Sediment and Nutrient Total Maximum Daily Loads For

South Branch South Fork Pine Creek

Stream Code - 47197

Armstrong County, PA (17-E)

Prepared by

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I. TMDL Overview

The TMDL development process is a nationwide effort to inventory and improve the health of our waters. Each water body in Pennsylvania has water quality standards that define the amount of substances with pollution-potential that can exist therein. The attainment of these standards is essential to ensure that the quality of each water body can support its "protected use." Water quality may be protected to support coldwater fishes, recreational activities, potable water, or many other "protected uses." When the water quality standards of a water body are not met, the water is classified as being "impaired." Section 303(d) of the Clean Water Act requires all impaired waters to be identified and documented. Consequently, the Pennsylvania Department of Environmental Protection is assessing all of its water bodies, and listing those that are impaired on its own 303(d) list. Furthermore, regulations require that a TMDL study must be completed for each impaired water body on this list. The goal of such a study is to determine how to restore impaired water bodies.

Identifying and eliminating all sources of the pollutant would of course be the optimal method of restoration; however, this is rarely feasible or possible. Instead, a TMDL study is directed at determining the total maximum daily load (TMDL) of a pollutant that a water body can assimilate (uptake) and still maintain its water quality standards. Once a TMDL is determined in terms of a pollutant load (e.g., lbs nitrogen/yr), this value is compared to the existing load. In general, the difference between the TMDL and the existing load constitutes the targeted load reduction.

To reach this targeted load, reductions from the loads of both point (e.g., sewage treatment facility discharge) and non-point (e.g., farmland runoff) sources are considered. Pollutant contributions from non-point sources often comprise the majority of the total load. To reduce these loads, Best Management Practices (BMPs) are reviewed and recommended to land owners. Riparian buffer strips (Figure 1) and contour buffers strips (Figure 2) are examples of BMPs. Proper implementation of these land management strategies can cause substantial reductions of pollutants, and consequently can have a meaningful and positive effect on the health of our waters.

Figures 1 and 2 (left to right). Photographs of areas where BMPs have been implemented to reduce nutrient leaching. Fig. 1 – Riparian buffer strip, and Fig 2. – Contour buffer strip.

II. Executive Summary

This TMDL was developed for a section of the South Branch South Fork Pine Creek watershed, Armstrong County (17-E). Streams in this section were identified on the 1998 Section 303(d) list as having sediment and nutrient impairments caused primarily by agriculture. Specific sediment sources in the watershed have been identified to be 1) direct sediment runoff and streambank decay resulting from overgrazed and trampled riparian areas, and 2) in-stream erosion caused by accelerated stream flow resulting from large volumes of overland runoff during rainy events. The primary source of excessive nutrients was determined to be overland runoff from livestock containment areas.

Using AVGWLF® (Appendix A), a watershed that is not impaired, and has several relevant similarities with the impaired watershed was found: Spra Run. This watershed is located approximately five miles southwest of the impaired watershed. It has a similar amount of agricultural land; however, land management practices are in place that reduce sedimentation and nutrient leaching issues that typically result from agricultural practices. Using the GWLF® model, the existing loads of sediment and phosphorus from non-point pollution sources were determined for both the impaired and reference watersheds. Using this data, the sediment and phosphorus loading rates of the reference watershed were calculated, and used to determine the TMDLs for the impaired watershed.

A 10% margin of safety (MOS), and non-point source loads that will not be reduced (LNRs) were then subtracted from the TMDL (Table i). The remaining load (ALA) was then allocated among non-point sources, and required reductions were determined. The overall required reductions for the watershed were calculated to be 39% for sediment, and 24% for phosphorus. Required reductions for the South Branch South Fork Pine Creek watershed can be achieved by implementing Best Management Practices (BMPs). Based upon field assessments, the following BMPs are suggested: 1) Pasture Land Management, 2) Vegetative Buffer Strips, and 3), Streambank Protection. Sediment reduction efficiencies for these three BMPS are 13%, 58%, and 76%, respectively, and phosphorus reduction efficiencies for these three BMPS are 34%, 52%, and 78%, respectively (Evans and Corradini 2001).

Table i. Table i. Summary of major parameters.

Parameter	Sediment (tons/yr)	Phosphorus (lbs/yr)
WLA (Wasteload Allocation)	**0**	**0**
ALA (Adjusted Load Allocation)	**504.7**	**517.3**
LNRs (Loads not reduced)	**5.2**	**5.3**
MOS (Margin of Safety)	**56.66**	**58.07**
TMDL (Total Max Daily Load)	**566.62**	**580.65**
TMDL / 365 Days	**1.55 (tons/day)**	**1.59 (lbs/day)**

III. Introduction

A. Watershed Description

1. Location and General Description

This TMDL was developed for the upper section of South Branch South Fork Pine Creek (stream code – 47197). This watershed is located in mid-eastern Armstrong County, north of Rural Valley. Its watershed boundaries lie within Cowanshannock and Wayne Townships (USGS quadrangle – Rural Valley) (Figure 1). From its headwaters, South Branch South Fork Pine Creek flows northwesterly through sub-basin 17-E for about 3.8 miles before joining with North Branch South Fork Pine Creek to form South Fork Pine Creek. However, this TMDL targets only the area delineated below because no impairments were reported on any downstream segments. The targeted area is 3.6 mi^2, and encompasses about 9 miles of stream.

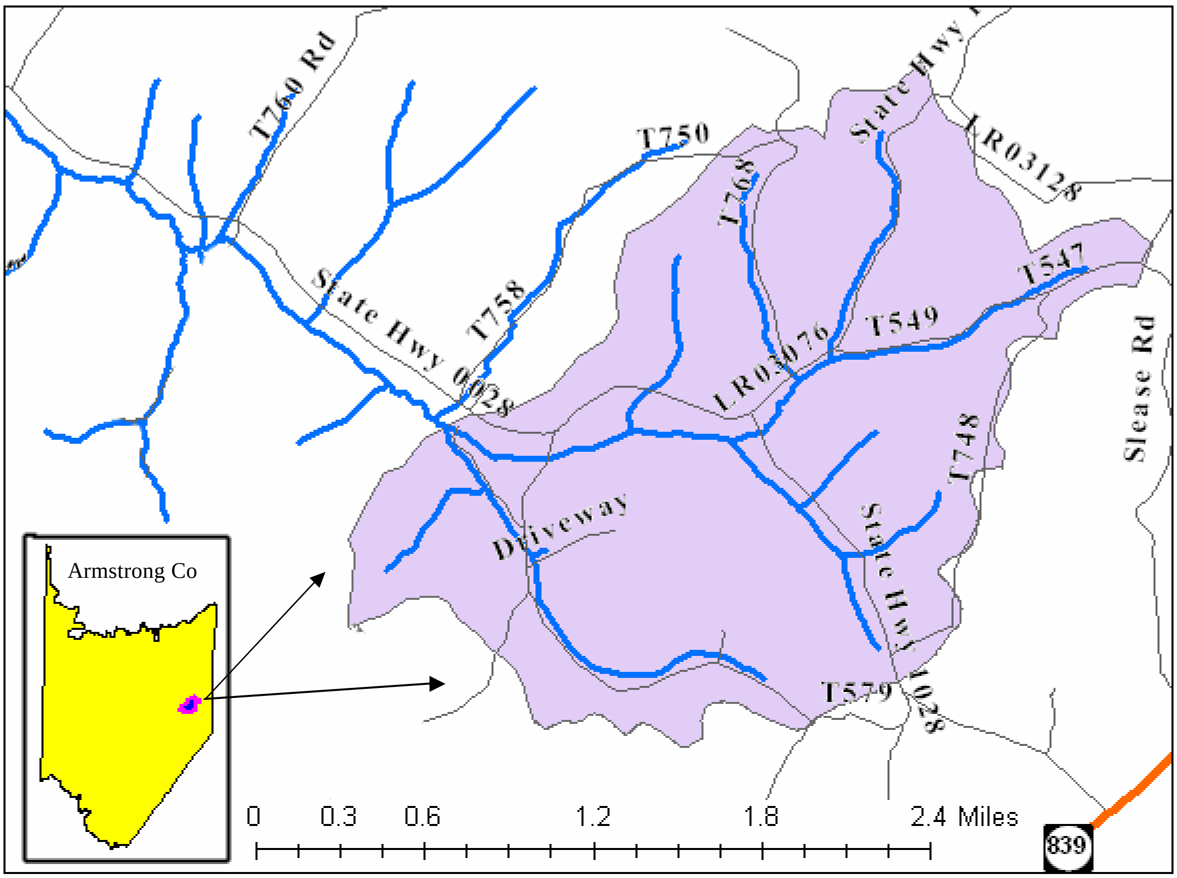

Figure 1. Targeted area of South Branch South Fork Pine Creek (Armstrong County, PA).

2. Topography and Geology

The targeted area of the South Branch South Fork Pine Creek watershed lies within the Pittsburgh Low Plateau Section of the Appalachian Plateau Province. This section consists of a smooth undulating upland surface cut by numerous, narrow, relatively shallow valleys. Elevation ranges from 365 to 451 m above sea level (Figure 2). Rocks within the watershed are entirely interbedded sedimentary, and the three underlying bedrock groups are the Casselman Formation, Allegheny Group and Glenshaw Formation, with the latter being dominant. The strata of the Glenshaw Formation consist predominantly of sandstones and mudrocks with thin limestones and coals.

