Description of Impact</i>	<i>Remediation Strategy</i>	<i>Possible Funding Sources</i>	<i>Priority Rating</i>
Hannas Run through Wilpen	Homeowners have removed vegetation along stream banks with lawnmowers.	<ul style="list-style-type: none"> Educate Land owners on importance of streamside buffers Riparian planting 	<ul style="list-style-type: none"> DEP LWV WREN PACD USDA WPWP 	High
Mack's Run Headwaters	Headwaters comprised of mostly agricultural operations, ie: livestock and hay fields.	<ul style="list-style-type: none"> Install Agricultural Best Management Practices on active farms 	<ul style="list-style-type: none"> CUP DEP Pa Act 6 Program USDA 	Medium
Mill Creek in Oak Grove	Homeowners have removed vegetation along stream banks with lawnmowers. Canopy cover is limited and stream temperature increases noticeably because of this.	<ul style="list-style-type: none"> Riparian planting Educate public and landowners on best practices of creating and maintaining healthy streams 	<ul style="list-style-type: none"> DEP LWV WREN NFWF PACD USDA WPWP 	High
Mill Creek by Mallard Lane	Homeowners have removed vegetation along stream banks with lawnmowers.	<ul style="list-style-type: none"> Riparian planting Educate public and landowners on importance of streamside buffers 	<ul style="list-style-type: none"> DEP LWV WREN PACD USDA WPWP 	High
Mill Creek from West Main Street Bridge to the mouth	Riparian vegetation is severely limited due to roads. Only grasses line banks. Very few trees are located on either side of the bank.	<ul style="list-style-type: none"> Limit dredging Install instream structures to keep flow in center of stream channel so silt will be deposited on the banks 	<ul style="list-style-type: none"> EPA DEP NFWF USDA WPWP 	Medium
Numerous unnamed tributaries to Mill Creek	Most are impacted by landowners mowing to banks and/or agriculture	<ul style="list-style-type: none"> Riparian planting Educate public and landowners on importance of streamside buffers 	<ul style="list-style-type: none"> DEP LWV WREN PACD USDA WPWP 	High



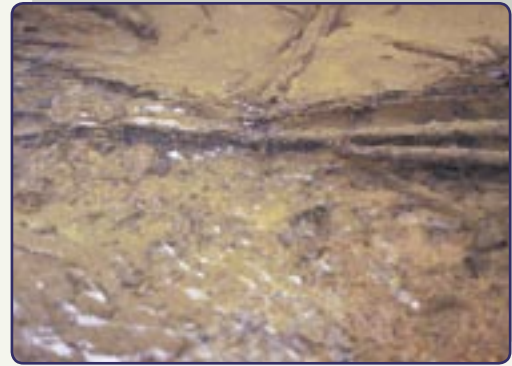
A braided channel and > excessive siltation. The absence of riparian vegetation has allowed the bank to erode.

< A lack of riparian cover has exposed the stream to the warming effects of sunlight. The stream has dropped sediment here forming an island.





Mill Creek's tributaries muddy quickly in a rainstorm and bring in silt, smothering the cobblestones and woody debris in the stream bed that serves as habitat for macroinvertebrates.