The sole soil association is Gilpin-Weikert-Ernest, and the dominant hydrologic soil group is C; this soil group is characterized as having a slow infiltration rate when thoroughly wetted.

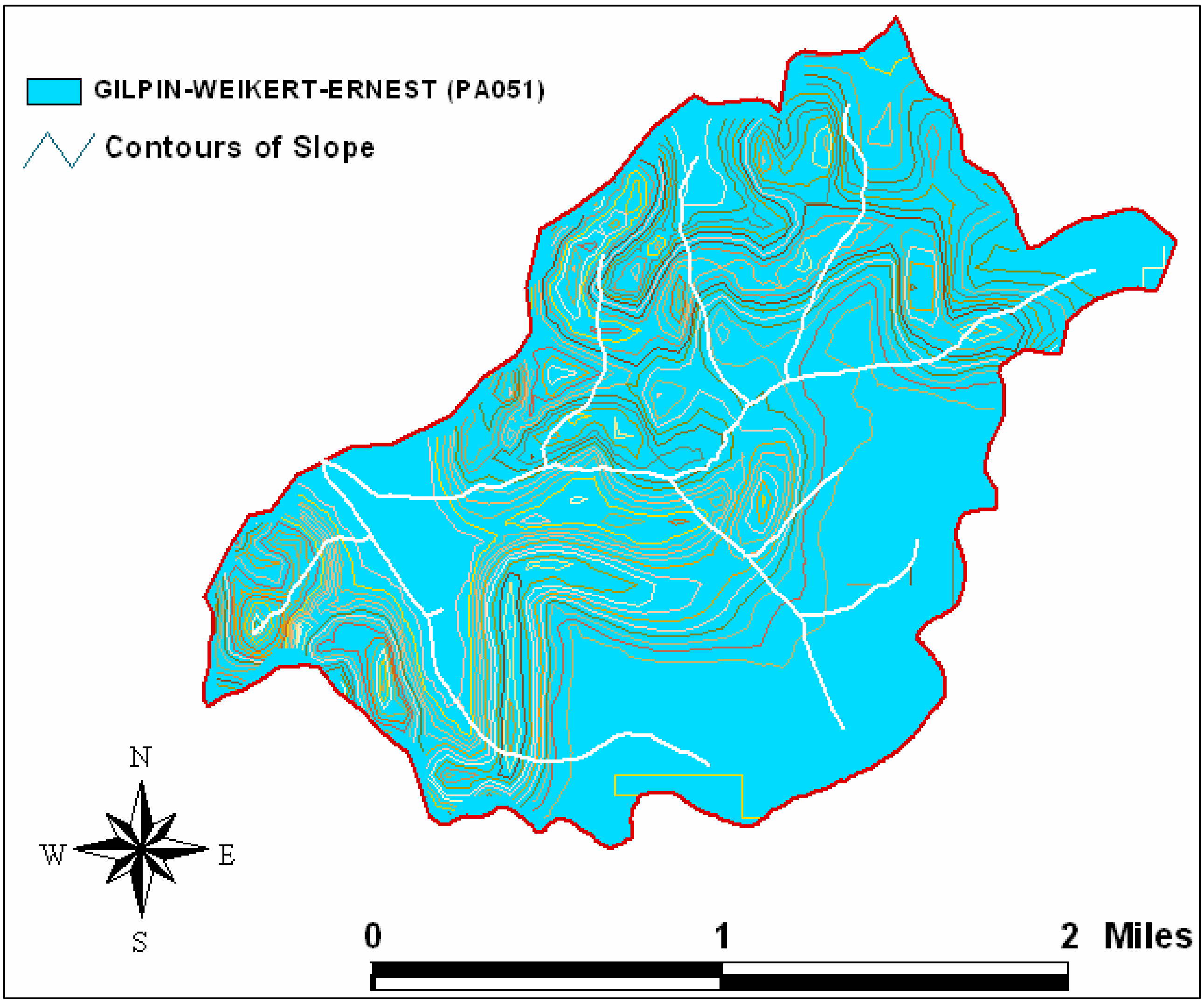

Figure 2. Illustration of soil associations and slope contours within the South Branch South Fork Pine Creek watershed (Armstrong County, PA).

3. Land Use

The ArcView® Generalized Watershed Loading Function (AVGWLF®) model version 7.1.2 (Appendix A) was used to estimate the landuse for the South Branch South Fork Pine watershed (Figure 7). Furthermore, a survey was conducted to verify the accuracy. Less cropland was found to exist in the watershed; the model was adjusted accordingly. The current land use for dominant categories is as follows: Agriculture - 54%, Forest – 43%, Development – 3%.

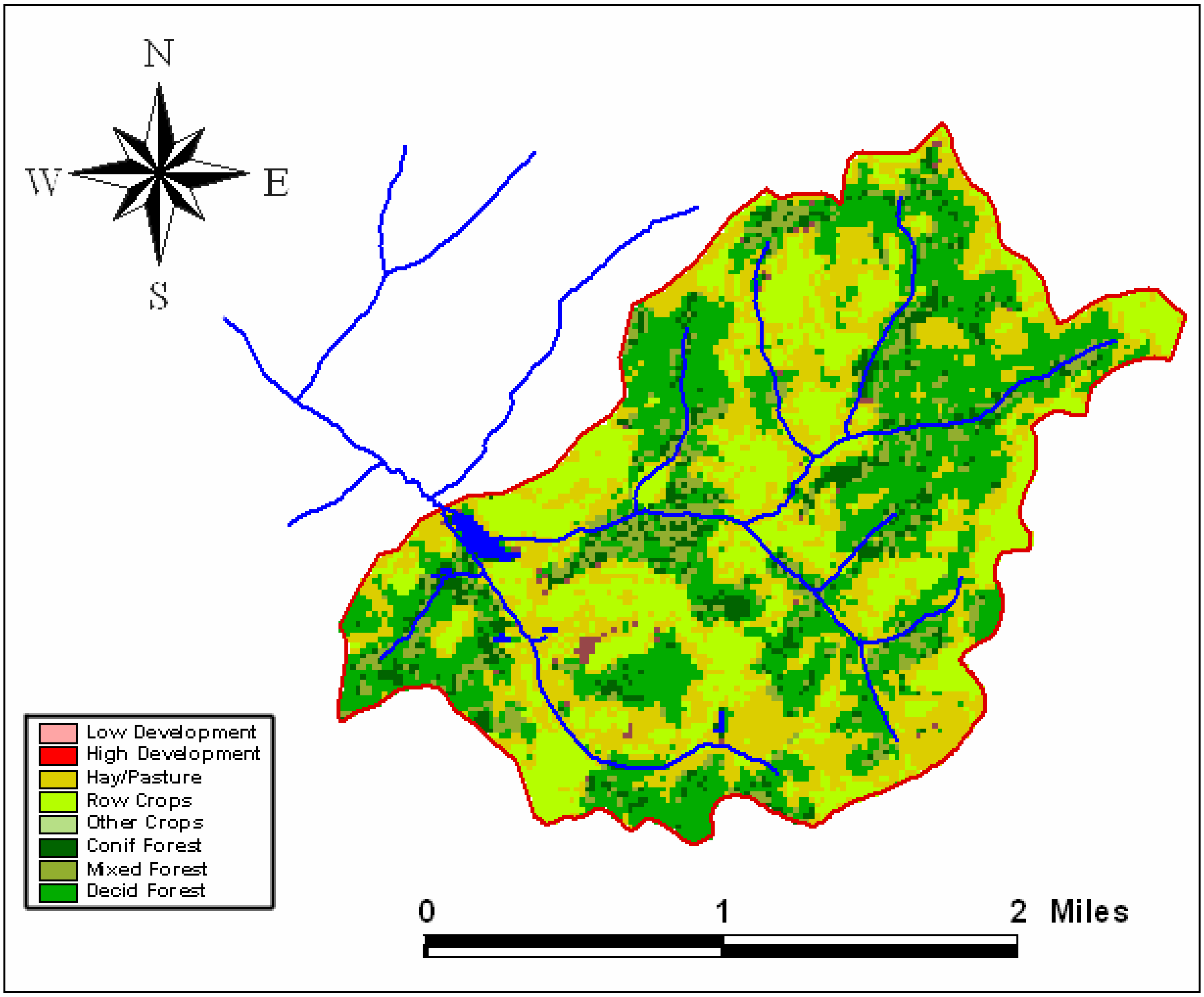

Figure 3. Landuse distribution for the targeted area of the South Branch South Fork Pine Creek watershed, Armstrong County. Although not shown in the above figure, "agricultural disturbed riparian" is a landuse that was added to the model. This landuse describes areas along the stream that have been over-grazed, and/or trampled resulting in either bare or minimally vegetated land.