LIMITING FACTOR: COMPROMISED FISH AND MACROINVERTEBRATE HABITAT

<i>Stream Segment Name</i>	<i>Description of Impact</i>	<i>Remediation Strategy</i>	<i>Possible Funding Sources</i>	<i>Priority Rating</i>
Mill Creek (Waterford) Route 271 bridge downstream to second Route 271 bridge	Landowners have removed stones from the stream thus eliminating fish cover and stream structure. (in the name of flood control).	<ul style="list-style-type: none"> Place cover rocks in stream Riparian planting Outreach and education of the public and landowners on best practices for creating and maintaining healthy streams 	<ul style="list-style-type: none"> DEP LWV WREN NFWF PACD TU WPWP 	Medium
From McInchok's scrap yard downstream to Forks Inn	Urbanization has caused a decrease in viable fish and macroinvertebrate habitat. Warm runoff and higher peak flows eliminate a majority of habitat.	<ul style="list-style-type: none"> Work together with businesses and property owners Outreach and education on proper stewardship of riparian zones Streamside plantings 	<ul style="list-style-type: none"> DEP LWV WREN NFWF PACD PaF&BC TU WPWP 	Medium
Headwaters of Hannas Run	Hannas Run headwaters are primarily impacted by agriculture the majority of the stream bottom is covered with silt.	<ul style="list-style-type: none"> Streamside planting Install Agricultural Best Management Practices on active farms 	<ul style="list-style-type: none"> CUP DEP NFWF Pa Act 6 Program USDA 	High
Hannas Run through downtown Wilpen	Landowners have removed all fish and macroinvertebrate structures to reduce the risk of flooding.	<ul style="list-style-type: none"> Outreach and education of the public and landowners on best practices for creating and maintaining healthy streams 	<ul style="list-style-type: none"> DCNR LWV WREN PACD TU 	High
Mill Creek from Peoples Road downstream to Athletic Field	Sediment has clogged the stream, essentially eliminating all fish and macroinvertebrate habitat from this section.	<ul style="list-style-type: none"> Bank stabilization Riparian plantings and Agricultural Best Management Practices on upstream tributaries 	<ul style="list-style-type: none"> CUP DEP Pa Act 6 Program USDA 	High
Mill Creek from West Main Street bridge to the mouth	Penn Dot Dredging has removed all habitat. Flood control does not allow habitat to be in place.	<ul style="list-style-type: none"> Stop dredging Install instream devices to improve habitat Riparian planting 	<ul style="list-style-type: none"> DEP EPA PaF&BC WPWP 	Medium
Headwaters of Mack's Run	Livestock access to streams have caused segments to clog with silt.	<ul style="list-style-type: none"> Agricultural Best Management Practices Streamside planting 	<ul style="list-style-type: none"> CUP DEP NFWF Pa Act 6 Program USDA 	High
Numerous Un-named tributaries to Mill Creek	Inappropriate agriculture and landowner practices.	<ul style="list-style-type: none"> Agricultural Best Management Practices Riparian planting 	<ul style="list-style-type: none"> CUP DEP NFWF Pa Act 6 Program USDA 	High

LIMITING FACTOR: EROSION AND CHANNEL ALTERATION

<i>Stream Segment Name</i>	<i>Description of Impact</i>	<i>Remediation Strategy</i>	<i>Possible Funding Sources</i>	<i>Priority Rating</i>
Mill Creek on Ellswick Property	Gigantic hemlock is undercut and in danger of falling, damaging homes and further impairing bank.	<ul style="list-style-type: none"> • Stabilize undercut bank and root system • Remove tree leaving root system • Construct high water device to allow stream to drop sediment where needed 	<ul style="list-style-type: none"> • DEP • Pa F&BC • TU • WPWP 	High
Private drive parrallel to Mill Creek below the 271 bridge by Watkins Market	Private drive is being undercut and the road is in danger of collapsing.	<ul style="list-style-type: none"> • Streambank stabilization • Install deflector • Riparian planting 	<ul style="list-style-type: none"> • DEP • NFWF • Pa F&BC • TU • WPWP 	Medium
Mack's Run Headwaters	Agricultural impact has created erosion in multiple areas.	<ul style="list-style-type: none"> • Install Agricultural Best Management Practices on active farms • Educate public and landowners on importance of streamside buffers 	<ul style="list-style-type: none"> • CUP • CVI • LWV WREN • Pa Act 6 Program • PACD • USDA 	Medium
Mack's Run near mouth	Landowner mows to stream bank and the lack of vegetation has allowed for the erosion of the stream bank.	<ul style="list-style-type: none"> • Educate Land owners on importance of streamside buffers • Riparian planting 	<ul style="list-style-type: none"> • CVI • LWV WREN • PACD • USDA • WPWP 	Medium
Residential area between the second Rt. 271 bridge in Waterford and Mckelvey Road	High natural outside bank erosion through entire stream section.	<ul style="list-style-type: none"> • Streambank restoration • Instream structure such as log veins to prevent further erosion • Riparian planting 	<ul style="list-style-type: none"> • DEP • EPA • PaF&BC • USDA • WPWP 	Medium
Mill Creek by Mallard Lane	Erosion of banks through entire section, most noticeably behind residential section.	<ul style="list-style-type: none"> • Streambank restoration • Install instream structure • Riparian planting 	<ul style="list-style-type: none"> • DEP • EPA • PaF&BC • USDA • WPWP 	Medium