B. Nature of Impairments, Water Quality Standards, and Pollutants

In accordance with Title 25 PA Code Chapter 93, all streams in Pennsylvania must be protected so that they can support an "Aquatic Life Use". Pennsylvania DEP analyzes aquatic macro-invertebrate communities of streams to determine whether these streams are supporting an Aquatic Life Use. Macro-invertebrates are relatively small organisms that dwell on or within a streams bottom, and include mayflies, stoneflies, and caddisflies. Because these organisms are excellent indicators of a stream's health, a stream is considered to be supporting an Aquatic Life Use if its macro-invertebrate communities meet certain biological criteria.

Biologists routinely perform assessments to make this determination. This is done by collecting samples of macro-invertebrate communities throughout a stream, and then identifying and counting them. The biologist then analyzes abundance, diversity, and the balance between macro-invertebrates that are generally pollution-tolerant, and those that are not. If the community does not meet certain biological criteria, the stream is deemed "impaired". The source and cause of the impairment is then determined, and all of this information is placed on Pennsylvania's Integrated Water Quality Monitoring and Assessment Report.

Several streams within the South Branch South Fork Pine Creek watershed were determined to be impaired (Figure 4). Impairment information from Pennsylvania's Integrated Water Quality Monitoring and Assessment Report is shown in Table 1. There currently are no point sources of pollution contributing to the listed cause of impairment for this watershed.

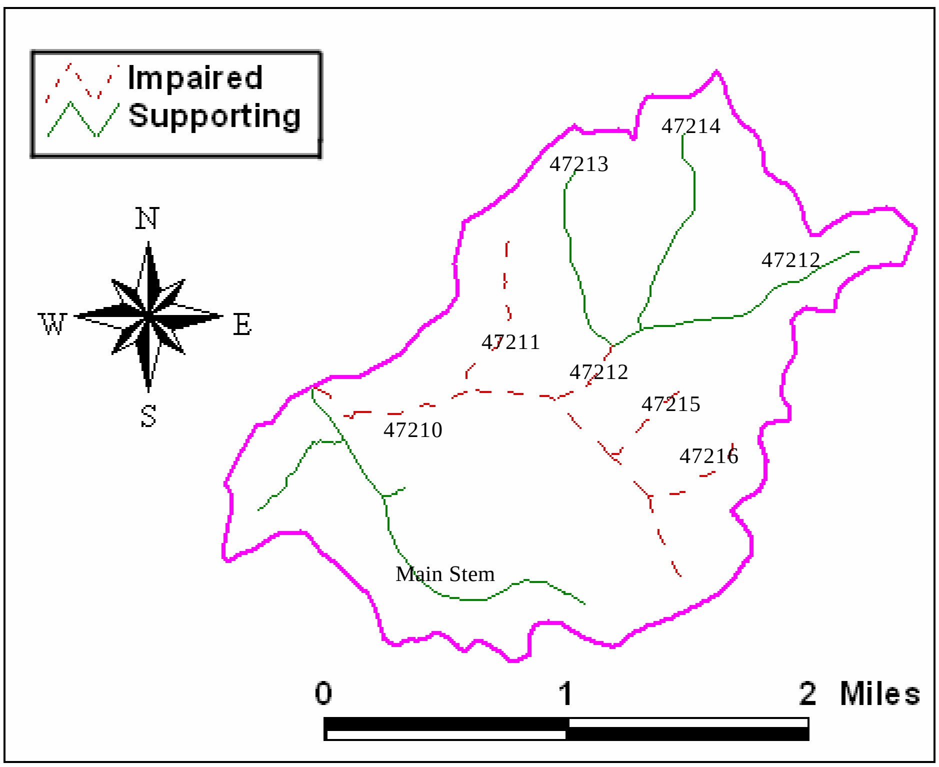

Figure 4. Impaired and supporting streams with the South Br. South Fk. Pine Ck. Watershed.

Table 1. Impairment information from Pennsylvania's 2006 Integrated Water Quality Monitoring and Assessment Report for the South Branch South Fork Pine Creek watershed. All streams are in HUC – 05010006.

Stream Name	Assessment ID	Stream Code	Source	Cause	Miles
Tributary 47210 to South Branch South Fork Pine	8357	47210	Agriculture	Nutrients and Siltation	3.95
Tributary 47211 of South Branch South Fork Pine	8357	47211	Agriculture	Nutrients and Siltation	
Tributary 47212 of South Branch South Fork Pine	8357	47212	Agriculture	Nutrients and Siltation	
Tributary 47215 of South Branch South Fork Pine	8357	47215	Agriculture	Nutrients and Siltation	
Tributary 47216 of South Branch South Fork Pine	8357	47216	Agriculture	Nutrients and Siltation	

C. Source Assessment

Pennnsylvania's 2006 Integrated Water Quality Monitoring and Assessment Report indicates that streams within the South Branch South Fork Pine Creek watershed are impaired due to siltation and excessive nutrients, both stemming from agricultural activities (Table 1). Field surveys were conducted in May 2008 to better characterize the impairments. Problematic areas identified within the watershed are denoted by numbers on Figure 5 and their corresponding descriptions and photographs follow.

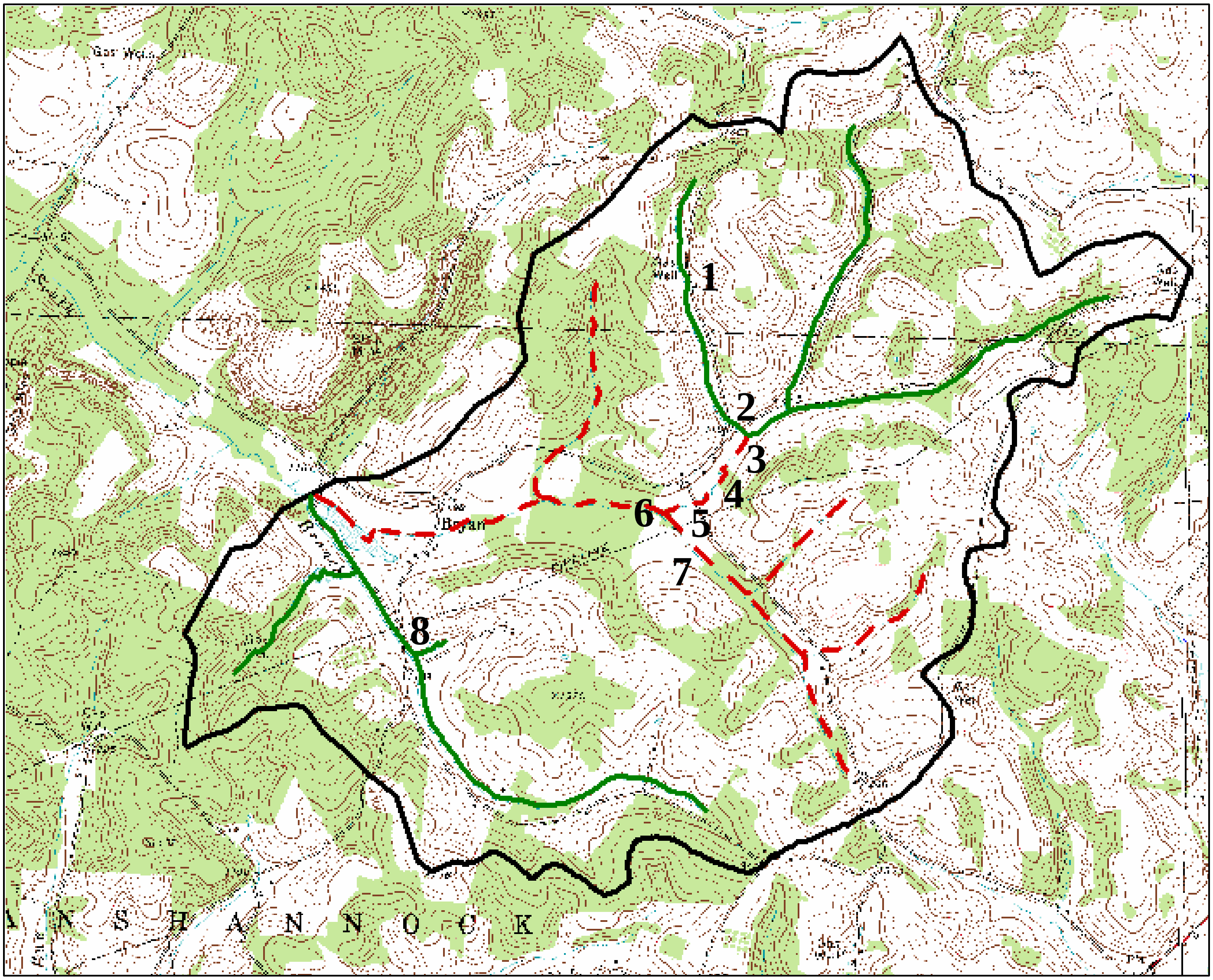

Figure 5. Survey site locations (numbers) where problematic areas were noticed – descriptions and photographs follow.

1. Excessive nutrient runoff from livestock manure (Figure 6) is over-stimulating algal growth (Figure 7). Figure 7 illustrates location **2.**

Figure 6.

Figure 7.

3. Surrounding area contains vast steep, lightly vegetated hills. Large amounts of overland runoff are generated herein during rain events. This runoff is entering the stream channel, and accelerating the flow to a point whereby streambanks are being eroded (Figures 8 and 9). In addition, there is a lack of deep-rooted shoreline vegetation, and consequently streambanks are destabilized and collapsing into the stream (Figures 8 and 9).

Figure 8.

Figure 9.

4. There is heavy sedimentation in this area stemming from 1) streambank scouring from accelerated flows, 2) trampling of streambank by cattle, and 3) lack of deep-rooted shoreline vegetation and consequent streambank collapse (Figure 10). In addition, nutrient runoff from cattle manure is entering the stream (Figure 11).

Figure 10.

Figure 11.

5. Large amounts of overland runoff are being generated in this area, and consequently increasing the stream flow to a point whereby streambanks are being scoured (Figure 12). In addition, streambank collapse due to a lack of deep-rooted shoreline vegetation, and cattle trampling are also problems here (Figure 13).

Figure 12.

Figure 13.

6. Sedimentation problems from upstream are causing high turbidity, and have reduced the stream's substrate to silt (Figures 14 and 15).

Figure 14.

Figure 15.

7. Sediment from trampled riparian zone is entering stream (Figure 16). In addition, nutrient runoff from livestock manure is entering stream and over-stimulating the growth of periphytonic algae (Figure 17).

Figure 16.

Figure 17.

8. Large amounts of overland runoff are being generated in this area, and consequently increasing the stream flow to a point whereby streambanks are being scoured (Figure 18). In addition, streambank collapse due to a lack of deep-rooted shoreline vegetation, and cattle trampling are also problems here (Figure 19).

Figure 18.

Figure 19.

D. Pollutant Backgrounds, Linkage Analysis, and Endpoints

Impairments within the watershed were addressed by targeting sediment and nutrient loading. "Siltation", which is listed as a cause of impairment in the watershed, is the process whereby a stream becomes choked, or covered with sediment. Because nutrients, especially phosphorus, are often adsorbed to sediment, an increase in sediment loading to a water body often correlates with an increase in nutrients (USEPA 1992, 1999). Thus, a reduction in sediment loading can address nutrient problems to some extent; however, the exact relationship between these two substances is not well defined, as many factors are involved in their relationship. Therefore, sediment will be addressed in addition to nutrients in this TMDL; although, land management practices that will be recommended to reduce nutrient loading will be similar to those for reducing sediment.

1. Nutrients

Nutrients are essential components of any aquatic ecosystem. The two most recognized nutrients are nitrogen (N) and phosphorus (P), which fuel photosynthetic growth of aquatic vegetation such as aquatic plants and algae. The existence of aquatic vegetation is crucial, as it provides food and habitat for animals such as aquatic insects, fish, frogs, and waterfowl. More importantly, it provides (via photosynthesis) the key substance that most aquatic organisms must have to survive: dissolved oxygen.

Among other elements, N and P play a direct role in governing growth of aquatic plants; a shortage of either can impede growth, and an excess can accelerate growth to undesirable proportions (Stickney 1994). Because of their ability to proliferate and out-compete aquatic plants, infestations of algae are typically more problematic and receive more attention than do aquatic plants. In most circumstances, however, algae are not problematic, but when nutrients become over-abundant, problems result.

Nitrogen and phosphorus also fuel growth of farm crops and lawn grasses, and therefore are often used to increase crop production and produce fertile lawns. Unfortunately, it is difficult to retain these nutrients, and they often are washed into nearby water bodies during rainy events. Moreover, agricultural land is typically comprised of short grasses or no grasses at all; therefore, little buffer exists to impede the flow of water across the land. Resultantly, dissolved nutrients or nutrients bound to soil are washed into streams uninterruptedly. Algae in the receiving waters exploit these nutrients, and their populations often explode sometimes engulfing all available substrate.

Although they produce oxygen during the day via photosynthesis, algae uptake oxygen from the water during the night; this process is termed *respiration*. If the algal population becomes dense, dissolved oxygen levels can fall below the requirements of fish and other aquatic inhabitants during the night. Organisms that can directly withstand low levels of oxygen may survive temporarily; however face a constant diurnal fluctuation of dissolved oxygen that may prove to be lethal. In addition to directly causing dissolved oxygen shortages, dense aquatic plant establishments can also render habitat unsuitable for indigenous organisms by slowing the movement of water, which consequently increases thermal loading and decreases dissolved oxygen renewal.

Although many short-term methods exist for controlling algae, the only true solution is to limit their food supply: nutrients. A reduction in both N and P can impede algal growth; however, a more practical approach is to reduce the nutrient that most limits growth. Phosphorus is often the most growth-limiting element in freshwater ecosystems due to its limited supply (Horne and Goldman 1994). Unlike nitrogen, phosphorus has no gaseous phase, and therefore rainwater carries little or no phosphorus. Furthermore, the little P that is weathered from rocks is quickly absorbed by the root zone on land, or is adsorbed onto particles making it unavailable for uptake by aquatic plant. Although in some circumstances P may not be the limiting nutrient, our analysis shows that it is for this watershed. A common N:P ratio is 10:1, and an increase in this ratio indicates a limitation of P (Horne and Goldman 1994). The ratio for this watershed was determined to be 20:1, which indicates a limitation of P. When phosphorus is limited, a direct and linear relationship exists between the concentrations of P and algae (Horne and Goldman 19964). Therefore, our endpoint was the reduction in P required to render the watershed unimpaired.

2. Sediment

Sedimentation is an essential component of aquatic ecosystems, as it often contains minerals used by many aquatic organisms, and also provides habitat. Sedimentation is a natural process that is caused by the weathering of landscape, whereby wind and water erode the surfaces of rocks and soils creating small particles. When these particles enter streams, they may flow with the current (suspended solids), or be deposited on the streambed. Typically, natural inputs of sediment to streams do not cause problems; however, when landscape is modified, excessive amounts of sediment can enter streams or erode from streams and cause undesirable effects (Bryan and Rutherford 1995).

Agricultural practices such as row cropping involve the tilling of landscapes to make the soil porous and fertile, which consequently loosens soil directly, as well as indirectly by removing plants whose roots once held soil in place. During rainy events, loosened soil is directed toward nearby streams via overland runoff, and depending upon the density of vegetation along the shoreline, sediment enters into the water.

The soil of pasture land is often more stable than that of cropland, yet sedimentation issues inherently arise from this landuse. Vegetation grown within pasture land typically has little water retention ability, and often is not thick enough to impede overland runoff during rainy events. Consequently, large volumes of overland runoff often generate and enter nearby streams. The sudden increase in water volume in a stream raises the velocity of the flow to a point where soil from the streambanks begins to erode into the channel. Runoff volume from this landuse is further increased in areas with steep topography, and areas in which cattle have overgrazed the vegetation. In addition to facilitating hydrology-related sedimentation issues, the overgrazing and trampling of vegetation in riparian zones leads to loosened soil that directly enters streams.

Eroded sediment can cause numerous problems for aquatic organisms. Suspended sediment causes turbidity, which can interfere with predation efficiency; cause respiration problems by clogging gills of aquatic organisms (Horne and Goldman 1994); and also reduces sunlight penetration, which affects plant photosynthesis (Waters 1995). Causing a higher magnitude of problems, deposited sediment can 1) suffocate eggs of fish and other organisms, 2) suffocate small organisms, 3) severely reduce habitat and habitat diversity, and 4) alter flow patterns (USEPA 1999). Therefore, our endpoint was the reduction in sediment required to render the Ross Run watershed unimpaired.

IV. TMDL Development Methods

A. Reference Watershed Approach: Setting the Standard

The first step of this approach was to find a non-impaired watershed (reference watershed) that was similar to the impaired watershed in terms of factors such as land-use, soil associations, drainage area, precipitation, physiographic province, and geology. Once found, the model data for this watershed was adjusted to account for BMPs (Best Management Practices) that exist within the watershed, or to account for other reasons why it is not impaired, whereas the similarly natured Ross Run watershed is. This process is necessary because the model does not account for land management practices, such as streambank fencing, that may be in place. The sediment loading rate for the reference watershed was then determined, and the general objective then became to reduce the sediment loading of the Ross Run watershed to or slightly below that of the reference watershed.

B. Watershed Assessment Approach and Modeling

1. Reference Watershed Loading Rate

The ArcView® Generalized Watershed Loading Function (AVGWLF®) model version 7.1.2 (described in Appendix A) was used to acquire pertinent information about the reference watershed. This model was used to generate the total area as well as non-point sediment loads of the reference watershed. Its loading rate for sediment was then determined by dividing its total sediment load by the total area of its watershed.

Reference Watershed Loading Rate = Total Sed Load (tons/yr) / Total Area (Acres) = Tons/yr/ Acre

2. Total Maximum Daily Load

This resulting value was then multiplied by the total area of the <u>impaired</u> watershed. This value constitutes the "total maximum daily load" (TMDL) that the impaired water should be able to uptake and still maintain a healthy aquatic community, as this load is proportional to the load of the reference water, relative to total area.

TMDL = Ref Loading Rate (tons/yr/acre) x Total Area Impaired (acres) = Tons/Year Sediment

3. Margin of Safety and Total Allowable Load

A "margin of safety" is a percent of the TMDL that will not be included in the total load that we will allocate among the various pollutant sources. This step was implemented to recognize and account for any uncertainty that may exist about the relationship between pollutant loads and receiving water quality. Use of a 10% MOS is standard practice in most TMDL reports where water quality criteria are not explicitly defined for the targeted pollutant; this MOS level was used herein. When the MOS is subtracted from the TMDL, the resulting value can be termed the total allowable load (TAL), which essentially is the total load that pollutant sources, as a whole, must be limited to.