Bank erosion in the Mallard Lane area.



^ Bank erosion threatens a private road.

A severely eroded bank and a hemlock tree > in danger of falling in the Mill Road area.

LIMITING FACTOR: EROSION AND CHANNEL ALTERATION CONTINUED

<i>Stream Segment Name</i>	<i>Description of Impact</i>	<i>Remediation Strategy</i>	<i>Possible Funding Sources</i>	<i>Priority Rating</i>
Headwaters of Hannas Run	Erosion due to the action of agricultural operations.	<ul style="list-style-type: none"> • Agricultural Best Management Practices • Riparian planting 	<ul style="list-style-type: none"> • DEP • EPA • USDA • WPWP 	Medium
Hannas Run 1000 yards upstream of Mallard Drive's wooden bridge	High outside bank erosion from high volume of water flowing.	<ul style="list-style-type: none"> • Streambank stabilization • Riparian planting • Install instream structure 	<ul style="list-style-type: none"> • DEP • PaF&BC • TU • WPWP 	Medium
Mouth of Hannas Run	High volume of water has created erosion right at the mouth.	<ul style="list-style-type: none"> • Stabilize streambank • Riparian planting • Remove remains of old railroad bridge 	<ul style="list-style-type: none"> • DEP • USDA • WPWP 	High
Mill Creek downstream of the confluence of Hannas Run and Mill Creek. (LCCC Bank)	Side bank parallel to conference center pond is eroding and disappearing.	<ul style="list-style-type: none"> • Stabilize streambank • Riparian planting • Install instream water deflection device • Educate public and landowners on best practices of creating and maintaining healthy streams 	<ul style="list-style-type: none"> • CVI • DEP • LWV WREN • PaF&BC • USDA • WPWP 	Medium
Mill Creek downstream of People's Road to the athletic fields	Bottom lands with high eroding banks on both sides. Log jams have diverted water, creating side channels and collection areas for silt and sediment. Braiding noticeable throughout the entire section.	<ul style="list-style-type: none"> • Stabilize streambank • Riparian planting • Install instream water deflection device • Educate public and landowners on best practices of creating and maintaining healthy streams • Remove log jams and litter 	<ul style="list-style-type: none"> • CVI • DEP • LWV WREN • NFWF • PaF&BC • USDA • WPWP 	Medium
Mill Creek at the mouth	Erosion on both banks due to high water flow and past dredging operations.	<ul style="list-style-type: none"> • Stop dredging • Install habitat improvement devices • Riparian planting 	<ul style="list-style-type: none"> • DEP • PaF&BC • USDA 	Medium
Numerous unnamed tributaries to Mill Creek	Erosion is less severe, but still prevalent on unnamed tributaries.	<ul style="list-style-type: none"> • Agricultural Best Management Practices • Riparian planting 	<ul style="list-style-type: none"> • CUP • DEP • Pa Act 6 Program • USDA • WPWP 	Medium