MOS (Margin of Safety) = 0.10 x TMDL

TAL (Total Allowable Load) = TMDL - MOS

4. Wasteload Allocations and Load Allocation.

Ultimately the total allowable load is divided between point and non-point sources. The "wasteload allocation" (WLA) is the total load that point sources will be allowed to emit, and the "load allocation" (LA) is the total load that non-point sources must be limited to. To determine the WLA, the total load from all point sources is calculated; individual WLAs are typically calculated using permitted design flows and monthly average effluent limits. If there are no point sources in the watershed, the WLA is set to zero. The WLA is then subtracted from the total allowable load, and the resulting value is the load allocation. With this, the TMDL is equivalent to the sum of the LA, WLA, and MOS.

LA (load allocation) = TAL (total allowable load) – WLA
or,
LA (load allocation) = TMDL – MOS – WLA

thus, TMDL (total max daily load) = LA + WLA + MOS (margin of safety)

5. Loads Not Reduced and Adjusted Load Allocation

"Loads not reduced" (LNRs) included all loads from non-point sources that were not subjected to a reduction. The loads of some pollution sources are uncontrollable, for example, a load coming from a forest. We also may not reduce a source's load because its contribution to the total load may be minute, and therefore implementing land management practices to achieve a load reduction would not be practical, or meaningful. Because the loads from these sources were not subjected to a reduction, they were subtracted from the load allocation (LA). However, they were accounted for by requiring the further reduction of loads from other sources. The resulting adjusted load allocation (ALA) is the load that was allocated among the non-point pollutant sources that will receive reductions.

ALA (Adjusted Load Allocation) = Load Allocation (LA) - LNRs
ALA (Adjusted Load Allocation) = TMDL - MOS (margin of safety) – WLA - LNRs

With this, the following equation holds true:

TMDL = ALA + MOS + WLA (Wasteload Allocation) + LNRs (Loads Not Reduced)

6. Adjusted Load Allocation Distribution and Required Reductions

The adjusted load allocation (ALA) was allocated among the non-point pollutant sources using the Equal Marginal Percent Reduction (EMPR) spreadsheet. The computations within this spreadsheet determine the percentage of the ALA that the load of each non-point source constitutes (percent reduction allocation). Each source's load reduction is then produced by multiplying its percent reduction allocation by the ALA. The source's load reduction is then subtracted from its initial load, and its allocated load is produced. For more detail, see Appendix B.

C. Quality Assurance

1. Consideration of Critical Conditions

The AVGWLF model is a continuous simulation model that uses daily time-steps for weather data and water balance calculations. Monthly calculations are made for sediment loads based upon the daily water balance accumulated to monthly values. Therefore, all flow conditions are taken into account for loading calculations. Because there is generally a significant lag time between the introduction of sediment to a waterbody and the resulting impact on beneficial uses, establishing these TMDLs using average annual conditions is protective of the waterbody.

2. Consideration of Seasonal Variations

The continuous simulation model used for this analysis considers seasonal variation through a number of mechanisms. Daily time steps are used for weather data and water balance calculations. The model requires specification of the growing season and hours of daylight for each month. The model also considers the months of the year when manure is applied to the land. The combination of these actions by the model accounts for seasonal variability.

V. TMDL Results

A. Reference Watershed Selection

A closely matched reference watershed was found: Spra Run (stream code – 47003), Armstrong County (Figure 20). According to the Pennsylvania's 2006 Integrated Water Quality Monitoring and Assessment Report, this stream is not impaired. It is located about five miles southwest of the South Branch South Fork Pine Creek watershed (USGS quadrangle –Mosgrove). Its watershed is part of State Water Plan 17-E, and has a total drainage area of 2.9 mi^2. Spra Run consists of about 6 miles of stream, and drains into Cowanshannok Creek (stream code – 46965).

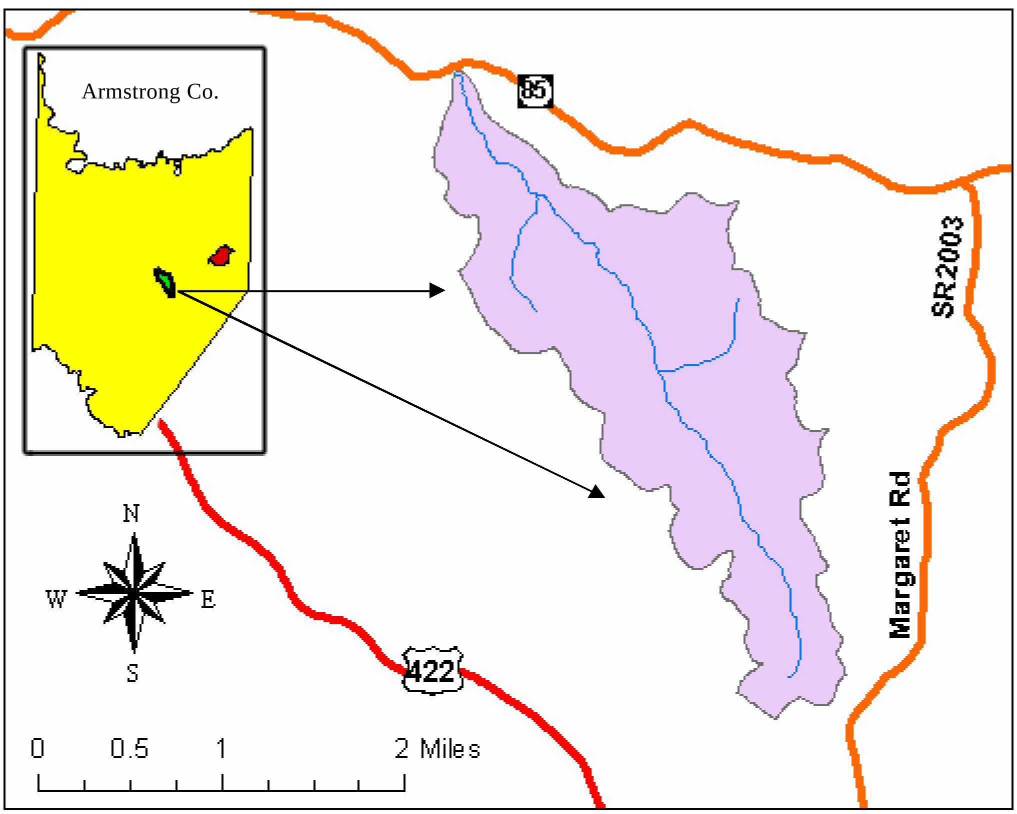

Figure 20. Location of Spra Run, Armstrong County (reference watershed).

Both GIS imagery through ArcView®, and a physical survey (May 2008) indicate that the Spra Run watershed is similar to that of South Branch South Fork Pine Creek watershed. Table 2 illustrates the similarities between the watersheds. Because the impaired watershed was determined to be impaired by sedimentation and nutrients from agricultural activities, it was important to find a reference watershed with a similar amount of agricultural landuse.

Table 2. A comparison of the attributes used to deem Spra Run a suitable reference watershed to be used in the TMDL development of South Branch South Fork Pine Creek.

ATTRIBUTE	WATERSHED	
	South Branch South Fork Pine Creek **State Water Plan – 17-E Stream Code - 42342**	***Spra Run*** **State Water Plan -17-E Stream Code - 46216**
Physiographic Province	Appalachian Plateau Province (Pittsburgh Low Plateau Section)	Appalachian Plateau Province (Pittsburgh Low Plateau Section)
Drainage Area (mi^2)	3.6	2.9
Major Landuse Categories	Agriculture – 50% Forested – 48% Development – 1%	Agriculture – 46% Forested – 52% Development –2%
Geology	Interbedded Sedimentary (100%)	Interbedded Sedimentary (100%)
Soils	Gilpin-Weikert-Ernest (100%)	Gilpin-Weikert-Ernest (96%) Hazelton-Dekalb-Buchanan (4%)
Dominant Hydro Soil Group	C	C
24-Year Average Rainfall (in)	42.4	42.4
23-Year Average Runoff (in)	2.46	2.44

Although both the impaired and reference watersheds are similar, differences were found that likely explain why Spra Run is not impaired, whereas South Branch South Fork Pine Creek and some of its tributaries are. It should be noted that some areas in the Spra Run watershed could be improved; however, there are more areas in this watershed that are protective of the streams relative to the South Branch South Fork Pine Creek watershed.

Because most of the sediment impairments within the South Branch South Fork Pine Creek watershed arise from within agricultural land, attention was given to such areas that exist within the reference watershed. The three major issues in the South Branch South Fork Pine Creek watershed are 1) direct sediment runoff and streambank decay resulting from overgrazed and trampled riparian areas, 2) in-stream erosion caused by accelerated flow resulting from large volumes of overland runoff during rainy events, and 3) excessive nutrient runoff from livestock areas.

Land management practices were observed in areas of the Spra Run watershed that protect its streams against the above mentioned issues. These include 1) streambank fencing, riparian buffers, and troughs which are used in some livestock areas to prevent the riparian area and streambanks from being trampled and also to lessen or impede nutrient runoff (Figure 21), and 2) fencing and livestock rotation which are used in pasture land areas to prevent grasses from being overgrazed (Figures 22 and 23).

Figure 21. Streambank fencing and riparian buffers within Spra Run watershed (Armstrong County).

Figure 22. Streambank fencing and riparian buffers within Spra Run watershed (Armstrong County).

Figure 23. Grazing rotation within Spra Run watershed (Armstrong County).

B. Pollutant Loads and Reference Watershed Loading Rates

1. Pollutant Loads

Table 3. Sediment and phosphorus loads of sources within the watersheds of South Branch South Fork Pine Creek, and Spra Run (Armstrong County).

	South Br. South Fk. Pine Creek			Spra Run (Reference)		
Pollutant Source	Area (Acres)	Sediment (Tons/yr)	Total P (Pounds/yr)	Area (Acres)	Sediment (Tons/yr)	Total P (Pounds/yr)
Hay/Pasture	884.6	91.0	224.3	612.8	59.1	125.1
Cropland	197.7	184.5	117.7	210.0	186.1	176.0
Decid_forest	1057.6	4.2	5.3	929.1	8.4	8.1
Unpaved Rd	4.9	7.0	5.7	4.9	10.8	8.7
Ag_Dist_Riparian	19.8	154.8	100.6	2.5	13.3	9.9
Low_Int_Dev	61.8	1.0	8.1	39.5	0.5	1.0
Streambank	-	387.1	17.0	-	179.6	7.9
Groundwater	-	-	214.4	-	-	133.4
TOTAL	2226.4	829.6	693.2	1798.9	457.8	469.1

2. Reference Watershed Loading Rate

Reference Watershed Loading Rate = Total Load (tons/yr) / Total Area (Acres) = Tons/yr Sed / Acre

1. **(Sediment)** = 457.8 tons / 1 yr / 1798.9 Acres = <u>0.2545 tons/yr/acre</u>

2. **(Phosphorus)** = 469.1 lbs / 1 yr / 1798.9 Acres = <u>0.2608 lbs/yr/acre</u>

C. Total Maximum Daily Load

TMDL = Ref Watershed Loading Rate (tons or lbs/acre) x Total Area Impaired Watershed (acres)

1. **(Sediment)** = 0.2545 tons/yr/acre x 2226.40 Acres = 566.62 tons/yr
2. **(Phosphorus)** = 0.2608 lbs/yr/acre x 2226.4 Acres = 580.65 lbs/yr

D. Margin of Safety and Total Allowable Load

MOS *(Margin of Safety) = 0.10 x TMDL*

1. **(Sediment)** = 0.10 x 566.62 tons/yr/acre = 56.66 tons/yr
2. **(Phosphorus)** = 0.10 x 580.65 lbs/yr/acre = 58.07 lbs/yr

TAL *(Total Allowable Load) = TMDL – MOS*

1. **(Sediment) =** 566.62 tons/yr – 56.66 tons/yr = 509.96 tons/yr
2. **(Phosphorus) =** 580.65 lbs/yr – 58.07 lbs/yr = 522.58 tons/yr

E. Wasteload Allocation and Load Allocation

LA (load allocation) = TMDL (total max daily load) – WLA - MOS (margin of safety)

WLAs = 0

1. **(Sediment LA)** = 566.62 tons/yr/acre - 0 tons/yr/acre - 56.66 tons/yr/acre = 509.96 tons/yr
2. **(Phosphorus LA)** = 580.65 lbs/yr/acre - 0 lbs/yr/acre - 58.07 lbs/yr/acre = 522.58 lbs/yr

F. Loads Not Reduced and Adjusted Load Allocation

Table 4. Loads of pollutant sources that will not be reduced (LNRs). These loads were determined to have an insignificant impact relative to other loads, or, they cannot feasibly be controlled.

Loads Not Reduced (LNRs)	Sediment (tons/yr)	Phosphorus (lbs/yr)
Forest	4.2	5.3
Low Intensity Development	1	-
TOTAL	**LNRs = 5.2**	**LNRs = 5.3**

ALA (adjusted load allocation) = LA – LNRs

1. **(Sediment)** = 509.96 tons/yr – 5.2 tons/yr = 504.7 tons/yr

2. **(Phosphorus)** = 522.58 lbs/yr – 5.3 tons/yr = 517.3 lbs/yr

G. Adjusted Load Allocation Distribution and Required Reductions

Table 5. Allowable and existing **sediment** loads, as well as required reductions for individual pollutant sources.

Pollutant Source	Current Loading Rate (tons/yr/acre)	Allowable Loading Rate (tons/yr/acre)	Current Load (tons/yr))	Allowable Load (tons/yr)	Percent Load Reduction
Hay/Pasture	0.10	0.06	91	56	**39%**
Cropland	0.93	0.57	185	113	**39%**
Ag_Dist_Riparian	7.82	4.79	155	95	**39%**
Streambank	0.17	0.11	387	237	**39%**
Unpaved Road	1.43	0.87	7	4	**39%**
TOTAL	-	-	824	505	Overall = **39%**

Table 6. Allowable and existing **phosphorus** loads, as well as required reductions for individual pollutant sources.

Pollutant Source	Current Loading Rate (lbs/yr/acre)	Allowable Loading Rate (lbs/yr/acre)	Current Load (lbs/yr))	Allowable Load (lbs/yr)	Percent Load Reduction
Hay/Pasture	0.26	0.19	224	171	**24%**
Cropland	0.60	0.45	118	90	**24%**
Ag_Dist_Riparian	5.08	3.87	101	77	**24%**
Streambank	0.01	0.01	17	13	**24%**
Unpaved Road	1.14	0.87	6	4	**24%**
Groundwater	0.10	0.07	214	163	**24%**
TOTAL	-	-	680	517	Overall = **24%**

H. Summary Table

Table 6. Summary of major parameters.

Parameter	Sediment (tons/yr)	Phosphorus (lbs/yr)
WLA (Wasteload Allocation)	**0**	**0**
ALA (Adjusted Load Allocation)	**504.7**	**517.3**
LNRs (Loads not reduced)	**5.2**	**5.3**
MOS (Margin of Safety)	**56.66**	**58.07**
TMDL (Total Max Daily Load)	**566.62**	**580.65**
TMDL / 365 Days	**1.55 (tons/day)**	**1.59 (lbs/day)**

VI. Reasonable Assurance and Recommendations

The objective of this TMDL was to determine a sediment and phosphorus reduction scheme that would ultimately lead to the attainment of an Aquatic Life Use in South Branch South Fork Pine Creek and its tributaries. Sediment and phosphorus reductions required from non-point sources are shown in tables 5 and 6, respectively. If these reduction schemes, or other applicable reduction schemes were attained, the "cumulative loading" [PA Code Title 25, Chapter 96.4 (f)] of sediment and phosphorus in South Branch South Fork Pine Creek would become similar to that of the reference watershed, i.e., Spra Run. According to Pennsylvania's 2006 Integrated Water Quality Monitoring and Assessment Report, Spra Run and its tributaries are not impaired, i.e., they attain an Aquatic Life Use.

Required reductions of loads from these sources can be achieved by implementing BMPs (Best Management Practices). BMPs are techniques that can be employed by land owners to either reduce the production of a pollutant, or prevent a pollutant from entering a waterbody. Interested parties are eligible to exploit funding offered through Growing Greener as a result of the completion of this TMDL. PA DEP Watershed Managers actively encourage this, and work closely with these groups offering assistance as needed. Based upon field assessments, the following BMPs are suggested: 1) Pasture Land Management, 2) Vegetative Buffer Strips, and 3), Streambank Protection. Sediment reduction efficiencies for these three BMPS are 13%, 58%, and 76%, respectively, and phosphorus reduction efficiencies for these three BMPS are 34%, 52%, and 78%, respectively (Evans and Corradini 2001).

DEP will support local efforts to develop and implement watershed restoration plans based on the reduction goals specified in this TMDL. Interested parties should contact the appropriate Watershed Manager in the Department's Southwestern Regional Office (412-442-4149) for information regarding technical and financial assistance that is currently available. Individuals and/or local watershed groups interested in the reclamation of the watershed of South Branch South Fork Pine Creek are strongly encouraged to exploit funding sources available through DEP and other state and federal agencies (e.g., Growing Greener or 319 Program).

VII. Public Participation

TO BE COMPLETED.

VIII. References

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IX. Appendices

Appendix A. AVGWLF Model Overview & GIS-Based Derivation of Input Data.

TMDLs for the watershed of South Branch South Fork Pine Creek were developed using the Generalized Watershed Loading Function or GWLF model. The GWLF model provides the ability to simulate runoff and sediment loadings from watershed given variable-size source areas (e.g., agricultural, forested, and developed land). It also has algorithms for calculating septic system loads, and allows for the inclusion of point source discharge data. It is a continuous simulation model, which uses daily time steps for weather data and water balance calculations. Monthly calculations are made for sediment and nutrient loads, based on the daily water balance accumulated to monthly values.