LIMITING FACTOR: NUTRIENT ENRICHMENT

<i>Stream Segment Name</i>	<i>Description of Impact</i>	<i>Remediation Strategy</i>	<i>Possible Funding Sources</i>	<i>Priority Rating</i>
Headwaters of Hannas Run	Agriculture impacts the headwaters. Cows have direct access to the stream.	<ul style="list-style-type: none"> • Agricultural Best Management Practices • Riparian planting 	<ul style="list-style-type: none"> • CUP • DEP • EPA • Pa Act 6 Program • USDA • WPWP 	Medium
Hannas Run through Wilpen	Multiple homes have compromised septic systems.	<ul style="list-style-type: none"> • Educate public and landowners on best practices of creating and maintaining healthy streams • Initiate public sewage project 	<ul style="list-style-type: none"> • CVI • LWV WREN • PACD 	Medium
Hannas Run below Wilpen	Suspected failing septic systems.	<ul style="list-style-type: none"> • Educate public and landowners on best practices of creating and maintaining healthy streams • Initiate public sewage project 	<ul style="list-style-type: none"> • CVI • LWV WREN • PACD 	Medium
Mill Creek below People's Road (Marker's Farm)	Agriculture impacts the headwaters. Cows have direct access to the stream.	<ul style="list-style-type: none"> • Agricultural Best Management Practices • Streambank fencing • Educate land owners on importance of streamside buffers 	<ul style="list-style-type: none"> • CUP • DEP • EPA • Pa Act 6 Program • USDA • WPWP 	Medium
Mill Creek behind Athletic Fields	Suspected sewage impacts from unknown sources.	<ul style="list-style-type: none"> • Educate public and landowners on best practices of creating and maintaining healthy streams • Initiate public sewage project 	<ul style="list-style-type: none"> • CVI • LWV WREN • PACD 	High
Numerous unnamed tributaries to Mill Creek	Most tributaries are impacted by failing septic systems, especially those outside of Ligonier Borough.	<ul style="list-style-type: none"> • Educate public and landowners on best practices of creating and maintaining healthy streams • Initiate public sewage project 	<ul style="list-style-type: none"> • CVI • LWV WREN • PACD 	Medium



Excessive algae growth from nutrient enrichment.

PRIORITY AREAS FOR PROTECTION

<i>Stream Segment Name</i>	<i>Description</i>	<i>Potential Partners</i>	<i>Priority Rating</i>
Headwaters	<ul style="list-style-type: none"> • Exceptional Value watersheds — Middle and South Branches • High Quality Cold Water Fishery watershed — North Branch • Wild Brook Trout 	WPC, LWA, DCNR, PGC	High
McKelvey Road	<ul style="list-style-type: none"> • Forested, good canopy • Pools, riffles, pocket water • Good fishing access • Wild trout • Development pressure 	WPC, LWA	High
Mack's Run	<ul style="list-style-type: none"> • Cold-water fishery • Good habitat, canopy • Good potential for habitat improvement 	WPC, LWA, WCALP	Medium

ABBREVIATIONS KEY

DCNR ...Department of Conservation and Natural Resources
 LWALoyalhanna Watershed Association
 PGC.....Pennsylvania Game Commission

WPC..... Western Pennsylvania Conservancy
 WCALP... Westmoreland County Agricultural Land Preservation

GLOSSARY OF TERMS

Braided Channel A stream channel that has split into two or more smaller channels.

Canopy In this booklet, the word canopy is used to describe the out-stretched branches of trees shading the stream surface.

Channelized A section of stream where the size and direction of the stream channel has been altered to move the stream flow through more quickly in an effort to alleviate flooding.

Deflector A device built of logs and / or stone designed to protect a stream bank from erosion and to narrow a wide and shallow stream channel.

FTTU Forbes Trail Trout Unlimited

Log Vein A stream improvement device made of logs and stone designed to trap sediment in order to build up an eroded bank.

Macroinvertebrate For the purpose of this booklet, a small aquatic organism such as an insect or crustacean. The presence of macroinvertebrates is an indicator of good water quality.

PAF&BC Pennsylvania Fish and Boat Commission

Pool..... A slower moving, deeper section of a stream.

Riffle Faster moving water in a stream caused by a steeper decline in the stream's elevation. The water is usually more shallow in riffles.

Riparian Zone The land immediately surrounding a stream or river.

Rip Rap..... Large stone used to stabilize stream banks.

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