GWLF is a combined distributed/lumped parameter watershed model. For surface loading, it is distributed in the sense that it allows multiple land use/cover scenarios. Each area is assumed to be homogenous in regard to various attributes considered by the model. Additionally, the model does not spatially distribute the source areas, but aggregates the loads from each area into a watershed total. In other words, there is no spatial routing. For sub-surface loading, the model acts as a lumped parameter model using a water balance approach. No distinctly separate areas are considered for sub-surface flow contributions. Daily water balances are computed for an unsaturated zone as well as a saturated sub-surface zone, where infiltration is computed as the difference between precipitation and snowmelt minus surface runoff plus evapotranspiration.

GWLF models surface runoff using the Soil Conservation Service Curve Number (SCS-CN) approach with daily weather (temperature and precipitation) inputs. Erosion and sediment yield are estimated using monthly erosion calculations based on the Universal Soil Loss Equation (USLE) algorithm (with monthly rainfall-runoff coefficients) and a monthly composite of KLSCP values for each source area (e.g., land cover/soil type combination). The KLSCP factors are variables used in the calculations to depict changes in soil loss erosion (K), the length slope factor (LS) the vegetation cover factor (C) and conservation practices factor (P). A sediment delivery ratio based on watershed size and transport capacities based on average daily runoff are applied to the calculated erosion to determine sediment yield for each source area. Surface nutrient losses are determined by applying dissolved N and P coefficients to surface runoff and a sediment coefficient to the yield portion for each agricultural source area. Point source discharges can also contribute to dissolved losses to the stream and are specified in terms of kilograms per month. Manured areas, as well as septic systems, can also be considered. Urban nutrient inputs are all assumed to be solid-phase, and the model uses an exponential accumulation and washoff function for these loadings. Sub-surface losses are calculated using dissolved N and P coefficients for shallow groundwater contributions to stream nutrient loads, and the sub-surface sub-model only considers a single, lumped-parameter contributing area. Evapotranspiration is determined using daily weather data and a cover factor dependent upon land use/cover type. Finally, a water balance is performed daily using supplied or computed precipitation, snowmelt, initial unsaturated zone storage, maximum available zone storage, and evapotranspiration values.

All of the equations used by the model can be viewed in GWLF Users Manuel, available from the Department's Bureau of Watershed Conservation, Division of Assessment and Standards.

For execution, the model requires three separate input files containing transport-, nutrient-, and weather-related data. The transport (TRANSPRT.DAT) file defines the necessary parameters for each source area to be considered (e.g., area size, curve number, etc.) as well as global parameters (e.g., initial storage, sediment delivery ratio, etc.) that apply to all source areas. The nutrient (NUTRIENT.DAT) file specifies the various loading parameters for the different source areas identified (e.g., number of septic systems, urban source area accumulation rates, manure concentrations, etc.). The weather (WEATHER.DAT) file contains daily average temperature and total precipitation values for each year simulated.

The primary sources of data for this analysis were geographic information system (GIS) formatted databases. A specially designed interface was prepared by the Environmental Resources Research Institute of the Pennsylvania State University in ArcView (GIS software) to generate the data needed to run the GWLF model, which was developed by Cornell University. The new version of this model has been named AVGWLF (ArcView Version of the Generalized Watershed Loading Function).

In using this interface, the user is prompted to identify required GIS files and to provide other information related to "non-spatial" model parameters (e.g., beginning and end of the growing season, the months during which manure is spread on agricultural land and the names of nearby weather stations). This information is subsequently used to automatically derive values for required model input parameters, which are then written to the TRANSPRT.DAT, NUTRIENT.DAT and WEATHER.DAT input files needed to execute the GWLF model. For use in Pennsylvania, AVGWLF has been linked with statewide GIS data layers such as land use/cover, soils, topography, and physiography; and includes location-specific default information such as background N and P concentrations and cropping practices. Complete GWLF-formatted weather files are also included for eighty weather stations around the state. The following table lists the statewide GIS data sets and provides an explanation of how they were used for development of the input files for the GWLF model.

GIS Data Sets	
DATASET	**DESCRIPTION**
Censustr	Coverage of Census data including information on individual homes septic systems. The attribute *usew_sept* includes data on conventional systems, and *sew_other* provides data on short-circuiting and other systems.
County	The County boundaries coverage lists data on conservation practices, which provides C and P values in the Universal Soil Loss Equation (USLE).
Gwnback	A grid of background concentrations of N in groundwater derived from water well sampling.
Land-use5	Grid of the MRLC that has been reclassified into five categories. This is used primarily as a background.
Majored	Coverage of major roads. Used for reconnaissance of a watershed.
MCD	Minor civil divisions (boroughs, townships and cities).
Npdespts	A coverage of permitted point discharges. Provides background information and cross check for the point source coverage.
Padem	100-meter digital elevation model. This used to calculate landslope and slope length.
Palumrlc	A satellite image derived land cover grid that is classified into 15 different landcover categories. This dataset provides landcover loading rate for the different categories in the model.
Pasingle	The 1:24,000 scale single line stream coverage of Pennsylvania. Provides a complete network of streams with coded stream segments.
Physprov	A shapefile of physiographic provinces. Attributes *rain_cool* and *rain_warm* are used to set recession coefficient
Pointsrc	Major point source discharges with permitted N and P loads.
Refwater	Shapefile of reference watersheds for which nutrient and sediment loads have been calculated.
Soilphos	A grid of soil Phosphorus loads, which has been generated from soil sample data. Used to help set phosphorus and sediment values.
Smallsheds	A coverage of watersheds derived at 1:24,000 scale. This coverage is used with the stream network to delineate the desired level watershed.
Statsgo	A shapefile of generalized soil boundaries. The attribute *mu_k* sets the k factor in the USLE. The attribute *mu_awc* is the unsaturated available capacity., and the *muhsg_dom* is used with land-use cover to derive curve numbers.
Strm305	A coverage of stream water quality as reported in the Pennsylvania's 305(b) report. Current status of assessed streams.
Surfgeol	A shapefile of the surface geology used to compare watersheds of similar qualities.
T9sheds	Data derived from a DEP study conducted at PSU with N and P loads.
Zipcode	A coverage of animal densities. Attribute *aeu_acre* helps estimate N & P concentrations in runoff in agricultural lands and over manured areas.
Weather Files	Historical weather files for stations around Pennsylvania to simulate flow.

Appendix B. Equal Marginal Percent Reduction Method

The Equal Marginal Percent Reduction (EMPR) allocation method was used to distribute Adjusted Load Allocations (ALAs) between the appropriate contributing non-point sources. The load allocation and EMPR procedures were performed using MS Excel and results are presented in Appendix E for sediment and in Appendix F for phosphorous. The 5 major steps identified in the spreadsheet are summarized below:

Step 1: Calculation of the TMDL based on impaired watershed size and unit area loading rate of reference watershed.

Step 2: Calculation of Adjusted Load Allocation based on TMDL, Margin of Safety, and existing loads not reduced.

Step 3: Actual EMPR Process.

a. Each land use/source load is compared with the total ALA to determine if any contributor would exceed the ALA by itself. The evaluation is carried out as if each source is the only contributor to the pollutant load of the receiving water-body. If the contributor exceeds the ALA, that contributor would be reduced to the ALA. If a contributor is less than the ALA, it is set at the existing load. This is the baseline portion of EMPR.

b. After any necessary reductions have been made in the baseline, the multiple analyses are run. The multiple analyses will sum all of the baseline loads and compare them to the ALA. If the ALA is exceeded, an equal percent reduction will be made to all contributors' baseline values. After any necessary reductions in the multiple analyses, the final reduction percentage for each contributor can be computed.

Step 4: Calculation of total loading rate of all sources receiving reductions.

Step 5: Summary of existing loads, final load allocations, and % reduction for each pollutant source.

Appendix C. GWLF Output for South Branch South Fork Pine Creek.

GWLF Total Loads for file: SBSFP-0

Period of analysis: 24 years from 1975 to 1998

Source	Area (Acres)	Runoff (in)	Tons		Total Loads (Pounds)			
			Erosion	Sediment	Dis N	Total N	Dis P	Total P
Hay/Past	884.6	2.3	491.6	91.0	1888.4	2434.1	170.0	224.3
Cropland	197.7	4.2	997.2	184.5	232.3	1339.2	7.4	117.7
Forest	1057.6	2.0	22.5	4.2	90.3	115.3	2.8	5.3
Unpaved_Rd	4.9	6.6	38.1	7.0	21.4	63.7	1.5	5.7
Ag_Dist_Riparian	19.8	8.9	837.0	154.8	116.0	1045.1	8.0	100.6
Lo_Int_Dev	61.8	4.6	7.7	1.0	0.0	52.2	0.0	8.1
Farm Animals						0.0		0.0
Tile Drainage				0.0		0.0		0.0
Stream Bank				387.1		38.7		17.0
Groundwater					8932.9	8932.9	214.4	214.4
Point Sources					0.0	0.0	0.0	0.0
Septic Systems					0.0	0.0	0.0	0.0
Totals	2226.4	2.50	2394.1	829.6	11281.4	14021.2	404.0	693.2

Appendix D. GWLF Output for Spra Run

GWLF Total Loads for file: Spra_Run-7336

Period of analysis: 24 years from 1975 to 1998

Source	Area (Acres)	Runoff (in)	Tons		Total Loads (Pounds)			
			Erosion	Sediment	Dis N	Total N	Dis P	Total P
Hay/Past	612.8	2.3	314.3	59.1	850.6	1205.1	85.5	125.1
Cropland	210.0	4.2	989.8	186.1	525.3	1641.8	51.3	176.0
Forest	929.1	2.0	44.6	8.4	79.3	129.6	2.5	8.1
Unpaved_Rd	4.9	6.6	57.5	10.8	21.4	86.3	1.5	8.7
Ag_Dist_Riparian	2.5	8.9	70.7	13.3	14.5	94.2	1.0	9.9
Lo_Int_Dev	39.5	4.6	4.1	0.5	0.0	0.1	0.0	0.0
Farm Animals						0.0		0.0
Tile Drainage				0.0		0.0		0.0
Stream Bank				179.6		18.0		7.9
Groundwater					6097.9	6097.9	133.4	133.4
Point Sources					0.0	0.0	0.0	0.0
Septic Systems					0.0	0.0	0.0	0.0
Totals	1798.9	2.40	1480.9	457.8	7589.0	9272.9	275.2	469.1

Appendix E. Equal Marginal Percent Reduction Calculations for South Br. S. Fk. Pine Ck.

SEDIMENT

TMDL Total Load
Load = T loading rate in ref. * Acres in Impaired

567

Step 2: Adjusted WLA = (TMDL total load - MOS) - uncontrollable

505	505

Source	Annual Average Load	Load Sum	Check	Initial Adjust	Recheck	% reduction allocation	Load Reduction	Initial LA	Acres
Hay/Past.	91	430.3	good	91	ADJUST	0.11	35	56	885
Cropland	185		good	185	0	0.22	72	113	198
Ag_Dist_Riparian	155		good	155	320	0.19	60	95	20
Streambank	387		good	387		0.47	150	237	2226
Unpaved Road	7		good	7		0.01	3	4	5
				824		1		505	

All Ag. Loading Rate	0.16

	Acres	Allowable (Target) Loading Rate	Final LA	Current Loading Rates	Current Load	% Red.
Final Hay/Past. LA	885	0.06	56	0.10	91	39%
Final Cropland LA	198	0.57	113	0.93	185	39%
Ag_Dist_Riparian	20	4.79	95	7.82	155	39%
Streambank	2226	0.11	237	0.17	387	39%
Unpaved Road	5	0.87	4	1.43	7	39%
			505		824	

Appendix F. Equal Marginal Percent Reduction Calculations for South Br. S. Fk. Pine Ck.

Phosphorous

TMDL Total Load
Load = T loading rate in ref. * Acres in Impaired

581

Step 2:

Adjusted WLA = (TMDL total load - MOS) - uncontrollable

517	517

Source	Annual Average Load	Load Sum	Check	Initial Adjust	Recheck	% reduction allocation	Load Reduction	Initial LA	Acres
Hay/Past.	224.3	442.6	good	224	ADJUST	0.33	54	171	885
Cropland	118		good	118	0	0.17	28	90	198
Ag_Dist_Riparian	101		good	101	163	0.15	24	77	20
Streambank	17		good	17		0.03	4	13	2226
Unpaved Road	6		good	6		0.01	1	4	5
Groundwater	214		good	214		0.32	51	163	2226
				680		1		517	

All Ag. Loading Rate	0.24

	Acres	Allowable (Target) Loading Rate	Final LA	Current Loading Rates	Current Load	% Red.
Final Hay/Past. LA	885	0.19	171	0.25	224	24%
Final Cropland LA	198	0.45	90	0.60	118	24%
Ag_Dist_Riparian	20	3.87	77	5.08	101	24%
Streambank	2226	0.01	13	0.01	17	24%
Unpaved Road	5	0.87	4	1.14	6	24%
Groundwater	2226	0.07	163	0.10	214	24%
			517		680	

Appendix G. TMDL Information Sheet for South Branch S. Fk. Pine Ck.

What is being proposed?
Total Maximum Daily Load (TMDL) plans have been developed to improve water quality in the watershed of South Branch South Fork Pine Creek, Armstrong County (stream code – 47197).

Who is proposing the plans? Why?
The Pennsylvania Department of Environmental Protection (PADEP) is proposing to submit the plans to the U.S. Environmental Protection Agency (U.S. EPA) for review and approval as required by federal regulation. In 1995, U.S. EPA was sued for not developing TMDLs when Pennsylvania failed to do so. PADEP has entered into an agreement with U.S. EPA to develop TMDLs for certain specified waters over the next several years. These TMDLs have been developed in compliance with the state/U.S. EPA agreement.

What is a TMDL?
A TMDL sets a ceiling on the pollutant loads that can enter a water-body so that it will meet water quality standards. The Clean Water Act requires states to list all waters that do not meet their water quality standards even after pollution controls required by law are in place. For these waters, the state must calculate how much of a substance can be put in the water without violating the standard, and then distribute that quantity to all sources of the pollutant on that water body. A TMDL plan includes waste load allocations for point sources, load allocations for non-point sources, and a margin of safety. The Clean Water Act requires states to submit their TMDLs to U.S. EPA for approval. Also, if a state does not develop the TMDL, the Clean Water Act states that U.S. EPA must do so.

What is a water quality standard?
The Clean Water Act sets a national minimum goal that all waters are to be "fishable" and "swimmable." To support this goal, states must adopt water quality standards. Water quality standards are state regulations that have two components. The first component is a designated use, such as "warm water fishes" or "recreation." States must assign a "use" or several uses to each of their waters. The second component relates to the in-stream conditions necessary to protect the designated use(s). These conditions or "criteria" are physical, chemical, or biological characteristics such as temperature and minimum levels of dissolved oxygen, and maximum concentrations of toxic pollutants. It is the combination of the "designated use" and the "criteria" to support that use that make up a water quality standard. If any criteria are being exceeded, then the use is not being met and the water is said to be in violation of water quality standards.

What is the purpose of the plans?
South Branch South Fork Pine Creek is impaired by excess sediment and nutrients. These TMDL plans include a calculation of both sediment and phosphorus loadings that will meet water quality objectives.

Why was this watershed selected for TMDL development?
In 1998, PADEP listed South Branch South Fork Pine Creek under Section 303(d) of the federal Clean Water Act as impaired due to excess sediment and nutrients.

What pollutants do these TMDLs address? The proposed plans provide calculations of the stream's total capacity to accept sediment and phosphorus. Sediment loading is being used to address siltation impairments.

Where do the pollutants come from?
Sediment related impairments in the watershed of South branch South Fork Pine Creek stem from agricultural activity. Specific sources include 1) direct sediment runoff and streambank decay resulting from overgrazed and trampled riparian areas, and 2) in-stream erosion caused by accelerated flow resulting from large volumes of overland runoff during rainy events. Nutrient-related impairments also stem primarily from agricultural activities, i.e., overland runoff from livestock areas.

How was the TMDL developed?
PADEP used a reference watershed approach to estimate the necessary loading reduction of sediment and phosphorus that would be needed to restore an Aquatic Life Use. The reference watershed approach is based on selecting a non-impaired watershed that has similar land use characteristics and determining the current loading rates for the pollutants of interest. This is done by modeling the loads that enter the stream, using precipitation and land use characteristic data. For this analysis, PADEP used the AVGWLF model (the Environmental Resources Research Institute of the Pennsylvania State University's ArcView based version of the Generalized Watershed Loading Function model developed by Cornell University). This modeling process uses loading rates in the non-impaired watershed as a target for load reductions in the impaired watershed. The impaired watershed is modeled to determine the current loading rates and determine what reductions are necessary to meet the loading rates of the non-impaired watershed. The reference stream approach was used to set allowable loading rates in the affected watershed because neither Pennsylvanian nor U.S. EPA has water quality criteria for sediment or phosphorus.

How much pollution is too much?
The allowable amount of pollution in a water body varies depending on several conditions. TMDLs are set to meet water quality standards at the critical flow condition. For a free flowing stream impacted by non-point source pollution loading of sediment or phosphorus, the TMDL is expressed as an annual loading. This accounts for pollution contributions over all stream flow conditions. PADEP established the water quality objectives for sediment by using the reference watershed approach. This approach assumes that the impairment is eliminated when the impaired watershed achieves loadings similar to the reference watershed. Reducing the current loading rates in the impaired watershed to the current loading rates in the reference watershed will result in meeting the water quality objectives.

How will the loading limits be met?
Best Management Practices (BMPs) will be encouraged throughout the watershed to achieve the necessary load reductions. Grant money may be available as a result of this TMDL document.

How can I get more information on the TMDL?
To request a copy of the full report, contact Joseph Boylan at 412-442-4049 during the business hours of 8:00 a.m. to 4:00 p.m., Monday through Friday. One may also contact Mr. Boylan by e-mail at joboylan@state.pa.us, or mail at: Pennsylvania Department of Environmental Protection; Water Management Program; Southwest Regional Office; 400 Waterfront Drive; Pittsburgh, PA 15222-4745. You may provide e-mail or written comments postmarked no later than August 1, 2008 to the above address.